ANDERSON

DAYTON NATIONAL CEMETERY

GRAVESITE EXPANSION

SPECIFICATIONS w/GEOTECHNICAL

BID DOCUMENTS

AE COMM. #18125
VA PROJECT #810CM3033
TASK ORDER #36C78624N0910
FEBRUARY 5, 2026

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VA | U.S. Department of Veterans Affairs

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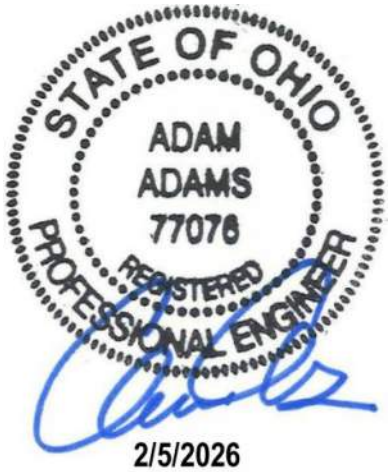
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2/5/2026

DEPARTMENT OF VETERANS AFFAIRS
VHA MASTER SPECIFICATIONS

TABLE OF CONTENTS
Section 00 01 10

SECTION NO	DIVISION AND SECTION TITLES	DATE
	DIVISION 00 - SPECIAL SECTIONS	
00 00 00	Specification Cover	
00 01 10	Table of Contents	
00 01 15	List of Drawing Sheets	05-20
	DIVISION 01 - GENERAL REQUIREMENTS	
01 00 02	General Requirements (Minor NCA Projects)	10-23
01 32 17	Network Schedules	06-19
01 33 23	Shop Drawings, Product Data, and Samples	11-23
01 42 19	Reference Standards	11-20
01 43 39	Mockup Requirements	02-21
01 45 00	Quality Control	02-21
01 45 29	Testing Laboratory Services	11-18
01 57 19	Temporary Environmental Controls	01-21
01 74 19	Construction Waste Management	04-22
	DIVISION 02 – EXISTING CONDITIONS	
02 21 00	Site Surveys	12-23
02 35 00	Tree Protection and Preservation	
02 41 00	Demolition	08-17
	DIVISION 03 – CONCRETE	
03 30 53	Cast-in-Place Concrete (Short-Form)	01-21
03 48 21	Precast Concrete Burial Crypts	01-21
03 48 24	Precast Concrete Columbarium Units	01-21
03 48 26	Precast Concrete Memorial Wall Units	01-21
	DIVISION 04 – MASONRY	
04 05 13	Masonry Mortaring	10-17
04 05 16	Masonry Grouting	01-21
04 20 00	Unit Masonry	08-17
04 43 00	Natural Stone Veneer	01-21
04 73 00	Columbarium Niche Covers	01-21
04 73 10	Memorial Wall Markers	01-21

SECTION NO	DIVISION AND SECTION TITLES	DATE
	DIVISION 05 – METALS	
05 50 00	Metal Fabrications	08-18
	DIVISION 07 - THERMAL AND MOISTURE PROTECTION	
07 92 00	Joint Sealants	04-22
	DIVISION 09 – FINISHES	
09 06 00	Schedule for Finishes	01-21
	DIVISION 10 – SPECIALTIES	
10 14 00	Exterior Signage	01-21
	DIVISION 23 – Heating, Ventilation, & Air Conditioning	
23 15 23	Concrete Fuel Storage	05-10
	DIVISION 26 – ELECTRICAL	
26 05 11	Requirements for Electrical Installations	11-22
26 05 19	Low-Voltage Electrical Power Conductors and Cables	11-22
26 05 26	Grounding and Bonding for Electrical Systems	11-22
26 05 33	Raceway and Boxes for Electrical Systems	11-22
26 05 41	Underground Electrical Construction	11-22
26 05 73	Overcurrent Protective Device Coordination Study	11-22
26 32 13	Engine Generators	11-22
26 36 23	Automatic Transfer Switches	11-22
	DIVISION 31 – EARTHWORK	
31 20 11	Earthwork (Short Form)	10-12
31 23 19	Dewatering	10-12
	DIVISION 32 – EXTERIOR IMPROVEMENTS	
32 05 23	Cement and Concrete for Exterior Improvements	08-16
32 12 16	Asphalt Paving	09-15
32 17 23	Pavement Markings	08-16
32 31 13	Chain-Link Fences & Gates	
32 31 19	Decorative Metal Fences and Gates	
32 33 00	Site Furnishings	
32 84 00	Planting Irrigation	08-16
32 84 00 A	Booster Pump Reno	
32 90 00	Planting	08-16

SECTION NO	DIVISION AND SECTION TITLES	DATE
	DIVISION 33 – UTILITIES	
33 10 00	Water Utilities	03-17
33 30 00	Sanitary Sewer Utilities	06-13
33 40 00	Storm Sewer Utilities	12-17
33 46 13	Foundation Drainage	10-11
	GEOTECHNICAL REPORT	
APPENDIX A	Geotechnical Engineering Report – Phase 2	04-25

SECTION 00 01 15
LIST OF DRAWING SHEETS

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

Drawing No.	Title	Page No.
Sheet	Sheet Title	Page No.
GENERAL		
GI001	COVER SHEET	1
GI002	SHEET INDEX	2
TOPOGRAPHIC SURVEY		
VF100	EXISTING CONDITIONS SURVEY - OVERALL	3
VF101	EXISTING CONDITIONS SURVEY 1	4
VF102	EXISTING CONDITIONS SURVEY 2	5
VF103	EXISTING CONDITIONS SURVEY 3	6
VF104	EXISTING CONDITIONS SURVEY 4	7
VF105	EXISTING CONDITIONS SURVEY 5	8
VF106	EXISTING CONDITIONS SURVEY 6	9
VF107	EXISTING CONDITIONS SURVEY 7	10
VF108	EXISTING CONDITIONS SURVEY 8	11
VF109	EXISTING CONDITIONS SURVEY 9	12
GEOTECHNICAL		
B-100	BORING LOCATION MAP	13
B-101	2020 BORING LOGS 1-6	14
B-102	2020 BORING LOGS 7-12	15
B-103	2024-2025 BORING LOGS 13-18	16
B-104	2024-2025 BORING LOGS 19-22	17
OPERATIONS & LOGISTICS		
CO100	ACCESS & LOGISTICS - OVERALL	18
DEMOLITION		
CD100	DEMOLITION PLAN - OVERALL	19
CD101	DEMOLITION PLAN - ENTRY	20
CD102	DEMOLITION PLAN - COLUMBARIUM C	21
CD103	DEMOLITION PLAN - COLUMBARIUM A	22
CD104	DEMOLITION PLAN - MEMORIAL WALL	23
CD105	DEMOLITION PLAN - SECTION 19 NORTH	24
CD106	DEMOLITION PLAN - SECTION 19 SOUTH	25
CD107	DEMOLITION PLAN - TRAD SECTION 33A	26
CD108	DEMOLITION PLAN - IGC SECTION 45	27
CD109	DEMOLITION PLAN - SECTION 29 & 30	28
CD110	DEMOLITION PLAN - PPC SECTIONS 48 & 52	29

CD111 DEMOLITION PLAN - PPC SECTION 49 & 50 30
CD112 DEMOLITION PLAN - PPC SECTION 51 31
CD113 DEMOLITION PLAN - ADMIN BLDG 32
CD114 DEMOLITION PLAN – COMMITTAL SHELTER A 33

SITE PLAN

CS100 SITE PLAN - OVERALL 34
CS101 SITE PLAN - ENTRANCE 35
CS102 SITE PLAN - COLUMBARIUM C 36
CS103 SITE PLAN – COLUMBARIUM A 37
CS104 SITE PLAN - MEMORIAL WALL 38
CS105 SITE PLAN – COMMITAL SHELTER A 39
CS106 SITE PLAN - ADMIN BUILDING 40
CS501 SITE DETAILS - 1 41
CS502 SITE DETAILS - 2 42
CS503 SITE DETAILS - 3 43
CS504 SITE DETAILS - 4 44
CS505 SITE DETAILS - 5 45
CS506 SITE DETAILS - 6 46

GRAVESITE BURIAL SECTIONS

CB101 GRAVESITE PLAN - TRAD SECTION 33A 47
CB102 GRAVESITE NUMBERING PLAN - TRAD SECTION 33A 48
CB103 GRAVESITE PLAN - IGC SECTION 45 49
CB104 GRAVESITE NUMBERING PLAN - IGC SECTION 45 50
CB105 GRAVESITE PLAN - PPC SECTIONS 48 & 52 51
CB106 GRAVESITE NUMBERING PLAN - PPC SECTIONS 48 & 52 52
CB107 GRAVESITE PLAN - PPC SECTION 49 & 50 53
CB108 GRAVESITE NUMBERING PLAN - PPC SECTIONS 49 & 50 54
CB109 GRAVESITE PLAN - PPC SECTION 51 55
CB110 GRAVESITE NUMBERING PLAN - PPC SECTION 51 56
CB501 CRYPT DETAILS - 1 57
CB502 CRYPT DETAILS - 2 58

COLUMBARIUM & MEMORIAL WALL & ENTRY WALL: SITE PLAN

LS100 COLUMBARIUM - SITE PLAN 59
LS101 MEMORIAL WALL - SITE PLAN 60
LS102 ENTRY WALL - SITE PLAN 61

COLUMBARIUM & MEMORIAL WALL & ENTRY WALL: PRECAST UNIT LAYOUT PLAN

LS110 COLUMBARIUM - PRECAST UNIT LAYOUT PLAN 62
LS111 MEMORIAL WALL - PRECAST LAYOUT PLAN 63

COLUMBARIUM & MEMORIAL WALL & ENTRY WALL: FLATWORK LAYOUT PLAN

LS120 COLUMBARIUM - FLATWORK LAYOUT PLAN 64
LS121 MEMORIAL WALL - FLATWORK LAYOUT PLAN 65
LS122 ENTRY WALL - FLATWORK LAYOUT PLAN 66

COLUMBARIUM & MEMORIAL WALL & ENTRY WALL: CAP PLAN

LS130 COLUMBARIUM - CAP LAYOUT PLAN 67
LS131 MEMORIAL WALL - CAP LAYOUT PLAN 68
LS132 ENTRY WALL - CAP LAYOUT PLAN 69

COLUMBARIUM & MEMORIAL WALL & ENTRY WALL: ADDRESSING PLAN

LS140 COLUMBARIUM - ADDRESSING PLAN 70
LS141 MEMORIAL WALL - ADDRESSING PLAN 71

COLUMBARIUM & MEMORIAL WALL & ENTRY WALL: ELEVATIONS

LS200 COLUMBARIUM - FRONT ELEVATIONS WALLS 1-5 72
LS201 COLUMBARIUM - FRONT ELEVATIONS WALLS 6-13 73
LS202 COLUMBARIUM - FRONT ELEVATIONS WALLS 14-21 74
LS203 COLUMBARIUM - WING WALL ELEVATIONS 75
LS204 MEMORIAL WALL - ELEVATIONS 76
LS205 ENTRY WALL - ELEVATIONS 77

COLUMBARIUM & MEMORIAL WALL & ENTRY WALL: SECTIONS

LS300 COLUMBARIUM - SECTIONS - 1 78
LS301 COLUMBARIUM - SECTIONS - 2 79
LS302 MEMORIAL WALL - SECTIONS 80

COLUMBARIUM & MEMORIAL WALL & ENTRY WALL: ENLARGEMENTS

LS400 COLUMBARIUM - COLUMMN ENLARGEMENT DETAILS 81
LS401 MEMORIAL WALL - COLUMMN ENLARGEMENT DETAILS 82
LS402 ENTRY WALL – COLUMN ENLARGEMENT DETAILS 83

COLUMBARIUM & MEMORIAL WALL & ENTRY WALL: DETAILS

LS500 COLUMBARIUM - PRECAST DETAILS 84
LS501 MEMORIAL WALL - PRECAST DETAILS 85
LS502 WALL DETAILS 86
LS503 CAP SETTING DETAILS 87
LS504 COLUMBARIUM DETAILS 88
LS505 MEMORIAL WALL - DETAILS 89
LS506 ENTRY WALL - DETAILS 90

COLUMBARIUM & MEMORIAL WALL & ENTRY WALL: CAP PROFILES

LS510 COLUMBARIUM - CAP PROFILES 91
LS511 MEMORIAL WALL - CAP PROFILES 92
LS512 ENTRY WALL - CAP PROFILES
COLUMBARIUM, MEMORIAL WALL, & ENTRY WALL - STONE 93
LS513 DETAILS 94

GRADING DRAINAGE & EROSION CONTROL

CG100	GRADING & DRAINAGE PLAN - OVERALL	95
CG101	GRADING & DRAINAGE PLAN - ENTRY WALL	96
CG102	GRADING & DRAINAGE PLAN - COLUMBARIUM	97
CG103	GRADING & DRAINAGE PLAN - MEMORIAL WALL	98
CG104	GRADING & DRAINAGE PLAN - TRAD SECTION 33A	99
CG105	GRADING & DRAINAGE PLAN - IGC SECTION 45	100
CG106	GRADING & DRAINAGE PLAN - PPC SECTIONS 48 & 52	101
CG107	GRADING & DRAINAGE PLAN - PPC SECTIONS 49 & 50	102
CG108	GRADING & DRAINAGE PLAN - PPC SECTION 51	103
CG200	STORMWATER POLLUTION PREVENTION PLAN	104

UTILITY

CU100	UTILITY PLAN - OVERALL	105
CU101	UTILITY PLAN - COLUMBARIUM	106
CU102	UTILITY PLAN - MEMORIAL WALL	107
CU103	UTILITY PLAN - SECTION 19 NORTH	108
CU104	UTILITY PLAN - SECTION 19 SOUTH	109
CU105	UTILITY PLAN - TRAD SECTION 33A	110
CU106	UTILITY PLAN - IGC SECTION 45	111
CU107	UTILITY PLAN - SECTIONS 29 & 30	112
CU108	UTILITY PLAN - PPC SECTIONS 48 & 52	113
CU109	UTILITY PLAN - PPC SECTIONS 49 & 50	114
CU110	UTILITY PLAN - PPC SECTION 51	115
CU111	STORM SEWER PLAN & PROFILE - PPC SECTIONS 48 & 49	116
CU112	STORM SEWER PLAN & PROFILE - PPC SECTIONS 50 & 51	117
CU113	STORM SEWER PLAN & PROFILE - PPC SECTION 52	118
CU114	SANITARY SEWER PLAN & PROFILES - PPC SECTIONS 49 & 50	119
CU115	GRAVESITE DRAINTILE LAYOUT - PPC SECTIONS 48 & 52	120
CU116	GRAVESITE DRAINTILE LAYOUT - PPC SECTIONS 49 & 50	121
CU117	GRAVESITE DRAINTILE LAYOUT - PPC SECTION 51	122

STREET PLAN & PROFILE

CR101	STREET PLAN & PROFILE - NEW MEXICO AVENUE 0+00 to 7+50	123
CR102	STREET PLAN & PROFILE - NEW MEXICO AVENUE 7+50 to 17+51	124

PLANTING

LP100	PLANTING PLAN - OVERALL	125
LP101	PLANTING PLAN - ENTRY WALL	126
LP102	PLANTING PLAN - COLUMBARIUM	127
LP103	PLANTING PLAN - MEMORIAL WALL	128
LP104	PLANTING PLAN - TRAD SECTION 33A	129

LP105	PLANTING PLAN - IGC SECTION 45	130
LP106	PLANTING PLAN - PPC SECTIONS 48 & 52	131
LP107	PLANTING PLAN - PPC SECTION 49 & 50	132
LP108	PLANTING PLAN - PPC SECTION 51	133
LP501	PLANTING DETAILS	134
IRRIGATION		
IR100	IRRIGATION GENERAL DIRECTION	135
IR101	EXISTING IRRIGATION CONDITIONS	136
IR102	IRRIGATION PLAN - OVERALL	137
IR103	MEMORIAL WALL IRRIGATION PLAN	138
IR104	COLUMBARIUM IRRIGATION PLAN 1	139
IR105	COLUMBARIUM IRRIGATION PLAN 2	140
IR106	ENTRY WALL IRRIGATION PLAN	141
IR107	EXISTING SECTIONS 36-42 IRRIGATION PLAN 1	142
IR108	EXISTING SECTIONS 36-42 IRRIGATION PLAN 2	143
IR109	NEW SECTIONS 48-52 IRRIGATION PLAN 1	144
IR110	NEW SECTIONS 48-52 IRRIGATION PLAN 2	145
IR111	NEW SECTIONS 33A AND 46 IRRIGATION PLAN	146
IR112	HAWAII PLACE REPLACE FLOWER WATERING STATION PIPELINE	147
IR200	IRRIGATION SCHEDULE	148
IR500	IRRIGATION DETAILS	149
IR501	IRRIGATION DETAILS & GENERAL NOTES	150
IR502	GENERAL, PUMP STATION, AND CONTROLLER NOTES	151
STRUCTURAL		
S-001	STRUCTURAL NOTES	152
S-101	COLUMBARIUM FOUNDATION PLAN	153
S-102	FOUNDATION & FOUNDATION DETAILS	154
S-103	MEMORIAL WALL FOUNDATION PLAN	155
S-104	ENTRY WALL FOUNDATION PLAN	156
ELECTRICAL		
E-001	ELECTRICAL SYMBOLS, ABBREVIATIONS, GENERAL NOTES	157
ES101	ELECTRICAL SITE PLAN	158
E-501	ELECTRICAL DETAILS	159
MECHANICAL		
MP111	FUEL TANK DETAILS	160

- - - END - - -

SECTION 01 00 02
GENERAL REQUIREMENTS (MINOR NCA PROJECTS)
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..... 2
1.6 OPERATIONS AND STORAGE AREAS..... 6
1.7 ALTERATIONS..... 10
1.8 ENVIRONMENTAL CONTROLS..... 10
1.9 DISPOSAL AND RETENTION..... 11
1.10 PROTECTION OF EXISTING VEGETATION, STRUCTURES, EQUIPMENT, UTILITIES, AND IMPROVEMENTS..... 12
1.11 RESTORATION..... 14
1.12 PHYSICAL DATA..... 15
1.13 PROFESSIONAL SURVEYING SERVICES..... 15
1.14 LAYOUT OF WORK..... 15
1.15 AS-BUILT DRAWINGS..... 17
1.16 USE OF ROADWAYS..... 18
1.17 TEMPORARY USE OF MECHANICAL AND ELECTRICAL EQUIPMENT..... 18
1.18 TEMPORARY TOILETS..... 18
1.19 AVAILABILITY AND USE OF UTILITY SERVICES 20
1.20 TESTS..... 20
1.21 INSTRUCTIONS..... 22
1.22 GOVERNMENT-FURNISHED PROPERTY..... 23
1.23 RELOCATED ITEMS..... 10
1.24 CONSTRUCTION SIGN..... 24
1.25 SAFETY SIGN..... 24
1.26 CONSTRUCTION DIGITAL IMAGES..... 25
1.27 FINAL ELEVATION PHOTOGRAPHS..... 26
1.28 HISTORIC PRESERVATION..... 27
1.29 PROJECT HEALTH AND SAFETY PLAN..... 28

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SECTION 01 00 02
GENERAL REQUIREMENTS (MINOR NCA PROJECTS)

1.1 GENERAL INTENTION

A. Contractor shall completely prepare site for building operations, including demolition and removal of existing structures, and furnish labor, materials, equipment and services and perform and complete all work for Gravesite expansion as required by drawings and specifications.

B. Visits to the site by Bidders may be made only by appointment with the Cemetery Director.

C. Offices of Anderson Engineering of Minnesota, LLC, 13605 1st Ave. N., Plymouth, MN 55441, as Architect-Engineers (A/E), may 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 Officers Representative (COR) or the duly authorized representative.

D. All Testing Laboratory services will be retained and paid for by the Contractor (see Spec Section 01 45 29, Testing Laboratory Services). However, the Department of Veterans Affairs may elect to retain its own Testing Laboratory for any purpose. Before placement and installation of work subject to tests by testing laboratory retained by Department of Veterans Affairs, the Contractor shall notify the RE/COR 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 RE/COR.

E. All employees of general contractor and subcontractors shall comply with VA security management program as established by the RE/COR, be identified by name and employer. They shall be 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.

G. Training:

1. All employees of general contractor or subcontractors shall, at the minimum, have successfully completed the 10-hour OSHA certified Construction Safety course and/or other relevant competency training, as determined by VA CP.
2. Submit OSHA training records of all employees for approval before the start of work.

1.2 STATEMENT OF BID ITEM(S)

A. ITEM I, GENERAL CONSTRUCTION: Installation of all work shown on the plans and described in the specifications including but not limited to: Cemetery elements (2,400 columbarium niches, 2,472 in-ground cremains), 7,508 pre-placed crypts, 82 traditional casketed sites, 154 marker memorial wall, architectural entry wall w/ornamental fencing, electrical backup generator FCA Repairs, remove and replace fuel tanks/pumps, irrigation expansion and repairs, ornamental fencing repairs, 6’ height construction fencing with screening, walks, grading, drainage, irrigation, site furnishings and landscaping and construction of other items as required to complete all the work described in the Contract Documents.

1.3 SPECIFICATIONS AND DRAWINGS FOR CONTRACTOR

A. AFTER AWARD OF CONTRACT, 3 bond paper set(s) of specifications and drawings will be furnished.

B. Additional sets of drawings may be made by the Contractor, at Contractor's expense, from electronic PDF furnished by the Issuing Office.

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 site without following the procedures approved by the RE/COR. 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", 7:30am to 4:00pm (cemetery office hours) as defined in the contract, The General Contractor shall give 3 days notice to the RE/COR so that appropriate arrangements can be provided for the Cemetery 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 RE/COR.
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 RE/COR.

C. Guards:

1. The General Contractor shall provide unarmed guards at the project site after construction hours when theft or vandalism warrants.

D. Key Control:

1. The General Contractor shall provide duplicate keys and lock combinations to the RE/COR for the purpose of security inspections of every area of project including tool boxes and parked machines, and to take any necessary emergency action.

E. 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".
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.
3. 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 RE/COR upon request.

4. These security documents shall not be removed or transmitted from the project site without the written approval of RE/COR.
5. All paper waste or electronic media such as CD's and diskettes shall be shredded and destroyed in a manner acceptable to the VA.
6. Notify RE/COR immediately when there is a loss or compromise of "sensitive information".
7. All electronic information shall be stored in a 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.
   b. "Sensitive information" including drawings and other documents may be attached to e-mail provided all VA encryption procedures are followed.

F. 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.

1.5 FIRE SAFETY

A. Applicable Publications: Publications listed below form part of this Article to the extent referenced. Publications are referenced in text by basic designations only.
1. American Society for Testing and Materials (ASTM):
   E84-2009a Surface 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-2009 Standard for Fire Prevention During Welding, Cutting and Other Hot Work
   70-2008 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 RE/COR/Cemetery Director for review for compliance with contract requirements in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA AND SAMPLES. Prior to any worker for the contractor or subcontractor's 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, safety guidelines, means of egress, break areas, work hours, locations of restrooms, use of NCA equipment, etc. Documentation shall be provided to the RE/COR that individuals have undergone the Contractor's safety briefing.

C. Site and Building Access: Maintain free and unobstructed access to 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 RE/COR/Cemetery Director.

G. Egress Routes for Construction Workers: Maintain free and unobstructed egress. Inspect daily. Report findings and corrective actions weekly to RE/COR.

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. 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. Request interruptions in accordance with Article, OPERATIONS AND STORAGE AREAS, and coordinate with RE/COR. All existing or temporary fire protection systems (fire alarms) located in construction areas shall be tested as coordinated with the Cemetery. Parameters for the testing and results of any tests performed shall be recorded by the Cemetery and copies provided to the RE/COTR.

K. Hot Work: Perform and safeguard hot work operations in accordance with NFPA 241 and NFPA 51B. Coordinate with RE/COR. Designate Contractor's responsible project-site fire prevention program manager to permit hot work.

L. Fire Hazard Prevention and Safety Inspections: Inspect entire construction areas weekly. Coordinate with, and report findings and corrective actions weekly to RE/COR.

M. 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.

N. Dispose of waste and debris in accordance with NFPA 241. Remove from worksites to dumpsters or other receptacles daily. Provide waste receptacles within work areas to prevent personal litter and food trash from accumulating on the ground.

O. Perform other construction, alteration and demolition operations in accordance with 29 CFR 1926.

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 RE/COR. 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 trailers, office trailers) and utilities may be erected by the Contractor only with the approval of the RE/COR 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 RE/COTR, the buildings and utilities may be abandoned and need not be removed.

C. The Contractor shall, under regulations prescribed by the RE/COR, use only established roadways, or use temporary roadways constructed by the Contractor when and as authorized by the RE/COR. 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 or as determined by the RE/COR with agreement of the Cemetery. Contractor parking will be only in areas and on roadways designated and agreed to by the RE/COR in agreement of the Cemetery.

E. Workmen are subject to rules of the Cemetery applicable to their conduct.

F. Execute work so as to interfere as little as possible with normal functioning of Cemetery as a whole, including operations of utility services, fire protection systems and any existing equipment, and with work being done by others.

1. Do not store materials and equipment in other than assigned areas.
2. Provide unobstructed access to the Cemetery areas required to remain in operation.
3. Where access by Cemetery 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. All such actions shall be coordinated with the Utility Company involved:
   a. 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.

G. Phasing: To insure such executions, the Contractor shall furnish the RE/COR with a schedule of approximate phasing dates on which the Contractor intends to accomplish work in each specific area of site,

building or portion thereof. In addition, the Contractor shall notify the RE/COR two weeks in advance of the proposed date of starting work in each specific area of site, building or portion thereof. Arrange such phasing dates to ensure accomplishment of this work in successive phases mutually agreeable to the Cemetery Director, RE/COR, and Contractor, as follows:

Phase I: Initial preparation and construction fencing erection as indicated on the drawings. Work in this area is limited to three weeks to allow the contractor to prepare an internal staging area for the site.

Phase II: General construction with staging internal to construction limits.

H. Construction Fence: Before construction operations begin, the Contractor shall provide a chain link construction fence with screening, six 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 a maximum of 375mm (15 inches). The bottom of fences shall extend to 25mm (one inch) above grade. The temporary fencing shall encompass the construction work area(s) to serve as a pedestrian barrier to alert cemetery patrons of the construction site. Remove the fence when directed by RE/COR.

I. Utilities Services: Maintain existing utility services for the Cemetery at all times. Provide temporary facilities, labor, materials, equipment, connections, and utilities to assure uninterrupted services. Where necessary to cut existing water, sewer or air pipes, or conduits, wires, cables, etc. 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 RE/COR. All such actions shall be coordinated with the Utility Company involved.

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 RE/COR. 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 RE/COR, and the Cemetery Director's prior knowledge and written approval.

2. The Contractor shall submit a request to interrupt any such services to both RE/COR and the Cemetery Director in writing, 48 hours in advance of the proposed interruption. Requests shall state reason, date, exact time of, and approximate duration of such interruption.
3. The 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 the Cemetery. Interruption time approved by the Cemetery and RE/COR 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 RE/COR.
5. In case of a contract construction emergency, service will be interrupted on approval of RE/COR. 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.

J. 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.

K. To minimize interference of construction activities with flow of Cemetery 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 RE/COR.

L. Coordinate the work for this contract with other construction operations as directed by RE/COR. This includes the scheduling of traffic and the use of roadways, as specified in Article, USE OF ROADWAYS.

M. Coordination of Construction with Cemetery Director: The burial activities at a National Cemetery shall take precedence over construction activities. The Contractor must cooperate and coordinate with the Cemetery Director, through the RE/COR, in arranging construction schedule to cause the least possible interference with Cemetery activities in actual burial areas. Construction noise during the committal services shall not disturb the service. Trucks and workmen shall not pass through the service area during this period.

1. The Contractor is required to discontinue his work sufficiently in advance of Easter Sunday, Mother's Day, Father's Day, Memorial Day, Veteran's Day and/or Federal holidays, to permit him to clean up all areas of operation adjacent to existing burial plots before these dates.
2. Cleaning up shall include the removal of all equipment, tools, materials and debris and leaving the areas in a clean, neat condition.

1.7 ALTERATIONS

A. Survey: Before any work is started, the Contractor shall make a thorough survey with the RE/COR of areas in which alterations occur and areas which are anticipated routes of access, and furnish a signed report, to the Contracting Officer. This report shall list:

1. Existing condition of pavements, curbs, retaining walls, and vegetation not required to be altered throughout affected areas.
2. Shall note any discrepancies between drawings and existing conditions at site.
3. Shall designate areas for working space, materials storage and routes of access to areas within buildings where alterations occur and which have been agreed upon by Contractor and COR.

B. Any items required by drawings to be either reused or relocated or both, found during this survey to be nonexistent, or in opinion of RE/COR, to be in such condition that their use is impossible or impractical, shall be furnished and/or replaced by the Contractor with new items in accordance with specifications which will be furnished by the Government. Provided the contract work is changed by reason of this subparagraph B, the contract will be modified accordingly, under provisions of clause entitled "DIFFERING SITE CONDITIONS" (FAR 52.236-2) and "CHANGES" (FAR 52.243-4 and VAAR 852.236-88).

C. Re-Survey: Thirty days before expected partial or final inspection date, the Contractor and RE/COR together shall make a thorough re-survey of the areas of the site involved. They shall furnish a report on conditions then existing, pavements and other surfaces as compared with conditions of same as noted in first condition survey report.

1. Re-survey report shall also list any damage caused by the Contractor to such flooring and other surfaces, despite protection measures; and, will form the basis for determining extent of repair work required of the Contractor to restore damage caused by the Contractor's workmen in executing work of this contract.

D. Protection: Provide the following protective measures:

1. Wherever existing roof surfaces are disturbed they shall be protected against water infiltration. In case of leaks, they shall be repaired immediately upon discovery.
2. Temporary protection against damage for portions of existing structures and grounds where work is to be done, materials handled and equipment moved and/or relocated.

1.8 ENVIRONMENTAL CONTROLS

A. In general, following preventive measures shall be adopted during construction to keep down dust and prevent mold.

1. Provide water trucks or other suitable distribution equipment to water haul roads and grading sites to prevent dust migration to neighboring properties.
2. Masonry mortar mixing areas are to have protective surroundings to prevent dust migration.

3. If dry sawing of stone is utilized, a temporary enclosure and/or misting system to prevent dust migration shall be implemented.

B. Vacuum and wet mop all transition areas from construction to the occupied Cemetery buildings at the end of each workday.

C. Final Cleanup:

1. Upon completion of the project, or as work progresses, remove all construction debris from work areas that have been part of the construction.

1.9 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. Reserved items which are to remain property of the Government are noted on drawings or in specifications as items to be stored. Items that remain property of the Government shall be removed or dislodged from present locations in such a manner as to prevent damage which would be detrimental to re-installation and reuse. Store such items where directed by RE/COR.
2. Items not reserved shall become property of the Contractor and be removed by Contractor from the Cemetery.
3. 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 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.

1.10 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 RE/COR.

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 RE/COR may have the necessary work performed and charge the cost to the Contractor.

(FAR 52.236-9)

C. Refer to Section 01 57 19, 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 NCA Central/Cemetery) 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, but are not limited to the following:

1. Designating areas for equipment maintenance and repair;

2. Providing waste receptacles at convenient locations and provide regular collection of wastes;
3. Locating equipment wash down areas on site, and provide appropriate control of wash-waters;
4. Providing protected storage areas for chemicals, paints, solvents, fertilizers, and other potentially toxic materials; and
5. Providing adequately maintained sanitary facilities.

1.11 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, water/irrigation or electric work without approval of the RE/COR. Existing work to be altered or extended and that is found to be defective in any way, shall be reported to the RE/COR 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, landscape stone, lawns, paving, roads, walks, etc.) 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 the Contractor's own expense, the Contractor shall immediately restore to service and repair any damage caused by the Contractor's workmen to existing piping and conduits, wires, cables, etc., of utility services, fire protection systems, communications systems (including telephone), irrigation system control and power 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) and "DIFFERING SITE CONDITIONS" (FAR 52.236-2).

1.12 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.

B. Subsurface conditions have been developed by core borings and test pits. Logs of subsurface exploration conducted by Terracon, 611 Lunken Park Drive, Cincinnati, Ohio, 45226 are shown diagrammatically on drawings.

C. A copy of the geotechnical investigation report is an Appendix to these specifications and shall be considered part of the contract documents.

D. The 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 the site of work and logs of borings and, after investigation, decide for themselves the character of materials and make their bids accordingly. Upon proper application to the Department of Veterans Affairs, including approved scheduling bidders will be permitted to make subsurface explorations of their own at site.

1.13 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.

1.14 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 the 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 RE/COR. The Contractor shall also be responsible

for maintaining and preserving all stakes and other marks established by the RE/COR until authorized to remove them. If such marks are destroyed by the Contractor or through Contractor's negligence before their removal is authorized, the RE/COR may replace them and deduct the expense of the replacement from any amounts due or to become due to the Contractor.

(FAR 52.236-17)

B. Establish and plainly mark center lines for each building and/or addition to each existing building, lines for each gravesite control monument, 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, roads, parking lots, gravesite control monuments, are in accordance with lines and elevations shown on contract drawings. Provide report by professional surveyor or engineer of project control check, including any discrepancies in elevation or coordinate prior to commencing layout of site.

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. The Survey shall include, but not be limited to, 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 RE/COR before any work (such as footings, floor slabs, columns, walls, utilities and other major controlling features) is placed.

D. During progress of work, the Contractor shall have lines, grades, locations 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 RE/COR before any major items of concrete work are placed. In addition, furnish to the RE/COR 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 of grave plot documentation.
5. Lines of elevations of all swales and interment areas.
6. Lines and elevations of roads, streets and parking lots.
7. Northing/Easting coordinate locations and elevation depth below finished grade of all water, sanitary, storm, gas and irrigation structures, directional fittings, control wire and lines.
8. Northing/Easting coordinate locations and elevation for each gravesite grid monument.

E. Upon completion of the work, the Contractor shall furnish the RE/COR with reproducible drawings, in AutoCAD form, at the scale of the contract drawings, showing the finished grade on the grid developed for constructing the work. These drawings shall bear the seal of the registered land surveyor or registered civil engineer.

F. Final layout or curb, pavement, sidewalks and structures (columbaria, and retaining walls) shall utilize equipment capable of +/- 0.07 feet for horizontal and+/- 0.03 feet for vertical tolerance. Elevation layout shall be conducted using total station or spirit levels. GPS may be utilized for initial staking and earthwork only.

G. 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".

1.15 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, which will 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 RE/COR's review, as often as requested.

C. The Contractor shall deliver two approved completed sets of as-built drawings to the RE/COR within 15 calendar days after acceptance of the project by the RE/COR.

D. Paragraphs A, B, & C shall also apply to all shop drawings.

E. Upon completion of the work, the Contractor shall furnish the COR with reproducible (electronic) drawings, in AutoCAD form, at the scale of the contract drawings, showing the finished grade on the grid developed for constructing the work, including burial monuments. These drawings shall be sufficient for 1 foot contour accuracy of the entire site and include ASCII point files. These drawings shall bear the seal of the registered land surveyor or registered civil engineer. In addition, as built elevations and locations of all utilities and drainage pipes shall be included on the as built drawings.

1.16 USE OF ROADWAYS AND 3RD STREET ACCESS PERMIT

A. For hauling, use only established public roads and designated permanent roads on Cemetery property and, when authorized by the COR, such temporary roads which are necessary in the performance of contract work. Temporary roads shall be constructed by the Contractor at the Contractor's expense. When necessary to cross curbing, sidewalks, or similar construction, they must be protected by well-constructed bridges.

B. 3rd Street Construction Access Permit Acquired by Contractor:

1. Coordinate 3rd Street construction access with the City of Dayton.
2. Call Lisa Moell at 937-333-3840 and request a construction permit for off street construction access.
3. Permit needs to be completed and paid for (by Contractor) prior to commencement of construction.
4. Please note: Permit lasts for 3 months and will need to be renewed if construction outlasts permit. Estimated cost is $20.00 for 3 months.
5. All damage or disturbed areas shall be replaced and repaired in kind.

1.17 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 RE/COR. If the equipment is not installed and maintained in accordance with the following provisions, the RE/COR 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, 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.
6. All components of heat production and distribution system, metering equipment, condensate returns, and other auxiliary facilities used in temporary service shall be cleaned prior to use; maintained to prevent corrosion internally and externally during use; and cleaned, maintained and inspected prior to acceptance by the Government.

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.

1.18 TEMPORARY TOILETS

A. Provide where directed, (for use of all Contractor's workers) ample temporary sanitary toilet accommodations with suitable sewer and water

connections, or when approved by RE/COR 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.

1.19 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 RE/COR, 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. The Contractor shall install meters at the Contractor's expense and furnish the Cemetery 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 Cemetery 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. Where not available or not convenient to connect to the Cemetery distribution system, the contractor shall supply power via portable generators at own expense. Generators

shall be acoustically screened so as not to disturb committal services and/or visitation to the adjacent columbarium.

F. Water (for Construction and Testing): Furnish temporary water service.
   1. Obtain water by connecting to the Cemetery irrigation distribution system. Backflow preventer may not be required at connections to the irrigation system. Water is available at no cost to the Contractor.
   2. If potable water is required and convenient connection is available the contractor may connect to the Cemetery potable water distribution system. The contractor shall install reduced pressure backflow preventer at each connection at own expense.
   3. 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 RE/COR's discretion) of use of water from the Cemetery's system.
   4. Where not available or not convenient to connect to the Cemetery distribution system, the Contractor shall supply water via portable/temporary means at his own expense.

G. Fuel: Not available on site. Fuel shall be furnished by the Contractor at Contractor's expense.

1.20 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 RE/COTR. 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. For example, air conditioning supply; air is only one part of entire system which provides comfort conditions for a building. Other related components are return air, exhaust air, hot water, controls and electricity, etc. Another example of a complex which involves several components of different disciplines is a burner

installation. Efficient and acceptable burner operation depends upon the coordination and proper operation of fuel, combustion air, controls, and other related components.

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.

E. 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.

1.21 INSTRUCTIONS

A. The 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 RE/COR 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: the 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 RE/COR and shall be considered concluded only when the RE/COR 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 RE/COR, does not demonstrate sufficient qualifications in accordance with requirements for instructors above.

1.22 GOVERNMENT-FURNISHED PROPERTY

A. The Government shall deliver to the Contractor, the Government-furnished property shown on drawings.

B. Materials furnished by the Government to be installed by the Contractor will be furnished to the Contractor at the Cemetery.

C. Storage space for materials will be provided by the Contractor and the Contractor shall be prepared to unload and store such equipment therein upon its receipt at the Cemetery.

D. Notify RE/COR in writing, 60 days in advance, of date on which Contractor will be prepared to receive materials furnished by Government. Arrangements will then be made by the Government for delivery of materials.

1. Immediately upon delivery of materials, the Contractor shall arrange for a joint inspection thereof with a representative of the Government. At such time the Contractor shall acknowledge receipt of materials described, make notations, and immediately furnish the Government representative with a written statement as to its condition or shortages.
2. The Contractor thereafter is responsible for such material until such time as acceptance of contract work is made by the Government.

E. Completely assemble and install the Government furnished equipment in place ready for proper operation in accordance with specifications and drawings.

F. Furnish supervision of installation of equipment at construction site by qualified factory trained technicians regularly employed by the equipment manufacturer.

1.23 RELOCATED ITEMS

A. Contractor shall disconnect, dismantle as necessary, remove and reinstall in new location, all existing items indicated on the drawings.

B. Perform relocation of such equipment or items at such times and in such a manner as directed by the RE/COR.

1.24 CONSTRUCTION SIGN

A. Provide a Construction Sign where directed by the RE/COR. 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. Signface shall be 4 feet x 5 feet and 6 inches. Provide two 100 by 100 mm (4 inch by 4 inch) posts (or equivalent round posts) set 900 mm (three 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 50mm x 100 mm (two by four inch) material as directed.

B. Paint all surfaces of sign and posts two coats of white semi-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 RE/COR.

D. Detail Drawing of construction sign showing required legend and other characteristics of sign is a part of this specification.

E. Provide shop drawing of sign for COR approval prior to fabrication and installation.

1.25 SAFETY SIGN

A. Provide a Safety Sign where directed by RE/COR. Signboard shall be shall be three feet x four feet, 19 mm (3/4-inch) thick exterior grade plywood. Provide two 100 mm by 100 mm (four by four inch) posts extending full height of sign and 900 mm (three feet) into ground. Set bottom of sign level at 1200 mm (four feet) above ground.

B. Paint all surfaces of Safety Sign and posts with one prime coat and two coats of white gloss paint. Letters and design shall be painted with gloss paint of colors noted.

C. Maintain sign and remove it when directed by RE/COR.

D. Detail Drawing of safety sign showing required legend and other characteristics of sign is included in this specification.

E. Post the number of accident free days on a daily basis.

F. Provide shop drawing of sign for COR approval prior to fabrication and installation.

1.26 CONSTRUCTION DIGITAL IMAGES

A. During construction period through completion, furnish Department of Veterans Affairs weekly color digital photographs of construction progress (8 to 10 images per week.) Photographs of the reinforcing steel shall be taken after all reinforcing steel, sleeves, inserts, etc. are in place but prior to setting of runways. Photographs must show distinctly, at as large a scale as possible, all parts of work embraced in picture.

B. Photographs are to be taken with a high-resolution digital camera, minimum 6 megapixels, with good wide-angle capability. The images shall be recorded in JPEG format with a minimum of 24-bit color and no reduction in actual picture size.

1. Compressed size of the file shall be no less than 80% or the original with no loss of information.
2. File names shall contain the Project number, the date the image was taken, and a unique sequential identifier, for example: 810CM3029_10-01-2021_0001. Use underscore, not spaces in digital file names.

C. The digital photo files shall become property of Government and will be both e-mailed and submitted on CD-ROM.

1. The images shall be forwarded electronically to the COR/Project Manager via email to NAME@va.gov within 2 days of when the photo was taken. Identify the content of each picture by a caption incorporated in the photo.
2. The digital photo files shall also be submitted on CD-ROM to the COR/Project Manager at the conclusion of the project. The CD-ROM

shall also contain an index of all the images contained therein in either a TXT or Microsoft Word format.

D. Aerial Photographs: Submit aerial photographs at one-month intervals during the entire construction period. The first aerial photo shall be taken just prior to the start of construction and then at one-month intervals. The final aerial photograph shall be taken at full project completion during a growing season when lawns are green and not dormant. Provide aerial image electronically in jpg format via email or FTP site to the entire project team on a monthly basis.

1.27 FINAL ELEVATION PHOTOGRAPHS

A. Final photographs shall be taken by a commercial/professional photographer. They shall be taken upon completion, including landscaping. They shall be taken on a clear sunny day at as large a scale as possible to obtain sufficient detail to show depth and to provide clear, sharp pictures. All images shall become property of the Government.

B. Photographs shall be artistically composed showing full front elevations of new columbarium court(s), memorial wall, ossuary, bridge, site features and surrounding landscapes. A minimum of thirty six (36) images shall be taken as per these specifications.

C. Minimum digital photo file size for final photos is 20 mb un-interpolated, preferably 52 mb. Submit proofs, via e-mail or web photo gallery, from which the COR/Project Manager will select the final images for printing.

D. Pictures selected by the COR/Project Manager for printing shall be 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. Photographs shall have full picture print with no margin.

E. Submit two (2) 400 mm x 500 mm (16 x 20) framed prints and three (3) 8 x 10 prints of the final selected photos. Deliver to the COR/Project Manager, in boxes suitable for shipping,

F. Submit a CD-ROM to the COR/Project Manager containing all (minimum 36) final digital photo files.

1. 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.

2. File names shall contain the date the image was taken, the Project number and a unique sequential identifier.
3. The CD-ROM shall also contain an index of all the images contained therein in either a TXT or Microsoft Word format.

G. Each of the selected 16 x 20 prints shall be placed in a frame with a minimum 2 inches, maximum 3 inches, of appropriate matting as a border. Provide a selection of 3 different mats and 3 different frames from which the COR will select one mat and one frame style to frame both prints. Preferred frame style is wood molding, matte black finish, box frame, 1-1/8" wide x 7/8-inch deep.

H. Place a typewritten self-adhesive identity label on the back of each final print without damage to photograph. PHOTO NUMBER shall be included in both the digital file name on the CD and on the photo print label.

I. The following information shall be on the identity-label for photographs:

1. PHOTO NUMBER;
2. CEMETERY NAME
3. LOCATION;
4. PROJECT TITLE;
5. PROJECT NUMBER;
6. DATE TAKEN;
7. CONSTRUCTION COMPANY;
8. CONTRACT NUMBER.

1.28 HISTORIC PRESERVATION

A. 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 RE/COR verbally, and then with a written follow up.

1.29 PROJECT HEALTH AND SAFETY PLAN

A. Prior to commencing any construction, the Contractor shall submit a site specific Project Health and Safety Plan (PHSP). At a minimum, the PHSP shall cover the following topics:

1. Organizational structure (including Responsible Persons)
2. Site Characterization and Job Hazard Identification
3. Site Control and Security
4. Training
5. PPE
6. Heat Stress
7. Spill Containment
8. Decontamination
9. Emergency Response
10. Trench Safety

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SECTION 01 32 17
NETWORK ANALYSIS SCHEDULES
(MICROSOFT PROJECT GANTT CHART)

PART 1 - GENERAL

1.1 DESCRIPTION:

A. The Contractor shall develop a Microsoft Project 2003 (or later) Gantt Chart (bar chart) schedule demonstrating fulfillment of the contract requirements. The Contractor shall keep the network up-to-date in accordance with the requirements of this section. The Contractor shall utilize the plan for scheduling, coordinating and monitoring work under this contract (including all activities of subcontractors, equipment vendors and suppliers). The Gantt Chart will be utilized to satisfy time applications.

1.2 CONTRACTOR'S REPRESENTATIVE:

A. The Contractor shall designate an in-house representative who will be responsible to prepare the schedule, review the schedule and report progress of the project to the Contracting Officer's Representative.

B. The Contractor's in-house representative shall be given authority to act on behalf of the Contractor in fulfilling the requirements of this specification section. Such authority shall not be interrupted throughout the duration of the project.

1.3 COMPUTER PRODUCED SCHEDULES:

A. The contractor shall provide to VA monthly computer processing of all computer produced schedules generated from monthly project updates. The Contractor shall provide to VA two (2) copies of the updated Microsoft Project Gantt Chart and an electronic copy of this data. This must be submitted with and substantively support the contractor's monthly payment request.

B. The Contractor is responsible for the correctness and timeliness of the computer-produced reports. The Contractor is also responsible for the accurate and timely submittal of the updated project schedule.

C. VA shall report errors in computer-produced reports to the Contractor's representative within ten (10) calendar days from receipt of reports. The Contractor shall reprocess the Gantt Chart and associated CDs, when requested by the Contracting Officers Representative, to correct errors that affect the schedule for the project.

1.4 THE COMPLETE PROJECT GANTT CHART SUBMITTAL:

A. The Complete Project Microsoft Project Gantt Chart will contain approximately 150-250 work activities/events as necessary to fully detail the project schedule.

B. Within ten (10) calendar days after receipt of the Notice to Proceed, the Contractor shall submit for the Contracting Officer's review, a Microsoft Project Gantt Chart and a CD. Each activity/event on the Gantt Chart schedule shall contain as a minimum, but not limited to, activity/event description, duration, start dates and finish dates. Activity constraints, not required by the contract, will not be accepted. Logic events (non-work) will be permitted where necessary to reflect proper sequence among work events, but must have zero duration.

C. The complete working Gantt Chart shall reflect the Contractor's approach to scheduling the complete project. The final Gantt Chart in its original form shall contain no contract changes or delays that may have been incurred during the final Gantt Chart development period. It shall reflect the Contractors "AS BID" or "DAY 1" schedule. Changes and /or delays shall be entered at the first monthly update after the final Gantt Chart 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.

D. Within ten calendar days after receipt of the complete project Gantt Chart, 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. Schedule a meeting with the Contractor at, or near the job site, for joint review, correction or adjustment of the proposed plan. Within ten (10) calendar days after the joint review, the Contractor shall revise and shall submit two (2) copies of the revised Gantt Chart and a revised CD as specified to 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.

1.5 WORK ACTIVITY/EVENT AND COST DATA INFORMATION:

A. The Contractor shall not be required to "cost load" the computerized Microsoft Project Gantt Chart. As part of this submission, the Contractor shall provide a separate **Schedule of Costs** on AIA document G703. This Schedule of Costs shall reflect and contain all the same activities/events identified on the Gantt Chart.

B. The Contractor and the Contracting Officer shall use this Schedule of Costs for monthly payment purposes as referenced in the General Conditions of this agreement.

C. The Contractor and Contracting Officer shall agree on percentages for monthly work accomplished. The cumulative total amount of all cost loaded activities/events (including alternates) shall equal the total contract price.

D. Prorate overhead, profit and general conditions on all work activities/events for the entire project. Negative work activity/event cost data will not be acceptable, except on VA issued contract changes.

1.6 GANTT CHART REQUIREMENTS:

A. Show on the Gantt Chart the sequence and interdependence of work activities/events required for complete performance of all items of work. In preparing the Gantt Chart, the Contractor shall:

1. Show the following on each work activity/event:
   a. Concise description of the work represented by the activity/event.
   b. Duration (in work days.)
2. 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 Representative's and Architect-Engineer's review and approval of shop drawings, equipment schedules, samples, template, or similar items.
   c. Interruption of VA Cemetery utilities, delivery of Government furnished equipment, project phasing and any other specification requirements.
   d. Test, balance and adjust various systems and pieces of equipment.

e. VA inspection and acceptance activity/event with a minimum duration of five (5) work days at the end of each phase and immediately preceding any VA move activity/event required by the contract phasing for that phase.

3. Break up the work into activities/events of durations no longer than thirty (30) work days each, 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 Contracting Officer may approve the showing of a longer duration. [The duration for VA approval of any required submittal, shop drawing, or other submittals shall not be less than ten (10) workdays.] The construction time as determined by the Gantt Chart schedule from start to finish for any sub-phase, phase or the entire project shall not exceed the total contract duration. 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.
4. Exterior Label Information: Provide the following information on an external label attached to each diskette(s):
   a. VA project number and project location.
   b. Name and telephone number of a point of contact, preferably the person who created the CD
   c. The CD number and total number of CDs in the set
   d. The project data status date.

1.7 PAYMENT TO THE CONTRACTOR:

A. Monthly, the contractor shall submit the Gantt Chart updated for remaining activity durations and a Schedule of Costs updated for costs. AIA application and certification for payment documents G702 and G703 will be used. The payment request should reflect and be 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, PAYMENT UNDER FIXED-PRICE CONSTRUCTION CONTRACTS of Section GENERAL CONDITIONS. The Contractor is entitled to a monthly progress payment upon approval of estimates as determined from the

currently approved updated Schedule of Costs unless, in special situations, the Contracting Officer permits an exception to this requirement. Monthly payment requests shall include: two (2) copies of the updated Microsoft Project Gantt Chart, a listing of all project schedule changes, and associated data, made at the update. These must be submitted with and substantively support the contractor's monthly application and certificate for payment request documents.

B. When the Contractor fails or refuses to furnish to the Contracting Officer the information and the associated updated Gantt Chart data, which, in the sole judgment of the Contracting Officer, are necessary for validating the monthly progress payment, the Contractor shall not be deemed to have provided supporting schedule data upon which progress payment may be reasonably determined.

1.8 PAYMENT AND PROGRESS REPORTING:

A. Monthly job site progress meetings shall be held on dates mutually agreed to by the Contracting Officer (or Contracting Officer's Representative) and the Contractor. Presence of subcontractors during the progress meeting is optional unless required by the Contracting Officer (or Contracting Officer's Representative). Job progress will be reviewed to verify:

1. Actual start and/or finish dates for updated/completed activities/events.
2. Remaining duration, required to complete each activity/event started, or scheduled to start, but not completed.
3. Time and cost data for change orders, and supplemental agreements that are to be incorporated into the Gantt Chart.
4. Percentage for completed and partially completed activities/events.
5. Logic and duration revisions required by this section of the specifications.
6. Activity/event duration and percent complete shall be updated independently.

B. The Contractor shall submit a narrative report as a part of his monthly review and update, in a form agreed upon by the Contracting Officer. The narrative report shall include a description of problem areas; current and anticipated delaying factors and their estimated impact on performance of other activities/events and completion dates; and an

explanation of corrective action taken or proposed. This report is in addition to the daily reports pursuant to the provisions of Article, DAILY REPORT OF WORKERS AND MATERIALS in the GENERAL CONDITIONS.

C. As part of the monthly jobsite progress meeting, the General Contractor, specifically requested subcontractors and the Contracting Officers Representative 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.

1.9 RESPONSIBILITY FOR COMPLETION:

A. Whenever it becomes apparent from the monthly progress review meeting or the monthly computer-produced Gantt Chart 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 Contracting Officer for the proposed schedule changes. If such actions are approved, the revisions shall be incorporated by the Contractor into the Gantt Chart before the next update, at no additional cost to the Government.

1.10 CHANGES TO GANTT CHART SCHEDULE:

A. Within ten (10) calendar days after VA acceptance and approval of any updated computer-produced schedule, the Contractor shall submit a revised Gantt Chart, the associated CDs, 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 indicate an extension of the project completion by twenty (20) working days or 10 percent of the

remaining project duration, whichever is less. Such delays 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 Gantt Chart 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 of the network diagram regardless of the cause for these revisions.

B. Revisions made under this paragraph, which affect the previously approved computer-produced schedules for Government furnished equipment, contract phase(s) and sub phase(s), utilities furnished by the Government to the Contractor, or any other previously contracted item, must be furnished in writing to the Contracting Officer for approval.

C. Contracting Officer's approval for the revised Gantt Chart 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 Contracting Officer’s Representative.

D. The cost of revisions to the Gantt Chart resulting from contract changes will be included in the cost of the change.

E. The cost of revisions to the Gantt Chart not resulting from contract changes is the responsibility of the Contractor.

1.11 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, Gantt Chart data and supporting evidence as the Contracting Officer 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.

B. The Contracting Officer's determination as to the total number of days of contract extension will be based upon the current computer-produced Gantt Chart schedule for the time period when the change took place and all other relevant information. The Contracting Officer will, within thirty (30) calendar days after receipt of such justification and supporting evidence, advise the Contractor in writing of his decision on the matter.

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 Article, CHANGES, in the Section, GENERAL CONDITIONS. The Contractor shall include, as a part of each change order proposal, a sketch showing all 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.

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SECTION 01 33 23
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 (including laboratory samples to be tested), 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 (including any laboratory samples to be tested) 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 Resident Engineer 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.

Submittal numbers will be based upon specification section. Only materials from the same section may be submitted in the same submittal. All submittals shall be reviewed by a qualified person employed by the general contractor for content, completeness, and proper processing procedure prior to submittal – provide name of qualified reviewing personal on submittal. All incomplete, mixed section, or improperly formatted submittals will be returned un-reviewed.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 required by Section 09 06 00, SCHEDULE FOR FINISHES, in quadruplicate. Submit other samples in single units unless otherwise specified. 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 and shall contain the list of items, name of Cemetery, 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.

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 Cemetery, 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 five 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 Resident Engineer and to Architect-Engineer simultaneously with submission of material to a commercial testing laboratory.

5. Laboratory test reports shall be sent directly to Resident Engineer 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 Resident Engineer 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 Cemetery 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. Mock Ups: The construction of several mock ups will be required for A/E and COR review as part of this contract.

A. The mock ups will be used to make final material selection, evaluate installation techniques, and evaluate compatibility of selected components. The completed mock ups will serve as a mutual understanding of the workmanship and methods to be used on actual installation. As such, some re-work may be required at no additional cost to the government.

B. Refer to Specifications Section 01 43 39 MOCKUP REQUIREMENTS and also individual product specification sections for additional mockup information.

C. Materials not to be ordered prior to NCA approval of finished Mockup.

1-11. Samples, shop drawings, test reports, certificates and manufacturers' literature and data, shall be submitted for approval to both the VA and:

Anderson Engineering of MN, LLC.
13605 1st Avenue North, Suite 100
Plymouth, MN 55441

1-12. At the time of transmittal to the Architect-Engineer, the Contractor shall also send a copy of the complete submittal directly to the Resident Engineer.

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SECTION 01 42 19

REFERENCE STANDARDS

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section specifies the availability and source of references and standards specified in the project manual under paragraphs APPLICABLE PUBLICATIONS and/or shown on the drawings.

1.2 AVAILABILITY OF SPECIFICATIONS LISTED IN THE GSA INDEX OF FEDERAL SPECIFICATIONS, STANDARDS AND COMMERCIAL ITEM DESCRIPTIONS FPMR PART 101-29 (FAR 52.211-1) (AUG 1998)

A. The GSA Index of Federal Specifications, Standards and Commercial Item Descriptions, FPMR Part 101-29 and copies of specifications, standards, and commercial item descriptions cited in the solicitation may be obtained for a fee by submitting a request to – GSA Federal Supply Service, Specifications Section, Suite 8100, 470 East L'Enfant Plaza, SW, Washington, DC 20407, Telephone (202) 619-8925, Facsimile (202) 619-8978.

B. If the General Services Administration, Department of Agriculture, or Department of Veterans Affairs issued this solicitation, a single copy of specifications, standards, and commercial item descriptions cited in this solicitation may be obtained free of charge by submitting a request to the addressee in paragraph (a) of this provision. Additional copies will be issued for a fee.

1.3 AVAILABILITY FOR EXAMINATION OF SPECIFICATIONS NOT LISTED IN THE GSA INDEX OF FEDERAL SPECIFICATIONS, STANDARDS AND COMMERCIAL ITEM DESCRIPTIONS (FAR 52.211-4) (JUN 1988)

A. The specifications and standards cited in this solicitation can be examined at the following location:
United States Department of Veteran Affairs
Technical Information Library
http://www.cfm.va.gov/til/

1.4 AVAILABILITY OF SPECIFICATIONS NOT LISTED IN THE GSA INDEX OF FEDERAL SPECIFICATIONS, STANDARDS AND COMMERCIAL ITEM DESCRIPTIONS (FAR 52.211-3) (JUN 1988)

A. The specifications cited in this solicitation may be obtained from the associations or organizations listed below.

AA	Aluminum Association, Inc. http://www.aluminum.org
AABC	Associated Air Balance Council http://www.aabchq.com
AADM	American Association of Automatic Door Manufacturers http://www.aaadm.com
AATC	American Association of Textile Chemists and Colorist http://www.aatcc.org
AAMA	American Architectural Manufacturer's Association http://www.aamanet.org
AAN	American Nursery and Landscape Association http://www.anla.org
AASHTO	American Association of State Highway and Transportation Officials http://www.transportation.org/Pages/default.aspx
ACGIH	American Conference of Governmental Industrial Hygienists http://www.acgih.org
ACI	American Concrete Institute http://www.aci-int.net
ACPA	American Concrete Pipe Association http://www.concrete-pipe.org
ACPPA	American Concrete Pressure Pipe Association http://www.acppa.org
ADA	American with Disabilities Act http://www.access-board.gov/guidelines-and-standards/buildings-and-sites/about-the-ada-standards/background/adaag
ADC	Air Diffusion Council http://flexibleduct.org
AGA	American Gas Association http://www.aga.org
AGC	Associated General Contractors of America http://www.agc.org
AHA	American Hardboard Association http://www.domensino.com/AHA/

AIHA	American National Standards Institute/American Industrial Hygiene Association http://www.aiha.org/Pages/default.aspx
AISC	American Institute of Steel Construction http://www.aisc.org
AISI	American Iron and Steel Institute http://www.steel.org
AITC	American Institute of Timber Construction http://www.aitc-glulam.org
ALI	Automotive Lift Institute http://www.autolift.org/
AMCA	Air Movement and Control Association http://www.amca.org/
ANLA	American Nursery & Landscape Association http://www.anla.org
ANSI	American National Standards Institute, Inc. http://www.ansi.org
APA	Architectural Precast Association http://www.archprecast.org/
APA	The Engineered Wood Association http://www.apawood.org
ARI	Air-Conditioning and Refrigeration Institute http://www.lightindustries.com/ARI/
ARMA	Asphalt Roofing Manufacturers Association http://www.asphaltroofing.org/
ASAE	American Society of Agricultural Engineers http://www.asabe.org
ASCE	American Society of Civil Engineers http://www.asce.org
ASHRAE	American Society of Heating, Refrigerating, and Air-Conditioning Engineers http://www.ashrae.org
ASME	American Society of Mechanical Engineers http://www.asme.org
ASSE	American Society of Sanitary Engineering http://www.asse-plumbing.org

ASTM	American Society for Testing and Materials http://www.astm.org
AWI	Architectural Woodwork Institute http://www.awinet.org
AWS	American Welding Society http://www.aws.org
AWPA	American Wood Protection Association http://www.awpa.com
AWWA	American Water Works Association http://www.awwa.org
BHMA	Builders Hardware Manufacturers Association http://www.buildershardware.com
BIA	The Brick Industry Association http://www.bia.org
CAGI	Compressed Air and Gas Institute http://www.cagi.org
CARB	California Environmental Protection Agency Air Resources Board http://arb.ca.gov/hompage.html/
CFR	Code of Federal Regulations http://www.gpo.gov/fdsys/browse/collectionCfr.action?collectionCode=CFR
CGA	Compressed Gas Association, Inc. http://www.cganet.com
CID	Commercial Item Description http://www.gsa.gov/portal/content/100847
CISCA	Ceilings and Interior Systems Construction Association http://www.cisca.org
CISPI	Cast Iron Soil Pipe Institute http://www.cispi.org
CLFMI	Chain Link Fence Manufacturers Institute http://www.chainlinkinfo.org
CPA	Composite Panel Association http://www.compositepanel.org/
CRA	California Redwood Association http://www.calredwood.org

CRI	Carpet and Rug Institute http://www.carpet-rug.com
CRRC	Cool Roof Rating System http://coolroofs.org/
CRSI	Concrete Reinforcing Steel Institute http://www.crsi.org
CSI	Cast Stone Institute http://www.caststone.org
DASMA	Door and Access Systems Manufacturers Association http://www.dasma.com/
DHI	Door and Hardware Institute http://www.dhi.org
DOE	U.S. Department of Energy http://www.energy.gov/
EEI	Edison Electric Institute http://www.eei.org
EGSA	Electrical Generating Systems Association http://www.egsa.org
EIMA	Exterior Insulation Manufacturers Association http://www.eima.com/
EPA	Environmental Protection Agency http://www.epa.gov
ETL	ETL Testing Laboratories, Inc. http://www.envirotestinglabs.com/
FCC	Federal Communications Commission http://www.fcc.gov
FHA	Federal Highway Administration http://www.fhwa.dot.gov/
FM	FM Global http://www.fmglobal.com
FPS	The Forest Products Society http://www.forestprod.org
FSC	Forest Stewardship Council http://www.fscus.org
GA	Gypsum Association http://www.gypsum.org

GANA	Glass Association of North America
	http://www.glasswebsite.com
GBI	Green Building Initiative
	http://www.thegbi.org/
GS	Green Seal
	http://www.greenseal.org
GSA	General Services Administration
	http://www.gsa.gov
HI	Hydraulic Institute
	http://www.pumps.org
HPVA	Hardwood Plywood & Veneer Association
	http://www.hpva.org
ICC	The International Code Council
	http://www.iccsafe.org/Pages/default.aspx
ICEA	Insulated Cable Engineers Association Inc.
	http://www.icea.net
IEEE	Institute of Electrical and Electronics Engineers
	http://www.ieee.org\
IGMA	Insulating Glass Manufacturers Alliance
	http://www.igmaonline.org
ITS	Intertek Training Services
	http://www.intertek.com/
MBMA	Metal Buildings Manufacturers Association
	http://www.mbma.com
MHI	Material Handling Industry of America
	http://www.mhi.org/
MIA	Marble Institute of America
	http://www.marble-institute.com/
MIC	Masonry Industry Council
MPI	Master Painters Institute
	http://www.mpi.net/
MSJC	Masonry Standards Joint Committee
	http://www.masonrysociety.org/msjc/
NAAMM	National Association of Architectural Metal Manufacturers
	http://www.naamm.org

NAPHCC Plumbing-Heating-Cooling Contractors Association
http://www.phccweb.org/

NBS National Bureau of Standards
See - NIST

NEC National Electric Code
See - NFPA National Fire Protection Association

NEMA National Electrical Manufacturers Association
http://www.nema.org

NFPA National Fire Protection Association
http://www.nfpa.org

NFRC National Fenestration Rating Council
http://www.nfrc.org/

NHLA National Hardwood Lumber Association
http://www.natlhardwood.org

NIH National Institute of Health
http://www.nih.gov

NIOSH The National Institute for Occupational Safety and Health
http://www.cdc.gov/niosh/

NIST National Institute of Standards and Technology
http://www.nist.gov

NLMA Northeastern Lumber Manufacturers Association, Inc.
http://www.nelma.org

NPA National Particleboard Association
18928 Premiere Court
Gaithersburg, MD 20879
(301) 670-0604

NPCA National Precast Concrete Association
http://www.precast.org

NRCA National Roofing Contractors Association
http://www.nrca.net

NSF National Sanitation Foundation
http://www.nsf.org

NSF NSF International
http://www.nsf.org/

NTMA National Terrazzo and Mosaic Association
http://ntma.com/

NWWDA	Window and Door Manufacturers Association http://www.nwwda.org
OSHA	Occupational Safety and Health Administration Department of Labor http://www.osha.gov
PCA	Portland Cement Association http://www.cement.org/
PCI	Precast Prestressed Concrete Institute http://www.pci.org
PPI	The Plastic Pipe Institute http://www.plasticpipe.org
PEI	Porcelain Enamel Institute, Inc. http://www.porcelainenamel.com
PTI	Post-Tensioning Institute http://www.post-tensioning.org
RCSC	Research Council of Structural Connections http://www.boltcouncil.org/
RFCI	The Resilient Floor Covering Institute http://www.rfci.com
RIS	Redwood Inspection Service See - CRA
RMA	Rubber Manufacturers Association, Inc. http://www.rma.org
SCAQMD	South Coast Air Quality Management District http://www.aqmd.gov
SCMA	Southern Cypress Manufacturers Association http://www.cypressinfo.org
SDI	Steel Deck Institute http://www.sdi.org
SDI	Steel Door Institute http://www.steeldoor.org
SEI	Structural Engineering Institute http://www.asce.org/SEI/
SJI	Steel Joist Institute http://www.steeljoist.org

SMACNA	Sheet Metal and Air-Conditioning Contractors National Association, Inc. http://www.smacna.org
SPRI	Single Ply Roofing Industry http://www.spri.org
SSPC	The Society for Protective Coatings http://www.sspc.org
STI	Steel Tank Institute http://www.steeltank.com
SWI	Steel Window Institute http://www.steelwindows.com
SWRI	Sealant Waterproofing and Restoration Institute http://www.swrionline.org/
TCNA	Tile Council of North America, Inc. http://www.tileusa.com
TPI	Truss Plate Institute, Inc. http://www.tpinst.org/
UL	Underwriters' Laboratories Incorporated http://www.ul.com
ULC	Underwriters' Laboratories of Canada http://www.ulc.ca
USDA	U.S. Department of Agriculture http://www.usda.gov
USGBC	U.S. Green Building Council http://www.usgbc.org
WCLIB	West Coast Lumber Inspection Bureau http://www.wclib.org/
WDMA	Window and Door Manufacturers Association https://www.wdma.com/
WH	Warnock Hersey http://www.intertek.com/marks/wh/
WRCLA	Western Red Cedar Lumber Association http://www.wrcla.org/
WWPA	Western Wood Products Association http://www2.wwpa.org/

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SECTION 01 43 39
MOCKUP REQUIREMENTS

PART 1 - GENERAL

1.1 DESCRIPTION

This section covers MOCKUP REQUIREMENTS; see also the individual specification sections for additional requirements.

1.2 RELATED WORK

A. Submittals: Section 01 33 23 SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES

B. Individual SPECIFICATION SECTIONS from all SPECIFICATION DIVISIONS pertaining to Columbaria, Concrete Unit Paving and Concrete for Exterior Improvements.

C. Section 03 30 53 CAST-IN-PLACE CONCRETE

D. Section 03 48 24 PRE-CAST CONCRETE COLUMBARIUM UNITS

E. Section 04 05 13 MASONRY MORTARING

F. Section 04 20 00 UNITE MASONRY

G. Section 04 43 00 NATURAL STONE CAPS AND PANELS

H. Section 04 73 00 COLUMBARIA NICHE COVERS

I. Section 07 92 00 JOINT SEALANTS

J. Section 09 06 00 SCHEDULE FOR FINISHES

K. Section 32 05 23 CEMENT AND CONCRETE FOR EXTERIOR IMPROVEMENTS

1.3 SUBMITTALS

A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES all required submittals. Submittals must be approved prior to constructing the mockup.

B. Provide shop drawings for proposed Mockup. Include sketch of proposed location, where mock-up can remain in place until work has progressed and removal is authorized by COR.

1.4 DEFINITIONS

A. Mockups (General): Full-size physical assemblies that are constructed on-site. Mockups are constructed to verify selections made under sample submittals; to demonstrate aesthetic effects and, where indicated, qualities of materials and execution; to review coordination, testing, or operation; to show interface between dissimilar materials; and to demonstrate compliance with specified installation tolerances.

1. Mockups are not provided in lieu of submittals (See Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES and individual specification sections associated with the mockup).
2. Unless otherwise indicated, all approved mockups establish the standard by which the WORK will be judged.

B. Mockups of the columbarium, staircase and retaining wall complete with all materials including but not limited to: stem walls, masonry ledges, structural wall elements, finishes, joint sealants, flashings, type of formwork, formwork details, pre-cast columbaria units, stone cap, stand-off metal lettering and numbering, mortar joints and bedding layer.

1.5 QUALITY ASSURANCE

A. Mockup Plan: Detailed, dimensioned plans and elevations showing mockup size, and items and materials that will be included in proposed mockup. Provide for each mockup.

B. Pre-Construction Conference: Prior to the construction of the mockups, a conference shall be scheduled by the contractor for the purpose of reviewing the requirements and intent of mockups.

C. Mock-ups may be constructed in-place of the final location or independently from the Columbaria wall and plaza construction. If the wall is built in-place of the final location, the mock-up shall be approved prior to any additional construction of the columbarium wall. If the mock-up is built independently, the mock-ups shall be removed as indicated by COR after all construction and final inspection punchlist is complete.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 INSTALLATION

A. Before installing portions of the Work requiring mockups, build mockups for each form of construction and finish as directed.

1. Build mockups in either final (in-place) location or independently and of full scale size and profile indicated or, as directed by the COR.
2. Notify the COR a minimum of 14 calendar days in advance of dates and times when mockups will be completed and able to be inspected.

3. Employ supervisory personnel to oversee mockup construction. Employ same workers that will be employed during the construction of Project.
4. Demonstrate the proposed range of aesthetic effects and workmanship.
5. Commence ordering of materials after mockup has been inspected and approved in writing by COR.
6. The mockup will establish the standard of quality of workmanship by which the Work will be judged. Some rework may be required to correct deficiencies and demonstrate standard of final work.
7. Commence work and finish mockups with final approval prior to beginning construction of the Columbaria, Staircases and Plaza pavement.
8. Mockup to remain up during construction and removed after final inspection / punch list preparation after approval by COR, if constructed independently.

B. Mockup Type: Construct mockup in accordance with approved shop drawings, project manual, and Contract Drawings, using exact materials and methods approved for the Project, including required accessories. - See also drawings and individual material specification sections for Mock-up requirements

C. Mock-up approval: The construction of several mock ups is required for A/E and COR review and approval as part of this contract.
   1. Mock-ups will be used to make final material selection, evaluate installation techniques, and evaluate compatibility of selected components. The completed mock-ups will serve as a mutual understanding of the workmanship and methods to be used on actual installation. As such, some re-work may be required at no additional cost to the government.
   2. Mock-ups shall be constructed on site to allow visual inspection in conditions to the final location, whether constructed in-place or independently.
   3. Mock-ups shall include architectural elements and geometry similar to the final product.
   4. Mock-ups shall be constructed with full-scale size materials.

5. Mock-ups shall be completed to allow sufficient time for evaluation prior to ordering of materials.

D. Mock-ups

1. COLUMBARIUM

Independent columbarium mock-up, construct columbarium including two closed 3-niche wide units minimum (back to back 5-high niche walls). A second mock-up shall include the corner at conditions shown on plans at "Grid C1" and extend 3 niches in both directions. Mockups shall include full scale length and height of at least one corner or end pier, flower gravel strip, and concrete pavement extending 4' minimum beyond the flower gravel strip and columbarium end pier. Provide cap stone for columbarium niches and end pier, all connections including weld plates, and all joint conditions including (but not limited to) the following:

03 30 00 – Cast-in-Place Concrete
03 48 24 – Precast Concrete Columbaria Unit
04 05 13 – Masonry Mortaring
04 20 00 – Unit Masonry
04 43 00 – Natural Stone Caps and Panels
04 73 00 - Columbarium Niche Covers Marble & Hardware
07 92 00 - Joint Sealants
32 05 23 - Cement and Concrete for Exterior Improvements

2. MEMORIAL WALL:

Provide cast-in-place concrete footing and masonry ledge for stone veneer mock-up, concrete memorial wall unit with natural stone cap, connections to concrete memorial wall unit and memorial wall markers, and show conditions at end column (including but not limited to):

03 30 00 – Cast-in-Place Concrete
03 48 24 – Precast Concrete Columbaria Unit
04 05 13 – Masonry Mortaring
04 05 16 – Masonry Grouting
04 43 00 – Natural Stone Veneer
04 73 10 – Memorial Wall Markers
07 13 00 – Sheet Waterproofing
07 60 00 – Flashing & Sheet Metal

07 92 00 - Joint Sealants

3. ENTRY WALL

Provide cast-in-place concrete footing and masonry ledge for stone veneer mock-up, concrete wall unit with natural stone cap and ornamental fencing and connections, and show conditions at end column (including but not limited to):

03 30 00 – Cast-in-Place Concrete

03 48 24 – Precast Concrete Columbaria Unit

04 05 13 – Masonry Mortaring

04 05 16 – Masonry Grouting

04 43 00 – Natural Stone Veneer

04 73 10 – Memorial Wall Markers

07 13 00 – Sheet Waterproofing

07 60 00 – Flashing & Sheet Metal

07 92 00 - Joint Sealants

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SECTION 01 45 00
QUALITY CONTROL

PART 1 - GENERAL

1.1 DESCRIPTION

This section specifies requirements for Contractor Quality Control (CQC).

1.2 APPLICABLE PUBLICATIONS

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

B. ASTM International (ASTM)

1. D3740 - (2012a) Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction
2. E329 - (2014a) Standard Specification for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction

1.3 SUBMITTALS

Government approval is required for all submittals. CQC inspection reports shall be submitted under this Specification section and follow the [Applicable CQC Control Phase (Preparatory, Initial, or Follow-Up)]: [Applicable Specification section] naming convention.

1. Preconstruction Submittals
    a. Interim CQC Plan
    b. CQC Plan
    c. Additional Requirements for Design Quality Control (DQC) Plan
2. Design Data
    a. Discipline-Specific Checklists
    b. Design Quality Control
3. Test Reports
    a. Verification Statement

PART 2 PRODUCTS – NOT USED

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

Establish and maintain an effective quality control (QC) system. that complies with the FAR Clause 52.246.12 titled "Inspection of Construction". QC consists of plans, procedures, and organization necessary to produce an end product which complies with the Contract requirements. The QC system covers all design and construction operations, both onsite and offsite, and be keyed to the proposed design and construction sequence. The project superintendent will be held responsible for the quality of work and is subject to removal by the Contracting Office or Authorized designee for non-compliance with the quality requirements specified in the Contract. In this context the highest level manager responsible for the overall construction activities at the site, including quality and production is the project superintendent. The project superintendent maintains a physical presence at the site at all times and is responsible for all construction and related activities at the site, except as otherwise acceptable to the Contracting Officer.

3.2 CQC PLAN:

A. Submit the CQC Plan no later than 30 days after receipt of Notice to Proceed (NTP) proposed to implement the requirements of the FAR Clause 52.246.12 titled "Inspection of Construction". The Government will consider an Interim CQC Plan for the first 30 days of operation, which must be accepted within 10 business days of NTP. Design and/or construction will be permitted to begin only after acceptance of the CQC Plan or acceptance of an Interim plan applicable to the particular feature of work to be started. Work outside of the accepted Interim CQC Plan will not be permitted to begin until acceptance of a CQC Plan or another Interim CQC Plan containing the additional work scope is accepted.

B. Content of the CQC Plan: Include, as a minimum, the following to cover all design and construction operations, both onsite and offsite, including work by subcontractors, designers of record consultants,

architects/engineers (A/E), fabricators, suppliers, and purchasing agents:

1. A description of the QC organization, including a chart showing lines of authority and acknowledgement that the CQC staff will implement the three phase control system for all aspects of the work specified. Include a CQC System Manager that reports to the project superintendent.
2. The name, qualifications (in resume format) duties, responsibilities, and authorities of each person assigned a CQC function.
3. A copy of the letter to the CQC System Manager signed by an authorized official of the firm which describes the responsibilities and delegates sufficient authorities to adequately perform the functions of the CQC System Manager, including authority to stop work which is not in compliance with the Contract. Letters of direction to all other various quality control representatives outlining duties, authorities, and responsibilities will be issued by the CQC System Manager. Furnish copies of these letters to the Contracting Officer or Authorized designee.
4. Procedures for scheduling, reviewing, certifying, and managing submittals including those of subcontractors, designers of record, consultants, A/E's offsite fabricators, suppliers and purchasing agents. These procedures must be in accordance with Section 01 33 23 Shop Drawings, Product Data, and Samples.
5. Control, verification, and acceptance of testing procedures for each specific test to include the test name, specification paragraph requiring test, feature of work to be tested, test frequency, and person responsible for each test. (Laboratory facilities approved by the Contracting Officer or Authorized designee are required to be used)
6. Procedures for tracking Preparatory, Initial, and Follow-Up control phases and control, verification, and acceptance tests including documentation.
7. Procedures for tracking design and construction deficiencies from identification through acceptable corrective action. Establish

verification procedures that identified deficiencies have been corrected.

8. Reporting procedures, including proposed reporting formats.
9. A list of the definable features of work. A definable feature of work is a task which is separate and distinct from other tasks has separate control requirements, and is identified by different trades or disciplines, or it is work by the same trade in a different environment. Although each section of specifications can generally be considered as a definable feature of work, there are frequently more than one definable feature under a particular section. This list will be agreed upon during the Coordination meeting.
10. Coordinate schedule work with Special Inspections required by Section 01 45 35 Special Inspections, the Statement of Special Inspections and Schedule of Special Inspections. Where the applicable Code issue by the International Code Council (ICC) calls for inspections by the Building Official, the Contractor must include the inspections in the CQC Plan and must perform the inspections required by the applicable ICC. The Contractor must perform these inspections using independent qualified inspectors. Include the Special Inspection Plan requirements in the CQC Plan.

C. Additional Requirements for Design Quality Control (DQC) Plan: The following additional requirements apply to the DQC Plan for DB projects only and not DBB projects:

1. Submit and maintain a DQC Plan as an effective QC program which assures that all services required by this contract are performed and provided in a manner that meets professional architectural and engineering quality standards. As a minimum, all documents must be technically reviewed by competent, independent reviewers identified in the DQC Plan. The same element that produced the product may not perform the independent technical review (ITR). Correct errors and deficiencies in the design documents prior to submitting them to the Government.
2. Include the design schedule in the master project schedule, showing the sequence of events involved in carrying out the project design tasks within the specific Contract period. This should be at a detailed level of scheduling sufficient to identify all major design

tasks, including those that control the flow of work. Include review and correction periods associated with each item. This should be a forward planning as well as a project monitoring tool. The schedule reflects calendar days and not dates for each activity. If the schedule is changed, submit a revised schedule reflecting the change within 7 calendar days. Include in the DQC Plan the discipline-specific checklists to be used during the design and quality control of each submittal. Submit at each design phase as part of the project documentation these completed discipline-specific checklists.

3. Implement the DQC Plan by a DQC Manager who has the responsibility of being cognizant of and assuring that all documents on the project have been coordinated. This individual must be a person who has verifiable engineering or architectural design experience and is a Professional Engineer or Registered Architect within the state of Construction location. Notify the Contracting Officer or Authorized designee, in writing, of the name of the individual, and the name of an alternate person assigned to the position.

D. Acceptance of Plan: Acceptance of the Contractor's plan is required prior to the start of design and construction. Acceptance is conditional and will be predicated on satisfactory performance during the design and construction. The Government reserves the right to require the Contractor to make changes in the CQC Plan and operations including removal of personnel as necessary, to obtain the quality specified.

E. Notification of Changes: After acceptance of the CQC Plan, notify the Contracting Officer or Authorized designee in writing of any proposed change. Proposed changes are subject to acceptance by the Government prior to implementation by the Contractor.

3.3 COORDINATION MEETING:

After the Preconstruction Conference Post-award Conference before start of design or construction, and prior to acceptance by the Government of the CQC Plan, meet with the Contracting Officer or Authorized designee to discuss the Contractor's quality control system. Submit the CQC Plan a minimum of 5 business days prior to the Coordination Meeting. During the meeting, a mutual understanding of the system details must be

developed, including the forms for recording the CC operations, design activities (if applicable), control activities, testing, administration of the system for both onsite and offsite work, and the interrelationship of Contractor's Management and control with the Government's Quality Assurance. Minutes of the meeting will be prepared by the Government, signed by both the Contractor and Contracting Officer or Authorized designee and will become a part of the contract file. There can be occasions when subsequent conferences will be called by either party to reconfirm mutual understandings or address deficiencies in the CQC system or procedures which can require corrective action by the Contractor.

3.4 QUALITY CONTROL ORGANIZATION:

A. Personnel Requirements: The requirements for the CQC organization are a Safety and Health Manager, CQC System Manager, a Design Quality Manager (if applicable), and sufficient number of additional qualified personnel to ensure safety and Contract compliance. The Safety and Health Manager shall satisfy the requirements of Specification 01 35 26 Safety Requirements and reports directly to a senior project (or corporate) official independent from the CQC System Manager. The Safety and Health Manager will also serve as a member of the CQC Staff. Personnel identified in the technical provisions as requiring specialized skills to assure the required work is being performed properly will also be included as part of the CQC organization. The Contractor's CQC staff maintains a presence at the site at all times during progress of the work and have complete authority and responsibility to take any action necessary to ensure Contract compliance. The CQC staff will be subject to acceptance by the Contracting Officer or Authorized designee. Provide adequate office space, filing systems, and other resources as necessary to maintain an effective and fully functional CQC organization. Promptly complete and furnish all letters, material submittals, shop drawings submittals, schedules and all other project documentation to the CQC organization. The CQC organization is responsible to maintain these documents and records at the site at all times, except as otherwise acceptable to the Government.

B. CQC System Manager: Identify as CQC System Manager an individual within the onsite work organization that is responsible for overall management of CQC and has the authority to act in all CQC matters for the Contractor. The CQC system Manager is required to be a PM or SRE to determine qualifications based on project complexity at construction review with construction experience on construction similar to the scope of this Contract. This CQC System manager is on the site at all times during construction and is employed by the General Contractor. The CQC System Manger is assigned as CQC System Manager but has duties as project superintendent in addition to quality control. Identify in the plan an alternate to serve in the event of the CDQC System Manager's absence. The requirements for the alternate are the same as the CQC System Manager.

C. CQC Personnel: In addition to CQC personnel specified elsewhere in the contract, provide as part of the CQC organization specialized personnel to assist in the CQC System Manager for the following areas, as applicable: electrical, mechanical, civil, structural, environmental, architectural, materials technician submittals clerk, Commissioning Agent/LEED specialist, and low voltage systems. These individuals or specified technical companies are employees of the prime or subcontractor ; be responsible to the CQC System Manager; be physically present at the construction site during work on the specialized personnel's areas of responsibility; have the necessary education or experience in accordance with the Experience Matrix listed herein. These individuals can perform other duties but need to be allowed sufficient time to perform the specialized personnel's assigned quality controls duties as described in the CQC Plan. A single person can cover more than one area provided that the single person is qualified to perform QC activities in each designated and that workload allows.

EXPERIENCE MATRIX

Area	Qualifications
Civil	Graduate Civil Engineer or Construction Manager with 2 years experience in the type of work being performed on this project or technician with 5 years related experience.
Mechanical	Graduate Mechanical Engineer with 2 years experience or construction professional with 5 years of experience supervising mechanical features of work in the field with a construction company.
Electrical	Graduate Electrical Engineer with 2 years related experience or construction professional with 5 years of experience supervising electrical features of work in the field with a construction company.
Structural	Graduate Civil Engineer (with Structural Track or Focus), Structural Engineer, or Construction Manager with 2 years experience or construction professional with 5 years experience supervising structural features of work in the field with a construction company.
Architectural	Graduate Architect with 2 years experience or construction professional with 5 years of related experience.
Environmental	Graduate Environmental Engineer with 3 years experience.
Submittals	Submittal Clerk with 1 year experience.
Concrete, Pavement, and Soils	Materials Technician with 2 years experience for the appropriate area.
Testing, Adjusting, and Balancing (TAB)	Specialist must be a member of AABC or an experienced technicaion of the firm certified by the NEBB.
Design Quality Control Manager	Registered Architect or Professional Engineer

D. Additional Requirements: In addition to the above experience and education requirements, the CQC System Manager and Alternate CQC System Manager are required to have completed the Construction Quality Management (CQM) for Construction course. If the CQC System Manager does not have a current specification, obtain the CQM for Contractors course identification within 90 days of award. This course is periodically offered by the Naval Facilities Engineering Command and the Army Corps of Engineers. Contact the Contracting Officer or Authorized designee for information on the next scheduled class.

E. Organizational Changes: Maintain the CQC staff at full strength at all times. When it is necessary to make changes to the CQC staff, revise the CQC Plan to reflect the changes and submit the changes to the Contracting Officer or Authorized designee for acceptance.

3.5 **SUBMITTALS AND DELIVERABLES:** Submittals have to comply with the requirements in Section 01 33 23 Shop Drawings, Product Data, and Samples. The CQC organization is responsible for certifying that all submittals and deliverables are in compliance with the contract requirements. When Section 01 91 00 General Commissioning Requirements is included in the contract, the submittals required by the section have to be coordinated with the Section 01 33 23 Shop Drawings, Product Data, and Samples to ensure adequate time is allowed for each type of submittal required.

3.6 CONTROL:

A. CQC is the means by which the Contractor ensures that the construction, to include that of subcontractors and suppliers, complies with the requirements of the contract. At least three phases of control are required to be conducted by the CQC System Manager for each definable feature of the construction work as follows:

1. Preparatory Phase: This phase is performed prior to beginning work on each definable feature of work after all required plans/documents/materials are approved/accepted, and after copies are at the work site. This phase includes:
   a. A review of each paragraph of applicable specifications, references codes, and standards. Make available during the preparatory inspection a copy of those sections of referenced

codes and standards applicable to that portion of the work to be accomplished in the field. Maintain and make available in the field for use by Government personnel until final acceptance of the work.

b. Review of the Contract drawings.

c. Check to assure that all materials and equipment have been tested, submitted, and approved.

d. Review of provisions that have been made to provide required control inspection and testing.

e. Review Special Inspections required by Section 01 45 35 Special Inspections, that Statement of Special Inspections and the Schedule of Specials Inspections.

f. Examination of the work area to assure that all required preliminary work has been completed and is in compliance with the Contract.

g. Examination of required materials, equipment, and sample work to assure that they are on hand conform to approved shop drawings or submitted data, and are properly stored.

h. Review of the appropriate Activity Hazard Analysis (AHA) to assure safety requirements are met.

i. Discussion of procedures for controlling quality of the work including repetitive deficiencies. Document construction tolerances and workmanship standards – contract defined or industry standard if not contract defined - for that feature of work.

j. Check to ensure that the portion of the plan for the work to be performed has been accepted by the Contracting Officer.

k. Discussion of the initial control phase.

l. The Government needs to be notified at least 48 hours or 2 business days in advance of beginning the Preparatory control phase. Include a meeting conducted by the CQC System Manager and attended by the superintendent, other CQC personnel (as applicable), and the foreman responsible for the definable feature. Document the results of the Preparatory phase actions by separate minutes prepared by the CQC System Manager and attach to the daily CQC report. Instruct applicable workers as

to the acceptable level of workmanship required in order to meet contract specifications.

B. Initial Phase: This phase is accomplished at the beginning of a definable feature of work. Accomplish the following:

1. Check work to ensure that it is in full compliance with contract requirements. Review minutes of the Preparatory meeting.
2. Verify adequacy of controls to ensure full contract compliance. Verify the required control inspection and testing is in compliance with the contract.
3. Establish level of workmanship and verify that it meets minimum acceptable workmanship standards. Compare with required sample panels as appropriate.
4. Resolve all differences.
5. Check safety to include compliance with an upgrading of the safety plan and activity hazard analysis. Review the activity analysis with each worker.
6. The Government needs to be notified at least 48 hours or 2 business days in advance of beginning the initial phase for definable features of work. Prepare separate minutes of this phase by the CQC System Manager and attach to the daily CQC report. Indicate the exact location of initial phase for definable feature of work for future reference and comparison with Follow-Up phases.
7. The initial phase for each definable feature of work is repeated for each new crew to work onsite, or any time acceptable specified quality standards are not being met.
8. Coordinate scheduled work with Special Inspections required by Section 01 45 35 Special Inspections, the Statement of Special Inspections, and the Schedule of Special Inspections.

C. Follow-Up Phase: Perform daily checks to assure control activities, including control testing, are providing continued compliance with contract requirements until the completion of the particular feature of work. Record the checks in the CQC documentation. Conduct final Follow-Up checks and correct all deficiencies prior to the start of additional features of work which may be affected by the deficient work. Do not build upon nor conceal non-conforming work. Coordinate scheduled work with Special Inspections required by Section 01 45 35 Special

Inspections, the Statement of Special Inspections, and the Schedule of Special Inspections

D. Additional Preparatory and Initial Phases on the same definable features of work if: the quality ongoing work is unacceptable; if there are changes in the applicable CQC staff, onsite production supervision or work crew; if work on a definable feature is resumed after a substantial period of inactivity, or if other problems develop.

3.7 TESTS

A. Testing Procedure: Perform specified or required tests to verify that control measures are adequate to provide a product which conforms to contract requirements. Upon request, furnish to the Government duplicate samples of test specimens for possible testing by the Government. Testing includes operation and acceptance test when specified. Procure the services of a Department of Veteran Affairs approved testing laboratory or establish an approved testing laboratory at the project site. Perform the following activities and record and provide the following data:

1. Verify that testing procedures comply with contract requirements.
2. Verify that facilities and testing equipment are available and comply with testing standards.
3. Check test instrument calibration data against certified standards.
4. Verify that recording forms and test identification control number system, including all of the test documentation requirements, have been prepared.
5. Record results of all tests taken, both passing and failing on the CQC report for the date taken. Specification paragraph reference, location where tests were taken, and the unique sequential control number identifying the test. If approved by the Contracting Officer or Authorized designee, actual test reports are submitted later with a reference to the test number and date taken. Provide an information copy of tests performed by an offsite or commercial test facility directly to the Contracting Officer or Authorized designee. Failure to submit timely test reports as stated results in nonpayment for related work performed and disapproval of the test facility for this Contract.

B. Testing Laboratories: All testing laboratories must be validated through the procedures contained in Specification section 01 45 29 Testing Laboratory Services.
   1. Capability Check: The Government reserves the right to check laboratory equipment in the proposed laboratory for compliance with the standards set forth in the contract specifications and to check the laboratory technician's testing procedures and techniques. Laboratories utilized for testing soils, concrete, asphalt and steel is required to meet criteria detailed in ASTM D3740 and ASTM E329.
   2. Capability Recheck: If the selected laboratory fails the capability check, the Contractor will be assessed a charge equal to value of recheck to reimburse the Government for each succeeding recheck of the laboratory or the checking of a subsequently selected laboratory. Such costs will be deducted from the Contract amount due the Contractor.

C. Onsite Laboratory: The Government reserves the right to utilize the Contractor's control testing laboratory and equipment to make assurance tests, and to check the Contractor's testing procedures, techniques, and test results at no additional cost to the Government.

3.8 COMPLETION INSPECTION

A. Punch-Out Inspection: Conduct an inspection of the work by the CQC system Manager near the end of the work, or any increment of the work established by the specifications. Prepare and include in the CQC documentation a punch list of items which do not conform to the approved drawings and specifications. Include within the list of deficiencies the estimated date by which the deficiencies will be corrected. Make a second inspection the CQC System Manager or staff to ascertain that all deficiencies have been corrected. Once this is accomplished, notify the Government that the facility is ready for the Government Pre-Final Inspection.

B. Pre-Final Inspection: The Government will perform the Pre-Final Inspection to verify that the facility is complete and ready to be occupied. A Government Pre-Final Punch List may be developed as a result of this inspection. Ensure that all items on this list have been corrected before notifying the Government, so that a Final Acceptance Inspection with the customer can be scheduled. Correct any items noted

on the Pre-Final Inspection in a timely manner. These inspections and any deficiency corrections required by this paragraph need to be accomplished within the time slated for completion of the entire work or any particular increment of the work if the project is divided into increments by separate construction completion dates.

C. Final Acceptance Inspection: The Contractor's QC Inspection personnel, plus the superintendent or other primary management person, and the Contracting Officer's Authorized designee is required to be in attendance at the Final Acceptance Inspection. Additional Government personnel can also be in attendance. The Final Acceptance Inspection will be formally scheduled by the Contracting Officer's or Authorized designee based upon results of the Pre-Final Inspection. Notify the Contracting Officer through the Resident Engineer office at least 14 days prior to the Final Acceptance Inspection and include the Contractor's assurance that all specific items previously identified to the Contractor as being unacceptable, along with all remaining work performed under the contract, will be complete and acceptable by the date schedule for the Final Acceptance Inspection. Failure of the Contractor to have all contract work acceptably complete for this inspection will be cause for the Contracting Officer to bill the Contractor for the Government's additional inspection cost in accordance with FAR Clause 52.246-12 titled "Inspection of Construction".

3.9 DOCUMENTATION

A. Quality Control Activities: Maintain current records providing factual evidence that required QC activities and tests have been performed. Include in these records the work of subcontractors and suppliers on an acceptable form that includes, as a minimum, the following information:

1. The name and area of responsibility of the Contractor/Subcontractor
2. Operating plant/equipment with hours worked, idle, or down for repair.
3. Work performed each day, giving location, description, and by whom. When Network Analysis (NAS) is used, identify each phase of work performed each day by NAS activity number.
4. Test and control activities performed with results and references to specification/drawing requirements. Identify the Control Phase

(Preparatory, Initial, and/or Follow-Up). List deficiencies noted, along with corrective action.

5. Quantity of materials received at the site with statement as to acceptability, storage, and reference to specification/drawing requirements.
6. Submittals and deliverables reviewed, with Contract reference, by whom, and action taken.
7. Offsite surveillance activities, including actions taken.
8. Job safety evaluations stating what was checked, results, and instructions or corrective actions.
9. Instructions given/received and conflicts in plans and specifications.
10. Provide documentation of design quality control activities. For independent design reviews, provide, as a minimum, identification of the Independent Technical Reviewer (ITR) team, the ITR review comments, responses, and the record of resolution of the comments.

B. Verification Statement: Indicate a description of trades working on the project; the number of personnel working; weather conditions encountered; and any delays encountered. Cover both conforming and deficient features and include a statement that equipment and materials incorporated in the work and workmanship comply with the Contract. Furnish the original and one copy of these records in report form to the Government daily with 1 week after the date covered by the report, except that reports need not be submitted for days on which no work is performed. As a minimum, prepare and submit on report for every 7 days of no work and on the last day of a no work period. All calendar days need to be accounted for throughout the life of the contract. The first report following a day of no work will be for that day only. Reports need to be signed and dated by the CQC System Manager. Include copies of test reports and copies of reports prepared by all subordinate QC personnel within the CQC System Manager Report.

3.10 SAMPLE FORMS

Templates of various quality control reports can be found on the Whole Building Design Guide website at https://www.wbdg.org/FFC/NAVGRAPH/01%2045%2000.00%2020_quality_control_reports.pdf

3.11 **NOTIFICATION OF NONCOMPLIANCE:** The Contracting Officer or Authorized designee will notify the Contractor of any detected noncompliance with the foregoing requirements. The Contractor should take immediate corrective action after receipt of such notice. Such notice, when delivered to the Contractor at the work site will be deemed sufficient for the purpose of notification. If the Contractor fails or refuses to comply promptly, the Contracting Officer can issue an order stopping all or part of the work until satisfactory corrective action has been taken. No part of the time lost due to such stop orders will be made the subject of claim for extension of time or for excess costs or damages by the Contractor.

--- End of Section ---

SECTION 01 45 29
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 and paid for by Contractor. Refer to Section 01 00 02, GENERAL REQUIREMENTS, for additional information.

1.2 RELATED DOCUMENTS

A. Section 01 00 02, GENERAL REQUIREMENTS.

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

T27-11	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
T99-10	The Moisture-Density Relations of Soils Using a 2.5 Kg (5.5 lb.) Rammer and a 305 mm (12 in.) Drop
T104-99(R2007)	Soundness of Aggregate by Use of Sodium Sulfate or Magnesium Sulfate
T180-10	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):

A325-10	Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
A370-12a	Definitions for Mechanical Testing of Steel Products

A490-12	Heat Treated Steel Structural Bolts, 150 ksi Minimum Tensile Strength
C31/C31M-12	Making and Curing Concrete Test Specimens in the Field
C33/C33M-13	Concrete Aggregates
C39/C39M-12	Compressive Strength of Cylindrical Concrete Specimens
C109/C109M-12	Compressive Strength of Hydraulic Cement Mortars
C138/C138M-12a	Unit Weight, Yield, and Air Content (Gravimetric) of Concrete
C140-13	Sampling and Testing Concrete Masonry Units and Related Units
C143/C143M-12	Slump of Hydraulic Cement Concrete
C172/C172M-10	Sampling Freshly Mixed Concrete
C173/C173M-12	Air Content of freshly Mixed Concrete by the Volumetric Method
C330/C33OM-09	Lightweight Aggregates for Structural Concrete
C567/C567M-11	Density Structural Lightweight Concrete
C780-12a	Pre-construction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry
C1019-11	Sampling and Testing Grout
C1064/C1064M-12	Freshly Mixed Hydraulic Cement Concrete
C1077-13	Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation
C1314-12	Compressive Strength of Masonry Prisms
C1364-10b	Architectural Cast Stone
D698-12	Laboratory Compaction Characteristics of Soil Using Standard Effort
D1143/D1143M-07	Deep Foundations 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
D1557-12	Laboratory Compaction Characteristics of Soil Using Modified Effort
D2166-06	Unconfined Compressive Strength of Cohesive Soil
D2167-08	Density and Unit Weight of Soil in Place by the Rubber Balloon Method
D2216-10	Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
D2974-07	Moisture, Ash, and Organic Matter of Peat and Other Organic Soils
D3666-11	Minimum Requirements for Agencies Testing and Inspection Bituminous Paving Materials
D3740-12a	Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock
E94-04(2010)	Radiographic Examination
E164-08	Contact Ultrasonic Testing of Weldments
E329-11c	Agencies Engaged in Construction Inspection, Testing, or Special Inspection
E543-13	Agencies Performing Nondestructive Testing
E709-08	Guide for Magnetic Particle Testing
E1155-96(2008)	Determining FF Floor Flatness and FL Floor Levelness Numbers

D. American Welding Society (AWS):

D1.1-07	Structural Welding Code-Steel

1.4 REQUIREMENTS

A. Accreditation Requirements: Testing Laboratory retained and paid for by Contractor must be accredited by one or more of the National Voluntary Laboratory Accreditation Program (NVLAP) programs acceptable in the geographic region for the project. Furnish to the RE/COR a copy of the Certificate of Accreditation and Scope of Accreditation. For testing laboratories that have not yet obtained accreditation by a NVLAP program, submit an acknowledgement letter from one of the laboratory accreditation authorities indicating that the application for accreditation has been received and the accreditation process has

started, and submit to the RE/COR for approval, certified statements, signed by an official of the testing laboratory attesting that the proposed laboratory, meets or conforms to the ASTM standards listed below as appropriate to the testing field.

1. Laboratories engaged in testing of construction materials must meet the requirements of ASTM E329.
2. Laboratories engaged in testing of concrete and concrete aggregates must meet the requirements of ASTM C1077.
3. Laboratories engaged in testing of bituminous paving materials must meet the requirements of ASTM D3666.
4. Laboratories engaged in testing of soil and rock, as used in engineering design and construction, must meet the requirements of ASTM D3740.
5. Laboratories engaged in inspection and testing of steel, stainless steel, and related alloys will be evaluated according to ASTM A880.
6. Laboratories engaged in non-destructive testing (NDT) must meet the requirements of ASTM E543.
7. Laboratories engaged in Hazardous Materials Testing must meet the requirements of OSHA and EPA.

B. Inspection and Testing: Testing laboratory to inspect materials and workmanship and perform tests described herein and additional tests requested by RE/COR. When it appears materials furnished, or work performed by Contractor fail to meet construction contract requirements, Testing Laboratory must direct attention of RE/COR to such failure.

C. Written Reports: Testing laboratory to submit test reports to RE/COR, Contractor, and Local Building Authority within 24 hours after each test is completed unless other arrangements are agreed to in writing by the RE/COR. Submit reports of tests that fail to meet construction contract requirements on colored paper.

D. Verbal Reports: Give verbal notification to RE/COR immediately of any irregularity.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 EARTHWORK

A. General: The Testing Laboratory is to 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 is as identified herein including, but not be limited to, 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 RE/COR regarding suitability or unsuitability of areas where proof-rolling was observed. Where unsuitable results are observed, witness excavation of unsuitable material and recommend to RE/COR extent of removal and replacement of unsuitable materials and observe proof-rolling of replaced areas until satisfactory results are obtained.
2. Provide full time observation of fill placement and compaction and field density testing in areas containing structural foundations and provide full 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 D698 and/or 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, AASHTO T191, or ASTM D2167 to 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 must provide satisfactory explanation to the RE/COR before the tests are conducted.

a. Slab Subgrade: At least one test of subgrade for every 185 m^2 (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 m^2 (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 m^2 (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 RE/COR. 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.
g. Structural Fills: Compaction testing required per ASTM D-698 and verified meeting at least 95% of the maximum dry density.

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 RE/COR.

3.2 NOT USED

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.

3. Test for moisture absorption capacity.

B. Submit laboratory test report of topsoil to RE/COR.

C. Submit recommendations for soil amendments, from a regional soil conservation service or cooperative extension, to bring soil into compliance with minimum parameters in these specifications.

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. Perform continuous batch plant inspection until concrete quality is established to satisfaction of RE/COR with concurrence of Contracting Officer and perform periodic inspections thereafter as determined by RE/COR.
2. Periodically inspect and test batch proportioning equipment for accuracy and report deficiencies to RE/COR.

3. Sample and test mix ingredients as necessary to insure compliance with specifications.
4. Sample and test aggregates daily and as necessary for moisture content. Test the dry rodded weight of the coarse aggregate whenever a sieve analysis is made, and when it appears there has been a change in the aggregate.
5. 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 three cylinders for each 40 m^3 (50 cubic yards) or less of each concrete type, and at least three cylinders for any one day's pour for each concrete type. After good concrete quality control has been established and maintained as determined by RE/COR make three cylinders for each 80 m^3 (100 cubic yards) or less of each concrete type, and at least three cylinders from any one day's pour for each concrete type. Label each cylinder with an identification number. RE/COR may require additional cylinders to be molded and cured under job conditions.
4. Perform slump tests in accordance with ASTM C143. Test the first truck each day, and every time test cylinders are made. 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, test the first truck and every 20 m^3 (25 cubic yards) thereafter each day. For concrete not required to be air-entrained, test every 80 m^3 (100 cubic yards) at random. 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 and ASTM C567 for lightweight 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 during hot weather and cold weather concreting operations:
    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 RE/COR 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. Inspect cast-in-place concrete formwork for foundations and foundation/monument stem and retaining walls prior to concrete being cast.
    a. Measure elevations, dimensions, and confirm locations or faces, widths, and top surfaces.
    b. Inspect location of steel embedments to ensure coordination with precast components.
20. Other inspections:
    a. Welding of steel embed attachments between cast-in-place and precast elements.

b. Installation of post-erection/expansion/epoxy anchorages from cat-in-place foundation to precast elements.
c. Grouting under base plates.
a. 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 one cylinder at 7 days and one cylinder at 28 days. Use remaining cylinder as a spare tested as directed by RE/COR. Compile laboratory test reports as follows: Compressive strength test to be the result of one cylinder, except when one cylinder shows evidence of improper sampling, molding or testing, in which case it must be discarded and strength of spare cylinder to be used.
2. Make weight tests of hardened lightweight structural concrete in accordance with ASTM C567.
3. Furnish certified compression test reports (duplicate) to RE/COR. 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. Weight of lightweight structural concrete in kg/m^3 (pounds per cubic feet).
f. Weather conditions during placing.
g. Temperature of concrete in each test cylinder when test cylinder was molded.
h. Maximum and minimum ambient temperature during placing.
i. Ambient temperature when concrete sample in test cylinder was taken.
j. Date delivered to laboratory and date tested.

3.7 REINFORCEMENT

A. Review mill test reports furnished by Contractor.
B. Make one tensile and one bend test in accordance with ASTM A370 from each pair of samples obtained.

C. Written report must include, in addition to test results, heat number, manufacturer, type and grade of steel, and bar size.

D. Perform tension tests of mechanical and welded splices in accordance with ASTM A370.

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, except make two test cylinders for each day's production of each strength of concrete produced.

C. Test tendons for conformance with ASTM A416 and furnish report to RE/COR.

D. Inspect members to insure that specification requirements for curing and finishes have been met.

3.9 ARCHITECTURAL PRECAST CONCRETE

A. Inspection at Plant: Forms, placement of reinforcing steel, concrete cover, and placement and finishing of concrete.

B. Concrete Testing: Test concrete including materials for concrete as required in Article CONCRETE of this section, except make two test cylinders for each day's production of each strength of concrete produced.

C. Inspect members to insure specification requirements for curing and finishes have been met.

3.10 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 m^2 (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 m^2 (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 m^2 (5000 square feet) of wall area. Prepare one set of prisms for testing at 7 days and one set for testing at 28 days.

E. Field Inspection and Materials Testing:
   1. Verify the following prior to grouting:
      a. Grout space is clean.
      b. Type, spacing, and placement of reinforcement, connectors, and anchors comply with the contract requirements.

- - - E N D - - -

SECTION 01 57 19
TEMPORARY ENVIRONMENTAL CONTROLS

PART 1 – GENERAL

1.1 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, and radioactive materials, 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 preparation, cooking, dispensing, and consumption of food.

1.2 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.

1.3 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 328.....Definitions

1.4 SUBMITTALS

A. In accordance with Section, 01 33 23, 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 Contracting Officer’s Representative (COR) 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 Contracting Officer for approval, a written and/or graphic Environmental Protection Plan including, but not limited to, 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, vines, grasses, ground cover, landscape features, air and water quality, fish and wildlife, soil, historical, and archeological and cultural resources.

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.

l. Inclusion of “best management practices” and methodologies.

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.

1.5 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, vines, grasses, topsoil, and landforms without permission from the COR. Do not fasten or attach ropes, cables, or guys to trees for anchorage unless specifically authorized, or where special emergency use is permitted. Provide erosion control plans, in phases where required.

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. Protect monuments, works of art, and markers before construction operations begin. Convey to all personnel the purpose of marking and protecting all necessary objects.
2. Protection of Landscape: Protect trees, shrubs, vines, 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. Reuse or conserve the collected topsoil sediment as directed by the COR. Topsoil use and requirements are specified in Section 31 20 11, EARTHWORK (SHORT FORM).
   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 on the Environmental Protection Plan. Maintain temporary erosion and sediment control measures such as berms, dikes, drains, silt fence, rock socks, 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 on the Environmental Protection Plan and prevent erosion of soil or sediment from entering nearby water courses or lakes.
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. Store chemical waste away from the work areas in corrosion resistant containers and dispose of waste in accordance with Federal, State, and local regulations.
11. Handle discarded materials other than those included in the solid waste category as directed by the COR.

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 water areas.
2. Control movement of materials and equipment during construction to prevent violation of water pollution control standards of the Federal, State, or local government.
3. Monitor water areas affected by construction.

D. Protection of Fish and Wildlife Resources: Keep construction activities under surveillance, management, and control to minimize interference with, disturbance of, or damage to fish and wildlife. Prior to beginning construction operations, list species that require specific attention along with measures for their protection.

E. 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 State of Ohio 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, 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. Sprinklering, chemical treatment of an approved type, light bituminous treatment, baghouse, scrubbers, electrostatic

precipitators, or other methods are permitted to control particulates in the work area.

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 COR. Maintain noise-produced work at or below the decibel levels and within the time periods specified.

1. Perform construction activities involving repetitive, high-level impact noise only between 8:00a.m. and 6:00p.m unless otherwise permitted by local ordinance or the COR. 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, take noise abatement measures that are necessary to comply with the requirements of this contract, consisting of, but not limited to, the following:
   a. Maintain maximum permissible construction equipment noise levels at 15 meter (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, STATIONARY	80	PNEUMATIC TOOLS	80
PUMPS	75	SAWS	75
GENERATORS	75	VIBRATORS	75
COMPRESSORS	75		

b. Use shields or other physical barriers to restrict noise transmission.
c. Provide soundproof housings or enclosures for noise-producing machinery.
d. Use efficient silencers on equipment air intakes.
e. Use efficient intake and exhaust mufflers on internal combustion engines that are maintained so equipment performs below noise levels specified.
f. Line hoppers and storage bins with sound deadening material.
g. Conduct truck loading, unloading, and hauling operations so that noise is kept to a minimum.
h. Blasting is not permitted for this project.

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 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 COR 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 COR. 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.

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SECTION 01 74 19
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, as much of the waste material as economically feasible shall be salvaged, recycled or reused.

C. Contractor shall use all reasonable means to divert construction and demolition waste from landfills and incinerators, and facilitate their salvage and recycle not limited 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 and I-joists, 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. Paint.

1.2 RELATED WORK

A. Section 01 00 02, GENERAL REQUIREMENTS.

B. Section 02 41 00, DEMOLITION.

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/tools/cwm.php 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.

I. Waste materials shall not be allowed to accumulate on site for greater than 2 weeks. Provide sufficient enclosed dumpster space to avoid debris accumulation.

J. Contractor shall provide waste receptacles onsite for disposal of worker food and personal trash.

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 RE/COR a written demolition debris management plan. The plan shall include, but not be limited to, 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

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.

A. U.S. Green Building Council (USGBC):
LEED Green Building Rating System for New Construction

1.7 RECORDS

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.

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SECTION 02 21 00
SITE SURVEYS

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section specifies the performance of a topographic survey and preparation of a topographic survey map for as-built data.

1.2 DEFINITIONS

A. Professional Land Surveyor: One who possesses a valid state license as a "Professional Land Surveyor" from the state in which they practice.

B. Professional Civil Engineer: One who possesses a valid state license as a "Professional Civil Engineer" from the state in which they practice. For this section, the term "surveyor" shall also include Professional Civil Engineers authorized to practice Land Surveying under the laws of the state in which they practice.

1.3 SUSTAINABILITY REQUIREMENTS

A. Materials in this section may contribute towards contract compliance with sustainability requirements. See Section 01 81 11, SUSTAINABLE DESIGN REQUIRMENTS, for project low-emitting materials, recycled content, requirements.

PART 2 - EXECUTION

A. The surveyor shall research available public records for all mapping, monumentation, plats, governmental surveys etc. that may pertain to the subject property. Research all applicable public utilities for substructure data such as sewers, storm drains, water lines, electrical conduits, gas mains, telephone, etc.

B. The survey shall be performed on the ground in accordance with the current "Accuracy Standards for Land Title Surveys" as adopted, from time to time, by the American Congress on Surveying and Mapping, the National Society of Professional Surveyors, and the American Land Title Association.

C. The surveyor, when applicable, shall consult with the project Architect to determine scale of plat or map and size of drawings.

D. The surveyor shall furnish two sets of prints of the plat or map of survey and an electronic CADD file. If the plat or map of survey consists of more than one sheet, the sheets shall be numbered, the

total number of sheets indicated and the match lines be shown on each sheet.

E. On the plat or map, the survey boundary shall be drawn to a convenient scale, or the scale designated by the Architect, with the scale clearly indicated. A graphic scale, shown in feet or meters or both, shall be included. A north arrow shall be shown and when practicable, the plat or map of survey shall be oriented so that north is at the top of the drawing. Symbols or abbreviations used shall be identified on the face of the plat or map by use of a legend or other means. Supplementary or exaggerated diagrams shall be presented accurately on the plat or map where dimensional data is too small to be shown clearly at full scale. The plat or map shall be 760 mm by 1060 mm (30 by 42 inches).

F. The survey shall contain the following applicable information:

1. The name, address, telephone number, and signature of the Professional Land Surveyor who made the survey, his or her official seal and registration number, the date the survey was completed and the dates of all revisions.
2. The survey drawing(s) submitted shall bear the following certification adjacent to the Engineer's official seal:
    1. "I hereby certify that all information indicated on this drawing was obtained or verified by actual measurements in the field and that every effort has been made to furnish complete and accurate information."
3. Vicinity map showing the property surveyed in reference to nearby highways or major street intersections.
4. Flood zone designation (with proper annotation based on Federal Flood Insurance Rate Maps or the state or local equivalent, by scaled map location and graphic plotting only).
5. Land area as defined by the boundaries of the legal description of the surveyed premises.
6. All data necessary to indicate the mathematical dimensions and relationships of the boundary represented by bearings and distances, and the length and radius of each curve, together with elements necessary to mathematically define each curve. The point of beginning of the surveyor's description and the basis of bearings shall also be shown.

7. When record bearings or angles or distances differ from measured bearings, angles or distances, both record and measured bearings, angles, and distances shall be clearly indicated. If the record description fails to form a mathematically closed figure, the surveyor shall so indicate.
8. Measured and record distances from corners of parcels surveyed to the nearest right-of-way lines of streets in urban or suburban areas, together with recovered lot corners and evidence of lot corners, shall be noted. The distances to the nearest intersecting street shall be indicated and verified. Names and widths of streets and highways abutting the property surveyed and widths of rights of way shall be given. Observable evidence of access (or lack thereof) to such abutting streets or highways shall be indicated. Observable evidence of private roads shall be so indicated. Streets abutting the premises, which have been described in Record Documents, but not physically opened, shall be shown and so noted.
9. The identifying titles of all recorded plats, filed maps, right of way maps, or similar documents which the survey represents, wholly or in part, with their appropriate recording data. The survey shall indicate platted setback or building restriction lines which have been recorded in subdivision plats or which appear in a Record Document which has been delivered to the surveyor. Contiguity, gores, and overlaps along the exterior boundaries of the survey premises, where ascertainable from field evidence or Record Documents, or interior to those exterior boundaries, shall be clearly indicated or noted. Where only a part of a recorded lot or parcel is included in the survey, the balance of the lot or parcel shall be indicated.
10. All evidence of found monuments shall be shown and noted. All evidence of monuments found beyond the surveyed premises on which establishment of the corners of the survey premises are dependent, and their application related to the survey shall be indicated.
11. The character of any and all evidence of possession shall be stated and the location of such evidence carefully given in relation to both the measured boundary lines and those established by the record. An absence of notation on the survey shall be presumptive of

no observable evidence of possession. The term "possession" does not imply "ownership".

12. The location of all buildings upon the plot or parcel shall be shown and their locations defined by measurements perpendicular to the boundaries. If there are no buildings, so state. Proper street numbers shall be shown where available.
13. All easements evidenced by a Record Document which have been delivered to the surveyor shall be shown, both those burdening and those benefiting the property surveyed, indicating recording information. If such an easement cannot be located, a note to this affect shall be included. Observable evidence of easements and/or servitudes of all kinds, such as those created by roads, rights-of-ways, water courses, drains, telephone, telegraph, or electric lines, water, sewer, oil or gas pipelines on or across the surveyed property and on adjoining properties if they appear to affect the surveyed property, shall be located and noted. Surface indications, if any, or of underground easements and/or servitudes shall also be shown.
14. The character and location of all walls, buildings, fences, and other visible improvements within five feet of each side of the boundary lines shall be noted. Without expressing a legal opinion, physical evidence of all encroaching structural appurtenances and projections, such as fire escapes, bay windows, windows and doors that open out, flue pipes, stoops, eaves, cornices, areaways, trip, etc., by or on adjoining property or on abutting streets, on any easement or over setback lines shown by Record Documents shall be indicated with the extent of such encroachment or projection.
15. Driveways and alleys on or crossing the property must be shown. Where there is evidence of use by other than the occupants of the property, the surveyor must so indicate on the plat or map. Where driveways or alleys on adjoining properties encroach, in whole or in part, on the property being surveyed, the surveyor must so indicate on the plat or map with appropriate measurements.
16. Location, alignment and dimensions of all roads, curbs, walks, parking and paved areas abutting the subject land. Indicate road centerlines with true bearings and lengths by 15 m (50 foot)

stationing. Describe curves by designating the points of curvature and tangency by station. Include all curve data as well a location of radius and vertex points. Elevations on 15 m (50') centers on centerline of roads, edges of roads and top and bottom of curbs.

17. As accurately as the evidence permits, the location of cemeteries and burial grounds disclosed in the process of researching title to the premises or observed in the process of performing the field work for the survey, shall be shown.
18. Ponds, lakes, springs, or rivers bordering on or running through the premises being surveyed shall be shown. When a property surveyed contains a natural water boundary, the surveyor shall measure the location of the boundary according to appropriate surveying methods and note on the plat or map the date of the measurement and the caveat that the boundary is subject to change due to natural causes and that it may or may not represent the actual location of the limit of title. When the surveyor is aware of changes in such boundaries, the extent of those changes shall be identified.
19. Contours at a minimum interval of 1 foot if not applicable to project. Base vertical control on the permanent (not assumed) National Geodetic Survey (NGS). Note location, description and datum. Install a permanent National Geodedic Survey (NGS) Bench Mark within the property for use by any future surveyors for projects on the property. Furnish and install two monuments on the property, or property lines, that are tied to the State Plane Coordinate system, and indicate the respective Northing and Easting coordinates for the points in feet, with 3 decimal place accuracy. Provide notes that these two points are the basis for the coordinate system indicated on the CADD survey drawings. Unless specifically noted otherwise, provide CADD drawing of the survey, in DWG format in a version no older that two versions earlier than the most recent version of the software.
20. Identify and show if possible, setback, height, and floor space area restrictions of record or disclosed by applicable zoning or building codes (in addition to those recorded in subdivision maps). If none, so state.

21. Exterior dimensions of all buildings at ground level. Show square footage of exterior footprint of all buildings at ground level and gross floor area of all buildings.
22. Measured height of all buildings above grade at a defined location. If no defined location is provided, the point of measurement shall be shown.
23. Elevations at each entrance to buildings, service docks, building corners, steps, ramps and grade slabs.
24. Substantial, visible improvements (in addition to buildings) such as signs, parking areas, plazas, planter beds, benches, walls, swimming pools, etc.
25. Parking areas and, if striped, the striping and the type (eg. handicapped, motorcycle, regular, etc.) and number of parking spaces.
26. Indication of access to a public way such as curb cuts and driveways.
27. Location of utilities existing on or serving the surveyed property as determined by observed evidence together with plans and markings provided by utility companies, and other appropriate sources (with references as to the source of information. Locate and show all fire hydrants located within 150 m (500 feet) of the subject property.
28. Railroad tracks and sidings.
29. Manholes, catch basins, valve vaults or other surface indications of subterranean uses.
30. Wires and cables (including their function) crossing the survey premises, all poles on or within ten feet of the surveyed premises, and the dimensions of all cross-wires or overhangs affecting the surveyed premises.
31. Utility company installations on the surveyed premises.
32. Names of adjoining owners of platted lands.
33. Observable evidence of earth moving work, building construction or building additions within recent months.
34. Any changes in street right-of-way lines either completed or proposed, and available from the controlling jurisdiction. Observable evidence of recent street or sidewalk construction or repairs.

35. Observable evidence of site use as a solid waste dump, sump or sanitary landfill.
36. All trees with a minimum diameter of 150 mm (6") measured at 1200 mm (48") above the base of the tree. Perimeter outline only of thickly wooded areas with description of predominant vegetation.

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SECTION 02 35 00
TREE PROTECTION AND PRESERVATION

PART 1 – GENERAL

1.1 DESCRIPTION

This section covers furnishing all labor, materials, tools and equipment required to protect trees to remain on site within the construction limits. Protection shall include directing construction work / activity away from the protected trees and execution of construction improvements to limit the impact on said trees.

1.2 RELATED WORK

A. Erosion Control: Section 01 57 19, TEMPORARY ENVIRONMENTAL CONTROLS.
B. Site Preparation: Section 02 41 00, DEMOLITION
C. Earthwork: Section 31 20 11, EARTHWORK (SHORT FORM)
D. Planting: Section 32 90 00, PLANTING
E. Native Seeding: Section 32 02 20, NATIVE SEEDING

1.3 SUBMITTALS

A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES all required submittals. Submittals must be approved prior to constructing the mockup.
B. Provide product data for each type of product indicated.
C. Submit manufacturer’s shop drawings, product data and certificates for Tree Root Protection System including specific section layout for each area of use.
C. Tree Pruning Schedule: Written schedule from a Certified Arborist detailing scope and extent of pruning of trees to remain that interfere with or are affect by construction.
D. Qualification Data: For tree service firm and arborist, ISA certification is required.
E. Maintenance Recommendations: From a Certified Arborist, for care and protection of trees affected by construction during and after completion of the Work.
F. Provide final log of work performed including any damage that occurred during construction and subsequent repairs.

1.4 DEFINITIONS

A. International Society of Arboriculture (ISA): https://www.isa-arbor.com/

B. ANSI A300: Accredited Standards Committee (ASC) A300, Industry Standards for Tree Care Practices.

1.5 QUALITY ASSURANCE

A. Tree Service Qualifications: An experienced tree service firm that has successfully completed tree protection and trimming work similar to that required for this project and that will assign an experienced, qualified and ISA certified arborist to the project site on a full-time basis during execution of the Work.

B. Certified Arborist Qualifications: An arborist certified by the International Society of Arboriculture (ISA).

C. Tree Pruning Standards: Comply with ANSI A300 (Part 1), "Tree, Shrubs, and other Woody Plant Maintenance - Standard Practices (Pruning)."

D. Pre-installation Conference: Before starting tree protection and trimming, meet with COR, NCA District Agronomist, Cemetery Staff and Landscape Architect to review tree protection and trimming procedures and responsibilities.

PART 2 - PRODUCTS

A. Tree Protection Fence: Materials for tree protection barriers shall conform to the following requirements:

   a. Temporary Fencing:

      i. Height: 4 Feet

      ii. Color: Orange

      iii. Thickness: 30 MIL.

      iv. Tensile Strength: 204 LBS/FT.

   b. Fence Posts:

      i. Length: 6 Feet

      ii. Weight: 3 lbs. Minimum

B. Shall include: Metal Tabs to hold fencing in place, ground anchor plate for stability

C. Temporary Signs: White weatherproof material, 10 inches by 48 inches minimum, with 3 inch black lettering. Text shall read: "Tree Protection Area - DO NOT ENTER".PART 3 - EXECUTION

2.1 PREPERATION

A. Temporary Fencing: Install temporary fencing around the trees protection zones designated on the plans or where directed by the COR to protect remaining vegetation from construction damage. Maintain temporary fence and remove when construction is complete.

B. Temporary Signs: Install temporary signs 45 feet apart, or two per protected tree, whichever is greater, on posts of temporary fencing. Maintain temporary signs and remove when construction is complete.

C. A protection barrier of a temporary fence, at least 4 feet (1.2 Meters) in height shall be installed around each tree to be protected and preserved within the construction limits. The tree protection shall be installed prior to the actual construction start and maintained for the duration of the project.

1. Within this protection zone, construction materials shall not be stored, equipment operated and/or temporary storage buildings or work trailers placed.
2. The protection barrier shall be constructed of orange snow fencing securely fastened to fence posts spaced a maximum of 5 feet (1.5 meters) on center. Posts are 6 feet (1.8 meters) in length set 2 feet (60 cm) into the ground. The fencing shall be attached to the post with a minimum of four (4) nylon-locking ties evenly placed at each post.

E. Materials shall be disposed of in accordance with the specifications.

F. Protect tree root systems from damage caused by runoff or spillage of noxious materials while mixing, placing, or storing construction materials. Protect root systems from ponding, eroding, or excessive wetting caused by dewater operations.

2.2 EXCAVATION

A. Install shoring or other protective support systems to minimize impact of excavations on existing root zones.

B. Do not excavate within tree protection zones, unless noted otherwise.

C. Where excavation for new construction is required within the drip line of trees, hand clear and excavate to minimize damage to root systems. Use narrow-tine spacing forks and comb soil to expose roots.

1. Relocate roots in backfill areas where possible. If encountering large, main lateral roots, expose roots beyond excavation limits as required to bend and relocate them without breaking. If encountered immediately adjacent to location of new construction and relocation is not practical; the Certified Arborist shall provide written documentation of how to proceed.
2. Do not allow exposed roots to dry out before placing permanent backfill. Provide temporary earth cover or pack with peat moss and wrap with burlap. Water and maintain in a moist condition. Temporarily support and protect.
3. Do not allow heavy equipment in tree protection areas. All excavation work is to be performed by hand.

D. Root Pruning: Do not cut main lateral roots; cut only smaller roots that interfere with installation of utilities or construction. Cut roots with sharp pruning instruments; do not break or chop.
E. When excavating, place excavated soil on opposite side of trench from tree.

2.3 ROOT PRUNING

A. Root pruning shall take place only where the roots of existing trees have been damaged by the Contractor during construction of the Project, as directed by the Certified Arborist.
B. If construction is to occur within the root zone of existing plant material, root pruning and special plant care including fertilizing and watering will be required, as directed by the Certified Arborist and hereinafter specified. Prior to root pruning, remove all weeds growing in existing tree mulch rings. Root pruning using an approved mechanical root pruning saw shall be performed prior to digging where noted on the plans, or directed by the Certified Arborist. Air Spading excavation consisting of hand and/or pneumatic excavation may be required if indicated on plans or as directed by Certified Arborist. Whenever roots of plant material to remain are exposed during construction, the damaged root ends are to be removed by cutting them off cleanly.
C. Initial watering shall be performed on all trees, which are designated for root pruning. Water trees immediately by thoroughly saturating root balls and provide a horticultural watering bag, such as a Gator

Bag or Equivalent, filled with water to keep root balls thoroughly saturated during first three weeks following root pruning. Thereafter refill bags as required, according to weather conditions, to keep root balls in a moist condition, through the duration of the Project. Test root balls for optimal moisture once a week using a soil auger.

D. All pruning shall be overseen by the ISA Certified Arborist, whose principal occupation is the care and maintenance of trees. All pruning shall be done according to the National Arborist Association's Pruning Standards for Shade Trees Class 11 – Standard Pruning Specifications.

E. Any damage to the root zone, as determined by the Certified Arborist, will be compensated by pruning an equivalent amount of the top vegetative growth of the material within one (1) week following root damage, fertilization and supplemental watering.

F. Fertilize damaged trees with fertilizer that promotes root growth. Fertilizer nutrients shall be applied within 48 hours after root damage occurs. A fertilizer with a 1: 1: 1 ration shall be applied at a rate of .5 pounds of nutrients per 1000 square feet.

G. Application shall be accomplished by placing dry fertilizer in holes in the soil. The holes shall be 8 inches (200mm) to 12 inches (300 mm) deep and spaced 24 inches (600mm) apart in an area beginning 30 inches (1 meter) from the base of the plant. Holes can be punched with a punch bar, dug with a spade, drilled with an auger or any other method approved by the Certified Arborist.

H. Approximately 0.02 pounds (10 Grams) of fertilizer nutrients shall be placed in each hole, 250 holes per 1000 square feet. If the Certified Arborist determines that the whole method of fertilizer placement is not practical or desirable, an approved method of uniform surface application will be allowed.

I. Supplemental water shall be applied within 48 hours of any root damage. The water shall be applied at the rate of 7 quarts per square yard of surface area within the root zone of the plant material having sustained damage to the root zone. Root zone shall be calculated as the areas, which extend three meters beyond the limits of the crown's branches. Subsequent weekly watering shall be applied if deemed necessary by the Certified Arborist.

J. The Contractor shall repair or replace any and all damage determined by the Certified Arborist to any existing or newly installed plant material at its own expense. Unnecessary damage to ground cover or turf shall be repaired or replaced as specified or restoration of similar areas within the plans, or as directed by the Certified Arborist.

2.4 REGRADING

A. DO NOT fill within tree protection zones, unless otherwise indicated and approved by COR.

B. Where filling for new construction is required with drip line of trees, perform work by hand to minimize damage to root systems.

1. Where existing grade is below elevation of finish grade, fill with topsoil. Place topsoil by hand in a single uncompacted layer and hand grade to required finish elevations.

2.5 TREE PRUNING

A. Prune trees to remain that are affected by temporary and permanent construction.

B. Pruning Standards: Prune trees according to ANSI A300 (Part 1).

C. Cut branches with sharp pruning instruments; do not break or chop.

1. Clean all pruning instruments with antimicrobial solution between performing work on separate trees to avoid the potential spread of pathogens.

D. Chip removed tree branches and use as organic mulch for tree protection or dispose of off-site. All chipped material shall be removed from the site upon completion of construction.

2.6 TREE REPAIR

A. Promptly repair trees damaged by construction operations within 24 hours. Treat damaged trunks, limbs, and roots according to arborist's written instructions.

B. Remove and replace dead and damaged trees that arborist determines to be incapable of restoring to a normal growth pattern.

1. Provide new trees of a 6-inch caliper size and of a species selected by the Landscape Architect when damaged trees more than 6-in caliper size, measured at breast height, are required to be replaced.

2. Planting of new trees shall be in accordance 32 90 00 – Planting.

2.7 DISPOSAL OF WASTE MATERIALS

A. Burning is not permitted.

B. Disposal: Remove excess excavated material, displaced trees, and excess chips from Owner's property. Disposal shall be in a legal manner.

--END--

SECTION 02 41 00
DEMOLITION

PART 1 – GENERAL

1.1 DESCRIPTION:

This section specifies demolition and removal of buildings, portions of buildings, utilities, other structures and debris from trash dumps shown.

1.2 RELATED WORK:

A. Demolition and removal of roads, walks, curbs, and on-grade slabs outside buildings to be demolished: Section 31 20 11, EARTH MOVING (SHORT FORM).

B. Safety Requirements: Section 01 35 26 Safety Requirements Article, ACCIDENT PREVENTION PLAN (APP).

C. Disconnecting utility services prior to demolition: Section 01 00 02, GENERAL REQUIREMENTS MINOR.

D. Reserved items that are to remain the property of the Government: Section 01 00 02, GENERAL REQUIREMENTS MINOR.

E. Environmental Protection: Section 01 57 19, TEMPORARY ENVIRONMENTAL CONTROLS.

F. Construction Waste Management: Section 01 74 19 CONSTRUCTION WASTE MANAGEMENT.

G. Infectious Control: Section 01 35 26, SAFETY REQUIREMENTS.

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 01 00 02, GENERAL REQUIREMENTS MINOR, 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, but not limited to; 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 Cemetery Property; 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 01 57 19, TEMPORARY ENVIRONMENTAL CONTROLS.

I. The work shall comply with the requirements of Section 01 00 02, GENERAL REQUIREMENTS MINOR and Section 01 35 26, SAFETY REQUIREMENTS.

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. Completely demolish and remove structures, including all appurtenances related or connected thereto, as noted below:

1. As required for installation of new utility service lines.
2. To full depth within an area defined by hypothetical lines located 1500 mm (5 feet) outside of new structures.

B. Debris, including brick, concrete, stone, metals and similar materials shall become property of Contractor and shall be disposed of by him daily, off the Cemetery Property to avoid accumulation at the demolition site. Materials that cannot be removed daily shall be stored in areas specified by the Resident Engineer. Break up concrete slabs below grade that do not require removal from present location into pieces not exceeding 600 mm (24 inches) square to permit drainage. Contractor shall dispose debris in compliance with applicable federal, state or local permits, rules and/or regulations.

C. Remove and legally dispose of all materials, other than earth to remain as part of project work, from any trash dumps shown. Materials removed shall become property of contractor and shall be disposed of in compliance with applicable federal, state or local permits, rules and/or regulations. All materials in the indicated trash dump areas, including above surrounding grade and extending to a depth of 1500mm (5feet) below surrounding grade, shall be included as part of the lump sum compensation for the work of this section. Materials that are located beneath the surface of the surrounding ground more than 1500 mm

(5 feet), or materials that are discovered to be hazardous, shall be handled as unforeseen. The removal of hazardous material shall be referred to Hazardous Materials specifications.

E. 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 Cemetery Property 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.

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SECTION 03 30 53
(SHORT-FORM) CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section specifies cast-in-place structural concrete and material and mixes for other concrete.

1.2 RELATED WORK

A. Materials testing and inspection during construction: Section 01 45 29, TESTING LABORATORY SERVICES.

B. Concrete roads, walks, and similar exterior site work: Section 32 05 23, CEMENT AND CONCRETE FOR EXTERIOR IMPROVEMENTS.

1.3 TOLERANCES

A. ACI 117.

1.4 REGULATORY REQUIREMENTS

A. ACI SP-66 - ACI Detailing Manual.

B. ACI 318 - Building Code Requirements for Reinforced Concrete.

1.5 SUSTAINABILITY REQUIREMENTS

A. Blended Cement: It is the intent of this specification to reduce CO2 emissions and other environmentally detrimental effects resulting from the production of Portland cement by requiring that all concrete mixes, in aggregate, utilize blended cement mixes to displace Portland cement typically included in conventional construction. Provide the following submittals:

1. Copies of concrete design mixes for all installed concrete.
2. Copies of typical regional baseline concrete design mixes for all compressive strengths used on the Project.
3. Quantities in cubic yards of each installed concrete mix.

B. Biobased Material: For products designated by the USDA's BioPreferred® program, provide products that meet or exceed USDA recommendations for biobased content, subject to the products compliance with performance requirements in this Section. For more information regarding the product categories covered by the BioPreferred® program, visit http://www.biopreferred.gov.

1.6 REGULATORY REQUIREMENTS FOR RECYCLED CONTENT

A. Products and Materials with Post-Consumer Content and Recovered Materials Content:

1. Contractor is obligated by contract to satisfy Federal mandates for procurement of products and materials meeting recommendations for post-consumer content and recovered materials content; the list of designated product categories with recommendations has been compiled by the EPA - refer to http://www.epa.gov/wastes/conserve/tools/cpg/products/.
2. Materials or products specified by this section may be obligated to satisfy this Federal mandate and Comprehensive Procurement Guidelines program.
3. The EPA website also provides tools such as a Product Supplier Directory search engine and product resource guides.

1.7 SUBMITTALS

A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

B. Concrete Mix Design.

C. Shop Drawings:

1. Submit Steel Reinforcement Shop Drawings and Product Data to include all information necessary for fabrication and placement of reinforcement.
2. Indicate grades of reinforcing steel.
3. Clearly indicate the splice length for every size and type of bar used.
4. Indicate the type, size and location of all accessories required for the proper assembly, placement and support of the reinforcement.

D. Manufacturer's Certificates: Air-entraining admixture, chemical admixtures, curing compounds.

1.8 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. American Concrete Institute (ACI):

117-10	Tolerances for Concrete Construction and Materials and Commentary
211.1-91(R2009)	Selecting Proportions for Normal, Heavyweight, and Mass Concrete

301-10	Structural Concrete
305R-10	Guide to Hot Weather Concreting
306R-10	Guide to Cold Weather Concreting
SP-66-04	ACI Detailing Manual
318/318M-14	Building Code Requirements for Structural Concrete and Commentary
347R-04	Guide to Formwork for Concrete

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

A185/A185M-07	Steel Welded Wire Reinforcement, Plain, for Concrete
A615/A615M-12	Deformed and Plain Carbon Steel Bars for Concrete Reinforcement
A996/A996M-09b	Rail Steel and Axle Steel Deformed Bars for Concrete Reinforcement
C31/C31M-12	Making and Curing Concrete Test Specimens in the Field
C33/C33M-13	Concrete Aggregates
C39/C39M-12a	Compressive Strength of Cylindrical Concrete Specimens
C94/C94M-13	Ready Mixed Concrete
C143/C143M-12	Slump of Hydraulic Cement Concrete
C150/C150M-12	Portland Cement
C171-07	Sheet Materials for Curing Concrete
C172/C172M-10	Sampling Freshly Mixed Concrete
C173/C173M-12	Air Content of Freshly Mixed Concrete by the Volumetric Method
C192/C192M-12a	Making and Curing Concrete Test Specimens in the Laboratory
C231/C231M-10	Air Content of Freshly Mixed Concrete by the Pressure Method
C260/C260M-10a	Air-Entraining Admixtures for Concrete
C494/C494M-13	Chemical Admixtures for Concrete
C618-12a	Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete

D1751-04(R2008) Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)

PART 2 - PRODUCTS

2.1 FORMS

A. Wood, plywood, metal, or other materials, approved by RE/COR, of grade or type suitable to obtain type of finish specified.

B. Form releasing agents to be commercial formulations that will not bond with, stain or adversely affect concrete surfaces. Agents must not impair subsequent treatment of concrete surfaces depending upon bond or adhesion nor impede the wetting of surfaces to be cured with water or curing compounds. If special form liners are to be used, follow the recommendation of the form coating manufacturer. Submit manufacturer's recommendation on method and rate of application of form releasing agents.

2.2 MATERIALS

A. Portland Cement: ASTM C150, Type I or II.

B. 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.

C. Coarse Aggregate: ASTM C33, Size 67. Size 467 may be used for footings and walls over 300 mm (12 inches) thick.

D. Fine Aggregate: ASTM C33.

E. Mixing Water: Fresh, clean, and potable.

F. Air-Entraining Admixture: ASTM C260.

G. Chemical Admixtures: ASTM C494.

H. Reinforcing Steel: ASTM A615 or ASTM A996, deformed. See structural drawings for grade.

I. Expansion Joint Filler: ASTM D1751.

J. Sheet Materials for Curing Concrete: ASTM C171.

K. Grout, Non-Shrinking: Premixed ferrous or non-ferrous, mixed and applied in accordance with manufacturer's recommendations. Grout cannot show settlement or vertical drying shrinkage at 3 days or thereafter based on initial measurement made at time of placement. Grout must produce a compressive strength of minimum 18 MPa (2500 psi) at 3 days and minimum 35 MPa (5000 psi) at 28 days.

2.3 CONCRETE MIXES

A. Design of concrete mixes using materials specified as set forth under Option C of ASTM C94.

B. Compressive strength at 28 days: Per Drawings.

C. Establish strength of concrete by testing prior to beginning concreting operation. Test consists of average of three cylinders made and cured in accordance with ASTM C192 and tested in accordance with ASTM C39.

D. Maximum slump for vibrated concrete is 100 mm (4 inches) tested in accordance with ASTM C143.

E. Cement and water factor (See Table I):

TABLE I – CEMENT AND WATER FACTORS FOR CONCRETE

Concrete: Strength	Air-Entrained	
Min. 28 Day Comp. Str. MPa (psi)	Min. Cement kg/m^3 (lbs/c. yd)	Max. Water Cement Ratio
30 (4000)[1,3]	340 (570)	0.50

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

F. Air-entrainment is required for all exterior concrete and as required for Section 32 05 23, CEMENT AND CONCRETE FOR EXTERIOR IMPROVEMENTS. Air content must conform with ACI 318 Table 19.3.3.1.

2.4 BATCHING AND MIXING

A. Store, batch, and mix materials as specified in ASTM C94.

1. Job-Mixed: Mix in a batch mixer in manner specified for stationary mixers in ASTM C94.
2. Ready-Mixed: Comply with ASTM C94, except use of non-agitating equipment for transporting concrete to the site will not be permitted. With each load of concrete delivered to project, ready-mixed concrete producer must furnish, in duplicate, certification as required by ASTM C94.

PART 3 – EXECUTION

3.1 FORMWORK

A. Installation conforms to ACI 347. Sufficiently tight to hold concrete without leakage, sufficiently braced to withstand vibration of concrete, and to carry, without appreciable deflection while remaining within allowable construction tolerances, all dead and live loads to which they may be subjected.

B. 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.

C. Inserts, sleeves, and similar items: Flashing reglets, masonry ties, anchors, inserts, wires, hangers, sleeves, boxes for floor hinges and other items specified as furnished under this and other sections of specifications are required to be in their final position at time concrete is placed – properly located, accurately positioned, built into construction, and maintained securely in place.

D. Construction Tolerances:
   1. Set and maintain concrete formwork to assure erection of completed work within tolerances specified to accommodate installation or other rough and finish materials.
   2. Cast-in-place concrete installed as part of columbarium elements to have concrete (on or above finished grade) constructed to dimensions indicated on Drawings within 6 mm (1/4 inch) of location and elevation.
   3. Engage a professional surveyor to survey the form work for the exposed portions of the foundations for the columbarium , including wall segments, piers and/or columns, prior to concrete being poured. If the forms are not correct, they must be corrected and resurveyed. When correct, provide a written certification from the surveyor, to the RE/COR, that the forms are set according to the plans, within

the allowable tolerances for elevation, location, orientation, and dimensions called for on the plans.

4. Properly brace the forms so the set concrete is correct within the allowable construction tolerances when the forms are removed.
5. Upon removal of the forms, the professional surveyor must survey the placed concrete and provide information to the RE/COR where the work is not in conformance with the design drawings, within the allowable construction tolerances. The work cannot progress until the exposed concrete for the foundations are brought into compliance.
6. Remedial work necessary for correcting installations that is in excess of allowable tolerances are the responsibility of the Contractor.
7. Erected work that exceeds specified tolerance limits must be remedied or removed and replaced, at no additional cost to the Government.
8. Any remediation work is subject to approval of the RE/COR in advance of the work.
9. 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.

3.2 REINFORCEMENT

A. Details of concrete reinforcement, unless otherwise shown, in accordance with ACI 318 and ACI SP-66. Support and securely tie reinforcing steel to prevent displacement during placing of concrete.

3.3 PLACING CONCRETE

A. Remove water from excavations before concrete is placed. Remove hardened concrete, debris and other foreign materials from interior of forms, and from inside of mixing and conveying equipment. Obtain approval of RE/COR before placing concrete.

B. Roughen and clean set concrete free from laitance, foreign matter, and loose particles, before placing new concrete on or against concrete which has set.

C. Convey concrete from mixer to final place of deposit by method which will prevent segregation or loss of ingredients. Do not deposit in work

concrete that has attained its initial set or has contained its water or cement more than 1 1/2 hours. Do not allow concrete to drop freely more than 1500 mm (5 feet) in unexposed work nor more than 900 mm (3 feet) in exposed work. Place and consolidate concrete in horizontal layers not exceeding 300 mm (12 inches) in thickness. Consolidate concrete by spading, rodding, and mechanical vibrator. Do not secure vibrator to forms or reinforcement. Provide vibration continuously with placing of concrete.

D. Hot weather placing of concrete: Follow recommendations of ACI 305R to prevent problems in the manufacturing, placing, and curing of concrete that can adversely affect the properties and serviceability of the hardened concrete.

E. Cold weather placing of concrete: Follow recommendations of ACI 306R, to prevent freezing of thin sections less than 300 mm (12 inches) and to permit concrete to gain strength properly, except that use of calcium chloride cannot be used without written approval from RE/COR.

3.4 PROTECTION AND CURING

A. Protect exposed surfaces of concrete from premature drying, wash by rain or running water, wind, mechanical injury, and excessively hot or cold temperature. Curing method is subject to approval by RE/COR.

3.5 FORM REMOVAL

A. Forms remain in place until concrete has a sufficient strength to carry its own weight and loads supported. Removal of forms at any time is the Contractor's sole responsibility.

3.6 SURFACE PREPARATION

A. Immediately remove loose materials, after forms have been removed and work has been examined and approved by RE/COR, and patch all stone pockets, surface honeycomb, or similar deficiencies with cement mortar made with 1 part portland cement and 2 to 3 parts sand.

B. For exposed surfaces of concrete for the columbarium and walls in their complexes, follow the procedures identified in Paragraph FINISHES for Exterior Exposed Areas (finished).

C. For columbarium and their complexes, immediately after forms are removed, take steps to prepare and smooth the exposed portions of the concrete. Remove the form marks, including joint marks, fins, burrs and similar projections to produce a smooth surface. Complete the

surface finish to result in a uniform textured surface with homogeneous color, unless surface is to be otherwise treated. Work must be as approved during the review of the mock-up.

3.7 FINISHES

A. Vertical and Overhead Surface Finishes:

1. Unfinished Areas: Vertical and overhead concrete surfaces exposed in unfinished areas, above suspended ceilings in manholes, and other unfinished areas exposed or concealed will not require additional finishing.
2. Interior and Exterior Exposed Areas (to be painted): Fins, burrs and similar projections on surface must be knocked off flush by mechanical means approved by RE/COR and rubbed lightly with a fine abrasive stone or hone. Use an ample amount of water during rubbing without working up a lather of mortar or changing texture of concrete.
3. Interior and Exterior Exposed Areas (finished): Provide grout finish of uniform color and smooth finish treated as follows:
   a. After concrete has hardened and laitance, fins and burrs have been removed, scrub concrete with wire brushes. Clean stained concrete surfaces by use of a hone or stone.
   b. Apply grout composed of 1 part Portland cement and 1 part clean, fine sand (smaller than 600 micro-m (No. 30) sieve). Work grout into surface of concrete with cork floats or fiber brushes until all pits and honeycomb are filled.
   c. After grout has hardened, but still plastic, remove surplus grout with a sponge rubber float and by rubbing with clean burlap.
   d. In hot, dry weather use a fog spray to keep grout wet during setting period. Complete finish for any area in same day. Confine limits of finished areas to natural breaks in wall surface. Do not leave grout on concrete surface overnight.

3.8 RETAINING WALLS

A. Provide concrete for retaining walls as shown and air-entrained.

B. Install and construct expansion and contraction joints, waterstops, weep holes, reinforcement and railing sleeves as shown.

C. Finish exposed surfaces to match adjacent concrete surfaces, new or existing.

D. Place porous backfill as shown.

3.9 PRECAST CONCRETE ITEMS

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

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SECTION 03 48 21
PRECAST CONCRETE BURIAL CRYPTS
(DOUBLE DEPTH LAWN CRYPT)

PART 1 - GENERAL

1.1 DESCRIPTION

A. The work of this Section is to furnish all labor, materials, manpower, tools and equipment required to complete the manufacturing and installation of the precast concrete burial crypts as specified and/or shown, including but not limited to the work to:

1. Fabricate
2. Transport and deliver to site
3. Unload units on dunnage or gravel
4. Store and/or install precast concrete burial crypts (units or crypts)
5. Install sub base foundation and drainage
6. Install units in the prepared crypt fields
7. Backfill between and around the crypts
8. Install sand and/or backfill on top of crypts
9. Compact fill materials
10. Topsoil
11. Provide additional Materials:
    a. Three (3) OSHA -approved crypt lid lifting apparatus
    b. Five (5) extra concrete crypt lids
    c. A device to easily retrieve and lower the inside shelf by one man without entering the crypt.
12. Other Associated Work

1.2 DESIGN OVERVIEW

A. The design of the units shall be as described in this Section and their installation layout shall be as illustrated on the Drawings. Design requirements shall be as follows:

1. All perimeter crypts shall be structurally designed for overhead and lateral soil pressure plus live loads specified hereafter.
2. All designs will require that the manufacturer provide fabrication drawings stamped by a Professional Engineer indicating that the design meets or exceeds the structural requirements contained herein.

3. Alternative crypt component designs may be proposed if all the following requirements are met:
   a. Comply with the design criteria and the functional tests of this specification.
   b. All provisions of this specification shall apply to any proposed alternative design.
   c. The Government may accept or reject part or all of any proposed alternative design. The Contractor will pay for all cost for alternate designs, submittals, and reviews.

1.3 RELATED WORK

A. Excavation and Backfill: Division 31 "EARTHWORK."

B. Materials Testing and Inspection during Fabrication and Construction: Division 1 Section TESTING LABORATORY SERVICES.

1.4 SUSTAINABILITY REQUIREMENTS

A. Materials in this section may contribute towards contract compliance with sustainability requirements. See Section 01 81 11, SUSTAINABLE DESIGN REQUIRMENTS, for project low-emitting materials, requirements.

B. Blended Cement: It is the intent of this specification to reduce CO2 emissions and other environmentally detrimental effects resulting from the production of portland cement by requiring that all concrete mixes, in aggregate, utilize blended cement mixes to displace portland cement typically included in conventional construction. Provide the following submittals:
   1. Copies of concrete design mixes for all installed concrete.
   2. Copies of typical regional baseline concrete design mixes for all compressive strengths used on the Project.
   3. Quantities in cubic yards of each installed concrete mix.

C. Biobased Material: For products designated by the USDA's BioPreferred® program, provide products that meet or exceed USDA recommendations for biobased content, subject to the products compliance with performance requirements in this Section. For more information regarding the product categories covered by the BioPreferred® program, visit http://www.biopreferred.gov.

1.5 REGULATORY REQUIREMENTS FOR RECYCLED CONTENT

A. Products and Materials with Post-Consumer Content and Recovered Materials Content:

1. Contractor is obligated by contract to satisfy Federal mandates for procurement of products and materials meeting recommendations for post-consumer content and recovered materials content; the list of designated product categories with recommendations has been compiled by the EPA - refer to http://www.epa.gov/wastes/conserve/tools/cpg/products/
2. Materials or products specified by this section may be obligated to satisfy this Federal mandate and Comprehensive Procurement Guidelines program.
3. The EPA website also provides tools such as a Product Supplier Directory search engine and product resource guides.

B. Fulfillment of regulatory requirements does not relieve the Contractor of satisfying sustainability requirements stipulated by Section 01 81 11, SUSTAINABLE DESIGN REQUIREMENTS, as it relates to recycled content; additional product and material selections with recycled content may be required, as determined by Contractor's Sustainability Action Plan.

1.6 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Bid documents shall include documentation that manufacturer has a minimum of three years of experience with pre-casting units of similar type. Current plant certification for the location(s) that will be producing units for this project from the National Precast Concrete Association (NPCA) shall be provided as a submittal prior to any work being performed.

B. Provide a written stamped certification from a licensed Structural Engineer that certifies that the units being manufactured conform to the specified design and performance requirements.

C. Installation Qualifications: Provide written documentation that verifies:
1. The installer has been regularly engaged, for at least three years, in installation of pre-cast concrete similar to this project.

D. Fabricate crypts to the interior dimensions described below.
1. Replace or repair units that do not comply with the individual dimensions and tolerances.

E. Prior to, or in the initial stage of crypt production, furnish at the site:
1. Proposed shelf removal tool.

2. Two (2) perimeter crypts.
3. One (1) interior crypt.
   a. The three (3) crypts shall:
      1) Demonstrate acceptable quality of construction.
      2) Be used to conduct the on-site buried crypt functional load test as described herein below.

F. Functional Load Tests: Functional on-site load tests will be made at the Contractor's expense to insure the units are capable of supporting loads stated. The functional tests will consist of following loading conditions:
   1. Confined Loading: An interior unit between two perimeter units shall:
      a. Be placed in a hole dug in the ground on site and covered with 600 mm (24 inches) of soil or covered to the maximum depth as shown on the plans, whichever is greater.
         1) The soil will be compacted to Standard Proctor (AASHTO T-99) density along the sides of 95% and reduced density over the lid, both as shown on the plans.
            a) Impact type of equipment shall not be used on the sides of the crypts as they can cause conditions that exceed the design parameters.
      b. An axle load of 5500 kg (12,000 lbs.) shall be passed over the covered crypts for a minimum of 10 times in repetition as follows:
         1) In a manner that causes maximum lateral pressure due to wheel load on the sides of the crypts.
      c. The crypts shall then:
         1) Be fully excavated, exposed and the lids removed to allow careful examination inside and outside.
            a) The crypts must not show any signs of stress or cracking.
   2. Shelf Load Testing for the intermediate shelf shall be as follows:
      a. Apply load to individual support struts. Use one worker with a minimum weight of 90kg (200 lbs.)
         1) Worker shall carefully walk on individual supports to confirm structural integrity and load bearing capability.

a) Worker shall adhere to all safety regulations while performing test.

b. Upon completion of shelf load testing, the inside shelf shall be removed by the removal tool as follows:
1) Without entering the crypt and by one man.
2) Inspected, and lowered back into the crypt in the 2nd interment position.
3) The inside shelf must not show any signs of stress, cracking or deflection.

3. Demonstrate the removal and replacement process for the inside shelf. The functioning of the shelf removal tool shall be approved by the NCA Crypt Specialist.

G. Commence production of crypts only after the written submittal(s) are approved and on-site load testing and demonstration have been scheduled for witnessing by the NCA Crypt Specialist.

1.7 DESIGN CRITERIA

A. Design Criteria (Double Depth Crypt): All design calculations and drawings shall be signed and sealed by qualified licensed Structural Engineer.
1. The units shall be of the following type, style, and size:
a. Type: Precast concrete.
b. Style: One-piece box with separate outer lid and the following:
1) A removable one-piece inside shelf
2) Four casket risers or two casket support bars
3) Drain Holes 100 mm (4-inch) diameter in the floor bottom as follows:
a) Two drain holes at opposite ends when there are casket risers.
b) Three drain holes at opposite ends and in middle, when there are two support bars.
c. Crypt interior size: Interior minimum dimensions are as follows:
1) 750 mm (30”) minimum width at the inside bottom floor and for the full height of the crypt
2) 2.2 m (86”) minimum length along the inside bottom floor and for the full height of the crypt

3) 640 mm (25”) minimum clear height from the highest part of the inside shelf to the underside of the lid
4) 640 mm (25”) minimum clear height from the lowest part of the inside shelf to the top of the casket risers
5) 20 mm (3/4”) minimum height casket risers from the crypt floor spaced 500 mm (20”) from crypt centerline to eliminate pinching of the lowering straps during removal. Four risers required.

e. Crypt height and wall thickness:
1) Exterior maximum height dimension: 1.6 m (60") including the lid.
2) Crypt wall thickness: 50 mm minus 12mm (2-inches minus 1/2 inch) for inside shelf bearing.
3) Perimeter crypts are allowed thicker walls where additional reinforcing is included.
4) Crypt wall sections at support slots originated from the top for the inside shelf may be of lesser thickness.

f. Layout:
1) Crypts shall fit in a 920 mm by 2450 mm (3-foot by 8-foot) plot or a lesser plot size as noted on the plans.
2) The lesser plot size shall govern. If the proposed crypts will not fit into the designed/indicated plot size, with adequate room for the between crypt backfill, or if a different plot size is suggested, the Contractor, at no cost to the Owner, shall prepare a revised Layout/Size Plan and submit it for review and approval by the RE/COR.

2. Load Conditions for design of units shall be as follows:
a. A burial depth with soil cover as indicated on the plans.
b. A center point load of 2700 kg (6,000 lbs.) on one square foot, prior to burial.
c. Passage of a wheel axle load of 5500 kg (12,000 lbs.) after burial.
d. A 900 mm (3-foot) tall pile of excavated material on top of or adjacent to buried crypts.

3. Submit to the RE/COR for approval the following:

a. Five sets of design documentation showing structural design of the units. **In addition, the Contractor shall provide one additional set to NCA Crypt Specialist.**
   1) This documentation shall include dimensions, methods of construction, and calculations.
b. The Structural Engineer that stamps the design calculations and drawings shall provide:
   1) Written recommendations indicating the extent of voids that are allowable in the produced units, without causing any degradation of loading capacity from the design load values.
   2) Written recommendations on the conditions where repairs will be allowed, and materials and methods to be used for repairs.
   3) Written statement that all repairs to the units shall only be allowed if they are performed according to the written recommendations of the Structural Engineer.

B. Design Criteria (Concrete Lids):
1. To be removable and replaceable.
2. Lid lifting shall be from top positioned hot-dipped galvanized anchors (4-required per lid).
   a. Furnish the cemetery with three (3) OSHA approved and tag certified wire rope lifting devices for removing the lid. No chain lifting devices allowed.

C. Design Criteria (Inside shelf):
1. One piece rigid construction
2. Fully conceal the lower casket with a rigid barrier
3. Weigh 18 kg (40 lbs.) or less
4. Allow for easy casket lowering belt removal
5. Capable of holding 180 kg (400 lbs.) indefinitely.
6. The entire inside shelf should be rigid, non-brittle, non-deteriorating, and have a maximum 6 mm (1/4 inch) gap from all shelf edges to the crypt wall to create a visual barrier.
7. Have one lifting hole in the middle about 50 mm (2-inches) from the edge 19 mm (3/4-inch) maximum diameter.

D. Design Criteria (Inside Shelf Removal Tool(s):
1. Be constructed so one man can easily retrieve and install the shelf from ground level without entering the crypt.

a. Demonstrate the use and functionality of said tool at the crypt buried load testing, for the conditions that will occur at the cemetery during the interments at the crypt sections(s).

E. Design Criteria (Quad Crypt):

1. An alternate concrete Quad unit (one piece) may be used as an approved equal in lieu of two (2) double depth lawn crypt units. The Quad units shall conform to all other specified herein including:
   a. The shared interior concrete wall thickness may be increased to allow for a gap between lids as deemed appropriate to meet layout requirements.

F. Design Criteria (Oversized Crypt):

1. Oversized crypts shall conform to all provisions of this section with the exception that the Interior dimensions and Wall thickness are as follows:
   a. 1065 mm by 2335 mm (42-inches by 92-inches) inside clear span
   b. Oversized crypt wall thickness: 65 mm – 12 mm (2-1/2 inches minus 1/2 inch) for inside shelf bearing.

G. Miscellaneous manufacturing requirements:

1. The concrete lid shall be beveled along the entire top perimeter. Chamfer top edge of lid with a 1:1 chamfer beginning 12 mm (1/2 inch) down from top.
2. The design of casket risers, whether individual spots or bars crossing the bottom, shall allow the casket to rest a minimum of 19 mm (3/4 inch) above the inside floor of the crypt and above the top of the inside shelf in order to aid in casket lowering straps removal. In addition, rests location shall not exceed 530 mm (21 inches) from crypt centerline.
3. The crypt outside lifting wire shall be designed for transport and installation along with provisions for removal/abandonment of crypt lifting wire once crypt has been installed.

1.8 ALLOWABLE TOLERANCES

A. Tolerances of individual units shall be as follows:

1. Variation in overall crypt outside dimensions of unit (height, length and width): 3 mm (1/8”) plus or minus. There is zero tolerance for any lesser crypt inside minimum clear dimensions.

2. Variation in thickness of precast panels and elements: 1.5 mm (1/16") plus or minus.
3. Maximum height differential in final placement in the ground: 6 mm (1/4") above or below design grade.
4. Cracks greater than 0.75 mm (0.030 inches) in width are cause for crypt rejection. With evidence of fiber or steel reinforcement, any cracking 0.75 mm (0.030") or lesser width that does **not** extend thru wall is acceptable. Any cracking 0.4 mm (0.016 inch) or lesser that extends thru wall is acceptable. All other cracks are cause for rejecting crypts that shall be repaired or removed and replaced at no cost to VA.

1.9 SUBMITTALS

A. In accordance with Section 01 33 23, SAMPLES AND SHOP DRAWINGS, within 45 days of the approval of the shop drawings, furnish to the RE/COR and the NCA Crypt Specialist the following:
   1. Samples: deliver to the site for testing and inspection:
      a. Two perimeter crypts and one interior crypt.

B. Submit a detailed concrete Mix Design of Self Consolidating Concrete (SCC) with a ***15% minimum requirement*** of a cement substitute of fly ash and/or other pozzalons.

C. Submit Shop Drawings:
   1. Installation Narrative:
      a. Method of transportation.
      b. Method of handling and placement.
   2. Production Drawings:
      a. Elevation view of each unit.
      b. Plan view of unit.
      c. Sections and details to show quantities, sizes and position of reinforcing steel, inserts, and essential embedded hardware for fabrication, handling, transportation and installation.
      d. Section, details and location of specialty lid lifting anchors, caps, and lid lifting system.
      e. Dimensions and finishes.

D. Submit Product Design Data:
   1. Structural adequacy calculations of units (crypts), performed by a licensed Structural Engineer.

2. Loadings for Design Calculations:
   a. Initial handling and erection stresses.
   b. Dead and live loads specified.
   c. Other loads specified for units as applicable.
   d. Deflection of precast members.
   e. Product test reports:
      1) The concrete shall be tested for the compressive strength and beam flexural strength as specified herein. An approved independent, commercial testing laboratory shall perform tests. Certified copies of test reports, including test data and results shall be submitted to the RE/COR immediately after the strength tests have been completed. The tests shall be as specified herein.
      2) Prior to backfilling over crypts and at contractor expense, the RE/COR may pick a single crypt for coring another bottom slab drainage hole by an independent lab with said core being analyzed (petrography testing) and results submitted verifying evidence of fly ash or other pozzalons as specified.
      3) Based on failed testing, the RE/COR may request more frequent testing to ensure quality of the product and pozzalons content is present, again at contractor expense.
3. Manufacturer's Literature and Data:
   a. Each type of anchorage, angle, and fastener.

1.10 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery and Handling: Units shall be transported, stored and handled so as to prevent damage to surfaces, edges and corners and to prevent development of stresses and cracks. Provide temporary bracing protection devices and measures as necessary to prevent damage to the units during handling, transportation and storage. Transportation, storage and handling of units without damage is required. Any damage caused by accident or negligence on the Contractor's part shall be corrected at the Contractor's expense. Use the designed crypt lifting wire system to transport crypts. On the job site, forklift handling of crypts may be approved by the RE/COR only following:
1. Verification that the structural design is adequate.

2. Verification by the manufacturer and demonstration that the field procedures will cause no crypt damage.
3. Submission of written safety procedures to be followed so the procedure is maintained as SAFE.

B. Storage:

1. Units may be stored within crypt fields being constructed on gravel, or at other designated locations(s) on site, as long as they are set on blocking, gravel or other approved methods to prevent damage or plugging of the bottom drainage holes.

C. Markings and Identifications:

1. Markings, including logos, trademarks and proprietary information are prohibited on surfaces of crypts.
2. Date of manufacture (month, day, and year) shall be written on the box and lid with permanent ink or an equivalent marking.

1.11 COORDINATION

A. Coordinate the manufacture, delivery, storage and installation of the units with related work.

1.12 GUARANTEE

A. After erection, completed work will be, subject to terms of Article, GUARANTEE in Division 01, GENERAL CONDITIONS, except guarantee period is extended to five years.

1.13 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. American Association of State Highway and Transportation Officials

T99-01(2011)	Moisture-Density Relations of Soils Using a 2.5 kg (5.5 lb) Rammer and a 305 mm (12 inch) Drop.
T180-01(2011)	Moisture-Density Relations of Soils using a 4.54 kg (10 lb) Rammer and a 457 mm (18 inch) Drop.

C. American Concrete Institute:

ACI Manual of Concrete Practice 2011 Edition.

ACI 318-05	Building Code Requirements for Structural Concrete

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

A36/A36M-12	Standard Specification for Carbon Structural Steel.
A153/A153M-09	Standard Specification for Zinc Coating (Hot Dip) on Iron and Steel Hardware.
A615/A615M-13	Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
A1064/A1064M-13	Standard Specifications for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
C31/C31M-12	Standard Practice for Making and Curing Concrete Test Specimens in the Field.
C33/C33M-13	Standard Specification for Concrete Aggregates
C39/C39M-14	Standard Test Method for Compressive Strength of Cylindrical Concrete Specimen
C78/C78M-10e1	Standard Test Method for Flexural Strength for Concrete (Using Simple Beam with Third-Point Loading)
C150/C150M-12	Standard Specification for Portland Cement.
C172/C172M-14	Standard Practice for Sampling Freshly Mixed Concrete.
C260/C260M-10a	Standard Specification for Air-Training Admixtures for Concrete.
C494/C494M-13	Standard Specification for Chemical Admixtures for Concrete
C595/C595-13	Standard Specification for Blended Hydraulic Cement.
C1017/C1017M-13	Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete.
C1116/C1116M-10a	Standard Specification for Fiber-Reinforced Concrete.
C1157/C1157M-11	Standard Performance Specification for Hydraulic Cement

C1399/C1399M-10	Standard Test Methods for Obtaining Residual-Strength of Fiber-Reinforced Concrete.
C1602/C1602M-12	Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Precast Concrete: All crypts shall be of concrete with the following:
   1. A minimum 28 days compressive strength of 35 MPa (5,000 psi)
   2. Self-Consolidating Concrete (SCC) containing structural fiber with an inverted slump between 550 mm and 700 mm (22” and 28”)
   3. A minimum of 15% cement substitute of fly ash and/or other pozzalons. Fiber is not required for crypt lids
   4. Hydraulic Cement: ASTM C150 or ASTM C1157 or ASTM C595
   5. Normal weight Aggregates: ASTM C 33
   6. Water: ASTM C1602
   7. Chemical Admixtures:
      a. Water reducers, accelerating and retarding: ASTM C 494
      b. Air Entraining: ASTM C260
      c. Admixtures for flowing concrete: ASTM C1017
      d. Admixtures with no standard designation shall be used only with approval of VA.
   8. Prohibited Admixtures: Calcium Chloride thyocyanates or admixtures containing more than 0.1 percent chloride ions.

B. Reinforcement:
   1. Welded Steel Wire Fabric: ASTM A1064.
   2. Steel Wire Reinforcement: ASTM A82, cold drawn.
   3. Steel Reinforcement: ASTM A615 Grade 60, deformed.
   4. Inserts, Anchors, Dowels and Accessories: Steel, ASTM A36, zinc coated ASTM A153 hot-dipped galvanized finish G90.
   5. Fiber: Macrofiber complying with ASTM C1116

C. Form Coatings:
   1. Use commercial formulation form-coating compounds that will not bond with, stain, or adversely affect concrete surfaces.

D. Paint:
   1. Use commercial Concrete & Garage Floor Epoxy Acrylic Paint for crypt concrete lid & inside wall surface numbering. Paint as manufactured

by BEHR Deep Base #930 or approved equal. The use of an approved equivalent spray paint product, if approved by the NCA Crypt Specialist, shall only be for use on the interior crypt numbers.

2.2 FABRICATION

A. General:

1. Units shall be fabricated in accordance with the minimum interior dimensions and tolerances indicated herein, with concrete surfaces that are smooth and free of irregularities.

B. Finishes:

1. Surface holes 6 mm (1/4”) and smaller caused by air bubbles, normal color variations, normal form joint marks, small chips 6mm (1/4”) and smaller and spalling no more than 0.1 square meter (one square foot) total per unit are permitted.
2. Exposed steel reinforcing, honeycomb, bugholes, and cracks not within tolerances are not permitted.
3. The lid lifting system shall be as follows:
   a. Top mounted and consist of hot dip galvanized steel anchors (four per lid) each in a 65 mm (2-1/2”) diameter minimum recessed bowl of depth sufficient to easily connect lifting device as designated compatible by anchor manufacturer.
   b. Anchors to be installed at locations to ensure maximum lid lifting stability.
   c.
4. Concrete shall have no evidence of segregation of materials.

C. Reinforcement:

1. Provide steel and fiber reinforcing as required for casting, handling, erection loads, lateral and overhead fill, and equipment live loads.
2. Reinforcing steel shall be free of dirt, mill scale, rust, oil, grease, ice, snow, water and placed within approved tolerances in accordance with ACI 318. Careful placement of reinforcing is required to avoid overlapping at thin points of the units.

D. Concrete Placement:

1. Porosity, strength, weight and gradation of coarse aggregate shall be as required to produce specified characteristics.

2. Units shall be cast in steel forms designed to suit shape and finish required. Each element of the unit shall be cast as an integral piece free of joints and seams.

E. Curing:

1. 75% of specified concrete compressive strength shall be attained before transportation of units to the cemetery or storage site.
2. Units shall be cured as required to develop specified structural characteristics and shall be stored in a manner that will permit all surfaces to cure equally.
3. Units shall be properly cured in accordance with the applicable provisions of the current ACI Manual of Concrete Practice.

F. Surface Treatment and Corrective Work:

1. Units that have minor chipping of edges and corners shall be repaired by a method approved by the RE/COR.
2. Cracked/damaged units exceeding tolerances shall be removed by the contractor at no cost to the government.
3. Any corrective work beyond what the RE/COR determines is minor, shall be handled according to written procedures from the Structural Engineer that stamped the design for the units. Otherwise, the units shall be removed and replaced.

2.3 TESTING AND INSPECTION

A. Contractor's Responsibility for Inspection: The Contractor is responsible for the performance of all inspection requirements including:

1. Removal of lids
2. Number painting inside crypts
3. Replacement of the lids for inspection by the RE/COR.
   a. The RE/COR reserves the right to perform any of the inspections set forth in the specification when deemed necessary to assure that the units conform to prescribed requirements.

PART 3 - EXECUTION

3.1 CRYPT FIELD QUALITY ASSURANCE

A. Testing: The contractor shall procure an independent qualified testing agency to perform concrete tests during crypt production and prepare test reports.

1. Concrete Cylinder testing for compressive strength:

a. Three cylinders per day of crypt production to be taken in accordance to ASTM C172 as applicable to SCC.
b. Strength to exceed 35 MPa (5000 psi) after 28 days curing in accordance to ASTM C31 & C39.
c. Test inverted slump when cylinders are made.

2. Beam testing to confirm design flexure strength:
   a. Once at the beginning of crypt production, a minimum of three beams with fiber shall be taken for testing of Flexural Performance of Fiber-Reinforced Concrete in accordance with ASTM C78 and C1399. All beams' flexural strength shall exceed the crypt design flexural strength requirements and residual strength of fiber reinforced concrete, and shall exceed capacity of conventionally reinforced concrete wall design as submitted by the Structural Engineer and approved by VA. Fiber Manufacturer shall verify type and dosage rate of the test beams are identical in crypt production.
3. A single verification test of fly ash in the crypt concrete mix required at the discretion of the RE/COR.

3.2 GENERAL LAYOUT CONTROL

A. A professional registered Land Surveyor shall establish sufficient lines, grades and control for the horizontal placement, slope of the base and top, and vertical alignment for the sides of units in accordance with the design drawings.

3.3 PREPARATION

A. Before beginning installation, inspect work of other trades insofar as it affects the work of this section. Commencing installation of units will be construed as accepting as suitable the work of other trades.
B. Verify by survey, rough grading of aggregate for first row of crypts to be installed in a field. Provide a certification by the professional surveyor to the RE/COR that the rough grading for the base stone for the first row of crypts to be installed, as well as that the survey control points for crypt setting have been set according to the plans, prior to the Contractor starting to set crypts in the field. The Surveyor shall indicate to the RE/COR where the control points are located and how they are protected.

C. Verify by testing, compaction of prepared subgrade and subbase to meet Standard Proctor (AASHTO T-99).

D. Verify by survey locations and elevations of units relative to control points indicated on plans. Submit new control point layout if a crypt size other than specified is used.

3.4 HANDLING, INSTALLATION AND PAINTING

A. Handling:

1. Units shall be handled in a vertical plane at all times and stacked vertically on wood supports of adequate strength, or placed on gravel until erected. Use of approved designed OEM lifting cable system that has been deemed to be safe for handling the units shall be used during the setting process, where workers are nearby.
2. Lift units with suitable lifting devices at points provided by manufacturer.
3. Provide temporary wood bracing to comply with manufacturer's recommendations to keep crypt bottom off ground during storage.

B. Installation and Painting:

1. Install units by competent erector crews trained and certified as competent by units manufacturer.
2. Use all means necessary to protect units from being damaged in transport and during and after installation. Lids or other parts of the crypt that show damage from bouncing during transport shall be replaced by the contractor at no cost to the Owner.
3. Accurately install by aligning and leveling units in accordance with plans. Assure that crypts are in straight horizontal alignment.
4. After crypt installation and prior to backfill, remove lids with the specified lifting apparatus for crypt inspection by the RE/COR inspector and numbering. Numbers furnished by NCA shall be painted on the outside of the crypt lids and on the upper inside crypt short wall, both at the headstone end. Numbers shall be permanent paint as specified and approximately twelve inches high. Crypt lid number painting must be applied to a clean, dust-free surface requiring paint application **within 10 seconds** of surface cleaning. After completion of inspection and marking, the Contractor shall replace the lids. Any damage to lids or crypts will be the responsibility of the contractor.

3.5 PROTECTION OF WORK

A. Use all means necessary to protect units from being damaged during and after installation.

3.6 REPLACEMENT AND REPAIR

A. Remove and replace units that the RE/COR has determined are damaged, cracked beyond tolerances, broken, improperly fabricated, or otherwise defective and are structurally unsound and unacceptable.

B. Units having minor defects not affecting serviceability or appearance may be repaired when approved by NCA Inspector.

C. Proposed repair work shall be sound, permanent, and flush with adjacent surfaces and submitted for approval by NCA Crypt Specialist.

D. Replacements and repairs shall be done at no additional cost to the Government.

3.7 BACKFILLING AND CRYPT FIELD PROTECTION

A. Prior to the backfill being placed between the crypts, a professional registered Land Surveyor shall:

1. Survey the in place crypts and provide a written certification that they are, within allowable tolerances installed:
   a. At the design locations
   b. Properly aligned
   c. At correct elevations and slopes

B. The following documents shall be provided to the RE/COR:

1. An electronic drawing of the as-built conditions for the installed crypts.
2. A paper copy at appropriate scale so the crypt field is fully shown on a maximum sheet size of 600 mm x 900 mm (24” x 36”) with all indications of variances in the placement from the design drawings shown.
3. A written certification that during the manufacturing, handling, setting, and or crypt numbering process that each of the lifting bowls were operated using the designed lifting device, and that any excessive concrete debris has been removed to allow free operation of the lifting bowls. A description of when in the process each of the lifting bowls were used shall also be provided.

C. When all of the crypts in a specific field are installed as indicated in the design drawings and details, and the surveyor has so certified,

the RE/COR will approve the Contractor proceeding with the backfill between the crypts. The Contractor is responsible for insuring that the crypts do not move during the backfill operations, including but not limited to providing adequate blocking at the base of the units, if deemed necessary, to prevent them from moving during the backfill operations.

D. Protect installed crypt units during backfill operations.

E. Install approved backfill against outside walls of all units, insuring no voids are remaining. Approved backfill shall:
   1. Contain no materials that will cause a concentrated point load.
   2. The perimeter wall backfill shall be compacted to Standard Proctor (AASHTO T-99) to 95% density to the level equal to the top of the crypts.
   3. Shall be compacted without using large vibratory equipment near crypts as impact loading may cause damage or failure of the crypt.

F. Backfill between the crypts where gap is less than 50mm (2-inches) shall be as follows:
   1. Install approved (rounded) gravel that meets the specified gradation into gaps between crypts leaving no voids.
      a. At RE/COR's discretion, a non-rounded stone may be considered as a substitute for the rounded stone. The RE/COR may accept the (non-rounded) stone only following demonstration, through an approved submittal process, that rounded stone is not available for less than 4 times the cost of a cut/crushed angular (non-rounded) aggregate substitute. Largest size for the non-rounded stones shall not exceed the gradation size for the rounded stones. (A smaller gradation size will be required for the non-rounded stones to insure that the stones are not larger that their rounded counterparts.)The non-rounded stone shall only be considered when with the largest size of the stone passing a sieve size does not exceed the allowable stone size for the rounded stone gradations. The non-rounded stone may be approved when the size is as described above, and with a successful demonstration that filling gaps between crypts leaves no voids, because the stones fall into place without bridging as should occur when using rounded stones.

2. Use rodding to assure no bridging occurs and void areas are eliminated.
3. No sand allowed.
4. As a resource saving measure, the use of angular stone of suitable gradation (typically the same stone used as drainage stone for below the crypts) shall be allowed in the space between the head and foot of the crypts only, if the Contractor demonstrates a successful method of placement that prevents the larger angular stone from spreading into the gaps along the long sides of side by side crypts.

Aggregate Size No.	Grading Requirements - Amounts finer than Each Sieve (Square Openings), Mass Percent					
	12.5 mm (1/2″)	**9.5 mm (3/8″)**	**4.75 mm (No. 4)**	**8.36 mm (No. 8)**	**1.18 mm (No. 16)**	**300 µ (No.50)**
8	100	85 to 100	10 to 30	0 to 10	0 to 5	
89	100	90 to 100	20 to 55	5 to 30	0 to 10	0 to 5

G. Install backfill on top of units and compact. Backfill shall be as shown on plans. In absence of plan detail, backfill on top of units working from bottom up consists of 50 mm (2 inches) of identification sand, soil to specified level, and 100 mm (4 inches) minimum of topsoil as the final layer. The entire backfill atop units shall be compacted to 85% density (Standard Proctor (AASHTO T-99).

H. Install drainage board for pea gravel flow containment located in perimeter crypt gaps in areas shown on Drawings.
   1. Drainage board shall be installed at the perimeter of crypt field in locations where standard or oversize traditional gravesite burial spaces are identified on the drawings and other areas so designated.
   2. Drainage board shall be as appropriate to fill gap and stop pea gravel flow, and provide for drainage rates of 1000 L/hr/m (100 gal/hr/lf) in any direction.
   3. The drainage board shall be made of “non-deteriorating” recycled materials and be able to be compressed and return to its original thickness.

4. Drainage board shall contain pea gravel between Crypts. Attach board to Crypt wall exterior with fastening method approved during functional load testing. Ensure board material re-expands to original thickness if compressed. Drainage board shall be installed from bottom of Crypt to bottom of lid. Exterior edge of board shall be inset at least 50 mm (2 inches) from edge of crypt and extend 600 mm (2 feet) in between Crypts.

I. No equipment over the crypts should exceed crypt design loads as specified herein 5500 kg (12,000 lbs axle), which includes compacting equipment. No vibratory compaction equipment over or along side crypts unless impact loads are shown not to exceed crypt design loads.

J. Immediately during crypts install, mark the crypt field edges with temporary driven 5-foot tall lathes & signage for easy identification by vehicles carrying fill, topsoil, compost, sod, water or other. Signage shall state ***"5500-kg axel load maximum. Keep 9 m away"***(***"12,000-lb axle load maximum. Keep 10 yards away")*** and placed minimum 15 m (50-ft) apart.

K. Lathes & signage to be maintained in-place during backfilling thru final acceptance of the crypt field.

L. Finish grading and prepare topsoil as indicated on plans.

M. Do not store or stockpile any stone, sand, backfill, crypts or any other material over 1200 mm (4-feet) high within 9 m (10 yards) of ground on top of installed crypts. Affected crypts subject to said loading condition as determined by the RE/COR shall be inspected for possible damages with all excavation, lid lifting, fill replacement and all other work as necessary, all at contractor's expense.

N. Do not allow any vehicle that exceeds a 5500 kg (12,000-lb) axle load, 2700 kg (6000-lb) wheel load or equivalent pressure per square inch to traverse or park within 9 m (10 yards) of or on top of installed crypts. Affected crypts subject to said loading condition as determined by the RE/COR shall be inspected for possible damages with all excavation, lid lifting, fill replacement and all other work as necessary, all at contractor's expense.

3.8 INSPECTION AND ACCEPTANCE

A. Final inspection and acceptance will be by RE/COR following receipt of:

1. Recommendations from NCA Crypt Specialist and/or A/E team, as applicable.
2. Electronic DWG files of each individual crypt field, with coordinates of the monument markers indicated, and each burial plot being indicated with a closed polygon, and corresponding NCA burial plot identification number, along with the section markers and number for the section.

- - E N D - - -

SECTION 03 48 24
PRECAST CONCRETE COLUMBARIUM UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. This section covers the manufacture and installation of precast concrete columbarium units, as shown on the drawings and specified herein, including but not limited to: the steel reinforcement, steel embedment plates, required sleeves, finished exposed surfaces, preparation of setting surface, adhesive, columbarium fasteners, and niche cover anchor clip assemblies.

B. Acceptable designs of the columbarium units' components are provided as shown on the Drawings. The Contractor may use this design for this Work or may propose alternate designs of the corresponding components as follows:

1. Design for alternate columbarium units shall comply with the design criteria as per Articles 1.3.F and shall comply with the functional tests as per Article 1.3.G of this Specification.
2. Unless indicated otherwise, all provisions of this Specification shall apply to the Contractor proposed design.

C. The Government may accept or reject part or all of any design proposed by the Contractor.

D. This section includes preparation, cleaning and finishing of exposed faces of the columbarium units as indicated on drawings or described herein.

1. Finish of exposed faces of columbarium units shall be free of imperfections and match Existing Columbarium.

1.2 RELATED DOCUMENTS

A. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES

B. Section 01 43 39, MOCKUP REQUIREMENTS

C. Section 03 30 53, CAST-IN-PLACE CONCRETE (SHORT FORM) for Cast-in-place concrete work.

D. Section 04 13 00, NATURAL STONE VENEER for stone work and accessories.

E. Section 07 92 00, JOINT SEALANTS, Materials and Workmanship for sealant application.

F. Section 31 20 00, EARTH MOVING

1.3 QUALITY ASSURANCE

A. Manufacturer's and Installer's Qualifications: Prior to commencement of work, submit documentation regarding the experience of his precast concrete supplier and his precast concrete installer in the design, manufacture and installation of Precast Concrete structures and custom units.

B. Precast concrete manufacturer's qualified Registered Professional Structural Engineer to certify that precast reinforced concrete conforms to specified requirements.

C. Codes and regulations of the Federal, State and County authorities shall apply.

D. Fabricate to dimensions shown or approved. Replace or correct Columbarium Units that do not comply with the individual dimensions and tolerances.

E. Before starting production of Precast Concrete Columbarium Units, furnish at the site, two complete Precast Concrete Columbarium Units, to demonstrate quality of construction. Commence production of columbarium units only after written approval has been obtained from the COR.

F. Performance and Design Criteria:

1. The Contractor shall provide professional design services (delegated design) by a Structural Engineer licensed in the state of the project location. The Contractor shall provide all drawings, calculations, specifications, shop drawings, and other submittals prepared, stamped and sealed by such professional. The Contractors Structural Engineer shall be responsible for providing the design of the precast columbarium units and connections to the primary structure.

2. The Columbarium Units shall be of the following type, style, and size:

   a. Type: Precast concrete, reinforced.

   b. Size: Interior and exterior dimensions as indicated on plans.

   c. Structural Design Requirements: Refer to Structural Series for additional information.

3. Columbarium top shall be capable of structurally supporting imposed service live load of no less than 240 Kgs./Square Meter (50 lb./

ft²), and dead loads based on specified cap thickness and heights, including material composition and element section properties, mortar and grout, and dead loads based on concrete top element sectional properties.

4. Submit to the COR for review and approval 5 sets of design documentation showing structural design of the complete Columbarium. This documentation shall include dimensions, methods of construction, and calculations indicating and including loading of top pre-cast units with the designed natural stone caps, connection of natural stone caps to pre-cast units, connection of pre-cast units to pre-cast units and connection of pre-cast units to the primary structure per all loading and structural design requirements. All design calculations and drawings shall be signed and sealed by qualified Professional Structural Engineer licensed in the state of the project location.

G. Functional Load Tests: If required by the Resident Engineer, a functional load test will be made at the Contractor's expense to insure that the columbarium proposed by the Contractor, as furnished, will be capable of supporting loads stated in Article 1.3.F.2. The functional test will consist of the following loading conditions:

1. Unconfined Loading: The columbarium will be placed on a flat surface with no support against the sides. The entire top of the columbarium will be subjected to a simulated uniform load of live load of 240 Kgs./Square Meter (50 lb./ft²) and required dead load simulating cap, mortar, and grout as they will be installed. The load will be maintained for no less than 72 hours. At end of the loading period, the maximum deflection of the Columbarium top elements shall be no more than 3 mm (1/8"). Upon removal of the load from the unit the residual deflection shall be no more than 1.5 mm (1/16") and concrete elements shall be free of all structural distress.

1.4 MANUFACTURER AND INSTALLER QUALIFICATIONS

A. Precast concrete columbarium units shall be product of manufacturer who has a minimum of 3 years of experience in fabrication of the precast

concrete columbarium units similar in material, design, and quantity to that indicated on the drawings and specified herein.

B. Precast concrete columbarium units installer shall have been regularly engaged for at least three years in installation of precast concrete similar to this project.

C. Supply and Installation of fastener system shall be by product manufacturers and installers, both whom have had a minimum of 3 years of experience in installation of similar design to that indicated on the drawing.

1.5 SUSTAINABILITY REQUIREMENTS

A. Materials in this section may contribute towards contract compliance with sustainability requirements.

B. Blended Cement: It is the intent of this specification to reduce CO2 emissions and other environmentally detrimental effects resulting from the production of portland cement by requiring that all concrete mixes, in aggregate, utilize blended cement mixes to displace portland cement typically included in conventional construction. Provide the following submittals:

1. Copies of concrete design mixes for all installed concrete.
2. Copies of typical regional baseline concrete design mixes for all compressive strengths used on the Project.
3. Quantities in cubic yards of each installed concrete mix.

C. Biobased Material: For products designated by the USDA's BioPreferred® program, provide products that meet or exceed USDA recommendations for biobased content, subject to the products compliance with performance requirements in this Section. For more information regarding the product categories covered by the BioPreferred® program, please visit http://www.biopreferred.gov/.

1.6 REGULATORY REQUIREMENTS FOR RECYCLED CONTENT

A. Products and Materials with Post-Consumer Content and Recovered Materials Content:

1. Contractor is obligated by contract to satisfy Federal mandates for procurement of products and materials meeting recommendations for post-consumer content and recovered materials content; the list of designated product categories with recommendations has been compiled

by the EPA - refer to http://www.epa.gov/wastes/conserve/tools/cpg/products/

2. Materials or products specified by this section may be obligated to satisfy this Federal mandate and Comprehensive Procurement Guidelines program.
3. The EPA website also provides tools such as a Product Supplier Directory search engine and product resource guides.

1.7 ALLOWABLE TOLERANCES

A. In addition to tolerances of individual elements required by American Concrete Institute Publication 533.3R, erection tolerances shall be as follows:

1. Variation of anchors and fasteners from dimensions specified: 3 mm (1/8”)
2. Variation in overall dimensions of precast element (height and width): 3 mm (1/8”)
3. Maximum differential between adjacent units in erected position: 3 mm (1/8”)
4. Variation in thickness of precast panels and elements: 3 mm (1/8”)
5. Maximum vertical differential between adjacent columbarium units in installed position: 3 mm (1/8")

1.8 SUBMITTALS

A. In accordance with Division 1 Section 01 33 23 SHOP DRAWINGS, PRODUCT DATA, and SAMPLES, Shop Drawings and Material Testing Reportsfurnish the following:

1. Physical Samples of all fastening systems, mounting hardware and exposed surface finishes including, but not limited to, the following:
   a. Stainless Steel Angle with threaded stainless steel spring clip to receive the Tamper Proof Stainless Steel Bolt
   b. Stainless Steel Bolt, Nut and Washers
   c. Tamper Proof Stainless Steel Bronze Bolt
   d. Stainless Steel Bronze Rosette
   e. Stainless Steel Expansion Anchors, Bolts and pins
   f. Stainless Steel Ferrule loop insert.
   g. Shims

h. Washers

i. Connection fasteners/bolts/weldplates

2. Samples of two complete Precast Concrete Columbarium Units, to demonstrate quality of construction, delivered to the site to be approved prior to production…

3 Samples of adhesives and grouts.

4. Samples of concrete repair and/or patching materials.

5. Delegated Design Package: All drawings, calculations, specifications, certifications, shop drawings, and other submittals bearing the signature and seal of the design professional.

6. Shop Drawings: Complete shop and erection drawings of all precast concrete columbarium units, showing:

   a. All dimensions and details of construction.

   b. Installation and relation to adjoining work.

      1) Show the individual units open ended against closed ended, where applicable and that web centerline distance is maintained across the joint between units.

      2) Show that the overall length of the wall, with multiple precast units is to be set with the indicated overall in place length, within the allowable tolerances (show the installation tolerances).

      3) For back to back precast niche units show that the web centerlines for the back to back units will align, for the locations below the cap joints, within the allowable tolerances.

      4) Detail where the precast niche units are to be set in the field so the centerline of niche webs will align with the centerline of cap joints above, within the allowable tolerances, when the drawings or details indicate this alignment.

   c. Reinforcements, anchorage, attachments, inserts, location of all pre-drilled sleeves and other items to be installed in the work of other trades.

   d. Joint treatment, joint alignment coordinated with cap stone joints.

   e. Any other work required for a complete installation.

f. Provide evidence that the Contractor to be installing the cast in place concrete foundations for the columbarium and pier units has been contacted prior to any work relating to the footings for the columbarium construction, and that the construction of the concrete support (foundations) work has been coordinated with the precast columbarium unit manufacturer and installer.

7. Production Drawings:
   a. Elevation view of each structural element.
   b. Planametric view of unit.
   c. Sections and details to show quantities and position of reinforcing steel, anchors, inserts, and essential embedded and non-embedded hardware for fabrication, handling, transportation and installation.
   d. Lifting and erection inserts.
   e. Dimensions and finishes.
   f. Method of transportation.
   g. Method of erection and handling.
8. Erection Drawings:
   a. Elevation view of each typical wall segment of interconnected precast niche units, with the overall in place length and position of the precast niche assembly.
   b. Section view of the precast niche units, as they are to be installed, with the critical alignment elements and field placed dimensions indicated. For double sided units, as an example, the face of niche unit to face of backed up niche unit shall be indicated with the construction tolerances for the in place units indicated. Clearly indicate how the units are going to be set in the field to achieve the intended installed conditions.
   c. Provide setting drawing(s) that indicate how the precast niche units are to be positioned on the foundations, to meet the design drawings. The setting drawings shall be submitted based upon the field conditions for the foundations for the segments upon which the precast niche units are to be set. Any discrepancies that exist greater than 1/4” from the design drawings shall be clearly indicated as the foundations are to be constructed within this tolerance. The setting of the precast concrete niche units shall

not begin until this information has been provided and approved by the COR, or adjustments made to the foundations that are acceptable to the COR.

d. Provide coordination drawings indicating the locations for the weld plates in the precast niche units as well as in the foundations, and coordinate this information so the weld plates are installed in the correct locations to align within allowable tolerances.

9. Manufacturer’s Literature and Data:
   a. Each type of Concrete Fastener, including adhesive and anchor devices.
   b. Instructions for final cleaning.
   c. Written instructions of how the exposed concrete of the precast niche units is to be cleaned and prepared prior to application of the approved stain/coating indicated above.
10. Certificates: Manufacturer’s qualifications specifying precast concrete columbarium units meet the requirements of ACI 533.3R and as specified.
11. Certificates: Installer’s qualifications documenting the quality and quantity of experience of the precast concrete installer in the installation of Precast Concrete structures and custom units.
12. Certificates: Manufacturer of the precast niche units shall provide a written certification, prior to shipping the materials, that the products being shipped have been checked and that they meet the dimensional criteria as indicated, within the allowable tolerances for individual units, and that they can be assembled as part of the identified wall segments, within the allowable in place dimensions indicated, within the allowable tolerances indicated. The above manufacturing certifications shall be provided no later than immediately before the units are offloaded at the site. Units that do not meet these criteria shall either be returned or marked in such a manner that indicates they are not to be used for the project work. It is the Contractor's responsibility to ensure that all units that are installed in the project work have been certified by the manufacturer of the units. The Contractor shall be responsible

for disposal of any units that are not acceptable for installation in the project work at no cost to the Government.

1.9 DELIVERY, STORAGE

A. Ship precast concrete columbarium units to site with adequate protection to prevent chipping, breaking and other damage. Materials shall be marked giving proper identifications and location. Store materials in protected areas to prevent damage including vandalism, injurious effects of weather and inclusion of foreign matter.

B. Provide access to the units for field verification of the manufacturing dimensions and whether the units are within allowable tolerances.

1.10 COORDINATION

A. Coordinate the manufacture and erection of precast concrete columbarium units with related work of other sections of the Specifications. Provide templates for inserts and other devices for anchoring precast concrete columbarium units to the work of other trades, in sufficient time to be built into adjoining construction. Perform cutting, fitting and other related work in connection with erection of precast concrete columbarium unit work. See Section 01 33 23 SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES for details regarding the coordination of work.

1.11 GUARANTEE

A. Guarantee precast concrete columbarium unit work, including anchorage, joint treatment and related components to be free from all defects in materials and workmanship, including cracking and spalling, and after erection, completed work will be subject to terms of “Guarantee” article in Division 1 Specification Sections except that guarantee period is one year.

1.12 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. Federal Specifications (Fed. Spec.):

QQ-S-766C (5)	Steel Plates, Sheets, and Strip-Corrosion Resisting
QQ-W-423B	Wire, Steel, Corrosive-Resisting

TT-S-00227E (3)	Sealing Compound Elastomeric Type, Multi-Component (For Caulking, Sealing, And Glazing In Building And Other Structures)
TT-S-00230C (2)	Sealing Compound: Elastomeric Type, Single Component (For Caulking, Sealing and Glazing In Building and Other Structures)

C. American Concrete Institute (ACI) Publications:

ACI 533.3R-70	Fabrication, Handling And Erection of Precast Concrete.

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

A36/A36M-08	Structural Steel
ASTM A276-13	Stainless Steel Bars and Shapes
A615/A615M-12	Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
A1064/A1064M-13	Standard Specifications for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
C33/C33M-12	Concrete Aggregates
C150/C150M-12	Portland Cement

E. American Welding Society (AWS) Publications:

AWS D1.1/D1.1M-12(e11)	Structural Welding Code
AWS D1.4/D1.4M-11	Welding Reinforcing Steel

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURER

A. Manufacturers that have previously completed at least one successful NCA columbarium project are deemed to be acceptable for processing their units through the procedures according to these specifications and the drawings.

B. Manufacturers that do not have previous successful experience for a NCA columbarium project may be selected by the Contractor for the project. Contractor is hereby notified that the submittal process for a manufacturer with no previous NCA experience with a successful columbarium project, typically takes longer to process.

2.2 COARSE AGGREGATE

A. Hard durable aggregate carefully graded from coarse to fine in proportions required to match approved samples of precast concrete columbarium units.

2.3 AGGREGATE FOR BACK-UP MIX (FINE AND COARSE AGGREGATE LIGHTWEIGHT):

A. ASTM C33. Limit gradation as required to produce the specified appearance and quality of concrete.

2.4 PORTLAND CEMENT

A. ASTM C150, Type I and Type II; Color as required.

2.5 STRUCTURAL STEEL

A. ASTM A36.

2.6 STEEL FABRIC REINFORCEMENT

A. ASTM A1064, galvanized.

2.7 STEEL WIRE REINFORCEMENT

A. ASTM A1064, cold drawn.

2.8 REINFORCING STEEL

A. ASTM A615, deformed, Grade 60.

2.9 MISCELLANEOUS GALVANIZED STEEL ITEMS

A. Bolts, nuts, washers, anchors, inserts, and the like for handling, erection, or use by trades.

2.10 NICHE COVER ATTACHMENT HARDWARE (ROSETTES)

A. VA National Cemetery Administration, standard stainless steel rosette, mounting brackets, and bolts for complete attachment of the niche covers to the precast columbarium units are to be as shown on drawings:

1. Rosettes
   a. ASTM Type 316 stainless steel sheet goods, 2.7 mm (0.100 inch) thick.
   b. Die stamp, producing an eight-petal flower pattern as shown on drawings, 25 mm (one-inch) diameter with slight convex; center hole of 5.5 mm (0.218"), concentric to outer edge, with shoulder recess of 10 mm(0.400") in diameter and 1mm (0.035") in depth.
   c. Luster finish.
2. Interior mounting and attachment elements:
   a. ASTM Type 304 or 316 stainless steel tamper-resistant bolts, nuts, washers, anchors, mounting brackets, inserts and the like.

2.11 BACK-UP MATERIAL

A. Closed cell neoprene, butyl, polyurethane, vinyl or polyethylene foam rod, diameter approximately 1-1/3 times the joint width.

2.12 BOND BREAKERS IF USED

A. Type and material recommended by sealant manufacturer.

2.13 SEALING COMPOUND IF USED

A. Fed. Spec. TT-S-00230 C, Type II, Class A, or ASTM C 920-11, Type S, Grade NS, Class 25.

2.14 FABRICATION

A. Precast concrete columbarium units shall NOT be: fabricated, delivered or incorporated in the work until samples have been approved. Precast concrete shall comply with ACI 533.3R, except as modified herein.
   1. Concrete for precast columbarium units shall have minimum compressive strength of 35 MPa (5,000 psi) at 28 days.
   2. Provide additional steel reinforcing as required for casting, handling and erection loads.
   3. Back-up Mix: Porosity, strength, weight and gradation of coarse aggregate shall be as required to produce specified characteristics.
   4. Columbarium units shall be cast in steel forms designed to suit shape and finish required and to withstand high frequency vibration. Concrete shall be deposited in oiled forms. Form oil shall be non-staining type. Vibrations, where required, shall be continuous during process of casting to attain through compaction, complete embedment of reinforcement and to assure concrete of uniform and maximum density without segregation of mix and full thickness of precast element is attained.
      a. Anchors, lifting devices, provisions for cutouts and openings, dovetail slots, notches, reglets, inserts and similar items required for the work of other trades shall be accurately positioned in forms before casting elements.
      b. Fastener location holes, including those for anchoring of units and attachment of niche covers, shall be cast into units. Drilling into precast concrete columbarium units, after fabrication, shall not be acceptable, except where pins are to be inserted through the tops of the units into the caps above, or

where pins are to be inserted through the bottom of the precast niche units into the foundation below.

5. Cement, aggregate and water shall be obtained from single sources for facing mix of precast concrete work in order to assure regularity of appearance and uniformity of color.
6. Finish: Exposed faces shall have smooth natural concrete finish, unless otherwise noted. The face of the units shall be processed by the manufacturer, following removal from the forms to ensure that the discoloration and blemishes on the niche faces are removed before shipping to the site.
7. Curing: Precast concrete shall be cured as required to develop specified structural characteristics and shall be stored in a manner that will permit all surfaces to cure equally and minimize warping, without staining the exposed faces.

2.15 FINISH

A. All exposed faces shall have a coated finish to match existing Columbarium. Rubcrete or an approved equal shall be applied to remove rough textures and blemishes. An acrylic coating matching the color and texture of the existing Columbarium shall be applied after the Rubcrete or approved equal finish has fully cured.

PART 3 - EXECUTION

3.1 HANDLING AND INSTALLATION

A. Before beginning installation, inspect work of other trades in-so-far as it affects the work of this Section. Install units by competent installation crews meeting the requirements of paragraph 1.4 B. Commencing installation of precast concrete columbarium units will be construed as acceptance, as suitable, of such work of other trades. Concrete base for the columbarium units shall be inspected and modified as required, grinding off high spots, to become an acceptable base upon which to install the units. Columbarium units shall be handled in a nearly vertical plane at all times and stacked vertically on wood supports of adequate strength, until erected. Cover and protect precast concrete columbarium units against staining and other damage. Reinstall, realign and otherwise correct improperly installed units.

1. Accurately place and securely anchor precast concrete columbarium units to adjoining construction in accordance with approved shop and erection drawings.

3.2 SETTING

A. Each precast element shall be set level and true to line with uniform joints as specified within the allowable tolerances, and as needed to result in the overall length of the wall assembly being the specified dimension, within the allowable construction tolerances. Joints that are required to have sealants shall be kept free of dirt and other contaminants for at least the depth to the contact points of the backer rod. Precautions shall be taken to protect precast concrete work from being damaged and soiled during and after installation. Wedges, spacers or other appliances which are likely to cause staining shall be removed from joints.

B. Setting of the precast niche units is intended to meet the design drawings within the allowable construction tolerances indicated. There are certain visual relationships that are most critical in the final installation to achieve the design intent. Generally, the consistency of the cap overhang in front of the precast niches, as well as the symmetry of the overhang distance are critical. For double sided columbarium units, as an example, the distance from the face of niche unit to the face of niche units, when installed back to back, is a critical dimension when setting the units. Maintaining this dimension in setting the units, especially at the top of the precast niche units, will allow that the caps be manufactured the same width, and the placement should produce the correct overhang and be symmetrical. The distance from the center of vertical webs on adjoining units, especially across the joints between precast niche units where open and closed end units are joined, are critical as maintaining these allows the proper setting of the niche covers. Refer to the drawings for additional information regarding the critical element relationships to be used during the creation of the foundations and setting of precast units.

C. Where shown, joints shall be filled with sealant. Surfaces and other joints for precast concrete columbarium units shall be cleaned of all dust, dirt and other foreign matter.

3.3 SEALING OF JOINTS

A. Where shown and/or wherever required to make the work watertight, joints between precast concrete columbarium units and between other precast elements and adjoining masonry, concrete and other materials shall be filled with back-up material for depth extending as required to form joint of depth as shown or recommended by sealant manufacturer. Provide bond breakers, at base of sealant where space for back-up does not exist and to prevent sealant from bonding to material at base of joint.

1. Workmanship shall be in accordance with Division 1 Specification Sections and Section 07 92 00, JOINT SEALANTS.

3.4 CLEANING

A. After erection is complete, clean precast columbarium units using materials, equipment and methods recommended by manufacturer.

3.5 REPLACEMENT AND REPAIR

A. Precast concrete columbarium units which are damaged, cracked, stained, improperly fabricated or otherwise defective shall be removed and replaced. Precast units having minor defects not affecting serviceability or appearance may be repaired when approved by the Resident Engineer. Repaired work shall be sound, permanent, flush with adjacent surfaces and of color and texture matching similar adjoining surfaces and shall show no line of demarcation between original and patched surfaces. Replacement and repairs shall be done at no additional cost to the Government.

- - - END - - -

SECTION 03 48 26
PRECAST CONCRETE MEMORIAL WALL UNITS

PART 1 - GENERAL

1.1 GENERAL PROVISIONS

A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 1 – GENERAL REQUIREMENTS, which are hereby made part of this Section of the Specifications.

1.1 DESCRIPTION

A. This section covers the manufacture and installation of precast concrete memorial wall units, as shown on the plans and specified herein, including, but not limited to, the applicable steel reinforcement, steel embedment plates, pins, required sleeves, and fasteners.

1.2 RELATED WORK

A. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
B. Section 03 30 53, CAST-IN-PLACE CONCRETE (SHORT FORM).
C. Section 07 92 00, JOINT SEALANTS.
D. Section 04 43 00, NATURAL STONE VENEER.
E. Section 04 73 10, MEMORIAL WALL MARKERS.
F. Section 07 60 00 FLASHING AND SHEET METAL.
G. Section 07 92 00, JOINT SEALANTS.
H. Section 31 20 00, EARTH MOVING (SHORT FORM).

1.3 QUALITY ASSURANCE FOR PRECAST CONCRETE MEMORIAL WALL UNITS

A. Manufacturer’s and Installer’s Qualifications: Prior to commencement of work, submit documentation regarding the experience of the precast concrete supplier and the precast concrete installer in the design, manufacture and installation of Precast Concrete structures and custom units.
B. Precast concrete manufacturer’s qualified Registered Professional Structural Engineer, registered with the state where the work shall be performed to certify the precast reinforced concrete conforms to specified requirements.
C. Codes and regulations of the Federal, State and County authorities shall apply.

D. Fabricate to dimensions shown or approved. Replace or correct Memorial Wall Units that do not comply with the individual dimensions and tolerances.

E. Before starting production of Precast Concrete Memorial Wall Units, furnish at the site, one complete Precast Concrete Memorial Wall Unit, to demonstrate quality of construction. Commence production of memorial wall units only after written approval has been obtained from the Contracting Officer's Representative (COR).

1.4 MANUFACTURER / INSTALLER QUALIFICATIONS

A. Precast concrete memorial wall units shall be product of manufacturer/ installer who has a minimum of 3 years' experience in fabrication and installation of precast concrete units similar in material, design features, manufacturing tolerances and product quality, to the extent indicated on the drawings and specified herein. Current plant certification for the location(s) that will be producing units for this project from the National Precast Concrete Association (NPCA) shall be provided as a submittal prior to any work being performed. The Company that is to perform the work for the construction of the memorial wall precast concrete core, to which the attachment hardware is to be installed, shall demonstrate compliance with the qualifications through submittal of adequate and acceptable documentation in the submittal process.

1.5 ALLOWABLE TOLERANCES

A. Manufacturing and installation tolerances shall be as follows:

1. Variation of location for the anchors and fasteners for memorial marker attachment brackets from the dimensions specified – within 3 mm (1/8")
2. Variation in overall dimensions of precast element (height and width and depth inside and outside) – 3 mm (1/8-inch)
3. Variation in thickness of walls of precast units – 3 mm (1/8-inch)
4. Maximum vertical and horizontal differential between adjacent units in installed position – 3 mm (1/8-inch)

1.6 SUSTAINABILITY REQUIREMENTS

A. Materials in this section may contribute towards contract compliance with sustainability requirements. See Section 01 81 13, SUSTAINABLE CONSTRUCTION REQUIREMENTS, for project requirements.

B. Blended Cement: It is the intent of this specification to reduce CO2 emissions and other environmentally detrimental effects resulting from the production of portland cement by requiring that all concrete mixes, in aggregate, utilize blended cement mixes to displace portland cement typically included in conventional construction. Provide the following submittals:
   1. Copies of concrete design mixes for all installed concrete.
   2. Copies of typical regional baseline concrete design mixes for all compressive strengths used on the Project.
   3. Quantities in cubic yards of each installed concrete mix.

C. Biobased Material: For products designated by the USDA's BioPreferred® program, provide products that meet or exceed USDA recommendations for biobased content, subject to the products compliance with performance requirements in this Section. For more information regarding the product categories covered by the BioPreferred® program, please visit http://www.biopreferred.gov/.

1.7 REGULATORY REQUIREMENTS FOR RECYCLED CONTENT

A. Products and Materials with Post-Consumer Content and Recovered Materials Content:
   1. Contractor is obligated by contract to satisfy Federal mandates for procurement of products and materials meeting recommendations for post-consumer content and recovered materials content; the list of designated product categories with recommendations has been compiled by the EPA - refer to https://www.epa.gov/greenerproducts/identify-greener-products-and-services/
   2. Materials or products specified by this section may be obligated to satisfy this Federal mandate and Comprehensive Procurement Guidelines program.
   3. The EPA website also provides tools such as a Product Supplier Directory search engine and product resource guides.

B. Fulfillment of regulatory requirements does not relieve the Contractor of satisfying sustainability requirements stipulated by Section 01 81 11, SUSTAINABLE CONSTRUCTION REQUIREMENTS, as it relates to recycled content; additional product and material selections with recycled content may be required, as determined by Contractor's Sustainability Action Plan.

1.8 SUBMITTALS

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

1. Samples: Submit sample of all fastening systems and mounting hardware including, but not limited to, the following:
   a. Stainless-Steel Angle (rosette plates of varying sizes depending on position of Government provided memorial wall memorial markers on the memorial wall- see drawings).
   b. Stainless-Steel Bolt and Washers.
   c. Stainless-Steel Spring Plate.
   d. Tamperproof Stainless-Steel Bolt.
   e. Stainless-Steel Ferrule loop insert.
   f. Stainless-Steel Rosette.
   g. Stainless-Steel Expansion Anchors, Bolts and Pins.
   h. Shims.
   i. Stainless-Steel connection fasteners/bolts/weldplates.
2. Shop Drawings: Complete fabrication and installation drawings of all precast concrete memorial wall units, showing all dimensions, sizes of units, and details of construction, installation and relation to adjoining work, joint locations and details, reinforcements, anchorage, attachments, inserts, location of all predrilled sleeves (see paragraph “Fabrication” in Part 2) and other trades, joint treatment, finishes, and other work required for a complete installation.
3. Calculations indicating and including loading of top precast memorial wall units with the designed stone cap, connection of caps to the memorial wall unit, connection of memorial wall unit to stem wall as per all loading conditions including Seismic loads and calculations indicating the location and loading of the stem wall embedment plates studs, memorial precast unit to concrete stem wall weld plates, memorial wall back plates (to be welded to the stem wall embedment plate) and stem wall/memorial wall anchor bolts. All design calculations and drawings shall be signed and sealed by qualified Professional Structural Engineer.
4. Manufacturer’s Literature and Data:
   a. Each type of fastener or anchorage

b. Instructions for final cleaning

5. Certificates:

a. Current plant certification for the location(s) that will be producing precast concrete units for this project from the National Precast Concrete Association (NPCA).

b. Manufacturers qualifications specifying precast concrete memorial wall units meet the requirements of ACI 533.3R and as specified.

c. Installers qualifications documenting the quality and quantity of experience of the precast concrete installer in the installation of Precast Concrete.

d. Guarantee of precast concrete memorial wall units, materials, and workmanship.

e. Manufacturer of the precast memorial wall units shall provide a written certification, prior to shipping the materials, that the products being shipped have been checked and that they meet the dimensional criteria as indicated, within the allowable tolerances for individual units, and that they can be assembled as part of the identified wall segments, within the allowable in place dimensions indicated, within the allowable tolerances indicated. The above manufacturing certifications shall be provided no later than immediately before the units are offloaded at the site. Units that do not meet these criteria shall either be returned or marked in such a manner that indicates they are not to be used for the project work. It is the Contractor's responsibility to ensure that all units that are installed in the project work have been certified by the manufacturer of the units. The Contractor shall be responsible for disposal of any units that are not acceptable for installation in the project work at no cost to the Government.

f. Provide registered structural engineering precast memorial wall certification and load and connection calculations. Design shall be specifically prepared for this project.

1.9 DELIVERY, STORAGE

A. Ship precast concrete memorial wall units to site with adequate protection to prevent chipping, breaking and other damage. Provide lifting devices that will allow the units to be set without the use of

lifting straps that wrap around the unit. Materials shall be marked giving proper identification and location. Store materials in protected areas to prevent damage, injurious effects of weather and foreign matter.

1.10 COORDINATION

A. Submit documentation (meeting minutes) of coordination between the manufacturer and installer of precast concrete memorial wall units with related work of other sections of the Specifications. Provide templates for hardware inserts and other devices for anchoring precast concrete memorial wall units to the work of other trades, or other adjoining units, in sufficient time to be built into adjoining construction. Perform cutting, fitting and other related work in connection with erection of precast concrete memorial wall unit work.

1.11 GUARANTEE

A. Guarantee precast concrete memorial wall unit work, including: anchorage, joint treatment and related components to be free from all defects in materials and workmanship, including cracking and spalling, even after erection, for a period of not less than one year.

1.12 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. NPCA National Precast Concrete Association

C. American Society for Testing Materials (ASTM) Standards:

A36/A36M-19	Carbon Structural steel.
A1064/A1064M-18a	Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
A615/A615M-12	Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
C33/C33M-18	Concrete aggregates.
C150/C150M-12	Portland Cement.
C920-18	Elastomeric Joint Sealants.

D. American Welding Society (AWS) Publications:

AWS D1.1/D1.1M:2020	Structural Welding Code - Steel
AWS D1.4/D1.4M:2011	Structural Welding Code - Reinforcing Steel

PART 2 – PRODUCTS

2.1 COARSE AGGREGATE

A. Hard durable aggregate carefully graded from coarse to fine in proportions required to match approved samples.

2.2 AGGREGATE FOR BACK-UP MIX (FINE AND COARSE AGGREGATE LIGHTWEIGHT):

A. ASTM C33/C33M-18. Limit gradation as required to produce specified appearance and quality of concrete.

2.3 PORTLAND CEMENT

A. ASTM C150/C150M-12, Type I and Type III; Color as required to match existing.

2.4 WATER

A. Water shall be clean, fresh and potable.

2.5 STRUCTURAL STEEL

A. ASTM A36/A36M-19.

2.6 STEEL FABRIC REINFORCEMENT

A. ASTM A1064/A1064M-18a, galvanized.

2.7 STEEL WIRE REINFORCEMENT

A. ASTM A1064/A1064M-18a, cold drawn.

2.8 REINFORCING STEEL

A. ASTM A615/A615-M12, deformed, Grade 60.

2.9 MISCELLANEOUS STAINLESS STEEL ITEMS

A. Bolts, nuts, washers, anchors, inserts, and the like for handling, erection, or use by other trades.

2.10 JOINT BACK-UP MATERIAL

A. Closed cell neoprene, butyl, polyurethane, vinyl or polyethylene foam rod, diameter approximately 1- 1/3 times the Joint width.

2.11 BOND BREAKERS

A. Type and material recommended by sealant manufacturer.

2.12 JOINT SEALANTS

A. Elastomeric, single-component, non-staining silicone sealant, meeting requirements of ASTM C920-18, Type S, Grade NS, Class 25 or higher. Color as selected during the Submittal Review process.

2.13 ROSETTES

A. VA National Cemetery Administration, standard stainless-steel rosette, mounting brackets, and bolts for complete attachment of the memorial markers to the memorial wall units are to be as shown on drawings:

1. Rosettes
   a. ASTM Type 316 stainless steel sheet goods, 2.7 mm (0.100 inch) thick.
   b. Die stamp, producing an eight-petal flower pattern as shown on drawings, 25 mm (one-inch) diameter with slight convex; center hole of 5.5 mm (0.218"), concentric to outer edge, with shoulder recess of 10 mm (0.400") in diameter and 1mm (0.035") in depth.
   c. Luster finish.
   d. Where indicated, Rosettes shall match existing in place at the site in color, finish, and design.
2. Interior mounting and attachment elements:
   a. ASTM Type 316 stainless steel tamper-resistant bolts, nuts, washers, anchors, mounting brackets, inserts and the like.

2.14 NATURAL STONE CAPS

A. Natural Stone Caps shall meet the requirements of Section 04 43 00 NATURAL STONE VENEER for the type of stone identified in the drawings.

2.15 DECORATIVE ROUNDED PEA GRAVEL

A. See Section 32 90 00, PLANTING.

2.16 CONCRETE FOOTINGS

A. See Section 03 30 00, CAST-IN-PLACE-CONCRETE.

2.17 PRECAST FABRICATION

A. Memorial wall units shall be of size and form as indicated on the plans. Adhere to National Precast Concrete Association (NPCA) for fabrication, handling, and erection standards. Tolerances shall be as indicated herein.

B. Concrete for precast memorial wall units shall have minimum compressive strength of 35 MPa (5,000 psi) at 28 days.

C. Provide additional steel reinforcing as required for casting, handling and erection loads. Adhere to American Welding Society (AWS) Publications AWS D1.1/D1.1M:2020 and AWS D1.4/D1.4M:2011 for structural welding codes. Contractor shall coordinate reinforcing locations with memorial wall hardware.

D. Back-up Mix: Porosity, strength, weight, and gradation of coarse aggregate shall be as required to produce specified characteristics.

E. Precast memorial wall units shall be cast in steel forms designed to suit shape and finish required and to withstand high frequency

vibration. Concrete shall be deposited in oiled forms. Form oil shall be non-staining type. Vibrations, where required, shall be continuous during process of casting to attain through compaction, complete embedment of reinforcement and to assure concrete of uniform and maximum density without segregation of mix and full thickness of precast element is attained.

a. Anchors, lifting devices, provisions for cutouts and openings, inserts and similar items required for the work of all other trades shall be accurately positioned in forms before casting elements.
b. All fastener location holes, including those for anchoring of units and attachment of memorial wall markers, shall be field drilled for anchor bolts.

F. Cement, aggregate, and water shall be obtained from single sources for facing mix of precast concrete work to assure regularity of appearance and uniformity of color.

G. Architectural Finish: Exposed faces shall have smooth finish, rubbed with a fine abrasive or stone hone to create a uniformly smooth cast stone like finish. Use ample water during rubbing to prevent working up a lather of mortar or changing texture of concrete. There shall be no air bubble marks or other such imperfections visible on the surface.

H. Curing: Precast concrete shall be cured as required to develop specified structural characteristics and shall be stored in a manner that will permit all surfaces to cure equally and minimize warping, without staining the exposed faces.

PART 3 - EXECUTION

3.1 CONCRETE FOOTINGS

A. Place concrete footings per lines and grades indicated on the drawings and in accordance with Section 03 30 53, (SHORT FORM) CAST-IN-PLACE CONCRETE.

3.2 HANDLING AND INSTALLATION OF PRECAST CONCRETE MEMORIAL WALLS

A. Before beginning installation, inspect work of other trades insofar as it affects the work of this Section. Commencing installation of precast concrete memorial wall units will be construed as acceptance, as suitable, of such work of other trades. Precast Memorial wall units shall be handled in a nearly vertical plane at all times and stacked vertically on wood supports of adequate strength, until erected. Cover

and protect precast concrete memorial wall units against staining and other damage. Reinstall, realign and otherwise correct improperly installed units.

1. Accurately place and securely anchor precast concrete memorial wall units to adjoining construction in accordance with approved shop and installation drawings. Each precast element shall be set level and true to line with uniform joints.

3.3 SETTING

A. Concrete footings (pads) for memorial wall(s) shall be constructed to meet all structural requirements to meet local soil and climate conditions and the weight and dimensions of the memorial wall(s) being supported by the respective footing.

B. Joints shall be filled with sealant. Surfaces and other joints for precast concrete memorial wall units shall be cleaned of all dust, dirt and other foreign matter. Joints required to have sealant shall be kept free of dirt and other contaminants for their full depth. Precautions shall be taken to protect memorial wall concrete work from being damaged and soiled during and after installation. Wedges, spacers or other appliances that are likely to cause staining shall be removed from joints. Where two units are butted together, alignment shall be precise so that a smooth continuous line is produced.

C. Natural Stone caps shall be installed on top of the memorial wall(s). An epoxy grout shall be in place prior to setting the capping as indicated on the drawings. Two (2) anchor pins shall be placed between the concrete core for the wall and the caps to secure the caps on top of the wall. The cap lengths shall be such that the joints between the caps align with the memorial wall markers as indicated on the drawings. The cap installation shall follow the details on the drawings.

D. Place decorative rounded pea gravel to the line and grade as indicated on the drawings. See Section 32 90 00, PLANTING.

3.4 SEALING OF JOINTS

A. Where shown and where required for either the precast or cast-in-place installation, to make the work watertight furnish and install backer rod and sealant in the joints where indicated on the drawings. Joints shall be cleaned and primed with manufacturer recommended primer, and the joints shall have backer rod installed as recommended by the

manufacturer, with the recommended width to depth ratio according to the sealant manufacturer. Provide bond breakers, at base of sealant where space for back-up does not exist and to prevent sealant from bonding to material at base of joint.

B. Workmanship shall be in accordance with Section 07 92 00, JOINT SEALANTS.

3.5 CLEANING

A. After installation is complete, clean memorial wall units using materials, equipment and methods recommended by manufacturer.

3.6 REPLACEMENT AND REPAIR

A. Precast concrete memorial wall units that are damaged, cracked, stained, improperly fabricated, have exposed reinforcing, or otherwise defective shall be removed and be replaced at no additional cost to the Government. Precast units having minor defects, not affecting serviceability, structural integrity of memorial marker anchorage system, or appearance (when fully covered with markers and filler strips) may be repaired when approved by the Contracting Officer's Representative (COR). Minor defects on exposed to view concrete memorial wall units shall be repaired. Repaired work shall be sound, permanent, smooth, and flush with adjacent surfaces and of color and texture matching similar adjoining surfaces and shall show no line of demarcation between original and patched surfaces. Replacement and repairs shall be done at no additional cost to the Government.

- - -END- - -

SECTION 04 05 13
MASONRY MORTARING

PART 1 - GENERAL

1.1 DESCRIPTION:

Section specifies mortar materials and mixes.

1.2 RELATED WORK:

A. Mortar used in Section:
   1. Section 03 30 53, CAST-IN-PLACE CONCRETE (SHORT-FORM).
   2. Section 04 43 00, NATURAL STONE VENEER.

B. Mortar Color: Section 09 06 00, SCHEDULE FOR FINISHES.

1.3 TESTING LABORATORY-CONTRACTOR RETAINED

A. Engage a commercial testing laboratory approved by Resident Engineer to perform tests specified below.

B. Submit information regarding testing laboratory's facilities and qualifications of technical personnel to Resident Engineer.

1.4 TESTS

A. Test materials proposed for use for compliance with specifications in accordance with test methods contained in referenced specifications and as follows:

B. Mortar:
   1. Test for compressive strength and water retention; ASTM C270.
   2. Mortar compressive strengths 28 days as follows:
      Type M: Minimum 17230 kPa (2500 psi) at 28 days.
      Type S: Minimum 12400 kPa (1800 psi) at 28 days.
      Type N: Minimum 5170 kPa (750 psi) at 28 days.

C. Cement:
   1. Test for water soluble alkali (nonstaining) when nonstaining cement is specified.
   2. Nonstaining cement shall contain not more than 0.03 percent water soluble alkali.

D. Sand: Test for deleterious substances, organic impurities, soundness, and grading.

1.5 SUBMITTALS

A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

B. Certificates:

1. Indicating that following items meet specifications:
   a. Portland cement.
   b. Masonry cement.
   c. Mortar cement.
   d. Hydrated lime.
   e. Fine aggregate (sand).
   f. Color admixture.

C. Laboratory Test Reports:
   1. Mortar, each type.
   2. Admixtures.

D. Manufacturer's Literature and Data:
   1. Cement, each kind.
   2. Hydrated lime.
   3. Admixtures.
   4. Liquid acrylic resin.

1.6 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver masonry materials in original sealed containers marked with name of manufacturer and identification of contents.

B. Store masonry materials under waterproof covers on planking clear of ground, and protect damage from handling, dirt, stain, water, and wind.

1.7 APPLICABLE PUBLICATIONS

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

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

C40-11.....Organic Impurities in Fine Aggregates for Concrete
C91-12.....Masonry Cement
C109-11.....Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or 50-MM Cube Specimens)
C144-04.....Aggregate for Masonry Mortar
C150-12.....Portland Cement
C207-06(2011).....Hydrated Lime for Masonry Purposes
C270-12.....Mortar for Unit Masonry
C595-13.....Blended Hydraulic Cement
C780-10.....Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry
C979-10.....Pigments for Integrally Colored Concrete
C1329-12.....Mortar Cement

PART 2 - PRODUCTS

2.1 HYDRATED LIME

ASTM C207, Type S.

2.2 AGGREGATE FOR MASONRY MORTAR

A. ASTM C144 and as follows:

1. Light colored sand for mortar for laying natural stone veneer.

B. Test sand for color value in accordance with ASTM C40. Sand producing color darker than specified standard is unacceptable.

2.3 BLENDED HYDRAULIC CEMENT

ASTM C595, Type IS, IP.

2.4 MASONRY CEMENT

A. ASTM C91. Type N, S, or M.

2.5 MORTAR CEMEMT

ASTM C1329, Type N, S or M.

2.6 PORTLAND CEMENT

A. ASTM C150, Type I.

2.7 LIQUID ACRYLIC RESIN

A formulation of acrylic polymers and modifiers in liquid form designed for use as an additive for mortar to improve physical properties.

2.8 WATER

Potable, free of substances that are detrimental to mortar, masonry, and metal.

2.9 MASONRY MORTAR

A. Conform to ASTM C270.

B. Admixtures:

1. Do not use mortar admixtures, except color admixtures if approved by COR.
2. Submit laboratory test report showing effect of proposed admixture on strength, water retention, and water repellency of mortar.
3. Do not use antifreeze compounds.

C. Colored Mortar:

1. Maintain uniform mortar color for exposed work throughout.
2. Match mortar color in approved sample or mock-up.
3. Color of mortar for exposed work in alteration work to match color of existing mortar unless specified otherwise in section 09 06 00, SCHEDULE FOR FINISHES.

D. Color Admixtures:
   1. Proportion as specified by manufacturer.
   2. For color, see Section 09 06 00, SCHEDULE FOR FINISHES.

2.10 COLOR ADMIXTURE

A. Pigments: ASTM C979.
B. Use mineral pigments only. Organic pigments are not acceptable.
C. Pigments inert, stable to atmospheric conditions, nonfading, alkali resistant and water insoluble.

PART 3 - EXECUTION

3.1 MIXING

A. Mix in a mechanically operated mortar mixer.
   1. Mix mortar for at least three minutes but not more than five minutes.
B. Measure ingredients by volume. Measure by the use of a container of known capacity.
C. Mix water with dry ingredients in sufficient amount to provide a workable mixture which will adhere to vertical surfaces of masonry units.
D. Mortar that has stiffened because of loss of water through evaporations:
   1. Re-tempered by adding water to restore to proper consistency and workability.
   2. Discard mortar that has reached its initial set or has not been used within two hours.

3.2 MORTAR USE LOCATION

A. Use Type M mortar for waterproof parging below grade.
B. Use Type S mortar for masonry containing vertical reinforcing bars (non-engineered) masonry below grade, and engineered reinforced unit masonry work.
C. For stone veneer over frame back up walls, use Type N portland cement-lime mortar or Type S masonry cement or mortar cement mortar.
D. Use Type N mortar for other masonry work, except as otherwise specified.

- - - E N D - - -

SECTION 04 05 16
MASONRY GROUTING

PART 1 - GENERAL

1.1 DESCRIPTION:

A. Section specifies grout materials and mixes.

1.2 RELATED WORK:

A. Grout used in Section:
   1. Section 04 20 00, UNIT MASONRY
   2. Section 04 43 00, NATURAL STONE VENEER.

1.3 TESTS:

A. Certified test reports for grout and materials specified.
B. Identify materials by type, brand name and manufacturer or by origin.
C. After tests have been made and materials approved, do not change without additional test and approval of Resident Engineer.
D. Testing:
   1. Grout:
      a. Test for compressive strength; ASTM C1019.
      b. Grout compressive strength of 13790 kPa (2000 psi) at 28 days.
   2. Cement:
      a. Test for water soluble alkali (non-staining) when non-staining cement is specified.
      b. Non-staining cement shall contain not more than 0.03 percent water soluble alkali.
   3. Sand: Test for deleterious substances, organic impurities, soundness and grading.

1.4 SUBMITTALS:

A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
B. Certificates:
   1. Indicating that following items meet specifications:
      a. Portland cement.
      b. Masonry cement.
      c. Grout.
      d. Hydrated lime.
      e. Fine aggregate (sand).
C. Laboratory Test Reports:

1. Grout, each type.
2. Admixtures.

D. Manufacturer's Literature and Data:

1. Cement, each kind.
2. Hydrated lime.
3. Admixtures.
4. Liquid acrylic resin.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING:

A. Deliver masonry materials in original sealed containers marked with name of manufacturer and identification of contents.

B. Store masonry materials under waterproof covers on planking clear of ground, and protect damage from handling, dirt, stain, water and wind.

1.6 APPLICABLE PUBLICATIONS:

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

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

C40/C40M-20.....Standard Test Method for Organic Impurities in Fine Aggregates for Concrete
C91/C91M-18.....Standard Specification for Masonry Cement
C150/C150M-22.....Standard Specification for Portland Cement
C207-18.....Standard Specification for Hydrated Lime for Masonry Purposes
C404-18.....Standard Specification for Aggregate for Masonry Grout
C476-22.....Standard Specification for Grout for Masonry
C595/C595M-21.....Standard Specification for Blended Hydraulic Cement
C1019-20.....Standard Test Method for Sampling and Testing Grout

PART 2 - PRODUCTS

2.1 HYDRATED LIME:

A. ASTM C207, Type S.

2.2 AGGREGATE FOR MASONRY GROUT:

A. ASTM C404, Size 8.

2.3 BLENDED HYDRAULIC CEMENT:

A. ASTM C595, Type IS, IP.

2.4 MASONRY CEMENT:

A. ASTM C91. Type N, S, or M.

2.5 PORTLAND CEMENT:

A. ASTM C150, Type I.

2.6 LIQUID ACRYLIC RESIN:

A.A formulation of acrylic polymers and modifiers in liquid form designed for use as an additive for mortar to improve physical properties.

2.7 WATER:

A.-Potable, free of substances that are detrimental to grout, masonry, and metal.

2.8 GROUT:

A. Conform to ASTM C476 except as specified.

B. Grout type proportioned by volume as follows:

1. Fine Grout:
   a. Portland cement or blended hydraulic cement: one part.
   b. Hydrated lime: 0 to 1/10 part.
   c. Fine aggregate: 2-1/4 to three times sum of volumes of cement and lime used.
2. Coarse Grout:
   a. Portland cement or blended hydraulic cement: one part.
   b. Hydrated lime: 0 to 1/10 part.
   c. Fine aggregate: 2-1/4 to three times sum of volumes of cement and lime used.
   d. Coarse aggregate: one to two times sum of volumes of cement and lime used.
3. Sum of volumes of fine and coarse aggregates: Do not exceed four times sum of volumes of cement and lime used.

PART 3 - EXECUTION

3.1 MIXING:

A. Mix in a mechanically operated grout mixer.

1. Mix grout for at least five minutes.

B. Measure ingredients by volume.

C. Mix water with grout dry ingredients in sufficient amount to bring grout mixture to a pouring consistency.

3.2 GROUT USE LOCATIONS:

A. Use fine grout for filling wall cavities and cells of concrete masonry units where the smallest dimension is 50 mm (2 inches) or less.

B. Use either fine grout or coarse grout for filling wall cavities and cells of concrete masonry units where the smallest dimension is greater than 50 mm (2 inches).

C. Do not use grout for filling bond beam or lintel units.

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SECTION 04 20 00
UNIT MASONRY

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section specifies requirements for construction of masonry unit walls.

1.2 RELATED WORK

A. Mortars and Grouts: Section 04 05 13, MASONRY MORTARING, Section 04 05 16, MASONRY GROUTING.

B. Steel Lintels and Shelf Angles: Section 05 50 00, METAL FABRICATIONS.

C. Cavity Insulation: Section 07 21 13, THERMAL INSULATION.

D. Flashing: Section 07 60 00, FLASHING AND SHEET METAL.

E. Sealants and Sealant Installation: Section 07 92 00, JOINT SEALANTS.

F. Anchorage Requirements: Section 04 43 00 NATURAL STONE VENEER

G. Anchorage requirements for unit masonry: 03 48 26 PRECAST CONCRETE COLUMBARIUM UNITS.

1.3 SUBMITTALS

A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA AND SAMPLES.

B. Samples:

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.
2. Concrete masonry units, when exposed in finish work.

C. Shop Drawings:

1. Indicate special masonry shapes.
2. Indicate reinforcement, applicable dimensions and methods of hanging soffit or lintel masonry and reinforcing masonry for embedment of anchors for hung fixtures.
3. Submit shop drawings for fabrication, bending, and placement of reinforcing bars prepared in accordance with ACI 315.

D. Certificates:

1. Submit 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. Indicate that the following items meet specification requirements:

b. Solid and load-bearing concrete masonry units.

3. Identify testing laboratories facilities and qualifications of its principals and key personnel to perform tests specified.

E. Manufacturer's Literature and Data:

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

1.4 SAMPLE PANEL

A. Before starting masonry, lay up a sample panel in accordance with Masonry Standards Joint Committee (MSJC)

1. Use masonry units from random cubes of units delivered on site.
2. Include reinforcing, ties, and anchors.

B. Use sample panels approved by RE/COR for standard of workmanship of new masonry work.

C. Use sample panel to test cleaning methods.

D. Sample Panel Size: Minimum 1220mm x 1220mm (4’ x 4’).

1.5 WARRANTY

A. Warranty exterior masonry walls against moisture leaks and subject to terms of "Warranty of Construction", FAR clause 52.246-21, except that warranty period to be five 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. American Society for Testing and Materials (ASTM):

A615/A615M-12	Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
A675/A675M-03 (2009)	Steel Bars, Carbon, Hot-Wrought, Special Quality, Mechanical Properties
A951/A951M-11	Steel Wire for Masonry Joint Reinforcement
C90-12	Load bearing Concrete Masonry Units
C476-10	Grout for Masonry
C612-10	Mineral Fiber Block and Board Thermal Insulation

D1056-07 Flexible Cellular Materials - Sponge or Expanded Rubber

C. American Welding Society (AWS):

D1.4/D1.4M-11 Structural Welding Code – Reinforcing Steel

E. Masonry Industry Council:

Hot and Cold Weather Masonry Construction Manual, 1999

F. Masonry Standards Joint Committee; Specifications for Masonry Structures (TMS 602-11/ACI 530.1-11/ASCE 6-11) (MSJC)

G. American Concrete Institute (ACI):

SP-66(2004) ACI Detailing Manual

1.7 PRE-INSTALLATION CONFERENCE

A. Convene a meeting on site, after submittals are received and approved but before any work, to review drawings and specifications, submittals, schedule, manufacturer instructions, site logistics and pertinent matters of coordination, temporary protection, governing regulations, tests, and inspections; participants to include RE/COR and all parties whose work is affected or related to the work of this section.

PART 2 - PRODUCTS

2.1 CONCRETE MASONRY UNITS

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

1. Unit Weight: Normal weight.
2. Sizes: Modular.

2.2 REINFORCEMENT

A. Steel Reinforcing Bars: ASTM A615, deformed bars, 420 MPa (Grade 60) for bars No. 10 to No. 57 (No. 3 to No. 18), except as otherwise indicated.

B. Where 6 mm diameter (No. 2) bars are shown, provide plain, round, carbon steel bars, ASTM A675, 550 MPa (Grade 80).

2.3 PREFORMED COMPRESSIBLE JOINT FILLER

A. Thickness and depth to fill the joint as specified.

B. Closed Cell Neoprene: ASTM D1056, Type 2, Class A, Grade 1.

C. Non-Combustible Type: ASTM C612, Type V, 1800 degrees F.

2.4 ACCESSORIES

A. Weeps: Glass fiber ropes, 10 mm (3/8 inch) minimum diameter, 300 mm (12 inches) long.

B. Mesh Weep/Vent: Free-draining mesh; made from polyethylene strands, of length required to extend from exterior face of stone to cavity behind, in color selected from manufacturer's standard.

C. Cavity Drain Material: Recycled polyester/polyethylene mesh trapezoidal shaped to maintain cavity air flow and drainage while suspending mortar droppings at unequal heights.

D. Reinforcing Bar Positioners: Wire units designed to fit into mortar bed joints spanning masonry unit cells with loops for holding reinforcing bars in center of cells. Units are formed from 0.148-inch steel wire, hot-dip galvanized after fabrication. Provide units designed for number of bars indicated.

E. Masonry Cleaner:
   1. Detergent type cleaner selected for each type of masonry used.
   2. Acid cleaners are not acceptable.
   3. Use soap-less type specially prepared for cleaning brick or concrete masonry as appropriate.

PART 3 - EXECUTION

3.1 JOB CONDITIONS

A. Protection:
   1. Cover tops of walls with non-staining waterproof covering, when work is not in progress; secure to prevent wind blow off.
   2. On new work protect base of wall from mud, dirt, mortar droppings, and other materials that will stain face, until final landscaping or other site work is completed.

B. Cold Weather Protection:
   1. Masonry may be laid in freezing weather when methods of protection are utilized.
   2. Comply with MSJC and “Hot and Cold Weather Masonry Construction Manual”.

3.2 CONSTRUCTION TOLERANCES

A. Lay masonry units plumb, level and true to line within the tolerances as per MSJC requirements and as follows:

B. Maximum variation from plumb:
   1. In 3,000 mm (10 feet) - 6 mm (1/4 inch).
   2. In 6,000 mm (20 feet) - 10 mm (3/8 inch).

C. Maximum variation from level:

1. In any bay or up to 6,000 mm (20 feet) - 6 mm (1/4 inch).
2. In 12,000 mm (40 feet) or more - 13 mm (1/2 inch).

D. Maximum variation from linear building lines:
1. In any bay or up to 6,000 mm (20 feet) - 13 mm (1/2 inch).
2. In 12,000 mm (40 feet) or more - 19 mm (3/4 inch).

E. Maximum variation in cross-sectional dimensions of columns and thickness of walls from dimensions shown:
1. Minus 6 mm (1/4 inch).
2. Plus 13 mm (1/2 inch).

F. Maximum variation in prepared opening dimensions:
1. Accurate to minus 0 mm (0 inch).
2. Plus 6 mm (1/4 inch).

3.3 INSTALLATION GENERAL

A. Keep finish work free from mortar smears or spatters and leave neat and clean.

B. Anchor masonry as specified in Paragraph, ANCHORAGE.

C. Wall Openings:
1. Fill hollow metal frames built into masonry walls and partitions solid with mortar as laying of masonry progresses.
2. If items are not available when walls are built, prepare openings for subsequent installation.

D. Tooling Joints:
1. Do not tool until mortar has stiffened enough to retain thumb print when thumb is pressed against mortar.
2. Tool while mortar is soft enough to be compressed into joints and not raked out.
3. Finish joints in exterior face masonry work with a jointing tool, and provide smooth, water-tight concave joint unless specified otherwise.
4. Tool Exposed interior joints in finish work concave unless specified otherwise.

E. Lintels:
1. Lintels are not required for openings less than 1,000 mm (3 feet 4 inches) wide that have hollow metal frames.
2. Openings 610 mm (2 feet 0 inches) wide to 1600 m (5 feet 4 inches) wide with no structural steel lintel or frames, require a lintel

formed of concrete masonry lintel or bond beam units filled with grout per ASTM C476 and reinforced with 1- #15m (1-#5) rod top and bottom for each 100 mm (4 inches) of nominal thickness unless shown otherwise.

3. Use steel lintels, for openings over 1600 m (5 feet 4 inches) wide, and brick masonry unless shown otherwise.
4. Provide length for minimum bearing of 100 mm (4 inches) at ends.

F. Before connecting new masonry with previously laid, remove loosened masonry or mortar, and clean and wet work in place as specified under wetting.

G. When new masonry partitions start on existing floors, machine cut existing floor finish material down to concrete surface.

H. Wetting and Wetting Test:
1. Test and wet brick in accordance with BIA 11B.
2. Do not wet concrete masonry units before laying.

3.4 REINFORCEMENT

A. Steel Reinforcing Bars:
1. Install in cells of hollow masonry units where required for vertical reinforcement and in bond beam units for lintels and bond beam horizontal reinforcement. Install in wall cavities of reinforced

3.5 CMU CONTROL JOINTS

A. Provide CMU control (CJ) joints where shown on drawings.

B. Keep joint free of mortar and other debris.

C. Where joints occur in masonry walls:
1. Install preformed compressible joint filler in brick wythe.
2. Install cross shaped shear keys in concrete masonry unit wythe with preformed compressible joint filler on each side of shear key unless otherwise specified.
3. Install filler, backer rod, and sealant on exposed faces.

D. Use standard notched concrete masonry units (sash blocks) made in full and half-length units where shear keys are used to create a continuous vertical joint.

F. Fill opening in exposed face of expansion and control joints with sealant as specified in Section 07 92 00, JOINT SEALANTS.

3.6 EXPANSION JOINTS

A. Keep joint free of mortar. Remove mortar and other debris.

B. Install non-combustible, compressible type joint filler to fill space completely except where sealant is shown on joints in exposed finish work.

C. Where joints are on exposed faces, provide depth for backer rod and sealant as specified in Section 07 92 00, JOINT SEALANTS, unless shown otherwise.

3.7 CONCRETE MASONRY UNITS

A. Kind and Users:

1. Provide special concrete masonry shapes as required, including lintel and bond beam units, sash units, and corner units. Use solid concrete masonry units, where full units cannot be used, or where needed for anchorage of accessories.
2. Provide solid load-bearing concrete masonry units or grout the cell of hollow units at jambs of openings in walls, where structural members impose loads directly on concrete masonry, and where shown.

B. Laying:

1. Lay concrete masonry units with 10 mm (3/8 inch) joints, with a bond overlap of not less than 1/4 of the unit length.
2. Do not wet concrete masonry units before laying.
3. Bond external corners of partitions by overlapping alternate courses.
4. Lay first course in a full mortar bed.
5. Set anchorage items as work progress.
6. Where ends of anchors, bolts, and other embedded items, project into voids of units, completely fill such voids with mortar or grout.
7. Lay concrete masonry units with full face shell mortar beds and fill head joint beds for depth equivalent to face shell thickness.
8. Lay concrete masonry units so that cores of units, that are to be filled with grout, are vertically continuous with joints of cross webs of such cores completely filled with mortar.
9. Do not wedge the masonry against the steel reinforcing. Minimum 13 mm (1/2 inch) clear distance between reinforcing and masonry units.
10. Hold vertical steel reinforcement in place by centering clips, caging devices, tie wire, or other approved methods, vertically at spacing noted.

11. Grout cells of concrete masonry units, containing the reinforcing bars, solid as specified under grouting.

3.8 GROUTING

A. Preparation:
   1. Clean grout space of mortar droppings before placing grout.
   2. Close cleanouts.

B. Placing:
   1. Consolidate each lift of grout after free water has disappeared but before plasticity is lost.
   2. Interruptions: When grouting must be stopped for more than an hour, top off grout 40 mm (1-1/2 inch) below top of last masonry course.

3.9 PLACING REINFORCEMENT

A. General: Clean reinforcement of loose rust, mill scale, earth, ice or other materials which will reduce bond to mortar or grout. Do not use reinforcement bars with kinks or bends not shown on the Contract Drawings or final shop drawings, or bars with reduced cross-section due to excessive rusting or other causes.

B. Position reinforcement accurately at the spacing indicated. Support and secure vertical bars against displacement. Horizontal reinforcement may be placed as the masonry work progresses. Where vertical bars are shown in close proximity, provide a clear distance between bars of not less than the nominal bar diameter or 25 mm (1 inch), whichever is greater.

C. Splice reinforcement bars where shown; do not splice at other places unless accepted by the RE/COR. Provide lapped splices, unless otherwise indicated. In splicing vertical bars or attaching to dowels, lap ends, place in contact and wire tie.

D. Provide not less than minimum lap as indicated on shop drawings, or if not indicated, as required by governing code.

E. Embed metal ties in mortar joints as work progresses, with a minimum mortar cover of 15 mm (5/8 inch) on exterior face of walls and 13 mm (1/2 inch) at other locations.

F. Pipe enclosures and other special conditions.

G. Anchoring: Anchor reinforced masonry work to supporting structure as indicated.

3.10 CLEANING AND REPAIR

A. General:

1. Clean exposed masonry surfaces on completion.
2. Protect adjoining construction materials and landscaping during cleaning operations.
3. Cut out defective exposed new joints to depth of approximately 19 mm (3/4 inch) and repoint.
4. Remove mortar droppings and other foreign substances from wall surfaces.

C. Concrete Masonry Units:

1. Immediately following setting, brush exposed surfaces free of mortar or other foreign matter.
2. Allow mud to dry before brushing.

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SECTION 04 43 00
NATURAL STONE VENEER AND CAPS

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section specifies requirements for construction of natural stone veneer.

1.2 RELATED WORK

A. Cast-in-place concrete columbarium wall complexes: Section 03 30 53, CAST-IN-PLACE CONCRETE (SHORT FORM).

B. Precast Concrete Columbarium Niches: 03 48 24, PRECAST CONCRETE COLUMBARIUM UNITS.

C. Mortars and grouts: Section 04 05 13, MASONRY MORTARING

E. Sealants and sealant installation: Section 07 92 00, JOINT SEALANTS.

F. Color and texture of masonry units: Section 09 06 00, SCHEDULE FOR FINISHES.

G. Mockup: Section 01 43 39 MOCKUP REQUIREMENTS

1.3 SUBMITTALS

A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA AND SAMPLES.

B. Samples:

1. Stone Type 1 and Stone Type 2 (Full and Thin), minimum 1” thick, 200 mm by 400 mm (8 inches by 16 inches), showing full color range and texture of stone, bond, and proposed mortar joints.
2. Anchors and ties, one each, and joint reinforcing 1200 mm (48 inches) long.
3. Masonry accessories including all stainless steel hardware, cell vents (each type), 4-inch x 4-inch self adhesive EPDM, thru-wall flashing, 12-inches stainless steel termination bar, 12-inches x 12-inches rainscreen mat and 12-inches x 12-inches stainless steel expanded metal lath and 12” x 8” mortar mesh.

C. Certificates

1. Certificates signed by stone source, including name and address of contractor, project location, and the quantity, and date or dates of shipment of delivery to which certificate applies; indicate that the stone veneer meets specification requirements.

2. Certificates shall indicate that the following items meet specification requirements:
   a. Full Stone veneer – 4 inch
   b. Thin Stone veneer – 1-1/8 inch
   c. Stone caps

D. Manufacturer's Literature and Data:
   1. ASTM stone classification, stone type, color, texture, grade and finish.
   2. Anchors, ties, and reinforcement.
   3. Weeps/Cell Vents.
   4. Self Adhesive EPDM.
   5. Thru-Wall Flashings.
   6. Stainless Steel Termination Bar.
   7. Mortar Mesh.
   8. Reinforcing bars.
   10. Recommended cleaning products and techniques.
   11. Natural Stone Repair Kits.
   12. Rainscreen Drainage Mat.

E. Submit stone suppliers installation instructions and field erection drawings.

F. Test Reports: Prior to erection of mockup and ordering stone, submit information copies of test reports by approved independent testing laboratory as specified herein to VA in triplicate – for review and approval. Test reports of stone to be installed shall indicate stone ASTM classification, stone type, color, texture, grade and finish.

G. Cutting and setting drawings indicating unit location number.
   1. Indicate pertinent dimensioning, layout, anchorages, construction details, method of installation, adjacent construction and jointing. Construction document drawings may not be used as cutting and setting drawings.

1.4 MOCKUPS

A. See section 01 43 39 MOCKUP REQUIREMENTS.

1.5 QUALITY ASSURANCE

A. Comply with requirements of listed standards and manufacturer's unless otherwise indicated. Where there is conflict between construction

documents and manufacturer's requirements the most stringent shall apply.

B. Obtain stone from a single quarry with consistent, quality, grade, color range and texture throughout work.

C. Subcontract (if necessary) the fabrication of stone to a firm which has successfully fabricated stone similar in quality specified for period of not less than 5 years and is equipped to provide quantity and sizes shown. Provide written documentation of the above, for VA approval, prior to ordering stone.

1.6 WARRANTY SHIPPING

A. Do not ship stone with spacer material that will stain or mark the stone finish.

1.7 ENVIRONMENTAL REQUIREMENTS

A. At the end of each working day, and also during precipitation events, cover stonework exposed to weather with waterproof coverings, securely anchored extending at least 2 feet down both sides of walls.

B. Stone cap joints and wall joints: Continue to cover stonework (including stone caps) until all cap and wall joints are properly sealed and cured and are able to protect the columbaria and memorial wall from all weather and from cleaning.

C. Maintain materials and surrounding air to minimum 40 degrees F prior to, during, and 48 hours after completion of work.

D. Do not use frozen materials or materials mixed or coated with ice or frost. Do not use salt to thaw ice in anchor holes or slats. Do not lower freezing point of mortar by use of admixtures or antifreeze agents.

E. Do not build on frozen work; remove and replace stonework damaged by frost or freezing.

F. Do not use calcium chloride in mortar or grout.

1.8 PRODUCT DELIVERY

A. Cover and protect stone during storage and construction against moisture, soiling, staining and physical damage.

B. Handle stone to prevent chipping, breakage, soiling, or other damage. Do not use pinch or wrecking bars without protecting edges of stone with wood or other rigid materials.

C. Store stone on wood skids or pallets. Place and stack skids and stones to distribute weight evenly and to prevent breakage or cracking of stones. Protect stored stone from weather with waterproof, non-staining covers or enclosures, allow air to circulate around stones. Protect stone from ground splatter and contamination with earth.

D. Protect mortar materials and stonework accessories from weather, moisture, and contamination with earth and other foreign materials.

1.9 WARRANTY

A. Warrant exterior stone veneer against moisture leaks and subject to terms of "Warranty of Construction", FAR clause 52.246-21, except that warranty period to be five years.

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

A82/A82M-07	Steel Wire, Plain, for Concrete Reinforcement
A153/A153M-09	Zinc Coating (Hot-Dip) on Iron and Steel Hardware
A951/A951M-11	Steel Wire for Masonry Joint Reinforcement
C97/C97M-09	Absorption and Bulk Gravity of Dimension Stone
C99/C99M-09	Modulus of Rupture of Dimension Stone
C119-11	Standard Terminology Relating to Dimension Stone
C170/C170M-09	Compressive Strength of Dimension Stone
C568/C568M-10	Limestone Dimension Stone
C615/C615M-11	Granite Dimension Stone
C616/C616M-10	Quartz-Based Dimension Stone
C880/C880M-09	Flexural Strength of Dimension Stone
C1242-12ae1	Selection, Design, and Installation of Dimension Stone Attachment Systems
C1353-09	Abrasion Resistance of Dimension Stone Subjected to Foot Traffic Using a Rotary Platform, Double-Head Abraser

C1515-11	Cleaning of Exterior Dimension Stone, Vertical and Horizontal Surfaces, New or Existing
C1528-12b	Selection of Dimension Stone
D1056-07	Flexible Cellular Materials – Sponge Expanded Rubber
D7089-06	Determination of the Effectiveness of Anti-Graffiti Coating for Use on Concrete, Masonry, and Natural Stone Surfaces by Pressure Washing

C. Masonry Industry Council:
All Weather Masonry Construction Manual, 2000

D. International Masonry Industry All Weather Council (IMIAC):
Recommended Practices and Guide Specification for Cold Weather Masonry Construction

1.11 PRE-INSTALLATION CONFERENCE

A. Convene a meeting on site, after the mockup is constructed and submittals are received and approved but before any work, to review drawings and specifications, submittals, schedule, manufacturer instructions, site logistics and pertinent matters of coordination, temporary protection, governing regulations, tests and inspections; participants to include COR and all parties whose work is affected or related to the work of this section.

PART 2 - PRODUCTS

2.1 ACCEPTABLE STONE PRODUCTS

A. Type 1 Stone Veneer and Caps: Meet ASTM C568, Classification: II Medium-Density.
1. Maximum Absorption per ASTM C97: 7.5 percent.
2. Minimum Compressive Strength per ASTM C170: 4,000 PSI.
3. Density per ASTM C97: 144lb/ft3.
4. Minimum Modulus of Rupture per ASTM C99: 700 PSI.
5. Size: See drawings.
6. Color Range, finish, manufacturer/producer as demonstrated on approved material board and shall match existing columbaria veneer and caps.
7. Basis of Design:
A. Polycor: Indiana Limestone Standard Silver Buff.

8. Grade(ILI Range): Select, Monochromatic in color
   A. Select – fine grained stone having a controlled minimum of the following blemishes:
      1. Streaks, spots, fossil formations, pit holes, reedy formations, texture streaks, honeycomb, travertine-like formations and grain formations changes.

B. Type 2 Stone Full and Thin Veneer: Dolomitic Limestone.
   1. Maximum Absorption per ASTM C97: 0.36 percent.
   2. Minimum Compressive Strength with rift per ASTM C170: 29,040 PSI.
   3. Minimum Modulus of Rupture per ASTM C99: 1,470 PSI.
   4. Minimum Flextural Strength per ASTM C880: 1,740 PSI.
   5. Minimum Density per ASTM C97: 174.2lb/ft3.
   6. Size: Shall match existing columbaria stone veneer sizes.
   7. Color Range, finish, manufacturer/producer as demonstrated on approved material board and mockup.
   8. Basis of Design:
      A. Buechel Stone Corp: Dimensional Fond Du Lac Tailored Blend

2.2 REINFORCEMENT AND ANCHORAGES

A. Materials: Provide anchors specified in subsequent paragraphs that are made from materials that comply paragraphs below, unless otherwise indicated.
   1. Stainless Steel: Type 304.
      a. Sheet Metal: ASTM A 167 or ASTM A 240/A 240M

B. Anchors, General: Unless otherwise indicated, size anchors to extend at least halfway through veneer. Outer ends of anchor are bent 90 degrees and extend 3/4-inches minimum parallel to face of veneer.

C. Adjustable Masonry-Veneer Anchors for Full Veneer Masonry:
   1. General: Provide anchors that allow vertical adjustment but resist tension and compression forces perpendicular to plane of wall, for attachment to cast-in-place concrete stem wall, and as follows:
      a. Structural Performance Characteristics: Conform to stone supplier’s requirements and recommendations.
      b. Acceptable Product: Heckmann Building Products, Inc.; No. 274 Stainless Steel Screw-On Split-Bend Stone Anchor, 1/8” thickness x 1-1/4” wide, 1” minimum (both ways) at split bend or approved equal.

2.3 ACCESSORIES

A. Joint Sealant: Refer to Section 07 92 00.

B. Nailing Strips: Western softwood, preservative treated, sized to masonry joints.

C. Cell Vents:

1. Full Veneer - Hohmann & Barnard QV – Quadro-Vent, standard size (3/8” x 2-1/2” x 3-3/8”) or approved equal.

2. Thin Veneer - Buechel Stone Corp. WOW-3639 or approved equal.

D. Rainscreen Drainage Mat (Thin Veneer): 0.024” thick high impact polystyrene sheets, formed with corrugations and spunbond polypropylene fabric on one side with a 4-inch minimum skirt on one edge.

1. Acceptable Product: Buechel Stone Corp. EMC-3639 or approved equal.

E. Mortar Mesh: Free-draining mesh, made from polymer strands that will not degrade within the wall cavity.

1. Strips, full-depth of cavity and 250 mm (10 inches) wide, with dovetail shaped notches 175 mm (7 inches) deep that prevent mesh from being clogged with mortar droppings.

2. Acceptable Product: Hohmann & Barnard Mortar Trap or approved equal.

F. Thru-Wall Flashings & Self Adhesive EPDM: Minimum 40-mil EPDM membrane, UV & Ozone resistant, Minimum Tensile Strength 6,000 PSI, Minimum Puncture Resistance 300 lbf./in.

1. Acceptable Product: Hohmann & Barnard Inc. Textroflash Flashing Self Adhering Flashing or approved equal.

G. Stainless Steel Termination Bar: 26 gauge x 1-1/2”-inch stainless steel with 1/4-inch diameter holes every 8-inches O.C. 3/8” flange on the top of the termination bar.

1.Acceptable Product: Hohmann & Barnard Inc. T2 - Termination Bar or approved equal.

H. Expansion Joint Fillers: ASTM D1056 Class RE-11.

I. Cementitious Dampproofing: Cementitious formulation nonstaining to stone; compatible with joint sealants and noncorrosive to anchors and attachments. Damp proofing to be compatible with stone product as per stone manufacturer’s requirements and recommendations utilize cementitious coatings such as Thoroseal.

2.4 STONE FABRICATION

A. Fabricate as shown and as detailed on reviewed shop drawings and in compliance with recommendations of applicable stone association.
B. Provide holes and sinkage cuts or drilled for anchors, fasteners, supports and lifting devices, as indicated and required to secure stonework in place. Shape beds to fit supports.
C. Accurately cut, dress, drill, fit and finish stonework to shapes and sizes indicated. Cut edges square to face. Make arise straight, sharp, and true.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that field conditions are acceptable and are ready to receive work.
B. Verify items provided by other Sections of work are properly sized and located.
C. Verify that built-in items are in proper location, and ready for roughing into masonry work.
D. Beginning of installation means installer has erected a fully approved on-site mockup and accepts existing conditions.

3.2 PREPARATION

A. Verify final approval of the mockup as detailed in section 1.4 herein.
B. Verify items provided by other Sections of work are properly sized and located.
C. Establish lines, levels, and coursing; protect from disturbance.
D. Provide temporary bracing during erection of masonry work. Maintain in place until building structure provides permanent bracing.
E. Scaffolding: Provide, erect, maintain, move, and finally remove scaffolding and staging required for masonry installation. Construct and maintain scaffolding in compliance with applicable ordinances, laws, rules and regulations. Scaffolding must be sufficiently substantial to support workmen, and necessary materials and equipment. Provide adequate guard rails for protection of property, workmen, and passerby.
F. Clean dirty or stained stone surfaces by removing soil, stains, and foreign materials before setting. Clean stone by thoroughly scrubbing

with fiber brushes and then drenching with clear water. Use only mild cleaning compounds that contain no caustic or harsh materials or abrasives.

G. Coat stone with dampproofing to extent indicated below:
   1. Stone at Grade: Beds, joints, and back surfaces to at least 12 inches above finish-grade elevations.
   2. Stone Extending Below Grade: Beds, joints, back surfaces, and face surfaces below grade.
   3. Allow dampproofing to cure before setting dampproofed stone. Do not damage or remove dampproofing while handling and setting stone.

3.3 INSTALLATION

A. All work performed under this section shall be in accordance with the Specifications, Drawings, and Manufacturer's instructions and recommendations. In the event of a conflict, the stricter requirement shall prevail.

B. Erect stone in accordance with stone manufacturer's instructions, in the event that there is conflict with the construction documents, the stricter requirement shall prevail. Provide chases, reveals, reglets, openings, and other spaces as indicated or required for contiguous work.

C. Arrange stone pattern to provide consistent joint work throughout as per approved shop drawings.

D. Place setting buttons in full mortar setting bed to support stone over and establish joint dimension.

E. Set stone in full mortar setting bed to support stone over full bearing surface and to establish joint dimensions.
   1. Point joints after setting by tooling to concave profile (verify profile with VA during job mock-up).

F. Shore up units until settling bed will maintain panel in position without movement.

G. Maintain uniform joint widths of 3/8 inch in exterior locations unless otherwise indicated.

H. Allowable tolerances:
   1. Variation from Plumb: For lines, corners, and surfaces of walls, do not exceed 1/4 inch in 10 feet.
   2. Maximum variation from plane of unit to adjacent unit: 1/32 inch.

I. Where stonework will contact ferrous metal surfaces concealed in back-up construction, apply heavy coat of bituminous paint on metal surfaces prior to setting of stone. Do not stain stone.

J. Cavity Construction: Keep open space between back of stone units and back-up as shown, keep cavity open; fill with mortar mesh; do not fill with mortar or grout – allow any moisture to exit at lower cell vents. See Section 07 60 00 Flashing and Sheet Metal.

3.4 COURSING

A. Place masonry to lines and level indicated.

B. For stone Type 1, arrange stones as shown on the drawings.

C. For stone Type 2, arrange and trim stones for adequate fit in a range ashlar pattern with course heights as indicated, random lengths, uniform joint widths with offset between vertical joints as indicated.

3.5 PLACING AND BONDING

A. Lay masonry in full bed of mortar (horizontal, vertical, and collar joints), properly jointed with other work. Buttering corners of joints and deep or excessive furrowing of mortar joints is not permitted.

B. Fully bond intersections, and external and internal corners.

C. Do not shift or tap masonry units after mortar has taken initial set. Where adjustment must be made, remove mortar and replace.

D. Remove excess mortar on surface and in cavities.

E. Perform job site saw cutting with proper tools to provide straight unchipped edges. Take care to prevent breaking masonry unit corners or edges.

3.6 TOLERANCES

A. Alignment of Columns: Maximum of 6 mm (1/4 inch) from true line.

B. Variation from Unit to Adjacent Unit: 0.8 mm (1/32 inch) maximum.

C. Variation from Plane of Wall: 6 mm (1/4 inch) in 3 m (10 feet) and 12 mm (1/2 inch) in 6 m (20 feet) or more.

D. Variation from Plumb: 6 mm (1/4 inch) per story non-cumulative, 12 mm (1/2 inch) in two stories or more.

E. Variation from Level Coursing: 3 mm (1/8 inch) in 1 m (3 feet); 6 mm (1/4 inch) in 3 m (10 feet); 6 mm (1/4 inch) maximum.

F. Variation of Joint Thickness: 3 mm (1/8 inch) in 1 m (3 feet).

G. Maximum variation from Cross Sectional Thickness of Walls: Plus or minus 6 mm (1/4 inch).

3.7 REINFORCEMENT AND ANCHORAGES

A. Attach wall anchors to cast-in-place concrete walls for full veneer construction at maximum 400 mm (16 inches) o.c. vertically and 400 mm (16 inches) o.c. horizontally. Place at maximum 200 mm (8 inches) o.c. (or every third course) each way around perimeter of openings, within 300 mm (12 inches) of openings.

B. Anchor stone veneer to cast in place concrete with metal veneer anchors as follows:

1. Secure anchors to cast-in-place concrete wall with 3/8” dia. stainless steel masonry screws.
2. Cut a slot within the top and bottom of stone veneer to accept split bend anchor. Embed split bend anchor into stone veneer within 25 mm (1 inch) of face.

3.8 MASONRY FLASHINGS

A. Install mortar hauch as shown on the drawings. Extend flashing to 1/2" of the exterior face of veneer, turn up over the mortar haunch and seal onto face of the cast-in-place concrete with the termination bar and sealant.

B. Install EPDM membrane over the top of cast-in-place concrete walls and piers and precast niche units. Extend EPDM membrane to 1/2" of the exterior face of the veneer and precast niche units.

B. Lap end joints minimum 150 mm (6 inches) and seal watertight per manufacturer’s recommendation.

C. Use flashing manufacturer’s recommended adhesive and termination sealant.

D. Create end dams at end of cast-in-place concrete piers and precast niches, and other vertical elements to channel water to nearest weep vent.

3.9 LINTELS

A. Install loose steel lintels as scheduled or shown. Leave space at end of lintels to expand.

3.10 WEEP VENTS AND SEALANT

A. Install weep vents vertically between stone veneer joints at the bottom of veneer walls and columns at 24 inches on center minimum horizontally above through-wall flashing.
B. Install weep vents above EPDM horizontally below each cap joint. Install backrod and sealant between each weep vent
C. Install weep vents below EPDM vertically between stone veneer joints at each cap joint.
C. Install weep vents horizontally at the bottom of each precast niche/niche and precast niche/stone veneer junction. Install sealant between cast-in-place concrete and precast niches.
D. Install sealant between cell vent and stone veneer if gap exceeds 1/16” or greater.
E. Cell vents shall be free of any debris, mortar, sealant, etc.

3.11 CONTROL/EXPANSION JOINTS

A. Size control joints in accordance with Section 07 92 00 for sealant performance, but in no case larger than adjacent mortar joints.
B. Provide expansion joints as indicated.

3.12 BUILT-IN WORK

A. As work progresses, fabricated metal weld plates, anchor bolts, plates, and other items to be built in the work supplied by other Sections. All hardware to be stainless steel.
B. Build-in items plumb and level.
C. Bed anchors in mortar joints. Fill frame voids solid with mortar.
D. Do not build-in organic materials subject to deterioration.

3.13 CUTTING AND FITTING

A. Cut and fit for cavities and sleeves. Cooperate with other Sections of work to provide correct size, shape, and location.
B. Obtain approval prior to cutting or fitting any area not indicated or where appearance or strength of masonry work may be impaired.

3.14 CLEANING

A. Remove excess mortar and smears.
B. Replace defective mortar. Match adjacent work.
C. Clean soiled surfaces with non-acidic solution which will not harm masonry or adjacent materials. Consult masonry manufacturer for

acceptable cleaners. Leave surfaces thoroughly clean and free of all mortar and other soiling.

D. Use non-metallic tools in cleaning operations.

E. Comply with ASTM C1515 and D7089.

3.15 PROTECTION

A. Maintain protective boards at exposed external corners which may be damaged by construction activities.

B. Provide protection without damaging completed work.

C. Keep expansion joint voids clear of mortar.

D. At end of each working day, and during working day rainy weather, cover stonework exposed to weather with waterproof coverings, securely anchored extending at least 2 feet down both sides of walls. Cover stonework (including stone caps) until all cap and wall joints are properly sealed and cured to be able to protect the wall/columbarium wall from weather and cleaning.

3.16 REPLACEMENT AND REPAIR

A. Stone caps and veneer which are damaged, chipped, cracked, stained, improperly fabricated or otherwise defective shall be removed and replaced. Stone units having minor defects not affecting serviceability or appearance may be repaired when approved by the COR. Repaired work shall be sound, permanent, flush with adjacent surfaces and of color and texture matching adjoining surfaces and shall show no line of demarcation between original and patched surfaces. Replacement and repairs shall be done at no additional cost to the Government.

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SECTION 04 73 00
COLUMBARIUM NICHE COVERS

PART 1 - GENERAL

1.1 GENERAL PROVISIONS

1. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 1 – GENERAL REQUIREMENTS, which are hereby made part of this Section of the Specifications.

1.2 DESCRIPTION

A. Work Included: Provide labor and materials necessary to complete the work of this Section, including but not limited to the following:
   1. The Department of Veterans Affairs (VA) shall furnish niche covers for all of the new Columbarium Niches being installed by the Contractor. This specification section is for all work necessary for the Contractor to accept, handle, store, move and install one, government approved and provided, blank columbarium niche cover for each of the new precast niches created in the new columbarium walls. The government shall also provide, as part of the niche cover products manufactured for this project, a predetermined minimum number of approved blank niche covers to act as spares. The spare niche covers are to be used to replace niche covers should any damage occur, or for re-inscription necessitated by additional interment at a specific niche location.
   2. The number of approved government provided spare columbarium niche covers for this project to be accepted, offloaded and stored at the designated location is 10 percent above the total number of columbarium niche covers.

1.3 INSTALLER QUALIFICATIONS

A. Installation of columbarium niche covers will be performed by those companies who, through an approved certification process, have demonstrated previous experience in installation of similar design as indicated in the drawings and specified herein.

1.4 RELATED WORK

A. The following items are not included in this Section and will be performed under the designated Sections:
   1. Section 03 48 24: PRECAST CONCRETE COLUMBARIUM UNITS, the precast concrete niche units with: niche cover mounting hardware assemblies

(installed); and niche cover attachment hardware assemblies (provided for use to attach the Government provided niche covers). Four each of the niche cover mounting hardware assemblies shall be furnished and installed for each precast concrete niche opening. Four of each of the niche cover attachment hardware assemblies shall be provided for each precast niche opening, to be used to mount the approved government niche covers as indicated and on the drawings.

1.5 SUSTAINABILITY REQUIREMENTS

A. Materials in this section may contribute towards contract compliance with sustainability requirements. See Section 01 81 11, SUSTAINABLE DESIGN REQUIRMENTS, for project requirements.

B. Biobased Material: For products designated by the USDA's BioPreferred® program, provide products that meet or exceed USDA recommendations for biobased content, subject to the products compliance with performance requirements in this Section. For more information regarding the product categories covered by the BioPreferred® program, please visit http://www.biopreferred.gov/.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 NICHE COVERS (GOVERNMENT PROVIDED) - CONTRACTOR ACCEPTANCE

A. Niche covers that have been inspected and accepted as being in compliance with manufacturing tolerances for size, hole size and placement, perpendicularity, finish, and product stone quality shall be furnished by the Government and delivered to the site on pallets. They shall be of size, type, manufacturing, finish and quantities required for this project. The covers shall be delivered to the site Freight on Board (FOB) and the Contractor shall be responsible to offload and secure them at the job site. The general quantity and condition shall be observed and an adequate count to cover all the installed columbarium units, plus required spares shall be verified by the Contractor prior to accepting the units and performing the offloading operations. Note any shipping damage and reject any damaged covers before the delivery truck leaves the site. Once satisfied, take ownership of the acceptable covers, as all being approved as meeting the government specifications and being suitable for installation at this project. Once the niche covers are accepted at the site, they

shall become the Contractors responsibility until installed and the installation is accepted by the Contracting Officer's Representative (COR).

3.2 INSPECTION

A. All materials shall be inspected prior to installation to ensure compliance with the contract documents and to ensure there is no damage. Should conditions be different from those indicated on the contract documents, contractor should immediately notify the RE/COR.

3.3 NICHE COVER ATTACHMENT HARDWARE

A. Each of the four niche cover attachment hardware assemblies provided, for each new precast concrete niche opening, as part of Section 03 48 24, PRECAST CONCRETE COLUMBARIUM UNITS, consists of: the stainless steel tamperproof screw and the white or clear washer beneath the rosette, that is to bear against the niche cover when rosette is snugged up causing the cover to stay in place against the face of the niche opening due to friction. All of the niche cover hardware (mounting and attachment assemblies) shall be as submitted and approved as part of the work in Section 03 48 24, PRECAST CONCRETE COLUMBARIUM UNITS.

B. The Contractor performing the installation of the niche covers shall maintain control of the niche cover attachment hardware assemblies from delivery to the site through acceptance of the installation of the government provided niche covers.

3.4 INSTALLATION

A. Installation of the government provided niche covers shall include all materials, manpower, tools and equipment required to receive the approved government provided niche covers from the manufacturer, and handle them as necessary and perform whatever work is needed to result in the successful installation of one niche cover for every precast concrete niche space created for this project.

B. The niche covers shall be installed so as to create a visual straight line along the top of the row of covers agreed to by the Resident Engineer as the primary visual vertical reference line in the installation. The covers shall be spaced to achieve, as close as possible, the intended design spacing, taking into consideration the

allowable fluctuations in the manufacturing tolerances for the government provided niche covers.

C. The niche cover attachment assemblies shall be installed so that the threaded end of the tamperproof screw is inserted into the threads of the spring clip on the mounted angle bracket behind each of the mounting holes in the niche covers. This should result in the head of the screw being parallel with the face of the niche cover. The threaded hole in the spring clip shall be fully visible when looking through the mounting hole in the niche cover to the respective spring clip behind the hole. The position of the spring clip shall be adjusted so the threaded tamperproof screw will enter the threaded hole in the spring clip and that the attachment assembly can be tightened to secure the cover in the intended position. To achieve this installation, the angle brackets shall be adjusted to be the correct height from the niche wall so the hole in the spring clip can have the respective tamper proof screw inserted and tightened. To achieve the proper positioning of the spring clips, the angle brackets shall be adjusted in their position, or the hole in the angle bracket through which the tamper proof screw passes when tightened into the spring clip, shall be enlarged as necessary to allow the adjustment of the spring clip to align with the hole in the niche cover so the tamper proof screws through the individual rosettes can each be inserted and tightened using the threaded spring clip. Only correct installations of the tamperproof screws, inserted into the threads of the spring clip and being tightened are acceptable. The head of the tamperproof screw shall be snugged up tight against the rosette, and shall be seated against the rosette, which occurs when the tamperproof screw is approximately perpendicular to the face of the niche cover.

3.5 CLEANING AND PROTECTION

A. Columbarium niche covers shall be shop cleaned at the time of fabrication. After installation, carefully clean the markers, removing all dirt stains, and all other incident defacements.

1. Stiff bristle fiber brushes may be used, but the use of wire brushes or acid-type cleaning agents and other solutions which may cause discoloration is expressly prohibited. Fabricator should be

contacted regarding the use of any cleaners and must approve of them before use.

2. Protection of Finished Work: All covers that are installed as part of the work in progress shall be protected at all times during construction by use of a suitable strong, impervious film or fabric securely held in place.

B. Clean up area of excess material and debris. Clean visible portions of all covers.

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SECTION 04 73 10
MEMORIAL WALL MARKERS

PART 1 - GENERAL

1.1 GENERAL PROVISIONS

A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 1 – GENERAL REQUIREMENTS, which are hereby made part of this Section of the Specifications.

1.2 DESCRIPTION

A. Work Included: Provide labor and materials necessary to complete the work of this Section, including but not limited to the following:

1. The Department of Veterans Affairs (VA) shall furnish memorial wall markers for installation in the memorial wall(s) to be constructed by the Contractor. This specification section provides all work necessary for the Contractor to accept, handle, store, move and install one approved blank memorial wall marker for each of the memorial wall marker sites in the new memorial wall(s).
2. The number of approved government provided spare memorial wall markers for this project to be accepted, offloaded and stored at the designated location is 40.

1.3 INSTALLER QUALIFICATIONS

A. Installation of memorial wall markers will be performed by those companies who, through an approved certification process, have demonstrated previous experience in installation of similar design as indicated in the drawings and specified herein.

1.4 RELATED WORK

A. The following items are not included in this Section and will be performed under the designated Sections:

1. Section 03 48 26: CONCRETE MEMORIAL WALL UNITS, the cast-in-place concrete memorial wall units with: memorial wall marker mounting hardware assemblies (installed); and memorial wall marker attachment hardware assemblies (provided for use to attach the Government provided memorial markers). The memorial marker mounting hardware assemblies shall be furnished and installed at the corners of the memorial markers, whether they adjoin other markers, filler strips, or are a shadow box concrete installation. Refer to the drawings for specific details. A memorial wall marker attachment hardware

assembly will secure the corner of each approved government provided memorial wall marker, as shown on the drawings.

1.5 SUSTAINABILITY REQUIREMENTS

A. Materials in this section may contribute towards contract compliance with sustainability requirements. See Section 01 81 11, SUSTAINABLE DESIGN REQUIRMENTS, for project low-emitting materials, requirements.

B. Biobased Material: For products designated by the USDA's BioPreferred® program, provide products that meet or exceed USDA recommendations for biobased content, subject to the products compliance with performance requirements in this Section. For more information regarding the product categories covered by the BioPreferred® program, please visit http://www.biopreferred.gov/.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 MEMORIAL WALL MARKERS (GOVERNMENT PROVIDED) - CONTRACTOR ACCEPTANCE

A. Memorial wall markers that have been inspected and accepted as being in compliance with manufacturing tolerances for size, perpendicularity, finish, and product stone quality shall be furnished by the Government and delivered to the site on pallets. They shall be of size, type, manufacturing, finish and quantities required for this project. The markers shall be delivered to the site Freight on Board (FOB) and the Contractor shall be responsible to offload and secure them at the job site. The general quantity and condition shall be observed and an adequate count to cover all the intended memorial wall marker locations, plus required spares, shall be verified by the Contractor prior to accepting the units and performing the offloading operations. The Contractor shall note any shipping damage and reject any damaged markers before the delivery truck leaves the site. Once satisfied, the Contractor shall take ownership of the acceptable markers, as all being approved as meeting the government specifications and being suitable for installation at this project. Once the memorial markers are accepted at the site, they shall become the Contractors responsibility until installed and the installation is accepted by the Resident Engineer/Contracting Officer's Representative (RE/COR).

3.2 INSPECTION

A. All materials shall be inspected prior to installation to ensure compliance with the contract documents and to ensure there is no damage. Should conditions be different from those indicated on the contract documents, contractor should immediately notify the RE/COR.

3.3 MEMORIAL WALL MARKER ATTACHMENT HARDWARE

A. Hardware for attachment shall be specifically designed for attaching markers that will be engraved. The hardware is designed to be recessed or totally hidden, except for the rosettes at the corners of the markers and the hardware visible through the cracks between the individual markers, or filler strips. The hardware allows for the removal of an individual marker for engraving, without having to remove multiple markers. The material for the attachment hardware shall be verified to be compatible with stainless steel rosettes and rosette attachment screws, without adverse reactions during the submittal process. The hardware provided shall not cause staining on the markers. The marker attachment hardware shall only be visible when looking in the cracks between or adjoining the markers, and shall be installed being recessed from the face of the markers. The marker attachment hardware shall be suitable for the project installation using cast-in-place memorial wall installation(s). The shop drawing and submittal process shall be used to indicate that the installation of the memorial wall markers is in compliance with design and installation as indicated in the drawings. The submittal, shop drawings and narrative of the work to be performed and coordinated shall clearly indicate how the work is to be coordinated, from the installation of the memorial wall concrete core to the completed installation of the memorial wall markers in the finished memorial wall(s). The attachment hardware shall be suitable for a permanent installation, out of doors, be suitable for the indicated loads, and shall produce the finish installation as indicated on the contract drawings.

B. The Contractor performing the installation of the memorial wall markers shall maintain control of the memorial wall marker attachment hardware assemblies from delivery to the site through acceptance of the installation of the government provided memorial wall markers.

3.4 INSTALLATION

A. Installation of the government provided memorial wall markers shall include all materials, manpower, tools and equipment required to receive the approved government provided memorial wall markers from the manufacturer, and handle them as necessary and perform whatever work is needed to result in the successful installation of one memorial marker for every marker location in the memorial wall(s), as indicated on the drawings.

B. The installation shall be such that the joints are straight, even width or height, and the face of the markers shall all be in the same plane as the filler strips with a maximum allowable deviation from the plane of 1 mm (1/32").

C. The installation of the memorial wall markers shall be coordinated with the work of constructing and finishing the memorial wall as designed so the end result is a complete and accepted memorial wall installation with the government provided memorial wall markers installed as indicated in the drawings, details, notes and specifications.

3.5 CLEANING AND PROTECTION

A. Memorial wall markers shall be shop cleaned at the time of fabrication. After installation, carefully clean the markers, removing all dirt stains, and all other incident defacements.

1. Stiff bristle fiber brushes may be used, but the use of wire brushes or acid-type cleaning agents and other solutions which may cause discoloration is expressly prohibited. Fabricator should be contacted regarding the use of any cleaners and must approve of them before use.
2. Protection of Finished Work: All markers that are installed as part of the work in progress shall be protected at all times during construction by use of a suitable strong, impervious film or fabric securely held in place.

B. Clean up area of excess material and debris.

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SECTION 05 50 00
METAL FABRICATIONS

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section specifies items and assemblies fabricated from structural steel shapes and other materials as shown and specified.

B. Items specified:

1. Stainless Steel Handrails.

1.2 RELATED WORK

A. Section 03 30 00. CAST-IN-PLACE CONCRETE (SHORT-FORM).

B. Section 09 06 00, SCHEDULE FOR FINISHES.

1.3 SUSTAINABILITY REQUIREMENTS

A. Materials in this section may contribute towards contract compliance with sustainability requirements. See Section 01 81 11, SUSTAINABLE DESIGN REQUIRMENTS, for project requirements.

1.4 SUBMITTALS

A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS AND PRODUCT DATA.

B. Product Data: Manufacturer's data sheets on each product to be used, including:

1. Preparation instructions and recommendations.
2. Storage and handling requirements and recommendations.
3. Installation methods.
4. Description of materials, components, fabrication, and finishes.

C. Shop Drawings:

1. Indicate 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.

D. Manufacturer's Certificates:

1. Anodized finish as specified.
2. Live load designs as specified.

E. Submit Design Calculations for specified live loads including dead loads prepared by professional engineer licensed in the location of their practice.

F. Furnish setting drawings and instructions for installation of anchors to be preset into concrete and masonry work, and for the positioning of items having anchors to be built into concrete or masonry construction.

1.5 QUALITY ASSURANCE

A. Each manufactured product must meet or exceed the requirements specified and be a standard commercial product of a manufacturer regularly presently manufacturing items of type specified.

B. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum 10 years documented experience.

C. Installer Qualifications: Manufacturer's trained installers or an installer acceptable to the manufacturer

D. Each product type to be the same and be made by the same manufacturer.

E. Assembled product to the greatest extent possible before delivery to the site.

F. Include additional features, which are not specifically prohibited by this specification, but which are a part of the manufacturer's standard commercial product.

G. Mock-Up: See section

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. American Society of Mechanical Engineers (ASME):

B18.6.1-81(R2008)	Wood Screws
B18.2.2-10	Nuts for General Applications

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

A36/A36M-12	Carbon Structural Steel
A123/A123M-12	Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
A276	Stainless Steel Bars and Shapes.

A307-12	Carbon Steel Bolts, Studs, and Threaded Rod 60,000 PSI Tensile Strength
A312	Seamless and Welded Austenitic Stainless Steel Pipes.
A314	Stainless Steel Billets and Bars for Forging.
A492	Standard Specification for Stainless Steel Rope Wire.
A500/A500M-10a	Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
A554	Welded Stainless Steel Mechanical Tubing.
A653/A653M-11	Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process
C1107/C1107M-13	Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
E488-10	Strength of Anchors in Concrete Elements
F436-11	Hardened Steel Washers

D. American Welding Society (AWS):

D1.1/D1.1M:2010	Structural Welding Code Steel
D1.2/D1.2M:2008	Structural Welding Code Aluminum
D1.3/D1.3M:2008	Structural Welding Code Sheet Steel

E. National Association of Architectural Metal Manufacturers (NAAMM):

AMP 500-06-2006	Metal Finishes Manual

F. Structural Steel Painting Council (SSPC):

SSPC-SP 1	Solvent Cleaning
SSPC-SP 2	Hand Tool Cleaning
SSPC-SP 3	Power Tool Cleaning

PART 2 - PRODUCTS

2.1 MATERIALS

A. Design Requirements: Provide handrails and railings systems, including top rail, end posts, intermediate posts and hardware of withstanding the following structural loads without exceeding allowable design working stress of materials for handrails, railings, anchors and connections in conformance with applicable codes:

1. Concentrated load of 200lbf applied at any point and in any direction.

B. Basis of Design: P & P Artec inc. Chicago System, or approved equal: System design is based on a 5/8 inch wide flat stainless steel balusters spacing up to 6 feet apart. The system is completely seamless with no splices, saddles, miters, or seams. All directional changes are welded and polished seamlessly in the field.
   1. Stainless Steel Structural Tubing: ASTM A 554, Type 304 or 316, minimum tensile strength 70,000 psi.
   2. Handrails: Stainless steel with a 360 - 400 grit finish. Size as follows: 1.5 inch O.D. tube.
   3. Balusters: Solid stainless steel 5/8 inch by 2-1/2 inch bar with a #4 finish.
   4. Connection Fittings: ASTM A 554, Type 304 stainless steel with the following finish: #5 satin (brushed).
   5. Bolts, Screws, Washers and Nuts: Stainless steel with a #7 polished finish on all visible surfaces. Do not use metals that will be corrosive and incompatible with materials being fastened.
   6. Cover plate: Stainless steel to match handrail finish.
C. Standard flush fittings, designed to be welded, may be used.
D. Exposed threads will not be approved.
E. Form handrail brackets to size and design shown.
B. Grout: ASTM C1107, pourable type.

2.3 FABRICATION

A. Fabricate systems in accordance with approved shop drawings and the manufacturer's instructions.
B. Preassemble items in shop to greatest extent practicable to minimize assembly at project site. Disassemble units only to extent necessary for shipping and handling limitations. Mark units for reassembly.
C. All connection fittings must be bolted, clamped or screwed. The finish of handrail welds must be completely seamless and invisible.
B. 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.

C. Size:

1. Size and thickness of members as shown.

D. Connections:

1. Except as otherwise specified, connections may be made by welding, 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 punch or drill; 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 member’s machine screws or bolts.

E. Fasteners and Anchors:

1. Use methods for fastening or anchoring metal per manufacturer requirements/recommendations.
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.

F. 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, sinkage, 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. Fabricate surfaces and edges free from sharp edges, burrs and projections which may cause injury.
2. Welding:
   a. Weld in accordance with AWS standards as listed in article Applicable Publications.
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. Provide as indicated.
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. Fabricate fit of components and the alignment of holes to 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.

G. Finish:

1. Finish exposed surfaces as indicated.

PART 3 - EXECUTION

3.1 INSTALLATION

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. Install railing system in accordance with manufacturer's instructions.

C. Attach railing system securely in place using fasteners supplied by manufacturer.

D. Separate incompatible materials to prevent galvanic corrosion.

E. Attach railing system to supports approved by manufacturer.

F. Repair minor damages to finish in accordance with manufacturer's instructions and as approved by Architect.

G. Remove and replace defective or damaged components that cannot be successfully repaired as determined by Architect.

H. Items set into concrete.

1. Provide temporary bracing for such items until concrete or masonry is set.

2. Place in accordance with setting drawings and instructions as indicated on the approved shop drawings.

I. Field weld in accordance with AWS.

1. Design and finish as specified for shop welding.

2. Use continuous weld unless specified otherwise.

3.2 CLEANING

A. Remove temporary coverings and protection of adjacent work areas.

B. 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.

C. Clean railing system after installation as recommended by the manufacture.

D. Do not use harsh cleaning materials or methods that would cause damage to the finish.

E. Do not use abrasive cleaners.

3.3 PROTECTION

A. Protect installed products until project completion.

B. Provide plastic sheet protection for all surfaces of completed installations to prevent damage during remainder of construction activities.

C. Replace defective or damaged components as directed by Architect.

D. Touch-up, repair or replace damaged products before substantial completion.

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SECTION 07 92 00
JOINT SEALANTS

PART 1 - GENERAL

1.1 DESCRIPTION:

A. This section covers interior and exterior sealant and their application, wherever required for complete installation of building materials or systems.

1.2 RELATED WORK (INCLUDING BUT NOT LIMITED TO THE FOLLOWING):

A. Sealing joints in stone veneer: Section 04 43 00, NATURAL STONE VENEER AND CAPS.

B. Sealing of Site Work Concrete Paving: Section 32 05 23, CEMENT AND CONCRETE FOR EXTERIOR IMPROVEMENTS.

1.3 QUALITY ASSURANCE:

A. Installer Qualifications: An experienced installer with a minimum of three (3) years' experience and 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. Submit qualification.

B. Source Limitations: Obtain each type of joint sealant through one (1) 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.

1. Testing Agency Qualifications: An independent testing agency qualified according to ASTM C1021.
2. Test elastomeric joint sealants for compliance with requirements specified by reference to ASTM C920, and where applicable, to other standard test methods.
3. Test elastomeric joint sealants according to SWRI's Sealant Validation Program for compliance with requirements specified by reference to ASTM C920 for adhesion and cohesion under cyclic movement, adhesion-in peel, and indentation hardness.
4. Test other joint sealants for compliance with requirements indicated by referencing standard specifications and test methods.

D. Lab Tests: Submit samples of materials that will be in contact or affect joint sealants to joint sealant manufacturers for tests as follows:
   1. Adhesion Testing: Before installing elastomeric sealants, test their adhesion to protect joint substrates according to the method in ASTM C794 to determine if primer or other specific joint preparation techniques are required.
   2. Compatibility Testing: Before installing elastomeric sealants, determine compatibility when in contact with glazing and gasket materials.
   3. Stain Testing: Perform testing per ASTM C1248 on interior and exterior sealants to determine if sealants or primers will stain adjacent surfaces. No sealant work is to start until results of these tests have been submitted to the Contracting Officer Representative (COR) and the COR has given written approval to proceed with the work.

E. Preconstruction Field-Adhesion Testing: Before installing elastomeric sealants, field test their adhesion to joint substrates according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1.1 in ASTM C1193 or Method A, Tail Procedure, in ASTM C1521.
   1. Locate test joints where indicated in construction documents or, if not indicated, as directed by COR.
   2. Conduct field tests for each application indicated below:
      a. Each type of elastomeric sealant and joint substrate indicated.
      b. Each type of non-elastomeric sealant and joint substrate indicated.
   3. Notify COR seven (7) days in advance of dates and times when test joints will be erected.

F. Mockups: See Section 01 43 39 MOCKUP REQUIREMENTS.
   1. Joints in mockups of assemblies that are indicated to receive elastomeric joint sealants.

1.4 CERTIFICATION:

A. Contractor is to submit to the COR written certification that joints are of the proper size and design, that the materials supplied are compatible with adjacent materials and backing, that the materials will properly perform to provide permanent watertight, airtight or vapor

tight seals (as applicable), and that materials supplied meet specified performance requirements.

1.5 SUBMITTALS:

A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

B. Sustainable Design Submittals, as described below:

1. Volatile organic compounds per volume as specified in PART 2 - PRODUCTS.

C. Installer qualifications.

D. Contractor certification.

E. Manufacturer's installation instructions for each product used.

F. Cured samples of exposed sealants for each color.

G. Manufacturer's Literature and Data:

1. Primers
2. Sealing compound, each type, including compatibility when different sealants are in contact with each other.

H. Manufacturer warranty.

1.6 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 degrees C (40 degrees 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.

1.7 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 32 degrees C (90 degrees F) or less than 5 degrees C (40 degrees F).

1.8 DEFINITIONS:

A. Definitions of terms in accordance with ASTM C717 and as specified.

B. Backing 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.

1.9 WARRANTY:

A. Construction Warranty: Comply with FAR clause 52.246-21 "Warranty of Construction".

B. Manufacturer Warranty: Manufacturer shall warranty their sealant for a minimum of five (5) years from the date of installation and final acceptance by the Government. Submit manufacturer warranty.

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. ASTM International (ASTM):

C509-06.....Elastomeric Cellular Preformed Gasket and Sealing Material

C612-14.....Mineral Fiber Block and Board Thermal Insulation

C717-14a.....Standard Terminology of Building Seals and Sealants

C734-06(R2012).....Test Method for Low-Temperature Flexibility of Latex Sealants after Artificial Weathering

C794-10.....Test Method for Adhesion-in-Peel of Elastomeric Joint Sealants

C919-12.....Use of Sealants in Acoustical Applications.

C920-14a.....Elastomeric Joint Sealants.

C1021-08(R2014).....Laboratories Engaged in Testing of Building Sealants
C1193-13.....Standard Guide for Use of Joint Sealants.
C1248-08(R2012).....Test Method for Staining of Porous Substrate by Joint Sealants
C1330-02(R2013).....Cylindrical Sealant Backing for Use with Cold Liquid Applied Sealants
C1521-13.....Standard Practice for Evaluating Adhesion of Installed Weatherproofing Sealant Joints
D217-10.....Test Methods for Cone Penetration of Lubricating Grease
D1056-14.....Specification for Flexible Cellular Materials—Sponge or Expanded Rubber
E84-09.....Surface Burning Characteristics of Building Materials

C. Sealant, Waterproofing and Restoration Institute (SWRI).
The Professionals' Guide

D. Environmental Protection Agency (EPA):
40 CFR 59(2014).....National Volatile Organic Compound Emission Standards for Consumer and Commercial Products

PART 2 - PRODUCTS

2.1 SEALANTS:

A. Exterior Sealants:
1. S-1 Vertical surfaces, provide non-staining ASTM C920, Type S or M, Grade NS, Class 25, NT
2. S-11 Horizontal surfaces, provide ASTM C920, Type S or M, Grade P, Class 25, Use T.
3. Provide location(s) of exterior sealant as follows:
a. Metal to metal.
b. Masonry to masonry or stone.
c. Stone to stone.
d. Masonry expansion and control joints.
e. Masonry joints where shelf angles occur.
f. Voids where items penetrate exterior walls.

2.2 COLOR:

A. Sealants used with exposed masonry are to match color of mortar joints.

B. Sealants used with unpainted concrete are to match color of adjacent concrete.

C. Color of sealants for other locations to be light gray or aluminum, unless otherwise indicated in construction documents.

2.3 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 or synthetic rubber (ASTM C509), nonabsorbent to water and gas, and capable of remaining resilient at temperatures down to minus 32 degrees C (minus 26 degrees 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.

2.4 WEEPS:

A. Weep Vent: See Section 04 43 00, NATURAL STONE VENEER AND CAPS.

2.5 FILLER:

A. Mineral fiberboard: 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 POROUS SURFACES:

A. Chemical cleaners compatible with sealant and acceptable to manufacturer of sealants and sealant backing material. Cleaners to be 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 (The Professionals' Guide).

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 but are not limited to 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. Nonporous surfaces include but are not limited to the following:
   a. Metal.

b. Glass.

c. Porcelain enamel.

d. Glazed surfaces of ceramic tile.

C. Do not cut or damage joint edges.

D. Apply non-staining 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 or as indicated by pre-construction joint sealant substrate test.

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. Avoid application to or spillage onto adjacent substrate surfaces.

3.3 BACKING INSTALLATION:

A. Install backing 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 backing rod and position the rod at proper depth.

C. Cut fillers installed by others to proper depth for installation of backing rod and sealants.

D. Install backing 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 backing rod does not exist, install bond breaker tape strip at bottom (or back) of joint so sealant bonds only to two opposing surfaces.

3.4 SEALANT DEPTHS AND GEOMETRY:

A. At widths up to 3/8 inch, sealant depth equal to width.

B. At widths over 3/8 inch, sealant depth 1/2 of width up to 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 degrees C and 38 degrees C (40 degrees and 100 degrees F).
2. Do not install polysulfide base sealants where sealant may be exposed to fumes from bituminous materials, or where water vapor in continuous contact with cementitious materials may be present.
3. Do not install sealant type listed by manufacture as not suitable for use in locations specified.
4. Apply caulking and sealing compound in accordance with manufacturer's printed instructions.
5. Avoid dropping or smearing compound on adjacent surfaces.
6. Fill joints solidly with compound and finish compound smooth.
7. Tool exposed joints to form smooth and uniform beds, with slightly concave surface conforming to joint configuration per Figure 5A in ASTM C1193 unless shown or specified otherwise in construction documents. Remove masking tape immediately after tooling of sealant and before sealant face starts to “skin” over. Remove any excess sealant from adjacent surfaces of joint, leaving the working in a clean finished condition.
8. Finish paving or floor joints flush unless joint is otherwise detailed.
9. Apply compounds with nozzle size to fit joint width.
10. Test sealants for compatibility with each other and substrate. Use only compatible sealant. Submit test reports.
11. Replace sealant which is damaged during construction process.

B. Weep Vents: Place weep vents in joints where moisture may accumulate, including at base of cavity walls, above shelf angles, at all flashing, and as indicated on construction documents.

1. Space weep vents as indicated on the drawings.
2. Weep vents shall be flush with exterior wall face after sealant has set.

C. For application of sealants, follow requirements of ASTM C1193 unless specified otherwise. Take all necessary steps to prevent three-sided adhesion of sealants.

D. Interior Sealants: Where gypsum board partitions are of sound rated, fire rated, or smoke barrier construction, follow requirements of ASTM C919 only to seal all cut-outs and intersections with the adjoining construction unless specified otherwise.
   1. Apply a 6 mm (1/4 inch) minimum bead of sealant each side of runners (tracks), including those used at partition intersections with dissimilar wall construction.
   2. Coordinate with application of gypsum board to install sealant immediately prior to application of gypsum board.
   3. Partition intersections: Seal edges of face layer of gypsum board abutting intersecting partitions, before taping and finishing or application of veneer plaster-joint reinforcing.
   4. Openings: Apply a 6 mm (1/4 inch) bead of sealant around all cutouts to seal openings of electrical boxes, ducts, pipes and similar penetrations. To seal electrical boxes, seal sides and backs.
   5. Control Joints: Before control joints are installed, apply sealant in back of control joint to reduce flanking path for sound through control joint.

3.6 FIELD QUALITY CONTROL:

A. Field-Adhesion Testing: Field-test joint-sealant adhesion to joint substrates according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1 in ASTM C1193 or Method A, Tail Procedure, in ASTM C1521.
   1. Extent of Testing: Test completed elastomeric sealant joints as follows:
      a. Perform 10 tests for first 305 m (1000 feet) of joint length for each type of elastomeric sealant and joint substrate.
      b. Perform one test for each 305 m (1000 feet) of joint length thereafter or one test per each floor per elevation.

B. Inspect joints for complete fill, for absence of voids, and for joint configuration complying with specified requirements. Record results in a field adhesion test log.

C. Inspect tested joints and report on following:
   1. Whether sealants in joints connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each type of product and joint substrate.

2. Compare these results to determine if adhesion passes sealant manufacturer's field-adhesion hand-pull test criteria.
3. Whether sealants filled joint cavities and are free from voids.
4. Whether sealant dimensions and configurations comply with specified requirements.

D. Record test results in a field adhesion test log. Include dates when sealants were installed, names of persons who installed sealants, test dates, test locations, whether joints were primed, adhesion results and percent elongations, sealant fill, sealant configuration, and sealant dimensions.

E. Repair sealants pulled from test area by applying new sealants following same procedures used to originally seal joints. Ensure that original sealant surfaces are clean and new sealant contacts original sealant.

F. Evaluation of Field-Test Results: Sealants not evidencing adhesive failure from testing or noncompliance with other indicated requirements, will be considered satisfactory. Remove sealants that fail to adhere to joint substrates during testing or to comply with other requirements. Retest failed applications until test results prove sealants comply with indicated requirements.

3.7 CLEANING:

A. Fresh compound accidentally smeared on adjoining surfaces: Scrape off immediately and rub clean with a solvent as recommended by manufacturer of the adjacent material or if not otherwise indicated by the caulking or sealant manufacturer.

B. Leave adjacent surfaces in a clean and unstained condition.

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SECTION 09 06 00
SCHEDULE FOR FINISHES

PART I – GENERAL

1.1 DESCRIPTION

A. This section contains a coordinated system in which requirements for materials specified in other sections shown are identified by abbreviated material names and finish codes in the Room Finish Schedule or shown for other locations.

1.2 MANUFACTURERS

A. Manufacturer's trade names and numbers used herein are only to identify colors, finishes, textures and patterns. Products of other manufacturer's equivalent to colors, finishes, textures and patterns of manufacturers listed that meet requirements of technical specifications will be acceptable upon approval in writing by contracting officer for finish requirements.

1.3 SUBMITALS

A. Submit in accordance with SECTION 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES, provide quadruplicate samples for color approval of materials and finishes specified in this section.

B. Color Schedule: Submit full color schedule including manufacturers intending to be provided for project, with equivalent colors to selections provided by this section; format to match this section.

1.4 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. MASTER PAINTING INSTITUTE: (MPI)
Architectural Painting Specification Manual

PART 2 - PRODUCTS

2.1 COLOR BOARD

A. Size: As required to display building finishes.

B. Labeled for:

1. All finishes used.

2.2 DIVISION 03 – CONCRETE

A. SECTION 03 30 53, CAST IN PLACE CONCRETE (SHORT FORM)

Surface	Finish Description
Exposed Concrete (Vertical)	Grout Finish – Sack Rub
Exterior Slabs/Flatwork (Horizontal)	Broom Finish

2.3 DIVISON 04 – MASONRY

A. SECTION 04 05 13, MASONRY MORTARING

Finish Code	Finish Description
Mortar color for Stone Veneer	Match mortar color at existing columbarium. Match color in approved mock-up.

C. SECTION 04 43 00, NATURAL STONE VENEER

Name of Stone	Size	Color, Texture, Finish, Grain	Pattern	Stone Source
Type 1 Stone Full Veneer – Silver Buff Limestone (Color to match existing Columbarium)	4” Thick, Varies, See Drawings for Sizes	Smooth Finish, Cut Stone	N/A	Indiana Limestone Company or approved equal
Type 2 – Fon Du Lac Tailored Blend (Color to match existing Columbarium)	4” Thick and Thin Veneer, Varies, See Drawings for Sizes	Finish Shall match existing columbarium.	Ashlar, See Drawings for Sizes, Match Existing Columbarium Pattern	Buechel Stone Corp. or approved equal

2.4 DIVISION 05 – METALS

E. SECTION 05 50 00, METAL FABRICATIONS

Item	Finish	Manufacturer
Handrails (Ramp and Staircases)	Stainless Steel	P & P Artec inc. Chicago System, or approved equal

I. SECTION 07 92 00, JOINT SEALANTS

Location	Color	Manufacturer	Manufacturer Color
Masonry Expansion Joints	Limestone	Sikaflex	2c Limestone
Precast Concrete Panels	Gray	Sikaflex	2c Gray
Masonry to Concrete Sealed Joints	Gray	Sikaflex	2c Gray
Stone Caps Sealed Joints	Limestone	Sikaflex	2c Limestone
Concrete Pavement	Gray	Sikaflex	2c Gray

2.9 DIVISION 10 - SPECIALTIES

A. SECTION 10 14 00, EXTERIOR SIGNAGE

Component	Background Finish/ Material	Manufacturer	Mfg. Color Name/No.
Identification Sign - Post and Panel	Match Existing	Contractor to provide shop drawings of fabrication	N/A
"Do Not Drink" Sign	(match existing flower watering stations)		
Columbarium & Memorial Wall Row Letter Medallion	Cast Bronze, Times New Roman, (match existing columbarium A)		
Columbarium & Memorial Wall Column Number Medallion	Cast Bronze, Times New Roman, (match existing columbarium A)		
Columbarium & Memorial Wall Wall Number Standoff Metal Lettering	Cast Bronze, Times New Roman, (match existing columbarium A)		

2.14 DIVISION 32 - EXTERIOR IMPROVEMENTS

C. SECTION 32 30 00, SITE FURNISHINGS

Item	Style Name/No.	Finish	Manufacturer	Mfg. Color Name/No.
Benches without Back	RB-12(VS),	Powder coat	Victor Stanley, Sitescapes, or approved equal.	Bronze

Item	Style Name/No.	Finish	Manufacturer	Mfg. Color Name/No.
Trash Receptacles	RB-36(VS),	Powder coat	Victor Stanley, Sitescapes, or approved equal.	Bronze
Flower Water Station Post and spigot	Murdock Jug Filler	Powder Coat	Murdock or approved equal	Bronze

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SECTION 10 14 00
EXTERIOR SIGNAGE

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section specifies the work required to furnish and install the indicated and specified exterior cemetery site signage systems, including, but not limited to, posts and mow strips.

B. Signs shall be products of manufacturers regularly engaged in manufacturing signs of types specified.

C. Signs included are as follows:

1. Post and Panel
   a. One Line of Text
   b. Three Lines of Text
2. Spigot Post with Sign Panel
3. Dimensional Letters and emblems.
4. Cemetery Directory Sign.

1.2 RELATED WORK

A. Post Setting Excavation, Material, Backfill, Section 31 20 11, EARTHWORK (SHORT FORM).

B. Concrete Bases for posts: Section 03 30 53, CAST-IN-PLACE CONCRETE (SHORT FORM)

C. Flower Watering Station piping, appurtenances and mounting: Section 32 30 00 SITE FURNISHINGS.

1.3 MANUFACTURER'S QUALIFICATIONS

A. Sign manufacturer shall regularly and presently manufacture signs similar to those specified as one of their principal products. Sign manufacturer shall submit qualifications demonstrating a minimum of three years of experience manufacturing the qualifying signs and shall, if possible, demonstrate the successful manufacturing of exterior site signs installed at one or more State or National Veteran Cemeteries.

1.4 SUSTAINABILITY REQUIREMENTS

A. Materials in this section may contribute towards contract compliance with sustainability requirements.

B. Biobased Material: For products designated by the USDA's BioPreferred® program, provide products that meet or exceed USDA recommendations for biobased content, subject to the products compliance with performance

requirements in this Section. For more information regarding the product categories covered by the BioPreferred® program, please visit http://www.biopreferred.gov/.

1.5 SUBMITTALS

A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

B. Samples: Submit 3 sets. One set to the Contractor, one set to the Resident Engineer or Contracting Officer's Representative (RE/COR) and one set to the A/E Designer. The Contractor shall provide submittal documents that indicate each of the sign types, mounting types and materials to be used for the various combinations to be used for this project. Submittal materials shall indicate the location(s) for the various sign types including their mounting.

1. Post & panel sign mock-up, not less than 200 mm by 250 mm (8" by 10"), shall be constructed and submitted, showing typical color, texture and fonts shown on Contract Drawings. Mock-up shall show typical fabrication methods, including panel to post(s) connection. Sample shall be capable of demonstrating how the face panels can be removed, for repair or replacement, from the mounted location between the posts, for a two post sign system. Mock-ups of all other sign systems for post mounted signs shall be capable of demonstrating how the sign panels are to be removed and replaced from the posts, or mounting support system attached to the posts, without moving the posts.
2. Aluminum samples showing full range of finish colors available.
3. Cast Metal Letter, of the style, size and finish indicated
4. Color samples of each color, 150 mm x 150 mm (6 inches x 6 inches). Show anticipated range of color and texture.
5. Sample of typeface, arrow and symbols in a typical full size layout.
6. Directory panels and frames, with letters and symbols, each type.

C. Shop Drawings: All signs showing material, finish, colors, size of members, details of construction, letter spacing, size and type, numbers, symbols or image details, and mounting details. Identify materials, show joints, welds, anchorage, accessory items, mounting and finishes. The details of construction shall clearly show how the sign

is to be disassembled to replace the entire sign or just one side panel, where applicable.

D. Full size layout template of the cast lettering shown on the entry wall, showing pin locations and letter spacing of all words. Approved template shall be used during the actual installation of the lettering.

E. Full size layout in full color of the Sign Panels.

F. Manufacturer's Literature and Data (Mark literature to indicate items proposed to be furnished): Signs, each type. Manufacturer's printed specifications, anchorage details, installation and maintenance instructions. Manufacturer's recommendations for mounting the Sign Panels shall be provided.

G. Manufacturer's Certificates: Provide certification from the coating installer, indicating exactly what they did to prepared the aluminum as and applied the coating(s) to the specified thickness(es). The certification shall indicate that the coating has been installed according to specific and identified contract specifications and/or approved submittal materials so it is absolutely clear what was done.

H. Sample(s) shall be submitted of sign(s) of sufficient size to show the full scaled features of each of the sign types, including frame, mounting, panels, panel mounting, sign mounting facilities, lettering, color and texture. All aluminum signs shall have full exterior Powder Coated finish, with color and quality as specified herein.

1.6 DELIVERY AND STORAGE

A. 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.

B. Deliver signs only when the site, mounting materials, and equipment are ready for installation work to proceed.

C. Store products in dry condition inside enclosed facilities.

1.7 WARRANTY

A. Sign Manufacturer shall guarantee the text and symbols applied to the powder coated aluminum for an extended warranty period of five years following final acceptance of the project. A warranty inspection shall be performed no later than one year following project final acceptance and the Contractor shall be responsible for removing and replacing any text and/or symbols identified, during the inspection, that have

started to fade, chip, peel or otherwise fail. The Contractor shall remove and replace any sign panel faces with new, where the applied lettering, or the paint system itself, is causing damage to, or failure of, the paint system. All work to produce replacement sign panels with new lettering and/or paint system shall be provided at no cost to the Government, as part of the Warranty work for the signage system.

1.8 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. Americans with Disabilities Act - 1990, as amended and in effect as of 01-01-2009

C. Federal Highway Administration:
Manuals on Uniform Traffic Control Devices for Street and Highways - Single Post Traffic Regulatory Signs.

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

B209-10	Aluminum and Aluminum-Alloy Sheet and Plate
B221-12	Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes and Tubes.
B449-93(2010)e1	Standard Specification for Chromates on Aluminum

E. American Architectural Manufacturer's Association (AAMA):

AAMA 2605-05	Performance Requirements and Test Procedures for High Performance Organic Coatings on Aluminum extrusions and Panels.

F. Federal Specifications (Fed. Spec.):

MIL-P-8184F	Plastic Sheet, Acrylic, Modified.
A-A-59502	Plastic Sheet, Polycarbonate

G. VA Signage Design Guide:
Section 12 National Cemetery Signs -
http://wbdg.org/ccb/VA/VASIGN/signage12.pdf

PART 2 - PRODUCTS

2.1 MATERIALS

A. Aluminum, Extruded: Fed. Spec. QQA-200-9, alloy 6063-T5, applicable as material.

B. Aluminum, Sheet and Plate: ASTM B209

C. Aluminum, Extrusions and Tubing: ASTM B221

D. Zinc Chromate Primer: Fed. Spec. TT-P-645.

E. Wood signage shall match wood type and dimensions of existing signage.

2.2 SIGNAGE GENERAL

A. Signs shall be of type, size and design shown on the drawings and as specified.

B. Signs shall be complete with lettering, framing, and related components for a complete sign 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. Verify all dimensions and conditions shown by the drawings. Resident Engineer and/or Contracting Officer's Representative (RE/COR) is to be notified of any discrepancy in drawing(s), in field directions or conditions, and/or of any changes required for any such related 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. Warrant: That all components, specified or required to satisfactorily complete the installation are compatible with each other and with conditions of installations.

2.3 SIGN STANDARDS

A. Typography:

1. Type Style: Match existing type, unless otherwise indicated.
2. Arrow: See graphic standards in drawings.
3. Letter spacing: See graphic standards on drawings.
4. All text, arrows, 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. Text to be installed on specific signs shall be as submitted, reviewed and finally approved in shop drawings processed as submittal materials.

B. Sign Colors and Finishes: As specified in this Specification Section and approved in the Shop Drawing & Submittal process.

2.4 SIGNS TYPES

A. General: The exterior sign system shall match existing cemetery family signage.

B. Location, layout and construction details for the all of the project exterior signs shall be found in the Construction Drawings. Refer to the signage details for the specific sign panel sizes, text and graphic sizes as well as the layout and content for the text and images for the respective individual signs.

2.5 TEXT AND GRAPHICS

A. There are multiple Message Layout types for some of the different size signs within the same type of sign. See the drawing layout and detail drawings for the specifics of the locations for the signs, as well as the size, types, materials and messages for the individual signs for the project.

1. Surface applied letters, numbers and graphics shall be of a published quality and life expectancy equal to or exceeding that for reflective white opaque Engineering Grade 3M™ Scotchlite™ vinyl, unless otherwise noted. Color shall match existing. Font Type Style shall be as indicated in Paragraph "SIGN STANDARDS" as approved during the submittal process.

B. All text and graphics for the exterior signage shall be provided in detailed submittal information. Each sign face shall be represented in scaled drawings, with exact font, letter style, font, letter spacing, graphics being shown. Only signs and or sign faces approved in the submittal process shall be manufactured.

2.6 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 shall be true. Assemble 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 shall be smooth flat and without oil-canning, free of rack and twist. Maximum variation from true plane of surface shall be plus or minus 0.4mm (1/64 inch). 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. Members shall have square turns and corners sharp, and curves shall be 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. 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, peeling, foreign matter and other imperfections.

J. Movable parts, including hardware, are be cleaned and adjusted to operate as designed without binding of deformation of members. All contact surfaces fit tight and even without forcing or warping components.

K. 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.

L. Completed sign installations shall not have any exposed openings so insect nesting inside of signs will be prevented.

M. No signs are to be manufactured until final sign message schedule and location review has been completed by the RE/COR & forwarded to contractor.

N. Final sign fabrication shall not proceed until samples and shop drawings detailing the sign system as it will be installed, have been submitted and approved during the submittal process.

2.7 PROTECTION OF ALUMINUM

A. Isolate aluminum in contact with or fastened to dissimilar metals other than stainless steel, white bronze or other metals compatible with aluminum by one of the following:
   1. Painting the dissimilar metal with a prime coat of zinc-chromate or other suitable primer, followed by two coats of aluminum paint.
   2. Placing an approved caulking compound, or a non-absorptive tape, or gasket between the aluminum and the dissimilar metal.

B. Paint aluminum in contact with or built into mortar, concrete, or other masonry materials with bituminous paint or zinc chromate primer.

2.8 DOUBLE-POST-PANEL SIGNS

1. Shall match existing sign family within Dayton National Cemetery.

2.9 SPIGOT POST WITH SIGN

A. Spigot posts with signs shall match existing flower watering stations.

2.11 DIMENSIONAL LETTERS

A. Dimensional Letters shall be individually mounted on the provided substrate material. The location, alignment, letter configuration, size, font, material and finish shall be as indicated on the Drawings.

B. Dimensional lettering shall be sized and depth as indicated on the drawings.

C. Materials, color, and finish for the individual letters shall be as indicated on the drawings and approved during the submittal process.

2.12 GRANITE SECTION MARKERS

A. Details for the Granite Section Markers are to be as indicated on the drawings and associated notes.

B. Granite Section Markers shall be of materials that match those existing on the site, or are as approved by Memorial Program Services (MPS) for use as niche covers.

2.13 DIRECTORY MAP

A. Each graphic panel shall be sized to fit onto the designated double faced post and panel sign with the sign panel and posts as indicated on the drawings. The maximum size for the sign panel shall be 900mm x

1200mm (3' x 4') or as indicated on the drawings, horizontal as shown on the drawings, based upon the image to be displayed.

B. Graphics for these panels shall be as indicated on the drawing details and final graphics will be provided by the designer prior to the submittal process.

C. Graphic process shall be performed by a manufacturer that regularly produces similar products using materials, colors and sizes as indicated, and has performed this work for a minimum of three years. The graphics process shall produce sign panels that are curable, UV resistant, have crisp colors, shall not delaminate, be designed so surfaces scratches do not remove or damage the graphics, have been used for similar signs that have been exposed to the elements while mounted tipped up from horizontal to facilitate viewing, and have performed without failure for long periods of time. The longer the performance life of comparable products used elsewhere, the better. Minimum acceptable performance of similar signs shall be 15 years or more. Samples of the graphic sign panel, with the colors and detail that will be provided for the final sign shall be submitted, reviewed, modifications made as required, and eventually approved if fully compliant, prior to the signs being manufactured. Graphics shall be on 1/8” thick fiber reinforced plastic panel with color graphic printed onto surface in UV resistant ink. Panel shall be fastened to the aluminum frame with tamper proof stainless steel hardware.

D. Colors for the graphic image shall be white and necessary colors to create the map as indicated in the graphic file provided by the design A/E.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Set work accurately, in alignment and where shown. Signs shall be plumb, level, free of rack and twist and set parallel or perpendicular as required to line and plane the surface.

B. Signs shall be installed with direct burial of post into concrete as shown on Contract Drawings. Depth of posts shall be such that the bottom of the concrete surrounding the posts is at least below the frost, or as indicated in the drawings, whichever is the greater depth.

C. Protect aluminum in contact with dissimilar metals or mortar as specified in Paragraph "PROTECTION OF ALUMINUM".

D. Furnish setting drawings and instructions for installation of anchors and for the positioning of items having anchors or sleeves to be built into construction. Provide temporary bracing for such items until permanent anchors are set.

E. Provide anchoring devices and fasteners as shown and as necessary for securing signs to construction as specified.

F. Utilize approved layout template for the installation of the cast bronze lettering. Pins shall be securely anchored as detailed. Face of all lettering shall be in a constant plane, while at the same time minimizing the distance between the back of the letters and the stone wall. Maintain a minimum gap as detailed between the back of the letter and the face of the stone wall.

G. Verify that behind or beneath each sign location there are no utility lines, or other buried infrastructure elements, that will be affected by installation of signs. Any damage during installation of signs to utilities, or other buried infrastructure will be the sole responsibility of the Contractor to correct and repair.

H. 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.

I. Furnish and install concrete collars, with reinforcing to prevent cracking as well as expansion joints around the posts, or other elements of this section installed in the lawn areas, to allow for movement due to frost action. The mow strips shall be set so they are parallel to the finished grade around the sign posts, so mowers can drive around them without hitting the concrete, or going into a depression.

J. Sign message panels shall be mounted using tamper-proof mechanical fasteners that are coated and colored to match the message panels.

K. Mounting details and materials shall be provided as samples during the submittal process, and complete demonstration of all of the installation features, materials and methods shall be provided during the submittal process.

3.3 CLEANING

A. After installation, all items shall be cleaned as recommended by the manufacturer and protected from damage until completion of the project.

3.4 PROTECTION

A. Protect finished surfaces from damage during fabrication, erection and after completion of the work.

- -END- - -

SECTION 23 13 23
CONCRETE ABOVE GROUND FUEL STORAGE

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work Included: Provide all labor, materials and equipment necessary to complete the work of this section.

1. Furnish and install a 1000 gallon Above ground Storage Tank (AST) with two separate tanks, one for diesel and one gasoline storage (750 gallons diesel and 250 gallons gasoline maximum), each with integral weatherproof secondary containment, vehicle impact and projectile resistance, and complete operational and safety systems, pad mounted with integral fuel dispensing system.

1.2 RELATED WORK

A. Section 03 30 53, SHORT FORM CAST-IN-PLACE CONCRETE

B. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS

C. Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

D. Section 32 30 00, SITE FURNISHINGS, Pipe Bollards.

E. Section 32 12 16, ASPHALT PAVING

1.3 SUBMITTALS

A. Refer to Section 01 33 23 – SHOP DRAWINGS, PRODUCT DATA AND SAMPLES

B. Manufacturers' Literature and Data:

1. Full details of all components of the systems from the manufacturer, with installation recommendations.

C. Shop Drawing:

1. Complete detailed shop drawings covering design of system showing layout, installation and all connection details. Do not start work before final shop drawing approval.

1.4 QUALITY ASSURANCE

A. Manufacturer will have a minimum of 5 years experience in producing specified tank for commercial use and document at least 10 installations in satisfactory operation.

B. The protected and insulated AST system shall be warranteed against leakage for a period of 30 years from the date of installation.

1.5 REFERENCE STANDARDS

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. Underwriters Laboratories, Inc. (UL):

142.....Steel Aboveground Tanks for Flammable and Combustible Liquids

2085.....Protected Insulated Aboveground Tanks for Flammable and Combustible Liquids

C. National Fire Protection Association (NFPA):

30-08.....Flammable and Combustible Liquids Code

70-08.....National Electrical Code

780-08.....Standard for the Installation of Lightning Protection Systems

D. The California Air Resource Board

Aboveground Filling/Dispensing Vapor Recovery

E. American Welding Society (AWS):

D1.1/D1.1M-2008.....Structural Welding Code – Steel

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

B117-07a.....Standard Practice for Operating Salt Spray (Fog) Apparatus

PART 2 - PRODUCTS

2.1 MATERIALS

1. The primary and insulated secondary containment Above Ground Storage Tank system for flammable and combustable liquids, Protection Type: Vehicle Impact Protected, and Projectile Resistant, shall be tested to and listed for the following:

a. UL 142: Above Ground Steel Tanks for Flammable and Combustible Liquids.
b. UL 752: Standard for Bullet-Resisting Equipment
c. UL 2085: 2-Hour Furnace Fire Test and 2-Hour Simulated Pool Fire Test for insulated and protected tanks.

2. The primary steel tank shall be rectangular in shape and have continuous welds on all exterior seams, manufactured in accordance with UL Listing requirements and UL Standard 142. Steel tank thickness shall be 3/16" thick (7 gauge).
3. The primary steel tank shall be pressure tested at 5 psig for 24 to 48 hours.
4. The primary steel tank shall have emergency vent system as per NFPA 30 Code requirements.
5. The primary steel tank shall have 2 inch positive shutoff valve (125-6,000).
6. The protected and insulated AST systems shall have a thru-tank leak detector tube to allow for physical checkup and monitoring capability between the primary and the secondary containment.
7. The primary steel tank shall be pressurized at 5 psig during concrete encasement.
8. The outer surface of the primary steel tank shall be covered by a minimum of ¼" thick (6.4mm) Styrofoam insulation panels.
9. The secondary containment shall be impervious to corrosion, including damage or failure due to microbial infestation. Because steel is known to be affected by microbal influenced corrosion, the secondary containment shall consist of A 30 mil thick (0.76 mm) High-Density Polyethylene membrane enclosing the steel tank and insulation material.

10. The primary steel tank and secondary containment shall be encased in six (6) inches of monolithic reinforced concrete, with minimum design strength of 4,000 and 5,000 psi at 28 days. The concrete design shall include the following for long-term durability: air entrainment, water reducing admixture, and steel reinforcement. Concrete encasements with seams will not be approved.
11. The protected and insulated AST system shall be of concrete exterior and a continuous and visually verifiable monolithic (seamless) pour on top, bottom, ends, and sides and contain no cold joints or heat sinks. The AST must be shop fabricated and tested in accordance with the UL listings. Designs that use two layers of steel with insulation materials between them will not be approved.
12. No steel or insulating materials shall come in contact with the concrete or other corrosive materials.
13. All openings shall be from the top only.
14. The vault enclosure shall have concrete support legs of unitized monolithic construction raising the concrete enclosure a minimum of 3” above the ground to meet visual inspection requirements. A mid-level seam or other cold joint construction which could compromise the liquid tightness (secondary containment) and fire protection capability of the vault is not permitted.
15. All exposed metal with the exception of stainless steel must be powder coated to inhibit corrosion.
16. The protected and insulated AST system shall include a 15 gallon powder coated or stainless steel, UL listed spill containment, and shall include normally closed valve to release spilled product into the primary steel tank. Spill containment which route the spilled product into interstitial area will not be approved.
17. The protected and insulated AST system shall have a coated concrete exterior to resist weather and reflect sunlight. Models with steel exteriors will not be approved.
18. The protected and insulated AST system shall be warranted by the manufacturer against defects in material or workmanship for 20 years following delivery of the tank.

19. Lighting Protection: The protected and insulated AST system shall have two (2) bolts for connecting grounding conductors for lighting protection in accordance with NFPA 780.

20. Fire Resistance: The tank system shall be designed and tested to provide 2 hour fire protection for the primary tank as per UL 2085 2-hour furnace fire test and 2 hour simulated pool fire test. The average maximum rise in temperature of the primary tank during the test shall not exceed 260° F and the maximum temperature of any single point on the primary tank shall not exceed 400° F. No steel members shall penetrate the walls or floor of the concrete encasement to assure isolation from pool fire heat.

21. Leak Monitoring: A thru-tank leak detection monitoring tube terminating between the primary tank and the secondary containment shall be provided to monitor any leaks from the primary tank. The leak monitoring shall be double unit high level and leak detection system.

22. Spill/Overfill Containment: The tank system shall include a UL listed 7 gallon spill/overfill container manufactured as an integral part of the primary tank, surrounding the fill pipe, and protected by 2 hour fire rating of the enclosure. The spill/overfill container shall include a stick port and normally closed drain valve to release spilled product into the main tank. Exterior steel shall be anti-oxidant powder coated to inhibit rust. Overfill containment systems that are designed to release spilled product into the interstitial area will not be accepted.

23. Overfill Protection: Overfill protection shall be provided by the following methods: a) direct reading level gauge visible from fill pipe access; b) valve rated for pressurized delivery located within fill pipe to close automatically at 95% full level; and c) high level alarm.

24. Coordinate crane & rigging based on the following notional tank sizes & weights:

a. Capacity: 1,000 gallons
b. Weight: 18,000 lbs
c. Length: 11’ – 0”
d. Width: 5’ – 8”
e. Vault Height: 4’ – 4”
f. Shipping Height approximately 6’ – 4”

2.2 ACCESSORIES

A. The tank shall be equipped with a Tank Mounted Pump Package in addition to the Basic Vent Package.

B. The tank system shall contain the following minimum features and equipment: Level gauge, spare capped penetration 100mm (4 inch), fill cap adaptor 100mm (4 inch), spare capped penetration 100mm (4 inch), interstitial monitoring tube, atmospheric vent and standard vent cap, emergency vent (with vent package), spare capped penetration 100mm (4 inch), suction pipe for fuel supply to pump, fuel supply piping to pump, and remote register assembly (on/off switch/nozzle/meter).

C. Provide and install a fully functional fill system with fill limiter.

D. Provide and install a fully functional liquid level indicator, 50mm (2 inch) size.

E. Provide and install a fully functional commercial fuel pump system designed for use with aboveground fuel tanks.

F. Provide a high-hang hose retractor system.

G. Provide 3.5m (12 feet) of hose for each pump.

H. The fuel-control system shall consist of a fuel-site controller that governs system operation. It is a turnkey system that allows for immediate use after installation without any configuration changes. The default configuration allows for all purchased cards to be configured with unique PINs by the user on the first use of the card. After configuration of the card’s PIN, a second swipe of the card will provide access to authorized fuels dispensed by the system.

   b. Power Requirements. The fuel-control system’s power requirements shall be 115/230 VAC, 50/60 Hz, and 200 watts maximum.

   c. Operating Temperature. The fuel-control system shall operate at a temperature range of -40°F to 122°F (-40°C to 50°C).

   d. Graphics Display. The fuel-control system shall have a 5.0” (12.7 cm) monochrome graphics display.

   e. Enclosure & Pedestal. The fuel-control system shall be constructed of painted steel.

   f. Memory. The fuel-control system’s memory shall include:

   • Standard tracking of up to 50 proprietary cards

   • Expandability to 250 proprietary cards

- Storage of a virtually unlimited number of transactions on an optional USB flash drive

g. Additional Components. The fuel-control system's mechanical pump relay board shall be expandable up to two (2) hoses and have the following characteristics:

- Power rating shall be 240 VAC, 20 A, 3.0 Hp maximum
- "In-Use" detection shall be Voltage Sense 120-240 VAC or Handle Switch
- Pulser type shall be single-channel
- Pulser input shall be mechanical (contact) or electronic (5-12 VDC)
- Divide rate shall be 1:1 – 1,000:1; 1-pulse increments
- Maximum pulse speed at 50% duty cycle shall be 6,000 mechanical; 100,000 electronic.

I. The dispensing system controller (DSC) shall be a Nema 4X enclosure, panel mounted emergency stop control, motor starter for multiple pumps includes wiring diagram.

a. Stainless steel emergency stop (new or existing).

J. Manufacturer support and services shall be provided. At a minimum:

a. The manufacturer shall provide technical phone support to Authorized Warranty Service Organizations, Authorized Distributors and their service personnel.

b. 4.2 The manufacturer shall require training and certification for all of its authorized distributors and installers.

c. The manufacturer shall provide certification information on authorized distributors and installers.

d. The manufacturer shall offer re-certification training to keep authorized distributors and installers updated with current product information, installations and procedures.

e. The distributor or service organization shall be available to offer on-site training of company maintenance personnel on installation, programming and troubleshooting of the system.

f. The manufacturer shall offer replacement parts to authorized service organizations for servicing systems.

g. The manufacturer shall offer overnight shipping on replacement parts to minimize system downtime.

h. The manufacturer will supply, upon request, a formal list of all authorized and certified distributors and service contractors for sales, support and installation.

PART 3 – EXECUTION

3.1 INSTALLATION

A. The tank system including accessories shall be installed in strict accordance with the manufacturer's recommendations and applicable fire and environmental codes. All state and local permits shall be obtained by contractor prior to installation.

B. Tanks shall be installed on a reinforced concrete base slab designed to support the fully loaded tank. Protective bollards shall be installed as indicated on the drawings or where required by state and local codes.

C. Tanks shall be marked on all sides with warning signs: "FLAMMABLE" or "COMBUSTIBLE", "NO SMOKING", product identification and other signs as required by applicable codes.

D. Coordinate connection of the electrical conduit from the emergency disconnect switch located between 50-75 feet from tank AST. The emergency disconnect shall cut all power to the AST facility.

E. Electrical work shall be in accordance with applicable codes and shall be rated for hazardous area as required. Electric feed for dispensing pumps, and any electrical devices at or serving the AST equipment location shall be connected to an emergency shutoff switch located per code requirements. Tanks shall be electrically grounded in accordance with NFPA 780. Once power is connected to the equipment, testing and start up of the equipment shall be performed by the manufacturer's representative.

F. The system installation shall be inspected and approved by the system supplier or its certified contractor. The system supplier shall submit a comprehensive checklist of quality and safety items critical to the system and verify that the installation has been in accordance with these standards and applicable fire and environmental codes.

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SECTION 26 05 11
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 systems, materials, equipment, and accessories in accordance with the specifications and drawings. Capacities and ratings of motors, transformers, conductors and cable, switchboards, switchgear, panelboards, motor control centers, generators, automatic transfer switches, and other items and arrangements for the specified items are shown on the drawings.

C. Electrical service entrance equipment and arrangements for temporary and permanent connections to the electric utility company’s system shall conform to the electric utility company's requirements. Coordinate fuses, circuit breakers and relays with the electric utility company’s system, and obtain electric utility company approval for sizes and settings of these devices.

D. Conductor ampacities specified or shown on the drawings are based on copper conductors, with the conduit and raceways sized per NEC. Aluminum conductors are prohibited.

1.2 MINIMUM REQUIREMENTS

A. The latest International Building Code (IBC), Underwriters Laboratories, Inc. (UL), Institute of Electrical and Electronics Engineers (IEEE), and National Fire Protection Association (NFPA) codes and standards are the minimum requirements for materials and installation.

B. The drawings and specifications shall govern in those instances where requirements are greater than those stated in the above codes and standards.

1.3 TEST STANDARDS

A. All materials and equipment shall be listed, labeled, or certified by a Nationally Recognized Testing Laboratory (NRTL) to meet Underwriters Laboratories, Inc. (UL), standards where test standards have been established. Materials and equipment which are not covered by UL standards will be accepted, providing that materials and equipment are

listed, labeled, certified or otherwise determined to meet the safety requirements of a NRTL. Materials and equipment which no NRTL accepts, certifies, lists, labels, or determines to be safe, will be considered if inspected or tested in accordance with national industrial standards, such as ANSI, NEMA, and NETA. Evidence of compliance shall include certified test reports and definitive shop drawings.

B. Definitions:

1. Listed: Materials and equipment 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 materials and equipment or periodic evaluation of services, and whose listing states that the materials and equipment either meets appropriate designated standards or has been tested and found suitable for a specified purpose.
2. Labeled: Materials and equipment 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 materials and equipment, and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.
3. Certified: Materials and equipment which:
   a. Have been tested and found by a NRTL to meet nationally recognized standards or to be safe for use in a specified manner.
   b. Are periodically inspected by a NRTL.
   c. Bear a label, tag, or other record of certification.
4. Nationally Recognized Testing Laboratory: Testing laboratory which is recognized and approved by the Secretary of Labor in accordance with OSHA regulations.

1.4 QUALIFICATIONS (PRODUCTS AND SERVICES)

A. Manufacturer’s Qualifications: The manufacturer shall regularly and currently produce, as one of the manufacturer's principal products, the materials and equipment specified for this project, and shall have manufactured the materials and equipment for at least three years.

B. Product Qualification:

1. Manufacturer's materials and equipment shall have been in satisfactory operation, on three installations of similar size and type as this project, for at least three years.
2. The Government reserves the right to require the Contractor to submit a list of installations where the materials and equipment have been in operation before approval.

C. Service Qualifications: There shall be a permanent service organization maintained or trained by the manufacturer which will render satisfactory service to this installation within four hours of receipt of notification that service is needed. Submit name and address of service organizations.

1.5 APPLICABLE PUBLICATIONS

A. Applicable publications listed in all Sections of Division 26 shall be the latest issue, unless otherwise noted.

B. Products specified in all sections of Division 26 shall comply with the applicable publications listed in each section.

1.6 MANUFACTURED PRODUCTS

A. Materials and equipment furnished shall be of current production by manufacturers regularly engaged in the manufacture of such items, and for which replacement parts shall be available. Materials and equipment furnished shall be new, and shall have superior quality and freshness.

B. When more than one unit of the same class or type of materials and 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 and terminals shall be identified on the equipment being furnished and on all wiring diagrams.

E. When Factory Tests are specified, Factory Tests shall be performed in the factory by the equipment manufacturer, and witnessed by the contractor. In addition, the following requirements shall be complied with:

1. The Government shall have the option of witnessing factory tests. The Contractor shall notify the Government through the COR a minimum of thirty (30) days prior to the manufacturer's performing of the factory tests.
2. When factory tests are successful, contractor shall furnish four (4) copies of the equipment manufacturer's certified test reports to the COR fourteen (14) days prior to shipment of the equipment, and not more than ninety (90) days after completion of the factory tests.
3. When factory tests are not successful, factory tests shall be repeated in the factory by the equipment manufacturer, and witnessed by the Contractor. The Contractor shall be liable for all additional expenses for the Government to witness factory re-testing.

1.7 VARIATIONS FROM CONTRACT REQUIREMENTS

A. Where the Government or the Contractor requests variations from the contract requirements, 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 MATERIALS AND EQUIPMENT PROTECTION

A. Materials and equipment shall be protected during shipment and storage against physical damage, vermin, dirt, corrosive substances, fumes, moisture, cold, freeze and rain.

1. Store materials and equipment indoors in clean dry space with uniform temperature to prevent condensation.
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 repaired or replaced, as determined by the COR.

4. Painted surfaces shall be protected with factory installed removable heavy kraft paper, sheet vinyl or equal.
5. Damaged paint on equipment 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 shall comply with requirements of the latest NFPA 70 (NEC), NFPA 70B, NFPA 70E, NFPA 99, NFPA 110, NFPA 780, OSHA Part 1910 subpart J – General Environmental Controls, OSHA Part 1910 subpart K – Medical and First Aid, and OSHA Part 1910 subpart S – Electrical, 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. However, energized electrical work may be performed only for the non-destructive and non-invasive diagnostic testing(s), or when scheduled outage poses an imminent hazard to patient care, safety, or physical security. In such case, all aspects of energized electrical work, such as the availability of appropriate/correct personal protective equipment (PPE) and the use of PPE, shall comply with the latest NFPA 70E, as well as the following requirements:
   1. Only Qualified Person(s) shall perform energized electrical work. Supervisor of Qualified Person(s) shall witness the work of its entirety to ensure compliance with safety requirements and approved work plan.
   2. At least two weeks before initiating any energized electrical work, the Contractor and the Qualified Person(s) who is designated to perform the work shall visually inspect, verify and confirm that the work area and electrical equipment can safely accommodate the work involved.
   3. At least two weeks before initiating any energized electrical work, the Contractor shall develop and submit a job specific work plan, and energized electrical work request to the COR, and Medical Center’s Chief Engineer or his/her designee. At the minimum, the work plan must include relevant information such as proposed work

schedule, area of work, description of work, name(s) of Supervisor and Qualified Person(s) performing the work, equipment to be used, procedures to be used on and near the live electrical equipment, barriers to be installed, safety equipment to be used, and exit pathways.

4. Energized electrical work shall begin only after the Contractor has obtained written approval of the work plan, and the energized electrical work request from the COR, and Medical Center's Chief Engineer or his/her designee. The Contractor shall make these approved documents present and available at the time and place of energized electrical work.
5. Energized electrical work shall begin only after the Contractor has invited and received acknowledgment from the COR, and Medical Center's Chief Engineer or his/her designee to witness the work.

D. For work that affects existing electrical systems, arrange, phase and perform work to assure minimal interference with normal functioning of the facility. Refer to Article OPERATIONS AND STORAGE AREAS under Section 01 00 02, GENERAL REQUIREMENTS MINOR.

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 01 00 02, GENERAL REQUIREMENTS MINOR.

F. Coordinate location of equipment and conduit with other trades to minimize interference.

1.10 EQUIPMENT INSTALLATION AND REQUIREMENTS

A. Equipment location shall be as close as practical to locations shown on the drawings.

B. Working spaces or working clearances shall comply with NEC's requirements, at a minimum.

C. Inaccessible Equipment:

1. Where the Government determines that the Contractor has installed equipment not readily accessible for operation and maintenance, the equipment shall be removed and reinstalled as directed at no additional cost to the Government.
2. "Readily 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, but not limited to, motors, pumps, belt guards, transformers, piping, ductwork, conduit and raceways.

D. Electrical service entrance equipment and arrangements for temporary and permanent connections to the electric utility company's system shall conform to the electric utility company's requirements. Coordinate fuses, circuit breakers and relays with the electric utility company's system, and obtain electric utility company approval for sizes and settings of these devices.

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 switchboards and switchgear, panelboards, cabinets, motor controllers, fused and non-fused safety switches, generators, automatic transfer switches, separately enclosed circuit breakers, individual breakers and controllers in switchboards, switchgear and motor control assemblies, control devices and other significant equipment.

B. Identification signs for Normal Power System equipment shall be laminated black phenolic resin with a white core with engraved lettering. Identification signs 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 12 mm (1/2 inch) high. Identification signs 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.

C. Install adhesive arc flash warning labels on all equipment as required by the latest NFPA 70E. Label shall show specific and correct information for specific equipment based on its arc flash calculations. Label shall show the followings:

1. Nominal system voltage.
2. Equipment/bus name, date prepared, and manufacturer name and address.
3. Arc flash boundary.

4. Available arc flash incident energy and the corresponding working distance.
5. Minimum arc rating of clothing.
6. Site-specific level of PPE.

1.12 SUBMITTALS

A. Submit to the COR in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

B. The Government's approval shall be obtained for all materials and equipment before delivery to the job site. Delivery, storage or installation of materials and equipment which has not had prior approval will not be permitted.

C. All submittals shall include six copies of adequate descriptive literature, catalog cuts, shop drawings, test reports, certifications, samples, and other data necessary for the Government to ascertain that the proposed materials and equipment comply with drawing and specification requirements. Catalog cuts submitted for approval shall be legible and clearly identify specific materials and 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, manuals, 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 information for replacement parts and ordering instructions, as recommended by the equipment manufacturer.

F. Maintenance and Operation Manuals:

1. Submit as required for systems and equipment specified in the technical sections. Furnish in hardcover binders or an approved equivalent.
2. Inscribe the following identification on the cover: the words "MAINTENANCE AND OPERATION MANUAL," the name and location of the system, material, equipment, building, name of Contractor, and contract name and 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 material 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.
   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 and replacement 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 shop drawings, manuals, test reports, certifications, and samples as applicable.

H. After approval and prior to installation, furnish the COR with one sample of each of the following:
   1. A minimum 300 mm (12 inches) length of each type and size of wire and cable along with the tag from the coils or reels from which the sample was taken. The length of the sample shall be sufficient to show all markings provided by the manufacturer.
   2. Each type of conduit coupling, bushing, and termination fitting.
   3. Conduit hangers, clamps, and supports.
   4. Duct sealing compound.
   5. Each type of receptacle, toggle switch, lighting control sensor, outlet box, manual motor starter, device wall plate, engraved nameplate, wire and cable splicing and terminating material, and branch circuit single pole molded case circuit breaker.

1.13 SINGULAR NUMBER

A. 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

A. The Contractor shall furnish the instruments, materials, and labor for tests.

B. Where systems are comprised of components specified in more than one section of Division 26, the Contractor shall coordinate the installation, testing, and adjustment of all components between various manufacturer’s representatives and technicians so that a complete, functional, and operational system is delivered to the Government.

C. When test results indicate any defects, the Contractor shall repair or replace the defective materials or equipment, and repeat the tests for the equipment. Repair, replacement, and re-testing shall be accomplished at no additional cost to the Government.

1.15 WARRANTY

A. All work performed and all equipment and material furnished under this Division shall be free from defects and shall remain so for a period of one year from the date of acceptance of the entire installation by the Contracting Officer for the Government.

1.16 INSTRUCTION

A. Instruction to designated Government personnel shall be provided for the particular equipment or system as required in each associated technical specification section.

B. Furnish the services of competent and factory-trained instructors to give full instruction in the adjustment, operation, and maintenance of the specified equipment and system, including pertinent safety requirements. Instructors shall be thoroughly familiar with all aspects of the installation, and shall be factory-trained in operating theory as well as practical operation and maintenance procedures.

C. A training schedule shall be developed and submitted by the Contractor and approved by the COR at least 30 days prior to the planned training.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

---END---

SECTION 26 05 19
LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section specifies the furnishing, installation, connection, and testing of the electrical conductors and cables for use in electrical systems rated 600 V and below, indicated as cable(s), conductor(s), wire, or wiring in this section.

1.2 RELATED WORK

A. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: Requirements that apply to all sections of Division 26.

B. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path for possible ground fault currents.

C. Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS: Conduits for conductors and cables.

D. Section 26 05 41, UNDERGROUND ELECTRICAL CONSTRUCTION: Installation of conductors and cables in manholes and ducts.

1.3 QUALITY ASSURANCE

A. Quality Assurance shall be in accordance with Paragraph, QUALIFICATIONS (PRODUCTS AND SERVICES) in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 SUBMITTALS

A. Submit in accordance with Paragraph, SUBMITTALS in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, and the following requirements:

1. Shop Drawings:
   a. Submit sufficient information to demonstrate compliance with drawings and specifications.
   b. Submit the following data for approval:
      1) Electrical ratings and insulation type for each conductor and cable.
      2) Splicing materials and pulling lubricant.
2. Certifications: Two weeks prior to final inspection, submit the following.

a. Certification by the manufacturer that the conductors and cables conform to the requirements of the drawings and specifications.
b. Certification by the Contractor that the conductors and cables have been properly installed, adjusted, and tested.

1.5 APPLICABLE PUBLICATIONS

A. Publications listed below (including amendments, addenda, revisions, supplements and errata) form a part of this specification to the extent referenced. Publications are reference in the text by designation only.

B. American Society of Testing Material (ASTM):

D2301-10.....Standard Specification for Vinyl Chloride Plastic Pressure-Sensitive Electrical Insulating Tape

D2304-18.....Test Method for Thermal Endurance of Rigid Electrical Insulating Materials

D3005-17.....Low-Temperature Resistant Vinyl Chloride Plastic Pressure-Sensitive Electrical Insulating Tape

C. National Electrical Manufacturers Association (NEMA):

WC 70-21.....Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy

D. National Fire Protection Association (NFPA):

70-23.....National Electrical Code (NEC)

E. Underwriters Laboratories, Inc. (UL):

44-18.....Thermoset-Insulated Wires and Cables

83-17.....Thermoplastic-Insulated Wires and Cables

467-13.....Grounding and Bonding Equipment

486A-486B-18.....Wire Connectors

486C-18.....Splicing Wire Connectors

486D-15.....Sealed Wire Connector Systems

486E-15.....Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors

493-18.....Thermoplastic-Insulated Underground Feeder and Branch Circuit Cables

514B-12.....Conduit, Tubing, and Cable Fittings

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

A. Conductors and cables shall be in accordance with ASTM, NEMA, NFPA, UL, as specified herein, and as shown on the drawings.

B. Conductors shall be copper.

C. Single Conductor:

1. No. 12 AWG: Minimum size, except where smaller sizes are specified herein or shown on the drawings.
2. No. 8 AWG and larger: Stranded.
3. No. 10 AWG and smaller: Solid; except shall be stranded for final connection to motors, transformers, and vibrating equipment.
4. Insulation: THHN-THWN and XHHW-2. XHHW-2 shall be used for isolated power systems.

D. Conductor Color Code:

1. No. 10 AWG and smaller: Solid color insulation or solid color coating.
2. No. 8 AWG and larger: Color-coded using one of the following methods:
   a. Solid color insulation or solid color coating.
   b. Stripes, bands, or hash marks of color specified.
   c. Color using 19 mm (0.75 inches) wide tape.
4. For modifications and additions to existing wiring systems, color coding shall conform to the existing wiring system.
5. Conductors shall be color-coded as follows:

208/120 V	Phase	480/277 V
Black	A	Brown
Red	B	Orange
Blue	C	Yellow
White	Neutral	Gray *
* or white with colored (other than green) tracer.		

2.2 SPLICES

A. Splices shall be in accordance with NEC and UL.

B. Above Ground Splices for No. 10 AWG and Smaller:

1. Solderless, screw-on, reusable pressure cable type, with integral insulation, approved for copper and aluminum conductors.
2. The integral insulator shall have a skirt to completely cover the stripped conductors.
3. The number, size, and combination of conductors used with the connector, as listed on the manufacturer's packaging, shall be strictly followed.

C. Above Ground Splices for No. 8 AWG to No. 4/0 AWG:
1. Compression, hex screw, or bolt clamp-type of high conductivity and corrosion-resistant material, listed for use with copper and aluminum conductors.
2. Insulate with materials approved for the particular use, location, voltage, and temperature. Insulation level shall be not less than the insulation level of the conductors being joined.
3. Splice and insulation shall be product of the same manufacturer.
4. All bolts, nuts, and washers used with splices shall be zinc-plated steel.

D. Above Ground Splices for 250 kcmil and Larger:
1. Long barrel “butt-splice” or “sleeve” type compression connectors, with minimum of two compression indents per wire, listed for use with copper and aluminum conductors.
2. Insulate with materials approved for the particular use, location, voltage, and temperature. Insulation level shall be not less than the insulation level of the conductors being joined.
3. Splice and insulation shall be product of the same manufacturer.

2.3 CONNECTORS AND TERMINATIONS

A. Mechanical type of high conductivity and corrosion-resistant material, listed for use with copper and aluminum conductors.

B. Long barrel compression type of high conductivity and corrosion-resistant material, with minimum of two compression indents per wire, listed for use with copper and aluminum conductors.

C. All bolts, nuts, and washers used to connect connections and terminations to bus bars or other termination points shall be zinc-plated steel.

2.4 CONTROL WIRING

A. Unless otherwise specified elsewhere in these specifications, control wiring shall be as specified herein, except that the minimum size shall be not less than No. 14 AWG, or as required by the control wiring equipment manufacturer.

B. Control wiring shall be sized such that the voltage drop under in-rush conditions does not adversely affect operation of the controls.

2.5 WIRE LUBRICATING COMPOUND

A. Lubricating compound shall be suitable for the wire insulation and conduit, and shall not harden or become adhesive.

B. Shall not be used on conductors for isolated power systems.

PART 3 - EXECUTION

3.1 GENERAL

A. Installation shall be in accordance with the NEC, as shown on the drawings, and manufacturer’s instructions.

B. Install conductors in raceway systems.

C. Splice conductors only in outlet boxes, junction boxes, pullboxes, manholes, or handholes.

D. Conductors of different systems (e.g., 120 V and 277 V) shall not be installed in the same raceway.

E. For conductors installed in vertical raceways, provide conductor support (also known as cable support), to counter gravity pull on conductor weight. Conductor support shall be split-wedge conductor support type. Prior to installing the conductor support plug, remove all pulling compound from conductors where they pass through the conductor support body. After installing the conductor support plug, tap the conductor support plug firmly in the conductor support body.

F. In panelboards, cabinets, wireways, switches, enclosures, and equipment assemblies, neatly form, train, and tie the conductors with non-metallic “zip” ties.

G. For connections to motors, transformers, and vibrating equipment, stranded conductors shall be used only from the last fixed point of connection to the motors, transformers, or vibrating equipment.

H. Use expanding foam or non-hardening duct-seal to seal conduits entering a building, after installation of conductors.

I. Conductor Pulling:

1. Provide installation equipment that will prevent the cutting or abrasion of insulation during pulling. Use lubricants approved for the cable.
2. Use nonmetallic pull ropes.
3. Attach pull ropes by means of either woven basket grips or pulling eyes attached directly to the conductors.
4. All conductors in a single conduit shall be pulled simultaneously.
5. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

J. Number of conductors for branch circuits shall not exceed more than three branch circuits in any one conduit.

K. When stripping stranded conductors, use a tool that does not damage the conductor or remove conductor strands.

3.2 INSTALLATION IN MANHOLES

A. Train the conductors around the manhole walls, but do not bend to a radius less than six times the overall conductor diameter.

3.3 SPLICE AND TERMINATION INSTALLATION

A. Splices and terminations shall be mechanically and electrically secure, and tightened to manufacturer's published torque values using a torque screwdriver or wrench.

B. Where the Government determines that unsatisfactory splices or terminations have been installed, replace the splices or terminations at no additional cost to the Government.

3.4 CONDUCTOR IDENTIFICATION

A. When using colored tape to identify phase, neutral, and ground conductors larger than No. 8 AWG, apply tape in half-overlapping turns for a minimum of 75 mm (3 inches) from terminal points, and in junction boxes, pullboxes, and manholes. Apply the last two laps of tape with no tension to prevent possible unwinding. Where markings are covered by tape, apply tags to conductors, stating size and insulation type.

3.5 FEEDER CONDUCTOR IDENTIFICATION

A. In each interior pullbox and each underground manhole and handhole, install brass tags on all feeder conductors to clearly designate their circuit identification and voltage. The tags shall be the embossed type, 40 mm (1-1/2 inches) in diameter and 40 mils thick. Attach tags with plastic ties.

3.6 EXISTING CONDUCTORS

A. Unless specifically indicated on the plans, existing conductors shall not be reused.

3.7 CONTROL WIRING INSTALLATION

A. Unless otherwise specified in other sections, install control wiring and connect to equipment to perform the required functions as specified or as shown on the drawings.

B. Install a separate power supply circuit for each system, except where otherwise shown on the drawings.

3.8 CONTROL WIRING 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.

3.9 ACCEPTANCE CHECKS AND TESTS

A. Perform in accordance with the manufacturer's recommendations. In addition, include the following:

1. Visual Inspection and Tests: Inspect physical condition.
2. Electrical tests:
   a. After installation but before connection to utilization devices, such as fixtures, motors, or appliances, test conductors phase-to-phase and phase-to-ground resistance with an insulation resistance tester. Existing conductors to be reused shall also be tested.
   b. Applied voltage shall be 500 V DC for 300 V rated cable, and 1000 V DC for 600 V rated cable. Apply test for one minute or until reading is constant for 15 seconds, whichever is longer. Minimum insulation resistance values shall not be less than 25 megohms for 300 V rated cable and 100 megohms for 600 V rated cable.
   c. Perform phase rotation test on all three-phase circuits.

---END---

SECTION 26 05 26
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section specifies the furnishing, installation, connection, and testing of grounding and bonding equipment, indicated as grounding equipment in this section.

B. "Grounding electrode system" refers to grounding electrode conductors and all electrodes required or allowed by NEC, as well as made, supplementary, and lightning protection system grounding electrodes.

C. The terms "connect" and "bond" are used interchangeably in this section and have the same meaning.

1.2 RELATED WORK

A. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: Requirements that apply to all sections of Division 26.

B. Section 26 05 19, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES: Low-voltage conductors.

C. Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS: Conduit and boxes.

D. Section 26 32 13, ENGINE GENERATORS: Engine generators.

E. Section 26 36 23, AUTOMATIC TRANSFER SWITCHES: Automatic transfer switches.

1.3 QUALITY ASSURANCE

A. Quality Assurance shall be in accordance with Paragraph, QUALIFICATIONS (PRODUCTS AND SERVICES) in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 SUBMITTALS

A. Submit in accordance with Paragraph, SUBMITTALS in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, and the following requirements:

1. Shop Drawings:

a. Submit sufficient information to demonstrate compliance with drawings and specifications.

b. Submit plans showing the location of system grounding electrodes and connections, and the routing of aboveground and underground grounding electrode conductors.

2. Test Reports:

a. Two weeks prior to the final inspection, submit ground resistance field test reports to the COR.

3. Certifications:

a. Certification by the Contractor that the grounding equipment has been properly installed and tested.

1.5 APPLICABLE PUBLICATIONS

A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by designation only.

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

B1-13.....Standard Specification for Hard-Drawn Copper Wire

B3-13(R2018).....Standard Specification for Soft or Annealed Copper Wire

B8-11(R2017).....Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft

C. Institute of Electrical and Electronics Engineers, Inc. (IEEE):

81-12.....IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System Part 1: Normal Measurements

D. National Fire Protection Association (NFPA):

70-23.....National Electrical Code (NEC)

70E-21.....National Electrical Safety Code

99-21.....Health Care Facilities

E. Underwriters Laboratories, Inc. (UL):

44-18 .....Thermoset-Insulated Wires and Cables

83-17 .....Thermoplastic-Insulated Wires and Cables

467-13 .....Grounding and Bonding Equipment

PART 2 - PRODUCTS

2.1 GROUNDING AND BONDING CONDUCTORS

A. Equipment grounding conductors shall be insulated stranded copper, except that sizes No. 10 AWG and smaller shall be solid copper. Insulation color shall be continuous green for all equipment grounding conductors, except that wire sizes No. 4 AWG and larger shall be identified per NEC.

B. Bonding conductors shall be bare stranded copper, except that sizes No. 10 AWG and smaller shall be bare solid copper. Bonding conductors shall be stranded for final connection to motors, transformers, and vibrating equipment.

C. Conductor sizes shall not be less than shown on the drawings, or not less than required by the NEC, whichever is greater.

D. Insulation: THHN-THWN and XHHW-2.

2.2 GROUND RODS

A. Steel or copper clad steel, 19 mm (0.75 inch) diameter by 3 M (10 feet) long.

B. Quantity of rods shall be as shown on the drawings, and as required to obtain the specified ground resistance.

2.3 CONCRETE ENCASED ELECTRODE

A. Concrete encased electrode shall be No. 4 AWG bare copper wire, installed per NEC.

2.4 GROUND CONNECTIONS

A. Below Grade and Inaccessible Locations: Exothermic-welded type connectors.

B. Above Grade:

1. Bonding Jumpers: Listed for use with aluminum and copper conductors. For wire sizes No. 8 AWG and larger, use compression-type connectors. For wire sizes smaller than No. 8 AWG, use mechanical type lugs. Connectors or lugs shall use zinc-plated steel bolts, nuts, and washers. Bolts shall be torqued to the values recommended by the manufacturer.
2. Connection to Building Steel: Exothermic-welded type connectors.
3. Connection to Grounding Bus Bars: Listed for use with aluminum and copper conductors. Use mechanical type lugs, with zinc-plated steel

bolts, nuts, and washers. Bolts shall be torqued to the values recommended by the manufacturer.

4. Connection to Equipment Rack and Cabinet Ground Bars: Listed for use with aluminum and copper conductors. Use mechanical type lugs, with zinc-plated steel bolts, nuts, and washers. Bolts shall be torqued to the values recommended by the manufacturer.

PART 3 - EXECUTION

3.1 GENERAL

A. Installation shall be in accordance with the NEC, as shown on the drawings, and manufacturer's instructions.

B. System Grounding:

1. Secondary service neutrals: Ground at the supply side of the secondary disconnecting means and at the related transformer.
2. Separately derived systems (transformers downstream from the service entrance): Ground the secondary neutral.

C. Equipment Grounding: Metallic piping, building structural steel, electrical 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

A. Make grounding connections, which are normally buried or otherwise inaccessible, by exothermic weld.

3.3 SECONDARY VOLTAGE EQUIPMENT AND CIRCUITS

A. Main Bonding Jumper: Bond the secondary service neutral to the ground bus in the service equipment.

B. Metallic Piping, Building Structural Steel, and Supplemental Electrode(s):

1. Provide a grounding electrode conductor sized per NEC between the service equipment ground bus and all metallic water pipe systems, building structural steel, and supplemental or made electrodes. Provide jumpers across insulating joints in the metallic piping.
2. Provide a supplemental ground electrode as shown on the drawings and bond to the grounding electrode system.

C. Switchgear, Switchboards, Unit Substations, Panelboards, Motor Control Centers, Engine-Generators, Automatic Transfer Switches, and other electrical equipment:

1. Connect the equipment grounding conductors to the ground bus.
2. Connect metallic conduits by grounding bushings and equipment grounding conductor to the equipment ground bus.

D. Transformers:

1. Exterior: Exterior transformers supplying interior service equipment shall have the neutral grounded at the transformer secondary. Provide a grounding electrode at the transformer.
2. 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 nearest component of the grounding electrode system.

3.4 RACEWAY

A. Conduit Systems:

1. Ground all metallic conduit systems. All metallic conduit systems shall contain an equipment grounding conductor.
2. Non-metallic conduit systems, except non-metallic feeder conduits that carry a grounded conductor from exterior transformers to interior or building-mounted service entrance equipment, shall contain an equipment grounding conductor.
3. Metallic conduit that only contains a grounding conductor, and is provided for its mechanical protection, shall be bonded to that conductor at the entrance and exit from the conduit.
4. Metallic conduits which terminate without mechanical connection to an electrical equipment housing by means of locknut and bushings or adapters, shall be provided with grounding bushings. Connect bushings with a equipment grounding conductor to the equipment ground bus.

B. Feeders and Branch Circuits: Install equipment grounding conductors with all feeders, and all branch circuits.

C. 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.

D. Wireway Systems:
   1. Bond the metallic structures of wireway to provide electrical continuity throughout the wireway system, by connecting a No. 6 AWG bonding jumper at all intermediate metallic enclosures and across all section junctions.
   2. Install insulated No. 6 AWG bonding jumpers between the wireway system, bonded as required above, and the closest building ground at each end and approximately every 16 M (50 feet).
   3. Use insulated No. 6 AWG bonding jumpers to ground or bond metallic wireway at each end for all intermediate metallic enclosures and across all section junctions.

E. Receptacles shall not be grounded through their mounting screws. Ground receptacles with a jumper from the receptacle green ground terminal to the device box ground screw and a jumper to the branch circuit equipment grounding conductor.

F. Ground lighting fixtures to the equipment grounding conductor of the wiring system. 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.

G. Fixed electrical appliances and equipment shall be provided with a ground lug for termination of the equipment grounding conductor.

H. Raised Floors: Provide bonding for all raised floor components as shown on the drawings.

3.5 CORROSION INHIBITORS

A. When making grounding and bonding connections, apply a corrosion inhibitor to all contact surfaces. Use corrosion inhibitor appropriate for protecting a connection between the metals used.

3.6 CONDUCTIVE PIPING

A. Bond all conductive piping systems, interior and exterior, to the grounding electrode system. Bonding connections shall be made as close as practical to the equipment ground bus.

B. In operating rooms and at intensive care and coronary care type beds, bond the medical gas piping and medical vacuum piping at the outlets

3.7 GROUND RESISTANCE

A. Grounding system resistance to ground shall not exceed 5 ohms. Make any modifications or additions to the grounding electrode system necessary for compliance without additional cost to the Government. Final tests shall ensure that this requirement is met.

B. Grounding system resistance shall comply with the electric utility company ground resistance requirements.

3.8 GROUND ROD INSTALLATION

A. For outdoor installations, drive each rod vertically in the earth, until top of rod is 610 mm (24 inches) below final grade.

B. For indoor installations, leave 100 mm (4 inches) of each rod exposed.

C. Where buried or 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.

D. Where rock or impenetrable soil prevents the driving of vertical ground rods, install angled ground rods or grounding electrodes in horizontal trenches to achieve the specified ground resistance.

3.9 ACCEPTANCE CHECKS AND TESTS

A. 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 or connected to the electric utility company ground system, and shall be made in normally dry conditions not fewer than 48 hours after the last rainfall.

B. Resistance measurements of separate grounding electrode systems shall be made before the systems are bonded together. 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. Below-grade connections shall be visually inspected by the COR prior to backfilling. The Contractor shall notify the COR 24 hours before the connections are ready for inspection.

---END---

SECTION 26 05 33
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. Section 07 92 00, JOINT SEALANTS: Sealing around conduit penetrations through the building envelope to prevent moisture migration into the building.

B. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements and items that are common to more than one section of Division 26.

C. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path for possible ground fault currents.

D. Section 26 05 41, UNDERGROUND ELECTRICAL CONSTRUCTION: Underground conduits.

E. Section 31 20 11, EARTHWORK (SHORT FORM): Bedding of conduits.

1.3 QUALITY ASSURANCE

A. Quality Assurance shall be in accordance with Paragraph, QUALIFICATIONS (PRODUCTS AND SERVICES) in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 SUBMITTALS

A. Submit in accordance with Paragraph, SUBMITTALS in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, and the following requirements:

1. Shop Drawings:
   a. Size and location of main feeders.
   b. Size and location of panels and pull-boxes.

c. Layout of required conduit penetrations through structural elements.

d. Submit the following data for approval:

1) Raceway types and sizes.

2) Conduit bodies, connectors and fittings.

3) Junction and pull boxes, types and sizes.

2. Certifications: Two weeks prior to final inspection, submit the following:

a. Certification by the manufacturer that raceways, conduits, conduit bodies, connectors, fittings, junction and pull boxes, and all related equipment conform to the requirements of the drawings and specifications.

b. Certification by the Contractor that raceways, conduits, conduit bodies, connectors, fittings, junction and pull boxes, and all related equipment have been properly installed.

1.5 APPLICABLE PUBLICATIONS

A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by designation only.

B. American Iron and Steel Institute (AISI):

S100-16.....North American Specification for the Design of Cold-Formed Steel Structural Members

C. National Electrical Manufacturers Association (NEMA):

C80.1-20.....Electrical Rigid Steel Conduit

C80.3-20.....Steel Electrical Metal Tubing

C80.6-18.....Electrical Intermediate Metal Conduit

FB1-14.....Fittings, Cast Metal Boxes and Conduit Bodies for Conduit, Electrical Metallic Tubing and Cable

FB2.10-21.....Selection and Installation Guidelines for Fittings for use with Non-Flexible Conduit or Tubing (Rigid Metal Conduit, Intermediate Metallic Conduit, and Electrical Metallic Tubing)

FB2.20-21.....Selection and Installation Guidelines for Fittings for use with Flexible Electrical Conduit and Cable
TC-2-20.....Electrical Polyvinyl Chloride (PVC) Tubing and Conduit
TC-3-21.....PVC Fittings for Use with Rigid PVC Conduit and Tubing

D. National Fire Protection Association (NFPA):
70-23.....National Electrical Code (NEC)

E. Underwriters Laboratories, Inc. (UL):
1-05.....Flexible Metal Conduit
5-16.....Surface Metal Raceway and Fittings
6-07.....Electrical Rigid Metal Conduit - Steel
50-15.....Enclosures for Electrical Equipment
360-13.....Liquid-Tight Flexible Steel Conduit
467-13.....Grounding and Bonding Equipment
514A-13.....Metallic Outlet Boxes
514B-12.....Conduit, Tubing, and Cable Fittings
514C-14.....Nonmetallic Outlet Boxes, Flush-Device Boxes and Covers
651-11.....Schedule 40 and 80 Rigid PVC Conduit and Fittings
651A-11.....Type EB and A Rigid PVC Conduit and HDPE Conduit
797-07.....Electrical Metallic Tubing
1242-06.....Electrical Intermediate Metal Conduit - Steel

PART 2 - PRODUCTS

2.1 MATERIAL

A. Conduit Size: In accordance with the NEC, but not less than 13 mm (0.5-inch) unless otherwise shown. Where permitted by the NEC, 13 mm (0.5-inch) flexible conduit may be used for tap connections to recessed lighting fixtures.

B. Conduit:
1. Size: In accordance with the NEC, but not less than 13 mm (0.5-inch).
2. Rigid Steel Conduit (RMC): Shall conform to UL 6 and NEMA C80.1.

3. Rigid Intermediate Steel Conduit (IMC): Shall conform to UL 1242 and NEMA C80.6.
4. Electrical Metallic Tubing (EMT): Shall conform to UL 797 and NEMA C80.3. Maximum size not to exceed 105 mm (4 inches) and shall be permitted only with cable rated 600 V or less.
5. Flexible Metal Conduit: Shall conform to UL 1.
6. Liquid-tight Flexible Metal Conduit: Shall conform to UL 360.
7. Direct Burial Plastic Conduit: Shall conform to UL 651 and UL 651A, heavy wall PVC or high density polyethylene (PE).
8. Surface Metal Raceway: Shall conform to UL 5.

C. Conduit Fittings:
1. Rigid Steel and Intermediate Metallic Conduit Fittings:
   a. Fittings shall meet the requirements of UL 514B and NEMA FB1.
   b. Standard threaded couplings, locknuts, bushings, conduit bodies, and elbows: Only steel or malleable iron materials are acceptable. Integral retractable type IMC couplings are also acceptable.
   c. Locknuts: Bonding type with sharp edges for digging into the metal wall of an enclosure.
   d. Bushings: Metallic insulating type, consisting of an insulating insert, molded or locked into the metallic body of the fitting. Bushings made entirely of metal or nonmetallic material are not permitted.
   e. Erickson (Union-Type) and Set Screw Type Couplings: Approved for use in concrete are permitted for use to complete a conduit run where conduit is installed in concrete. Use set screws of case-hardened steel with hex head and cup point to firmly seat in conduit wall for positive ground. Tightening of set screws with pliers is prohibited.
   f. Sealing Fittings: Threaded cast iron type. Use continuous drain-type sealing fittings to prevent passage of water vapor. In concealed work, install fittings in flush steel boxes with blank cover plates having the same finishes as that of other electrical plates in the room.
2. Electrical Metallic Tubing Fittings:

a. Fittings and conduit bodies shall meet the requirements of UL 514B, NEMA C80.3, and NEMA FB1.
b. Only steel or malleable iron materials are acceptable.
c. Compression Couplings and Connectors: Concrete-tight and rain-tight, with connectors having insulated throats.
d. Indent-type connectors or couplings are prohibited.
e. Die-cast or pressure-cast zinc-alloy fittings or fittings made of "pot metal" are prohibited.

4. Flexible Metal Conduit Fittings:
   a. Conform to UL 514B. Only steel or malleable iron materials are acceptable.
   b. Clamp-type, with insulated throat.
5. Liquid-tight Flexible Metal Conduit Fittings:
   a. Fittings shall meet the requirements of UL 514B and NEMA FB1.
   b. Only steel or malleable iron materials are acceptable.
   c. Fittings must incorporate a threaded grounding cone, a steel or plastic compression ring, and a gland for tightening. Connectors shall have insulated throats.
6. Direct Burial Plastic Conduit Fittings: Fittings shall meet the requirements of UL 514C and NEMA TC3.
7. Surface Metal Raceway Fittings: As recommended by the raceway manufacturer. Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, conduit entry fittings, accessories, and other fittings as required for complete system.
8. Expansion and Deflection Couplings:
   a. Conform to UL 467 and UL 514B.
   b. Accommodate a 19 mm (0.75-inch) deflection, expansion, or contraction in any direction, and allow 30 degree angular deflections.
   c. Include internal flexible metal braid, sized to guarantee conduit ground continuity and a low-impedance path for fault currents, in accordance with UL 467 and the NEC tables for equipment grounding conductors.
   d. Jacket: Flexible, corrosion-resistant, watertight, moisture and heat-resistant molded rubber material with stainless steel jacket clamps.

D. Conduit Supports:
   1. Parts and Hardware: Zinc-coat or provide equivalent corrosion protection.
   2. Individual Conduit Hangers: Designed for the purpose, having a pre-assembled closure bolt and nut, and provisions for receiving a hanger rod.
   3. Multiple Conduit (Trapeze) Hangers: Not less than 38 mm x 38 mm (1.5 x 1.5 inches), 12-gauge steel, cold-formed, lipped channels; with not less than 9 mm (0.375-inch) diameter steel hanger rods.
   4. Solid Masonry and Concrete Anchors: Self-drilling expansion shields, or machine bolt expansion.

E. Outlet, Junction, and Pull Boxes:
   1. Comply with UL-50 and UL-514A.
   2. Rustproof cast metal where required by the NEC or shown on drawings.
   3. Sheet Metal Boxes: Galvanized steel, except where shown on drawings.

F. Metal Wireways: Equip with hinged covers, except as shown on drawings. Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for a complete system.

PART 3 - EXECUTION

3.1 PENETRATIONS

A. Cutting or Holes:
   1. Cut holes in advance where they should be placed in the structural elements, such as ribs or beams. Obtain the approval of the COR prior to drilling through structural elements.
   2. Cut holes through concrete and masonry in new and existing structures with a diamond core drill or concrete saw. Pneumatic hammers, impact electric, hand, or manual hammer-type drills are not allowed, except when permitted by the COR where working space is limited.

B. Firestop: 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 07 84 00, FIRESTOPPING.

C. Waterproofing: At floor, exterior wall, and roof conduit penetrations, completely seal the gap around conduit to render it watertight, as specified in Section 07 92 00, JOINT SEALANTS.

3.2 INSTALLATION, GENERAL

A. In accordance with NEC, NEMA, UL, as shown on drawings, and as specified herein.

B. Install conduit as follows:

1. In complete mechanically and electrically continuous runs before pulling in cables or wires.
2. Unless otherwise indicated on the drawings or specified herein, installation of all conduits shall be concealed within finished walls, floors, and ceilings.
3. Flattened, dented, or deformed conduit is not permitted. Remove and replace the damaged conduits with new conduits.
4. Assure conduit installation does not encroach into the ceiling height head room, walkways, or doorways.
5. Cut conduits square, ream, remove burrs, and draw up tight.
6. Independently support conduit at 2.4 M (8 feet) on centers with specified materials and as shown on drawings.
7. Do not use suspended ceilings, suspended ceiling supporting members, lighting fixtures, other conduits, cable tray, boxes, piping, or ducts to support conduits and conduit runs.
8. Support within 300 mm (12 inches) of changes of direction, and within 300 mm (12 inches) of each enclosure to which connected.
9. Close ends of empty conduits with plugs or caps at the rough-in stage until wires are pulled in, to prevent entry of debris.
10. Conduit installations under fume and vent hoods are prohibited.
11. Secure conduits to cabinets, junction boxes, pull-boxes, and outlet boxes with bonding type locknuts. For rigid steel and IMC conduit installations, provide a locknut on the inside of the enclosure, made up wrench tight. Do not make conduit connections to junction box covers.
12. Conduit bodies shall only be used for changes in direction, and shall not contain splices.

C. 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.

D. Layout and Homeruns:
1. Install conduit with wiring, including homeruns, as shown on drawings.
2. Deviations: Make only where necessary to avoid interferences and only after drawings showing the proposed deviations have been submitted and approved by the COR.

3.3 CONCEALED WORK INSTALLATION

A. In Concrete:
1. Conduit: Rigid steel, IMC, or EMT. Do not install EMT in concrete slabs that are in contact with soil, gravel, or vapor barriers.
2. Align and run conduit in direct lines.
3. Install conduit through concrete beams only:
a. Where shown on the structural drawings.
b. As approved by the COR prior to construction, and after submittal of drawing showing location, size, and position of each penetration.
4. Installation of conduit in concrete that is less than 75 mm (3 inches) thick is prohibited.
a. Conduit outside diameter larger than one-third of the slab thickness is prohibited.
b. Space between conduits in slabs: Approximately six conduit diameters apart, and one conduit diameter at conduit crossings.
c. Install conduits approximately in the center of the slab so that there will be a minimum of 19 mm (0.75-inch) of concrete around the conduits.
5. Make couplings and connections watertight. Use thread compounds that are UL approved conductive type to ensure low resistance ground continuity through the conduits. Tightening setscrews with pliers is prohibited.

B. Above Furred or Suspended Ceilings and in Walls:
1. Conduit for Conductors Above 600 V: Rigid steel. Mixing different types of conduits in the same system is prohibited.

2. Conduit for Conductors 600 V and Below: Rigid steel, IMC, or EMT. Mixing different types of conduits in the same system is prohibited.
3. Align and run conduit parallel or perpendicular to the building lines.
4. Connect recessed lighting fixtures to conduit runs with maximum 1.8 M (6 feet) of flexible metal conduit extending from a junction box to the fixture.
5. Tightening set screws with pliers is prohibited.
6. For conduits running through metal studs, limit field cut holes to no more than 70% of web depth. Spacing between holes shall be at least 457 mm (18 inches). Cuts or notches in flanges or return lips shall not be permitted.

3.4 EXPOSED WORK INSTALLATION

A. Unless otherwise indicated on drawings, exposed conduit is only permitted in mechanical and electrical rooms.
B. Conduit for Conductors Above 600 V: Rigid steel. Mixing different types of conduits in the system is prohibited.
C. Conduit for Conductors 600 V and Below: Rigid steel, IMC, or EMT. Mixing different types of conduits in the system is prohibited.
D. Align and run conduit parallel or perpendicular to the building lines.
E. Install horizontal runs close to the ceiling or beams and secure with conduit straps.
F. Support horizontal or vertical runs at not over 2.4 M (8 feet) intervals.
G. Surface Metal Raceways: Use only where shown on drawings.

3.5 HAZARDOUS LOCATIONS

A. Use rigid steel conduit only.
B. Install UL approved sealing fittings that prevent passage of explosive vapors in hazardous areas equipped with explosion-proof lighting fixtures, switches, and receptacles, as required by the NEC.

3.6 WET OR DAMP LOCATIONS

A. Use rigid steel or IMC conduits unless as shown on drawings.
B. Provide sealing fittings to prevent passage of water vapor where conduits pass from warm to cold locations, i.e., refrigerated spaces,

constant-temperature rooms, air-conditioned spaces, building exterior walls, roofs, or similar spaces.

C. Use rigid steel or IMC conduit within 1.5 M (5 feet) of the exterior and below concrete building slabs in contact with soil, gravel, or vapor barriers, unless as shown on drawings. Conduit shall be half-lapped with 10 mil PVC tape before installation. After installation, completely recoat or retape any damaged areas of coating.

D. Conduits run on roof shall be supported with integral galvanized lipped steel channel, attached to UV-inhibited polycarbonate or polypropylene blocks every 2.4 M (8 feet) with 9 mm (3/8-inch) galvanized threaded rods, square washer and locknut. Conduits shall be attached to steel channel with conduit clamps.

3.7 MOTORS AND VIBRATING EQUIPMENT

A. Use flexible metal conduit for connections to motors and other electrical equipment subject to movement, vibration, misalignment, cramped quarters, or noise transmission.

B. Use liquid-tight flexible metal conduit for installation in exterior locations, moisture or humidity laden atmosphere, corrosive atmosphere, water or spray wash-down operations, inside airstream of HVAC units, and locations subject to seepage or dripping of oil, grease, or water.

C. Provide a green equipment grounding conductor with flexible and liquid-tight flexible metal conduit.

3.8 EXPANSION JOINTS

A. Conduits 75 mm (3 inch) and larger that are secured to the building structure on opposite sides of a building expansion joint require expansion and deflection couplings. Install the couplings in accordance with the manufacturer's recommendations.

B. Provide conduits smaller than 75 mm (3 inch) with junction boxes on both sides of the expansion joint. Connect flexible metal conduits to junction boxes with sufficient slack to produce a 125 mm (5 inch) vertical drop midway between the ends of the flexible metal conduit. Flexible metal conduit shall have a green insulated copper bonding jumper installed. In lieu of this flexible metal conduit, expansion and deflection couplings as specified above are acceptable.

C. Install expansion and deflection couplings where shown.

3.9 CONDUIT SUPPORTS

A. Safe working load shall not exceed one-quarter of proof test load of fastening devices.

B. Use pipe straps or individual conduit hangers for supporting individual conduits.

C. Support multiple conduit runs with trapeze hangers. Use trapeze hangers that are designed to support a load equal to or greater than the sum of the weights of the conduits, wires, hanger itself, and an additional 90 kg (200 lbs). Attach each conduit with U-bolts or other approved fasteners.

D. Support conduit independently of junction boxes, pull-boxes, fixtures, suspended ceiling T-bars, angle supports, and similar items.

E. Fasteners and Supports in Solid Masonry and Concrete:

1. New Construction: Use steel or malleable iron concrete inserts set in place prior to placing the concrete.
2. Existing Construction:
   a. Steel expansion anchors not less than 6 mm (0.25-inch) bolt size and not less than 28 mm (1.125 inch) in embedment.
   b. Power set fasteners not less than 6 mm (0.25-inch) diameter with depth of penetration not less than 75 mm (3 inch).
   c. Use vibration and shock-resistant anchors and fasteners for attaching to concrete ceilings.

F. Hollow Masonry: Toggle bolts.

G. Bolts supported only by plaster or gypsum wallboard are not acceptable.

H. Metal Structures: Use machine screw fasteners or other devices specifically designed and approved for the application.

I. Attachment by wood plugs, rawl plug, plastic, lead or soft metal anchors, or wood blocking and bolts supported only by plaster is prohibited.

J. Chain, wire, or perforated strap shall not be used to support or fasten conduit.

K. Spring steel type supports or fasteners are prohibited for all uses except horizontal and vertical supports/fasteners within walls.

L. 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.

3.10 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 or where more than the equivalent of 4-90 degree bends are necessary.

C. Locate pullboxes so that covers are accessible and easily removed. Coordinate locations with piping and ductwork where installed above ceilings.

D. Remove only knockouts as required. Plug unused openings. Use threaded plugs for cast metal boxes and snap-in metal covers for sheet metal boxes.

E. Outlet boxes mounted back-to-back in the same wall are prohibited. A minimum 600 mm (24 inch) center-to-center lateral spacing shall be maintained between boxes.

F. Flush-mounted wall or ceiling boxes shall be installed with raised covers so that the front face of raised cover is flush with the wall. Surface-mounted wall or ceiling boxes shall be installed with surface-style flat or raised covers.

G. Minimum size of outlet boxes for ground fault circuit interrupter (GFCI) receptacles is 100 mm (4 inches) square x 55 mm (2.125 inches) deep, with device covers for the wall material and thickness involved.

H. Stencil or install phenolic nameplates on covers of the boxes identified on riser diagrams; for example "ELECTRICAL PB No. 1."

I. On all branch circuit junction box covers, identify the circuits with black marker.

- - - E N D - - -

SECTION 26 05 41
UNDERGROUND ELECTRICAL CONSTRUCTION

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section specifies the furnishing, installation, and connection of underground ducts and raceways, and precast manholes and pullboxes to form a complete underground electrical raceway system.

B. The terms "duct" and "conduit" are used interchangeably in this section.

1.2 RELATED WORK

A. Section 07 92 00, JOINT SEALANTS: Sealing of conduit penetrations.

B. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: Requirements that apply to all sections of Division 26.

C. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path for possible ground fault currents.

D. Section 31 20 11, EARTH MOVING (SHORT FORM): Trenching, backfill, and compaction.

1.3 QUALITY ASSURANCE

A. Quality Assurance shall be in accordance with Paragraph, QUALIFICATIONS (PRODUCTS AND SERVICES) in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

B. Coordinate layout and installation of ducts, manholes, and pullboxes with final arrangement of other utilities, site grading, and surface features.

1.4 SUBMITTALS

A. Submit in accordance with Paragraph, SUBMITTALS in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, and the following requirements:

1. Shop Drawings:

a. Submit sufficient information to demonstrate compliance with drawings and specifications.

b. Submit information on manholes, pullboxes, ducts, and hardware. Submit manhole plan and elevation drawings, showing openings,

pulling irons, cable supports, cover, ladder, sump, and other accessories.

c. Proposed deviations from the drawings shall be clearly marked on the submittals. If it is necessary to locate manholes, pullboxes, or duct banks at locations other than shown on the drawings, show the proposed locations accurately on scaled site drawings, and submit to the COR for approval prior to construction.

2. Certifications: Two weeks prior to the final inspection, submit the following.

a. Certification by the manufacturer that the materials conform to the requirements of the drawings and specifications.

b. Certification by the Contractor that the materials have been properly installed, connected, and tested.

1.5 APPLICABLE PUBLICATIONS

A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by designation only.

B. American Concrete Institute (ACI):
Building Code Requirements for Structural Concrete
318-19/318M-19.....Building Code Requirements for Structural Concrete & Commentary
MNL-66-20.....ACI Detailing Manual

C. American National Standards Institute (ANSI):
77-17.....Underground Enclosure Integrity

D. American Society for Testing and Materials (ASTM):
C478/C478M-20.....Standard Specification for Precast Reinforced Concrete Manhole Sections
C858-19.....Underground Precast Concrete Utility Structures
C990/C990M-09.....Joints for Concrete Pipe, Manholes and Precast Box Sections Using Preformed Flexible Joint Sealants.

E. National Electrical Manufacturers Association (NEMA):
TC 2-20.....Electrical Polyvinyl Chloride (PVC) Conduit
TC 3-21.....Polyvinyl Chloride (PVC) Fittings for Use With Rigid PVC Conduit And Tubing

TC 6 & 8-20.....Polyvinyl Chloride (PVC) Plastic Utilities Duct For Underground Installations
TC 9-20.....Fittings For Polyvinyl Chloride (PVC) Plastic Utilities Duct For Underground Installation

F. National Fire Protection Association (NFPA):
70-23.....National Electrical Code (NEC)
70E-21.....National Electrical Safety Code

G. Underwriters Laboratories, Inc. (UL):
6-07.....Electrical Rigid Metal Conduit-Steel
467-13.....Grounding and Bonding Equipment
651-11.....Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings
651A-11.....Schedule 40 and 80 High Density Polyethylene (HDPE) Conduit

PART 2 - PRODUCTS

2.1 PRE-CAST CONCRETE MANHOLES AND HARDWARE

A. Structure: Factory-fabricated, reinforced-concrete, monolithically-poured walls and bottom. Frame and cover shall form top of manhole.

B. Cable Supports:
1. Cable stanchions shall be hot-rolled, heavy duty, hot-dipped galvanized "T" section steel, 56 mm (2.25 inches) x 6 mm (0.25 inch) in size, and punched with 14 holes on 38 mm (1.5 inches) centers for attaching cable arms.
2. Cable arms shall be 5 mm (0.1875 inch) gauge, hot-rolled, hot-dipped galvanized sheet steel, pressed to channel shape. Arms shall be approximately 63 mm (2.5 inches) wide x 350 mm (14 inches) long.
3. Insulators for cable supports shall be porcelain, and shall be saddle type or type that completely encircles the cable.
4. Equip each cable stanchion with one spare cable arm, with three spare insulators for future use.

D. Ground Rod Sleeve: Provide a 75 mm (3 inches) PVC sleeve in manhole floors so that a driven ground rod may be installed.

2.2 DUCTS

A. Number and sizes shall be as shown on the drawings.

B. Ducts (concrete-encased):
1. Plastic Duct:

a. UL 651 and 651A Schedule 40 PVC conduit.
b. Duct shall be suitable for use with 90˚ C (194˚ F) rated conductors.

2. Conduit Spacers: Prefabricated plastic.

2.3 GROUNDING

A. Ground Rods and Ground Wire: Per Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS.

2.4 WARNING TAPE

A. 4-mil polyethylene 75 mm (3 inches) wide detectable tape, red with black letters, imprinted with "CAUTION - BURIED ELECTRIC CABLE BELOW" or similar.

2.5 PULL ROPE FOR SPARE DUCTS

A. Plastic with 890 N (200 lb) minimum tensile strength.

PART 3 - EXECUTION

3.1 MANHOLE AND PULLBOX INSTALLATION

A. Assembly and installation shall be per the requirements of the manufacturer.
   1. Install manholes level and plumb.
   2. Units shall be installed on a 300 mm (12 inches) thick level bed of 90% compacted granular fill, well-graded from the 25 mm (1 inch) sieve to the No. 4 sieve. Granular fill shall be compacted with a minimum of four passes with a plate compactor.

B. Access: Ensure the top of frames and covers are flush with finished grade.

C. Grounding in Manholes:
   1. Ground Rods in Manholes: Drive a ground rod into the earth, through the floor sleeve, after the manhole is set in place. Fill the sleeve with sealant to make a watertight seal. Rods shall protrude approximately 100 mm (4 inches) above the manhole floor.
   2. Install a No. 3/0 AWG bare copper ring grounding conductor around the inside perimeter of the manhole and anchor to the walls with metallic cable clips.
   3. Connect the ring grounding conductor to the ground rod by an exothermic welding process.
   4. Bond the ring grounding conductor to the duct bank equipment grounding conductors, the exposed non-current carrying metal parts

of racks, sump covers, and like items in the manholes with a minimum No. 6 AWG bare copper jumper using an exothermic welding process.

3.2 TRENCHING

A. Refer to Section 31 20 11 EARTH MOVING (SHORT FORM) for trenching, backfilling, and compaction.

B. Before performing trenching work at existing facilities, a Ground Penetrating Radar Survey shall be carefully performed by a certified technician to reveal all existing underground ducts, conduits, cables, and other utility systems.

C. Work with extreme care near existing ducts, conduits, and other utilities to avoid damaging them.

D. Cut the trenches neatly and uniformly.

E. For Concrete-Encased Ducts:

1. After excavation of the trench, stakes shall be driven in the bottom of the trench at 1.2 M (4 feet) intervals to establish the grade and route of the duct bank.
2. Pitch the trenches uniformly toward manholes or both ways from high points between manholes for the required duct line drainage. Avoid pitching the ducts toward 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 the 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, and appropriate warning tape installed.

F. Individual conduits to be installed under existing paved areas and roads that cannot be disturbed shall be jacked into place using rigid metal conduit, or bored using plastic utilities duct or PVC conduit, as approved by the COR.

3.3 DUCT INSTALLATION

A. General Requirements:

1. Ducts shall be in accordance with the NEC, as shown on the drawings, and as specified.

2. Join and terminate ducts with fittings recommended by the manufacturer.
3. Slope ducts to drain towards manholes and pullboxes, and away from building and equipment entrances. Pitch not less than 100 mm (4 inches) in 30 M (100 feet).
4. Underground conduit stub-ups and sweeps to equipment inside of buildings shall be galvanized rigid metal conduit half-lap wrapped with PVC tape, and shall extend a minimum of 1.5 M (5 feet) outside the building foundation. Tops of conduits below building slab shall be minimum 610 mm (24 inches) below bottom of slab.
5. Stub-ups and sweeps to equipment mounted on outdoor concrete slabs shall be galvanized rigid metal conduit half-lap wrapped with PVC tape, and shall extend a minimum of 1.5 M (5 feet) away from the edge of slab.
6. Install insulated grounding bushings on the conduit terminations.
7. Radius for sweeps shall be sufficient to accomplish pulls without damage. Minimum radius shall be six times conduit diameter.
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 the bottom of the trench during the concrete pour. Spacer spacing shall not exceed 1.5 M (5 feet). Secure spacers to ducts and earth to prevent floating during concrete pour. Provide nonferrous tie wires to prevent displacement of the ducts during concrete pour. Tie wires shall not act as substitute for spacers.
9. Duct lines shall be installed no less than 300 mm (12 inches) from other utility systems, such as water, sewer, chilled water.
10. Clearances between individual ducts:
    a. For similar services, not less than 75 mm (3 inches).
    b. For power and signal services, not less than 150 mm (6 inches).
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 ensure maximum strength and rigidity of the duct bank.
13. Keep ducts clean of earth, sand, or gravel, and seal with tapered plugs upon completion of each portion of the work.

14. Spare Ducts: 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.
15. Duct Identification: Place continuous strip of warning tape approximately 300 mm (12 inches) above ducts before backfilling trenches. Warning tape shall be preprinted with proper identification.
16. Duct Sealing: Seal ducts, including spare ducts, at building entrances and at outdoor terminations for equipment, with a suitable non-hardening compound to prevent the entrance of foreign objects and material, moisture, and gases.
17. Use plastic ties to secure cables to insulators on cable arms. Use minimum two ties per cable per insulator.

B. Concrete-Encased Ducts:
1. Install concrete-encased ducts for medium-voltage systems, low-voltage systems, and signal systems, unless otherwise shown on the drawings.
2. Duct banks shall be 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. Additional burial depth shall be required in order to accomplish NEC-required minimum bend radius of ducts.
   d. Conduits crossing under grade slab construction joints shall be installed a minimum of 1.2 M (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.
5. Within 3 M (10 feet} of building and manhole 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 and concrete envelopes are to be joined to existing manholes, pullboxes, ducts, and concrete envelopes, make the joints with the proper fittings and fabricate the concrete envelopes to ensure smooth durable transitions.
8. Duct joints in concrete may be placed side by side horizontally, but shall be staggered at least 150 mm (6 inches) vertically.
9. Pour each run of concrete envelope between manholes or other terminations in one continuous pour. If more than one pour is necessary, terminate each pour in a vertical plane and install 19 mm (0.75 inch) reinforcing rod dowels extending 450 mm (18 inches) into concrete on both sides of joint near corners of envelope.
10. Pour concrete so that open spaces are uniformly filled. Do not agitate with power equipment unless approved by COR.

3.4 ACCEPTANCE CHECKS AND TESTS

A. Duct Testing and Cleaning:

1. Upon completion of the duct installation, a standard flexible mandrel shall be pulled through each duct to loosen particles of earth, sand, or foreign material left in the duct, and to test for out-of-round conditions.
2. The mandrel shall be not less than 300 mm (12 inches) long, and shall have a diameter not less than 13 mm (0.5 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.
3. If testing reveals obstructions or out-of-round conditions, the Contractor shall replace affected section(s) of duct and retest to the satisfaction of the COR.
4. Mandrel pulls shall be witnessed by the COR.

---END---

SECTION 26 05 73
OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section specifies the overcurrent protective device coordination study, related calculations and analysis, indicated as the study in this section.

B. A short-circuit and selective coordination study, and arc flash calculations and analysis shall be prepared for the electrical overcurrent devices to be installed under this project.

C. The study shall present a well-coordinated time-current analysis of each overcurrent protective device from the MAIN DISTTRIBUTION PANEL up to the medium voltage transformer and the on-site generator sources.

1.2 RELATED WORK

A. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements that are common to more than one section of Division 26.

B. Section 26 32 13, ENGINE GENERATORS: Engine generators.

C. Section 26 36 23, AUTOMATIC TRANSFER SWITCHES: Automatic transfer switches.

1.3 QUALITY ASSURANCE

A. Quality Assurance shall be in accordance with Paragraph, QUALIFICATIONS (PRODUCTS AND SERVICES) in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

B. The study shall be prepared by the equipment manufacturer, and performed by the equipment manufacturer’s licensed electrical engineer.

1.4 SUBMITTALS

A. Submit in accordance with Paragraph, SUBMITTALS in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, and the following requirements:

1. Product data on the software program to be used for the study. Software shall be in mainstream use in the industry, shall provide device settings and ratings, and shall show selective coordination by time-current drawings.

2. Complete study as described in paragraph 1.6. Submittal of the study shall be well-coordinated with submittals of the shop drawings for equipment in related specification sections.
3. Certifications: Two weeks prior to final inspection, submit the following.
   a. Certification by the Contractor that the overcurrent protective devices have been set in accordance with the approved study.

1.5 APPLICABLE PUBLICATIONS

A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by designation only.

B. Institute of Electrical and Electronics Engineers (IEEE):

241-90.....Recommended Practice Electrical Systems in Commercial Buildings

242-01.....Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems

399-97.....Recommended Practice for Industrial and Commercial Power Systems Analysis

1584-18.....Performing Arc-Flash Hazards Calculations

C. National Fire Protection Association (NFPA):

70-23.....National Electrical Code (NEC)

70E-21.....Standard for Electrical Safety in the Workplace

99-21.....Health Care Facilities Code

1.6 STUDY REQUIREMENTS

A. The study shall be in accordance with IEEE and NFPA standards.

B. The study shall include one line diagram, short-circuit and ground fault analysis, protective coordination plots for all overcurrent protective devices, and arc flash calculations and analysis.

C. One Line Diagram:
   1. Show all electrical equipment and wiring to be protected by the overcurrent devices.
   2. Show the following specific information:
      a. Calculated fault impedance, X/R ratios, and short-circuit values at each feeder and branch circuit bus.

b. Relay, circuit breaker, and fuse ratings.
c. Generator kW/kVA and transformer kVA and voltage ratings, percent impedance, X/R ratios, and wiring connections.
d. Voltage at each bus.
e. Identification of each bus, matching the identification on the drawings.
f. Conduit, conductor, and busway material, size, length, and X/R ratios.

D. Short-Circuit Study:
1. The study shall be performed using computer software designed for this purpose. Pertinent data and the rationale employed in developing the calculations shall be described in the introductory remarks of the study.
2. Calculate the fault impedance to determine the available short-circuit and ground fault currents at each bus. Incorporate applicable motor and/or generator contribution in determining the momentary and interrupting ratings of the overcurrent protective devices.
3. Present the results of the short-circuit study in a table. Include the following:
a. Device identification.
b. Operating voltage.
c. Overcurrent protective device type and rating.
d. Calculated short-circuit current.

E. Coordination Study:
1. Prepare the coordination curves to determine the required settings of overcurrent protective devices to demonstrate selective coordination. Graphically illustrate on log-log paper that adequate time separation exists between devices, including the utility company upstream device if applicable. Plot the specific time-current characteristics of each overcurrent protective device in such a manner that all devices are clearly depicted.
2. The following specific information shall also be shown on the coordination curves:
a. Device identification.
b. Potential transformer and current transformer ratios.

c. Three-phase and single-phase ANSI damage points or curves for each cable, transformer, or generator.
d. Applicable circuit breaker or protective relay characteristic curves.
e. No-damage, melting, and clearing curves for fuses.
f. Transformer in-rush points.

3. Develop a table to summarize the settings selected for the overcurrent protective devices. Include the following in the table:
a. Device identification.
b. Protective relay or circuit breaker potential and current transformer ratios, sensor rating, and available and suggested pickup and delay settings for each available trip characteristic.
c. Fuse rating and type.

F. Arc Flash Calculations and Analysis:
1. Arc flash warning labels shall comply with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
2. Arc flash calculations shall be based on actual over-current protective device clearing time. Maximum clearing time shall be in accordance with IEEE 1584.
3. Arc flash analysis shall be based on the lowest clearing time setting of the over-current protective device to minimize the incident energy level without compromising selective coordination.
4. Arc flash boundary and available arc flash incident energy at the corresponding working distance shall be calculated for all electrical power distribution equipment specified in the project, and as shown on the drawings.
5. Required arc-rated clothing and other PPE shall be selected and specified in accordance with NFPA 70E.

1.7 ANALYSIS

A. Analyze the short-circuit calculations, and highlight any equipment determined to be underrated as specified. Propose solutions to effectively protect the underrated equipment.

1.8 ADJUSTMENTS, SETTINGS, AND MODIFICATIONS

A. Final field settings and minor modifications of the overcurrent protective devices shall be made to conform with the study, without additional cost to the Government.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

---END---

SECTION 26 32 13
ENGINE GENERATORS

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section specifies the furnishing, installation, connection, and testing of the low-voltage engine generators.

1.2 RELATED WORK

A. Section 03 30 00, CAST-IN-PLACE CONCRETE: Requirements for concrete equipment pads.

B. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: Requirements that apply to all sections of Division 26.

C. Section 26 05 19, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES: Low-voltage conductors.

D. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path for possible ground fault currents.

E. Section 26 05 73, OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY: Short circuit and coordination study, and requirements for a coordinated electrical system.

F. Section 26 36 23, AUTOMATIC TRANSFER SWITCHES: Requirements for automatic transfer switches for use with engine generators.

1.3 QUALITY ASSURANCE

A. Quality Assurance shall be in accordance with Paragraph, QUALIFICATIONS (PRODUCTS AND SERVICES) in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

B. A factory-authorized representative shall be capable of providing emergency maintenance and repairs at the project site within 4 hours maximum of notification.

1.4 FACTORY TESTS

A. Factory Tests shall be required.

B. Factory Tests shall be in accordance with Paragraph, MANUFACTURED PRODUCTS in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, and the following requirement:

1. Load Test: Shall include two hours while the engine generator is delivering 100% of the specified kW, and four hours while the engine

generator is delivering 80% of the specified kW. During this test, record the following data at 20-minute intervals:

Time	Engine RPM	Oil Temperature Out
kW	Water Temperature In	Fuel Pressure
Voltage	Water Temperature Out	Oil Pressure
Amperes	Oil Temperature In	Ambient Temperature

2. Cold Start Test: Record time required for the engine generator to develop specified voltage, frequency, and kW load from a standstill condition with engine at ambient temperature.
3. The manufacturer shall furnish fuel, load banks, testing instruments, and all other equipment necessary to perform these tests.

1.5 SUBMITTALS

A. Submit in accordance with Paragraph, SUBMITTALS in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, and the following requirements:

1. Shop Drawings:
   a. Submit sufficient information to demonstrate compliance with drawings and specifications.
   b. Scaled drawings, showing plan views, side views, elevations, and cross-sections.
2. Diagrams:
   a. Control system diagrams, control sequence diagrams or tables, wiring diagrams, interconnections diagrams (between engine generators, automatic transfer switches, paralleling switchgear, local control cubicles, remote annunciator panels, and fuel storage tanks, as applicable), and other like items.
3. Technical Data:
   a. Published ratings, catalog cuts, pictures, and manufacturer’s specifications for engine generator, governor, voltage regulator, radiator, muffler, dampers, day tank, pumps, fuel tank, batteries and charger, jacket heaters, torsional vibration, and control and supervisory equipment.
   b. Description of operation.
   c. Short-circuit current capacity and sub-transient reactance.

d. Sound power level data.

4. Calculations:
   a. Calculated performance derations appropriate to installed environment.
5. Manuals:
   a. When submitting the shop drawings, submit complete maintenance and operating manuals, to include the following:
      1) Technical data sheets.
      2) Wiring diagrams.
      3) Include information for testing, repair, troubleshooting, and factory recommended periodic maintenance procedures and frequency.
      4) Provide a replacement and spare parts list. Include a list of tools and instruments for testing and maintenance purposes.
   b. If changes have been made to the maintenance and operating manuals originally submitted, submit updated maintenance and operating manuals two weeks prior to the final inspection.
6. Test Reports:
   a. Submit certified factory test reports for approval.
   b. Submit field test reports two weeks prior to the final inspection.
7. Certifications:
   a. Prior to fabrication of the engine generator, submit the following for approval:
      1) A certification in writing that an engine generator of the same model and configuration, with the same bore, stroke, number of cylinders, and equal or higher kW/kVA ratings as the proposed engine generator, has been operating satisfactorily with connected loads of not less than 75% of the specified kW/kVA rating, for not fewer than 2,000 hours without any failure of a crankshaft, camshaft, piston, valve, injector, or governor system.
      2) A certification in writing that devices and circuits will be incorporated to protect the voltage regulator and other components of the engine generator during operation at speeds other than the rated RPM while performing maintenance. Submit

thorough descriptions of any precautions necessary to protect the voltage regulator and other components of the system during operation of the engine generator at speeds other than the rated RPM.

3) A certification from the engine manufacturer stating that the engine exhaust emissions meet the applicable federal, state, and local regulations and restrictions. At a minimum, this certification shall include emission factors for criteria pollutants including nitrogen oxides, carbon monoxide, particulate matter, sulfur dioxide, non-methane hydrocarbon, and hazardous air pollutants (HPAs).

b. Prior to installation of the engine generator at the job site, submit certified factory test data.

c. Two weeks prior to the final inspection, submit the following.

1) Certification by the manufacturer that the engine generators conform to the requirements of the drawings and specifications.

2) Certification by the Contractor that the engine generators have been properly installed, adjusted, and tested.

1.6 STORAGE AND HANDLING

A. Engine generators shall withstand shipping and handling stresses in addition to the electrical and mechanical stresses which occur during operation of the system. Protect radiator core with wood sheet.

B. Store the engine generators in a location approved by the COR.

1.7 JOB CONDITIONS

A. Job conditions shall conform to the arrangements and details shown on the drawings. The dimensions, enclosures, and arrangements of the engine generator system shall permit the operating personnel to safely and conveniently operate and maintain the system in the space designated for installation.

1.8 APPLICABLE PUBLICATIONS

A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by designation only.

B. American Society of Testing Materials (ASTM):

A53/A53M-20.....Standard Specification for Pipe, Steel, Black, and Hot-Dipped, Zinc Coated Welded and Seamless
B88-20.....Specification for Seamless Copper Water Tube
B88M-20.....Specification for Seamless Copper water Tube (Metric)
D975-21.....Diesel Fuel Oils

C. Institute of Electrical and Electronic Engineers (IEEE):
C37.13-15.....Low Voltage AC Power Circuit Breakers Used In Enclosures
C37.90.1-12.....Surge Withstand Capability (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus

D. International Code Council (ICC):
IBC-21.....International Building Code

E. International Organization for Standardization (ISO):
8528-1-18.....Reciprocating Internal Combustion Engine-Driven Alternate Current Generating Sets – Part 1: Application, Ratings and Performance

F. National Electrical Manufacturers Association (NEMA):
ICS 6-93(R2016).....Enclosures
ICS 4-15.....Application Guideline for Terminal Blocks
MG 1-16.....Motor and Generators
MG 2-14.....Safety Standard and Guide for Selection, Installation and Use of Electric Motors and Generators
PB 2-11.....Dead-Front Distribution Switchboards
250-20.....Enclosures for Electrical Equipment (1000 Volts Maximum)

G. National Fire Protection Association (NFPA):
30-21.....Flammable and Combustible Liquids Code
37-21.....Installations and Use of Stationary Combustion Engine and Gas Turbines
70-23.....National Electrical Code (NEC)
99-21.....Health Care Facilities
110-22.....Standard for Emergency and Standby Power Systems

H. Underwriters Laboratories, Inc. (UL):

50-15.....Enclosures for Electrical Equipment
142-19.....Steel Aboveground Tanks for Flammable and Combustible Liquids
467-13.....Grounding and Bonding Equipment
489-16.....Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures
508-18.....Industrial Control Equipment
891-19.....Switchboards
1236-15.....Battery Chargers for Charging Engine-Starter Batteries
2085-97.....Insulated Aboveground Tanks for Flammable and Combustible Liquids
2200-20.....Stationary Engine Generator Assemblies

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. The engine generator system shall be in accordance with ASTM, ISO, NEMA, NFPA, UL, as shown on the drawings, and as specified herein.

B. Provide a factory-assembled, wired (except for field connections), complete, fully automatic engine generator system, as well as all associate equipment and devices intended for the operating, control, monitoring, and remote manual stop functions.

C. Engine Generator Parameter Schedule:

1. Power Rating: Standby
2. Voltage: 120/208V
3. Rated Power: 250 kW, 312.5 kVA continuous
4. Power Factor: 0.8 lagging
5. Engine Generator Application: stand-alone
6. Fuel: diesel
7. Voltage Regulation: + 2% (maximum) (No Load to Full Load) (standalone applications)
8. Phases: 3 Phase, Wye
9. Each component of the engine generator system shall be capable of operating at 742 feet above sea level which will have average ambient air temperature ranging from a minimum of (20 ˚F) in winter to maximum of 90 ˚F) in summer.

D. Assemble, connect, and wire the engine generator at the factory so that only the external connections need to be made at the construction site.
E. Engine Generator Unit shall be factory-painted with manufacturer's primer and standard finishes.
F. Connections between components of the system shall conform to the recommendations of the manufacturer.
G. Couplings, shafts, and other moving parts shall be enclosed and guarded. Guards shall be metal, ruggedly constructed, rigidly fastened, and readily removable for convenient servicing of the equipment without disassembling any pipes and fittings.
H. Engine generator shall have the following features:
   1. Factory-mounted on a common, rigid, welded, structural steel base.
   2. Engine generator shall be statically and dynamically balanced so that the maximum vibration in the horizontal, vertical, and axial directions shall be limited to 0.15 mm (0.0059 inch), with an overall velocity limit of 24 mm/sec (0.866 inch per second) RMS, for all speeds.
   3. The isolators shall be constrained with restraints capable of withstanding static forces in any direction equal to twice the weight of the supported equipment.
   4. Shall be capable of operating satisfactorily as specified for not fewer than 10,000 hours between major overhauls.

2.2 ENGINE

A. The engine shall be coupled directly to a generator.
B. Minimum four cylinders.
C. The engine shall be able to start in a 4.5 ˚C (40 ˚F) ambient temperature while using No. 2 diesel fuel oil without the use of starting aids such as glow plugs and ether injections.
D. The engine shall be equipped with electric heater for maintaining the coolant temperature between 32-38 ˚C (90-100 ˚F), or as recommended by the manufacturer.
   1. Install thermostatic controls, contactors, and circuit breaker-protected circuits for the heaters.
   2. The heaters shall operate continuously except while the engine is operating or the water temperature is at the predetermined level.

2.3 GOVERNOR

A. Isochronous, electronic type.

B. Steady-state speed band at 60 Hz shall not exceed plus or minus 0.33%.

2.4 LUBRICATION OIL SYSTEM

A. Pressurized type.

B. Positive-displacement pump driven by engine crankshaft.

C. Full-flow strainer and full-flow or by-pass filters.

D. Filters shall be cleanable or replaceable type and shall remove particles as small as 3 microns without removing the additives in the oil. For by-pass filters, flow shall be diverted without flow interruption.

E. Extend lube oil sump drain line out through the skid base and terminate it with a drain valve and plug.

F. Provide a 120-volt oil heater for exterior engine generator.

2.5 FUEL SYSTEM

A. Shall comply with NFPA 37 and NFPA 30, and have the following features:

1. Injection pump(s) and nozzles.
2. Plungers shall be carefully lapped for precision fit and shall not require any packing.
3. Filters or screens that require periodic cleaning or replacement shall not be permitted in the injection system assemblies.
4. Return surplus oil from the injectors to the main storage tank by gravity or a pump.
5. Filter System:
   a. Dual primary filters shall be located between the main fuel oil storage and day tank.
   b. Secondary filters (engine-mounted) shall be located such that the oil will be thoroughly filtered before it reaches the injection system assemblies.
   c. Filters shall be cleanable or replaceable type and shall entrap and remove water from oil as recommended by the engine manufacturer.

B. Day Tank:

1. Each engine generator shall be provided with a welded steel integral day tank with double-wall fuel containment.

2. Each day tank shall have capacity to supply fuel to the engine for a minimum 20-hour period at 100% rated load without being refilled, including fuel that is returned to the main fuel storage tank. The calculation of the capacity of each day tank shall incorporate the requirement to stop the supply of fuel into the day tank at 90% of the ultimate volume of the tank.
3. Secure, pipe, and connect the tank adequately for maximum protection from fire hazards, including oil leaks.
4. Incorporate a vent, drain cock, shutoff cocks, and gauge glass. Terminate the vent piping outdoors with mushroom vent cap.

2.6 COOLING SYSTEM

A. Liquid-cooled, closed loop, with fin-tube radiator mounted on the engine generator.

B. Cooling capacity shall not be less than the cooling requirements of the engine generator and its lubricating oil while operating continuously at 100% of its specified rating.

C. Water circulating pumps shall be gear driven by engine. Incorporate pressure relief devices where required to prevent excessive pressure increase after the engine stops.

D. Coolant shall be extended-life antifreeze solution, 50% ethylene glycol and 50% soft water, with corrosion inhibitor additive as recommended by the manufacturer.

E. Fan shall be driven by a totally enclosed electric motor.

F. Coolant hoses shall be flexible, per manufacturer's recommendation.

G. Self-contained thermostatic-control valve shall modulate coolant flow to maintain optimum constant coolant temperature, as recommended by the engine manufacturer.

2.7 AIR INTAKE AND EXHAUST SYSTEMS

A. Air Intake:

1. Provide an engine-mounted air cleaner with replaceable dry filter and dirty filter indicator.

B. Exhaust System:

2. Exhaust Muffler:
   Shall be critical grade type and capable of the following noise attenuation:

Octave Band Hertz (Mid Frequency)	Minimum db Attenuation (.0002 Microbar Reference)
31	5
63	10
125	27
500	37
1000	31
2000	26
4000	25
8000	26

3. Pressure drop in the complete exhaust system shall be small enough for satisfactory operation of the engine generator while it is delivering 100% of its specified rating.
4. Exhaust pipe size from the engine to the muffler shall be as recommended by the engine manufacturer. Pipe size from muffler to air discharge shall be two pipe sizes larger than engine exhaust pipe.
5. Connections at the engine exhaust outlet shall be made with a flexible exhaust pipe. Provide bolted type pipe flanges welded to each end of the flexible section.

C. Condensate drain at muffler shall be made with schedule 40 black steel pipe through a petcock.

2.8 ENGINE STARTING SYSTEM

A. The engine starting system shall start the engine at any position of the flywheel.

B. Electric cranking motor:
1. Shall be engine-mounted.
2. Shall crank the engine via a gear drive.
3. Rating shall be adequate for cranking the cold engine at the voltage provided by the battery system, and at the required RPM during five consecutive starting attempts of 10 seconds cranking each at 10-second intervals, for a total of 50 seconds of actual cranking

without damage (the fifth starting attempt will be manually initiated upon failure of a complete engine cranking cycle).

C. Batteries shall be nickel-cadmium high discharge rate type.
   1. Each battery cell shall have minimum and maximum electrolyte level indicators and a flip-top flame arrestor vent cap.
   2. Batteries shall have connector covers for protection against external short circuits.
   3. With the charger disconnected, the batteries shall have sufficient capacity so that the total system voltage does not fall below 85% of the nominal system voltage with the following demands:
      Five consecutive starting attempts of 10 seconds cranking at 10 second intervals for a total of 50 seconds of actual cranking (the fifth starting attempt will be manually initiated upon failure of a complete engine cranking cycle).
   4. Battery racks shall be metal with an alkali-resistant finish and thermal insulation, and secured to the floor.

D. Battery Charger:
   1. A current-limiting battery charger, conforming to UL 1236, shall be provided and shall automatically recharge the batteries. The charger shall be capable of an equalize-charging rate for recharging fully depleted batteries within 24 hours and a floating charge rate for maintaining the batteries at fully charged condition.
   2. An ammeter shall be provided to indicate charging rate. A voltmeter shall be provided to indicate charging voltage.

2.9 LUBRICATING OIL HEATER

A. Provide a thermostatically-controlled electric heater to automatically maintain the oil temperature within plus or minus 1.7 °C (3 °F) of the control temperature.

2.10 JACKET COOLANT HEATER

A. Provide a thermostatically-controlled electric heater mounted in the engine coolant jacketing to automatically maintain the coolant within plus or minus 1.7 °C (3 °F) of the temperature recommended by the engine manufacturer to meet the starting time specified at the minimum winter outdoor temperature.

2.11 GENERATOR

A. Synchronous, amortisseur windings, bracket-bearing, self-venting, rotating-field type connected directly to the engine.

B. Lifting lugs designed for convenient connection to and removal from the engine.

C. Integral poles and spider, or individual poles dove-tailed to the spider.

D. Designed for sustained short-circuit currents in conformance with NEMA Standards.

E. Designed for sustained operation at 100% of the RPM specified for the engine generator without damage.

F. Telephone influence factor shall conform to NEMA MG 1.

G. Furnished with brushless excitation system or static-exciter-regulator assembly.

H. Nameplates attached to the generator shall show the manufacturer's name, equipment identification, serial number, voltage ratings, field current ratings, kW/kVA output ratings, power factor rating, time rating, temperature rise ratings, RPM ratings, full load current rating, number of phases and frequency, and date of manufacture.

I. The grounded (neutral) conductor shall be electrically isolated from equipment ground and terminated in the same junction box as the phase conductors.

2.12 GENERATOR OVERCURRENT AND FAULT PROTECTION

A. Generator circuit breaker shall be molded case type. Molded case circuit breaker shall have automatic, trip free, non-adjustable, inverse time and instantaneous magnetic trips for 400 A frame size or less. Magnetic trip shall be adjustable from 5x to 10x for breakers with 400 A frame size and higher. Factory setting shall be LOW unless otherwise noted. Provide shunt trip to trip breaker when engine generator is shut down by other protective devices.

2.13 CONTROLS

A. Shall include Engine Generator Control Cubicle(s).

B. General:

1. Control equipment shall be in accordance with UL 508, NEMA ICS-4, ICS-6, and ANSI C37.90.1.

2. Panels shall be in accordance with UL 50.

3. Cubicles shall be in accordance with UL 891.
4. Coordinate controls with the automatic transfer switches shown on the drawings so that the systems will operate as specified.
5. Cubicles:
   a. Code gauge steel: manufacturer's recommended heavy gauge steel with factory primer and light gray finish.
   b. Doors shall be gasketed, attached with concealed or semi-concealed hinges, and shall have a permanent means of latching in closed position.
   c. Panels shall be wall-mounted or incorporated in other equipment as indicated on the drawings or as specified.
   d. Door locks for panels and cubicles shall be keyed identically to operate from a single key.
6. Wiring: Insulated, rated at 600 V.
   a. Install the wiring in vertical and horizontal runs, neatly harnessed.
   b. Terminate all external wiring at heavy duty, pressure-type, terminal blocks.
7. The equipment, wiring terminals, and wires shall be clearly and permanently labeled.
8. The appropriate wiring diagrams shall be laminated or mounted under plexiglass within the frame on the inside of the cubicles and panels.
9. All indicating lamps and switches shall be accessible and mounted on the cubicle doors.
10. The manufacturer shall coordinate the interconnection and programming of the generator controls with all related equipment, including automatic transfer switches.

C. Engine generator Control Cubicle:
1. Starting and Stopping Controls:
   a. A three-position, maintained-contact type selector switch with positions marked "AUTOMATIC," "OFF," and "MANUAL." Provide flashing amber light for OFF and MANUAL positions.
   b. A momentary contact push-button switch with positions marked "MANUAL START" and "MANUAL STOP."

c. Selector switch in AUTOMATIC position shall cause the engine to start automatically when a single pole contact in a remote device closes. When the generator's output voltage increases to not less than 90% of its rated voltage, and its frequency increases to not less than 58 Hz, the remote devices shall transfer the load to the generator. An adjustable time delay relay, in the 0 to 15 minute range, shall cause the engine generator to continue operating without any load after completion of the period of operation with load. Upon completion of the additional 0 to 15 minute (adjustable) period, the engine generator shall stop.

d. Selector switch in OFF position shall prevent the engine from starting either automatically or manually. Selector switch in MANUAL position shall also cause the engine to start when the manual start push-button is depressed momentarily.

e. With selector switch is in MANUAL position, depressing the MANUAL STOP push-button momentarily shall stop the engine after a cool-down period.

f. A maintained-contact, red mushroom-head push-button switch marked "EMERGENCY STOP" will cause the engine to stop without a cool-down period, independent of the position of the selector switch.

2. Engine Cranking Controls:

a. The cranking cycles shall be controlled by a timer that will be independent of the battery voltage fluctuations.

b. The controls shall crank the engine through one complete cranking cycle, consisting of four starting attempts of 10 seconds each with 10 seconds between each attempt.

c. Total actual cranking time for the complete cranking cycle shall be 40 seconds during a 70-second interval.

d. Cranking shall terminate when the engine starts so that the starting system will not be damaged. Termination of the cranking shall be controlled by self-contained, speed-sensitive switch. The switch shall prevent re-cranking of the engine until after the engine stops.

e. After the engine has stopped, the cranking control shall reset.

3. Supervisory Controls:

a. Overcrank:

1) When the cranking control system completes one cranking cycle (four starting attempts), without starting the engine, the OVERCRANK signal light and the audible alarm shall be energized.
2) The cranking control system shall lock-out, and shall require a manual reset.

b. Coolant Temperature:
1) When the temperature rises to the predetermined first stage level, the HIGH COOLANT TEMPERATURE - FIRST STAGE signal light and the audible alarm shall be energized.
2) When the temperature rises to the predetermined second stage level, which shall be low enough to prevent any damage to the engine and high enough to avoid unnecessary engine shutdowns, the HIGH COOLANT TEMPERATURE - SECOND STAGE signal light and the audible alarm shall be energized and the engine shall stop.
3) The difference between the first and second stage temperature settings shall be approximately -12 ˚C (10 ˚F).
4) Permanently indicate the temperature settings near the associated signal light.
5) When the coolant temperature drops to below 21 ˚C (70 ˚F), the "LOW COOLANT TEMPERATURE" signal light and the audible alarm shall be energized.

c. Low Coolant Level: When the coolant level falls below the minimum level recommended by the manufacturer, the LOW COOLANT LEVEL signal light and audible alarm shall be energized.

d. Lubricating Oil Pressure:
1) When the pressure falls to the predetermined first stage level, the OIL PRESSURE - FIRST STAGE signal light and the audible alarm shall be energized.
2) When the pressure falls to the predetermined second stage level, which shall be high enough to prevent damage to the engine and low enough to avoid unnecessary engine shutdowns, the OIL PRESSURE - SECOND STAGE signal light and the audible alarm shall be energized and the engine shall stop.

3) The difference between the first and second stage pressure settings shall be approximately 15% of the oil pressure.
4) The pressure settings near the associated signal light shall be permanently displayed so that the running oil pressure can be compared to the target (setpoint) value.

e. Overspeed:
1) When the engine RPM exceeds the maximum RPM recommended by the manufacturer of the engine, the engine shall stop.
2) Simultaneously, the OVERSPEED signal light and the audible alarm shall be energized.

f. Low Fuel - Main Storage Tank:
When the fuel oil level in the storage tank decreases to less than one-third of total tank capacity, the LOW FUEL-MAIN STORAGE TANK signal light and audible alarm shall be energized.

g. Reset Alarms and Signals:
Overcrank, Coolant Temperature, Coolant Level, Oil Pressure, Overspeed, and Low Fuel signal lights and the associated audible alarms shall require manual reset. A momentary-contact silencing switch and push-button shall silence the audible alarm by using relays or solid state devices to seal in the audible alarm in the de-energized condition. Elimination of the alarm condition shall automatically release the sealed-in circuit for the audible alarm so that it will be automatically energized again when the next alarm condition occurs. The signal lights shall require manual reset after elimination of the condition which caused them to be energized. Install the audible alarm just outside the engine generator room in a location as directed by the COR. The audible alarm shall be rated for 85 dB at 3 M (10 feet).

h. Generator Breaker Signal Light:
1) A flashing green light shall be energized when the engine generator circuit breaker is in the OPEN or TRIPPED position.
2) Simultaneously, the audible alarm shall be energized.

4. Monitoring Devices:
a. Electric type gauges for the cooling water temperatures and lubricating oil pressures. These gauges may be engine mounted with proper vibration isolation.

b. A running time indicator, totalizing not fewer than 9,999 hours, and an electric type tachometer.

c. A voltmeter, ammeter, frequency meter, kilowatt meter, manual adjusting knob for the output voltage, and the other items shown on the drawings shall be mounted on the front of the generator control panels.

d. Install potential and current transformers as required.

e. Visual Indications:

1) OVERCRANK
2) HIGH COOLANT TEMPERATURE - FIRST STAGE
3) HIGH COOLANT TEMPERATURE - SECOND STAGE
4) LOW COOLANT TEMPERATURE
5) OIL PRESSURE - FIRST STAGE
6) OIL PRESSURE - SECOND STAGE
7) LOW COOLANT LEVEL
8) GENERATOR BREAKER
9) OVERSPEED
10) LOW FUEL – MAIN STORAGE TANK

f. Lamp Test: The LAMP TEST momentary contact switch shall momentarily actuate the alarm buzzer and all the indicating lamps.

5. Automatic Voltage Regulator:

a. Shall correct voltage fluctuations rapidly and restore the output voltage to the predetermined level with a minimum amount of hunting.

b. Shall include voltage level rheostat located inside the control cubicle.

c. Provide a 3-phase automatic voltage regulator immune to waveform distortion.

2.14 REMOTE MANUAL STOP STATION

A. Shall be provided per NFPA 101 and shall be a red mushroom-head push-button switch.

B. Shall be connected to the main generator control panel to provide emergency shutdown of the generator.

C. Shall be located outside the room housing the generator.

D. Shall have permanent label reading “EMERGENCY STOP”.

2.15 REMOTE ANNUNCIATOR PANEL

A. A remote annunciator panel shall be installed at location as shown on the drawings and coordinated with local AHJ and owner.

B. The annunciator shall indicate alarm conditions as required by NFPA and 110.

C. Include control wiring between the remote annunciator panel and the engine generator. Wiring shall be as required by the manufacturer.

2.16 SOUND-ATTENUATED ENCLOSURE

A. The engine generator and related equipment shall be housed in an outdoor weatherproof enclosure.

B. Enclosure shall be weatherproof and sound-attenuated (maximum 85 dBA at 1525 mm (5 feet) from any side, top and bottom to no more than 75 dBA when measured at 15 M (50 feet) horizontally from any part of the enclosure). Sound ratings shall be based on full load condition of engine generator in a single unit operation condition.

C. Airflow configuration shall be intake through rear of unit, and discharge air vertically up. Enclosure shall be suitable for winds up to 193 kmh (120 miles per hour) roof load shall be equal to or greater than 200 kg/sq m (40 pounds per square foot) Non-distributed loading as required.

E. The enclosure shall meet the following requirements:

1. Radiator exhaust outlet shall be ducted through the end of the enclosure.
2. All exterior surfaces shall be factory-painted with industrial enamel.
3. Unit shall have sufficient guards to prevent entrance by small animals.
4. Batteries shall fit inside enclosure and alongside the engine generator. Batteries under the generator are not acceptable.
5. The muffler shall be mounted and thermally-insulated inside the enclosure.

2.17 SPARE PARTS

A. For each engine generator:

1. Six lubricating oil filters.
2. Six primary fuel oil filters.

3. Six secondary fuel oil filters.
4. Six intake air filters.

B. For each battery charger:

1. Three complete sets of fuses.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install concrete bases of dimensions shown on the drawings.

B. Installation of the engine generator shall comply with manufacturer's written instructions and with NFPA 110.

C. Mounting:

1. Support the base of engine generator on vibration isolators, each isolator bolted to the floor (pad), and the generator base bolted to isolator.
2. Install sufficient isolators so that the floor (pad) bearing pressure under each isolator is within the floor (pad) loading specification.
3. Install equal number of isolators on each side of the engine generator's base.
4. Locate isolators for approximately equal load distribution and deflection per isolator. The base of the engine generator shall be drilled at the factory for the isolator bolts.
5. Isolators shall be shipped loose with the engine generator.
6. All connections between the engine generator and exterior systems, such as fuel lines, electrical connections, and engine exhaust system and air exhaust shroud, shall be flexible.

E. Balance:

1. The vibration velocity in the horizontal, vertical, and axial directions shall not exceed 16.25 mm (0.65 inch) per second peak at any specific frequency. These limits apply to main structural components such as the engine block and the generator frame at the bearings.

F. Connect all components of the generator system so that they will continue to be energized during failure of the normal electrical power supply system.

G. Install piping between engine generator and remote components of cooling, fuel, and exhaust systems.

H. Flexible connection between radiator and exhaust shroud at the wall damper:

1. Install noncombustible flexible connections made of 20-oz neoprene-coated fiberglass fabric approximately 150 mm (6 inches) wide.
2. Crimp and fasten the fabric to the sheet metal with screws 50 mm (2 inches) on center. The fabric shall not be stressed, except by the air pressure.

I. Exhaust System Insulation:

1. Adhesive and insulation materials shall be applied on clean, dry surfaces from which loose scale and construction debris has been removed by wire brushing.
2. Fill all cracks, voids, and joints of applied insulation material with high temperature 1093 °C (2000 °F) insulating cement before applying the outer covering.
3. The installation shall be clean and free of debris, thermally and structurally tight without sag, neatly finished at all hangers or other penetrations, and shall provide a smooth finished surface.
4. Insulation and jacket shall terminate hard and tight at all anchor points.
5. Insulate completely from engine exhaust flexible connection through roof or wall construction, including muffler.

3.2 ACCEPTANCE CHECKS AND TESTS

A. Provide the services of a factory-authorized, factory-trained representative of the engine generator manufacturer to inspect field-assembled components and equipment installation, and to supervise the field tests.

B. When the complete engine generator system has been installed and prior to the final inspection, test all components of the system in the presence of the COR for proper operation of the individual components and the complete system and to eliminate electrical and mechanical defects.

C. Furnish fuel oil, lubricating oil, anti-freeze liquid, water treatment, rust-inhibitor, and load bank for testing of the engine generator.

D. Visual Inspection: Visually verify proper installation of engine generator and all components per manufacturer's pre-functional installation checklist.

E. Set engine generator circuit breaker protective functions per Section 26 05 73, OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY.

F. Field Tests:

1. Perform manufacturer's after-starting checks and inspections.
2. Test the engine generator for six hours of continuous operation as follows:
   a. Two hours while delivering 100% of the specified kW.
   b. Four hours while the engine generator is delivering 80% of its specified kW rating.
   c. If during the 6-hour continuous test, an engine generator failure occurs or the engine generator cannot maintain specified power output, the test(s) are null and void. After repair and/or adjustments, the test(s) shall be repeated at no additional cost to the Government until satisfactory results are attained.
3. Record the following test data at 30-minute intervals:
   a. Time of day, as well as reading of running time indicator.
   b. kW.
   c. Voltage on each phase.
   d. Amperes on each phase.
   e. Engine RPM.
   f. Frequency.
   g. Coolant water temperature.
   h. Fuel pressure.
   i. Oil pressure.
   j. Outdoor temperature.
   k. Average ambient temperature in the vicinity of the engine generator.
4. Demonstrate that the engine generator will attain proper voltage and frequency within the specified time limit from a cold start after the closing of a single contact.
5. Furnish a resistance-type load for the testing of the engine generator. Test loads shall always include adequate resistance to assure stability of the loads and equipment during all of the

testing operations. The test load kW rating shall not be less than 100% of the specified kW rating of the engine generator.

G. Starting System Test:
   1. Demonstrate that the batteries and cranking motor are capable of five starting attempts of 10 seconds cranking each at 10-second intervals with the battery charger turned off.

H. Remote Annunciator Panel and Remote Manual Stop Tests:
   Simulate conditions to verify proper operation of each visual or audible indication, interconnecting hardware and software, and reset button. Simulate emergency stop of the generator by initiating the remote manual stop station, while the generator is in operation.

I. Automatic Operation Tests:
   Test the engine generator and associated automatic transfer switches to demonstrate automatic starting, loading and unloading. The load for this test shall be the actual connected loads. Initiate loss of normal source and verify the specified sequence of operation. Restore the normal power source and verify the specified sequence of operation. Verify resetting of controls to normal.

3.3 FOLLOW-UP VERIFICATION

A. After completion of acceptance checks, settings, and tests, the Contractor shall demonstrate that the engine generator(s) and control and annunciation components are in good operating condition and properly performing the intended function.

3.4 INSTRUCTIONS AND FINAL INSPECTIONS

A. Laminate or mount under acrylic resin a set of operating instructions for the system and install instructions within a frame mounted on the wall near the engine generator at a location per the COR.

B. Furnish the services of a competent and factory-trained technician for one 4-hour period for instructions to VA personnel in operation and maintenance of the equipment, on the date requested by the COR.

---END---

SECTION 26 36 23
AUTOMATIC TRANSFER SWITCHES

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section specifies the furnishing, installation, connection, and testing of open-transition automatic transfer switches, indicated as automatic transfer switches or ATS in this section.

1.2 RELATED WORK

A. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: Requirements that apply to all sections of Division 26.

B. Section 26 05 19, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES: Low-voltage conductors.

C. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personal safety and to provide a low impedance path for possible ground fault currents.

D. Section 26 05 33, RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS: Conduits.

E. Section 26 05 73, OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY: Short circuit and coordination study, and requirements for a coordinated electrical system.

F. Section 26 32 13, ENGINE-GENERATORS: Requirements for normal and emergency power generation.

1.3 QUALITY ASSURANCE

A. Quality Assurance shall be in accordance with Paragraph, QUALIFICATIONS (PRODUCTS AND SERVICES) in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

B. A factory-authorized representative shall be capable of providing emergency maintenance and repairs at the project site within 4 hours maximum of notification.

1.4 FACTORY TESTS

A. ATS shall be thoroughly tested at the factory to assure that there are no electrical or mechanical defects.

B. Factory Tests shall be in accordance with Paragraph, MANUFACTURED PRODUCTS in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, and the following requirements:

1. Perform visual inspection to verify that each ATS is as specified.

2. Perform mechanical test to verify that ATS sections are free of mechanical defects.
3. Perform insulation resistance test to ensure electrical integrity and continuity of entire system.
4. Perform main switch contact resistance test.
5. Perform electrical tests to verify complete system electrical operation.

1.5 SUBMITTALS

A. Submit in accordance with Paragraph, SUBMITTALS in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, and the following requirements:

1. Shop Drawings:
   a. Submit sufficient information to demonstrate compliance with drawings and specifications.
   b. Include voltage rating, continuous current rating, number of phases, withstand and closing rating, dimensions, weights, mounting details, conduit entry provisions, front view, side view, equipment and device arrangement, elementary and interconnection wiring diagrams, factory relay settings, and accessories.
   c. Complete nameplate data, including manufacturer's name and catalog number.
   d. A copy of the markings that are to appear on the automatic transfer switches when installed.
2. Manuals:
   a. Submit, simultaneously with the shop drawings, companion copies of complete maintenance and operating manuals, including technical data sheets, wiring diagrams, and information for ordering replacement parts.
      1) Schematic signal and control diagrams, with all terminals identified, matching terminal identification in the automatic transfer switches.
      2) Include information for testing, repair, troubleshooting, assembly, disassembly, and factory recommended/required periodic maintenance procedures and frequency.

3) Provide a replacement and spare parts list. Include a list of tools and instruments for testing and maintenance purposes.

b. If changes have been made to the maintenance and operating manuals originally submitted, submit updated maintenance and operating manuals two weeks prior to the final inspection.
   1) Include complete "As Installed" diagrams that indicate all pieces of equipment and their interconnecting wiring.
   2) Include complete diagrams of the internal wiring for each piece of equipment, including "As Installed" revisions of the diagrams.
   3) The wiring diagrams shall identify the terminals to facilitate installation, maintenance, operation, and testing.

3. Certifications:
   a. When submitting the shop drawings, submit a certified test report from a recognized independent testing laboratory that a representative sample has passed UL 1008 prototype testing.
   b. Two weeks prior to final inspection, submit the following.
      1) Certification by the manufacturer that the ATS conform to the requirements of the drawings and specifications.
      2) Certification by the Contractor that transfer switches have been properly installed, adjusted, and tested.

1.6 APPLICABLE PUBLICATIONS

A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by designation only.

B. Institute of Electrical and Electronic Engineers (IEEE):

446-95.....Emergency and Standby Power Systems for Industrial and Commercial Applications

C37.90.1-12.....Surge Withstand Capability (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus

C62.41.1-02.....Guide on the Surges Environment in Low-Voltage (1000 V and Less) AC Power Circuits

C62.41.2-02.....Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits

C. International Code Council (ICC):

IBC-18.....International Building Code

D. National Electrical Manufacturers Association (NEMA):

250-20.....Enclosures for Electrical Equipment (1000 Volts Maximum)

ICS 6-93.....Enclosures

ICS 4-15.....Application Guideline for Terminal Blocks

MG 1-21.....Motors and Generators

E. National Fire Protection Association (NFPA):

70-23.....National Electrical Code (NEC)

99-21.....Health Care Facilities

110-22.....Emergency and Standby Power Systems

F. Underwriters Laboratories, Inc. (UL):

50-15.....Enclosures for Electrical Equipment

508-18.....Industrial Control Equipment

891-19.....Switchboards

1008-14.....Transfer Switch Equipment

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Automatic transfer switches shall comply with IEEE, NEMA, NFPA, UL, and have the following features:

1. Automatic transfer switches shall be open transition switches, 3-pole, electrically operated, mechanically held open contact type, with integral overcurrent protection. Automatic transfer switches utilizing automatic or non-automatic molded case circuit breakers, insulated case circuit breakers, or power circuit breakers as switching mechanisms are not acceptable.
2. Automatic transfer switches shall be completely factory-assembled and wired such that only external circuit connections are required in the field.
3. Ratings:

a. Phases, voltage, continuous current, poles, and withstand and closing ratings shall be as shown on the drawings.
b. Transfer switches are to be rated for continuous duty at specified continuous current rating on 60Hz systems.
c. Maximum automatic transfer switch rating: 800 A.

4. Markings:
   a. Markings shall be in accordance with UL 1008.
5. Tests:
   a. Automatic transfer switches shall be tested in accordance with UL 1008. The contacts of the transfer switch shall not weld during the performance of withstand and closing tests when used with the upstream overcurrent device and available fault current specified.
6. Surge Withstand Test:
   a. Automatic transfer switches utilizing solid-state devices in sensing, relaying, operating, or communication equipment or circuits shall comply with IEEE C37.90.1.
7. Housing:
   a. Enclose automatic transfer switches in floor-mounted steel cabinets, with metal gauge not less than No. 14, in accordance with UL 508, or in a switchboard assembly in accordance with UL 891, as shown on the drawings.
   b. Automatic transfer switch components shall be removable without disconnecting external source or load power conductors.
   c. Finish: Cabinets shall be given a phosphate treatment, painted with rust-inhibiting primer, and finish-painted with the manufacturer's standard enamel or lacquer finish.
   d. Viewing Ports: Provide viewing ports so that contacts may be inspected without disassembly.
8. Operating Mechanism:
   a. Actuated by an electrical operator.
   b. Electrically and mechanically interlocked so that the main contact cannot be closed simultaneously in either normal and emergency position.

c. Normal and emergency main contacts shall be mechanically locked in position by the operating linkage upon completion of transfer. Release of the locking mechanism shall be possible only by normal operating action.
d. Contact transfer time shall not exceed six cycles.
e. Operating mechanism components and mechanical interlocks shall be insulated or grounded.

9. Contacts:
   a. Main contacts: Silver alloy.
   b. Neutral contacts: Silver alloy, with same current rating as phase contacts.
   c. Current carrying capacity of arcing contacts shall not be used in the determination of the automatic transfer switch rating, and shall be separate from the main contacts.
   d. Main and arcing contacts shall be visible for inspection with cabinet door open and barrier covers removed.
10. Manual Operator:
   a. Capable of operation by one person in either direction under no load.
11. Replaceable Parts:
   a. Include the main and arcing contacts individually or as units, as well as relays, and control devices.
   b. Automatic transfer switch contacts and accessories shall be replaceable from the front without removing the switch from the cabinet and without removing main conductors.
12. Sensing Features:
   a. Undervoltage Sensing for Each Phase of Normal Source: Sense low phase-to-ground voltage on each phase. Pickup voltage shall be adjustable from 85 to 100% of nominal, and dropout voltage is adjustable from 75 to 98% of pickup value. Factory set for pickup at 90% and dropout at 85%.
   b. Adjustable Time Delay: For override of normal-source voltage sensing to delay transfer and engine start signals. Adjustable from zero to six seconds, and factory set for one second.
   c. Voltage/Frequency Lockout Relay: Prevent premature transfer to the engine-generator. Pickup voltage shall be adjustable from 85

to 100% of nominal. Factory set for pickup at 90%. Pickup frequency shall be adjustable from 90 to 100% of nominal. Factory set for pickup at 95%.

d. Time Delay for Retransfer to Normal Source: Adjustable from 0 to 30 minutes, and factory set for 10 minutes to automatically defeat delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.
e. Test Switch: Simulate normal-source failure.
f. Switch-Position Indication: Indicate source to which load is connected.
g. Source-Available Indication: Supervise sources via transfer switch normal- and emergency-source sensing circuits.
h. Normal Power Indication: Indicate "Normal Source Available."
i. Emergency Power Indication: Indicate "Emergency Source Available."
j. Transfer Override Control: Overrides automatic retransfer control so that automatic transfer switch shall remain connected to emergency power source regardless of condition of normal source. Control panel shall indicate override status.
k. Engine Starting Contacts: One isolated and normally closed and one isolated and normally open; rated 5 A at 30 V DC minimum.
l. Engine Shutdown Contacts: Time delay adjustable from zero to 15 minutes, and factory set for 5 minutes. Contacts shall initiate shutdown at remote engine-generator controls after retransfer of load to normal source.

m. Engine-Generator Exerciser: Programmable exerciser starts engine-generator(s) and transfers load to them from normal source for a preset time, then retransfers and shuts down engine-generator(s) after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods are adjustable from 10 to 30 minutes. Factory settings shall be for 7-day exercise cycle, 20-minute running period, and 5-minute cool-down period.

13. Controls:

a. Controls shall provide indication of switch status and be equipped with alarm diagnostics.
b. Controls shall control operation of the automatic transfer switches.

14. Factory Wiring: Train and bundle factory wiring and label either by color-code or by numbered/lettered wire markers. Labels shall match those on the shop drawings.
15. Annunciation, Control, and Programming Interface Components: Devices for communicating with remote programming devices, annunciators, or control panels shall have open-protocol communication capability matched with remote device.

2.2 SEQUENCE OF OPERATION

A. The specified voltage decrease in one or more phases of the normal power source shall initiate the transfer sequence. The automatic transfer switch shall start the engine-generator(s) after a specified time delay to permit override of momentary dips in the normal power source.

B. The automatic transfer switch shall transfer the load from normal to emergency source when the frequency and voltage of the engine-generator(s) have attained the specified percent of rated value.

C. Engine Start: A voltage decrease, at any automatic transfer switch, in one or more phases of the normal power source to less than the specified value of normal shall start the engine-generator(s) after a specified time delay.

D. Transfer to Emergency System Loads: Automatic transfer switches for Emergency System loads shall transfer their loads from normal to emergency source when frequency and voltage of the engine-generator(s) have attained the specified percent of rated value. Only those switches with deficient normal source voltage shall transfer.

E. Retransfer to Normal (All Loads): Automatic transfer switches shall retransfer the load from emergency to normal source upon restoration of normal supply in all phases to the specified percent or more of normal voltage, and after a specified time delay. Should the emergency source fail during this time, the automatic transfer switches shall immediately transfer to the normal source whenever it becomes available. After restoring to normal source, the engine-generator(s)

shall continue to run unloaded for a specified interval before shut-down.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install automatic transfer switches and associated remote components in accordance with the NEC, as shown on the drawings, and manufacturer's instructions.

B. Anchor automatic transfer switches with rustproof bolts, nuts, and washers not less than 12 mm (1/2 inch) diameter, in accordance with manufacturer's instructions, and as shown on drawings.

C. Mount automatic transfer switches on concrete slab. Unless otherwise indicated, the slab shall be at least 100 mm (4 inches) thick. The top of the concrete slab shall be approximately 100 mm (4 inches) above finished floor. Edges above floor shall have 12.5 mm (1/2 inch) chamfer. The slab shall be of adequate size to project at least 100 mm (8 inches) beyond the equipment. Provide conduit turnups and cable entrance space required by the equipment to be mounted. Seal voids around conduit openings in slab with water- and oil-resistant caulking or sealant. Cut off and bush conduits 75 mm (3 inches) above slab surface. Concrete work shall be as specified in Section 03 30 00, CAST-IN-PLACE CONCRETE.

3.2 ACCEPTANCE CHECKS AND TESTS

A. An authorized representative of the automatic transfer switch manufacturer shall technically supervise and participate during all of the field adjustments and tests. Major adjustments and field tests shall be witnessed by the COR. The manufacturer's representative shall certify in writing that the equipment has been installed, adjusted and tested in accordance with the manufacturer's recommendations.

B. Perform manufacturer's required field tests in accordance with the manufacturer's recommendations. In addition, include the following:

1. Visual Inspection and Tests:
   a. Compare equipment nameplate data with specifications and approved shop drawings.
   b. Inspect physical, electrical, and mechanical condition.

c. Confirm correct application of manufacturer's recommended lubricants.
d. Verify appropriate anchorage, required area clearances, and correct alignment.
e. Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method, or performing thermographic survey after energization.
f. Verify grounding connections.
g. Verify ratings of sensors.
h. Vacuum-clean enclosure interior. Clean enclosure exterior.
i. Exercise all active components.
j. Verify that manual transfer warning signs are properly placed.
k. Verify the correct operation of all sensing devices, alarms, and indicating devices.

2. Electrical tests:
   a. Perform insulation-resistance tests.
   b. After energizing circuits, demonstrate the interlocking sequence and operational function for each automatic transfer switch at least three times.
      1) Power failure of normal source shall be simulated by opening upstream protective device. This test shall be performed a minimum of five times.
      2) Power failure of emergency source with normal source available shall be simulated by opening upstream protective device for emergency source. This test shall be performed a minimum of five times.
      3) Low phase-to-ground voltage shall be simulated for each phase of normal source.
      4) Operation and settings shall be verified for specified automatic transfer switch operational feature, such as override time delay, transfer time delay, return time delay, engine shutdown time delay, exerciser, auxiliary contacts, and supplemental features.
      5) Verify pickup and dropout voltages by data readout or inspection of control settings.

d. When any defects are detected, correct the defects and repeat the tests as requested by the COR at no additional cost to the Government.

3.3 FIELD SETTINGS VERIFICATION

A. The automatic transfer switch settings shall be verified in the field by an authorized representative of the manufacturer.

3.4 FOLLOW-UP VERIFICATION

A. Upon completion of acceptance checks and tests, the Contractor shall show by demonstration in service that the automatic transfer switches are in good operating condition and properly performing the intended function.

3.5 INSTRUCTION

A. Furnish the services of a factory-trained technician for one 4-hour training period for instructing personnel in the maintenance and operation of the automatic transfer switches, on the dates requested by the COR.

---END---

SECTION 31 20 11
EARTHWORK (SHORT FORM)

PART 1 – GENERAL

1.1:DESCRIPTION:

This section specifies the requirements for furnishing all equipment, materials, labor and techniques for earthwork including excavation, fill, backfill and site restoration utilizing fertilizer, seed and/or sod.

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 materials, including silts, which are unstable; and inorganic materials, including silts, too wet to be stable.
2. Existing Subgrade (except footings): Same materials as above paragraph, that are not capable of direct support of slabs, pavement, and similar items, with the possible exception of improvement by compaction, proofrolling, or similar methods of improvement.
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. Earthwork: Earthwork operations required within the new construction area. It also includes earthwork required for auxiliary structures and buildings and sewer and other trenchwork throughout the job site.

C. Degree of Compaction: Degree of compaction is expressed as a percentage of maximum density obtained by the test procedure presented in ASTM D698 Method A.

D. The term fill means fill or backfill as appropriate.

1.3 RELATED WORK:

A. Materials testing and inspection during construction: Section 01 45 29, TESTING LABORATORY SERVICES.

C. Protection of existing utilities, fire protection services, existing equipment, roads, and pavements: Section 01 00 02, GENERAL REQUIREMENTS MINOR.

D. Subsurface Investigation: Section 01 00 02, GENERAL REQUIREMENTS MINOR, Article, PHYSICAL DATA.

E. Dewatering excavations and open trenches: Section 31 23 19, DEWATERING.

1.4 CLASSIFICATION OF EXCAVATION:

A. Unclassified Excavation: Removal and disposal of pavements and other man-made obstructions visible on the 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.

1.5 MEASUREMENT AND PAYMENT FOR EXCAVATION:

Excavation will be paid for on a lump sum basis as a percent complete for each pay period.

1.6 SUBMITTALS:

A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

B. Contractor shall submit procedure and location for disposal of unused satisfactory material. Proposed source of borrow material.

C. Qualifications of the commercial testing laboratory or Contractor's Testing facility shall be submitted.

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 Nursery and Landscape Association (ANLA):
2004.....American Standard for Nursery Stock

C. American Association of State Highway and Transportation Officials (AASHTO):
T99-10.....Moisture-Density Relations of Soils Using a 2.5 kg (5.5 lb) Rammer and a 305 mm (12 inch) Drop

T180-10.....Standard Method of Test for Moisture-Density Relations of Soils Using a 4.54-kg [10 lb] Rammer and a 457 mm (18 inch) Drop

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

C33-03.....Concrete Aggregate

D698-e1.....Laboratory Compaction Characteristics of Soil Using Standard Effort

D1140-00.....Amount of Material in Soils Finer than the No. 200 (75-micrometer) Sieve

D1556-00.....Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method

D1557-09.....Laboratory Compaction Characteristics of Soil Using Modified Effort

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)

D6938-10.....Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)

E. Standard Specifications of Ohio State Department of Transportation, latest revision.

PART 2 - PRODUCTS

2.1 MATERIALS:

A. Fills: Materials approved from on site and off site sources having a minimum dry density of 1760 kg/m3 (110 pcf), a maximum Plasticity Index of 6, and a maximum Liquid Limit of 30.

B. Granular Fill:

1. Under concrete slab, granular fill shall consist of clean, poorly graded crushed rock, or crushed gravel. Fine aggregate grading shall conform to ASTM C33 with a maximum of 3 percent by weight passing ASTM D1140, 75 micrometers (No. 200) sieve, and no more than 2 percent by weight passing the 4.75 mm (No. 4) size sieve or coarse aggregate Size 67.

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).

C. Fertilizer: (5-10-5) delivered to site in unopened containers that clearly display the manufacturer's label, indicating the analysis of the contents.

D. Seed: Grass mixture comparable to existing turf delivered to site in unopened containers that clearly display the manufacturer's label, indicating the analysis of the contents.

E. Sod: Comparable species with existing turf. Use State Certified or State Approved sod when available. Deliver sod to site immediately after cutting and in a moist condition. Thickness of cut must be 19 mm to 32 mm (3/4 inch to 1 1/4 inches) excluding top growth. There shall be no broken pads and torn or uneven ends

F. Requirements For Offsite Soils: Offsite soils brought in for use as backfill shall be tested for TPH, BTEX and full TCLP including ignitability, corrosivity and reactivity. Backfill shall contain less than 100 parts per million (ppm) of total hydrocarbons (TPH) and less than 10 ppm of the sum of Benzene, Toleune, Ethyl Benzene, and Xylene (BTEX)and shall not fail the TCLP test. TPH concentrations shall be determined by using EPA 600/4-79/020 Method 418.1. BTEX concentrations shall be determined by using EPA SW-846.3-3a Method5030/8020. TCLP shall be performed in accordance with EPA SW-846.3-3a Method 1311. Provide Borrow Site Testing for TPH, BTEX and TCLP from a composite sample of material from the borrow site, with at least one test from each borrow site. Material shall not be brought on site until tests have been approved by the Resident Engineer.

G. Buried Warning and Identification Tape: Polyethylene plastic and metallic core or metallic-faced, acid- and alkali-resistant polyethylene plastic warning tape manufactured specifically for warning and identification of buried utility lines. Provide tape on rolls, 3 inch minimum width, color coded as specific below for the intended utility with warning and identification imprinted in bold black letters continuously over the entire tape length. Warning and identification to read, "CAUTION, BURIED (intended service) LINE BELOW" or similar

wording. Color and printing shall be permanent, Unaffected by moisture or soil. Warning tape color codes:

Red:	Electric
Yellow:	Gas, Oil, Dangerous Materials
Orange:	Telephone and Other Communications
Blue:	Water Systems
Green:	Sewer Systems
White:	Steam Systems

H. Warning Tape for Metallic Piping: Acid and alkali-resistant polyethylene plastic tape conforming to the width, color, and printing requirements specified above. Minimum thickness of tape shall be 0.076 mm (0.003 inch). Tape shall have a minimum strength of 10.3 MPa (1500 psi) lengthwise, and 8.6 MPa (1250 psi) crosswise, with a maximum 350 percent elongation.

I. Detectable Warning Tape for Non-Metallic Piping: Polyethylene plastic tape conforming to the width, color, and printing requirements specified above. Minimum thickness of the tape shall be 0.102 mm (0.004 inch). Tape shall have a minimum strength of 10.3 MPa (1500 psi) lengthwise and 8.6 MPa (1250 psi) crosswise. Tape shall be manufactured with integral wires, foil backing, or other means of enabling detection by a metal detector when tape is buried up to 0.9 m(3 feet) deep. Encase metallic element of the tape in a protective jacket or provide with other means of corrosion protection.

J. Detection Wire For Non-Metallic Piping: Detection wire shall be Insulated single strand, solid copper with a minimum of 12 AWG.

PART 3 - EXECUTION

3.1 SITE PREPARATION:

A. Clearing: Clearing within the limits of earthwork operations as described or designated by the Resident Engineer. Work includes removal of trees, shrubs, fences, foundations, incidental structures, paving, debris, trash and any other obstructions. Remove materials from the Cemetery Property.

B. Grubbing: Remove stumps and roots 75 mm (3 inches) and larger diameter. Undisturbed sound stumps, roots up to 75 mm (3 inches) diameter, and nonperishable solid objects which will be a minimum of 900 mm (3 feet) below subgrade or finished embankment may be left. Cemetery Projects: do not leave material within the burial profile up to 2400 mm (8 feet) below finished grade.

C. Trees and Shrubs: Trees and shrubs, not shown for removal, may be removed from the areas within 4500 mm (15 feet) of new construction and 2250 mm (7'-6") of utility lines if such removal is approved in advance by the Resident Engineer. Remove materials from the Cemetery Property. Box, and otherwise protect from damage, existing trees and shrubs which are not shown to be removed in the construction area. Repair immediately damage to existing trees and shrubs by trimming, cleaning and painting damaged areas, including the roots, in accordance with standard industry horticultural practice for the geographic area and plant species. Building materials shall not be stored closer to trees and shrubs that are to remain, than the farthest extension of their limbs.

D. Stripping Topsoil: Unless otherwise indicated on the drawings, the limits of earthwork operations shall extend anywhere the existing grade is filled or cut or where construction operations have compacted or otherwise disturbed the existing grade or turf. Strip topsoil as defined herein, or as indicated in the geotechnical report, from within the limits of earthwork operations as specified above unless specifically indicated or specified elsewhere in the specifications or shown on the drawings. Topsoil shall be fertile, friable, natural topsoil of loamy character and characteristic of the locality. Topsoil shall be capable of growing healthy horticultural crops of grasses. Stockpile topsoil and protect as directed by the Resident Engineer. Eliminate foreign material, 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 the 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 the soil is wet so that the tilth of the soil will be destroyed.

1. Cemetery Projects: Recommend that the top soil be tested for chemicals, pesticides and fertilizers if topsoil is to be removed from lands formerly utilized as farmland, to verify suitability for use as topsoil in the cemetery where new lawn areas are to be established.
2. 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 the Cemetery Property.

E. 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. No burning of materials is permitted onsite.

3.2 EXCAVATION:

A. Shoring, Sheeting and Bracing: Shore, brace, or slope to it's angle of repose banks of excavations to protect workmen, banks, adjacent paving, structures, and utilities, in compliance with OSHA requirements.
   1. Extend shoring and bracing to the bottom of the excavation. Shore excavations that are carried below the elevations of adjacent existing foundations.
   2. If the bearing of any foundation is disturbed by excavating, improper shoring or removal of shoring, placing of backfill, and similar operations, provide a concrete fill support 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 excavations free of water and subgrades dry, firm, and undisturbed until approval of permanent work has been received from Resident Engineer. Approval by

the Resident Engineer is also required before placement of the permanent work on all subgrades. When subgrade for foundations has been disturbed by water, remove the disturbed material to firm undisturbed material after the water is brought under control. Replace disturbed subgrade in trenches by mechanically tamped sand or gravel. Groundwater flowing toward or into excavations shall be controlled to prevent sloughing of excavation slopes and walls, boils, uplift and heave in the excavation and to eliminate interference with orderly progress of construction. French drains, sumps, ditches or trenches will not be permitted within 0.9 m (3 feet) of the foundation of any structure, except with specific written approval, and after specific contractual provisions for restoration of the foundation area have been made. Control measures shall be taken by the time the excavation reaches the water level in order to maintain the integrity of the in situ material. While the excavation is open, the water level shall be maintained continuously, at least 1.0 foot below the working level. Operate dewatering system continuously until construction work below existing water levels is complete. Submit performance records weekly. Measure and record performance of dewatering system at same time each day by use of observation wells or piezometers installed in conjunction with the dewatering system. Relieve hydrostatic head in pervious zones below subgrade elevation in layered soils to prevent uplift.

C. Blasting: Blasting shall not be permitted.

D. 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 suitable undisturbed earth unless a mechanical support is shown. Unstable material removed from the bottom of the trench or excavation shall be replaced with select granular material placed in layers not exceeding 150 mm (6 inches) loose thickness.

d. The length of open trench in advance of pipe laying shall not be greater than is authorized by the Resident Engineer.

e. Provide buried utility lines with utility identification tape. Bury tape 300 mm (12 inches) below finished grade; under pavements and slabs, bury tape 150 mm (6 inches) below top of subgrade.

f. Bury detection wire directly above non-metallic piping at a distance not to exceed 300 mm (12 inches) above the top of pipe. The wire shall extend continuously and unbroken, from manhole to manhole. The ends of the wire shall terminate inside the manholes at each end of the pipe, with a minimum of 0.9 m (3 feet) of wire, coiled, remaining accessible in each manhole. The wire shall remain insulated over it's entire length. The wire shall enter manholes between the top of the corbel and the frame, and extend up through the chimney seal between the frame and the chimney seal. For force mains, the wire shall terminate in the valve pit at the pump station end of the pipe.

g. Bedding shall match the type and thickness of existing utility bedding. Initial backfill material shall be placed and compacted with approved tampers to a height of at least one foot above the utility pipe or conduit. The backfill shall be brought up evenly on both sides of the pipe for the full length of the pipe. Care shall be taken to ensure thorough compaction of the fill under the haunches of the pipe. Except as specified otherwise in the individual piping section, provide bedding for buried piping in accordance with AWWA C600, Type 4, except as specified herein. Backfill to top of pipe shall be compacted to 95 percent of ASTM D 698maximum density. Plastic piping shall have bedding to spring line of pipe. Provide materials as follows:

1) Class I: Angular, 6 to 40 mm (0.25 to 1.5 inches), graded stone, including a number of fill materials that have regional significance such as coral, slag, cinders, crushed stone, and crushed shells.

2) Class II: Coarse sands and gravels with maximum particle size of 40 mm (1.5 inches), including various graded sands and

gravels containing small percentages of fines, generally granular and noncohesive, either wet or dry. Soil Types GW, GP, SW, and SP are included in this class as specified in ASTM D 2487.

2. Sanitary and storm sewer trenches:

a. Trench width below a point 150 mm (6 inches) above top of the pipe shall be 600 mm (24 inches) for 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 (l2 inches). Width of trench above that level shall be as necessary for sheeting and bracing and proper performance of the work.

b. The bottom quadrant of the pipe shall be bedded on suitable undisturbed soil or granular fill. Unstable material removed from the bottom of the trench or excavation shall be replaced with select granular material placed in layers not exceeding 150 mm (6 inches) loose thickness.

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 the pipe of 300 mm (12 inches) above top of pipe. Place and tamp fill material by hand.

c. Place and compact as specified the 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.

e. Provide buried utility lines with utility identification tape. Bury tape 300 mm (12 inches) below finished grade; under pavements and slabs, bury tape 150 mm (6 inches) below top of subgrade.

f. Bury detection wire directly above non-metallic piping at a distance not to exceed 300 mm (12 inches) above the top of pipe. The wire shall extend continuously and unbroken, from manhole to manhole. The ends of the wire shall terminate inside the manholes at each end of the pipe, with a minimum of 0.9 m (3 feet) of

wire, coiled, remaining accessible in each manhole. The wire shall remain insulated over its entire length. The wire shall enter manholes between the top of the corbel and the frame, and extend up through the chimney seal between the frame and the chimney seal. For force mains, the wire shall terminate in the valve pit at the pump station end of the pipe.

g. Bedding shall be of the type and thickness shown. Initial backfill material shall be placed and compacted with approved tampers to a height of at least one foot above the utility pipe or conduit. The backfill shall be brought up evenly on both sides of the pipe for the full length of the pipe. Care shall be taken to ensure thorough compaction of the fill under the haunches of the pipe. Except as specified otherwise in the individual piping section, provide bedding for buried piping in accordance with AWWA C600, Type 4, except as specified herein. Backfill to top of pipe shall be compacted to 95 percent of ASTM D698 maximum density. Plastic piping shall have bedding to spring line of pipe. Provide materials as follows:
   1) Class I: Angular, 6 to 40 mm (0.25 to 1.5 inches), graded stone, including a number of fill materials that have regional significance such as coral, slag, cinders, crushed stone, and crushed shells.
   2) Class II: Coarse sands and gravels with maximum particle size of 40 mm (1.5 inches), including various graded sands and gravels containing small percentages of fines, generally granular and noncohesive, either wet or dry. Soil Types GW, GP, SW, and SP are included in this class as specified in ASTM D2487.

E. Site Earthwork: Excavation shall be accomplished as required by drawings and specifications. Remove subgrade materials that are determined by the 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, the 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 meters (yardage) in cut section only.

F. Finished elevation of subgrade shall be as follows:
   1. Pavement Areas - bottom of the pavement or base course as applicable.
   2. Planting and Lawn Areas - 100 mm (4 inches) below the finished grade, unless otherwise specified or indicated on the drawings.

3.3 FILLING AND BACKFILLING:

A. General: Do not fill or backfill until all debris, unsatisfactory soil materials, obstructions, and deleterious materials have been removed from the excavation. Proof-roll exposed subgrades with a fully loaded dump truck. Use excavated materials or borrow for fill and backfill, as applicable. Do not use unsuitable excavated materials. Do not backfill until foundation walls have been completed above grade and adequately braced, waterproofing or dampproofing applied, and pipes coming in contact with backfill have been installed, and inspected and approved by Resident Engineer.

B. Proof-rolling Existing Subgrade: - Proof rolling shall be done on an exposed subgrade free of surface water (wet conditions resulting from rainfall) which would promote degradation of an otherwise acceptable subgrade. After stripping, proof roll the existing subgrade with six passes of a dump truck loaded with 6 cubic meters (4 cubic yards) of soil. Operate the truck in a systematic manner to ensure the number of passes over all areas, and at speeds between 4 to 5.5 km/hour (2 1/2 to 3 1/2 mph). When proof rolling, one-half of the passes made with the roller shall be in a direction perpendicular to the other passes. Notify the Resident Engineer a minimum of 3 days prior to proof rolling. Proof rolling shall be performed in the presence of the Resident Engineer. Rutting or pumping of material shall be undercut as directed by the Resident Engineer and replaced with fill material.

C. Placing: Place material in horizontal layers not exceeding 200 mm (8 inches) in loose depth and then compacted. Do not place material on surfaces that are muddy, frozen, or contain frost.

D. Compaction: Use approved equipment (hand or mechanical) well suited to the type of material being compacted. Do not operate mechanized vibratory compaction equipment within 3000 mm (10 feet) of new or existing building walls without the prior approval of the Resident Engineer. Moisten or aerate material as necessary to provide the moisture content that will readily facilitate obtaining the specified compaction with the equipment used. Compact each layer to not less than 95 percent of the maximum density determined in accordance with the following test method ASTM D698 Method A. Backfill adjacent to any and all types of structures shall be placed and compacted to at least 90 percent laboratory maximum density for cohesive materials or 95 percent laboratory maximum density for cohesionless materials to prevent wedging action or eccentric loading upon or against the structure.

E. Borrow Material: Borrow material shall be selected to meet the requirements and conditions of the particular fill or embankment for which it is to be used. Borrow material shall be obtained from within the limits of the project site, or from approved private sources. Unless otherwise provided in the contract, the Contractor shall obtain from the owners the right to procure material, pay royalties and other charges involved, and bear the expense of developing the sources, including rights-of-way for hauling. Borrow material from approved sources on Government-controlled land may be obtained without payment of royalties. Unless specifically provided, no borrow shall be obtained within the limits of the project site without prior written approval. Necessary clearing, grubbing, and satisfactory drainage of borrow pits and the disposal of debris thereon shall be considered related operations to the borrow excavation.

3.4 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 unfinished areas, fill low spots and level off with coarse sand or fine gravel.

C. Slope backfill outside the building away from the building walls for a minimum distance of 3048 mm (10 feet)at a minimum five percent (5%) slope.

D. The finished grade shall be 150 mm (6 inches) below bottom line of windows or other building wall openings unless greater depth is shown.

E. Place crushed stone or gravel fill under concrete slabs on grade tamped and leveled. The thickness of the fill shall be 150 mm (6 inches), unless otherwise indicated.

F. Finish subgrade in a condition acceptable to the Resident Engineer at least one day in advance of the paving operations. Maintain finished subgrade in a smooth and compacted condition until the succeeding operation has been accomplished. Scarify, compact, and grade the subgrade prior to further construction when approved compacted subgrade is disturbed by contractor's subsequent operations or adverse weather.

G. Grading for Paved Areas: Provide final grades for both subgrade and base course to +/- 6 mm (0.25 inches) of indicated grades.

3.5 LAWN AREAS:

A. General: Harrow and till to a depth of 100 mm (4 inches), new or existing lawn areas to remain, which are disturbed during construction. Establish existing or design grades by dragging or similar operations. Do not carry out lawn areas earthwork out when the soil is wet so that the tilth of the soil will be destroyed. Plant bed must be approved by Resident Engineer before seeding or sodding operation begins.

B. Finished Grading: Begin finish grading after rough grading has had sufficient time for settlement. Scarify subgrade surface in lawn areas to a depth of 100 mm (4 inches). Apply topsoil so that after normal compaction, dragging and raking operations (to bring surface to indicated finish grades) there will be a minimum of 100 mm (4 inches) of topsoil over all lawn areas; make smooth, even surface and true grades, which will not allow water to stand at any point. Shape top and bottom of banks to form reverse curves in section; make junctions with undisturbed areas to conform to existing topography. Solid lines within

grading limits indicate finished contours. Existing contours, indicated by broken lines are believed approximately correct but are not guaranteed.

C. Fertilizing: Incorporate fertilizer into the soil to a depth of 100 mm (4 inches) at a rate of 12 kg/100 m2 (25 pounds per 1000 square feet).

D. Seeding: Seed at a rate of 2 kg/100 m2 (4 pounds per 1000 square feet) and accomplished only during periods when uniform distribution may be assured. Lightly rake seed into bed immediately after seeding. Roll seeded area immediately with a roller not to exceed 225 kg/m (150 pounds per foot) of roller width.

E. Sodding: Topsoil shall be firmed by rolling and during periods of high temperature the topsoil shall be watered lightly immediately prior to laying sod. Sod strips shall be tightly butted at the ends and staggered in a running bond fashion. Placement on slopes shall be from the bottom to top of slope with sod strips running across slope. Secure sodded slopes by pegging or other approved methods. Roll sodded area with a roller not to exceed 225 kg/m (150 pounds per foot) of the roller width to improve contact of sod with the soil.

F. Watering: The Resident Engineer is responsible for having adequate water available at the site. As sodding is completed in any one section, the entire sodded area shall be thoroughly irrigated by the contractor, to a sufficient depth, that the underside of the new sod pad and soil, immediately below sod, is thoroughly wet. Resident Engineer will be responsible for sod after installation and acceptance.

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 Cemetery 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 debris, rubbish, and excess material from the Cemetery Property.

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SECTION 31 23 19
DEWATERING

PART 1 – GENERAL

1.1 DESCRIPTION:

This section specifies performance of dewatering required to lower and control ground water table levels and hydrostatic pressures to permit excavation, backfill, and construction to be performed in the dry. Control of surface water shall be considered as part of the work under this specification.

1.2 SUMMARY:

A. The work to be completed by the Contractor includes, but is not necessarily limited to the following:
   1. Implementation of the Erosion and Sedimentation Control Plan.
   2. Dewater excavations, including seepage and precipitation.

B. The Contractor shall be responsible for providing all materials, equipment, labor, and services necessary for care of water and erosion control. Excavation work shall not begin before the Erosion and Sedimentation Control Plan is in place.

1.3 REQUIREMENT:

A. Dewatering system shall be of sufficient size and capacity necessary to lower and maintain ground water table to an elevation at least 300 mm (1 foot) below lowest foundation subgrade or bottom of pipe trench and to allow material to be excavated, and concrete placed, in a reasonably dry condition. Materials to be removed shall be sufficiently dry to permit excavation to grades shown and to stabilize excavation slopes where sheeting is not required. Operate dewatering system continuously until backfill work has been completed.

B. Reduce hydrostatic head below any excavation to the extent that water level in the construction area is a minimum of 300 mm (1 foot) below prevailing excavation surface.

C. Prevent loss of fines, seepage, boils, quick conditions or softening of foundation strata.

D. Maintain stability of sides and bottom of excavation.

E. Construction operations are performed in the dry.

F. Control of surface and subsurface water is part of dewatering requirements. Maintain adequate control so that:
   1. The stability of excavated and constructed slopes are not adversely affected by saturated soil, including water entering prepared subbase and subgrades where underlying materials are not free draining or are subject to swelling or freeze-thaw action.
   2. Erosion is controlled.
   3. Flooding of excavations or damage to structures does not occur.
   4. Surface water drains away from excavations.
   5. Excavations are protected from becoming wet from surface water, or insure excavations are dry before additional work is undertaken.

G. Permitting Requirements: The contractor shall comply with and obtain the required State and County permits where the work is performed.

1.4 RELATED WORK:

A. Materials testing and inspection during construction: Section 01 45 29, TESTING LABORATORY SERVICES.

C. Submittal requirements as specified in Section 01 33 23 SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

D. Protection of existing utilities, fire protection services, existing equipment, roads, and pavements: Section 01 00 02, GENERAL REQUIREMENTS MINOR.

E. Subsurface Investigation: Section 01 00 02, GENERAL REQUIREMENTS MINOR, Article 1.11, PHYSICAL DATA.

F. Excavation, backfilling, site grade and utilities: Section 31 20 11, EARTH MOVING (SHORT FORM).

1.5 SUBMITTALS:

A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

B. Drawings and Design Data:
   1. Submit drawings and data showing the method to be employed in dewatering excavated areas 30 days before commencement of excavation.
   2. Material shall include: location, depth and size of wellpoints, headers, sumps, ditches, size and location of discharge lines, capacities of pumps and standby units, and detailed description of

dewatering methods to be employed to convey the water from site to adequate disposal.

3. Include a written report outlining control procedures to be adopted if dewatering problem arises.
4. Capacities of pumps, prime movers, and standby equipment.
5. Design calculations proving adequacy of system and selected equipment. The dewatering system shall be designed using accepted and professional methods of design and engineering consistent with the best modern practice. The dewatering system shall include the deep wells, wellpoints, and other equipment, appurtenances, and related earthwork necessary to perform the function.
6. Detailed description of dewatering procedure and maintenance method.
7. Materials submitted shall be in a format acceptable for inclusion in required permit applications to any and all regulatory agencies for which permits for discharge water from the dewatering system are required due to the discharge reaching regulated bodies of water.

C. Inspection Reports.

D. All required permits.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.1 INSTALLATION:

A. Install a dewatering system to lower and control ground surface water in order to permit excavation, construction of structure, and placement of backfill materials to be performed under dry conditions. Make the dewatering system adequate to pre-drain the water-bearing strata above and below the bottom of structure foundations, utilities and other excavations.

B. In addition, reduce hydrostatic pressure head in water-bearing strata below structure foundations, utility lines, and other excavations, to extent that water levels in construction area are a minimum of 300 mm (1 foot) below prevailing excavation surface at all times.

3.2 OPERATION:

A. Prior to any excavation below the ground water table, place system into operation to lower water table as required and operate it continuously 24 hours a day, 7 days a week until utilities and structures have been

satisfactorily constructed, which includes the placement of backfill materials and dewatering is no longer required.

B. Place an adequate weight of backfill material to prevent buoyancy prior to discontinuing operation of the system.

3.3 WATER DISPOSAL:

A. Dispose of water removed from the excavations in such a manner as:
   1. Will not endanger portions of work under construction or completed.
   2. Will cause no inconvenience to Government or to others working near site.
   3. Will comply with the stipulations of required permits for disposal of water.
   4. Will Control Runoff: The Contractor shall be responsible for control of runoff in all work areas including but not limited to: excavations, access roads, parking areas, laydown, and staging areas. The Contractor shall provide, operate, and maintain all ditches, basins, sumps, culverts, site grading, and pumping facilities to divert, collect, and remove all water from the work areas. All water shall be removed from the immediate work areas and shall be disposed of in accordance with applicable permits.

B. Excavation Dewatering:
   1. The Contractor shall be responsible for providing all facilities required to divert, collect, control, and remove water from all construction work areas and excavations.
   2. Drainage features shall have sufficient capacity to avoid flooding of work areas.
   3. Drainage features shall be so arranged and altered as required to avoid degradation of the final excavated surface(s).
   4. The Contractor shall utilize all necessary erosion and sediment control measures as described herein to avoid construction related degradation of the natural water quality.

C. Dewatering equipment shall be provided to remove and dispose of all surface and ground water entering excavations, trenches, or other parts of the work during construction. Each excavation shall be kept dry during subgrade preparation and continually thereafter until the structure to be built, or the pipe to be installed therein, is

completed to the extent that no damage from hydrostatic pressure, flotation, or other cause will result.

3.4 STANDBY EQUIPMENT:

Provide complete standby equipment, installed and available for immediate operation, as may be required to adequately maintain de-watering on a continuous basis and in the event that all or any part of the system may become inadequate or fail.

3.5 CORRECTIVE ACTION:

If dewatering requirements are not satisfied due to inadequacy or failure of the dewatering system (loosening of the foundation strata, or instability of slopes, or damage to foundations or structures), perform work necessary for reinstatement of foundation soil and damaged structure or damages to work in place resulting from such inadequacy or failure by Contractor, at no additional cost to Government.

3.6 DAMAGES:

Immediately repair damages to adjacent facilities caused by dewatering operations.

3.7 REMOVAL:

Insure compliance with all conditions of regulating permits and provide such information to the Resident Engineer. Obtain written approval from Resident Engineer before discontinuing operation of dewatering system.

----- E N D -----

SECTION 32 05 23
CEMENT AND CONCRETE FOR EXTERIOR IMPROVEMENTS

PART 1 – GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Subbase for concrete pavements.
   2. Curbs, gutters, combination curbs and gutters, and wheel stops.
   3. Pedestrian Pavement: Walks, grade slabs, pedestrian crossings, wheelchair curb ramps, detectable warning panels, truncated domes, and steps.
   4. Vehicular Pavement: Service courts, driveways, and parking lots.
   5. Equipment Pads: transformers, and generator pads.

1.2 RELATED REQUIREMENTS

A. Field Testing: Section 01 45 29, TESTING LABORATORY SERVICES.
B. Step Nosings and Railings: Section 05 50 00, METAL FABRICATIONS.
C. Subgrade Preparation and Subbase Compaction: Section 31 20 11, EARTHWORK (SHORT FORM).

1.3 APPLICABLE PUBLICATIONS

A. Comply with references to extent specified in this section.
B. American Association of State Highway and Transportation Officials (AASHTO):
   1. M147-65-UL-04 – Materials for Aggregate and Soil-Aggregate Subbase, Base and Surface Courses.
   2. M233-86 – Boiled Linseed Oil Mixture for Treatment of Portland Cement Concrete.
C. American Concrete Institute (ACI):
   1. 305R-10 – Guide to Hot Weather Concreting.
   2. 306R-10 – Guide to Cold Weather Concreting.
D. American National Standards Institute (ANSI):
   1. B101.3 – Wet DOCF of Common Hard Surface Floor Materials (Including Action and Limit Thresholds for the Suitable Assessment of the Measured Values).
E. ASTM International (ASTM):
   1. A615/A615M-16 – Deformed and Plain Carbon Steel Bars for Concrete Reinforcement.

2. A996/A996M-15 - Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement.
3. A1064/A1064M-16 - Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
4. C33/C33M-16 - Concrete Aggregates.
5. C94/C94M-16 - Ready Mixed Concrete.
6. C143/C143M-15a - Slump of Hydraulic Cement Concrete.
7. C150/C150M-16 - Portland Cement.
8. C171-16 - Sheet Materials for Curing Concrete.
9. C260/C260M-10a - Air Entraining Admixtures for Concrete.
10. C309-11 - Liquid Membrane Forming Compounds for Curing Concrete.
11. C494/C494M-15a - Chemical Admixtures for Concrete.
12. C618-15 - Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
13. C979/C979M-16 - Pigments for Integrally Colored Concrete.
14. C989/C989M-14 - Slag Cement for Use in Concrete and Mortars.
15. C1240-15 - Silica Fume Used in Cementitious Mixtures.
16. D1751-04(2013)e1 - Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
17. D5893/D5893M-10 - Cold Applied, Single Component, Chemically Curing Silicone Joint Sealant for Portland Cement Concrete Pavements.
18. D6690-15 - Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements.

1.4 PREINSTALLATION MEETINGS

A. Conduct preinstallation meeting at project site minimum 30 days before beginning Work of this section.
   1. Required Participants:
      a. Contracting Officer's Representative.
      b. Architect/Engineer.
      c. Inspection and Testing Agency.
      d. Contractor.
      e. Installer.
      f. Other installers responsible for adjacent and intersecting work, including excavation, erosion control, dewatering, utility construction, plantings, traffic markings, and restoration.

2. Meeting Agenda: Distribute agenda to participants minimum 3 days before meeting.
   a. Installation schedule.
   b. Installation sequence.
   c. Preparatory work.
   d. Protection before, during, and after installation.
   e. Installation.
   f. Terminations.
   g. Transitions and connections to other work.
   h. Inspecting and testing.
   i. Other items affecting successful completion.
3. Document and distribute meeting minutes to participants to record decisions affecting installation.

1.5 SUBMITTALS

A. Submittal Procedures: Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

B. Submittal Drawings:
   1. Show size, configuration, and fabrication and installation details.
   2. Show reinforcing.
   3. Include jointing plan for concrete pavements, curbs and gutters.

C. Manufacturer's Literature and Data:
   1. Description of each product.
   2. Installation instructions.

D. Samples:
   1. Exposed Aggregate Concrete Panel: 0.4 sq. m by 50 mm (4 sq. ft. by 2 inches) thick, 2 required, each color and finish.
   2. Colored Concrete Panel: As specified in Section 09 06 00, SCHEDULE FOR FINISHES, with mix data.

E. Test reports: Certify products comply with specifications.
   1. Concrete materials.
   2. Select subbase materials.
   3. Field test reports.

F. Certificates: Certify products comply with specifications.
   1. Expansion joint filler.
   2. Reinforcement.
   3. Curing materials.

4. Concrete protective coating.

G. Qualifications: Substantiate qualifications comply with specifications.
   1. Installer with project experience list.
   2. Land surveyor.

H. Concrete mix design.

I. Select subbase job-mix design.

J. Proposed hot and cold weather concreting methods.

K. Land surveyor's construction staking notes, before placing concrete.
   1. Identify discrepancies between field conditions and Drawings.

1.6 QUALITY ASSURANCE

A. Installer Qualifications:
   1. Regularly installs specified products.
   2. Installed specified products with satisfactory service on five similar installations.
      a. Project Experience List: Provide contact names and addresses for completed projects.

B. Land Surveyor: Professional land surveyor or engineer registered to provide land surveys in jurisdiction where project is located.

C. Preconstruction Testing:
   1. Engage independent testing laboratory to perform tests and submit reports.
      a. Deliver samples to laboratory in number and quantity required for testing.
   2. Concrete mix design.
   3. Select subbase job-mix design. Report the following:
      a. Material sources.
      b. Gradation.
      c. Plasticity index.
      d. Liquid limit.
      e. Laboratory compaction curves indicating maximum density at optimum moisture content.

1.7 DELIVERY

A. Deliver steel reinforcement to prevent damage.

B. Before installation, return or dispose of distorted or damaged steel reinforcement.

C. Bulk Products: Deliver bulk products away from buildings, utilities, pavement, and existing turf and planted areas. Maintain dry bulk product storage away from contaminants.

1.8 STORAGE AND HANDLING

A. Store products indoors in dry, weathertight facility.

B. Protect products from damage during handling and construction operations.

1.9 FIELD CONDITIONS

A. Hot Weather Concreting Procedures: ACI 305R.

B. Cold Weather Concreting Procedures: ACI 306R.

1. Use non-corrosive, non-chloride accelerator admixture.
2. Do not use calcium chloride, thiocyanates or admixtures containing more than 0.05 percent chloride ions.

1.10 WARRANTY

A. Construction Warranty: FAR clause 52.246-21, "Warranty of Construction."

PART 2 - PRODUCTS

2.1 CONCRETE MATERIALS

A. Portland Cement: ASTM C150/C150M, Type I or II.

B. Coarse Aggregate: ASTM C33/C33M; size to suit application.

C. Fine Aggregate: ASTM C33/C33M.

D. Mixing Water: Fresh, clean, and potable.

E. Air-Entraining Admixture: ASTM C260/C260M.

F. Chemical Admixtures: ASTM C494/C494M.

G. Reinforcing Steel: ASTM A615/A615M or ASTM A996/A996M, Grade 420 (60) deformed.

H. Welded Wire Fabric: ASTM A1064/A1064M, deformed; Grade 485 (70).

I. Expansion Joint Filler: ASTM D1751.

J. Sheet Materials for Curing Concrete: ASTM C171.

2.2 SELECT SUBBASE

A. Subbase: AASHTO M147; Grade E or Grade F.

1. Select granular material composed of sand, sand-gravel, crushed stone, crushed or granulated slag, with or without soil binder, or combinations of these materials.

SUBBASE GRADING REQUIREMENTS							
Sieve Size		Percentage Passing by Mass					
		Grades					
(mm)	(in)	A	B	C	D	E	F
50	2	100	100				
25	1		75-95	100	100	100	100
9.5	3/8	30-65	40-75	50-85	60-100		
4.47	No. 4	25-55	30-60	35-65	50-85	55-100	70-100
2.00	No. 10	15-40	20-45	25-50	40-70	40-100	55-100
0.425	No. 40	8-20	15-30	15-30	25-45	20-50	30-70
0.075	No. 200	2-8	5-20	5-15	5-20	6-20	8-25

B. Other Acceptable Gradations: Materials within three to five percent, plus or minus, of specified gradation, or as recommended by the geotechnical engineer and approved by the Contracting Officer's Representative.

2.3 FORMS

A. Forms: Wood, plywood, metal, or other materials, approved by Contracting Officer's Representative, of grade or type suitable to obtain type of finish specified.
   1. Plywood: Exterior grade, free of defects and patches on contact surface.
   2. Lumber: Sound, grade-marked, S4S stress graded softwood, minimum 50 mm (2 inches) thick, free from warp, twist, loose knots, splits, or other defects.
   3. Form Coating: As recommended by Architect/Engineer.

B. Provide forms suitable in cross-section, depth, and strength to resist springing during depositing and consolidating concrete.
   1. Do not use forms varying from straight line more than 3 mm in 3000 mm (1/8 inch in 10 feet), horizontally and vertically.

C. Provide flexible or curved forms for forming radii.

2.4 CONCRETE CURING MATERIALS

A. Concrete curing materials, conform to one of the following:
   1. Burlap: Minimum 233 g/sq. m (7 ounces/sq. yd.) dry.
   2. Sheet Materials for Curing Concrete: ASTM C171.

3. Curing Compound: ASTM C309, Type 2; liquid membrane forming type, without paraffin or petroleum.

2.5 CONCRETE MIXES

A. Design concrete mixes according to ASTM C94/C94M, Option C.

B. Concrete Type: Air-entrained. See Table I.

TABLE I – CONCRETE TYPES

Concrete Type	Minimum 28 Day Compressive Strength f'c MPa (psi)	Non-Air-Entrained		Air-Entrained	
		Min. Cement kg/cu. m (lbs./cu. yd.)	Max. Water Cement Ratio	Min. Cement kg/cu. m (lbs./cu. yd.)	Max. Water Cement Ratio
A	35 (5000)1,3	375 (630)	0.45	385 (650)	0.40
B	30 (4000)1,3	325 (550)	0.55	340 (570)	0.50
C	25 (3000)1,3	280 (470)	0.65	290 (490)	0.55
D	25 (3000)1,2	300 (500)	*	310 (520)	*

Footnotes:
1. If trial mixes are used, achieve compressive strength 8.3 MPa (1,200 psi) in excess of f'c. For concrete strengths greater than 35 MPa (5,000 psi), achieve compressive strength 9.7 MPa (1,400 psi) in excess of f'c.
2. For Concrete Exposed to High Sulfate Content Soils: Maximum water cement ratio is 0.44.
3. Laboratory Determined according to ACI 211.1 for normal weight concrete.

C. Maximum Slump: ASTM C143/C143M. See Table II.

TABLE II – MAXIMUM SLUMP

APPLICATION	MAXIMUM SLUMP
Curb & Gutter	75 mm (3 inches)
Pedestrian Pavement	75 mm (3 inches)
Vehicular Pavement	50 mm (2 inches) Machine Finished 100 mm (4 inches) Hand Finished
Equipment Pad	75 to 100 mm (3 to 4 inches)

2.6 ACCESSORIES

A. Equipment and Tools: Obtain Contracting Officer's Representative's, approval of equipment and tools needed for handling materials and performing work before work begins.

B. Maintain equipment and tools in satisfactory working condition.

C. Sealants:

1. Concrete Paving Expansion Joints: ASTM D5893/D5893M, Type SL, single component, self-leveling, silicone joint sealant.
2. Concrete Paving Joints: ASTM D6690, Type IV, hot-applied, single component joint sealant.

D. Concrete Protective Coating: AASHTO M233 linseed oil mixture.

PART 3 - EXECUTION

3.1 PREPARATION

A. Examine and verify substrate suitability for product installation.

B. Protect existing construction and completed work from damage.

C. Prepare, construct, and finish subgrade. See Section 31 20 11, EARTHWORK (SHORT FORM).

D. Maintain subgrade in smooth, compacted condition, in conformance with the required section and established grade until the succeeding operation has been accomplished.

3.2 SELECT SUBBASE

A. Placing:

1. Place subbase material on prepared subgrade in uniform layer to required contour and grades, and to maximum 200 mm (8 inches) loose depth.
2. When required compacted thickness exceeds 150 mm (6 inches), place subbase material in equal thickness layers.
3. When subbase elevation is 13 mm (1/2 inch) or more below required grade, excavate subbase minimum 75 mm (3 inches) deep. Place and compact subbase to required grade.

B. Compaction:

1. Perform compaction with approved hand or mechanical equipment well suited to the material being compacted.
2. Maintain subbase at optimum moisture content for compaction.

3. Compact each subbase layer to minimum 95 percent or 100 percent of maximum density as specified in Section 31 20 11, EARTHWORK (SHORT FORM).

C. Subbase Tolerances:
   1. Variation from Indicated Grade: Maximum 9 mm (3/8 inch).
   2. Variation from Indicated Thickness: Maximum 13 mm (1/2 inch).

D. Protection:
   1. Protect subbase from damage until concrete is placed.
   2. Reconstruct damaged subbase before placing concrete.

3.3 SETTING FORMS

A. Form Substrate:
   1. Compact form substrate to uniformly support forms along entire length.
   2. Correct substrate imperfections and variations by cutting, filling, and compacting.

B. Form Setting:
   1. Set forms to indicated line and grade with tight joints. Rigidly brace forms preventing movement.
   2. Remove forms when removal will not damage concrete and when required for finishing.
   3. Clean and oil forms before each use.
   4. Correct forms, when required, immediately before placing concrete.

C. Land Surveyor: Establish control, alignment, and grade for forms and slip forming machine operations.
   1. Notify Contracting Officer's Representative immediately when discrepancies exist between field conditions and drawings.
   2. Correct discrepancies greater than 25 mm (1 inch) before placing concrete.

D. Form Tolerances:
   1. Variation from Indicated Line: Maximum 6 mm (1/4 inch).
   2. Variation from Indicated Grade: Maximum 3 mm in 3000 mm (1/8 inch in 10 feet).

3.4 PLACING REINFORCEMENT

A. Keep reinforcement clean from contamination preventing concrete bond.

B. Install reinforcement shown on drawings.

C. Support and securely tie reinforcing steel to prevent displacement during concrete placement.

D. Obtain Contracting Officer's Representative's reinforcement placement approval before placing concrete.

3.5 JOINTS – GENERAL

A. Place joints, where shown on approved submittal Drawings.

1. Conform to details shown.
2. Install joints perpendicular to finished concrete surface.

B. Make joints straight and continuous from edge to edge of pavement.

3.6 CONSTRUCTION JOINTS

A. Locate longitudinal and transverse construction joints between slabs of vehicular pavement as shown on approved submittal Drawings.

B. Place transverse construction joints of type shown, where indicated, and whenever concrete placement is suspended for more than 30 minutes.

C. Provide butt-type joint with dowels in curb and gutter at planned joint locations.

D. Provide keyed joints with tie bars when joint occurs in middle third of planned curb and gutter joint interval.

3.7 CONTRACTION JOINTS

A. Tool or cut joints to width, depth, and radius edge shown on drawings using grooving tool, jointer, or saw.

B. Construct joints in curbs and gutters by inserting 3 mm (1/8 inch) steel plates conforming to curb and gutter cross sections.

1. Keep plates in place until concrete can hold its shape.

C. Finish joint edges with edging tool.

D. Score pedestrian pavement with grooving tool or jointer.

3.8 EXPANSION JOINTS

A. Form expansion joints with expansion joint filler of thickness shown on drawings.

1. Locate joints around perimeter of structures and features abutting site work concrete.
2. Create complete, uniform separation between structure and site work concrete.

B. Extend expansion joint material full depth of concrete with top edge of joint filler below finished concrete surface where sealant is indicated on Drawings.

C. Cut and shape material matching cross section.

D. Anchor with approved devices to prevent displacing during placing and finishing operations.

E. Round joint edges with edging tool.

3.9 PLACING CONCRETE – GENERAL

A. Preparation before Placing Concrete:

1. Obtain Contracting Officer's Representative approval.
2. Remove debris and other foreign material.
3. Uniformly moisten substrate, without standing water.

B. Convey concrete from mixer to final location without segregation or loss of ingredients. Deposit concrete to minimize handling.

C. During placement, consolidate concrete by spading or vibrating to minimize voids, honeycomb, and rock pockets.

1. Vibrate concrete against forms and along joints.
2. Avoid excess vibration and handling causing segregation.

D. Place concrete continuously between joints without bulkheads.

E. Install construction joint in concrete placement suspended for more than 30 minutes.

F. Replace concrete with cracks, chips, bird baths, and other defects to nearest joints, approved by Contracting Officer's Representative.

3.10 PLACING CONCRETE FOR CURB AND GUTTER, PEDESTRIAN PAVEMENT, AND EQUIPMENT PADS

A. Place concrete in one layer conforming to cross section shown on Drawings after consolidating and finishing.

B. Deposit concrete near joints without disturbing joints. Do not place concrete directly onto joint assemblies.

C. Strike concrete surface to proper section ready for consolidation.

D. Consolidate concrete by tamping and spading or with approved mechanical finishing equipment.

E. Finish concrete surface with wood or metal float.

F. Construct concrete pads and pavements with sufficient slope to drain, preventing standing water.

3.11 PLACING CONCRETE FOR VEHICULAR PAVEMENT

A. Deposit concrete as close as possible to its final position.

B. Place concrete continuously between construction joints without cold joints.

C. Strike and consolidate concrete with finishing machine, vibrating screed, or by hand-finishing.

D. Finish concrete surface to elevation and crown shown on drawings.

E. Deposit concrete near joints without disturbing joints. Do not place concrete directly onto joint assemblies.

F. Obtain Contracting Officer's Representative's approval before placing adjacent lanes.

G. Curb-Forming Machines: Curb-forming machines for constructing curbs and gutter will be approved based on trial use on the project. When equipment produces unsatisfactory results, discontinue use of the equipment at any time during construction and accomplish work by hand method construction. Remove unsatisfactory work and reconstruct full length between regularly scheduled joints. Dispose of removed portions off the project site.

3.12 FORM REMOVAL

A. Keep forms in place minimum 12 hours after concrete placement. Remove forms without damaging concrete.

B. Do not use bars or heavy tools against concrete to remove forms. Repair damage concrete found after form removal.

3.13 CONCRETE FINISHING - GENERAL

A. Follow operation sequence below, unless otherwise indicated on Drawings:

1. Consolidating, floating, striking, troweling, texturing, and joint edging.

B. Use edging tool with 6 mm (1/4 inch) radius.

C. Keep finishing equipment and tools clean and suitable for use.

3.14 CONCRETE FINISHING - PEDESTRIAN PAVEMENT

A. Walks, Grade Slabs, Pedestrian Crossings, Wheelchair Curb Ramps, Truncated Domes, and Steps:

1. Finish concrete surfaces with metal float, troweled smooth, and finished with a broom moistened with clear water.

2. Finish slab edges and formed transverse joints with edger.
3. Broom surfaces transverse to traffic direction.
   a. Use brooming to eliminate flat surface produced by edger.
   b. Produce uniform corrugations, maximum 1.5 mm (1/16 inch) deep profile.
4. Provide surface uniform in color and free of surface blemishes, form marks, and tool marks.
5. Paving Tolerances:
   a. Variation from Indicated Plane: Maximum 5 mm in 3000 mm (3/16 inch in 10 feet).
   b. Variation from Indicated Thickness: Maximum 6 mm (1/4 inch).
6. Replace paving within joint boundary when paving exceeds specified tolerances.

B. Step Treads, Risers and Sidewalls: Finish as specified for pedestrian pavement, except as follows:
1. Remove riser forms sequentially, starting with top riser.
2. Rub riser face with wood or concrete rubbing block and water. Remove blemishes, form marks, and tool marks. Use outside edger to round nosing; use inside edger to finish bottom of riser.
3. Apply uniform brush finish to treads, risers, and sidewall.
   a. Apply stiff brush finish to treads to provide slip resistant surface complying with ANSI B101.3.
4. Step Tolerance:
   a. Variation from Indicated Plane: Maximum 5 mm in 3000 mm (3/16 inch in 10 feet).

3.15 CONCRETE FINISHING – VEHICULAR PAVEMENT

A. Align finish surfaces where new and existing pavements abut.
B. Longitudinally float pavement surface to profile and grade indicated on drawings.
C. Straighten surface removing irregularities and maintaining specified tolerances while concrete is plastic.
D. Finish pavement edges and joints with edging tool.
E. Broom finish concrete surface after bleed water dissipates and before concrete hardens.
1. Broom surface transverse to traffic direction.
   a. Use brooming to eliminate flat surface produced by edger.

b. Produce uniform corrugations, maximum 3 mm (1/8 inch) deep profile.

F. Pavement Tolerances:

1. Variation from Indicated Plane: Maximum 6 mm in 3000 mm (1/4 inch in 10 feet) tested parallel and perpendicular to traffic direction at maximum 1500 mm (5 feet) intervals.
2. Variation from Indicated Thickness: Maximum 6 mm (1/4 inch).

G. Replace paving within joint boundary when paving exceeds specified tolerances.

3.16 CONCRETE FINISHING – CURBS AND GUTTERS

A. Round edges of gutter and top of curb with edging tool.

B. Gutter and Curb Top:

1. Float surfaces and finish with smooth wood or metal float until true to grade and section and uniform color.
2. Finish surfaces, while still plastic, longitudinally with bristle brush.

C. Curb Face:

1. Remove curb form and immediately rub curb face with wood or concrete rubbing block removing blemishes, form marks, and tool marks and providing uniform color.
2. Brush curb face, while still plastic, matching gutter and curb top.

D. Curb and Gutter Tolerances: Except at grade changes or curves.

1. Variation from Indicated Plane and Grade:
   a. Gutter: Maximum 3 mm in 3000 mm (1/8 inch in 10 feet).
   b. Curb Top and Face: Maximum 6 mm in 3000 mm (1/4 inch in 10 feet).

E. Replace curbs and gutters within joint boundary when curbs and gutters exceed specified tolerances.

F. Correct depressions causing standing water.

3.17 CONCRETE FINISHING – EQUIPMENT PADS

A. Strike pad surface to elevation shown on Drawings.

B. Provide smooth, dense float finish, free from depressions or irregularities.

C. Finish pad edges with edger.

D. After removing forms, rub pad edge faces with wood or concrete rubbing block, removing blemishes, form marks, and tool marks and providing uniform color.

E. Pad Tolerances:

1. Variation from Indicated Plane: Maximum 3 mm in 3000 mm (1/8 inch in 10 feet).
2. Variation from Indicated Elevation: Maximum 6 mm (1/4 inch).
3. Variation from Indicated Thickness: Maximum 6 mm (1/4 inch).

F. Replace pads when pads exceed specified tolerances.

3.18 SPECIAL FINISHES

A. Exposed Aggregate Finish:

1. Prepare concrete base 10 to 13 mm (3/8 to 1/2 inch) lower than the finish grade.
2. Scatter aggregate over concrete base surface and embed by use of hand float, straight edge, or darby.
3. Apply concrete mix and mark off surface as indicated on Drawings with surface joints at least 10 mm (3/8 inch) deep. Level off finish to a true surface and compact with wood float, working as little as possible so that coarse material will remain at the top. Before finish has set, treat top surface with cement retarding material. When body of concrete finish has set, remove retarded surface film by wire brushes and fine water spray to remove mortar from top of colored aggregate. Continue washing and brushing until flush water runs clear and no noticeable cement film left on the aggregate.

3.19 CONCRETE CURING

A. Concrete Protection:

1. Protect unhardened concrete from rain and flowing water.
2. Provide sufficient curing and protection materials available and ready for use before concrete placement begins.
3. Protect concrete to prevent pavement cracking from ambient temperature changes during curing period.
   a. Replace pavement damaged by curing method allowing concrete cracking.
   b. Employ another curing method as directed by Contracting Officer's Representative.

B. Cure concrete for minimum 7 days by one of the following methods appropriate to weather conditions preventing moisture loss and rapid temperature change:
   1. Burlap Mat: Provide minimum two layers kept saturated with water during curing period. Overlap Mats at least 150 mm (6 inches).
   2. Sheet Materials:
      a. Wet exposed concrete surface with fine water spray and cover with sheet materials.
      b. Overlap sheets minimum 300 mm (12 inches).
      c. Securely anchor sheet materials preventing displacement.
   3. Curing Compound:
      a. Protect joints indicated to receive sealants preventing contamination from curing compound.
      b. Insert moistened paper or fiber rope into joint or cover joint with waterproof paper.
      c. Apply curing compound before concrete dries.
      d. Apply curing compound in two coats at right angles to each other.
      e. Application Rate: Maximum 5 sq. m/L (200 sq. ft./gallon), both coats.
      f. Immediately reapply curing compound to surfaces damaged during curing period.

3.20 CONCRETE PROTECTIVE COATING

A. Apply protective coating of linseed oil mixture to exposed-to-view concrete surfaces, drainage structures, and features that project through, into, or against concrete exterior improvements to protect the concrete against deicing materials.
B. Complete backfilling and curing operation before applying protective coating.
C. Dry and thoroughly clean concrete before each application.
D. Apply two coats, with maximum coverage of 11 sq. m/L (50 sq. yds./gal.); first coat, and maximum 16 sq. m/L (70 sq. yds./gal.); second coat, except apply commercially prepared mixture according to manufacturer's instructions.
E. Protect coated surfaces from vehicular and pedestrian traffic until dry.

F. Do not heat protective coating, and do not expose protective coating to open flame, sparks, or fire adjacent to open containers or applicators. Do not apply material at temperatures lower than 10 degrees C (50 degrees F).

3.21 FIELD QUALITY CONTROL

A. Field Tests: Performed by testing laboratory specified in Section 01 45 29, TESTING LABORATORY SERVICES.
   1. Compaction.
      a. Pavement subgrade.
      b. Curb, gutter, and sidewalk.
   2. Concrete:
      a. Delivery samples.
      b. Field samples.
   3. Slip Resistance: Steps and pedestrian paving.

3.22 CLEANING

A. After completing curing:
   1. Remove burlap and sheet curing materials.
   2. Sweep concrete clean, removing foreign matter from the joints.
   3. Seal joints as specified.

3.23 PROTECTION

A. Protect exterior improvements from traffic and construction operations.
   1. Prohibit traffic on paving for minimum seven days after placement, or longer as directed by Contracting Officer's Representative.
B. Remove protective materials immediately before acceptance.
C. Repair damage.
   1. Replace concrete containing excessive cracking, fractures, spalling, and other defects within joint boundary, when directed by Contracting Officer's Representative, and at no additional cost to the Government.

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SECTION 32 12 16
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 01 45 29, TESTING LABORATORY SERVICES.

B. Subgrade Preparation: Paragraph 3.3 and Section 31 20 11, EARTHWORK (SHORT FORM).

C. Pavement Markings: Section 32 17 23, 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 01 33 23, 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 State Highway Specification.

D. One copy of State Highway Department 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 Asphaltic Wear Course materials shall conform to the requirements of the following and other appropriate sections of the latest version of the State of Ohio 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. Aggregate Base: Provide material conforming to ODOT item 304 Aggregate Base:

Sieve Sizes	Percentage Passing
2 inch	100
1 inch	70 to 100
3/4 inch	50 to 90

Sieve Sizes	Percentage Passing
No. 4	30 to 60
No. 30	9 to 33
No. 200	0 to 15

C. Asphaltic Base Course: Provide material conforming to ODOT item 441 AC Intermediate, Type 2, PG64-22

Sieve Sizes	Percentage Passing
1-1/2 inch	100
1 inch	95 to 100
3/4 inch	85 to 100
1/2 inch	65 to 85
No. 4	35 to 60
No. 8	25 to 48
No. 16	16 to 36
No. 30	12 to 30
No. 50	5 to 18
No. 100	2 to 10

D. Asphaltic Wear Course: Provide material conforming to ODOT item 441 AC Surface, Type 1, PG64-22.

Sieve Sizes	Percentage Passing
1/2 inch	100
3/8 inch	90 to 100
No. 4	45 to 57
No. 8	30 to 45
No. 16	17 to 35
No. 30	12 to 25
No. 50	5 to 18
No. 100	2 to 10

1. Plus 50/60 penetration liquid asphalt at 5 percent to 6-1/2 percent of the combined dry aggregates.

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

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 of Ohio 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 own 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. 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.

C. When sealing new asphalt paving wait an entire year to allow for the expansion and contraction of a year's cycle of both warm and cool temperatures. This allows for the asphalt's oils to properly cure and begin oxidation before applying a seal coat.

E. When seal coating existing paving that has new asphalt patches, apply two coats sprayed to the existing asphalt and a single lighter coat on new patch work, just enough to make the color of the new patches match the rest of the reseal coated paving.

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.

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SECTION 32 17 23
PAVEMENT MARKINGS

PART 1 – GENERAL

1.1 SUMMARY

A. Section Includes:

1. Paint on pavement surfaces, in form of traffic lanes, parking bays, areas restricted to handicapped persons, crosswalks, and other detail pavement markings.

1.2 RELATED REQUIREMENTS

A. Paint Color: Section 09 06 00, SCHEDULE FOR FINISHES.

1.3 APPLICABLE PUBLICATIONS

A. Comply with references to extent specified in this section.

B. Federal Specifications (Fed. Spec.):

1. TT-P-1952F – Paint, Traffic and Airfield Marking, Waterborne.

C. Master Painters Institute (MPI):

1. No. 97 – Traffic Marking Paint, Latex.

1.4 SUBMITTALS

A. Submittal Procedures: Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

B. Submittal Drawings:

1. Show pavement marking configuration and dimensions.
2. Show international symbol of accessibility at designated parking spaces.

C. Manufacturer's Literature and Data:

1. Description of each product.
2. Application instructions.

D. Samples:

1. Paint: 200 mm (8 inches) square, each type and color.

E. Certificates: Certify products comply with specifications.

F. Qualifications: Substantiate qualifications comply with specifications.

1. Installer with project experience list.

1.5 QUALITY ASSURANCE

A. Installer Qualifications:

1. Regularly installs specified products.

2. Installed specified products with satisfactory service on five similar installations for minimum five years.
   a. Project Experience List: Provide contact names and addresses for completed projects.

1.6 DELIVERY

A. Deliver products in manufacturer's original sealed packaging.
B. Mark packaging, legibly. Indicate manufacturer's name or brand, type, color, production run number, and manufacture date.
C. Before installation, return or dispose of products within distorted, damaged, or opened packaging.

1.7 STORAGE AND HANDLING

A. Store products indoors in dry, weathertight conditioned facility.
B. Protect products from damage during handling and construction operations.

1.8 FIELD CONDITIONS

A. Environment:
   1. Product Temperature: Minimum 13 degrees C (55 degrees F) for minimum 48 hours before installation.
      a. Surface to be painted and ambient temperature: Minimum 10 degrees C (50 degrees F) and maximum 35 degrees C (95 degrees F).
B. Field Measurements: Verify field conditions affecting traffic marking installation. Show field measurements on Submittal Drawings.

1.9 WARRANTY

A. Construction Warranty: FAR clause 52.246-21, "Warranty of Construction."

PART 2 – PRODUCTS

2.1 SYSTEM PERFORMANCE

A. Design paint complying with specified performance:
   1. Application: Fed. Spec. TT-P-1952.

2.2 PRODUCTS – GENERAL

A. Basis of Design: Section 09 06 00, SCHEDULE FOR FINISHES.
B. Provide each product from one manufacturer and from one production run.

2.3 SANDBLASTING EQUIPMENT

A. Air compressor, hoses, and nozzles of proper size and capacity as required for cleaning painted surfaces. Compressor to provide minimum 0.08 cu. m/s (150 cfm) of air at pressure of minimum 625 kPa (90 psi) at each nozzle used.

2.4 PAINT APPLICATOR

A. Apply marking paint with approved mechanical equipment. Provide equipment with constant agitation of paint and travel at controlled speeds. Synchronize one or more paint "guns" to automatically begin and cut off paint flow in case of skip lines. Equipment to have manual control to apply continuous lines of varying length and marking widths as indicated on Drawings. Provide pneumatic spray guns for hand application of paint in areas where mobile paint applicator cannot be used.

2.5 PAINT

A. Paint: MPI No. 97. For obliterating existing markings comply with Fed. Spec. TT-P-1952. Provide minimum 18 L (5 gallons) containers.

PART 3 - EXECUTION

3.1 PREPARATION

A. Examine and verify substrate suitability for product installation.
   1. Allow new pavement surfaces to cure for period of minimum 14 days before application of marking materials.
B. Protect existing construction and completed work from damage.
C. Clean substrates. Remove contaminants capable of affecting subsequently installed product's performance.
   1. Remove dust, dirt, and other granular surface deposits by sweeping, blowing with compressed air, rinsing with water, or combination of these methods.
   2. Completely remove rubber deposits, existing paint markings, and other coatings adhering to pavement with scrapers, wire brushings, sandblasting, mechanical abrasion, or approved chemicals as directed by Contracting Officer's Representative.

3. As an option, comply with Fed. Spec. TT-P-1952 for removal of existing paint markings on asphalt pavement. Apply black paint in as many coats as necessary to completely obliterate existing markings.
4. Scrub affected areas with several applications of trisodium phosphate solution or other approved detergent or degreaser, and rinse thoroughly after each application, Where oil or grease are present on old pavements to be marked, .
   a. After cleaning, seal oil-soaked areas with cut shellac to prevent bleeding through new paint.
5. Clean and dry surface before pavement marking.Do not begin any marking until Contracting Officer's Representative inspected surface and gives permission to proceed.

3.2 TEMPORARY PAVEMENT MARKING

A. Apply Temporary Pavement Markings of colors, widths and lengths shown on drawings or directed by Contracting Officer's Representative. After temporary marking has served its purpose and when so ordered by Contracting Officer's Representative, remove temporary marking by carefully controlled sandblasting, approved grinding equipment, or other approved method to prevent damage on applied surface.

B. As an option, provide approved preformed pressure sensitive, adhesive tape type of temporary pavement marking of required colors, widths and lengths in lieu of temporary painted marking. Continuous durability and effectiveness of such marking is required during period for which its use is required. Remove any unsatisfactory tape type marking and replace with painted markings.

3.3 INSTALLATION - GENERAL

A. Install products according to manufacturer's instructions and approved submittal drawings.
   1. When manufacturer's instructions deviate from specifications, submit proposed resolution for Contracting Officer's Representative consideration.

3.4 PAINT APPLICATION

A. Apply uniformly painted pavement marking of required colors, length, and width with true, sharp edges and ends on properly cured, prepared, and dried surfaces.

B. Comply with details as indicated on drawings and established control points.

C. Apply paint at wet film thickness of 0.4 mm (0.015 inch). Apply paint in one coat. When directed by Contracting Officer's Representative, apply additional coats at markings showing light spots. Comply with paint manufacturer's maximum drying time requirements to prevent undue softening of asphalt, and pick-up, displacement, or discoloration by tires of traffic.

D. When deficiency in marking drying occurs, discontinue paint operations until cause of slow drying is determined and corrected.

E. Remove and replace marking applied 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.

F. Remove marking by carefully controlled sandblasting, approved grinding equipment, or other approve method to prevent damage on applied surface.

3.5 DETAIL PAVEMENT MARKING APPLICATION

A. Apply Detail Pavement Markings, exclusive of actual traffic lane marking as follows:

1. At crosswalks.
2. At parking bays.

B. Apply International Handicapped Symbol at indicated parking spaces. Color as shown on drawings. Apply paint for symbol using suitable template that will provide pavement marking with true, sharp edges and ends.

C. Install detail pavement markings of colors, widths and lengths, and design pattern at locations indicated on drawings.

3.6 TOLERANCES

A. Length and Width of Lines: Plus or minus 75 mm (3 inches) and plus or minus 3 mm (1/8 inch), respectively, in case of skip markings.

B. Length of intervals exceeding line length tolerance are not acceptable.

3.7 CLEANING

A. Remove excess paint before paint sets.

3.8 PROTECTION

A. Protect pavement markings from traffic and construction operations.

1. Protect newly painted markings from vehicular traffic until paint is dry and track free.
2. Place warning signs at beginning of wet line, and at points well in advance of marking equipment for alerting approaching traffic from both directions.
3. Place small flags or other similarly effective small objects near freshly applied markings at frequent intervals to reduce crossing by traffic.

B. Repair damage.

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SECTION 32 33 00
SITE FURNISHINGS

PART 1 - GENERAL

1.1 GENERAL PROVISIONS

Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 1 – GENERAL REQUIREMENTS, which are hereby made part of this Section of the Specifications.

1.2 DESCRIPTION

A. Work Included: Provide labor, materials and equipment necessary to complete the work of this Section, including but not limited to the following:
   1. Furnish and install the Gravesite Layout Markers at the specified locations.
   2. Furnish and install the Flower-watering stations, including trash receptacles, water spigot, and flower vase container and complete any required work necessary to make the water supply equipment operate using the water supply source indicated.
   3. Furnish and install benches at the specified locations.
   4. Steel Pipe Bollards, Chain and Locks
   5. Flag Sleeves

1.3 RELATED WORK

A. The following items are not included in this Section and will be performed under the designated Sections:
   1. Section 03 30 53: CAST-IN-PLACE-CONCRETE (SHORT FORM)

1.4 SUBMITTALS

A. Submit the following in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES:
   1. General: For each item specified in description of work or Part 2 - Products, provide information 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. Mark items requiring field assembly for erection identification and furnish erection drawings and instruction.
   2. Provide templates and rough-in measurements as required.
   3. Provide samples of full range of colors and finishes available for review and approval, prior to ordering.

1.5 REFERENCE STANDARDS

The publications listed below form a part of this specification and the work shall comply with pertinent standards of the latest editions as specified below or by industry standards unless designated otherwise herein.

A. American Society for Testing and Materials (ASTM):
B221-08 .....Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes, and Tubes

B. American Welding Society (AWS):
D1.2-97..... Structural Welding Code Aluminum

C. National Association of Architectural Metal Manufacturers (NAAMM)

PART 2 - PRODUCTS

2.1 GRAVESITE LAYOUT MARKERS

A. General: Gravesite layout markers for this project shall consist of Gravesite Grid Monuments.
   1. Gravesite grid monuments shall be comprised of a bronze survey marker (monument marker) set into a cast-in-place concrete base.
      a. Materials:
         1) Monument Base: cast-in-place concrete monument base, shall be a minimum of 24.1 MPa (3,500 psi) @ 28 days, reinforced as shown on details; dimensions as shown on Contract Documents.
         2) Monument Marker: Domed-top, 89 mm (3 1/2") diameter, domed aluminum concrete survey marker with integral locator magnet, and flared anchor post for securing to concrete.

B. Text and Cross-hairs: Text of top as shown on Contract Drawings; text all caps with height to be 3/16”. Cross hairs shall be field engraved as shown on the Contract Drawings, aligned with the gravesite grid and field set cross-hairs generally in alignment with the crypts, set based upon Contractor-surveyed location data.

C. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the work include, those manufacturer’s that can demonstrate, during the submittal process, that they have provided these products as part of successful installations matching the specifications and drawings, at a minimum of three State or National Veterans Cemeteries.

2.2 FLOWER WATERING STATIONS: GENERAL

A. Flower watering station materials, finishes and colors fully comply with the specifications and Contract Drawings or be deemed as approved equal.

2.3 TRASH RECEPTACLE

A. Trash receptacles shall completely meet the specifications and Contract Drawings or be approved as an equal. To achieve approval as an equal, submittal of a point by point comparison of the proposed equal product to the specifications and Contract Drawings is required by the Contractor during the submittal process. If the product being submitted for approval as an equal has any features that are different than the specifications and Contract Drawings, they must be identified in the submittal. If the differences result in a product that is deemed less than that specified and shown in the Contract Drawings, then the process for attempting approval as an equal shall NOT be performed during submittals. The product should be submitted with a variance request along with explanation of the differences, why they should be accepted and any cost or project completion factors shall be included.

B. MATERIALS

1. Main body construction shall be 9.53mm x 25.4mm (3/8” x 1”) vertical solid steel bar; 6.35mm x 63.5mm (1/4” x 2-1/2”) horizontal solid steel bands; 9.53mm x 76.2mm (3/8” x 3”) steel support bars; 15.88mm (5/8”) solid steel top ring; leveling feet with a 9.53mm (3/8”) diameter threaded steel shaft. All trash receptacles shall be signed to read “TRASH” as indicated on the details in the Contract Drawings. Sign material, finish, color, font and font size shall be as shown on the Contract Drawings. Mounting of signs shall be as shown on approved Shop Drawings. All joints of steel components shall be fully welded and ground smooth throughout.
2. Unit shall contain one 136 liter (36-gallon) capacity high density plastic inner liner with its weight not to exceed 2.72 kg (6 lbs.). The unit manufacturer shall provide the black plastic inner liners which shall be molded on tooling designed for and owned by the unit manufacturer. They inner liner shall offer maximum capacity and strength with lightweight construction using critical molded ribs, integral handholds, and high strength materials. This style of inner

liner shall minimizes handling difficulty and facilitate easy emptying and storage while affording long service life.

C. REQUIRED OPTIONS

1. Lids: Units shall be shipped with manufacturer’s standard tapered formed lid with formed dome and with self-closing door. The lids shall be made of the manufacturer’s standard high strength plastic material designed to match the selected manufacturer’s standard color. Each lid shall be provided with a stainless steel aircraft cable and attachments to secure the lid to the unit.
2. Color shall match existing.
3. Mounting plate: Standard (1) anchor bolt hole.

D. FINISHES

1. All fabricated metal components are steel shot-blasted, etched, phosphatized, preheated, and electrostatically powder-coated with TGIC polyester powder coatings. Products are fully cleaned and pretreated, preheated and coated while hot to fill crevices and build coating film. Coated parts are then fully cured to coating manufacturer's specifications.
   The thickness of the resulting finish averages 8-10 mils (200-250 microns).
2. Project location has been determined to be a high salt abusive climate. Hot dip galvanizing before powder coating is required. Hot dip galvanizing will provide greater protection in salty climates but yields a slightly less smooth coating finish. All of the fabricated metal components and castings shall be hot dip galvanized.

2.4 FLOWER VASE RECEPTACLE

A. Flower vase receptacles shall completely meet the specifications and Contract Drawings or be approved as an equal. To achieve approval as an equal, submittal of a point by point comparison of the proposed equal product to the specifications and Contract Drawings is required by the Contractor during the submittal process. If the product being submitted for approval as an equal has any features that are different than the specifications and Contract Drawings, they must be identified in the submittal. If the differences result in a product that is deemed less than that specified and shown in the Contract Drawings, then the

process for attempting approval as an equal shall NOT be performed during submittals. The product should be submitted for consideration as part of a variance request along with explanation of the differences, why they should be accepted and any cost or project completion factors shall be included.

B. MATERIALS:

1. Flower vase receptacles shall be regularly produced by the manufacturer for use at VA Cemeteries, with a special light weight hinged lid designed for the VA Cemeteries. Flower vase receptacles shall be of the size indicated on the Contract Drawings, and shall be of the same construction, finish and indicated Victor Stanley color as the trash receptacles, with the following exceptions:
2. All flower vase receptacles shall be signed to read "FLOWER VASES" as indicated on the details in the Contract Drawings.
3. The "Floral Regulations" decal shall be as indicated on the Contract Drawings and be factory applied to the top of the receptacle lid. Decal shall be pressure sensitive vinyl designed for outdoor use. The content of the decal, lettering color and background color of decal shall be as approved during the shop drawing process. The materials for the decal shall be regularly used by the manufacturer for flower vase receptacles at VA National Cemeteries.

2.5 WATER SPIGOT ASSEMBLIES

A. Water spigots, to match existing or approved equal, freeze resistant, with integral shut-off valve.

1. Housing: Cast aluminum, paint finish, color to match Victor Stanley Bronze paint system.
2. Inner Supply: Solid-brass castings, ASTM B61 and B62.
3. Lever Handle: Aluminum-bronze casting, self-closing, operates with maximum 2 kg (5 lbs.) force at maximum 275 kPa (40 psi) inlet water pressure.
4. Outer casings and inner supply line: Manufacturer's standard galvanized steel pipe.
5. Nozzle: Solid brass casting.
6. Outlet: Plain ends, no threads.

B. Water spigots to match existing and as indicated on Drawings, ADA compliant.

2.6 STEEL PIPE BOLLARDS

A. Bollards shall match existing on site as defined here in or approved equal.

B. Bollards material shall be cast aluminum from 100% recycled materials. All castings shall be manufactured true to pattern and component parts, and shall fit together in a satisfactory manner. The castings shall be of uniform pattern and quality, free from blowholes, hard spots, shrinkage, distortion, or other defects.

C. Bollards shall be installed for mounting over 4” schedule 40 pipe (filled with concrete) as identified in contract drawings.

D. Finish: Bollards shall be supplied with a Factory applied Polyester powder coat over degassing primer low gloss texture black.

2.7 BENCHES

A. To establish an acceptable level of quality for the bench materials and fabrication process, the following manufacturing features are listed and required for the purpose of identifying manufacturers that provide work and materials generally complying with these specifications. Their selection for this work shall not relieve them from performing the work as specified.

B. Manufacturing Features: Front welds are to be ground and polished until they form a continuous surface from the top tubular section to each vertical steel slat. Steel seat members shall be gently reverse contoured for maximum comfort. The end sections shall be solid steel bar, welded and ground, structurally adequate for the maximum loads, including an industry standard or greater design load safety factor. End arm rests are required and shall be standard integral welded configuration, with no center arm rests. All fabricated metal components are to be steel shot-blasted, etched, phosphatized, preheated and electrostatically powder-coated with TGIC polyester powder coatings.

C. Benches shall match existing on site, Victor Stanley PRS-10.

D. Benches shall be at the locations, sizes and in the quantities indicated on the Contract drawings.

E. Bench color shall match existing and, as approved during the submittal process.

F. All mounting hardware shall be stainless steel. Use of acorn nuts is required; exposed bolt ends or flat bolt heads are not acceptable.

F. WARRANTY:

1. All benches shall be free from defects in material and/or workmanship for a minimum period of three years, from final acceptance. Warranty shall not apply to damage resulting from accident, alteration, misuse, tampering, negligence or abuse.

PART 3 - EXECUTION

3.1 INSPECTION

A. Prior to installation of any of the work in this section, contractor shall inspect the planned installation locations to ensure that conditions are not significantly different from those indicated on the contract drawings. All materials shall be inspected prior to installation to ensure compliance with the contract documents and to ensure there is no damage. Should conditions be different from those indicated on the contract documents, contractor should immediately notify the Resident Engineer.

3.2 PREPARATION

A. Stake alignment and locations for all site furnishings for review and approval by Resident Engineer. Verify that all elements in this section “fit” within location provided.

B. Install items rigid, plumb and true to lines and levels shown.

C. Assemble (if required) and install items as per manufacturer’s printed instructions, or approved shop drawings, unless otherwise specified or shown.

3.3 INSTALLATION

A. Gravesite Grid Monuments and Markers:

1. All material must be checked upon receipt at the job site prior to installation to check for any damage that may have occurred during transport. Units will be installed in complete accordance with manufacturers' recommendations and as shown the Contract Drawings.
2. Cross-hairs on bronze monuments and marker shall be field inscribed, based upon accurate Contractor-survey: refer to Contract Drawings.

B. Flower Watering Stations:

1. Stake location of flower watering stations and obtain approval from Owner’s Representative prior to forming concrete pad. Install

concrete pad in accordance with SECTION 03 30 53 – CAST-IN-PLACE CONCRETE (SHORT FORM).

2. Anchor trash receptacle and flower vase containers as shown on the Contract Drawings and following the manufacturer's recommended installation instructions. All anchoring hardware shall be stainless steel. Following installation of water spigot, install washed stone for splash area.
3. Install water spigot assemblies according to manufacturer's recommendations, including pipe, isolation valve, fittings, pressure reducing valve and valve boxes. All anchoring hardware shall be stainless steel. Coordinate all work with other trades.

C. Pipe Bollards:

1. Install schedule 40 pipe in concrete footings, 21 MPa (3,000 PSI) @ 28 days, conforming to dimensions as indicated in Contract Drawings and in accordance with SECTION 03 30 53 - CAST-IN-PLACE CONCRETE (SHORT FORM).
2. Backfill and compact excavation around bollard or sleeve in accordance with SECTION 31 20 11 – EARTHWORK (SHORT FORM).
3. Ensure that all bollards are plumb and aligned within a maximum one-fourth inch tolerance of indicated location on plans or by requirement of regulatory requirements, whichever is more stringent.
4. Fill pipe bollard with concrete as shown. Provide rounded smooth, trowel finish top for positive drainage.
5. Clean any excess material from surface of bollard, and apply finish according to specifications.

D. Benches:

1. Benches shall be shipped assembled. Mount benches as recommended by the manufacturer and as specified herein. All mounting hardware shall be stainless steel. Use of acorn nuts is required; exposed bolt ends or flat bolt heads are unacceptable.

3.4 CLEAN UP

A. Clean up area of excess material and debris. Clean above ground portions of all receptacles and other site improvements.

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SECTION 32 31 13
CHAIN LINK FENCES AND GATES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Zinc-coated chain link fence, gates and accessories.

1.2 RELATED REQUIREMENTS

A. Temporary Construction Fence: Section 01 00 00, GENERAL REQUIREMENTS.

B. Concrete Footings: Section 03 30 00, CAST-IN-PLACE CONCRETE.

C. Gate Hardware: Section 08 71 00, DOOR HARDWARE.

D. Fence Color: Section 09 06 00, SCHEDULE FOR FINISHES.

E. Grounding: Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS.

F. Finish Grading: Section 31 20 00, EARTH MOVING, and Section 32 90 00, PLANTING.

1.3 APPLICABLE PUBLICATIONS

A. Comply with references to extent specified in this section.

B. ASTM International (ASTM):

1. A121-13 - Metallic Coated Carbon Steel Barbed Wire.
2. A392-11a - Zinc-Coated Steel Chain-Link Fence Fabric.
3. A817-12 - Metal-Coated Steel Wire for Chain-Link Fence Fabric and Marcelled Tension Wire.
4. F567-14a - Installation of Chain-Link Fence.
5. F626-14 - Fence Fittings.
6. F668-11 - Polyvinyl Chloride (PVC) and other Organic Polymer-Coated Steel Chain-Link Fence Fabric.
7. F900-11 - Industrial and Commercial Swing Gates.
8. F934-96 (R2013) - Standard Colors for Polymer-Coated Chain Link Fence Materials.
9. F1083-16 - Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures.
10. F1184-16 - Industrial and Commercial Horizontal Slide Gates. Federal Specifications (Fed. Spec.):

C. American Welding Society (AWS):

1. D1.2/D1.2M-14 - Structural Welding Code - Aluminum.

D. Federal Specifications (Fed. Spec.):
   1. FF-P-110H - Padlock, Changeable Combination .

1.4 SUBMITTALS

A. Submittal Procedures: Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA AND SAMPLES.

B. Submittal Drawings:
   1. Show size, configuration, and fabrication and installation details.
   2. Coordinate with wall manufacturer for appropriate wall and fence construction details to withstand applicable horizontal and vertical loadings

C. Manufacturer's Literature and Data:
   1. Description of each product.
   2. Installation instructions.
   3. Warranty.

D. Samples:
   1. Polymer Coated Product: 150 mm (5 inch) square each type and color
      a. Submit quantity required to show full color and texture range
   2. Accessories: Full sized, complete assembly.
   3. Approved samples may be incorporated into work.

E. Certificates: Certify products comply with specifications.
   1. Fence alignment.
   2. Zinc-coating.

F. Qualifications: Substantiate qualifications comply with specifications.
   1. Manufacturer .
   2. Installer.

G. Operation and Maintenance Data.
   1. Care instructions for each exposed finish product.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications:
   1. Regularly manufactures specified products.
   2. Manufactured specified products with satisfactory service on five similar installations for minimum five years.

B. Installer Qualifications:
   1. Regularly installs specified products.

2. Installed specified products with satisfactory service on five similar installations for minimum five years.

C. Surveyor Qualifications:

1. Trained and experienced to provide services typically provided by a surveyor as defined by state law in the project location.
2. Registered professional qualified to perform survey services in the project location.

D. Welders and Welding Procedures Qualifications: AWS D1.3/D1.3M.

1.6 DELIVERY

A. Deliver products in manufacturer's original sealed packaging.

B. Mark packaging, legibly. Indicate manufacturer's name or brand, type, color, production run number, and manufacture date.

C. Before installation, return or dispose of products within distorted, damaged, or opened packaging.

1.7 STORAGE AND HANDLING

A. Protect products from damage during handling and construction operations.

1.8 WARRANTY

A. Construction Warranty: FAR clause 52.246-21, "Warranty of Construction."

B. Manufacturer's Warranty: Warrant fence post and fabric against material and manufacturing defects.

1. Warranty Period: Five years.

PART 2 - PRODUCTS

2.1 PRODUCTS - GENERAL

A. Basis of Design: Section 09 06 00, SCHEDULE FOR FINISHES.

B. Provide fences and gates from one manufacturer.

2.2 CHAIN-LINK FENCE

A. Materials: ASTM F1083 and ASTM A392 ferrous metals, zinc-coated.

1. ASTM A934 PVC coating system of color indicated.

B. Chain-Link Fabric: ASTM A392 9 gage wire woven in 50 mm (2 inch) mesh. Knuckle top and bottom selvage. Zinc-coating weight 570 grams/sq. m (2.0 ounces per square foot).

C. Post: ASTM F1083, Grade SK-40A, round, zinc-coated steel. Size and type as indicated on Drawings. 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.

D. Top and Bottom Tension Wires: ASTM A817 and ASTM F626, zinc-coated, with minimum coating same as fence fabric.

2.3 GATES

A. Swing Gates: ASTM F900, type as indicated on Drawings. Zinc-coating weight same as fabric.

1. Gate leaves more than 2400 mm (8 feet) wide, provide intermediate members and diagonal truss rods or tubular members, free from sag or twist.
2. Attach fabric to frame according to manufacturer's instructions, except welding is not be permitted. Arrange latches for padlocking with padlock accessible from both sides regardless of latching arrangement.

B. Chain Link Cantilever Slide Gate: ASTM F 1184, Type II, Class 2.

1. Frames: ASTM B 221, aluminum, alloy and temper 6063-T6, 50 mm (2 inch) square, 1.4 Kgs/M (0.94 lb./ft.) in weight. Weld members together forming rigid one-piece frame integral with top track. Provide 2 truck assemblies each gate leaf.
2. Gate Fabric Assembly: Attach fabric to frame with hook bolts and tension bars at 4 sides, maximum 375 mm (15 inches) on center.
   a. Bracing: 9 mm (3/8”) galvanized steel diagonal adjustable length truss rods, each panel.
   b. Top Track and Rail: Extruded aluminum, enclosed combination one-piece track and rail, 6 mm (3.72 lb./ft.) in weight. Track to withstand reaction load of 900 kg (2,000 lbs.).
   c. Truck assembly: Swivel type, zinc die cast, with 4 sealed lubricant ball bearing rollers, 50 mm (2 inches) in diameter by 14 mm (9/16”) in width, and 2 side rolling wheels. Mount trucks on post brackets with 22 mm (7/8”) diameter ball bolts and 13 mm (1/2”) shank. Truck assembly to withstand same reaction load as track.

d. Gate Hangers, Latches, Brackets, Guide Assemblies, and Stops: Malleable iron or steel, galvanized after fabrication. Provide positive latch with provisions for padlocking.

e. Bottom Guide Wheel Assemblies: 75 mm (3") diameter rubber wheels, and straddling bottom horizontal gate rail, allowing adjustment to maintain gate frame plumb and in proper alignment. Attach one assembly to each guidepost.

f. Gates Posts: ASTM F 1083 galvanized steel, 100 mm (4") OD Schedule 40 pipe, 14 Kgs/M (9.1 lb./ft.) in weight. Provide 1 latch post and 2 support posts for single slide gate.

g. Gate Finish: PVC Vinyl Coated (except track/bottom guide wheel assemblies) 250 to 375 microns (10 to 15 mils) thick thermally fused, ASTM Class-2b, black color.

2.4 HARDWARE

A. General: Manufacturer's standard products, installed complete.

B. Hinges: 180 degree gate hinges per leaf.

C. Stop and Keepers: Arrange latches with plunger-bar for locking to engage center stop. Provide keepers with mechanical device to secure free end of gate when in full open position.

D. Padlocks: As specified under Section 08 71 00, DOOR HARDWARE. Provide padlock chains, securely attached to gate or gate post.

E. Equip gate openings with padlock. Comply with Fed. Spec. FF-P-110H, Type EPC, size 50 mm (2 inch). Securely attached padlock with chain to gate or gate post. Key padlock as directed by RE/COR).

2.5 CONCRETE

A. Concrete: As specified in Section 03 30 00, Cast-in-Place Concrete.

2.6 ACCESSORIES

A. General: ASTM F626, caps, rail and brace ends, wire ties or clips, braces and tension bands, tension bars, truss rods, and miscellaneous accessories.

B. Primers:

C. Barrier Coating: ASTM D1187/D1187M.

D. Welding Materials: AWS D1.2/D1.2M, type to suit application.

E. Galvanizing Repair Paint: MPI No. 18.

F. Touch-Up Paint: Match shop finish.

PART 3 - EXECUTION

3.1 PREPARATION

A. Examine and verify substrate suitability for product installation.

B. Protect existing construction and completed work from damage.

C. Apply barrier coating to aluminum surfaces in contact with dissimilar metals and cementitious materials to minimum 0.7 mm (30 mils) dry film thickness.

3.2 INSTALLATION - CHAIN LINK FENCES AND GATES

A. General: Comply with ASTM F567. Install products according to manufacturer's instructions and approved submittal drawings.

1. When manufacturer's instructions deviate from specifications, submit proposed resolution for RE/COR consideration.

B. Registered Professional Land Surveyor or Registered Civil Engineer specified in Section 01 00 00, GENERAL REQUIREMENTS, will stake out and certify fence alignment meeting requirements as indicated on Drawings.

C. Excavation: Excavate concrete-embedded items of dimensions indicated on Drawings, except in bedrock. When bedrock is encountered before reaching required depth, continue excavation to depth indicated or 450 mm (18 inches) into bedrock, whichever is less, and provide minimum 50 mm (2 inches) larger diameter than outside diameter of post. Clear loose material from post holes. Grade area around finished concrete footings as shown and dispose of excess earth as directed by the RE/COR.

D. Post Setting: Install posts plumb and in alignment. Set post in concrete footings of dimensions indicated on Drawings, except in bedrock. Compact concrete free of voids and finish in slope or dome. Straight runs between braced posts maximum 150 m (500 feet). Install posts in bedrock with non-shrink grout minimum 25 mm (one inch) around each post, free of voids and finish in slope or dome. Cure concrete and grout minimum 72 hours.

E. Post Setting In Structures: Install post in retaining walls, curbs, concrete slabs, or similar construction with galvanized pipe sleeves set into concrete or built into masonry as indicated on Drawings. Set sleeves plumb and 13 mm (1/2 inch) above finished structure. Fill space

solidly between sleeve and post with non-shrinking grout, molten lead, or sulphur, and finish.

F. Post Caps: Snugly fit exposed ends of post with caps. Install caps to accommodate top rail. Install post caps according to manufacturer's instructions and as indicated on Drawings.

G. Supporting Arms: Install supporting arms according to manufacturer's instructions and as indicated on Drawings.

H. Top Rails and Bottom Rails: Install rails before installing chain link fabric. Pass top rails through intermediate post supporting arms or caps as indicated on Drawings. Install expansion couplings (rail sleeves) spaced according to manufacturer's instructions. Install expansion couplings over expansion joints in wall when fence is on top of wall.

I. Tension Wire: Install and pull taut tension wire before installing chain-link fabric.

J. Accessories: Install accessories (posts braces, tension bands, tension bars, truss rods, and miscellaneous accessories), as required and recommended by the manufacturer, for complete fence installation, with fabric taut and attached to posts, rails, and tension wire.

K. Touch up damaged factory finishes.

1. Repair galvanized surfaces with galvanized repair paint.

3.3 FABRIC

A. Pull fabric taut and secure with wire ties or clips to bottom rail and tension wire close to both sides of each post and at intervals maximum 600 mm (24 inches) on centers. Secure fabric to posts using stretcher bars and ties or clips.

3.4 GATES

A. Install gates plumb, level, and secure for full opening without interference. Set keepers, stops and other accessories into concrete as indicated on Drawings and according to manufacturer's instructions. Adjust hardware for smooth operation and lubricate when necessary.

3.5 REPAIR OF GALVANIZED SURFACES

A. Use galvanized repair compound, stick form, or other method, where galvanized surfaces need field or shop repair. Repair surfaces according to manufacturer's directions.

3.6 CLEANING

A. Remove debris, rubbish and excess material from site.

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SECTION 32 31 19
DECORATIVE METAL FENCES AND GATES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Decorative fence system at location indicated on Drawings.
2. Decorative fence gates at location indicated on Drawings.

1.2 RELATED REQUIREMENTS

A. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

B. Section 03 30 53: (SHORT FORM) CAST-IN-PLACE-CONCRETE.

C. Section 04 73 00: NATURAL STONE

D. Footing Excavation: Section 31 20 11: EARTHWORK (SHORT FORM).

1.3 APPLICABLE PUBLICATIONS

A. Comply with references to extent specified in this section.

B. American Institute of Steel Construction (AISC):

1. ASCE/SEI 7-10 Minimum Design Loads for Buildings and Other Structures.

C. ASTM International (ASTM):

1. B221-12 Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles and Tubes.

D. American Welding Society (AWS):

1. D1.2/D1.2M-14 - Structural Welding Code - Aluminum.

E. Master Painters Institute (MPI):

1. No. 18 - Primer, Zinc Rich, Organic.

1.4 SUBMITTAL

A. Submittal Procedures: Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES:

B. Submittal Drawings:

1. Show size, configuration, and fabrication and installation details.

C. Manufacturer's Literature and Data:

1. Description of each product.
   a. Point by point comparison of proposed "Equal" products.
2. Grommets indicating manufacturer recommendation for each application.
3. Installation instructions.

4. Warranty.

D. Samples:
   1. Fence Material: 12 inches long, each type and color.
      a. Submit quantity required to show full color and texture range.
   2. Product: Full sized, complete assembly.
   3. Approved samples may be incorporated into work.

E. Certificates: Certify each product complies with specifications.

F. Qualifications: Substantiate qualifications comply with specifications.
   1. Manufacturer with project experience list.
   2. Fabricator with project experience list.
   3. Installer with project experience list.
   4. Welders and welding procedures.

G. Delegated Design Drawings and Calculations: Signed and sealed by responsible design professional.
   1. Show location and magnitude of loads applied to building structural frame.
   2. Identify deviations from details shown on drawings.

1.5 QUALITY ASSURANCE

A. Manufacturer, Fabricator, Installer Qualifications:
   1. Regularly manufactures, fabricates, and installs specified products.
   2. Manufactured, Fabricated, and Installed specified products with satisfactory service on five similar installations for minimum five years.
      a. Project Experience List: Provide contact names and addresses for completed projects.
      b. Provide photographs, drawings and other documents showing character and quality of completed installation.

B. Installer Qualifications: Product manufacturer.
   1. Regularly installs specified products.
   2. Installed specified products with satisfactory service on five similar installations for minimum five years.
      a. Project Experience List: Provide contact names and addresses for completed projects.
      b. Provide photographs, drawings and other documents showing character and quality of completed installation.

C. Welders and Welding Procedures Qualifications: AWS D1.1/D1.1M. , AWS D1.2/D1.2M, AWS D1.3/D1.3M.

D. Delegated Design: Comply with system performance.

1.6 DELIVERY

A. Deliver products in manufacturer's original sealed packaging.

B. Mark packaging, legibly. Indicate manufacturer's name or brand, type, color, production run number, and manufacture date.

C. Before installation, return or dispose of products within distorted, damaged, or opened packaging.

1.7 STORAGE AND HANDLING

A. Protect products from damage during handling and construction operations.

1.8 WARRANTY

A. Construction Warranty: FAR clause 52.246-21, "Warranty of Construction."

B. Manufacturer's Warranty: Warrant decorative fences against material and manufacturing defects.

1. Warranty Period: five years.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Industrial Decorative aluminum fence system with concealed picket attachment.

2.2 SYSTEM PERFORMANCE

A. Delegated Design: Prepare submittal documents including design calculations and drawings signed and sealed by registered design professional, licensed in state where work is located.

1. Minor deviations to details shown on drawings to accommodate manufacturer’s standard products may be accepted by RE/CORwhen deviations do not affect design concept and specified performance.

B. Design framework complying with specified performance:

1. Load Resistance: ASCE/SEI 7; Design criteria as indicated by manufacturer requirements and building codes when tested according to ASTM E330/E330M.

C. Completed panels capable of supporting 135 kg (300 lb.) load (applied at midspan) without permanent deformation, 25 percent inclination change in grade.

2.3 PRODUCTS - GENERAL

A. Ornamental Fence: The fence system shall be from one manufacturer that has proven industry experience in decorative fence systems with concealed picket attachment systems and conforming to the specifications below:

6' Height Ornamental Fence and Gate: Basis of Design (or approved equal):

a. Manufacturer: **Ameristar Perimeter Security USA, Inc.**
Website: www.ameristarperimeter.com/us/en
Phone: 888-333-3422

b. Model: Montage II, Classic (2-rail) style, Industrial

c. Color: To match existing on cemetery grounds, or as approved by VA/RE on site; Submit Samples for approval.

2. 3' Height Ornamental Fence: Basis of Design (or approved equal):

a. Manufacturer: **Ameristar Perimeter Security USA, Inc.**
Website: www.ameristarperimeter.com/us/en
Phone: 888-333-3422

b. Model: Montage II, Classic (2-rail) style, Industrial

c. Color: To match existing on cemetery grounds, or as approved by VA/RE on site; Submit Samples for approval.

B. Provide decorative fences and gates from one manufacturer and from one production run.

C. DECORATIVE FENCE SYSTEM.

1. Framework: Steel material for fence panels and posts shall conform to the requirements of ASTM A653/A653M, with a minimum yield strength of 45,000 psi (310 MPa) and a minimum zinc (hot-dip galvanized) coating weight of 0.60 oz/ft2 (184 g/m2), Coating Designation G-60

2. Picket Fence: Material for pickets shall be 5/8" square x 18 Ga. tubing. The rails shall be steel channel, 1.25" x 0.92" x 14 Ga. Picket holes in the rail shall be spaced (specify 4.334" o.c. for standard picket space or 3.500" o.c. for 3" air space). Fence posts

shall be a minimum of 2" square x 16 Ga. Gate posts shall meet the minimum requirements of Table 1.

3. Rails: Welded Steel, 44mm (1.75 inch) square, 2.5mm (0.100 inch) thick top, 3mm (0.120 inch) thick sidewalls, 2mm (0.080 inch) thick inner side channel, and holes at 118mm (4.715 inch) o.c. to receive picket; seal with PVC grommets.
4. Retaining Rod: Welded steel, 3mm (0.125 inch).
5. Posts: Welded steel, minimum 62.5mm (2-1/2 inch) square tube, 2mm (0.0800) thick, 2mm (0.080 inch) thick interior reinforcing web.
6. Fasteners: Welded steel.
   a. Rail Attachment Bracket: One-way tamperproof security bolts with inverted "T-nuts".
   b. Post Connections Bracket: Self-drilling hex-head screws.
7. Rings, Post Caps, Finials, and Miscellaneous adornments: Welded Steel.

D. Color: Victor Stanley Bronze (or approved equal from manufacturer's standard color chart).

2.4 FABRICATION

A. Pre-cut pickets, rails, and posts in lengths indicated on Drawings. Pre-punch manufacturer's concealed design system rails to accept pickets.
B. Fully insert rail inner slide into outer channel for internal retaining rod raceway.
C. Insert pickets through grommets into pre-punched holes in rails; align pre-drilled picket holes with internal raceway.
D. Insert retaining rods in rail passing through pre-drilled holes in each picket.

2.5 FINISHES

A. Steel Paint finish:
   1. Powder-Coat or Electro-Deposition Finish: Polyester powder coating, 0.0508 mm (2 mils) minimum thickness. Comply with manufacturer's coating process.
      a. Color: Bronze

2.6 ACCESSORIES

A. Grommets: PVC, High quality.

B. Primer: Manufacturer's spray cans or paint pens.

C. Welding Materials: AWS D1.2/D1.2M, type to suit application.

D. Fasteners: As recommended by manufacturer.

E. Galvanizing Repair Paint: MPI No. 18.

F. Touch-Up Paint: Match shop finish.

PART 3 - EXECUTION

3.1 PREPARATION

A. Examine and verify substrate suitability for product installation.

B. Correct substrate deficiencies.

1. Fill.
2. Grind.
3. Level.

3.2 FENCE INSTALLATION

A. Layout fence symmetrically, as shown on plans.

B. Installation:

1. Install fence according to manufacturer's instructions.
2. Set posts in concrete footers minimum 800mm (32 inches) depth, or as indicated on Drawings, whichever is greater.
3. Earthwork: As specified in Section 31 20 00 EarthWORKS (SHORT FORM).
4. Concrete: As specified in Section 03 30 53 Cast-in-Place Concrete (SHORT FORM).
5. Where required, posts setting by other methods such as grouted core-drilled footers are permissible when shown in engineering analysis of sufficient in strength for intended application.

C. Installation Tolerances:

1. Variation from horizontal and vertical alignment: Maximum 1/2 inches).

D. Touch up damaged factory finishes.

1. Repair galvanized surfaces with galvanized repair paint.
2. Repair painted surfaces with touch up primer.

3.3 FENCE INSTALLATION MAINTENANCE

A. Seal expose surfaces when cutting or drilling rails or posts as follows:

1. Remove metal shavings from cut area.

2. Apply custom finish paint to match fence color. Prime and finish exposed surfaces with manufacturer's spray cans or paint pens.

3.4 GATE INSTALLATION

A. Install gates according to manufacturer's instructions.

B. Set posts plumb, in concrete footings as indicated on Drawings.

3.5 CLEANING

A. Clean exposed surfaces. Remove contaminants and stains.

B. Clean site of excess materials, post-hole excavations, and debris removed or scattered uniformly.

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SECTION 32 84 00
PLANTING IRRIGATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Programmable fully automatic irrigation system with full and complete 100 percent coverage within areas indicated on drawings. Refer to the irrigation project General Direction on plan sheet IR100 for detailed orientation of landscape irrigation, controls booster pump station work to be performed.
2. Sleeving irrigation pipes and wires as indicated, and beneath hardscape surfaces.
3. Manufacturer of primary irrigation equipment, including but not limited to sprinklers, controllers, control valves, weather station and decoders shall be compatible with the existing components on the cemetery.
4. Do not trench through the root balls of plants or trees. Wherever possible, trench outside of the dripline of a plant or tree and in no case shall trenches cross closer than 48-inches from a tree with a trunk diameter of six-inches or larger. Obtain approval by the COR's designated representative of any proposed trench pathway before trenching through areas containing mature trees.
5. Contractor shall probe each vault or burial location and verify a clear trench path before crossing.
6. Should any on-site activity, incident, emergency or disaster result in exposure and/or damage to any remains (i.e. casket or urn), or outer burial container, the contractor shall immediately notify the cemetery director, the COR or the C.O. take immediate steps to protect and render safe any exposed remains and stop any further work that could affect those remains or gravesite until the cemetery director provides the contractor with guidance regarding disposition of the remains and permission to proceed.
7.

B. Project Direction:

1. MEMORIAL WALL AND COLUMBARIUM-SHEET REFERENCE NOTES SCHEDULE CODE 1

a. Located at the northwest area of the cemetery, south of West Third Street and north of McMahon Avenue, this re-design area is currently irrigated by six stations of turf sprinklers controlled by the System A controller. To complement the redesigned area, the landscape irrigation distribution equipment (control valves, decoders, quick couplers, lateral piping and sprinklers) will be amended to accommodate the landscape changes and additional columbaria section. The existing irrigation pressure main and decoder wire path serving the area will be preserved for reuse wherever practical.

b. The selected irrigation installer shall salvage and catalogue existing surface-based irrigation equipment that may be removed for turnover to the owner. Surface-based equipment to be salvaged includes service boxes, control valves, decoders, quick couplers and sprinklers. Obsolete underground irrigation equipment in Sections 36-42 shall be abandoned in-place.

c. The existing System A irrigation sprinkler and control equipment brands will be specified for new installation in this area. There will be approximately six replacement stations of turf sprinkler irrigation plus approximately three new stations of irrigation to water planting beds. Sprinkler models specified will be amended from the originally installed models to include contemporary water-efficient features and will be placed in the design area to compliment the landscape being irrigated.

2. NORTH PRIMARY ENTRY AND MONUMENT-SHEET REFERENCE NOTES SCHEDULE CODE 2

a. Located at the intersection of West Third Avenue and Wisconsin Avenue, the north primary entry to the cemetery is currently irrigated by four stations of turf sprinklers controlled by the System B controller. To complement the redesigned area, the landscape irrigation distribution equipment (control valves, decoders, quick couplers, lateral piping and sprinklers) will be amended. The existing irrigation pressure main and decoder wire path serving the area will be preserved for reuse wherever practical.

b. The selected irrigation installer shall salvage and catalogue existing surface-based irrigation equipment that may be removed for turnover to the owner. Surface-based equipment to be salvaged includes service boxes, control valves, decoders, quick couplers and sprinklers. Obsolete underground irrigation equipment in Sections 36-42 shall be abandoned in-place.

c. The existing System B irrigation sprinkler and control equipment brands will be specified for new installation in this area. There will be approximately four replacement stations of turf sprinkler irrigation plus approximately four new stations of irrigation to water planting beds. Sprinkler models specified will be amended from the originally installed models to include contemporary water-efficient features and will be placed in the design area to compliment the landscape being irrigated.

3. SECTION 46 INGROUND CREMAINS–SHEET REFERENCE NOTES SCHEUDLE CODE 3

a. Located along the south side of Ohio Avenue and west of the intersection of Pennsylvania Avenue, a new area of turf irrigation will cover approximately 1.25 acres (new Section 45) and 2473 inground cremains. The area is adjacent to another section that is controlled by System C controller located on the north side of Ohio Avenue. System C shall be designated to operate the new MP4 area irrigation.

b. The selected irrigation installer shall connect new irrigation pressure piping and System C decoder control wire located in the adjacent Section 46 and install along the south side of Ohio Avenue to Area 4 and proceed to install new landscape irrigation distribution equipment in the area to be irrigated.

c. The existing System C irrigation sprinkler and control equipment brands will be specified for new installation in this area. There shall be approximately six new turf sprinkler irrigation stations installed and added to System C controller. Sprinkler models specified will include contemporary water-efficient features and will be placed in the design area to compliment the landscape being irrigated.

d. System C shall be configured to enable the area to be flow managed. The design shall include a point of connection that shall distribute system C product water to system C control valves. The point of connection shall include a three-inch Rain Bird 300bpes master valve in an appropriately sized service box with toro TW-D-1 single valve decoder, Badger Dynasonics RS-900W polymer model D8-C-020NAAP9SS-BMXX two-inch pulse ultrasonic flow sensor in an appropriately sized service box with toro TW-DAC-FLOW pulse decoder and a quick coupler in an appropriately sized service box downstream of the flow sensor on the system C sub mainline.

4. SECTION 33a TRADITIONAL BURIAL-SHEET REFERENCE NOTES CODE 4

a. Located south of Section 33, at the northcentral intersection of Michigan Avenue and Ohio Avenue, New Section 33A will cover approximately 0.30 acres and include space for 75 single burial plots. The area is currently irrigated by Controller D, a 24-volt conventional wire controller located approximately 300 feet to the northwest of new Section 33a.

b. The new Section 33a area will be redesigned to accommodate the planned use. To complement the redesigned area, the landscape irrigation distribution equipment (control valves, decoders, quick couplers, lateral piping and sprinklers) will be replaced. The existing irrigation pressure main and decoder wire path serving the area will be preserved for reuse wherever practical.

c. The selected irrigation installer shall salvage and catalogue existing surface-based irrigation equipment that may be removed for turnover to the owner. Surface-based equipment to be salvaged includes service boxes, control valves, decoders, quick couplers and sprinklers. Obsolete underground irrigation equipment in new Section 33a shall be abandoned in-place.

d. The existing System D irrigation sprinkler and control equipment brands will be specified for new installation in this area. There will be approximately two replacement stations of turf sprinkler irrigation to serve new Section 33a. Sprinkler models specified will be amended from the originally installed models

to include contemporary water-efficient features and will be placed in the design area to compliment the landscape being irrigated.

e. Should new 24-volt field wire be required to operate the new replacement Section 33a irrigation field controls, the selected irrigation installer shall install the approximately two 24-volt field wires, a common wire and one spare signal wire from the System D controller to the new Section 33a irrigation control valve locations. The selected irrigation installer shall make all terminal connections and tag each new control valve in its respective service box. The selected irrigation installer shall neatly coil the spare wire, identity tag the wire at both ends placing one end in one of the two new control valve surface boxes and the other end placed neatly inside the System D control cabinet.

f. It remains unclear if the existing System D conventional 24-volt field wire is contained in conduit. If so, the selected irrigation installer shall contain new replacement 24-volt field wire in schedule 40pvc conduit sized not less than 1.25-inch, from the System D controller to the new Section 33a irrigation control valve locations including pull boxes every 200 feet. The selected irrigation installer shall repair all damage caused by the installation of new 24-volt irrigation field wire from the System D controller to the new Section 33a irrigation control valve locations.

g. System D shall be configured to enable the area to be flow managed. The design shall include a point of connection that shall distribute system D product water to system D control valves. The point of connection shall include a three-inch Rain Bird 300bpes master valve in an appropriately sized service box with toro TW-D-1 single valve decoder, Badger Dynasonics RS-900W polymer model D8-C-020NAAP9SS-BMXX two-inch pulse ultrasonic flow sensor in an appropriately sized service box with toro TW-DAC-FLOW pulse decoder and a quick coupler in an appropriately sized service box downstream of the flow sensor on the system D sub mainline.

5. NEW SECRTIONS 48-52 PREPLACED CRYPTS–SHEET REFERENCE NOTES SCHEDULE CODE 5

   a. Located along South Gettysburg Avenue and east of Kenesaw Avenue, a new area of irrigation will cover approximately 8.11 acres (new Sections 48-52) and 7,912 preplaced crypts. There shall be approximately 30 new turf sprinkler irrigation stations installed by the selected irrigation installer. A new pedestal-based irrigation controller shall be installed, programmed and placed into service by the selected irrigation installer to operate the new sprinkler irrigation stations serving Area 5. The controller and system shall be designated as System F. System F controller shall be set near and shall derive 115volt power from the electric service serving the nearby irrigation booster pump station.

   b. System F shall be configured to enable the area to be flow managed. The design shall include a point of connection from the nearby existing 10-inch irrigation pipeline to a sub mainline that shall distribute System F product water to System F control valves. The point of connection shall include a four-inch manual isolation valve with blow point for winterization, three-inch Rain Bird 300BPES master valve in an appropriately sized service box with Toro TW-D-1 single valve decoder, three-inch Netafim Octave® model 36OCT03GAL0.1 pulse hydrometer in an appropriately sized service box with Toro TW-DAC-FLOW pulse decoder and a quick coupler in an appropriately sized service box downstream of the flow sensor on the System F sub mainline.

   c. System F shall be configured to enable the area to be flow managed. The design shall include a point of connection from the nearby existing 10-inch irrigation pipeline to a sub mainline that shall distribute system F product water to system F control valves. The point of connection shall include a four-inch manual isolation valve with blow point for winterization, three-inch Rain Bird 300BPES master valve in an appropriately sized service box with toro TW-D-1 single valve decoder, Badger Dynasonics RS-900W polymer model D8-C-020NAAP9SS-BMXX two-inch

pulse ultrasonic flow sensor in an appropriately sized service box with toro TW-DAC-FLOW pulse decoder and a quick coupler in an appropriately sized service box downstream of the flow sensor on the system F sub mainline.

6. SECTIONS 36 THROUGH 42-SHEET REFERENCE NOTES SCHEDULE CODE 6

a. The non-functional and obsolete irrigation equipment in Sections 36-42 is re-designed and specified for re-installation by the selected irrigation installer. The replacement equipment includes pressure pipe, decoder control wire, quick couplers, control valves and decoders in service boxes, lateral piping and sprinkler emission devices. There shall be approximately 45 stations of replacement irrigation. The existing 24-volt conventional wire System E controller shall be replaced with a new decoder-based System E controller consistent with all other controllers (see the Field Controller Intercommunication and Central Control section below).

b. The selected irrigation installer shall salvage and catalogue existing surface-based irrigation equipment for turnover to the owner. Surface-based equipment to be salvaged includes service boxes, control valves, quick couplers and sprinklers. Obsolete underground irrigation equipment in Sections 36-42 shall be abandoned in-place. Existing irrigation corridors in Sections 36-42 shall be re-utilized for re-installation of new replacement irrigation equipment.

c. System E shall be configured to enable the area to be flow managed. The design shall include a point of connection that shall distribute system E product water to system E control valves. The point of connection shall include a three-inch Rain Bird 300bpes master valve in an appropriately sized service box with toro TW-D-1 single valve decoder, Badger Dynasonics RS-900W polymer model D8-C-020NAAP9SS-BMXX two-inch pulse ultrasonic flow sensor in an appropriately sized service box with toro TW-DAC-FLOW pulse decoder and a quick coupler in an appropriately sized service box downstream of the flow sensor on the system E sub mainline.

7. HAWAII PLACE FLOWER WATERING STATIONS–SHEET REFERENCE NOTES SCHEDULE CODE 7
   a. The irrigation supply pipeline along Hawaii Place identified as non-functional shall be replaced from a point of known operation of the existing irrigation supply pipeline near the intersection of Wisconsin Avenue/New Mexico Place and Hawaii Place and shall extend approximately 400 feet southwest along Hawaii Place.
   b. The replacement pipeline and fittings along Hawaii Place shall be of HDPE SDR11 Class 200 BUTT FUSE WELD polyethylene and shall be associated to System B controller pressure pipeline. Trace wire and warning tape shall be installed above the new pipeline feeding the flower watering stations per applicable NCA irrigation pipeline installation guidelines. The existing irrigation pipeline corridor along Hawaii Avenue shall be re-utilized for re-installation of the new replacement equipment.
   c. The selected irrigation installer shall reconnect three (3) flower water stations along Hawaii Place.

8. BOOSTER PUMP STATION-SHEET REFERENCE NOTES SCHEDULE CODE 8
   a. See also Specification Section 32 84 00-A, BOOSTER PUMP STATION AND BACKFLOW and incorporate tasks listed with tasks herein.
   b. The existing irrigation municipal water supply and booster pump station shall continue to be utilized to furnish product water to all landscape irrigation.
   c. Sole Source duty to be performed by a factory authorized WaterTronics Servicing Agent. The selected irrigation installer shall contact Mike Green of WaterTronics, Hartland, WI Mike.Green@watertronics.com, 262-337-3318 to facilitate the dispatching of a factory authorized Watertronics Servicing Agent.
   d. Provide for not less than five business days for a complete review, repair, adjustment, testing, documentation and placement into service of the existing municipal water irrigation booster pump station per the manufacturer programming and features records. Upon verification of proper operation and base

programming, adjust the booster pump station performance as needed to accommodate irrigation expansion.

e. Additionally, the Watertronics Servicing Agent shall Install, program, test, document and place into service:
   1) Watertronics Watervision pump station monitoring hardware and software onto the new irrigation system laptop furnished by the selected irrigation installer.
   2) An optocoupler to enable sharing of the booster pump station flow sensor signal and coordination with the selected irrigation installer who shall hardwire the connection of the flow sensor to new satellite irrigation controller F using PE-39 six pair shielded communication cable, properly grounded per manufacturer recommendations.

f. The selected irrigation installer shall remove and dispose of the existing non-functional wall mount Toro Sentinel® radio-based booster pump performance transmitter. Professionally patch wall penetrations against weather and insect intrusion. The selected irrigation installer shall coordinate with the Watertronics Servicing Agent to hardwire the connection of the flow sensor to new satellite irrigation Controller F using PE-39 six pair shielded telecom cable properly grounded per manufacturer recommendations. The selected irrigation installer shall perform the required Toro DXi irrigation database tasks to fully integrate and activate the Pump Station flow sensor signal into the Toro Sentinel DXi irrigation software database. See Field Controller Intercommunication and Central Control section.

g. The Watertronics Servicing Agent shall furnish not less than three hours of detailed booster pump station hardware, software and Watervision training to the owner’s designated personnel. The training shall include orientation of the pump station components and features, sequence of operation, user interphase, status interpretations and reset procedures, malfunction and alarm condition detection and remedies, user appropriate maintenance and contact information to receive live offsite support and onsite service by a manufacturer-authorized servicing agent. The booster pump station training shall be

clear and understandable and shall include video and audio recording. The recording shall be edited to include searchable chapters/topics and shall be delivered to the owner for future reference as a condition of project closeout.

9. FIELD CONTROLLER INTERCOMMUNICATION AND CENTRAL CONTROL

a. The obsolete irrigation controls, including the central computer, software and field controllers shall be replaced by the selected irrigation installer with new Toro Sentinel DXi cellular internet connected remote central control hardware and software including:

CONTROLLER	SPECIFIED MODEL	TYPE	Cell SERVICE & HDWR WARRANTY	MASTER VALVE	FLOW SENSOR
Controller A (decoder controller)	DXi-PPED-TW-M8C DXi-CELL-KIT DXi-FMW-WMS 5Y-EXT-WARRANTY	Decoder 200 stations	10-year	NONE	Booster pump station shared signal
Controller B (decoder controller)	DXi-PPED-TW-M8C DXi-CELL-KIT DXi-FMW-WMS 5Y-EXT-WARRANTY	Decoder 200 stations	10-year	NONE	Booster pump station shared signal
Controller C (decoder controller)	DXi-PPED-TW-M8C DXi-CELL-KIT DXi-FMW-WMS	Decoder 200 stations	10-year	RAIN BIRD 300BPES with	Badger Dynasonics RS-900W MODEL D8-C-020NAAP9SS-

	5Y-EXT-WARRANTY			TORO TW-D-1 Decoder	BMXX with Toro TW-DAC-FLOW Decoder
Controller D (conventional controller)	DXi-PWM-48-M8C DXi-CELL-KIT DXi-FMW-WMS 5Y-EXT-WARRANTY	24-volt 48 stations	10-year	RAIN BIRD 300BPES with TORO TW-D-1 Decoder	Badger Dynasonics RS-900W MODEL D8-C-020NAAP9SS-BMXX with Toro TW-DAC-FLOW Decoder
Controller E (decoder controller)	DXi-PPED-TW-M8C DXi-CELL-KIT DXi-FMW-WMS 5Y-EXT-WARRANTY	Decoder 200 stations	10-year	RAIN BIRD 300BPES with TORO TW-D-1 Decoder	Badger Dynasonics RS-900W MODEL D8-C-020NAAP9SS-BMXX with Toro TW-DAC-FLOW Decoder
Controller F (decoder controller)	DXi-PPED-TW-M8C DXi-CELL-KIT DXi-FMW-WMS 5Y-EXT-WARRANTY	Decoder 200 stations	10-year	RAIN BIRD 300BPES with TORO TW-D-1 Decoder	Badger Dynasonics RS-900W MODEL D8-C-020NAAP9SS-BMXX with Toro TW-DAC-FLOW Decoder
Rain Can	Texas Instruments TR-525I	Use pulse decoder. Connect to Controller F. Signal	1-year		

		to be relayed to Sentinel software			
Tablet PC	Microsoft Surface Pro 10 for Business Intel Core Ultra 7 165U-5g-32GB RAM 256GB SSD MS Complete 2yr exchange warranty, Thunderbolt 4 Dock, Surface USB-C Travel Hub, Type Cover w/Pen	Or approved equal with Toro WMS software installed via free licensed installation from the Toro Company. Consult authorized Toro Sentinel Servicing Agent.	One-year cell service, two year equipment warranty.		
Tablet PC Bump Case	URBAN ARMOR GEAR UAG Designed for Microsoft Surface Pro 10 Case with Built-in Kickstand Hand & Shoulder	Or approved equal	1-year		

	Strap Pen Holder Compatible with Type Cover Keyboard				

b. The selected irrigation installer shall install and connect all irrigation controllers, test, troubleshoot, place into service and enter basic irrigation station data and irrigation schedules that enable coordinated irrigation operations within 10 hour water windows and without hydraulic overloading.

c. The selected irrigation installer shall contact Chris Nagy of The Toro Company chris.nagy@toro.com 248-342-4570 to arrange for the correct configuration of the new tablet PC and software registration in the owner's name including administrator and lower user credentials, satellite controller communications and communication with the Pump Station Monitor.

d. Jim Laiche of The Toro Company Jim.Laiche@toro.com 248-342-4570 shall arrange for a factory authorized Toro Sentinel Servicing Agent to deliver to designated owner personnel, extensive training furnish support to the selected irrigation installer to deliver to designated owner personnel, extensive irrigation computer central control hardware and software training.

e. Refer to Sheet IR100 for detailed recitation of the Toro Sentinel remote control hardware and software duties and tasks to be performed by the Toro Authorized Servicing Agent.

f. The Toro Sentinel Authorized Servicing Agent shall furnish and document not less than four hours of training to the owner of Toro Sentinel remote control software, basic through advanced, training in the installation and use of the cellular phone/field tablet application, administrator training in the assignment and revocation of subordinate user privileges.

g. The irrigation computer central control hardware and software training shall be clearly and understandably video and audio recorded. The recording shall be edited to include searchable chapters/topics and shall be delivered to the owner for future reference as a condition of project closeout.

1.2 RELATED REQUIREMENTS

A. Maintenance of Existing Utilities: Section 01 00 00, GENERAL REQUIREMENTS.
B. As-Built Drawings: Section 01 00 00, GENERAL REQUIREMENTS.
C. Availability and Use of Utility Services: Section 01 00 00, GENERAL REQUIREMENTS.
D. Submittals: Section 01 33 23 SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
E. Concrete: Section 03 30 53, CAST-IN-PLACE CONCRETE (SHORT FORM).
F. Excavation, Backfill: Section 31 20 00, EARTH MOVING.
G. Electrical supply and connection to irrigation controller and irrigation pumps: Section 26 05 00, COMMON WORK RESULTS FOR ELECTRICAL.
H. Spigot: Section 323000, SITE FURNISHINGS.
I. Water Distribution Systems: Section 33 10 00, WATER UTILITIES.
J. Irrigation Pressure Booster System: Section 32 82 00, IRRIGATION PUMPS.
K. Plants, Turf, and Grasses: Section 32 90 00, PLANTING.

1.3 DEFINITIONS

A. Lateral Piping: Piping located downstream from control valves to sprinklers and specialties. Piping is under pressure during flow.
B. Mainline Piping: Located downstream from point of connection to water distribution piping to, and including, control valves. Piping is under system pressure.
C. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 Volts or for remote-control, signaling power-limited circuits.
D. Hardscape: Site roads, walks, walls, or any other surface improvements for which removal for excavation to perform maintenance or replacement of the irrigation system pipes, or wires will require disturbance of other than landscape materials.
E. RE: Contracting Officer's Representative (COR).
F. COR: Contracting Officer's Technical Representative.

1.4 APPLICABLE PUBLICATIONS

A. Comply with references to the extent specified in this section.

B. American National Standard Institute (ANSI).

1. B40.1-05 - Gauges-Pressure Indicating Dial Type-Elastic Element.

C. American Society of Sanitary Engineers (ASSE).

1. 1013-2005 - Reduced Pressure Principle Backflow Preventers.

D. ASTM International (ASTM).

1. A36/A36M-14 - Carbon Structural Steel.
2. A53/A53M-12 - Pipe, Steel, Black and Hot-Dipped, Zin-Coated, Welded and Seamless.
3. A242/A242M-04 (2009) - High Strength Low-Alloy Structural Steel.
4. A307-14 - Carbon Steel Bolts, Studs, and Threaded Rod 60,000 PSI Tensile Strength.
5. A536-84 (2009) - Ductile Iron Castings.
6. B33-10(2014) - Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes.
7. B61-08 - Steam or Valve Bronze Castings.
8. B62-09 - Composition Bronze or Ounce Metal Castings.
9. B584-14 - Copper Alloy Sand Casting for General Applications.
10. D1785-15 - Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedule 40, 80, and 120.
11. D1238-04c - Standard Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer.
12. D1784-11 - Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
13. D1785-06 - Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, 120.
14. D2241-15 - Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series).
15. D2464-15 - Threaded Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
16. D2466-15 - Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
17. D2564-12 - Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems.

18. D3139-98 (2005) - Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.
19. D3261-15 - Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing.
20. D3350-10 - PE Pipe & Fittings Materials.
21. F477-14 - Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
22. F656-15 - Primers for Use in Solvent Cement Joints of Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings.

E. American Water Works Association (AWWA).
1. C110/A21.10-08 - Ductile-Iron and Gray-Iron Fittings, 3 inch Through 48 inch for Water.
2. C111/A21.11-06 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
3. C115/A21.15-05 - Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges.
4. C151/A21.51-09 - Ductile-Iron Pipe, Centrifugally Cast.
C153/A21.53-00 - Ductile-Iron Compact Fittings for Water Service.
5. C504-15 - Rubber Seated Butterfly Valves.
6. C509-09 - Resilient-Seated Gate Valves for Water Supply Service.
7. C600-10 - Installation of Ductile Iron Water Mains and Their Appurtenances.
8. C900-07 - Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fitting, 100 mm and Through 300mm (4 In. Through 12 inches) for Water Transmission and Distribution.
9. C901-08 - Polyethylene (PE) Pressure Pipe and Tubing, 13 mm (1/2 inches) through 76 mm (3 inches), for Water Service.
10. C905-10 - Polyvinyl Chloride (PVC) Water Transmission Pipe, Nominal Diameters 14 In. Through 48 In. (350 Through 1,200 mm) for Water Transmission and Distribution.

F. Manufacturers Standardization Society (MSS).
1. SP70-2006 - Cast Iron gate Valves, Flanged and Thread Ends.

G. National Electrical Manufacturers Association (NEMA).
1. 250-2008 - Enclosures for Electrical Equipment (1000 Volts Maximum).

1.5 PREINSTALLATION MEETINGS

A. Conduct preinstallation meeting at project site before beginning Work of this section.

1. Required Participants:
   a. COR (COR).
   b. Architect/Engineer.
   c. Inspection and Testing Agency.
   d. Contractor.
   e. Installer.
   f. Manufacturer's field representative.
   g. Other installers responsible for adjacent and intersecting work, including booster pump station renovation and irrigation software update and commissioning.
2. Meeting Agenda: Distribute agenda to participants minimum 3 days before meeting.
   a. Installation schedule.
   b. Installation sequence.
   c. Preparatory work.
   d. Protection before, during, and after installation.
   e. Installation.
   f. Terminations.
   g. Transitions and connections to other work.
   h. Inspecting and testing.
   i. Other items affecting successful completion.
3. Document and distribute meeting minutes to participants to record decisions affecting installation.

1.6 SUBMITTALS

A. Submittal Procedures: Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

B. Submittal Drawings:
   1. Shop Drawings: Show size, configuration, and fabrication and installation details.

A. Furnish qualification data for:
   1. A qualified irrigation Installer(s).
   2. A qualified service provider maintained and/or trained by the manufacturer to render satisfactory service within 24 hours of service request notification.

B. Make submittals and provide number of copies per Specifications Section 01 33 23. Unless otherwise noted, provide four (4) paper copies and one

electronic copy in PDF format of irrigation information in separate identical 3-ring binders with tables of contents and index sheets. Provide sections that are indexed and labeled for controls, remote central control, flow sensors, low voltage remote control valves, decoders, weather station or service, emission devices, pipe and fittings, wire and wire connectors, ID tags, shop drawings, full-range sample paint colors for the municipal water booster pump station enclosure, and all other irrigation equipment shown or described on the drawings and within these specifications. Highlight items being supplied in or upon the furnished catalog cut sheets. Sequentially number each page of the submittal for ease in referencing during submittal review. Pages within a letter or number identified Tab section may be numbered sequentially as long as the process is consistent and provide unique page identification for each page of the submittal. Submittal package shall be complete prior to being reviewed by the COR. Incomplete submittals will be returned without review.

C. Materials List: Include all materials and products that are part of the irrigation system including, but not limited to pipe, fittings, low voltage remote control valves, mainline components, and electrical components. Quantities of materials need not be included.

D. Manufacturers' Data: Submit manufacturers' catalog cuts and specifications for equipment to be included in the project work. For rotary emission devices include Center for Irrigation Technology Space Pro Single Leg Profile showing the Distribution Uniformity and Scheduling Coefficient for the nozzles being used at the specified spacing.

E. Shop Drawings: Complete detailed layout shop drawings covering design of system showing pipe sizes and lengths; fittings, locations, types and sizes of emission devices; valves and decoders; complete wiring diagram showing routes and wire sizes; wiring details and source of current and connections to existing services. Do not start work before final shop drawing approval.

F. Testing: Submit a proof-of-testing report following completion of each test listed in these specifications. Unless otherwise noted, include name of test, date of test, name of the individual completing the test, name of the company completing the test and a summary of the test

results. If system fails test, document all retests until system passes test.

G. Maintenance and Operation Instructions: Submit information listed in these specifications.

H. Record Drawings: Submit information listed in these specifications.

I. Include a professionally-prepared and presentable station/zone chart and controller timing schedule showing each irrigation flow zone, station/zone and its corresponding control valve and corresponding decoder information and show the time settings, expected flow and relevant remote central control programming information for each zone/station and for each associated sensor or secondary control element including but not limited to flow sensing, rain sensing and connected electric master valve(s).

J. Name and address of a permanent service organization maintained or trained by the manufacturers that shall as a result of determined warranty work, or after warranty period following execution of a service contract for this facility, render satisfactory service within 24 hours of receipt of notification that service is requested.

K. Reproducible "as-built" drawings. Submit information for approval by the COR indicating the “as-built” conditions for the irrigation system to the COR as electronic DWG files of the original bid drawings posted with all addenda, clarifications, and approved modifications.

L. After electronic "as-built" drawing(s) have been approved, the selected irrigation installer shall utilize as-built drawings to prepare a professionally prepared and presentable overall irrigation system drawing proximate to the irrigation central control computer or a location designated by the COR.

M. Controller Chart(s) - Waterproof:

1. Prepare a map diagram showing location of all valves, lateral lines, and route of the control wires. Identify all valves as to size, station, number and type of irrigation. "As-built" drawings shall be submitted and approved before charts are prepared.
2. Provide one controller chart showing the area covered by controller for placement at or inside each automatic controller at the maximum size controller door will allow. Chart shall be one or more reduced drawing sheets of the actual "as-built" system in sections that

result in easy to read or decipher format. If controller sequence is not legible when the drawing is reduced to door size, the drawing shall be enlarged to a size that is readable and placed folded, in a sealed plastic container at or inside the controller door.

3. Chart shall be a print with a different color used to show area of coverage for each station. Charts shall be completed and approved by COR prior to final inspection of the irrigation system.

1.6 SUBSTITUTIONS

A. Unless otherwise noted, use specified equipment. COR shall approve all equipment prior to construction.

B. No equipment substitutions shall be used unless expressly approved in writing by COR. Any requested substitutions shall be submitted in writing by the requesting party with all required associated data in justification of the requested change, not less than close of business the 21st day prior to the date of bid opening. Any requested substitutions shall be furnished in writing with associated product cut sheets and rationale for the requested change including cost changes to the owner for use of such proposed equipment and improvements to irrigation system performance that shall be realized by implementation of any proposed changes. Changes and associated design costs to accommodate alternative equipment are the responsibility of the proposing submitter. "As-Built" information shall show the final sizes, types and models installed.

C. Pipe sizes referenced in the construction documents are minimum sizes and may be increased at the discretion of the selected irrigation installer.

1.7 PERFORMANCE REQUIREMENTS

A. Minimum Working Pressures: The landscape irrigation pump station settings is programmed to maintain system pressure of not less than 90 psi dynamic (or not less than 78 psi pressure boost from municipal water static pressure) while not less than two stations of similar water use volume are in simultaneous operation including stations at or near the furthest uphill interval from the irrigation system point of connection. In no case shall pump station programming be set to exceed 110 psig. Station-specific pressure regulation shall be included or set by the selected irrigation installer to the optimum or manufacturer

recommended operating pressure of the associated irrigation emission devices. The following are minimum pressure requirements for piping, valves, and appurtenance unless otherwise indicated.

1. Irrigation Mainline Piping: 1380 kPa (200 psig).
2. Lateral Piping: 1035 kPa (150 psig).

1.7 QUALITY ASSURANCE

A. Irrigation Contractor/Installer:

1. The selected irrigation system installer shall furnish proof of use of persons directly employed by the Contractor who have successful experience in the construction and programming of not less than five (5) landscape irrigation systems having large diameter gasketed pipe (4-inch and larger), computer centralized control systems with hardwired or radio or Wi-Fi or cellular-based communication, flow sensing equipment and software, landscape irrigation weather stations or weather data services, electrically operated remote control valves and other control or monitoring equipment using decoder technology, large radius rotary sprinkler emission devices (minimum 1-inch inlet with swing joint), medium radius rotary sprinkler emission devices, fixed spray sprinkler emission devices, features including pressure-regulation, pressure-compensation, check-valve included; bubbler-style irrigation, spray-style irrigation, irrigation on slopes and pre-fabricated municipal water booster pump stations with variable speed controls.
2. The selected irrigation installer shall be an employer of on-site field workers that shall include not less than one Certified Irrigation Contractor in good standing as accredited by The Irrigation Association, Falls Church, VA and who shall be currently employed by the selected irrigation installer and who shall personally conduct or oversee the conduct of all work upon this project. The selected irrigation installer shall be licensed or registered where required in the State of Nevada as a professional landscape irrigation installer and whose license or registration includes professional possession of a Backflow prevention assembly tester and/or installer and/or repairer accreditation(s) in good standing.

3. Experience List: Provide contact names and addresses for completed projects.

B. Equipment Manufacturer:
1. Manufacturer regularly and presently manufactures the items submitted as among its principal products.
2. There is a permanent service organization, maintained or trained by the manufacturer which shall provide satisfactory service within 24 hours of receipt of notification that service is requested.
3. Installer or supplier of a service has technical qualifications, experience, and trained personnel and facilities to perform the specified work.

C. Products Criteria:
1. Multiple Units: When two or more units of the same type or class of materials or equipment are required, the units shall be products of one manufacturer.
2. Assembled Units: Manufacturers of equipment assemblies, which use components made by others, assume complete responsibility for the final unit assembled.
   a. All components of an assembled unit need not be products of the same manufacturer but component parts which are alike shall be the product of a single manufacturer.
   b. Components shall be compatible and as a total assembled unit for the intended use.
3. Nameplates: Nameplate bearing manufacturer's name or identification 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.

D. System Requirements:
1. Full (sprinkler-to-sprinkler when broadcast irrigated) and complete coverage of the irrigated areas is required except where indicated otherwise on the plans. The actual and the spirit of intent of this project outcome is clearly indicated upon the drawing sheets and within the specification documents. The selected irrigation installer shall, at no additional cost to the Government, make necessary adjustments to component locations as required to achieve

the intended outcome of the design and specifications including coverage of irrigated areas.

2. Layout work as closely as possible to drawings. Drawings are diagrammatic to the extent that swing joints, offsets and all fittings are not shown. "Diagrammatic" also refers to the location of the pipelines, valves and other irrigation infrastructure which may have been presented for clarity of the drawings. Lines in tight areas shall be common trenched wherever possible. Irrigation emission devices along roadways shall be placed between 3 cm (1 inch) to 8 cm (3 inches) from back of curb, unless otherwise specified.
3. Locations of remote-control valves is diagrammatic. Remote control valves shall be grouped wherever possible and aligned at a set dimension back of curb along roads. Where the exact location for the valve(s) has not been set or there are any conflicts, the location shall be coordinated with the COR before installation.
4. Irrigation pipelines, communication wire, control wire and power wire shall run at boundaries of graves, thru designated utility lanes or beside roadways such that any gravesite may be opened in the future without disruption of the irrigation system.
5. Irrigation lines, communication wire, control wire and power wire shall be run in trenches as indicated on the drawings or as typical for industry standards or best practices, if not indicated.
6. Connect the irrigation system to the potable water mainline piping furnished and at the approximate location shown upon the drawings.
7. Unless noted otherwise, all irrigation lines, communication wire, control wire and power wire shall be contained in conduit. Low voltage wire shall be contained in conduit separate from high voltage wire. Where installed beneath any site hardscape materials conduit with wire shall be placed in sleeves and separate from pressure pipe (in sleeves) and separate from high voltage conduit with wire (in sleeves).

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70 by a qualified testing agency and marked for intended location and application.

F. Program all remote central control software and hardware to accommodate the installed irrigation equipment and/or its individual components designated for interphase with or by the completed landscape irrigation system.

G. Follow manufacturer's instructions for all installation.

H. Manufacturer of the municipal water booster pump station and the remote central control hardware, communication module(s)and software shall certify control system is complete, including all related components, and completely operational. Furnish certificate(s) of proof of manufacturer certification to COR as a condition of system acceptance.

1.8 WARRANTY

A. The purpose of the warranty is to ensure that the Government receives irrigation materials of new and prime quality, installed and maintained in a thorough and careful manner.

B. Warranty irrigation materials, equipment, and workmanship against defects for a period of one year from Final Acceptance by COR. Fill and repair depressions. Restore landscape, utilities, structures or site features damaged by the settlement of irrigation trenches or excavations. Repair damage to the premises caused by construction or defective items. Make repairs within 72 hours of notification from COR.

C. Replace damaged items with identical materials and methods per contract documents or applicable codes. Make replacements at no additional cost to the contract price.

D. Warranty applies to originally installed materials and equipment and replacements made during the Warranty period.

E. Construction Warranty: FAR clause 52.246-21, "Warranty of Construction."

F. Manufacturer's Warranty: Warrant irrigation materials against material and manufacturing defects.

1. Warranty Period: One year.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. System Requirements:

1. Refer to project narrative and plansheets.

2. Full (head-to-head plus 10-percent) and complete coverage of irrigated areas. Adjust head locations as required to achieve full coverage of irrigated areas.
3. Layout work as shown on the drawings. Drawings are diagrammatic to the extent that swing joints, offsets and fittings are not shown. Diagrammatic also refers to the location of the pipelines and valves, which may have been adjusted for clarity of Drawings. Lines are to be common trenched wherever possible. Place irrigation heads shown along roadways between 10 cm (4 inches) and x 15cm (6 inches) from edge of pavement, unless otherwise specified.
4. Locations of remote-control valves is schematic. Group remote control valves wherever possible and align at set dimension back of curb along roads or at the perimeter of burial sections. Locate remote control valves individually or in groups of two. Where exact location for valves has not been set, or there are conflicts, coordinate location with COR before installation.
5. Run irrigation lines and control wire at boundaries of graves, thru designated utility lanes or beside roadways.
6. Run irrigation lines, control wires and power wires in trenches as indicated on Drawings or as typical for industry standards, when not indicated.
7. Connect new system to existing mains. Disconnect and abandon existing irrigation system where indicated. Refer to project narrative and plansheets. Connect to new mains where indicated. Refer to project narrative and plansheets.
8. Unless noted otherwise, run irrigation lines, power wires and control wires in sleeves or conduit where installed beneath any site hardscape materials.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70 by a qualified testing agency, and marked for intended location and application. Run irrigation lines, cables, control wires, and high voltage conduits in separate sleeves.
C. Completely program central controller and satellite controllers to demonstrate full and reliable communication, operation and functionality of features. Refer to project narrative and plansheets.
D. Follow manufacturer instructions for installation.

E. Submit manufacturer's written certification that Control System is complete, including related components, and fully operational to COR.

2.2 MATERIALS

A. Use new materials without flaws or defects.

2.3 PRODUCTS - GENERAL

A. Provide each product from one manufacturer.

2.4 PIPE AND FITTINGS

A. Irrigation Main Pipe:
   1. Ductile Iron Pipe: AWWA C151, minimum working pressure 1025 kPa (150 psi), cement lined, exterior bituminous coated.
   2. Polyvinyl Chloride (PVC) Pressure Pipe: ASTM D1784, PVC 1120, SDR 21 minimum working pressure 1375 kPa (200 psi), gasketing conforming to ASTM F477. Pipe outside diameters, comply with AWWA C151 cast iron pressure pipe to accommodate cast iron fittings.
   3. Polyvinyl Chloride (PVC) Pressure Pipe: ASTM D1784, Class 200, SDR-21, rated at 1375 kPa (200 psi), gasketing conforming to ASTM F477.
   4. High Density Polyethylene (HDPE) pipes: AWWA C901. Pipe and fittings PE 3408 HDPE resin compound meeting cell classification 345434C, ASTM D3350; and Type lll, Class C, Category 5, Grade P34, ASTM D1238.
   5. Mainline Pipe Within Sleeves: Provide restrained casing spacers for gasketed joints.

B. Irrigation Main Fittings:
   1. Ductile Iron Pipe Fittings:
      a. Mechanical Joint Fittings: ANSI A 21.10 (AWWA C110) and ANSI A21.11 (AWWA C111).
      b. Flanged Fittings: ANSI/AWWA C110 and ANSI B16.1 850 kPa(125 lbs.).
      c. Push-On Joints: ASTM D3139 for Laboratory Qualifying Tests. Use push-on rubber-gasketed ductile iron fittings.
      d. Gaskets: ASTM F477, rubber.
      e. Joint Restraints: Class 350 Ductile Iron per ASTM A536.
   2. PVC Pipes Fittings:

a. Mechanical Joint Fittings: ANSI A 21.10 (AWWA C110) and ANSI A21.11 (AWWA C111).
b. Flanged Fittings: ANSI/AWWA C110 and ANSI B16.1 850 kPa(125 lbs.).
c. Gaskets: ASTM F477, rubber.
d. Joint Restraints: Class 350 Ductile Iron per ASTM A536.

3. High Density Polyethylene (HDPE)Fittings:
   a. Butt, Heat-Fusion Fittings: ASTM D3261.

C. Lateral Pipe:
1. PVC Pipe: ASTM D1784 Rigid, Unplasticized (PVC) 1120, Class 12454-A or 12454-B, with integral bell end suitable for solvent welding.
2. Pressure Rated PVC Pipe: ASTM D2241, Class 200, SDR-21, 1375 kPa(200 psi) pressure rating.
3. PVC Pipe: ASTM D2466 and D1784.
4. Threaded Pipe: ASTM D1785, PVC 1120, Schedule 80 threaded connections, risers and swing joints.

D. Lateral Fittings:
1. Irrigation Laterals: ASTM D2466 PVC, Schedule 40, solvent welded socket type.
2. Threaded Pipe: ASTM D2464, PVC, Schedule 80.
3. Swing Joints: Manufacturer's standard with elastomeric seal, allows 360 degree rotation, minimum 1375 kPa (200 psig) working pressure.

E. Joining Materials:
1. Irrigation Mains: Rubber gaskets, AWWA C111.
2. Irrigation Laterals: ASTM D2466 and D1784 PVC Schedule 40, Type 1, solvent weld fittings.
   a. Primer: ASTM F656.
   b. Solvent Cement: ASTM D2564.
3. Threaded pipes: Teflon-type tape or Teflon based paste pipe joint sealant. Use non-hardening, non-toxic pipe joint sealant for water-carrying pipes on metal threaded connections.

2.5 SLEEVES

A. Sleeves: ASTM D1784 Rigid, Unplasticized (PVC) 1120, Class 12454-A or 12454-B, with integral bell end.
1. Pipes Larger than 300 mm (12 inch): AWWA C905, DR-18 rated at 1615 kPa (235 psi).

2. Pipes Smaller than 300 mm (12 inch): ASTM D2241, Class 200, SDR-21 or AWWA C905, DR-25 rated at 1375 kPa (200 psi).

B. Size: As indicated on Drawings or twice nominal pipe diameter when not shown. Wiring bundle area not exceeding 40 percent of sleeve cross sectional area, according to NEC recommendations.

C. Restrained Casing Spacers: ASTM A536, Grade 65-45-12 high strength ductile iron.
1. Restraining Rods: ASTM A242 and ANSI/AWWA C111/A21.11, high strength low alloy material.
2. Runners: ASTM D-1894, ultra-high molecular weight polymer, 175-350 Joules/cm (600-1200 ft-lbs./in.) tensile impact and coefficient of friction 0.14-0.17.

2.6 RESTRAINTS

A. Self-Restrained Fittings: Meeting ASTM A536.
1. Provide on rubber gasketed pipe pipes 75 mm (3 inch) diameter or larger.
2. Size: As indicated on Drawings.

B. Thrust Blocks: Concrete, 20 MPa (3,000 psi), 50 micrometers (2-mil) plastic and 12.7 mm (No. 4) rebar wrapped or painted with asphalt tar based mastic coating.
1. Provide on pipe fittings greater than or equal to 75 mm (3 inch) diameter or rubber gasketed pipe.
2. Size: As indicated on Drawings.

C. Joint Restraint Harness: Provide joint restraint harness where joints not positively restrained by flanged fittings, threaded fittings, or retainer glands and thrust blocks.
1. Provide in ductile iron fittings 76 mm (3 inch) and larger, transition fittings between metal and PVC pipe, where thrust block is not allowed, or where extra support is required to retain fitting or joint.
2. Provide joint restraint harness or retainer glands with preset torque shearing set screws on mainline gate valve assemblies 76 mm (3 inch) and larger.
3. Provide stainless steel bolts, nuts, retaining clamps, all-thread, or other joint restraint harness materials retainer, ASTM A536, and

high strength, low alloy steel bolts and connecting hardware, ANSI/AWWA C111/A21.11.

2.7 MAINLINE COMPONENTS

A. Valves (Except Remote Control Valves):

1. Underground Shut-Off Valves:
   a. Gate Valves 50 mm (2 inches) and Larger: AWWA C509, iron body, bronze mounted, double disc with parallel or inclined seats, non-rising stem turning clockwise to close, 1375 kPa (200 psi) minimum working pressure.
   b. Butterfly Valves 80 mm (3 inches) and Larger: AWWA C504, cast iron body with stainless steel shaft, ductile iron valve disc and resilient rubber coated, 1375 kPa (200psi) minimum pressure.
2. Check Valves: Swing.
   a. Smaller than 100 mm (4 inches): ASTM B61 or B62, bronze body and bonnet, 850 kPa (125 pound) WSP.
   b. Larger than 100 mm (4 inches): Iron body, bronze trim, vertical or horizontal installation, flange connection, 1375 kPa (200 pound) WOG.
3. Bronze Ball Valve with Stainless Steel Handle:
   a. Maximum Pressure: 4140 kPa (600 psi) CWP.
   b. Federal Specification: WW-V-35C.
      1) Type II.
      2) Composition BZ.
      3) Style 3.
4. Master Control Valve:
   a. Rain Bird 300BPES or approved equal, System F. Refer to project narrative and plansheets.
   b. Body and Cover: Polyester-coated.
   c. Spring: Stainless steel.
   d. Diaphragm: Nylon fabric reinforced with rugged insert.
   e. Bolts, Studs, and Nuts: Zinc-cobalt coated steel.
   f. Tubing and Fitting Control Accessories: Reinforced plastic and brass.
   g. Solenoid: 24V AC.
   h. Operation: Normally closed with automatic control globe valve with contamination-proof, self-flushing filter screen.

i. .Pressure Rating: 16 bar (232 psig).

j. Operating Pressure Range: 0.5 to 16 bar (7 to 232 psig).

5. Quick Coupling Valve Assembly:

a. Description: Brass construction, 1 inch nominal size, operating pressure 35-860 kPa (5-125 psi), locking rubber or vinyl cover.

b. Swing Joints: Joint with offsets for flexible joints.

c. Quick Coupler Anchor: Bolt on anchor type.

d. Valve Box: Acrylonitrile Butadiene Styrene (ABS) Plastic, 10 inch round valve box minimum, with green lid. Refer to plansheet details for valve box sizing guidance.

e. Filter Fabric: Spunbonded polyester 3.5 oz per sq. yard (118.7 grams per sq. m.) landscape fabric.

B. Flower Water Station Spigot Connection Assembly: As indicated on Drawings. Refer to project narrative and plansheets.

1. Flower Watering Station Spigot: As specified in Section 32 30 00, SITE FURNISHINGS.

2. Curb Stop Valve: ASTM B62, brass body, 2070 kPa (300 psi) minimum working pressure, female threaded connections, with stop and waste feature.

3. Inline pressure regulator: Low lead cast body confirming to ASTM B584, 2750 kPa (400 psi) maximum inlet pressure, with 105 to 515 kPa (15 to 75 psi) adjustable outlet pressure.

4. Copper Pipe: ASTM B88, type “M” soft tubing, wrought copper or cast bronze fittings, soldered, flared mechanical, or threaded joint.

a. Solder: 95-percent tin and 5-percent antimony.

5. Valve Box: Concrete curb valve box, cast iron lid, 200 mm ID x 300mm (8 inch ID by 12 inch), face anchored in concrete.

C. Valve Box:

1. Gate and Butterfly Valve:

a. Materials:

1) Precast Concrete: Precast concrete, 30 MPa (4000 psi) compressive strength.

2) HDPE: Structural foam Type A, Class III, tan in color when in concrete or street, green in color when in softscape, minimum 475 mm (19 inches) long by 350 mm (14 inches) wide, 305 mm (12 inches) deep, key-lockable hinged lid.

b. Cover: Mark box cover, differentiate between lawn irrigation system and domestic water supply system, set flush on finished grade.

c. Operations:

1) T-Handle Socket Wrench Operation: Underground valves 50 mm (2 inch) nut.

2) Handwheels: MSS SP70 Above ground and in pits.

3) Enclosed Gear Drive Operators: Butterfly valves 150 mm (6 inches) and above.

d. Accommodate end valves with type of pipe being installed. Provide mechanical joint ends with self-restrained joints on buried irrigation main valves.

2. Remote Control Valves:

a. Materials:

1) Precast Concrete: Precast concrete, 30 MPa (4000 psi) compressive strength for pavement areas.

2) Polymer Concrete: Fiberglass reinforced plastic with Plastic resin binder where vehicular traffic is expected. Lid to have minimum loading capacity of 3630 kg (8,000 lbs.) per 254 mm by 254 mm (10 inch by 10 inch) square.

3) HDPE: Structural foam, Type A, Class III.

a) Color: Green in softscape, Tan in concrete or roads.

b) Size: Minimum 475 mm (19 inches) long by 350 mm (14 inches) deep with key-lockable hinged lid.

b. After installation, hot brand valve box lid 75 mm (3 inch) high, 1 mm (3/16 inch) deep with permanent white epoxy paint, designating controller and circuit numbers. Place numbers in center of valve cover facing nearest main or service road.

3. Drip zone Lateral Flush Cap Assembly: HDPE round reinforced plastic valve box and lid, minimum 14.5 cm (5-3/4 inches) diameter top opening with lift-hole. Access box height, 23cm (9-1/16 inches) minimum.

2.8 SPRINKLER IRRIGATION COMPONENTS

A. Remote Control Valve Assembly:

1. Remote Control Valve: Rain Bird PEB-series, Rain Bird PGA-series as shown on drawings. Globe type, heavy construction, manual shut-off

and flow control adjustment for manual operation, minimum 1025 kPa (150 psi) working pressure; higher working pressure for systems that operates with working pressures above 140 psi.

a. Install underground, operated by a 24-volt AC electric solenoid with Toro TW-D-1 single valve decoder Provide unions on both sides of valve. Provide assembly over gravel sump as indicated on Drawings.

b. Provide valves with scrubber features.

c. Valves Serviceability: From top without removing valve body from system. Provide 10 750 mm (30 inch) long adjustment keys. Operate valves maximum 50 kPa (7 psi) pressure loss at manufacturers maximum recommended flow rate.

2. PVC Union: Schedule 80 threaded union with O-ring seal.

3. Bronze Ball Valve with Stainless Steel Handle:

a. Maximum Pressure: 4140 kPa (600 psi) CWP.

b. Federal Specification: WW-V-35C.

1) Type II.

2) Composition BZ.

3) Style 3.

4. Filter Fabric: Spunbond polyester 3.5 oz. per square yard landscape fabric.

5. Wire connectors: Direct burial 600 V maximum voltage. Wire combination size: (2 to 5) 18 AWG to (2) 12 AWG. UL approved. 3M DBY or DBR.

6. Identification Tags: Christy I.D. tags. Standard Yellow, one sided. Tag Size: 57 mm by 69 mm (2.25 inch by 2.7 inch), hot stamped black letters on, yellow background. Hot stamp component number code as indicated.

B. Popup Gear Driven Rotary Sprinkler Assembly:

1. Radius, arc and nozzle size as shown on drawings

2. Rain Bird 8005-series

3. Rain Bird 5006-series

4. Rain Bird 3504-series

C. Spray Sprinkers: High impact plastic or brass nozzle with adjusting screw to regulate radius and flow. Heavy-duty stainless steel

retracting spring and ratcheting system for pattern alignment. Soft elastomer pressure-activated co-molded wiper seal; as shown on drawings

1. Rain Bird 1800-series
2. Body: Heavy duty, ultraviolet resistant plastic sprinkler body, stem, nozzle, with non-clogging filter and pressure compensating feature (PRS).
3. Head Type: Pop-up, matched precipitation rate nozzle as shown on drawings.
4. Flow Rate: As indicated on Drawings.

D. Low Voltage Control Valve Wire:
   1. Wire: Toro TW-CAB-14 decoder cable.
      a. Solid copper wire, UL LLC approved for direct burial.
      b. Size: According to manufacturer's instructions, minimum AWG 14.
   2. Splicing Materials: Toro TW-SPLICE-14AWG water-tight wire splice

E. Warning Tape: Polyethylene film warning tape, 0.1 mm (4 mils) thick, 75 mm (3 inches) wide, non-detectable, imprinted with “CAUTION BURIED IRRIGATION WATER LINE BELOW”, colored as follows:
   1. Blue with Black Letters: Potable water.
   2. Purple with Black Letters: Reclaimed or untreated well water.

F. Tracer Wires: Plastic-coated copper tracer wire, 1.8 mm (14 gage), green, Type TW. Install with non-metallic irrigation main lines.

G. Decoders for Two-Wire Operation:
   1. Decoder: Toro TW-D-1 single valve decoder. Solid-state design, housed in a watertight molded plastic housing.
      a. Decoder leads: 18-gauge, insulated, stranded copper.
      b. Colors as indicated.
      c. Wire Leads: Minimum of 305 mm (12 inches) long.
      d. Wire Connections: Toro TW-SPLICE-14AWG Watertight electrical connections suitable for the wire type being connected.
   2. Decoders: Mounted underground in separate 305 mm by 457 mm (12 inch by 18 inch) valve boxes, or with remote control valves. Fastened to inside of valve boxes with stainless steel self-tapping screws. Brand valve boxes containing decoders “SP” in 50 mm (2 inch) high letters, painted with permanent white epoxy paint. Place boxes on 457 mm (18 inch) deep bed of pea gravel.
      a. 26VAC input service provided by the two-wire communication path.

3. Include Toro TW-LA-1 line surge protection per manufacturer recommendations.
4. Provide manufacturer's decoder programming unit.
   a. Field Decoders: TW-D-1 (One station decoder, includes dry splices)
5. Decoder Cable Fuse Device: Paige Electric DCFD 2-way and DCFD3 3-way electrical isolation devices; or approved equal.
6. Lightning Arrestor: Toro TW-LA-1, or approved equal.
7. Grounding Rods: 16 mm by 2.5 meters (5/8 inch diameter by 8-foot long) copper ground rod, copper clamp and #6 bare copper wire; UL-approved; sized per manufacturer's instructions.

H. Two-Wire Decoder Cable: Toro TW-CAB-14AWG
1. Two-conductor control cable design consisting of tin coated copper conductors, insulated with PVC and having a high density polyethylene direct burial jacket. Conductors are listed as Type UF by UL or ETL or CSA.
2. Conductor: Minimum conductor size 14 AWG; soft annealed tin coated solid copper conforming to ASTM B33.
3. Insulation: Polyvinyl Chloride conforming to UL Standard 493 for TYPE UF rated 60°C.
4. Cable Assembly: Insulated conductors are laid parallel.
5. Outer Jacket: Pressure Extruded High Density PE conforming to ICEA S-61-402, and NEMA WC5 Jacket Thickness 1.2 mm (3/64 inch) minimum jacket material to completely fill interstices between the two insulated conductors.
6. Color Coding: Black, Red.
7. Jacket Color: Blue. (Use a different jacket color for each controller on the project).

I. Flow Sensor Cable: Direct-burial, polymer-coated aluminum shielded, insulated, 1-pair multi-conductor, with polyethylene outer jacket for connecting flow sensors with satellite controllers.
1. Two 20 AWG foil shield w/drain, black jacket, rated for direct-burial BLK, WHT. Two conductor direct burial shielded cable used with all field sensor connections to satellites such as flow sensors. Cables not to exceed 609 meters (2000 feet) in length.

J. Communication Cable Splice and Cap: Toro TW-SPLICE-14

K. Electrical Conduit and Fittings: High-impact Schedule 40 PVC C-2000 compound, UL approved, gray color, size as required. Solvent-weld fittings.

L. Pull Rope for Empty Conduits: 1/4 inch diameter, 12-strand, 544 kg (1,200 lb) tensile strength braided polypropylene rope.

M. Drainage Backfill: Clean gravel or crushed stone, graded from 6 mm (1/4 inches) minimum to 19 mm (3/4 inch) maximum.

N. Pipe Bedding and Initial Backfill: Clean sand per Section 31 20 00 EARTH MOVING for trenching and backfilling of utilities.

2.9 CONTROL SYSTEM COMPONENTS

A. Refer to General Direction on Sheet IR100 and chart on page 9 of this specification section.

B. Automatic Central Control Equipment-Field Satellites:

1. Overall Control Concept: Central computer system; contains irrigation starting controls, capable of overriding field satellite units, and operating individual remote control valves according to timing schedules programmed into central.
   a. Number of Units and Locations: As indicated in project narrative and on Drawings.
2. Central Computer Control System: Toro DXi decoder and 24-volt conventional controllers with Sentinel WMS software, 10-year cellular service, tablet PC. Manufacturer's standard components; Central Computer, Master Flow Meter attached to new System F, WMS cloud-based Central Control Software, Field Controllers and necessary components and software in standard package supplied by irrigation control manufacturer.
3. The obsolete irrigation controls, including the central computer, software and field controllers shall be replaced by the selected irrigation installer with new Toro Sentinel DXi cellular internet connected remote central control hardware and software including:
4. The selected irrigation installer shall install and connect all irrigation controllers, test, troubleshoot, place into service and enter basic irrigation station data and irrigation schedules that enable coordinated irrigation operations within 10 hour water windows and without hydraulic overloading.

5. The selected irrigation installer shall contact Chris Nagy of The Toro Company Chris.Nagy@toro.com, 248-342-4570 to arrange for the correct configuration of the new tablet PC and software registration in the owner's name including administrator and lower user credentials, satellite controller communications and communication with the Pump Station Monitor.
6. Jim Laiche of The Toro Company Jim.Laiche@toro.com 804-334-2225 shall assist the selected irrigation installer to furnish to the designated owner personnel, extensive irrigation computer central control hardware and software training. Manufacturer-sponsored training or manufacturer-authorized training shall include hardware and software orientation, internet communication, troubleshooting, basic and advanced database programming, basic and advanced water-efficient scheduling, field maintenance operation, water-efficient techniques, alarm monitoring and enunciating, water use and booster pump station reporting.
7. The irrigation computer central control hardware and software training shall be clearly and understandably video and audio recorded. The recording shall be edited to include searchable chapters/topics and shall be delivered to the owner for future reference as a condition of project closeout.
8. Flow Meter: Systems, C, D, E, F:
   a. Badger Dynasonics Ultrasonic Flow Meter
      1) RS-900W DB-C020NAAP9SS-BMXX or approved equal.
      2) Toro TW-DAC-FLOW pulse decoder
   b. Contain in a suitably sized service box
   c. Connect to new System F decoder controller
   d. Test, program and place into service.
   e. Verify flow readings on Toro WMS cloud based central control software.
9. Rain Measurement Device: Toro internet weather compatible with Toro Sentinel WMS software and site tipping rain bucket
10. Central Computer Software. Toro WMS Cloud-based central control software compatible with Toro Sentinel DXi controllers
11. Field Controllers with Central Communication:

a. Conduct an on-site cellular test with manufacturer to verify satisfactory cellular signal operation before ordering equipment.

12. Control System: System consists of Independent controllers, and accessories necessary to operate irrigation system. Refer to project narrative and plansheets.

PART 3 - EXECUTION

3.1 PREPARATION

A. Refer to project narrative and plansheets.

B. Examine and verify substrate suitability for product installation.

C. Protect existing construction and completed work from damage.

D. Remove existing service boxes, control valves, decoders, quick couplers and sprinklers.

1. Retain and catalogue existing surface-based irrigation equipment for turnover to the owner.
2. Dispose of other removed materials.

3.2 INSPECTIONS AND REVIEWS

A. Site Inspections:

1. Verify site conditions and note irregularities affecting work. Report irregularities to COR before beginning work.

B. Utility Location ("Call Before You Dig"):

1. Arrange and coordinate underground utility locations with local authorities and cemetery maintenance personnel.
2. Repair underground utilities damaged during construction with no increase in contract price.

C. Irrigation System Layout Review: Stake locations of irrigation system components as defined below for COR's review. Notify the COR one week in advance of review. COR will identify and approve modifications during this review.

Contractor shall probe each vault or burial location and verify a clear trench path before crossing.

D. Contractor shall probe each vault or burial location and verify a clear trench path before crossing.

E. Should any on-site activity incident emergency or disaster result in exposure and/or damage to any remains (I.E casket or urn), or outer

burial container the contractor shall immediately notify the cemetery director, the COR or the C.O. take immediate steps to protect and render safe any exposed remains and stop any further work that could affect those remains or gravesite until the cemetery director proved the contractor with guidance regarding disposition of the remains and permission to proceed.

3.3 INSTALLATION - GENERAL

A. Install products according to manufacturer's instructions.
   1. When manufacturer's instructions deviate from specifications, submit proposed resolution for COR consideration.

B. Perform excavation, trenching, and backfilling for sprinkler system as specified in Section 31 20 00, EARTHWORK and as indicated on Drawings.

3.4 LAYOUT OF WORK

A. Stake alley and sprinklers locations in existing burial sections using a licensed surveyor. Use alleys as indicated on Drawings.

B. Stake out irrigation system.

C. When staked irrigation components conflict with utilities or other components or site features, coordinate rerouting of components with COR. To comply with requirements of the following conditions specified herein this specification section to obtain compliance of regulatory regulations.

D. Do not trench through the root balls of plants or trees. Wherever possible, trench outside of the dripline of a plant or tree and in no case shall trenches cross closer than 48-inches from a tree with a trunk diameter of six-inches or larger. Obtain approval by the COR’s designated representative of any proposed trench pathway before trenching through areas containing mature trees.

3.5 SLEEVING AND BORING

A. Provide and install sleeves where pipe and control wires pass under walks, paving, walls, and other similar areas.

B. Extend sleeve minimum 300 mm (12 inches) beyond edge of paved surface, wall, etc. Cover pipe ends and mark edge of pavement.

C. Verify sleeve sizing is adequate before installation. Note that sleeves required for pipe with restrained casing spacers are larger than twice the diameter of the pipe.

D. Bed sleeves, minimum 100 mm (4 inches) sand backfill above top of sleeve.

3.6 PIPE AND FITTING ASSEMBLY

A. General:

1. Keep pipe free from dirt and pipe scale. Cut pipe ends square and debur.
2. Cap assembled pipe ends. Remove caps only to continue assembly.
3. Curve trenches to change direction or avoid obstructions within limits of pipe curvature. No deflection allowed at pipe joint. Minimum radius of curvatures as follows:

SIZE	RADIUS	OFFSET PER 6 m (20 feet) LENGTH
38 mm (1 1/2 inches)	7.5 m (25 feet)	2.3 m (7 ft-8 inches)
50 mm (2 inches)	7.5 m (25 feet)	2.3 m (7 ft-8")
63 mm (2 1/2 inches)	30 m (100 feet)	575 mm (1 ft-11 inches)
75 mm (3 inches)	30 m (100 feet)	575 mm (1 ft-11 inches)
100 mm (4 inches)	30 m (100 feet)	575 mm (1 ft-11 inches)
150 mm (6 inches)	45 m (150 feet)	400 mm (1 ft-4 inches)
200 mm (8 inches)	60 m (200 feet)	300 mm (1 ft-0 inch)
250 mm (10 inches)	75 m (250 feet)	225 mm (9 inches)
300 mm (12 inches)	90 m (300 feet)	200 mm (8 inches)

B. Mainline Pipe and Fittings:

1. Plastic Pipe:
   a. Lay pipe "snake fashion" in trench 1 meter to 100 meters (1 foot per 100 feet) to allow for thermal construction and expansion and to reduce strain on connections.
   b. Provide expansion joints every 1525 cm (50’) o.c. Install per manufacturer’s instructions.
      1) Acceptable manufacturer is Spears (S119-XX) or approved equal.
   c. Joints:

1) Solvent Welded Socket Type, ASTM D2855.
2) Threaded Type: Apply liquid Teflon, thread lubricant. Tighten joint with strap wrench up to two additional full turns after joint is hand tight (hard).
3) Elastomeric Gasket: ASTM F477, compatible with bell annular groove.
   a) Thoroughly clean inside of bell or coupling, outside of spigot, and elastomeric gasket immediately before joining two lengths of PVC pipe.
   b) Lubricate joint and rubber gasket according to pipe manufacturer's instructions.
   c) Insert elastomeric gasket in the annular groove of bell or coupling according to the manufacturer's instructions. Mark pipe not furnished with depth mark before assembly and insert to full depth of joint.
   d) Align spigot and bell or coupling and push until spigot is fully inserted in bell or coupling. Push with smooth steady motion.

2. Ductile Iron Pipe: AWWA C600.
   a. Joints:
      1) Mechanical: AWWA C111. Provide bolts, nuts, glands and gaskets on pipe and fittings socket opening.
      2) Push on: Apply thin film gasket lubricant and place in proper position in bell contour. Insert bevel end of joining pipe and make contact with gasket. Force pipe bevel end to bottom of bell without displacing gasket. Do not caulk. Use lubricant furnished by pipe manufacturer.
      3) Flanges: AWWA C115. Install only in concrete pits. Make watertight and set minimum 150 mm (6 inches) from walls or floor.

C. Lateral Pipe and Fittings:
   1. PVC Solvent Weld Pipe:
      a. Use primer and solvent cement. Join pipe according to manufacturer's instructions and accepted industry practices.
      b. Cure 30 minutes before handling and 24 hours before pressurizing or installing vibratory plow.

c. Snake pipe from side to side within trench or install with expansion joints.

d. In irrigation isles, coordinate location of monuments to avoid conflicts.

2. Fittings: Cross type fittings is not acceptable.

D. Emitter hose:

1. Use Type 1/11 solvent weld.

2. Use line size by 10 mm (3/8 inch) insert bushings to transition from PVC Schedule 40 fittings to flex-vinyl hose.

E. Specialized Pipe and Fittings:

1. Mechanical Joint Connections: Install fittings, fasteners and gaskets according to manufacturer's instructions and accepted industry practices.

2. PVC Threaded Connections:

a. Factory-formed threads. Field-cut threads are not acceptable.

b. Apply thread sealant according to manufacturer's instructions and accepted industry practices.

c. Use plastic components male threads and metal components female threads for plastic-to-metal connection.

F. Thrust Blocks:

1. Use cast-in-place concrete bearing against undisturbed soil.

2. Size, orientation and placement as indicated in installation details on Drawings.

3. Wrap fitting with plastic protecting bolts, joint, and fitting from concrete.

4. Install rebar with mastic coating as indicated on Drawings.

G. Joint Restraint Harness:

1. Install harness according to manufacturer's instructions and accepted industry practices.

2. Use restrained casing spacers for gasketed pipe routed through sleeving. Install self-restraining casing spacers at gasketed pipe bell joints and every 10-feet along gasketed mainline pipe installed through sleeving. Provide correct number and type of restraints per manufacturer's instructions.

3.7 INSTALLATION OF MAINLINE COMPONENTS

A. General: Install as indicated in project narrative and on Drawings.

B. Valve for Existing Facilities: Match existing of the same type, unless specifically noted otherwise.

C. All valves meet or exceed specified parameters identified herein, or parameters for existing valves being matched, whichever provide higher quality product.

D. Valves Setting:
   1. Install as indicated on Drawings and according to manufacturer's instructions.
   2. Do not set valves under roads, pavement or walks.
   3. Clean valve interior before installation.
   4. Place valves in same valve box where pressure control valves are installed adjacent to remote control valve.
   5. Set valve box cover flush with finished grade.
   6. Brand or cast "GV" in 50 mm (2 inch) high by 5 mm (3/16 inch) deep letters on valve box lid.

E. Air/Vacuum Relief Valve Assembly:
   1. Install as indicated on Drawings and according to manufacturer's instructions.
   2. Brand "AV" in 2 inch high by 3/16 inch deep letters on valve box lid.

F. Quick Coupling Valve Assembly:
   1. Install as indicated on Drawings and according to manufacturer's instructions.
   2. Brand "QC" in 2 inch high by 3/16 inch deep letters on valve box lid.

G. Flower Watering Station Hydrant Connection Assembly:
   1. Install as indicated on Drawings and according to manufacturer's instructions.
   2. Sequence of Construction:
      a. Coordinate exact location with COR.
      b. Install components before concrete pad. Coordinate installation with Section 03 30 53, CAST-IN-PLACE CONCRETE (SHORT FORM).
   3. Location:
      a. Install stations at locations indicated on Drawings, centered between adjacent sprinkler locations.

b. Route adjacent piping around stations. Do not install mainline or lateral pipe under Flower Watering Stations.

4. Paint "FW" in 2 inch high by 3/16 inch deep letters on valve box lid.

3.8 INSTALLATION OF SPRINKLER IRRIGATION COMPONENTS AND QUICK COUPLERS

A. Remote Control Valve Assembly: Install as indicated on Drawings and according to manufacturer's instructions.

1. Mainline Flushing:
   a. Flush mainline before installation of Remote Control Valve Assemblies.
   b. Identify remote control valve service tees for mainline flushing. Plug service tees not used for flushing.
   c. Connect 50 mm (2 inch) pipe to flushing service tees, to direct water away from trench and into drainage swale, curb section or storm sewer, away from work area and not disrupt cemetery operations.
   d. Use water volume 0.9 m/s (3 FPS) velocity in largest pipe flushing.
   e. Flush multiple points simultaneously.
   f. Flush minimum 20 minutes. Continue flushing until water is clear of debris.
   g. COR will review flushing operation and water clarity before stopping flushing operation.
   h. Disconnect pipe from service tees and install remote control valves.
2. Adjust valve to regulate downstream operating pressure as follows:
   a. Rotor Sprinklers: 480 kPa (70 psi).
   b. Rotating Stream Nozzles: 310 kPa (45 psi).
   c. Spray Sprinklers: 240 kPa (35 psi).
3. Connect control wires to solenoid wires with wire connectors and waterproof sealant. Install connectors and sealant according to manufacturer's instructions.
4. Install only one remote control valve to valve box. Locate valve box 1.5m (5-feet) from and align square from adjacent edges of paved areas.

5. Attach ID tag to solenoid with controller station number to control wiring.
6. Brand controller and station number in 50 mm (2 inch) high by 5 mm (3/16 inch) deep letters on valve box lid.

B. PopUp Gear-Driven Rotary Sprinkler Assembly:
1. Flush lateral pipe before installing sprinkler assembly. Clear water of debris before flushing operation stops.
2. Install at locations indicated on drawings.
3. Locate rotary sprinklers 150 mm (6 inches) from adjacent edges of paved areas, walls or fences.
4. Install sprinklers perpendicular to finish grade.
5. Install swing joint as indicated on Drawings.
6. Supply appropriate nozzle or adjust arc coverage of each sprinkler.
7. Adjust each sprinkler throw radius.
8. Install sod 600 mm (2-foot) square around rotary sprinklers in seeded areas.

C. Spray Sprinkler Assembly:
1. Flush lateral pipe before installing sprinkler assembly. Clear water of debris before flushing operation stops.
2. Install at locations indicated on drawings.
3. Locate rotary sprinklers 150 mm (6 inches) from adjacent edges of paved areas, walls or fences.
4. Install sprinklers perpendicular to and flush with finish grade.
5. Install swing joint as indicated on Drawings.
6. Supply appropriate nozzle or adjust each sprinkler arc coverage.
7. Adjust each sprinkler throw radius.

D. Sprinkler Heads and Quick Couplers:
1. Place on temporary nipples extending at least 80 mm (3 inches) above finished grade. After turf is established, remove temporary nipples and install sprinkler heads and quick couplers at flush with ground surface ensuring no dirt or foreign matter enters outlet.
2. Place part-circle rotary sprinkler heads maximum 150 mm (6 inches) from edge, of and flush with top adjacent walks, header boards, curbs, and mowing aprons, or paved areas at time of installation.
3. Install shrub sprays, sprinklers, and quick couplers on swing joints as detailed on Drawings.

4. Set shrub heads 200 mm (8 inches) above grade and 300 mm (1 foot) from curb or pavement edges. Place adjacent to walls. Stake heads parallel to riser before backfilling trenches.

3.9 INSTALLATION OF CONTROL SYSTEM COMPONENTS

A. Control Units:
1. Install control units at locations indicated on Drawings.
2. Install electrical connections according to manufacturer's instructions and as indicated on Drawings.
3. Lightning Protection: Drive full length grounding rods into soil. Provide and install grounding plates as indicated on Drawings or as required to create grounding connection with field-tested resistance value equal to or lower than specified values identified in this specification. Connect 4mm diameter (#6 AWG) copper grounding wire to rod and plate using CADWELD style connections. Brand “GR” in 50 mm (2 inch) high by 5 mm (3/16 inch) deep letters on valve box lid.
4. Attach wire markers to control wire ends inside controller unit housing. Label remote control valve wires with identification number indicated on Drawings, where control wire is connected.
5. Connect control wire to corresponding control unit terminal.
6. Install permanent receiver for hand held radio when not factory installed or, if cloud connected, conduct all work required to enable full and complete cloud-based access for walk-through and maintenance activities.
7. Install rain sensor and/or weather station equipment and complete electrical connections according to manufacturer’s instructions.

B. Power Wire:
1. Route power wire as indicated on Drawings. Install minimum number field splices. When power wire is spliced, make splice with recommended connector. Place splices in separate 300 mm (12 inch) standard valve box. Coil 600 mm (2 feet) wire in valve box. Brand “WS” in 50 mm (2 inch) high by 5 mm (3/16 inch) deep letters on valve box lid.
2. Lay power wire in trenches. Do not use vibratory plow.
3. Wire: NEC code compliant, green wire as common ground wire from power source to satellites and white for common (neutral) wire.

4. Carefully backfill around power wire, avoid wire insulation or wire connector damage.
5. Unless noted on Drawings, install wire parallel with and below mainline pipe. Install wire minimum 50 mm (2 inches) below bottom of PVC mainline pipe.
6. Encase wire in electrical conduit not installed with PVC mainline pipe, with continuous run of warning tape placed in backfill, 200 to 250mm (8 to 10 inches) below ground surface, directly over wiring.
7. Surface mount wire installed above grade in a professional manner, routing approved by COR.
8. Connect wire to power source.

C. Control Wire:

1. Bundle two or more control wires in the same trench. Bundle with pipe wrapping tape spaced 3 m (10-foot) intervals.
2. Chisel control wiring into soil utilizing vibratory plow device manufactured for pipe pulling and wire installation. Use appropriate chisel with wire, fed into chute on chisel, and not subject to pulling tension. Minimum burial depth equal minimum cover previously listed.
3. Provide 600 mm (24 inch) excess wire length in 200mm (8 inch) diameter loop at each 90 degree change in direction, at both ends of sleeves, and at 30 m (100-foot) intervals along continuous wire runs. Do not tie wiring loop. Coil 600mm (24 inch) wire length within each remote control valve box.
4. Install common ground wire and one control wire for each remote control valve. Multiple valves on single control wire are not acceptable.
5. Install spare control and common wires as indicated on Drawings.
6. Use wire connectors and waterproof sealant to splice wire according to manufacturer's instructions. Locate splices in valve box containing irrigation valve assembly, or in separate valve box. Use same procedure for valve connection and in-line splices. When separate valve box is used for wire splices, brand “WS” in 50 mm (2 inch) high by 5 mm (3/16 inch) deep letters on valve box lid.
7. Install wire parallel with and below mainline pipe, unless indicated on Drawings.

8. Protect wire not installed with PVC mainline pipe with continuous run of warning tape place in backfill 150 mm (6 inches) above wiring.
9. Cap exposed wire ends with waterproof wire splices.
10. Locate wiring in trench from master controllers to satellites and stub-cuts for future extension, with new mains or in separate trench at back of curb, unless cross-country route is indicated on Drawings. Locate in trench with mains when possible on cross-country routes.
11. Set wiring bundles located with piping, below bottom of pipe. No two wires of same colors in any bundle. Bundle and tie or taped wiresat 3 m (10 foot) intervals. Provide same numbered tag at each wire end, i.e., at valve, at field located controllers and at master controller.
12. Minimize splicing. Provide pull box at each splice. No splice will be allowed between field located controllers and remote control valves.
13. Provide 300 mm (12 inch) expansion loops in wiring at each wire connection or change in wire direction. Provide 600 mm (24 inch) loop at remote control valves.
14. Do not place irrigation system power wiring in same conduit as control wiring.

D. Instrumentation:
   1. Install according to manufacturer’s instructions at location indicated on drawings.
   2. Provide electrical connections between central control system hardware and weather station under direction and observation of central control system manufacturer’s personnel.

3.10 TRACER WIRE INSTALLATION

A. Install tracer wire on trench bottom, adjacent to vertical pipe projections, continuous throughout pipe length, with spliced connections soldered and wrap with insulation tape.

B. Install tracer wire following main line pipe and branch lines and terminate in yard box with gate valve controlling main irrigation lines. Provide sufficient wire length to reach finish grade, bend back

wire end making loop and attach Dymo-Tape type plastic label with designation "Tracer Wire."

C. Record tracer wire locations and terminations on project record documents.

3.11 INSTALLATION OF OTHER COMPONENTS

A. Tools and Spare Parts:
   1. Before punch list review, provide operating keys, servicing tools, spare parts, and other items indicated on Drawings.

B. Other Materials: Install other materials or equipment indicated on Drawings or installation details that are part of irrigation system.

3.12 FIELD QUALITY CONTROL

A. Special Inspections and Tests:
   1. On-Site Radio Test: Conduct on-site radio test before submitting bid for type of radio control.

B. Field Inspections:

C. Field Tests: Performed by testing laboratory specified in Section 01 45 29, TESTING LABORATORY SERVICES.
   1. Test irrigation system per procedures listed in section 1.10.
   2. Notify the COR three days in advance of testing.
   3. Newly installed irrigation pipelines jointed with rubber gaskets or threaded connections shall be subject to pressure and leakage testing after partial completion of backfill. Pipelines jointed with solvent-welded PVC joints will be allowed to cure at least 24 hours before testing.
   4. Subsections of mainline pipe may be tested independently, subject to the review of the COR.
   5. Provide clean, clear water, pumps, labor, fittings, power and equipment necessary to conduct tests or retests.
   6. Volumetric Leakage Test - Gasketed Mainline Pipe:
      a. Backfill to prevent pipe from moving under pressure. Expose couplings and fittings.
      b. Purge all air from the pipeline before test.
      c. Provide all necessary pumps, bypass piping, storage tanks, meters, 75 mm (3 inch) test gauge, supply piping, and fittings in order to properly perform testing. Testing pump must provide

a continuous 700 kPa (100 psi) pressure to the mainline pipe. Where main lines are installed with significant elevation change, perform the test at the mid elevation of the segment being tested. Main lines may be tested in segments where the terrain makes it difficult to maintain the test pressure throughout. The test pressure is the minimum pressure on the line at the highest point of the line segment being tested.

d. Allowable deviation in test pressure, 35 kPa (5 psi) during test period; average pressure during test, 700 kPa (100 psi) therefore the pressure shall start at 5 psi above and be re-pressurized when the pressure is 5 psi below the test pressure. Restore test pressure to 700 kPa (100 psi) at end of test. Measure water added to mainline pipe volumetrically to nearest 10 ml (0.025 gallons).

e. Subject mainline pipe to the anticipated operating pressure of 700 kPa (100 psi) for two hours. Amount of additional water pumped in during test not exceeding the value in table, or the calculated value using the formula below, based on differing number of joints, duration or pressure of the test:

1) Leakage Allowable (Gallons per (100 Joints)/Hour).

PIPE SIZE mm (INCHES)	Test Pressure (PSI)								
	60	70	80	90	100	110	120	130	140
63mm (2 1/2”)	0.26	0.28	0.30	0.32	0.34	0.35	0.37	0.39	0.40
75mm (3”)	0.31	0.34	0.36	0.38	0.41	0.43	0.44	0.46	0.48
100 mm (4")	0.42	0.45	0.48	0.51	0.54	0.57	0.59	0.62	0.64
150 mm (6")	0.63	0.68	0.73	0.77	0.81	0.85	0.89	0.92	0.96
200 mm (8”)	0.84	0.90	0.97	1.03	1.08	1.13	1.18	1.23	1.28
250 mm (10")	1.05	1.13	1.21	1.28	1.35	1.42	1.48	1.54	1.60
300 mm (12”)	1.26	1.36	1.45	1.54	1.62	1.70	1.78	1.85	1.92

Note: Allowable Leakage calculated using $L = (ND\sqrt{P})/7400$.

Where: L = Allowable Leakage (gph).

N = Number of Joints.

D = Nominal Diameter of Pipe (inches).

P = Average Test Pressure (psi).

2) The following are the values for a 2 hour duration test at 100 psi for pipe length containing 100 joints.
   a) 3.10 L (0.82 gallons) per 100 joints of 75 mm (3 inch) diameter pipe.
   b) 4.09 L (1.08 gallons) per 100 joints of 100 mm (4 inch) diameter pipe.
   c) 6.13 L (1.62 gallons) per 100 joints of 150 mm (6 inch) diameter pipe.
   d) 8.18 L (2.16 gallons) per 100 joints of 200 mm (8 inch) diameter pipe.
   e) 10.22 L (2.70 gallons) per 100 joints of 250 mm (10 inch) diameter pipe.
   f) 12.26 L (3.24 gallons) per 100 joints of 300 mm (12 inch) diameter pipe.
   g) Volumetric leakage exceeding the amounts indicated above, adjusted for system test pressure, number of joints and shall be a failure of the test. Replace defective pipe, fitting, joint, valve, or appurtenance. Repeat the test until the pipe passes test.

f. Cement or caulking to seal leaks is prohibited.

g. Contractor may sub-contract testing to pipeline testing company approved by RE/COTR.

7. Hydrostatic Pressure Test - Solvent Weld Lateral Pipe:
   a. Subject lateral pipe to a hydrostatic pressure equal to the anticipated operating pressure of 550 kPa (80 psi) for 30 minutes.
   b. Cap all sprinkler risers.
   c. Backfill to prevent pipe from moving under pressure. Expose couplings and fittings.
   d. Leakage will be detected by visual inspection. Replace defective pipe, fitting, joint, valve, or appurtenance. Repeat the test until the pipe passes test.
   e. Cement or caulking to seal leaks is prohibited.

f. After lateral passes test and before operational test, install sprinklers and backfill and compact all pipe, fittings, joints, or appurtenance.

8. Operational Test - Remote Control Valves, Lateral Piping and Sprinklers:
   a. Activate each remote control valve in sequence from each new satellite controller manually at the controller, automatically from the Central Computer, and via any handheld units // through central controller // through standalone communication system //. Manual operation on the valves from the bleed valve on the remote control valve is not an acceptable method of activation. COR will visually observe operation, water application patterns, and leakage.
   b. Replace defective remote control valve, solenoid, wiring, or appurtenance to correct operational deficiencies.
   c. Replace, adjust, add, or move water emission devices to correct operational or coverage deficiencies.
   d. Replace defective pipe, fitting, joint, valve, sprinkler, or appurtenance to correct leakage problems. Cement or caulking to seal leaks is prohibited.
   e. Repeat tests until each lateral passes all tests. Repeat tests, replace components, and correct deficiencies at no additional cost to the Owner.
   f. // Test backflow prevention device with certified tester before project acceptance. //.
9. Distribution Uniformity (DU):
   a. Perform DU Test on one zone of burial section rotors and one zone of tree lawn rotors per satellite controller.
   b. Select the zones of sprinklers representative of area being irrigated by satellite controller in the presence of the COR.
   c. Perform catch can test using procedures recommended by Irrigation Association.
   d. Where DU test fails, adjust zone pressures or nozzle sizes to meet required Distribution Uniformity.
   e. Calculate and provide written documentation of DU for each zone tested.

f. Irrigation Association Certified Landscape Irrigation Auditor must perform the test. Provide written evidence of certification before conducting test.

10. Control System Grounding:
    a. Test all new satellite controllers for proper grounding of control system with installed grounding equipment that creates grounding resistance readings of 5 ohms or less or higher levels not to exceed 15 ohms, when acceptable by equipment manufacturer without equipment warranty invalidation. Test results meet or exceed control system manufacturer's instructions for acceptance, while maintaining equipment warranty.
    b. Replace defective wire, grounding rod or appurtenances. Repeat test until manufacturer's instructions are met. Add grounding rods as needed, bond all rods together.
    c. When test is acceptable, document results of grounding test on inside of each satellite controller pedestal door and via written report submitted to the COR. Documentation includes satellite name or number, date of test, name or initials of the individual completing the test, and the ohms resistance to ground. Mark test results on the inside of each satellite controller pedestal door using a permanent marker.
    d. Submit to the COR, written report of test data listing satellite name or number, date of test, name of the individual completing the test, name of the company completing the test and the ohms resistance to the local ground for each satellite.
11. Irrigation System Acceptance Test (Burn inches) before Final Inspection:
    a. Upon completion of construction and before Final Inspection, an Acceptance Test (Burn inches) must be passed.
    b. Coordinate start of Test with COR.
    c. During Test, irrigation system must be fully operational from the central control system. Operate irrigation system, with no faults for 14 consecutive days. When at any time during the 14 day test period, system fault occurs, determine source of the fault and correct, and restart 14 day evaluation period. When system fault occurs, make repairs within 24 hours of

notification from COR. Document any faults of test report listing date, fault, cause of fault and corrective action taken.

d. When system has operated for 14 days without fault, contact the COR to schedule Final Inspection.

e. When system is designed to detect flow and shut down and this condition happens during test, this is considered a success and test continues; when does not shut down, test starts over.

1) Applicable to new System F. Refer to project narrative and plansheets.

12. Flushing: After testing, flush system beginning with larger mains and continuing through smaller mains in sequence. Flush lines before installing sprinkler heads and quick couplers.

13. Operation Test: Upon completion of the final adjustment of sprinkler heads to permanent level at ground surface, test each sprinkler section by pan test and visual test to indicate uniform distribution within any one sprinkler head area and over the entire area. Operate entire installation to demonstrate the complete and successful operation of all equipment.

D. Maintenance Services:

1. Maintenance and Operating Instructions: Before final acceptance, provide organized, in-person, video and audio recorded instructions, minimum sixteen (16) hours, to operating personnel. Provide two additional years of software support for one hour each month. Provide Maintenance and Operating Instructions for the irrigation system provided in the form of manuals as follows:

a. Unless otherwise noted, provide irrigation operation and maintenance information in a 3-ring binder with table of contents and index sheet. Provide sections that are indexed and labeled. Provide the following information:

b. Catalog cut sheets for control system, valves, sprinklers, pipe and fittings, wire and wire connectors, ID tags, shop drawings, and all other irrigation equipment shown or described on the drawings and within these specifications.

c. Manufacturer’s Operation and Maintenance manuals.

d. Manufacturer’s Technical Service Bulletins.

e. Manufacturer’s Warranty Documentation.

f. Software License Information.

g. Recommended routine maintenance inspections for weekly, monthly and annual inspections and recommended actions for the inspections and a recommended method for recording the findings of the inspections.

h. Predictive schedule for component replacement.

i. Listing of technical support contacts.

3.13 WINTERIZATION AND SPRING START-UP

A. Winterize new irrigation system according to local practices in first fall after completion of construction of irrigation system and start up in spring after completion of construction. Repair any damage caused in improper winterization. Coordinate winterization and start-up with cemetery landscape maintenance personnel.

3.14 CLEANING

A. Clean exposed surfaces. Remove contaminants and stains.

3.15 DEMONSTRATION AND TRAINING

A. Instruct VA personnel in proper irrigation system operation and maintenance.
   1. Trainer: Manufacturer approved instructor.
   2. Training Time: 30 days minimum.
   3. Include provision for video and audio recording of training services.

B. Submit training plan and trainer qualifications. Refer to project narrative and plansheets.

C. Acceptance Condition: After completing work, operate the irrigation system 15 consecutive calendar days without breakdown.

D. Provide training video on DVD or CD, whichever is compatible with the computer system provided for the central computer, to familiarize maintenance personnel with equipment provided. Coordinate final training presentation with Architect/Engineer and COR in outline form before creation, verify format and organization of content is applicable for facility staff utilization.

3.16 PROTECTION

A. Protect products from traffic and construction operations.

B. Cover products with reinforced kraft paper, and plywood or hardboard.

C. Remove protective materials immediately before acceptance.

D. Repair damage.

- - - E N D - - -

SECTION 32 84 40

BOOSTER PUMP STATION RENOVATION

PART 1 - GENERAL

1.1 SCOPE

A. Contractor shall provide a complete and working irrigation pump station control system. Furnish all labor, materials, supplies, equipment, tools, and transportation, and perform all operations in connection with and incidental to the complete manufacturing and installation of the pump station controls and system upgrades, and guarantee/warranty as specified herein. Items of work specifically included are:

1. Procurement of all applicable licenses, permits, and fees as required by local utilities and regulations.
2. Coordination of Utility Locates ("Call Before You Dig").
3. Services of a factory field service person to supervise the assembly, installation, and start-up of the pumping system, and the training of maintenance staff.
4. Upgrading, retrofitting, furnishing and installing a complete pump station control system, pressure maintenance pump and motor, electrical controls for operating new and existing motors, flow meter and pressure transducer, check valves, pressure regulating valves, electronic butterfly valves, pressure gauges, and all other items as specified and required for proper operation.
5. Warranty and maintenance period of one (1) year.

1.2 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 Standard Institute (ANSI):

1. B16.5: Pipe Flanges and Flanged Fittings

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

1. A53: Standard Specification for Pipe, Steel, Black and Hot- Dipped, Zinc-Coated, Welded and Seamless

2. A234: Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service

D. National Electrical Manufacturers Association (NEMA):
   1. NEMA 4: Indoor or Outdoor Enclosures with Protection Against Wind Blown Dust and Rain, Splashing Water, Hose Directed Water, and Undamaged by the Formation of Ice on the Enclosure.
   2. MG-1-12: Motors and Generators

E. Underwriters Laboratories Inc. (UL):
   1. File #E142155: Industrial Control Panels

F. National Electric Code: (latest edition)

G. Florida Administrative Code Chapter 62-610 Reuse of Reclaimed Water and Land Application

1.3 RELATED WORK

A. Maintenance of Existing Utilities: Section 01 00 00 GENERAL REQUIREMENTS

B. Submittals: SECTION 01 33 23 SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES

C. Concrete: Section 03 30 53, CAST-IN-PLACE CONCRETE (SHORT FORM).

D. 32 84 00, PLANTING IRRIGATION

E. Division 26, ELECTRICAL

F. Section 32 90 00, PLANTING

G. Section 33 10 00, WATER UTILITIES

1.4 DESCRIPTION

This section 32 84 40 is a complement to Section 32 84 00 and landscape irrigation construction plans to serve the Dayton National Cemetery Expansion Construction project, Dayton, Ohio. It is the intention of this specification to describe all parts and labor to update an automatic, prefabricated, self-enclosed, variable speed drive (VFD), horizontal centrifugal booster pump station with integrated backflow prevention assembly, piping, valves, and enclosure. The controls shall be an industrial grade PLC incorporating a color touch screen operator interface with software programming written and updated specifically for this project. The pump station shall provide water to the system simultaneously maintaining a constant discharge pressure by variable

frequency drive (VFD) operated pump(s) and under varying flow conditions up to the maximum specified capacity. All testing and service shall be the sole responsibility of the pump station manufacturer.

PART 2 – DIRECTION

a. The existing irrigation municipal water supply and booster pump station model RET-HC-(Y)-(20X2/5)-68 Kit capable of delivering up to 1000 gallons per minute at 45psi boost shall continue to be utilized to furnish product water to all landscape irrigation.

b. Sole Source duty to be performed by a factory authorized WaterTronics Servicing Agent. The selected irrigation installer shall contact Mike Green of WaterTronics, Hartland, WI Mike.Green@watertronics.com, 262-337-3318 to facilitate the dispatching of a factory authorized Watertronics Servicing Agent. Reference WaterTronics Project number 2022279.

c. Provide for not less than five business days for a complete review, repair, adjustment, testing, documentation and placement into service of the existing municipal water irrigation booster pump station per the manufacturer programming and features records. Upon verification of proper operation and base programming, adjust the booster pump station performance as needed to accommodate irrigation expansion.

d. Additionally, the Watertronics Servicing Agent shall Install, program, test, document and place into service:

1) Watertronics Watervision pump station monitoring hardware and software onto the new irrigation system laptop furnished by the selected irrigation installer.

2) An optocoupler to enable sharing of the booster pump station flow sensor signal and coordination with the selected irrigation installer who shall hardwire the connection of the flow sensor to new satellite irrigation controller F using PE-39 six pair shielded communication cable, properly grounded per manufacturer recommendations.

e. The selected irrigation installer shall remove and dispose of the existing non-functional wall mount Toro Sentinel® radio-based booster pump performance transmitter. Professionally patch wall penetrations against weather and insect intrusion. The selected irrigation installer shall

coordinate with the Watertronics Servicing Agent to hardwire the connection of the flow sensor to new satellite irrigation Controller F using PE-39 six pair shielded telecom cable properly grounded per manufacturer recommendations. The selected irrigation installer shall perform the required Toro DXi irrigation database tasks to fully integrate and activate the Pump Station flow sensor signal into the Toro Sentinel DXi irrigation software database. See Field Controller Intercommunication and Central Control section.

f. The Watertronics Servicing Agent shall furnish not less than three hours of detailed booster pump station hardware, software and Watervision training to the owner's designated personnel. The training shall include orientation of the pump station components and features, sequence of operation, user interphase, status interpretations and reset procedures, malfunction and alarm condition detection and remedies, user appropriate maintenance and contact information to receive live offsite support and onsite service by a manufacturer-authorized servicing agent. The booster pump station training shall be clear and understandable and shall include video and audio recording. The recording shall be edited to include searchable chapters/topics and shall be delivered to the owner for future reference as a condition of project closeout.

2.1 HYDRAULIC AND SENSOR COMPONENTS

A. Inspect, calibrate and test all discharge an inlet pressure transducers.
B. Verify integrity of temperature sensors for each pump and system sustain sensor.
C. Confirm master valve open/close function under command control.
D. Inspect flow sensor for accuracy (+/-2%) and signal integrity to control systems.
E. Verify pressure and functionality of flow signal sharing with the Toro Sentinel irrigation software.

2.2 CONTROL PANEL, LOGIC AND SENSORS

A. Pump station controls shall be inspected for compliance with Watertronics UL File E142155 Standard.

B. Panel construction shall be verified and confirmed for integrity of gaskets, seals, and weatherproofing.

C. Confirm that no water-activated devices or pressurized piping exists within the control enclosure.

2.2 MAIN SERVICE DISCONNECT

A. Verify proper function of fused three-pole disconnect within control enclosure.

B. Ensure mechanical interlock prevents access with disconnect in ON position.

2.3 VARIABLE FREQUENCY DRIVES (VFDs)

A. Confirm correct operation of VFD 1, 2 and 3. Tests shall include Enable, Fault, Reset, Speed reference and diagnostics.

B. Inspect protective features including Current limit, Short circuit protection, Overload protection, Ground fault protection.

C. Verify all displays, programming access and capacitor charge indicator(s).

D. Confirm ride-through capability under momentary power loss.

2.4 PLC AND CONTROL LOGIC

A. Verify operation of pump sequence controller.

B. Confirm analog inputs/outputs are functional and properly scaled.

C. Test alarm conditions including low discharge pressure, high discharge pressure, low inlet pressure, high pump temperature, phase faults, voltage faults, starter failure, VFD fault(s).

D. Confirm automatic restart attempts and transition to Hard Shutdown if alarm conditions persist.

2.5 OPERATOR INTERPHASE (HMI)

A. Confirm seven-inch color LCD display is functional.

B. Verify display of system status, pressure regulation, pump run hours and alarm history.

C. Confirm password protection is active.

D. Review logging and data export functionality.

PART 3 – REMOTE MONITORING

3.1 WATERVISION 2.0

A. Install or verify operation of RTU for remote monitoring.
B. Confirm cellular connectivity.
C. Test alarm notifications, data logging, and historical graphing features.
D. Activate and verify five-year subscription.

PART 4 – MECHANICAL CONDITION

4.1 INSPECTION

A. Verify the integrity of the pump station enclosure, including but not limited to flooring, paint, locks, fasteners, hinges.
B. Verify all pump station cooling or venting functionality.
C. Verify all pump station interior lighting.
D. Inspect pump assemblies for seals, bearings, impellers, alignment, vibration, and wear.
E. Verify operation of check valves, isolation valves, pressure relief valves.
F. Inspect drains, hose bibs, and washdown fittings.
G. Verify all gauges function properly including gauge
H. Inspect irrigation pump motors for proper bearing operation and alignment.
I. Confirm motor insulation, temperature rise, and overall condition.
J. Inspect pressure maintenance pump motor for integrity and operation.

PART 5 – DELIVERABLES AND WARRANTY

4.1 ALL PUMP STATION ELEMENTS, SETTINGS, OPERATION

A. Detailed inspection report with findings.
B. Calibration records for sensors and VFDs.
C. Photos and screenshots of alarms, diagnostics, and readings.
D. Confirmation of Watervision activation and Toro Sentinel flow integration.
    a. Coordinate Toro Sentinel integration with the authorized Toro Sentinel commissioning agent. See plansheets and Section 32 84 00.
E. Conduct, record and document Owner training of all pump station operation and maintenance including all tasks and intervals, winterization checklist and seasonal startup checklist, Watervision operation and user tips, Toro Sentinel integration and tips.

F. Furnish a written 90-day workmanship warranty. Furnish as written 1-year manufacturer's parts warranty.

G. Furnish contact information for labor service and for parts ordering.

--END--

SECTION 32 90 00
PLANTING

PART 1 - GENERAL

1.1 DESCRIPTION AND REQUIREMENTS

A. This work consists of furnishing and installing all planting materials required for landscaping at all NCA construction projects hereinafter specified in locations as shown. The landscape contractor shall be required to visit the site prior to submitting Bid Proposal to become familiar with all conditions affecting the proposed work. The contractor shall identify and review all underground utility locations prior to commencing work and shall exercise caution when working close to utilities and shall notify the COR (RE) and/or Contracting Officer's Technical Representative (COTR) of apparent conflicts with construction and utilities so that adjustment can be planned prior to installation.

B. Agronomic consultation on the appropriateness of all plant materials proposed for installation during this project must be obtained from the MSN Agronomist and/or NCA Chief Agronomist via coordination through the RE and/or COTR prior to project initiation and actual plant installation. In general, all plant material must be regionally adapted to the climate of the site, be of appropriate mature dimensions to fit the planting location and be low maintenance species. This requirement will generally exclude or severely limit the use of rose plants, wild flowers and ground covers.

C. Any exceptions to these species exclusions must be approved by the MSN Agronomist and/or NCA Chief Agronomist via coordination through the RE and / COTR prior to project initiation.

1.2 EQUIPMENT

Maintain all equipment, tools and machinery while on the project in sufficient quantities and capacity for proper execution of the work.

1.3 RELATED WORK

A. Section 31 20 11, EARTHWORK (SHORT FORM), Stripping Topsoil and Stock Piling.

B. Section 01 45 29, TESTING LABORATORY SERVICES, Topsoil Testing.

C. Section 31 20 11, EARTHWORK (SHORT FORM), Topsoil Materials.

D. Section 32 84 00, PLANTING IRRIGATION.

E. Section 01 57 19, TEMPORARY ENVIRONMENTAL CONTROLS.

1.4 SUBMITTALS

A. Samples: Submit the following samples for approval before work is started:

Inert Mulch	2.3 kg (5 pounds) of each type to be used.
Organic Mulch	2.3 kg (5 pounds) of each type to be used.
All pesticides required such as preemergence or post emergence herbicides, insecticides, or fungicides.	EPA approved labeling and MSDS sheet for each such product selected for use.

B. Certificates of Conformance or Compliance: Before delivery, notarized certificates attesting that the following materials meet the requirements specified shall be submitted to the COR for approval:
   1. Plant Materials (Department of Agriculture certification by State Nursery Inspector from the state in which the plant material originates declaring material to be free from insects and disease).
   2. Fertilizers.
   3. Lime
   4. Peat
   5. Seed
   6. Sod
   7. Membranes
   8. Asphalt Adhesive

C. Manufacturer's Literature and Data:
   1. Antidesiccant
   2. Erosion control materials
   3. Hydro mulch
   4. Pre-emergent herbicide

D. Licenses: Licenses of Arborist shall be submitted (one copy), to the COR.

E. Soil laboratory testing results and any soil amendment recommendations from the Contractor. Submit soil test results for each variable soil type and condition that exists on the construction site.

1. Organic Soil Amendment and Imported Topsoil: The Contractor shall provide a 5 pound representative sample from each proposed source for testing, analysis, and approval. Contractor shall deliver samples to testing laboratories and shall have the testing report sent directly to the COR. Testing reports shall include the following tests and recommendations.
   a. Mechanical gradation (sieve analysis) and chemical (pH soluble salts) shall be performed by public extension service agency or a certified private testing laboratory in accordance with the current standards of the Association of Official Agricultural Chemists. A hydrometer shall be used to determine percent of clay and silt.
   b. Percent of organics shall be determined by the loss on ignition of oven-dried samples. Test samples shall be oven-dried to a constant weight at a temperature of 110 ºC, plus or minus 5ºC.
   c. Chemical analysis shall be undertaken for Nitrate Nitrogen, Ammonium Nitrogen, Phosphorus, Potassium, Calcium, Aluminum, Soluble Salts, and acidity (pH).
   d. Tests, as specified, for gradation, organics, soil chemistry and pH shall be performed by a testing laboratory retained by the Department of Veterans Affairs as described in Section 01410, TESTING LABORATORY SERVICES.
   e. Soil analysis tests shall show recommendations for soil additives to correct soils deficiencies as necessary, and for fertilizing and liming applications to support successful turfgrass growth.
   f. All tests shall be performed in accordance with the current standards of the Association of Official Agricultural Chemists.
2. Amended soil (in place): Following the incorporation of amendments and additives, the Contractor shall provide a minimum of six (6) samples per forty thousand (40,0000) square feet, six inch (6”) depth by three inch (3”) diameter core samples of amended soil taken from the site for testing, analysis, and approval. The location of each sample shall be as directed by the COR from areas designated to receive turfgrass or be established to turfgrass on the Contract Drawings. No seeding or hydroseeding operations shall occur until acceptance of the amended soil samples has been obtained. Contractor shall deliver samples to testing

laboratories and shall have the testing report sent directly to the COR. Tests shall be as directed in paragraph 1.4 E.1.d. of this Section.

3. Seed: Submit a manufacturer's Certificate of Compliance to the Specifications with each shipment of each type of seed. These certificates shall include the guaranteed percentages of purity, weed content and germination of the seed, and also the net weight and date of shipment. No seed may be sown until the Contractor has submitted the certificates.
4. Fertilizer: Submit four (4) certificates of analysis for each type of fertilizer.
5. Hydro Mulching: Prior to the start of hydro mulching, submit a certified statement for approval as to the number of pounds of materials to be used per gallon of water.

1.5 DELIVERY AND STORAGE

A. Delivery:

1. Notify the COR of the delivery schedule in advance so the plant material may be inspected upon arrival at the job site. Remove unacceptable plant material from the job site immediately.
2. Protect plants during delivery to prevent damage to root balls or desiccation of leaves. Protect trees during transport by tying in the branches and covering all exposed branches.
3. The use of equipment such as "tree spades" is permitted provided the plant balls are sized in accordance with ANSI Z60.1 and tops are protected from damage.
4. Deliver fertilizer and lime to the site in the original, unopened containers bearing the manufacturer's warranted chemical analysis, name, trade name or trademark, and in conformance to state and federal law. In lieu of containers, fertilizer and lime may be furnished in bulk and a certificate indicating the above information shall accompany each delivery.
5. During delivery: Protect sod from drying out and seed from contamination.

B. Storage:

1. Sprinkle sod with water and cover with moist burlap, straw or other approved covering, and protect from exposure to wind and direct sunlight. Covering should permit air circulation to alleviate heat development.
2. Keep seed, lime, and fertilizer in dry storage away from contaminants.

3. Store plants not installed on the day of arrival at the site as follows:
   a. Shade and protect plants from the wind when stored outside.
   b. Heel in bare root plants.
   c. Protect plants stored on the project from drying out at all times by covering the balls or roots with moist sawdust, wood chips, shredded bark, peat moss, or other similar mulching material.
   d. Keep plants, including those in containers, in a moist condition until planted, by watering with fine mist spray.

1.6 PLANTING AND TURFGRASS INSTALLATION SEASONS AND CONDITIONS

A. Perform landscape planting operations during planting seasons normally recognized in the job locality for the species being utilized, but not before irrigation system installed, tested, and approved.

B. Perform turfgrass installation operations within the following dates, but not before irrigation system installed, tested, and approved.
   1. Spring Planting: March 15 to June 15.
   2. Fall Planting: August 15 to October 15.

C. Planting Restrictions: the following species have planting restrictions.
   1. Balled and Burlapped Deciduous Trees, Spring Planting only: March-April
      a. Oaks (Quercus) except for Swamp White Oak (Quercus bicolor)
      c. Buckeye (Aesculus)
      d. Coffeetree (Gymnocladus)
      f. Redbud (Cercis)

D. No work shall be done when the ground is frozen, snow covered, too wet or in an otherwise unsuitable condition for planting. Special conditions may exist that warrants a variance in the specified planting dates or conditions. Submit a written request to the COR stating the special conditions and proposal variance for approval.

1.7 LANDSCAPE PLANT AND TURF ESTABLISHMENT PERIOD

A. The Establishment Period for landscape plants and turfgrass shall begin immediately after installation, with the approval of the RE, PM or COTR and continue for a period of time during the growing season sufficiently long (optimally a minimum of 3 months) for the turfgrass and landscape plant materials to achieve an establishment condition and appearance satisfactory to the MSN Agronomist and NCA. These conditions and appearance are described as follows: Turfgrass shall have obtained a minimum of 98% surface cover that

is generally weed-free and Landscape Plant Materials shall be fully rooted, actively growing and healthy and planting beds generally weed-free. The contractor shall be responsible for the health and maintenance of plants and turfgrass during the establishment period. Plants and turfgrass will not be accepted until after completion of an acceptable establishment period. During the Landscape Plant and TurfGRASS Establishment Period the Contractor shall:

1. Water all plants and turfgrass to maintain a moist soil surface at all times until the plants and turfgrass are well established. An adequate supply of moisture must also be maintained within the root zone. Apply water at a moderate rate so as not to displace the mulch, create any water ponding or runoff from the soil supporting the plants and turfgrass. The actual quantity of applied water required to achieve and maintain these conditions is best determined on site by the MSN Agronomist in consultation with the Project Engineer.
2. Prune plants and replace mulch as required.
3. Replace and restore stakes, guy straps, and eroded plant saucers as required.
4. In plant beds and saucers, remove grass, weeds, and other undesired vegetation, including the root growth, before they reach a height of 75 mm (3 inches). After all unwanted vegetation has been removed and proper mulch quantities have been placed/restored, treat all mulched areas with pre-emergence granular ornamental herbicide containing 2.0% trifluralin and 0.5% isoxaben. Apply at 200 lb per acre prior to both early spring and early fall weed seed germination.
5. Spray with approved insecticides and fungicides to control pests and ensure plant survival in a healthy growing condition, as directed by the COR in coordination with the MSN Agronomist.
6. Provide the following during turfgrass establishment:
   a. Eradicate all weeds. Water, fertilize, overseed, and perform any other operation necessary to promote the growth of turfgrass.
   b. Mow the turfgrasses as often as necessary to maintain the NCA specified mowing height for each type of turfgrass prior to final acceptance. Begin mowing when cool season turfgrass is 100 mm (4 inches) high. For warm season turfgrasses mow at heights as appropriate for species and cultivar as directed by the RE/COTR in consultation with the MSN

Agronomist. Final mowing height is 65 mm (3.0 inch) for cool season turfgrasses and as appropriate for warm season turfgrasses and mow as often as necessary to maintain the proper height while never removing more than 1/3 of the total height of grass leaves in a single mowing. Mow any portion of the newly developing turfgrass stand that requires mowing without waiting for other areas of slowly developing seedlings to catch-up.

7. Replace dead, missing or defective plant material during the establishment period and an active growing season. Immediately replace each plant with one of the same size and species.
8. Replant any areas void of turfgrass during an active growing season only.
   a. Sod shall be evaluated for species and health thirty (30) days after laying the last piece of sod and reevaluated each 15 days during the establishment period. A satisfactory stand of grass plants from the sod operation shall be living sod uniform in color and leaf texture. Bare spots shall be a maximum two (2) square inches. Joints between sod pieces shall be tight and free from weeds and other undesirable growth.
   b. Seeding shall be evaluated for species and health thirty (30) days after final planting and reevaluated each 15 days during the establishment period. A satisfactory stand of grass plants from the seeding operation shall be 98% coverage uniform in color and leaf texture. Bare spots shall be a maximum of one-half (0.5) square foot. Unsatisfactory areas shall be reseeded within seven (7) days during an active growing season.
9. Complete remedial measures directed by the RE/COTR in consultation with the MSN Agronomist to ensure plant and turfgrass survival.
10. Repair damage caused while making plant or turfgrass replacements.

1.8 LANDSCAPE PLANT AND TURFGRASS ACCEPTANCE.

A. Landscape plant and turfgrass acceptance will occur after completion of the LANDSCAPE PLANT AND TURFGRASS ESTABLISHMENT PERIOD. The Contractor shall have completed, located, and installed all plants and turfgrass according to the plans and specifications. All plants and turfgrass are expected to be living and in a healthy condition at the time of inspection and acceptance. The Contractor shall make a written request two weeks prior to final inspection of the landscape plants and turfgrass. Upon inspection when work is found to

not meet the specifications, the PLANT AND TURFGRASS ESTABLISHMENT PERIOD shall be extended at no additional cost to the Government until work has been satisfactorily completed, inspected and accepted.

B. Criteria for acceptance of landscape plants.
   1. Planter beds and earth mound water basins are properly mulched and free of weeds.
   2. Tree support stakes, guys, and turnbuckles are in good condition.
   3. Total plants on site as required by specifications and required number of replacements have been installed.
   4. Remedial measures directed by the Contracting Officer to ensure plant material survival and promote healthy growth have been completed.

C. Criteria for acceptance of turfgrass shall be as follows:
   1. A satisfactory stand of grass plants from the sod operation shall be living sod uniform in color and leaf texture and well rooted into the soil below so that gentle pulling of the turfgrass leaves by hand does not dislodge the sod. Bare spots shall be a maximum two (2) square inches. Joints between sod pieces shall be tight and free from weeds and other undesirable growth.
   2. A satisfactory stand of turfgrass plants from the seeding operation shall be 98% coverage uniform in color and leaf texture. Bare spots shall be a maximum of one-half (0.5) square foot.

1.9 PLANT AND TURFGRASS WARRANTY

A. All work shall be in accordance with the terms of the Paragraph, "Warranty" of Section 00 72 00, GENERAL CONDITIONS, including the following supplements:
   1. A One Year Plant and Turfgrass Warranty will begin on the date that the Government accepts the plants and turfgrass but not before the end of the Landscape Plant and Turfgrass Establishment Period.
   2. The Contractor will replace any dead plant material and any areas void of turfgrass immediately during the warranty period and during an active growing season. A one year warranty for the plants and turfgrass that are replaced will begin on the day the replacement work is completed and accepted.
   3. Replacement of relocated plants, that the Contractor did not supply, is not required unless they die from improper handling and care during

transplanting. Loss through Contractor improper handling, care, or negligence requires replacement in kind and size.

4. The Government will reinspect all replacement plants and turfgrass at the end of the One Year Warranty. The Contractor will replace any dead, missing, or defective plant material and turfgrass immediately and during an active growing season. The Warranty will end on the date of this inspection provided the Contractor has complied with the work required by this specification.
5. The Contractor shall remove stakes, guy straps and any required tree wrappings from plants having been installed for one year, unless otherwise directed by the RE/COTR in consultation with the MSN Agronomist.

1.10 APPLICABLE PUBLICATIONS

A. NCA Handbook 3420 – Turfgrass Maintenance in VA National Cemeteries re-certified 2011. The Agronomic and Horticultural practices specified in this handbook shall serve as the contractor's official reference guide to all establishment and preliminary maintenance practices employed during this construction project.

B. 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.

C. American National Standards Institute (ANSI) Publications:

ANSI Z60.1-04 ..... Nursery Stock
ANSI Z133.1-06 ..... Tree Care Operations-Pruning, Trimming, Repairing, Maintaining, and Removing Trees and Cutting Brush- Safety Requirements

D. Hortus Third, most current edition. A Concise Dictionary of Plants Cultivated in the U.S. and Canada.

E. American Society for Testing and Materials (ASTM) Publications:

C136-06 ..... Sieve Analysis of Fine and Coarse Aggregates
C516-08 ..... Vermiculite Loose Fill Thermal Insulation
C549-06 ..... Perlite Loose Fill Insulation
D977-05 ..... Emulsified Asphalt (AASTHO M140)
D1557-09 ..... Test Methods for Laboratory Compaction of Soil
D2028-97 (Rev. 2004) ... Cutback Asphalt (Rapid-curing Type)
D2103-08 ..... Polyethylene Film and Sheeting

D5851 (Rev 2006) ..... Planning and Implementing a Water Monitoring Program

F. Turfgrass Producers International: Turfgrass Sodding.

G. U. S. Department of Agriculture Federal Seed Act.
Amended July 2011 ..... Rules and Regulations

PART 2 - PRODUCTS

2.1 GENERAL

All plant and turfgrass material will conform to the varieties specified or shown in the plant list and be true to botanical name as listed in Hortus Third.

2.2 ORGANIC SOIL AMENDMENT

A. All areas to receive turfgrass seeding, sodding or sprigging may require an organic soil amendment to increase organic content and water retention as well as enhance turfgrass growth. If native topsoil has an organic matter content below 4% it should be amended in-place after grading activities are completed to effectively create a satisfactory topsoil horizon.

B. Organic soil amendment will be spread and incorporated into the finished subgrade at the depths indicated on the Contract Drawings in order to raise the organic content of the soil to a minimum of four percent (4%) and a maximum of six percent (6%). Contractor will allow for additional depth of the organic soil amendment to bring all grades to the required finished grades as per the grading plans.

1. Organic Soil Amendment shall be dark brown or black in color and capable of enhancing plant growth. Ninety-eight percent (98%) of the material should pass a one inch (1”) screen. There shall be no admixture of refuse (i.e. noticeable inert contamination) or other materials toxic to plant growth.
2. Acceptable types of Organic Soil Amendments include peat moss, humus or peat, well rotted manure, various mature composts, and commercially available combinations thereof. Acceptable compost may be derived from natural organic sources such as food or animal residuals, yard trimmings, or biosolids. Organic Soil Amendment shall be free of all woody fibers, seeds, and leaf structures, plastic and other petroleum products, and free of toxic and non-organic matter. Unacceptable sole sources of organic

matter include untreated sludge from wastewater treatment plants, fresh manure, sawdust, and immature composts.

3. Organic Soil Amendment shall conform to the following minimum material requirements:

Test Parameter	Acceptable Ranges
Organic Matter	27% to 80%
pH	5.5-8.5
Ash	20-65%
Nitrogen	0.4%-3.5%
Phosphorus	0.2%-1.5%
Potassium	0.4%-1.5%
C:N Ratio	25-30:1
CEC	50-150 meq/100 g
	Heavy Metals Less than max. limits established by EPA 503
Inert Contents	< 1% by weight
Water-Holding Capacity	150-200%
Pathogen/Weed Seed Destruction	Proof of EPA minimum Heating requirements

4. Organic content to be determined by the loss of ignition of oven-dried samples. Test samples shall be oven-dried to a constant weight at a temperature of 110 °C, plus or minus 5°C.
5. Any topsoil stripped and stockpiled on the site may be used provided that, after testing and addition of necessary additives, it meets the above specification. The Contractor shall provide additional Organic Soil Amendment as required to complete the required work.
6. All Organic Soil Amendment proposed for use shall be tested for conformance to the specifications and results provided to the RE/COTR/MSN Agronomist.

2.3 PLANTS

A. Plants shall be in accordance with ANSI Z60.1, except as otherwise stated in the specifications or shown on the plans. Where the drawings or specifications are in conflict with ANSI Z60.1, the drawings and specification shall prevail.

B. Provide well-branched and formed planting stock, sound, vigorous, and free from disease, sunscald, windburn, abrasion, harmful insects or insect eggs with healthy, normal, and unbroken root systems. Provide trees, deciduous and evergreen, that are single trunked with a single leader, unless otherwise indicated, display no weak crotches. Provide symmetrically developed deciduous trees and shrubs of uniform habit of growth, with straight boles or stems and free from objectionable disfigurements, and evergreen trees and shrubs with well developed symmetrical tops with typical spread of branches for each particular species or variety. Provide ground cover and vine plants with the number and length of runners for the size specified, and the proper age for the grade of plants specified. Provide vines and ground cover plants well established in removable containers, integral containers, or formed homogeneous soil sections. Plants shall have been grown under climatic conditions similar to those in the locality of the project.

C. The minimum acceptable sizes of all plants, measured before pruning with branches in normal position, shall conform to the measurements designated. Plants larger in size than specified may be used with the approval of the COR, with no change in the contract price. When larger plants are used, increase the ball of earth or spread of roots in accordance with ANSI Z60.1.

D. Provide nursery grown, Grade 1, plant material conforming to the requirements and recommendations of ANSI Z60.1. Dig and prepare plants for shipment in a manner that will not cause damage to branches, shape, and future development after planting. Never pick-up or move tree species by grasping the trunk. Trees must be moved by lifting the root ball, box or container.

E. Balled and burlapped (B&B) plant ball sizes and ratios will conform to ANSI Z60.1, consisting of firm, natural balls of soil wrapped firmly with burlap or strong cloth and tied.

F. Bare-root (BR) plants shall have the root system substantially intact, but with the earth carefully removed. Cover roots with a thick coating of mud by "puddling" after the plants are dug.

G. Container grown plants shall have sufficient root growth to hold the earth intact when removed from containers, but shall not be root bound.

H. Make substitutions only when a plant (or its alternates as specified) is not obtainable and the COR in consultation with the MSN Agronomist authorizes a change order providing for use of the nearest equivalent obtainable size or

variety of plant having the same essential characteristics with an equitable adjustment of the contract price.

I. When existing plants are to be relocated, ball sizes shall conform to requirements for collected plants in ANSI Z60.1, and plants shall be dug, handled, and replanted in accordance with applicable sections of these specifications.

2.4 LABELS

Each plant, or group and bundles or containers of the same species, variety, and size of plant, shall be legibly tagged with a durable, waterproof and weather-resistant label indicating the correct plant name and size specified in the plant list. Labels shall be securely attached and not be removed.

2.5 TOPSOIL

A. Topsoil shall be a well-graded soil of good uniform quality. It shall be a natural, friable soil representative of productive soils in the vicinity. Topsoil shall be free of admixture of subsoil, foreign matter, objects larger than 25 mm (one inch) in any dimension, toxic substances, weeds and any material or substances that may be harmful to plant growth and shall have a pH value of not less than 6.0 nor more than 7.0, and should be best suited to the region, climate and plant material specific to the project.

B. Obtain material from stockpiles established under Section 31 20 11, EARTHWORK (SHORT FORM), subparagraph, Stripping Topsoil that meet the general requirements as stated above. Amend topsoil not meeting the pH range specified by the addition of pH Adjusters.

C. If sufficient topsoil is not available on the site to meet the depth as specified herein, the Contractor shall furnish additional topsoil. At least 10 days prior to topsoil delivery, notify the COR of the source(s) from which topsoil is to be furnished. Obtain topsoil from well drained areas. Additional topsoil shall meet the general requirements as stated above and comply with the requirements specified in Section 01 45 29, TESTING LABORATORY SERVICES. Amend topsoil not meeting the pH range specified by the addition of pH adjusters.

2.6 LIME

Lime shall be agricultural limestone containing not less than 90 percent calcium and magnesium carbonates. Lime must be ground to such fineness that

not less than 90% must pass No. 8 mesh and not less than 25% must pass No. 100 mesh. Moisture is not to exceed 10%.

2.7 SOIL CONDITIONERS

A. Peat shall be a natural product of sphagnum peat moss derived from a fresh-water site conforming to Fed. Spec. Q-P-166, except as otherwise specified. Peat shall be shredded and granulated to pass through a 13 mm (1/2 inch) mesh screen and conditioned in storage piles for at least six months after excavation.

B. Coarse Sand: Coarse concrete sand, ASTM C-33 Fine Aggregate, shall be clean, sharp, and free of limestone, shale and slate particles and of toxic materials.

C. Perlite shall conform to ASTM C549.

D. Vermiculite shall be horticultural grade and free of any toxic materials and conform to ASTM C516.

E. Pine Bark shall be horticultural-grade milled pine bark, with 80 percent of the material by volume sized between 0.1 and 15.0 mm. (.004in. and .59in.).

1. Pine bark shall be aged sufficiently to break down all woody material. Pine bark shall be screened
2. pH shall range between 4.0 and 7.0.
3. Submit manufacturer’s literature for approval.

F. Organic Matter shall be commercially prepared compost, composted sufficiently to be free of all woody fibers, seeds, and leaf structures, and free of toxic and nonorganic matter.

2.8 PLANTING SOIL MIXTURE

The planting soil mixture shall be composed of 3 parts topsoil, and 1 part peat moss.

2.9 PLANT FERTILIZERS

A. Provide plant fertilizer that is commercial grade and uniform in composition and conforms to applicable state and federal regulations.

B. For new plant material, provide a uniform free-flowing granular complete analysis fertilizer containing a minimum of 10% by weight of nitrogen, phosphoric acid and potash with a minimum of 50% of the nitrogen from a controlled release source such as sulfur coated urea.

C. For existing trees, provide a uniform free-flowing granular fertilizer bearing the manufacturer's warranted statement of analysis. Granular fertilizer shall contain a minimum percentage by weight of 10% nitrogen (of which 50 percent shall be from a controlled release source such as sulfur coated urea.), 10% available phosphoric acid, and 10% potash.

2.10 TURFGRASS FERTILIZER

Provide turfgrass fertilizer that is commercial grade, free flowing, uniform in composition, and conforms to applicable state and federal regulations. Granular fertilizer shall bear the manufacturer's warranted statement of analysis. Granular fertilizer shall contain a minimum percentage by weight of 20% nitrogen (of which 50 percent shall be from a controlled release source such as sulfur coated urea), 5% available phosphoric acid, and 15% potash. Liquid starter fertilizer for use in the hydro mulch slurry will be commercial type with 50 percent of the nitrogen from a controlled release source.

2.11 MEMBRANES

A. Polyethylene shall conform to ASTM D2103 and shall be 0.1 mm (four mils) thick and clear in color.

B. Fiberglass mat shall be of lime borosilicate glass fibers with an average fiber diameter of 0.3 mm (8 to 12 microns) and 50 to 100 mm (2 to 4 inch) strands of fiber bonded with phenol formaldehyde resin. The mat shall be 100 percent textile glass fiber. Mat shall be roll type, water permeable, and a minimum of 6 mm (1/4 inch) and maximum of 13 mm (1/2 inch) thick with a density of not less than 12 kg/m3 (3/4 pound per cubic foot).

C. Landscape Fabric shall be a spun bonded polyester fabric weighing 18 grams per square meter (¾ oz per sq. yd) and with a 9,000 liter per minute flow rate per sq. meter (225 gal. per minute flow rate per sq. ft.)

2.12 MULCH

A. Mulch shall be free from deleterious materials and shall be stored as to prevent inclusion of foreign material.

B. Inert mulch materials shall be riverbank stone, granite chips, marble chips, volcanic rock or similar and shall range in size from 25 mm (one inch) to 65 mm (2-1/2 inches) in accordance with ASTM C 136.

C. Organic mulch materials shall be wood based products such as chips, nuggets or shredded hardwood:

1. Straw for turfgrass seed bed mulch shall be stalks from oats, wheat, rye, barley, or rice that are free from noxious weeds, mold or other objectionable material. Straw shall be in an air-dry condition and suitable for placing with blower equipment.
2. Wood cellulose fiber mulch for use with hydraulic application (Hydro mulch) with fertilizer shall consist of specially prepared wood cellulose fiber, processed to contain no growth or germination-inhibiting factors, and dyed an appropriate color to facilitate visual metering of the application of materials. Do not apply any turfgrass seed in this type mixture. On an air-dry weight basis, the wood cellulose fiber shall contain a maximum of 12 percent moisture, plus or minus three percent at the time of manufacture. The pH range shall be from 3.5 to 5.0. The wood cellulose fiber shall be manufactured so that:
   a. After addition and agitation in slurry tanks with fertilizers, water, and other approved additives, the fibers in the material will become uniformly suspended to form a homogenous slurry.
   b. When hydraulically sprayed on the ground, the material will form a blotter like cover.
   c. The cover will allow the absorption of moisture and allow rainfall or applied water to percolate to the underlying soil.

D. Rock Mulch at flower watering stations shall match existing flower watering stations materials. Material shall be 3/4” dia. clear material matching existing flower water stations types.

2.13 ASPHALT ADHESIVE

Asphalt adhesive for application with straw mulch shall be liquid asphalt conforming to ASTM D2028, designation RC-70, or emulsified asphalt conforming to ASTM D977, Grade RS-1.

2.14 EROSION CONTROL

A. Erosion control net material shall be heavy, twisted jute mesh weighing 0.92 pounds per square yard) with 60-65% open area. Material will be secured with 150 mm (6 inch) wire staples made by the same manufacturer as the netting. All erosion control material is to be installed according to the respective manufacturer's recommendations.

2.15 TREE WRAP

A. Breathable synthetic fabric tree wrap. White in color, delivered in 75 mm (3 in.) wide rolls, specifically manufactured for tree wrapping. Tree wrap shall be "Breathable Fabric Tree Wrap" as manufactured by the Dewitt Company, Inc., Sikeston, MO, or approved equal. Submit manufacturer literature for approval.

B. Tree wrap shall be secured to the trunk using bio-degradable tape suitable for nursery use and which is expected to degrade in sunlight in less than two years after installation.

2.16 STAKES AND GUYING STRAPS

A. Provide stakes for tree support of rough sawn wood, free from knots, rot, cross grain, or other defects that would impair the strength. Stakes shall be a minimum of 50 mm by 50 mm (2 inches by 2 inches), or 65 mm (2-1/2 inches) in diameter, by 2400 mm (8 feet) long and pointed at one end or galvanized steel pipe 32 mm (1 ¼ in.) x 3000 mm (10’) with cap, primed with 2 coats flat black exterior enamel.

B. Hose chafing guards shall be new or used 2-ply reinforced rubber or plastic hose of all the same color on the project.

C. Flags to be fastened to guys shall be surveyor's plastic tape, white in color and 150 mm (6 inches) in length.

D. Guying straps shall be a fabric material designed specifically to guy newly planted trees. No wire should ever be used for this purpose.

E. Turnbuckles shall be galvanized or cadmium-plated and have a 75 mm (3 inch) minimum lengthwise opening fitted with screw eyes.

F. Eye bolts shall be galvanized or cadmium plated having a 50 mm (one inch) diameter eye with a minimum screw length of 40 mm (1-1/2 inches).

G. Deadmen shall be 100 mm by 200 mm (4 inch by 8 inch) rectangular, or 200 mm (8 inch) diameter by 900 mm (36 inch) long sound wood.

H. Arrow shaped or auger iron anchors shall be noncorrosive, and sized according to the manufacturer's recommendation.

2.17 EDGING

As a general requirement no artificial or constructed product shall be used to edge landscape beds that are bordered by turfgrass. Any deviation from this requirement must be approved by the COR after consultation with both the MSN and Chief Agronomist. Properly mulched beds shall be edged by the newly established turfgrass plantings that border and/or surround them.

2.18 WATER

Water shall not contain elements toxic to plant life. It shall be obtained as specified in Section 01 00 02, GENERAL REQUIREMENTS (MINOR NCA PROJECTS), paragraph, Availability and Use of Utility Services at the current billing rate as determined by the cemetery utility billing to the Contractor.

2.19 ANTIDESICCANT

Antidesiccant shall be an emulsion specifically manufactured for agricultural use that will provide a protective film over plant surfaces permeable enough to permit transpiration.

2.20 SEED

A. Seed shall be state-certified seed of the latest season's crop and shall be delivered in original sealed packages bearing the producer's warranted analysis for percentages of mixtures, purity, germination, weed seed content, and inert material. Seed shall be labeled in conformance with U. S. Department of Agriculture rules and regulations under the Federal Seed Act and applicable state seed laws. Seed that has become wet, moldy, or otherwise damaged will not be acceptable. Onsite seed mixing shall be done only in the presence of the COR. All turfgrass seeding operations shall be done separately and prior to the application of any mulch material.

B. Minimum Acceptable Seed Quality standards for all turfgrass seed utilized are as follows: Purity 95%, Germination 85%, Weed Seed Content less than 0.5%, Noxious Weeds 0.0%, Inert Material less than 3%, Germination Test Date no older than 6 months.

C. All turfgrass seed mixtures, or sod composition shall conform to the species and cultivar requirements detailed here: The seed mixtures listed below are representative of an almost endless list of acceptable seed mixtures that roughly approximate these guidelines.

Cool Season Turfgrass Seed Mixtures: Seed is % by weight

Primary mixture* – 50% perennial ryegrass, 30% Ky bluegrass, 20% fine fescue
SEEDING RATE = 6 lb/1000 sq.ft.

Secondary mixture* – 50% tall fescue and 50% perennial ryegrass
SEEDING RATE = 10 lb/1000 sq.ft.

Each of these species components should be a blend composed of a minimum of 2 regionally adapted cultivars.

Note: Verify seed mix variety with current seed used by cemetery. Notify COR and AE of any deviation from plans and specifications.

Any deviation from these turfgrass species requirements must be approved in writing by the NCA Chief Agronomist and/or appropriate MSN Agronomist in coordination with the RE and/or COTR.

2.21 SOD

Sod shall be nursery grown, certified sod as classified in the TPI Guideline Specifications to Turfgrass Sodding. Sod must also conform to the turfgrass species limitations as outlined in seeding mixtures in 2.20C above in this spec.

2.22 HERBICIDES AND OTHER PESTICIDES

All herbicides and other pesticides shall be properly labeled and registered with the U.S. Environmental Protection Agency. Keep all pesticides in the original labeled containers indicating the analysis and method of use.

2.23 GLACIAL BOULDERS

Glacial Boulders shall be naturally harvested, free of scrapes and fractures. Boulders shall be native to the Akron, Ohio area. Boulders shall not be less than a 2 to 1 width to height ratio as measured by the exposed vertical face of the in-place stone. Boulders shall not be less than 6 cubic feet nor more than 36 cubic feet in volume. The mix of stone sizes shall be such that no single size shall comprise more than 15% of the total exposed face of the stone placement.

All stones shall be hand set. Stones shall be placed in a manner that most realistically mimics natural conditions. Stones shall be placed so that the widest dimension of the stone is parallel to the ground plane. The boulders shall be chosen to insure a secure fit and stable final installation.

The Contractor shall notify the COR / SRE with a minimum notice of 14 days prior to beginning stone installation. The landscape Architect shall be on site during the initial day of stone installation and provide the Contractor with additional aesthetic guidance in placement of the boulders.

2.24 DECORATIVE AGGREGATE (FLOWER STRIP)

Washed, narrowly graded mixture of uncrushed gravel coarse aggregate with 100 percent passing 3/4” sieve, 90-100 percent passing 1/2” sieve, 40-70 percent 3/8” sieve, and 0-15 percent passing No. 4 sieve and less than 5 percent

passing the No. 8 sieve. Stone color to match existing gravel flower strips (brown-beige-white-gray).

PART 3 – EXECUTION

3.1 LAYOUT

Stake plant material locations and bed outlines on project site for approval by the COR before any plant pits or beds are dug. The COR may approve adjustments to plant material locations to meet field conditions.

3.2 FINE GRADING AND ORGANIC SOIL AMENDMENT INCORPORATION

A. Contractor shall obtain COR's written approval of previously completed rough grading work prior to commencing organic soil amendment incorporation work.

B. Immediately prior to dumping and spreading the approved organic soil amendment, the subgrade shall be cleaned of all stones greater than two inches (2") and all debris or rubbish. Such material shall be removed from the site. Prior to spreading of the organic soil amendment, subgrades which are too compact to drain water and too compact based upon compaction tests shall be ripped with a claw one foot (1') deep, pulled by a bulldozer two feet (2') on center, both directions. Contractor shall then regrade surface.

C. Organic soil amendment material shall be placed and uniformly spread over approved finish sub-grades to a depth sufficiently greater than the specified depth so that after natural settlement and light rolling, the specified minimum compacted depth will have been provided and the completed work will conform to the lines, grades and elevations indicated. Incorporate organic soil amendment by disc harrowing, rototilling or other means in a uniform manner. The depth of incorporation shall be based upon the organic content of the tested and approved organic soil amendment, so as to produce a finished soil with an organic matter content of between four (4) and six percent (6%). Supply additional organic soil amendment material, after in-place testing and approval (see paragraph 1.4. E.1d), as may be needed to give the required organic matter content and finished grades under the Contract without additional cost to the Government.

D. Disturbed areas outside the limit of work shall be spread with four inch (4") minimum depth of organic soil amendment material to the finished grade.

E. No subsoil or organic soil amendment material shall be handled in any way if it is in a wet or frozen condition.

F. Sufficient grade stakes shall be set for checking the finished grades. Stakes must be set in the bottom of swales and at the top of slopes. Connect contours and spot elevations with an even slope.

G. After organic soil amendment material has been incorporated into the subsoil, it shall be carefully prepared by scarifying or harrowing and hand raking. Remove all large stiff clods, lumps, brush, roots, stumps, litter and other foreign matter. Remove all stones over one and one half inch (1-1/2”) diameter from the amended soil bed. The amended soil shall also be free of smaller stones in excessive quantities as determined by the COR.

3.3 EXCAVATION FOR PLANTING

A. The whole surface shall then be compacted with a roller or other suitable means to achieve a maximum dry density of 88 to 90 percent in accordance with compaction standards of ASTM D1557 Method D. During the compaction process, all depressions caused by settlement or rolling shall be filled with additional organic soil amendment and the surface shall be regraded and rolled until presenting a smooth and even finish corresponding to the required grades. The acceptable condition of the finished soil grade for all areas that are to be established to turfgrass is best described as “**fine textured and firm**”. **The test for satisfactory firmness requires that the surface soil not be fluffy or powdery and will support the weight of an average adult person without creating a visible depression.**

B. Prior to excavating for plant pits and bed, verify the location of any underground utilities. Damage to utility lines will be repaired at the Contractor's expense. Where lawns have been established prior to planting operation, cover the surrounding turfgrass before excavations are made in a manner that will protect turfgrass areas. Barricade existing trees, shrubbery, and beds that are to be preserved in a manner that will effectively protect them during the project construction.

C. Remove rocks and other underground obstructions to a depth necessary to permit proper planting according to plans and specifications. Where underground utilities, construction, or solid rock ledges are encountered, the COR may select other locations for plant material.

D. Dig plant pits by any approved method so that they have vertical sides and flat bottoms. When pits are dug with an auger and the sides of the pits become glazed, scarify the glazed surface.

E. Where ground cover and planting beds occur in existing turfgrass areas, remove turfgrass to a depth that will ensure the removal of the entire root system, with additional bed preparation as specified in the next paragraph.

F. Where existing soil is to be used in place, till new ground cover and plant beds to a depth of 100 mm (4 inches). Spread peat soil amendment uniformly over the bed to depth of 50 mm (2 inches) and thoroughly incorporate it into the existing soil to a depth of 100 mm (4 inches) using a roto-tiller or similar type of equipment to obtain a uniform and well pulverized soil mix. Where existing soil is compacted (former roadways, parking lots, etc.) till the soil down to a depth necessary to support the growth of new planting. During tillage operations, remove all sticks, stones, roots, and other objectionable materials. Bring plant beds to a smooth and even surface conforming to established grades.

G. In areas of new grading where existing soil is being replaced for the construction of new ground cover and plant beds, remove 100 mm (4 inches) of existing soil and replace with topsoil. Plant beds shall be brought to a smooth and even surface conforming to established grades. Till 50 mm (2 inches) of peat soil amendment into the topsoil as specified.

H. Using topsoil, form earth saucers or water basins for watering around plants. Basins to be 2” high for shrubs and 4” high for trees.

I. Treat plant saucers, shrub, and ground cover bed areas, after mulching, with preemergence granular ornamental herbicide containing 2.0% trifluralin and 0.5% isoxaben. Apply at 200 lb per acre prior to both early spring and early fall weed seed germination. Plant ground cover in areas to receive erosion control material through that material after material is in place.

3.4 SETTING PLANTS

A. Handle balled and burlapped and container-grown plants only by the ball or container. Remove container-grown plants in such a way to prevent damage to plants or root system. Set plants plumb and hold in position until sufficient soil has been firmly placed around the roots or ball. Set plants so that the root crown is 1” higher than the surrounding grade. Plant ground cover plants

after the mulch is in place. Avoid contaminating the mulch with the planting soil.

B. Backfill balled and burlapped and container-grown plants with the native soil removed from the planting hole to approximately half the depth of the ball and then tamp and water. It is desirable to use 100% percent native soil to backfill the hole, but do not use unsuitable fill containing clay, rock or other unsuitable material. For balled and burlapped plants, carefully fold back the top half of the burlap and remove tying materials. Any wire caging or similar material, must be completely removed. Where plastic wrap or treated burlap is used in lieu of burlap, completely remove these materials before backfilling. Tamp and water remainder of backfill native soil; then form earth saucers or water basins around isolated plants with topsoil.

C. Plant bare-root stock arranging the roots in a natural position. Form a hill or mound in the center of the planting hole to allow the plant to sit at the proper depth. The roots are then spread out, over, and down the "hill" in a natural position. The "hill" should be firm to avoid settlement of the entire plant. Remove damaged roots with a clean cut. Carefully work native soil in among the roots. Tamp and water the remainder of native soil; then form earth saucers or water basins around isolated plants with topsoil.

3.5 TRUNK WRAPPING

Wrap the trunks of deciduous trees immediately after planting. Wrap the trunks of deciduous trees, 40 mm (1-1/2 inches) or greater in caliber with the specified material beginning at the base and extending to the first branches. Remove wrapping after one year. When using Crinkled Paper Wrap, securely tie wrapping at the top and bottom and at 450 mm (18 inch) maximum intervals with twine.

3.6 STAKING AND GUYING

A. Stake and guy plants as shown on the drawings and as specified.

B. Drive stakes vertically into the ground to a depth of 800 to 900 mm (2-1/2 to 3 feet) in such a manner as not to injure the ball or roots, unless otherwise shown on the drawings.

C. Place deadmen not less than 450 mm (18 inches) below the surface of the ground, unless otherwise shown on the drawings.

D. Install iron anchors according to manufacturer's recommendations.

E. Fasten flags securely on each guy strap approximately 2/3 of the distance up from ground level.

F. Remove stakes and guy straps after one year.

3.7 EDGING PLANT BEDS

A. Uniformly edge beds using a sharp tool to provide a clear cut division line between the planted area and the adjacent turfgrass. Do not use any type of manufactured edging material. The properly mowed and maintained turfgrass will serve as edging for all landscape beds.

3.8 MULCHING PLANTS

A. Mulch within 48 hours after planting and apply a preemergence granular ornamental herbicide containing 2.0% trifluralin and 0.5% isoxaben. Apply at 200 lb per acre prior to both early spring and early fall weed seed germination. Do not mulch in ground cover areas that shall have organic material placed before planting.

B. Placing Inert Material: Place polyethylene sheet fiberglass mat Landscape fabric with edges lapped 150 mm to 300 mm (6 inches to 12 inches) to receive inert mulch material. Punch a grid of 6 mm (1/4 inch) holes for drainage in the polyethylene sheet fiberglass mat 300 mm (one foot) on centers over the entire area. Spread inert mulch to a uniform thickness over the membrane as shown.

C. Placing Organic Material: Spread a mulch of wood based origin to a uniform minimum thickness of 50-75 mm (2-3 inches).

D. Keep mulch out of the crowns of shrubs and off buildings, sidewalks, light standards, and other structures.

3.9 PRUNING

A. Prune new plant material and indicated existing plant material in the following manner: Remove dead, broken and crossing branches. Make cuts with sharp instruments as close as possible to the branch collar. Do not make flush cuts. Do not make "Headback" cuts at right angles to line of growth. Do not pole trees or remove the leader. Remove trimmings from the site. Do not use any type of wound dressing on pruning cuts.

B. Existing trees to be pruned are shown on the drawings. Perform tree pruning and cavity work by a licensed arborist an arborist in accordance with ANSI Z 133.1. Remove dead wood 13 mm (1/2 inch) or more in diameter, branches interfering with or hindering the healthy growth of the trees, and diseased

branches with a clean cut made flush with the branch collar. Cut back or remove branches as necessary to give the trees proper shape and balance. In removing large limbs, make the initial cut on the underside at a safe distance from the trunk or lateral, to prevent ripping of bark. Ensure branches and trimmings do not endanger traffic or cause damage to property during removal. Section large branches or limbs that cannot be removed in one piece without endangering traffic or property. Lower sections by ropes. Repair any damage resulting from the Contractor's negligence during pruning. Workmen are not permitted to climb trees with climbing spurs. To promote proper healing, cut off flush with the branch collar stubs or limbs that have resulted from improper cuts or broken as a result of former pruning. Remove girdling roots.

3.10 FERTILIZATION OF EXISTING TREES

Apply fertilizer to existing trees shown on the drawings at the rate of 36 g/mm (2 pounds per inch) caliper. Apply in 300 mm to 450 mm (4 inch to 8 inch) deep holes 40 to 50 mm (1-1/2 to 2 inches) in diameter, made by an earth auger, distributed evenly at not more than 600 mm (2 feet) on center throughout the outer half of the branch spread zone of each tree. Fertilize to within 100 mm (4 inches) of the surrounding grade. Use topsoil to bring the surface up to the surrounding grade. When using fertilizer in packet, tablet, or wedge form, apply in accordance with manufacturer's recommendations.

3.11 TILLAGE FOR TURFGRASS AREAS

Thoroughly till the soil to a depth of at least 150 mm (6 inches) by scarifying, disking, harrowing, or other approved methods. This is particularly important in areas where heavy equipment has been used. Remove all debris and stones larger than 25 mm (one inch) remaining on the surface after tillage in preparation for finish grading. To minimize erosion, do not till areas of 3:1 slope ratio or greater. Scarify these areas to a 50 mm (one inch) depth and remove debris and stones.

3.12 FINISH GRADING

After tilling the soil for bonding of topsoil with the subsoil, spread the topsoil evenly to a minimum depth of ____150____ mm (6 inches). Incorporate topsoil at least 50 to 75 mm (2 to 3 inches) into the subsoil to avoid soil layering. Do not spread topsoil when frozen or excessively wet or dry.

Correct irregularities in finished surfaces to eliminate depressions. Protect finished topsoil areas from damage by vehicular or pedestrian traffic. Complete lawn work only after areas are brought to finished grade.

3.13 APPLICATION OF FERTILIZER AND LIME FOR TURFGRASS AREAS

A. Apply turfgrass fertilizer at a rate that will deliver 1 pound of nitrogen per 1000 sq.ft. In addition, adjust soil acidity as recommended by soil test results and add any soil conditioners as specified herein for suitable topsoil under PART 2, Paragraph 2.2AandB, and 2.5 TOPSOIL.

B. Spread lime as recommended by the soil test results.

C. Incorporate lime into the soil to a depth of at least 100 mm (4 inches) as part of the finish grading operation. Starter fertilizer should be lightly mixed with the top ½ inch of soil. Immediately restore the soil to an even condition before any seeding or sod placement.

3.14 MECHANICAL SEEDING

A. Broadcast seed by approved application equipment at the rate as outlined in section 2.20C in this spec above. All turfgrass seed shall be planted prior to the application of any mulch material. The seed shall be uniformly distributed in a minimum of 2 directions at right angles to each other. Drag the seeded area to inter-mingle the seed and surface soil by means of spike-tooth harrow, cultipacker, or other approved device.

B. Immediately after dragging, firm the entire area with a roller not exceeding 225 kg/m (150 pounds per foot) of roller width.

C. Immediately after preparing the seeded area, evenly spread an organic mulch of straw by hand or by approved mechanical blowers at the rate of 0.5 kg/m2 (2 tons per acre). Application shall allow some sunlight to penetrate and air to circulate but also reduce soil and seed erosion and conserve soil moisture. Anchor mulch by a mulch tiller, asphalt emulsion, twine, or netting. When asphalt emulsion is used, apply either simultaneously or in a separate application. Take precautionary measures to prevent asphalt materials from marking or defacing structures, pavements, utilities, or plantings.

3.15 HYDRO-MULCHING

When hydro-mulching, mix the slow release starter fertilizer, approved wood cellulose mulch material in the required amount of water to produce a homogenous slurry and then uniformly apply slurry under pressure to deliver the recommended quantity of fertilizer per 1000 sq.ft.

3.16 SODDING

A. Accomplish sodding in accordance with the ASPA Guideline Specifications for sodding. Lay sod at right angles to slope or the flow of water. On slope areas, start at the bottom of the slope.

B. After completing the sodding operation, blend the edges of the sodded area smoothly into the surrounding area. All sod should be rolled with a light-weight roller after being laid to eliminate air spaces between the sod and the firmed soil.

3.17 WATERING

A. Apply water to the turfgrass areas immediately following installation at a rate sufficient to ensure thorough wetting of the soil to a depth of at least 50 mm (2 inches). Supervise watering operation to prevent run-off. Supply all pumps, hoses, pipelines, and sprinkling equipment. Repair all areas damaged by water operations. Keep soil surface constantly moist, not wet, until turfgrass plants are well established.

B. Contractor shall deep water all trees twice each week during the Plant Establishment Period, providing water penetration throughout the root zone to the full depth of the planting pits, as verified in the field by the COR. Watering shall cease at the first hard frost in the fall and shall resume upon ground thaw in the spring.

3.18 PROTECTION OF TURFGRASS AREAS

Immediately after installation of the turfgrass areas, protect against traffic or other use by erecting barricades, as required, and placing approved signs at appropriate intervals until final acceptance.

3.19 EROSION CONTROL MATERIAL

A. Install and maintain erosion control material meeting the requirements of this specification on the designated areas as shown and specified. Prepare, fertilize and vegetate the area(s) to be covered, as specified, before the erosion material is placed. Immediately following the planting operations lay the material evenly and smoothly and in contact with the soil throughout.

Omit the straw mulch from all seeded areas receiving the erosion control material.

B. For waterways, unroll the material in the direction of water flow. When two or more strips are required to cover a ditch area, they shall overlap at least 100 mm (4 inches). In case a strip is to be spliced lengthwise, the ends of the strips shall overlap at least 150 mm (6 inches) with the upgrade section on top.

C. When using erosion control material on slopes, place the material either horizontally or vertically to the slope with the edges and ends of adjacent strips butted tightly against each other.

D. Staple each strip in three rows (each edge and center with the center row alternately spaced) with staples spaced not more than 1200 mm (4 feet) longitudinally. When using two or more strips side by side on slopes, use a common row of staples on the adjoining strips. Staple all end strips at 300 mm (one foot) intervals at the end. Firmly embed staples in the underlying soil.

E. Maintenance shall consist of repairs made necessary by erosion, wind, or any other cause. Maintain, protect, repair, or replace the erosion control material until the Termination of the Plant and Warranty Period.

3.20 RESTORATION AND CLEAN-UP

Where existing or new turfgrass areas have been damaged or scarred during planting and construction operations, restore disturbed area to their original condition. Keep at least one paved pedestrian access route and one paved vehicular access route to each building clean at all times. In areas where planting and turfgrass work have been completed, clear the area of all debris, spoil piles, and containers. Clear all other paved areas when work in adjacent areas are completed. Remove all debris, rubbish and excess material from the station.

3.21 ENVIRONMENTAL PROTECTION

All work and Contractor operations shall comply with the requirements of Section 01 57 19, TEMPORARY ENVIRONMENTAL CONTROLS.

--END--

SECTION 33 10 00

WATER UTILITIES

PART 1 – GENERAL

1.1 DESCRIPTION

A. This section specifies materials and procedures for construction of underground water distribution within the cemetery to re-route existing water mains around proposed gravesites, install flower watering stations, and proposed water main extensions to serve proposed irrigation systems. This includes proposed connections to existing water distribution system, piping, structures, appurtenances and all other incidentals that provides water supply to the on-site buildings, fire hydrants, flower water stations, and irrigation systems. However, this Specification Section excludes irrigation piping, sprinkler heads, and other irrigation appurtenances.

1.2 RELATED WORK

A. Excavation, Trench Widths, Pipe Bedding, Backfill, Shoring, Sheeting, Bracing: Section 31 20 11, EARTH MOVING (SHORT FORM).

B. Concrete: Section 03 30 00, CAST IN-PLACE CONCRETE.

C. Submittals: Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA AND SAMPLES.

D. Erosion and Sediment Control: Section 01 57 19, TEMPORARY ENVIRONMENTAL CONTROLS.

E. Irrigation: Section 32 84 00 PLANTING IRRIGATION.

1.3 DEFINITIONS

A. Water distribution system: Pipelines and appurtenances which are part of the distribution system outside the building for potable water and fire supply.

B. Water service line: Pipeline from main line to 5 feet outside of building.

1.4 ABBREVIATIONS

A. PVC: Polyvinyl chloride plastic.

B. DI: Ductile iron pipe.

1.5 DELIVERY, STORAGE AND HANDLING

A. Ensure that valves are dry and internally protected against rust and corrosion. Protect valves against damage to threaded ends and flange faces.

B. Use a sling to handle valves if size requires handling by crane or lift. Rig valves to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

C. Deliver piping with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe-end damage and to prevent entrance of dirt, debris, and moisture.

D. Protect stored piping from moisture and dirt by elevating above grade. Protect flanges, fittings, and specialties from moisture and dirt.

E. Store plastic piping protected from direct sunlight and support to prevent sagging and bending.

F. 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.

1.6 QUALITY ASSURANCE:

A. Products Criteria:

1. 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. A nameplate bearing manufacturer's name or trademark, including model number, shall be securely affixed in a conspicuous place on equipment. In addition, the model number shall be either cast integrally with equipment, stamped, or otherwise permanently marked on each item of equipment.

B. Materials and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products for at least three years.

C. Regulatory requirements:

1. Comply with the rules and regulations of the public utility company having jurisdiction over the connection to public water lines and the extension and/or modifications to public utility systems.
2. Comply with the rules and regulations of the Federal, State, and/or Local Health Department having jurisdiction for potable water-service.
3. Comply with rules and regulations of Local authorities having jurisdiction for fire-suppression piping including materials, hose threads, installation and testing.

D. Provide certification of factory hydrostatic testing of not less than 500 psi (3.5 MPa) in accordance with AWWA C151. Piping materials shall bear the label, stamp or other markings of the specified testing agency.

E. 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.

F. 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.

G. Applicable codes:
1. Plumbing Systems: IPC, International Plumbing Code.
2. Electrical components, devices and accessories shall be listed and labeled as defined in NFPA 70, Article 100, by a testing agency

acceptable to authorities having jurisdiction and marked for intended use.

3. Fire-service main products shall be listed in the FM Global "Approval Guide" or Underwriters Laboratories (UL) "Fire Protection Equipment Directory".

1.7 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):

MSS SP-60-2004 .....Connecting Flange Joint Between Tapping Sleeves and Tapping Valves

MSS SP-123-1998(R2006)..Non-Ferrous Threaded and Solder-Joint Unions for Use With Copper Water Tube

C. American Society of Mechanical Engineers (ASME):

A112.1.2-2004.....Air Gaps in Plumbing Systems (for Plumbing Fixtures and Water-Connected Receptors))

B16.18-2001.....Cast Copper Alloy Solder Joint Pressure Fittings

B16.22-2001.....Wrought Copper and Copper Alloy Solder Joint Pressure Fittings

B16.24-2006.....Cast Copper Alloy Pipe Flanges and Flanged Fittings; Classes 150, 300, 600, 900, 1500 and 2500

B31.....Code for Pressure Piping Standards

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

B88/B88M-09.....Seamless Copper Water Tube

C651-05.....Disinfecting Water Mains

D1785-06.....Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120

D2464-06.....Threaded Poly (Vinyl Chloride) PVC Pipe Fittings, Schedule 80

D2466-06.....Poly (Vinyl Chloride) (PVC) Pipe Fittings, Schedule 40

D2467-06.....Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80

E. American Water Works Association (AWWA):

B300-10.....Hypochlorites

B301-10.....Liquid Chlorine

C111/A21.11-07.....Rubber-Gasket Joints for Ductile Iron Pressure Pipe and Fittings

C151/A21.51-09.....Ductile Iron Pipe, Centrifugally Cast

C509-09.....Resilient-Seated Gate Valves for Water Supply Service

C550-05.....Protective Interior Coatings for Valves and Hydrants

C600-10.....Installation of Ductile Iron Mains and Their Appurtenances

C605-11.....Underground Installation of Polyvinyl Chloride (PVC) Pressure Pipe and Fittings for Water

C606-11.....Grooved and Shouldered Joints

C651-05.....Disinfecting Water Mains

C800-05.....Underground Service Line Valves and Fittings

C900-09.....Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 In. Through 12 In. (100 mm Through 300 mm), for Water Transmission and Distribution

C907-04.....Injection-Molded PVC Pressure Fittings, 4 Inch through 12 Inch (100 mm through 300 mm), for Water Distribution

M23-2nd Ed.....PVC Pipe, Design and Installation

M44-2nd Ed.....Distribution Valves: Selection, Installation, Field Testing and Maintenance

F. NSF International (NSF):

NSF/ANSI 14 (2013).....Plastics Piping System Components and Related Materials

NSF/ANSI 61-2012.....Drinking Water System Components - Health Effects

NSF/ANSI 372-2011.....Drinking Water System Components - Lead Content

G. American Welding Society (AWS):

A5.8/A5.8M-2004 .....Filler Metals for Brazing and Braze Welding

H. Underwriters' Laboratories (UL):

262.....Gate Valves for Fire-Protection Service

1285.....Pipe and Couplings, Polyvinyl Chloride (PVC), and Oriented Polyvinyl Chloride (PVCO) for Underground Fire Service

1.8 WARRANTY

A. The Contractor shall remedy any defect due to faulty material or workmanship and pay for any damage to other work resulting therefrom within a period of two years from final acceptance. Further, the Contractor will furnish all manufacturers' and supplier's written guarantees and warranties covering materials and equipment furnished under this Contract.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Material or equipment containing a weighted average of greater than 0.25 percent lead shall not be used in any potable water system intended for human consumption, and shall be certified in accordance with NSF/ANSI 61 or NSF 372.

B. Plastic pipe, fittings, and solvent cement shall meet NSF/ANSI 14 and shall be NSF listed for the service intended.

2.2 FACTORY-ASSEMBLED PRODUCTS

A. Standardization of components shall be maximized to reduce spare part requirements. The contractor shall guarantee performance of assemblies of components, and shall repair or replace elements of the assemblies as required to deliver specified performance of the complete assembly.

2.3 SAFETY GUARDS

A. All equipment shall have moving parts protected to prevent personal injury. Pump shafts and couplings shall be fully guarded by a sheet steel guard, covering coupling and shaft but not bearings. Material shall be minimum 16-gauge sheet steel; ends shall be braked and drilled and attached to pump base with minimum of four 1/4 inch (6 mm) bolts. Reinforce guard as necessary to prevent side play forcing guard onto couplings.

2.4 LIFTING ATTACHMENTS

A. Equipment shall be provided with suitable lifting attachments to enable equipment to be lifted in its normal position. Lifting attachments shall withstand any handling conditions that might be encountered, without bending or distortion of shape, such as rapid lowering and braking of load.

2.5 DUCTILE IRON PIPE AND FITTINGS

A. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated, 350 psi (2400 kPa).

1. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.

2. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

B. Push-on-Joint, Ductile-Iron Pipe: AWWA C151, with push-on-joint bell and plain spigot end unless grooved or flanged ends are indicated, 350 psi (2400 kPa).

1. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
2. Gaskets: AWWA C111, rubber.

C. Grooved-Joint, Ductile-Iron Pipe: AWWA C151, with cut, round-grooved ends.

1. Grooved-End, Ductile-Iron Pipe Appurtenances: ASTM A47, malleable-iron castings or ASTM A536, ductile-iron castings with dimensions matching pipe, 350 psi (3400 kPa).
2. Grooved-End, Ductile-Iron-Piping Couplings: AWWA C606, for ductile-iron-pipe dimensions, Include ferrous housing sections, gasket suitable for water, and bolts and nuts.
3. Gaskets: AWWA C111.

D. Cement Mortar Internal Lining: Cement mortar lining and bituminous seal coat as per AWWA C104.

E. Exterior Pipe Coating: The exterior of pipe shall have the standard asphaltic coating.

2.6 POLYVINYL CHLORIDE PIPE AND FITTINGS

A. PVC, Schedule 40 Pipe: ASTM D1785.

1. PVC, Schedule 40 Socket Fittings: ASTM D2466.

B. PVC, Schedule 80 Pipe: ASTM D1785.

1. PVC, Schedule 80 Socket Fittings: ASTM D2467.
2. PVC, Schedule 80 Threaded Fittings: ASTM D2464.

2.7 COPPER TUBE AND FITTINGS

A. Soft Copper Tubing: ASTM B88, Type K and Type L water tube, annealed temper.

B. Hard Copper Tubing: ASTM B88, Type K and Type L water tube, drawn temper.

C. Fittings: ASME B16.18, cast copper alloy or ASME B16.22, wrought copper alloy, solder joint pressure fittings.

D. Copper Unions: ANSI MSS SP-123, cast copper alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces and solder-joint or threaded ends.

2.8 VALVES

A. Gate Valves: AWWA C509, Non-rising Stem, Resilient Seat, 200 psi (1380 kPa).
   1. Valves 3 inches (75 mm) and larger: Resilient seat valve with gray- or ductile iron body and bonnet; cast iron or bronze double-disc gate; bronze gate rings; non-rising bronze stem and stem nut.
   2. Interior and exterior coating: AWWA C550, thermo-setting or fusion epoxy.
   3. Underground valve nut: Furnish valves with 2 inch (50 mm) nut for socket wrench operation.
   4. Aboveground and pit operation: Furnish valves with hand wheels.
   5. End connections shall match main line pipe.

B. Gate Valve Accessories and Specialties
   1. Tapping-Sleeve Assembly: ANSI MSS SP-60; sleeve and valve to be compatible with the drilling matching.
      a. Tapping Sleeve: Ductile Iron, two-piece bolted sleeve. Sleeve to match the size and type of pipe material being tapped.
      b. Valve shall include one raised face flange mating tapping-sleeve flange.
   2. Valve Boxes: AWWA M44 with top section, adjustable extension of length required for depth of burial of valve, plug with lettering "WATER," and bottom section with base that fits over valve and with a barrel.
   3. Operating Wrenches: Steel, tee-handle with one pointed end, stem of length to operate deepest buried valve, and socket matching valve operating nut. (Provide two wrenches for Project.)

C. Corporation Valves and Curb Valves
   1. Service-Saddle Assemblies: AWWA C800.
      a. Service Saddle: Copper alloy with seal and threaded outlet for corporation valve.
      b. Corporation Valve: Bronze body and ground-key plug, with threaded inlet and outlet matching service piping material.

2. Curb Valves: AWWA C800, bronze body, ground-key plug or ball, wide tee head, with inlet and outlet matching service piping material, minimum pressure of 200 psi (1375 kPa).
3. Service Boxes for Curb Valves: AWWA M44, cast iron telescoping top section; plug shall include lettering "WATER"; bottom section with base that fits over curb valve.
4. Shutoff Rods: Steel, tee-handle with one pointed end. Stem length shall extend 2 feet (600 mm) above top of valve box for operation of deepest buried valve, with slotted end matching curb valve.

2.9 DISINFECTION CHLORINE

A. Liquid chlorine: AWWA B301.
B. Sodium Hypochlorite: AWWA B300 with 5 percent to 15 percent available chlorine.
C. Calcium hypochlorite: AWWA B300 supplied in granular form of 5 g. tablets, and shall contain 65 percent chlorine by weight.

2.10 WARNING TAPE

A. Warning tape shall be standard, 4 mil. Polyethylene, 3 inch (76 mm) wide tape, detectable type, blue with black letters and imprinted with “CAUTION BURIED WATER LINE BELOW”.

PART 3 – EXECUTION

3.1 PIPING APPLICATIONS

A. Use pipe, fittings, and joining methods for piping systems according to the following applications.
   1. Transition couplings and special fittings with pressure ratings at least equal to piping pressure rating may be used, unless otherwise indicated.
   2. Do not use flanges or unions for underground piping.
   3. Flanges, unions, grooved-end-pipe couplings, and special fittings may be used, instead of joints indicated, on aboveground piping and piping in vaults.
B. Underground water-service piping NPS 1-1/2” shall be the following:
   1. Soft copper tube with wrought-copper, solder-joint fittings; and brazed copper, pressure-seal fittings; and pressure-sealed joints.
C. Underground water main piping NPS 4 to NPS 8 (DN 100 to DN 200) shall be the following:

1. Ductile iron, push-on-joint pipe; ductile iron, push-on-joint fittings; and gasketed.
2. PVC, Schedule 40 pipe; socket fittings; and solvent-cemented joints (only at connections to existing PVC water main. All new water main to be Ductile iron complying with paragraph 1 immediately above.

D. Underground Combined Water-Service and Fire-Service-Main Piping NPS 6 to NPS 12 (DN 150 to DN 300) shall be the following:
1. Ductile iron, push-on-joint pipe; Ductile Iron, push-on-joint fittings; and gasketed.

3.2 VALVE APPLICATIONS

A. Use mechanical-joint-end valves for NPS 3 (DN 80) and larger underground installation. Use threaded- or flanged-end valves for installation in vaults. Use UL/FMG, non-rising-stem gate valves for installation with indicator posts. Use corporation valves and curb valves with ends compatible with piping, for NPS 2 (DN 50) and smaller installation.

B. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
1. Underground Valves, NPS 3 (DN 80) and Larger: AWWA, cast iron, non-rising-stem, metal, resilient-seated gate valves with valve box.

3.3 DUCTILE IRON PIPE

A. Install Ductile Iron, water-service piping according to AWWA C600 and AWWA M41-3rd Edition.

B. 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. Push on joints shall be made in strict accordance with the manufacturer's instruction. Pipe shall be laid with bell ends looking ahead.

3.4 PVC PIPE

A. PVC piping shall be installed in strict accordance with the manufacturer's instructions and AWWA C605. Place selected material and thoroughly compacted to one foot above the top of the pipe.

B. Install Copper Tracer Wire, No. 14 AWG solid, single conductor, insulated. Install in the trench with piping to allow 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 per ASTM 828. Solder joints shall be wrapped with rubber tape and electrical tape. At least every 1000 feet (300 m) provide a 5 pound (2.3 kg) 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 also 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 location. Generally, install markers on 20 foot (6 m) centers. If pipe is in a congested piping area, install on 10 foot (3 m) centers. Prepare as-built drawing indicating exact location of magnetic markers.

3.5 COPPER PIPE

A. Copper piping shall be installed in accordance with the Copper Development Association's Copper Tube Handbook and manufacturer's recommendations.

B. Copper piping shall be bedded in 6 inches (150 mm) of sand.

3.6 ANCHORAGE INSTALLATION

A. Install water-distribution piping with restrained joints. Anchorages and restrained-joint types that may be used include: concrete thrust blocks, locking mechanical joints, or bolted flanged joints..

B. Install anchorages for tees, plugs and caps, bends, crosses, valves, and hydrant branches. Include anchorages for the following piping systems:

1. Gasketed-Joint, Ductile Iron, Water-Service Piping: According to AWWA C600.
2. Gasketed-Joint, PVC Water-Service Piping: According to AWWA M23.

C. Apply full coat of asphalt or other acceptable corrosion-resistant material to surfaces of installed ferrous anchorage devices.

3.7 VALVE INSTALLATION

A. AWWA Valves: Install each underground valve with stem pointing up and with valve box.

B. UL/FMG, Valves: Install each underground valve and valves in vaults with stem pointing up and with vertical cast iron indicator post.

C. MSS Valves: Install as component of connected piping system.

D. Corporation Valves and Curb Valves: Install each underground curb valve with head pointed up and with service box.

E. Raise or lower existing valve and curb stop boxes and fire hydrants to finish grade in areas being graded.

3.8 FIELD QUALITY CONTROL

A. Conduct piping tests before joints are covered and after concrete thrust blocks have hardened sufficiently. Fill pipeline 24 hours before testing and apply test pressure to stabilize system. Use only potable water.

B. Prior to final acceptance, provide a video record of all piping from the building to the municipal connection to show the lines are free from obstructions, properly sloped and joined.

C. Perform hydrostatic tests at not less than one-and-one-half times working pressure for two hours.

1. Increase pressure in 50-psi (350-kPa) increments and inspect each joint between increments. Hold at test pressure for 1 hour; decrease to 0 psi (0 kPa). Slowly increase again to test pressure and hold for 1 more hour. Maximum allowable leakage is 2 quarts (1.89 L) per hour per 100 joints. Remake leaking joints with new materials and repeat test until leakage is within allowed limits.

D. Prepare reports of testing activities.

3.9 IDENTIFICATION

A. Install continuous underground warning tape 12 inches (300 mm) directly over piping.

3.10 CLEANING

A. Purge new water-distribution piping systems and parts of existing systems that have been altered, extended, or repaired before use.

B. Use purging and disinfecting procedure prescribed by local utility provider or other authorities having jurisdiction or, if method is not prescribed by authorities having jurisdiction, use procedure described in AWWA C651 or do as follows:
   1. Fill the water system with a water/chlorine solution containing at least 50 ppm of chlorine; isolate and allow to stand for 24 hours.
   2. Drain the system of the previous solution and refill with water/chlorine solution containing at least 200 ppm of chlorine; isolate and allow system to stand for 3 hours.
   3. After standing time, flush system with clean, potable water until no chlorine remains in water coming from system.
   4. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedure if biological examination shows evidence of contamination.

C. Prepare reports of purging and disinfecting activities.

--- E N D ---

SECTION 33 30 00

SANITARY SEWER UTILITIES

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section specifies materials and procedures for construction of outside, underground sanitary sewer systems that are complete and ready for operation. This includes piping, structures and all other incidentals.

1.2 RELATED WORK

A. Excavation, Trench Widths, Pipe Bedding, Backfill, Shoring, Sheeting, Bracing: Section 31 20 11, EARTH MOVING (SHORT FORM).

B. Excavation, Trench Widths, Pipe Bedding, Backfill, Shoring, Sheeting, Bracing: Section 31 23 19, DEWATERING

C. Submittals: Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA AND SAMPLES.

D. Erosion and Sediment Control: Section 01 57 19, TEMPORARY ENVIRONMENTAL CONTROLS.

1.3 ABBREVIATIONS

A. PVC: Polyvinyl chloride plastic

B. VCP: Vitrified clay pipe

1.4 DELIVERY, STORAGE AND HANDLING

A. Store plastic piping protected from direct sunlight and support to prevent sagging and bending. Protect stored piping from moisture and dirt by elevating above grade. Protect flanges, fittings, and specialties from moisture and dirt.

B. Handle manholes according to manufacturer's written rigging instructions.

1.5 QUALITY ASSURANCE:

A. Products Criteria:

1. 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. A nameplate bearing manufacturer's name or trademark, including model number, shall be securely affixed in a conspicuous place on equipment. In addition, the model number shall be either 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.

1.6 SUBMITTALS:

A. Manufacturers' Literature and Data shall be submitted for 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.

1.7 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):

A185/A185M-07.....Steel Welded Wire Reinforcement, Plain, for Concrete

A615/A615M-09b.....Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement

C478-09.....Precast Reinforced Concrete Manhole Sections

C857-11.....Minimum Structural Design Loading for Underground Precast Concrete Utility Structures

C890-11.....Minimum Structural Design Loading for Monolithic or Sectional Precast Concrete Water and Wastewater Structures

C913-08.....Precast Concrete Water and Wastewater Structures

C923-08.....Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals

C990-09.....Joints for Concrete Pipe, Manholes, and precast Box Sections using Preformed Flexible Joint Sealants

C1173-10.....Flexible Transition Couplings for Underground Piping Systems

C1460-08.....Shielded Transition Couplings for Use With Dissimilar DWV Pipe and Fittings Above Ground

D3034-08.....Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings

F477-10.....Elastomeric Seals (Gaskets) for Joining Plastic Pipe

F1417-11.....Standard Test Method for Installation Acceptance of Plastic Gravity Sewer Lines Using Low-Pressure Air

F1668-08.....Construction Procedures for Buried Plastic Pipe

1.8 WARRANTY

A. The Contractor shall remedy any defect due to faulty material or workmanship and pay for any damage to other work resulting therefrom within a period of two years from final acceptance. Further, the Contractor will provide all manufacturers' and supplier's written guarantees and warranties covering materials and equipment furnished under this Contract.

PART 2 - PRODUCTS

2.1 FACTORY-ASSEMBLED PRODUCTS

A. Standardization of components shall be maximized to reduce spare part requirements.

B. The Contractor shall guarantee performance of assemblies of components, and shall repair or replace elements of the assemblies as required to deliver specified performance of the complete assembly.

2.2 PVC, GRAVITY SEWER PIPE AND FITTINGS

A. PVC Gravity Sewer Piping:

1. Pipe and Fittings shall conform to ASTM D3034 SDR 26.
2. Gaskets: ASTM F477.

2.3 NONPRESSURE-TYPE TRANSITION COUPLINGS

A. Comply with ASTM C1173, elastomeric, sleeve type, reducing or transition coupling, for joining underground nonpressure piping. Include ends to match same sizes of main line piping and install corrosion-resistant metal tension bands and tightening mechanism on each end.

B. Sleeve Materials:

1. For Plastic Pipes: ASTM F477, elastomeric seal.
2. For Dissimilar Pipes: PVC or other material compatible with pipe materials being joined.

C. Unshielded, Flexible Couplings:

1. Couplings shall be elastomeric sleeve with stainless steel shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.

D. Shielded, Flexible Couplings:

1. Couplings shall meet ASTM C1460 with elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield with corrosion-resistant-metal tension band and tightening mechanism on each end.

E. Ring-Type, Flexible Couplings:

1. Couplings shall be elastomeric compression seal with dimensions to fit inside bell of larger mainline pipe and for spigot of smaller main line pipe to fit inside ring.

2.4 MANHOLES

A. Standard precast concrete manholes and vaults shall be constructed of precast concrete segmental blocks, precast reinforced concrete rings, precast reinforced sections or cast-in-place concrete.

1. Precast Concrete Manholes: Material shall be as per ASTM C478, precast, reinforced concrete, of depth indicated, with sealed joints.
2. Concrete Base: Concrete for base of manhole shall have a minimum compressive strength of 5000 psi (35 MPa) at 28 days. Thickness to be 8 inches (200 mm), minimum.
3. Riser Section: 4 inch (100 mm) minimum thickness, of lengths to provide the total depth of manhole.

4. Top Section: Eccentric-cone type unless otherwise indicated. Top section to match adjustment ring configurations.
5. Joint Sealant: ASTM C990.
6. Resilient Pipe Connectors: ASTM C923.
7. Steps: If over 60 inches (1500 mm) in depth, individual FRP ladder ASTM A615 deformed, 1/2 inch (13 mm) steel reinforcing rods encased in precast concrete sections, with 16 inch (400 mm) minimum width, 12 to 16 inches (300 to 400 mm) center-to-center from top to bottom.
8. Adjusting Rings: Reinforced-concrete rings; 6 to 9 inch (150 to 225 mm) total thickness, with diameter matching manhole frame and cover, and with height as required to adjust manhole frame and cover to indicated elevation and slope.

B. Manhole Base Channels: Manhole channels shall be main line pipe material. Lay main pipe through manhole and cut top of pipe out to be three-fourths of pipe diameter. Slope through manhole to match run slopes of the main pipe.

2.5 CONCRETE

A. Cast-in-place concrete shall be 4000 psi (27.6 MPa) minimum, with 0.45 maximum water/cementitious materials ratio.

B. Reinforcement
1. Reinforcing fabric shall be ASTM A185, steel, welded wire fabric, plain.
2. Reinforcing bars shall be ASTM A615, Grade 60 (420 MPa) deformed steel.

C. Benches shall be concrete, sloped to drain into the channel. Provide 6 inches (150 mm) from the cut section of top of pipe to edge of manhole.

D. Ballast and Pipe Supports shall be Portland cement design mix, 3000 psi (20.7 MPa) minimum, with 0.58 maximum water/cementitious materials ratio.

2.6 WARNING TAPE

A. Warning tape shall be standard, 4 mil (0.1 mm) polyethylene 3 inch (76 mm) wide tape non-detectable type, green with black letters and imprinted with "CAUTION BURIED SEWER LINE BELOW".

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

A. Drawing plans and details indicate the general location and arrangement of underground sanitary sewer piping. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.

B. Install piping beginning at the low point, true to grades and alignment indicated on the drawings, with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for using lubricants, cements, and other installation requirements.

C. Do not lay pipe on unstable material, in wet trench or when trench and weather conditions are unsuitable for the work.

D. Support pipe on compacted bedding material. Excavate bell holes only large enough to properly make the joint.

E. 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.

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 walk on pipe in trenches until covered by layers of bedding or backfill material to a depth of 12 inches (300 mm) over the crown of the pipe.

H. Warning tape shall be continuously placed 12 inches (300 mm) above sewer pipe

I. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.

J. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.

K. Install gravity-flow, non-pressure, drainage piping according to the following:

1. Install piping pitched down in direction of flow, at minimum slope of 0.4 percent unless otherwise indicated.
2. Install piping with minimum cover as shown on Drawings.
3. Install PVC gravity sewer according to ASTM D2321 and ASTM F1668.

L. Clear interior of piping and manholes of dirt and superfluous material as work progresses. Maintain swab or drag in piping, and pull past each joint as it is completed. Place plug in end of incomplete piping at end of day and when work stops.

3.2 PIPE JOINT CONSTRUCTION

A. Join gravity-flow, non-pressure, drainage piping according to the following:
1. Join PVC piping according to ASTM D2321.
2. Join dissimilar pipe materials with nonpressure-type, flexible couplings.

B. Pipe couplings, expansion joints, and deflection fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
1. Use non-pressure flexible couplings where required to join gravity-flow, non-pressure sewer piping unless otherwise indicated.
a. Unshielded or Shielded, and Flexible couplings for pipes of same or slightly different OD.
b. Unshielded, increaser/reducer-pattern, flexible couplings for pipes with different OD.
c. Ring-type flexible couplings for piping of different sizes where annular space between smaller piping's OD and larger piping's ID permits installation.

3.3 MANHOLE INSTALLATION

A. Install manholes complete with appurtenances and accessories indicated.
1. 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 as per manufacturer’s recommendations. Adjust the length of the rings so that the top section will be at the required elevation. Cutting the top section is not acceptable.
2. Concrete manhole risers and tops: Install as specified.

3.4 CONNECTIONS

A. Make connections to existing piping and underground manholes by coring and installing the pipe at the design invert. Install an elastomeric gasket around the pipe, and grout the interstitial space between the pipe and the core.

B. Connection to an existing manhole: The bench of the manhole shall be cleaned and reshaped to provide a smooth flowline for all new pipes connected to the manhole.

C. Use commercially manufactured wye fittings for piping branch connections. Encase entire wye fitting plus 6-inch (150-mm) overlap with not less than 6 inches (150 mm) of concrete with 28-day compressive strength of 3000 psi (20.7 MPa).

1. Make branch connections from the side into existing piping, NPS 4 to NPS 20 (DN 100 to DN 500), by removing a section of the existing pipe.
2. Make branch connections from the side into existing piping, NPS 21 (DN 525) or larger, or to underground manholes by cutting an opening into existing unit large enough to allow 3 inches (76 mm) of concrete to be packed around entering connection. Cut end of connection pipe passing through pipe or structure wall to conform to shape of and be flush with inside wall unless otherwise indicated. On outside of pipe or manhole wall, encase entering connection in concrete to provide additional support of collar from connection to undisturbed ground.
3. Protect existing piping and manholes to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.

3.5 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.

3.6 CLOSING ABANDONED SANITARY SEWER SYSTEMS

A. Close open ends of abandoned underground piping indicated to remain in place. Include closures strong enough to withstand hydrostatic and earth pressures that may result after ends of abandoned piping have been closed.
   1. Piping under and within 5 feet (1500 mm) of building areas shall be completely removed.
   2. Piping outside of building areas shall be completely removed, or plugged with concrete, and abandoned in-place.

B. Excavate around manholes as required and use either procedure below:
   1. Manholes and structures outside of building areas: Remove frame and cover, cut and remove the top of an elevation of 2 feet (600 mm) below finished grade. Fill the remaining portion with compacted gravel or crushed rock or concrete.
   2. Manholes and structures with building areas: Remove frame and cover and remove the entire structure and the base.

C. Backfill to grade according to Division 31 Section 31 20 11, EARTH MOVING (SHORT FORM).

D. 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.

3.7 PIPE SEPARATION

A. Horizontal Separation – Water Mains and Sewers:
   1. Existing and proposed water mains shall be at least 10 feet (3 m) 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 10 feet (3 m) but not closer than 6 feet (1.8 m) to a water main when:

a. Local conditions prevent a lateral separation of 10 feet (3 m); and

b. The water main invert is at least 18 inches (450 mm) above the crown of the gravity sewer or 24 inches (600 mm) above the crown of the pressure (force) main; and 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.

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 24 inches (600 mm) above the crown of gravity flow sewer or 48 inches (1200 mm) above the crown of pressure (force) mains. The vertical separation shall be maintained within 10 feet (3 m) 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 24 inches (600 mm) of water lines.

3. When it is impossible to meet (1) above, the gravity flow sewer may be installed 18 inches (450 mm) above or 12 inches (300 mm) 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 24 inches (600 mm) below the water line provided both the water line and sewer line are constructed of ductile iron pipe.

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 10 feet (3 m).

3.8 IDENTIFICATION

A. Install green warning tape directly over piping and at outside edges of underground manholes.

3.9 FIELD QUALITY CONTROL

A. All systems shall be inspected and obtain the Resident Engineer's approval. Prior to final acceptance, provide a video record of all

piping from the building to the municipal connection to show the lines are free from obstructions, properly sloped and joined.

B. To inspect, thoroughly flush out the lines and manholes before inspection. Lamp test between structures and show full bore indicating sewer is true to line and grade. Lips at joints on the inside of gravity sewer lines are not acceptable.
   1. Submit separate report for each system inspection.
   2. Defects requiring correction include the following:
      a. Alignment: Less than full diameter of inside of pipe is visible between structures.
      b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
      c. Damage: Crushed, broken, cracked, or otherwise damaged piping.
      d. Infiltration: Water leakage into piping.
      e. Exfiltration: Water leakage from or around piping.
   3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
   4. Re-inspect and repeat procedure until results are satisfactory.

C. Air Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction and the following:
   1. Test plastic gravity sewer piping according to ASTM F1417.
   2. Test concrete gravity sewer piping according to ASTM C924.
   3. 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 4 psi (28 kPa) and allowed to stabilize. After pressure stabilization, the pressure shall be dropped to 3.5 psi (24 kPa) greater than the average back-pressure of any groundwater above the sewer.

3.10 CLEANING

A. Clean dirt and superfluous material from interior of piping.

--- E N D ---

SECTION 33 40 00

STORM SEWER UTILITIES

PART 1 – GENERAL

1.1 DESCRIPTION

This section specifies materials and procedures for construction of outside, underground storm sewer systems that are complete and ready for operation. This includes piping, structures and all other incidentals.

1.2 RELATED WORK

A. Excavation, Trench Widths, Pipe Bedding, Backfill, Shoring, Sheeting, Bracing: Section 31 20 11, EARTH MOVING (SHORT FORM).

B. Concrete Work, Reinforcing, Placement and Finishing: Section 03 30 53, CAST-IN-PLACE CONCRETE (SHORT FORM).

C. Materials and Testing Report Submittals: Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA AND SAMPLES.

D. Erosion and Sediment Control: Section 01 57 19, TEMPORARY ENVIRONMENTAL CONTROLS.

1.3 ABBREVIATIONS

A. HDPE: High-density polyethylene

B. RCP: Reinforced concrete pipe

C. PVC: Polyvinyl chloride

1.4 DELIVERY, STORAGE, AND HANDLING

A. Do not store plastic manholes, pipe, and fittings in direct sunlight.

B. Handle manholes, catch basins, and stormwater inlets according to manufacturer's written rigging instructions.

1.5 COORDINATION

A. Coordinate connection to storm sewer main with the Public Agency providing storm sewer off-site drainage.

B. Coordinate exterior utility lines and connections to building services up to the actual extent of building wall.

1.6 QUALITY ASSURANCE:

A. Products Criteria:

1. 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. A nameplate bearing manufacturer's name or trademark, including model number, shall be securely affixed in a conspicuous place on equipment. In addition, the model number shall be either cast integrally with equipment, stamped, or otherwise permanently marked on each item of equipment.

1.7 SUBMITTALS

A. Manufacturers' Literature and Data shall be submitted, as one package, for pipes, fittings and appurtenances, including jointing materials, hydrants, valves and other miscellaneous items.

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):

A185/A185M-07.....Steel Welded Wire Reinforcement, Plain, for Concrete

A242/A242M-04(2009).....High-Strength Low-Alloy Structural Steel

A536-84(2009).....Ductile Iron Castings

A615/A615M-09b.....Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement

C33/C33M-08.....Concrete Aggregates

C76-11.....Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe

C150/C150M-11.....Portland Cement

C443-10.....Joints for Concrete Pipe and Manholes, Using Rubber Gaskets

C478-09.....Precast Reinforced Concrete Manhole Sections

C857-07.....Minimum Structural Design Loading for Underground Precast Concrete Utility Structures

C891-09.....Installation of Underground Precast Concrete Utility Structures

C923-08.....Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals

C924-02(2009).....Testing Concrete Pipe Sewer Lines by Low-Pressure Air Test Method

C990-09.....Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants

C1103-03(2009).....Joint Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines

C1173-08.....Flexible Transition Couplings for Underground Piping Systems

C1479-10.....Installation of Precast Concrete Sewer, Storm Drain, and Culvert Pipe Using Standard Installations

D698-07e1.....Laboratory Compaction Characteristics of Soil Using Standard Effort (12 400 ft-lbf/ft3 (600 kN-m/m3))

D1056-07.....Flexible Cellular Materials—Sponge or Expanded Rubber

D1785-06.....Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120

F477-10.....Elastomeric Seals (Gaskets) for Joining Plastic Pipe

F1417-11.....Installation Acceptance of Plastic Gravity Sewer Lines Using Low-Pressure Air

F1668-08.....Construction Procedures for Buried Plastic Pipe

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

M198-10.....Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants

D. American Society of Mechanical Engineers (ASME):

A112.36.2M-1991.....Cleanouts

1.9 WARRANTY

The Contractor shall remedy any defect due to faulty material or workmanship and pay for any damage to other work resulting therefrom within a period of two years from final acceptance. Further, the Contractor will furnish all manufacturers' and suppliers' written guarantees and warranties covering materials and equipment furnished under this Contract.

PART 2 - PRODUCTS

2.1 FACTORY-ASSEMBLED PRODUCTS

A. Standardization of components shall be maximized to reduce spare part requirements. The Contractor shall guarantee performance of assemblies of components, and shall repair or replace elements of the assemblies as required to deliver specified performance of the complete assembly.

2.2 HDPE PIPE AND FITTINGS

A. Corrugated HDPE drainage pipe and fittings size 4 to 60 inch.
   1. Pipe shall be dual wall, with smooth water way and meet ASTM F2648.
   2. Pipe joints shall be integral bell and spigot and be watertight. 4- through 60-inch (100 to 1500 mm) shall be watertight according to the requirements of ASTM D3212. Gaskets shall meet the requirements of ASTM F477. Gaskets shall be installed by the pipe manufacturer and covered with a removable, protective wrap to ensure the gasket is free from debris. A joint lubricant available from the manufacturer shall be used on the gasket and bell during assembly. 12- through 60-inch (300 to 1500 mm) diameters shall have an exterior bell wrap installed by the manufacturer.

3. Fittings shall conform to ASTM F 2306. Bell and spigot connections shall utilize a spun-on or welded bell and valley or saddle gasket meeting the watertight joint performance requirements of ASTM F 2306.
4. Material for pipe production shall be an engineered compound of virgin and recycled high-density polyethylene conforming with the minimum requirements of cell classification 424420C (ESCR Test Condition B) for 4- through 10-inch (100 to 250 mm) diameters, and 435420C (ESCR Test Condition B) for 12- through 60-inch (300 to 1500 mm) diameters, as defined and described in the latest version of ASTM D3350, except that carbon black content should not exceed 4%. The design engineer shall verify compatibility with overall system including structural, hydraulic, material and installation requirements for a given application.

B. PVC Gravity Sewer Piping
1. Pipe and fittings shall be ASTM F679, SDR 35, PVC gravity sewer pipe with bell-and-spigot ends.
2. Gaskets: ASTM F477, elastomeric seals for gasketed joints.

2.3 CONCRETE PIPE AND FITTINGS

A. Reinforced-Concrete sewer pipe and fittings shall be ASTM C76 or ASTM C655.
1. Bell-and-spigot or tongue-and-groove ends and gasketed joints with ASTM C443, rubber gaskets sealant joints with ASTM C990, bitumen or butyl-rubber sealant.
2. Class III: Wall A

2.4 NONPRESSURE TRANSITION COUPLINGS

A. Comply with ASTM C1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground non-pressure piping. Include ends of same sizes as piping to be joined, and corrosion-resistant-metal tension band and tightening mechanism on each end.

B. Sleeve Materials
1. For concrete pipes: ASTM C443, rubber.
2. For plastic pipes: ASTM F477, elastomeric seal or ASTM D5926, PVC.
3. For dissimilar pipes: ASTM D5926, PVC or other material compatible with pipe materials being joined.

C. Unshielded, Flexible Couplings: Couplings shall be an elastomeric sleeve with stainless-steel shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.

D. Shielded, flexible couplings shall be elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

E. Ring-Type, flexible couplings shall be elastomeric compression seal with dimensions to fit inside bell of larger pipe and for spigot of smaller pipe to fit inside ring.

2.5 CLEANOUTS

A. Cast-Iron Cleanouts: ASME A112.36.2M, round, gray-iron housing with clamping device and round, secured, scoriated, gray-iron cover. Include gray-iron ferrule with inside calk or spigot connection and countersunk, tapered-thread, brass closure plug.
   1. Top-Loading Classification(s): Light Duty.
   2. Pipe fitting and riser to cleanout shall be same material as main pipe line.

B. Plastic Cleanouts shall have PVC body with PVC threaded plug. Pipe fitting and riser to cleanout shall be of same material as main line pipe.

2.6 MANHOLES AND CATCH BASINS

A. Standard Precast Concrete Manholes:
   1. Description: ASTM C478 (ASTM C478M), precast, reinforced concrete, of depth indicated, with provision for sealant joints.
   2. Diameter: 48 inches (1200 mm) minimum unless otherwise indicated.
   3. Ballast: Increase thickness of precast concrete sections or add concrete to base section as required to prevent flotation.
   4. Base Section: 6 inch (150 mm) minimum thickness for floor slab and 4-inch (102 mm) minimum thickness for walls and base riser section, and separate base slab or base section with integral floor.
   5. Riser Sections: 4 inch (102 mm) minimum thickness, and lengths to provide depth indicated.
   6. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated, and top of cone of size that matches grade rings.
   7. Joint Sealant: ASTM C990 (ASTM C990M), bitumen or butyl rubber.

8. Resilient Pipe Connectors: ASTM C923 (ASTM C923M), cast or fitted into manhole walls, for each pipe connection.
9. Steps: If total depth from floor of manhole to finished grade is greater than 60 inches (1500 mm). Individual FRP ladder; or ASTM A615, deformed, 1/2 inch (13 mm) steel reinforcing rods encased in ASTM D4101, PP ASTM A615, deformed, 1/2 inch (13 mm) steel reinforcing rods encased in ASTM D4101, PP, width of 16 inches (400 mm) minimum, spaced at 12 to 16 inch (300 to 400 mm) intervals.
10. Adjusting Rings: Reinforced-concrete rings, 6 to 9 inch (150 to 225 mm) total thickness, to match diameter of manhole frame and cover, and height as required to adjust manhole frame and cover to indicated elevation and slope.

B. Manhole Frames and Covers:
1. Description: Ferrous; 24 inch (610 mm) ID by 7 to 9 inch (175 to 225 mm) riser with 4 inch (102 mm) minimum width flange and 26-inch (600 mm) diameter cover. Include indented top design with lettering cast into cover, using wording equivalent to "STORM SEWER."
2. Material: ASTM A536, Grade 60-40-18 ductile iron unless otherwise indicated.

2.7 CONCRETE FOR MANHOLES AND CATCH BASINS

A. General: Cast-in-place concrete according to ACI 318, ACI 350/350R, and the following:
1. Cement: ASTM C150, Type II.
2. Fine Aggregate: ASTM C33, sand.
3. Coarse Aggregate: ASTM C33, crushed gravel.
4. Water: Potable.

B. Concrete Design Mix: 4000 psi (27.6 MPa) minimum, compressive strength in 28 days.
1. Reinforcing Fabric: ASTM A185, steel, welded wire fabric, plain.
2. Reinforcing Bars: ASTM A615, Grade 60 (420 MPa) deformed steel.

C. Manhole Channels and Benches: Channels shall be the main line pipe material. Include benches in all manholes and catch basins.
1. Channels: Main line pipe material or concrete invert. Height of vertical sides to three-fourths of pipe diameter. Form curved channels with smooth, uniform radius and slope. Invert Slope: Same slope as the main line pipe. Bench to be concrete, sloped to drain

into channel. Minimum of 6 inch slope from main line pipe to wall sides.

2.8 PIPE OUTLETS

A. Riprap basins: Broken, irregularly sized and shaped, graded stone according to NSSGA's "Quarried Stone for Erosion and Sediment Control."
   1. Average Size: NSSGA No. R-3, screen opening 2 inches (51 mm).
   2. Average Size: NSSGA No. R-4, screen opening 3 inches (76 mm).
   3. Average Size: NSSGA No. R-5, screen opening 5 inches (127 mm).

B. Filter Stone: NSSGA's "Quarried Stone for Erosion and Sediment Control," No. FS-2, No. 4 screen opening, average-size graded stone.

C. Energy Dissipaters: To be as per NSSGA's "Quarried Stone for Erosion and Sediment Control," No. A-1, 3-ton (2721-kg) average weight armor stone, unless otherwise indicated.

2.9 FLARED END SECTIONS

A. Flared End Sections: Sections shall be of standard design fabricated from zinc-coated steel sheets conforming to requirements of ASTM A929.

2.10 WARNING TAPE

A. Standard, 4-Mil polyethylene 3 inch (76 mm) wide tape non-detectable type, green with black letters, and imprinted with "CAUTION BURIED STORM DRAIN LINE BELOW".

PART 3 - EXECUTION

3.1 PIPE BEDDING

A. 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.

3.2 PIPING INSTALLATION

A. Drawing plans and details indicate general location and arrangement of underground storm drainage piping. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.

B. Install piping with minimum cover as shown on the Drawings.

C. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.

1. Do not lay pipe on unstable material, in wet trench or when trench and weather conditions are unsuitable for the work.
2. Support pipe on compacted bedding material. Excavate bell holes only large enough to properly make the joint.
3. 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.
4. 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.
5. 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.
6. Do not walk on pipe in trenches until covered by layers of shading to a depth of 12 inches (300 mm) over the crown of the pipe.
7. Warning tape shall be continuously placed 12 inches (300 mm) above storm sewer piping.

D. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.

E. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.

F. Install gravity-flow, nonpressure drainage piping according to the following:
   1. Install piping pitched down in direction of flow.
   2. Install piping NPS 6 (DN 150) and larger with restrained joints at wye fittings and at changes in direction. Use corrosion-resistant rods, pipe or fittings; or cast in-place concrete supports or anchors.
   3. Install hub-and-spigot cast iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook."
   4. Install PVC cellular-core piping, PVC sewer piping, and PVC profile gravity sewer piping, according to ASTM D2321 and ASTM F1668.
   5. Install reinforced concrete sewer piping according to ASTM C1479.

3.3 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.

3.4 CONNECTIONS TO EXISTING VA-OWNED MANHOLES

A. Make pipe connections and alterations to existing manholes so that finished work will conform as nearly as practicable to the applicable requirements specified for new manholes, including concrete and masonry work, cutting, and shaping.

3.5 MANHOLE INSTALLATION

A. Install manholes, complete with appurtenances and accessories indicated. Install precast concrete manhole sections with sealants according to ASTM C891.

B. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops 3 inches (76 mm) Insert dimension above finished surface elsewhere unless otherwise indicated.

C. Circular Structures:

1. 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 1/2 inch (15 mm) or cement mortar applied with a trowel and finished to an even glazed surface.
2. 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.
3. Precast reinforced concrete manhole risers and tops. Install as specified for precast reinforced concrete rings.

D. Rectangular Structures:

1. Precast concrete structures shall be placed on a 8 inch (200 mm) reinforced concrete pad, or be provided with a precast concrete base section. Structures provided with a base section shall be set on an 8 inch (200 mm) 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.
2. Do not build structures when air temperature is 32 deg F (0 deg C), or below.
3. 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.
4. Floor of structure outside the channels shall be smooth and slope toward channels not less than 1 to 12 or more than 1 to 6. Bottom slab and benches shall be concrete.

5. The wall that supports access rungs or ladder shall be 90 deg vertical from the floor of structure to manhole cover.
6. 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.
7. 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 2 inches (50 mm) above the adjacent finish grade. Install an 8 inch (203 mm) thick, by 12 inch (300 mm) concrete collar around the perimeter of the frame. Slope the top of the collar away from the frame.

3.6 CATCH BASIN INSTALLATION

A. Construct catch basins to sizes and shapes indicated.
B. Set frames and grates to elevations indicated.

3.7 STORMWATER INLET AND OUTLET INSTALLATION

A. Construct inlet head walls, aprons, and sides of reinforced concrete.
B. Construct riprap of broken stone.
C. Install outlets that spill onto grade, anchored with concrete.
D. Install outlets that spill onto grade, with flared end sections that match pipe.
E. Construct energy dissipaters at outlets.

3.8 CONNECTIONS

A. Encase entire connection fitting, plus 6 inch (150 mm) overlap, with not less than 6 inches (150 mm) of concrete with 28-day compressive strength of 3000 psi (20.7 MPa).
B. Make connections to existing piping and underground manholes.
   1. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe; install wye fitting into existing piping.
   2. Make branch connections from side into existing piping, NPS 4 to NPS 20 (DN 100 to DN 500). Remove section of existing pipe, install wye fitting into existing piping.
   3. Make branch connections from side into existing piping, NPS 21 (DN 525) or larger, or to underground manholes and structures by cutting

into existing unit and creating an opening large enough to allow 3 inches (76 mm) of concrete to be packed around entering connection. Cut end of connection pipe passing through pipe or structure wall to conform to shape of and be flush with inside wall unless otherwise indicated. On outside of pipe, manhole, or structure wall, use epoxy-bonding compound as interface between new and existing concrete and piping materials.

4. Protect existing piping, manholes, and structures to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.

C. Pipe couplings, expansion joints, and deflection fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

1. Use nonpressure-type flexible couplings where required to join gravity-flow, nonpressure sewer piping unless otherwise indicated.
   a. // Unshielded // Shielded // flexible couplings for same or minor difference OD pipes.
   b. Unshielded, increaser/reducer-pattern, flexible couplings for pipes with different OD.
   c. Ring-type flexible couplings for piping of different sizes where annular space between smaller piping's OD and larger piping's ID permits installation.

3.9 CLOSING ABANDONED STORM DRAINAGE SYSTEMS

A. Abandoned Piping: Close open ends of abandoned underground piping indicated to remain in place. Include closures strong enough to withstand hydrostatic and earth pressures that may result after ends of abandoned piping have been closed. Use either procedure below:

1. Close open ends of piping with at least 8 inch (203 mm) thick, brick masonry bulkheads.
2. Close open ends of piping with threaded metal caps, plastic plugs, or other acceptable methods suitable for size and type of material being closed. Do not use wood plugs.

B. Abandoned Manholes and Structures: Excavate around manholes and structures as required and use one procedure below:

1. Remove manhole or structure and close open ends of remaining piping.

2. Remove top of manhole or structure down to at least 36 inches (915 mm) below final grade. Fill to within 12 inches (300 mm) of top with stone, rubble, gravel, or compacted dirt. Fill to top with concrete.

C. Backfill to grade according to Division 31 Section EARTH MOVING.

3.10 IDENTIFICATION

A. Install green warning tape directly over piping and at outside edge of underground structures.

3.11 FIELD QUALITY CONTROL

A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Prior to final acceptance, provide a video record of all piping from the building to the municipal connection to show the lines are free from obstructions, properly sloped and joined.
   1. Submit separate reports for each system inspection.
   2. Defects requiring correction include the following:
      a. Alignment: Less than full diameter of inside of pipe is visible between structures.
      b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
      c. Damage: Crushed, broken, cracked, or otherwise damaged piping.
      d. Infiltration: Water leakage into piping.
      e. Exfiltration: Water leakage from or around piping.
   3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
   4. Reinspect and repeat procedure until results are satisfactory.

3.12 TESTING OF STORM SEWERS:

A. Submit separate report for each test.

B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.
   1. Do not enclose, cover, or put into service before inspection and approval.
   2. Test completed piping systems according to requirements of authorities having jurisdiction.
   3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours advance notice.
   4. Submit separate report for each test.

5. Air test gravity sewers. 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.

C. Leaks and loss in test pressure constitute defects that must be repaired. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

3.13 CLEANING

A. Clean interior of piping of dirt and superfluous materials. Flush with water.

--- E N D ---

SECTION 33 46 13

FOUNDATION DRAINAGE

PART 1 - GENERAL

1.1 DESCRIPTION

This section specifies materials and procedures for construction of foundation drainage systems, including installation, backfill, and cleanout extensions, to a point of connection to storm sewer.

1.2 RELATED WORK

A. Excavation, Trench Widths, Pipe Bedding, Backfill, Shoring, Sheeting, Bracing: Section 31 20 11, EARTH MOVING (SHORT FORM).

B. Materials testing and inspection during construction: Section 01 45 29, TESTING LABORATORY SERVICES.

C. Submittals: Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA AND SAMPLES.

1.3 DEFINITIONS

Subdrainage: Foundation drainage system that collects and removes subsurface or seepage water from columbarium wall or memorial wall foundation to on-site storm sewer system.

1.4 ABBREVIATIONS

A. HDPE: High-density polyethylene plastic.

B. PVC: Polyvinyl chloride plastic.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Do not store plastic manholes, pipe, and fittings in direct sunlight.

B. Protect pipe, pipe fittings, and seals from dirt and damage.

1.6 COORDINATION

A. Coordinate connection to storm sewer main, if approved, with the Public Agency responsible for the storm sewer system.

B. Coordinate exterior utility lines and connections to foundation building drain.

1.7 QUALITY ASSURANCE:

A. Products Criteria:

1. 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. A nameplate bearing manufacturer's name or trademark, including model number, shall be securely affixed in a conspicuous place on equipment. In addition, the model number shall be either cast integrally with equipment, stamped, or otherwise permanently marked on each item of equipment.

B. Comply with the rules and regulations of the Public Agency having jurisdiction over the connection to public storm sewer lines or the requirements for discharge of subsurface drainage.

1.8 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 Society for Testing and Materials (ASTM):

C33/C33M-11.....Concrete Aggregates

C1173-08.....Flexible Transition Couplings for Underground Piping Systems

D1621-10.....Standard Test Method for Compressive Properties of Rigid Cellular Plastics

D3034-08.....Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings

D4491-99a(2009).....Test Methods for Water Permeability of Geotextiles by Permittivity

D4716-08.....Test Method for Determining the (In-plane) Flow Rate per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using a Constant Head

D5926-09.....Poly (Vinyl Chloride) (PVC) Gaskets for Drain, Waste, and Vent (DWV), Sewer, Sanitary, and Storm Plumbing Systems

D6707-06 (2011).....Circular-Knit Geotextile for Use in Subsurface Drainage Applications

F477-10.....Elastomeric Seals (Gaskets) for Joining Plastic Pipe

1.9 WARRANTY

The Contractor shall remedy any defect due to faulty material or workmanship and pay for any damage to other work resulting therefrom within a period of two years from final acceptance. Further, the Contractor will furnish all manufacturer's and supplier's written guarantees and warranties covering materials and equipment furnished under this Contract.

PART 2 - PRODUCTS

2.1 FACTORY-ASSEMBLED PRODUCTS

A. Standardization of components shall be maximized to reduce spare part requirements.

B. Contractor shall guarantee performance of assemblies of components, and shall repair or replace elements of the assemblies as required to deliver specified performance of the complete assembly.

2.2 COMPATIBILITY OF RELATED EQUIPMENT

Equipment and materials installed shall be compatible in all respects with other items being furnished and with existing items so that the result will be a complete and fully operational system that conforms to contract requirements.

2.3 UNDERSLAB HEADER

A. PVC sewer pipe and fittings per ASTM D3034, with ASTM F477, elastomeric seal gaskets.

2.4 PERFORATED-WALL PIPES AND FITTINGS FOR VAULTS OR MANHOLES

A. Perforated PVC Sewer Pipe and Fittings shall be ASTM D3034.

2.5 SOLID-WALL PIPES AND FITTINGS

A. PVC Sewer Pipe and Fittings: ASTM D3034.

1. Gaskets: ASTM F477.

2.6 SPECIAL PIPE COUPLINGS

A. Comply with ASTM C1173 for joining underground non-pressure piping. Include ends of same sizes as piping to be joined and corrosion-resistant metal tension band and tightening mechanism on each end.

1. Sleeve Materials:

a. For Dissimilar Pipes: ASTM D5926, PVC or other material compatible with pipe materials being joined.

2. Unshielded Flexible Couplings: Elastomeric sleeve with stainless-steel shear ring and corrosion-resistant metal tension band and tightening mechanism on each end.

2.7 CLEANOUTS

A. Cleanout PVC Extension shall conform to ASTM D3034. PVC extensions shall have watertight joints and long sweep elbow fittings. PVC cleanout shall have threaded plug and threaded pipe hub.

2.8 DRAINAGE CONDUITS

A. Smooth PVC Drainage Conduits shall have perforated fittings and couplings complying with ASTM D3034.

1. Nominal size shall be 8 inches (200 mm).

a. Minimum flow rate equal to a NPS 4 (DN 100) pipe.

2. Fittings shall be as per manufacturer.

2.9 SOIL MATERIALS

A. Drainage Material

1. Bedding shall be crushed stone, 3/4 inch (20 mm) to No. 4 per ASTM D448, at a minimum or as per geotechnical recommendations.

2. Fill to 1 foot (300 mm) above pipe shall be Crushed stone, 3/4 inch (20 mm) to No. 4 per ASTM D448, at a minimum or as per geotechnical recommendations.

B. Concrete Sand shall be ASTM C33.

2.10 GEOTEXTILE FILTER FABRICS

A. Geotextile fabric shall conform to ASTM 6707. Elongation will be greater than 50 percent and the flow rate shall range from 110 to 330 gpm/sq. ft. (4480 to 13440 L/min. per sq. m).

1. Structure Type shall be Nonwoven, needle-punched continuous filament or woven, monofilament or multifilament.

2. Style(s) shall be Flat or sock.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces and areas for suitable conditions where subdrainage systems are to be installed.

B. If subdrainage is required for landscaping, locate and mark existing utilities, underground structures, and aboveground obstructions before beginning installation and avoid disruption and damage of services.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PIPING APPLICATIONS

A. Underground Subdrainage Piping shall be:

1. Perforated PVC sewer pipe and fittings for loose, bell-and-spigot joints.

B. Underslab Subdrainage Piping shall be:

1. Perforated PVC sewer pipe and fittings and loose, bell-and-spigot joints.

C. Header Piping shall be:

1. PVC sewer pipe and fittings, couplings, and coupled joints.

3.3 CLEANOUT APPLICATIONS

A. In Underground Subdrainage Piping:

1. At Grade in Earth shall be PVC cleanouts.
2. At Grade in Paved Areas shall be Cast-iron cleanouts.

3.4 FOUNDATION DRAINAGE INSTALLATION

A. Place impervious fill material on subgrade adjacent to bottom of footing after concrete footing forms have been removed. Place and compact impervious fill to dimensions indicated, but not less than 6 inches (150 mm) deep and 12 inches (300 mm) wide.

B. Lay flat-style geotextile filter fabric in trench and overlap trench sides.

C. Place supporting layer of drainage course over compacted subgrade and geotextile filter fabric, to compacted depth of not less than 4 inches (100 mm).

D. Encase pipe with sock-style geotextile filter fabric before installing pipe. Connect sock sections with adhesive or tape and install drainage piping.

E. Add drainage course to width of at least 6 inches (150 mm) on side away from wall and to top of pipe to perform tests.

F. After satisfactory testing, cover drainage piping to width of at least 6 inches (150 mm) on side away from footing and above top of pipe to within 12 inches (300 mm) of finish grade.

G. Install drainage course and wrap top of drainage course with flat-style geotextile filter fabric.

H. Place layer of flat-style geotextile filter fabric over top of drainage course, overlapping edges at least 4 inches (100 mm).

I. Install vertical drainage panels as follows:

1. Coordinate placement with other drainage materials.
2. Lay perforated drainage pipe at base of footing. Do not install aggregate.
3. Separate 4 inches (100 mm) of fabric at beginning of roll and cut away 4 inches (100 mm) of core. Wrap fabric around end of remaining core.
4. Wrap bottom of panel around drainage pipe.
5. Attach panel to wall at horizontal mark and at beginning of pipe. Place core side of panel against wall. Use concrete nails with washers through product cylinders to attach panel to wall. Place nails from 2 to 6 inches (50 to 150 mm) below top of panel, approximately 48 inches (1200 mm) apart. Construction adhesives, metal stick pins, or double double-sided tape may be used instead of nails. Do not penetrate waterproofing. Before using adhesives, discuss with waterproofing manufacturer.
6. If additional panels are required on same row, cut away 4 inches (100 mm) of installed panel core, install new panel against installed panel, and overlap new panel with installed panel fabric.
7. If additional rows of panels are required, overlap lower panel with 4 inches (100 mm) of fabric.
8. Cut panel as necessary to keep top 12 inches (300 mm) below finish grade.
9. For inside corners, bend panel. For outside corners, cut core to provide 3 inches (75 mm) for overlap.

J. Do not use drainage panels as protection for waterproof membrane unless approved by factory-authorized service representative of waterproofing membrane manufacturer. Submit approval if so used.

K. Place initial backfill material over compacted drainage course. Place material in loose-depth layers not exceeding 6 inches (150 mm). Thoroughly compact each layer. Final backfill to finish elevations and slope away from building.

3.5 UNDERSLAB DRAINAGE INSTALLATION

A. Excavate for underslab drainage system after subgrade material has been compacted but before drainage course has been placed. Include horizontal distance of at least 6 inches (150 mm) between drainage pipe and trench walls. Grade bottom of trench excavations to required slope, and compact to firm, solid bed for drainage system.

B. Lay flat-style geotextile filter fabric in trench and overlap trench sides.

C. Place supporting layer of drainage course over compacted subgrade and geotextile filter fabric, to compacted depth of not less than 4 inches (100 mm).

D. Encase pipe with sock-style geotextile filter fabric before installing pipe. Connect sock sections with adhesive or tape. Install drainage piping.

E. Add drainage course to width of at least 6 inches (150 mm) on side away from wall and to top of pipe to perform tests.

F. After satisfactory testing, cover drainage piping with drainage course to elevation of bottom of slab, and compact and wrap top of drainage course with flat-style geotextile filter fabric.

G. Install horizontal drainage panels as follows:

1. Coordinate placement with other drainage materials.
2. Lay perforated drainage pipe at inside edge of footings.
3. Place drainage panel over drainage pipe with core side up. Peel back fabric and wrap fabric around pipe. Locate top of core at bottom elevation of floor slab.
4. Butt additional panels against other installed panels. If panels have plastic flanges, overlap installed panel with flange.

3.6 LANDSCAPING DRAINAGE INSTALLATION

A. Provide trench width to allow installation of drainage conduit. Grade bottom of trench excavations to required slope, and compact to firm, solid bed for drainage system.

B. Lay flat-style geotextile filter fabric in trench and overlap trench sides.

C. Place supporting layer of drainage course over compacted subgrade and geotextile filter fabric, to compacted depth of not less than 4 inches (100 mm).

D. Install drainage conduits with horizontal distance of at least 6 inches (150 mm) between conduit and trench walls. Wrap drainage conduits without integral geotextile filter fabric with flat-style geotextile filter fabric before installation. Connect fabric sections with adhesive or tape.

E. Add drainage course to top of drainage conduits.

F. After satisfactory testing, cover drainage conduit to within 12 inches (300 mm) of finish grade.

G. Install drainage course and wrap top of drainage course with flat-style geotextile filter fabric.

H. Place layer of flat-style geotextile filter fabric over top of drainage course, overlapping edges at least 4 inches (100 mm).

I. Fill to Grade: Place satisfactory soil fill material over drainage course. Place material in loose-depth layers not exceeding 6 inches (150 mm. Thoroughly compact each layer. Fill to finish grade.

3.7 PIPING INSTALLATION

A. Install piping beginning at low points of system, true to grades and alignment indicated, with unbroken continuity of invert. Bed piping with full bearing in filtering material. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions and other requirements indicated.

1. Foundation Subdrainage: Install piping pitched down in direction of flow, at a minimum slope of 0.5 percent and with a minimum cover of 36 inches (915 mm), unless otherwise indicated.
2. Underslab Subdrainage: Install piping pitched down in direction of flow, at a minimum slope of 0.5 percent.
3. Landscaping Subdrainage: Install piping pitched down in direction of flow, at a minimum slope of 0.5 percent and with a minimum cover of 36 inches (915 mm), unless otherwise indicated.
4. Lay perforated pipe with perforations down.
5. Excavate recesses in trench bottom for bell ends of pipe. Lay pipe with bells facing upslope and with spigot end entered fully into adjacent bell.

B. Use increasers, reducers, and couplings made for different sizes or materials of pipes and fittings being connected. Reduction of pipe size in direction of flow is prohibited.

C. Install PVC piping according to ASTM D2321.

3.8 PIPE JOINT CONSTRUCTION

A. Cast-Iron Soil Pipe and Fittings: Hub and spigot, with rubber compression gaskets according to ASTM A74. Use gaskets that match class of pipe and fittings.

B. Join PVC pipe and fittings according to ASTM D2729.

C. Join perforated PVC pipe and fittings according to ASTM D2729.

D. Special Pipe Couplings: Join piping made of different materials and dimensions with special couplings made for this application. Use couplings that are compatible with and fit materials and dimensions of both pipes.

3.9 CLEANOUT INSTALLATION

A. Cleanouts for Foundation and Landscaping Subdrainage:

1. Install cleanouts from piping to grade. Locate cleanouts at beginning of piping run and at changes in direction. Install fittings so cleanouts open in direction of flow in piping.
2. In vehicular-traffic areas, use NPS 4 (DN 100) cast-iron soil pipe and fittings for piping branch fittings and riser extensions to cleanout. Set cleanout frames and covers in a cast-in-place concrete anchor, 18 by 18 by 12 inches (450 by 450 by 300 mm) in depth. Set top of cleanout flush with grade. Cast-iron pipe may also be used for cleanouts in nonvehicular-traffic areas.
3. In nonvehicular-traffic areas, use NPS 4 (DN 100) PVC pipe and fittings for piping branch fittings and riser extensions to cleanout. Set cleanout frames and covers in a cast-in-place concrete anchor, 12 by 12 by 4 inches (300 by 300 by 100 mm) in depth. Set top of cleanout plug 1 inch (25 mm) above grade.

B. Cleanouts for Underslab Subdrainage:

1. Install cleanouts and riser extensions from piping to top of slab. Locate cleanouts at beginning of piping run and at changes in direction. Install fittings so cleanouts open in direction of flow in piping.
2. Use NPS 4 (DN 100) cast-iron soil pipe and fittings for piping branch fittings and riser extensions to cleanout flush with top of slab.

3.10 IDENTIFICATION

A. Install PE warning tape or detectable warning tape over ferrous piping.

B. Install detectable warning tape over nonferrous piping and over edges of underground structures.

3.11 FIELD QUALITY CONTROL

Testing: After installing drainage course to top of piping, test drain piping with water to ensure free flow before backfilling. Remove obstructions, replace damaged components, and repeat test until results are satisfactory.

3.12 CLEANING

Clear interior of installed piping and structures of dirt and other superfluous material as work progresses. Maintain swab or drag in piping and pull past each joint as it is completed. Place plugs in ends of uncompleted pipe at end of each day or when work stops.

--- E N D ---

APPENDIX - A

ANDERSON

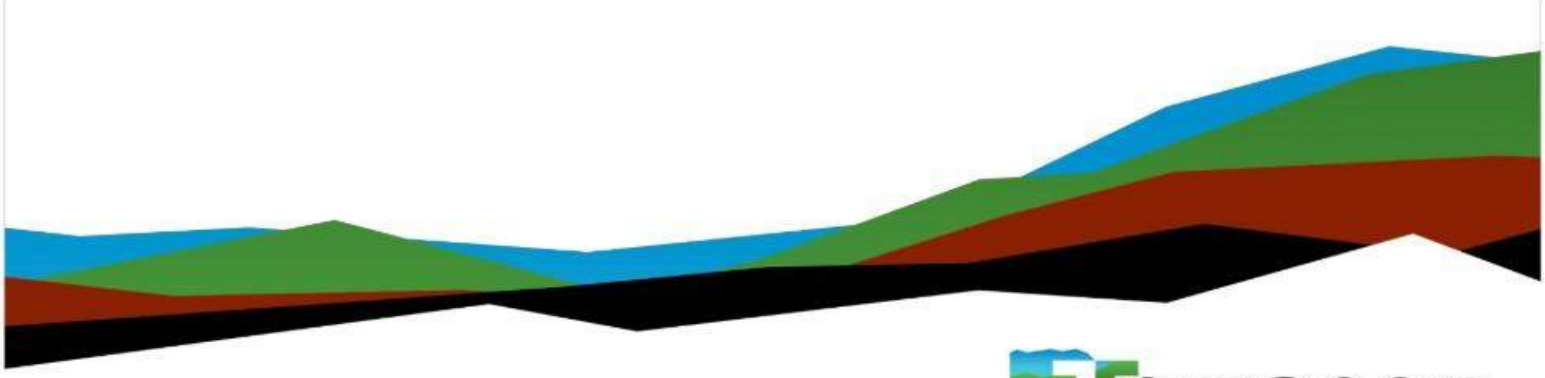
Dayton VA Cemetery Improvements

Geotechnical Engineering Report – Phase 2

April 4, 2025 | Terracon Project No. N1245267

Prepared for:

Anderson Engineering
13605 1st Ave N Ste 100
Plymouth, MN 55441-5454



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April 4, 2025

Anderson Engineering
13605 1st Ave N Ste 100
Plymouth, MN 55441-5454

Attn: Jessica Fahrenkamp
P: (763) 412-4064
E: JFahrenkamp@ae-mn.com

Re: Geotechnical Engineering Report – Phase 2
Dayton VA Cemetery Improvements
4400 West Third Street
Dayton, Ohio
Terracon Project No. N1245267

Dear Ms. Fahrenkamp:

We have completed the Phase 1 and 2 scope of Geotechnical Engineering services for the above-referenced project in general accordance with Terracon Proposal No. PN1245267 dated August 8,2024. This report presents the findings of the subsurface exploration and provides final geotechnical recommendations concerning earthwork and construction of Inground cremains and Pre-placed crypts for Areas 4 and 5, and Columbaria for Area 1 and a new main entry feature. The recommendations in this report replace the preliminary recommendations provided in the Phase I report dated December 27, 2024.

We appreciate the opportunity to be of service to you on this project. If you have any questions concerning this report or if we may be of further service, please contact us.

Sincerely,

Terracon

Sushanta Bhattarai, E.I.T
Field Engineer

Jeffrey D. Dunlap, P.E.
Senior Engineer / Principal

Table of Contents

Introduction **1**
Project Description **1**
Site Conditions **3**
Geotechnical Characterization **4**
Groundwater Conditions 5
Seismic Site Class **6**
Geotechnical Overview **7**
Earthwork **8**
Site Preparation 8
Excavation 9
Subgrade Preparation 9
Existing Fill 10
Fill Material Types 11
Fill Placement and Compaction Requirements 12
Grading and Drainage 13
Earthwork Construction Considerations 13
Construction Observation and Testing 15
Shallow Foundations **16**
Design Parameters – Compressive Loads 16
Design Parameters – Overturning and Uplift Loads 17
Foundation Construction Considerations 17
Slabs-on-Grade **18**
Floor Slab Design Parameters 18
Slab-on-Grade Construction Considerations 19
Pavements **20**
Pavement Subgrade Support Characteristics 20
General Pavement Comments 20
Pavement Drainage 20
Pavement Maintenance 21
General Comments **21**

Figures

GeoModel

Attachments

Exploration and Testing Procedures
Site Location and Exploration Plans
Exploration and Laboratory Results

Supporting Information

Note: This report was originally delivered in a web-based format. **Blue Bold** text in the report indicates a referenced section heading. The PDF version also includes hyperlinks which direct the reader to that section and clicking on the Terracon logo will bring you back to this page. For more interactive features, please view your project online at **client.terracon.com**.

Refer to each individual Attachment for a listing of contents.

Introduction

This report presents the results of our subsurface exploration and Geotechnical Engineering services performed for the proposed expansion of Dayton National Cemetery located at 4400 West Third Street in Dayton, Ohio. This report combines the results of our Phase 1 and Phase 2 field explorations. The purpose of these services was to provide information and geotechnical engineering recommendations relative to:

- Subsurface soil and rock conditions
- Groundwater conditions
- Seismic site classification per IBC
- Site preparation and earthwork
- Demolition considerations
- Dewatering considerations
- Foundation design and construction
- Exterior slab design and construction
- Pavement design and construction

The geotechnical engineering Scope of Services for Phase 2 of this project included the advancement of four test borings, laboratory testing, engineering analysis, and preparation of this report. The current Phase 2 borings have been supplemented with archive test boring and laboratory data from the Phase 1 exploration, 2020 preliminary geotechnical report and 1993 geotechnical report performed by Terracon (formerly H.C. Nutting Company).

Drawings showing the site and boring locations are shown on the **Site Location** and **Exploration Plan**, respectively. The results of the laboratory testing performed on soil samples obtained from the site during our field exploration are included on the boring logs and/or as separate graphs in the **Exploration Results** section.

Project Description

Our initial understanding of the project was provided in our proposal and was discussed during project planning. A period of collaboration has transpired since the project was initiated, and our final understanding of the project conditions is as follows:

Item	Description
Information Provided	An email request for proposal was provided by Anderson Engineering dated August 2, 2024. Further emails and phone conversation occurred on Jan 2025 to confirm the boring locations. Dayton National Cemetery Gravesite Expansion drawings prepared by Anderson Engineering dated January 20, 2025, and typical Crypt Details provided by Anderson Engineering.
Project Description	New pre-placed crypts, new in-ground cremains, improvements to the existing entrance from Third Street and new columbarium. The proposed Areas indicated on the Master Plan are outlined below for Phases 1 and 2. Phase 1 ▪ Area 4 is around 8.8 acres with in-ground cremains and pre-placed crypts, and ▪ Area 5 is around 7.5 acres with pre-placed crypts. Phase 2 ▪ Area 4 is around 8.8 acres with in-ground cremains and pre-placed crypts, and ▪ Area 1 is around 1 acre for columbaria ▪ There is also an entry point off of Third Street that will include a new sign. Phase 1 included borings for Areas 4 and 5. Phase 2 included borings for Areas 1, 4 and the entryway. Please note that the Master Plan calls for in-ground cremains and pre-placed crypts in Areas 2 and 3, but these areas are beyond our current scope. In addition, there are some areas north and west of Area 4 that have some drainage issues, which are also outside our scope. We have included existing archive boring logs and test pit logs for these areas for use by others on the design team.
Proposed Structures	The columbarium project includes columbarium niches with piers, concrete walks and plaza areas and parking area. In-ground cremains will include burial area and associated roads, walkways, signage, site features, utilities, and irrigation. A new front entrance feature sign is also proposed.
Building Construction	Slab-on-grade concrete walks. We anticipate that columbaria will be constructed using concrete and slab-on-grade construction techniques.

Item	Description
Finished Floor Elevation	Slab elevations in the Columbarium area are unknown at this time.
Maximum Loads	Anticipated structural loads were not provided.
Grading/Slopes	Up to about 5 feet of cut and 5 feet of fill will be required to develop final grade. Final slope angles on the order of 20H:1V (Horizontal: Vertical) are expected.
Below-Grade Structures	In-ground cremains are at a depth of about 4 feet below final grade. With granular material below the crypts, the depth of the pre-placed crypts is about 7.5 feet below final grade.
Free-Standing Retaining Walls	None are anticipated
Pavements	Paved drive and parking areas are anticipated in the in-ground cremains areas. We assume both rigid (concrete) and flexible (asphalt) pavement sections will be considered. No traffic loads have been provided at this time.

Terracon should be notified if any of the above information is inconsistent with the planned construction, especially the grading limits, as modifications to our recommendations may be necessary.

Site Conditions

The following description of site conditions is derived from our site visit in association with the field exploration and our review of publicly available geologic and topographic maps.

Item	Description
Parcel Information	▪ The project is located at 4400 West Third Street in Dayton, Montgomery County, Ohio. ▪ Latitude/Longitude 39.7449834, -84.2556928 (approximate) (See Exhibit D) ▪ See **Site Location**
Existing Improvements	Existing drives, cemetery structures, residential structures, grass covered areas, and trees.

Item	Description
Existing Topography	The pre-placed crypt area (Area 5) is gradually sloping down southwest to northeast from about Elevation 930 feet MSL to about Elevation 910 feet MSL. Area 4 is also sloping down southwest from northeast from about Elevation 950 feet MSL to about Elevation 920 feet MSL. Area 3 slopes northward from about Elevation 940 feet MSL to approximately Elevation 930 feet MSL. Area 2 is relatively level and has grade around Elevation 957 feet MSL. The columbaria (Area 1) slopes eastward from about Elevation 950 feet MSL to about Elevation 940 feet MSL.

Geotechnical Characterization

We have developed a general characterization of the subsurface conditions based upon our review of the subsurface exploration, laboratory data, geologic setting and our understanding of the project. This characterization, termed GeoModel, forms the basis of our geotechnical calculations and evaluation of the site. Conditions observed at each exploration point are indicated on the individual logs. The individual logs can be found in the **Exploration Results** and the GeoModel can be found in the **Figures** attachment of this report. We have also included the GeoModel from the preliminary study performed in 2020.

As part of our analyses, we identified the following model layers within the subsurface profile encountered in the Phase 1 and Phase 2 portions of the recent study. For a more detailed view of the model layer depths at each boring location, refer to the GeoModel.

Model Layer	Layer Name	General Description
1	**Existing Fill**	Lean clay/ silty clay, with gravel and sand, occasional limestone fragments/floaters, dark brown to brownish gray trace gray
2	**Brown Glacial Till**	Lean clay to sandy lean clay/silty clay, with gravel and sand, brown/brown trace gray, stiff to hard with some medium stiff zones
3	**Gray Glacial Till**	Lean clay/silty clay, with gravel and sand, gray to olive/gray trace brown, very stiff to hard
4	**Shale and Limestone Bedrock**	Gray shale very weak rock, limestone strong to very strong rock

Model Layer	Layer Name	General Description
5	**Lean Clay**	Lean clay, trace/with sand, trace/with gravel, gray/olive gray to brown/grayish brown, stiff to hard
6	**Granular Soil**	Poorly graded gravel, silty gravel or silty sand, clayey gravel with sand, silt, dark brown to brown/ olive and gray, trace/with shale and limestone fragments, medium dense to dense

Existing fill was encountered in each of the borings except in PR-21, PR-B22, and 2020 Borings B-1, B-2, B-5, B-7 and B-9. The existing fill within the borings is considered undocumented as there is no record of the placement and compaction of the placed fill. In Borings PR-13 to PR-16, and PR-B19 to PR-B20, the existing fill varied from 3 to 3.5 feet thick. In the remaining borings (PR-17 and PR-18), the depth of fill varied from 6 feet to 8.5 feet. In the 2020 Borings B-3, B-4, B-6, B-8, B-10, B-11 and B-12, the depth of the existing fill ranged from 3.5 to 8.5 feet below existing grades. The natural moisture contents of 8 samples of the existing fill in Borings PR-13 to PR-B20 ranged from 9 to 31 percent and was 20 percent on average. Natural moisture contents of tested existing fill samples in the 2020 borings ranged from 4 to 45 percent and averaged about 19 percent. Liquid limits of select tested existing fill samples in the archive and 2024 borings indicated liquid limit of 36 and plasticity indices ranging from 16 to 18, indicating lean clay soil classification per the Unified Soil Classification System (USCS). The wide variation in natural moisture content of the tested existing fill samples indicates poor moisture control during placement of the existing fill soils.

Glacial till or native lean clay was encountered below the existing fill followed by shale and limestone bedrock. Granular soils in the glacial till were encountered at Borings PR-14, PR-18, PR-B20 and PR-B22 beginning at about 6 to 8.5 feet below existing grade. The moisture contents of cohesive samples of the tested glacial till samples in the archive and 2024 borings ranged from 7 to 23 percent. Select samples of the glacial till from the 2020 and 2024 Phase 1 and 2025 Phase 2 borings were subjected to Atterberg limits testing, which yielded liquid limits varying from 20 to 38 percent and plasticity indices varying from 5 to 19, indicating silty clay to lean clay per USCS. Two granular samples were also selected for particle-size analyses with one yielding fines contents (i.e., silt- and clay-sized particles) of 43 percent and was classified as a silty sand, other yielding 45% silt 22 percent sand and 21 percent gravel, and classified as sandy silt with gravel per USCS.

Groundwater Conditions

The borings were advanced in the dry using a hollow-stem auger drilling technique that allow short-term groundwater observations to be made while drilling. Groundwater

seepage was encountered while drilling at a depth of 8.5 feet in Boring PR-18, and at depth of 13.5 feet in Boring PR-B22 at the time of our field exploration. Boring PR-18 caved above the encountered groundwater seepage depth and no at-completion groundwater was encountered in Boring PR-18, however the groundwater seepage depth at Boring PR-B22 was 15.5 at completion of drilling. Boring PR-B19 encountered water seepage within the bedrock during drilling and sampling and at completion of the boring. The remaining 2024 Phase 1, 2025 Phase 2 and 2020 test borings did not encounter groundwater seepage during or upon completion of drilling.

It is common in glacial till soils to have seams, layers or pockets of silt, sand or gravel sandwiched between the lower permeability silty clay or lean clay soils, which generally represented the conditions encountered in Borings PR-14, PR-18, PR-B20 and PR-B22. Boring PR-18 encountered saturated silty sand soils at a depth of 8.5 feet, Boring PR-B22 encountered saturated sandy silt at a depth of a depth of 8.5 feet whereas the granular layers at Boring PR-14 at 8.5 feet below and at Boring PR-18 at 6 feet below existing grade were not saturated. Sometimes the silt, sand or gravel seams, layers or pockets are saturated and can sometimes be under pressure. The aerial extent of the water-bearing seams, layers and pockets can vary, and the higher permeability seams, layers and pockets can be connected or disconnected hydraulically. The groundwater conditions in these perched groundwater zones can fluctuate due to seasonal changes and after precipitation events. It is also common to encounter groundwater seepage within existing fill soils, at the soil bedrock interface and within layers and fractures within the bedrock. Long-term groundwater monitoring was outside the scope of services for this project.

Seismic Site Class

The seismic design requirements for buildings and other structures are based on Seismic Design Category. Site Classification is required to determine the Seismic Design Category for a structure. The Site Classification is based on the upper 100 feet of the site profile defined by a weighted average value of either shear wave velocity, standard penetration resistance, or undrained shear strength in accordance with Section 20.4 of ASCE 7 and the International Building Code (IBC). Based on the soil/bedrock properties observed at the site and as described on the exploration logs and results, our professional opinion is that a **Seismic Site Classification of C** be considered for the project. Subsurface explorations at this site were extended to a maximum depth of 15 feet. The site properties below the boring depth to 100 feet were estimated based on our experience and knowledge of geologic conditions of the general area. Additional deeper borings or geophysical testing may be performed to confirm the conditions below the current boring depth.

Geotechnical Overview

The near surface, stiff to hard medium plasticity lean clay and silty clay could become unstable with typical earthwork and construction traffic, especially after precipitation events. The effective drainage should be completed early in the construction sequence and maintained after construction to avoid potential issues. If possible, the grading should be performed during the warmer and drier times of the year. If grading is performed during the wetter and cooler winter and spring months, an increased risk for possible undercutting and replacement of unstable subgrade will persist. Additional site preparation recommendations, including subgrade improvement and fill placement, are provided in the **Earthwork** section.

The saturated silty sand soil encountered in Boring PR-18 may be close enough to proposed subgrade elevation and cause issues with the subgrade stability near Boring PR-18 and anywhere else where saturated granular soils are encountered at or near proposed subgrade elevation. The saturated sandy silt encountered at Boring PR-22 at depth of 8.5 feet and below should not pose any issue to the proposed in ground cremains if they bear 3 feet above this layer. It is common in glacial till soil profiles to encounter pockets, seams or layers of silt, sand, or gravel sandwiched between less permeable clay soils as encountered in Borings PR-14, PR-18 and PR-B22 within Areas 4 and 5. As a result, saturated granular soils that could impact the subgrade stability in Areas 4 and 5 could be encountered within other areas away from these borings. Further discussion regarding impacts of saturated granular soils are discussed within the **Earthwork** section.

Up to 3 to 8.5 feet of existing fill was encountered in the test borings. No records of the degree of control (moisture conditioning and compaction) during fill placement was provided to Terracon. Natural moisture contents of tested existing fill samples varied from 4 to 45 percent indicating a lack of moisture control during placement of the existing fill soils. Hence, this existing fill is considered to be undocumented, uncontrolled fill that is unsuitable for direct support of structural elements. Foundations will need to completely penetrate existing fill and be placed on competent native soils. The **Shallow Foundations** section addresses support of the foundations directly bearing on native stiff to hard lean clay, silty clay or engineered fill. In Areas 4 and 5, the proposed cut for the pre-placed crypts and in-ground cremains should remove most if not all of the encountered existing fill, and if any existing fill remains at the subgrade elevation, consideration should be given to fully undercutting any remaining existing fill within Areas 4 and 5 to provide firm support of the in-ground cremains and pre-placed crypts and reduce potential of long-term settlement within the existing fill soils. The stiff to very stiff native soil in Area 1 and north main entrance is considered suitable to support the shallow foundations for the Columbaria and entrance features as per recommendations provided in the **Shallow Foundations.**

Some of the glacial till soils have elevated moisture content, which needs proper moisture conditioning before using them as subgrade or as structural fill. These areas if encountered in Areas 4 and 5 could either be undercut and replaced with drier materials or stabilized in place per recommendations provided in the **Earthwork** section.

Support of exterior slabs and pavements on or above existing fill materials is discussed in this report. However, even with the recommended construction procedures, an inherent risk remains for the owner that compressible fill or unsuitable material, within or buried by the fill, will not be discovered. This risk of unforeseen conditions cannot be eliminated without completely removing the existing fill but can be reduced by following the recommendations contained in this report. To take advantage of the cost benefit of not removing the entire amount of undocumented fill, the owner must be willing to accept the risk of increased differential performance which can result in increased cracking and abrupt differential settlement. Should this risk be acceptable, floor slabs and pavements can be supported on a shallow foundation system. The **Floor Slabs** section addresses slab-on-grade support of the building. A rigid pavement system is recommended for the site. The **Pavements** section addresses the design of pavement systems.

The recommendations contained in this report are based upon the results of field and laboratory testing (presented in the **Exploration Results**), engineering analyses, and our current understanding of the proposed project. The **General Comments** section provides an understanding of the report limitations.

Earthwork

Earthwork is anticipated to include clearing and grubbing, excavations, and engineered fill placement in some areas. The following sections provide recommendations for use in the preparation of specifications for the work. Recommendations include critical quality criteria, as necessary, to render the site in the state considered in our geotechnical engineering evaluation for foundations, slabs-on-grade, and pavements.

Site Preparation

Prior to placing fill and performing excavations, existing vegetation, topsoil, and root mats should be removed. Complete stripping of the topsoil should be performed in the proposed in-ground cremains, pre-paced crypt, building and parking/driveway areas.

Mature trees are located within the in-ground cremains area in Area 4, which will require removal at the onset of construction. Tree root systems can remove substantial moisture from surrounding soils. Where trees are removed, the full root ball and all associated dry and desiccated soils should be removed. The soil materials which contain less than 4 percent organics can be reused as engineered fill provided the material is moisture

conditioned and properly compacted. Any resulting holes from the root ball removal at or below proposed subgrade elevation should be replaced with structural fill as recommended later in this report.

Although no underground facilities (such as septic tanks, cesspools, basements, and utilities) were observed during the exploration and site reconnaissance, such features could be encountered during construction. If unexpected fills or underground facilities are encountered, such features should be removed, and the excavation thoroughly cleaned prior to backfill placement and/or construction.

Excavation

We anticipate that excavations for the proposed construction can be accomplished with conventional earthmoving equipment. The bottom of excavations should be thoroughly cleaned of loose soils and disturbed materials prior to backfill placement and/or construction.

Subgrade Preparation

The excavated subgrade and any areas to receive new fill should be proofrolled with an adequately loaded vehicle such as a fully loaded tandem-axle dump truck (minimum 15 tons). Where granular soils are exposed at subgrade, these areas should be proofrolled using a minimum 10-ton smooth drum roller. The proofrolling should be performed under the observation of the Geotechnical Engineer or representative. Areas excessively deflecting under the proofroll should be delineated and subsequently addressed by the Geotechnical Engineer. Such areas should be excavated and filled with structural fill and recompacted. Excessively wet or dry material should either be removed or moisture conditioned and recompacted. In the area near Boring PR-18 and other areas where saturated granular soils are encountered above/at or within a few feet of subgrade elevation, these conditions will impact the stability of the subgrade. Discussion regarding potential dewatering and permanent drainage systems in these areas are discussed in the Earthwork Construction Considerations section.

All exposed areas that will receive fill, once properly cleared, should be scarified to a minimum depth of 10 inches, moisture conditioned as necessary, and compacted per the compaction requirements in this report. Compacted structural fill soils should then be placed to the proposed design grade, and the moisture content and compaction of subgrade soils should be maintained until underdrainage is installed and geosynthetics and compacted drain rock are placed in the preplaced crypts areas and foundation for the Memorial Wall and Columbarium Niches or pavement construction.

We anticipate cohesive soils with moisture contents greater than 20 percent will be exposed upon removal of the surficial materials. Given the moisture content and

cohesive soils observed in our test borings, we anticipate soft yielding areas to be exposed during proofrolling activities. Where yielding areas are delineated and are not improved with moisture conditioning and compaction, they should be undercut and replaced with structural fill, or chemical modification of the in-situ soil using lime, cement, or lime kiln dust containing excess lime, or a combination thereof could be considered. Alternatively, undercut and replacement of these soils with crushed stone or crushed gravel in combination with geogrids designed for subgrade stabilization could also be considered. In general, smaller yielding areas could be improved by removal and replacement of the existing soils or geogrid and crushed stone. For larger areas, chemical modification is typically more economical.

Based upon the subsurface conditions determined from the geotechnical exploration, subgrade soils exposed during construction are anticipated to be relatively workable; however, the workability of the subgrade may be affected by precipitation, repetitive construction traffic or other factors. If unworkable conditions develop, workability may be improved by scarifying and drying.

In general, the on-site soils are considered suitable to be used as structural fill materials.

Existing Fill

As noted in **Geotechnical Characterization**, each of the Phase 1 2024 borings, some of the Phase 2 2025 borings, and a majority of the 2020 borings encountered previously placed existing fill to depths ranging from about 3.5 to 8.5 feet. We have no records to indicate the degree of control. Support of slabs and pavements on or above existing fill soils is discussed in this report. However, even with the recommended construction procedures, inherent risk exists for the owner that compressible fill or unsuitable material, within or buried by the fill will, not be discovered. This risk of unforeseen conditions cannot be eliminated without completely removing the existing fill but can be reduced by following the recommendations contained in this report.

If the owner elects to construct the slabs-on-grade on the existing fill to reduce initial construction costs in exchange for increased potential longer-term distress, the following protocol should be followed. Once the planned subgrade elevation has been reached, a minimum 2-feet undercut or an undercut to expose at least still native soils (whichever is shallower), must be completed. Following this overexcavation, the entire area should be proofrolled with heavy, rubber tire construction equipment, to aid in delineating areas of soft or otherwise unsuitable soil. Once unsuitable materials have been remediated, and the subgrade has passed the proofroll test, backfill to finished subgrade elevation can begin.

If the owner elects to construct pavements on the existing fill, the following protocol should be followed. Once the planned subgrade elevation has been reached, the entire

exposed area should be proofrolled. Areas of soft or otherwise unsuitable material should be further undercut and replaced with either a new structural fill or suitable, existing on-site materials placed and compacted as structural fill.

In Areas 4 and 5, the proposed cut for the pre-placed crypts and in-ground cremains should remove most if not all of the encountered existing fill, and if any existing fill remains at the subgrade elevation, consideration should be given to fully undercutting any remaining existing fill within the areas. At the north main entrance, the excavation for foundations should remove most, if not all, of the existing fill. If any existing fill remains at the bottom of the footing excavations, it should be undercut until firm native soil is exposed, and the footing could be constructed at the lower elevation, or the undercut can be replaced with lean concrete (minimum 28-day f'c=1,000 psi) from the base of the undercut to the design footing bearing elevation.

Fill Material Types

Fill required to achieve design grade should be classified as structural fill and general fill. Structural fill is material used below, or within 5 feet of structures, pavements. General fill is material used to achieve grade outside of these areas.

Reuse of On-Site Soil: Excavated on-site soil may be selectively reused as fill below pavement, slabs, foundations and landscaping areas after some moisture conditioning and culling of floaters and other debris. The excavated on-site soils may also be selectively reused as fill over the proposed pre-placed crypts and in-ground cremains vaults. Some moisture conditioning of the excavated on-site soils should be anticipated. Frozen material should not be used, and fill should not be placed on a frozen subgrade. The suitability of onsite material must be evaluated in the field by geotechnical personnel at the time of construction.

Material property requirements for on-site soil for use as general fill and structural fill are noted in the table below:

Property	General Fill[1]	Structural Fill[1]
Composition	Free of deleterious material	
Maximum particle size	6 inches	3 inches
Fines content	Not limited	Not limited
Plasticity	Not limited	Maximum plasticity index of 23

1. Based on subsurface exploration. Actual material suitability should be determined in the field at time of construction.

Imported Fill Materials: Imported fill materials should meet the following material property requirements. Regardless of its source, compacted fill should consist of

approved materials that are free of organic matter and debris. Frozen material should not be used, and fill should not be placed on a frozen subgrade.

Soil Type [1]	USCS Classification	Acceptable Parameters (for Structural Fill)
Low Plasticity Cohesive	CL, CL-ML, SW-SM, SC	Liquid Limit less than 40 Plasticity index less than 20
Granular	GW, GP, GM, GC, SW, SP, SM, SC	Less than 10% passing No. 200 sieve
Granular (Drainage Only)	GP, SP, SP-SM, GP-SM	Less than 10% fines Less than 5% fines to be considered free draining

1. Structural and general fill should consist of approved materials free of organic matter and debris. Frozen material should not be used, and fill should not be placed on a frozen subgrade. A sample of each material type should be submitted to the Geotechnical Engineer for evaluation prior to use on this site. Additional geotechnical consultation should be provided prior to use of uniformly graded gravel on the site.

Fill Placement and Compaction Requirements

Structural and general fill should meet the following compaction requirements.

Item	Structural Fill	General Fill
Maximum Lift Thickness	▪ 6 inches or less in loose thickness when heavy, self-propelled compaction equipment is used ▪ 3 to 6 inches in loose thickness when hand-guided equipment (i.e. jumping jack or plate compactor) is used	Same as structural fill
Minimum Compaction Requirements [1,2,3]	▪ 98% of max. dry density below foundations, slabs and pavement areas	92% of max. if the areas will not support structures in the future
Water Content Range [1,4]	▪ Low plasticity cohesive: -3% to +3% of optimum ▪ High plasticity cohesive: 0 to +4% of optimum ▪ Granular: -3% to +3% of optimum	As required to achieve min. compaction requirements

Item	Structural Fill	General Fill

1. Maximum density and optimum water content as determined by the standard Proctor test (ASTM D 698).
2. High plasticity cohesive fill should not be compacted to more than 100% of standard Proctor maximum dry density.
3. If the granular material is a coarse sand or gravel, or of a uniform size, or has a low fines content, compaction comparison to relative density may be more appropriate. In this case, granular materials should be compacted to at least 70% relative density (ASTM D 4253 and D 4254). Materials not amenable to density testing should be placed and compacted to a stable condition observed by the Geotechnical Engineer or representative.
4. Where granular soils are encountered, drum rollers should be used for compaction in those areas.

Grading and Drainage

All grades must provide effective drainage away from the pre-placed crypts and in-ground cremains during and after construction and should be maintained throughout the life of the structure. Surface drainage during construction should be directed away from open excavations using temporary berms, temporary ditches, or other surface water controls. Use of temporary sumps and pumps may be required during construction to control surface water that may enter the excavations for the pre-placed crypts and in-ground cremains.

Exposed ground should be sloped and maintained at a minimum 5% away to drainage features. Locally, flatter grades may be necessary to transition ADA access requirements for flatwork. After construction and landscaping have been completed, final grades should be verified to document effective drainage has been achieved. Grades around the structure should also be periodically inspected and adjusted, as necessary, as part of the structure's maintenance program.

Earthwork Construction Considerations

Shallow excavations for the proposed structure are anticipated to be accomplished with conventional construction equipment. Upon completion of filling and grading, care should be taken to maintain the subgrade water content prior to construction of grade-supported improvements such as slabs-on-grade and pavements. Construction traffic over the completed subgrades should be avoided. The site should also be graded to prevent ponding surface water on the prepared subgrades or in excavations. Water collecting over or adjacent to construction areas should be removed. If the subgrade freezes, desiccates, saturates, or is disturbed, the affected material should be removed,

or the materials should be scarified, moisture conditioned, and recompacted prior to floor slab construction.

A temporary dewatering system consisting of sumps with pumps may be necessary to achieve the recommended depth of excavation or potential over-excavation where weak soils are encountered at subgrade elevation due to presence of granular material layers at depths below 8.5 feet in some of the borings (PR-14,PR-18 and PR-B22) during the time of construction.

It is common in glacial till soil profiles to encounter pockets, seams or layers of silt, sand, or gravel sandwiched between less permeable clay soils as encountered in Borings PR-14, PR-18 and PR-B22 within Areas 4 and 5. Oftentimes, these pockets, layers or seams of silt, sand, or gravel can contain perched groundwater (Boring PR-18 and PR-B22). The volume and flow of water from these perched groundwater zones will depend if these pockets, layers or seams are recharged from surface water or interconnected to other silt, sand, or gravel pockets, layers, or seams. The groundwater level and/or perched groundwater trapped in silt, sand, or gravel seams could affect over-excavation efforts, especially for excavation and replacement of lower strength soils or for the planned excavations within the in-ground cremains or pre-placed crypt areas in Areas 4 and 5. For excavations in the cohesive soils predominantly encountered on this site, a temporary dewatering system consisting of sumps with pumps may be necessary to achieve the recommended depth of over excavation or excavation depending on groundwater conditions at the time of construction. If excavations extend into saturated granular soils a temporary dewatering system consisting of high volume and/or multiple sump pits or well points outside and/or within the limits of the excavation may be necessary to achieve the recommended depth of planned excavation or over excavation depending on groundwater conditions at the time of construction. Typically, these systems are designed by a specialty dewatering contractor. Pumping/slug tests or installation of long-term monitoring wells to measure groundwater levels or flow rates were beyond our scope and budget.

Once any temporary dewatering is performed in saturated granular soils during construction, we recommend that a permanent drainage system consisting of perforated or slotted PVC pipes at regular intervals (approximately 25 to 30 feet on-center) be installed across the granular soil dewatered areas, which can be incorporated into the already planned subsurface drainage system planned for the pre-placed crypts. The lateral slotted or perforated PVC pipes should be surrounded by free-draining crushed rock material and separated from the underlying subgrade material and any overlying soils using a minimum Class 2 AASHTO nonwoven geotextile filter/separation fabric. The subsurface drainage system should be designed to gravity flow to a permanent stormwater collection system.

As a minimum, excavations should be performed in accordance with OSHA 29 CFR, Part 1926, Subpart P, "Excavations" and its appendices, and in accordance with any applicable local and/or state regulations.

Construction site safety is the sole responsibility of the contractor who controls the means, methods, and sequencing of construction operations. Under no circumstances shall the information provided herein be interpreted to mean Terracon is assuming responsibility for construction site safety or the contractor's activities; such responsibility shall neither be implied nor inferred.

Excavations or other activities resulting in ground disturbance have the potential to affect adjoining properties and structures. Our scope of services does not include review of available final grading information or consider potential temporary grading performed by the contractor for potential effects such as ground movement beyond the project limits. A preconstruction/ precondition survey should be conducted to document nearby property/infrastructure prior to any site development activity. Excavation or ground disturbance activities adjacent or near property lines should be monitored or instrumented for potential ground movements that could negatively affect adjoining property and/or structures.

Construction Observation and Testing

The earthwork efforts should be observed by the Geotechnical Engineer (or others under their direction). Observation should include documentation of adequate removal of surficial materials (vegetation, topsoil, and pavements), evaluation and remediation of existing fill materials, as well as proofrolling and mitigation of unsuitable areas delineated by the proofroll.

Each lift of compacted fill should be tested, evaluated, and reworked, as necessary, as recommended by the Geotechnical Engineer prior to placement of additional lifts. Each lift of fill should be tested for density and water content.

In areas of foundation excavations, the bearing subgrade should be evaluated by the Geotechnical Engineer. If unanticipated conditions are observed, the Geotechnical Engineer should prescribe mitigation options.

In addition to the documentation of the essential parameters necessary for construction, the continuation of the Geotechnical Engineer into the construction phase of the project provides the continuity to maintain the Geotechnical Engineer's evaluation of subsurface conditions, including assessing variations and associated design changes.

Shallow Foundations

If the columbaria and the main entry feature site has been prepared in accordance with the requirements noted in **Earthwork**, the following design parameters are applicable for shallow foundations. If existing fill is encountered at the planned bearing elevation, it should be completely undercut until firm native soil is exposed.

Design Parameters – Compressive Loads

Item	Description
Maximum Net Allowable Bearing Pressure [1,]	2,500 psf - foundations bearing upon structural fill or undisturbed native soils.
Required Bearing Stratum [2]	Undisturbed native soils or structural fill extending to undisturbed native soils
Minimum Foundation Dimensions	Columns: 30 inches Continuous: 18 inches
Ultimate Passive Resistance4 [3] **(equivalent fluid pressures)**	250 pcf
Sliding Resistance [4]	0.35 ultimate coefficient of friction – native soil or new structural fill
Minimum Embedment below Finished Grade [5]	32 inches
Estimated Total Settlement from Structural Loads	Less than about 1 inch
Estimated Differential Settlement [6]	About 1/2 of total settlement

1. The maximum net allowable bearing pressure is the pressure in excess of the minimum surrounding overburden pressure at the footing base elevation. Values assume that exterior grades are no steeper than 20% within 10 feet of structure.
2. Unsuitable or soft soils should be overexcavated and replaced per the recommendations presented in **Earthwork**.
3. Use of passive earth pressures require the sides of the excavation for the spread footing foundation to be nearly vertical and the concrete placed neat against these vertical faces or that the footing forms be removed and compacted structural fill be placed against the vertical footing face. Assumes no hydrostatic pressure. Applicable to portion of the foundation located below 32 inches below adjacent finished grades.
4. Can be used to compute sliding resistance where foundations are placed on suitable soil/materials. Frictional resistance for soil materials is dependent on the bearing pressure which may vary due to load combinations.
5. Embedment necessary to minimize the effects of frost and/or seasonal water content variations. For sloping ground, maintain depth below the lowest adjacent exterior grade within 5 horizontal feet of the structure.

Item	Description

6. Differential settlements are noted for equivalent-loaded foundations and bearing elevation as measured over a span of 50 feet or between adjacent column or individual footings.

Design Parameters – Overturning and Uplift Loads

Shallow foundations subjected to overturning loads should be proportioned such that the resultant eccentricity is maintained in the center-third of the foundation (e.g., e < b/6, where b is the foundation width). This requirement is intended to keep the entire foundation area in compression during the extreme lateral/overturning load event. Foundation oversizing may be required to satisfy this condition.

Uplift resistance of spread footings can be developed from the effective weight of the footing and the overlying soils with consideration to the IBC basic load combinations.

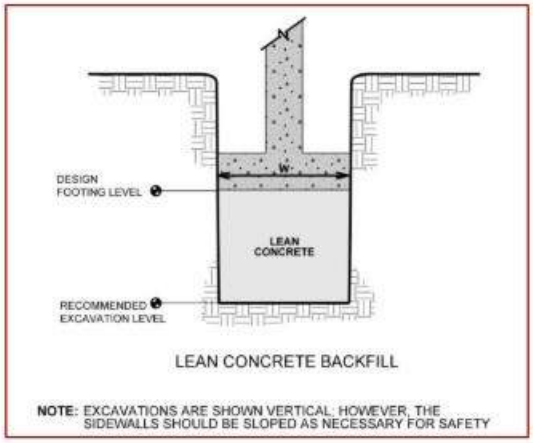
Item	Description
Soil Moist Unit Weight	120 pcf
Soil Effective Unit Weight[1]	60 pcf
Soil weight included in uplift resistance	Soil included within the prism extending up from the top perimeter of the footing at an angle of 20 degrees from vertical to ground surface

1. Effective (or buoyant) unit weight should be used for soil above the foundation level and below a water level. The high groundwater level should be used in uplift design as applicable.

Foundation Construction Considerations

As noted in **Earthwork**, the footing excavations should be evaluated under the observation of the Geotechnical Engineer. The base of all foundation excavations should be free of water and loose soil, prior to placing concrete. Concrete should be placed soon after excavating to reduce bearing soil disturbance. Care should be taken to prevent wetting or drying of the bearing materials during construction. Excessively wet or dry material or any loose/disturbed material in the bottom of the footing excavations should be removed/reconditioned before foundation concrete is placed.

If unsuitable bearing soils are observed at the base of the planned footing excavation, such as soft/medium stiff soils or existing fill soils, the excavation should be extended deeper to suitable soils, and the footings could bear directly on these soils at the lower level or on lean concrete backfill (minimum 28-day f'c=1,000 psi) placed in the excavations. The lean concrete replacement zone is illustrated in the sketch below.



Slabs-on-Grade

Design parameters for exterior slabs-on-grade assume the requirements for **Earthwork** have been followed. Specific attention should be given to positive drainage away from the structure and positive drainage of the aggregate base beneath the exterior slab.

Floor Slab Design Parameters

Item	Description
Slab Support[1]	Minimum 6 inches of relatively free-draining (less than 10% passing the U.S. No. 200 sieve) crushed stone aggregate compacted to at least 98% of ASTM D 698 [2, 3]
Estimated Modulus of Subgrade Reaction [2]	100 pounds per square inch per inch (psi/in) for point loads

1. Exterior slabs should be structurally independent of any structure footings or walls to reduce the possibility of slab cracking caused by differential movements between the slab and foundation.
2. Modulus of subgrade reaction is an estimated value based upon our experience with the subgrade condition, the requirements noted in **Earthwork**, and the exterior slab support as noted in this table. It is provided for point loads. For large area loads the modulus of subgrade reaction would be lower.
3. Free-draining crushed stone material should have less than 5% fines (material passing the No. 200 sieve, such as No. 57 crushed limestone material). Other design considerations such as cold temperatures and condensation development could warrant more extensive design provisions. Rounded gravel and crushed gravel materials should be avoided. Subgrades should be sloped, and subsurface drains installed to collect and remove surface water that finds its

Item	Description
	way into granular base. Preferably the subgrades should slope away from foundations to prevent water from collecting near foundations.

Saw-cut contraction joints should be placed in the slab to help control the location and extent of cracking. For additional recommendations, refer to the ACI Design Manual. Joints or cracks should be sealed with a waterproof, non-extruding compressible compound specifically recommended for heavy duty concrete pavement and wet environments.

Where slabs are tied to perimeter walls or turn-down slabs to meet structural or other construction objectives, our experience indicates differential movement between the walls and slabs will likely be observed in adjacent slab expansion joints or floor slab cracks beyond the length of the structural dowels. The Structural Engineer should account for potential differential settlement through use of sufficient control joints, appropriate reinforcing or other means.

Settlement of slabs supported on existing fill materials cannot be accurately predicted but could be larger than normal and result in some cracking. Mitigation measures, as noted in **Existing Fill** within **Earthwork**, are critical to the performance of floor slabs. In addition to the mitigation measures, the slab can be stiffened by adding steel reinforcement, grade beams, and/or post-tensioned elements.

Slab-on-Grade Construction Considerations

Finished subgrade, within and for at least 10 feet beyond the exterior slabs, should be protected from traffic, rutting, or other disturbance and maintained in a relatively moist condition until slabs are constructed. If the subgrade should become damaged or desiccated prior to construction of exterior slabs, the affected material should be removed, and structural fill should be added to replace the resulting excavation. Final conditioning of the finished subgrade should be performed immediately prior to placement of the slab support course.

The Geotechnical Engineer should observe the condition of the exterior slab subgrades immediately prior to placement of the slab support course, reinforcing steel, and concrete. Attention should be paid to high traffic areas that were rutted and disturbed earlier, and to areas where backfilled trenches are located.

Pavements

Pavement Subgrade Support Characteristics

Sufficient information is not available for us to provide an opinion of minimum pavement thickness for the project. For pavement design by others, we recommend that a subgrade California Bearing Ratio, CBR, of 3 be used for the asphaltic concrete pavement designs. We recommend that a modulus of subgrade reaction of 100 pci be used for the Portland cement concrete (PCC) pavement designs. These values were empirically derived based upon our experience with the encountered subgrade soils, the presence of the existing fill and our expectation of the quality of the subgrade as prescribed by the **Site Preparation** conditions as outlined in **Earthwork**.

General Pavement Comments

A critical aspect of pavement performance is site preparation. Pavement designs performed by others must be applied to the site which has been prepared as recommended in the **Earthwork** section.

Support characteristics of subgrade for pavement design do not account for shrink/swell movements of an expansive clay subgrade, such as soils observed on this project. Thus, the pavement may be adequate from a structural standpoint, yet still experience cracking and deformation due to shrink/swell related movement of the subgrade.

Pavement Drainage

Pavements should be sloped to provide rapid drainage of surface water. Water allowed to pond on or adjacent to the pavements could saturate the subgrade and contribute to premature pavement deterioration. In addition, the pavement subgrade should be graded to provide positive drainage within the granular base section. Appropriate sub-drainage or connection to a suitable daylight outlet should be provided to remove water from the granular subbase.

We recommend pavement subgrades be crowned at least 2% to promote the flow of water towards the subdrains, and to reduce the potential for ponding of water on the subgrade. If grades are directed toward proposed pavement areas, ditches should be incorporated into the design where the invert of the ditches extend below the proposed pavement subgrade elevation. Alternatively, edge drains extending at least 12 inches below the subgrade elevation and designed for positive drainage could also be incorporated into the pavement design.

Pavement Maintenance

The pavement sections designed by others will represent the minimum recommended thicknesses and, as such, periodic upkeep should be anticipated. Preventive maintenance should be planned and provided for through an on-going pavement management program. Maintenance activities are intended to slow the rate of pavement deterioration and to preserve the pavement investment. Pavement care consists of both localized (e.g., crack and joint sealing and patching) and global maintenance (e.g., surface sealing). Additional engineering consultation is recommended to determine the type and extent of a cost-effective program. Even with periodic maintenance, some movements and related cracking may still occur, and repairs may be required.

Pavement performance is affected by its surroundings. In addition to providing preventive maintenance, the civil engineer should consider the following recommendations in the design and layout of pavements:

- Final grade adjacent to paved areas should slope down from the edges at a minimum 2%.
- Subgrade and pavement surfaces should have a minimum 2% slope to promote proper surface drainage and 1% for ADA accessible areas.
- Install pavement drainage systems surrounding areas anticipated for frequent wetting or where grades adjacent to pavements slope toward the pavement areas.
- If curb and gutter are not part of the pavement section, use ditches with inverts extending below pavement subgrade elevation to control surface water adjacent to pavement areas.
- Install joint sealant and seal cracks immediately.
- Seal all landscaped areas in or adjacent to pavements to reduce moisture migration to subgrade soils.
- Place compacted, low permeability backfill against the exterior side of curb and gutter.
- Place curb, gutter and/or sidewalk directly on clay subgrade soils rather than on unbound granular base course materials.

General Comments

Our analysis and opinions are based upon our understanding of the project, the geotechnical conditions in the area, and the data obtained from our site exploration. Variations will occur between exploration point locations or due to the modifying effects of construction or weather. The nature and extent of such variations may not become evident until during or after construction. Terracon should be retained as the Geotechnical Engineer, where noted in this report, to provide observation and testing

services during pertinent construction phases. If variations appear, we can provide further evaluation and supplemental recommendations. If variations are noted in the absence of our observation and testing services on-site, we should be immediately notified so that we can provide evaluation and supplemental recommendations.

Our Scope of Services does not include either specifically or by implication any environmental or biological (e.g., mold, fungi, bacteria) assessment of the site or identification or prevention of pollutants, hazardous materials or conditions. If the owner is concerned about the potential for such contamination or pollution, other studies should be undertaken.

Our services and any correspondence are intended for the sole benefit and exclusive use of our client for specific application to the project discussed and are accomplished in accordance with generally accepted geotechnical engineering practices with no third-party beneficiaries intended. Any third-party access to services or correspondence is solely for information purposes to support the services provided by Terracon to our client. Reliance upon the services and any work product is limited to our client and is not intended for third parties. Any use or reliance of the provided information by third parties is done solely at their own risk. No warranties, either express or implied, are intended or made.

Site characteristics as provided are for design purposes and not to estimate excavation cost. Any use of our report in that regard is done at the sole risk of the excavating cost estimator as there may be variations on the site that are not apparent in the data that could significantly affect excavation cost. Any parties charged with estimating excavation costs should seek their own site characterization for specific purposes to obtain the specific level of detail necessary for costing. Site safety and cost estimating including excavation support and dewatering requirements/design are the responsibility of others. Construction and site development have the potential to affect adjacent properties. Such impacts can include damage due to vibration, modification of groundwater/surface water flow during construction, foundation movement due to undermining or subsidence from excavation, as well as noise or air quality concerns. Evaluation of these items on nearby properties are commonly associated with contractor means and methods and are not addressed in this report. The owner and contractor should consider a preconstruction/precondition survey of surrounding development. If changes in the nature, design, or location of the project are planned, our conclusions and recommendations shall not be considered valid unless we review the changes and either verify or modify our conclusions in writing.

Rock Classification Notes

WEATHERING	
Term	**Description**
Fresh	Mineral crystals appear bright; show no discoloration. Features show little or now staining on surfaces. Discoloration does not extend into intact rock.
Slightly weathered	Rock generally fresh except along fractures. Some fractures stained and discoloration may extend <0.5 inches into rock.
Moderately weathered	Significant portions of rock are dull and discolored. Rock may be significantly weaker than in fresh state near fractures. Soil zones of limited extent may occur along some fractures.
Highly weathered	Rock dull and discolored throughout. Majority of rock mass is significantly weaker and has decomposed and/or disintegrated; isolated zones of stronger rock and/or soil may occur throughout.
Completely weathered	All rock material is decomposed and/or disintegrated to soil. The rock mass or fabric is still evident and largely intact. Isolated zones of stronger rock may occur locally.

STRENGTH OR HARDNESS		
Description	**Field Identification**	**Uniaxial Compressive Strength, psi**
Extremely strong	Can only be chipped with geological hammer. Rock rings on hammer blows. Cannot be scratched with a sharp pick. Hand specimens require several hard hammer blows to break.	>36,000
Very strong	Several blows of a geological hammer to fracture. Cannot be scratched with a 20d common steel nail. Can be scratched with a geologist's pick only with difficulty.	15,000-36,000
Strong	More than one blow of a geological hammer needed to fracture. Can be scratched with a 20d nail or geologist's pick. Gouges or grooves to ¼ inch deep can be excavated by a hard blow of a geologist's pick. Hand specimens can be detached by a moderate blow.	7,500-15,000
Medium strong	One blow of geological hammer needed to fracture. Can be distinctly scratched with 20d nail. Can be grooved or gouged 1/16 in. deep by firm pressure with a geologist's pick point. Can be fractured with single firm blow of geological hammer. Can be excavated in small chips (about 1-in. maximum size) by hard blows of the point of a geologist's pick;	3,500-7,500
Weak	Shallow indent by firm blow with geological hammer point. Can be gouged or grooved readily with geologist's pick point. Can be excavated in pieces several inches in size by moderate blows of a pick point. Small thin pieces can be broken by finger pressure.	700-3,500
Very weak	Crumbles under firm blow with geological hammer point. Can be excavated readily with the point of a geologist's pick. Pieces 1-in. or more in thickness can be broken with finger pressure. Can be scratched readily by fingernail.	150-700

DISCONTINUITY DESCRIPTION			
Fracture Spacing (Joints, Faults, Other Fractures)		**Bedding Spacing (May Include Foliation or Banding)**	
Description	**Spacing**	**Description**	**Spacing**
Intensely fractured	< 2.5 inches	**Laminated**	< ½-inch
Highly fractured	2.5 – 8 inches	**Very thin**	½ – 2 inches
Moderately fractured	8 inches to 2 feet	**Thin**	2 inches – 1 foot
Slightly fractured	2 to 6.5 feet	**Medium**	1 – 3 feet
Very slightly fractured	> 6.5 feet	**Thick**	3 – 10 feet
		Massive	> 10 feet

ROCK QUALITY DESIGNATION (RQD) [1]	
Description	**RQD Value (%)**
Very Poor	0 - 25
Poor	25 – 50
Fair	50 – 75
Good	75 – 90
Excellent	90 - 100

1. The combined length of all sound and intact core segments equal to or greater than 4 inches in length, expressed as a percentage of the total core run length.

Figures

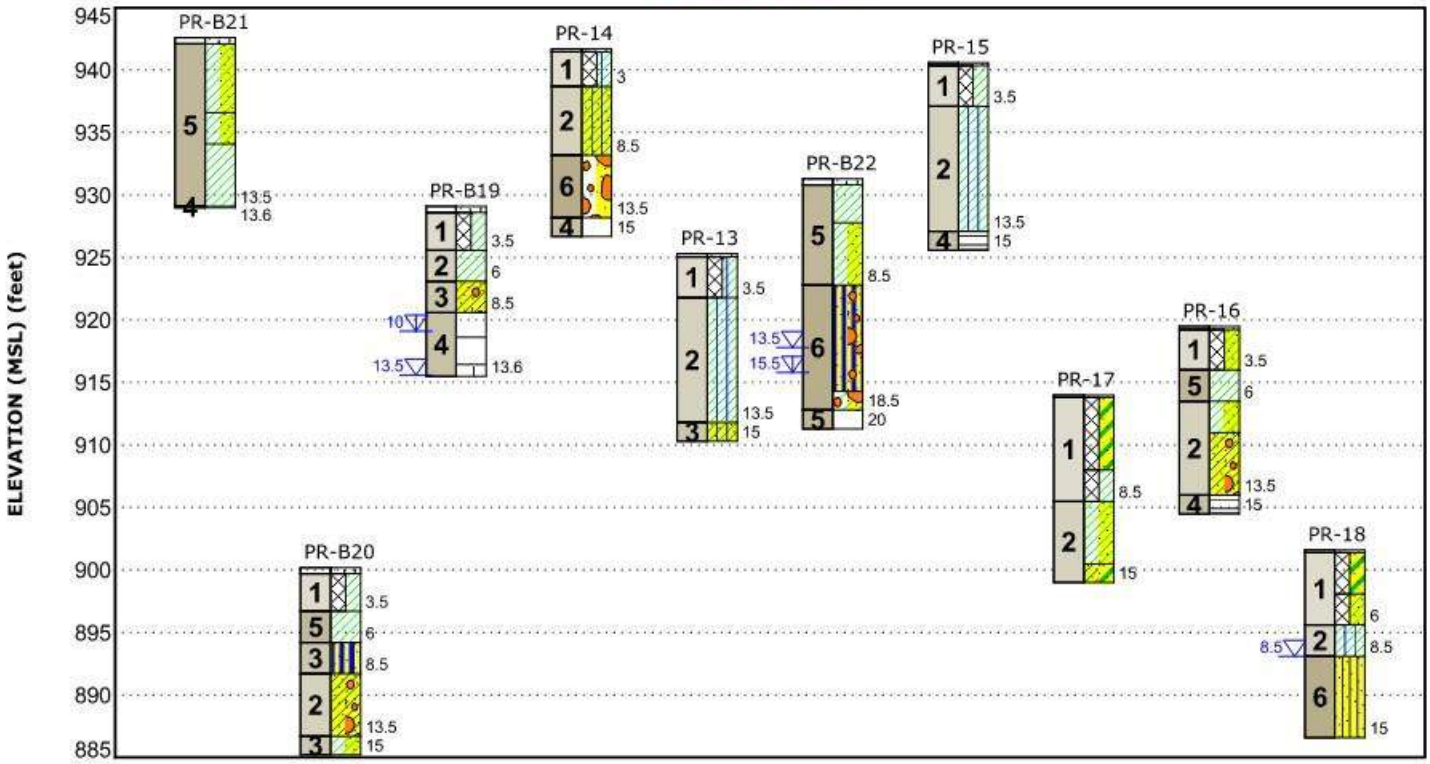
Contents:

GeoModel (Phase 1 and 2 Borings)
GeoModel (2020 Archive Borings)

Dayton National Cemetery Expansion
4400 West Third Street | Dayton, OH
Terracon Project No. N1245267

Terracon
611 Lunken Park Dr
Cincinnati, OH

GeoModel



This is not a cross section. This is intended to display the Geotechnical Model only. See individual logs for more detailed conditions.

Model Layer	Layer Name	General Description
1	**Existing Fill**	Lean clay/ silty clay, with gravel and sand, occasional limestone fragments/floaters, dark brown to brownish gray trace gray
2	**Brown Glacial Till**	Lean clay to sandy lean clay/silty clay, with gravel and sand, brown/brown trace gray, stiff to hard with some medium stiff zones
3	**Gray Glacial Till**	Lean clay/silty clay, with gravel and sand, gray to olive/ gray trace brown, very stiff to hard
4	**Shale and Limestone Bedrock**	Gray shale very weak rock, limestone strong to very strong rock
5	**Lean Clay**	Lean clay, trace/with sand, trace/with gravel, gray/olive gray to brown/grayish brown, stiff to hard
6	**Granular Soil**	Poorly graded gravel, silty gravel or silty sand, clayey gravel with sand, silt, dark brown to brown/ olive and gray, trace/with shale and limestone fragments, medium dense to dense

Legend

- Topsoil
- Sandy Silty Clay Interbedded
- Shale
- Sandy Lean Clay with Gravel
- Silty Sand
- Sandy Silt
- Clayey Gravel with Sand
- Silty Clay
- Poorly-graded Gravel with Sand
- Lean Clay
- Lean Clay with Sand
- Sandy Lean Clay/Clayey Sand Interbedded
- Limestone and Shale
- Sandy Silt with Gravel

NOTES:
Layering shown on this figure has been developed by the geotechnical engineer for purposes of modeling the subsurface conditions as required for the subsequent geotechnical engineering for this project.

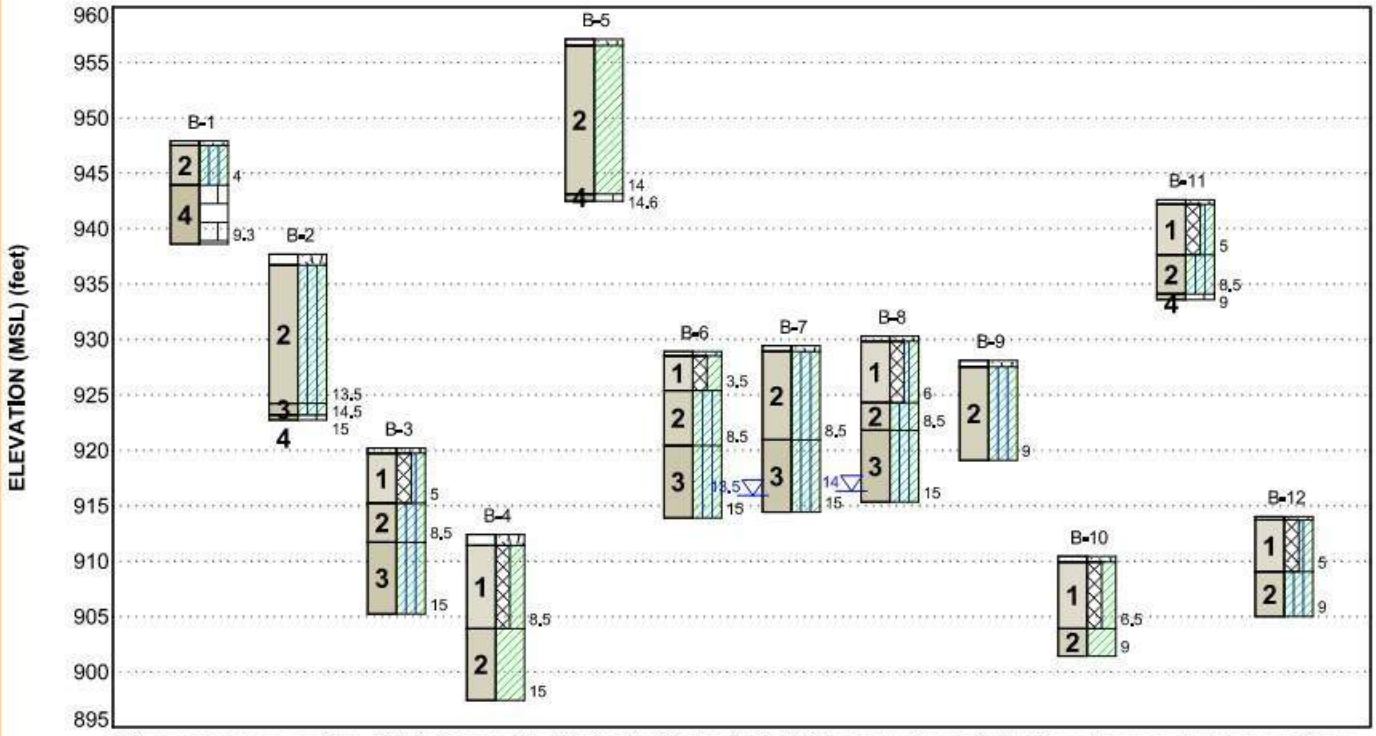
▽ First Water Observation
▽ Second Water Observation

Groundwater levels are temporal. The levels shown are representative of the date and time of our exploration. Significant changes are possible over time.
Water levels shown are as measured during and/or after drilling. In some cases, boring advancement methods mask the presence/absence of groundwater. See individual logs for details.

GEOMODEL

Dayton VA Niche Columbarium and In-ground Cremains ■ Dayton, OH
Terracon Project No. N1205096

Terracon GeoReport



This is not a cross section. This is intended to display the Geotechnical Model only. See individual logs for more detailed conditions.

Model Layer	Layer Name	General Description
1	EXISTING FILL	lean clay/ silty clay, with gravel and sand, occasional limestone fragments/floaters, dark brown trace brown
2	BROWN GLACIAL TILL	lean clay/silty clay, with gravel and sand, brown/ brown trace gray, stiff to hard with some medium stiff zones
3	GRAY GLACIAL TILL	lean clay/silty clay, with gravel and sand, gray/ gray trace brown, very stiff to hard
4	LIMESTONE BEDROCK	gray, strong rock

LEGEND

Topsoil
Lean Clay
Silty Clay
Limestone

▽ First Water Observation

Groundwater levels are temporal. The levels shown are representative of the date and time of our exploration. Significant changes are possible over time. Water levels shown are as measured during and/or after drilling. In some cases, boring advancement methods mask the presence/absence of groundwater. See individual logs for details.

NOTES:
Layering shown on this figure has been developed by the geotechnical engineer for purposes of modeling the subsurface conditions as required for the subsequent geotechnical engineering for this project. Numbers adjacent to soil column indicate depth below ground surface.

Attachments

Exploration and Testing Procedures

Field Exploration

Number of Borings	Approximate Boring Depth (feet) [1]	Location
1	20	Phase 2 - IGC locations (Area4)
1	13.6	Phase 2 - IGC locations (Area 4)
1	13.6	Phase 2 – Columbaria location (Area 1)
1	15	Phase 2 - North Entrance Gate
3	15	Phase 1 - IGC Locations (Area 4)
3	15	Phase 1 – Pre-Placed Crypts Location (Area 5)

1. Refer to the Exploration Plans in **Site Location and Exploration Plans**.

The Phase 2 test borings were supplemented with Phase 1 2024 and 2020 archive borings performed by Terracon at the site. The archive borings were performed using similar procedures as the 2025 Phase 2 borings.

Boring Layout and Elevations: Terracon personnel provided the boring layout using handheld GPS equipment (estimated horizontal accuracy of about ±10 feet) and referencing existing site features. Approximate ground surface elevations were obtained by interpolation from the topographic contours downloaded from the Montgomery County GIS Website. If more precise elevations and boring layout are desired, we recommend borings be surveyed.

Subsurface Exploration Procedures: We advanced the borings with a track-mounted rotary drill rig using continuous-flight hollow-stem augers. Four samples were obtained in the upper 10 feet and at intervals of 5 feet thereafter. In the split-barrel sampling procedure, a standard 2-inch outer diameter split-barrel sampling spoon was driven into the ground by a 140-pound automatic hammer falling a distance of 30 inches. The number of blows required to advance the sampling spoon the last 12 inches of a normal 18-inch penetration is recorded as the Standard Penetration Test (SPT) resistance value. The SPT resistance values, also referred to as N-values, are indicated on the boring logs at the test depths. Two Shelby tube samples were collected using thin-walled tube sampling procedures. In the thin-walled tube sampling procedure, a thin-walled, seamless steel tube

with a sharp cutting edge was pushed hydraulically into the soil to obtain a relatively undisturbed sample. For safety purposes, all borings were backfilled with auger cuttings and a concrete plug after their completion.

We also observed the boreholes while drilling and at the completion of drilling for the presence of groundwater. The groundwater levels are shown on the attached boring logs.

The sampling depths, penetration distances, and other sampling information were recorded on the field boring logs. The samples were placed in appropriate containers and taken to our soil laboratory for testing and classification by a Geotechnical Engineer. Our exploration team prepared field boring logs as part of the drilling operations. These field logs included visual classifications of the materials observed during drilling and our interpretation of the subsurface conditions between samples. Final boring logs were prepared from the field logs. The final boring logs represent the Geotechnical Engineer's interpretation of the field logs and include modifications based on observations and tests of the samples in our laboratory.

Laboratory Testing

The project engineer reviewed the field data and assigned laboratory tests. The laboratory testing program included the following types of tests:

- Moisture Content
- Atterberg Limits
- Grain size analysis

The laboratory testing program often included examination of soil samples by an engineer. Based on the results of our field and laboratory programs, we described and classified the soil samples in accordance with the Unified Soil Classification System.

Rock classification was conducted using locally accepted practices for engineering purposes. Boring log rock classification was determined using the Description of Rock Properties.

The Phase 2 laboratory program was supplemented with laboratory testing performed on selected soil and bedrock samples from 2020 and Phase 1 geotechnical study. Laboratory testing performed on selected soil samples from the archive borings included moisture content, Atterberg limits and unconfined compressive strength of soil.

Site Location and Exploration Plans

Contents:

Site Location Plan
Exploration Plan – 2025 Phase 2
Exploration Plan – Phase 1,2 and Archive Borings and Test Pits

Note: All attachments are one page unless noted above.

Site Location

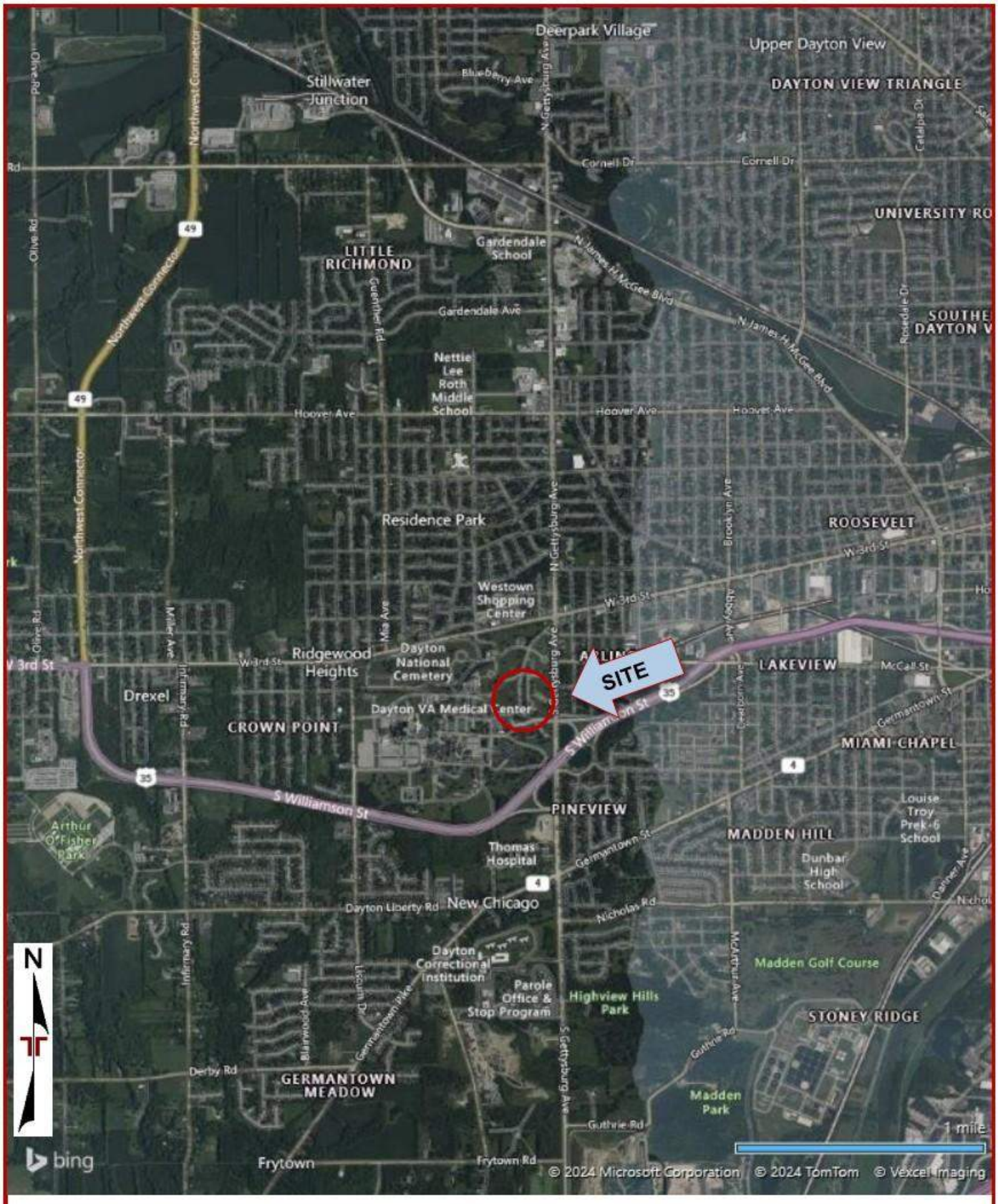


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES MAP PROVIDED BY MICROSOFT BING MAPS

Exploration Plan – 2025 Phase 2

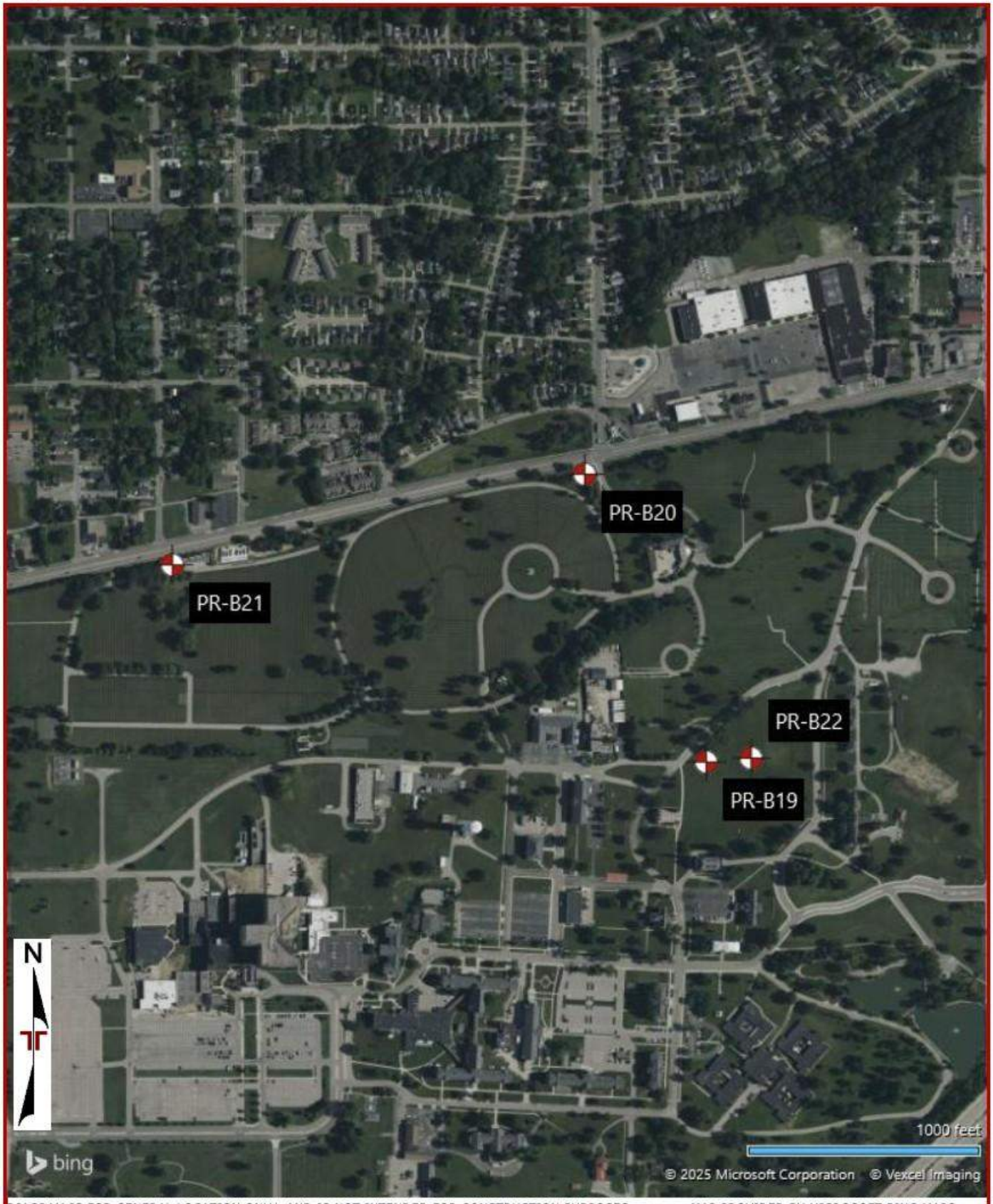


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

MAP PROVIDED BY MICROSOFT BING MAPS

Exploration Plan – Phase 1, 2 and Archive Borings and Test Pits

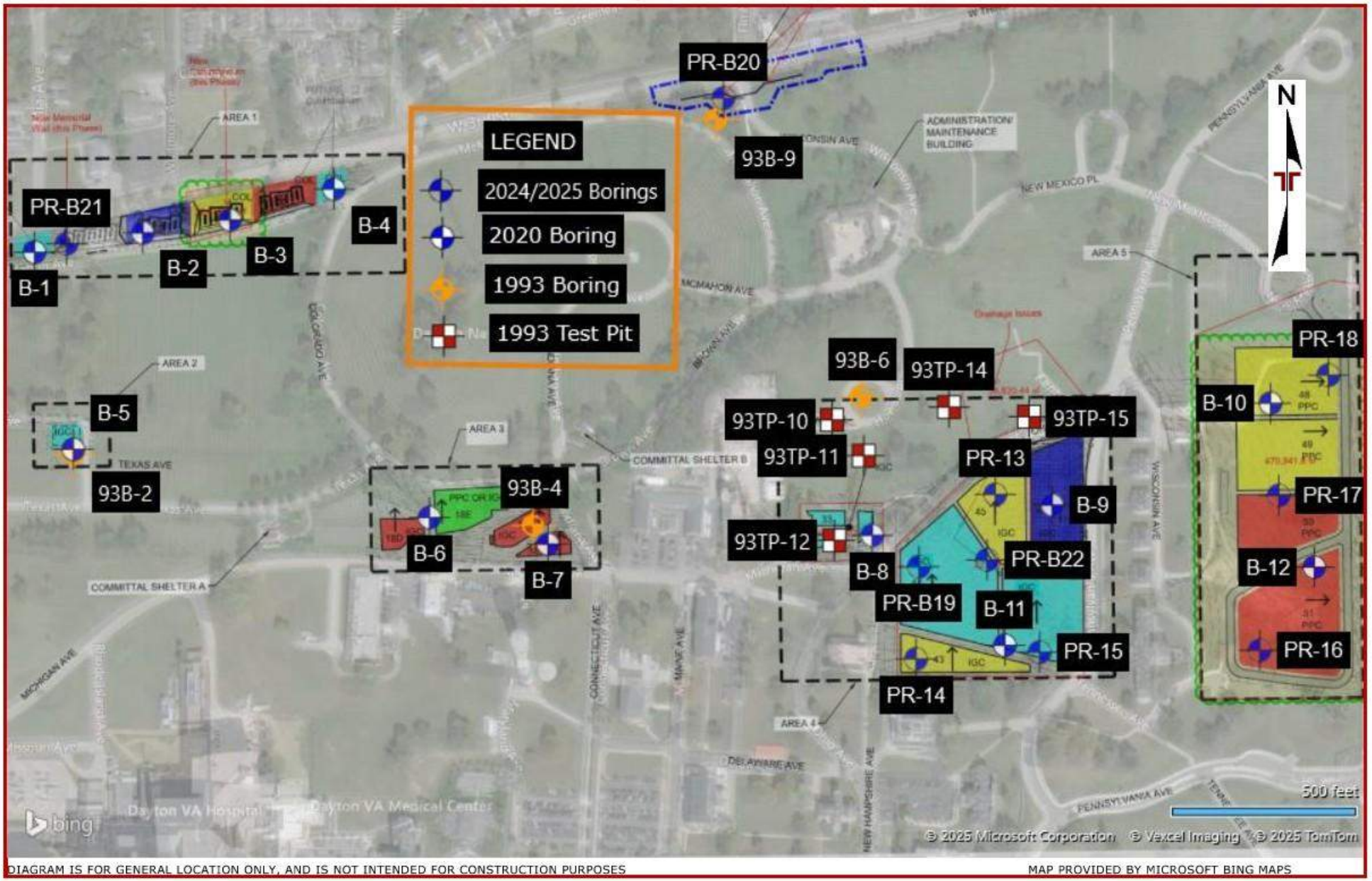


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

MAP PROVIDED BY MICROSOFT BING MAPS

Exploration and Laboratory Results

Contents:

Boring Logs Phase 1 and 2 (PR-13 through PR-18, PR-B19 through PR-B22)
Archive 2020 Boring Logs (B-1 through B-12)
Archive 1993 Boring and Test Pit Logs (8 pages)
Phase 1 and 2 Atterberg Limits
Atterberg Limits (2020 Archive Data)
Phase 1 and 2 Grain Size Distribution
Unconfined Compressive Strength (2020 Archive Data)
Unconfined Compressive Strength (1993 Archive Data)

Note: All attachments are one page unless noted above.

Dayton National Cemetery Expansion
4400 West Third Street | Dayton, OH
Terracon Project No. N1245267

Terracon
611 Lunken Park Dr
Cincinnati, OH

Boring Log No. PR-13

Location: See Exploration Plan

Latitude: 39.745254° Longitude: -84.256709°

Model Layer	Graphic Log	Depth (Ft.)	Elevation: 925.3 (Ft.) +/-	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (%)	Field Test Results	HP (tsf)	Water Content (%)	Atterberg Limits LL-PL-PI
		0.3	**TOPSOIL (3")** 925.05								
1			**FILL - SILTY CLAY**, with gravel, trace root hairs, brown				78	3-4-5 N=9	2.5 (HP)	20.0	
		3.5	921.8								
2			**SILTY CLAY (CL-ML)**, with limestone fragments, trace sand and gravel, brown and gray, stiff to hard, (Glacial Till)	5			100	13-16-16 N=32	4.5 (HP)	8.8	
							100	8-7-6 N=13	4.5 (HP)	11.1	
					▨		100	5-6-7 N=13	1.5 (HP)	10.1	
		13.5	911.8	10							
3			**SANDY SILTY CLAY (CL-ML)**, with gravel, gray, very stiff, (Glacial Till)				100	4-6-10 N=16	3.75 (HP)	8.7	
		15.0	910.3	15							
			Boring Terminated at 15 Feet								

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevation Reference: Elevations were measured in the field using an EMLID GPS unit.

Water Level Observations
Water not encountered at completion of drilling.

▨ Boring caved at 8.5'

Notes
Automatic Hammer Energy Transfer Ratio=92%

Advancement Method
3-1/4" Continuous Flight Hollow Stem Auger
2" Split-Barrel Sampler

Abandonment Method
Boring backfilled with auger cuttings upon completion.

Drill Rig
CME 55

Hammer Type
Automatic

Driller
C. Kinsley

Logged by
J. Friend

Boring Started
11-21-2024

Boring Completed
11-21-2024

Dayton National Cemetery Expansion
4400 West Third Street | Dayton, OH
Terracon Project No. N1245267

Terracon
611 Lunken Park Dr
Cincinnati, OH

Boring Log No. PR-14

Location: See Exploration Plan

Latitude: 39.744039° Longitude: -84.257470°

Model Layer	Graphic Log	Depth (Ft.)	Elevation: 941.7 (Ft.) +/-	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (%)	Field Test Results	HP (tsf)	Water Content (%)	Atterberg Limits LL-PL-PI
		0.3	**TOPSOIL (3")** 941.45								
1			**FILL - SILTY CLAY**, trace sand and gravel, brown				78	2-3-5 N=8	4.5 (HP)	26.7	
		3.0	938.7								
2			**SANDY SILTY CLAY (CL-ML)**, with gravel, brown, very stiff, (Glacial Till)				67		3 (HP)	15.4	
			- soft below 6 feet	5			100	5-4-3 N=7	0.25 (HP)	17.7	21-16-5
		8.5	933.2								
6			**POORLY GRADED GRAVEL WITH SILT AND SAND (GP)**, with limestone fragments, brown, dense				100	8-17-16 N=33		12.7	
		13.5	928.2	10							
4			**SHALE AND LIMESTONE**, shale very weak, limestone strong, gray				100	24-25-16 N=41		9.5	
		15.0	926.7	15							
			Boring Terminated at 15 Feet								

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevation Reference: Elevations were measured in the field using an EMLID GPS unit.

Water Level Observations
Water not encountered at completion of drilling.

Boring caved at 8.7'

Drill Rig
CME 55

Hammer Type
Automatic

Driller
C. Kinsley

Notes
Automatic Hammer Energy Transfer Ratio=92%

Advancement Method
3-1/4" Continuous Flight Hollow Stem Auger
2" Split-Barrel Sampler

Abandonment Method
Boring backfilled with auger cuttings upon completion.

Logged by
J. Friend

Boring Started
11-21-2024

Boring Completed
11-21-2024

Dayton National Cemetery Expansion
4400 West Third Street | Dayton, OH
Terracon Project No. N1245267

Terracon
611 Lunken Park Dr
Cincinnati, OH

Boring Log No. PR-15

Location: See Exploration Plan

Latitude: 39.744090° Longitude: -84.256283°

Model Layer	Graphic Log	Depth (Ft.)	Elevation: 940.6 (Ft.) +/-	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (%)	Field Test Results	HP (tsf)	Water Content (%)	Atterberg Limits LL-PL-PI
		0.3	**TOPSOIL (3")** 940.35								
1			**FILL - LEAN CLAY**, trace sand, brown, (Glacial Till)								
							72	3-3-5 N=8	2.5 (HP)	19.3	
		3.5	937.1								
2			**SILTY CLAY (CL-ML)**, with sand, trace gravel, brown, very stiff to hard								
							100	4-7-9 N=16	3.75 (HP)	12.5	
				5							
							94	5-5-12 N=17	2.75 (HP)	13.3	
							100	7-7-12 N=19	4.5 (HP)	9.9	
				10							
4		13.5	927.1								
			SHALE, with limestone, gray trace brown, slightly weathered, very weak				94	21-20-18 N=38		7.5	
		15.0	925.6	15							
			Boring Terminated at 15 Feet								

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevation Reference: Elevations were measured in the field using an EMLID GPS unit.

Water Level Observations
Water not encountered at completion of drilling.

Boring caved at 10'

Drill Rig
CME 55

Hammer Type
Automatic

Driller
C. Kinsley

Notes
Automatic Hammer Energy Transfer Ratio=92%

Advancement Method
3-1/4" Continuous Flight Hollow Stem Auger
2" Split-Barrel Sampler

Abandonment Method
Boring backfilled with auger cuttings upon completion.

Logged by
J. Friend

Boring Started
11-21-2024

Boring Completed
11-21-2024

Dayton National Cemetery Expansion
4400 West Third Street | Dayton, OH
Terracon Project No. N1245267

Terracon
611 Lunken Park Dr
Cincinnati, OH

Boring Log No. PR-16

Location: See Exploration Plan

Latitude: 39.744103° Longitude: -84.254169°

Model Layer	Graphic Log	Depth (Ft.)	Elevation: 919.5 (Ft.) +/-	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (%)	Field Test Results	HP (tsf)	Water Content (%)	Atterberg Limits LL-PL-PI
		0.3	**TOPSOIL (3")** 919.25								
1			**FILL - LEAN CLAY WITH SAND**, trace gravel, trace roots, brown								
						X	50	2-2-2 N=4	2.25 (HP)	19.6	
		3.5	916								
5			**LEAN CLAY (CL)**, trace sand, dark brown, stiff								
						X	39	2-3-4 N=7	1.75 (HP)	21.4	
		6.0	913.5	5							
2			**LEAN CLAY WITH SAND (CL)**, trace gravel, trace limestone fragments, trace concretions, brown trace gray, hard, (Glacial Till)								
						X	100	4-7-7 N=14	4.5 (HP)	13.1	
		8.5	911								
2			**SANDY LEAN CLAY WITH GRAVEL (CL)**, brown and gray, very stiff, (Glacial Till)								
						X	100	4-5-5 N=10	4 (HP)	13.6	
				10							
		13.5	906								
4			**SHALE**, gray, slightly weathered, very soft								
						X	100	7-9-13 N=22		14.5	
		15.0	904.5	15							
			Boring Terminated at 15 Feet								

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevation Reference: Elevations were measured in the field using an EMLID GPS unit.

Water Level Observations
Water not encountered at completion of drilling.

Cave in not observed.

Drill Rig
CME 55

Hammer Type
Automatic

Driller
C. Kinsley

Notes
Automatic Hammer Energy Transfer Ratio=92%

Advancement Method
3-1/4" Continuous Flight Hollow Stem Auger
2" Split-Barrel Sampler

Abandonment Method
Boring backfilled with auger cuttings upon completion.

Logged by
A. Moore

Boring Started
11-20-2024

Boring Completed
11-20-2024

Dayton National Cemetery Expansion
4400 West Third Street | Dayton, OH
Terracon Project No. N1245267

Terracon
611 Lunken Park Dr
Cincinnati, OH

Boring Log No. PR-17

Location: See Exploration Plan

Latitude: 39.745246° Longitude: -84.253986°

Model Layer	Depth (Ft.)	Elevation: 914.0 (Ft.) +/-	Sample Type	Recovery (%)	Field Test Results	HP (tsf)	Water Content (%)	Atterberg Limits LL-PL-PI
	0.2	**TOPSOIL (2")** 913.8						
1		**FILL - SANDY LEAN CLAY**, with gravel, with limestone fragments, brown to gray, trace cinders and burned materials, petroleum odor						
				89	7-10-9 N=19	4 (HP)	8.9	
				46		4 (HP)	31.3	
	6.0	908						
		FILL - LEAN CLAY, trace sand, trae root hairs, dark gray						
				100	3-5-6 N=11	3 (HP)	25.3	
	8.5	905.5						
2		**LEAN CLAY WITH SAND (CL)**, trace limestone fragments, brown, hard, (Glacial Till)						
				89	3-4-6 N=10	4.5 (HP)	13.1	23-13-10
	13.5	900.5						
		SANDY LEAN CLAY (CL), with limestone fragments, dark grayish brown, very stiff, (Glacial Till)						
				100	7-7-10 N=17	4 (HP)	10.2	
	15.0	899						
		Boring Terminated at 15 Feet						

Depth (Ft.): 5, 10, 15

Water Level Observations: Boring caved at 10.5'

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevation Reference: Elevations were measured in the field using an EMLID GPS unit.

Water Level Observations
Water not encountered at completion of drilling.

Notes
Automatic Hammer Energy Transfer Ratio=92%

Advancement Method
3-1/4" Continuous Flight Hollow Stem Auger
2" Split-Barrel Sampler

Abandonment Method
Boring backfilled with auger cuttings upon completion.

Drill Rig
CME 55

Hammer Type
Automatic

Driller
C. Kinsley

Logged by
J. Friend

Boring Started
11-21-2024

Boring Completed
11-21-2024

Dayton National Cemetery Expansion
4400 West Third Street | Dayton, OH
Terracon Project No. N1245267

Terracon
611 Lunken Park Dr
Cincinnati, OH

Boring Log No. PR-18

Location: See Exploration Plan

Latitude: 39.746135° Longitude: -84.253510°

Model Layer	Depth (Ft.)	Elevation: 901.6 (Ft.) +/-	Sample Type	Recovery (%)	Field Test Results	HP (tsf)	Water Content (%)	Atterberg Limits LL-PL-PI
	0.2	**TOPSOIL (2")** 901.4						
1	3.5	**FILL - SANDY LEAN CLAY**, trace gravel, trace limestone fragments, organics, trace root hair, brown, hard 898.1		78	3-4-9 N=13	4.5 (HP)	14.6	
	6.0	**FILL - LEAN CLAY WITH SAND**, trace root hairs, dark gray trace reddish brown 895.6		83	4-5-5 N=10	3.5 (HP)	26.6	
2	8.5	**SILTY CLAY (CL-ML)**, with sand and gravel, trace root hairs, brown, very stiff, (Glacial Till) 893.1		100	4-4-6 N=10	2.75 (HP)	14.9	
6	15.0	**SILTY SAND (SM)**, trace gravel, trace clay, brown, medium dense 886.6		89	4-5-7 N=12			
					3-4-6 N=10			
		Boring Terminated at 15 Feet						

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevation Reference: Elevations were measured in the field using an EMLID GPS unit.

Water Level Observations
Water encountered at depth 8.5 feet while drilling.

Boring caved at 8'

Drill Rig
CME 55

Hammer Type
Automatic

Driller
C. Kinsley

Notes
Automatic Hammer Energy Transfer Ratio=92%

Advancement Method
3-1/4" Continuous Flight Hollow Stem Auger
2" Split-Barrel Sampler

Abandonment Method
Boring backfilled with auger cuttings upon completion.

Logged by
J. Friend

Boring Started
11-21-2024

Boring Completed
11-21-2024

Dayton National Cemetery Expansion
4400 West Third Street | Dayton, OH
Terracon Project No. N1245267

Terracon
611 Lunken Park Dr
Cincinnati, OH

Boring Log No. PR-B19

Location: See Exploration Plan

Latitude: 39.7447° Longitude: -84.2574°

Depth (Ft.) | Approximate Elevation: 929.1 (Ft.)

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (%)	Field Test Results	HP (tsf)	Water Content (%)	Atterberg Limits LL-PL-PI
		0.5 **TOPSOIL**, (6 INCHES) 928.6							
1		**FILL - LEAN CLAY**, trace sand and gravel, brownish gray trace gray			33	2-2-4 N=6	2	21.9	
		3.5 925.6							
2		**LEAN CLAY (CL)**, trace sand and gravel, brownish gray trace gray, very stiff, (Glacial Till)			78	5-9-10 N=19	2.5	13.0	24-13-11
		6.0 923.1							
3		**SANDY LEAN CLAY WITH GRAVEL (CL)**, trace limestone fragments, olive gray, very stiff, (Glacial Till)			94	7-10-11 N=21	3	6.9	
		8.5 920.6							
4		**INTERBEDDED SHALE AND LIMESTONE** **SHALE**, brown and gray, highly weathered, very to extremely weak **LIMESTONE**, gray, slightly weathered, medium strong to strong			92	11-36-50/1"		7.4	
		13.6 915.5			20	50/1"		18.5	
		Auger Refusal at 13.6 Feet							

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See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevation Reference: Elevations were measured in the field using an EMLID GPS unit.

Water Level Observations
- Water encountered at depth 13.5 feet while drilling.
- Water encountered at depth 10 feet at completion of drilling.
- Boring caved at 10 feet

Drill Rig
Mobile B57

Hammer Type
Automatic

Driller
A. Fay

Notes
Hammer Energy Transfer Ratio (ETR)=(87.1 +/- 2.1)%

Advancement Method
3-1/4" Continuous Flight Hollow Stem Auger
2" Split-Barrel Sampler

Abandonment Method
Boring backfilled with auger cuttings upon completion.

Logged by
E. Hammonds

Boring Started
03-10-2025

Boring Completed
03-10-2025

Dayton National Cemetery Expansion
4400 West Third Street | Dayton, OH
Terracon Project No. N1245267

Terracon
611 Lunken Park Dr
Cincinnati, OH

Boring Log No. PR-B20

Location: See Exploration Plan

Latitude: 39.7482° Longitude: -84.2593°

Depth (Ft.) | Approximate Elevation: 900.2 (Ft.)

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (%)	Field Test Results	HP (tsf)	Water Content (%)	Atterberg Limits LL-PL-PI
		0.5 **TOPSOIL**, (6 INCHES) 899.7							
1		**FILL - LEAN CLAY**, trace sand, trace gravel, trace root hairs, brownish gray to gray			33	1-2-2 N=4	1.5	12.1	
		3.5 896.7							
5		**LEAN CLAY (CL)**, trace gravel, brown to grayish brown, stiff to very stiff			55	2-4-4 N=8	2.75	23.3	
		6.0 894.2							
3		**SANDY SILT (ML)**, trace gravel, gray and olive, medium dense, (Glacial Till)			78	4-6-10 N=16		15.2	
		8.5 891.7							
2		**SANDY LEAN CLAY WITH GRAVEL (CL)**, yellowish brown, very stiff, (Glacial Till)			67	3-3-7 N=10	3	8.6	
		13.5 886.7							
3		**LEAN CLAY WITH SAND (CL)**, trace gravel, gray, very stiff to hard, (Glacial Till)			78	3-7-9 N=16	4.5+		
		15.0 885.2							
		Boring Terminated at 15 Feet							

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15

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevation Reference: Elevations were measured in the field using an EMLID GPS unit.

Water Level Observations
Water not encountered at completion of drilling.

Drill Rig
Mobile B57

Hammer Type
Automatic

Driller
A. Fay

Notes
Hammer Energy Transfer Ratio (ETR)=(87.1 +/- 2.1)%

Advancement Method
3-1/4" Continuous Flight Hollow Stem Auger
2" Split-Barrel Sampler

Abandonment Method
Boring backfilled with auger cuttings upon completion.

Logged by
E. Hammonds

Boring Started
03-10-2025

Boring Completed
03-10-2025

Dayton National Cemetery Expansion
4400 West Third Street | Dayton, OH
Terracon Project No. N1245267

Terracon
611 Lunken Park Dr
Cincinnati, OH

Boring Log No. PR-B21

Location: See Exploration Plan

Latitude: 39.7471° Longitude: -84.2656°

Depth (Ft.) | Approximate Elevation: 942.6 (Ft.)

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (%)	Field Test Results	HP (tsf)	Water Content (%)	Atterberg Limits LL-PL-PI
		0.5 **TOPSOIL**, (6 INCHES) 942.1							
5		**LEAN CLAY WITH SAND (CL)**, with gravel, gray to grayish brown, stiff to very stiff			72	4-4-4 N=8	2.5	7.6	
					72	2-3-5 N=8	2	26.9	38-19-19
		6.0 936.6						21.6	
		LEAN CLAY WITH SAND (CL), trace gravel, olive trace gray, very stiff			89	2-3-6 N=9	4.5+	12.4	
		8.5 934.1							
		LEAN CLAY (CL), olive and gray, hard, laminated (Residuum)			83	7-14-28 N=42	4.5+	12.4	
		13.5 929.1							
4		13.6 929 **INTERBEDDED SHALE AND LIMESTONE**, trace clay seams **SHALE**, gray, highly weathered, very to extremely weak **LIMESTONE**, gray, slightly weathered, medium strong to strong			100	50/1"			
		Auger Refusal at 13.6 Feet							

Depth (Ft.): 5, 10

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevation Reference: Elevations were measured in the field using an EMLID GPS unit.

Water Level Observations
Water not encountered at completion of drilling.

Drill Rig
Mobile B57

Hammer Type
Automatic

Driller
A. Fay

Notes
Hammer Energy Transfer Ratio (ETR)=(87.1 +/- 2.1)%
An adjacent offset boring was performed to collect a Shelby Tube

Advancement Method
3-1/4" Continuous Flight Hollow Stem Auger
2" Split-Barrel Sampler

Abandonment Method
Boring backfilled with auger cuttings upon completion.

Logged by
E. Hammonds

Boring Started
03-10-2025

Boring Completed
03-10-2025

Dayton National Cemetery Expansion
4400 West Third Street | Dayton, OH
Terracon Project No. N1245267

Terracon
611 Lunken Park Dr
Cincinnati, OH

Boring Log No. PR-B22

Location: See Exploration Plan

Latitude: 39.7448° Longitude: -84.2568°

Depth (Ft.) | Approximate Elevation: 931.3 (Ft.)

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (%)	Field Test Results	HP (tsf)	Water Content (%)	Atterberg Limits LL-PL-PI
		0.5 **TOPSOIL**, (6 INCHES) 930.8							
		LEAN CLAY (CL), trace sand, trace gravel, gray, medium stiff to stiff			50	1-2-3 N=5	1.25	24.7	
		3.5 927.8							
5		**LEAN CLAY WITH SAND (CL)**, trace gravel, trace concretions, brown to grayish brown, stiff to very stiff			83	4-6-7 N=13	4	11.2	
					100	5-4-5 N=9	2.25	13.4	
		8.5 922.8							
6		**SANDY SILT WITH GRAVEL (ML)**, trace limestone fragments, gray and olive gray, medium dense to dense, (Glacial Till) - samples are wet			78	9-9-9 N=18		17.2	
					55	9-20-15 N=35		10.7	
		17.0 914.3							
		CLAYEY GRAVEL WITH SAND (GC), with limestone floaters and shale fragments, olive and gray, dense, (Glacial Till)			72	15-19-19 N=38		6.7	
		18.5 912.8							
5		**INTERBEDDED SHALE AND LIMESTONE**, with clay seams **SHALE**, gray, moderately weathered, very to extremely **LIMESTONE**, gray, slightly weathered, medium strong to strong			100	17-42-49 N=91		10.9	
		20.0 911.3							
		Boring Terminated at 20 Feet							

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevation Reference: Elevations were measured in the field using an EMLID GPS unit.

Water Level Observations

Water encountered at depth 13.5 feet while drilling.

Water encountered at depth 15.5 feet at completion of drilling.

Boring caved at 8 feet

Drill Rig
Mobile B57

Hammer Type
Automatic

Driller
A. Fay

Notes
Hammer Energy Transfer Ratio (ETR)=(87.1 +/- 2.1)%

Advancement Method
3-1/4" Continuous Flight Hollow Stem Auger
2" Split-Barrel Sampler

Abandonment Method
Boring backfilled with auger cuttings upon completion.

Logged by
E. Hammonds

Boring Started
03-10-2025

Boring Completed
03-10-2025

BORING LOG NO. B-1

PROJECT: Dayton VA Niche Columbarium and In-ground Cremains

CLIENT: Anderson Engineering Plymouth, MN

SITE: 4400 West Third Street Dayton, OH

LOCATION See Exploration Plan

Latitude: 39.747042° Longitude: -84.265936°
Northing: 641163.8489 Easting: 1471982.867

Surface Elev.: 947.9 (Ft.)

MODEL LAYER	GRAPHIC LOG	DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (%)	FIELD TEST RESULTS	LABORATORY HP (tsf)	UNCONFINED COMPRESSIVE STRENGTH (tsf)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI
		0.4	947.5										
			TOPSOIL (5 INCHES)										
2			**SILTY CLAY**, with gravel and sand, brown, very stiff to hard (Glacial Till)				28	5-7-7 N=14	4.5 (HP)		14.2		
		4.0	944				91	7-50/5"	4.5 (HP)		7.1		
4			**LIMESTONE**, gray, strong rock	5			100	50/1"			0.6		
		9.3	938.5				70	39-50/4"					
			Boring Terminated at 9.3 Feet										

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
3.25-inch Continuous-Flight Hollow-Stem Augers
2-inch Split-Barrel Sampler

Abandonment Method:
Backfill with auger cuttings and concrete batch

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevation Reference: Zeno GPS Survey

Notes:

WATER LEVEL OBSERVATIONS

No water observed during drilling

No water observed upon completeion of drilling

Terracon
611 Lunken Park Dr
Cincinnati, OH

Boring Started: 09-14-2020 | Boring Completed: 09-14-2020

Drill Rig: CME 55 | Driller: KH

Project No.: N1205096

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL N1205096 DAYTON VA NICHE C.GPJ TERRACON_DATATEMPLATE.GDT 9/29/20

BORING LOG NO. B-2

PROJECT: Dayton VA Niche Columbarium and In-ground Cremains

CLIENT: Anderson Engineering Plymouth, MN

SITE: 4400 West Third Street Dayton, OH

LOCATION See Exploration Plan

Latitude: 39.747185° Longitude: -84.264897°
Northing: 641210.158 Easting: 1472275.984

Surface Elev.: 937.7 (Ft.)

MODEL LAYER	GRAPHIC LOG	DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (%)	FIELD TEST RESULTS	LABORATORY HP (tsf)	UNCONFINED COMPRESSIVE STRENGTH (tsf)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI
		1.0	936.5										
			TOPSOIL (12 INCHES)										
2			**SILTY CLAY (CL-ML)**, with gravel and sand, brown, stiff to very stiff (Glacial Till)				89	2-3-3 N=6	2.5 (HP)		13.7		
							100	SHELBY TUBE		2.51	12.7	128	21-14-7
				5			100	5-6-9 N=15	1.5 (HP)		12.7		
							22	9-13-14 N=27	1.0 (HP)		11.7		
		13.5	924	10									
3		14.5	**SILTY CLAY**, with gravel and sand, gray, hard (Glacial Till) 923				83	13-29-29 N=58	4.5 (HP)				
4		15.0	**LIMESTONE**, gray, strong rock 922.5	15									
			Boring Terminated at 15 Feet										

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
3.25-inch Continuous-Flight Hollow-Stem Augers
2-inch Split-Barrel Sampler
3-inch Thin-Walled Tube

Abandonment Method:
Backfill with auger cuttings and concrete batch

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevation Reference: Zeno GPS Survey

Notes:

WATER LEVEL OBSERVATIONS

No water observed during drilling

No water observed upon completeion of drilling

Terracon
611 Lunken Park Dr
Cincinnati, OH

Boring Started: 09-14-2020 | Boring Completed: 09-14-2020

Drill Rig: CME 55 | Driller: KH

Project No.: N1205096

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL N1205096 DAYTON VA NICHE C.GPJ TERRACON_DATATEMPLATE.GDT 9/29/20

BORING LOG NO. B-3

PROJECT: Dayton VA Niche Columbarium and In-ground Cremains

CLIENT: Anderson Engineering Plymouth, MN

SITE: 4400 West Third Street Dayton, OH

LOCATION See Exploration Plan

Latitude: 39.74728° Longitude: -84.26406°
Northing: 641240.023 Easting: 1472511.787

Surface Elev.: 920.2 (Ft.)

MODEL LAYER	GRAPHIC LOG	DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (%)	FIELD TEST RESULTS	LABORATORY HP (tsf)	UNCONFINED COMPRESSIVE STRENGTH (tsf)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI
		0.5	919.5										
			TOPSOIL (6 INCHES)										
1			**FILL - SILTY CLAY**, with gravel and sand, dark brown				83	5-6-7 N=13	4.5 (HP)		27.5		
							100	SHELBY TUBE					
		5.0	915	5									
2			**SILTY CLAY**, with gravel and sand, brown trace gray, very stiff (Glacial Till)				83	8-6-5 N=11	2.75 (HP)		12.2		
		8.5	911.5										
3			**SILTY CLAY**, with gravel and sand, gray, very stiff to hard (Glacial Till)	10			100	8-10-11 N=21	4.5 (HP)				
		15.0	905	15			83	5-6-7 N=13	2.5 (HP)				
			Boring Terminated at 15 Feet										

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
3.25-inch Continuous-Flight Hollow-Stem Augers
2-inch Split-Barrel Sampler

Abandonment Method:
Backfill with auger cuttings and concrete batch

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevation Reference: Zeno GPS Survey

Notes:

WATER LEVEL OBSERVATIONS

No water observed during drilling

No water observed upon completeion of drilling

Terracon
611 Lunken Park Dr
Cincinnati, OH

Boring Started: 09-14-2020 | Boring Completed: 09-14-2020

Drill Rig: CME 55 | Driller: KH

Project No.: N1205096

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL N1205096 DAYTON VA NICHE C.GPJ TERRACON_DATATEMPLATE.GDT 9/29/20

BORING LOG NO. B-4

PROJECT: Dayton VA Niche Columbarium and In-ground Cremains

CLIENT: Anderson Engineering Plymouth, MN

SITE: 4400 West Third Street Dayton, OH

LOCATION See Exploration Plan

Latitude: 39.747508° Longitude: -84.263061°
Northing: 641317.5707 Easting: 1472794.271

Surface Elev.: 912.4 (Ft.)

MODEL LAYER	GRAPHIC LOG	DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (%)	FIELD TEST RESULTS	LABORATORY HP (tsf)	UNCONFINED COMPRESSIVE STRENGTH (tsf)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI
		0.0	**TOPSOIL (12 INCHES)**										
		1.0	911.5										
1			**FILL - LEAN CLAY**, with sand and silt, trace gravel, dark brown				83	2-1-2 N=3	0.75 (HP)		20.7		
							50	2-2-3 N=5	1.5 (HP)		22.0		
				5			100	2-3-5 N=8	2.25 (HP)		11.8		
		8.5	904										
2			**LEAN CLAY**, with sand and silt, trace gravel, gray trace brown, stiff to very stiff (Glacial Till)				100	3-4-8 N=12	1.75 (HP)				
				10									
							89	5-6-8 N=14	2.75 (HP)				
		15.0	897.5	15									
			Boring Terminated at 15 Feet										

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
3.25-inch Continuous-Flight Hollow-Stem Augers
2-inch Split-Barrel Sampler

Abandonment Method:
Backfill with auger cuttings and concrete batch

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevation Reference: Zeno GPS Survey

Notes:

WATER LEVEL OBSERVATIONS

No water observed during drilling

No water observed upon completeion of drilling

Terracon
611 Lunken Park Dr
Cincinnati, OH

Boring Started: 09-14-2020 | Boring Completed: 09-14-2020

Drill Rig: CME 55 | Driller: KH

Project No.: N1205096

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL N1205096 DAYTON VA NICHE C.GPJ TERRACON_DATATEMPLATE.GDT 9/29/20

BORING LOG NO. B-5

PROJECT: Dayton VA Niche Columbarium and In-ground Cremains

CLIENT: Anderson Engineering Plymouth, MN

SITE: 4400 West Third Street Dayton, OH

LOCATION See Exploration Plan

Latitude: 39.745587° Longitude: -84.265564°
Northing: 640631.858 Easting: 1472076.994

Surface Elev.: 957.1 (Ft.)

MODEL LAYER	GRAPHIC LOG	DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (%)	FIELD TEST RESULTS	LABORATORY HP (tsf)	UNCONFINED COMPRESSIVE STRENGTH (tsf)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI
		0.6	956.5										
			TOPSOIL (8 INCHES)										
2			**LEAN CLAY (CL)**, with gravel and sand, light brown trace gray, stiff to very stiff (Glacial Till)			X	83	3-4-5 N=9	3.0 (HP)		11.2		23-14-9
				5		X	94	3-4-6 N=10	2.5 (HP)		18.3		
						X	28	3-4-4 N=8	1.75 (HP)		16.0		
				10		X	100	3-8-8 N=16	2.25 (HP)				
		14.0	943										
4		14.6	942.5			X	41	16-29-50/1"					
			Boring Terminated at 14.6 Feet										

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
3.25-inch Continuous-Flight Hollow-Stem Augers
2-inch Split-Barrel Sampler

Abandonment Method:
Backfill with auger cuttings and concrete batch

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevation Reference: Zeno GPS Survey

Notes:

WATER LEVEL OBSERVATIONS

No water observed during drilling

No water observed upon completeion of drilling

Terracon
611 Lunken Park Dr
Cincinnati, OH

Boring Started: 09-15-2020 | Boring Completed: 09-15-2020

Drill Rig: CME 55 | Driller: KH

Project No.: N1205096

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL N1205096 DAYTON VA NICHE C.GPJ TERRACON_DATATEMPLATE.GDT 9/29/20

BORING LOG NO. B-6

PROJECT: Dayton VA Niche Columbarium and In-ground Cremains

CLIENT: Anderson Engineering
Plymouth, MN

SITE: 4400 West Third Street
Dayton, OH

LOCATION See Exploration Plan

Latitude: 39.745083° Longitude: -84.262143°
Northing: 640429.5245 Easting: 1473035.126

Surface Elev.: 928.9 (Ft.)

MODEL LAYER	GRAPHIC LOG	DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (%)	FIELD TEST RESULTS	LABORATORY HP (tsf)	UNCONFINED COMPRESSIVE STRENGTH (tsf)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI
		0.4	928.5										
			TOPSOIL (5 INCHES)										
1			**FILL - LEAN CLAY (CL)**, trace sand and silt, dark brown			X	56	3-1-2 N=3	1.75 (HP)		20.5		36-20-16
		3.5	925.5										
2			**SILTY CLAY**, with gravel and sand, brown, medium stiff to very stiff (Glacial Till)			X	67	2-4-4 N=8	2.0 (HP)		16.5		
				5									
			-- Sample was moist, with a silt seam encountered at 6 feet			X	100	3-2-4 N=6	0.75 (HP)		19.5		
		8.5	920.5										
3			**SILTY CLAY**, with gravel and sand, gray, very stiff (Glacial Till)			X	100	6-9-10 N=19	2.75 (HP)				
				10									
						X	67	6-8-10 N=18	2.75 (HP)				
		15.0	914	15									
			Boring Terminated at 15 Feet										

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
3.25-inch Continuous-Flight Hollow-Stem Augers
2-inch Split-Barrel Sampler

Abandonment Method:
Backfill with auger cuttings and concrete batch

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevation Reference: Zeno GPS Survey

Notes:

WATER LEVEL OBSERVATIONS

No water observed during drilling

No water observed upon completeion of drilling

Terracon
611 Lunken Park Dr
Cincinnati, OH

Boring Started: 09-15-2020 | Boring Completed: 09-15-2020

Drill Rig: CME 55 | Driller: KH

Project No.: N1205096

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL N1205096 DAYTON VA NICHE C.GPJ TERRACON_DATATEMPLATE.GDT 9/29/20

BORING LOG NO. B-7

PROJECT: Dayton VA Niche Columbarium and In-ground Cremains

CLIENT: Anderson Engineering Plymouth, MN

SITE: 4400 West Third Street Dayton, OH

LOCATION See Exploration Plan

Latitude: 39.744887° Longitude: -84.261006°
Northing: 640351.7278 Easting: 1473353.565

Surface Elev.: 929.4 (Ft.)

MODEL LAYER	GRAPHIC LOG	DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (%)	FIELD TEST RESULTS	LABORATORY HP (tsf)	UNCONFINED COMPRESSIVE STRENGTH (tsf)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI
		0.5	929										
			TOPSOIL (6 INCHES)										
2			**SILTY CLAY**, with gravel and sand, brown to brown trace gray, very stiff to hard (Glacial Till)			X	100	3-4-4 N=8	4.25 (HP)		12.7		
						X	89	4-4-4 N=8	2.75 (HP)		15.6		
			-- Limestone fragments encountered at 6 feet	5		X	72	5-5-13 N=18	3.0 (HP)		10.3		
		8.5	921										
3			**SILTY CLAY**, with gravel and sand, gray, very stiff (Glacial Till)			X	67	3-4-5 N=9	2.25 (HP)				
				10	▽								
		15.0	914.5			X	94	4-6-8 N=14	3.0 (HP)				
			Boring Terminated at 15 Feet	15									

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
3.25-inch Continuous-Flight Hollow-Stem Augers
2-inch Split-Barrel Sampler

Abandonment Method:
Backfill with auger cuttings and concrete batch

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevation Reference: Zeno GPS Survey

Notes:

WATER LEVEL OBSERVATIONS

▽ *Water observed at 13.5 feet during drilling*

No water observed upon completeion of drilling

Terracon
611 Lunken Park Dr
Cincinnati, OH

Boring Started: 09-15-2020 Boring Completed: 09-15-2020

Drill Rig: CME 55 Driller: KH

Project No.: N1205096

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL N1205096 DAYTON VA NICHE C.GPJ TERRACON_DATATEMPLATE.GDT 9/29/20

BORING LOG NO. B-8

PROJECT: Dayton VA Niche Columbarium and In-ground Cremains

CLIENT: Anderson Engineering Plymouth, MN

SITE: 4400 West Third Street Dayton, OH

LOCATION See Exploration Plan

Latitude: 39.744952° Longitude: -84.257891°
Northing: 640358.403 Easting: 1474229.556

Surface Elev.: 930.3 (Ft.)

MODEL LAYER	GRAPHIC LOG	DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (%)	FIELD TEST RESULTS	LABORATORY HP (tsf)	UNCONFINED COMPRESSIVE STRENGTH (tsf)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI
		0.5	930										
			TOPSOIL (6 INCHES)										
1			**FILL - SILTY CLAY**, with limestone fragments, gravel and sand, dark brown				55	7-14-11 N=25	2.0 (HP)		12.5		
							55	10-10-16 N=26	3.5 (HP)		9.5		
		6.0	924.5	5									
2			**SILTY CLAY (CL-ML)**, with gravel and sand, brown, very stiff (Glacial Till)				89	6-7-8 N=15	2.5 (HP)		12.2		20-14-6
		8.5	922										
3			**SILTY CLAY**, with sand, trace gravel, gray, very stiff to hard (Glacial Till)				55	6-6-8 N=14	3.0 (HP)				
			-- Sand and gravel seam encountered from 10 to 14 feet	10									
					▽		55	7-7-8 N=15	4.0 (HP)				
		15.0	915.5	15									
			Boring Terminated at 15 Feet										

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
3.25-inch Continuous-Flight Hollow-Stem Augers
2-inch Split-Barrel Sampler

Abandonment Method:
Backfill with auger cuttings and concrete batch

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevation Reference: Zeno GPS Survey

Notes:

WATER LEVEL OBSERVATIONS

▽ *Water observed at 14 feet during drilling*

No water observed upon completeion of drilling

Terracon
611 Lunken Park Dr
Cincinnati, OH

Boring Started: 09-15-2020 | Boring Completed: 09-15-2020

Drill Rig: CME 55 | Driller: KH

Project No.: N1205096

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL N1205096 DAYTON VA NICHE C.GPJ TERRACON_DATATEMPLATE.GDT 9/29/20

BORING LOG NO. B-9

PROJECT: Dayton VA Niche Columbarium and In-ground Cremains

CLIENT: Anderson Engineering Plymouth, MN

SITE: 4400 West Third Street Dayton, OH

LOCATION See Exploration Plan

Latitude: 39.745175° Longitude: -84.256162°
Northing: 640430.151 Easting: 1474717.248

Surface Elev.: 928.1 (Ft.)

MODEL LAYER	GRAPHIC LOG	DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (%)	FIELD TEST RESULTS	LABORATORY HP (tsf)	UNCONFINED COMPRESSIVE STRENGTH (tsf)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI
		0.6	927.5										
			TOPSOIL (6 INCHES)										
2			**SILTY CLAY**, with gravel and sand, brown trace gray to brown, stiff to very stiff (Glacial Till)				72	2-3-7 N=10			7.2		
							83	7-10-10 N=20	2.75 (HP)		9.5		
				5			72	3-3-5 N=8	3.5 (HP)		12.1		
							100	3-3-6 N=9	2.0 (HP)				
		9.0	919										
			Boring Terminated at 9 Feet										

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
3.25-inch Continuous-Flight Hollow-Stem Augers
2-inch Split-Barrel Sampler

Abandonment Method:
Backfill with auger cuttings and concrete batch

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevation Reference: Zeno GPS Survey

Notes:

WATER LEVEL OBSERVATIONS

No water observed during drilling

No water observed upon completeion of drilling

Terracon
611 Lunken Park Dr
Cincinnati, OH

Boring Started: 09-15-2020 | Boring Completed: 09-15-2020

Drill Rig: CME 55 | Driller: KH

Project No.: N1205096

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL N1205096 DAYTON VA NICHE C.GPJ TERRACON_DATATEMPLATE.GDT 9/29/20

BORING LOG NO. B-10

PROJECT: Dayton VA Niche Columbarium and In-ground Cremains

CLIENT: Anderson Engineering Plymouth, MN

SITE: 4400 West Third Street Dayton, OH

LOCATION See Exploration Plan

Latitude: 39.745927° Longitude: -84.254066°
Northing: 640692.4801 Easting: 1475312.016

Surface Elev.: 910.4 (Ft.)

MODEL LAYER	GRAPHIC LOG	DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (%)	FIELD TEST RESULTS	LABORATORY HP (tsf)	UNCONFINED COMPRESSIVE STRENGTH (tsf)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI
		0.5	910										
			TOPSOIL (6 INCHES)										
1			**FILL - LEAN CLAY (CL)**, with limestone floaters/fragments, gravel and sand, dark brown				72	2-4-6 N=10	2.0 (HP)		11.5		36-18-18
							33	5-12-14 N=26			4.3		
				5									
		6.5	904				83	3-3-5 N=8	0.75 (HP)		22.3		
2			**LEAN CLAY**, trace gravel and sand, brown trace gray, medium stiff to stiff (Glacial Till)										
		9.0	901.5				78	3-4-5 N=9	2.0 (HP)				
			Boring Terminated at 9 Feet										

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
3.25-inch Continuous-Flight Hollow-Stem Augers
2-inch Split-Barrel Sampler

Abandonment Method:
Backfill with auger cuttings and concrete batch

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevation Reference: Zeno GPS Survey

Notes:

WATER LEVEL OBSERVATIONS

No water observed during drilling

No water observed upon completeion of drilling

Terracon
611 Lunken Park Dr
Cincinnati, OH

Boring Started: 09-15-2020 Boring Completed: 09-15-2020

Drill Rig: CME 55 Driller: KH

Project No.: N1205096

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL N1205096 DAYTON VA NICHE C.GPJ TERRACON_DATATEMPLATE.GDT 9/29/20

BORING LOG NO. B-11

PROJECT: Dayton VA Niche Columbarium and In-ground Cremains

CLIENT: Anderson Engineering Plymouth, MN

SITE: 4400 West Third Street Dayton, OH

LOCATION See Exploration Plan

Latitude: 39.74414° Longitude: -84.256617°
Northing: 640055.8826 Easting: 1474582.165

Surface Elev.: 942.6 (Ft.)

MODEL LAYER	GRAPHIC LOG	DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (%)	FIELD TEST RESULTS	LABORATORY HP (tsf)	UNCONFINED COMPRESSIVE STRENGTH (tsf)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI
		0.4	942										
			TOPSOIL (5 INCHES)										
			FILL - SILTY CLAY, with sand, trace gravel				72	2-4-4 N=8	4.0 (HP)		45.0		
1							67	4-3-3 N=6	0.75 (HP)		23.0		
		5.0	937.5	5									
			SILTY CLAY (CL-ML), with sand, trace gravel, brown to brown trace gray, very stiff (Glacial Till)				89	4-7-8 N=15	2.25 (HP)		13.1		21-14-7
2			-- Limestone fragments were encountered at 7.5 feet										
		8.5	934				94	7-12-19 N=31					
4		9.0	933.5										
			LIMESTONE, gray, strong rock										
			Boring Terminated at 9 Feet										

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
3.25-inch Continuous-Flight Hollow-Stem Augers
2-inch Split-Barrel Sampler

Abandonment Method:
Backfill with auger cuttings and concrete batch

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevation Reference: Zeno GPS Survey

Notes:

WATER LEVEL OBSERVATIONS

No water observed during drilling

No water observed upon completeion of drilling

Terracon
611 Lunken Park Dr
Cincinnati, OH

Boring Started: 09-15-2020 Boring Completed: 09-15-2020

Drill Rig: CME 55 Driller: KH

Project No.: N1205096

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL N1205096 DAYTON VA NICHE C.GPJ TERRACON_DATATEMPLATE.GDT 9/29/20

BORING LOG NO. B-12

PROJECT: Dayton VA Niche Columbarium and In-ground Cremains

CLIENT: Anderson Engineering Plymouth, MN

SITE: 4400 West Third Street Dayton, OH

LOCATION See Exploration Plan

Latitude: 39.744717° Longitude: -84.253645°
Northing: 640249.4696 Easting: 1475421.777

Surface Elev.: 914.0 (Ft.)

MODEL LAYER	GRAPHIC LOG	DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (%)	FIELD TEST RESULTS	LABORATORY HP (tsf)	UNCONFINED COMPRESSIVE STRENGTH (tsf)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI
		0.3	913.5										
		TOPSOIL (4 INCHES)											
		FILL - SILTY CLAY, with sand, trace gravel, brown to dark brown											
1							83	3-10-11 N=21	4.5 (HP)		8.6		
							89	6-4-3 N=7	2.5 (HP)		23.6		
		5.0	909	5									
2		**SILTY CLAY**, with gravel and sand, brown trace gray, medium stiff to stiff (Glacial Till)					72	3-3-2 N=5	1.5 (HP)		23.5		
							72	2-2-4 N=6	1.0 (HP)				
		9.0	905										
		Boring Terminated at 9 Feet											

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
3.25-inch Continuous-Flight Hollow-Stem Augers
2-inch Split-Barrel Sampler

Abandonment Method:
Backfill with auger cuttings and concrete batch

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevation Reference: Zeno GPS Survey

Notes:

WATER LEVEL OBSERVATIONS

No water observed during drilling

No water observed upon completeion of drilling

Terracon
611 Lunken Park Dr
Cincinnati, OH

Boring Started: 09-15-2020 | Boring Completed: 09-15-2020

Drill Rig: CME 55 | Driller: KH

Project No.: N1205096

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL N1205096 DAYTON VA NICHE C.GPJ TERRACON_DATATEMPLATE.GDT 9/29/20

2-15-93 jg

LOG OF TEST BORING

CLIENT Bentley-Meisner & Associates

PROJECT Dayton National Cemetery Expansion (Dayton, Ohio)

BORING LOCATION As shown on plan

ELEV. REF. Estimated from provided topographic plan

BORING NO. B-4

DATE START 2-4-93

DATE COMP. 2-4-93

ORDER NO. 08330.005

ELEV.	DEPTH	DESCRIPTION OF MATERIALS	SAMPLE NO.	SAMPLE TYPE	SAMPLE DEPTH	BLOWS PER 6 INCHES	RECOVERY	SOIL PROPERTIES W	SOIL PROPERTIES LL/PL	TOV*
929.0'	0.0'									
		0.5' Dark brown LEAN CLAY (Topsoil) with roots, moist-soft	1	SS	0-.5	-2-				
928.5'	0.5'		2	SS	.5-1.5	3-4		19	25/19	<10
		2.0' Brown LEAN CLAY, moist-medium stiff								
926.5'	2.5'		3	SS	2.5-4	5-6-8		20		<10
		4.0' Brown LEAN CLAY with gravel, rock fragments and trace sand, moist-stiff	4	SS	5-6.5	6-7-7				<10
		--moist to very moist @ 5-6.5'								
922.5'	6.5'									
		TEST BORING COMPLETED								
		* TOV = Total Organic Vapor, ppm/v (per Organic Vapor Analyzer)								

GENERAL NOTES

DRILLER C. Haymond
RIG NO. 29
RIG TYPE Truck
METHOD HSA, SS

THE H.C. NUTTING COMPANY
GEOTECHNICAL, ENVIRONMENTAL AND TESTING ENGINEERS
SINCE 1921

4120 AIRPORT ROAD. • CINCINNATI, OH. 45226 • 513/321-5816
912 MORRIS ST. • CHARLESTON, WV. 25301 • 304/344-0821
1445 JAMIKE DR. • ERLANGER, KY. 41018 • 606/283-9914
790 MORRISON RD. • COLUMBUS, OH. 43004 • 614/863-3113

WATER LEVEL OBSERVATIONS

IMMEDIATE NW FT.
AT COMPLETION NW FT.
AFTER BF HRS. ____ FT.
WATER USED IN DRILLING NW FT.

LOG OF TEST BORING

2-15-93 jg

CLIENT Bentley-Meisner & Associates — **BORING NO.** B-6

PROJECT Dayton National Cemetery Expansion (Dayton, Ohio) — **DATE START** 2-4-93

BORING LOCATION As shown on plan — **DATE COMP.** 2-4-93

ELEV. REF. Estimated from provided topographic plan — **ORDER NO.** 08330.005

ELEV.	DEPTH	DESCRIPTION OF MATERIALS	SAMPLE NO.	SAMPLE TYPE	SAMPLE DEPTH	BLOWS PER 6 INCHES	RECOVERY	SOIL PROPERTIES W	SOIL PROPERTIES LL/PL	TOV*
~~933.0'~~	0.0'									TOV*
		2.5' Brown sandy lean clay with trace gravel and brick fragments (Fill), moist-medium stiff to stiff	1	SS	0-1.5	3-5-6	18"	19		<10
930.5'	2.5'		2	SS	2.5-4	5-7-9	18"	23	**	<10
		2.5' Brown LEAN CLAY with trace rock fragments, moist-stiff								
928.0'	5.0'		3	SS	5-6.5	8-14-14	18"			<10
		5.0' Brown LEAN CLAY with gravel, rock fragments and trace sand, moist-very stiff	4	SS	8.5-10	52-34-26	4"			<10
923.0'	10.0'									
		TEST BORING COMPLETED								

* TOV = Total Organic Vapors, ppm/v (per Organic Vapor Analyzer)

** Pocket Penetrometer Reading = 2.25 tsf

GENERAL NOTES

DRILLER C. Haymond
RIG NO. 29
RIG TYPE Truck
METHOD HSA, SS

THE H.C. NUTTING COMPANY
GEOTECHNICAL, ENVIRONMENTAL AND TESTING ENGINEERS
SINCE 1921

4120 AIRPORT ROAD. • CINCINNATI, OH. 45226 • 513/321-5816
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1445 JAMIKE DR. • ERLANGER, KY. 41018 • 606/283-9914
790 MORRISON RD. • COLUMBUS, OH. 43004 • 614/863-3113

WATER LEVEL OBSERVATIONS

IMMEDIATE NW FT.
AT COMPLETION NW FT.
AFTER BF HRS. ____ FT.
WATER USED IN DRILLING NW FT.

2-15-93 jg

LOG OF TEST BORING

CLIENT Bentley-Meisner & Associates — **BORING NO.** B-9

PROJECT Dayton National Cemetery Expansion (Dayton, Ohio) — **DATE START** 2-4-93

BORING LOCATION As shown on plan — **DATE COMP.** 2-4-93

ELEV. REF. Estimated from provided topographic plan — **ORDER NO.** 08330.005

ELEV.	DEPTH	DESCRIPTION OF MATERIALS	SAMPLE NO.	SAMPLE TYPE	SAMPLE DEPTH	BLOWS PER 6 INCHES	RECOVERY	SOIL PROPERTIES W	SOIL PROPERTIES LL/PL	TOV*
902.0′	0.0′									
		0.5′ Dark brown lean clay (Topsoil) with roots, (Possible Fill) moist-medium stiff	1	SS	0-.5	-3-	6"			
901.5′	0.5′		2	SS	.5-1	5-7	12"			<10
		2.0′ Brown and dark brown lean clay with gravel, rock fragments and sand traces (Possible Fill), moist-stiff								
899.5′	2.5′		3	SS	2.5-4	7-8-8	18"	23	**	<10
		7.5′ Brown LEAN CLAY with gravel, rock fragments and trace sand, moist-stiff to very stiff --Wet @ 5-6.5′ and 8.5-10′	4	SS	5-6.5	9-10-11	12"	13		<10
			5	SS	8.5-10	10-10-12	18"			<10
892.0′	10.0′									
		TEST BORING COMPLETED								
		* TOV = Total Organic Vapors, ppm/v (per Organic Vapor Analyzer)								
		** Qu = 1.62 tsf								

GENERAL NOTES

DRILLER C. Haymond
RIG NO. 29
RIG TYPE Truck
METHOD HSA, SS

THE H.C. NUTTING COMPANY
GEOTECHNICAL, ENVIRONMENTAL AND TESTING ENGINEERS SINCE 1921

4120 AIRPORT ROAD. • CINCINNATI, OH. 45226 • 513 / 321-5816
912 MORRIS ST. • CHARLESTON, WV. 25301 • 304 / 344-0821
1445 JAMIKE DR. • ERLANGER, KY. 41018 • 606 / 283-9914
790 MORRISON RD. • COLUMBUS, OH. 43004 • 614 / 863-3113

WATER LEVEL OBSERVATIONS

IMMEDIATE NW FT.
AT COMPLETION NW FT.
AFTER BF **HRS.** FT.
WATER USED IN DRILLING NW FT.

2-4-93 jg

LOG OF TEST PIT

CLIENT Bentley-Meisner Associates — PIT NO. TP-10

PROJECT Dayton National Cemetery Gravesite Expansion — DATE START 2-3-93

PIT LOCATION As shown on plan — DATE COMP. 2-3-93

ELEV. REF. Estimated from provided topographic map — ORDER NO. 08330.005

ELEV.	DEPTH	DESCRIPTION OF MATERIALS	SAMPLE NO.	SAMPLE TYPE	SAMPLE DEPTH	PENETROMETER (TSF)	SOIL PROPERTIES W	SOIL PROPERTIES LL/PL	TOV*
935.0'	0.0'								
		0.5' Topsoil with grass and roots	1		0-.5'				<10
934.5'	0.5'		2		0.5-8.5'	1.5			<10
		8.0' Brown sandy clay to clayey sand (Fill) with concrete fragments (2% ±), limestone fragments (4% ±), moist-soft --concrete (possible foundation wall) extending SE to NW, 24" thick --with concrete slab (4" thick), extending N-S --12" layer cinders @ 3'							
926.5'	8.5'		3		8.5-10'	4.5+			<10
		1.5' Brown and gray mottled SANDY LEAN CLAY, moist-hard							
925.0'	10.0'								
		TEST PIT TERMINATED @ 10.0'							
		* TOV = Total Organic Vapors, ppm/v (per Organic Vapor Analyzer)							

GENERAL NOTES

TECHNICIAN E. Muccillo

RIG TYPE Case 580 D

REMARKS 36" Bucket

Reorder No. 109-0225

THE H. C. NUTTING COMPANY
GEOTECHNICAL AND TESTING ENGINEERS SINCE 1921
4120 AIRPORT ROAD • P.O. BOX C • CINCINNATI, OHIO 45226 • 513-321-5816
912 MORRIS STREET • CHARLESTON, WEST VIRGINIA 25301 • 304-344-0821
BOX NUMBER 11 • HIGHLAND HEIGHTS, KENTUCKY 41076 • 606-261-2043
790 MORRISON RD. • BLACKLICK, OH. 43004 614/863-3113

WATER LEVEL OBSERVATIONS

IMMEDIATE NW FT.

AT COMPLETION NW FT.

AFTER ____ HRS. BF FT.

LOG OF TEST PIT

2-4-93 jg

CLIENT Bentley-Meisner Associates — PIT NO. TP-11

PROJECT Dayton National Cemetery Gravesite Expansion — DATE START 2-3-93

PIT LOCATION As shown on plan — DATE COMP. 2-3-93

ELEV. REF. Estimated from provided topographic map — ORDER NO. 08330.005

ELEV.	DEPTH	DESCRIPTION OF MATERIALS	SAMPLE NO.	SAMPLE TYPE	SAMPLE DEPTH	PENETROMETER (TSF)	SOIL PROPERTIES W	SOIL PROPERTIES LL/PL	TOV*
~~933.0'~~	~~0.0'~~								
		1.0' Topsoil with grass and roots	1		0-1'				<10
932.0'	1.0'		2		1-9'	1.5			<10
		8.0' Dark brown sandy clay (Fill) with brick fragments (10% ±), cinders (5% ±), wood (1% ±), concrete fragments (3% ±), limestone fragments (10% ±), moist-medium stiff --most debris @ 0-3.5' --5" concrete slab @ 0.2' (running N-S)							
924.0'	9.0'		3		9-10'	4.5			<10
		1.0' Dark brown SANDY CLAY with poorly graded gravel, moist-hard							
923.0'	10.0'		4		10-11'	4.5+			<10
		1.0' Brown and gray mottled LEAN CLAY with poorly graded gravel, moist-hard							
922.0'	11.0'	TEST PIT TERMINATED @ 11.0'							
		* TOV = Total Organic Vapors, ppm/v (per Organic Vapor Analyzer)							

GENERAL NOTES

TECHNICIAN E. Muccillo

RIG TYPE Case 580 D

REMARKS 36" Bucket

Reorder No. 109-0225

THE H. C. NUTTING COMPANY
GEOTECHNICAL AND TESTING ENGINEERS — SINCE 1921
4120 AIRPORT ROAD • P.O. BOX C • CINCINNATI, OHIO 45226 • 513-321-5816
912 MORRIS STREET • CHARLESTON, WEST VIRGINIA 25301 • 304-344-0821
BOX NUMBER 11 • HIGHLAND HEIGHTS, KENTUCKY 41076 • 606-261-2043
790 MORRISON RD. • BLACKLICK, OH. 43004 614/863-3113

WATER LEVEL OBSERVATIONS

IMMEDIATE ~~NW~~ NW FT.

AT COMPLETION ~~BF~~ FT.

AFTER ____ HRS. ____ FT.

LOG OF TEST PIT

2-4-93 jg

CLIENT Bentley-Meisner Associates — PIT NO. TP-12

PROJECT Dayton National Cemetery Gravesite Expansion — DATE START 2-3-93

PIT LOCATION As shown on plan — DATE COMP. 2-3-93

ELEV. REF. Estimated from provided topographic map — ORDER NO. 08330.005

ELEV.	DEPTH	DESCRIPTION OF MATERIALS	SAMPLE NO.	SAMPLE TYPE	SAMPLE DEPTH	PENETROMETER (TSF)	SOIL PROPERTIES W	SOIL PROPERTIES LL/PL	TOV*
~~933.5'~~	~~0.0'~~								
		2.0' Topsoil with grass, crushed brick layer, (Fill), moist-loose	1		0-2'				<10
931.5'	2.0'		2		2-3.5'	3.5			<10
		1.5' Brown SANDY LEAN CLAY with gravel, moist-very stiff							
930.0'	3.5'		3		3.5-10'	4.5+			<10
		6.5' Brown and gray mottled LEAN CLAY with poorly graded gravel, moist-hard							
923.5'	10.0'								
		TEST PIT TERMINATED @ 10.0'							
		* TOV = Total Organic Vapors, ppm/v (per Organic Vapor Analyzer)							

GENERAL NOTES

TECHNICIAN E. Muccillo

RIG TYPE Case 580 D

REMARKS 36" Bucket

Reorder No. 109-0225

THE H. C. NUTTING COMPANY
GEOTECHNICAL AND TESTING ENGINEERS SINCE 1921
4120 AIRPORT ROAD • P.O. BOX C • CINCINNATI, OHIO 45226 • 513-321-5816
912 MORRIS STREET • CHARLESTON, WEST VIRGINIA 25301 • 304-344-0821
BOX NUMBER 11 • HIGHLAND HEIGHTS, KENTUCKY 41076 • 606-261-2043
790 MORRISON RD. • BLACKLICK, OH. 43004 614/863-3113

WATER LEVEL OBSERVATIONS

IMMEDIATE NW FT.

AT COMPLETION NW FT.

AFTER ____ HRS. BF FT.

LOG OF TEST PIT

2-4-93 jg

CLIENT Bentley-Meisner Associates — PIT NO. TP-14

PROJECT Dayton National Cemetery Gravesite Expansion — DATE START 2-2-93

PIT LOCATION As shown on plan — DATE COMP. 2-2-93

ELEV. REF. Estimated from provided topographic map — ORDER NO. 08330.005

ELEV.	DEPTH	DESCRIPTION OF MATERIALS	SAMPLE NO.	SAMPLE TYPE	SAMPLE DEPTH	PENETROMETER (TSF)	SOIL PROPERTIES W	SOIL PROPERTIES LL/PL	TOV*
~~927.0'~~	~~0.0'~~								
		1.0' Topsoil with grass and roots	1		0-1'				<10
926.0'	1.0'		2		1-4'	2.5			<10
		3.0' Dark brown SANDY CLAY moist-stiff							
923.0'	4.0'		3		4-8'	3			<10
		4.0' Brown and gray mottled SANDY CLAY with poorly graded gravel, moist-very stiff to hard							
919.0'	8.0'		4		8-9'				<10
		1.0' Brown CLAYEY SAND, wet-medium dense							
918.0'	9.0'		5		9-10.5'	4.5+			<10
		1.5' Brown and gray SANDY LEAN CLAY with poorly graded gravel, moist-hard							
916.5'	10.5'								
		TEST PIT TERMINATED @ 10.5'							
		* TOV = Total Organic Vapors, ppm/v (per Organic Vapor Analyzer)							

GENERAL NOTES

TECHNICIAN E. Murrillo

RIG TYPE Case 580 D

REMARKS 36" Bucket

Reorder No. 109-0225

THE H. C. NUTTING COMPANY
GEOTECHNICAL AND TESTING ENGINEERS SINCE 1921
4120 AIRPORT ROAD • P.O. BOX C • CINCINNATI, OHIO 45226 • 513-321-5816
912 MORRIS STREET • CHARLESTON, WEST VIRGINIA 25301 • 304-344-0821
BOX NUMBER 11 • HIGHLAND HEIGHTS, KENTUCKY 41076 • 606-261-2043
790 MORRISON RD. • BLACKLICK, OH. 43004 614/863-3113

WATER LEVEL OBSERVATIONS

IMMEDIATE wet sand seam 8' FT.

AT COMPLETION – FT.

AFTER – HRS. BF FT.

LOG OF TEST PIT

2-4-93 jg

CLIENT Bentley-Meisner Associates — PIT NO. TP-15

PROJECT Dayton National Cemetery Gravesite Expansion — DATE START 2-2-93

PIT LOCATION As shown on plan — DATE COMP. 2-2-93

ELEV. REF. Estimated from provided topographic map — ORDER NO. 08330.005

ELEV.	DEPTH	DESCRIPTION OF MATERIALS	SAMPLE NO.	SAMPLE TYPE	SAMPLE DEPTH	PENETROMETER (TSF)	SOIL PROPERTIES W	SOIL PROPERTIES LL/PL	TOV*
~~919.5'~~	0.0'								TOV*
		1.0' Topsoil with grass	1		0-1'				<10
918.5'	1.0'		2		1-3'	2			<10
		2.0' Brown SANDY CLAY, moist-stiff							
916.5'	3.0'		3		3-8'	4			<10
		5.0' Brown and gray mottled SANDY LEAN CLAY with poorly graded gravel, moist-very stiff to hard							
911.5'	8.0'								
		1.5' Dark gray silty LEAN CLAY with poorly graded gravel, moist-hard			8-10.5'	4.5'			<10
910.0'	10.5'								
		TEST PIT TERMINATED @ 10.5'							
		* TOV = Total Organic Vapors, ppm/v (per Organic Vapor Analyzer)							

GENERAL NOTES

TECHNICIAN E. Muccillo

RIG TYPE Case 580 D

REMARKS 36" Bucket

Reorder No. 109-0225

THE H. C. NUTTING COMPANY
GEOTECHNICAL AND TESTING ENGINEERS SINCE 1921
4120 AIRPORT ROAD • P.O. BOX C • CINCINNATI, OHIO 45226 • 513-321-5816
912 MORRIS STREET • CHARLESTON, WEST VIRGINIA 25301 • 304-344-0621
BOX NUMBER 11 • HIGHLAND HEIGHTS, KENTUCKY 41076 • 606-261-2043
790 MORRISON RD. • BLACKLICK, OH. 43004 614/863-3113

WATER LEVEL OBSERVATIONS

IMMEDIATE NW FT.

AT COMPLETION NW FT.

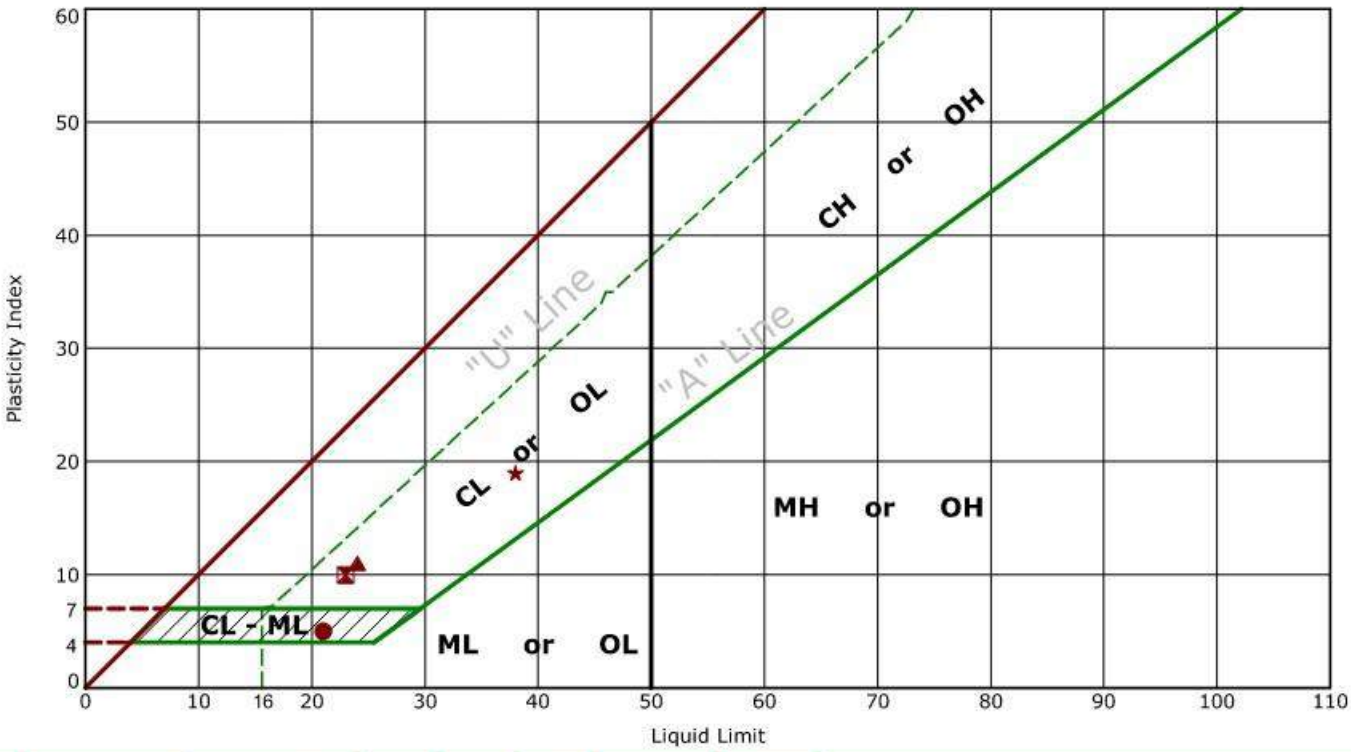
AFTER ____ HRS. BF FT.

Dayton National Cemetery Expansion
4400 West Third Street | Dayton, OH
Terracon Project No. N1245267

Terracon
611 Lunken Park Dr
Cincinnati, OH

Atterberg Limit Results

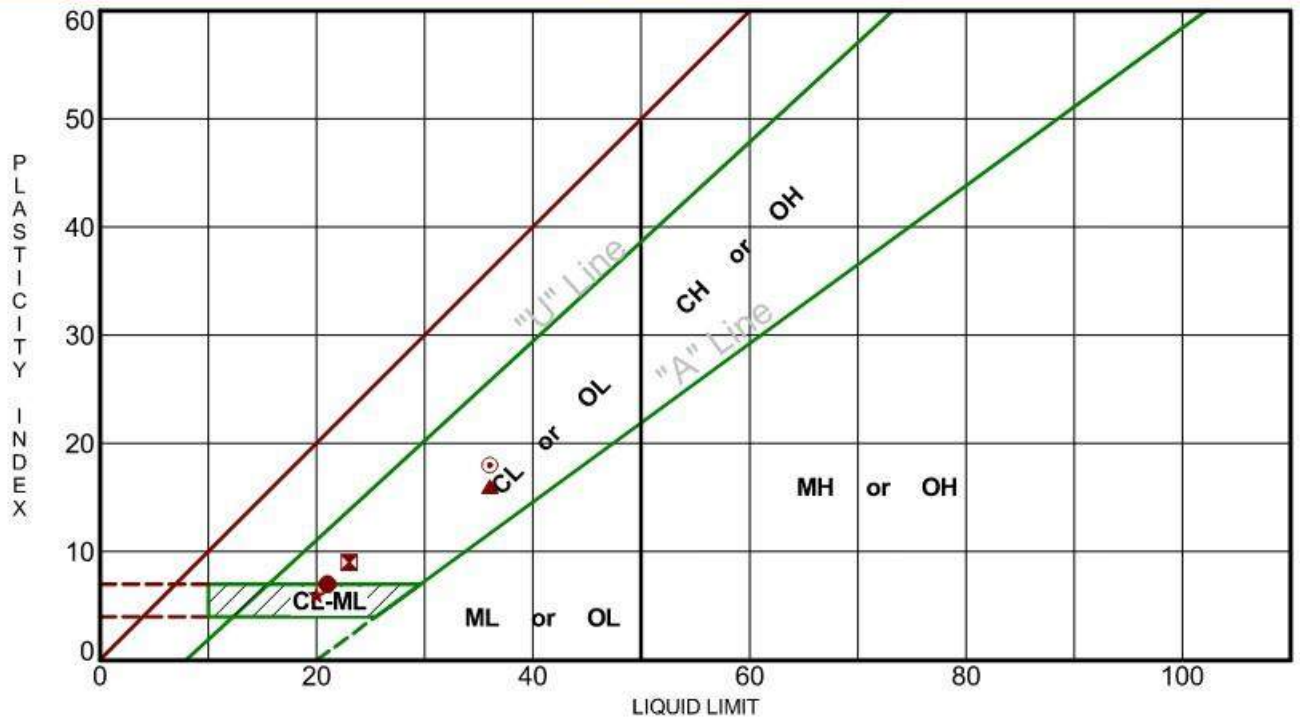
ASTM D4318



	Boring ID	Depth (Ft)	LL	PL	PI	Fines	USCS	Description
●	PR-14	6 - 7.5	21	16	5		CL-ML	Silty Clay
⊠	PR-17	8.5 - 10	23	13	10		CL	Lean Clay
▲	PR-B19	3.5 - 5	24	13	11		CL	LEAN CLAY
★	PR-B21	4 - 6	38	19	19		CL	LEAN CLAY

ATTERBERG LIMITS RESULTS

ASTM D4318



Boring ID		Depth (Ft)	LL	PL	PI	Fines	USCS	Description
●	B-2	3 - 5	21	14	7		CL-ML	BROWN SILTY CLAY
⊠	B-5	1 - 2.5	23	14	9		CL	LEAN CLAY
▲	B-6	1 - 2.5	36	20	16		CL	LEAN CLAY
★	B-8	6 - 7.5	20	14	6		CL-ML	SILTY CLAY
⊙	B-10	0 - 1.5	36	18	18		CL	LEAN CLAY
✿	B-11	5 - 6.5	21	14	7		CL-ML	SILTY CLAY

PROJECT: Dayton VA Niche Columbarium and In-ground Cremains

PROJECT NUMBER: N1205096

SITE: 4400 West Third Street
Dayton, OH

Terracon
611 Lunken Park Dr
Cincinnati, OH

CLIENT: Anderson Engineering
Plymouth, MN

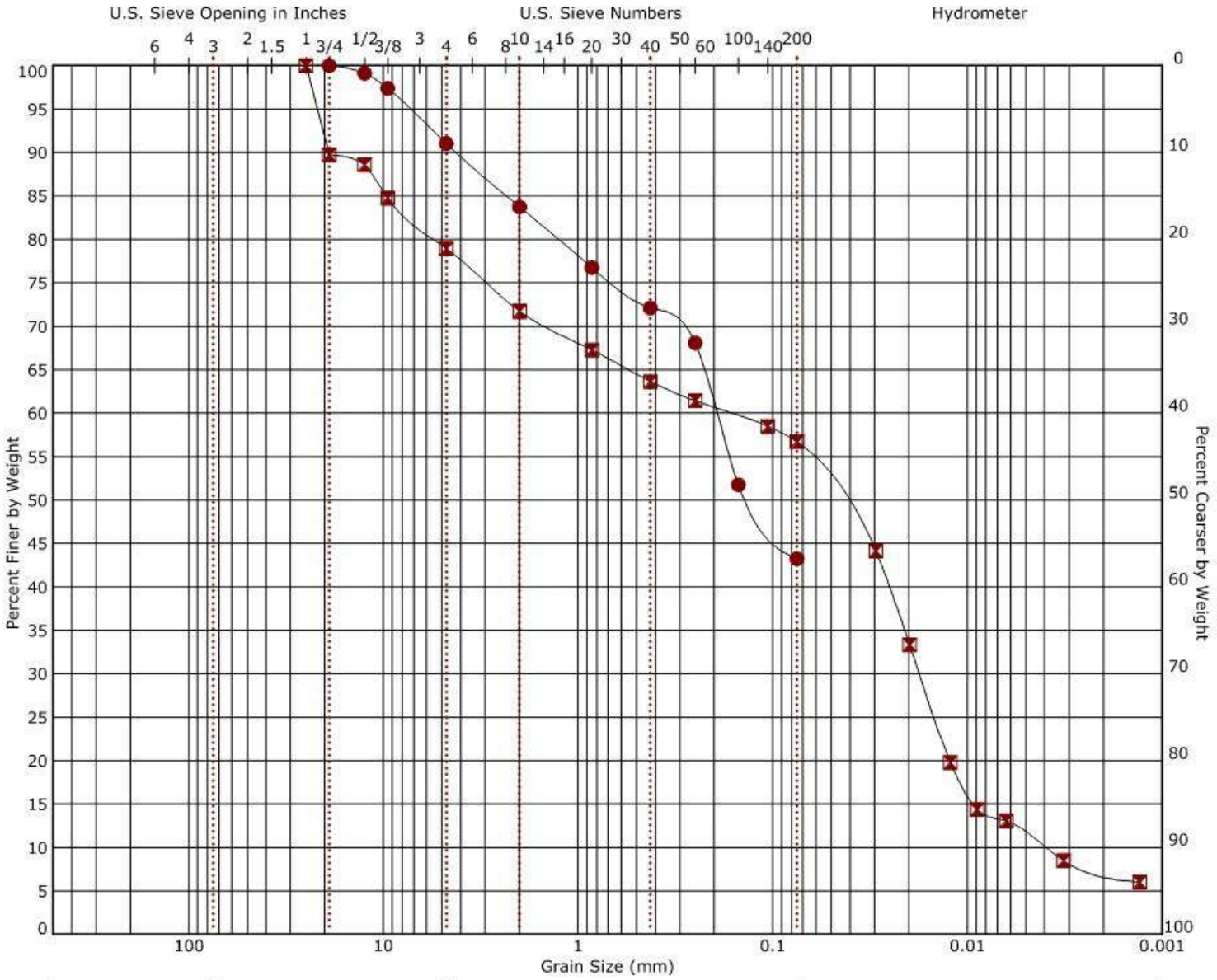
LABORATORY TESTS ARE NOT VALID IF SEPARATED FROM ORIGINAL REPORT. ATTERBERG LIMITS N1205096 DAYTON VA NICHE C.GPJ TERRACON_DATATEMPLATE.GDT 12/18/24

Dayton National Cemetery Expansion
4400 West Third Street | Dayton, OH
Terracon Project No. N1245267

Terracon
611 Lunken Park Dr
Cincinnati, OH

Grain Size Distribution

ASTM D422 / ASTM C136 / AASHTO T27



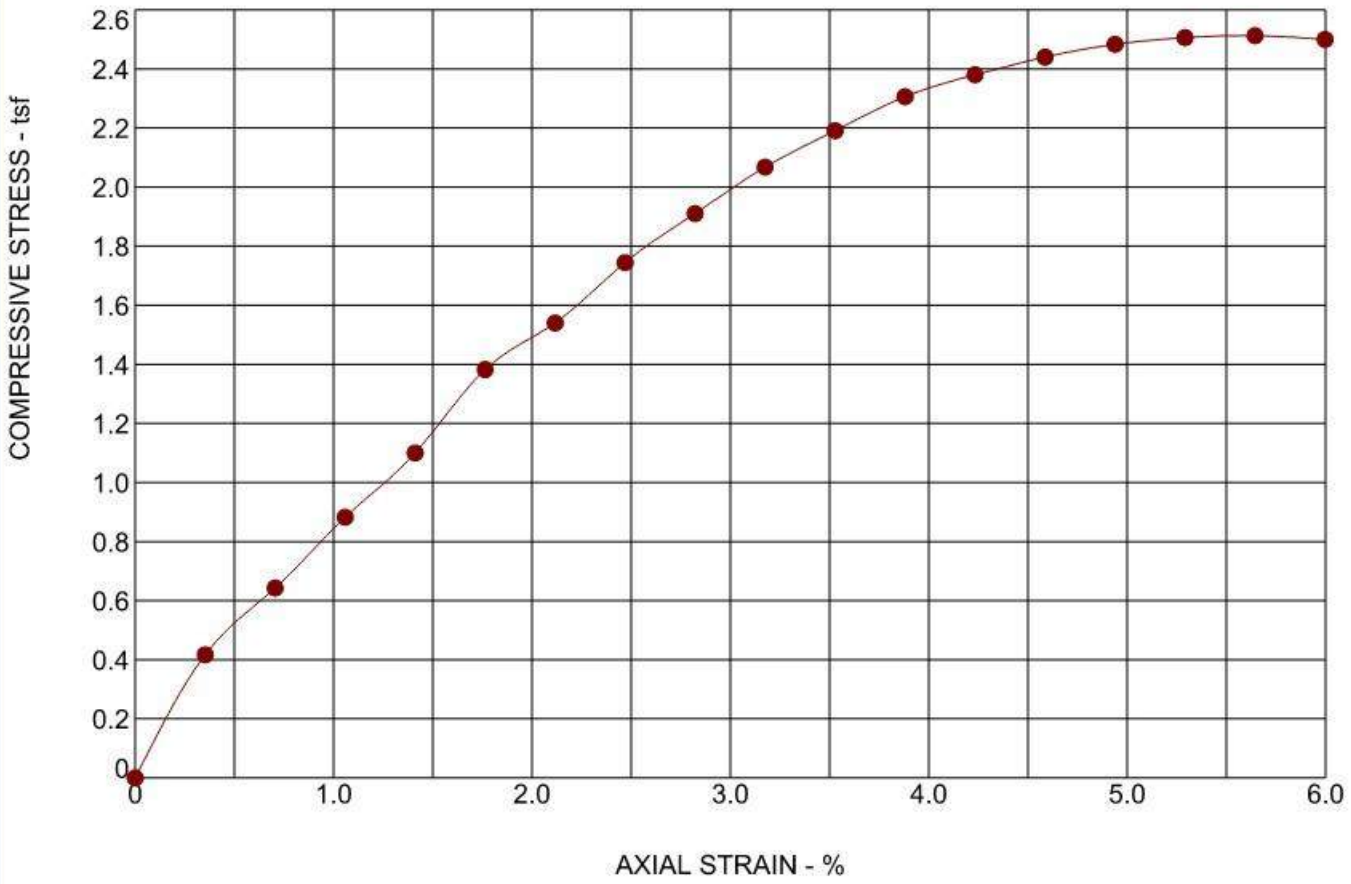
Cobbles	Gravel		Sand			Silt or Clay
	coarse	fine	coarse	medium	fine	

Boring ID	Depth (Ft)	Description	USCS	LL	PL	PI	Cc	Cu
● PR-18	8.5 - 10	SILTY SAND	SM					
⊠ PR-B22	8.5 - 10	SANDY SILT with GRAVEL	ML				0.47	41.16

Boring ID	Depth (Ft)	D_{100}	D_{60}	D_{30}	D_{10}	%Cobbles	%Gravel	%Sand	%Fines	%Silt	%Clay
● PR-18	8.5 - 10	19	0.194			0.0	9.0	47.8	43.2		
⊠ PR-22	8.5 - 10	25	0.165	0.018	0.004	0.0	21.1	22.3		45.2	11.5

UNCONFINED COMPRESSION TEST

ASTM D2166



SPECIMEN FAILURE PHOTOGRAPH

SPECIMEN TEST DATA

Moisture Content:	%	12.7
Dry Density:	pcf	128
Diameter:	in.	2.86
Height:	in.	5.67
Height / Diameter Ratio:		1.98
Calculated Saturation:	%	100
Calculated Void Ratio:		0.32
Assumed Specific Gravity:		2.7
Failure Strain:	%	5.64
Unconfined Compressive Strength	(tsf)	2.51
Undrained Shear Strength:	(tsf)	1.26
Strain Rate:	in/min	0.0567

Remarks: 5882

SAMPLE TYPE: Shelby Tube

SAMPLE LOCATION: B-2 @ 3 - 5 feet

DESCRIPTION: BROWN SILTY CLAY

LL	PL	PI	Percent < #200 Sieve
21	14	7	

PROJECT: Dayton VA Niche Columbarium and In-ground Cremains

SITE: 4400 West Third Street Dayton, OH

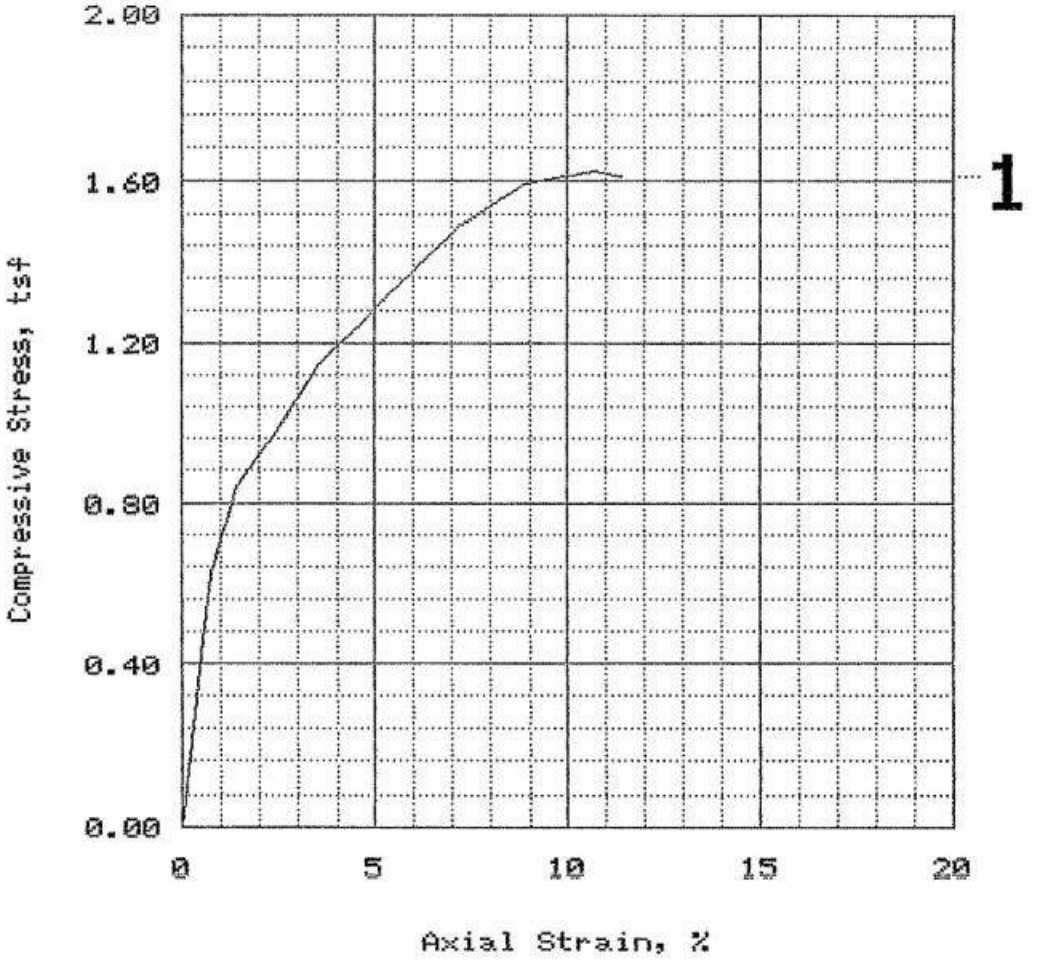
Terracon
611 Lunken Park Dr
Cincinnati, OH

PROJECT NUMBER: N1205096

CLIENT: Anderson Engineering Plymouth, MN

LABORATORY TESTS ARE NOT VALID IF SEPARATED FROM ORIGINAL REPORT. UNCONFINED WITH PHOTOS N1205096 DAYTON VA NICHE C.GPJ TERRACON_DATATEMPLATE.GDT 9/25/20

UNCONFINED COMPRESSION TEST



Sample number:	1			
Unconfined strength, tsf	1.62			
Undrained shear strength, tsf	0.81			
Rate of strain, %/min	1.000			
Water content, %	23.4			
Void ratio	0.6589			
Dry density, pcf	102.4			
Specimen diameter, in	1.34			
Specimen height, in	2.81			

Description: Br LEAN CLAY, tr gravel, moist-very stiff

LL =	PL =	PI =	GS =	Type:

Project No.: 08330.005
Date: 2-17-93
Remarks:
Lab No. 589

Fig No.

Client: Bentley Meisner Associates

Project: Dayton National Cemetery
Dayton, Ohio
Location: Boring:B-9
Depth:2.5-4' Sample

UNCONFINED COMPRESSION TEST

THE H. C. NUTTING COMPANY

Supporting Information

Contents:

General Notes
Unified Soil Classification System
Rock Classification Notes

Note: All attachments are one page unless noted above.

Terracon
611 Lunken Park Dr
Cincinnati, OH

General Notes

Sampling

Water Level

Water Initially Encountered

Water Level After a Specified Period of Time

Water Level After a Specified Period of Time

Cave In Encountered

Water levels indicated on the soil boring logs are the levels measured in the borehole at the times indicated. Groundwater level variations will occur over time. In low permeability soils, accurate determination of groundwater levels is not possible with short term water level observations.

Field Tests

N	Standard Penetration Test Resistance (Blows/Ft.)
(HP)	Hand Penetrometer
(T)	Torvane
(DCP)	Dynamic Cone Penetrometer
UC	Unconfined Compressive Strength
(PID)	Photo-Ionization Detector
(OVA)	Organic Vapor Analyzer

Descriptive Soil Classification

Soil classification as noted on the soil boring logs is based Unified Soil Classification System. Where sufficient laboratory data exist to classify the soils consistent with ASTM D2487 "Classification of Soils for Engineering Purposes" this procedure is used. ASTM D2488 "Description and Identification of Soils (Visual-Manual Procedure)" is also used to classify the soils, particularly where insufficient laboratory data exist to classify the soils in accordance with ASTM D2487. In addition to USCS classification, coarse grained soils are classified on the basis of their in-place relative density, and fine-grained soils are classified on the basis of their consistency. See "Strength Terms" table below for details. The ASTM standards noted above are for reference to methodology in general. In some cases, variations to methods are applied as a result of local practice or professional judgment.

Location And Elevation Notes

Exploration point locations as shown on the Exploration Plan and as noted on the soil boring logs in the form of Latitude and Longitude are approximate. See Exploration and Testing Procedures in the report for the methods used to locate the exploration points for this project. Surface elevation data annotated with +/- indicates that no actual topographical survey was conducted to confirm the surface elevation. Instead, the surface elevation was approximately determined from topographic maps of the area.

Strength Terms

Relative Density of Coarse-Grained Soils
(More than 50% retained on No. 200 sieve.)
Density determined by Standard Penetration Resistance

Relative Density	Standard Penetration or N-Value (Blows/Ft.)
Very Loose	0 - 3
Loose	4 - 9
Medium Dense	10 - 29
Dense	30 - 50
Very Dense	> 50

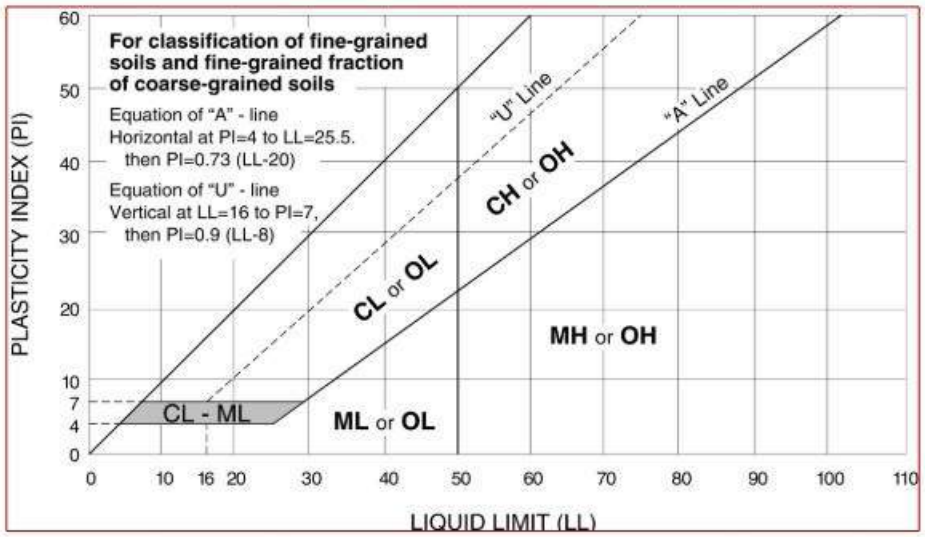
Consistency of Fine-Grained Soils
(50% or more passing the No. 200 sieve.)
Consistency determined by laboratory shear strength testing, field visual-manual procedures or standard penetration resistance

Consistency	Unconfined Compressive Strength Qu (tsf)	Standard Penetration or N-Value (Blows/Ft.)
Very Soft	less than 0.25	0 - 1
Soft	0.25 to 0.50	2 - 4
Medium Stiff	0.50 to 1.00	4 - 8
Stiff	1.00 to 2.00	8 - 15
Very Stiff	2.00 to 4.00	15 - 30
Hard	> 4.00	> 30

Relevance of Exploration and Laboratory Test Results

Exploration/field results and/or laboratory test data contained within this document are intended for application to the project as described in this document. Use of such exploration/field results and/or laboratory test data should not be used independently of this document.

Unified Soil Classification System

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests [A]				Soil Classification	
				Group Symbol	Group Name [B]
Coarse-Grained Soils: More than 50% retained on No. 200 sieve	**Gravels:** More than 50% of coarse fraction retained on No. 4 sieve	**Clean Gravels:** Less than 5% fines [C]	$Cu \geq 4$ and $1 \leq Cc \leq 3$ [E]	GW	Well-graded gravel [F]
			$Cu < 4$ and/or $[Cc < 1$ or $Cc > 3.0]$ [E]	GP	Poorly graded gravel [F]
		Gravels with Fines: More than 12% fines [C]	Fines classify as ML or MH	GM	Silty gravel [F, G, H]
			Fines classify as CL or CH	GC	Clayey gravel [F, G, H]
	Sands: 50% or more of coarse fraction passes No. 4 sieve	**Clean Sands:** Less than 5% fines [D]	$Cu \geq 6$ and $1 \leq Cc \leq 3$ [E]	SW	Well-graded sand [I]
			$Cu < 6$ and/or $[Cc < 1$ or $Cc > 3.0]$ [E]	SP	Poorly graded sand [I]
		Sands with Fines: More than 12% fines [D]	Fines classify as ML or MH	SM	Silty sand [G, H, I]
			Fines classify as CL or CH	SC	Clayey sand [G, H, I]
Fine-Grained Soils: 50% or more passes the No. 200 sieve	**Silts and Clays:** Liquid limit less than 50	**Inorganic:**	PI > 7 and plots above "A" line [J]	CL	Lean clay [K, L, M]
			PI < 4 or plots below "A" line [J]	ML	Silt [K, L, M]
		Organic:	$\frac{LL\ oven\ dried}{LL\ not\ dried} < 0.75$	OL	Organic clay [K, L, M, N]
					Organic silt [K, L, M, O]
	Silts and Clays: Liquid limit 50 or more	**Inorganic:**	PI plots on or above "A" line	CH	Fat clay [K, L, M]
			PI plots below "A" line	MH	Elastic silt [K, L, M]
		Organic:	$\frac{LL\ oven\ dried}{LL\ not\ dried} < 0.75$	OH	Organic clay [K, L, M, P]
					Organic silt [K, L, M, Q]
Highly organic soils:	Primarily organic matter, dark in color, and organic odor			PT	Peat

[A] Based on the material passing the 3-inch (75-mm) sieve.
[B] If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.
[C] Gravels with 5 to 12% fines require dual symbols: GW-GM well-graded gravel with silt, GW-GC well-graded gravel with clay, GP-GM poorly graded gravel with silt, GP-GC poorly graded gravel with clay.
[D] Sands with 5 to 12% fines require dual symbols: SW-SM well-graded sand with silt, SW-SC well-graded sand with clay, SP-SM poorly graded sand with silt, SP-SC poorly graded sand with clay.
[E] $Cu = D_{60}/D_{10}$ $\quad Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}}$
[F] If soil contains ≥ 15% sand, add "with sand" to group name.
[G] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.
[H] If fines are organic, add "with organic fines" to group name.
[I] If soil contains ≥ 15% gravel, add "with gravel" to group name.
[J] If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.
[K] If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel," whichever is predominant.
[L] If soil contains ≥ 30% plus No. 200 predominantly sand, add "sandy" to group name.
[M] If soil contains ≥ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.
[N] PI ≥ 4 and plots on or above "A" line.
[O] PI < 4 or plots below "A" line.
[P] PI plots on or above "A" line.
[Q] PI plots below "A" line.