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1.1 SUMMARY

This section lists the drawings for the project pursuant to contract clause "DFARS 252.236-7001, Contract Drawings and Specifications."

1.2 CONTRACT DRAWINGS

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V-103	17361634	EXISTING CONDITIONS - AREA 2
V-104	17361635	EXISTING CONDITIONS - AREA 3
V-105	17361636	EXISTING CONDITIONS - AREA 4
V-106	17361637	EXISTING CONDITIONS - AREA 5
V-107	17361638	EXISTING CONDITIONS - AREA 6
V-108	17361639	EXISTING CONDITIONS - AREA 7
V-109	17361640	EXISTING CONDITIONS - AREA 8
V-110	17361641	EXISTING CONDITIONS - AREA 9
V-111	17361642	EXISTING CONDITIONS - AREA 10
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V-113	17361644	EXISTING CONDITIONS - AREA 12
V-114	17361645	EXISTING CONDITIONS - AREA 13
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V-116	17361647	EXISTING CONDITIONS - AREA 15
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BB111	17361670	BORING LOGS
BB112	17361671	BORING LOGS
BB113	17361672	BORING LOGS
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CG122	17361820	GRADING AND DRAINAGE PLAN - AREA 21
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EP601	17361903	EXISTING DISTRUBUTION ONE LINE DIAGRAM - NEW WORK
EP602	17361904	ONE-LINE DIAGRAMS
EP701	17361905	PANELBOARD SCHEDULES
EA101	17361906	AIRFIELD ELECTRICAL PLAN 1
EA102	17361907	AIRFIELD ELECTRICAL PLAN 2
EA501	17361908	AIRFIELD LIGHTING DETAILS
EA502	17361909	AIRFIELD LIGHTING DETAILS
EA503	17361910	AIRFIELD LIGHTING DETAILS
EA504	17361911	AIRFIELD LIGHTING DETAILS
EA701	17361912	AIRFIELD LIGHTING POINTS SCHEDULE
EA702	17361913	AIRFIELD LIGHTING ONE-LINE DIAGRAMS
TS001	17361914	TELECOMMUNICATIONS SITE LEGEND
TD101	17361915	TELECOMMUNICATIONS SITE DEMOLITION PLAN 1
TD102	17361916	TELECOMMUNICATIONS SITE DEMOLITION PLAN 2
TS101	17361917	TELECOMMUNICATIONS SITE PLAN 1
TS102	17361918	TELECOMMUNICATIONS SITE PLAN 2
TS103	17361919	TELECOMMUNICATIONS SITE PLAN 3
TS104	17361920	TELECOMMUNICATIONS SITE PLAN 4
TS105	17361921	TELECOMMUNICATIONS SITE PLAN 5
TS106	17362001	TELECOMMUNICATIONS SITE PLAN 6

TS107	17362002	TELECOMMUNICATIONS SITE PLAN 7
TS108	17362003	TELECOMMUNICATIONS SITE PLAN 8
TS109	17362004	TELECOMMUNICATIONS SITE PLAN 9
TS501	17361922	TELECOMMUNICATIONS SITE DETAILS
TS502	17361923	TELECOMMUNICATIONS SITE DETAILS
TS701	17361924	TELECOMMUNICATIONS INTERBUILDING BACKBONE RISER
CF101	17361925	OVERALL FUELING PLAN
CF102	17361926	OVERALL COMM PLAN
CF201	17361927	FUEL PLAN AND PROFILE - AREA 1
CF202	17361928	FUEL PLAN AND PROFILE - AREA 2
CF203	17361929	FUEL PLAN AND PROFILE - AREA 3
CF204	17361930	FUEL PLAN AND PROFILE - AREA 4
CF205	17361931	FUEL PLAN AND PROFILE - AREA 5
CF206	17361932	FUEL PLAN AND PROFILE - AREA 6
CF207	17361933	FUEL PLAN AND PROFILE - AREA 7
CF208	17361934	FUEL PLAN AND PROFILE - AREA 8
CF209	17361935	FUEL PLAN AND PROFILE - AREA 9
CF210	17361936	FUEL PLAN AND PROFILE - AREA 10
CF211	17361937	FUEL PLAN AND PROFILE - AREA 11
CF212	17361938	FUEL PLAN AND PROFILE - AREA 12
CF221	17361939	COMM PLAN - AREA 1
CF222	17361940	COMM PLAN - AREA 2
CF223	17361941	COMM PLAN - AREA 3
CF224	17361942	COMM PLAN - AREA 4
CF225	17361943	COMM PLAN - AREA 5
CF226	17361944	COMM PLAN - AREA 6
CF227	17361945	COMM PLAN - AREA 7
CF228	17361946	COMM PLAN - AREA 8
CF229	17361947	COMM PLAN - AREA 9
CF230	17361948	COMM PLAN - AREA 10
CF231	17361949	COMM PLAN - AREA 11
CF232	17361950	COMM PLAN - AREA 12
CF233	17361951	COMM PLAN - AREA 13
CF234	17361952	COMM PLAN - AREA 14
CF501	17361953	FUELING DETAILS
CF502	17361954	FUELING DETAILS
SF001	17361955	STRUCTURAL GENERAL NOTES - SHEET 1
SF002	17361956	STRUCTURAL GENERAL NOTES - SHEET 2
SF003	17361957	LEGENDS AND ABBREVIATIONS
SF101	17361958	OVERALL STRUCTURAL LAYOUT
SF111	17361959	ISOLATION VALVE VAULT 1 - PLANS
SF112	17361960	ISOLATION VALVE VAULT 2 - PLANS - SHEET 1
SF113	17361961	ISOLATION VALVE VAULT 2 - PLAN - SHEET 2
SF114	17361962	HYDRANT PIT - PLANS AND SECTIONS
SF115	17361963	HPV PITS - PLANS AND SECTIONS
SF501	17361964	STANDARD STRUCTURAL DETAILS - SHEET 1
SF502	17361965	STANDARD STRUCTURAL DETAILS - SHEET 2
SF511	17361966	ISOLATION VALVE VAULT - SECTIONS - SHEET 1
SF512	17361967	ISOLATION VALVE VAULT - SECTIONS - SHEET 2
SF513	17361968	ISOLATION VALVE VAULT - SECTIONS AND DETAILS
SF521	17361969	ROLLING COVER - SHEET 1
SF522	17361970	ROLLING COVER - SHEET 2
SF523	17361971	ROLLING COVER - SHEET 3
SF524	17361972	ROLLING COVER - SHEET 4

SF525	17361973	ROLLING COVER - SHEET 5
SF551	17361974	PIPE SUPPORT DETAILS
MF001	17361975	FUELING MECHANICAL LEGEND
MF002	17361976	FUELING MECHANICAL GENERAL NOTES
MF011	17361977	FUELING MECHANICAL FLOW DIAGRAM - OVERALL
MF101	17361978	FUELING MECHANICAL OVERALL SITE PLAN
MF501	17361979	FUELING MECHANICAL DETAILS - ISOLATION VALVE VAULT (IVV-1)
MF502	17361980	FUELING MECHANICAL DETAILS - ISOLATION VALVE VAULT (IVV-2)
MF503	17361981	FUELING MECHANICAL DETAILS
MF504	17361982	FUELING MECHANICAL DETAILS
MF505	17361983	FUELING MECHANICAL DETAILS
MF506	17361984	FUELING MECHANICAL DETAILS
MF601	17361985	FUELING MECHANICAL P&ID
EF001	17361986	ELECTRICAL FUELING LEGEND - 1
EF002	17361987	ELECTRICAL FUELING LEGEND - 2
EF011	17361988	OVERALL FUELING HAZARDOUS AREA PLAN
EF101	17361989	OVERALL FUELING ELECTRICAL SITE PLAN
EF401	17361990	ENLARGED PLAN - PUMPHOUSE
EF501	17361991	ELECTRICAL DETAILS - EPDS
EF502	17361992	ELECTRICAL DETAILS - GROUNDING
EF503	17361993	ELECTRICAL SITE DETAILS - HANDHOLES
EF504	17361994	ELECTRICAL SITE DETIALS - DUCT BANKS
EF511	17361995	ELEVATION - PUMP CONTROL PANEL
EF611	17361996	PCP - CONTROL DIAGRAM
EF621	17361997	NORTH APRON EPDS - FRONT LAYOUT
EF622	17361998	NORTH ARON EPDS WIRING - 1
EK501	17361999	CATHODIC PROTECTION DETAILS
EK501	17362000	CATHODIC PROTECTION DETAILS

1.3 REFERENCE DRAWINGS

The following reference drawings are intended only to show the original construction. Drawings are the property of the Government and must not be used for any purpose other than that intended by the contract.

NAVFAC DWG NO.	TITLE
3201807	REPAIR/REPLACE OIL/WATER SEPARATORS BUILDING NO. 2550 JET ENGINE TEST FACILITY
7320181	REPAIR/REPLACE OIL/WATER SEPARATORS BLDG NO. 2550 JET ENGINE TEST FACILITY
AND-W-122	CONSTRUCT OIL SEPARATOR WET ENGINE TEST STAND (BLG 2550)
AND B-230	CONSTRUCT JET TEST STAND READY ROOM
AND-R-60	AIR CONDITIONING SHAW ESTES JET ENGINE TEST CELL CONTROL RM. BLDG. 2551

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(a)	(b)	(c)	(d)	(e)	(f)		(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)		(q)	(r)
		01 14 00	SD-01 Preconstruction Submittals																
			List of Contact Personnel	1.5.1.1															
			Personnel List	1.6.1															
			Free-Zone Request	1.5.1.2	G														
			Vehicle List	1.6.2	G														
			Statement Of Acknowledgement	1.6.3	G														
		01 20 00	SD-01 Preconstruction Submittals																
			Earned Value Report	1.2	G														
		01 30 00	SD-01 Preconstruction Submittals																
			View Location Map	1.3															
			Progress and Completion	1.4															
			Pictures																
		01 31 23.13 20	SD-01 Preconstruction Submittals																
			List of Contractor's Personnel	1.4.2															
		01 32 17.00 20	SD-01 Preconstruction Submittals																
			Baseline NAS	1.2.2	G														
			Designated Project Scheduler	1.9	G														
			SD-07 Certificates																
			Weekly Look Ahead Schedule	1.3															
			Monthly NAS Updates	1.4.2	G														
			SD-11 Closeout Submittals																
			As-Built NAS	1.4.3	G														
		01 33 00	SD-01 Preconstruction Submittals																
			Submittal Register	1.8	G														
		01 33 29	SD-01 Preconstruction Submittals																

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		01 33 29	Preliminary High Performance and Sustainable Building Checklist	1.5.3.2	G														
			Sustainability Action Plan	1.4.1	G														
			Preliminary Sustainability eNotebook	1.5.3.2	G														
			SD-11 Closeout Submittals																
			Final High Performance and Sustainable Building Checklist	1.5.3.2	G														
			Final Sustainability eNotebook	1.5.3.2	G														
		01 35 13.04 30	SD-01 Preconstruction Submittals																
			System Authorization Access Request (SAAR)	3.1	G														
			ICS IA Addendum	3.1	G														
			Dod CYBER AWARENESS CHALLENGE Training	3.1	G														
			Privileged User Cybersecurity Responsibilities Training	3.1	G														
			CONTRACTOR PERSONNEL REQUIREMENTS	3.1	G														
			SAAR User Agreement	3.1	G														
			Pre-Construction Hardware List	3.6.3.1	G														
			Pre-Construction Software List	3.6.3.2	G														
			Pre-Construction Network Diagam	3.6.3.3	G														
			SD-03 Product Data																
			Media Converters	2.3.2	G														

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		01 35 13.04 30	Uninterruptible Power Supply	2.3.3	G														
			(UPS)																
			Remote Terminal Unit (RTU)	2.3.4	G														
			Intermediary Network Devices	2.3.5	G														
			Ethernet Switches	2.3.1	G														
			SD-10 Operation and Maintenance																
			Data																
			Operator Manual	3.6.1	G														
			Sustainment Materials	3.6.2	G														
			Access Controls Summary	3.6.3.7	G														
			Auditing Controls Summary	3.6.3.8	G														
			Configuration Management Plan	3.6.3.9	G														
			Contingency Plan	3.6.3.10	G														
			Vulnerability Management Plan	3.6.3.12	G														
			Maintenance Plan	3.6.3.13	G														
			SD-11 Closeout Submittals																
			Technical Narrative	3.3.1	G														
			Systems Testing	3.4	G														
			Final Hardware List	3.6.3.4	G														
			Final Software List	3.6.3.5	G														
			Final Network Diagram	3.6.3.6	G														
			Security Features Guide	3.6.3.11	G														
			Documented Statements	3.6.3.14	G														
			Test Results	3.6.3.15	G														
		01 35 26	SD-01 Preconstruction Submittals																
			Accident Prevention Plan (APP)	1.9.1	G														

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		01 35 26	Indoor Air Quality (IAQ)	1.17	G														
			Management Plan																
			SD-06 Test Reports																
			Accident Reports	1.13.2	G														
			LHE Inspection Reports	1.13.3															
			Monthly Exposure Reports	1.5	G														
			SD-07 Certificates																
			Activity Hazard Analysis (AHA)	1.10	G														
			Certificate of Compliance	1.13.4															
			Contractor Safety Self-Evaluation	1.6															
			Checklist																
			Hot Work Permit	1.14															
			License Certificates	1.15															
			Portable Gauge Operations	1.15.1	G														
			Planning Worksheet																
			Radiography Operation Planning	1.15.1	G														
			Work Sheet																
			Standard Lift Plan	1.13.4.2	G														
			Critical Lift Plan	1.13.4.2	G														
		01 35 29.13	SD-02 Shop Drawings																
			Work Zones	3.8.1	G														
			Decontamination Facilities	3.9.1	G														
			SD-03 Product Data																
			Amendments to the APP/SSHP	1.4	G														
			G-RAM/LLRW Exposure	3.5	G														
			Monitoring/Air Sampling Program																

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		01 35 29.13	Site Control Log	3.8.2															
			SSHO's Daily Inspection Logs	1.8															
			SD-07 Certificates																
			Certificate Of Worker/Visitor	1.7															
			Acknowledgement																
			Certification Of 40 Hour Radiation	1.5.3	G														
			Safety Officer Training																
			SD-11 Closeout Submittals																
			Safety And Health Phase-Out	1.9	G														
			Report																
		01 45 00	SD-01 Preconstruction Submittals																
			Contractor Quality Control (CQC)	1.5.2	G														
			Plan																
			SD-06 Test Reports																
			Verification Statement	1.12.3															
		01 45 35	SD-06 Test Reports																
			Special Inspection Daily Reports	3.1.1															
			Special Inspection Daily Reports	3.1.2															
			Special Inspection Biweekly	3.1.1															
			Reports																
			SD-07 Certificates																
			AISC Certified Steel Fabricator	2.1															
			Certificate of Compliance	2.1															
			Special Inspector	1.5	G														
			SD-11 Closeout Submittals																
			Comprehensive Final Report	3.1.2	G														

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		01 50 00	SD-01 Preconstruction Submittals																
			Construction Site Plan	1.3	G														
			Traffic Control Plan	3.4.1	G														
			Haul Road Plan	2.2.1	G														
			Contractor Computer	1.6.1.4	G														
			Cybersecurity Compliance																
			Statements																
			Contractor Temporary Network	1.6.6	G														
			Cybersecurity Compliance																
			Statements																
			SD-06 Test Reports																
			Backflow Preventer Tests	3.5															
			SD-07 Certificates																
			Backflow Tester	1.4.1															
			Backflow Preventers	1.4															
		01 57 19	SD-01 Preconstruction Submittals																
			Contractor Hazardous Material	3.8.1	G														
			Inventory Log																
			Storage Material Inventory	1.5.4.1.2															
			Preconstruction Survey	1.6.1															
			Regulatory Notifications	1.6.2															
			Environmental Manager	1.6.4															
			Qualifications																
			Employee Training Records	1.6.5															
			Environmental Protection Plan	1.7	G														
			Dirt and Dust Control Plan	1.7.9.1															

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		01 57 19	Solid Waste Management Permit	1.10															
			Stormwater Pollution Prevention	3.2.1.1	G														
			Plan																
			Stormwater Notice of Intent	3.2.1.2															
			Spill Prevention Control and	3.15.2	G														
			Countermeasure (SPCC) Plan																
			Hazard Analysis and Critical	3.1.1	G														
			Control Point (HACCP) Plan																
			GEPA Clearing, Grubbing,	3.2.1.1	G														
			Grading, and Stockpiling Permit /																
			General Permit Application																
			Final Work Plan for Tarague	3.1.1	G														
			Forest Enhancement Area																
			Draft Work Plan for Tarague	3.1.1	G														
			Forest Enhancement Area																
			Draft Natural Resource Work	3.1.1	G														
			Plan																
			Final Natural Resource Work	3.1.1	G														
			Plan																
			Natural Resource Field	3.1.1	G														
			Assessment Report for P-012																
			Construction Footprint																
			Natural Resource Field	3.1.1	G														
			Assessment Report for Tarague																
			Forest Enhancement Area																

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		01 57 19	Archaeological Monitoring and	3.4.4	G														
			Discovery Plan																
			SD-02 Shop Drawings																
			Alignment of Ungulate Fence	3.1.1	G														
			SD-06 Test Reports																
			Monthly Solid Waste Disposal	1.10.1	G														
			Report																
			SWPPP Inspection Reports	3.2.1.3															
			Laboratory Analysis	3.7.1.1.2															
			SD-07 Certificates																
			ECATTS Certificate of	1.4.1.2	G														
			Completion																
			Employee Training Records	1.6.5	G														
			Erosion and Sediment Control	1.6.5															
			Inspector Qualifications																
			Qualification of Qualified	3.1.1	G														
			Biologist(S)																
			Qualification of Archaeologist(s)	3.4.2	G														
			SD-10 Operation and Maintenance																
			Data																
			Weekly Natural Resources	3.1.1	G														
			Conservation Status Report																
			Monthly Natural Resources	3.1.1	G														
			Conservation Progress Report																
			Annual Natural Resources	3.1.1	G														
			Conservation Progress Report																

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		01 57 19	Reports and Submittals required	3.4.3.2	G														
			by Data Recovery Plan																
			End of Field (EOF) Letter for	3.4.4	G														
			Archaeological Monitoring -																
			Tarague FEA																
			SD-11 Closeout Submittals																
			Contractor Hazardous Material	3.8.1	G														
			Inventory Log																
			Regulatory Notifications	1.6.2	G														
			Assembled Employee Training	1.6.5	G														
			Records																
			Solid Waste Management Permit	1.10	G														
			Stormwater Pollution Prevention	3.2.1.4	G														
			Plan Compliance Notebook																
			Stormwater Notice of Termination	3.2.1.5	G														
			As-Built Topographic Survey	3.2.1.5															
			Waste Determination	3.7.1	G														
			Documentation																
			Project Solid Waste Disposal	3.7.2.1	G														
			Documentation Report																
			Sales Documentation	3.7.2.1	G														
			Contractor Certification	3.7.2.1															
			Hazardous Waste/Debris	3.7.3.1	G														
			Management																
			Disposal Documentation for	3.7.3.6	G														
			Hazardous and Regulated Waste																

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		01 57 19	Draft Natural Resources	3.1.1	G														
			Conservation Report																
			Final Natural Resources	3.1.1	G														
			Conservation Report																
			Weekly archaeological monitoring	3.4.4	G														
			report-Tarague FEA																
			Draft Archaeological Monitoring	3.4.4	G														
			Report-Tarague FEA																
			Final Archaeological Monitoring	3.4.4	G														
			Report-Tarague FEA																
		01 57 19.03 21	SD-01 Preconstruction Submittals																
			MEC Work Plan	1.2.1	G														
			Initial GIS Data Files	1.2.2															
			SD-11 Closeout Submittals																
			Final GIS Data Files	1.2.3															
		01 58 00	SD-02 Shop Drawings																
			Preliminary Drawing Indicating	1.4.1	G														
			Layout And Text Content																
		01 74 19	SD-01 Preconstruction Submittals																
			Construction Waste Management	1.7															
			Plan																
			SD-06 Test Reports																
			Sampling and Analytical Report	1.12	G														
			for Surplus Soil																
			SD-07 Certificates																

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		01 74 19	Disposal Documentation or	1.12	G														
			Acceptance of Surplus Soil																
			SD-11 Closeout Submittals																
			Final Construction Waste	1.2.6	S														
			Diversion Report																
		01 78 00	SD-03 Product Data																
			Warranty Management Plan	1.6.1															
			Warranty Tags	1.6.4															
			Final Cleaning	3.4															
			Spare Parts Data	1.5															
			SD-08 Manufacturer's Instructions																
			Instructions	1.6.1															
			SD-10 Operation and Maintenance																
			Data																
			Operation and Maintenance	3.3	G														
			Manuals																
			SD-11 Closeout Submittals																
			As-Built Drawings	3.1	G														
			Record Drawings	3.2	G														
			As-Built Record of Equipment	1.6.1															
			and Materials																
			Certification of EPA Designated	2.1	G														
			Items																
			Certification Of USDA Designated	2.2	G														
			Items																
			Interim DD FORM 1354	3.5.1	G														

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		01 78 00	Checklist for DD FORM 1354	3.5.2	G													
			High Performance and	3.5.2	G													
			Sustainable Building (HPSB)															
			Checklist															
		01 78 23	SD-10 Operation and Maintenance															
			Data															
			Facility Data Workbook	1.4	G													
			Training Plan	3.1.1	G													
			Training Outline	3.1.3	G													
			Training Content	3.1.2	G													
			Operation And Maintenance	3.2.1	G													
			Manual, Progress Submittal															
			Operation And Maintenance	3.2.2	G													
			Manual, Prefinal Submittal															
			Operation And Maintenance	3.2.3	G													
			Manual, Final Submittal															
			SD-11 Closeout Submittals															
			Training Video Recording	3.1.4	G													
			Validation of Training Completion	3.1.6	G													
			Training Plan	3.1.1	G													
			Record Drawings And Utility	1.6.6.7	G													
			Systems															
		01 78 23.33	SD-10 Operation and Maintenance															
			Data															
			System Instructions	2.1.1	G													
		01 78 24.00 20	SD-11 Closeout Submittals															

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		01 78 24.00 20	Facility Data Workbook (FDW),	1.3.1	G														
			Progress Submittal																
			Facility Data Workbook (FDW),	1.3.2	G														
			Prefinal Submittal																
			Facility Data Workbook (FDW),	1.3.3	G														
			Final Submittal																
		02 41 00	SD-01 Preconstruction Submittals																
			Demolition Plan	1.2.2	G														
			Existing Conditions	1.9															
			SD-07 Certificates																
			Notification	1.6	G														
		02 56 13.13	SD-02 Shop Drawings																
			Layout And Detail Drawings	2.1.1.1	G														
			As-Built Drawings	3.6	G														
			SD-03 Product Data																
			Manufacturer's Quality Control	1.4.1															
			Manual																
			Installer's Quality Control Manual	1.4.2															
			Materials	2.2	G														
			Manufacturer's Warranty	1.7															
			Installer's Warranty	1.7															
			SD-06 Test Reports																
			Product Acceptance Tests	2.5.2.2															
			Trial Seam Logs	3.3.2.1															
			Non-Destructive Field Seam	3.4.2															
			Testing																

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		02 56 13.13	Manufacturer's Certified Raw And	2.5.1															
			Sheet Material Test Reports																
			SD-07 Certificates																
			Certificate Of Subgrade	3.1.1															
			Acceptance																
			Qualifications	1.4.3	G														
			SD-08 Manufacturer’s Instructions																
			Geomembrane Manufacturer's	3.3.1	G														
			Installation Instructions																
		02 61 13	SD-01 Preconstruction Submittals																
			Pre-Installation Meeting Agenda	1.3															
			Pre-Installation Meeting Minutes	1.3	G														
			SMP Work Plan	1.2	G														
			SMP Work Plan	1.2.1.1	G														
			Pre-Installation Examination	3.1.2															
			Report																
			Pre-Construction Equipment	3.1.3															
			Examination																
			Qualification of Professional	1.2	G														
			Engineer (PE) or Environmental																
			Consultant (EC)																
			Qualification of Nuclear	1.2	G														
			Regulatory Commission (NRC)																
			Licensed Service Provider																
			Key Personnel Qualification for	1.2	G														
			G-RAM/LLRW																

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		02 61 13	Radiation Work Plan	1.2	G														
			Qualification Of Radiation Safety	1.2	G														
			Officer (RSO)																
			SD-02 Shop Drawings																
			Surveys	3.1.1															
			SD-03 Product Data																
			Specifications Of Geomembrane	2.1.3	G														
			SD-06 Test Reports																
			Report for G-RAM Site Screening	1.2	G														
			Level																
			Additional PFAS Testing Report	1.2	G														
			With Sampling Procedures																
			SD-07 Certificates																
			Qualifications	1.5.2	G														
			SD-08 Manufacturer’s Instructions																
			Geomembrane Manufacturer's	1.2	G														
			Installation Instructions																
			Geomembrane Manufacturer's	2.1.3	G														
			Installation Instructions																
			SD-10 Operation and Maintenance																
			Data																
			Weekly G-RAM/LLRW Inventory	1.2	G														
			Report																
			SD-11 Closeout Submittals																
			SMP Closure Report	1.2	G														

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		02 61 13	Final G-RAM/LLRW Status	1.2	G														
			Survey Report																
			G-RAM/LLRW Closure Report	1.2	G														
			Topographic Survey Drawings for	1.2	G														
			PFAS-Impacted Soil Relocation																
			Area																
		02 81 00	SD-03 Product Data																
			Packaging Notifications	2.1.1															
			Hazardous Waste Management	3.1	G														
			Plan																
			Onsite Hazardous Waste	3.2	G														
			Management																
			Notices of Non-Compliance and	3.3															
			Notices of Violation																
			SD-06 Test Reports																
			Recordkeeping	3.8	G														
			Exception Report	3.8	G														
			Spill Response	3.9															
			SD-07 Certificates																
			Transportation and Disposal	1.4.1	G														
			Coordinator																
			Training	1.4.2	G														
			Pipeline Hazardous Materials	1.4.3															
			Safety Administration Certification																
			Shipping Documents and	3.3.3	G														
			Packagings Certification																

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		02 81 00	Security Plan	3.3.4															
			Certificates of Disposal	3.3.5															
			Waste Minimization	3.7															
		02 82 00	SD-01 Preconstruction Submittals																
			Asbestos Sampling And	1.3.2	G														
			Analytical Report																
			SD-03 Product Data																
			Amended Water	1.2.1	G														
			Safety Data Sheets (SDS) for All	1.3.9	G														
			Materials																
			Respirators	3.1.2.1	G														
			Local Exhaust Equipment	3.1.7	G														
			Pressure Differential Automatic	3.1.7	G														
			Recording Instrument																
			Vacuums	3.1.8	G														
			Glovebags	3.1.10	G														
			SD-06 Test Reports																
			Air Sampling Results	1.5.5	G														
			Pressure Differential Recordings	1.5.6	G														
			for Local Exhaust System																
			Clearance Sampling	3.2.11.4	G														
			Asbestos Disposal Quantity	3.3.3.2	G														
			Report																
			SD-07 Certificates																
			Employee Training	1.3.4	G														
			Notifications	1.3.5	G														

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		02 82 00	Respiratory Protection Program	1.3.7	G														
			Asbestos Hazard Abatement Plan	1.3.10	G														
			Testing Laboratory	1.3.11	G														
			Landfill Approval	1.3.12	G														
			Delivery Tickets	1.3.12	G														
			Waste Shipment Records	1.3.12	G														
			Transporter Certification	1.3.13	G														
			Medical Certification	1.3.14	G														
			Private Qualified Person	1.5.1	G														
			Documentation																
			Designated Competent Person	1.5.2	G														
			Worker's License	1.5.3	G														
			Contractor's License	1.5.4	G														
			Federal, State or Local Citations	1.5.7	G														
			on Previous Projects																
			Equipment Used to Contain	3.1	G														
			Airborne Asbestos Fibers																
			Water Filtration Equipment	3.1.3.2	G														
			Vacuums	3.1.8	G														
			Ventilation Systems	3.1.8	G														
			SD-11 Closeout Submittals																
			Permits and Licenses	1.3.5	G														
			Notifications	1.3.5	G														
			Respirator Program Records	1.3.7.1	G														
			Rental Equipment	1.7.1	G														
		02 83 00	SD-01 Preconstruction Submittals																

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		02 83 00	Competent Person	1.5.1.1	G														
			Training Certification	1.5.1.2	G														
			Occupational and Environmental	1.5.2.3	G														
			Assessment Data Report																
			Medical Examinations	1.5.2.4	G														
			Lead, Cadmium, Chromium	1.5.2.8	G														
			Waste Management Plan																
			Lead, Cadmium, Chromium	1.5.2.2	G														
			Compliance Plan																
			Lead, Cadmium, Chromium	3.1.1.3	G														
			Compliance Plan																
			Written Evidence of TSD	3.5.2.1	G														
			Approval																
			SD-03 Product Data																
			Respirators	1.6.1															
			Vacuum Filters	1.6.4															
			Negative Air Pressure System	1.6.6	G														
			Materials and Equipment	2.1															
			Expendable Supplies	2.1.1															
			Pressure Differential Log	3.1.1.3	G														
			SD-06 Test Reports																
			Occupational and Environmental	1.5.2.3	G														
			Assessment Data Report																
			Sampling Results	1.5.2.3	G														
			Pressure Differential Recordings	1.5.3															
			For Local Exhaust System																

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		02 83 00	SD-07 Certificates																
			Testing Laboratory	1.5.1.3	G														
			Clearance Certification	3.5.1.1	G														
			SD-11 Closeout Submittals																
			Hazardous Waste Manifest	3.5.2.1	G														
			Turn-In Documents or Weight Tickets	3.5.2.1	G														
		02 84 16	SD-07 Certificates																
			Qualifications of CIH	1.8.1	G														
			Training Certification	1.8.1	G														
			PCB and Lamp Removal Work Plan	1.8.2	G														
			PCB and Lamp Disposal Plan	1.8.3	G														
			SD-11 Closeout Submittals																
			Transporter Certification	3.5.2	G														
			Certification of Decontamination	3.2.4															
			Certificate of Disposal and/or recycling	3.5.2.1															
			Testing Results	3.3.1															
		02 84 33	SD-01 Preconstruction Submittals																
			PCB Removal Work Plan	1.7.3	G														
			PCB Disposal Plan	1.7.4	G														
			SD-07 Certificates																
			Training certification	1.7.1															
			Qualifications of IH	1.7.2	G														
			Notification	1.7.5															

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		02 84 33	Transporter Certification	3.8	G														
			Disposal Facility Certification	3.8	G														
			Certification of Decontamination	3.5.4															
			Post Cleanup Sampling	3.5.5															
			Certificate of Disposal	3.8.2															
		03 30 00	SD-01 Preconstruction Submittals																
			Concrete Curing Plan	1.6.3.1															
			Quality Control Program	1.6.5	G														
			Quality Control Personnel	1.6.6	G														
			Certifications																
			Quality Control Organizational	1.6.6															
			Chart																
			Laboratory Accreditation	1.6.8	G														
			Maturity Method Data	3.3.8															
			SD-02 Shop Drawings																
			Reinforcing Steel	1.6.2.1	G														
			SD-03 Product Data																
			Joint Sealants	2.4.5	G														
			Joint Filler	2.4.4	G														
			Formwork Materials	2.1															
			Recycled Aggregate Materials	2.3.3.2	G														
			Cementitious Materials	2.3.1	G														
			Vapor Retarder	2.4.6	G														
			Concrete Curing Materials	2.4.1	G														
			Reinforcement	2.6	G														

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		03 30 00	Liquid Chemical Floor Hardeners	2.4.3.1															
			and Sealers																
			Admixtures	2.3.4	G														
			Mechanical Reinforcing Bar	2.6.2	G														
			Connectors																
			Waterstops	2.2.2	G														
			Biodegradable Form Release	2.2.3															
			Agent																
			Pumping Concrete	1.6.3.2	G														
			Nonshrink Grout	2.4.2	G														
			SD-05 Design Data																
			Construction and Movement	2.2.5	G														
			Joints Locations and Details																
			Concrete Mix Design	1.6.1.1	G														
			SD-06 Test Reports																
			Concrete Mix Design	1.6.1.1	G														
			Fly Ash	1.6.4.1	G														
			Pozzolan	1.6.4.1	G														
			Slag Cement	1.6.4.2	G														
			Aggregates	1.6.4.3	G														
			Portland Cement	2.3.1.1	G														
			Blended Cements	2.3.1.2	G														
			Compressive Strength Tests	3.13.3.3	G														
			Slump Tests	3.13.3.1															
			Water	2.3.2															
			SD-07 Certificates																

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		03 30 00	Reinforcing Bars	2.6.1														
			Welder Qualifications	1.9														
			VOC Content for Form Release	1.6.3.3														
			Agents, Curing Compounds, and															
			Concrete Penetrating Sealers															
			Safety Data Sheets	1.6.3.4														
			Forest Stewardship Council	1.8.1														
			(FSC) Certification															
			Field Testing Technician and	1.6.6.2														
			Testing Agency															
			SD-08 Manufacturer's Instructions															
			Liquid Chemical Floor Hardeners	2.4.3.1														
			and Sealers															
			Joint Sealants	2.4.5	S													
			Curing Compound	2.4.1														
		04 20 00	SD-02 Shop Drawings															
			Cut CMU	3.3.2.1	G													
			Detail Drawings	3.4.1.1	G													
			SD-03 Product Data															
			Hot Weather Procedures	1.5.1	G													
			Cementitious Materials	2.4.1.1	G													
			SD-04 Samples															
			Concrete Masonry Units (CMU)	2.2.2.2	G													
			Admixtures for Masonry Mortar	2.4.1.3	G													
			Anchors, Ties, and Bar	2.6.2	G													
			Positioners															

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		04 20 00	Joint Reinforcement	2.6.3	G														
			SD-05 Design Data																
			Masonry Compressive Strength	2.1.2	G														
			Bracing Calculations	3.2.4	G														
			SD-06 Test Reports																
			Field Testing of Mortar	3.6.1.1															
			Field Testing of Grout	3.6.1.2															
			SD-07 Certificates																
			Concrete Masonry Units (CMU)	2.2.2.2															
			Cementitious Materials	2.4.1.1															
			Admixtures for Masonry Mortar	2.4.1.3															
			Admixtures for Grout	2.4.2.2															
			Anchors, Ties, and Bar	2.6.2															
			Positioners																
			Joint Reinforcement	2.6.3															
			SD-08 Manufacturer's Instructions																
			Admixtures for Masonry Mortar	2.4.1.3															
			Admixtures for Grout	2.4.2.2															
		05 05 20	SD-01 Preconstruction Submittals																
			Installer Qualifications	1.5.1.1	G														
			Post-Installed Anchor Special	1.5.1.2	G														
			Inspector Qualifications																
			SD-03 Product Data																
			Mechanical Anchors in Concrete	2.1.1.3	G														
			Adhesive Anchor System in	2.1.1.4	G														
			Concrete																

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		05 05 20	Non-Shrink, Non-Metallic Grout	3.1.3	G													
			SD-06 Test Reports															
			Post-Installed Anchor Special	3.3.4	G													
			Inspections Report															
			SD-07 Certificates															
			Post-Installed Anchor	2.1.1.1	G													
			Certification															
			SD-08 Manufacturer’s Instructions															
			Manufacturer's Printed	2.1.1.2	G													
			Installation Instructions															
			Non-Shrink, Non-Metallic Grout	3.1.3	G													
			Manufacturer's Safety Data	1.5														
			Sheets															
		05 50 13	SD-02 Shop Drawings															
			Floor Gratings	2.4	G													
			Bollards/Pipe Guards	2.5	G													
			Angles and Plates	2.6	G													
			Pit Access Hatches	2.7	G													
			Installation Drawings	2.6	G													
			Structural System	1.5.1	G													
			SD-03 Product Data															
			Floor Gratings	2.4	G													
			Pit Access Hatches	2.7	G													
			Certified Mill	2.2	G													
		05 59 10	SD-01 Preconstruction Submittals															
			Assembly Tests	2.6.2	G													

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		05 59 10	Acceptance Testing	3.3	G														
			SD-02 Shop Drawings																
			Detail Drawings	1.4.3	G														
			SD-03 Product Data																
			Wheel Assemblies	2.1.7	G														
			Materials List	1.4.3	G														
			Welding	2.4	G														
			Welding of Aluminum	2.4.2	G														
			Steel Welding Repairs	2.4.4	G														
			SD-07 Certificates																
			Welder Qualifications	1.4.1															
			Welding of Aluminum	2.4.2															
		07 11 13	SD-03 Product Data																
			Asphalt Primer	2.1	G														
			Fibrated Emulsion-Based Asphalt	2.2.1	G														
			Glass Fabric Reinforcement	2.3	G														
			Saturated Felt	2.4.1	G														
			Geotextile Fabric	2.4.2	G														
			SD-07 Certificates																
			Materials	1.3															
		09 90 00	SD-02 Shop Drawings																
			Piping Identification	3.9															
			SD-03 Product Data																
			Coating	2.1	G														
			Product Data Sheets	2.1															
			SD-07 Certificates																

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		09 90 00	Qualification Testing	1.6.5.2	G														
			Indoor Air Quality for Paints and	1.6.4															
			Primers																
			SD-08 Manufacturer's Instructions																
			Mixing	2.1															
			Manufacturer's Safety Data	1.8.1															
			Sheets																
			SD-10 Operation and Maintenance																
			Data																
			Coatings	2.1	G														
		09 96 00	SD-01 Preconstruction Submittals																
			Equipment List	1.3															
			SD-03 Product Data																
			Epoxy Coatings	2.2.1	G														
			SD-04 Samples																
			Color Chips	1.3	G														
			SD-07 Certificates																
			Epoxy Coatings	2.2.1	G														
			Manufacturer's Printed	3.1.4															
			Instructions																
		09 96 53.13	SD-01 Preconstruction Submittals																
			Equipment List	1.3															
			SD-03 Product Data																
			Silicone Elastomeric Coating	2.2.1															
			Primer	2.3															
			Sealants	2.4															

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		09 96 53.13	SD-04 Samples																
			Color Selection Guide	2.2.1															
		09 97 13.27	SD-05 Design Data																
			Containment System	1.4.4.1															
			SD-06 Test Reports																
			Joint Sealant Qualification Test	1.4.5.1															
			Reports																
			Coatings Qualification Test	1.4.5.2															
			Reports																
			Metallic Abrasive Qualification	1.4.5.3															
			Test Reports																
			Coating Sample Test Reports	3.1.3															
			Abrasive Sample Test Reports	3.1.4	G														
			Inspection Report Forms	3.8.2.2															
			Daily Inspection Reports	3.8.2.3															
			Recycled Metallic Abrasive Field	1.4.5.4															
			Test Reports (Daily and Weekly)																
			SD-07 Certificates																
			Contract Errors, Omissions, and	1.4.1															
			Other Discrepancies																
			Corrective Action Procedures	1.4.2.1															
			Coating Work Plan	1.4.3	G														
			Qualifications of Certified	1.4.6.1															
			Industrial Hygienist (CIH)																
			Qualifications Of Individuals	1.4.6.5															
			Performing Abrasive Blasting																

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		09 97 13.27	Qualifications of Certified	1.4.6.2															
			Protective Coatings Specialist																
			(PCS)																
			Qualifications of Coating	1.4.6.3															
			Inspection Company																
			Qualifications of QC Specialist	1.4.6.4															
			Coating Inspector																
			Qualifications of Testing	1.4.6.6															
			Laboratory for Coatings																
			Qualifications of Testing	1.4.6.7															
			Laboratory for Abrasive																
			Qualifications of Coating	1.4.6.8															
			Contractors																
			Joint Sealant Materials	1.4.6.9															
			Coating Materials	1.4.6.10															
			Coating System Component	1.4.6.11															
			Compatibility																
			Non-metallic Abrasive	1.4.6.12															
			Metallic Abrasive	1.4.6.13															
			SD-08 Manufacturer’s Instructions																
			Joint Sealant Instructions	1.5.1															
			Coating System Instructions	1.5.2															
			SD-11 Closeout Submittals																
			Disposal of Used Abrasive	3.5.6	G														
			Inspection Logbook	3.8.2.4	G														
		25 05 11.26	SD-01 Preconstruction Submittals																

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		25 05 11.26	Device Account Lock Exception	3.3.2	G														
			Request																
			Contractor Computer	1.10.1.6	G														
			Cybersecurity Compliance																
			Statements																
			Contractor Temporary Network	1.10.6	G														
			Cybersecurity Compliance																
			Statements																
			Cybersecurity Subject Matter	1.7.2	G														
			Expert Qualifications																
			SD-02 Shop Drawings																
			Network Communication, Ports,	1.8.1	G														
			Protocols and Services Report																
			Cybersecurity Network (Riser)	1.8.4	G														
			Diagram																
			SD-03 Product Data																
			Control System Cybersecurity	1.8.6	G														
			Documentation																
			SD-06 Test Reports																
			Control System Cybersecurity	3.12.1	G														
			Testing Procedures																
			Control System Cybersecurity	3.12.3	G														
			Testing Report																
			SD-07 Certificates																
			Software Licenses	1.9	G														
			SD-11 Closeout Submittals																

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		25 05 11.26	Password Change Summary Report	3.4.5.3	G														
			Enclosure Keys	3.3.5	G														
			Software and Configuration Backups	1.8.3	G														
			Auditing Front End Software	3.5.3	G														
			Device Audit Record Upload Software	3.5.4.1	G														
			System Maintenance Tool Software	3.9	G														
			Control System Scanning Tools	3.11.1	G														
			Vendor Guide Compliance Result Report	1.8.5	G														
			Final Control System Inventory Report	1.8.2	G														
		26 05 48	SD-02 Shop Drawings																
			Equipment Requirements	2.1	G														
			SD-03 Product Data																
			Equipment Requirements	2.1	G														
			Anchors	3.3	G														
			SD-06 Test Reports																
			Anchors	3.3	G														
		26 05 73	SD-01 Preconstruction Submittals																
			Field Examination Plan	3.1	G														
			Arc Flash Label Formats	3.2.9	G														
			SD-06 Test Reports																

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		26 05 73	Field Examination	3.1.1															
			SD-07 Certificates																
			System Analyzer	1.4.1	G														
			SD-11 Closeout Submittals																
			Model Files	3.3	G														
			Load Flow Study	3.2.4	G														
			Fault Current Study	3.2.5	G														
			System Coordination Study	3.2.6	G														
			Arc Flash Hazard Study	3.2.7	G														
		26 08 00	SD-06 Test Reports																
			Acceptance Tests and	3.1	G														
			Inspections																
			SD-07 Certificates																
			Qualifications	1.4.1	G														
			Acceptance Test and Inspections	1.4.3	G														
			Procedure																
		26 12 19	SD-02 Shop Drawings																
			Pad-mounted Transformer	1.5.1	G														
			Drawings																
			SD-03 Product Data																
			Pad-mounted Transformers	2.2	G														
			SD-06 Test Reports																
			Acceptance Checks and Tests	3.7.1	G														
			SD-07 Certificates																
			Transformer Efficiencies	2.2.2.1	G														

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		26 12 19	SD-09 Manufacturer's Field																
			Reports																
			Transformer Test Schedule	2.7.1	G														
			Design Tests	2.7.2	G														
			Routine and Other Tests	2.7.3	G														
			SD-10 Operation and Maintenance																
			Data																
			Transformer(s)	1.6.1	G														
		26 13 00	SD-02 Shop Drawings																
			Switchgear Drawings	1.5.1	G														
			SD-03 Product Data																
			Electronic Overcurrent Control	1.5.3	G														
			Curves																
			SF6/High-Firepoint Fluid	1.6.1	G														
			Insulated Pad-mounted Switchgear																
			SF6/High-Firepoint Fluid	2.1	G														
			Insulated Pad-mounted Switchgear																
			Insulated High-Voltage	2.2	G														
			Connectors																
			Surge Arresters	2.3	G														
			SD-06 Test Reports																
			Acceptance Checks and Tests	3.4.1	G														
			SD-07 Certificates																
			Paint Coating System	1.5.2	G														
			SD-09 Manufacturer's Field																
			Reports																

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		26 13 00	Switchgear Design and	2.4.1	G														
			Production Tests																
		26 20 00	SD-02 Shop Drawings																
			Panelboards	2.7	G														
			Transformers	2.8	G														
			Wireways	2.12	G														
			Marking Strips	3.1.3.1	G														
			SD-03 Product Data																
			Receptacles	2.6	G														
			Circuit Breakers	2.7.3	G														
			Transformers	2.8	G														
			Surge Protective Devices	2.13	G														
			SD-06 Test Reports																
			Grounding System Test	3.5.3	G														
			Transformer Tests	3.5.2	G														
			SD-09 Manufacturer's Field																
			Reports																
			Transformer Factory Tests	2.15.1															
		26 27 14.00 20	SD-02 Shop Drawings																
			Installation Drawings	1.3.1	G														
			SD-06 Test Reports																
			Acceptance Checks and Tests	3.2.1	G														
			System Functional Verification	3.2.2	G														
			Building Meter Installation Sheet,	3.2.1	G														
			per Building																

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		26 27 14.00 20	Completed Meter Installation Schedule	3.2.1	G														
			Completed Meter Data Schedule	3.2.1	G														
			Meter Configuration Template	2.1.1	G														
			Meter Configuration Report	3.2.1	G														
			SD-10 Operation and Maintenance Data																
			Electricity Meters and Accessories	1.4.1	G														
			SD-11 Closeout Submittals																
			System Functional Verification	3.2.2	G														
		26 42 13	SD-02 Shop Drawings																
			Drawings	1.4.3	G														
			Dielectric Gasket Kit	2.2.4	G														
			Test Station Housing	2.1.1	G														
			Over Voltage Protector (OVP)	2.2.6	G														
			Materials List	2.2	G														
			SD-03 Product Data																
			Test Station Housing	2.1.1	G														
			Test Station Terminal Board	2.1.3	G														
			Calibrated Shunt	2.1.2	G														
			Insulated Ring Terminals	2.1.3	G														
			Magnetic Switch	2.2.3	G														
			Magnetic Switch Key	2.2.3	G														
			Printed Label	2.1.3	G														
			Pipe Test Lead	3.2.6	G														

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		26 42 13	Exothermic Weld Mold	2.2.7	G													
			Exothermic Weld Charge	2.2.7	G													
			Exothermic Weld Coating	2.2.7	G													
			Galvanic Anode Ingot	2.2.1.2.2	G													
			Galvanic Anode Backfill	2.2.1.2.3	G													
			Galvanic Anode Test Lead	2.2.1.2.2	G													
			Coupon and Test Lead	2.2.3	G													
			Dielectric Gasket Kit	2.2.4	G													
			Dielectric Tubing Union	2.2.5	G													
			Dielectric Tubing Union	3.2.9	G													
			Over Voltage Protector (OVP)	2.2.6	G													
			OVP Mounting Bracket	2.2.6.2	G													
			Protective Flange Band	2.2.6.3	G													
			SD-06 Test Reports															
			Final Compliance Test Report	3.3.1.3	G													
			As-built Drawings	3.3.1.3	G													
			SD-07 Certificates															
			Qualifications	1.4.2	G													
			SD-10 Operation and Maintenance															
			Data															
			Cathodic Protection System	3.3.1.3	G													
			Training Course Outline	3.3.1.2	G													
			SD-11 Closeout Submittals															
			Final Compliance Test Report	3.3.1.3	G													
		26 56 00	SD-02 Shop Drawings															
			Luminaire Drawings	1.5.1.1	G													

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		26 56 00	Pole Drawings	1.5.1.2	G														
			Control System One-Line	1.8.2	G														
			Diagram																
			Sequence of Operation for	2.5.1	G														
			Exterior Lighting Control System																
			SD-03 Product Data																
			Luminaires	2.2	G														
			Light Sources	2.3	G														
			LED Drivers	2.4	G														
			Luminaire Warranty	1.7.1	G														
			Lighting Controls Warranty	1.7.2	G														
			Pole Warranty	1.7.3	G														
			Photosensors	2.5.2.2	G														
			Time Clock	2.5.2.1	G														
			Poles	2.6	G														
			Brackets	2.6.2															
			Pole Foundations	2.6.3	G														
			Obstruction Marker Luminaires	2.2.2	G														
			SD-05 Design Data																
			Luminaire Design Data	1.5.2	G														
			SD-06 Test Reports																
			ANSI/IES LM-79 Test Report	1.5.3	G														
			ANSI/IES LM-80 Test Report	1.5.4	G														
			ANSI/IES TM-21 Test Report	1.5.5	G														
			SD-08 Manufacturer's Instructions																
			Poles	2.6															

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		26 56 00	SD-10 Operation and Maintenance																
			Data																
			Lighting System	1.8.1	G														
			Exterior Lighting Control System	1.8.2	G														
			Maintenance Staff Training Plan	3.3.1.1	G														
			End-User Training Plan	3.3.1.2	G														
		26 56 20	SD-01 Preconstruction Submittals																
			Protection plan	1.4.4	G														
			Training	3.10.2	G														
			SD-02 Shop Drawings																
			Lighting and visual navigation	2.1	G														
			aids																
			Posted instructions	3.10.4	G														
			SD-03 Product Data																
			Taxiway edge lights	2.2.1	G														
			Guidance signs	2.3.3	G														
			Obstruction lighting	2.4	G														
			Light bases	2.5	G														
			Isolation transformers	2.6	G														
			Constant current regulators	3.9.1	G														
			Frangible couplings	2.7.2.5	G														
			Materials and equipment	1.4.2	G														
			SD-06 Test Reports																
			Visual inspection	3.8	G														
			Visual inspection	3.8.1	G														

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		26 56 20	Progress testing for series lighting circuits	3.8.5	G														
			Counterpoise system test and inspection	3.8.4	G														
			Operating test	3.8.2	G														
			Distribution conductors, 600-volt class	3.8.3	G														
			Electrical acceptance tests	3.8.6	G														
			Low-voltage continuity tests	3.8.7	G														
			High-voltage insulation resistance tests	3.8.8	G														
			Constant current regulators	3.9.1	G														
			SD-07 Certificates																
			Qualifications of contractor	1.4.3	G														
			Special tools	2.8.1	G														
			Special tools	3.10.2	G														
			Crimping tool	3.2.2.2	G														
			Cable penciler	3.2.2.3															
			List of parts	3.11.1	G														
			SD-08 Manufacturer’s Instructions																
			Posted instructions	3.10.4	G														
			SD-10 Operation and Maintenance Data																
			Constant current regulators	3.9.1	G														
			Maintenance and repair instructions	3.11.2	G														

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		26 56 20	Posted operations and	3.11.3														
			maintenance instructions															
			SD-11 Closeout Submittals															
			As-built drawings	3.10.3														
		31 00 00	SD-01 Preconstruction Submittals															
			Excavation and Trenching Plan	3.1.3	G													
			Borrow Plan	3.2	G													
			Dewatering Work Plan	3.1.2.2	G													
			Disposition of Surplus Materials	3.10	G													
			Preconstruction Meeting	1.6.4	G													
			SD-06 Test Reports															
			Material Test Report	3.11	G													
			Borrow Site Testing	3.2.3	G													
			Pipe Inspection Report	3.6.1.6	G													
			Geotechnical Evaluation Report	1.6.1	G													
			Subsurface Extents of Karst	3.3.3	G													
			Features Report															
			Karst Feature Repair	3.3.3	G													
			Methodology and Hydrogeologic															
			Assessment Report															
		31 32 19.16	SD-03 Product Data															
			Thread	2.1.2														
			Manufacturing Quality Control	2.2														
			Sampling and Testing															
			SD-04 Samples															

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		31 32 19.16	Quality Assurance Samples and	3.1														
			Tests															
			SD-07 Certificates															
			Geotextile	2.1.1														
		31 33 10	SD-01 Preconstruction Submittals															
			Grout Installation Procedure	3.1.2														
			SD-02 Shop Drawings															
			Grouting Location Plan	3.1.1														
			SD-03 Product Data															
			Drilling Equipment	3.2.2														
			Grouting Equipment	3.2.3														
			Grout Plant	3.2.3	G													
		32 01 19.61	SD-03 Product Data															
			Sealants	2.1														
			Manufacturer's	3.5.2														
			Recommendations															
			SD-04 Samples															
			Sealants	2.1														
			Blocking Media/Backup Materials	2.3.1														
			Backer Rod	3.3.1.1														
			Bond Breaking Tapes	2.3.2														
			SD-06 Test Reports															
			Sealants	2.1														
			SD-07 Certificates															
			Equipment List	3.1														
			SD-08 Manufacturer’s Instructions															

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		32 01 19.61	Sealants	2.1														
		32 05 33	SD-01 Preconstruction Submittals															
			Integrated Pest Management	2.4	G													
			Plan															
			SD-03 Product Data															
			Fertilizer	2.1	G													
			Mulches Topdressing	2.3														
			Organic Mulch Materials	2.3.1														
			SD-07 Certificates															
			Maintenance Inspection Report	3.5.1														
			Plant Quantities	3.5.2	G													
			SD-10 Operation and Maintenance															
			Data															
			Maintenance	1.5														
		32 11 20	SD-03 Product Data															
			Plant, Equipment, and Tools	2.3	G													
			Waybills and Delivery Tickets	1.1.1														
			SD-06 Test Reports															
			Initial Tests	2.2.1	G													
			In-Place Tests	3.13.1	G													
			Test Section Report	1.7.2	G													
		32 11 23	SD-03 Product Data															
			Plant, Equipment, and Tools	2.5	G													
			SD-06 Test Reports															
			Initial Tests	2.4.1	G													
			In-Place Tests	3.13.1	G													

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		32 11 23	Test Section Report	1.6.2	G														
		32 11 23.23	SD-03 Product Data																
			Plants, Equipment, and Tools	2.2.1	G														
			SD-06 Test Reports																
			Initial Tests	1.3.3.1	G														
			Test Section Construction Report	1.5.2.7	G														
		32 12 13	SD-03 Product Data																
			Prime Coat Certificate Of	2.2	G														
			Analysis (COA)																
			Tack Coat Certificate Of Analysis	2.3	G														
			(COA)																
			SD-06 Test Reports																
			Sampling and Testing	3.7.1															
			Application Rate Calibration	3.3.4	G														
			Daily Application Rate Verification	3.3.5															
			SD-07 Certificates																
			Certificates Of Compliance	3.7															
			(COC)																
		32 12 15.13	SD-01 Preconstruction Submittals																
			Equipment	2.2	G														
			SD-02 Shop Drawings																
			Placement Plan	2.1	G														
			SD-03 Product Data																
			Diamond Grinding Plan	2.2.6	G														
			Mix Design	2.5	G														
			Contractor Quality Control	3.1	G														

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		32 12 15.13	SD-04 Samples																
			Aggregates	2.3															
			Asphalt Binder	2.4															
			Warm-mix Additive	2.5.1															
			SD-06 Test Reports																
			Aggregates	2.3	G														
			QC Monitoring	3.1.3.10															
			Pavement Lots	1.7.3	G														
			SD-07 Certificates																
			Asphalt Binder	2.4	G														
			Testing Laboratory	3.1.2															
			Warm-mix Additive	2.5.1															
			Airfield Asphalt Pavement QC Manager	1.6															
			Airfield Asphalt Pavement Inspector	1.6															
			Airfield Asphalt Pavement Laboratory Technician	1.6															
		32 12 16.16	SD-02 Shop Drawings																
			Placement Plan	2.1	G														
			SD-03 Product Data																
			Diamond Grinding Plan	2.1.6	G														
			Mix Design	2.4	G														
			Contractor Quality Control	3.1	G														
			SD-04 Samples																
			Aggregates	2.2															

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		32 12 16.16	Asphalt Cement Binder	2.3															
			Warm-mix Additive	2.4.1															
			SD-06 Test Reports																
			Aggregates	2.2	G														
			QC Monitoring	3.1.3.9															
			SD-07 Certificates																
			Asphalt Cement Binder	2.3	G														
			Laboratory Accreditation and	1.5.11															
			Validation																
			Warm-mix Additive	2.4.1															
		32 13 14.13	SD-01 Preconstruction Submittals																
			Proposed Techniques	3.1.2	G														
			Preliminary Proposed	2.13.2	G														
			Proportioning																
			Pavement Quality Control Plan	1.4.3.3	G														
			Stringless Technology	3.5.6.3	G														
			SD-03 Product Data																
			Diamond Grinding Plan	2.1.7	G														
			Dowels	2.9.1	G														
			Dowel Bar Assemblies	2.9.2	G														
			Equipment	2.11	G														
			Concrete Patching Mixture	2.1.5	G														
			SD-05 Design Data																
			Proportioning Studies	2.13.2	G														
			SD-06 Test Reports																

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		32 13 14.13	Batch Plant Manufacturer's Inspection Report	1.4.1	G														
			Batch Plant Manufacturer's Inspection Report	1.4.1	G														
			Slipform Paver Manufacturer's Inspection Report	1.4.1	G														
			Sampling and Testing	2.1.4.1	G														
			Diamond Grinding of PCC Surfaces	2.1.7	G														
			Mixer Performance (Uniformity) Testing	2.11.2.1	G														
			Repair Recommendations Plan	3.9.1	G														
			Paving Lot Report	3.12.5	G														
			Test Section Lot Report	1.4.6.4	G														
			SD-07 Certificates																
			Contractor Quality Control (CQC) Staff	1.4.1	G														
			Laboratory Accreditation and Validation	1.4.3	G														
			NRMCA Certificate of Conformance	2.11															
			Petrographer Resume	1.4.2	G														
			Licensed Surveyor	1.4.2	G														
			Concrete Batch Plant Operator	1.4.2	G														
			Profilograph Operator	1.4.2	G														
		32 13 73.19	SD-03 Product Data																

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		32 13 73.19	Equipment	2.1															
			Manufacturer's Instructions	3.1.1															
			SD-04 Samples																
			Compression Seals	2.2	G														
			SD-06 Test Reports																
			Test Requirements	2.1.3	G														
		32 16 19	SD-03 Product Data																
			Concrete	2.1															
			Biodegradable Form Release	2.6.4															
			Agent																
			Biodegradable Form Release	3.2															
			Agent																
			SD-06 Test Reports																
			Field Quality Control	3.7															
		32 17 23.16	SD-01 Preconstruction Submittals																
			Quality Control Plan	1.3.1	G														
			Qualifications	1.3.2	G														
			Safety Data Sheets For Each	2.2	G														
			Paint Type																
			Surface Preparation Equipment	2.1	G														
			List																
			Marking Applications Equipment	2.1.2	G														
			List																
			Detour Plans	1.5.2	G														
			SD-03 Product Data																

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		32 17 23.16	Manufacturer Data Sheets for all	2.2	G													
			Marking Materials															
			Manufacturer Data Sheets for all	2.2.3	G													
			Reflective Media															
			SD-04 Samples															
			Samples of Marking Materials	3.5.2	G													
			Samples of each Reflective	3.5.2	G													
			Media															
			SD-06 Test Reports															
			Marking Application Wet Film	3.1.1	G													
			Thickness Test															
			Marking Application Wet Film	3.5.4.1	G													
			Thickness Test															
			Marking Application Wet Film	3.5.4.2	G													
			Thickness Test															
			Reflective Media Reflectivity Test	3.1.2	G													
			Reflective Media Reflectivity Test	3.5.4.1	G													
			SD-07 Certificates															
			Manufacturer Certificate of	2.2	G													
			Compliance for Marking Materials															
			Manufacturer Certificate of	2.2	G													
			Compliance for Reflective															
			Materials															
			Manufacturer Certificate of	1.5.1.3	G													
			Conformance for Volatile Organic															
			Compliance															

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		32 17 23.16	SD-08 Manufacturer's Instructions																
			Marking Materials Storage and	1.4	G														
			Application																
			Reflective Media Storage and	1.4	G														
			Application																
			Chemicals Used in Surface	1.4	G														
			Preparation																
		32 17 23.19	SD-01 Preconstruction Submittals																
			Quality Control Plan	1.3.1	G														
			Qualifications	1.3.2.1	G														
			Safety Data Sheets For Each	2.2	G														
			Paint Type																
			Marking Applications Equipment	2.1.2	G														
			List																
			SD-03 Product Data																
			Manufacturer Data Sheets for all	2.2	G														
			Marking Materials																
			Manufacturer Data Sheets for all	2.2	G														
			Reflective Materials																
			SD-04 Samples																
			Samples Of Marking Materials	3.5.2	G														
			Samples Of Each Reflective	3.5.2	G														
			Media																
			SD-06 Test Reports																
			Marking Application Wet Film	3.1.1	G														
			Thickness																

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		32 17 23.19	Marking Application Wet Film Thickness	3.5.4.1	G														
			Marking Application Wet Film Thickness	3.5.4.2	G														
			Reflective Media Reflectivity Test	3.1.2	G														
			Reflective Media Reflectivity Test	3.5.4.1	G														
			Reflective Media Reflectivity Test	3.5.4.3	G														
			SD-07 Certificates																
			Manufacturer Certificate of Compliance for Marking Materials	2.2	G														
			Manufacturer Certificate of Compliance for Reflective Materials	2.2	G														
			Manufacturer Certificate Of Conformance For Volatile Organic Compliance	1.5.1.3	G														
			SD-08 Manufacturer’s Instructions																
			Marking Materials Storage and Application	1.4	G														
			Reflective Media Storage and Application	1.4	G														
			Chemicals Used in Surface Preparation	1.4	G														
		32 31 13.53	SD-02 Shop Drawings																
			Fence Installation Drawings	3.2.1	G														
			SD-03 Product Data																

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		32 31 13.53	Fabric	2.1.1.1															
			Posts	2.1.2															
			Post Caps	2.1.2.2															
			Chain Link Braces	2.1.3															
			Rails	2.1.3															
			Barbed Wire	2.2.1.2															
			Barbed Wire Supporting Arms	2.1.2.2															
			Latches	2.1.4.3															
			Hinges	2.1.4.3															
			Stops	2.1.4.3															
			Keepers	2.1.4.3															
			Rollers	2.1.4.3															
			Wire Ties	2.2.1.1															
			Swing Gates	2.1.5.1															
			SD-07 Certificates																
			Chain Link Fence	2.1.2.1															
			Fabric	2.1.1.1															
			Barbed Wire	2.2.1.2															
			Gate Hardware and Accessories	3.2.1															
			Concrete	2.2.2															
		32 84 24	SD-02 Shop Drawings																
			Temporary Irrigation Sprinkler	1.2															
			System																
			SD-03 Product Data																
			Piping Materials	2.1	G														
			Valves	2.3	G														

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		32 84 24	Heads	2.2	G														
			Backflow Preventers	2.3.4	G														
			Automatic Controller	2.5	G														
			Controller Enclosure	2.5.1	G														
			Solvent Cement	2.1.4	G														
			Control Wiring	2.6.1	G														
			Water Meter	2.4.1	G														
			Rain Shut-Off Device	2.4.3.1	G														
			SD-06 Test Reports																
			Tests	1.6.1															
			Backflow Preventers	2.3.4															
			Pressure Test	3.2.1															
			Operation Test	3.2.2															
			SD-07 Certificates																
			Backflow Preventers	2.3.4															
			SD-08 Manufacturer’s Instructions																
			Automatic Controller	2.5															
			Heads	2.2															
			Backflow Preventers	2.3.4															
			Valves	2.3															
			Rain Shut-Off Device	2.4.3.1															
		32 92 19	SD-03 Product Data																
			Wood Cellulose Fiber Mulch	2.5.1															
			Fertilizer	2.4															
			SD-06 Test Reports																
			Topsoil Composition Tests	2.2.3															

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		32 92 19	SD-07 Certificates																
			Seed	2.1															
			SD-08 Manufacturer's Instructions																
			Erosion Control Materials	2.7															
		32 93 00	SD-01 Preconstruction Submittals																
			State Landscape Contractor's License	1.4.2															
			Time Restrictions and Planting Conditions	1.6															
			SD-03 Product Data																
			Peat	2.2.5															
			Composted Derivatives	2.2.8															
			Gypsum	2.2.9															
			Fertilizer	2.4															
			SD-06 Test Reports																
			Topsoil Composition Tests	2.1.4															
		33 08 53	SD-01 Preconstruction Submittals																
			System Start-Up Plan	1.2.1	G														
			Performance Testing Plan	3.5.2	G														
			SD-06 Test Reports																
			Equipment Tests	3.4	G														
			Final Reports	1.4.1	G														
			SD-11 Closeout Submittals																
			Certification of Entire System	1.5.2															
		33 09 53	SD-02 Shop Drawings																
			Shop Drawing	3.3.1	G														

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		33 09 53	SD-03 Product Data																
			EPDS Cabinet and Components	2.1.1	G														
			EPDS Cabinet and Components	3.1	G														
			Programmable Logical Controller	2.2	G														
			(PLC) Hardware and Software																
			Programmable Logical Controller	3.2	G														
			(PLC) Hardware and Software																
			Control Wiring Data Lists	3.1.2	G														
			Tools and Spare Parts	1.5															
			SD-06 Test Reports																
			Certified EPDS Cabinet Shop	3.1.3															
			Test Report																
			Record of Test	3.3.2															
			SD-07 Certificates																
			Experience and Qualifications	1.6	G														
			Training Plan for Instructing	3.3.3	G														
			Personnel																
			Testing Plan	3.3.2	G														
			SD-10 Operation and Maintenance																
			Data																
			Operation and Maintenance	1.3	G														
			Manuals																
		33 11 00	SD-01 Preconstruction Submittals																
			Connections	3.1.1	G														
			SD-03 Product Data																

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		33 11 00	Pipe, Fittings, Joints and Couplings	2.1.1	G														
			Valves	2.1.2	G														
			Valve Boxes	2.1.2.3	G														
			Fire Hydrants	2.1.3.1	G														
			Pipe Restraint	2.2.1	G														
			Tapping Sleeves	2.2.2	G														
			Disinfection Procedures	3.2.2	G														
			SD-06 Test Reports																
			Backflow Preventer Tests	3.3.1.5	G														
			Bacteriological Samples	3.3.1.4	G														
			Hydrostatic Sewer Test	3.2.1.1.6															
			Leakage Test	3.3.1.3															
			Hydrostatic Test	3.3.1.1															
			SD-07 Certificates																
			Pipe, Fittings, Joints and Couplings	2.1.1															
			Lining for Fittings	2.1.1.1.1.3															
			Valves	2.1.2															
			Fire Hydrants	2.1.3.1															
			SD-08 Manufacturer's Instructions																
			PVC Piping	2.1.1.1.1.1															
			PVCO Piping	2.1.1.1.1.2															
		33 40 00	SD-07 Certificates																
			Oil Resistant Gasket	2.2.1.1															
			Leakage Test	3.8.1.1															

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		33 40 00	Hydrostatic Test on Watertight	2.5.1														
			Joints															
			Density	3.2.1.1														
			Frame and Cover or Gratings	2.4.4														
			Post-Installation Inspection	3.8.2.1.2														
			Report															
			SD-08 Manufacturer's Instructions															
			Placing Pipe	3.3														
			SD-11 Closeout Submittals															
			LID Verification Report	3.8.2.2	G													
		33 46 16	SD-04 Samples															
			Geotextile	2.2														
			Pipe and Pipe Fittings	2.1														
			SD-07 Certificates															
			Geotextile	2.2														
			Pipe and Pipe Fittings	2.1														
			Cleanout Risers	3.2														
		33 52 23.15	SD-01 Preconstruction Submittals															
			Welding Procedure Specification	1.9.1	G													
			Procedure Qualification Record	1.9.2	G													
			Welder Performance Qualification	1.9.3.1	G													
			Weld Plan	1.7.5	G													
			SD-02 Shop Drawings															
			POL Service Piping	1.2.16	G													
			Pigging Plan	3.7.1	G													
			SD-06 Test Reports															

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		33 52 23.15	Weld Log	1.8.2	G														
			Examinations, Inspections and	3.2	G														
			Tests																
			SD-07 Certificates																
			Weld Inspector Certificate	1.9.6.2	G														
			Independent Test Organization	1.9.5	G														
			In-Process Weld Inspector	1.9.6.3	G														
			Certificates																
			Weld Examiner Certificate	1.9.6.4	G														
		33 52 43.11	SD-02 Shop Drawings																
			Hydrant Outlet Pits	2.7	G														
			Hydrant Valve	2.4	G														
			Hydrant Isolation Valve	2.5	G														
			High Point Vent Pits	2.8	G														
			SD-03 Product Data																
			Hydrant Valve	2.4	G														
			Hydrant Isolation Valve	2.5	G														
			SD-07 Certificates																
			System Supplier	1.4	G														
			SD-10 Operation and Maintenance																
			Data																
			Hydrant Valve	2.4	G														
			Hydrant Isolation Valve	2.5	G														
		33 52 43.13	SD-01 Preconstruction Submittals																
			Contractor Qualifications	1.4.2	G														
			SD-03 Product Data																

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		33 52 43.13	Stainless Steel Piping	2.2.1	G														
			Protective Coatings for Buried	2.2.2.1	G														
			Stainless Steel Piping																
			Protective Coatings for Buried	3.6.2	G														
			Stainless Steel Piping																
			Fittings	2.2.3	G														
			Isolating Gasket Kits	2.2.3.3	G														
			Flange Protectors	2.2.3.4	G														
			Lightning Surge Arrester	2.2.3.3	G														
			Nuts and Bolts	2.2.4	G														
			Gaskets	2.2.5	G														
			Ball Valves	2.3.1	G														
			Plug (Double Block and Bleed)	2.3.2	G														
			Valves																
			Thermal Relief Valves	2.4	G														
			Strainers	1.2	G														
			Strainers	2.5.2	G														
			Pigging Accessories	2.5.4	G														
			SD-05 Design Data																
			Pipeline Inventory	1.4.1.1	G														
			SD-06 Test Reports																
			Pneumatic Test	3.8.1															
			Hydrostatic Test	3.8.1.2															
			SD-07 Certificates																
			Stainless Steel Piping	2.2.1															

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		33 52 43.13	Protective Coatings for Buried	2.2.2.1															
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			Isolating Gasket Kits	2.2.3.3	G														
		33 52 80	SD-01 Preconstruction Submittals																
			Contract Errors, Omissions, and Other Discrepancies	1.5.1															
			Corrective Action Procedures	1.5.2.1															
			Corrective Action Request (CAR) Form	1.5.2.2															
			Coatings Work Plan	1.5.3															
			Inspection Report Forms	3.6.1.2															
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			SD-05 Design Data																
			Containment System	1.5.4.1															
			SD-06 Test Reports																
			Inspection Report Forms	3.6.1.2															
			Daily Inspection Reports	3.6.1.3															
			Coatings Qualification Test Reports	1.5.5.1															
			Non-Metallic Abrasive Qualification Test Reports	1.5.5.2															
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		33 52 80	SD-07 Certificates																
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			Corrective Action Procedures	1.5.2.1															
			Coatings Work Plan	1.5.3															
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			Qualifications of Pipe Coating	1.5.6.2															
			Shop																
			Qualifications of Certified	1.5.6.3															
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			(PCS)																
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		33 52 80	Qualifications of Testing	1.5.6.10														
			Laboratory for Abrasive															
			Coating Materials Certificate of	1.5.6.11														
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			Non-Metallic Abrasive Certificate	1.5.6.12														
			of Conformance															
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			Disposal of Used Abrasive Field	3.5.1.6														
			Applied Coating															
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			Corrective Action Log	1.5.2.3	G													
		33 71 02	SD-02 Shop Drawings															
			Precast Underground Structures	1.5.1	G													
			SD-03 Product Data															
			Medium Voltage Cable	2.5	G													
			Medium Voltage Cable Joints	2.7	G													
			Medium Voltage Cable	2.6	G													
			Terminations															
			Precast Concrete Structures	2.13.2.1	G													
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		33 71 02	Handhole Frames and Covers	2.13.4	G														
			Frames and Covers for Airfield	2.13.5	G														
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			Ductile Iron Frames and Covers	2.13.6	G														
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			Composite/Fiberglass Handholes	2.13.8	G														
			Cable Supports	2.14	G														
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			Tests																
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			Cable Installation Plan and	3.3	G														
			Procedure																
			SD-07 Certificates																
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			Cable Installer Qualifications	1.5.3	G														
			Certificate of Conformance	1.5.4	G														
		33 82 00	SD-02 Shop Drawings																
			Telecommunications Outside	1.5.1.1	G														
			Plant																
			Telecommunications Entrance	1.5.1.2	G														
			Facility Drawings																
			Existing Telecommunications	1.5.1.3	G														
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		33 82 00	SD-03 Product Data																
			Wire and Cable	2.8	G														
			Cable Splices, and Connectors	2.5	G														
			Closures	2.3	G														
			Building Protector Assemblies	2.2.1	G														
			Protector Modules	2.2.2	G														
			Cross-Connect Terminal	2.4	G														
			Cabinets																
			Spare Parts	1.7.2	G														
			SD-06 Test Reports																
			Pre-installation Tests	3.5.1	G														
			Acceptance Tests	3.5.2	G														
			Outside Plant Test Plan	1.5.3	G														
			SD-07 Certificates																
			Telecommunications Contractor	1.5.2.1	G														
			Key Personnel	1.5.2.2	G														
			Manufacturer's Qualifications	1.5.2.3	G														
			SD-08 Manufacturer’s Instructions																
			Building Protector Assembly	2.2.1	G														
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			Cable Tensions	3.1.8.1	G														
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			SD-09 Manufacturer’s Field																
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		33 82 00	SD-10 Operation and Maintenance																
			Data																
			Telecommunications Outside	1.5.1.1	G														
			Plant (OSP)																
			SD-11 Closeout Submittals																
			Record Documentation	1.7.1	G														
		34 73 16	SD-02 Shop Drawings																
			As-Built Drawings	1.3	G														
			SD-06 Test Reports																
			Tests	3.2															
			SD-07 Certificates																
			Grounding Rods	2.2															
			Copper Conductors	2.3															
			Grounding Connectors	2.4															

SOP #8: Post-Review Discovery of Archaeological Remains

Purpose

This SOP provides uniform guidelines in the event that archaeological remains are inadvertently disturbed during the course of any action, undertaking, or activity at AAFB (including those caused by natural occurrences such as erosion). Inadvertent discovery refers to the unintentional discovery of archaeological resources during the course of operations at AAFB. This SOP is based on the NHPA, implemented by regulations of the ACHP (36 CFR Part 800 [DOI 2004]); ARPA (DOI 1979); and DoD Directive 4710.1 (DoD 1984a).

The primary responsibility for carrying out this SOP lies with on-site managers of the undertaking, the CRM, and NAVFAC Marianas. A copy of this SOP should be provided to all on-site managers and supervisors who are carrying out work that could result in inadvertent discovery of remains.

Point of Contact

AAFB CRM
36 CES/CEV
Andersen Air Force Base, Guam
Unit 14007
APO, AP 96543-4007

Typical Trigger Events

The discovery of archaeological materials during any activity, action, or undertaking at AAFB, regardless of whether a project has met compliance with Section 106 review or Section 110 of the NHPA (DOI 1992b).

Procedures

The 2009 and 2011 PAs both have provisions for Inadvertent Discoveries of Archaeological Remains. The following are default procedures for Inadvertent Discoveries of Archaeological Remains during activities that are not covered by the PAs.

Preplanning for Subsequent Discoveries

Federal agencies may plan for subsequent discoveries through PAs pursuant to 36 CFR Part 800, Section 800.14(b) (agency program alternatives) or other agreement documents when a survey (in accordance with 36 CFR Part 800, Section 800.4) for a project area indicates that historic properties are likely to be discovered during implementation of an undertaking (DOI 2004).

Discoveries without Prior Planning

For all other inadvertent discoveries of historic properties or unanticipated effects to historic properties, AAFB shall make reasonable efforts to avoid, minimize, or mitigate adverse effects to such properties until a mitigation plan is carried out.

(1) Upon discovery of unanticipated archaeological remains, the individual making the discovery should notify the on-site manager or person in charge of the action, undertaking, or activity. The on-site manager should immediately halt the action, undertaking, or activity in the vicinity of the discovery.

(2) The on-site manager should ensure that a reasonable effort is made to secure the area and protect the archaeological resource from damage (including vandalism). This might include cordoning the area and covering exposed items with a tarp or similar material.
(3) The on-site manager should notify the CRM and NAVFAC Marianas of the nature, location, and circumstances of the inadvertent discovery.
(4) The CRM, NAVFAC Marianas, and NAVFAC Pacific EV23 should respond as promptly as possible. If no human remains are involved, the CRM will carry out the following steps:
    (a) Determine the nature, context, and preliminary significance (under the criteria of the NRHP) of the uncovered archaeological deposits or arrange for such an evaluation by a professional archaeologist. The CRM may call on subject-matter experts at NAVFAC Marianas for assistance.
    (b) Notify the SHPO and any appropriate consulting parties as soon as practical.
    (c) If the site is evaluated as significant and is of such size and/or configuration that it cannot be avoided by the undertaking, develop a treatment plan to mitigate the adverse effects of the undertaking and consult with NAVFAC Marianas subject-matter experts, Guam SHPO, and any appropriate consulting parties in regard to the adequacy and appropriateness of the recommended treatment.
    (d) Coordinate implementation of the treatment plan, which should include full documentation; written documentation of all activities undertaken as part of the treatment plan should be submitted to the CRM (if CRM not performing the work directly), NAVFAC Marianas, and the SHPO at the termination of the archaeological investigations.
(5) If human remains are involved, then the SOP for inadvertent discovery of human remains should be followed (see **SOP #9**). If the inadvertent discovery of human remains is the result of an activity covered under the 2009 or 2011 PA, please consult **Appendix II**.
(6) Prior to resuming the action, undertaking, or activity, the CRM should ensure that the cultural resources discovered by this process are protected and/or adverse effects are mitigated. If the cultural resources are protected, the CRM should ensure that they will not be further impacted by continuing the activity.
(7) If the cultural remains are found to be not eligible for the NRHP or if Section 106 procedures have been carried to completion, the action, undertaking, or activity may resume.
    (a) The CRM will make a tracking report of the inadvertent discovery for inclusion in an annual record of historic preservation activities at AAFB. Any new data on sites will be added to the cultural resource database.
    (b) The CRM, with assistance from subject-matter experts at NAVFAC Marianas, will review the results of any archaeological investigations undertaken in compliance with this SOP and will evaluate and, if necessary, revise the archaeological probability maps.

SOP #9: Post-Review Discovery of Human Remains

Purpose

This SOP provides uniform guidelines in the event that human remains are inadvertently disturbed during the course of any action, undertaking, or activity at AAFB (including those caused by natural occurrences such as erosion). Inadvertent discovery refers to the unintentional discovery of human remains during the course of operations at AAFB. This SOP is based on the NHPA, implemented by regulations of the ACHP (36 CFR Part 800 [DOI 2004]); ARPA (DOI 1979); and DoD Directive 4710.1 (DoD 1984a), OPNAVINST 11170.2A (DoN 2007b), and NAVFACENGCOM P-73, Chapter 3 (DoN 2008). Section 10.1 of the Native American Graves Protection and Repatriation Act (NAGPRA) (DOI 1990a) states that NAGPRA does not apply to U.S. Territories, but this SOP roughly mimics the requirements of NAGPRA.

The primary responsibility for carrying out this SOP lies with on-site managers of the undertaking and the CRM. A copy of this SOP should be provided to all on-site managers and supervisors who are carrying out work that could result in inadvertent discovery of human remains. A copy should also be provided to AAFB security staff.

Point of Contact

AAFB CRM
36 CES/CEV
Andersen Air Force Base, Guam
Unit 14007
APO, AP 96543-4007

Typical Trigger Events

Discovery of human remains during an action, undertaking, or activity at AAFB, regardless of whether a project has met compliance with Section 106 review or Section 110 of the NHPA (DOI 1992a).

Procedures

The 2009 and 2011 PAs (**Appendix II**) both have provisions for Inadvertent Discoveries of Human Remains. The following are default procedures for Inadvertent Discoveries of Human Remains during activities that are not covered by the PAs.

(1) Upon discovery of unanticipated human remains, the individual making the discovery should notify the on-site manager or person in charge of the action, undertaking, or activity. The on-site manager should immediately halt the action, undertaking, or activity in the vicinity of the discovery.
(2) The on-site manager should ensure that a reasonable effort is made to secure the area and protect the remains from damage (including vandalism). This might include cordoning the area and covering exposed items with soil and also a tarp or similar material. The remains should not be moved.
(3) The on-site manager should notify the CRM.
(4) If the discovery turns out to be modern, the CRM should notify Military Police, NCIS, and NAVFAC Marianas to report the nature, location, and circumstances of the inadvertent discovery. The Guam SHPO does not need to be involved, and no burial treatment plan from an archaeological perspective is needed. NCIS will take over the investigation.
(5) If the remains are determined to be Japanese (civilian or military) from WWII, the CRM will notify NAVFAC Marianas and the Government of Japan.

(6) If the remains are determined to be American remains from WWII, the CRM shall notify the Joint Prisoners of War, Missing in Action Accounting Command and NAVFAC Marianas.
(7) For all other remains (non-modern and non-WWII), the CRM will contact the Guam SHPO and NAVFAC Marianas. In consultation with Guam SHPO, a burial treatment plan will be developed and implemented.
(8) The CRM will make a tracking report of the inadvertent discovery for inclusion in an annual record of historic preservation activities at AAFB. Any new data on sites will be added to the cultural resource database.
(9) Prior to resuming the action, undertaking, or activity, the CRM should ensure that associated cultural resources discovered by this process are protected and/or adverse effects are mitigated. If associated cultural resources are protected the CRM should ensure that they will not be further impacted by continuing the activity.
(10) The CRM, with assistance from subject-matter experts at NAVFAC Marianas, will review the results of any archaeological investigations undertaken in compliance with this SOP and evaluate and, if necessary, revise the archaeological probability maps.

SECTION 01 57 19
TEMPORARY ENVIRONMENTAL CONTROLS

ATTACHMENT F.
NATURAL RESOURCES
PERFORMANCE WORK STATEMENT (NR PWS)

9 January 2026

Amendment Log

3/5/2026 (AM002)	Section 5.2 Tarague FEA, Item f: Delete "and Munitions and Explosives of Concern (MEC) screening."
4/15/2026 (AM003)	Section 5.1.4.2.1: Delete Item, "g. Invasive species within a 20-foot radius around salvaged plants must be removed and maintained to ensure no more that 15 percent of vegetation is invasive species within the plots."
4/15/2026 (AM003)	Section 3.0 Mariana Fruit Bats Item 4: Include "immediately" at the end of the sentence. Item 5: Include "Maintain the Fruit Monitoring Bat Data Sheet. Example #1 presents an example." Last Sentence to revise to read "During nighttime work, the qualified biologist must perform biological monitoring on site while nighttime work is underway to observe Mariana fruit bats."
4/15/2026 (AM003)	Include F8. Final Biological Assessment for Infrastructure Upgrade at AAFB, Guam (May 2022)
4/15/2026 (AM003)	Section 4.0 Natural Resources Best Management Practices (BMP) Item e: Include "Provide similar brown tree snake traps with a live mouse that AAFB is utilizing. The Contractor shall determine the monitoring and maintenance requirements in the Work Plan for the Government's and USFWS's approval or concurrence."
4/15/2026 (AM003)	Section 1.0 General 2nd Paragraph: Include "The Contractor and the qualified biologist shall prepare the detailed schedule for NR Mitigation upon the project award for the Government review and approval."
4/15/2026 (AM003)	Section 5.1.5 Protect and Monitor ESA-Listed Species to be Remained Include "Monitor adverse effects to the monitored plants that are clearly attributed to construction activities (e.g., physical disturbance, dust accumulation, and sedimentation from run-off). If adverse effects are observed, corrective actions shall be implemented."
4/15/2026 (AM003)	Section 5.2.2 Install Ungulate-Proof Fence Include "Provide reoccurring vegetation clearance and maintenance every two weeks or more frequently as needed."

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F8. Final Biological Assessment for Infrastructure Upgrade at AAFB, Guam (May 2022) (AM003)

NATURAL RESOURCES PERFORMANCE WORK STATEMENT
FOR
FY24 MCAF PROJECT P-012 / AJJY183012, NORTH AIRCRAFT PARKING RAMP
JOINT REGION MARIANAS (JRM), ANDERSEN AIR FORCE BASE, GUAM

1.0 GENERAL

Comply with and implement the natural resources requirements, including conservation measures and Best Management Practices (BMP), specified in the 2025 Biological Opinion (BO) for the project. Comply with and implement all requirements for the P-012 construction footprint, Tarague Forest Enhancement Area (Tarague FEA), and Habitat Management Unit (HMU). The locations of Tarague FEA and HMU are presented in Attachment F1, Figures for Natural Resources Conservation.

The Contractor must review, understand, and execute the 2025 BO. The PWS provides summaries of the 2025 BO; however, it does not include all requirements of the 2025 BO. The Contractor must be responsible for implementing all BMP and conservation measures specified in the 2025 BO. The Contractor must retain qualified biologists to implement the 2025 BO accordingly. The Contractor and the qualified biologist shall prepare the detailed schedule for NR Mitigation upon the project award for the Government review and approval **(AM003)**. The Government will be responsible for the following long-term monitoring only after Contractor has fulfilled initial obligations.

a. Conduct intermittent monitoring throughout the 20-year period once after the salvaged plants have become established at the Tarague FEA and HMU.
b. Conduct monitoring and maintaining brown tree snake traps for 20 years after the Government accepts the permanent perimeter fencing constructed by the Contractor.
c. Conduct long-term management of the invasive species at the FEA after the 5 years of following transplant of salvaged plants conducted by the Contractor.

The following Endangered Species Act (ESA)-listed Endangered and Threatened (T&E) species are known and will be affected within the P-012 construction footprint:

- Cycas micronesica
- Tabernaemontana rotensis (T. rotensis)
- Bulbophyllum guamense, Dendrobium guamense, and Tuberolabium guamense
- Mariana fruit bats

The locations of these T&E plants have been recorded by the Government during the 2021 and 2024 Biological Surveys. The survey reports and GPS coordinates for the T&E species are available to the selected Contractor.

1.1 Natural and Cultural Resources Protection Training

The Installation Environmental Office will provide the initial biosecurity/natural resources and cultural resources awareness training to protect Natural and Cultural Resources. Ensure all personnel take the training prior to starting work on the project. This education/awareness program will be conducted prior to site preparation and construction activities. The Contractor is responsible for providing additional training for the new construction workers. All construction workers must be aware of biological resources and requirements within the construction footprint, including Endangered Species Act (ESA)-listed species, invasive species, special status species, avoidance measures, and reporting requirements. The qualified biologist retained by the Contractor must provide project-

specific training as needed.

1.2 Hazard Analysis and Critical Control Point (HACCP) Plan

Prepare and implement a Hazard Analysis and Critical Control Point (HACCP) Plan to ensure that invasive species are not moved or introduced in association with site preparation, construction, and T&E species salvage and transplantation activities. The HACCP plan must be developed by the contractor and reviewed/approved by the installation and JRM Biosecurity Program Managers.

1.3 Cleaning Facility

Provide a cleaning facility to clean Contractor's vehicles and construction equipment. If the project has multiple sites or entry/exit points, each site must have a designated cleaning facility to prevent/minimize the spread of invasive species. Provide a cleaning facility for Tarague FEA.

1.4 Pesticide Application Certification

If pesticide is used, the Contractor must have a DoD or Guam pesticide applicator's license, report all chemical usage on the NAVFAC Online Pesticide Reporting System (https://noprs.pestlogics.com/), and follow all EPA labeling and local requirements/instructions.

1.5 Green Waste Management

Green waste can be managed onsite or disposed of at off-base permitted green waste compost facilities. Determine the amounts of green waste to be processed onsite or disposed of. Include green waste management plan in the Environmental Protection Plan (EPP).

Green waste generated from the assumed PFAS-Impacted Soil Areas must be processed onsite. Reuse the compost material after processing in the PFAS-relocation Area to support the vegetated cover of the 1-ft clean soil cap. Refer to Section 02 61 13, Attachment A, Soil Management Plan, for the assumed PFAS-Impacted Soil Areas and PFAS-Relocation Area.

1.5.1 Onsite Green Waste Management and Reuse

Onsite green waste processing and reuse must adhere to Coconut Rhinoceros Beetle (CRB) and Little Fire Ant (LFA) Management Procedures attached in the PWS Attachment F7. Process the green waste into compost material that may then be reused on site. The composting material must be suitable for the intended application. It is the Contractor's responsibility to process this green waste to a form suitable for onsite use. Raw feedstock or green waste must be stockpiled once generated (commencing upon mechanical or manual manipulation of vegetative matter) but may not be stockpiled for longer than 30 calendar days without Contracting Officer approval and notification to the Government Biological Monitor. There must be no volume of raw green waste and/or unprocessed or uncured compost upon facility turnover to the government by the construction contractor. Handling of green waste must follow appropriate environmental, health, and safety procedures and USEPA and GEPA requirements and guidelines. Obtain a solid waste management facility permit (e.g. Composting Permit) to process green waste and include the permit in the EPP.

1.5.2 Off-Base Green Waste Compost Facility

Green waste can be disposed of at a permitted off-base green waste facility. Comply with the local regulations and facility requirements. The facility must have the necessary permits, including the following:

- GEPA Clearing, Grubbing, Grading, and Stockpiling Permit
- GEPA solid waste management facility permit (e.g. Composting Permit)

2.0 QUALIFIED BIOLOGIST(S)

Retain qualified biologists. Submit the qualification of qualified biologist(s) for the Government review and approval. Three references to validate experience are required prior to implementing the 2025 BO requirements. Include the references in the qualification review package. A qualified biologist is defined as a person who:

a. has successfully completed a full 4-year course of study in an accredited college or university leading to a bachelor's or higher degree, which includes a major field (24 semester hours) of study in biological sciences, wildlife biology, botany, natural resources management, environmental sciences, or related disciplines appropriate to this position; AND has a minimum of 20 documented hours of field identification (positive results) of the ESA-listed species or closely related species.

b. has a minimum of 24 semester hours (or equivalent quarter hours) in biological sciences, wildlife biology, botany, natural resources management, environmental sciences, or related disciplines appropriate to this position at an accredited college or university; has 1 year (2,000 hours) of field biology survey experience in the Pacific Islands; AND has a minimum of 20 documented hours of field identification (positive results) of the ESA-listed species or closely related species.

The qualified biologist can be one person or more than one person who meets the qualifications listed above. The qualified biologist(s) must provide as follows but are not limited to:

1. Implement natural resources conservation measures and best management practices as specified in the 2025 BO.
2. Prepare required planning documents and reports.
3. Conduct all required NR surveys and assessments (e.g., field assessment, biological survey/health assessment for T&E species, coconut rhinoceros beetles (CRB) survey, Little Fire Ant (LFA) survey, Mariana fruit bat survey).
4. Implement all activities related to T&E Species (e.g., salvaging, nursing, translocation/maintenance, and monitoring). T&E species monitoring is required for the species to remain onsite and be transplanted to the Tarague FEA or HMU.
5. Implement green waste management requirements.

3.0 MARIANA FRUIT BATS

The qualified biologist must conduct a pre-construction fruit bat survey and train the contractor personnel who will conduct fruit bat monitoring. A qualified biologist or contractor personnel (trained by a qualified biologist) must conduct visual observations for Mariana fruit bats within 492 ft (150 m) of the construction footprint at the start of each day:

1. No earlier than 1 week prior to project initiation, complete a pre-construction fruit bat survey of all forest habitat within 492 ft (150 m) of the aforementioned construction footprint for the presence of any fruit bat colonies and associated day roosts. The survey must be conducted by the Qualified

Biologist retained by the Contractor.

2. Methods used to identify a colony and associated roost include watching above the tree canopy to see where bats are flying from when they take flight at dusk or pre-dawn. The recommended techniques are direct observations and counts of bats during either dawn or dusk. The survey area must be observed from 60 minutes before and at least 30 minutes after sunrise. A minimum of two surveys must be conducted within 1 week to determine the presence of a fruit bat colony and associated day roosts. Do not conduct surveys if the night prior was a moonless night as fruit bats may not forage without sufficient light.
3. If a fruit bat is observed within line of sight up to 492 ft (150 m) prior to the start of construction work, which includes site preparation and vegetation clearance, no work would be conducted within the area that generates noise (e.g., use of heavy equipment, generators) until the fruit bat has left the area of its own volition.
4. If a fruit bat enters within 492 ft (150 m) of the construction footprint after the start of construction work, work would continue but NAVFAC Marianas natural resources staff will be notified to document any instances of incidental take immediately (Amend: 4/7/2026).
5. Maintain the Fruit Monitoring Bat Data Sheet. Example #1 presents an example **(AM003)**.

Project Name:	AFSPC Radome South Parking Pad, DET2
Observers:	John Smith, Jane Doe
Station #:	1
Location:	Northwest Field

Date:	#Bats	Time seen	Distance	Bearing	Flew From	Flew To	Notes: (bat activity- flying, foraging, weather condition, etc.)
Oct 27, 2020	1	5:45AM	100 feet		West	East	One flying bat, Overcast Day, Sunrise.
Oct 28, 2020	0						Raining, Windy, Sunrise, None Seen
Oct 29, 2020	0						Clear Day, Sunrise, None Seen

For internal use only

Example #1. AAFB Fruit Monitoring Bat Data Sheet

During nighttime work, the qualified biologist must perform biological monitoring on site while nighttime work is underway to observe Mariana fruit bats (Amend: 4/7/2026).

4.0 NATURAL RESOURCES BEST MANAGEMENT PRACTICES (BMP)

Implement all BMP measures specified in the 2025 BO. The section summarizes the list and does not include all BMP specified in the 2025 BO. The Contracting Officer and AAFB Environmental will inspect the contractor's work to ensure that BMPs are implemented for the entire project duration.

a. For off-site fill material, obtain aggregate/soil from contractors/vendors who have local permits.

Imported sand and other quarried products from abroad are subject to inspection by the Guam Department of Agriculture, which issues an importation permit. All sand and aggregate material imported must be accompanied by official records indicating chemical composition, pest-free certification, treatment certification, and certificate of origin. Treatment (disinfection) must be conducted at the point of origin. Fill material and aggregate must be inspected again for little fire ants (LFA) at the destination site prior to off-loading from the barge and will be rejected if found to be infested.

b. Conduct site preparation, vegetation clearance, construction, salvage, and transplant using the Government-approved work plan. Process green waste and mulch piles to prevent the spread of LFA, CRB, and other invasive species, in accordance with green waste protocols. Control their spread if present. A qualified biologist or a biological monitor with supervision of the qualified biologist must inspect the work sites to confirm that vegetation debris is properly managed in accordance with green waste protocols.
c. Conduct LFA surveys throughout the construction duration to ensure that construction activities do not introduce LFA to the construction footprint and Tarague FEA. There is no known presence of LFA at the P-012 construction footprint and Tarague FEA. Provide the initial and recurring 4-month surveys.
    i. If LFA or other invasive species (not previously present) are discovered, proven control and eradication actions must be implemented and followed by post-eradication monitoring. For LFA, comply with Attachment F4, Standard Operating Protocol for the Control and Monitoring of Little Fire Ant, Wasmannia auropunctata (Puliafico et al. 2022).
    ii. Conduct a thorough initial survey of the project and Tarague FEA prior to construction to confirm the presence (or absence) of invasive species that could be transported by these activities, including but not limited to LFA, brown tree snake, new species, or invasive plants.
d. Install and maintain silt fences, straw wattles, or another Government-approved BMP method to prevent soil erosion into adjacent areas. Use dust screens to shield ESA-listed plants that are within 10 ft (3 m) of the construction clearing line. When a major storm or high-wind event (greater than 39 miles/hour) is anticipated, remove silt fences and dust screens to prevent damage to ESA-listed species. After the event is over, reinstall the BMP method.
e. Deploy brown tree snake traps every 65 feet (20 meters) on the temporary construction fencing and permanent perimeter fencing of the North Ramp. Monitor and maintain the traps until the Government accepts the permanent perimeter fence. Provide similar brown tree snake traps with a live mouse that AAFB is utilizing. The Contractor shall determine the monitoring and maintenance requirements in the Work Plan for the Government's and USFWS's approval or concurrence **(AM003)**.

Example #2. BTS Trap

f. Do not conduct site preparation during nighttime as part of this project. All site preparation must end 30 minutes before sunset.
g. Nighttime Construction
    i. Nighttime Construction will be required for specific activities, including, but not limited to,

removal of Munitions and Explosives of Concern (MEC) and Unexploded Ordnance as well as pouring and cutting of concrete. Provide the nighttime construction schedule to the Contracting Officer at least 14 days before the activity is required.

ii. The extent and frequency of working during nighttime must be minimized by ensuring shifts begin on time. Saw cutting must be initiated as soon as the concrete is ready, and night shift work must not be made routine.

iii. Lighting associated with nighttime work must be hooded, pointed downwards, and directed to not shine toward the known roosting location to minimize potential effects to Mariana fruit bat roosting activities.

5.0 NATURAL RESOURCES CONSERVATION MEASURES

Implement the 2025 BO Conservation Measures. Vegetation clearing at P-012 construction footprint must not begin until the Government approves the salvage and collection of T&E species.

5.1 T&E Species

5.1.1 Success Criteria and Bid Assumptions

The Natural Resource Work Plan must include a detailed NR project schedule and performance period. Monitoring for T&E species must continue until the salvaged plants are established at the Tarague FEA and the Government accepts these established species. Keep detailed records of the outplanting activities and report them in the reports. The Contractor is responsible for the security of the plants and nursery if the individuals are stolen/misplaced/disappear. They must be replaced at the Contractor's expense until plants meet the success criteria.

Successful fulfillment of T&E Species conservation is based on the plants being established in the wild, not requiring any supplemental watering, disease/pest free, fertilizer, or support structures for a period of six months after meeting the individual plant species success criteria. The bid assumptions and T&E species success criteria are presented in Table 1. The salvageable T&E quantities can be adjusted based on the Contractor's pre-construction survey and field assessment.

Table 1. **T&E Species Success Criteria and Bid Assumptions**

T&E Species	Conservation Measures	Bid Assumptions (EA)		
		Salvageable Quantity	Outplanting Quantity (Rate)	Success Criteria - Survival Quantity (Rate) of T&E Species after Transplanting
Cycas micronesica	• Seed collection and salvage preparation • Propagation and nursing • Transplant into Tarague FEA. • Maintenance of transplants and transplant area	120	120 (100 % of salvaged plants)	89 ea (74 % of salvaged plants after 5 yr of transplanting. Assume a 5.8% annual decline.)
Tabernaemontana rotensis	• Seed collection and propagation • Propagation and nursing • Transplant into Tarague FEA • Maintenance of transplants and transplant area	63	63 (100 % of salvaged plants)	63 (100 % of salvaged plants)
Bulbophyllum guamense	• Salvage • Transplant into the HMU. • Maintenance of transplants into the HMU	1	1 (100 % of salvaged plant)	1 (100 % of salvaged plant)
Dendrobium guamense		2	2 (100 % of salvaged plants)	2 (100 % of salvaged plants)
Tuberolabium guamense		50	50 (100 % of salvaged plants)	50 (100 % of salvaged plants)

5.1.2 Draft and Final Natural Resource Work Plans

Submit a Draft Natural Resource Work Plan including the plan for natural resource field assessment and plant salvage and transplant. Submit the draft plan when the Contractor submits the EPP.

Submit a Final Natural Resource Work Plan incorporating the findings from the Natural Resource Field Assessment within 45 days upon completion of the Field Assessment including P-012 construction footprint and Tarague FEA.

The focus of the Natural Resource Work Plan must explain the details and protocols to collect T. rotensis seeds; germination of T. rotensis/cycad seeds; collection of cycad basal shoots; monitoring of plants in the nursery; collection of guamense; maintenance of outplanted plants in the Tarague FEA; and criteria for plants to be deemed established in the wild. The Natural Resource Work Plan must include the following:

a. Cover page
b. Table of contents
c. Introduction, Scope of Work, and Success Criteria
d. List of personnel involved in the project and their role (i.e., job title and area of responsibility)
e. Methods, protocols and survey equipment used during the field assessment including but not limited to:
    i. Spatial layout
    ii. Equipment and supplies needed to conduct transplanting services
    iii. Ecological data

iv. Field data forms that will be used to collect detailed condition of plants during salvage and monitoring and maintenance efforts, database forms, and data entry

f. Methods, protocols, survey equipment, and nursery descriptions to be utilized for salvaging, germination, plant hardening, outplanting, maintenance and monitoring, survival criteria, pesticides to be used, etc.
g. Data analysis and mapping
h. Results of the field assessment including copies of the completed field data forms, figures depicting surveyor tracks of areas surveyed, data analysis and mapping
i. Schedule for field assessment, salvaging, nursing, outplanting, and monitoring
j. Removal and disposal of invasive plant species
k. Survey and removal of invasive species (e.g., CRB, LFA, BTS)
l. Schedule for meetings, draft and final deliverables, and maps

5.1.3 Natural Resource Field Assessment Reports for P-012 Construction footprint and Tarague FEA

After the draft Natural Resource Work Plan is approved, perform a field assessment, by qualified biologists, of construction footprint and a 10-foot (3-meter) buffer as well as Tarague FEA to map the locations of all T&E species, including home/host plant locations.

5.1.3.4 P-012 Construction Footprint

Utilize Government provided maps and coordinates contained in the 2021 and 2024 Biological Survey Reports, Special Status Species Data to locate the federally listed plants that have been identified within the construction footprint.

Determine the current number of individuals and health status assessment of Cycas micronesica, T. rotensis, Bulbophyllum guamense, Dendrobium guamense, and Tuberolabium guamense that cannot be avoided within the construction footprint.

Determine how many individuals can be salvaged through seed collection, plant part salvage, and/or whole plant salvage. Submit a Natural Resource Field Assessment Report with 30 days upon completion of the Field Assessment. The number of plants identified by the Contractor may be different from the numbers reported in the previous Biological Survey Reports. Deviations must be explained and documented in the Field Assessment Report.

5.1.3.4.1 Cycas Micronesica

Refer to the 2025 BO for specific requirements associated with the salvage, collection, transplantation, and maintenance of Cycas micronesica. Utilize Government provided maps and coordinates to locate tagged plants that have been identified in the vicinity of the construction footprint. Conduct a qualitative field assessment to determine how much cycad material (basal shoots and seeds) can be successfully salvaged from the construction footprint. Cycad material classified as good and fair must be considered salvageable and must be included in the collection number.

5.1.3.4.2 T. Rotensis

Refer to the 2025 BO for specific requirements associated with the salvage, collection, transplantation, and maintenance of T. rotensis. Conduct field assessments to identify the number of mature T. rotensis within the

projet footprint and evaluate mature plants. Collect seeds equal to the amount of mature plants lost by construction. Search for flowers/fruit on plants for eventual collection.

5.1.3.4.3 Federally Listed Orchid (Guamense)

Refer to the 2025 BO for specific requirements associated with the salvage, collection, transplantation, and maintenance of federally listed orchid. Determine the current number and health status assessment of Orchids that cannot be avoided within the construction footprint. A health assessment must be performed to determine how many genetically unique individuals can potentially be salvaged and directly transplanted to new host trees

5.1.3.4 Tarague FEA

The health of a subset of the Cycas micronesica in the Tarague FEA was recorded during January and February 2024. The health of all Cycas micronesica was not recorded to expedite surveys, but anecdotal evidence from surveyors noted a higher number of healthy Cycas micronesica than other areas of Andersen AFB and less frequent occurrence of cycad Aulacaspis scale. Trees were also frequently observed to have multiple pups. The health assessment results from a subset of Cycas micronesica in the habitat assessment area are shown in the 2025 BO, Figure 13.

5.1.4 Salvage, Nurse, and Transplant T&E Species

Salvage the T&E species that cannot be avoided within the P-012 construction footprint using the methods described in the Government approved work plan. Transplant salvaged Cycas Micronesica and T. Rotensis within Tarague FEA and the orchids within the HMU.

5.1.4.1 Salvage

5.1.4.1.1 Cycas Micronesica

Refer to the 2025 BO for specific requirements associated with the salvage, collection, transplantation, and maintenance of Cycas micronesica.

Salvage as many healthy cycads basal shoots from adult plants and collect seeds for germination that are suitable for transplantation. Determine the appropriate cycad basal shoots for collection depending on the health, size, and viability of the plant. All collected cycads must be assigned to a unique alpha numeric identifier to track its information and parent plant.

If cycad seeds are available, they must be collected for germination, cleaned of pests, stored in a nursery, propagated, and outplanted. The Contractor may consider implementing the methods to remove basal shoots as described in Attachment F2, Sample Accepted Methodologies for Cycad Slavage and Transplantaion.

If during field collection the number of plants suitable for salvage is less than identified in the Natural Resource Work Plan, provide a detailed explanation in the progress report. The Contractor must keep a record of the number of basal shoots that are collected from the project footprint and document how the basal shoots are handled post collection. Cycads that are outside the construction footprint limits must be avoided. If additional cycads are needed to meet the success criteria, the Contractor may request to collect cycad seeds outside P-012 construction footprint, subject to Government approval.

Cycas micronesica will be considered established when they do not require supplemental watering, fertilizer, or support structures, and show stem growth of at least 0.4 inches (1.0 centimeter) as measured below the base of the existing leaves (fronds).

5.1.4.1.2 T. Rotensis

Monitor mature T. rotensis plants for seeds, collect seeds, germinate and propagate seeds for outplanting. Conduct weekly seed collection surveys within the construction footprint to collect all available seeds up to the start of vegetation clearing. The Contractor must attempt to collect ripe T. rotensis seeds within the P-012 footprint to the maximum extent practicable. Take advantage of seasonal patterns when T. rotensis seeds are available and monitor the development of ripe fruit for seed collection. If seeds are not available, the Contractor may pursue plant collection or plant division. All seeds collected must be germinated and hardened according to the Government approved Natural Resource Work Plan.

T. rotensis will be considered established when they are between 2 and 3 ft (0.6 and 0.9 m) tall; leaves remain turgid on the plant; individuals produce apical stem growth; and individuals no longer require supplemental watering, fertilizer, or support structures.

5.1.4.1.3 Federally Listed Orchid (Guamense)

Orchids will be transplanted into the HMU. After transplantation, provide monitoring and maintenance including watering, fertilizing, pesticide treatment, use of supplemental host tree attachments, invasive species removal, or removal of plant parts to reduce stress following transplantation.

Bulbophyllum guamense, Dendrobium guamense, and Tuberolabium guamense will be considered established following documented observation of new root growth after transplant and root attachment to the host tree.

5.1.4.2 Nursing, Transplanting/Maintenance, and Monitoring

Cycads, T. rotensiss, and guamense plant material salvaged from the P-012 construction footprint must be transported to the Contractor's nursery for hardening and eventual outplanting. Monitor and maintain the plants until they are deemed established at the transplant sites.

5.1.4.2.1 Nursery Storage

Provide a nursery at the Contractor's facility until deemed suitable for transplanting. Propagated plants must be maintained in a nursery that follows Attachment F6, Hawaii Rare Plant Restoration Group's (HRPRG's) Phytosanitation Standards and Guidelines (HRPRG 2010).

Propagation must include supplemental watering, mechanical weed or pest removal, pruning, treatment with fertilizer or pesticide, and other adaptive management techniques to maximize survivorship and plant health. Use the following guidelines for Nursery Storage.

a. Ensure cycads entering the nursery are free of Asian cycad scale and other weeds/ vines/ epiphytes and use pesticide as necessary, following applicable pesticide rules.
b. Prior to removing cycads, complete a soil drench treatment using a product that is on AAFB's Authorized Use List (AUL) around each specimen. The Contractor may propose use of a product not on AAFB's AUL, however, it must be approved by the Contracting Officer and through the NAVFAC Pacific Terrestrial

Applied Biology Department. The applicator must have a DoD certification or Guam certification in Pest Control. All use must be reported using the NAVFAC Online Pesticide Reporting System.

c. To avoid cross contamination between each specimen harvested, wash down all equipment (10% bleach solution) prior to each subsequent removal.
d. Once the specimen has been removed, rid the plant specimen of any remaining debris and loose plant material, followed by the remaining treatments in this order: AUL fungicide, AUL insecticide, a cycad base wash (10% bleach solution), followed by application of a plant sealant (aerosol tree sealant), and root hormone.
e. Once harvested and treated as specified, pot each specimen into potting containers using Government-approved rooting media. Salvaged basal shoots must be processed and transplanted in the nursery in less than one week of salvage. Once potted, ensure safe transport and offload of all potted specimens to a secure Government approved nursery location.
f. During transportation, basal shoots must be covered for protection from sun and wind exposure. A clean blanket can be used to avoid damage during transport.
g. ~~Invasive species within a 20-foot radius around salvaged plants must be removed and maintained to ensure no more that 15 percent of vegetation is invasive species within the plots.~~ **(AM003)**

If plants do not meet the survival criteria, implement adaptive management techniques to include, but not limited to, seed collection, tissue germination, and plant division and/or stem cuttings, as suitable to the species, to meet outplanting success targets.

5.1.4.2.2 Transplanting/Maintenance

Determine when plants are ready to be outplanted. Plants must be outplanted before they become root bound in their containers to promote new growth. After transplanting, maintenance of ESA-listed species may include watering, fertilizing, pesticide treatment, use of support structures, or invasive species removal. Invasive species must be removed within a 20-ft (6-m) radius around transplanted vegetation. The maximum percent cover of invasive understory, overstory, and vine plants permitted within the Tarague FEA and details of removal will be determined following the field assessment.

If outplanted plants do not survive, notify the Contracting Officer and AAFB Natural Resource Specialist immediately and provide an explanation for why they died. Alternative techniques may be implemented if it is determined that the Natural Resource Work Plan approved methodology is not successful. Any remaining plant material at the completion of the performance period must be turned over to the AAFB.

5.1.5 Protect and Monitor ESA-Listed Species to be Remained

Protect and monitor the ESA-listed plant species that are not salvaged within 10 ft (3 m) of the construction perimeter once every 6 months during the entire construction period, including site preparation. Monitor adverse effects to the monitored plants that are clearly attributed to construction activities (e.g., physical disturbance, dust accumulation, and sedimentation from run-off). If adverse effects are observed, corrective actions shall be implemented **(AM003)**.

5.2 Tarague FEA

Implementing all conservation measures and BMPs for Tarague FEA specified in the 2025 BO. The requirements include the following, but are not limited to:

a. Prepare a work plan for forest enhancement that describes the forest enhancement area preparation, native seed collection, and forest enhancement (transplanting) methods.
b. Conduct a biological survey for the 151-ac (61-ha) FEA. The biological survey may include recording existing ESA-listed species (including a health assessment), native and non-native canopy trees, and invasive species.
c. Install an approximately 2.5-mile-long permanent ungulate-proof fence along the forest enhancement area.
d. Remove invasive plant species and invasive species (e.g., CRB, LFA, BTS).
e. After the ungulate-proof fencing is installed, eradicate ungulates (pigs and deer) within the fence limit.
f. Any ground-disturbing activities at the Tarague FEA require archaeological monitoring ~~and Munitions and Explosives of Concern (MEC) screening~~ **(AM002)**.

5.2.1 Draft and Final Work Plans for Tarague Forest Enhancement Area

Provide Draft and Final work plans for Tarague Forest Enhancement Area that describes the forest enhancement area preparation, native seed collection, and forest enhancement (transplanting) methods. The activities associated with forest enhancement (transplanting), such as, installation of ungulate fence including fence route and specifications; removal of vegetation; water lines, or invasive species removal, must adhere to recommended buffer distances (typically 3 ft [1 m]) to avoid adverse impacts to in-situ ESA-listed species.

5.2.2 Install Ungulate-Proof Fence

Install an approximately 2.5-mile-long permanent ungulate-proof fence along the forest enhancement area. Construction of ungulate-proof fencing must occur prior to, or concurrent with, the vegetation removal at the construction footprint.

Provide approximate alignment of the ungulate fence line and include it in the Work Plans for Tarague Forest Enhancement Area. The approximate alignment must be in accordance with the FEA alignment shown in Figure F1; however, the alignment must be adjusted to avoid sensitive environmental areas such as existing ESA-listed T&E species and potential cultural areas. Removal of vegetation for installation of fencing will adhere to recommended buffer distances (3-ft wide on each side of the fence) to avoid adverse impacts to in-situ ESA-listed T&E species. Thus, a 6-ft wide corridor with the fence must be situated.

Fencing must meet the JRM ungulate fencing standards (Refer to Attachment F5). Provide vegetation clearance and maintenance as needed to ensure integrity of the fence. Four (4) pedestrian gates must be provided. The preferred pedestrian gates are presented in the Attachment F1, Figures. No vehicle access gates are required. The ungulate-proof fencing does not require any controlled area signage.

There will be no salvage/transplanting ESA-listed species along the ungulate-proof fencing area/route since disturbing ESA-listed species will be avoided.

Provide reoccurring vegetation clearance and maintenance every two weeks or more frequently as needed **(AM003)**. Within 72 hours after a major storm or high-wind event (wind speeds equal to or greater than 39 miles per hour or 34 knots), ungulate fencing must be inspected for breaches, and fencing must be repaired or replaced immediately after detection until the contract is completed. Provide reoccurring vegetation clearance and maintenance every two weeks **(AM003)**.

5.3 Reporting, GIS Maps, Database

5.3.1 Weekly Natural Resources Conservation Status Report

During the salvage and transplantation phase, a Weekly Natural Resources Status Report to the Contracting Officer on Monday of the previous week. The report must document the Contractor's diligence in salvaging T&E species, task status, anticipated delays, major milestones, and outlook to the following week's tasks.

In the event that T&E species are no longer salvageable from the time of the field assessment until fieldwork occurs, document how the T&E species no longer meets the criteria established in the Natural Resource Work Plan. Pictures and explanations must be documented in the weekly Status Report and Project Report.

After the completion of salvage operations, the Contractor must identify the actual number of healthy cycads, guamense, and T. rotensis seeds salvaged from the P-012 construction footprint in the weekly Status Report. The Government will review the status report to evaluate any changes in the number of cycads and T. rotensis suitable for salvage and provide acknowledgement of the number of salvageable required to meet the success criteria.

5.3.2 Monthly Natural Resources Conservation Progress Reports

Submit monthly progress reports documenting the status of the salvage, transplantation, maintenance and monitoring efforts except in months no work has occurred. The report must be submitted by the 10th of the month. The report period must cover the first through the last day of each month. The reports must include the project name, contract number, report date, period covered (first day of month through last day of month), personnel involved, work completed during the time period, data collected, problems encountered and resolutions/action items, photo documentation of the T&E species, and work planned for the following month.

5.3.3 Annual Natural Resources Conservation Progress Reports

Submit annual reports summarizing the type of activities (e.g., health status of plants, propagation, transplantation, etc.) conducted on each species and the status of transplantation efforts. Include the number of cycad material collected from the parent plant, the number of T. rotensis seeds collected, propagation methods (number seeds germinated), the number of guamense collected, survival rate, and the number of plants meeting the success criteria.

5.3.4 Draft and Final Natural Resources Conservation Reports

Submit the Draft Natural Resources Conservation Report within 45 calendar days upon completion of the maintenance and monitoring phase for the transplanted T&E species. Address:

a. Title page showing title, date, contact information
b. Subtitle page showing title, prepared by listing, prepared for listing, date and recommended citation
c. Table of contents
d. Executive Summary
    i. Synopsis of qualitative cycad selection and prioritization for transplantation
    ii. Synopsis of T. rotensis seed collection, germination and outplanting
    iii. Synopsis of guamense collection and outplanting.
    iv. Synopsis of plant survival and condition for each specimen.
    v. Synopsis of outplanting and monitoring methods.

e. Introduction (including background information)
f. Master schedule of all project events.
g. Methodology
h. Results: Provide record, map, and photo of all specimens removed, including identification code associated with GPS coordinates from construction site, in addition to GPS coordinates and maps of each new cycad, T. rotensis, and guamense relocation site. Refer to Attachment G. GIS Standards for GIS deliverable.
i. Discussion (e.g., notable species presence or absences, include descriptive statistics such as means and standard deviations to document quantitative and qualitative results.)
j. Conclusion (recommendations for future projects or changes to methodology and document any problems encountered)

Submit the Final Natural Resources Conservation Report within 30 calendar days after receipt of Government comments. The Final Report must be submitted in Microsoft Word and Portable Document Format (PDF). In addition, provide all figures, graphics, and GIS data layers used in the report as separately labeled files

5.3.5 Comment Matrix

Incorporate all comments from the Government on all work plans and reports in a comment matrix. The comment matrix must identify how each comment was addressed by the Contractor and where in the document (page number, paragraph, and line) the corrections are to be found. The comment matrix will be used as a quality assurance tool. The comment matrix must be provided with each report submission.

Final

Biological Assessment for Infrastructure Upgrades at Andersen Air Force Base (AFB), Guam

Prepared by:

Headquarters Pacific Air Forces (PACAF)

Joint Base Pearl Harbor-Hickam,

Hawai'i, 96853-5233

May 2022

Abbreviations and Acronyms

AFB	Air Force Base
AFCEC	Air Force Civil Engineer Center
BA	Biological Assessment
BMP	best management practice
CLEO	Conservation Law Enforcement Officer
DAF	Department of the Air Force
dBA	A-weighted decibels
DoD	Department of Defense
DON	Department of the Navy
ECM	earth-covered magazine
EIS	Environmental Impact Statement
ESA	Endangered Species Act
FR	*Federal Register*
HACCP	Hazard Analysis and Critical Control Points
HMU	Habitat Management Unit
HRPRG	Hawaii Rare Plant Restoration Group
INRMP	Integrated Natural Resources Management Plan
JRM	Joint Region Marianas
MSA	Munitions Storage Area
NEPA	National Environmental Policy Act
USC	United States Code
USFWS	U.S. Fish and Wildlife Service

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Appendices

Appendix A. Proposed Conservation Measures
Appendix B. Biological Survey Report

1. Introduction

The Department of the Air Force (DAF) is preparing an Environmental Impact Statement (EIS) to assess the potential environmental effects associated with proposed Infrastructure Upgrades at Andersen Air Force Base (AFB), Guam. The EIS will satisfy requirements under the National Environmental Policy Act (NEPA; 42 United States Code [USC] 4321 *et seq.*).

This Biological Assessment (BA) has been prepared pursuant to Section 7 of the Endangered Species Act (ESA) (16 USC 1536(c)) to evaluate the potential effects of the federal action on listed and proposed species as well as on designated and proposed critical habitat as a result of the proposed federal action, and to determine whether any such species or habitat are likely to be adversely affected by the action.

This formal consultation is a combined effort of the installation management authority of Joint Region Marianas (JRM) and the DAF as the action proponent. The primary point of contact for the EIS and BA is the Air Force Civil Engineer Center (AFCEC).

1.1 Consultation History

This consultation is being completed in accordance with the Consultation Agreement between the Department of the Navy (DON) and the U.S. Fish and Wildlife Service (USFWS), Region 1 for ESA Section 7 Consultations, dated March 2019 (DON-USFWS 2019). As of the preparation date of this document, the following coordination has occurred:

- On April 20, 2021, the DAF issued a notice of intent to prepare an EIS for the Proposed Action and alternatives.
- On April 28, 2021, a request for early coordination for anticipated formal Section 7 consultation was sent from the DAF to the USFWS Pacific Islands Fish and Wildlife Office to request an early coordination meeting.
- On May 17, 2021, the USFWS responded to the April 20, 2021, notice of intent to prepare an EIS.
- On May 20, 2021, the USFWS responded to the request for an early coordination meeting.
- On June 3, 2021, the USFWS, DAF, and JRM held an initial coordination meeting and discussed the project overview, the natural resources survey plan, and formal consultation expectations. Meeting minutes, the natural resources survey plan, and responses to USFWS's comments on the survey plan were circulated in June 2021.
- On September 20, 2021, the DAF provided a summary to the USFWS of the natural resources survey findings and an anticipated schedule for coordination and formal consultation.
- On December 2, 2021, the DAF requested initial coordination with the USFWS on the Draft BA and provided the Draft BA to the USFWS for review.
- On January 27, 2022, the DAF met with the USFWS to discuss their comments on the Draft BA. Meeting minutes were circulated in February 2022.
- On March 2, 2022, the DAF met with the USFWS to further discuss comments on the Draft BA and questions raised during the January 27, 2021, meeting. The DAF provided

a Comment Response Matrix with all USFWS comments on the Draft BA and a summary of decisions made to address the comments received. Meeting minutes were circulated in March 2022.

- On March 22, 2022, the DAF met with the USFWS to further discuss comments on the Draft BA and questions raised during the meeting on March 2, 2022. The DAF provided a summary of decisions made and potential solutions to address the comments received. Meeting minutes were circulated in April 2022.

1.2 Purpose and Need for the Proposed Action

The purpose of the Proposed Action is to enhance Andersen AFB's capability to support forces within the Indo-Pacific region and strengthen the U.S.'s ability to respond regionally and worldwide, through construction of infrastructure upgrades, in alignment with evolving DAF and Department of Defense (DoD) strategies and initiatives for the region.

As the U.S seeks to strengthen deterrence and participate in stabilization of the Indo-Pacific region, the DAF, in accordance with their responsibilities mandated by 10 USC 8062 to ensure readiness and in alignment with DAF and DoD strategies and initiatives for the Indo-Pacific, needs to augment and adapt its forward presence capabilities. The Proposed Action is needed to meet national security objectives, enhance the design and posture of forces in the Indo-Pacific, improve Andersen AFB's ability to support the mission requirements for aircraft in the face of evolving global security challenges, and create a more agile defense posture. To support permanent and rotational forces at Andersen AFB, mission-related infrastructure needs to be upgraded. Increasing and improving the airfield and munitions infrastructure addresses capability gaps and allows for greater efficiencies and agility in the way ground operations are conducted. The proposed infrastructure would provide additional options for parking, storing, maintaining, refueling, loading, and unloading aircraft at the airfield as well as storing munitions, which would improve strategic capabilities and posture with regards to ground maneuverability.

1.3 Species Addressed in this Biological Assessment

The following five plant species and one animal species were recorded within the construction footprint during field surveys conducted specifically for this project and are included for analysis in this BA:

- *Cycas micronesica* – Threatened
- *Tabernaemontana rotensis* – Threatened
- *Bulbophyllum guamense* – Threatened
- *Dendrobium guamense* – Threatened
- *Tuberolabium guamense* – Threatened
- Mariana fruit bat (*Pteropus mariannus mariannus*) – Threatened

Throughout this document, animal species are referred to using their English common name, and plants are referred to using their scientific name since many of the plants do not have common names.

1.4 Species and Critical Habitat Eliminated from Detailed Analysis

Based on the results of the field surveys, the following ESA-listed species on Guam have been eliminated from further discussion and analysis because they do not occur within the action area (see **Section 2.2** for a definition of this area):

- *Eugenia bryanii* – Endangered
- *Hedyotis megalantha* – Endangered
- *Heritiera longipetiolata* – Endangered
- *Phyllanthus saffordii* – Endangered
- *Psychotria malaspinae* – Endangered
- *Serianthes nelsonii* – Endangered
- *Solanum guamense* – Endangered
- *Tinospora homosepala* – Endangered
- *Maesa walkeri* – Threatened
- *Nervilia jacksoniae* – Threatened
- Bridled white-eye (*Zosterops conspicillatus conspicillatus*) – Endangered, presumed extinct
- Guam Micronesian kingfisher (*Halcyon cinnamomina*) – Endangered, presumed extirpated
- Guam rail (*Rallus owstoni*) – Endangered, extirpated
- Mariana common moorhen (*Gallinula chloropus guami*) – Endangered
- Mariana crow (*Corvus kubaryi*) – Endangered, extirpated
- Mariana gray swiftlet (*Aerodramus vanikorensis bartschi*) – Endangered
- Nightingale reed-warbler (*Acrocephalus luscinia*) – Endangered, extirpated
- Little Mariana fruit bat (*Pteropus tokudae*) – Endangered, presumed extinct
- Pacific sheath-tailed bat (*Emballonura semicaudata rotensis*) – Endangered, presumed extirpated
- Green sea turtle (*Chelonia mydas*) – Endangered
- Hawksbill sea turtle (*Eretmochelys imbricate*) – Endangered
- Leatherback sea turtle (*Dermochelys coriacea*) – Endangered
- Loggerhead sea turtle (*Caretta caretta*) – Threatened
- Slevin's skink (*Emoia slevini*) – Endangered, presumed extirpated
- Fragile tree snail (*Samoana fragilis*) – Endangered
- Guam tree snail (*Partula radiolata*) – Endangered
- Humped tree snail (*Partula gibba*) – Endangered
- Mariana eight-spot butterfly (*Hypolimnas octocula marianensis*) – Endangered
- Mariana wandering butterfly (*Vagrans egistina*) – Endangered, presumed extirpated

Approximately 376 acres of critical habitat for the Mariana fruit bat, Guam Micronesian kingfisher, and Mariana crow were designated on Guam in 2004 (69 *Federal Register* [FR] 62944). The action area (**Section 2.2**) is not within any designated critical habitat, and no effect is anticipated to critical habitat. Critical habitat is located entirely on the fee-simple portion of the Guam National Wildlife Refuge at Ritidian Point, and is more than 2 miles from the closest portion of the construction footprint. No vegetation clearing is planned to occur within critical habitat, and noise and lighting at night would not be detectable within designated critical habitat.

2. Description of the Proposed Action and Action Area

2.1 Proposed Action

The DAF is proposing to construct infrastructure upgrades at Andersen AFB, Guam, in alignment with DAF and DoD strategies and initiatives for the Indo-Pacific, and to use this infrastructure consistent with existing installation operations once construction is completed. Andersen AFB currently has infrastructure that supports aircraft parking, storage, maintenance, refueling, loading, unloading, and munitions storage. The proposed infrastructure upgrades are intended to augment and improve the existing infrastructure at Andersen AFB and create a more agile defense posture. Increasing and improving the airfield and munitions infrastructure allows for greater efficiencies and agility in the way ground operations are conducted.

The proposed infrastructure would provide additional options for parking, storing, maintaining, refueling, loading, and unloading aircraft at the airfield as well as for storing munitions, which would improve strategic capabilities with regards to ground maneuverability. The DAF is not proposing to change the types of airfield or munitions activities that occur at Andersen AFB, but would expand the infrastructure that supports them.

Aircraft (e.g., bombers, tankers, fighters) would use the constructed infrastructure. Additionally, constructed infrastructure would support aircraft flight operations that have been addressed under previously prepared NEPA documentation, including the 2006 *Environmental Impact Statement, Establishment and Operation of an Intelligence, Surveillance, Reconnaissance, and Strike Capability, Andersen Air Force Base, Guam* (Andersen AFB 2006); the 2015 *Mariana Islands Training and Testing Final Environmental Impact Statement/Overseas Environmental Impact Statement* (DON 2015); and the 2020 *Mariana Islands Training and Testing Final Supplemental Environmental Impact Statement/Overseas Environmental Impact Statement* (DON 2020). While infrastructure upgrades at the airfield could change how ground and air operations are conducted from day to day by providing additional areas where aircraft can be parked, stored, maintained, refueled, loaded, and unloaded, annual aircraft operations and associated impacts would remain within the parameters analyzed in previously prepared NEPA documentation, and the DAF is not proposing any changes to aircraft operations or airspace. Additional information on aircraft taxiing and idling on the North Ramp under the Proposed Action is included in **Section 4.2.6**.

2.1.1 Summary of Infrastructure Upgrades

Infrastructure upgrades would occur adjacent to the existing airfield operations area and within the Munitions Storage Area (MSA), totaling approximately 203 acres (see **Figure 1**). Infrastructure upgrades adjacent to the existing airfield operations area would occur in a location referred to as the “North Ramp” construction footprint. The North Ramp footprint would require approximately 191 acres for construction. Infrastructure upgrades within the MSA, referred to as the “MSA-1” construction footprint, would require approximately 12 acres.

Figure 1. Andersen AFB Infrastructure Upgrade Locations

The DAF proposes to construct or install the following infrastructure at the North Ramp:

- Airfield pavements
- Aircraft hangar and maintenance facility
- Flightline maintenance facility and utility building
- Jet fuel receipt, storage, and distribution system extension
- Fencing and utilities extension
- Roadways and parking
- Stormwater management infrastructure

The DAF proposes to construct or install the following infrastructure within MSA-1:

- Three earth covered magazines (ECMs)
- Pavements along utilities corridors
- Utilities
- Generator
- Stormwater management infrastructure

Sections 2.1.2 through **2.1.4** provide additional information, including infrastructure sizes and descriptions, associated with site preparation, construction, and operation and maintenance of the Proposed Action at the North Ramp and MSA-1.

2.1.2 Site Preparation

Prior to construction, contractors would clear surface vegetation at the North Ramp and MSA-1 construction footprints. Due to the existing slope, grade, and topography of the North Ramp construction footprint, the DAF would clear surface vegetation from and grade the entire 191-acre construction footprint within the site layout boundary shown in **Figure 2**. Grading would create slopes of approximately 1.5 percent to no more than 10 percent across the entire North Ramp construction footprint. It is estimated that the grading could require approximately 35 feet of fill in some locations. It is assumed that the majority of the fill material would be obtained from higher elevations within the North Ramp construction footprint. Best management practices (BMPs) discussed in **Section 2.3.1** would be followed if any off-site fill material is required. It is not anticipated that the MSA-1 construction footprint would need substantial grading or fill material.

Site preparations would include activities in advance of clearing, such as geotechnical investigations and topographic surveys, which involve minimal vegetation clearing. These activities would follow applicable BMPs discussed in **Section 2.3.1**. Site preparations for construction at the North Ramp would also include demolition of existing buildings, roads, and fencing. This would include demolition of Buildings 2550, 2551, and 2552; removal of an existing access road within the southwestern corner of the North Ramp construction footprint; and demolition of a portion of the existing Marianas Boulevard, which is east of the proposed gate within the southwestern corner of the North Ramp construction footprint. New airfield fencing surrounding the North Ramp facilities would be installed and connected to the existing perimeter fence. A portion of the existing perimeter fence would then be removed to allow for taxiway connection to the existing airfield apron.

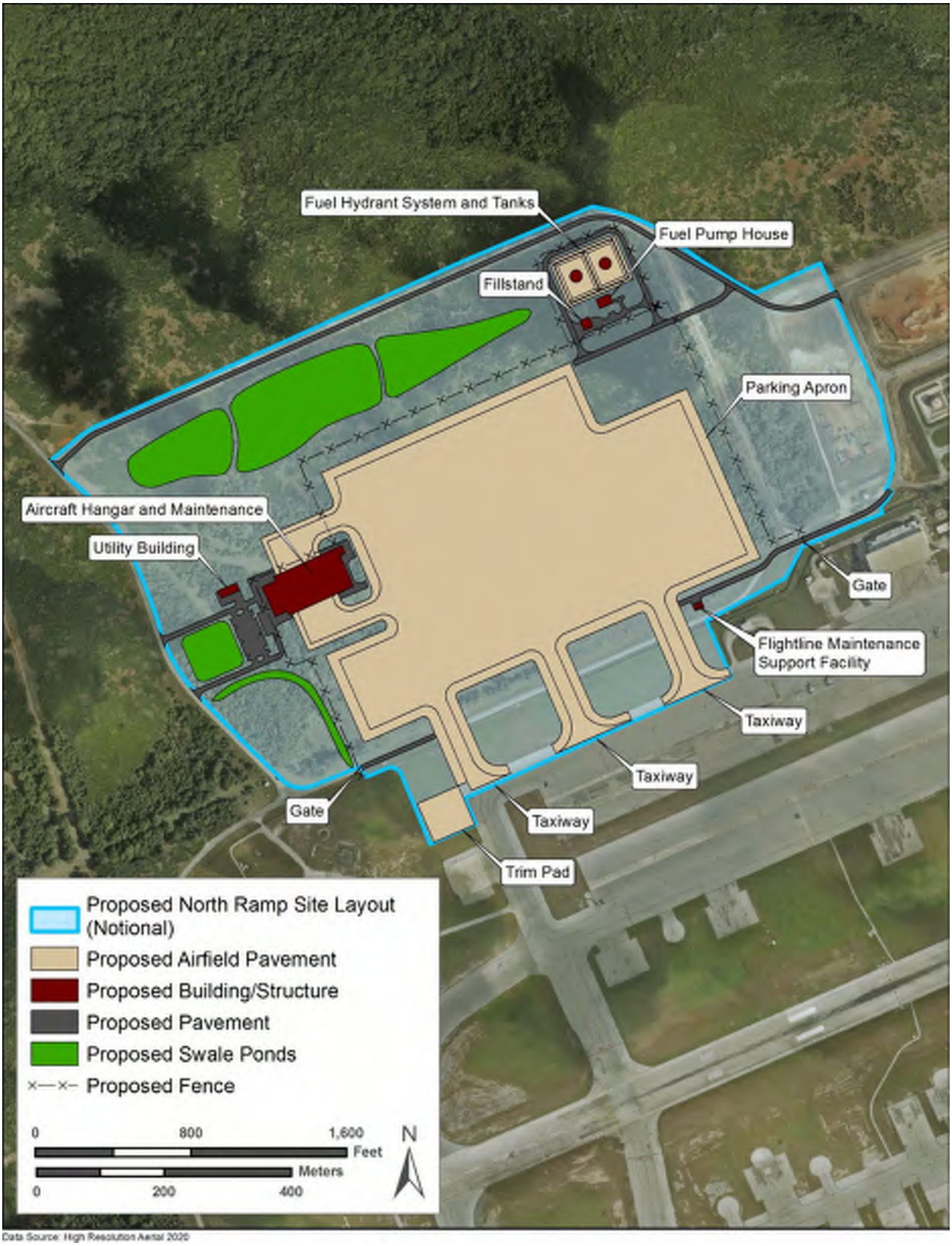

Figure 2. Proposed North Ramp Infrastructure Upgrades – Construction Footprint

BMPs for soil erosion and sedimentation control will be used in accordance with project-specific drainage and erosion control plans. No vegetation clearing or grading would occur at night.

2.1.3 Construction

North Ramp

Airfield Pavements. The DAF would construct a parking apron and taxiways to provide paved areas for aircraft parking, servicing, loading and unloading, and fueling. The taxiways would connect the parking apron to the existing taxilanes, parallel to the existing runway. The parking apron and taxiways, which would be approximately 750 feet from undisturbed limestone forest, would be constructed of concrete pavement with an overall depth of approximately 34 inches, which would include a drainage layer and separation layer atop a compacted subgrade or fill. The aircraft apron shoulder would be asphalt, with an overall depth of approximately 10 inches, including an aggregate base. Additionally, the existing trim pad adjacent to the proposed taxiways would be repaired with new concrete pavements and replacement of existing anchors.

Aircraft Hangar and Maintenance Facility. The proposed aircraft hangar and maintenance facility would provide a place to store aircraft during surge operations, inclement weather, contingency operations, and aircraft maintenance as well as provide space for administrative activities. Specifically, the proposed facility design includes three maintenance bays; a squadron operations facility; an aircraft maintenance unit; aircraft support shops (e.g., for wheels, tires, engines, batteries); a petroleum, oil, and lubricants storage area; an oil-water separator; warehouse space; office space; and an equipment shed.

Flightline Maintenance Facility and Utility Building. A flightline maintenance support facility would provide shelter and administrative space for operations personnel. The facility would also include storage space for tools and maintenance equipment. A utility building would support the entire North Ramp development, and would house water pumps and water storage, electrical and communications systems, and a stand-by generator.

Jet Fuel Receipt, Storage, and Distribution System Extension. The proposed jet fuel receipt, storage, and distribution system at the North Ramp would be an extension of the existing Andersen AFB fuel system. The upgrades would include a hydrant fueling system and pits, a pumphouse, truck fillstands, fuel storage tanks, a tie-in to existing fuel transfer lines, and a new transfer line. The DAF proposes to integrate the North Ramp hydrant fueling system into the existing fueling system and include loop piping, hydrant pits, low-point drains and high-point vent pits, and an isolation pit. Two truck fuel stands would be located adjacent to the pump house and fuel tanks, with convenient access to the airfield refueling aprons and proposed access roads. The hydrant system would connect to the existing fuel transfer line at an existing pumphouse located within the southeastern corner of the construction footprint, via a new fuel transfer pipeline.

Fencing and Utilities Extension. Fencing would be installed around the parking apron and fuel system infrastructure, and would include two gates within the southeastern and southwestern corners of the construction footprint. Utilities would also be installed either above or below ground within the construction footprint, and would include electricity, communication, water, and sewer lines to assist in operation of the proposed infrastructure.

Roadways and Parking. To address traffic flow, the DAF would relocate the existing airfield perimeter roadway outside the proposed airfield perimeter fence, and would modify the existing airfield perimeter road to provide access to the North Ramp construction footprint. Additional roadways could be constructed within the construction footprint to provide access to individual facilities.

Stormwater Management Infrastructure. The DAF would construct stormwater infiltration swales and basins along the northern and western boundaries of the construction footprint to redirect and capture stormwater runoff from the parking apron and other North Ramp paved surfaces.

Construction at the North Ramp would take place over approximately 3 to 7 years, and is estimated to begin in 2024. Construction of infrastructure upgrades at the North Ramp would disturb a total of approximately 191 acres, and would include the development of approximately 96 acres of facilities and infrastructure. Of this acreage, approximately 80 acres would be paved surfaces, 16 acres would be stormwater basins, and the remaining 96 acres would be revegetated and maintained (see **Table 1**).

The North Ramp construction footprint includes all proposed infrastructure, construction laydown areas, a concrete batch plant location, and areas that would be revegetated and permanently maintained. The final location of infrastructure proposed within the construction footprint could change from the notional layout provided in **Figure 2** based on engineering- or design-limiting factors as the planning process progresses and the site layout is finalized.

Table 1. Facilities and Infrastructure Projects within the North Ramp Construction Footprint

Project	Size[a] (Acres)
Airfield pavements (parking apron, taxiways, trim pad)	68
Aircraft hangar and maintenance facility	2
Flightline maintenance facility	0.05
Utility building	0.10
Jet fuel receipt, storage, and distribution system	4
Fencing and utilities extensions	N/A[b]
Roadways and parking	6
Stormwater management infrastructure	16
Total Acreage	**96.15**

N/A = not applicable
[a] Size provided is the footprint (i.e., first floor) for the facility.
[b] These extensions would be located within the proposed construction footprint or in areas that would be revegetated.

Approximately 500 construction workers would be required to construct the infrastructure upgrades proposed at the North Ramp during the construction period. This analysis anticipates that the infrastructure would be constructed sequentially, meaning that personnel support would not increase and decrease, but would remain consistent across the construction period. It is assumed that construction workers would commute daily to the construction footprint in personal or construction vehicles, with two workers per vehicle. In addition to worker travel, construction activities would generate additional traffic to and from Andersen AFB, resulting from delivery of materials as well as other miscellaneous trips by inspectors, project managers,

and other personnel visiting the site multiple times per day. It is estimated that a total of 270 construction-associated vehicles would enter and exit Andersen AFB each day during construction.

Construction activities would occur during both day and night, with night-time activities limited only to those that have unique safety or quality-control requirements. These night-time activities would typically include removal of Munitions of Concern or Unexploded Ordnance, which occurs when limited personnel are present nearby, as well as pouring, curing, cutting, and texturing of airfield concrete, which requires favorable weather conditions, minimization of impacts to base/airfield operations, and temporal specifications (i.e., cutting within 6 to 10 hours of pouring) for quality control.

MSA-1

The DAF would construct three “Hayman style” ECMs within MSA-1. ECMs would be constructed as cast-in-place concrete or precast concrete structures that are rated to store munitions, and would be covered with at least 2 feet of earth fill (soil) that is anticipated to come from borrow areas within the installation boundary or the North Ramp construction site. Existing roadway pavements would be demolished for installation of electrical and communications lines to the proposed ECMs and connection to the existing utilities networks. When the electrical and communications lines are installed and connections are complete, new roadway pavements and maintenance holes would be installed to replace those demolished for utilities installation. Stormwater swales and infiltration basins would be constructed adjacent to the ECMs to capture stormwater runoff from each ECM.

Construction within MSA-1 would be expected to occur over approximately 2 years and would coincide with North Ramp construction. Construction of infrastructure upgrades within the MSA-1 construction footprint would disturb approximately 12 acres (see **Figure 3**), and would include the development of approximately 1.3 acres. Of this acreage, approximately 1.2 acres would be paved surfaces (53,200 square feet), 0.1 acre (4,400 square feet) would be stormwater basins, and the remaining 10.7 acres would be revegetated and maintained.

The MSA-1 construction footprint includes all proposed infrastructure, construction laydown areas, and areas that would be revegetated and permanently maintained. The final location of infrastructure proposed within the construction footprint could change from the notional layout provided in **Figure 3** based on engineering- or design-limiting factors as the planning process progresses and the site layout is finalized.

The construction workforce supporting construction within the North Ramp construction footprint would be used for MSA-1 construction; therefore, no additional construction workers nor commuter traffic would be required for MSA-1.

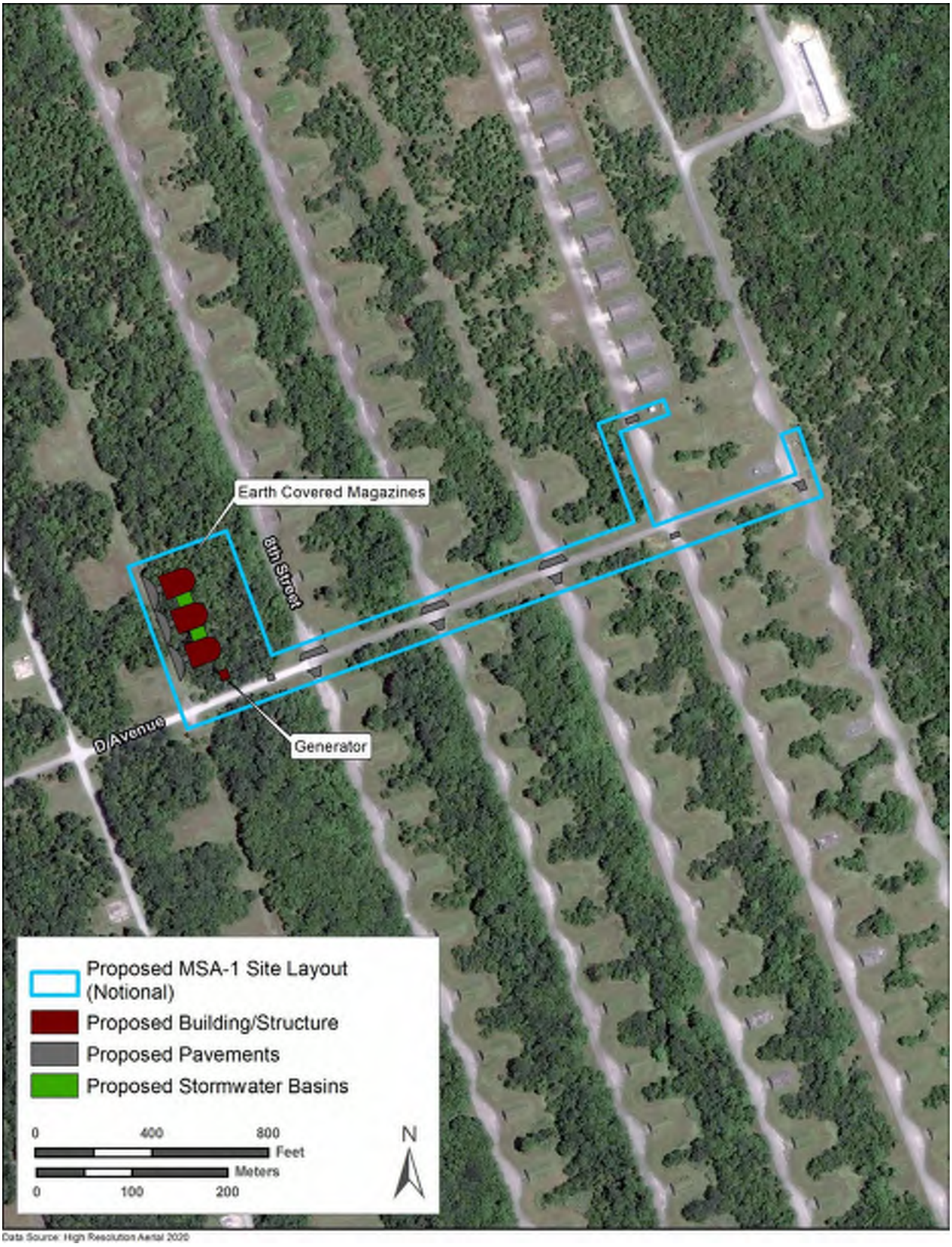

Figure 3. Proposed MSA-1 Infrastructure Upgrades – Construction Footprint

2.1.4 Operations and Maintenance

North Ramp

Once installed, it is not anticipated that the fencing, utilities, roadways, parking, or stormwater basins would be involved in "active" ground operations, require regular recurring maintenance (e.g., on a weekly basis), be staffed with personnel, or be operated differently than other similar infrastructure currently on Andersen AFB. Active operations on the North Ramp would include aircraft idling, taxiing, and maintenance activities (additional information is provided in **Section 4.2.6**). Following construction, access to the North Ramp construction footprint from the west on Marianas Boulevard would be gate access only, and general base traffic on Marianas Boulevard would be routed northwest on 5th Street and around the North Ramp construction footprint, rather than through it. Additionally, the entire North Ramp construction footprint would be subject to regular vegetation maintenance.

MSA-1

Use of the proposed ECMs for munitions storage would not require changes to existing munitions protocols, and would not require a change in the MSA-1 Explosive Safety Quantity Distance arcs. Munitions would be loaded, unloaded, and transported using the same routes, processes, and procedures currently used at Andersen AFB. Additionally, it is not anticipated that the infrastructure proposed within the MSA-1 construction footprint would be involved in "active" ground operations, require regular recurring maintenance (e.g., on a weekly basis), be staffed with personnel, or be operated differently than other similar infrastructure currently on Andersen AFB. The entire MSA-1 construction footprint would be subject to regular vegetation maintenance.

2.2 Proposed Action Area

The Section 7 regulations define "action area" as "all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action." The action area for the consultation regarding the Andersen AFB infrastructure upgrades includes:

- All areas physically disturbed by site preparation, construction, and operation of the North Ramp utility upgrades, totaling approximately 191 acres (**Figure 2** and **Figure 4**). This area is also referred to as the North Ramp construction footprint.
- All areas physically disturbed by site preparation, construction, and operation of the MSA-1 utility upgrades, totaling approximately 12 acres (**Figure 3** and **Figure 4**). This area is also referred to as the MSA-1 construction footprint.
- A buffer area of 3 meters (10 feet) surrounding the North Ramp and MSA-1 construction footprints (**Figure 5** and **Figure 6**). This buffer applies to ESA-listed plants and approximately encompasses the extent of dust disbursement, potential erosion and sedimentation, and edge effects from removal of adjacent vegetation. Although this buffer extends into the developed airfield area to the south of the North Ramp construction footprint, the ESA-listed plants are not expected to occur within this area consisting of pavement and mowed lawns.
- A buffer area of 150 meters (492 feet) surrounding the North Ramp and MSA-1 construction footprints (**Figure 5** and **Figure 6**). This buffer applies to Mariana fruit bat

and approximately encompasses the sound field resulting from noise produced by the operation of construction equipment or maintenance activities as well as the area that could be illuminated by security lighting. Although this buffer extends into the developed airfield area to the south of the North Ramp construction footprint, the Mariana fruit bat is not expected to forage or roost within this area consisting of pavement and mowed lawns.

- Three fenced and ungulate-free plots of mixed limestone forest that may be used for transplant and outplanting of salvaged and propagated ESA-listed plants (see **Section 2.3.2** and **Figure 4**). These managed plots were established in 2013 to intensively manage threats to *Cycas micronesica* in an effort to discover broad-scale conservation methods. In 2018, 1-acre control plots were established adjacent to the managed plots. Trees in each control plot were surveyed annually to track growth and mortality and serve as a comparison to trees inside the managed plots. Trees within the managed plots were treated with systemic pesticides to increase their resilience to invasive insect pests. Each month, trees were inspected for pests and seed production. In addition, seeds collected from within the management plots were recorded, cleaned, and planted. The *Cycas micronesica* within the managed plots have remained fairly constant over the past 5 years. Mortality remains low and growth varies by year (height differences vary by height of the tallest leaf), though there is a general trend of taller and larger trees each year. The percent mortality was significantly lower within managed plots when compared with control plots. Differences were also significant in the number of leaves and reproduction in managed plots, which suggests that trees inside the plots have greater carbohydrate reserves available for growth and reproduction. The number of seedlings produced inside managed plots was also significantly higher than control plots, likely a direct result of higher seed production (Andersen AFB 2020). These managed plots used for transplant and outplanting would be expanded; therefore, their final size and shape might differ from those shown in **Figure 4** as a result of fences avoiding steep topography and other obstacles. The size of the established managed plots (hereafter, vegetation plots) would be expanded as follows:
    - Route 3A Achae Point: currently 1.5 acres, expanded to 3 acres
    - Tarague Basin: currently 1 acre, expanded to 2 acres
    - Andersen Golf Course: currently 1 acre, expanded to 2 acres
- A of habitat area at Tarague totaling approximately 173 acres would be used as a Mariana fruit bat habitat enhancement area (hereafter, bat habitat enhancement area). This area would be fenced and ungulate-free, and would be used for outplanting of native tree species propagated from seed collected primarily from the North Ramp and MSA-1 construction footprints (see **Section 2.3.2** and **Figure 4**). This area may also be used for transplant and outplanting of ESA-listed plant species. No previous management actions have occurred within the bat habitat enhancement area. The final size and shape of the established area might differ from that shown in **Figure 4** as a result of fencing avoiding steep topography and other obstacles.

The total action area is approximately 593 acres. The action area is entirely located on Andersen AFB, on the northern end of the island of Guam.

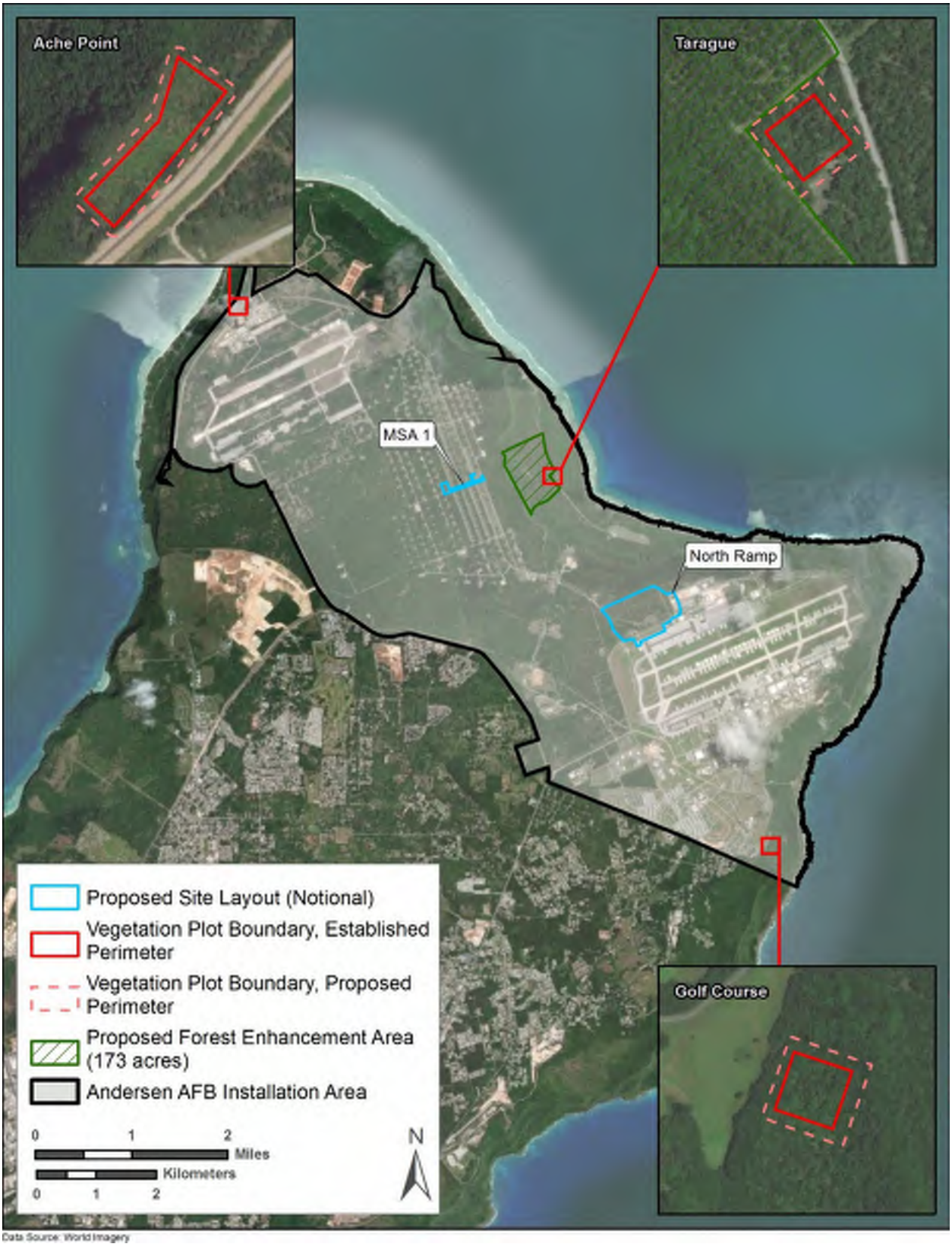

Figure 4. Proposed Action Area – Overview

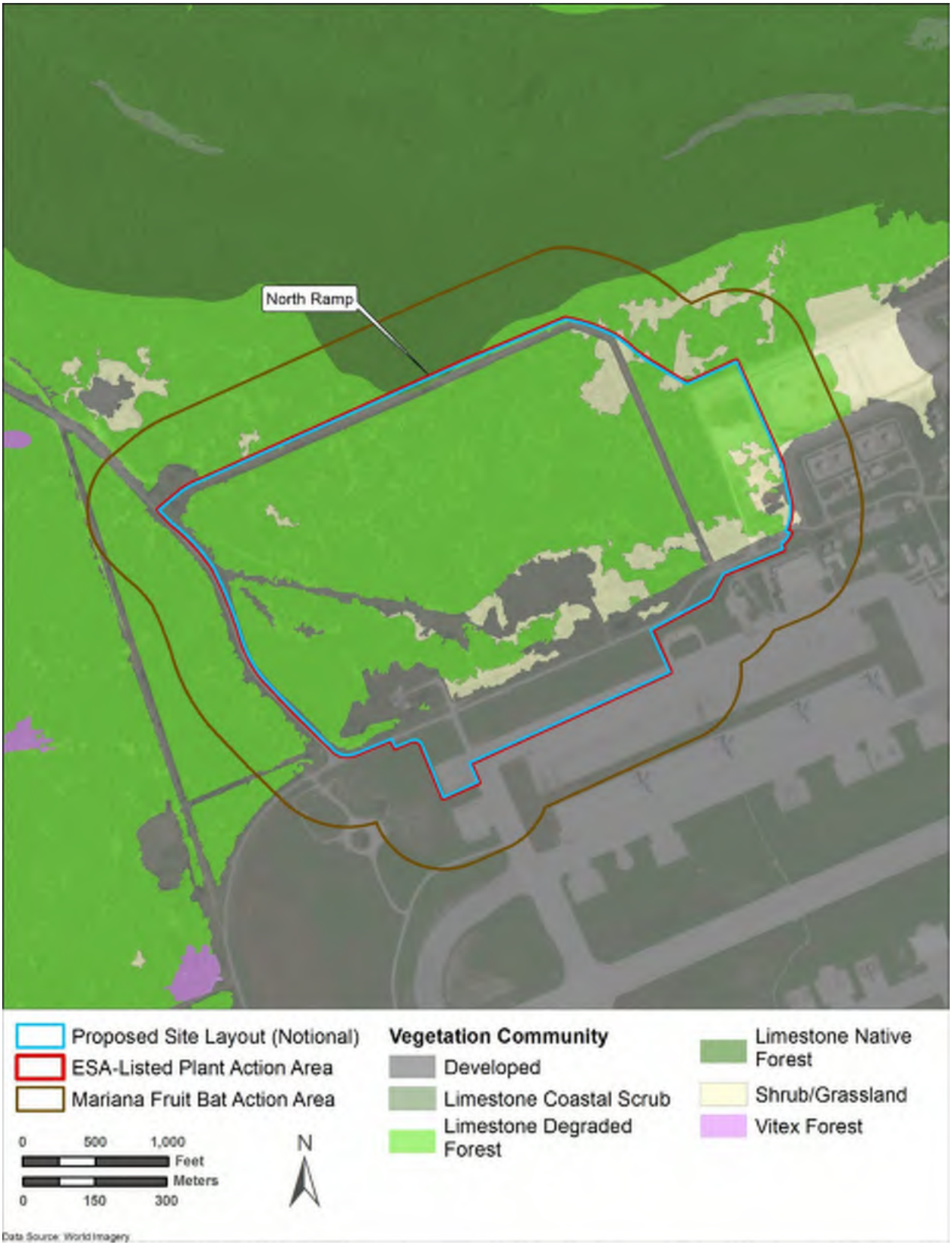

Figure 5. Proposed Action Area – North Ramp

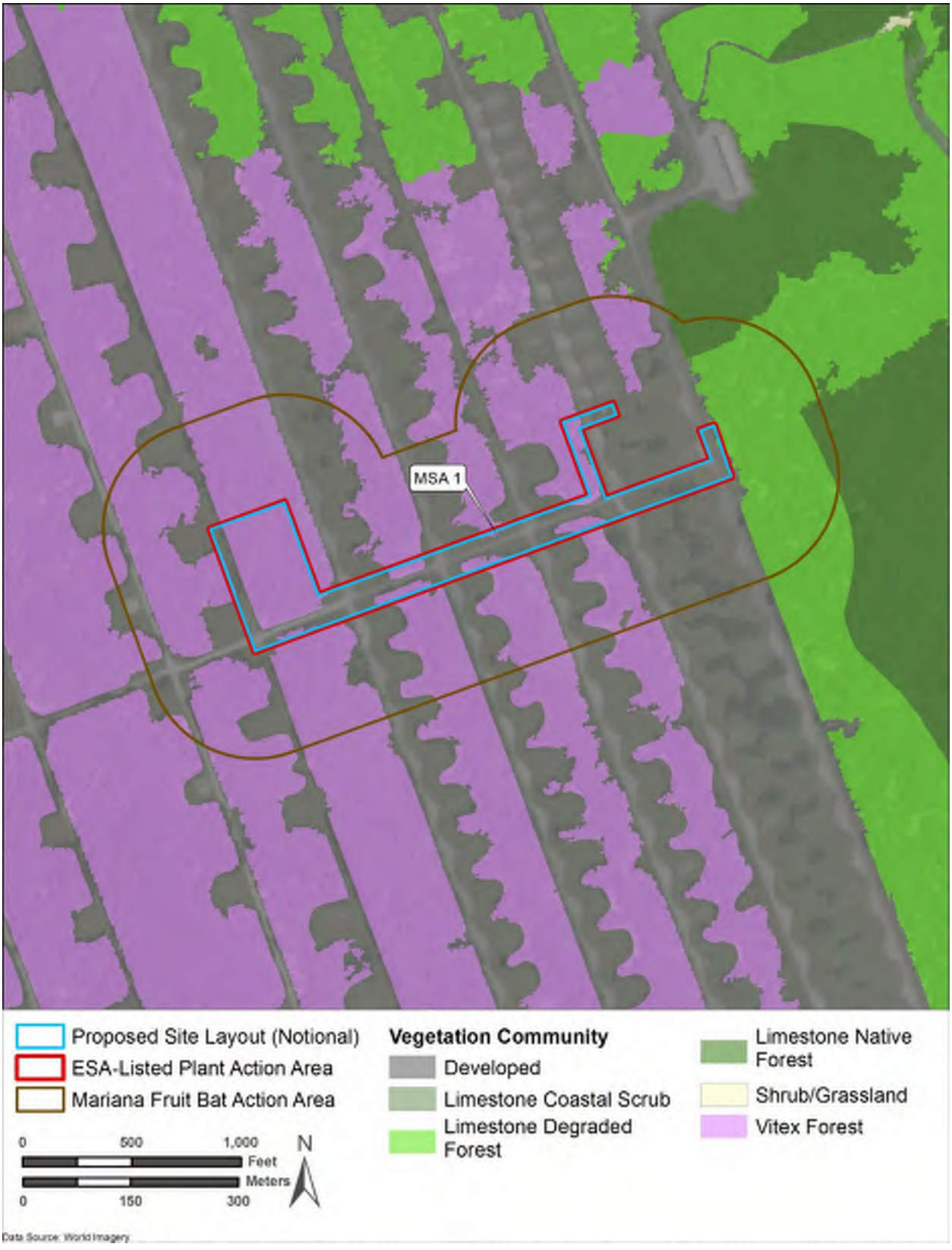

Figure 6. Proposed Action Area – MSA-1

2.3 Impact Minimization, Avoidance, Mitigation, and Conservation Measures

Impact minimization, avoidance, and mitigation measures will be implemented prior to or during infrastructure upgrade site preparation, construction, and operations to avoid or minimize the effects of the Proposed Action on ESA-listed species. This section identifies the BMPs dictated by federal, DoD, DAF, or Guam regulations or guidance, or that will be implemented under the Proposed Action and that are applicable to protection of ESA-listed species (**Section 2.3.1**). A complete list of BMPs implemented under the Proposed Action is available in the EIS.

This section also addresses proposed conservation measures for individual species that occur or may occur within the construction footprint. Proposed conservation measures in **Section 2.3.2** have been developed to complement the ongoing natural resources management activities on Andersen AFB and northern Guam. JRM is responsible for the long-term management of natural resources on Andersen AFB. The timeframes associated with conservation measures in this BA are based on the period of DAF funding in direct support of the Proposed Action. Following the conclusion of DAF funding for the Proposed Action, the long-term management of natural resources and perpetuation of these conservation measures will be ensured by incorporating them into the JRM *Integrated Natural Resources Management Plan* (INRMP) (DON 2019). The goals of the JRM INRMP include providing a conservation benefit to listed species and species of concern, as well as the interdiction, control, and eradication of invasive and nuisance species. The objectives and management actions compiled in the JRM INRMP are updated every 5 years in close coordination with the USFWS, and include commitments from completed Section 7 consultations as well as agreements with local and federal natural resource partners. The objectives and management actions integrate mission support, multi-purpose use, ecosystem- or landscape-level management, and environmental compliance and stewardship. The following management actions are ongoing at Andersen AFB. Full project descriptions and regulatory drivers are included in Appendix C of the 2019 JRM INRMP (DON 2019):

- Habitat Management Unit (HMU) brown treesnake (*Bioga irregularis*) barrier inspections and maintenance
- Brown treesnake monitoring and control in the HMU
- Non-Native plant removal and control in the HMU
- Little fire ant (*Wasmannia auropunctata*) early detection surveys as well as control and eradication (if detected).
- Coconut rhinoceros beetle (*Oryctes rhinoceros*) interdiction (including trapping and breeding site removal)
- Invasive species early detection surveys (including roadside weed surveys and all taxa surveys in cargo staging areas) and control/eradication of newly detected high-risk species
- Biosecurity arrival and pre-departure inspections of military training cargo and equipment
- Mariana fruit bat monitoring
- Monitoring and conservation of *Cycas micronesica*
- Native forest habitat restoration in ungulate-fenced areas

- Ungulate (pig and deer) fencing construction, inspection, and maintenance at various sites
- Ungulate eradication and control within fenced areas
- Environmental education outreach and awareness program for military personnel and their families

The proposed conservation measures were also developed using the best available science in accordance with the Consultation Agreement between the DON and USFWS for Section 7 consultations (DON-USFWS 2019). While a threat to a listed species may be reasonably expected or known, research providing quantifiable evidence directly linking a threat to the species is required to develop effective conservation measures that can be expected to successfully mitigate adverse effects from an action. Therefore, additional research may be required to address knowledge gaps and inform future conservation projects for a species.

Due to a lack of direct evidence of brown treesnake predation on the Mariana fruit bat, the proposed conservation measure in this BA related to brown treesnake management to benefit the Mariana fruit bat is research-based (NAVFAC Marianas 2022a). Additional information is included in **Section 2.3.2**A . However, ongoing invasive species management actions at Andersen AFB through the JRM INRMP include brown treesnake interdiction and suppression.

None of the proposed conservation measures address the little fire ant because there is a lack of evidence directly linking the little fire ant to adverse effects on the Mariana fruit bat, and the little fire ant has not been detected on Andersen AFB. Monitoring for the little fire ant already occurs on Andersen AFB; if the little fire ant is discovered, proven control and eradication actions will be implemented and followed by post-eradication monitoring (DON 2019). Additionally, little fire any surveys during construction (and eradication if detected) are included as a BMP (see **Section 2.3.1**).

2.3.1 Best Management Practices

Site Preparation and Construction

- During site preparation and prior to any clearing of surface vegetation, the construction perimeter will be clearly marked to prevent encroachment into adjacent areas.
- DAF's contractors will develop a *Hazard Analysis Critical Control Point* (HACCP) *Plan* to ensure that invasive species are not moved or introduced in association with site preparation, construction, or salvage and transplantation activities. The JRM Biosecurity Program Manager will review each plan, and the DAF must approve each plan prior to commencement of activities.
- If off-site fill material is needed, contractors will be required to obtain aggregate/soil from contractors/vendors who have local permits. Imported sand and other quarried products from abroad are subject to inspection by the Guam Department of Agriculture, which issues an importation permit. All sand and aggregate material imported must be accompanied by official records indicating chemical composition, pest-free certification, treatment certification, and certificate of origin. Treatment (disinfection) must be conducted at the point of origin.

- The DAF contracts for site preparation, construction, and salvage, and transplant will incorporate approved methods for processing of green waste and mulch piles to prevent the spread of little fire ant, coconut rhinoceros beetle, and other invasive species, and to control their spread if present. A biological monitor will inspect the work sites to confirm that vegetation debris is properly managed in accordance with green waste protocols.
- Little fire ant surveys will occur throughout construction to ensure that construction activities do not introduce the little fire ant to the area. As stated in **Section 2.3**, if the little fire ant is discovered, proven control and eradication actions will be implemented and followed by post-eradication monitoring (DON 2019).
- To prevent environmental stressors on the ESA-listed plants, plant assessments and collection of material will be conducted before any site preparation. Once all the plant material is collected, Andersen AFB will approve the site for site preparation.
- Silt fences, straw wattles, or another DAF-approved BMP method will be used to prevent soil erosion into adjacent areas. Dust screens will be used to shield ESA-listed plants that are within 10 feet of the construction clearing line.
- Andersen AFB will implement a contractor education program to ensure contractor personnel are informed of the biological resources within the construction footprint, including ESA-listed species, invasive species, special status species, avoidance measures, and reporting requirements. DoD staff will provide to contractors a natural resources orientation with special focus on ESA-listed plants and the Mariana fruit bat to ensure construction personnel are aware of these species and avoid inadvertent impacts due to lack of awareness of resource presence, sensitivities, and protective measures.
- Andersen AFB will monitor the ESA-listed plant species within 10 feet of the construction perimeter once every 6 months during site preparation and construction activities. Andersen AFB will contact the USFWS if adverse effects to the monitored plants that are clearly attributed to construction activities (e.g., physical disturbance, dust accumulation, and sedimentation from run-off) are detected. Monitoring will conclude at construction completion.
- Site preparation will not occur at night as part of this project, and all site preparation will end 30 minutes before sunset. Night construction will be required for specific activities, including, but not limited to, removal of Munitions of Concern and Unexploded Ordnance as well as pouring and cutting of concrete.
- Awareness training to prevent disturbance to Mariana fruit bats during site preparation and construction will be delivered to the contractor during an in-person meeting. A qualified biologist will conduct a daily bat survey within line of sight up to 492 feet (150 meters) of site preparation and construction activities to determine if Mariana fruit bats are present. If a fruit bat is present within the action area, any site preparation or construction work being conducted within the area that generates noise above the ambient levels will be postponed until the bat has left of its own volition (USFWS 2015a).
- If a fruit bat is observed within 492 feet (150 meters) of the project site where activities are being conducted while site preparation or construction work generating noise above the ambient levels is occurring, work will stop, and Andersen AFB Natural Resource staff will be notified. Work can resume after fruit bats have left the action area on their own volition. Site preparation or construction activities that cannot be halted due to safety or

quality control concerns, such as tree felling or concrete pouring and sawing or cutting, will proceed to an appropriate end point, and then work will stop.

- During night work, contractor personnel will be responsible for performing biological monitoring on site while night work is underway to observe for Mariana fruit bats. A variety of methods will be used, including infrared cameras if conditions allow for a bat's heat signature to be distinguished from background vegetation (i.e., if the vegetation is cool enough). If a bat is observed within 492 feet (150 meters) of the project site where activities are being conducted, activities within 492 feet (150 meters) of the bat will be postponed/halted until the bat has left of its own volition. One or more biological monitor(s) will have no other duties at the work site.
- The extent and frequency of working at night will be minimized by ensuring shifts begin on time, saw cutting is initiated as soon as the concrete is ready, and night shift work is not made routine.
- Lighting associated with night work will be hooded, pointed downwards, and directed to not shine towards the known roosting location to minimize potential effects to Mariana fruit bat roosting activities.
- Andersen AFB staff will inspect the contractor's work to ensure that BMPs are implemented for the entire duration of the project. Andersen AFB staff will conduct random inspections monthly and document the results in a log.

Operations and Maintenance

- New outdoor artificial lighting will be hooded and designed to provide the lighting levels required in the Unified Facilities Criteria while minimizing potential effects to Mariana fruit bat foraging or roosting activities.
- Infrastructure and utilities will be designed with appropriate spill prevention and response procedures to avoid introduction of hazardous chemicals that could affect ESA-listed species.
- Aircraft and cargo departing Andersen AFB for other locations will be subject to brown treesnake detector dog inspections as per Joint Regions Marianas Instruction 5090.10A.
- Invasive species management actions outlined in the 2019 JRM INRMP (and all subsequent updates) will continue to be implemented during operations to prevent the spread of invasive species (DON 2019).

2.3.2 Conservation Measures

The conservation measures included below provide an overview of the actions that the DAF will take to mitigate adverse effects to ESA-listed species considered in this BA. The goal of these conservation measures is to promote these species' continued existence by contributing to no net loss and minimizing indirect effects. A detailed list of the proposed conservation measures for each species are included in **Appendix A**, with additional details on the planned implementation for each conservation measure.

Cycas micronesica

Seed Collection and Salvage Preparation: Upon receipt of a Biological Opinion, Andersen AFB will begin monthly monitoring within the North Ramp and MSA-1 construction footprints for seed production as well as collecting and storing mature seed to support the goal of population

enhancement as recommended in the species' 5-Year Review (USFWS 2020a). The seed collection and storage process will provide additional opportunity to preserve the unique genetic diversity of the maximum number of individual *Cycas micronesica* removed by vegetation clearing. A pre-construction field assessment of the construction footprints will be conducted by an Authorized Biologist (defined in **Appendix A**, OTH-4) to assess individual *Cycas micronesica* health and determine the number of plants that are suitable for salvage and transplant.

Salvage and Transplant: Based on surveys conducted specifically for these construction footprints, 416 *Cycas micronesica* have been identified that would be subject to removal during vegetation clearing for site preparation, and 376 of those were in good or fair health at the time of surveys and are potentially suitable for salvage through removal and propagation of plant parts (apical stems or vegetative propagules [pups]). Andersen AFB will work with an Authorized Biologist to develop a work plan with a recommended salvage method for each plant. The final work plan will be developed by an Authorized Biologist following the field assessment to determine current health conditions prior to salvaging activities. The final work plan will be provided to the USFWS. Plant parts will be propagated in a DAF-approved nursery until suitable for transplanting. Nursery maintenance may include supplemental watering, mechanical weed or pest removal, pruning, treatment with fertilizer or pesticide, and other adaptive management techniques to maximize survivorship and plant health. Seed germination and propagation may be used as a contingency to meet survival criteria for the genetically unique individual that produced the seed. Once propagated plants are suitable for transplant, Andersen AFB will transplant them into either the vegetation plots or the bat habitat enhancement area (see **Figure 4**). Vegetation plots were previously established and will be expanded in size to accommodate the additional plantings (see **Appendix A**, CYMI-7). This salvage and transplanting effort supports the captive propagation for genetic storage and reintroduction as recommended in the *Cycas micronesica* 5-Year Review (USFWS 2020a).

Maintenance of Transplants and Transplant Areas: The vegetation plots and the bat habitat enhancement area (described further in the section outlining conservation measures for the Mariana Fruit Bat) will be prepared for transplants through installation or improvement of ungulate fencing and removal of ungulates. Each area will have a field assessment conducted to determine suitable transplanting locations. Fencing and invasive species will be regularly monitored, and repairs, treatment, or invasive species removal will be performed as needed. The establishment of ungulate-free areas is recommended in the *Cycas micronesica* 5-Year Review (USFWS 2020a), and will help prevent adverse effects from habitat destruction, dispersal of invasive species, and erosion caused by vegetation clearing and soil disturbance. All threatened plants salvaged from the North Ramp and MSA-1 construction footprints will be transplanted into the vegetation plots or bat habitat enhancement area. Transplants will be maintained and monitored until the survival criteria for *Cycas micronesica* have been met for a minimum of 25 percent of the genetically unique individuals that were suitable for salvage from the construction footprint (see **Appendix A**).

Tabernaemontana rotensis

Seed Collection and Propagation: A pre-construction field assessment of the North Ramp construction footprint will be conducted to assess individual *Tabernaemontana rotensis* health and maturity as well as to determine the number of plants that may potentially produce seed.

Based on surveys conducted specifically for the North Ramp and MSA-1 construction footprints, 99 *Tabernaemontana rotensis* have been identified within the North Ramp construction footprint that would be subject to removal during vegetation clearing for site preparation, and 74 of those were mature enough to potentially produce seed for collection. Mature trees will be monitored monthly for seed production and if available, will be germinated, propagated, and maintained in a DAF-approved nursery until suitable for outplanting to the vegetation plots or bat habitat enhancement area (see **Figure 4**) to support the goals of maintaining genetic diversity and population enhancement as recommended in the *Tabernaemontana rotensis* 5-Year Review (USFWS 2020b). If seed is not produced prior to vegetation clearing, propagation of cuttings from mature trees may be used as a contingency.

Outplanting: All threatened plants salvaged from the North Ramp and MSA-1 construction footprints will be outplanted into the vegetation plots or bat habitat enhancement area. The vegetation plots and bat habitat enhancement area will be surveyed and maintained as described in the conservation measures for *Cycas micronesica*. Similarly, these conservation measures are consistent with actions recommended in the *Tabernaemontana rotensis*' 5-Year Review (USFWS 2020b). Outplanted plants will be maintained and monitored until the survival criteria for *Tabernaemontana rotensis* has been met for a minimum of 25 percent of the genetically unique individuals that were suitable for salvage from the construction footprint (see **Appendix A**).

Orchids: Bulbophyllum guamense, Dendrobium guamense, Tuberolabium guamense

Salvage and Transplant: A pre-construction field assessment of the North Ramp construction footprint will be conducted to assess individual *Bulbophyllum guamense*, *Dendrobium guamense*, and *Tuberolabium guamense* health, and to determine the number of each species of orchid that is suitable for direct transplant. Based on surveys conducted specifically for the North Ramp and MSA-1 construction footprints, 1 *Bulbophyllum guamense*, 2 *Dendrobium guamense*, and 100 *Tuberolabium guamense* have been identified within the North Ramp construction footprint that would be subject to removal during vegetation clearing for site preparation. Of the 100 *Tuberolabium guamense*, only 73 were considered suitable for salvage at the time of the surveys, and the remainder were seedlings that were potentially too small to survive transplant.

Maintenance of Transplants: All threatened orchids salvaged from the North Ramp construction footprint will be directly transplanted onto native host trees and into the vegetation plots or bat habitat enhancement area (see **Figure 4**). Orchids will be transplanted at similar aspects and microclimates that are consistent with their original location. The transplant plots will be surveyed and maintained as described in the conservation measures for *Cycas micronesica*. Similarly, these conservation measures are consistent with actions recommended in the orchids' 5-Year Reviews (USFWS 2020c, 2020d, 2020e). Transplanted orchids will be maintained and monitored until the survival criteria for each of the three orchid species has been met for a minimum of 25 percent of the number of each species that were suitable for salvage from the construction footprint (see **Appendix A**).

Mariana Fruit Bat

Establishment of a Bat Habitat Enhancement Area: A 173-acre area on Andersen AFB will be designated as a bat habitat enhancement area (**Figure 4**) to support the goals of habitat protection and restoration as outlined in the *Draft Revised Recovery Plan for the Mariana Fruit Bat* (USFWS 2009) and the species' 5-Year Review (USFWS 2020f). Andersen AFB will install permanent ungulate-proof fencing around the bat habitat enhancement area, and ungulates will be removed. Fencing will be monitored once per month for 10 years. Degradation and/or breaches in the fencing will be repaired or replaced immediately after detection. If ungulates are detected after the initial removal, then they will be removed. Ungulate monitoring and control were listed as actions to support Mariana fruit bat recovery in the Draft Revised Recovery Plan (USFWS 2009) and the species' 5-Year Review (USFWS 2020f) because ungulates degrade Mariana fruit bat habitat.

Andersen AFB will perform a field assessment of the bat habitat enhancement area to record existing ESA-listed species (including a health assessment), native and non-native canopy trees, and invasive species that require treatment. Following completion of the field assessment, a forest enhancement work plan will be prepared to describe the methods to be used for native plant seed collection from the construction footprints and the forest enhancement activities, including outplanting, maintenance, and monitoring. The final work plan will be developed by an Authorized Biologist following the field assessment, and the final work plan will be provided to the USFWS. Following outplanting, Andersen AFB will conduct invasive species removal or pesticide treatment within the bat habitat enhancement area to enhance the existing native forest. Invasive canopy trees will be removed to promote establishment of outplanted native canopy tree species. Outplanting of native plant species and the removal of invasive plant species will provide a sustainable resource for the Mariana fruit bat by supporting the recovery of native forest habitat and increasing resiliency against invasive plant species establishment within the bat habitat enhancement area (USFWS 2009).

Seed Collection, Outplanting, and Maintenance: To support bat habitat enhancement and increase foraging opportunity for Mariana fruit bat, seeds from native trees within the MSA-1 and North Ramp construction footprints will be collected, germinated, propagated, and outplanted within the bat habitat enhancement area (USFWS 2009, 2020f). Target species for seed collection will include trees preferred for bat foraging (see **Appendix A**). Seeds will be germinated, propagated, and maintained in a nursery until they are suitable for outplanting. Andersen AFB will collect seeds from native tree species within the MSA-1 and North Ramp construction footprints, and will ensure survival of a minimum of 100 propagated individuals from a minimum of 5 different tree species. Native trees will be outplanted into the bat habitat enhancement area, and will be maintained and monitored until they are considered established. The bat habitat enhancement area will be monitored twice per year for a period of 7 years following outplanting of native tree species. Observations of Mariana fruit bat use of the area or presence of ungulates will be recorded.

Invasive Species Management for Bat Habitat Enhancement: Andersen AFB will eradicate feral ungulates as well as install and maintain fencing around the 173-acre bat habitat enhancement area to decrease habitat loss on Guam (USFWS 2020f) and to support the presence of native plant species that provide key resources for the Mariana fruit bat within the

bat habitat enhancement area (USFWS 2009). Fence installation and maintenance is described in **Appendix A**.

Conservation Law Enforcement Officer (CLEO): Mariana fruit bats are protected by Guam and federal law; however, they are likely still hunted opportunistically by hunters on Andersen AFB (GNWR 2005, as cited in USFWS 2017). It was reported by SWCA (2012) that roosting Mariana fruit bats were approached by observers as close as 16 feet, and suggested that hunters could, without difficulty, shoot and kill a roosting Mariana fruit bat. Additionally, decreasing poaching was included as an action to support Mariana fruit bat recovery in the Draft Revised Recovery Plan (USFWS 2009) and the species' 5-Year Review (USFWS 2020f). JRM will partner with the USFWS to employ a CLEO to conduct surveillance, investigations, and deter Mariana fruit bat poaching on Andersen AFB. Funding for the CLEO position will be provided by the DAF for five years before being transferred to the JRM INRMP for long-term sustainment. An Interagency Agreement will be prepared in cooperation with the USFWS to determine each party's responsibilities, financial administration, and general provisions (points of contact, correspondence procedures, etc.). Additionally, a Conservation Law Enforcement Program Operations Plan will be developed to establish CLEO standard operating procedures.

Bat Monitoring and Research: The Draft Revised Recovery Plan states that monitoring is needed to track the status of the Mariana fruit bat across the Mariana Islands, to assess their threats, and to assess the effectiveness of conservation actions (USFWS 2009). Up to five new or established monitoring stations will be used to record information on bat presence at the North Ramp construction footprint, MSA-1 construction footprint, and the bat habitat enhancement area. Monitoring at these stations will occur at least every 10 days and will begin when the Proposed Action construction contract public solicitation begins, continue throughout vegetation clearing, and conclude 1 year after vegetation clearing at the North Ramp and MSA-1 construction footprints is complete. Methods will follow the landscape counts for solitary bats (JRM 2010). Quarterly monitoring reports will be provided to the USFWS for situational awareness. These quarterly reports will contain information on any detection of changes in roost locations, number of bat detections, or bat movement. A bat monitoring and research work plan will be developed to describe the specific monitoring and research methods that will be implemented for the known roosting area north of the North Ramp construction footprint. The final work plan will be provided to the USFWS.

Additional Mariana fruit bat research is needed to address knowledge gaps that will help refine management approaches (USFWS 2009). The DAF will supplement DON funding to research the Mariana fruit bat recommended within the 2017 *Mariana Fruit Bat Management Plan for Andersen Air Force Base, Guam* (NAVFAC Marianas 2017), with the long-term goal of developing guidelines to be used in recovery and sustainable management of Mariana fruit bats on different islands. Research specific to this consultation will include deployment of thermal or near-infrared cameras at up to two roosting locations, including the known roosting area. Andersen AFB will also conduct a traffic noise study prior and subsequent to the re-routing of Marianas Boulevard around the northwestern corner of the North Ramp construction footprint.

The brown treesnake is listed as a threat to the Mariana fruit bat in the Draft Revised Recovery Plan and the species' 5-Year Review (USFWS 2009, 2020f); however, as discussed in **Section**

2.3, there is currently a lack of direct evidence that brown treesnake occurrence precludes Mariana fruit bat persistence in an area (NAVFAC Marianas 2022a). The DAF will develop and enhance existing methods and techniques in collaboration with the Interagency Brown Treesnake Technical Working Group to monitor brown treesnakes at varying landscape levels within brown treesnake enclosures and unbounded areas to provide a better understanding of the interspecies relationship and to aid in the development of appropriate future conservation actions.

Annual Reporting

Andersen AFB will submit an annual report to the USFWS 1 year after the Biological Opinion is prepared and each year thereafter for 10 years, or fewer if the Proposed Action and associated conservation measures are complete. The annual report will identify which conservation measures are complete based on survival criteria (specifically for transplanted and outplanted plants), and Andersen AFB will have no further monitoring or reporting requirements for those conservation measures.

3. Environmental Conditions

3.1 Baseline Conditions within the Construction Footprint

Baseline conditions for both the North Ramp and MSA-1 construction footprints are discussed in detail in the *Biological Survey Report* for this project, included as **Appendix B**.

3.1.1 North Ramp

The North Ramp construction footprint consists of a limestone degraded forest and developed land and open areas filled with shrubs/grassland (**Figure 5**; **Table 2**). Descriptions for the vegetation communities present within the construction footprint have been derived from the 2019 INRMP (DON 2019) and updated based on project-specific surveys, and include:

- **Limestone Degraded Forest.** The plant community in this construction footprint varies from full to intermediate closure with *Ficus-Premna* trees. Dominant plant species consistently observed during surveys include *Meiogyne cylindrocarpa*, *Aglaia mariannensis, Wikstroemia elliptica*, and *Chromolaena odorata*. Some areas of the upper canopy also consist of *Ficus prolixa, Intsia bijuga, Elaeocarpus joga*, and *Vitex parviflora*. Mid-canopy trees that occur frequently include *Meiogyne cylindrocarpa*, *Aglaia mariannensis, Ochrosia oppositifolia, Morinda citrifolia*, *Premna serratifolia*, and *Psychotria mariana*. *Eugenia palumbis, Pandanus tectorius*, *Cocos nucifera, Tabernaemontana rotensis, Cycas micronesica*, *Syzygium thompsonii*, and *Maytenus thompsonii* were occasionally encountered throughout the forest.
- **Shrub and Grassland.** This community is characterized by the presence of shrubs and grasses. This community is often present in degraded forest areas as clearings with herbaceous vegetation and scattered shrubs. Also included in this community are areas that have been cleared or mowed in the past. These areas may consist primarily of grassland, with limited regrowth of woody species.
- **Developed Land.** These lands are human-occupied or otherwise highly disturbed areas that include lawns and other landscaped areas, or actively maintained areas (e.g., mowed fields, utility corridors), buildings, roads, parking lots, and other paved areas.

Table 2. Vegetation Communities within the North Ramp and MSA-1 Construction Footprints

Vegetation Type/Land Cover	Acres within North Ramp	Acres within MSA-1	Total
Limestone Degraded Forest	127.2	0.0	127.2
Limestone Native Forest	0.4	0.0	0.4
Other Shrub/Grassland	15.9	0.0	15.9
Developed Land	47.9	6.3	54.2
Vitex Forest	0.0	5.2	5.2
Total	**191.4**	**11.5**	**202.9**

Source: NAVFAC Marianas 2016

3.1.2 MSA-1

The MSA-1 construction footprint consists of old Hayman-style munition storage bunkers surrounded by maintained grassy fields and pockets of forested vegetation. The forested vegetation is fragmented, consisting of limestone degraded forest and *Vitex* forest (**Figure 6; Table 2**).

- **Limestone Degraded Forest.** The forest canopy in this construction footprint varies from full to intermediate closure with *Ochrosia-Ficus*. Dominant plant species observed during surveys include *Meiogyne cylindrocarpa* and *Aglaia mariannensis*. Some areas of upper canopy trees consist of *Ficus prolixa* and *Intsia bijuga*. Mid-canopy trees that occur frequently include *Premna serratifolia*, *Meiogyne cylindrocarpa*, *Aglaia mariannensis*, *Morinda citrifolia*, *Cycas micronesica*, and *Psychotria mariana*. *Eugenia palumbis*, *Elaeocarpus joga*, *Pandanus tectorius*, *Cocos nucifera*, and *Maytenus thompsonii* were occasionally encountered throughout the forest.
- ***Vitex* Forest.** This vegetation type is a monotypic stand of *Vitex parviflora* with some areas of *Talipariti simile* scattered throughout the community. The understory of this community is often dominated by *Meiogyne cylindrocarpa* or *Aglaia mariannensis* as a small tree, shrub, or sapling.

3.2 Surveys Conducted for the Proposed Action

Surveys for vegetation communities, flora, and fauna, including ESA-listed species, were conducted between July 6 and September 17, 2021 (Chamorro Standard Time), within the MSA-1 and North Ramp construction footprints, to include a 30-meter (approximately 100-foot) buffer zone. Results of the survey are included in the *Biological Survey Report* in **Appendix B**.

Additionally, the *Biological Survey Report* summarizes the findings from previous surveys of the construction footprint from other consultations, specifically the *Biological Assessment for the Environmental Impact Statement, Establishment and Operation of an Intelligence, Surveillance, and Reconnaissance, and Strike Capability at Andersen AFB, Guam* (Andersen AFB 2006) and the *Biological Assessment for the Environmental Assessment, Construction of 48 Munition Storage Igloos at Andersen Air Force Base, Guam* (Andersen AFB 2020).

3.3 ESA-Listed Species within the Action Area

Based on the results of surveys conducted within the portions of the action area that are proposed for construction, five ESA-listed plant species and one ESA-listed mammal species, Mariana fruit bat, are present within the North Ramp construction footprint (see **Table 3**). Only one plant species, *Cycas micronesica*, was confirmed to occur within the MSA-1 construction footprint, and Mariana fruit bat is likely to occur.

The following sections provide a discussion of each ESA-listed species that occurs within the construction footprint, and includes a brief species description, regulatory status, major threats, current distribution and population, and available information on populations within the action area or Andersen AFB.

Table 3. ESA-listed Species Observed within the North Ramp and MSA-1 Construction Footprints

Common Name	Scientific Name	Federal Listing Status	Number of Observations
Fadang[Ch]	*Cycas micronesica*	Threatened	416
NCN	*Tabernaemontana rotensis*	Threatened	99
Cebello halumtan[Ch]	*Bulbophyllum guamense*	Threatened	1
NCN	*Dendrobium guamense*	Threatened	2
NCN	*Tuberolabium guamense*	Threatened	100
Fanihi[Ch]; Mariana Fruit Bat	*Pteropus mariannus mariannus*	Threatened	10[a]

Ch= Chamorro name; NCN= No common name
[a] Results of on-going monitoring and annual survey events are not reflected by count.

3.3.1 *Cycas micronesica*

Species Description. *Cycas micronesica*, commonly known as fadang in Chamorro or cycad, is a stout-trunked tree in the cycad family. Leaves are restricted to the terminal end of the trunk, or to the terminal end of branches that may form as the tree gets older. In addition to seed germination, this species can be propagated through stem cuttings or vegetative propagules, also known as pups, and nurtured to produce roots capable of growing into a healthy adult tree (Marler 2014; Marler and Cruz 2017).

Status and Threats. In 2003, the *Cycas micronesica* population began to decline rapidly due to arthropod pest damage caused by Asian cycad scale (*Aulacaspis yasumatsui*), cycad blue butterfly (*Chilades pandava*), leaf miner (*Erechthias* sp.), and the native longhorn beetle (*Dihammus marianarum*). In addition to the pests listed above, these plants are at risk from ungulate browsing. In 2013, it was determined that cycad mortality had reached 92 percent on Guam; this decline was mostly attributed to cycad scale (Marler and Lawrence 2012). In October 2015, *Cycas micronesica* was listed as a federally threatened species (USFWS 2015b).

Distribution and Population. *Cycas micronesica* are typically found growing within limestone native and degraded forests, limestone cliffs, forest edges, ravine forests, and savanna complex summits. They are found on the islands of Guam, Rota, Tinian, and Pagan in the Mariana Islands, Republic of Palau, and Federated States of Micronesia. The population is commonly known to occur abundantly in northern areas of Guam; however, as of 2020, it was estimated that 344,000 individuals were on Guam (USFWS 2020a). This estimate was determined by applying the 8.1 percent average annual rate of decline of the 2012 *Cycas micronesica* population on Guam (USFWS 2020a).

Populations within the Construction Footprint. A total of 416 *Cycas micronesica* were observed within both construction footprints during the 2021 surveys, including 97 within the MSA-1 (**Figure 7**) and 319 within the North Ramp (**Figure 8**) construction footprints. Each tree was assigned a health rating. Trees assigned a good or fair health rating are considered candidates for salvage and transplant; however, parts of individuals in poor condition may also be suitable for salvage and propagation to improve health prior to transplanting. Trees that were dead, with no signs of life and no potential for salvage, were not recorded. See **Table 10** in **Appendix B** for the health rating summary for *Cycas micronesica*.

Figure 7. ESA-listed Plants Located within the MSA-1 Construction Footprint

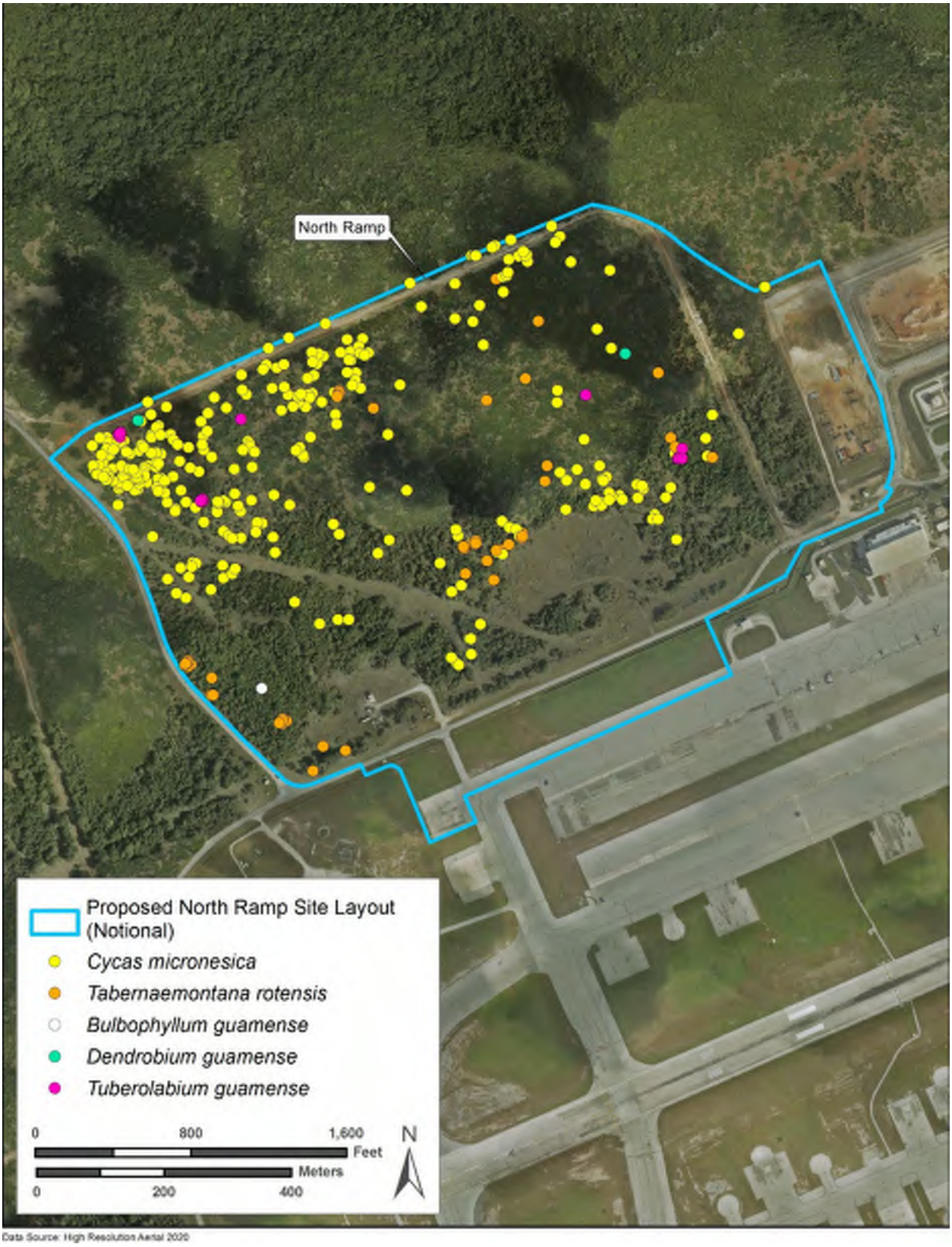

Figure 8. ESA-listed Plants Located within the North Ramp Construction Footprint

Cycas micronesica within the North Ramp construction footprint were found primarily within the degraded limestone forest and shrub/grassland vegetation communities. Living *Cycas micronesica* varied in health condition, and several appeared to have damage to the crown or trunk related to the non-native Philippine deer. Many *Cycas micronesica* leaves were also observed to have cycad scale and cycad blue butterfly damage. There was no apparent correlation between the *Cycas micronesica* location within the construction footprint and the health of individual trees. There were no observations of *Cycas micronesica* seedlings or juveniles, indicating that recruitment of new trees was not occurring.

3.3.2 *Tabernaemontana rotensis*

Species Description. *Tabernaemontana rotensis* is a small- to medium-sized tree in the *Apocynaceae* family typically found within limestone forests, or within primary or late successional secondary growth forests. This species can be considered an "edge" species, and is often found within canopy gaps and occasionally along roadsides (USFWS 2000). *Tabernaemontana rotensis* has been observed within deep shade to full sun, and is generally found within areas with little to no slope (less than 15 precent), most commonly co-occurring with *Cycas micronesica* (University of Guam 2007). Seedlings compete for resources when located near mature trees; however, this tree is relatively easy to propagate from seed and considered a pioneer species (USFWS 2017).

Status and Threats. *Tabernaemontana rotensis* was listed as a threatened species in October 2015 (USFWS 2015b). This species was previously proposed for listing in 2000 (65 FR 35025), but the USFWS refrained from listing it due to the taxonomic classification of *Tabernaemontana* on all Mariana Islands as one species (69 FR 18499). Threats to this species include habitat loss, agricultural destruction, urban development, invasive plants and animals, extreme weather events, fires, and a lack of avian seed dispersers (USFWS 2015b, 2017).

Distribution and Population. *Tabernaemontana rotensis* is found on the islands of Guam and Rota in the Mariana Islands. As of 2020, the abundance of *Tabernaemontana rotensis* on Guam was approximately 15,332 naturally occurring individuals (USFWS 2020b).

Populations within the Construction Footprint. No *Tabernaemontana rotensis* were observed within the MSA-1 construction footprint, and a total of 99 trees were observed within the North Ramp construction footprint (**Figure 8**). Size and maturity of seedlings and mature plants were recorded to determine the plant's likelihood to produce seed that could be collected, germinated, and propagated for future outplanting. See **Table 11** in **Appendix B** for the health rating summary for *Tabernaemontana rotensis*.

3.3.3 *Bulbophyllum guamense*

Species Description. *Bulbophyllum guamense*, commonly known as Cebello halumtan in Chamorro, is an epiphytic orchid endemic to the Mariana Islands. This orchid species has numerous long stems and narrow, alternate leaves with parallel veins. The flowers are creamy-white with a pale-yellow lip and occur in two-flowered racemes. *Bulbophyllum guamense* prefers moist and humid areas on tree branches and trunks, and grows within mat-like formations of pseudobulbs (GPEPP 2021).

Status and Threats. In October 2015, *Bulbophyllum guamense* was listed as a federally threatened species (USFWS 2015b). Threats to this species include habitat loss and destruction from cultivation, urban development, invasive plants and animals, extreme weather events, and predation by invertebrates such as slugs. It is anticipated that climate change may also impact *Bulbophyllum guamense* (DON 2019; USFWS 2015b).

Distribution and Population. *Bulbophyllum guamense* occurs on the islands of Guam and Rota in the Mariana Islands. This species is found growing on canopy to low canopy native and non-native trees within moist limestone and ravine forests on Guam. Historically, *Bulbophyllum guamense* have been observed to the west and northeast of the North Ramp and southeast of MSA-1 (DON 2019). During surveys conducted between October 2019 and April 2022, 7,434 individuals of this species were observed on Guam (NAVFAC Marianas 2022b).

Populations within the Construction Footprint. One *Bulbophyllum guamense* was observed within the North Ramp construction footprint during the 2021 surveys (**Figure 8**), and the host tree was a native *Intsia bijuga*.

3.3.4 *Dendrobium guamense*

Species Description. *Dendrobium guamense* (no common name) is an epiphytic orchid with crowded stems, endemic to the Mariana Islands. Historically, *Dendrobium guamense* has been observed in clumps on tree branches of coastal lowland limestone forests. This orchid species has cylindrical stems up to 60 centimeters tall that tend to taper at both ends. Two flowers arise together from a pedicel between two leaves (DON 2019). *Dendrobium guamense* prefers moist and humid areas on tree branches and trunks with filtered sunlight (GPEPP 2021; 94th AAMD 2017).

Status and Threats. In October 2015, *Dendrobium guamense* was listed as a federally threatened species (USFWS 2015b). This orchid species is threatened by urban and agricultural development, typhoons, fires, rats, and invasive plants (DON 2019).

Distribution and Population. *Dendrobium guamense* occurs throughout the Mariana Islands, including the islands of Guam, Rota, Tinian, and Aguiguan. They are found within canopy trees, growing on the tree trunks and branches of native and non-native trees within limestone and ravine forests. Recent surveys identified this species within limestone native forests north and northeast of Northwest Field and within the Pati Point limestone forests (DON 2019). During surveys conducted between October 2019 and April 2022, 4,113 individuals of this species were observed on Guam (NAVFAC Marianas 2022b).

Populations within the Construction Footprint. Two *Dendrobium guamense* were observed on two host trees, *Premna serratifolia* and *Meiogyne cylindrocarpa,* within the North Ramp construction footprint during the 2021 surveys (**Figure 8**).

3.3.5 *Tuberolabium guamense*

Species Description. *Tuberolabium guamense* (no common name) is an epiphytic monopodial orchid endemic to the Mariana Islands. This orchid species has leathery ovate-oblong leaves with roots that elevate the plant from the host tree trunk. Small white flowers found on the rachis

are 3.5 centimeters long and are open for 1 or 2 days at various times of the year. *Tuberolabium guamense* prefers moist and shady areas, less than 60 percent light, and higher elevations of limestone forests (GPEPP 2021).

Status and Threats. In October 2015, *Tuberolabium guamense* was listed as a federally threatened species (USFWS 2015b). This orchid species is threatened by urban and agricultural development, typhoons, fires, rats, and invasive plants (DON 2019).

Distribution and Population. *Tuberolabium guamense* is known to occur on the islands of Guam and Rota in the Mariana Islands. Historically, *Tuberolabium guamense* has been found within limestone forests on Andersen AFB, including west and northwest of the North Ramp construction footprint. During surveys conducted between October 2019 and April 2022, 57,962 individuals of this species were observed on Guam (NAVFAC Marianas 2022b).

Populations within the Construction Footprint. Out of the three ESA-listed orchid species, *Tuberolabium guamense* was the most frequently observed species, with 100 individuals recorded on 19 host trees within the North Ramp construction footprint (**Figure 8**). Evidence of reproduction was observed, with 27 of the 100 recorded plants being seedlings that were considered too small to be suitable for salvage due to the high potential for transplant shock. Common host trees include *Premna serratifolia, Aglaia mariannensis, Talipariti simile,* and *Vitex parviflora.*

3.3.6 Mariana Fruit Bat

Species Description. *Pteropus mariannus mariannus,* commonly known as fanihi in Chamorro or the Mariana fruit bat, is a subspecies endemic to Guam and the Mariana Islands. This medium-sized frugivorous bat in the *Pteropididae* family, weighs between 0.66 and 1.15 pounds, and has a black or brown underside and golden-brown shoulders. This species has been observed within multiple forest types: primary and secondary limestone forest; volcanic (or ravine) forest; and old coconut plantations with habitats dominated by native trees where bats can roost in large, emergent trees. Foraging can occur within areas with fruiting or flowering trees. Colonies typically occur within remote sites away from human interaction. The Mariana fruit bat has been observed feeding on 45 plant species (NAVFAC Marianas 2017).

Status and Threats. The Mariana fruit bat was originally listed as federally endangered in August 1984; however, in 2005, the Mariana fruit bat was determined to be a subspecies and reclassified as a threatened species throughout its range of Guam and the Commonwealth of the Northern Mariana Islands (USFWS 2005). Major threats to this species include habitat degradation and loss, ungulate effects on native forests, illegal hunting, and invasive brown treesnakes that may prey on juvenile fruit bats (USFWS 2005). Other threats may include disturbance from natural events, development, and military training. The Mariana Islands occasionally experience severe typhoons and storms, resulting in habitat loss, destruction of food-sourced trees, and behavioral changes in fruit bats.

Distribution and Population. A total of 26,075 acres of recovery habitat is available for bats on Guam (USFWS 2016), with approximately 140 of those acres falling within the North Ramp (135 acres) and MSA-1 (5 acres) construction footprints (**Figure 9**).

Figure 9. Mariana Fruit Bat Sign Recorded within the North Ramp Construction Footprint

The Mariana fruit bats form colonies ranging between a few to 2,000 individuals; however, colonies of more than 1,000 individuals are not common, particularly if roosts are smaller. This species groups into harems (one male with multiple females) or bachelor groups (predominantly males), but males have also been observed roosting solitarily (USFWS 2009). Mariana fruit bats forage primarily within primary and secondary limestone forests, and occasionally forage for fruit within agricultural forests. By 1995, the Guam population of the Mariana fruit bat was between 300 and 500 individuals (USFWS 2004). Historically, most of the Guam fruit bat population was located at Pati Point, below the northern runway of Andersen AFB; however, it was noted that this colony was in decline in 2002, with fewer than 100 individuals observed in 2003 (SWCA 2012).

Andersen AFB is implementing the 2017 *Mariana Fruit Bat Management Plan for Andersen Air Force Base, Guam* (NAVFAC Marianas 2017), which includes base-wide annual bat population assessments to locate colonies and assess flight paths; quarterly Pati Point monitoring; and pre-construction surveys to determine presence/absence of individuals. As of 2017, there were three known bat aggregation areas: Pati Point, the Habitat Management Unit, and the valley between Tarague and Tagua Points, with detections of small aggregations of fruit bats within the karst ravine area north of the Explosive Ordnance Disposal building (Building 2600) and along the cliff line above the Combat Arms Training and Maintenance Range (NAVFAC Marianas 2017). Base-wide surveys done between 2017 and 2021 recorded the following population sizes for the entire installation (University of Guam 2020):

- **2017:** 32 bats recorded; estimated population size of 57 to 68 individuals
- **2018:** 32 bats recorded; estimated population size of 57 to 76 individuals
- **2019:** 46 bats recorded; estimated population size of 79 to 89 individuals
- **2020:** 33 bats recorded; estimated population size of 69 to 92 individuals

Populations within the Construction Footprint. Over the past decade of base-wide Mariana fruit bat surveys, bats have been recorded from monitoring stations within and around the North Ramp and MSA-1 construction footprints (see **Appendix B** for historical sighting points), indicating regular use of both construction footprints by fruit bats. In early 2020, an aggregation area (roost area) was identified. Surveys and bat counts within the roost area are not routinely conducted to avoid flushing.

During the annual survey event in August 2020, an area of high bat activity was recorded at Station 67 (**Figure 9**). Routine monitoring began at Station 67 in October 2020, with multiple bat surveys conducted each month. Between October 2020 and August 2021, 35 monitoring events recorded more than 387 bat detections that averaged approximately 11 bats (**Table 4**). The number of bat detections in 2021 has ranged from a low of 2 observations during multiple surveys to a peak of 67 observations in February 2021. The 2020 Andersen AFB base-wide bat survey estimated the Mariana fruit bat population for the entire installation was between 69 and 92 individuals (University of Guam 2020).

In August and September 2021, more than 25 incidental observations of Mariana fruit bat sign, including bat droppings and scent, were detected within the North Ramp construction footprint (**Figure 9**). These incidental observations of bat sign were often detected on *Aglaia mariannensis* and *Premna serratifolia,* with neighboring *Ficus prolixa* trees, indicating a possible

preferred food source for the bats foraging within the construction footprint. In September 2021, a bat protocol survey recorded a total of 10 bat sightings at 6 vantage points around the North Ramp construction footprint (**Figure 9**). The MSA-1 construction footprint was excluded from the protocol surveys in 2021 due to unavailable escorts during dawn and dusk hours; however, this area is assumed to have bat presence based on historical observations.

Table 4. Bat Observations from Station 67, October 2020 through August 2021

Date	Number of Bat Detections
10/21/2020	3
10/28/2020	1
11/4/2020	9
11/11/2020	8
11/14/2020	3
11/18/2020	13
11/25/2020	11
12/2/2020	11
12/9/2020	8
12/16/2020	11
12/23/2020	9
12/30/2020	5
1/6/2021	17
1/13/2021	7
1/20/2021	7
1/27/2021	7
2/3/2021	37
2/10/2021	9
2/17/2021	21
2/24/2021	67
3/17/2021	44
3/24/2021	8
4/1/2021	8
4/7/2021	6
4/14/2021	10
4/21/2021	15
5/14/2021	4
5/21/2021	9
5/26/2021	3
6/17/2021	3
6/24/2021	3
7/16/2021	2
7/23/2021	3
8/6/2021	2
8/13/2021	3

Source: University of Guam 2020; Andersen AFB 2021

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4. Effects of the Proposed Action

This section describes how the Proposed Action has the potential to affect ESA-listed species. Effects of the Proposed Action are all consequences to ESA-listed species that are caused by the Proposed Action and would not occur but for the Proposed Action. These consequences are reasonably certain to occur, may occur later in time, and may occur outside the immediate area involved in the action.

A consequence is considered reasonably certain to occur based on clear and substantial information and using the best scientific and commercial data available. Factors that were considered when evaluating whether the Proposed Action, activities caused by the Proposed Action (but not part of the Proposed Action), or activities reviewed under cumulative effects are reasonably certain to occur included:

1. Past experiences with activities that have resulted from actions that are similar in scope, nature, and magnitude to the Proposed Action;
2. Existing plans for the activity caused by the Proposed Action; and
3. Any remaining economic, administrative, and legal requirements necessary for the activity to go forward.

Section 4.1 discusses the potential effects of the Proposed Action that may act as stressors on ESA-listed species. **Section 4.2** describes how those stressors may result in potential effects on each species that occur within the action area. Analyses of potential effects from stressors also incorporates the impact minimization, avoidance, and conservation measures (**Section 2.3.2**) that would be implemented. Following the analysis of effects for each species, an effects determination is provided. **Section 4.3** discusses cumulative effects that the Proposed Action may have on ESA-listed species.

4.1 Stressors Associated with the Proposed Action

The following stressors have the potential to affect ESA-listed species as a result of the Proposed Action:

- Physical disturbance, injury, or mortality to ESA-listed plants and animals
- Habitat loss and possible degradation of surface and groundwater due to vegetation removal during site preparation
- Degradation of habitat during construction and operations from noise, lighting, traffic, and human activity
- Habitat modification from introduction or displacement of invasive species or erosion

Potential effects may be associated with proposed site preparation and construction (e.g., ground-disturbing activities) and operations (e.g., aircraft parking, munitions storage), or would be caused by or result from project activities later in time (e.g., increased potential for non-native, invasive species moving into the area after disturbance). Potential stressors resulting from the Proposed Action are described in this section and summarized in **Table 5**.

Table 5. Stressors Associated with Andersen AFB Infrastructure Upgrades

Stressor	Stressor Sources	ESA-listed Species Potentially Affected	Avoidance, Minimization, or Mitigation Measures (Section 2.3 and Appendix A)
Physical Disturbance			
Injury or Mortality	Physical removal of genetically unique individual plants during site preparation Physical removal of roost trees during roosting	*Cycas micronesica* *Tabernaemontana rotensis* *Bulbophyllum guamense* *Dendrobium guamense* *Tuberolabium guamense* Mariana fruit bat	Conservation Measures for Salvage, Seed Collection, and Transplant for ESA-listed Plants Conservation Measures for Maintenance of Transplants and Transplant Areas BMPs for Pre-construction Plant Surveys BMPs for Pre-disturbance Bat Surveys BMPs for Contractor Education
Flushing from Roost	Human presence around roost trees within construction footprint Construction-generated noise	Mariana fruit bat	BMPs for Pre-disturbance Bat Surveys BMPs for Contractor Education Conservation Measures for Bat Research and Monitoring
Habitat Loss			
Vegetation Removal	Reduction in available native trees for roosting and reproduction Reduction of available forage (food sources)	Mariana fruit bat	Conservation Measures for Establishment of Bat Habitat Enhancement Area, Seed Collection, Outplanting, and Maintenance of the Bat Habitat Enhancement Area Conservation Measures for Invasive Species Management for Bat Habitat Enhancement
Habitat Degradation			
Noise	Degradation of adjacent foraging habitat due to construction-generated noise (short term) and operational noise (long term)	Mariana fruit bat	Conservation Measures for Establishment of Bat Habitat Enhancement Area, Seed Collection, Outplanting, and Maintenance of the Bat Habitat Enhancement Area BMPs for Site Preparation and Construction Activities at Night BMPs for Pre-disturbance Bat Surveys Conservation Measures for Bat Research and Monitoring
Lighting	Increased lighting within construction footprint from construction security lighting (during site preparation and construction) or exterior lighting on buildings and facilities (operations)	Mariana fruit bat	BMPs for Lighting Design to Minimize Number, Intensity, and Height of Outdoor Lighting Conservation Measures for Bat Research and Monitoring

Stressor	Stressor Sources	ESA-listed Species Potentially Affected	Avoidance, Minimization, or Mitigation Measures (Section 2.3 and Appendix A)
Traffic	Re-routing of routine traffic (approximately 1,064 trips per day) on Marianas Boulevard northwest to 5th Street along the western perimeter of the North Ramp construction area, and traffic on the proposed road along the northern perimeter of the North Ramp	Mariana fruit bat	Conservation Measures for Bat Research and Monitoring
Human Presence	Degradation of adjacent foraging habitat due to increased human activity within the area during construction (short term) and operations (long term)	Mariana fruit bat	BMPs for Pre-disturbance Bat Surveys BMPs for Contractor Education Conservation Measure for an Andersen AFB CLEO Conservation Measures for Bat Research and Monitoring
Habitat Modification			
Invasive Species	Spread of invasive plant species currently within the construction footprint to adjacent habitat, or import of new invasive species to Guam through construction Introduction of high-risk invasive species from other areas of Guam (e.g., little fire ant) Displacement of invasive predatory wildlife species (e.g., brown treesnakes, feral cats) from construction footprint into adjacent habitats Displacement of feral ungulates from construction footprint into adjacent habitats	*Cycas micronesica* *Tabernaemontana rotensis* *Bulbophyllum guamense* *Dendrobium guamense* *Tuberolabium guamense* Mariana fruit bat	BMPs for HACCP Plan Development and Implementation BMPs for Monitoring of ESA-listed Plants in Adjacent Habitat BMPs for Contractor Education BMPs for Brown Treesnake Detector Dog Inspections of Aircraft and Cargo Departing Andersen AFB for Other Locations BMPs for JRM INRMP Invasive Species Management Actions Conservation Measures for Salvage, Seed Collection, and Transplant for ESA-listed Plants Conservation Measures for Maintenance of Transplants and Transplant Areas Conservation Measures for Invasive Species Management for Bat Habitat Enhancement Area Conservation Measures for Bat Research and Monitoring
Erosion	Degradation of adjacent habitat from erosion within construction footprint	*Cycas micronesica* *Tabernaemontana rotensis* *Bulbophyllum guamense* *Dendrobium guamense* *Tuberolabium guamense* Mariana fruit bat	BMPs in Accordance with a Stormwater Pollution and Prevention Plan and Erosion Control Plan Conservation Measures for Salvage, Seed Collection, and Transplant for ESA-listed Plants

4.1.1 Physical Disturbance

The Proposed Action has the potential to injure or kill ESA-listed species located within the limits of construction, primarily during vegetation clearing for site preparation. The site would be prepared by clearing vegetation from the entire 203-acre construction footprint at both the North Ramp and MSA-1. More than 148.7 acres of vegetated land, including 127.2 acres of limestone degraded forest, would have all plants removed, including ESA-listed plants; 54.2 acres of land categorized as “developed” would also be disturbed (see **Table 2**).

There is low potential for Mariana fruit bats to be injured or killed during vegetation clearing activities if roosting near trees that are cleared. Additionally, construction-generated noise has the potential to disturb bats by flushing them from a roost location either inside or outside of the construction footprint boundaries. Individual pieces of heavy equipment typically generate noise levels of 80 to 90 A-weighted decibels (dBA) at a distance of 50 feet (FHWA 2021). With multiple items of equipment operating concurrently, noise levels can be relatively high within several hundred feet of active construction. Construction noise would be loud (i.e., greater than 85 dBA) both within and adjacent to the sites, and could potentially be audible for approximately 1 to 1.5 miles.

Removal of ESA-listed plant species from their in situ locations within the construction footprint cannot be avoided; however, implementation of the conservation measures to either salvage and transplant or collect seed, propagate, and outplant the five affected ESA-listed plant species would preserve the genetic diversity of the individuals being lost.

Through implementation of pre-construction bat surveys within the construction footprints and through contractor education and training to promote awareness of bats, the potential for injury or mortality to roosting bats would be avoided. Construction-related noise has the potential to result in physical disturbance by flushing bats from roost sites that are within the audible range.

4.1.2 Habitat Loss

The Proposed Action has the potential to affect ESA-listed species through the removal of limestone degraded and native forest. The proposed construction would remove vegetation from 203 acres. The largest vegetation type within the construction footprint, the limestone degraded forest, contains a mixture of native and non-native vegetation consistent with similar forests throughout Andersen AFB and northern Guam. Native vegetation was most frequently observed within the inner areas of the North Ramp construction footprint. Native species recorded within the construction footprint are included in **Appendix B.**

Vegetation clearing for the Proposed Action may result in changes in distribution of foraging for bats during construction and operations. The irreversible loss of limestone degraded forest is approximately 3.9 percent relative to the amount of available limestone degraded forest habitat at Andersen AFB (see **Table 6**).

Table 6. Vegetation Communities Impacted within the North Ramp and MSA-1 Construction Footprints Relative to Andersen AFB

Vegetation Type/ Land Cover	Construction Footprint	Acres	% of Construction Footprint	% of Construction Footprint Acres on Andersen AFB[a]
Limestone Degraded Forest	North Ramp	127.2	66.5	3.9
Limestone Native Forest	North Ramp	0.4	<1	<0.1
Other Shrub/Grassland	North Ramp	15.9	8.3	1.8
Developed Land	North Ramp	47.9	25.0	1.0
Total	**North Ramp**	**191.4**	**100**	**1.2**
Vitex Forest	MSA-1	5.2	45.2	<0.1
Developed Land	MSA-1	6.3	54.8	0.2
Total	**MSA-1**	**11.5**	**100**	**<0.1**

Source: NAVFAC Marianas 2016
[a] Based on vegetation types on 15,375 acres of Andersen AFB

The effects of habitat loss and reduction of available forage would be mitigated through establishment of a 173-acre bat habitat enhancement area. In addition to potentially being used for the transplant and outplanting of ESA-listed plants, the bat habitat enhancement area would be used for outplanting of native tree seedlings germinated from seed collected within the construction footprint. Target species for seed collection may include, but are not limited to, *Aglaia mariannensis*, *Ficus* spp., *Elaeocarpus joga*, *Eugenia reinwardtiana*, *Meiogyne cylindrocarpa*, *Intsia bijuga*, *Artocarpus mariannensis*, *Pandanus tectorius*, and *Pisonia grandis*.

4.1.3 Habitat Degradation

The Proposed Action has the potential to affect ESA-listed species by degrading habitat within the action area surrounding the construction footprint during site preparation, construction, and operations. The habitat adjacent to the northern and western perimeters of the construction footprint includes large tracts of undeveloped limestone native and degraded forest that have been historically documented as being used for Mariana fruit bat foraging (University of Guam 2020). Bats have been recorded foraging within these adjacent habitats.

Noise within the action area surrounding the proposed site preparation and construction activities would be subject to short-term increases, occurring primarily during daytime hours. Noise during foraging hours would not be expected to affect Mariana fruit bat during site preparation and many construction activities, since most of those activities would not occur at night and would end 30 minutes prior to sunset. Specific construction activities, such as removal of Munitions of Concern and Unexploded Ordnance as well as pouring and cutting of concrete, would be required to occur at night and may result in bats avoiding the action area while those activities are taking place.

No long-term increases in the overall noise environment would be expected from aircraft operations or aircraft maintenance activities under the Proposed Action. The proposed facilities would include back-up generators that would be used only during power outages and periodic testing. No changes in the number of aircraft operations would occur; however, some aircraft activities (e.g., idling, taxiing, maintenance) and associated noise could be relocated to the North Ramp. Additional information on expected noise levels from the proposed aircraft

operations is included in **Section 4.2.6**. Aircraft using the North Ramp would taxi under their own power; aircraft would not conduct runups (i.e., the final checks performed by pilots prior to take-off) on the apron. The existing trim pad would continue to support aircraft engine power checks and routine maintenance procedures.

Lighting associated with site preparation and construction would be minimal and limited to security and safety lighting on equipment. New outdoor lighting installed on facilities would be hooded and designed to provide the lighting levels required in the Unified Facilities Criteria while minimizing disruptions to Mariana fruit bat foraging or roosting activities.

Traffic associated with construction assumes that the North Ramp and MSA-1 construction footprints would require a workforce of 500 construction workers, with an average of two construction workers per vehicle traveling to and from the installation daily, resulting in an additional 250 vehicle roundtrips to the construction footprints. In addition, it is assumed there would be one vehicle for delivery of material for every 25 workers daily (20 total vehicles). It is anticipated that construction traffic would continue to access the construction footprint via Marianas Boulevard, directly into the construction footprint; however, general base traffic would be routed northwest around the North Ramp construction footprint on 5th Street. Based on the existing volume of traffic on Marianas Boulevard, it is anticipated that up to 1,064 daily trips could be re-routed onto 5th Street. During operations, general base traffic would occur along the proposed new road along the northern perimeter of the North Ramp. Long-term increases in the noise environment from traffic would occur, and additional information on expected noise levels from traffic is included in **Section 4.2.6**. Little is known about the effects of increased traffic noise and vehicle presence on roosting bats.

While increased human presence associated with construction and operations is not anticipated outside the construction footprint, those adjacent habitats may still see a decline in foraging activity related to the proximity of equipment, infrastructure, and humans.

4.1.4 Habitat Modification

The Proposed Action has the potential to affect ESA-listed plant species and the Mariana fruit bat through modification of the habitat within the action area surrounding the construction footprint through factors such as introduced or displaced invasive species or through erosion as a result of site preparation and construction. A number of BMPs and conservation measures would be implemented to avoid or minimize the potential for habitat modification (**Section 2.3** and **Appendix A**).

While it is not anticipated that fill material would be imported from outside Andersen AFB, construction within the North Ramp construction footprint would include grading to create slopes of approximately 1.5 to 10 percent, and the grading could require approximately 35 feet of fill in some locations. It is assumed that the majority of fill would come from earth moved within the North Ramp construction footprint or from borrow areas within the installation boundary. This amount of earth moving would create the potential for invasive plant species currently within the construction footprint to spread into adjacent habitats. Likewise, the transport of equipment and personnel from other locations on Guam could result in inadvertent introduction of seeds from invasive species. To minimize this threat, the construction contractor would develop and

implement a biosecurity plan, referred to as a HACCP Plan, to ensure that invasive species are not moved or introduced. HACCP Plan implementation would include rapid response to eradicate any high-risk invasive species found within the construction footprint. The HACCP Plan would also target high-risk invasive wildlife and insects, specifically little fire ant, which is currently only found in one location near the Andersen AFB perimeter. Additionally, invasive species management actions outlined in the 2019 JRM INRMP would continue to be implemented to prevent the spread of invasive species (DON 2019).

Vegetation clearing associated with the Proposed Action may result in the displacement of destructive and predatory wildlife into adjacent habitats. Surveys of the North Ramp construction footprint detected Philippine deer and feral cats, and brown treesnakes would be expected to occur (**Appendix B**). Existing Brown Treesnake Control and Interdiction instructions (Joint Regions Marianas Instruction 5090.10A) for the control and interdiction of brown treesnakes and other invasive species management requirements would continue to be followed for the movement and inspection of equipment, supplies, and other materials associated with construction.

Erosion from clearing and grading has the potential to modify adjacent habitats through the deposit of sedimentation that affects vegetation. A Stormwater Pollution Prevention Plan and an Erosion and Sediment Control Plan would be prepared and implemented to minimize erosion and sedimentation that has the potential to modify habitats for terrestrial ESA-listed species. As an additional BMP, ESA-listed plants within 10 feet of the construction perimeter would be monitored until construction has concluded to confirm no impacts from construction activities are occurring.

4.2 Effects of the Proposed Action on ESA-Listed Species

As required for a request to initiate formal consultation (50 Code of Federal Regulations 402.14(c)), this section describes the manner in which the Proposed Action described in this BA (**Section 2.1**) and the associated stressors (**Section 4.1**) may affect ESA-listed species.

4.2.1 *Cycas micronesica*

Anticipated effects to *Cycas micronesica* from the Proposed Action, which include the implementation of BMPs and conservation measures, consist of physical disturbance, including mortality, and habitat modification. It is anticipated that 416 *Cycas micronesica* would be removed during vegetation clearing at the North Ramp and MSA-1 construction footprints (**Table 7**). An additional 17 *Cycas micronesica* recorded within approximately 10 feet of the North Ramp and MSA-1 construction footprints may be subject to other impacts from dust, erosion, or sedimentation; introduction of invasive pests; or displacement of ungulates.

Table 7. Summary of *Cycas micronesica* within the Construction Footprint

Construction Footprint	*Cycas micronesica* within the Construction Footprint Subject to Removal	*Cycas micronesica* within 10 Feet of the Construction Footprint Subject to Other Impacts	Total
North Ramp	319	8	327
MSA-1	97	9	106
Total	**416**	**17**	**433**

Effects to *Cycas micronesica* would be mitigated through the implementation of conservation measures to salvage and transplant healthy *Cycas micronesica* for long-term protection against ungulates, specifically for protection of seedlings against herbivory (**Appendix A**). Maintenance of transplanted *Cycas micronesica* would include treatment with insecticides to combat all life stages of cycad scale. Transplanted plants would benefit from the conservation measures included in the Proposed Action. If plants remain within their in situ locations, a continued decline in health from pests, specifically cycad scale, and damage from ungulates would be expected to occur.

Impacts to plants outside the construction footprint would be minimized through a series of BMPs. Initial demarcation of the construction perimeter would avoid inadvertent damage to those plants. Use of dust screens and erosion control devices would minimize effects from heavy equipment and earth moving within adjacent areas. A contractor education program would ensure workers avoid *Cycas micronesica* outside the construction footprint. Pre-construction surveys combined with regular monitoring of the perimeter plants would likewise minimize impacts through reporting and corrective action if effects to plants outside the perimeter are observed.

The removal represents 0.12 percent of the estimated *Cycas micronesica* population on Guam as of 2020 and 0.16 percent of the estimated population on Andersen AFB (Marler 2014, USFWS 2020a). With the transplant survival criteria outlined in the conservation measures, the estimated *Cycas micronesica* loss is reduced to 0.09 percent of Guam's and 0.13 percent of Andersen AFB's total population.

Conclusion for *Cycas micronesica*
The Proposed Action may affect and would likely adversely affect approximately 416 individual *Cycas micronesica.*

4.2.2 *Tabernaemontana rotensis*

Anticipated effects to *Tabernaemontana rotensis* from the Proposed Action, which include the implementation of BMPs and conservation measures, consist of physical disturbance, including mortality, and habitat modification. It is anticipated that 99 *Tabernaemontana rotensis* would be removed during vegetation clearing at the North Ramp construction footprint; no *Tabernaemontana rotensis* were recorded during surveys of MSA-1. One additional mature *Tabernaemontana rotensis* was recorded within approximately 10 feet of the construction

footprint and has the potential to be affected from dust, erosion, or sedimentation; introduction of invasive pests; or displacement of ungulates (pigs and deer).

The Proposed Action includes conservation measures to mitigate for the removal of *Tabernaemontana rotensis*, including collection of seeds, propagation in a nursery setting, and outplanting of germinated seedlings into an ungulate-free location. Since natural dispersal of seeds by frugivorous birds is no longer occurring on Guam, outplanting within multiple vegetation plots on Andersen AFB would support an increase in the distribution of the species. Methods for propagation of cuttings have also been successful, improving the potential for exceeding the success criteria if seeds from mature trees are not produced.

The individual *Tabernaemontana rotensis* located outside the construction footprint may be subject to other effects from construction, but those would be minimized through the use of BMPs such as dust screens, perimeter demarcation, pre-construction surveys and monitoring, and contractor education. While *Tabernaemontana rotensis* are considered very edge tolerant, with occurrences along forest edges (Raulerson and Reinhart 1991), the proposed re-route of traffic around the North Ramp along 5th Avenue may have impacts from dust and exhaust, but would continue to be monitored as part of the Proposed Action.

The removal of *Tabernaemontana rotensis* represents 0.65 percent of the estimated population of 15,332 on Guam as of 2020 (USFWS 2020b); however, ongoing surveys for these plants have recorded higher numbers than previously expected. With the outplant survival criteria outlined in the conservation measures, the estimated *Tabernaemontana rotensis* loss is reduced to 0.49 percent of Guam's total population.

Conclusion for *Tabernaemontana rotensis*
The Proposed Action may affect and would likely adversely affect approximately 99 individual *Tabernaemontana rotensis.*

4.2.3 *Bulbophyllum guamense*

Anticipated effects to *Bulbophyllum guamense* from the Proposed Action, which include the implementation of BMPs and conservation measures, consist of physical disturbance, including injury or mortality, and habitat modification. It is anticipated that one host tree for one *Bulbophyllum guamense* would be removed during vegetation clearing at the North Ramp construction footprint; no *Bulbophyllum guamense* were recorded during surveys of MSA-1 and none were recorded within 10 feet of the North Ramp construction footprint. Therefore, no effects from dust, erosion, or sedimentation; introduction of invasive pests; nor displacement of ungulates are anticipated.

As part of the Proposed Action, ESA-listed orchids would be removed from their host trees and directly transplanted onto native trees within one of the designated vegetation plots. The transplant location for *Bulbophyllum guamense* would provide a comparable microclimate to the in situ locations, with similar light, humidity levels, and orientation on the new host tree. The transplanted *Bulbophyllum guamense* would be cared for in its new location through watering and application of pesticides, as needed.

The removal represents 0.01 percent of the *Bulbophyllum guamense* population of 7,434 individuals on Guam as of 2022 (NAVFAC Marianas 2022b); however, with the transplant survival criteria outlined in the conservation measures, no change would occur to the current total population on Guam.

Conclusion for *Bulbophyllum guamense*

The Proposed Action may affect and would likely adversely affect approximately one individual *Bulbophyllum guamense.*

4.2.4 *Dendrobium guamense*

Anticipated effects to *Dendrobium guamense* from the Proposed Action, which include the implementation of BMPs and conservation measures, consist of physical disturbance, including injury or mortality, and habitat modification. It is anticipated that two host trees, each with one *Dendrobium guamense*, would be removed during vegetation clearing at the North Ramp construction footprint; no *Dendrobium guamense* were recorded during surveys of MSA-1, and none were recorded within 10 feet of the North Ramp construction footprint. Therefore, no effects from dust, erosion, or sedimentation; introduction of invasive pests; nor displacement of ungulates are anticipated.

Similar to the other orchid species, the Proposed Action includes salvage and direct transplant of *Dendrobium guamense*. Based on the population of 4,113 individuals on Guam (NAVFAC Marianas 2022b), this removal represents 0.05 percent of the population. Transplant survival criteria that are part of the conservation measures would reduce this loss to no more than 0.04 percent of the total population on Guam.

Conclusion for *Dendrobium guamense*

The Proposed Action may affect and would likely adversely affect approximately two individual *Dendrobium guamense.*

4.2.5 *Tuberolabium guamense*

Anticipated effects to *Tuberolabium guamense* from the Proposed Action, which include the implementation of BMPs and conservation measures, consist of physical disturbance, including injury or mortality, and habitat modification. It is anticipated that 19 host trees, with a total of approximately 100 *Tuberolabium guamense*, would be removed during vegetation clearing at the North Ramp construction footprint; no *Tuberolabium guamense* were recorded during surveys of MSA-1, and none were recorded within 10 feet of the North Ramp construction footprint. Therefore, no effects from dust, erosion, or sedimentation; introduction of invasive pests; nor displacement of ungulates are anticipated.

The Proposed Action includes conservation measures for the salvage and direct transplant of *Tuberolabium guamense*. Recruitment of *Tuberolabium guamense* was observed within the construction footprint, with 27 of the plants being smaller than a quarter or having only one root

and therefore not suitable for salvage. If seedlings have grown to a suitable salvage size when the salvage is conducted, they would be moved as well.

Based on the population of 57,962 individuals on Guam (NAVFAC Marianas 2022b), this removal represents 0.17 percent of the total population on Guam. Transplant survival criteria that are part of the conservation measures would reduce this loss to 0.13 percent of Guam's total population.

Conclusion for *Tuberolabium guamense*
The Proposed Action may affect and would likely adversely affect approximately 100 individual *Tuberolabium guamense.*

4.2.6 Mariana Fruit Bat

Anticipated effects to the Mariana fruit bat from the Proposed Action, which include the implementation of BMPs and conservation measures, would consist of physical disturbance, habitat loss, habitat degradation, and habitat modification. Due to the history of bat activity within and around the North Ramp construction footprint (**Appendix B**), bats would be expected to experience adverse effects due to physical disturbance from construction-related noise (heavy equipment operation) and altered behavior in response to construction- and operations-related noise, increased traffic near the known roosting area, and loss of available foraging opportunities from the removal of native trees during vegetation clearing.

The highest levels of construction-related noise near the known bat roosting area would be generated from construction equipment and from the concrete batch plant. Noise from construction activities would attenuate to approximately 66.0 dBA at the known roosting area. As discussed in **Section 4.1.3**, specific construction activities would be required to occur at night. Noise at the roosting area from the loudest nighttime construction activity (concrete saw-cutting) would attenuate to between 42 dBA and 57 dBA (FHWA 2006). These construction noise levels would be clearly audible and may solicit minor behavioral responses in roosting bats, such as head turns or other minor body movements. Construction noise may not be loud enough to elicit a flush response or interfere with foraging behaviors, territorial occupancy, or reproductive success of the nearby roosting area; however, no studies specifically related to construction noise have been performed for Mariana fruit bat.

The reasonably expected upper-bound sound levels for aircraft operations (i.e., idling, taxiing) on the North Ramp are depicted on **Figure 10**. These sound levels represent the loudest aircraft (F-35) as if it were operating on the edge of and perpendicular to the North Ramp boundary, facing directly away (idle-out) or directly towards (idle-in) the North Ramp.

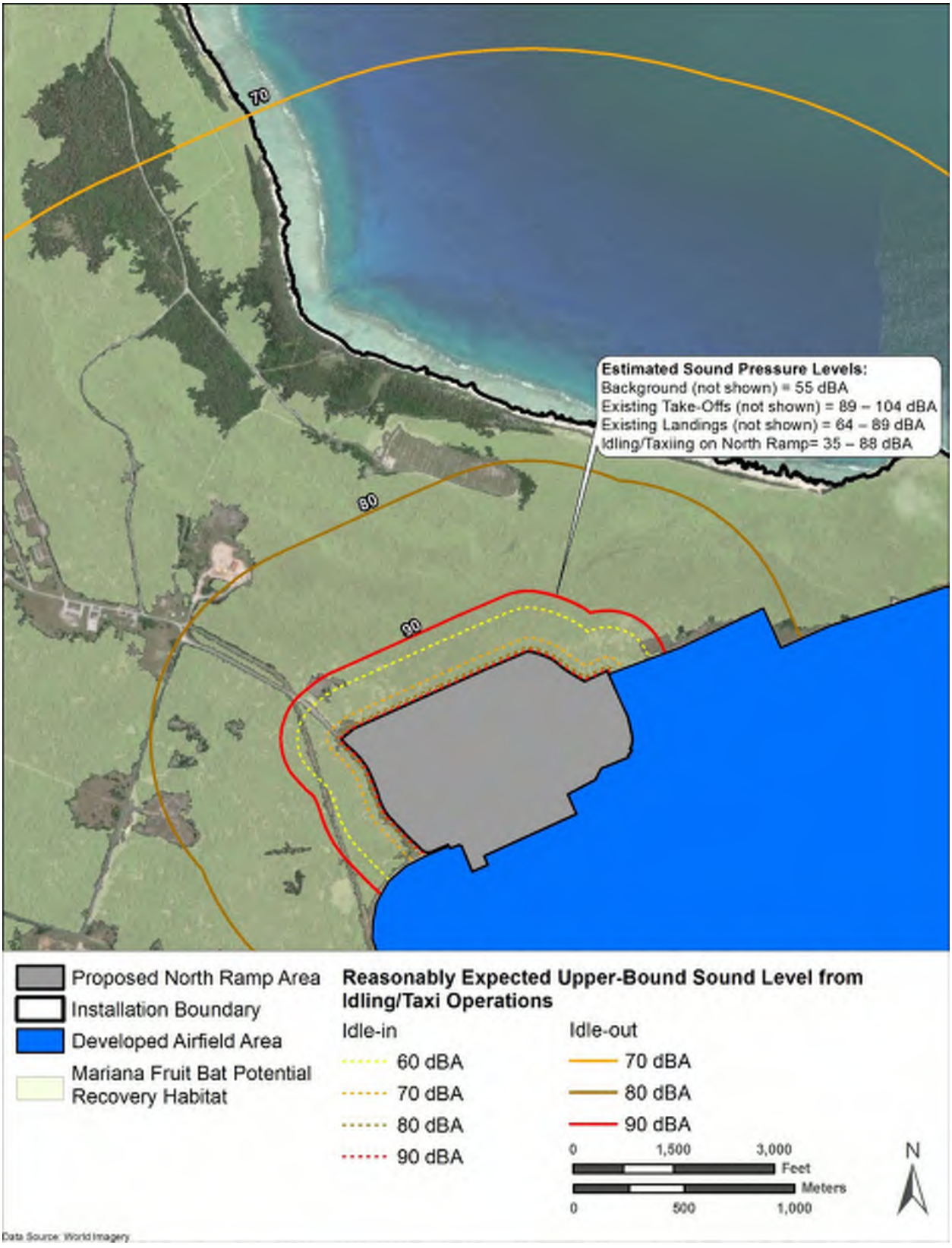

Figure 10. Reasonable Upper-bound Sound Levels (dBA) for Aircraft Idling and Taxiing on the North Ramp

Noise levels from idling and taxiing at the known roosting area would range from 35 to 88 dBA under the Proposed Action. These noise levels would be lower than those from existing take-offs on the nearby runway that generate noise levels between 89 and 104 dBA, and would generally be lower than those from existing landings that generate noise levels between 64 to 89 dBA. Noise levels depicted on **Figure 10** would be expected to be lower for quieter aircraft and for aircraft not operating at the edge of and perpendicular to the North Ramp boundary.

Mariana fruit bats have been observed consistently flushing from roost locations in response to aircraft overflights with noise levels above 90 dBA (SWCA 2012). Aircraft overflight noise generally exceeded those noise levels for approximately 1 minute, and bats were observed either returning to the roost or departing the site. The duration of the noise exposure for the Proposed Action would be longer than aircraft overflights and would occur over multiple hours for multiple days. The approximate times that the known roosting area would be exposed to direct noise levels from operations compared to existing conditions are outlined in **Table 8**. The amount of time the roosting area would be exposed to 60 dBA would increase from 32 to 43 minutes per day, 70 dBA from 5 to 10 minutes per day, and 80 dBA from 0.5 to 1 minute per day. The roosting area is not currently, and would continue not to be, exposed to levels above 90 dBA. These approximations reasonably assume an even distribution of idling and taxiing on the North Ramp from north to south (i.e., same amount near the northern edge as near the southern edge), a constant taxi speed, and the aircraft either being pointed outwards (idle-out) or inwards (idle-in).

Table 8. Approximate Time Above Sound Level at Known Roosting Area

Sound Level at Roosting Area[a]	Time Above Sound Level (minutes/day)			
	60 dBA	70 dBA	80 dBA	90 dBA
Existing	32.3 (3.23 at night)	4.5 (0.45 at night)	0.4 (0.04 at night)	0.0
Proposed Action	10.3 (1.03 at night)	4.9 (0.49 at night)	0.5 (0.05 at night)	0.0
Total	**42.6 (4.26 at night)**	**9.4 (0.94 at night)**	**0.9 (0.09 at night)**	**0.0**

Source: Andersen AFB 2013
[a] Nighttime estimates based on approximately 10 percent of total aircraft operations on Andersen AFB occurring between 2200 and 0700.

The DAF maintains low-frequency noise data in the 10 to 50 hertz range; however, it has a high level of uncertainty because the measurement equipment is not ideal for measuring in these low frequencies that are virtually inaudible to humans. Based on several audiograms of surrogate fruit bat species, including those that do and do not echolocate, aircraft noise is predominantly outside the hearing range of fruit bats; however, the lower-end frequencies of their hearing ranges do overlap with the highest-frequency aircraft noise (Koay et al. 1998, Neuweiler et al. 2004). Sound less than approximately 5 kilohertz is not audible by fruit bats, including extremely low-frequency sound. Additionally, no current or proposed aircraft operations would generate sonic booms nor impact type noises and would not introduce any airborne nor groundborne vibrations that would travel more than a few feet.

Lower levels of noise would also result from the Proposed Action's re-route of construction and commuter traffic onto 5th Street (running northwest along the western boundary of the North Ramp construction footprint), and from traffic on the proposed road (running east-west along the northern perimeter of the North Ramp). Attenuated noise from re-routed automobiles along 5th

Street would range from approximately 56.8 dBA (for a heavy truck) to 43.4 dBA (for a passenger automobile) at the known roosting area. Attenuated noise along the proposed road would range from approximately 61.9 dBA (for a heavy truck) to 44.5 dBA (for a passenger automobile) at the known roosting area (FHWA 2021). These traffic noise levels assume speed limits of 45 miles per hour on 5th Street and 35 miles per hour on the proposed road based on existing speed limits on Andersen AFB; however, these speed limits have not been finalized. This level of noise would be barely audible and may solicit minor behavioral responses in roosting bats, such as head turns or other minor body movements. Noise from re-routed traffic along 5th Street or general base traffic on the proposed road would not be loud enough to elicit a flush response nor interfere with foraging behaviors, territorial occupancy, or reproductive success at the known roosting area. The increased noise from traffic would occur within the first year of construction and would continue through the construction and operations period.

Increased noise levels can result in unnecessary expenditure of energy as well as stress-related behaviors (SWCA 2008) or flushing from the roosting area (SWCA 2012). Fruit bats show a high level of fidelity to maternity colonies unless disturbed (USFWS 2016). When colonies are disturbed, fruit bats may be negatively affected in a variety of ways, including, but not limited to, destruction of social structures, disruption of energetic and hormonal balance, forced relocation to lower quality habitat, abandonment of young, and disruption of breeding (Wingfield et al. 1998, Heideman 2000, Klose et al. 2006, and CNMI 2010, as cited in USFWS 2016). Exposure to construction-, operations-, or traffic-related noise may result in roosting area abandonment if intolerance to noise levels results in increased stress levels.

From October 2020 through August 2021, an average of 11 bat detections were made at Station 67, with a peak number (67) of bat detections in February 2021. The number of bats attending the known roosting area is not known, since this roosting area was recently detected in 2020 and dispersal counts have not occurred; however, the roosting area could be used by all bats on Andersen AFB. Conservation measures focused on the roosting area would be implemented to detect changes in bat behavior. Regular monitoring and dispersal counts would be performed, including quarterly reporting to the USFWS. Near-infrared or thermal cameras would be positioned to monitor bat responses to increased noise levels, and a traffic noise study would be conducted both prior and subsequent to changes in routing (**Appendix A**).

Bats roosting within 492 feet (150 meters) of the North Ramp or MSA-1 construction footprints have the potential to be flushed as a result of construction activities; however, BMPs for pre-construction bat surveys would minimize the potential for adverse impacts. A biological monitor would be required to conduct a daily survey prior to site preparation and construction activities that provide a line of sight for Mariana fruit bats of up to 492 feet (150 meters) from those activities. If a Mariana fruit bat is recorded roosting within the 492-foot (150-meter) buffer, construction work would be postponed until the bat(s) has voluntarily left the area.

Approximately 128 acres of limestone degraded and native forest vegetation would be cleared as part of the Proposed Action within the North Ramp construction footprint. This removal would be a permanent loss of trees used for foraging and potentially for roosting. Of the 26,075 acres of recovery habitat available for bats in Guam (USFWS 2016), approximately 140 of those acres fall within the North Ramp (135 acres) and MSA-1 (5 acres) construction footprints (**Figure 9**).

The vegetation cleared would result in a loss of 0.5 percent of the recovery habitat for this species.

During and following vegetation clearing within the North Ramp and MSA-1 construction footprints, foraging by Mariana fruit bats within the adjacent areas would be expected to continue as adverse impacts would be minimized through BMPs. No site preparation work would occur within 30 minutes of sunset or at night. Construction activities at night would be limited to those that are required to occur for safety or quality reasons, such as removal of Munitions of Concern and Unexploded Ordnance as well as pouring and cutting of concrete. Operation of infrastructure within the North Ramp would not normally occur at night, aircraft operations would primarily occur during the day, and the human presence within the area would experience only a nominal increase above current levels. Minimal security lighting would be used within the construction footprint during active construction, and lighting installed on new buildings and infrastructure would be designed to provide the lighting levels required in the Unified Facilities Criteria while minimizing potential effects to Mariana fruit bat foraging or roosting activities.

To meet requirements for breeding, feeding, and sheltering, a self-sustaining population of Mariana fruit bats requires a threat-managed, native limestone forest habitat containing diverse food resources that are available throughout the year (USFWS 2016). Conservation measures that are part of the Proposed Action include establishing a 173-acre bat habitat enhancement area on Andersen AFB (**Figure 4**). Seeds from tree species used for bat foraging would be collected prior to vegetation clearing and propagated for outplanting into the bat habitat enhancement area. The bat habitat enhancement area would be ungulate-free with ungulate-proof fencing and would be managed for treatment of invasive plant species. Success of the native forest establishment would be monitored for 7 years following outplanting, and monitoring stations for bats would be added to annual surveys to determine if the areas are being used.

While the North Ramp construction footprint is consistently used for bat foraging, the relative loss of 0.5 percent of available habitat would be offset with the enhancement of approximately 173 acres of limestone forests. Since bats forage over large areas (USFWS 1990), bats are anticipated to experience a minor disruption of their feeding and foraging behavior to an extent that creates the likelihood of extra energy output, but not injury or death. Andersen AFB anticipates that the vegetation removal as part of the Proposed Action may adversely affect Mariana fruit bats that would use the 173 acres of bat recovery habitat, which could include the entire bat population of Andersen AFB.

Conclusion for Mariana Fruit Bat

Even with implementation of avoidance and minimization measures, the Proposed Action may affect and would likely adversely affect Mariana fruit bats. Approximately 69 to 92 Mariana fruit bats may be adversely affected by physical disturbance due to construction- and operations-related noise, increased traffic near the known roosting area, and habitat loss.

4.3 Cumulative Effects

Cumulative effects include the effects of future state, tribal, local, or private actions that are reasonably certain to occur within the action area. Reasonably foreseeable future actions that would occur on Andersen AFB would be federal actions or state, local, or commercial actions coordinated through Andersen AFB as the federal landowner. Future federal actions that are unrelated to the Proposed Action are not considered in the analysis of cumulative effects because they would require separate consultation under Section 7 of the ESA.

5. Conclusion

The Proposed Action may affect and is likely to adversely affect *Cycas micronesica*, *Tabernaemontana rotensis*, *Bulbophyllum guamense*, *Dendrobium guamense*, *Tuberolabium guamense*, and the Mariana fruit bat (see **Table 9**). Conservation measures and BMPs (**Section 2.3** and **Appendix A**) that will be incorporated into the Proposed Action will avoid, minimize, and mitigate the consequences to those species.

Table 9. Effects Determination for ESA-listed Species Affected by the Proposed Action

Common Name	Scientific Name	Listing Status	Effects Determination
Fadang[Ch]	*Cycas micronesica*	Threatened	May Affect, Likely to Adversely Affect
NCN	*Tabernaemontana rotensis*	Threatened	May Affect, Likely to Adversely Affect
Cebello halumtan[Ch]	*Bulbophyllum guamense*	Threatened	May Affect, Likely to Adversely Affect
NCN	*Dendrobium guamense*	Threatened	May Affect, Likely to Adversely Affect
NCN	*Tuberolabium guamense*	Threatened	May Affect, Likely to Adversely Affect
Fanihi[Ch]; Mariana Fruit Bat	*Pteropus mariannus mariannus*	Threatened	May Affect, Likely to Adversely Affect

Ch= Chamorro name; NCN= No common name

The conservation measures for this Proposed Action have been developed to work in concert with the larger, landscape-level conservation efforts that are being implemented on JRM-administered and leased lands. The DoD supports a continuous effort to improve limestone forest habitat quality through the exclusion and eradication of the invasive species that have irrevocably altered the native vegetation and wildlife.

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Appendix A. Proposed Conservation Measures

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Target Species	Conservation Measure Area	Reference Number	Conservation Measure Details
Cycas micronesica (CYMI)	SEED COLLECTION AND SALVAGE PREPARATION	CYMI-1	Upon receipt of a Biological Opinion, Andersen AFB will initiate seed collection from *Cycas micronesica* within the portions of the action area that will be physically disturbed. An individual designated as an Authorized Biologist (see OTH-4) will conduct monthly monitoring of the construction footprints to determine if *Cycas micronesica* are producing seed and if the seed has matured for collection. As *Cycas micronesica* produces an orthodox seed that can be stored and remain viable in climate-controlled conditions, seeds will be collected and stored in accordance with a seed collection work plan and will be germinated as a contingency to meet survival goals described in CYMI-6.
		CYMI-2	Upon receipt of a Biological Opinion, all *Cycas micronesica* within the portion of the action area that will be physically disturbed will be treated with a slow-release imidacloprid insecticide to treat cycad *Aulacaspis* scale. The insecticide treatment will be performed by a Guam Environmental Protection Agency-certified pesticide applicator and overseen by an Authorized Biologist.
	SALVAGE AND TRANSPLANT	CYMI-3	Prior to vegetation clearing, a field assessment of the construction footprints will be conducted. The assessment will determine the current number and health status assessment of *Cycas micronesica* that cannot be avoided within the construction footprint. A health assessment will be performed by an individual designated as an Authorized Biologist to determine how many genetically unique individuals can be salvaged through removal and propagation of apical stems or vegetative propagules (pups). Following completion of the field assessment, a salvage and transplant work plan will be prepared to describe the salvage and transplant methods to be used. The final work plan will be provided to the USFWS.
		CYMI-4	Based on the results of surveys specifically for this project (see **Appendix B**), 416 individual *Cycas micronesica* trees are located within the action area that would be subject to impacts from removal during site preparation. Of those 416 trees, approximately 376 were recorded as being in good or fair health and potentially suitable for salvage. All plants in good or fair health will be salvaged as apical stems and/or vegetative propagules (pups). An individual designated as an Authorized Biologist will oversee salvage and plant transplantation in accordance with the plant salvage and transplant work plan.
		CYMI-5	Salvaged apical stems and vegetative propagules (pups) will be propagated and maintained in a nursery that follows the Hawaii Rare Plant Restoration Group's (HRPRG) "Phytosanitation Standards and Guidelines" (HRPRG 2010) until the Authorized Biologist determines they are suitable for transplanting. If collection and germination of seeds is used as a contingency to meet the survival criteria, those will also be maintained within the nursery until suitable for outplanting. Nursery maintenance may include supplemental watering, mechanical weed or pest removal, pruning, treatment with fertilizer or pesticide, and other adaptive management techniques to maximize survivorship and plant health.
		CYMI-6	Andersen AFB will ensure survival of a minimum of 92 genetically unique individuals, which is a minimum or 25% of the individuals in good or fair health at the time of surveys. If the survival rate falls below 92, seeds from *Cycas micronesica* within 30 meters of the North Ramp or MSA-1 construction footprints may be germinated for outplanting. This survival rate assumes the 367 *Cycas micronesica* rated as in good or fair health during the 2021 surveys have not changed. If greater or fewer than 367 *Cycas micronesica* are determined to be in good or fair health and suitable for salvage, then the survival criteria will be adjusted to be 25% of those remaining plants suitable for salvage.
		CYMI-7	*Cycas micronesica* will be transplanted as propagated apical stems and pups into vegetation plots (3A Achae, Tarague Basin, Golf Course) or the 173-acre bat habitat enhancement area, as depicted in **Figure 4**. The size of the vegetation plots will be expanded as follows: 3A Achae: expanded from 1.5 to 3 acres; Tarague Basin: expanded from 1 to 2 acres; and Golf Course: expanded from 1 to 2 acres. The final size and shape of the vegetation plots and bat habitat enhancement area might differ from those shown in **Figure 4** as a result of fences avoiding steep topography and other obstacles.
		CYMI-8	Transplanting will allow for a minimum of 10 feet between plants and maintain at least 10 feet from in situ *Cycas micronesica*. To the maximum extent possible, propagated plants from the same genetically unique individual (i.e., a stem and pup from the same parent tree) will be planted in different vegetation plots. When genetically matched transplants are within the same vegetation plot or the bat habitat enhancement area, they will be planted the maximum distance apart allowed by the planting arrangement.
	MAINTENANCE OF TRANSPLANTS AND TRANSPLANT AREA	CYMI-9	Prior to transplanting any ESA-listed plants, Andersen AFB will maintain existing fencing or install permanent ungulate-proof fencing around the vegetation plots and bat habitat enhancement area. Installation of fencing or vegetation removal for fence maintenance will include surveys to ensure fence alignment will not affect ESA-listed species. Additionally, protocols for Mariana fruit bat avoidance and minimization will be used during any fence construction, specifically BMPs from the JRM Mariana Fruit Bat Monitoring Protocol (JRM 2010). Fencing will adhere to the JRM Ungulate Fencing Standards. Ungulate-proof fencing will be monitored once per month for 10 years after transplanting is initiated. Vegetation maintenance will be implemented as needed to ensure integrity of the fence. Fencing will also be inspected for breaches within 72 hours after a major storm or high-wind event (wind speeds equal to or greater than 39 miles per hour or 34 knots). Degradation and/or breaches in the fencing will be repaired or replaced immediately after detection. If ungulates are detected after the initial removal, then they will be removed.
		CYMI-10	Andersen AFB will perform a field assessment of the vegetation plots and bat habitat enhancement area to record existing ESA-listed species (including a health assessment), native and non-native canopy trees, and invasive species that require treatment prior to transplant.
		CYMI-11	Andersen AFB will conduct invasive species removal or pesticide treatment within the vegetation plots and bat habitat enhancement area to enhance the existing native forest. Existing *Cycas micronesica* within the vegetation plots and bat habitat enhancement area will be subject to a one-time treatment with a slow-release imidacloprid insecticide to treat cycad *Aulacaspis* scale. Any pesticide application will be performed by a Guam Environmental Protection Agency-certified pesticide applicator and overseen by an Authorized Biologist.
		CYMI-12	After transplantation, maintenance of *Cycas micronesica* may include watering, fertilizing, pesticide treatment, use of support structures, invasive species removal, or removal of plant parts to reduce stress following transplantation. Invasive species within a 20-foot radius around transplanted vegetation will be removed and maintained to ensure that no more than 15% of the vegetation is invasive. The maximum percent cover of invasive understory, overstory, and vine plants permitted in the vegetation plots and bat habitat enhancement area and details of removal will be determined following the field assessment (CYMI-10). Monitoring will occur for a minimum of 12 months following transplanting. Maintenance will be reduced and eliminated during a hardening-off period, and monitoring will continue for a minimum of 6 months following cessation of maintenance activities. Maintenance will occur only during daylight hours and if bat roosting is detected within the immediate area of any *Cycas micronesica* that require maintenance, then the USFWS will be contacted to determine the appropriate modifications to the monitoring approach. The JRM Mariana Fruit Bat Monitoring Protocol (JRM 2010) will be followed.
		CYMI-13	Survival of 92 genetically unique individuals (or 25% of the plants suitable for salvage) will be determined based on the plant being established within the transplant area. Plants will be considered established within the transplant area when they do not require any supplemental watering, fertilizer, pest removal, or support structures. Plants must: (1) have a healthy crown of leaves; (2) be free of pests, diseases, and nutritional deficiencies; and (3) have a healthy stem, no stem borer, and no stem rot.

Target Species	Conservation Measure Area	Reference Number	Conservation Measure Details
Tabernaemontana rotensis (TARO)	SEED COLLECTION AND PROPAGATION	TARO-1	Prior to vegetation clearing, a field assessment of the North Ramp construction footprint will be conducted. The assessment will determine the current number and the health and maturity of *Tabernaemontana rotensis* that cannot be avoided within the construction footprint. A health and maturity assessment will be performed by an individual designated as an Authorized Biologist (see OTH-4) to determine how many genetically unique individuals can potentially be salvaged through seed collection. Following completion of the field assessment, a work plan will be prepared to describe the seed collection, propagation, and outplant methods to be used. The final work plan will be provided to the USFWS.
		TARO-2	Based on the results of surveys specifically for this project (see **Appendix B**), 99 individual *Tabernaemontana rotensis* trees within the action area would be subject to impacts from removal during site preparation. Of those 99 trees, approximately 74 were recorded as being mature enough to potentially produce seed for collection. All mature plants will be monitored monthly for seed production. An individual designated as an Authorized Biologist will oversee seed collection in accordance with the work plan.
		TARO-3	During seed collection efforts, an Authorized Biologist will collect ripe fruits available for seed germination from mature individual *Tabernaemontana rotensis* trees within the North Ramp construction footprint. Andersen AFB will salvage and propagate enough *Tabernaemontana rotensis* seeds to ensure the survival of a minimum of 19 genetically distinct individuals, which is a minimum of 25% of the mature individuals at the time of surveys. This survival rate assumes that at least 19 mature *Tabernaemontana rotensis* trees produce seed prior to site preparation and vegetation removal. If greater or fewer than 74 mature *Tabernaemontana rotensis* are present within the construction footprint during the pre-construction survey, then the survival criteria will be adjusted to be 25% of those remaining mature plants. If a minimum of 19 adult trees within the construction footprint do not produce seeds prior to being removed, then seeds will be collected from individuals within 30 meters of the construction footprint, or propagation of cuttings from trees within the construction footprint may be used as a contingency.
		TARO-4	Collected *Tabernaemontana rotensis* seeds (or cuttings) will be germinated in a nursery for propagation, maintenance, and subsequent outplanting. Propagated plants will be maintained in a nursery that follows the HRPRG's "Phytosanitation Standards and Guidelines" (HRPRG 2010) for 1 year, or less, until the Authorized Biologist determines they are suitable for outplanting. Nursery maintenance may include supplemental watering, mechanical weed or pest removal, pruning, treatment with fertilizer or pesticide, and other adaptive management techniques to maximize survivorship and plant health.
	OUTPLANTING	TARO-5	*Tabernaemontana rotensis* will be outplanted into vegetation plots (3A Achae, Tarague Basin, Golf Course) or the bat habitat enhancement area as depicted in **Figure 4**. The size of the vegetation plots will be expanded as follows: 3A Achae: expanded from 1.5 to 3 acres; Tarague Basin: expanded from 1 to 2 acres; and Golf Course: expanded from 1 to 2 acres. Vegetation plots and the bat habitat enhancement area will have ungulate fence installed and maintained as described in CYMI-9, have pre-transplant surveys conducted as described in CYMI-10, and have invasive species removal performed as described in CYMI-11. The final size and shape of the vegetation plots and bat habitat enhancement area might differ from those shown in Figure 4 as a result of fences avoiding steep topography and other obstacles.
		TARO-6	After outplanting, maintenance may include watering, fertilizing, pesticide treatment, use of support structures, or invasive species removal following outplanting. Invasive species within a 20-foot radius around outplanted vegetation will be removed and maintained to ensure that no more than 15% of the vegetation is invasive. The maximum percent cover of invasive understory, overstory, and vine plants permitted in the vegetation plots and bat habitat enhancement area and details of removal will be determined following the field assessment (CYMI-10). Maintenance will be reduced and eliminated during a hardening-off period and then monitored for at least 6 months following cessation of maintenance activities. Maintenance will occur only during daylight hours and if bat roosting is detected within the immediate area of any *Tabernaemontana rotensis* that require maintenance, then the USFWS will be contacted to determine the appropriate modifications to the monitoring approach. The JRM Mariana Fruit Bat Monitoring Protocol (JRM 2010) will be followed.
		TARO-7	*Tabernaemontana rotensis* plants will be considered as meeting the survival criteria when they are between 2 and 3 feet (0.6 and 0.9 meter) tall; leaves remain turgid on the plant; individuals produce apical stem growth; and individuals no longer require supplemental watering, fertilizer, or support structures. Plants will be maintained and monitored until they are considered established.
Bulbophyllum guamense (BUGU), *Dendrobium guamense* (DEGU), *Tuberolabium guamense* (TUGU)	SALVAGE AND TRANSPLANT	ORCHID-1	Prior to vegetation clearing, a field assessment of the North Ramp construction footprint will be conducted. The assessment will determine the current number and health status assessment of *Orchidaceae* that cannot be avoided within the construction footprint. A health assessment will be performed by an individual designated as an Authorized Biologist (see OTH-4) to determine how many genetically unique individuals can potentially be salvaged and directly transplanted to new host trees. Following completion of the field assessment, a plant salvage and transplant work plan will be prepared to describe the salvage and transplant methods to be used. The final work plan will be provided to the USFWS.
		ORCHID-2	Based on the results of surveys specifically for this project (see **Appendix B**), 100 *Tuberolabium guamense*, 1 *Bulbophyllum guamense*, and 2 *Dendrobium guamense* within the action area would be subject to impacts from removal during site preparation. Of those, approximately 73 *Tuberolabium guamense*, 1 *Bulbophyllum guamense*, and 2 *Dendrobium guamense* were recorded as being large and healthy enough to be potentially salvageable. An individual designated as an Authorized Biologist will oversee salvage and transplant in accordance with the work plan.
		ORCHID-3	Andersen AFB will ensure survival of a minimum of 19 *Tuberolabium guamense*, 1 *Bulbophyllum guamense*, and 1 *Dendrobium guamense*, which is a minimum of 25% of the mature individuals at the time of surveys. This survival rate assumes that the total of 73 salvageable *Tuberolabium guamense*, 1 salvageable *Bulbophyllum guamense*, and 2 salvageable *Dendrobium guamense* identified during the construction footprint surveys in 2021 have not changed. If greater or fewer than the salvageable number of orchids identified in the 2021 surveys are suitable for salvage, then the survival criteria will be adjusted to be at least 25% of those remaining plants suitable for salvage. If the survival rate falls below the specified numbers, propagation of orchid seeds from outside the construction footprint may occur.
		ORCHID-4	Orchids will be transplanted into vegetation plots or the bat habitat enhancement area, as depicted in **Figure 4.** Orchids will be transplanted onto native host trees in a micro-climate consistent with their salvage location. No more than 7 orchids will be affixed to an individual host tree. Orchids will be transplanted at least 6 feet above ground level to preclude ungulate herbivory. Individual orchids and host trees will be tagged using alphanumeric tags.
	MAINTENANCE OF TRANSPLANTS	ORCHID-5	Orchids will be transplanted into vegetation plots (3A Achae, Tarague, Golf Course) or the bat habitat enhancement area as depicted in **Figure 4**. The size of the plots will be expanded as follows: 3A Achae: expanded from 1.5 to 3 acres; Tarague: expanded from 1 to 2 acres; and Golf Course: expanded from 1 to 2 acres. Vegetation plots and the bat habitat enhancement area will have ungulate fence installed and maintained as described in CYMI-9, have pre-transplant surveys conducted as described in CYMI-10, and have invasive species removal performed as described in CYMI-11. The final size and shape of the vegetation plots and bat habitat enhancement area might differ from those shown in **Figure 4** as a result of fences avoiding steep topography and other obstacles.
		ORCHID-6	After transplantation, maintenance may include watering, fertilizing, pesticide treatment, use of supplemental host tree attachments, invasive species removal, or removal of plant parts to reduce stress following transplantation. Invasive species within a 20-foot radius around transplanted vegetation will be removed and maintained to ensure that no more than 15% of the vegetation is invasive. The maximum percent cover of invasive understory, overstory, and vine plants permitted in the vegetation plots and bat habitat enhancement area and details of removal will be determined following the field assessment (CYMI-10). Maintenance will be reduced and eliminated during a hardening-off period and then monitored for at least 6 months following cessation of maintenance activities. Maintenance will occur only during daylight hours and if bat roosting is detected within the immediate area of any *Orchidaceae* that require maintenance, then the USFWS will be contacted to determine the appropriate modifications to the monitoring approach. The JRM Mariana Fruit Bat Monitoring Protocol (JRM 2010) will be followed.

Target Species	Conservation Measure Area	Reference Number	Conservation Measure Details
		ORCHID-7	Orchids will be considered as meeting the survival criteria when observation of new root growth after transplantation and root attachment to the host tree is documented, and individuals no longer require supplemental watering, fertilizer, or support structures. Plants will be maintained and monitored until they are considered established.
Mariana Fruit Bat	ESTABLISHMENT OF BAT HABITAT ENHANCEMENT AREA	BAT-1	A 173-acre area on Andersen AFB will be designated as a bat habitat enhancement area (**Figure 4**).
		BAT-2	Andersen AFB will maintain existing fencing or install permanent ungulate-proof fencing around the bat habitat enhancement area. Installation of fencing or vegetation removal for fence maintenance will include a biological monitor to ensure no impacts to ESA-listed species. Ungulate-proof fencing will be monitored once per month for 10 years after outplanting is initiated. Vegetation maintenance will be implemented as needed to ensure integrity of the fence. Fencing will also be inspected for breaches within 72 hours after a major storm or high-wind event (wind speeds equal to or greater than 39 miles per hour or 34 knots). Degradation and/or breaches in the fencing will be repaired or replaced immediately after detection. If ungulates are detected after the initial removal, then they will be removed.
		BAT-3	Andersen AFB will perform a field assessment of the bat habitat enhancement area to record existing ESA-listed species (including a health assessment), native and non-native canopy trees, and invasive species that require treatment. Following completion of the assessment, a forest enhancement work plan will be prepared to describe the bat habitat enhancement area preparation, seed collection (BAT-5 and BAT-6), and forest enhancement (outplanting) methods to be used. The final work plan will be provided to the USFWS.
		BAT-4	Andersen AFB will conduct invasive species removal or pesticide treatment within the bat habitat enhancement area to enhance the existing native forest. Invasive canopy trees (i.e., *Vitex parviflora*) will be removed to support establishment of native canopy tree species as described in BAT-5 and BAT-6. Any pesticide application will be performed by a Guam Environmental Protection Agency-certified pesticide applicator.
	SEED COLLECTION, OUTPLANTING, AND MAINTENANCE	BAT-5	To support native forest enhancement and increase foraging opportunity for Mariana fruit bat, seeds from native trees within the construction footprints will be collected, germinated, propagated, and outplanted within the bat habitat enhancement area. Target species for seed collection may include, but are not limited to, *Aglaia mariannensis*, *Ficus* spp., *Elaeocarpus joga*, *Eugenia reinwardtiana*, *Meiogyne cylindrocarpa*, *Intsia bijuga*, *Artocarpus mariannensis*, *Pandanus tectorius*, *Pisonia grandis*, etc. Seeds will be germinated, propagated, and maintained in a nursery that follows the HRPRG's "Phytosanitation Standards and Guidelines" (HRPRG 2010) until they are determined suitable for outplanting. Nursery maintenance may include supplemental watering, mechanical weed or pest removal, pruning, treatment with fertilizer or pesticide, and other adaptive management techniques to maximize survivorship and plant health.
		BAT-6	Andersen AFB will collect seeds from native tree species within the construction footprints that will be physically removed to ensure survival of a minimum of 100 propagated individuals from a minimum of 5 different tree species. Recommended species, number of outplanted individuals, and planting configurations will be included in the forest enhancement work plan that is developed following field assessment of the bat habitat enhancement area.
		BAT-7	Native trees will be outplanted into the 173-acre bat habitat enhancement area. After outplanting, maintenance may include watering, fertilizing, pesticide treatment, use of supplemental host tree attachments, and invasive species removal. Invasive species within a 20-foot radius around outplanted vegetation will be removed and maintained to ensure that no more than 15% of the vegetation is invasive. The maximum percent cover of invasive understory, overstory, and vine plants permitted in the site and details of removal will be determined following field assessment of the bat habitat enhancement area (BAT-3). Maintenance will be reduced and eliminated during a hardening-off period and then monitored for at least 6 months following cessation of maintenance activities. Native trees will be considered as meeting the survival criteria when they are between 2 and 3 feet (0.6 and 0.9 meter) tall; leaves remain turgid on the plant; individuals produce apical stem growth; and individuals no longer require supplemental watering, fertilizer, or support structures. Plants will be maintained and monitored until they are considered established.
		BAT-8	The bat habitat enhancement area will be monitored twice per year for a period of 7 years following outplant of native tree species. Monitoring events will record information on new invasive plants, understory growth, canopy cover, species diversity, and increased number of forest tree seedlings and saplings. Invasive species within a 20-foot radius around outplanted vegetation will be removed and maintained to ensure that no more than 15% of the vegetation is invasive. The maximum percent cover of invasive understory, overstory, and vine plants permitted in the bat habitat enhancement area and details of removal would be determined following field assessment of the bat habitat enhancement area (BAT-3). Observations of fruit bat use of the area or presence of ungulates will be recorded. Information recorded during monitoring will be included in the annual report (OTH-1).
	INVASIVE SPECIES MANAGEMENT FOR BAT HABITAT ENHANCEMENT	BAT-9	Andersen AFB will eradicate feral ungulates (pigs and deer) and maintain fencing around ungulate exclusion areas for the 173-acre bat habitat enhancement area.
	BAT POACHING DETERRENCE	BAT-10	JRM will partner with the USFWS to employ a CLEO to conduct surveillance, investigations, and deter Mariana fruit bat poaching on Andersen AFB. Funding for the CLEO position will be provided by the DAF for five years before being transferred to the JRM INRMP for long-term sustainment. An Interagency Agreement will be prepared in cooperation with the USFWS to determine each party's responsibilities, financial administration, and general provisions (points of contact, correspondence procedures, etc.). Additionally, a Conservation Law Enforcement Program Operations Plan will be developed to establish CLEO standard operating procedures.
	BAT MONITORING AND RESEARCH	BAT-11	Up to 5 monitoring stations, including Station 67, will be used to record information on bat presence at the North Ramp and MSA-1 construction footprints and 173-acre bat habitat enhancement area. Monitoring at these stations will occur at least every 10 days and will begin when the Proposed Action construction contract public solicitation begins, continue throughout vegetation clearing, and conclude 1 year after vegetation clearing at the North Ramp and MSA-1 construction footprints is complete. Methods will follow the landscape counts for solitary bats (JRM 2010). Quarterly monitoring reports will be provided to the USFWS for situational awareness, and will contain information on any detection of changes in roost locations, number of bat detections, or movement.
		BAT-12	Andersen AFB will deploy thermal or near-infrared cameras at up to 2 roosting locations, targeting areas of high bat activity, including the known roosting area, to monitor bat activity and support research goals as discussed in BAT-14.
		BAT-13	Andersen AFB will conduct a traffic noise study prior and subsequent to the re-routing of traffic from Marianas Boulevard to 5th Street along the western perimeter of the North Ramp construction footprint. The traffic noise study report prior to construction and re-routing will recommend noise abatement that can be incorporated into the proposed design. The study report subsequent to construction and re-routing will incorporate data on changes to the known roosting area and determine if noise abatement methods were effective. The duration of the traffic study will be determined following the procurement of services to conduct the study.

Target Species	Conservation Measure Area	Reference Number	Conservation Measure Details
		BAT-14	The DAF will supplement DON funding to research the Mariana fruit bat recommended within the 2017 *Mariana Fruit Bat Management Plan for Andersen Air Force Base, Guam* (NAVFAC Marianas 2017). The long-term goal is to develop guidelines to be used in recovery and sustainable management of fruit bats on different islands. Research will include, but is not limited to, demographic information used in population viability analysis (age of sexual maturity, timing and frequency of births, survivorship, longevity, adult and juvenile dispersal, and frequency of inter-island movements); carrying capacity (quantification of habitat quality, density by habitat type, and habitat availability); island-wide population surveys throughout the range; estimates of predation by brown treesnakes and hunters; and identification of any other population-limiting factors. These project funds will be requested for a project start within 1 year of vegetation clearing.
		BAT-15	The DAF will develop and enhance existing methods and techniques in collaboration with the Interagency Brown Treesnake Technical Working Group to monitor brown treesnakes at varying landscape levels within brown treesnake enclosures and unbounded areas to provide a better understanding of the interspecies relationship between the brown treesnake and the Mariana fruit bat, and to aid in the development of appropriate future conservation actions.
Annual Reporting	ANNUAL REPORTING	OTH-1	Andersen AFB will submit an annual report to the USFWS 1 year after the Biological Opinion is prepared and each year thereafter for 10 years or fewer, until the project and associated conservation measures are complete. The annual report will identify which conservation measures are complete based on survival criteria (specifically for transplanted and outplanted plants), and Andersen AFB will have no further monitoring or reporting requirements for those conservation measures.
		OTH-2	Andersen AFB will provide a copy of the final plant salvage and transplant work plan and the forest enhancement work plan for USFWS situational awareness.
		OTH-3	Andersen AFB will provide a copy of the final bat monitoring and research work plan for USFWS situational awareness.
		OTH-4	All Authorized Biologists will be considered agents of the DON for the purposes of conducting conservation measures described in this BA. Authorized biologists will report directly to the DON regarding all compliance issues or questions, including all draft and final reports of noncompliance. The qualifications to work with the aforementioned species include the following: a. A bachelor's degree with an emphasis in botany, horticulture, ecology, or a related science OR a combination of natural resources-related education and related work experience, including on-the-ground work/training in the field; and b. At least 100 documented hours of experience conducting propagation, translocation (animals), transplantation (plants), pest control, monitoring, or a combination of these experiences with the aforementioned species or a closely related species; and c. Applicant must provide contact information of three references familiar with their work related to item b (above). Applicants that are using a combination of education and experience for item a must provide at least one reference that can verify their on-the-ground work/training in the field.

AFB = Air Force Base; BQ = Biological Assessment; BMP = best management practice; CLEO = Conservation Law Enforcement Officer; DAF = Department of the Air Force; DON = Department of the Navy; ESA = Endangered Species Act; HRPRG = Hawaii Rare Plant Restoration Group; JRM = Joint Region Marianas; USFWS = U.S. Fish and Wildlife Service

Appendix B. Biological Survey Report

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Biological Survey Report

Environmental Impact Statement for Infrastructure Upgrades at Andersen Air Force Base (AFB), Guam

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September 2021

Abbreviations and Acronyms

AFB	Air Force Base
BA	Biological Assessment
ChST	Chamorro Standard Time
DAF	Department of the Air Force
DON	Department of the Navy
EA	Environmental Assessment
EIS	Environmental Impact Statement
ESA	Endangered Species Act
INRMP	Integrated Natural Resources Management Plan
ISR/Strike	Intelligence, Surveillance, and Reconnaissance and Strike
JRM	Joint Region Marianas
MSA	Munitions Storage Area
USFWS	U.S. Fish and Wildlife Service
WERI	Water and Environmental Research Institute of the Western Pacific

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1. Introduction

1.1 Survey Purpose

The purpose of the surveys documented in this *Biological Survey Report* is to record the natural resources identified by the Department of the Air Force (DAF) within the project area for proposed future construction infrastructure upgrades at Andersen Air Force Base (AFB), Guam. An *Environmental Impact Statement (EIS) for Infrastructure Upgrades at Andersen Air Force Base, Guam* is being prepared to identify and analyze the potential environmental impacts associated with this proposed federal action and the alternatives. This *Biological Survey Report* provides information about current conditions to support the EIS analysis and the anticipated formal consultation with the U.S. Fish and Wildlife Service (USFWS) under Section 7 of the Endangered Species Act (ESA). This *Biological Survey Report* presents a brief overview of the project location and proposed action, desktop review results, survey area and methodology, and survey findings.

1.2 Project Description

1.2.1 Proposed Action

The DAF is proposing to construct infrastructure upgrades at Andersen AFB, Guam, in alignment with DAF and Department of Defense strategies and initiatives for the Indo-Pacific, and to use this infrastructure consistent with existing installation operations once construction is completed. Construction of upgrades would take place over approximately 7 years and would include airfield pavements, an aircraft hangar, maintenance and utilities buildings, fuel systems, fencing and utilities, roadways and parking, stormwater management infrastructure, and earth-covered magazines. A total of approximately 203 acres would be disturbed during construction, and would either be developed or maintained once construction is complete.

Andersen AFB currently has infrastructure that supports aircraft parking, storage, maintenance, refueling, loading, unloading, and munitions storage. The proposed infrastructure upgrades are intended to supplement and improve the existing infrastructure at Andersen AFB and create a more agile and flexible defense posture. Increasing and improving the airfield and munitions infrastructure allows for greater efficiencies and agility in the way ground operations are conducted. The proposed infrastructure would provide options for parking, storing, maintaining, refueling, loading, and unloading aircraft as well as for storing munitions, which would increase strategic capabilities with regards to ground maneuverability. The DAF is not proposing to change the types of airfield or munitions activities that occur at Andersen AFB.

1.2.2 Project Location

Guam is located on the southernmost of the Mariana Islands between Latitude 13° 15' and 13° 40' North and Longitude 144° 30' and 144° 57' East. The proposed facilities and infrastructure would be located on Andersen AFB at the northern end of Guam (**Figure 1**). Infrastructure upgrades would occur adjacent to the existing airfield area (“North Ramp”; **Figure 2**) and in Munitions Storage Area (MSA) 1 (**Figure 3**), totaling approximately 203 acres.

Figure 1. Project Area on Andersen AFB, Guam

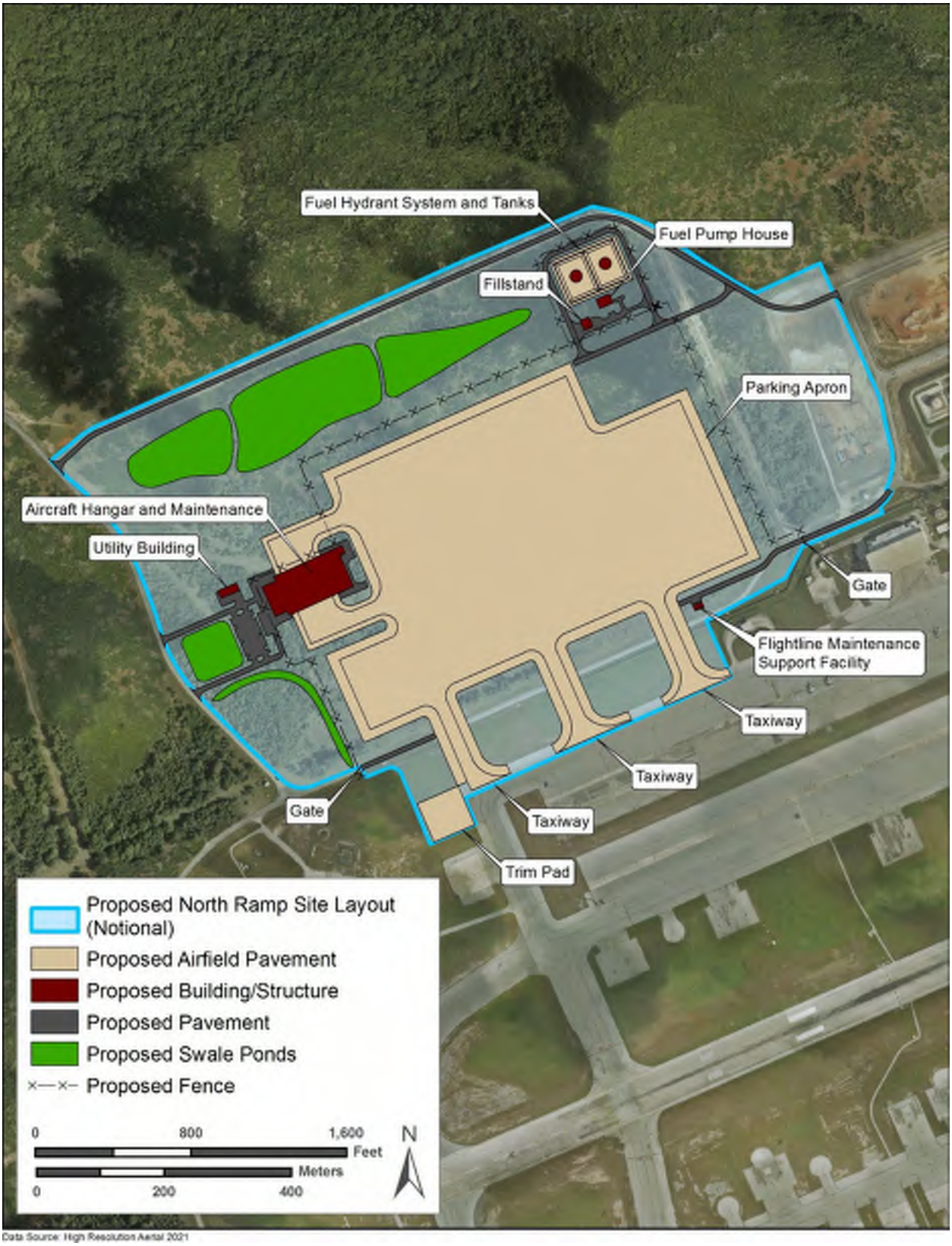

Figure 2. Project Area at North Ramp – Notional Layout

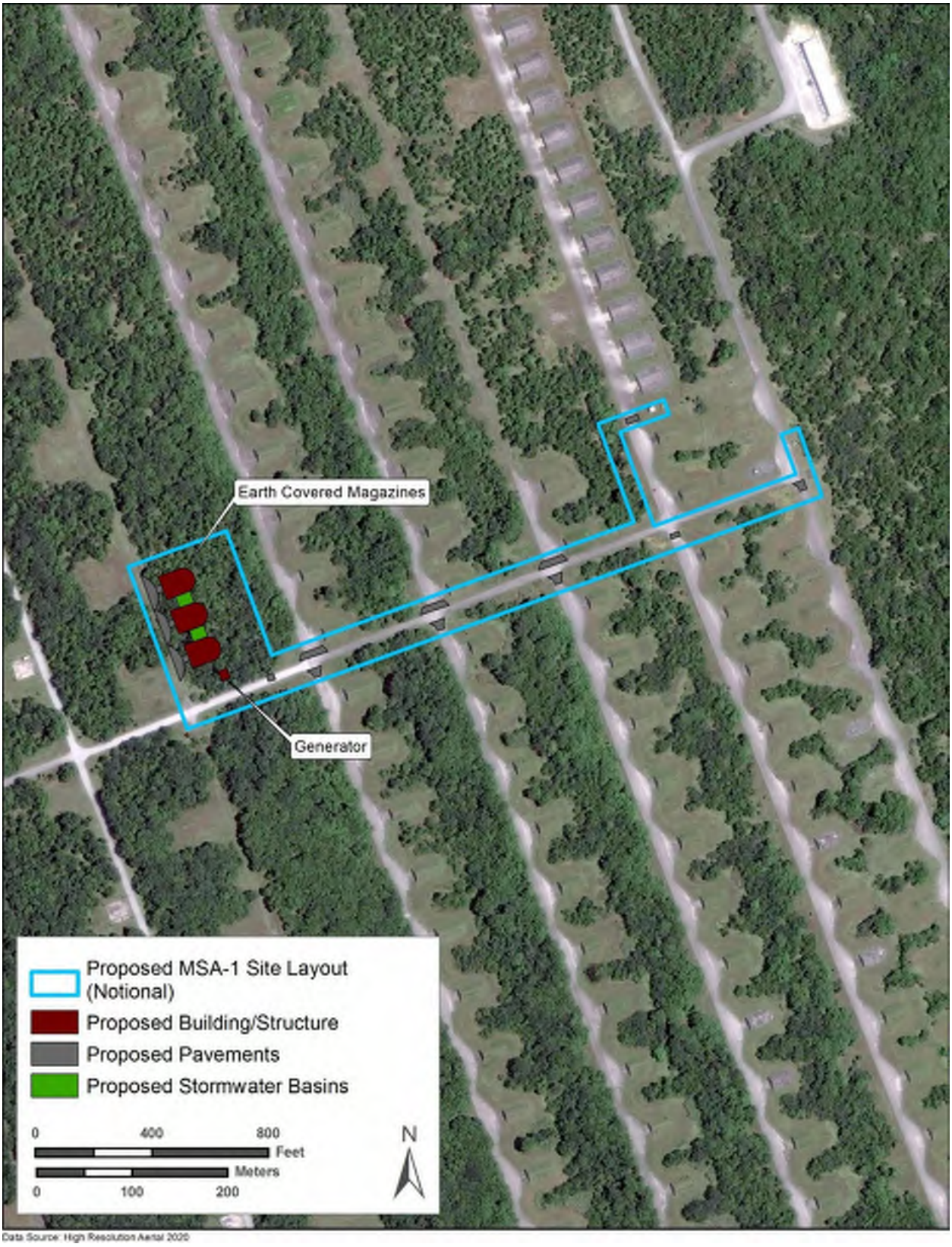

Figure 3. Project Area at MSA-1 – Notional Layout

2. Desktop Research

2.1 Previous Surveys of the Project Area

An Integrated Natural Resources Management Plan (INRMP) for all Joint Region Marianas (JRM) properties, including Andersen AFB, has been prepared in compliance with the Sikes Act (16 United States Code 670a *et seq.*), as amended, and Department of Defense Instruction 4715.03. The most recent INRMP was completed in 2019 (DON 2019). It provides a comprehensive review of all natural resources on Andersen AFB and the results of past biological surveys.

Vegetation. A vegetation study in 2015 was completed to update and standardize vegetation community classification for most JRM-administered lands on Guam, including Andersen AFB. The study assigned vegetation community and land use categories from aerial imagery, previous vegetation mapping, and field visits where appropriate. In total, 25 vegetation community categories were developed and applied across the study areas, with 12 represented on Andersen AFB. Andersen AFB vegetation communities include six native forest types (*Casuarina*, Coconut, Scrub, Limestone Coastal Scrub, Limestone Degraded, and Limestone Native), four non-native forest types (*Leucaena*, *Vitex*, Shrub/Grassland, and Strand), and two non-vegetative types (Barren and Developed) (NAVFAC Marianas 2016).

Birds. More than 20 avian species have been recorded on Andresen AFB. Surveys from 2008 through 2010 and 2011 identified common species of shorebirds and forest birds, such as Pacific golden plover (*Pluvialis fulva*), ruddy turnstone (*Arenaria interpres*), wood sandpiper (*Tringa glareola*), wandering tattler (*Tringa incana*), grey-tailed tattler (*Tringa brevipes*), sharp-tailed sandpiper (*Calidris acuminata*), Pacific reef heron (*Egretta sacra*), whimbrel (*Numenius phaeopus*), ruff (*Calidris pugnax*), black francolin (*Francolinus francolinus*), island collared dove (*Streptopelia bitorquata*), black drongo (*Dicrurus macrocercus*), and Eurasian tree sparrow (*Passer montanus*) (HDR 2013, DON 2019).

Reptile and Amphibian. Andersen AFB herpetological surveys have been intermittent. However, between 2008 and 2009, nine species of reptiles and amphibians were recorded. These included six introduced species—curious skink (*Carlia ailanpalai*), house gecko (*Hemidactylus frenatus*), brown tree snake (*Boiga irregularis*), Brahminy blind snake (*Ramphotyphlops braminus*), marine toad (*Rhinella* [=*Bufo*] *marina*), and greenhouse frog (*Eleutherodactylus planirostris*)—and three native species—Pacific blue-tailed skink (*Emoia caeruleocauda*), moth skink (*Lipinia noctua*), and mutating gecko (*Gehyra mutilata*) (DON 2019).

Invertebrates. Surveys conducted between 2009 and 2010 recorded four native butterfly species on Andersen AFB: lemon emigrant (*Catopsilia pomona*), monarch (*Danaus plexippus*), blue-banded king crow, (*Euploea eunice*) and blue moon (*Hypolimnas bolina*). Surveys conducted in 2009 and 2016 recorded four introduced species: giant African snail (*Lissachatina fulica*), rosy wolf snail (*Euglandina rosea*), cinnamon bun snail (*Satsuma mercatoria*), and New Guinea flatworms (*Platydemus manokwari*). Additionally, tropical American lined tree snail

(*Drymaeus multilineatus*) was observed in MSA-1 during the 2016 surveys (NAVFAC Pacific 2010, DON 2019).

Terrestrial Protected Species. Twelve federally listed species are known to occur on Andersen AFB. These include eight plant species—*Heritiera longipetiolata*, *Serianthes nelsonii*, *Eugenia bryanii, Bulbophyllum guamense, Cycas micronesica*, *Dendrobium guamense*, *Tabernaemontana rotensis*, and *Tuberolabium guamense*—and four animal species—Mariana fruit bat (*Pteropus mariannus mariannus*), green turtle (*Chelonia mydas*), Mariana eight-spot butterfly (*Hypolimnas octocula marianensis*), and Guam tree snail (*Partula radiolata*) (DON 2019). See **Sections 2.1.3**, **4.4.1,** and **4.4.2** for additional information on surveys for specific special status species that may be present in the project area.

2.1.1 North Ramp

In 2006, surveys were conducted and a Biological Assessment (BA) was prepared to determine natural resources affected by the proposed establishment and operation of an Intelligence, Surveillance, and Reconnaissance and Strike (ISR/Strike) capability at Andersen AFB (AAFB 2006). This survey included a large portion of the North Ramp project area.

The following federally listed species were present during the 2006 surveys: *Tabernaemontana rotensis,* Mariana crow (*Corvus kubaryi),* and Mariana fruit bat (*Pteropus mariannus mariannus).* Although not federally listed in 2006, *Cycas micronesica* were also observed. Foraging, nesting, roosting, and suitable habitats were also recorded for birds, mammals, and snails. **Table 1**, at the end of Section **2**, presents the results of the 2006 surveys, summarizing if a species was present or not.

Surveys conducted in 2006 in the ISR/Strike project area, including a large portion of the North Ramp project area, included:

- Vegetation surveys included circular quadrant sampling on 59 survey plots, each with a polygon, totaling a 100-square-meter sample area. The plots were randomly located using random number generators and were restricted to at least 20 meters apart. A delineation was created on vegetation communities outside of the cleared areas. This method was conducted to determine the vegetation community types within the ISR/Strike project area. Although not federally listed in 2006, *Cycas micronesica* were observed and recorded as vegetation community types within those plots, and it is currently protected under the ESA.
- Ungulate census surveys were conducted in conjunction with vegetation surveys to determine the population and approximate number of ungulates within a representative portion of habitat.
- Mariana fruit bat surveys, in conjunction with Mariana crow surveys, were conducted using three-point count stations established along perimeters and within the ISR/Strike project area during morning (30 minutes prior to sunrise) and evening (30 minutes prior to sunset) and in suitable weather conditions. Binoculars were used to determine any observations, and field maps were used to indicate the flight direction and duration of either species observed. Data forms were also used.

- Protected snail species, including the Guam tree snail*,* Humped tree snail (*Partula gibba)*, and fragile tree snail (*Samoana fragilis*), were surveyed. Suitable habitat, leaf litter, and surface rocks were examined for presence of live snails and ground shells.
- Mariana eight-spot butterfly host plants (*Procris pedunculata* and *Elatostema calcareum*) were surveyed to identify potential occurrence of Mariana eight-spot butterfly.
- The Guam rail, Micronesian kingfisher, Guam bridled white-eye, Mariana gray swiftlet, and the Micronesian honeyeater were included in suitable habitat and nesting surveys.

2.1.2 MSA-1

An Environmental Assessment (EA) was prepared by the Department of the Navy (DON) on behalf of Andersen AFB for the construction of 48 new Hayman-style munitions storage igloos, known as earth-covered magazines, at Andersen AFB. This EA project area includes the MSA-1 project area.

Surveys conducted between 2017 and 2019 in the Munitions Storage Igloo project area, including the entire MSA-1 project area, included:

- Determination of the presence of federally listed plants and host plants for the Mariana wandering butterfly (*Maytenus thomposonii*) and Mariana eight-spot butterfly (*Procris pedunculata* and *Elatostema calcareum*) (Cardno 2017).
- A count of the *Cycas micronesica* population, including an evaluation of health and presence of basal shoots and plant reproduction (AAFB 2019).
- Determination of the presence of any listed tree snail species using the transect survey method of 5 meters apart, accounting for vegetated and suitable habitat areas (NAVFAC 2019).

Table 1, at the end of this Section **2**, presents results of the 2017 to 2019 surveys, summarizing if a species was present or not.

2.1.3 Base-wide Surveys for Mariana Fruit Bats

Base-wide surveys for Mariana fruit bats on Andersen AFB have included the North Ramp and MSA-1 project areas (University of Guam 2020). Past base-wide surveys include, but are not limited to, the following:

- **2014:** Base-wide surveys covered approximately 5,200 acres (29.3 percent of the total Andersen AFB habitat), recorded 8 bats, and estimated a population size of 14 to 20 individuals. Sightings of Mariana fruit bats were made in the North Ramp project area in 2014.
- **2015:** Base-wide surveys covered approximately 5,245 acres (29.3 percent of the total Andersen AFB habitat), recorded 13 bats, and estimated a population size of 24 to 32 individuals.
- **2016:** Base-wide surveys covered approximately 5,070 acres (28 percent of the total Andersen AFB habitat), recorded 25 bats, and estimated a population size of 45 to 64 individuals; however, no bats were detected within the count stations of MSA-1. Peak abundance in the Habitat Management Unit located in the southwestern portion of Andersen AFB included 112 individuals in February 2016. An additional six surveys were

conducted at the historic Pati Point colony, documenting two bats. Sightings of Mariana fruit bats were made in the North Ramp project area in 2016.

- **2017:** Base-wide surveys covered approximately 6,125 acres (34 percent of the total Andersen AFB habitat), recorded 32 bats, and estimated a population size of 57 to 68 individuals, with most of the sightings in the Habitat Management Unit and the southern corner of MSA-1.
- **2018:** Base-wide surveys covered approximately 6,230 acres (41 percent of the total Andersen AFB habitat), recorded 32 bats, and estimated a population size of 57 to 76 individuals. An unknown number of bats were observed between MSA-1 and the Habitat Management Unit, with speculation that the species was seeking shelter from Rota due to Super-Typhoon Yutu, which passed through the area in October 2018.
- **2019:** Base-wide surveys covered approximately 7,310 acres (47 percent of the total Andersen AFB habitat), recorded 46 bats, and estimated a population size of 79 to 89 individuals. Andersen AFB conducted station surveys and recorded opportunistic sightings in MSA-1. Twenty-two sightings were observed within various locations of MSA-1, with all sightings being of bats passing through the area and no observed roosting and/or foraging. The 2018 group of bats was no longer present in the area at the time of these surveys.
- **2020:** Base-wide surveys covered approximately 5,270 acres (36 percent of the total Andersen AFB habitat), recorded 33 bats, and estimated a population size of 69 to 92 individuals. No observations were made at the MSA-1 observation station in 2020, and observations made at the two North Ramp stations did not record any bat sightings in 2020. An area of high bat activity (Station 67) was identified in late 2020 and was routinely monitored. More than 280 bat detections were made at this monitoring station site between October 2020 and February 2021, with 14 individual bats observed at this monitoring station during the annual bat survey in August 2020 (University of Guam 2020). Station 67 is approximately 1,000 feet from the northwest corner of the North Ramp project area.
- **2021:** Surveys for bats on Andersen AFB are ongoing in 2021. Station 67 continues to be routinely surveyed, and the roosting area is reported to still be active as of this report preparation. From January through mid-August 2021, there were 23 separate monitoring events that reported an average of approximately 12 bats. The number of bat detections in 2021 has ranged from 2 to a peak of 67 in February 2021.

2.2 Special Status Species Review

HDR conducted a desktop search on USFWS's Environmental Conservation Online System (https://ecos.fws.gov/ecp/) in January 2021 to determine the federally listed threatened and endangered species on Guam. HDR also reviewed the list of species protected by the Government of Guam through the Guam Endangered Species Act (DOAG 2009).

Table 1, at the end of **Section 2**, shows the federally and Guam-listed species that were present during previous surveys and that could potentially occur during surveys within the project areas. As summarized in **Section 2.1**, previous surveys conducted in the project areas were reviewed to note the presence or presumed absence of federally listed species or habitat.

Species identified as having a “Likely” or “Possible” potential to occur were the target species during the 2021 field surveys. However, all federally and Guam-listed species, including those “Not Likely” to occur, were included in the 2021 survey.

2.2.1 Species Eliminated from Further Discussion

Based on the results of the field surveys, the majority of species included in **Table 1** (at the end of **Section 2**) that are “Not Likely” to occur in the project area can be eliminated from further discussion and analysis in the EIS as well as during the Section 7 consultation process. Species were removed from further discussion either due to clear lack of habitat in the project area confirmed by the field surveys and/or through coordination with the USFWS in June 2021.

The following federally listed species are not discussed further in the EIS or BA for this Proposed Action:

- *Eugenia bryanii*
- *Hedyotis megalantha*
- *Phyllanthus saffordii*
- Nightingale reedwarbler, *Acrocephalus luscinia*
- Mariana gray swiftlet, *Aerodramus vanikorensis bartschi*
- Mariana common moorhen, *Gallinula chloropus guami*
- Bridled white-eye, *Zosterops conspicillatus*
- Little Mariana fruit bat, *Pteropus tokudae*
- Pacific sheath-tailed bat, *Emballonura semicaudata rotensis*
- Green sea turtle, *Chelonia mydas*
- Leatherback sea turtle, *Dermochelys coriacea*
- Hawksbill sea turtle, *Eretmochelys imbricate*
- Loggerhead sea turtle, *Caretta caretta*
- Slevin’s skink, *Emoia slevini*

Certain federally listed species that were identified as “Not Likely” to occur are discussed further in **Section 4.4.2**, as these species are considered extirpated from the wild on Guam, but were target species for these surveys. These include:

- Mariana crow, *Corvus kubaryi*
- Guam Micronesian kingfisher, *Halcyon cinnamomina*
- Guam rail, *Rallus owstoni*
- Mariana wandering butterfly, *Vagrans egistina*

Table 1. Federally and Guam-listed Species with Potential to Occur in the Project Area

Common/Chamorro Name	Scientific Name	Listing Status: USFWS/ Guam	Required Habitat	Present/Not Present in Previous Surveys	Potential to Occur in Project Area
			VEGETATION		
NCN	*Eugenia bryanii*	E / --	Occurs most often on coastal limestone and cliffsides, and occasionally on back strands	N/A	Not Likely
Paudedo [Ch]	*Hedyotis megalantha*	E / --	Occurs mostly in savanna habitat, usually in clearings and/or forest canopy; habitual to wind exposure	N/A	Not Likely
Ufa-halomtano [Ch]	*Heritiera longipetiolata*	E / E	Found in crevices of rough limestone, especially on cliffs	Not Present	Possible
NCN	*Phyllanthus saffordii*	E / --	Occurs mostly in savanna habitat, usually in clearings and/or forest canopy; habitual to wind exposure	N/A	Not Likely
Aplokating-palaoan [Ch]	*Psychotria malaspinae*	E / --	Occurs mostly in limestone forest	N/A	Possible
Hayun lågu [Ch]	*Serianthes nelsonii*	E / E	Occurs in limestone derived soils; on or near steep hillsides	Not Present	Possible
Berenghenas halomtano [Ch]	*Solanum guamense*	E / --	Occurs on limestone cliffs, and along road edges and promenades close to the coast	N/A	Possible
NCN	*Tinospora homosepala*	E / --	Occurs in limestone forest, back strand; usually hanging on subcanopy to canopy trees	N/A	Possible
Cebello halumtan [Ch]	*Bulbophyllum guamense*	T / --	Occurs commonly in moist, humid forested habitat; usually observed on tree trunks and branches	N/A	Possible
Micronesian cycad/ Fadang [Ch]	*Cycas micronesica*	T / --	Occurs on most habitat on island, mainly in closed, shaded limestone forest; occurs least on savanna habitat	Present	Likely
NCN	*Dendrobium guamense*	T / --	Occurs commonly in moist, humid forested habitat; usually observed on tree trunks and branches	N/A	Possible
NCN	*Maesa walkeri*	T / --	Occurs on limestone ridges with little to no canopy; habitual to wind exposure	N/A	Possible
NCN	*Nervilia jacksoniae*	T / --	Occurs in moist habitat areas with ground-coverings and shady areas	N/A	Possible

Common/Chamorro Name	Scientific Name	Listing Status: USFWS/ Guam	Required Habitat	Present/Not Present in Previous Surveys	Potential to Occur in Project Area
NCN	*Tabernaemontana rotensis*	T / --	Occurs in limestone forests along cliff line; edge species that now grows along roadsides and disturbed areas	Present	Possible
NCN	*Tuberolabium guamense*	T / --	Occurs commonly in moist, humid forested habitat; usually observed on tree trunks and branches	N/A	Possible
Tree Fern	*Cyathea lunulata*	-- / E	Found on the hills of southern Guam, along drainage slopes	Not Present	Not Likely
			BIRDS		
Nightingale Reedwarbler (*)	*Acrocephalus luscinia*	E / E	Unique to wetlands and non-native forest; extirpated from Guam	Not Present	Not Likely
Mariana Gray Swiftlet/Yayaguak [Ch]	*Aerodramus vanikorensis bartschi*	E / E	Occurs only in caves at southern end of Guam	Not Present	Not Likely
Mariana Crow/ Åga [Ch] (*)	*Corvus kubaryi*	E / E	Occurs in mature, native forest and late successional secondary forest; extirpated from Guam	Present	Not Likely
Mariana Common Moorhen/Pulattat [Ch]	*Gallinula chloropus guami*	E / E	Occurs only in wetlands	Not Present	Not Likely
Guam Micronesian Kingfisher/Sihek [Ch] (*)	*Halcyon cinnamomina*	E / E	Found in native primary-growth limestone forest, secondary-growth forest to some extent, and shrubby habitat of northern Guam; extirpated from Guam; in captive breeding program on mainland U.S.	Not Present	Not Likely
Guam Rail/Ko'ko [Ch]	*Rallus owstoni*	E / E	Found in savannas in southern Guam and scrubby secondary growth in northern Guam; recovered from extinction and currently established on Cocos Island, Guam	Not Present	Not Likely
Bridled White-Eye/ Nossa [Ch] (*)	*Zosterops conspicillatus conspicillatus*	E / --	Inhabits subtropical or tropical moist lowland forests, plantations, and rural gardens; presumed extirpated from Guam	N/A	Not Likely
Micronesian Honeyeater/ Egigi [Ch] (*)	*Myzomela rubrata*	-- / E	Uncommon, native resident on Guam; extirpated from Guam	Not Present	Not Likely
Rufous Fantal/ Chichirika [Ch]	*Rhipidura rufifrons uraniae*	-- / E	Inhabits native and non-native forest types; extirpated from Guam	N/A	Not Likely

Common/Chamorro Name	Scientific Name	Listing Status: USFWS/ Guam	Required Habitat	Present/Not Present in Previous Surveys	Potential to Occur in Project Area
White-throated Ground Dove/ Puluman apaka Ch (*)	*Gallicolumba xanthonura*	-- / E	Occurs in native forests; extirpated from Guam	N/A	Not Likely
Mariana Fruit-Dove/ Tottot Ch (*)	*Ptiliopus roseicapilla*	-- / E	Occurs in native forests; presumed extirpated from Guam since 1984	N/A	Not Likely
Micronesian Starling/ Såli Ch	*Aplonis opaca guami*	-- / E	Occurs in limestone cliff faces to forested mountain tops and on atolls	Not Present	Possible
MAMMALS					
Pacific Sheath-Tailed Bat/ Payeyi Ch (*)	*Emballonura semicaudata rotensis*	E / E	Forages in primary and secondary forest; presumed extirpated	N/A	Not Likely
Little Mariana Fruit Bat/Fanihi Ch	*Pteropus tokudae*	E / E	Forages in primary and secondary forest; presumed extinct	N/A	Not Likely
Mariana Fruit Bat/ Fanihi Ch	*Pteropus mariannus mariannus*	T / E	Forages in primary and secondary forest	Present	Likely
REPTILES AND AMPHIBIANS					
Green Sea Turtle/ Håggan Ch	*Chelonia mydas*	E / T	Native resident; rare	Not Present	Not Likely
Leatherback Sea Turtle	*Dermochelys coriacea*	E / --	Accidental visitor to Guam	Not Present	Not Likely
Hawksbill Sea Turtle	*Eretmochelys imbricate*	E / E	Native resident; rare	Not Present	Not Likely
Loggerhead Sea Turtle	*Caretta caretta*	T / --	Accidental visitor to Guam	Not Present	Not Likely
Slevin's Skink (*)	*Emoia slevini*	E / E	Habitat requirements poorly described but may use forests from coastal areas to mountainous areas; extirpated from Guam	Not Likely Present	Not Likely
Micronesian Gecko (*)	*Perochirus ateles*	-- / E	Habitat requirements poorly described but may use forests from coastal areas to mountainous areas; extirpated from Guam	Not Likely Present	Not Likely
Pacific Slender-Toed Gecko	*Nactus pelagicus*	-- / E	Habitat requirements poorly described but may use forests from coastal areas to mountainous areas; spotty distribution on Guam but common where it is found	Not Likely Present	Not Likely
Mottled Snake-eyed Skink	*Cryptoblepharus poecilopleurus*	--/ E	Habitat requirements poorly described but may use forests from coastal areas to mountainous areas	Not Likely Present	Not Likely

Common/Chamorro Name	Scientific Name	Listing Status: USFWS/ Guam	Required Habitat	Present/Not Present in Previous Surveys	Potential to Occur in Project Area
Tide-pool Skink	*Emoia atrocostata*	--/ E	Habitat requirements poorly described but may use forests from coastal areas to mountainous areas	Not Likely Present	Not Likely
Azure-tailed Skink	*Emoia cyanura*	-- / E	Habitat requirements poorly described but may use forests from coastal areas to mountainous areas	Not Likely Present	Not Likely
Moth Skink	*Lipinia noctua*	-- / E	Habitat requirements poorly described but may use forests from coastal areas to mountainous areas; has spotty distribution on Guam but common where it is found	Not Likely Present	Possible
Oceanic Gecko	*Gehyra oceanica*	-- / E	Habitat requirements poorly described but may use forests from coastal areas to mountainous areas; extirpated from mainland Guam but found on Cocos Island	Not Likely Present	Not Likely
MOLLUSKS					
Fragile Tree Snail/ Akaleha[Ch]	*Samoana fragilis*	E / E	Closed canopy mesic forest with relatively undisturbed understory	Not Likely Present	Possible
Guam Tree Snail	*Partula radiolata*	E / E	Closed canopy mesic forest with relatively undisturbed understory	Not Likely Present	Possible
Humped Tree Snail/ Akaleha[Ch]	*Partula gibba*	E / E	Closed canopy mesic forest with relatively undisturbed understory	Not Likely Present	Possible
Mt. Alifan Tree Snail/ Akaleha[Ch] (*)	*Partula salifana*	-- / E	Closed canopy mesic forest with relatively undisturbed understory; presumed to be extirpated from Guam	N/A	Not Likely
INSECTS					
Mariana Eight-spot Butterfly	*Hypolimnas octocula marianensis*	E / E	Occurs in karst areas with associative host plants (*Procris pedunculata* and *Elatostema calcareum*)	Not Likely Present	Possible
Mariana Wandering Butterfly (*)	*Vagrans egistina*	E / --	Occurs in karst areas with associative host plants (*Maytenus thompsonii*); presumed extirpated from Guam since 1979	N/A	Not Likely

Table Notes: (*) = extirpated; -- = not listed; Ch= Chamorro name; E= endangered; N/A= not a focus of previous surveys, not federally-listed at time of surveys; NCN= no common name; T= threatened

3. Methods

HDR conducted a biological survey of the proposed North Ramp and MSA-1 project areas at Andersen AFB from July 6 to August 25, 2021 (Chamorro Standard Time [ChST]). Surveys were conducted during appropriate weather conditions (sunny to light precipitation) within the project area and a 30-meter (approximately 100 feet) buffer zone. The purpose of the 30-meter buffer was to identify listed flora and fauna in areas where effects (e.g., noise, dust, and lighting) from the action may occur, and where motile species may occur and subsequently move into the limits of construction. The survey buffer also accounts for where "edge effects" may occur from changes to the adjacent habitat and forest canopy cover.

All notable plant or wildlife observations were recorded using a Trimble Geo7X Global Positioning System. A data dictionary, also referred to as attribute data, was developed prior to field surveys for species known or with potential to be present in the project area. Flagging tape was used, when necessary, to help relocate federally listed plants and/or host plants. All flora and fauna species observed within the project footprint, including invasive species, were recorded. Existing vegetation community geospatial data (NAVFAC Marianas 2016) was evaluated for accuracy, and deviations from reported vegetation community composition were noted. Plant species names were confirmed at World Flora Online (http://www.worldfloraonline.org/) and wildlife species names were confirmed at Global Biodiversity Information Facility (https://www.gbif.org) to verify the most current accepted taxonomy. General observations of water resources or other notable items were also recorded.

The methods used for this survey were coordinated with the USFWS in June 2021 through review of a natural resources survey plan.

3.1 Transect Method

To observe plant and certain wildlife species, the field team walked systematic, parallel, transects (as vegetation and terrain permitted) to survey the complete project area and survey buffer zone. The spacing between each biologist was approximately 5 meters. Transect spacing was increased in areas with increased visibility of vegetation (e.g., open canopy and grasslands) and with no suitable habitat for certain species (e.g., snails).

3.2 Observation Station Method

Surveys for Mariana fruit bat (*Pteropus mariannus mariannus*) within the project areas were conducted using the protocols outlined in the "Landscape counts for solitary bats" in the *Joint Region Marianas Mariana Fruit Bat Monitoring Protocol*, dated September 2010 (JRM 2010).

Three historical observation stations were used at the North Ramp project area (Stations 143. 68, and 68a) and two new observation locations that provided line of sight to the project area. The surveys were conducted 1 "event" day per week for 3 weeks and included 2 hours of dawn and 2 hours of dusk surveys. For dawn surveys, the Mariana fruit bat surveyors were in place as soon as it was light enough to see, and the survey continued for a full 2 hours after full light. For dusk surveys, surveys were conducted in the same location, approximately 2 hours prior to sunset until it was too dark to distinguish shapes and movement.

4. Results

The results of this survey will be considered valid for the duration of project planning, consultation, and construction. Methods used for this survey were intended to provide comprehensive coverage of the project area, and special status species not observed during the survey are presumed absent. Numbers of individuals for special status plant species may change between now and the initiation of construction due to natural changes, such as decline in plant health or storm events. However, the special status species for both plant and wildlife found in the project area are not expected to change.

4.1 Vegetation

The 2021 surveys reviewed the vegetation community categories and mapping from the 2015 vegetation study (NAVFAC Marianas 2016) to summarize the current condition and acres of land cover. Of the 12 vegetation types or land uses present on Andersen AFB, only 5 were mapped within the project area by the 2015 study (see **Figure 4**).

HDR biologists reviewed the 2015 vegetation communities while completing transect surveys during the 2021 surveys. No substantial deviations from the 2015 vegetation community mapping were observed. **Table 2** and **Table 3** summarize acreages for each description of vegetation communities identified within the project area for the North Ramp and MSA-1, respectively. **Table 4** provides the percentage of vegetation communities within the project area. Descriptions for the vegetation communities present in the project area have been derived from the 2019 INRMP (DON 2019) and include:

- **Limestone Degraded Forest.** Limestone forest plant communities in many areas have been significantly disturbed by clearing, invasive plants, and introduced animal species. This plant community has one or more of the following characteristics: (1) dominated by a variety of non-native woody species; (2) substantial forest clearings; or (3) dominated by *Talipariti simile* (previously known as *Hibiscus tiliaceus)*, a native tree species usually forming dense thickets in Guam's limestone forests. The most common non-native tree species in limestone degraded forest are *Vitex parviflora*, a non-native medium- to large-sized tree, or *Leucaena leucocephala* (tangantangan). Native tree species in these forests usually include one or more of the following: *Premna serratifolia*, *Pandanus tectorius*, *Meiogyne cylindrocarpa* (previously known as *Guamia mariannae)*, and/or *Aglaia mariannensis*. The limestone degraded forest is categorized separately from the limestone native forest due to the prevalence of these degraded lands on Guam and to aid natural resource managers in identifying areas for potential restoration.
- **Limestone Native Forest.** This community is a relatively undisturbed forest on shallow limestone soils and is dominated by native tree and shrub species. Forest clearings, resulting from ungulate or other disturbances, are absent or very limited based on aerial imagery. Dominant tree species in these forests usually include one or more of the following: *Ochrosia* (previously known as *Neisosperma) oppositifolia*, *Intsia bijuga, Premna serratifolia*, *Ficus* spp., *Pandanus* spp., *Meiogyne cylindrocarpa*, *Talipariti simile*, *Eugenia reinwardtiana*, *Cynometra ramiflora*, and/or *Macaranga thompsonii*. The

very large, canopy-emergent trees *Artocarpus mariannensis* or *Elaeocarpus joga* may be present.

- **Other Shrub/Grassland.** This community is characterized by the presence of shrubs and grasses. This community is often present in degraded forest areas as clearings with herbaceous vegetation and scattered shrubs. Also included in this community are areas that have been cleared in the relatively recent past or are being mowed periodically to prevent forest regeneration. These areas may consist primarily of grassland, with limited regrowth of woody species.
- **Vitex Forest.** This community is usually dominated by a canopy layer of non-native *Vitex parviflora*. In some areas, *Talipariti simile* may also be scattered throughout the community. The understory of this forest community is often dominated by the native *Pandanus tectorius*, which may be present as small trees, shrubs, or saplings. Common ferns such as *Pteris tripartita* and *Pyrrosia lanceolata* are also often present in this community.
- **Developed Land.** These are human-occupied or otherwise highly disturbed areas that include lawns and other landscaped areas, or actively maintained areas (e.g., mowed fields, utility corridors, etc.), buildings, roads, parking lots, and other paved areas.

Table 2. Vegetation Communities Within the North Ramp Project Area

Vegetation Type/Land Cover	Project Area	Project Area Acres	% of Project Area
Limestone Degraded Forest	North Ramp	127.2	66.5%
Limestone Native Forest	North Ramp	0.4	<1%
Other Shrub/Grassland	North Ramp	15.9	8.3%
Developed Land	North Ramp	47.9	25.0%
Total	**North Ramp**	**191.4**	**100%**

Source: NAVFAC Marianas 2016

Table 3. Vegetation Communities Within the MSA-1 Project Area

Vegetation Type/Land Cover	Project Area	Project Area Acres	% of Project Area
Vitex Forest	MSA-1	5.2	45.2%
Developed Land	MSA-1	6.3	54.8%
Total	**MSA-1**	**11.5**	**100%**

Source: NAVFAC Marianas 2016

Table 4. Percentage of Andersen AFB Vegetation Communities Within the Project Area

Vegetation Type/Land Cover	Project Area Acres	Vegetation Type/ Land Cover Acres on Andersen AFB	% of Project Area Acres on Andersen AFB
Limestone Degraded Forest	127.2	3,296.7	3.9%
Limestone Native Forest	0.4	2,533.2	<0.1%
Other Shrub/Grassland	15.9	872.8	1.8%
Developed Land	54.2	4,874.0	1.1%
Vitex Forest	5.2	2,784.0	0.2%
Other Land Cover Types	0.0	1,010.8	0.0%
Total	**202.9**	**15,371.5**	**1.32%**

Source: NAVFAC Marianas 2016

4.1.1 Native Vegetation

The largest vegetation type within the project area, the limestone degraded forest, contains a mixture of native and non-native vegetation consistent with similar forests throughout Andersen AFB and northern Guam. Native vegetation was more frequently observed within the inner areas of the North Ramp project area. **Table 5** summarizes the most frequently encountered native vegetation in both the MSA-1 and North Ramp project areas. A summary of the plant composition, both native and non-native species, by vegetation type is included in **Appendix A**. An example of the limestone degraded forest in the North Ramp project area is shown in see **Appendix B, Photograph 1**.

Pockets of low to medium height limestone karsts were present within the project buffer which count for <1% of acreage. Those native vegetations in the area included *Ficus prolixa*, *Meiogyne cylindrocarpa*, and *Aglaia mariannensis*.

Table 5. Common Native Plant Species Observed in the Project Area

Common/Chamorro Name	Scientific Name
NCN/Mapunyao [Ch]	*Aglaia mariannensis*
Micronesian cycad/Fadang [Ch]	*Cycas micronesica*
NCN/Nunu [Ch]	*Ficus prolixa*
Dryer's fig/Hodda [Ch]	*Ficus tinctoria*
Bornea teak/Ifit [Ch]	*Intsia bijuga*
NCN/Paipai [Ch]	*Meiogyne cylindrocarpa*
Indian Mulberry/Noni [Ch]	*Morinda citrifolia*
NCN/Fagot [Ch]	*Ochrosia oppositifolia*
False elder/Ahgoa [Ch]	*Premna serratifolia*
NCN/Aplokating [Ch]	*Psychotria mariana*
Abubo [Ch]	*Stictorcardia tiliaefolia*
Atoto [Ch]	*Syzygium thompsonii*
Beach hibiscus/Pågo [Ch]	*Taliparíti simile*
NCN/Gapit atayake [Ch]	*Wikstroemia elliptica*

Table Notes: Ch= Chamorro name; NCN= no common name

4.1.2 Non-Native Vegetation

Due to extensive disturbance in the project area from historical use and ungulate browsing, non-native vegetation is present throughout the project area. Non-native vegetation in the North Ramp and MSA-1 project areas is spread throughout open areas, roadsides, and outer edges of canopy forests. A non-native plant species, *Chromolaena odorata,* was observed frequently throughout the surveys, especially in shaded canopy forests with native vegetation.

Table 6 summarizes the most frequently encountered non-native vegetation in the project areas. A summary of the plant composition, both native and non-native species, by vegetation type is included in **Appendix A**.

Table 6. Common Non-native Plant Species Observed in the Project Area

Common Name	Scientific Name
Hairy beggartick	*Bidens pilosa*
Jack in the bush	*Chromolaena odorata*
Coconut	*Cocos nucifera*
Tangantangan	*Leucaena leucocephala*
Climbing hempvine	*Mikania scandens*
Corkystem passionflower	*Passiflora suberosa*
Coffeeweed	*Senna occidentalis*
Limeberry	*Triphasia trifolia*

4.2 Water Resources

No surface water or wetlands have been mapped or reported within the project area. Field surveys confirmed that no surface water or wetlands are present in the project area. However, surveys were conducted during the rainy season, and standing or flowing water was frequently observed following heavy rain events (see **Appendix B, Photograph 2**).

The University of Guam's Water and Environmental Research Institute of the Western Pacific (WERI) mapped one sinkhole near the project area. Two sinkholes, both one to two feet deep, were confirmed during field surveys. The sinkholes are approximately three feet and 15 feet from the northwest corner of the North Ramp project area (see **Appendix B, Photograph 9**).

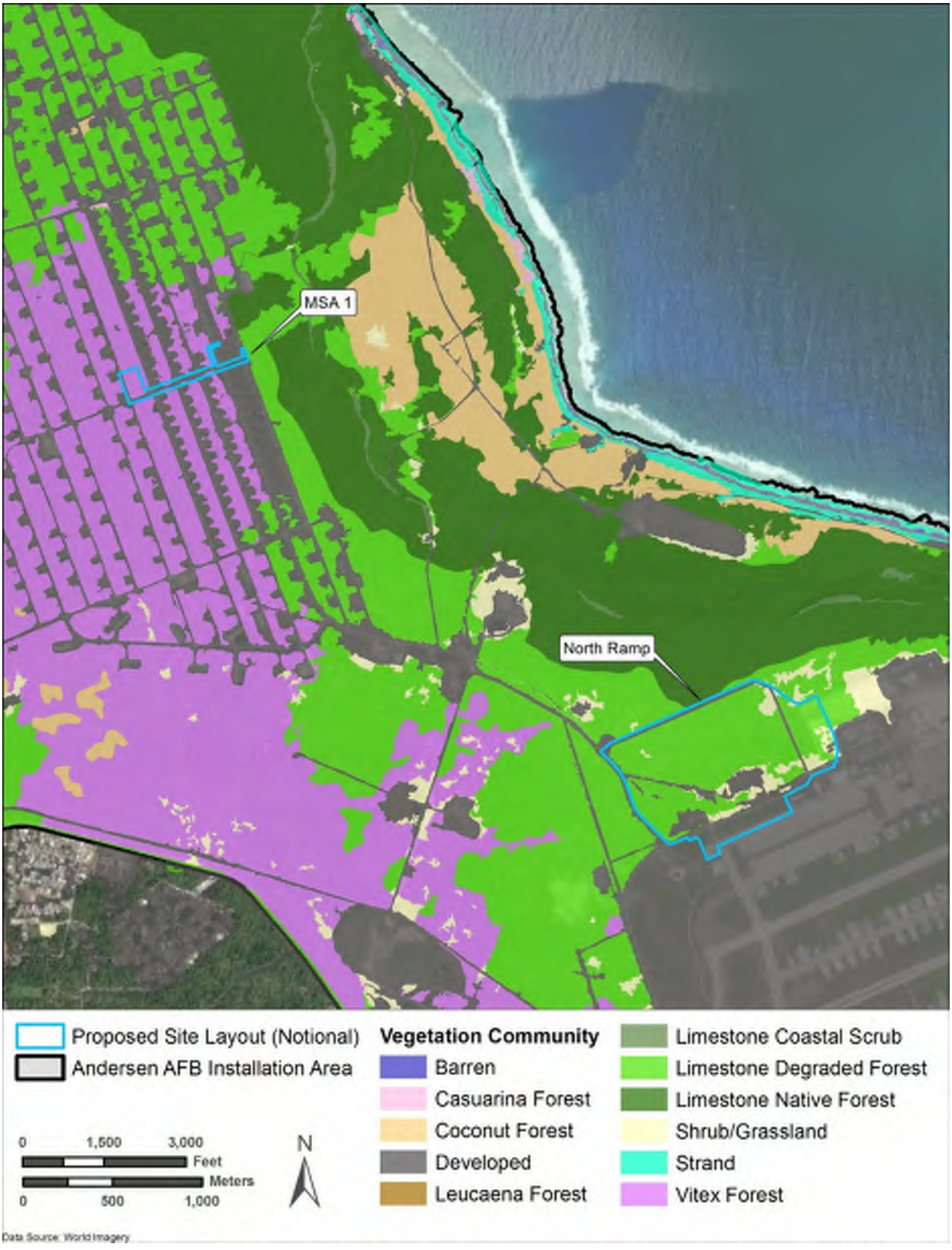

Figure 4. Vegetation Communities in the Project Area

4.3 Wildlife

The transect survey method was intended to locate and record target special status species, particularly plants, butterflies, and snails. Survey methods to detect other wildlife species, such as avian point counts, game cameras, or live traps, were not used for this survey. Incidental observations of native and non-native wildlife were recorded during the transect surveys as discussed in the following sections.

4.3.1 Native Wildlife

Table 7 lists native wildlife species recorded during the survey. Wildlife was recorded through visual observation, sign such as scat or prints, or auditory confirmation. Native special status species listed in **Table 7** are discussed in detail in **Section 4.4**.

Table 7. Native Wildlife Species Observed in the Project Area

Common/Chamorro Name	Scientific Name
MAMMALS	
Mariana Fruit Bat/Fanihi [Ch]	*Pteropus mariannus mariannus*
BIRDS	
Micronesian starling/Såli [Ch]	*Aplonis opaca guami*
Yellow bittern	*Ixobrychus sinensis*
REPTILES	
Snake-eyed skink	*Cryptoblepharus poecilopleurus*
Blue-tailed skink	*Emoia caeruleocauda*
House gecko	*Hemidactylus frenatus*
Mourning gecko	*Lepidodactylus lugubris*
ARTHROPODS	
Coconut crab	*Birgus latro*
Forest hermit crab	*Coenobita spinosus*
Guam long-legged land crab	*Discoplax michalis*

Table Notes: Ch= Chamorro name; NCN= no common name

In addition, native species known to be present on Andersen AFB such as Pacific golden plover (*Pluvialis fulva*), and Pacific reef heron (*Egretta sacra*) would be expected to transit the project area.

4.3.2 Non-Native Wildlife

Table 8 lists non-native wildlife species recorded during the survey. The following general observations about non-native wildlife within the project area were noted during the 2021 surveys:

- Philippine deer and their droppings were observed throughout the North Ramp project area (see **Appendix B, Photograph 5**). The federally listed *Cycas micronesica* seem to be directly impacted by the Philippine deer based on observations of antler rubbings on trunks of trees that had been knocked down.
- Although no nests were identified during surveys, a significant number of greater banded hornets (*Vespa tropica*) were observed daily flying and feeding on vegetation.

Table 8. Non-native Wildlife Species Observed in the Project Area

Common Name	Scientific Name
MAMMALS	
Domestic dogs	*Canis familiaris*
Domestic cats	*Felis catus*
Philippine deer	*Rusa marianna*
BIRDS	
Black drongo	*Dicrurus macrocercus*
Black francolin	*Francolinus francolinus*
Eurasian sparrow	*Passer montanus*
Philippine collared dove	*Streptopelia bitorquata*
REPTILES AND AMPHIBIANS	
Curious skink	*Carlia ailanpalai*
Cane toads	*Rhinella marina*
MOLLUSKS	
Lined tree snail	*Drymaeus multilineatus*
Cinnamon bun snail	*Satsuma* sp.
Cuban slug	*Veronicella cubensis*
INSECTS AND ARACHNIDS	
Croton caterpillar	*Achaea janata*
Hawaiian garden spider	*Argiope appensa*
Asian cycad scale	*Aulacaspis yasumatsui*
NCN	*Campsomeriella annulate*
Common emigrant	*Catopsilia pomona*
Monarch	*Danaus plexippus*
Blue-banded king crow	*Euploea eunice*
Giant crab spider/Huntsman spider	*Heteropoda venatoria*
Malayan eggfly	*Hypolimnas anomala*
Great eggfly	*Hypolimnas bolina*
Soapberry bug	*Leptocoris vicinus*
Japanese rice grasshopper	*Oxya japonica*
Longhorn crazy ant	*Paratrechina longicornis*
Common Mormon	*Papilio polytes*
NCN	*Protaetia pryeri*
Tropical paper wasp	*Polistes stigma*
Tropical fire ant	*Solenopsis geminata*
NCN	*Stenocatantops splendens*
NCN	*Valanga excavata*
Greater banded hornet	*Vespa tropica*
Yellow jacket wasps	*Vespula* spp.

Table Notes: NCN= no common name

In addition, non-native species such as the brown tree snake (*Boiga irregularis*), the coconut rhinoceros beetle (*Orycetes rhinoceros*), and feral pigs (*Sus scrofa*) may occur but were not observed during 2021 surveys.

4.4 Special Status Species

Surveys for special status species were conducted for all species listed for Guam, with a focus on the federally listed species known to occur on Andersen AFB and that have potential to occur in the project area. Five federally listed plants and one federally listed mammal were confirmed to occur in the North Ramp project area. Only one of those plant species, *Cycas micronesica*, was also recorded in the MSA-1 project area, and the Mariana fruit bat is assumed to be present in both the North Ramp and MSA-1 project areas based on suitable habitat availability.

Table 9 summarizes the special status species recorded during the 2021 surveys for both the survey area, which includes the 30-meter survey buffer around the project area, and the 203-acre project area. The transects walked to survey for special status species are included in mapbooks in **Appendix C**. Transect spacing was adjusted based on visibility of special status plants and suitable habitat conditions for certain species (e.g., snails and orchids).

Table 9. Special Status Species Observed in the Survey Area

Common Name	Scientific Name	Listing Status: USFWS/ Guam	Number of Individuals Recorded in the Survey Area	Number of Individuals Recorded in the Project Area
Fadang[Ch]	*Cycas micronesica*	T / --	587	416
NCN	*Tabernaemontana rotensis*	T / --	234	99
NCN/ Cebello halumtan[Ch]	*Bulbophyllum guamense*	T / --	4	1
NCN	*Dendrobium guamense*	T / --	2	2
NCN	*Tuberolabium guamense*	T / --	100	100
Mariana Fruit Bat/ Fanihi[Ch]	*Pteropus mariannus mariannus*	T / E	Multiple	Multiple
Micronesian starling/ Såli [Ch]	*Aplonis opaca guami*	-- / E	1	1

Table Notes: Ch= Chamorro name; E= endangered; NCN= no common name; -- = not listed; T= threatened

Federally listed species that were not observed during the field surveys are presumed absent. One Guam ESA-listed species, a juvenile Mariana starling, commonly known as såli in Chamorro, was briefly observed perching on a *Vitex parviflora* tree and flew to the northeast of the North Ramp project area. Såli birds are regularly observed throughout Andersen AFB.

4.4.1 Special Status Species Observed or Assumed to be Present

Cycas micronesica

Cycas micronesica, commonly known as fadang in Chamorro or cycad, is a stout-trunked tree in the cycad family and is found on the islands of Guam, Rota, and Pagan in the Mariana Islands, Republic of Palau, and Federated States of Micronesia. Leaves are restricted to the terminal end of the trunk, or to the terminal end of branches that may form as the tree gets older. *Cycas micronesica* are typically found growing in limestone native and degraded forests, ravine forest, and savanna complex summits. The population declined rapidly in 2003 from arthropod pest damage, including the Asian cycad scale (*Aulacaspis yasumatsui*), cycad blue butterfly (*Chilades pandava)*, leaf miner (*Erechthias* sp.), and the native longhorn beetle (*Dihammus marianarum*). In addition, these plants are at risk from ungulate browsing. In October 2015, *Cycas micronesica* were federally listed as a threatened species (USFWS 2015).

Historically, *Cycas micronesica* have been found in limestone forests throughout Andersen AFB. Surveys done between 2016 and 2017 recorded more than 18,000 individuals, although the majority of these plants were infested with scale and in declining or poor condition (DON 2019).

There were 587 *Cycas micronesica* observed within the survey area during the 2021 surveys, including 178 in MSA-1 (**Figure** 5) and 409 in the North Ramp (**Figure** 6). Of those 587 individuals, 416 *Cycas micronesica* fall within the project area and would be removed as part of the proposed action. Each tree was assigned a health rating. In general, those trees that are in fair or good health are considered candidates for salvage and transplant. Trees that were dead, with no signs of life and no potential for salvage, were not recorded.

Table 10 summarizes the status of *Cycas micronesica* observed during the 2021 field surveys. **Appendix D,Table D-1** provides a detailed list of each *Cycas micronesica* recorded during the field survey.

Cycas micronesica in the North Ramp project area were found growing primarily in the degraded limestone forest and shrub/grassland vegetation communities. In addition, several *Cycas micronesica* were observed to have been directly impacted by the non-native Philippine deer. Signs of damage were common on trees throughout the project area. Many *Cycas micronesica* leaves were also observed to have significant cycad scale or cycad butterfly damage. There were no observations of *Cycas micronesica* seedlings or juveniles, indicating that recruitment of new trees is not occuring.

Table 10. *Cycas micronesica* Summary

Health Rating	Rating Criteria	Number in Survey Area			Number in Project Area		
		MSA-1	North Ramp	Total	MSA-1	North Ramp	Total
Good	Tree has a full set of healthy erect leaves in the absence of old dead leaves; evidence of cycad scale is minor (low); no evidence of rot, termites, or other pests and defects	33	105	138	19	72	91
Fair	Tree has moderate presence of cycad scale and shows signs of stress in terms of yellowing and drooping leaves; new set of leaves may be present; low to moderate evidence of rot, termites, or other pest and defects (should be such that they do not pose a serious risk to the tree survivorship)	113	249	362	66	210	276
Poor	Tree has few living leaves; moderate to severe cycad scale infestation; and/or the evidence of rot, termites, or other pests and defects indicate a low probability of the tree surviving if salvaged	26	55	81	9	37	46
Not Recorded	Health assessment rating was not recorded during two survey days in the MSA-1 project area; all recorded points represent trees that were alive as of survey date	6	0	6	3	0	3
Total		**178**	**409**	**587**	**97**	**319**	**416**

Figure 5. Locations of *Cycas micronesica* in the MSA-1 Project Area

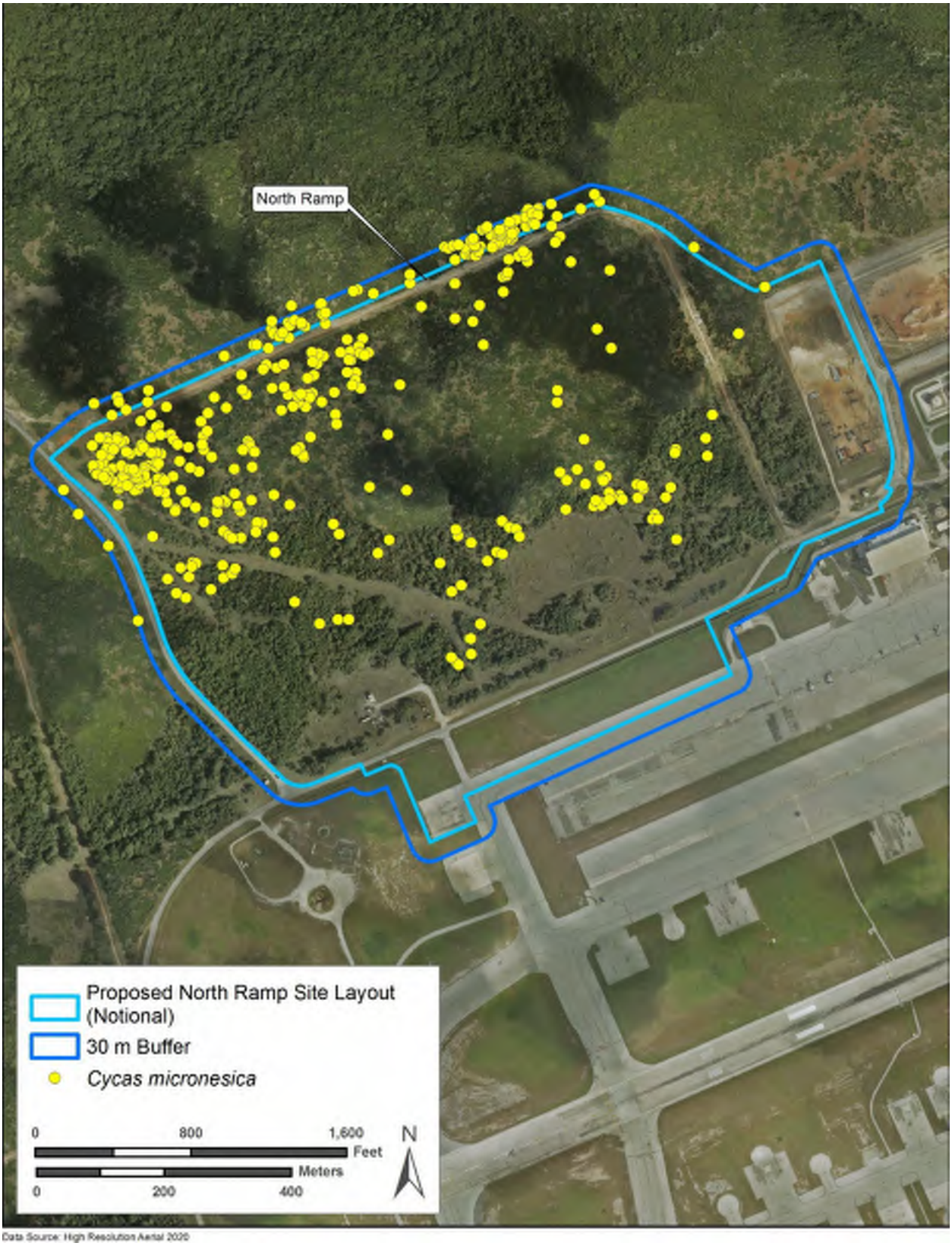

Figure 6. Locations of *Cycas micronesica* in the North Ramp Project Area

Tabernaemontana rotensis

Tabernaemontana rotensis (no common name) is a small- to medium-sized tree of the dogbane family and is found on the islands of Guam and Rota in the Mariana Islands. This species is threatened by habitat loss, agricultural destruction, urban development, typhoons, fires, and non-native plants and animals, including insect infestations and ungulate browsing. In October 2015, *Tabernaemontana rotensis* were federally listed as a threatened species (USFWS 2015).

Historically, *Tabernaemontana rotensis* have been found in limestone forests throughout Andersen AFB. Surveys done between 2005 and 2006 recorded more than 21,000 individuals, and surveys done between 2016 and 2017 confirmed additional individuals on Andersen AFB (DON 2019).

There were 234 *Tabernaemontana rotensis* recorded within the survey area, with 99 of those individuals in the project area that would be subject to removal as part of the proposed action. All *Tabernaemontana rotensis* were found within the North Ramp survey area (**Figure** 7). Each tree's size and maturity was recorded to determine if those trees have the potential to produce seed that could be collected, germinated, and propagated for future transplanting. Multiple trees were often recorded at one survey point, due to the clustered growth pattern of seedling and juvenile trees. One thick grouping of trees outside of the northwest corner of the project area, but within the survey area, included 54 mature individuals and 79 juvenile individuals (see **Appendix B, Photograph 12**). Three trees were observed flowering during the survey period and one was producing seed.

Table 11 summarizes the status of *Tabernaemontana rotensis* observed during the 2021 field surveys. **Appendix D, Table D-2** includes a detailed list of each *Tabernaemontana rotensis* recorded during the 2021 survey.

Table 11. *Tabernaemontana rotensis* Summary

Maturity	Diameter	Height	Total in Survey Area	Total in Project Area
Mature	Greater than 2 inches	Greater than 8 feet	129	74
Juvenile	1 to 2 inches	2 to 12 feet	97	18
Seedling	Less than 1 inch	Less than 10 feet	8	7
Total			**234**	**99**

Figure 7. Locations of *Tabernaemontana rotensis* in the Project Area

Bulbophyllum guamense

Bulbophyllum guamense, commonly known as Cebello halumtan in Chamorro, is an epiphytic orchid endemic to the Mariana Islands, and found growing on trees in moist limestone and ravine forests on native and non-native trees. This species has numerous long stems and narrow, alternate leaves with parallel veins. The flowers are creamy-white with a pale yellow lip and occur in two-flowered racemes. In October 2015, *Bulbophyllum guamense* were federally listed as a threatened species (USFWS 2015).

Historically, *Bulbophyllum guamense* have been observed to the west and northeast of North Ramp and southeast of MSA-1 (DON 2019). This species was not federally listed during the surveys of the North Ramp in support of the ISR/Strike EIS; therefore, it was not a target species for those surveys.

There were approximately four *Bulbophyllum guamense* observed on three host trees within the survey area during the 2021 surveys, all within the North Ramp (**Figure** 8). Only one of the host trees and orchids fall within the project area limits and would be subject to removal from the proposed action. Federally listed orchids were recorded by host tree from a ground observation; therefore, the exact number of individuals in the higher canopy was estimated. **Table 12** summarizes the approximate number of *Bulbophyllum guamense* observed during the 2021 surveys. **Appendix D, Table D-3** provides a detailed list of each *Bulbophyllum guamense* host tree recorded during the 2021 survey.

Table 12. Federally Listed Orchid Summary

Orchid Species	Orchids within Survey Area		Orchids within Project Area	
	Host Tree Count	Orchid Count	Host Tree Count	Orchid Count
Bulbophyllum guamense	3	4	1	1
Dendrobium guamense	2	2	2	2
Tuberolabium guamense	19	100*	19	100*
Total	**24**	**106**	**22**	**103**

*includes 27 seedlings considered not suitable for salvage

Dendrobium guamense

Dendrobium guamense (no common name) is an epiphytic orchid with crowded stems, endemic to the Mariana Islands, and found growing on the trunks and branches of native and non-native trees in moist limestone and ravine forest. This species has cylindrical stems up to 24 inches tall that tend to taper at both ends. Two flowers arise together from a pedicel between two leaves (DON 2019). In October 2015, *Dendrobium guamense* were federally listed as a threatened species (USFWS 2015).

Historically, *Dendrobium guamense* have been observed in clumps on tree branches of coastal lowland limestone forests. Recent surveys identified this species in limestone native forests north and northeast of Northwest Field and in the Pati Point limestone forests (DON 2019).

There were two *Dendrobium guamense* observed one two host trees within the North Ramp project area during the 2021 surveys (**Figure** 8). **Table 12** summarizes the host trees *Dendrobium guamense were* observed on during surveys. **Appendix D, Table D-3** provides a detailed list of each *Dendrobium guamense* host tree recorded during the survey.

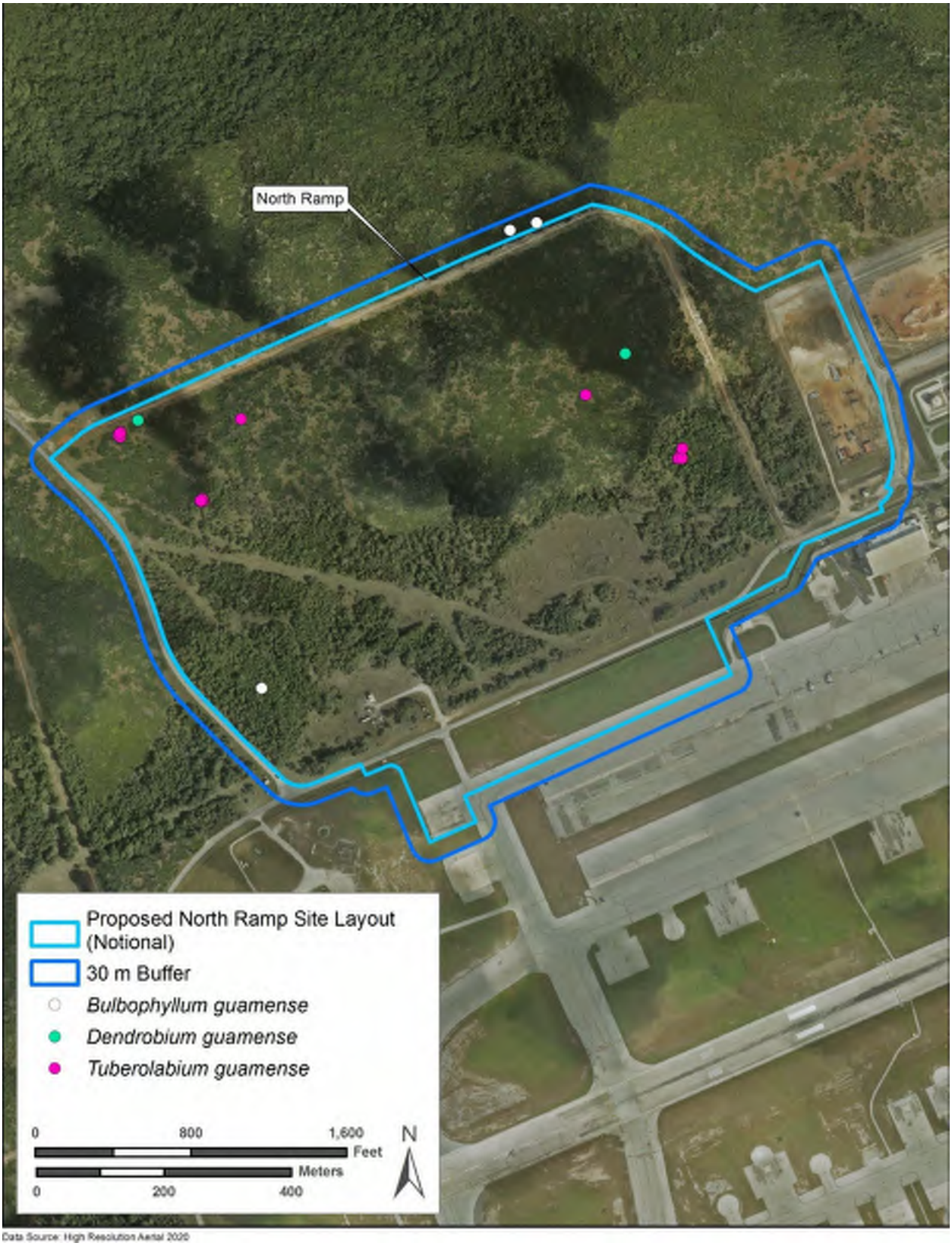

Figure 8. Locations of Federally Listed Orchid Host Trees in the Project Area

Tuberolabium guamense

Tuberolabium guamense (no common name) is an epiphytic monopodial orchid endemic to the Mariana Islands and found growing on trees in moist shady areas in the higher elevations of limestone and ravine forests. This species has leathery ovate-oblong leaves with roots that elevate the plant from the host tree trunk. Small white flowers found on the rachis are 1.5 inches long and are open for a day or two at various times of the year. This orchid species is threatened by urban and agricultural development, typhoons, fires, rats, and non-native plants (DON 2019). In October 2015, *Tuberolabium guamense* were federally listed as a threatened species (USFWS 2015).

Historically *Tuberolabium guamense* have been found in limestone forests on Andersen AFB, including west and northwest of the North Ramp. Surveys conducted in 2016 identified 4,278 individuals on Andersen AFB (DON 2019).

There were 100 *Tuberolabium guamense* observed on 19 host trees within the North Ramp project area during the 2021 surveys, with none observed in the adjacent survey buffer (**Figure** 8). **Table 12** summarizes the host trees *Tuberolabium guamense were* observed on during the 2021 surveys. **Appendix D, Table D-3** provides a detailed list of each *Tuberolabium guamense* host tree recorded during the 2021 survey.

In addition, general orchid observations from the 2021 surveys include the following:

- *Dendrobium guamense* and *Bulbophyllum guamense* were observed in large clumps on one host tree with no other host trees in the vicinity that indicated signs of dispersal.
- *Dendrobium guamense* were found on *Premna serratifolia* and *Meiogyne cylindrocarpa*.
- *Bulbophyllum guamense* were observed growing on *Intsia bijuga*, *Cycas micronesica*, *and Talipariti simile*.
- *Tuberolabium guamense* were observed on native plants such as *Aglaia mariannensis* and *Premna serratifolia* and non-native *Vitex parviflora.*
- *Tuberolabium guamense* observations included 27 seedlings.

Mariana Fruit Bat

Pteropus mariannus mariannus, commonly known as fanihi in Chamorro or the Mariana fruit bat, is a subspecies endemic to Guam and the Mariana Islands. This medium-sized frugivorous bat in the Pteropididae family, weighs between 0.66 and 1.15 pounds with a black or brown underside and golden-brown shoulders. The Mariana fruit bat forms colonies and roosts, forages primarily in native limestone forest, and occasionally forages for fruit within agricultural forests. Threats to this species include habitat loss, ungulates, illegal hunting, and invasive brown tree snakes that may prey on juvenile fruit bats (USFWS 2005a). The Mariana fruit bat was originally listed as endangered in 1984; however, in 2005, the Mariana fruit bat was determined to be a subspecies and reclassified as a federally threatened species throughout its range of Guam and the Commonwealth of the Northern Mariana Islands (USFWS 2005a). The majority of the fruit bat populations on Guam are located at the Pati Point below the north

runway of Andersen AFB. In 2004, the USFWS designated 376 acres at the Ritidian National Wildlife Refuge as critical habitat for the Mariana fruit bat, Guam Micronesian kingfisher, and Mariana crow.

Historically, the Mariana fruit bat has been observed at Pati Point and the Habitat Management Unit on Andersen AFB. It has also been reported from the forested cliffline habitat at Orote Point on the main base of Naval Base Guam and the Naval Magazine. Base-wide surveys for Mariana fruit bat have recorded multiple bat sightings in the North Ramp project area and near the MSA-1 project area within the last 10 years. Surveys performed in 2020 and early 2021 recorded an area of high bat activity with up to 67 individual bats (AAFB 2021). Bats from this roosting area have been observed foraging in the North Ramp project area.

There were more than 25 incidental observations of the Mariana fruit bat during the 2021 pedestrian survey, including bat sign (droppings) and odors. Fanihi droppings (see **Appendix B, Photograph 6**) and scent were detected in both the North Ramp and MSA-1 project areas. Droppings were frequently found on *Aglaia mariannensis* and *Premna serratifolia* indicating these and other neighboring native trees may be a preferred source of food. *Ficus prolixa* trees were often found in proximity to locaitons of droppings. The North Ramp project area has a dense population of *Aglaia mariannensis*.

Bat protocol surveys were conducted at established monitoring stations on September 2-3, 9-10, and 16-17, 2021 (ChST). The locations of established Mariana fruit bat monitoring stations as well as other observations of bat presence are shown in **Figure 9** for the MSA-1 project area and **Figure 10** for the North Ramp project area. **Table 13** summarizes observations of Marianas fruit bat during the 2021 bat protocol surveys. During two survey events along the northern perimeter of the North Ramp project area, bat sound was overheard to the north in adjacent habitat.

Table 13. Mariana Fruit Bat Survey Results

Survey Date (ChST)	Station Location	Survey Time	Surveyor	Bat Detections	Observations
09/02/2021	68A	1645-1900	J. Abrincia	0	Bat sound heard to north
09/02/2021	143	1645-1900	J. Horeg	1	
09/03/2021	68A	0500-0700	J. Abrincia	3	Bat sound heard to north
09/03/2021	143	0500-0700	J. Horeg	1	
09/09/2021	144	1700-1900	J. Abrincia	1	
09/09/2021	68	1700-1900	J. Horeg	2	
09/10/2021	144	0530-0730	J. Abrincia	3	
09/10/2021	68	0530-0730	J. Horeg	0	
09/16/2021	Southeast Corner	1700-1900	J. Abrincia	0	
09/17/2021	Southeast Corner	0530-0730	J. Abrincia	0	
09/17/2021	Western Edge	0500-0700	J. Horeg	0	

Figure 9. Mariana Fruit Bat Observations near the MSA-1 Project Area

Figure 10. Mariana Fruit Bat Observations near the North Ramp Project Area

Micronesian Starling

Aplonis opaca, commonly known as sali in Chamorro or the Micronesian starling, is endemic to Guam and the Mariana Islands in all habitat types. This small-sized glossy black bird, in the Sturnidae family, has a short tail and yellow eyes. The Micronesian starling lives in groups and prefers to nest in cavities of trees and rocky cliffs. The primary threats to this species are habitat destruction and predation by the invasive brown tree snake. The Micronesian starling is not federally listed or listed under the Migratory Bird Treaty Act, but it is a Guam designated Species of Greatest Conservation and Need and is listed by the Government of Guam as endangered (DOAG 2009). As an omnivore, this species is an important native plant seed disperser and considered an uncommon native breeding resident. Found scattered throughout Andersen AFB, these birds seem to do well with nest boxes and within man-made structures. Their success on the installation is generally attributed to brown tree snake control (DON 2019, Guampedia 2021).

There was one observation of a transient juvenile Micronesian starling within the project footprint on 11 August 2021 (ChST). The individual was observed perched momentarily on a *Vitex parviflora* on the northeast corner of the North Ramp project area and then dispersed out of the project area. No nest or other individuals were observed.

4.4.2 Special Status Species Surveyed but Not Recorded

Federally listed species that have the potential to occur within the project area but were not observed during the 2021 field surveys are discussed in the following sections. These species are not expected to move into the project area during the planning and construction period due to various factors, including:

- Lack of suitable habitat or host plants;
- Distance from the closest known potential seed source;
- Limited numbers of individuals on Andersen AFB or Guam;
- Limited extent on Andersen AFB or Guam; and/or
- No known occurrences in the wild.

Where available, **Figure** 11 shows locations of historical or recent observations of certain species in relation to the project area on Andersen AFB.

Heritiera longipetiolata

Heritiera longipetiolata, commonly known as Ufa-halomtano in Chamorro, is a tree endemic to Guam and the Northern Mariana Islands that prefers moist limestone forest along coastal cliffs. Mature trees are typically short and stout, frequently with a twisted trunk. The upper surface of the leaf is dark green, while the underside of the leaf is silvery-tawny. Fruits are brown and woody (Raulerson and Reinhart 1991). A 2007 study recorded *Heritiera longipetiolata* at numerous locations on Andersen AFB, primarily in the central portion of the base and near the limestone cliffs in the northeast and southeast corners (DON 2019). In October 2015, *Heritiera longipetiolata* were federally listed as an endangered species (USFWS 2015).

No *Heritiera longipetiolata* were recorded within the project area, and the nearest occurrence is 0.25 mile northeast of the North Ramp project area in the Tarague Basin.

Psychotria malaspinae

Psychotria malaspinae, commonly knowns as Aplokating-palaoan in Chamorro, is a shrub or small tree in the coffee family that is endemic to Guam, historically in the northeastern and southwestern sides of the island. While there are historical records of *Psychotria malaspinae* on Andersen AFB, there are no observations of the species on the installation since 2010 (DON 2019). In October 2015, *Psychotria malaspinae* were federally listed as an endangered species (USFWS 2015).

No *Psychotria malaspinae* were recorded within the project area, and the nearest known occurrence is outside of Andersen AFB.

Serianthes nelsonii

Serianthes nelsonii, commonly known as Hayun lagu in Chamorro, is endemic to Guam and Rota in the Northern Mariana Islands and prefers limestone forests. Known as one of the largest native trees within the Northern Mariana Islands, this species has spreading branches and dark green bi-pinnate leaves that are dense and covered with rusty hairs beneath. The delicate pink flowers grow in panicles from leaf axils. This species is threatened by limited range, a lack of recruitment, and low numbers of individuals. There are only six known adult trees recorded on Guam since the 1970s, one mature tree and associated seedlings at Ritidian Point on Andersen AFB, and one juvenile tree at Tarague Basin on Andersen AFB (DON 2019). This species was listed as endangered in 1987 (USFWS 2012).

No *Serianthes nelsonii* were recorded within the project area, and the nearest known occurrence is more than 0.25 mile from the project area in the Tarague Basin.

Solanum guamense

Solanum guamense, commonly known as Berenghenas halomtano in Chamorro, is a small shrub in the nightshade family that is endemic to Guam and the Northern Mariana Islands. This species has the unlikely potential to occur on Andersen AFB. Only a single *Solanum guamense* has been reported on Guam (USFWS 2015). In October 2015, *Solanum guamense* were federally listed as an endangered species (USFWS 2015).

No *Solanum guamense* were recorded within the project area, and no known occurrences of this species are recorded on Andersen AFB.

Tinospora homosepala

Tinospora homosepala is endemic to Guam. This vine is in the moonseed family, preferring limestone forest and limestone coastal scrub. Only three known populations of *Tinospora homosepala* are recorded on Guam, comprising approximately 300 individuals. This species is not known to occur on Andersen AFB (DON 2019). In October 2015, *Tinospora homosepala* were federally listed as an endangered species (USFWS 2015).

No *Tinospora homosepala* were recorded within the project area, and no known occurrences of this species are recorded on Andersen AFB.

Maesa walkeri

Maesa walkeri is a shrub or small tree in the primrose family endemic to Guam and Rota. This species prefers limestone forests and is not known to occur on Andersen AFB (DON 2019). In October 2015, *Maesa walkeri* were federally listed as a threatened species (USFWS 2015).

No *Maesa walkeri* were recorded within the project area, and no known occurrences of this species are recorded on Andersen AFB.

Nervilia jacksoniae

Nervilia jacksoniae, commonly known as Seyaihagon in Chamorro, is a small ground-dwelling orchid that prefers sandy soil or humus within shady environments. Only two known populations are recorded on Guam, one northwest of Tarague Beach at Andersen AFB (DON 2019). In October 2015, *Nervilia jacksoniae* were federally listed as a threatened species (USFWS 2015).

No *Nervilia jacksoniae* were recorded within the project area, and the nearest known occurrence is more than 0.5 mile from the MSA-1 project area.

Guam Micronesian Kingfisher

Todiramphus cinnamominus, also known as sihek in Chamorro or the Guam Micronesian kingfisher, is an avian species endemic to Guam. The Guam Micronesian kingfisher is a sexually dimorphic forest kingfisher in the family Alcedinidae. Males have a rusty-brown head, neck, upper back, and underparts as well as a blue tail and wings. The feet and iris of the eye are brown, and the bill is black except for some white at the base of the lower mandible. The females appear similar to males; however, the key difference is that the chin, throat, and the underparts are white (Jenkins 1983). This species prefers limestone forest, secondary growth stands, mixed woodlands, scrub, riparian, and coconut forests. The Guam Micronesian kingfisher was considered extirpated from the wild in 1988 due to brown tree snake predation, was listed as endangered in 1984, and a Recovery Plan was released in 2008 (USFWS 2008). Fewer than 200 individuals are now found in captivity on Guam and in United States mainland zoos (DON 2019). In 2004, the USFWS designated 376 acres of the Ritidian National Wildlife Refuge as critical habitat for the Guam Micronesian kingfisher, Mariana crow, and Mariana fruit bat (USFWS 2004).

This species was once known island-wide; however, no records exist of the Guam Micronesian kingfisher in the wild since 1988, and no records exist of historical nesting locations on Andersen AFB. In 2015, 5,318 acres of Recovery Habitat for the Guam Micronesian kingfisher were established in northern Guam on Department of Defense lands via a Memorandum of Agreement between the DON and the USFWS (DON 2015, DON 2019). This designated Recovery Habitat does not include the MSA-1 or North Ramp project areas.

No Guam Micronesian kingfisher were recorded within the project footprint, and this species is unlikely to occur since none have been observed in the wild since 1988.

Guam Rail

Rallus owstoni, also referred to as ko'ko in Chamorro or the Guam rail, is a medium-sized flightless rail known to be fast-running. The Guam rail is chocolate brown with underparts boldly barred in black and white. The Guam rail appears to have a pale grey eyebrow and yellow-

brown legs and feet. The Guam rail is endemic to Guam, had a population decline in 1968, and was listed as endangered in 1984 (USFWS 2009). A population count in 1981 determined approximately 2,000 Guam rails were on Guam. By 1985, a single rail was located near the flightline of Andersen AFB. The Guam rail was considered extirpated from the wild in 1987 (DON 2019). These species declines are most like attributed to brown tree snake predation. The remaining Guam rails were held in captive-breeding facilities and were reintroduced to the wild in 1998 after a snake exclusion fence was installed on 59-acres of forest on Northwest Field on Andersen AFB. However, a rapid population decline was observed and believed to be attributed to feral cats and other predators. A release of captive-bred Guam rails was attempted at the MSA in 2003, with a similar result as the 1998 release. Captive-breeding was conducted again and successful experimental populations were released on Cocos Island, a small island located off the southern tip of Guam and on Rota in the Mariana Islands (DON 2019).

This species was once known throughout Andersen AFB, but outside of the captive-bred release experiments in 1998 and 2003, has not been observed in the wild since 1995.

No Guam rails were recorded within the project area, and this species is unlikely to occur in the area since they have not been observed to occur naturally in the wild since 1995.

Mariana Crow

Corvus kubaryi, also known as aga in Chamorro or the Mariana crow, is an endemic species to Guam and Rota in the Mariana Islands (Jenkins 1983). The adult Mariana crow has a slight greenish black gloss on the head, with brown eyes and short nasal bristles that extend over their nostrils. The immature Mariana crow resembles the adult features except for the occasional brown gloss to its tail. This species declined in the wild due to predation by the invasive brown tree snake, diseases, human disturbance, and habitat degradation. Mariana crows were listed as endangered in 1984, and a draft Recovery Plan was released in 2005 (USFWS 2005b). While there is a small Mariana crow population on Rota, this species is considered extirpated from Guam, with the last Guam-born Mariana crow observation in 2000. In 2004, the USFWS dedicated 376 acres of the Ritidian National Wildlife Refuge as critical habitat for the Guam Micronesian kingfisher, Mariana crow, and Mariana fruit bat (USFWS 2004).

This species was once known island-wide, but no known historic records of the Mariana crow occur on Andersen AFB.

No Mariana crow were recorded within the project area, and this species is unlikely to occur in the area since no Guam-born crows have been observed in the wild since 2000.

Guam Tree Snail

Partula radiolata, commonly known as the Guam tree snail, is a terrestrial gastropod mollusk endemic to the island of Guam. Adults measure 0.5 to 0.7 inch long and 0.3 to 0.5 inch wide, with approximately five whorls that are pale yellow with brown lines and dark axial rays. This species occurs in cool, shaded forests on bushes or trees within native limestone and ravine forests that provide high humidity and low air movement to conserve moisture (Crampton 1925). This species is threated by habitat loss and the invasive manokwari flatworm. In October 2015, Guam tree snails were federally listed as an endangered species (USFWS 2015).

Historically the Guam tree snail has only been observed on Andersen AFB at Tarague Basin, more than 0.25 mile from the MSA-1 and North Ramp project areas (DON 2019).

No live Guam tree snails or weathered ground shells were recorded within the project footprint or within the surrounding 100-foot survey buffer during the 2021 field surveys. Surveyors confirmed that all limestone native and degraded forest vegetation community, approximately 127.6 acres, is considered suitable habitat for Partulid snails and is characterized by shaded forests with broad-leaved host trees such as *Ochrosia oppositifolia*, *Premna serratifolia*, and *Ficus tinctoria*.

Guam tree snails are presumed absent from the project area and are unlikely to move into the project area due to the distance from known snail populations.

Humped Tree Snail

Partula gibba, commonly known as Akaleha in Chamorro or the humped tree snail, is a small arboreal snail historically found in Guam and the Mariana Islands. Adults measure 0.5 to 0.7 inch long and 0.3 to 0.5 inch wide, with approximately five whorls that are pale yellow with brown lines and dark axial rays. Humped tree snails have a life span of up to 5 years and reproduce up to 18 live young upon reaching maturity at 12 months. This species occurs in cool, shaded forests on bushes or trees within native limestone and ravine forests that provide high humidity and low air movement to conserve moisture (Crampton 1925). This species is threated by habitat loss and the invasive manokwari flatworm. In October 2015, humped tree snails were federally listed as an endangered species (USFWS 2015).

No historic recordings of the humped tree snail occur on Andersen AFB (DON 2019). The only humped tree snail population known on Guam is at the protected Haputo Ecological Reserve Area at Camp Blaz (NAVFAC 2019).

No live humped tree snails or weathered ground shells were recorded within the project footprint or within the surrounding 100-foot survey buffer during the 2021 field surveys. Humped tree snails are presumed absent from the project area and are unlikely to move into the project area due to the distance from and limited extent of known populations.

Fragile Tree Snail

Samoana fragilis, commonly known as Akaleha in Chamorro or the fragile tree snail, is also a terrestrial gastropod mollusk endemic to the islands of Guam and Rota. Adults measure 0.5 to 0.6 inch long and 0.4 to 0.5 inch wide, with approximately four whorls that spiral to the right. The shell is semi-transparent and thin, with delicate striations and internal organs visible through the shell. And are pale yellow with brown lines and dark axial rays. This species occurs in cool, shaded forests on bushes or trees withing native limestone and ravine forests that provide high humidity and low air movement to conserve moisture (Crampton 1925). This species is threated by habitat loss and the invasive manokwari flatworm. In October 2015, fragile tree snails were federally listed as an endangered species (USFWS 2015).

No known historic records of the fragile tree snail occur on Andersen AFB (NAVFAC 2019). A 2011 survey misidentified juvenile Guam tree snails as fragile tree snails at Tarague Basin;

however, a subsequent 2013 survey determined these snails were juvenile Guam tree snails (DON 2019).

No live fragile tree snails or weathered ground shells were recorded within the project footprint or within the surrounding 100-foot survey buffer during the 2021 field surveys. Fragile tree snails are presumed absent from the project area and are unlikely to move into the project area due to the distance from and limited extent of known populations.

Mariana Eight-Spot Butterfly

Hypolimnas octocula mariannensis, commonly known as the Mariana eight-spot butterfly, is endemic to Guam and Saipan in the Mariana Islands. This butterfly is predominantly orange and black. Males are smaller than females and have an orange stripe running vertically on each wing. Hindwing strips have small black dots in a vertical row. The caterpillar larva is predominantly black, with red spikes and a black head. The larvae of this butterfly feed on two native plants, found in limestone forest habitats: *Procris pedunculata* and *Elatostema calcareum*. Both host plants are susceptible to ungulate browsing. The Mariana eight-spot butterfly is threatened by ant predation, parasitic wasps, and habitat alteration. Guam surveys recorded Mariana eight-spot butterfly in areas where host plants have not been impacted by ungulates, primarily on coastal karst on northern Guam, including Andersen AFB. In October 2015, Mariana eight-spot butterflies were federally listed as an endangered species (USFWS 2015).

Historically, the host plants for Mariana eight-spot butterfly and individual butterflies have been located in multiple locations on Andersen AFB, primarily along clifflines. The nearest recorded observation to the MSA-1 project area is approximately 1 mile east in the Tarague Basin, and the nearest to the North Ramp project area is approximately 0.25 mile to the north of the North Ramp project area, also in the Tarague Basin.

No *Procris pedunculata* or *Elatostema calcareum* were recorded in the MSA-1 or North Ramp project areas or the surrounding 100-foot survey buffer. No Mariana eight-spot butterflies were recorded within the project areas, and this species is unlikely to move into the project area due to lack of preferred habitat for host plants.

Mariana Wandering Butterfly

Vagrans egistina, commonly known as the Mariana wandering butterfly, is endemic to Guam and Rota in the Mariana Islands. This butterfly is predominantly black, with irregular large, orange patterns on the wings. The caterpillar larva is predominantly brown, with black spikes. The larvae of this butterfly feed on the native *Maytenus thompsonii*, commonly known at luluhut in Chamorro, frequently found in degraded limestone forests. The Mariana wandering butterfly is threatened by ant predation, parasitic wasps, rats, and typhoons. This species is considered extirpated from Guam and has not been observed since 1979 (USFWS 2015, DON 2019). In October 2015, Mariana wandering butterflies were federally listed as an endangered species (USFWS 2015).

The Mariana wandering butterfly host plant, *Maytenus thompsonii*, has previously been recorded within the MSA, in areas adjacent to the MSA-1 project area, and within 0.25 mile of

the North Ramp project area. Detailed surveys of *Maytenus thompsonii* conducted in the MSA in 2016 found no evidence of Mariana wandering butterfly life stages (Cardno 2017).

During 2021 surveys, *Maytenus thompsonii* trees were observed in the MSA-1 and North Ramp project area, however no evidence of Mariana wandering butterfly life stages were observed. The Mariana wandering butterfly is unlikely to move into the project area due to the absence of the species during surveys and the species has not been observed in Guam since 1979.

Figure 11. Historical Observations of Other Federally Listed Species

5. Conclusion

The 2021 field surveys of the construction footprint for the proposed infrastructure upgrades at Andersen AFB confirmed the presence of five federally threatened plants, one federally threatened mammal, and one Guam-listed endangered bird. Survey findings were consistent with expectations for the species present in the project area, based on previous surveys of the same areas and historical records from Andersen AFB.

The five threatened plant species and one threatened mammal species will be carried forward for analysis in the BA. Federally listed species that were not recorded during the 2021 field surveys are presumed absent from the project area and would not be directly impacted by the proposed action.

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Appendix A.

Plant Species Lists

Table A-1. Common Plant Species Observed by Vegetation Type in the Project Area

Common/Chamorro Name	Scientific Name
Limestone Native Forest	
NCN/ Mapunyao [Ch]	*Aglaia mariannensis*
Beach hibiscus/ Pågo [Ch]	*Talipariti simile [Hibiscus tiliaceus]*
NCN/ Paipai [Ch]	*Meiogyne cylindrocarpa [Guamia mariannae]*
NCN/ Nunu [Ch]	*Ficus prolixa*
NCN/ Fagot [Ch]	*Ochrosia oppositifolia [Neisosperma oppositifolia]*
NCN/ Ifit [Ch]	*Intsia bijuga*
False elder/ Ahgoa*	*Premna serratifolia*
Micronesian cycad / Fadang [Ch]	*Cycas micronesica*
Limestone Degraded Forest	
Beach hibiscus/ Pågo [Ch]	*Talipariti simile*
NCN/ Agatelang [Ch]	*Eugenia palumbis*
NCN/ Aploghating [Ch]	*Psychotria mariana*
NCN/ Nunu [Ch]	*Ficus prolixa*
Dryer's fig	*Ficus tinctoria*
Indian mulberry/ Noni [Ch]	*Morinda citrifolia*
Abubo [Ch]	*Stictocardia tiliifolia*
NCN/ Paipai [Ch]	*Meiogyne cylindrocarpa*
NCN/ Mapunyao [Ch]	*Aglaia mariannensis*
False elder/ Ahgoa [Ch]	*Premna serratifolia*
Mission grass	*Pennisetum polystachion*
Jack in the bush	*Chromolaena odorata*
NCN/ Gapit atayake [Ch]	*Wikstroemia elliptica*
Hairy beggarticks	*Bidens pilosa*
NCN/ Luluhut [Ch]	*Maytenus thompsonii*
Micronesian cycad/ Fadang [Ch]	*Cycas micronesica*
Other Shrub and Grass	
Jack in the bush	*Chromolaena odorata*
NCN/ Gapit atayake [Ch]	*Wikstroemia elliptica*
Hairy beggarticks	*Bidens pilosa*
Bermuda grass	*Cynodon dactylon*
Arrocillo	*Paspalum paniculatum*
Hurricanegrass	*Fimbristylis cymosa*
Vitex	
Jack in the bush	*Chromolaena odorata*
NCN/ Mapunyao [Ch]	*Aglaia mariannensis*
NCN/ Paipai [Ch]	*Meiogyne cylindrocarpa*
Micronesian cycad/ Fadang [Ch]	*Cycas micronesica*
NCN/ Fagot [Ch]	*Ochrosia oppositifolia*
Developed	
Hairy beggarticks	*Bidens pilosa*
Jack in the bush	*Chromolaena odorata*
Beach hibiscus/ Pågo [Ch]	*Talipariti simile*

Common/Chamorro Name	Scientific Name
Tahitian screwpine	*Pandanus tectorius*
Hurricanegrass	*Fimbristylis cymosa*
Arrocillo	*Paspalum paniculatum*
Bermuda grass	*Cynodon dactylon*
Indian mulberry	*Morinda citrifolia*
Guineagrass	*Urochloa maxima*
Indian goosegrass	*Eleusine indica*
Radiate fingergrass	*Chloris radiata*

Table Notes: Ch= Chamorro name; NCN= no common name * N = Native, E = Exotic/Introduced

Table A-2. Plant Species List for Project Area

Species	Origin	Growth Form
PTERIDOPHYTA		
ASPLENIACEAE		
Asplenium nidus	N	Epiphytic Fern
NEPHROLEPIDACEAE		
Davallia heterophylla	N	Epiphytic Fern
Davallia solida	N	Terrestrial Fern
Nephrolepis acutifolia	N	Epiphytic Fern
Giant swordfern (*Nephrolepis biserrata*)	N	Terrestrial Fern
POLYPODIACEAE		
Belvisia spicata	N	Epiphytic Fern
Cochlidium punctatum	N	Epiphytic Fern
Lanceleaf tongue fern (*Pyrrosia lanceolata*)	N	Epiphytic Fern
Monarch fern (*Phymatosorus scolopendria*)	N	Epiphytic Fern
PTERIDACEAE		
Ladder brake (*Pteris vittata*)	E	Terrestrial Fern
GYMNOSPERMAE		
CYCADACEAE		
Micronesian cycad (*Cycas micronesica*)	N	Tree
ANGIOSPERMAE		
APOCYNACEAE		
Tabernaemontana rotensis	N	Tree
MONOCOTYLEDONAE		
ARECACEAE		
Coconut palm (*Cocos nucifera*)	E	Tree
CYPERACEAE		
Hurricanegrass (*Fimbristylis cymosa*)	N	Sedge
Nutgrass (*Cyperus rotundus*)	E	Sedge
Pacific island flatsedge (*Cyperus cyperoides*)	N	Sedge
Poorland flatsedge (*Cyperus compressus*)	E	Sedge
Whitehead spikesedge (*Kyllinga nemoralis*)	N	Sedge
ORCHIDACEAE		
Bulbophyllum guamense	N	Epiphytic forb
Dendrobium guamense	N	Epiphytic forb
Taeniophyllum marianense	N	Epiphytic forb
Tuberolabium guamense	N	Epiphytic forb
PANDANACEAE		
Tahitian screwpine (*Pandanus tectorius*)	N	Tree
POACEAE		
Arrocillo (*Paspalum paniculatum*)	E	Grass
Basketgrass (*Oplismenus* sp.)	N	Grass
Bermuda grass (*Cynodon dactylon*)	E	Grass
Brown's lovegrass (*Eragrostis brownii*)	E	Grass
Caucasian bluestem (*Bothriochloa bladhii*)	E	Grass
Egyptian grass (*Dactyloctenium aegyptium*)	E	Grass

Species	Origin	Growth Form
Gophertail lovegrass (*Eragrostis ciliaris*)	E	Grass
Guineagrass (*Urochloa maxima*)	E	Grass
Indian goosegrass (*Eleusine indica*)	E	Grass
Mission grass (*Pennisetum polystachion*)	E	Grass
Radiate fingergrass (*Chloris radiata*)	E	Grass
Smut grass (*Sporobolus fertilis*)	N	Grass
Southern sandbur (*Cenchrus echinatus*)	E	Grass
Thin paspalum (*Paspalum setaceum*)	E	Grass
Wild sugar cane (*Saccharum spontaneum*)	N	Grass
DICOTYLEDONAE		
AMARANTHACEAE		
Devil's horsewhip (*Achyranthes aspera*)	N	Forb
Sessile joyweed (*Alternanthera sessilis*)	N	Forb
ANNONACEAE		
Meiogyne cylindrocarpa [Guamia mariannae]	N	Tree
APOCYNACEAE		
Ochrosia oppositifolia [Neisosperma oppositifolia]	N	Tree
BIGNONIACEAE		
Spathodea campanulate	E	Tree
BORAGINACEAE		
Cordia subcordata	N	Tree
Fourspike heliotrope (*Heliotropium procumbens*)	N	Herb
COMPOSITAE		
Climbing hempvine (*Mikania scandens*)	E	Vine
Coat buttons (*Tridax procumbens*)	E	Forb
Hairy beggarticks (*Bidens pilosa*)	E	Forb
Jack in the bush (*Chromolaena odorata*)	E	Forb
Little ironweed (*Cyanthillium cinereum*)	N	Forb
Sphagneticola [Wedelia] triloba	E	Forb
Straggler daisy (*Calyptocarpus vialis*)	E	Forb
CONVOLVULACEAE		
Littlebell (*Ipomoea triloba*)	N	Vine
Oceanblue morning-glory (*Ipomoea indica*)	N	Vine
Stictocardia tiliifolia	N	Vine
ELAEOCARPACEAE		
Elaeocarpus joga	N	Tree
EUPHORBIACEAE		
Carry me seed (*Phyllanthus amarus*)	E	Forb
Graceful sandmat (*Chamaesyce hypericifolia*)	E	Forb
Indian acalypha (*Acalypha indica*)	E	Forb
Macaranga thompsonii	N	Tree
Melanolepis multiglandulosa	N	Tree
Mexican fireplant (*Euphorbia heterophylla*)	E	Forb
Pillpod sandmat (*Chamaesyce hirta*)	E	Forb
Prostrate sandmat (*Chamaesyce prostrata*)	E	Forb
LAURACEAE		

Species	Origin	Growth Form
Cassytha filiformis	N	Vine
LEGUMINOSAE		
Vitex parviflora	E	Tree
LEGUMINOSAE		
Coffeeweed (*Senna occidentalis*)	E	Forb
Borneo teak (*Intsia bijuga [Ifit]*)	N	Tree
Purple bushbean (*Macroptilium atropurpureum*)	E	Vine
Sensitive partridge pea (*Chamaecrista nictitans*)	E	Shrub
Shameplant (*Mimosa pudica*)	E	Forb
Stylosanthes guianensis	E	Forb
Tangantangan (*Leucaena leucocephala*)	E	Tree
Threeflower ticktrefoil (*Desmodium triflorum*)	E	Forb
Ticktrefoil (*Desmodium umbellatum*)	N	Shrub
White moneywort (*Alysicarpus vaginalis*)	E	Forb
MALVACEAE		
Common wireweed (*Sida acuta*)	E	Forb
Melochia villosissima	N	Shrub
Uhaloa (*Waltheria indica*)	E	Forb
MELIACEAE		
Aglaia mariannensis	N	Tree
MORACEAE		
Dyer's fig (*Ficus tinctoria* var. *neoebudarum*)	N	Tree
Fig (*Ficus prolixa*)	N	Tree
MYRTACEAE		
Eugenia palumbis	N	Tree
Eugenia reinwardtiana	N	Tree
Syzygium thompsonii [Eugenia thompsonii]	N	Tree
NYCTAGINACEAE		
Pisonia grandis	N	Tree
OLACACEAE		
Jasminum marianum	N	Vine
PASSIFLORACEAE		
Corkystem passionflower (*Passiflora suberosa*)	E	Vine
PIPERACEAE		
Piper guahamense	N	Shrub
PORTULACACEAE		
Little hogweed (*Portulaca oleracea*)	N	Forb
RHAMNACEAE		
Asian nakedwood (*Colubrina asiatica*)	N	Vine
RUBIACEAE		
Aidia cochinchinensis	N	Tree
Flat-top mille grains (*Oldenlandia corymbosa*)	E	Forb
Indian mulberry (*Morinda citrifolia*)	N	Tree
Ixora triantha	N	Tree
Morinda umbellate	N	Vine
Psychotria mariana	N	Tree

Species	Origin	Growth Form
Beach gardenia (*Geuttarda speciosa)*	N	Tree
RUTACEAE		
Limeberry (*Triphasia trifolia*)	E	Shrub
SOLANACEAE		
Cestrum diurnum	E	Shrub
THYMELAECEAE		
Wikstroemia elliptica	N	Shrub
URTICACEAE		
Dendrocnide latifolia	N	Tree
Rockweed (*Pilea microphylla*)	E	Forb
VERBENACAE		
Light-blue snakeweed (*Stachytarpheta jamaicensis*)	E	Forb
Malbau (*Premna serratifolia*)	N	Tree
Turkey tangle fogfruit (*Phyla nodiflora*)	E	Forb

Table Notes: N = Native, E = Exotic/Introduced

Appendix B.

Survey Photos

Photograph 1. Limestone Degraded Forest with Native Trees

Photograph 2. Standing Water Following Heavy Rain Event

Photograph 3. Lined Tree Snail Along East of Project Area

Photograph 4. Cane Toad in Sinkhole to Northwest Project Area

Photograph 5. Ungulate Sign Common in Project Area

Photograph 6. Mariana Fruit Bat Droppings on *Meiogyne cylindrocarpa*

Photograph 7. Single *Tabernaemontana rotensis* in Open Grassland Area

Photograph 8. *Dendrobium guamense* on *Premna serrotifolia*

Photograph 7. Sinkhole Outside of Northwest Project Area Boundary

Photograph 8. *Dendrobium guamense* Flowering

Photograph 9. Juvenile *Tuberolabium guamense* Observed in *Aglaia* Forest

Photograph 10. Large Cluster of *Tabernaemontana rotensis* in Project Area

Appendix C.

Survey Mapbooks

Proposed MSA-1 Site Layout (Notional)

30 m Buffer

Track

Cycas micronesica

0 100 200

Feet

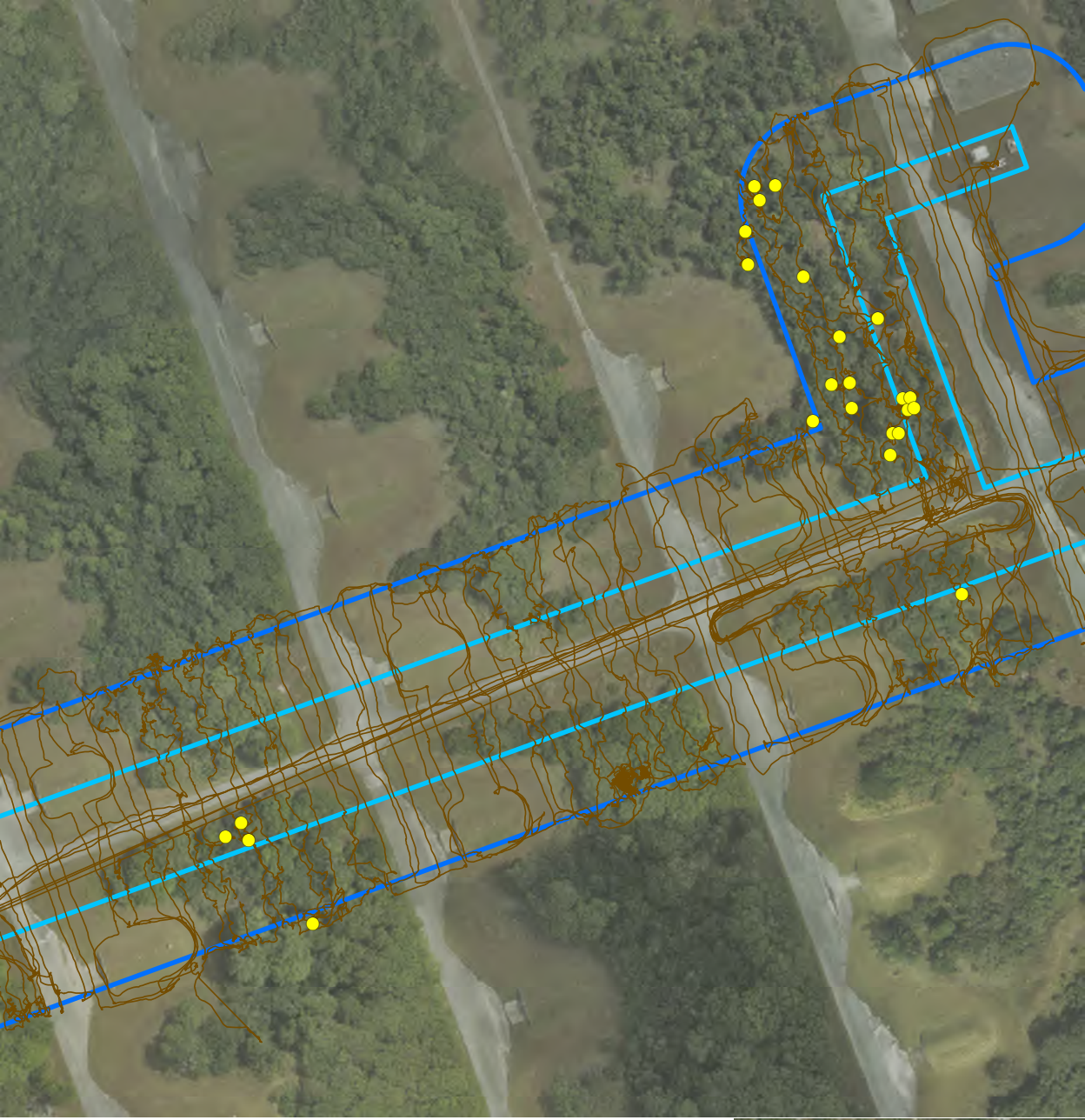
Meters

0 30 60

N

Amendment 0003

Data Source: AAFB High Res Imagery (2020)



Proposed MSA-1 Site Layout (Notional)

30 m Buffer

Track

Cycas micronesica

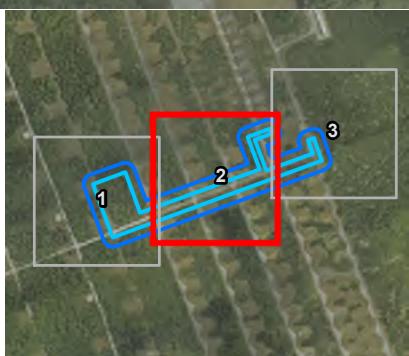
0 100 200

Feet

Meters

0 30 60

N



Amendment 0003

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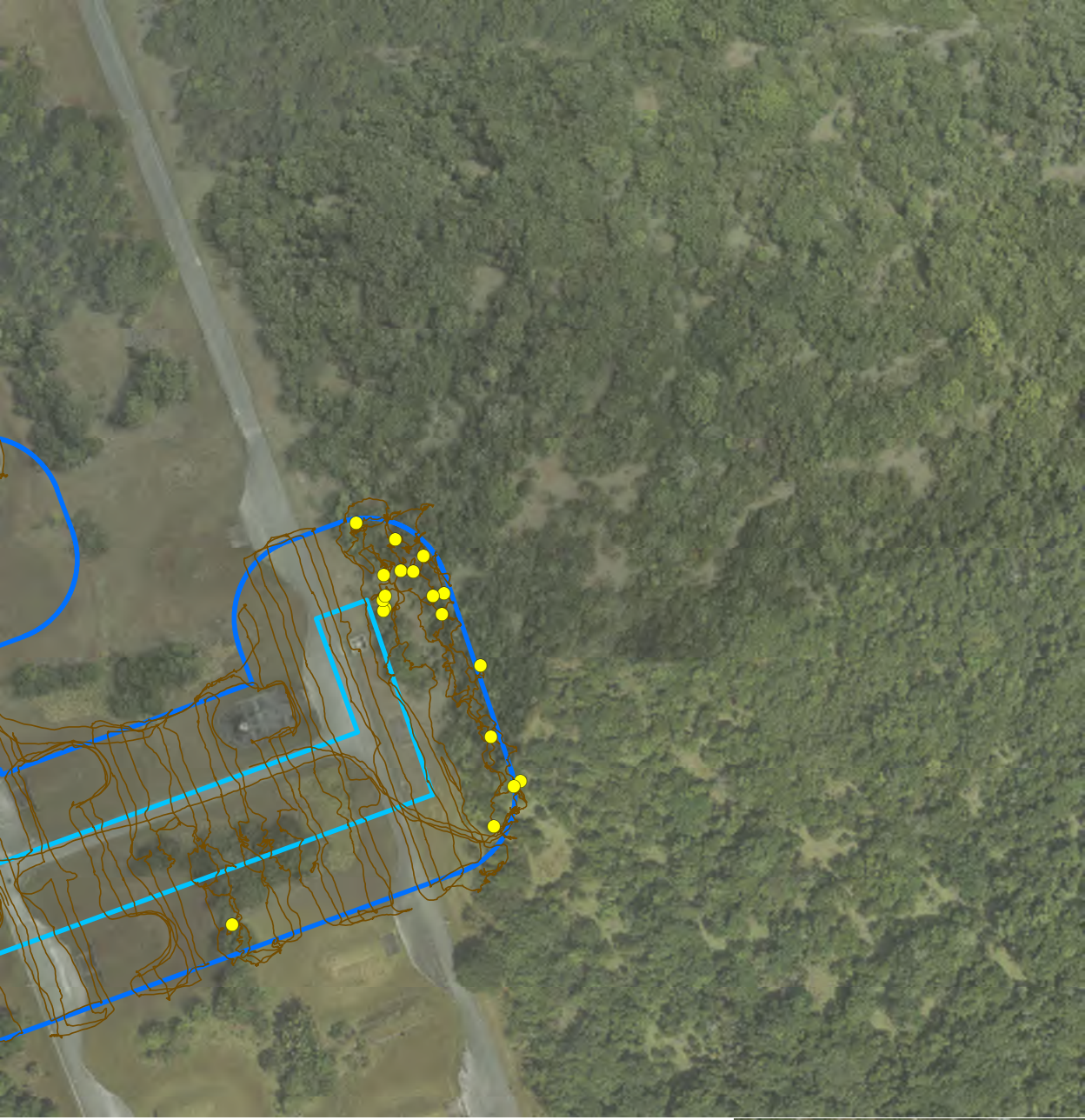


Proposed MSA-1 Site Layout (Notional)

30 m Buffer

Track

Cycas micronesica

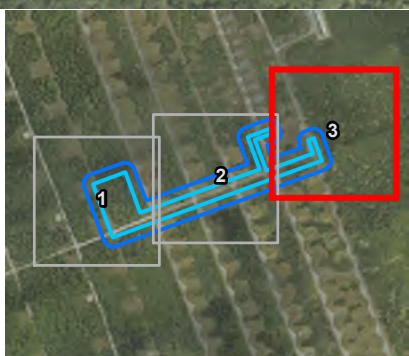
0 100 200

Feet

Meters

0 30 60

N



Amendment 0003

Data Source: AAFB High Res Imagery (2020)

Proposed North Ramp Site Layout (Notional)

30 m Buffer

Track

Cycas micronesica

Tabernaemontana rotensis

0 100 200

Feet

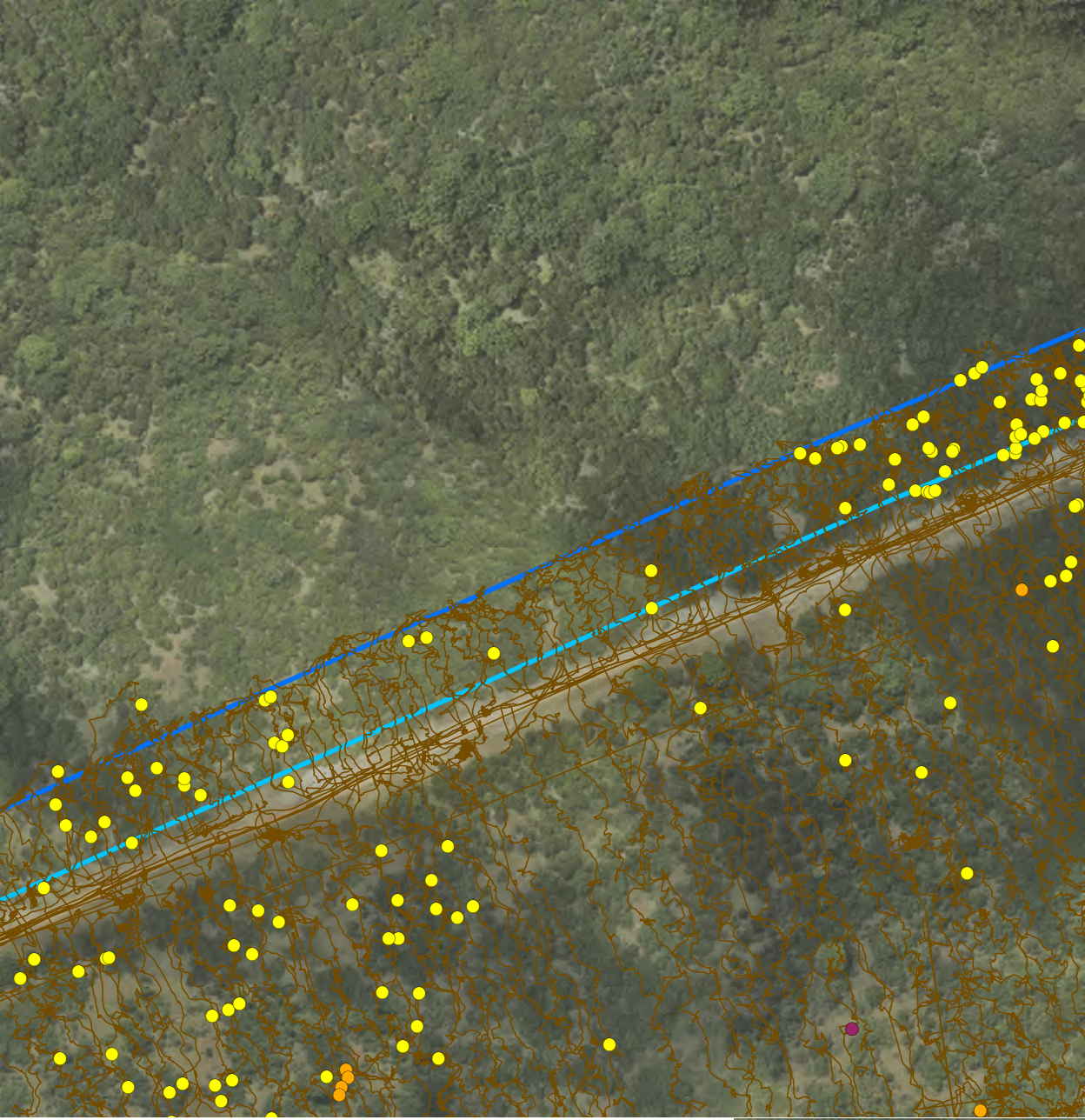
Meters

0 30 60

N

Amendment 0003

Data Source: AAFB High Res Imagery (2020)



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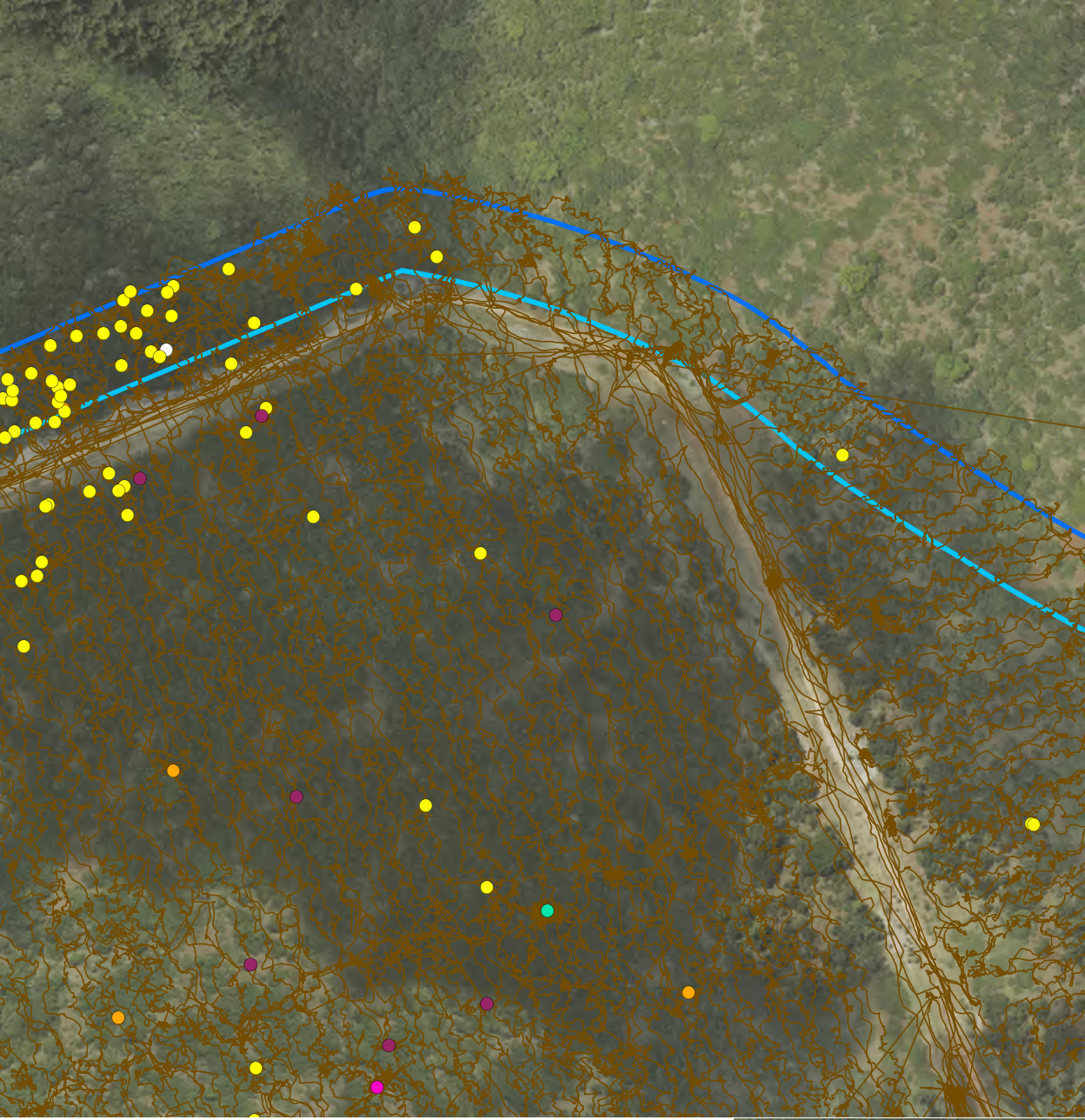


Proposed North Ramp Site Layout (Notional)

30 m Buffer

Track

Bat Sign

Cycas micronesica

Tabernaemontana rotensis

Bulbophyllum guamense

Dendrobium guamense

Tuberolabium guamense

0 100 200

Feet

Meters

0 30 60

N

Amendment 0003

Data Source: AAFB High Res Imagery (2020)

Proposed North Ramp Site Layout (Notional)

30 m Buffer

Track

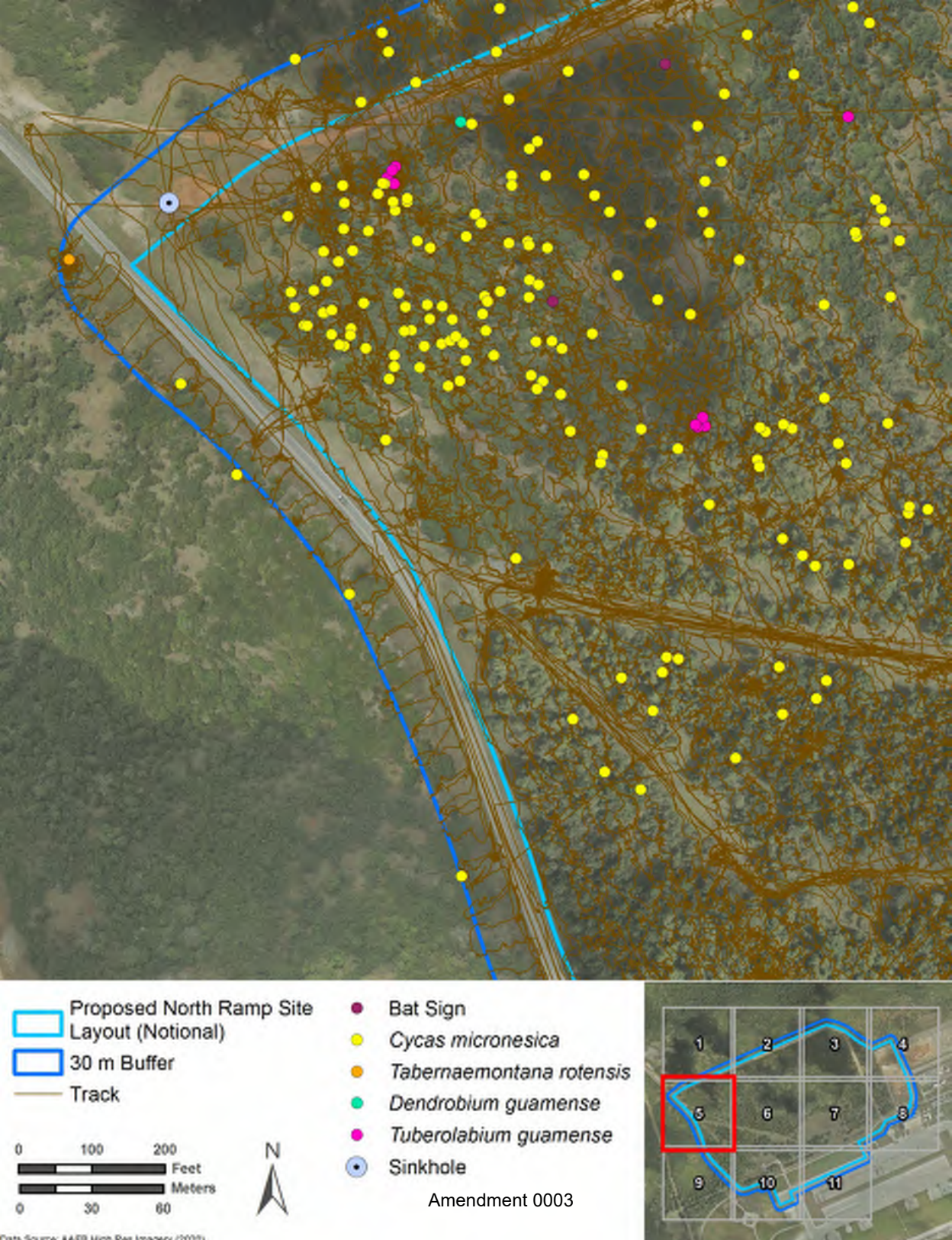
Cycas micronesica

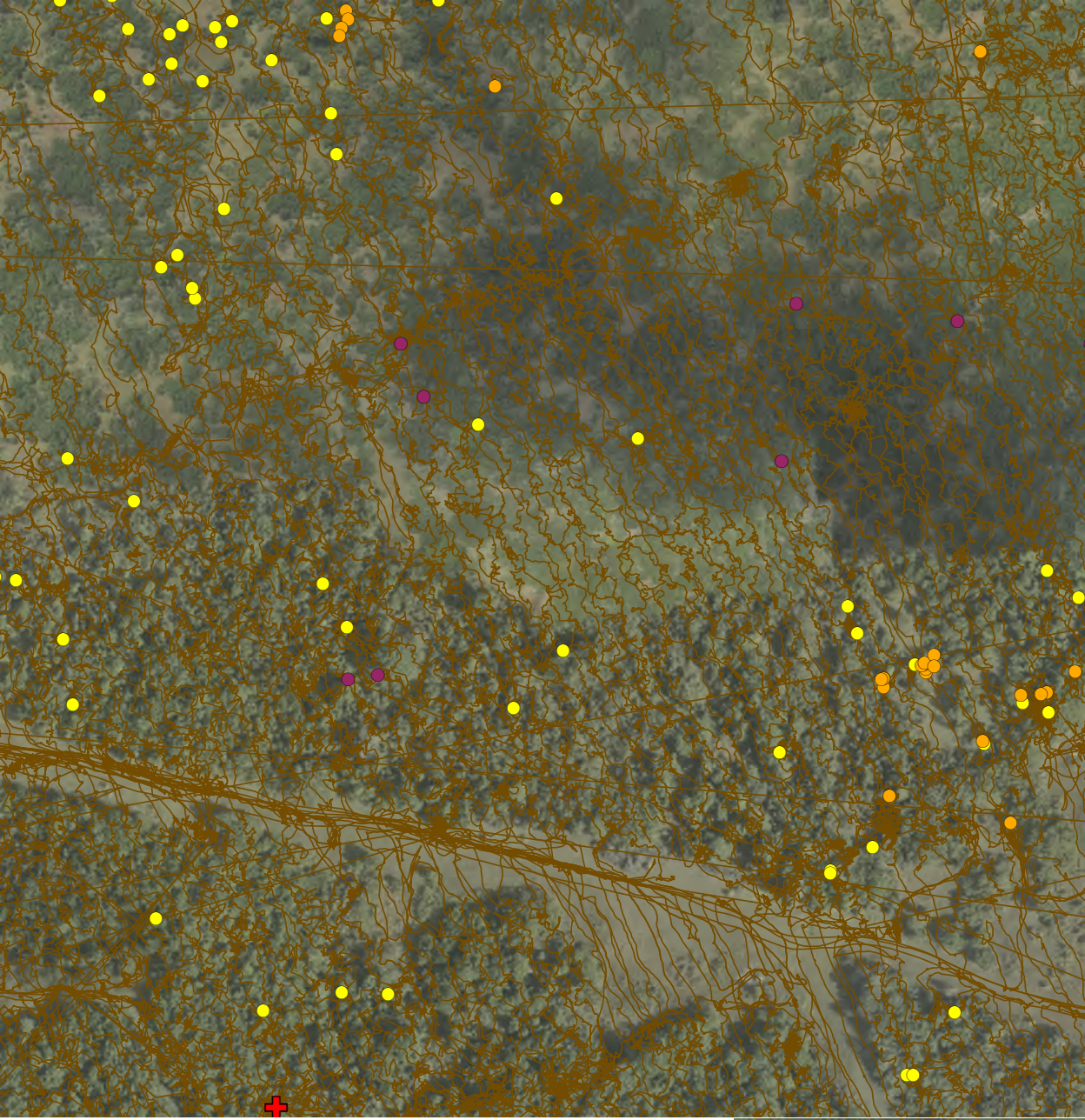
0 100 200
Feet
Meters
0 30 60

N

Amendment 0003

Data Source: AAFB High Res Imagery (2020)


Proposed North Ramp Site Layout (Notional)
30 m Buffer
Track
0
100
200
Feet
Meters
0
30
60
N
Bat Sign
Cycas micronesica
Tabernaemontana rotensis
Dendrobium guamense
Tuberolabium guamense
Sinkhole
1
2
3
4
5
6
7
8
9
10
11
Amendment 0003
Data Source: AAFB High Res Imagery (2020)



Proposed North Ramp Site Layout (Notional)

30 m Buffer

Track

Bat Sign

Cycas micronesica

Hazard

Tabernaemontana rotensis

0 100 200

Feet

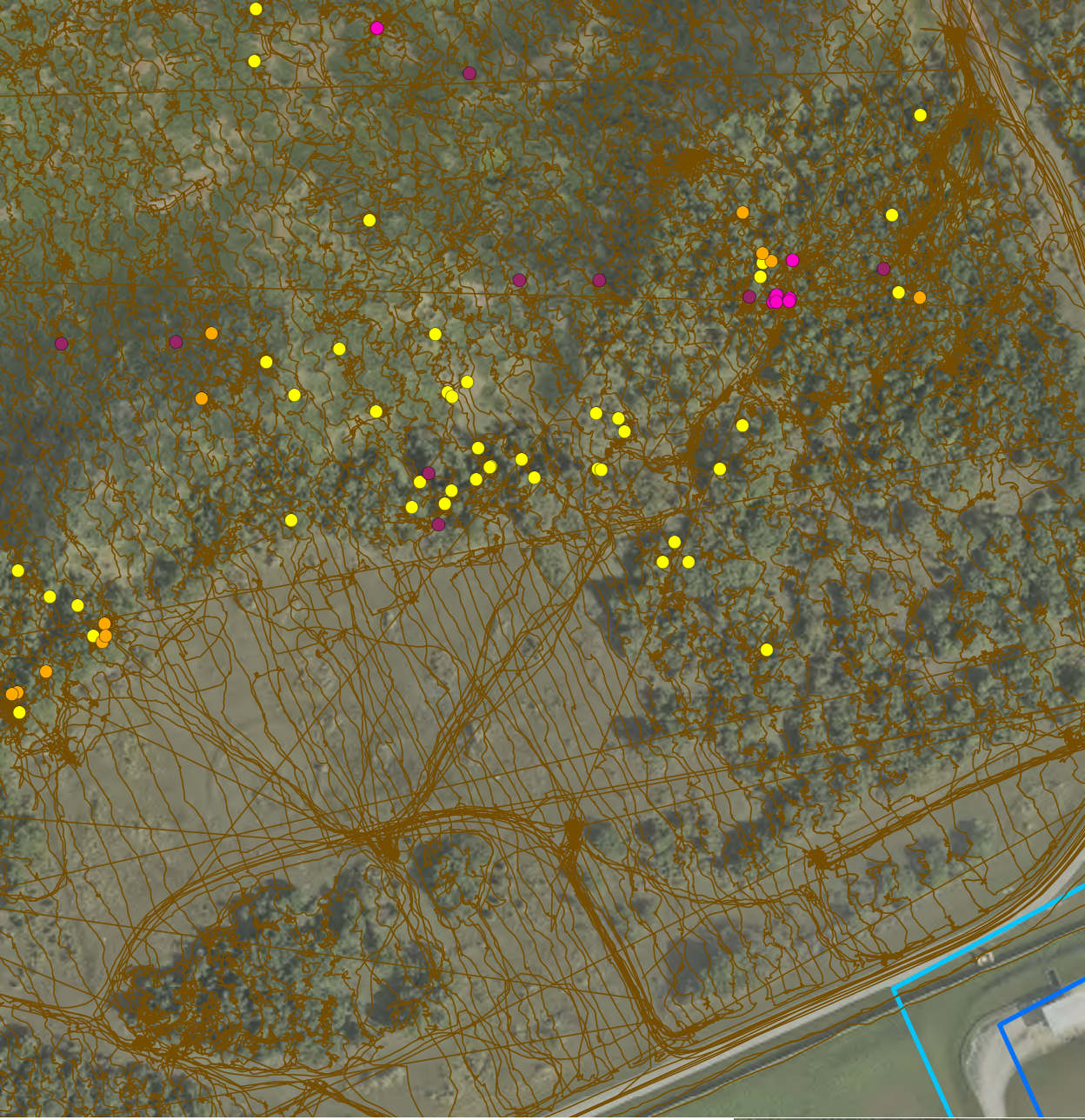
Meters

0 30 60

N

Amendment 0003

Data Source: AAFB High Res Imagery (2020)



Proposed North Ramp Site Layout (Notional)

30 m Buffer

Track

Bat Sign

Cycas micronesica

Tabernaemontana rotensis

Tuberolabium guamense

0 100 200

Feet

Meters

0 30 60

N

Amendment 0003

Data Source: AAFB High Res Imagery (2020)

Proposed North Ramp Site Layout (Notional)

30 m Buffer

Track

0 100 200

Feet

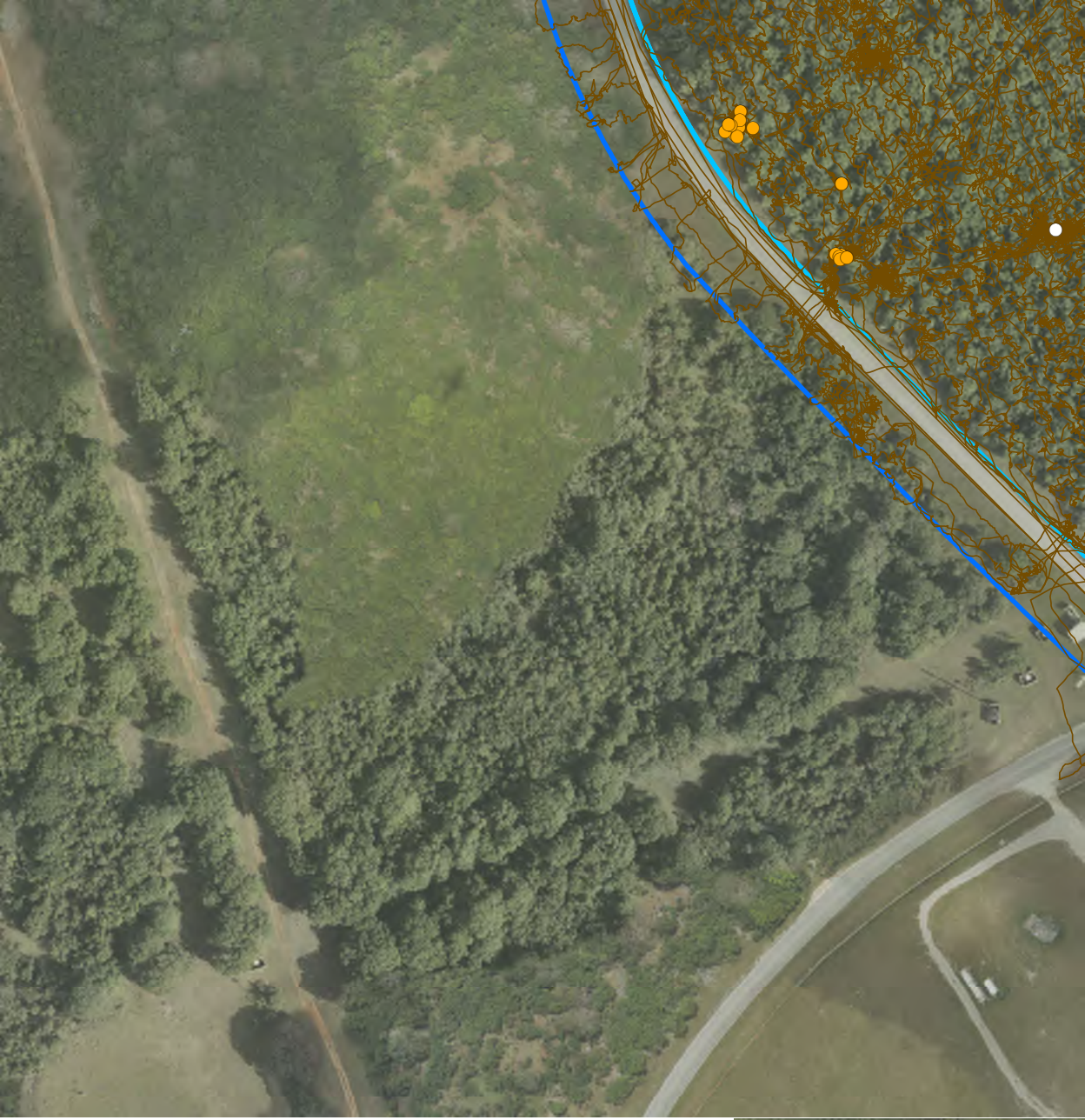
Meters

0 30 60

N

Amendment 0003

Data Source: AAFB High Res Imagery (2020)



Proposed North Ramp Site Layout (Notional)

30 m Buffer

Track

Tabernaemontana rotensis

Bulbophyllum guamense

0 100 200

Feet

Meters

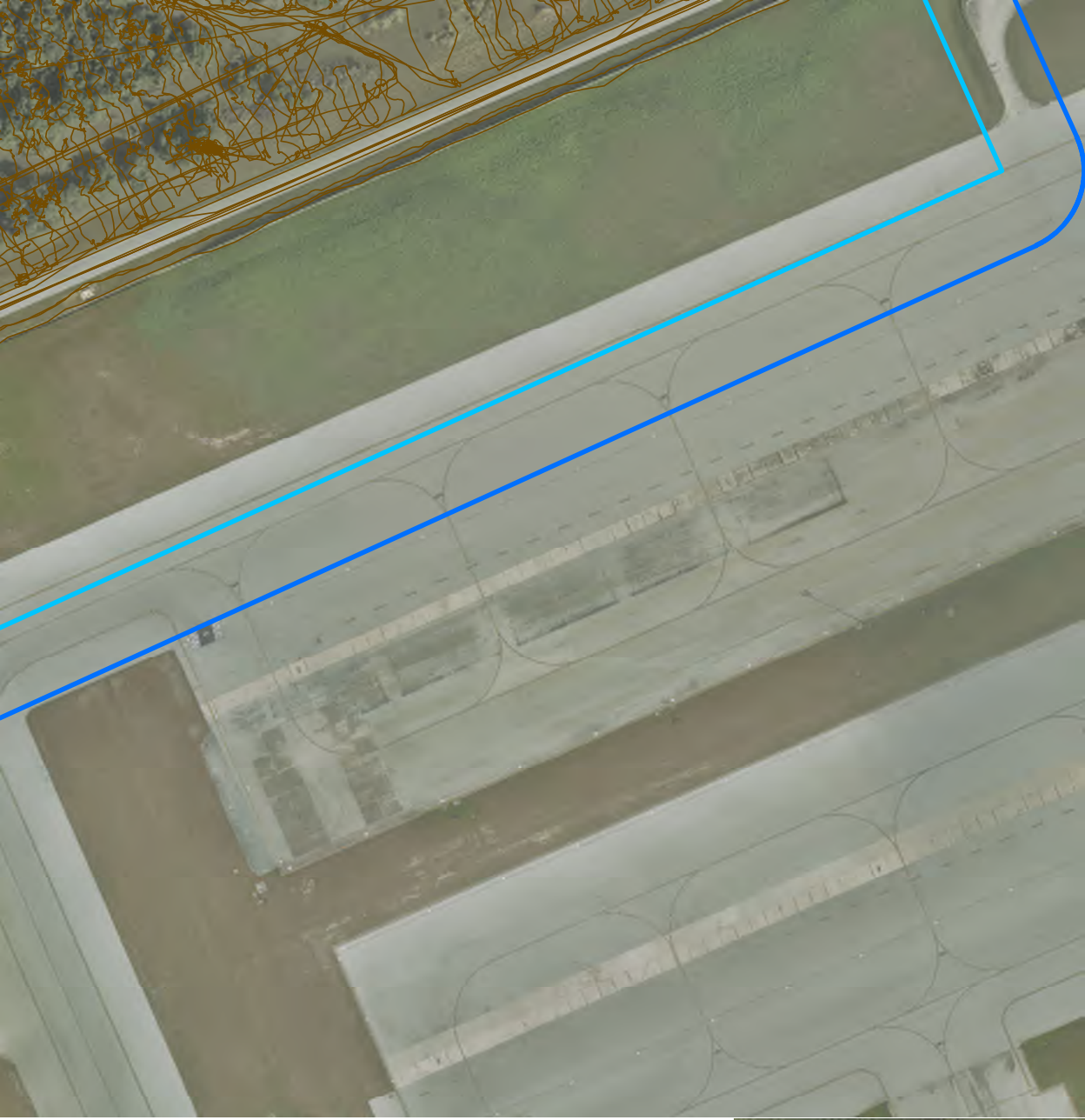
0 30 60

N

Amendment 0003

Data Source: AAFB High Res Imagery (2020)

Proposed North Ramp Site Layout (Notional)
30 m Buffer
Track
Cycas micronesica
Hazard
Tabernaemontana rotensis
Bulbophyllum guamense
0 100 200
Feet
Meters
0 30 60
N
Amendment 0003
1 2 3 4
5 6 7 8
9 10 11
Data Source: AAFB High Res Imagery (2020)



Proposed North Ramp Site Layout (Notional)

30 m Buffer

Track

0 100 200

Feet

Meters

0 30 60

N

Amendment 0003

Data Source: AAFB High Res Imagery (2020)

Appendix D.

Special Status Species Data

Table D-1. *Cycas micronesica* in the Survey Area

#	Location	Within Project Area	UTM (X)	UTM (Y)	Health Assess-ment	Pups	Diameter (inches)	Height (feet)
1	MSA-1	No	271053.68	1505351.72	--	--	3	6
2	MSA-1	No	271050.37	1505352.35	Fair	Yes	--	8
3	MSA-1	No	271000.58	1505464.34	Fair	Yes	--	8
4	MSA-1	No	270996.70	1505459.98	Fair	Yes	--	10
5	MSA-1	No	270985.11	1505466.42	Fair	Yes	--	8
6	MSA-1	No	270975.71	1505457.81	Poor	No	--	11
7	MSA-1	No	270975.62	1505456.61	Good	Yes	--	13
8	MSA-1	No	270969.58	1505451.61	Fair	Yes	--	10
9	MSA-1	No	270977.92	1505440.12	Good	No	--	10
10	MSA-1	No	270977.74	1505439.75	Fair	No	--	8
11	MSA-1	Yes	270990.20	1505426.03	Good	No	--	12
12	MSA-1	No	270996.04	1505428.41	Poor	--	--	7
13	MSA-1	No	270998.58	1505428.97	Poor	--	--	6
14	MSA-1	Yes	270993.22	1505431.58	Poor	--	--	--
15	MSA-1	Yes	270984.00	1505430.36	Poor	--	--	11
16	MSA-1	No	270981.25	1505435.91	Fair	--	--	13
17	MSA-1	No	271037.71	1505318.68	Poor	--	--	--
18	MSA-1	Yes	271032.23	1505314.46	Poor	--	--	--
19	MSA-1	Yes	271014.64	1505312.34	Fair	Yes	--	8
20	MSA-1	Yes	271015.69	1505318.45	Fair	--	--	8
21	MSA-1	Yes	271012.41	1505332.71	Fair	Yes	--	4
22	MSA-1	Yes	271011.07	1505331.96	Fair	Yes	--	7
23	MSA-1	Yes	271014.29	1505337.17	Fair	No	--	--
24	MSA-1	Yes	271005.01	1505348.98	Poor	Yes	--	8
25	MSA-1	Yes	271000.45	1505346.94	Fair	Yes	--	8
26	MSA-1	Yes	271001.01	1505347.50	Fair	No	--	6
27	MSA-1	Yes	271000.00	1505355.91	Fair	Yes	--	10
28	MSA-1	Yes	271001.21	1505356.81	Fair	Yes	--	9
29	MSA-1	Yes	271001.95	1505358.99	Fair	Yes	--	12
30	MSA-1	Yes	271000.47	1505360.08	Fair	Yes	--	12
31	MSA-1	Yes	271004.05	1505357.92	Fair	Yes	--	--
32	MSA-1	Yes	271004.87	1505362.80	Fair	Yes	--	10
33	MSA-1	Yes	271008.03	1505364.77	Fair	Yes	--	12
34	MSA-1	Yes	271008.18	1505354.51	Fair	Yes	--	--
35	MSA-1	Yes	271011.00	1505364.93	Poor	Yes	--	--
36	MSA-1	No	271015.55	1505376.18	Poor	--	--	--
37	MSA-1	Yes	270992.44	1505390.90	Fair	Yes	--	9
38	MSA-1	Yes	270988.04	1505390.28	Fair	Yes	--	--
39	MSA-1	Yes	270990.79	1505387.38	Fair	Yes	--	--
40	MSA-1	Yes	270986.06	1505393.46	Fair	No	--	--
41	MSA-1	Yes	270985.27	1505406.92	Good	Yes	--	--
42	MSA-1	Yes	270979.27	1505407.09	Good	Yes	--	13
43	MSA-1	Yes	270978.46	1505413.93	Fair	Yes	--	10
44	MSA-1	No	270977.84	1505431.11	Good	Yes	--	14
45	MSA-1	No	270975.15	1505430.67	Poor	Yes	--	8
46	MSA-1	Yes	270975.22	1505422.46	Good	Yes	--	14
47	MSA-1	Yes	270971.56	1505424.35	Fair	No	--	12

#	Location	Within Project Area	UTM (X)	UTM (Y)	Health Assess-ment	Pups	Diameter (inches)	Height (feet)
48	MSA-1	No	270973.40	1505434.07	Fair	No	--	12
49	MSA-1	No	270967.64	1505436.06	Good	No	--	12
50	MSA-1	No	270962.38	1505436.99	Fair	No	--	10
51	MSA-1	No	270891.43	1505329.91	--	--	5	9
52	MSA-1	No	270914.54	1505315.70	--	--	5	9
53	MSA-1	No	270901.12	1505425.02	--	--	7	14
54	MSA-1	Yes	270921.34	1505370.02	--	--	5	10
55	MSA-1	Yes	270930.89	1505356.23	--	--	5	9
56	MSA-1	Yes	270940.92	1505326.91	--	--	4	6
57	MSA-1	Yes	270970.62	1505273.25	Good	--	3	4
58	MSA-1	Yes	270965.19	1505282.51	Good	--	2	6
59	MSA-1	No	270904.37	1505305.85	Fair	Yes	4	8
60	MSA-1	No	270903.98	1505311.20	Poor	Yes	7	7
61	MSA-1	No	270915.74	1505317.29	Fair	Yes	6	12
62	MSA-1	Yes	270953.45	1505349.40	Fair	Yes	3	11
63	MSA-1	No	270895.02	1505316.73	Fair	--	8	13
64	MSA-1	Yes	270941.58	1505326.20	Fair	--	3	5
65	MSA-1	No	270898.02	1505318.78	Fair	--	6	13
66	MSA-1	Yes	270945.79	1505342.39	Good	--	4	9
67	MSA-1	Yes	270931.96	1505357.30	Fair	--	5	8
68	MSA-1	No	270900.65	1505334.77	Poor	Yes	8	9
69	MSA-1	Yes	270940.58	1505351.18	Fair	Yes	4	10
70	MSA-1	Yes	270923.64	1505369.51	Good	Yes	5	10
71	MSA-1	Yes	270919.97	1505394.28	Fair	Yes	12	18
72	MSA-1	Yes	270929.63	1505393.69	Good	Yes	14	20
73	MSA-1	Yes	270922.00	1505407.27	Fair	--	6	9
74	MSA-1	No	270920.47	1505410.35	Fair	--	7	8
75	MSA-1	No	270919.18	1505409.37	Poor	--	6	10
76	MSA-1	No	270912.42	1505410.21	Fair	Yes	4	8
77	MSA-1	No	270910.92	1505416.77	Fair	Yes	8	7
78	MSA-1	No	270911.08	1505423.15	Fair	--	7	10
79	MSA-1	No	270904.08	1505425.20	Fair	Yes	9	16
80	MSA-1	No	270915.89	1505426.71	Fair	Yes	6	8
81	MSA-1	No	270914.28	1505429.62	Poor	Yes	6	6
82	MSA-1	No	270914.27	1505437.08	Poor	Yes	5	7
83	MSA-1	No	270913.31	1505423.16	Good	--	9	15
84	MSA-1	Yes	270938.92	1505410.51	Poor	--	5	9
85	MSA-1	Yes	270946.04	1505391.59	Fair	--	5	6
86	MSA-1	Yes	270949.85	1505363.68	Good	Yes	4	7
87	MSA-1	Yes	270946.26	1505359.61	Fair	Yes	4	9
88	MSA-1	Yes	270952.00	1505359.09	Fair	--	6	10
89	MSA-1	No	270913.04	1505427.49	Fair	Yes	--	8
90	MSA-1	No	271015.60	1505248.05	Good	--	4	7
91	MSA-1	No	270914.89	1505425.58	Fair	Yes	--	11
92	MSA-1	Yes	270974.21	1505331.75	Good	Yes	3	5
93	MSA-1	Yes	270958.68	1505319.99	Fair	--	4	7
94	MSA-1	Yes	270967.31	1505338.90	Fair	Yes	7	11
95	MSA-1	Yes	270975.42	1505335.25	Fair	--	6	8

#	Location	Within Project Area	UTM (X)	UTM (Y)	Health Assess-ment	Pups	Diameter (inches)	Height (feet)
96	MSA-1	Yes	270963.53	1505343.57	Fair	Yes	5	9
97	MSA-1	Yes	270978.72	1505336.05	Good	Yes	2	4
98	MSA-1	Yes	270959.29	1505343.68	Good	--	12	12
99	MSA-1	Yes	270963.40	1505344.69	Fair	Yes	8	12
100	MSA-1	Yes	270970.52	1505352.66	Fair	--	6	9
101	MSA-1	Yes	270969.41	1505356.26	Fair	--	3	8
102	MSA-1	Yes	270960.97	1505357.44	Fair	Yes	9	13
103	MSA-1	Yes	270956.68	1505357.82	Good	--	9	18
104	MSA-1	Yes	270968.94	1505358.02	Fair	--	7	10
105	MSA-1	Yes	270959.59	1505354.59	Fair	Yes	6	7
106	MSA-1	Yes	270959.49	1505362.06	Fair	Yes	7	15
107	MSA-1	Yes	270959.21	1505381.41	Fair	Yes	6	9
108	MSA-1	Yes	270957.08	1505386.85	Good	Yes	7	11
109	MSA-1	Yes	270945.43	1505392.78	Poor	--	10	13
110	MSA-1	Yes	270940.11	1505396.00	Poor	--	7	10
111	MSA-1	Yes	270961.29	1505397.63	Fair	Yes	6	10
112	MSA-1	Yes	270959.13	1505396.90	Fair	--	4	9
113	MSA-1	Yes	270965.15	1505341.06	Fair	Yes	--	8
114	MSA-1	Yes	270950.11	1505371.03	Fair	Yes	--	10
115	MSA-1	Yes	270944.01	1505405.54	Fair	No	--	7
116	MSA-1	Yes	270995.57	1505343.14	Fair	Yes	6	11
117	MSA-1	Yes	270985.06	1505345.65	Fair	Yes	5	9
118	MSA-1	Yes	270976.15	1505347.90	Good	--	6	8
119	MSA-1	Yes	270991.05	1505343.90	Fair	--	6	9
120	MSA-1	Yes	270978.64	1505355.09	Good	--	14	9
121	MSA-1	Yes	270991.81	1505344.76	Fair	--	6	12
122	MSA-1	Yes	270975.14	1505359.50	Fair	--	7	8
123	MSA-1	Yes	270990.37	1505358.20	Fair	--	3	6
124	MSA-1	Yes	270984.48	1505348.28	Fair	Yes	9	11
125	MSA-1	Yes	270994.28	1505358.48	Fair	--	4	6
126	MSA-1	Yes	270977.81	1505364.31	Fair	--	6	19
127	MSA-1	Yes	270989.04	1505373.15	Fair	Yes	7	10
128	MSA-1	Yes	270966.37	1505413.63	Fair	--	5	12
129	MSA-1	No	270945.40	1505444.67	Fair	--	8	10
130	MSA-1	No	270949.73	1505438.93	Fair	--	6	12
131	MSA-1	No	270966.27	1505443.48	Fair	--	8	11
132	MSA-1	Yes	270970.01	1505423.05	Poor	--	4	6
133	MSA-1	Yes	270992.59	1505320.41	Good	Yes	--	9
134	MSA-1	Yes	270984.39	1505337.70	Good	Yes	--	10
135	MSA-1	No	270946.91	1505452.84	Fair	No	--	6
136	MSA-1	Yes	271163.23	1505313.80	Fair	Yes	--	12
137	MSA-1	No	271377.76	1505465.70	Good	Yes	--	15
138	MSA-1	No	271374.29	1505518.27	Good	--	--	9
139	MSA-1	No	271364.06	1505551.86	Fair	--	--	7
140	MSA-1	No	271542.50	1505425.07	Fair	Yes	--	10
141	MSA-1	No	271598.45	1505540.57	Good	--	--	8
142	MSA-1	No	271597.73	1505539.74	Good	--	--	10
143	MSA-1	No	271597.54	1505543.50	Fair	Yes	--	13

#	Location	Within Project Area	UTM (X)	UTM (Y)	Health Assess-ment	Pups	Diameter (inches)	Height (feet)
144	MSA-1	No	271598.29	1505544.86	Fair	--	--	8
145	MSA-1	No	271619.81	1505546.00	Fair	--	--	10
146	MSA-1	No	271633.26	1505519.52	Fair	--	--	8
147	MSA-1	No	271647.83	1505477.32	Good	--	--	10
148	MSA-1	No	271391.89	1505470.44	--	--	--	8
149	MSA-1	No	271391.32	1505479.66	Fair	--	--	6
150	MSA-1	No	271384.61	1505479.15	Fair	Yes	--	10
151	MSA-1	No	271358.29	1505546.24	Poor	--	--	8
152	MSA-1	No	271356.38	1505551.34	Fair	--	--	6
153	MSA-1	Yes	271401.46	1505503.04	Fair	--	--	5
154	MSA-1	No	271601.97	1505565.79	Good	--	--	11
155	MSA-1	No	271604.17	1505554.22	Good	--	--	8
156	MSA-1	No	271608.62	1505553.75	Good	Yes	--	10
157	MSA-1	No	271615.75	1505545.16	Fair	--	--	8
158	MSA-1	No	271637.07	1505493.75	Fair	--	--	7
159	MSA-1	No	271638.02	1505461.04	Fair	--	--	7
160	MSA-1	Yes	271171.83	1505312.68	Fair	Yes	--	9
161	MSA-1	No	271195.11	1505282.19	Poor	--	--	10
162	MSA-1	No	271387.62	1505496.30	Poor	--	--	7
163	MSA-1	Yes	271410.66	1505473.78	Fair	--	--	8
164	MSA-1	Yes	271412.43	1505469.70	Fair	--	--	10
165	MSA-1	Yes	271413.44	1505474.14	Fair	Yes	--	7
166	MSA-1	Yes	271414.77	1505470.35	Fair	--	--	9
167	MSA-1	No	271406.87	1505461.10	Poor	Yes	--	6
168	MSA-1	No	271409.11	1505461.20	Fair	Yes	--	9
169	MSA-1	No	271406.05	1505453.30	Fair	Yes	--	10
170	MSA-1	No	271432.25	1505402.63	Fair	Yes	--	11
171	MSA-1	No	271353.05	1505534.97	Fair	--	--	9
172	MSA-1	No	271354.09	1505522.78	Fair	Yes	--	13
173	MSA-1	No	271597.81	1505552.61	Fair	--	--	8
174	MSA-1	No	271587.73	1505571.59	Poor	--	--	7
175	MSA-1	No	271612.22	1505559.80	Poor	Yes	--	12
176	MSA-1	No	271619.16	1505538.56	Fair	--	--	7
177	MSA-1	No	271645.38	1505475.61	Fair	Yes	--	11
178	MSA-1	Yes	271168.99	1505319.02	Fair	Yes	--	9
179	North Ramp	Yes	274205.96	1502983.04	Poor	--	5	9
180	North Ramp	Yes	274214.43	1502974.10	Fair	--	8	10
181	North Ramp	Yes	274217.50	1502970.84	Good	--	5	6
182	North Ramp	Yes	274237.10	1502988.19	Fair	Yes	8	11
183	North Ramp	Yes	274234.46	1503012.53	Fair	--	13	10
184	North Ramp	Yes	274236.66	1503012.58	Good	--	6	8
185	North Ramp	Yes	274251.85	1503035.37	Fair	Yes	11	10
186	North Ramp	Yes	273794.62	1503109.20	Fair	Yes	9	10
187	North Ramp	Yes	273781.60	1503123.07	Good	--	8	12
188	North Ramp	Yes	273800.34	1503131.48	Good	Yes	5	8
189	North Ramp	Yes	273805.30	1503130.76	Good	Yes	9	12
190	North Ramp	Yes	273798.65	1503125.24	Good	--	12	10
191	North Ramp	Yes	273829.05	1503089.48	Fair	--	6	6

#	Location	Within Project Area	UTM (X)	UTM (Y)	Health Assess-ment	Pups	Diameter (inches)	Height (feet)
192	North Ramp	Yes	273847.25	1503127.47	Good	Yes	7	9
193	North Ramp	Yes	273848.58	1503107.76	Fair	No	--	12
194	North Ramp	Yes	273866.92	1503121.82	Fair	--	6	8
195	North Ramp	Yes	273862.62	1503114.22	Poor	No	--	15
196	North Ramp	Yes	273960.14	1503069.58	Fair	--	6	11
197	North Ramp	Yes	273999.31	1503035.93	Fair	--	10	11
198	North Ramp	Yes	274028.03	1503042.43	Poor	--	5	6
199	North Ramp	Yes	274044.94	1503042.05	Fair	--	8	10
200	North Ramp	Yes	273761.26	1503105.74	Fair	Yes	5	5
201	North Ramp	Yes	273789.52	1503076.42	Good	Yes	8	15
202	North Ramp	Yes	273789.52	1503076.42	Good	Yes	8	15
203	North Ramp	Yes	273774.48	1503083.75	Fair	--	6	7
204	North Ramp	Yes	274525.55	1503207.07	Fair	Yes	9	15
205	North Ramp	Yes	274521.20	1503199.49	Fair	Yes	8	12
206	North Ramp	Yes	274530.62	1503199.57	Fair	--	8	9
207	North Ramp	Yes	274559.08	1503167.69	Good	--	8	12
208	North Ramp	Yes	274541.99	1503233.76	Fair	--	9	13
209	North Ramp	Yes	274550.24	1503249.56	Fair	Yes	11	10
210	North Ramp	Yes	274221.85	1503095.59	Good	Yes	7	10
211	North Ramp	Yes	274206.55	1503087.02	Good	Yes	6	8
212	North Ramp	Yes	274206.40	1503086.13	Good	--	6	10
213	North Ramp	Yes	274656.65	1503490.29	Fair	Yes	20	12
214	North Ramp	Yes	274655.77	1503490.67	Good	Yes	8	11
215	North Ramp	Yes	274697.79	1503563.35	Fair	Yes	18	15
216	North Ramp	No	274586.83	1503625.41	Poor	Yes	18	11
217	North Ramp	Yes	274556.83	1503303.69	Good	--	8	10
218	North Ramp	Yes	274557.70	1503308.98	Fair	--	10	13
219	North Ramp	Yes	274604.88	1503326.47	Fair	--	12	16
220	North Ramp	Yes	274607.34	1503298.12	Poor	--	4	9
221	North Ramp	Yes	274456.87	1503467.63	Fair	--	6	6
222	North Ramp	Yes	274507.20	1503247.37	Good	--	8	7
223	North Ramp	Yes	274505.01	1503252.21	Fair	--	6	8
224	North Ramp	Yes	274497.54	1503233.46	Fair	--	9	14
225	North Ramp	Yes	274496.84	1503253.87	Fair	Yes	14	15
226	North Ramp	Yes	274498.59	1503233.34	Fair	--	7	8
227	North Ramp	Yes	274474.23	1503230.61	Fair	--	7	10
228	North Ramp	Yes	274458.47	1503234.51	Fair	Yes	9	10
229	North Ramp	Yes	274457.84	1503234.24	Fair	Yes	13	10
230	North Ramp	Yes	274453.69	1503241.14	Good	Yes	21	20
231	North Ramp	Yes	274442.56	1503261.72	Good	Yes	12	14
232	North Ramp	Yes	274444.09	1503259.96	Fair	Yes	14	15
233	North Ramp	Yes	274438.08	1503283.06	Fair	--	13	12
234	North Ramp	Yes	274469.61	1503237.15	Good	--	12	9
235	North Ramp	Yes	274372.60	1503401.58	Fair	Yes	12	13
236	North Ramp	Yes	274372.06	1503382.47	Fair	--	8	9
237	North Ramp	Yes	274449.79	1503265.41	Good	No	10	11
238	North Ramp	Yes	274414.03	1503324.51	Fair	Yes	15	14
239	North Ramp	Yes	274453.11	1503229.88	Good	--	7	11

#	Location	Within Project Area	UTM (X)	UTM (Y)	Health Assess-ment	Pups	Diameter (inches)	Height (feet)
240	North Ramp	Yes	274443.92	1503225.79	Fair	Yes	10	13
241	North Ramp	Yes	274441.47	1503220.99	Fair	--	7	8
242	North Ramp	Yes	274432.55	1503228.96	Fair	--	9	12
243	North Ramp	Yes	274429.56	1503219.74	Fair	Yes	8	9
244	North Ramp	Yes	274416.50	1503254.75	Fair	Yes	20	13
245	North Ramp	Yes	274403.03	1503277.69	Fair	Yes	8	8
246	North Ramp	Yes	274376.40	1503272.77	Fair	--	8	10
247	North Ramp	Yes	274386.67	1503260.64	Fair	Yes	16	20
248	North Ramp	Yes	274385.42	1503214.86	Fair	Yes	8	8
249	North Ramp	Yes	274285.65	1503196.47	Good	--	10	14
250	North Ramp	Yes	274307.48	1503183.99	Good	Yes	12	14
251	North Ramp	Yes	274297.25	1503186.79	Good	--	8	8
252	North Ramp	Yes	274313.24	1503172.53	Fair	--	12	15
253	North Ramp	Yes	274276.86	1503148.29	Good	--	9	12
254	North Ramp	Yes	274286.18	1503144.87	Fair	Yes	10	15
255	North Ramp	Yes	274262.63	1503133.49	Fair	Yes	7	12
256	North Ramp	Yes	274237.50	1503162.37	Fair	Yes	--	12
257	North Ramp	Yes	274216.37	1503173.89	Fair	Yes	20	12
258	North Ramp	Yes	274212.87	1503183.62	Fair	--	8	6
259	North Ramp	Yes	274136.30	1503244.85	Poor	--	7	10
260	North Ramp	Yes	274187.95	1503130.21	Fair	--	15	14
261	North Ramp	Yes	274077.88	1503249.88	Poor	Yes	16	12
262	North Ramp	Yes	274108.87	1503167.25	Fair	Yes	9	13
263	North Ramp	Yes	274090.69	1503146.37	Fair	--	12	9
264	North Ramp	Yes	274030.03	1503175.91	Fair	--	6	8
265	North Ramp	Yes	274021.12	1503191.94	Fair	--	5	9
266	North Ramp	Yes	273952.13	1503222.00	Fair	Yes	12	13
267	North Ramp	Yes	273927.82	1503237.54	Fair	Yes	13	12
268	North Ramp	Yes	273929.88	1503147.76	Poor	--	11	10
269	North Ramp	Yes	273909.05	1503193.00	Fair	--	12	13
270	North Ramp	Yes	273901.03	1503191.44	Fair	--	6	9
271	North Ramp	Yes	273901.28	1503194.29	Fair	Yes	4	9
272	North Ramp	Yes	273899.77	1503179.24	Fair	Yes	16	9
273	North Ramp	Yes	273926.35	1503171.61	Good	Yes	--	12
274	North Ramp	Yes	273876.10	1503170.25	Poor	Yes	5	8
275	North Ramp	Yes	273856.93	1503173.89	Fair	Yes	14	13
276	North Ramp	Yes	273862.11	1503169.49	Fair	Yes	7	10
277	North Ramp	Yes	273875.10	1503212.25	Fair	Yes	--	12
278	North Ramp	Yes	273848.51	1503180.83	Fair	No	--	10
279	North Ramp	No	273714.90	1503040.42	Fair	Yes	4	8
280	North Ramp	No	273668.34	1503157.90	Fair	Yes	9	8
281	North Ramp	No	273621.50	1503207.42	Poor	Yes	9	7
282	North Ramp	No	273598.09	1503245.20	Good	Yes	5	5
283	North Ramp	Yes	274615.28	1503362.72	Fair	--	13	12
284	North Ramp	Yes	274454.54	1503589.48	Fair	--	20	12
285	North Ramp	Yes	274393.42	1503602.79	Fair	Yes	19	13
286	North Ramp	Yes	274376.31	1503642.44	Fair	--	16	12
287	North Ramp	Yes	274368.98	1503633.68	Fair	--	10	9

#	Location	Within Project Area	UTM (X)	UTM (Y)	Health Assess-ment	Pups	Diameter (inches)	Height (feet)
288	North Ramp	Yes	274363.55	1503658.68	Poor	No	--	10
289	North Ramp	Yes	274434.64	1503497.43	Fair	No	--	15
290	North Ramp	Yes	274325.70	1503603.53	Fair	Yes	12	13
291	North Ramp	Yes	274322.34	1503612.37	Fair	Yes	19	13
292	North Ramp	Yes	274318.84	1503618.74	Fair	Yes	4	3
293	North Ramp	Yes	274311.71	1503611.95	Fair	--	6	10
294	North Ramp	Yes	274286.90	1503579.21	Fair	--	5	10
295	North Ramp	Yes	274292.66	1503581.26	Fair	Yes	15	12
296	North Ramp	Yes	274294.44	1503586.26	Fair	Yes	16	11
297	North Ramp	Yes	274295.78	1503606.53	Fair	Yes	12	7
298	North Ramp	Yes	274324.54	1503614.03	Good	No	--	15
299	North Ramp	Yes	274296.80	1503607.21	Good	No	--	5
300	North Ramp	Yes	274287.73	1503555.58	Good	No	--	11
301	North Ramp	Yes	274250.29	1503534.97	Good	Yes	7	13
302	North Ramp	Yes	274211.77	1503568.75	Fair	--	5	9
303	North Ramp	Yes	274256.48	1503472.80	Poor	Yes	19	9
304	North Ramp	Yes	274239.93	1503509.42	Poor	Yes	18	15
305	North Ramp	Yes	274211.95	1503514.13	Poor	No	--	8
306	North Ramp	Yes	274158.97	1503532.99	Fair	Yes	--	11
307	North Ramp	Yes	274125.77	1503410.10	Poor	--	6	7
308	North Ramp	Yes	274075.97	1503460.47	Fair	Yes	18	14
309	North Ramp	Yes	274060.81	1503470.21	Fair	--	16	12
310	North Ramp	Yes	274062.55	1503459.58	Fair	--	10	9
311	North Ramp	Yes	274070.26	1503456.47	Fair	--	18	15
312	North Ramp	Yes	274066.65	1503482.34	Fair	Yes	--	7
313	North Ramp	Yes	274106.41	1503332.46	Fair	--	20	16
314	North Ramp	Yes	274048.39	1503462.71	Fair	--	6	8
315	North Ramp	Yes	274063.36	1503404.99	Fair	Yes	21	15
316	North Ramp	Yes	274048.71	1503448.84	Fair	Yes	19	11
317	North Ramp	Yes	274045.13	1503448.93	Fair	Yes	12	13
318	North Ramp	Yes	274056.33	1503428.90	Fair	Yes	--	10
319	North Ramp	Yes	274055.49	1503416.93	Good	Yes	--	10
320	North Ramp	Yes	274042.45	1503481.02	Poor	Yes	--	11
321	North Ramp	Yes	274031.85	1503461.21	Fair	Yes	15	12
322	North Ramp	Yes	274042.79	1503429.31	Fair	Yes	16	13
323	North Ramp	Yes	274050.29	1503409.38	Fair	Yes	12	15
324	North Ramp	Yes	274022.51	1503398.29	Fair	Yes	18	13
325	North Ramp	No	273730.88	1503401.50	Fair	--	18	9
326	North Ramp	Yes	274005.13	1503454.87	Fair	--	5	6
327	North Ramp	Yes	273995.31	1503443.11	Fair	Yes	16	13
328	North Ramp	Yes	273997.60	1503458.98	Fair	Yes	12	13
329	North Ramp	Yes	273987.04	1503460.93	Poor	Yes	14	15
330	North Ramp	Yes	273988.68	1503446.18	Fair	--	7	6
331	North Ramp	Yes	274024.00	1503363.76	Fair	Yes	6	9
332	North Ramp	Yes	274026.18	1503348.60	Poor	--	4	6
333	North Ramp	Yes	274002.45	1503383.11	Poor	Yes	18	3
334	North Ramp	Yes	273986.55	1503422.66	Fair	Yes	18	13
335	North Ramp	Yes	273990.64	1503424.96	Fair	Yes	19	15

#	Location	Within Project Area	UTM (X)	UTM (Y)	Health Assess-ment	Pups	Diameter (inches)	Height (feet)
336	North Ramp	Yes	273980.67	1503420.59	Fair	Yes	16	11
337	North Ramp	Yes	273988.04	1503397.23	Fair	Yes	20	18
338	North Ramp	Yes	273981.71	1503395.13	Fair	--	19	16
339	North Ramp	Yes	273984.03	1503389.59	Fair	Yes	18	15
340	North Ramp	Yes	273977.12	1503375.22	Fair	--	8	12
341	North Ramp	Yes	273965.80	1503381.71	Fair	--	20	9
342	North Ramp	Yes	273957.57	1503375.92	Fair	Yes	19	13
343	North Ramp	Yes	273965.17	1503392.66	Fair	--	17	16
344	North Ramp	Yes	273969.86	1503395.76	Fair	--	18	14
345	North Ramp	Yes	273943.12	1503441.89	Fair	Yes	18	16
346	North Ramp	Yes	273985.03	1503328.69	Fair	Yes	17	15
347	North Ramp	Yes	273941.94	1503441.63	Fair	--	6	13
348	North Ramp	Yes	273950.08	1503394.51	Poor	Yes	18	2
349	North Ramp	Yes	273931.93	1503436.69	Good	--	6	10
350	North Ramp	Yes	273944.10	1503406.53	Poor	Yes	18	9
351	North Ramp	No	273849.77	1503455.31	Fair	Yes	7	8
352	North Ramp	Yes	273915.64	1503441.19	Fair	--	14	9
353	North Ramp	Yes	273910.69	1503434.32	Fair	--	10	10
354	North Ramp	Yes	273974.34	1503296.14	Good	--	5	11
355	North Ramp	Yes	273919.19	1503467.30	Poor	No	--	7
356	North Ramp	Yes	273973.35	1503299.84	Fair	--	5	9
357	North Ramp	Yes	273967.93	1503311.96	Poor	--	6	7
358	North Ramp	Yes	273939.49	1503370.01	Fair	Yes	20	17
359	North Ramp	Yes	273962.05	1503307.25	Poor	--	4	8
360	North Ramp	Yes	273925.05	1503404.84	Fair	Yes	--	12
361	North Ramp	Yes	273879.47	1503306.53	Fair	Yes	--	12
362	North Ramp	Yes	273876.64	1503425.99	Fair	--	6	7
363	North Ramp	Yes	273884.75	1503395.33	Fair	--	7	14
364	North Ramp	Yes	273877.88	1503402.07	Fair	--	5	10
365	North Ramp	Yes	273853.30	1503373.93	Fair	--	4	6
366	North Ramp	Yes	273887.25	1503321.91	Fair	Yes	9	10
367	North Ramp	Yes	273889.71	1503318.00	Good	--	8	12
368	North Ramp	Yes	273891.20	1503312.93	Poor	--	10	12
369	North Ramp	Yes	273878.89	1503308.25	Good	--	5	10
370	North Ramp	Yes	273897.37	1503304.74	Good	--	12	15
371	North Ramp	Yes	273893.45	1503281.55	Good	--	6	13
372	North Ramp	Yes	273892.41	1503228.90	Fair	--	16	15
373	North Ramp	Yes	273865.78	1503278.09	Fair	--	8	10
374	North Ramp	Yes	273824.35	1503365.89	Fair	Yes	4	6
375	North Ramp	Yes	273834.04	1503390.44	Fair	Yes	10	11
376	North Ramp	Yes	273813.23	1503352.54	Fair	Yes	20	12
377	North Ramp	Yes	273823.23	1503337.67	Fair	Yes	16	12
378	North Ramp	Yes	273830.59	1503296.86	Fair	Yes	8	9
379	North Ramp	Yes	273866.04	1503239.38	Good	Yes	8	10
380	North Ramp	Yes	273871.77	1503220.52	Fair	--	8	9
381	North Ramp	Yes	273816.28	1503329.50	Fair	No	--	9
382	North Ramp	Yes	273848.86	1503228.37	Fair	Yes	12	13
383	North Ramp	Yes	273841.48	1503225.33	Fair	--	6	11

#	Location	Within Project Area	UTM (X)	UTM (Y)	Health Assess-ment	Pups	Diameter (inches)	Height (feet)
384	North Ramp	Yes	273839.17	1503227.06	Fair	--	6	9
385	North Ramp	Yes	273815.43	1503316.77	Good	Yes	8	10
386	North Ramp	Yes	273759.38	1503375.32	Good	Yes	6	8
387	North Ramp	Yes	273810.18	1503274.10	Good	--	7	8
388	North Ramp	Yes	273793.74	1503312.18	Poor	--	12	9
389	North Ramp	Yes	273852.53	1503226.65	Poor	--	6	8
390	North Ramp	Yes	273818.15	1503308.11	Poor	Yes	--	2
391	North Ramp	Yes	273796.67	1503280.25	Good	Yes	6	7
392	North Ramp	Yes	273818.16	1503195.08	Fair	--	12	13
393	North Ramp	Yes	273805.03	1503218.23	Fair	Yes	9	12
394	North Ramp	Yes	273776.59	1503316.85	Good	Yes	6	7
395	North Ramp	Yes	273734.67	1503363.65	Good	Yes	7	7
396	North Ramp	Yes	273779.89	1503290.40	Fair	Yes	10	9
397	North Ramp	Yes	273838.16	1503213.76	Fair	Yes	--	10
398	North Ramp	Yes	273839.02	1503210.71	Fair	No	--	10
399	North Ramp	Yes	273770.34	1503323.64	Fair	Yes	9	11
400	North Ramp	Yes	273746.52	1503346.18	Good	--	7	6
401	North Ramp	Yes	273743.20	1503343.20	Good	Yes	10	12
402	North Ramp	Yes	273749.95	1503331.91	Good	--	6	5
403	North Ramp	Yes	273769.26	1503266.14	Poor	--	7	7
404	North Ramp	Yes	273735.82	1503331.81	Fair	Yes	16	14
405	North Ramp	Yes	273735.80	1503327.82	Fair	Yes	8	9
406	North Ramp	Yes	273750.68	1503301.85	Fair	--	15	11
407	North Ramp	Yes	273742.59	1503304.56	Fair	--	20	10
408	North Ramp	Yes	273743.04	1503302.98	Fair	Yes	18	12
409	North Ramp	Yes	273765.87	1503332.33	Fair	No	--	9
410	North Ramp	Yes	273781.65	1503244.60	Fair	Yes	8	12
411	North Ramp	Yes	273729.43	1503383.37	Poor	Yes	--	12
412	North Ramp	Yes	273773.69	1503215.61	Good	--	6	7
413	North Ramp	Yes	273772.75	1503212.30	Good	Yes	8	10
414	North Ramp	Yes	273760.24	1503225.63	Fair	Yes	8	12
415	North Ramp	Yes	273756.30	1503240.86	Fair	Yes	16	14
416	North Ramp	Yes	273756.79	1503259.81	Good	Yes	8	11
417	North Ramp	Yes	273752.53	1503263.09	Fair	--	4	9
418	North Ramp	Yes	273746.03	1503262.91	Fair	Yes	10	13
419	North Ramp	Yes	273747.00	1503286.60	Good	Yes	9	12
420	North Ramp	Yes	273742.98	1503281.39	Fair	--	5	6
421	North Ramp	Yes	273743.16	1503288.52	Fair	--	7	10
422	North Ramp	Yes	273789.65	1503226.40	Poor	Yes	--	10
423	North Ramp	Yes	273734.75	1503303.71	Poor	Yes	15	7
424	North Ramp	Yes	273719.22	1503353.42	Fair	Yes	16	14
425	North Ramp	Yes	273720.81	1503315.94	Fair	--	7	8
426	North Ramp	Yes	273720.43	1503315.59	Good	Yes	6	8
427	North Ramp	Yes	273723.25	1503312.10	Good	Yes	8	10
428	North Ramp	Yes	273716.98	1503306.55	Fair	--	8	9
429	North Ramp	Yes	273725.83	1503279.52	Fair	Yes	10	12
430	North Ramp	Yes	273723.68	1503274.36	Fair	Yes	16	12
431	North Ramp	Yes	273725.14	1503267.41	Fair	Yes	7	13

#	Location	Within Project Area	UTM (X)	UTM (Y)	Health Assess-ment	Pups	Diameter (inches)	Height (feet)
432	North Ramp	Yes	273743.96	1503248.73	Fair	--	10	12
433	North Ramp	Yes	273746.36	1503243.18	Fair	--	6	10
434	North Ramp	No	273696.04	1503370.69	Good	No	--	7
435	North Ramp	Yes	273731.04	1503283.69	Fair	No	--	8
436	North Ramp	Yes	273728.32	1503257.16	Good	Yes	7	10
437	North Ramp	Yes	273748.70	1503246.31	Fair	No	--	10
438	North Ramp	Yes	273714.33	1503246.40	Fair	--	10	11
439	North Ramp	Yes	273724.58	1503281.59	Good	Yes	6	10
440	North Ramp	Yes	273715.67	1503262.12	Good	Yes	10	8
441	North Ramp	Yes	273709.38	1503244.46	Fair	--	10	12
442	North Ramp	Yes	273712.48	1503264.86	Good	--	6	12
443	North Ramp	Yes	273716.79	1503255.03	Fair	Yes	16	15
444	North Ramp	Yes	273711.16	1503272.02	Good	Yes	7	12
445	North Ramp	Yes	273706.63	1503261.96	Fair	Yes	8	9
446	North Ramp	Yes	273699.48	1503260.93	Fair	Yes	6	12
447	North Ramp	Yes	273707.04	1503277.51	Good	--	6	9
448	North Ramp	Yes	273710.32	1503263.21	Poor	--	7	9
449	North Ramp	Yes	273701.76	1503272.21	Poor	Yes	15	11
450	North Ramp	Yes	273694.17	1503267.55	Fair	Yes	15	12
451	North Ramp	Yes	273701.87	1503301.84	Good	--	5	4
452	North Ramp	Yes	273691.08	1503267.12	Fair	--	12	14
453	North Ramp	Yes	273691.70	1503277.28	Fair	--	9	8
454	North Ramp	Yes	273696.55	1503304.74	Fair	Yes	7	8
455	North Ramp	Yes	273688.70	1503282.99	Fair	--	16	10
456	North Ramp	Yes	273700.77	1503278.15	Fair	--	15	12
457	North Ramp	Yes	273687.21	1503317.42	Fair	--	10	13
458	North Ramp	Yes	273686.42	1503321.08	Fair	--	15	16
459	North Ramp	Yes	273680.18	1503324.34	Fair	--	7	8
460	North Ramp	Yes	273692.31	1503320.94	Good	No	--	14
461	North Ramp	Yes	273692.36	1503322.38	Fair	No	--	6
462	North Ramp	Yes	273665.55	1503327.81	Good	Yes	10	12
463	North Ramp	Yes	273682.90	1503328.55	Good	Yes	--	13
464	North Ramp	Yes	273682.14	1503328.68	Good	No	--	15
465	North Ramp	Yes	273666.28	1503320.51	Good	Yes	8	7
466	North Ramp	No	273673.25	1503362.43	Poor	No	--	10
467	North Ramp	Yes	273665.94	1503309.79	Fair	--	15	14
468	North Ramp	Yes	273676.09	1503308.88	Fair	Yes	7	13
469	North Ramp	Yes	273697.61	1503252.06	Fair	--	6	12
470	North Ramp	Yes	273737.71	1503172.54	Fair	--	18	22
471	North Ramp	Yes	273675.13	1503260.12	Fair	Yes	15	1
472	North Ramp	Yes	273668.64	1503265.52	Fair	Yes	10	10
473	North Ramp	Yes	273661.02	1503275.83	Fair	--	6	10
474	North Ramp	Yes	273669.66	1503300.63	Fair	--	5	7
475	North Ramp	Yes	273658.94	1503287.86	Fair	--	8	9
476	North Ramp	Yes	273653.52	1503284.04	Fair	--	7	12
477	North Ramp	Yes	273657.55	1503300.22	Poor	Yes	18	3
478	North Ramp	Yes	273654.40	1503327.12	Fair	Yes	10	10
479	North Ramp	Yes	273684.92	1503247.32	Fair	Yes	--	8

#	Location	Within Project Area	UTM (X)	UTM (Y)	Health Assess-ment	Pups	Diameter (inches)	Height (feet)
480	North Ramp	Yes	273686.91	1503252.44	Fair	Yes	--	8
481	North Ramp	Yes	273686.89	1503257.12	Fair	Yes	--	12
482	North Ramp	Yes	273674.22	1503278.90	Good	No	--	8
483	North Ramp	Yes	273643.91	1503283.36	Fair	--	26	15
484	North Ramp	Yes	273657.72	1503274.58	Fair	--	7	7
485	North Ramp	Yes	273657.25	1503274.88	Poor	--	12	12
486	North Ramp	Yes	273649.46	1503269.65	Fair	--	6	9
487	North Ramp	Yes	273650.75	1503269.55	Fair	--	5	6
488	North Ramp	Yes	273683.40	1503221.89	Good	--	4	5
489	North Ramp	Yes	273663.81	1503296.12	Poor	Yes	--	2
490	North Ramp	Yes	273666.11	1503261.12	Fair	--	7	11
491	North Ramp	Yes	273664.13	1503261.40	Fair	Yes	8	12
492	North Ramp	Yes	273660.74	1503265.79	Fair	Yes	9	9
493	North Ramp	Yes	273642.76	1503314.98	Good	Yes	--	10
494	North Ramp	Yes	273645.46	1503277.20	Good	No	--	10
495	North Ramp	Yes	273669.07	1503268.19	Poor	No	--	7
496	North Ramp	No	273645.59	1503380.42	Good	Yes	9	8
497	North Ramp	No	273901.01	1503472.69	Fair	--	12	14
498	North Ramp	No	273923.47	1503497.69	Good	Yes	6	10
499	North Ramp	No	273927.13	1503490.08	Good	Yes	10	8
500	North Ramp	No	273924.40	1503509.78	Good	Yes	9	8
501	North Ramp	No	273681.84	1503391.39	Good	No	--	17
502	North Ramp	No	273941.51	1503491.38	Poor	Yes	18	6
503	North Ramp	No	273684.44	1503383.43	Good	No	--	12
504	North Ramp	No	273936.38	1503485.83	Good	--	6	10
505	North Ramp	Yes	273951.43	1503483.68	Good	--	8	12
506	North Ramp	No	273949.88	1503507.42	Good	--	5	8
507	North Ramp	No	273960.55	1503511.18	Poor	--	16	12
508	North Ramp	No	273952.66	1503502.77	Poor	--	6	11
509	North Ramp	No	273954.82	1503534.34	Good	--	8	15
510	North Ramp	No	273970.64	1503507.38	Good	Yes	11	15
511	North Ramp	No	273970.62	1503504.73	Fair	--	20	13
512	North Ramp	No	273895.39	1503472.80	Fair	No	--	9
513	North Ramp	No	274000.09	1503535.93	Fair	--	9	11
514	North Ramp	No	274002.16	1503537.20	Good	--	10	7
515	North Ramp	No	274003.42	1503520.28	Good	--	6	10
516	North Ramp	No	274008.30	1503523.17	Fair	Yes	15	13
517	North Ramp	No	274006.22	1503519.12	Poor	Yes	6	8
518	North Ramp	No	274083.68	1503553.09	Fair	Yes	7	8
519	North Ramp	No	274059.13	1503558.85	Poor	--	4	6
520	North Ramp	No	273976.45	1503501.19	Poor	No	--	10
521	North Ramp	No	274052.38	1503557.27	Poor	--	3	6
522	North Ramp	Yes	274008.56	1503505.94	Good	Yes	--	9
523	North Ramp	No	274141.08	1503583.07	Fair	Yes	7	8
524	North Ramp	Yes	274141.32	1503569.64	Fair	--	8	12
525	North Ramp	No	274211.93	1503605.98	Fair	Yes	10	10
526	North Ramp	No	274217.13	1503629.25	Fair	Yes	7	10
527	North Ramp	No	274210.58	1503628.66	Good	--	8	15

#	Location	Within Project Area	UTM (X)	UTM (Y)	Health Assess-ment	Pups	Diameter (inches)	Height (feet)
528	North Ramp	No	274209.03	1503627.86	Fair	--	6	5
529	North Ramp	Yes	274241.93	1503612.03	Fair	Yes	7	10
530	North Ramp	No	274248.33	1503619.44	Good	--	8	9
531	North Ramp	Yes	274242.98	1503611.85	Fair	--	15	14
532	North Ramp	Yes	274237.68	1503612.25	Poor	--	7	10
533	North Ramp	Yes	274244.72	1503612.49	Fair	--	6	10
534	North Ramp	No	274243.49	1503626.73	Good	--	9	9
535	North Ramp	No	274242.28	1503627.94	Fair	--	7	10
536	North Ramp	No	274240.56	1503639.36	Good	--	8	11
537	North Ramp	No	274236.62	1503636.29	Fair	Yes	6	10
538	North Ramp	No	274251.66	1503627.59	Fair	--	7	8
539	North Ramp	No	274253.89	1503652.74	Good	--	10	15
540	North Ramp	No	274259.20	1503655.23	Fair	--	6	12
541	North Ramp	No	274251.06	1503626.77	Fair	--	8	11
542	North Ramp	No	274262.03	1503657.70	Good	--	6	10
543	North Ramp	No	274195.48	1503626.17	Fair	No	--	8
544	North Ramp	No	274284.37	1503634.11	Fair	--	7	11
545	North Ramp	No	274201.09	1503624.23	Good	No	--	11
546	North Ramp	No	274268.45	1503644.78	Fair	--	6	7
547	North Ramp	Yes	274269.72	1503625.44	Good	Yes	6	8
548	North Ramp	No	274281.19	1503631.58	Poor	--	5	8
549	North Ramp	No	274276.13	1503633.00	Fair	--	16	13
550	North Ramp	Yes	274299.02	1503637.37	Fair	Yes	8	0
551	North Ramp	No	274227.78	1503614.58	Fair	Yes	--	9
552	North Ramp	No	274279.95	1503645.83	Good	--	11	12
553	North Ramp	No	274302.68	1503641.39	Fair	--	7	13
554	North Ramp	No	274283.45	1503645.32	Good	--	8	10
555	North Ramp	No	274300.36	1503644.72	Fair	--	8	13
556	North Ramp	No	274283.76	1503648.82	Fair	--	6	12
557	North Ramp	No	274281.77	1503653.03	Good	--	18	17
558	North Ramp	No	274230.05	1503623.66	Fair	No	--	6
559	North Ramp	No	274292.08	1503637.29	Good	Yes	8	10
560	North Ramp	No	274297.42	1503665.22	Fair	--	6	10
561	North Ramp	No	274298.09	1503652.36	Fair	--	8	11
562	North Ramp	No	274300.17	1503650.23	Good	Yes	8	9
563	North Ramp	Yes	274273.93	1503626.17	Fair	No	--	11
564	North Ramp	No	274304.70	1503651.10	Good	Yes	12	8
565	North Ramp	No	274307.05	1503668.79	Poor	Yes	6	6
566	North Ramp	Yes	274274.26	1503627.93	Fair	No	--	10
567	North Ramp	No	274301.25	1503646.93	Fair	Yes	8	10
568	North Ramp	No	274274.24	1503632.17	Good	No	--	12
569	North Ramp	No	274274.57	1503636.42	Good	Yes	--	13
570	North Ramp	No	274323.25	1503672.46	Poor	--	5	10
571	North Ramp	No	274332.91	1503678.19	Poor	--	7	11
572	North Ramp	No	274334.20	1503663.04	Good	--	6	12
573	North Ramp	No	274323.51	1503657.93	Poor	--	8	7
574	North Ramp	No	274337.34	1503661.31	Fair	--	6	10
575	North Ramp	No	274341.77	1503675.99	Poor	Yes	6	5

#	Location	Within Project Area	UTM (X)	UTM (Y)	Health Assess-ment	Pups	Diameter (inches)	Height (feet)
576	North Ramp	No	274290.52	1503655.40	Fair	No	--	10
577	North Ramp	No	274340.17	1503684.50	Poor	--	6	12
578	North Ramp	No	274362.65	1503693.26	Good	--	10	16
579	North Ramp	No	274371.85	1503673.65	Fair	--	5	6
580	North Ramp	No	274316.90	1503669.90	Fair	No	--	9
581	North Ramp	No	274328.85	1503669.73	Fair	Yes	--	12
582	North Ramp	No	274324.09	1503681.99	Good	Yes	--	8
583	North Ramp	No	274326.80	1503684.93	Fair	No	--	23
584	North Ramp	No	274409.19	1503685.90	Fair	Yes	8	8
585	North Ramp	No	274430.54	1503708.57	Good	--	7	15
586	North Ramp	No	274342.43	1503686.82	Fair	No	--	12
587	North Ramp	No	274438.53	1503697.72	Poor	--	5	7

Table D-2. *Tabernaemontana rotensis* in the Survey Area

#	Individual Tree Count at Point			UTM (X)	UTM (Y)	Diameter (inches)	Height (feet)
	Mature	Juvenile	Seedling				
1	1			274302.44	1503642.08	8	25
2	1			273832.28	1502924.34	4	16
3	1			273830.13	1502925.45	2	12
4		1		273828.26	1502925.53	1	8
5		1		273829.41	1502924.67	2	6
6		1		273829.77	1502923.58	2	5
7		1		273941.54	1502886.68	1	0
8	1			273943.22	1502882.80	5	12
9	1			273941.43	1502883.48	2	9
10	1			273942.21	1502879.26	2	14
11	1		5	273936.24	1502880.58	2	9
12	1			273945.48	1502882.39	4	15
13	1			273946.92	1502883.74	3	15
14			2	273988.98	1502805.39	<1	10
15		1		274004.94	1502844.07	2	8
16			1	274039.94	1502836.94	2	12
17	1			273830.27	1502951.18	5	15
18	1			273830.27	1502951.18	5	15
19	1			273792.91	1502972.02	4	22
20	1			273797.84	1502971.49	3	0
21		7		273791.48	1502968.93	2	10
22	1			273793.19	1502974.35	7	25
23	1			273792.19	1502968.56	3	15
24	1			273793.34	1502977.61	6	18
25	1			273789.92	1502972.63	3	13
26		4		273789.10	1502972.85	1	12
27	1			273787.85	1502970.41	3	18
28	1			274272.34	1503104.30	8	12
29	1			274550.39	1503327.28	4	8
30	1			274560.94	1503309.41	2	11
31	1			274557.51	1503312.51	3	17
32	1			274530.57	1503429.09	7	10
33	1			274615.07	1503296.29	3	20
34	1			274356.41	1503283.33	4	14
35	1			274352.58	1503259.48	6	12
36		1		274352.63	1503259.43	1	2
37	1			274261.31	1503385.99	9	12
38	1			274316.40	1503170.46	4	15
39	1			274317.73	1503172.81	6	17
40	1			274317.41	1503177.24	3	15
41	1			274295.99	1503159.71	3	12
42	1			274276.12	1503151.01	2	13
43	1			274262.16	1503134.41	7	14
44	1			274285.49	1503151.98	8	13
45	1			274283.41	1503151.58	4	15
46	1			274241.45	1503159.29	10	20
47	1			274241.39	1503160.71	7	20
48	1			274240.54	1503162.38	6	20
49	2			274239.88	1503161.99	4	20
50	5			274240.88	1503162.90	10	20

#	Individual Tree Count at Point			UTM (X)	UTM (Y)	Diameter (inches)	Height (feet)
	Mature	Juvenile	Seedling				
51	10			274244.32	1503165.61	7	17
52	4			274244.33	1503161.66	7	20
53	5			274225.99	1503157.27	5	15
54	1			274225.10	1503156.88	6	13
55	1			274228.08	1503114.23	15	30
56	54	79		273551.65	1503296.98	Multiple	Multiple
57	1			274342.35	1503509.99	6	21
58	1			274322.27	1503419.93	6	19
59	1			274276.38	1503576.04	6	16
60	1			274083.99	1503373.44	5	17
61	1			274029.59	1503400.93	5	15
62	2			274030.29	1503398.00	4	10
63	1			274027.93	1503394.67	5	12
64		1		274027.11	1503391.90	1	2
65	1			273776.46	1503441.73	6	11
TOTAL	**129**	**97**	**8**				

Table Notes: where multiple trees were recorded at one point, the diameter and height were recorded for the average of the cluster

Table D-3. Federally Listed Orchids in the Survey Area

#	Orchid Genus	Host Tree Species	UTM (X)	UTM (Y)	Approx. Number of Orchids
1	Bulbophyllum	*Intsia bijuga*	273908.56	1502934.54	1
2	Bulbophyllum	*Cycas micronesica*	274298.01	1503652.62	2
3	Bulbophyllum	*Taliparitis simile*	274339.75	1503663.78	1
4	Dendrobium	*Premna serratifolia*	274479.00	1503458.98	1
5	Dendrobium	*Meiogyne cylindrocarpa*	273714.63	1503354.24	1
6	Tuberolabium	*Aglaia mariannensis*	274561.39	1503294.46	7
7	Tuberolabium	*Aglaia mariannensis*	274562.46	1503294.91	1
8	Tuberolabium	*Premna serratifolia*	274567.64	1503295.87	10
9	Tuberolabium	*Aglaia mariannensis*	274567.39	1503294.95	1
10	Tuberolabium	*Premna serratifolia*	274562.30	1503296.35	11
11	Tuberolabium	*Vitex parviflora*	274562.83	1503297.17	2
12	Tuberolabium	*Aglaia mariannensis*	274562.67	1503294.65	2
13	Tuberolabium	*Aglaia mariannensis*	274568.57	1503309.80	1
14	Tuberolabium	*Premna serratifolia*	274416.77	1503394.62	18
15	Tuberolabium	*Premna serratifolia*	273875.86	1503356.41	3
16	Tuberolabium	*Aglaia mariannensis*	273813.26	1503227.40	4
17	Tuberolabium	*Vitex parviflora*	273812.38	1503228.21	1
18	Tuberolabium	*Aglaia mariannensis*	273816.39	1503227.65	23
19	Tuberolabium	*Aglaia mariannensis*	273815.34	1503231.28	4
20	Tuberolabium	*Taliparitis simile*	273684.04	1503330.99	2
21	Tuberolabium	*Taliparitis simile*	273686.89	1503328.48	4
22	Tuberolabium	*Taliparitis simile*	273686.09	1503334.08	3
23	Tuberolabium	*Taliparitis simile*	273686.16	1503329.03	1
24	Tuberolabium	*Taliparitis simile*	273687.54	1503335.71	2
	TOTAL				**106**

Table D-4. Bat Sign Observed in the Survey Area

#	Date Recorded	Observation Type	UTM (X)	UTM (Y)
1	7/29/2021	Bat dropping	274552.91	1503296.66
2	8/3/2021	Bat dropping	274601.71	1503306.78
3	8/3/2021	Bat dropping	274456.91	1503425.04
4	8/3/2021	Bat dropping	274497.98	1503302.57
5	8/3/2021	Bat dropping	274468.79	1503302.65
6	8/3/2021	Bat dropping	274450.61	1503378.26
7	8/3/2021	Bat dropping	274421.17	1503409.97
8	8/3/2021	Bat dropping	274435.67	1503231.96
9	8/3/2021	Bat odor	274439.29	1503213.41
10	8/4/2021	Bat dropping	274343.28	1503280.13
11	8/4/2021	Bat dropping	274301.49	1503279.34
12	8/4/2021	Bat dropping	274252.86	1503287.82
13	8/4/2021	Bat dropping	274194.12	1503294.09
14	8/5/2021	Bat dropping	274188.61	1503236.56
15	8/9/2021	Bat dropping	274058.00	1503260.30
16	8/9/2021	Bat dropping	274049.73	1503279.42
17	8/9/2021	Bat dropping	274041.28	1503158.53
18	8/9/2021	Bat dropping	274030.26	1503156.85
19	8/11/2021	Bat dropping	274482.11	1503566.82
20	8/11/2021	Bat dropping	274374.73	1503639.70
21	8/12/2021	Bat dropping	274387.35	1503500.48
22	8/12/2021	Bat odor	274330.31	1503616.60
23	8/12/2021	Bat odor	274370.59	1503439.34
24	8/13/2021	Bat dropping	274214.37	1503415.69
25	8/23/2021	Bat odor	273799.82	1503378.35
26	8/23/2021	Bat dropping	273752.90	1503279.57

SECTION 02 56 13.13

GEOMEMBRANE WASTE CONTAINMENT
02/25

PART 1 GENERAL

1.1 REFERENCES

The publications 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.

ASTM INTERNATIONAL (ASTM)

ASTM D4873/D4873M	(2017) Standard Guide for Identification, Storage, and Handling of Geosynthetic Rolls and Samples
ASTM D5820	(1995; R 2018) Standard Practice for Pressurized Air Channel Evaluation of Dual Seamed Geomembranes
ASTM D6392	(2012; R 2018) Standard Test Method for Determining the Integrity of Nonreinforced Geomembrane Seams Produced Using Thermo-Fusion Methods

GEOSYNTHETIC INSTITUTE (GSI)

GSI GRI GM7	(1995) Accelerated Curing of Geomembrane Test Strip Seams Made by Chemical Fusion Methods
GSI GRI GM13	(2016) Test Methods, Test Properties and Testing Frequency for High Density Polyethylene (HDPE) Smooth and Textured Geomembranes
GSI GRI GM19a	(2002; R 2017) Seam Strength and Related Properties of Thermally Bonded Homogeneous Polyolefin Geomembranes/Barriers

1.2 DEFINITIONS

a. Construction Quality Control (CQC): A planned system of inspections that is used to directly monitor and control the quality of the geomembrane installation project. CQC is normally performed by the geomembrane installation contractor/subcontractor, and is necessary to achieve quality in the geomembrane system. CQC refers to measures taken by the installer or contractor to determine compliance with the requirements for materials and workmanship as stated in the plans and specifications for the project.

b. Manufacturing Quality Control (MQC): A planned system of inspections that is used to directly monitor and control the manufacture of a material which is factory originated. MQC is normally performed by the manufacturer of the geomembrane material and is necessary to

ensure minimum (or maximum) specified values in the geomembrane. MQC refers to the measures taken by the manufacturer to determine compliance with the requirements for materials and workmanship as stated in certification documents and contract specifications.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" classification. Submittals not having a "G" classification are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Layout And Detail Drawings; G

As-Built Drawings; G

SD-03 Product Data

Manufacturer's Quality Control Manual

Installer's Quality Control Manual

Materials; G

Manufacturer's Warranty

Installer's Warranty

SD-06 Test Reports

Product Acceptance Tests

Trial Seam Logs

Non-Destructive Field Seam Testing

Manufacturer's Certified Raw And Sheet Material Test Reports

SD-07 Certificates

Certificate Of Subgrade Acceptance

Qualifications; G

SD-08 Manufacturer's Instructions

Geomembrane Manufacturer's Installation Instructions; G

1.4 QUALITY CONTROL

1.4.1 Manufacturer's Quality Control Manual

Submit the Manufacturer's Quality Control Manual which describes testing procedures, frequency of testing and acceptance/rejection criteria for MQC testing at least 14 calendar days prior to delivery of the geomembrane.

1.4.2 Installer's Quality Control Manual

Submit the installer's quality control manual a minimum of seven calendar days prior to geomembrane placement.

1.4.3 Qualifications

Submit manufacturer qualification statements a minimum of seven calendar days prior to geomembrane shipment. Also, submit installer, CQC inspector, and MQC laboratory qualification statements including resumes of key personnel involved in the project a minimum of seven calendar days prior to geomembrane placement.

1.4.3.1 Manufacturer

Manufacturer will have produced the proposed geomembrane sheets for at least five completed projects having a total minimum area of 0.5 million square feet.

1.4.3.2 Installer

The Installer is responsible for field handling, deploying, seaming, and anchoring of the geomembrane. The Installer will have installed the proposed geomembrane material for at least five completed projects having a total minimum area of 0.5 million square feet. At least one seamer, designated the Master Seamer, will have experience seaming a minimum of 0.5 million square feet of the proposed geomembrane using the same type of seaming equipment specified for this project.

1.4.3.3 CQC Inspector

The CQC inspector is the person or corporation hired by the Contractor, who is responsible for monitoring and documenting activities related to the CQC of the geomembrane from manufacturing through installation. The CQC inspector will have provided CQC inspection during installation of the proposed geomembrane material for at least three completed projects having a total minimum area of 0.5 million square feet.

1.4.3.4 MQC Laboratory

The MQC laboratory will have provided MQC testing of the proposed geomembrane and geomembrane seams for at least five completed projects having a total minimum area of 0.5 million square feet. The MQC laboratory must be accredited by the Geosynthetic Accreditation Institute's Laboratory Accreditation Program (GAI-LAP) for the tests the MQC laboratory will be required to perform.

1.5 DELIVERY, STORAGE, AND HANDLING

Deliver only approved geomembrane materials to the project site. Deliver, store, and handle geomembrane materials in accordance with ASTM D4873/D4873M and this section. Deliver and unload the geomembrane with the CQC inspector present. Confirm the presence of a label on each geomembrane roll with the manufacturer's name, product identification number, roll number, and roll dimensions. Reject geomembrane rolls which are not labeled upon delivery to the project site.

1.6 PROJECT/SITE CONDITIONS

Do not deploy or field-seam geomembrane in the presence of excess moisture (i.e., rain, fog, dew), in areas of ponded water, or in the presence of excess wind. Unless authorized by the Contracting Officer, do not place or seam at ambient temperatures of 104 degrees F or higher. Measure ambient temperature at a height less than 6 inches above the ground or geomembrane surface. In marginal conditions, cease seaming unless the CQC Inspector indicates otherwise, and confirm that seam properties meet the requirements listed in paragraph PERFORMANCE REQUIREMENTS.

1.7 WARRANTY

Provide manufacturer's warranty stating that the geomembrane materials meet all requirements of the Contract documents and that for the intended use, the geomembrane is warranted for 20 years against deterioration. Provide installer's warranty stating that the geomembrane will not fail due to improper installation within 2 years.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

2.1.1 Design Requirements

2.1.1.1 Layout And Detail Drawings

Submit geomembrane panel layout and penetration detail drawings a minimum of seven calendar days prior to geomembrane placement. Provide geomembrane penetration details as recommended by the geomembrane manufacturer.

2.1.2 Performance Requirements

2.1.2.1 Field Seams

Construct seams in the field conforming to the strength and related property requirements defined in GSI GRI GM19a.

2.2 MATERIALS

2.2.1 Raw Material Properties

Use raw materials meeting the requirements of GSI GRI GM13 and this paragraph. All regrind, reworked, or trim materials must be from the same manufacturer and exactly the same formulation as the geomembrane sheet being produced. Submit a copy of the test reports and MQC certificates for materials used in the manufacturing of the geomembrane shipped to the site.

2.2.2 Sheet Material Properties

Provide geomembrane sheets meeting the requirements in Table 1. Provide geomembrane sheets that are uniform in color, thickness, and surface texture. The textured surface features consist of raw materials identical to that of the parent sheet material and are uniform over the entire face of the geomembrane. Provide sheets that are free of and resistant to UV, fungal or bacterial attack and free of cuts, abrasions, holes, blisters, contaminants, and other imperfections.

TABLE 1 - GEOMEMBRANE PROPERTIES	
Minimum Nominal Thickness	20 mils
Manufactured in Accordance with	GSI GRI GM13 for HDPE
Material Type	HDPE
Category	unreinforced
Surface Finish	Smooth
Surface Finish for slopes greater than or equal to 4H:1V	Textured both
Minimum Manufactured Sheet Width	23 feet
Minimum Manufactured Sheet Length	150 feet

2.2.3 Field Seaming Materials

Manufacture seaming rods and pellets using materials which are essentially identical to that used in the geomembrane sheet. Test seaming rods and pellets for density, melt index and carbon black content in accordance with the approved Manufacturer's Quality Control manual. Do not use seaming rods and pellets which fail to meet the corresponding property values required for the sheet material for seaming.

2.3 EQUIPMENT

Use the geomembrane manufacturer's recommended equipment to perform the work and maintain equipment in satisfactory working condition.

2.4 ACCESSORIES

2.4.1 Temporary Ballast

Provide temporary ballast used during geomembrane installation including sandbags or other material as recommended by the geomembrane manufacturer. Use non-abrasive material, free of sharp edges or other features that may damage the geomembrane liner.

2.5 TESTS, INSPECTIONS, AND VERIFICATIONS

2.5.1 Manufacturing, Sampling, and Testing

Submit manufacturer's certified raw and sheet material test reports and a copy of the MQC certificates, a minimum of seven calendar days prior to shipment of geomembrane to the site.

2.5.1.1 Raw Material Testing

Test raw materials in accordance with the approved Manufacturer's Quality Control Manual and GSI GRI GM13; test according to the stricter standard if there are deviations. Do not use any raw material which fails to meet the requirements of paragraph RAW MATERIAL PROPERTIES.

2.5.1.2 Sheet Material Testing

Test geomembrane sheets in accordance with the approved Manufacturer's

Quality Control Manual and GSI GRI GM13; test according to the stricter standard if there are deviations. Do not send sheets not meeting the minimum requirements specified in paragraph SHEET MATERIAL PROPERTIES to the site.

2.5.2 Product Acceptance

2.5.2.1 Product Acceptance Samples

Obtain one CQC sample, 18 inches in length, for the entire width of a roll, for every 100,000 square feet of material delivered to the site. Do not obtain samples from the first three feet of the roll.

2.5.2.2 Product Acceptance Tests

Provide all CQC samples to the CQC laboratory to determine thickness, tensile strength at break, elongation at break, puncture, tear, and ply adhesion. Test the samples in accordance with the methods specified in GSI GRI GM13. Samples not meeting the specified requirements will result in the rejection of applicable rolls. As a minimum, test rolls produced immediately prior to and immediately after the failed roll for the same failed parameter. Continue testing until a minimum of three successive rolls on both sides of the original failing roll pass the failed parameter.

PART 3 EXECUTION

3.1 EXAMINATION

3.1.1 Certificate of Subgrade Acceptance

Each day during placement of geomembrane, the CQC Inspector and installer must inspect the surface on which geomembrane is to be placed and certify in writing on a Certificate of Subgrade Acceptance that the surface is acceptable. Examine the subgrade for compliance with the items in the list below. Perform repairs to the subgrade in accordance with paragraph PREPARATION, and at no additional cost to the Government. Use geomembrane cushioning materials/fabrics recommended by the manufacturer as needed to protect the geomembrane from damage.

a. All CQC of the underlying soils has been completed and results have been accepted by the Contracting Officer;

b. The subgrade is free of irregularities, protrusions, loose soil, and abrupt changes in grade;

c. The subgrade is not excessively deformed or rutted by construction equipment used to deploy geomembrane rolls. Ruts of the underlying soil should not exceed 1 inch in depth.

d. The underlying soil surface (if present) does not contain stones, litter, or organic matter which may be damaging to the geomembrane. Rocks larger than 0.5 inch in diameter and any other material which could damage the geomembrane must be removed from the surface to be covered with the geomembrane;

e. If installed on soil, no area of the underlying soil surface is excessively softened by high water content; and

f. If installed on soil, no area of the underlying soil surface contains

desiccation cracks which may damage the geomembrane.

3.2 PREPARATION

3.2.1 Subgrade Repair

For any subgrade found deficient in accordance with paragraph EXAMINATION, perform repairs in accordance with Section 31 00 00 EARTHWORK.

3.3 GEOMEMBRANE INSTALLATION

3.3.1 Geomembrane Placement

At least seven calendar days prior to placement, submit geomembrane manufacturer's installation instructions. Complete geomembrane placement in accordance with the geomembrane manufacturer's installation instructions and this paragraph. Do not elongate, wrinkle, scratch, or otherwise damage the geomembrane, other geosynthetic layers, or the underlying subgrade. Replace or repair geomembrane damaged during installation at the CQC inspector's and Contracting Officer's discretion. Only deploy geomembrane panels that can be anchored and seamed together the same day. Deploy a rub/slip sheet when placing the textured geomembrane and carefully remove the rub sheet to avoid shifting the geomembrane once the geomembrane is in place. Place adequate ballast on the geomembrane, without damaging the geomembrane, to prevent uplift by wind. On side slopes, anchor the geomembrane at the top and deploy down the slope to minimize wrinkles. Minimize dragging of geomembrane panels over the ground surface. Do not operate equipment on the top surface of the geomembrane without permission from the Contracting Officer. Orient seams parallel to the line of maximum slope. Where seams can only be oriented across the slope, lap the upper panel over the lower panel. Minimize wrinkles and tensile stresses in the geomembrane. Provide adequate slack to prevent the creation of tensile stress. Wrinkle height to width ratio for installed geomembrane exceeding 0.5 is unacceptable. In addition, geomembrane wrinkles exceeding 6 inches in height is prohibited. Cut out and repair wrinkles that do not meet the above criteria in accordance with the installer's approved CQC manual.

3.3.2 Field Seaming

3.3.2.1 Trial Seams

Make trial seams under field conditions on strips of excess geomembrane. Make trial seams each day prior to production seaming, whenever there is a change in seaming personnel or seaming equipment and at least once every four hours, by each seamer and each piece of seaming equipment used that day. Collect and test trial seam samples in accordance with ASTM D6392. Obtain one sample from each trial seam. This sample must be at least 36 inches long by 12 inches wide with the seam centered lengthwise. Where necessary, conduct accelerated curing of trial seams made by chemical methods in accordance with GSI GRI GM7. To be acceptable, four out of five replicate test specimens must meet seam strength requirements specified in paragraph PERFORMANCE REQUIREMENTS. If the field tests fail to meet these requirements, repeat the entire operation. If the additional trial seam fails, do not use the seaming apparatus or seamer until the deficiencies are corrected by the installer and two consecutive successful trial seams are achieved. Submit trial seam logs following the completion of installation.

3.3.2.2 Field Seams

Completely unroll and layout adjacent geomembrane panels/sheets before performing field seaming. Seam panels in accordance with the geomembrane manufacturer's recommendations and the requirements listed in this paragraph. Perform seaming with an automated seaming device recommended by the manufacturer. Where the geomembrane manufacturer's recommendations disagree with the requirements of this specification follow the more stringent requirement.

a. Complete seaming only when the Master Seamer is present.

b. In corners and odd-shaped geometric locations, minimize the number of field seams.

c. Overlap geomembrane panels a minimum of 3 inches and a maximum of 6 inches.

d. Only use temporary bonding procedures that are approved by the geomembrane manufacturer. Do not damage the geomembrane.

e. Extend seaming to the outside edge of panels.

f. Clean the seam area to provide an area that is free of moisture, dust, dirt, and foreign material at the time of seaming. Do not use solvent for cleaning.

g. If grinding is required, follow a grinding process approved by the geomembrane manufacturer. Complete grinding in a manner that does not damage the geomembrane.

h. Repair fish mouths (half-cylinder openings/voids caused by wrinkling/shifting) in seam.

i. Protect exposed geomembrane edges at the end of each day or whenever an installation activity is temporarily suspended during the day.

3.3.2.3 Polyethylene Seams

Seam polyethylene geomembranes by thermal fusion methods. Only use extrusion welding for patching and seaming in locations where thermal fusion methods are not feasible. Ground seam overlaps that are to be attached using extrusion welds prior to welding. Orient grinding marks perpendicular to the seam direction and do not extend marks beyond the extrudate after placement. Begin extrusion welding within 10 minutes after grinding. Where extrusion welds are temporarily terminated long enough to cool, ground prior to applying new extrudate over the existing seam. The total depth of the grinding marks greater than 10 percent of the sheet thickness is unacceptable.

3.3.3 Defects and Repairs

3.3.3.1 Patches

Repair tears, holes, blisters and other defects with patches. Provide patches that have rounded corners, are made of the same geomembrane, and extend a minimum of 6 inches beyond the edge of defects. Repair minor localized flaws by spot welding or seaming as determined by the CQC inspector. Non-destructively test repairs.

3.4 FIELD QUALITY CONTROL

3.4.1 Visual Inspection of Field Seams

Visually inspect each field seam to confirm that the seams are tightly bonded. Perform the inspection of a seam within 30 hours after the manufacturer's suggested application, curing, and cooling time. Repair and re-inspect seams found to be defective in accordance with manufacturer's recommendations.

3.4.2 Non-Destructive Field Seam Testing

Perform non-destructive testing on all field seams over the full seam length and on any other areas showing damage or other distresses. Alternate methods approved by the geomembrane manufacturer may be submitted for approval by the Contracting Officer. Submit non-destructive field seam test reports following the completion of installation and prior to covering the geomembrane liner. Non-destructively test field seams for penetrations in accordance with the installer's approved CQC manual. Repair seams that fail non-destructive testing in accordance with the installer's approved CQC manual and non-destructively test prior to acceptance.

3.4.2.1 Liner Pressurized Air Channel Test

Perform air pressure testing in accordance with ASTM D5820. Upon completion of the test, relieve pressure from the opposite end of the seam being tested to verify continuity of the seam.

3.4.3 Visual Inspection And Evaluation

Immediately prior to covering, the CQC inspector shall visually inspect the geomembrane, seams, and non-seam areas for defects, holes, or damage due to weather conditions or construction activities. At the Contracting Officer's or the CQC inspector's discretion, the surface of the geomembrane must be brushed, blown, or washed by the Installer if the quantity of dust, mud, or foreign material inhibits inspection or functioning of the overlying material. Non-destructively test each suspect location in accordance with paragraph NON-DESTRUCTIVE FIELD SEAM TESTING. Repair each location that fails non-destructive testing in accordance with paragraph PATCHES, and non-destructively retest.

3.5 PROTECTION AND BACKFILLING

Do not leave any tools or equipment on the geomembrane after active work ceases in the area. Do not cover the geomembrane until the Contracting Officer approves the geomembrane liner installation. Cover the deployed and seamed geomembrane with the specified material within five calendar days of acceptance. Prevent wrinkles in the geomembrane from folding over during placement of cover materials. Use geomembrane cushioning materials/fabrics recommended by the manufacturer as needed to protect the geomembrane from damage. Do not drop soil onto the geomembrane or overlying cushioning materials/fabrics from a height greater than 3 feet. Push the soil out over the geomembrane or overlying geosynthetics in an upward tumbling motion. Place soil from the bottom of the slope upward. Provide an initial loose soil lift thickness of 12 inches. Do not operate equipment directly on the geomembrane. Use equipment with ground pressures less than 7 psi to place the first lift over the geomembrane.

Maintain a minimum of 18 inches of soil between construction equipment with ground pressures greater than 7 psi and the geomembrane.

During the relocation of PFAS-Impacted soil, cover the soil to prevent erosion and control dust. Compact the relocated soil in accordance with Section 31 00 00 EARTHWORK. When relocation of PFAS-impacted soil is completed, cover the surface with geomembrane and seam cover geomembrane panels in accordane with the CQC Inspector's direction and/or recommended by the manufacturer.

Provide cover soil compaction in accordance with Section 31 00 00 EARTHWORK. While placing cover soil do not operate equipment by stopping abruptly, making sharp turns, spinning their wheels, or traveling at speeds exceeding 5 mph.

3.6 As-Built drawings

Submit final as-built drawings of the geomembrane installation.

-- End of Section --

SECTION 02 61 13

EXCAVATION AND HANDLING OF CONTAMINATED MATERIAL
02/25

PART 1 GENERAL

1.1 REFERENCES

The publications 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.

ASTM INTERNATIONAL (ASTM)

ASTM D5434	(2012) Field Logging of Subsurface Explorations of Soil and Rock

1.2 SYSTEM DESCRIPTION

The section includes the following Attachments:

A. Soil Management Plan (SMP) for FY24 MCAF Project P-012/AJJY183012, North Aircraft Parking Ramp, Joint Region Marianas, Andersen AFB, Guam

B. Performance Work Statement (PWS) for General Radioactive Material (G-RAM)/Low-Level Radioactive Waste (LLRW)

Comply with and implement the SMP and PWS. The project site includes contaminated areas with Per- and polyfluoroalkyl substances (PFAS), heavy metals (arsenic, lead), petroleum substances, and other residual contamination. G-RAM/LLRW can be encountered.

The construction workers can be exposed by incidental ingestion, dermal contact, and inhalation of soil and dust. Provide engineering and administrative hazard mitigation measures to minimize exposures from contaminants and low-level radiation. The mitigation measures must include hazard communication and engineering controls including erosion and dust controls, donning appropriate PPE, etc.

All personnel performing duties with potential for exposure to onsite contaminants and radiation must have 40-hour Hazardous Waste Operations and Emergency Response (HAZWOPER) training, hazard communication, and job-specific health and safety training.

Provide submittals specified in the SMP and PWS.

1. SMP Submittal List

a. Qualification of Professional Engineer (PE) or Environmental Consultant (EC)

b. SMP Work Plan including detaeild Contractor's means and methods for PFAS-impacted soil management

c. Additional PFAS testing report with sampling procedures

d. Geomembrane specification and Geomembrane manufacturer's installation instructions

e. SMP Closure Report

f. Topographic survey drawings for PFAS-Impacted Soil Relocation Area. Include GPS coordinates showing the relocation boundary and depth.

2. G-RAM/LLRW PWS Submittal List

a. Qualification of Radiation Safety Officer (RSO)

b. Radiation Work Plan

c. Qualification of Nuclear Regulatory Commission (NRC) licensed service provider

d. Key Personnel Qualification for G-RAM/LLRW

e. Report for G-RAM Site Screening Level

f. Weekly G-RAM/LLRW Inventory Report

g. Final G-RAM/LLRW Status Survey Report

h. G-RAM/LLRW Closure Report

1.2.1 Design Requirements

1.2.1.1 SMP Work Plan

Submit an Excavation Work Plan within 60 calendar days after notice to proceed. Do not perform work at the site, with the exception of site inspections and surveys, until the work plan is approved. Prepare draft for Government review, draft-final for regulatory review and final versions of the Excavation Work Plan. Allow 30 calendar days for Government review and 30 calendar days for regulatory review. Allow 45 days for comment resolution following each review and preparing the next version of the document. No adjustment for time or money will be made if resubmittals of the work plan are required due to deficiencies in the plan. At a minimum, include the following in the work plan:

a. Schedule of activities.

b. Method of excavation and equipment to be used.

c. Shoring or side-wall slopes proposed.

d. Dewatering and Leachate Management Plan which includes: anticipated sources and quantities of water that will enter the excavation, means of removing water from the excavation, means of storage and treatment, discharge requirements, and discharge methods.

e. Storage methods and locations for liquid and solid contaminated material. Provide design details for stockpiles including but not limited to: geomembrane liner and cover, berms, anchors/ballast for cover, vehicle access points, and leachate collection sumps.

f. Haul routes.

g. Decontamination procedures developed in accordance with Section 01 35 29.13 HEALTH, SAFETY, AND EMERGENCY RESPONSE PROCEDURES FOR CONTAMINATED SITES.

h. Temporary use areas required for staging equipment and supplies, for temporary storage of excavated materials, or for stockpiles.

i. Closure Report

1.2.1.2 G-RAM/LLRW Screening, Handling, Storage, and Disposal

Conduct G-RAM/LLRW screening in accordance with the PWS and approved Radiation Work Plan. The Contractor will be responsible for handling, packaging, storage, and management~~disposal~~ of G-RAM/LLRW~~S~~, if discovered, according to its Radiation Work Plan. At or prior to contract completion, the Government will provide direction for the final disposal of the G-RAM/LLRW at the Government G-RAM/LLRW storage unit. Retain a Radiation Safety Officer (RSO). Coordinate with the Naval Sea Systems Command Detachment (NAVSEADET) Radiological Affairs Support Office (RASO) through the Contracting Officer on G-RAM management, handling, and disposal.

Assume discovering and disposing of five (5)~~four~~ cubic yards of G-RAM/LLRW and other impacted materials, including soil, for the base bid work. In addition to the disposal, provide screening, monitoring, contamination control, and decontamination to manage discovered G-RAM, LLRW, and other impacted materials in accordance with the approved Radiation Work Plan.

1.2.1.2.1 Background Radiation and Site Screening Level

Determine the Site Screening Level for the Radiation Scan/Surveys.

1.3 PRE-INSTALLATION MEETING

Conduct a pre-installation meeting at least 30 business days prior to the start of contaminated soil excavation and G-RAM/LLRW screening operations on the project. The pre-installation meeting is to be arranged by the Contractor and is to follow the written pre-installation meeting agenda submitted prior to the meeting. The purpose of this meeting is to review the requirements of this specification and the associated plans. The following individuals must be in attendance at this meeting: Contractor's Project Manager, Site Foreman, RSO, NRC-licensed service provider, Contracting Officer, and respective Government stakeholders (e.g., RASO).

Record pre-installation meeting minutes and publish via email within 48 hours to all attendees. The minutes must be re-published within 48 hours via email pending any subsequent comments from the attendees.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" classification. Submittals not having a "G" classification are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Pre-Installation Meeting Agenda

Pre-Installation Meeting Minutes; G

SMP Work Plan; G

Pre-Installation Examination Report

Pre-Construction Equipment Examination

Qualification of Professional Engineer (PE) or Environmental Consultant (EC); G

Qualification of Nuclear Regulatory Commission (NRC) Licensed Service Provider; G

Key Personnel Qualification for G-RAM/LLRW; G

Radiation Work Plan; G

Qualification Of Radiation Safety Officer (RSO); G

SD-02 Shop Drawings

Surveys

SD-03 Product Data

Specifications Of Geomembrane; G

SD-06 Test Reports

Report for G-RAM Site Screening Level; G

Additional PFAS Testing Report With Sampling Procedures; G

SD-07 Certificates

Qualifications; G

SD-08 Manufacturer's Instructions

Geomembrane Manufacturer's Installation Instructions; G

SD-10 Operation and Maintenance Data

Weekly G-RAM/LLRW Inventory Report; G

SD-11 Closeout Submittals

SMP Closure Report; G

Final G-RAM/LLRW Status Survey Report; G

G-RAM/LLRW Closure Report; G

Topographic Survey Drawings for PFAS-Impacted Soil Relocation Area; G

1.5 QUALITY CONTROL

1.5.1 Regulatory Requirements

1.5.1.1 Permits and Licenses

Coordinate and obtain all necessary permits or notifications prior to the initiation of the relevant activities. Submit documentation of the completed permitting or permit equivalent to the Contracting Officer in accordance with Section 01 57 19, TEMPORARY ENVIRONMENTAL CONTROLS. Comply with all Federal, Guam, and local regulations. Obtain the permits and certifications, and meet the substantive regulatory requirements necessary for the execution of the project. For any of the above-listed items requiring a longer time frame, copies of applications, and scheduled dates for receiving final approval, must be included.

1.5.1.2 Environmental Protection

Develop and implement environmental protection requirements in accordance with Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS.

1.5.2 Qualifications

1.5.2.1 NRC Licensed Service Provider

Submit the qualification of NRC licensed service provider. Submit evidence of successful completion of at least 1 project of comparable size and scope for G-RAM/LLRW screening, handling/management, or disposal. Include the copy of the respective NRC license in the qualification submittal.

1.5.2.2 Key Personnel Qualification For G-RAM/LLRW

Provide key personnel with a minimum of 3 years of G-RAM/LLRW experience. Include the Site Foreman, quality control personnel, and supervisory engineering and technical staff involved with operation in key personnel. Perform all G-RAM/LLRW work under the supervision of an NRC-Licensed or qualified person. Submit a list of these personnel with their qualifications.

1.5.2.3 Key Personnel Qualification for Contaminated Soil Management

Retain a Professional Engineer (PE) or an Environmental Consultant (EC) experienced with soil investigation and removal/remediation. The PE or EC is required to evaluate the provided information; to incorporate PFAS testing and management requirements; and to develop Work Plans and a Closure Report. The PE or EC must have a minimum of five (5) years of experience managing environmental investigation and soil remedial/removal action projects. Professional licensing or professional registration is desired. Submit the Certification and Resume of the Contractor's PE or EC showing successful completion of soil investigation and removal/remediation.

1.5.2.4 Lab Validation

Perform testing by a DoD Environmental Laboratory Accreditation Program (DoD ELAP) accredited commercial testing laboratory meeting the requirements of Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS and approved by the Contracting Officer. Submit testing laboratory validation for the testing to be performed. Do not permit work requiring testing

until the Contracting Officer approves use of the testing laboratory.

1.6 PROJECT SITE CONDITIONS

1.6.1 Existing Conditions

The existing site conditions are presented in the SMP and PWS. The existing conditions presented are the result of site investigations at specific locations; variations in the existing site conditions could occur. Perform an independent interpretation of the site characterization data. Notify the Contracting Officer within 48 hours if discrepancies between the data provided and actual field conditions are discovered.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Backfill

After excavation of PFAS-contaminated soil, provide backfill in accordance with Section 31 00 00 EARTHWORK and project plans/drawings.

2.1.2 Topsoil for PFAS-Relocation Area

Comply with the SMP requirements. Provide a minimum 1-ft clean topsoil cap with vegetated cover. Provide topsoil in accordance with the requirements in Section 31 00 00 EARTHWORK. Stripping existing topsoil for re-use on-site is allowed if it meets requirements specified in Section 31 00 00.

2.1.3 Geomembrane

Submit specifications of geomembrane (geomembrane product data) to be used and Geomembrane Manufacturer's Installation Instructions. Provide geomembranes in accordance with Section 02 56 13.13 GEOMEMBRANE WASTE CONTAINMENT.

PART 3 EXECUTION

Furnish labor, materials, and equipment necessary to implement the SMP and PWS.

3.1 EXAMINATION

3.1.1 Surveys

Perform surveys immediately prior to and after excavation of contaminated material to determine the volume of contaminated material removed. Provide cross-sections on 25-foot intervals and at break points for all excavated areas.

3.1.2 Conditions

Conduct a pre-installation examination of the on-site infrastructure, utility conduits, monitoring points, site access constraints, and infrastructure. Photographically document, with identifying labels, the existing condition of infrastructure and utilities, particularly for comparison to post-excavation conditions. Verify locations of critical utilities that cannot be disrupted and those utilities that would

potentially have significant impacts on excavation and public safety. Submit a Pre-Installation Examination Report documenting the examination activity. Obtain all necessary utility clearances before initiation of subsurface work.

3.1.3 Pre-Construction Equipment Examination

Conduct a pre-construction examination of the excavation equipment for any damage, defect, and dilapidation. Submit the results of the pre-construction examination to the Contracting Officer for review and information. The Contracting Officer may conduct an independent examination to ascertain the condition and functionality of the equipment. Based on this examination, the Contracting Officer has the right to reject any damaged, defective or dilapidated equipment. The cost associated with equipment or control replacement or repair, and delays caused by the rejection must be borne by the Contractor. Routinely and properly inspect and maintain the equipment to provide the project execution as required by the contract schedule. Any schedule delay and cost associated with power failure, improper functioning of equipment and controls, unavailability of labor and materials, etc., must be the responsibility of the Contractor.

3.2 PREPARATION

3.2.1 Mobilization

Do not disturb the contaminated areas and G-RAM/LLRW Area of Interest until the SMP Work Plan and Radiation Work Plan have been approved by the Contracting Officer and the Contractor has received written confirmation. Delays caused by the Contractor's failure to meet regulatory requirements must result in no additional cost to the Government. In accordance with Section 01 35 29.13 HEALTH, SAFETY, AND EMERGENCY RESPONSE PROCEDURES FOR CONTAMINATED SITES, the equipment which is rented and/or previously used for other site remediation must be decontaminated and tested for contaminants of concern before being brought to the site.

3.2.2 Clearing

Perform clearing to the limits shown on the drawings.

3.3 CONTAMINATED MATERIAL REMOVAL

Notify the Contracting Officer 14 calendar days prior to the start of excavation of contaminated material. The Contractor is responsible for contacting regulatory agencies in accordance with the applicable reporting requirements, if required.

3.3.1 Excavation

Excavate areas of contamination to meet the requirements in the project drawings. Excavate additional material as directed by the Contracting Officer. Maintain an excavation log describing visible signs of contamination encountered for each area of excavation. Prepare excavation logs in accordance with ASTM D5434.

Use methods and equipment that result in minimal disturbance to remaining soil beyond the excavation limits. Remove and dispose of any material that becomes contaminated as a result of the Contractor's operation at no additional cost to the Government. Stage operations to minimize the time

the contaminated soil is exposed to the weather.

3.3.2 Shoring, Sloping, or Bracing

Implement shoring, sloping, bracing, or any other excavation health and safety requirements in accordance with Section 01 35 26 GOVERNMENTAL SAFETY REQUIREMENTS.

3.3.3 Dewatering

Divert surface water to prevent entry into the excavation. Conduct excavation and backfilling operations at the site in a manner that minimizes the amount of surface water which may collect in the open excavation.

Encountering groundwater or contaminated groundwater is not anticipated. However, if the construction dewatering is required, conduct dewatering in accordance with Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS. Limit dewatering to that necessary to assure adequate access, a safe excavation, prevent the spread of contamination, and to ensure that compaction requirements can be met. Do not perform dewatering without prior approval of the Contracting Officer. Conduct dewatering in accordance with the Dewatering and Leachate Management Plan developed as part of the Excavation Work Plan.

3.3.3.1 Collection and Disposal of Incidental Contaminated Water

Collect rinsewater, decontamination water, or leachate from contaminated soil stockpiles. Containerize, sample, and analyze contaminant absorbed material and dispose of based on the waste characterization results.

3.3.4 Contaminated Material Storage

Place material in temporary storage immediately after excavation. The following paragraphs describe acceptable methods of material storage. Provide storage units that are in good condition and constructed of materials that are compatible with the material or liquid to be stored. If multiple storage units are required, clearly label each unit with an identification number and keep a written log to track the source of contaminated material in each temporary storage unit.

3.3.4.1 Contaminated Material Stockpiles

Comply with the SMP and G-RAM/LLRW PWS.

3.3.5 Backfilling and Finishing/Finish Operations

Backfill excavations immediately after contaminated materials have been removed. Conduct backfilling and finishing operations in accordance with Section 31 00 00 EARTHWORK and construction plan/drawings.

3.3.6 ~~Treatment and~~ Disposal of ~~G-RAM, LLRW, and Radioactive Soil~~Heavy Metal Contaminated Soil

Perform offsite disposal of heavy metal contaminated soil~~, G-RAM, LLRW, and radioactive soil~~ in accordance with this Section, SMP, ~~PWS,~~ and Section 02 81 00 TRANSPORTATION AND DISPOSAL OF HAZARDOUS MATERIALS. Furnish labor, materials, and equipment necessary for collecting, storing, packaging, shipping, and disposing of contaminated or regulated materials.

3.3.7 Closeout Reports

Submit a SMP Closure Report and G-RAM/LLRW Closure Report. Submit 2 copies of each Closeout Report within 60 calendar days of completing work at the site. Label the report with the contract number, project name, location, date, name of general Contractor, and the Government agency contracting for the work. Refer to closure report requirements specified in the SMP and PWS. As a minimum, include the following information:

a. A cover letter signed by a responsible company official and principal personnel who is a responsible company official certifying that all services involved have been performed in accordance with the terms and conditions of the contract documents and regulatory requirements.

b. A narrative report including, but not limited to, the following:

(1) site conditions, ground water elevation, and cleanup goals;

(2) excavation logs;

(3) field screening readings;

(4) quantity of materials removed/excavated from each area of contamination;

(5) quantity of relocation of contaminated soil

(6) quantity of water/product removed during dewatering;

(7) sampling locations and sampling methods;

(8) sample collection data such as time of collection and method of preservation;

(9) sample chain-of-custody forms; and

(10) source of backfill.

c. Copies of all chemical and physical test results.

d. Copies of all manifests and land disposal restriction notifications.

e. Copies of all certifications of final disposal signed by the responsible disposal facility official.

f. Waste profile sheets.

g. Scale drawings showing limits of each excavation, limits of contamination, known underground utilities within 50 feet of excavation, sample locations, and sample identification numbers. Show on-site stockpile, storage, treatment, loading, and relocation or disposal areas on the drawings. Provide separate cross-sections of each excavation area before and after excavation and after backfilling, based on survey data. The topographic drawing must show the lateral and vertical extents and GPS coordinates of the encapsulated PFAS-impacted soil, including the ground elevations prior to PFAS-impacted soil placement and the finish grade of the top of the relocation after the impacted soil is encapsulated and capped.

h. Progress Photographs. Use color photographs to document progress of the work. Take a minimum of four views of the site showing the location of the area of contamination, entrance/exit road, and any other notable site conditions before work begins. After work has been started, photographically record weekly activities at each work location. Provide photographs including:

(1) Soil removal and sampling.

(2) Dewatering operations.

(3) Unanticipated events such as spills and the discovery of additional contaminated material.

(4) Contaminated material/water storage, handling, treatment, and transport.

(5) Site or task-specific employee respiratory and personal protection.

(6) Fill placement and grading.

(7) Post-construction photographs. After completion of work at each site, take a minimum of four views of each excavation site.

Include a digital version of all photos shown in the report with the Closure Report. Provide photographs with a minimum of 300 pixels per inch resolution for all photo files. Provide photos in a lossless compression file format that does not lose any pixels in the compression process (e.g. .TIFF, .PNG and .GIF). Ensure no loss of original resolution from the raw photo if converted to a lossless format. Create digital images and metadata that meet or exceed the specifications of the Exchangeable Image File Format (EXIF) version 2.3 or higher. In addition to the raw digital photo submissions, submit a PDF document as part of the Closeout Report displaying all required progress or other photos organized into separate documents. Render the photos in the PDF with a resolution that represents the original photo resolution to the human eye. Place photos according to their proper orientation (portrait or landscape). Create an index with bookmarks for each PDF organized by submittal section and suborganized by work area (if applicable) and then by date in the sequence which they were taken.

Process all raw photos for inclusion in the PDF submission with a border including a 0.5 inch caption at the base of each photo for descriptive information. Include the following information for each photographic image in the caption:

Project Name
Contract Number
Contractor Name
Date
Station and Offset
Photo Number
Orientation View
Work Element Depicted
General Project Area

ATTACHMENTS

A. Soil Management Plan for FY24 MCAF Project P-012/AJJY183012, North Aircraft Parking Ramp, Joint Region Marianas, Andersen AFB, Guam

B. G-RAM/LLRW Performance Work Statement

C. Soil Screening Survey Report for FY24 MCAF Project P-012/AJJY183012, North Aircraft Parking Ramp, Joint Region Marianas, Andersen AFB, Guam (2025)

-- End of Section --

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G-RAM/LLRW

PERFORMANCE WORK STATEMENT

9 January 2026

Amendment Log

4/16/2026 (AM003)	Section 1, 1st paragraph and Table 1; Add "At or prior to contract completion, the Government will provide direction for the final disposal of the G-RAM/LLRW at the Government G-RAM/LLRW storage unit (AM003)."
4/16/2026 (AM003)	Section 2.4, 1st sentence: Revise with "The Contractor will be responsible for handling, temporary storage, packaging, and transportation to the designated Government G-RAM/LLRW storage unit if G-RAM/LLRW is discovered. At or prior to contract completion, the Government will provide direction for the final disposal of the G-RAM/LLRW at the Government G-RAM/LLRW storage unit (AM003)."
4/16/2026 (AM003)	Section 2.4.1, 2nd paragraph, 2nd sentence: Revise with "Establish onsite storage units (e.g., Conex box or lockable storage container) to temporarily store discovered G-RAM/LLRW until disposal of the G-RAM/LLRW at the Government G-RAM/LLRW storage unit, in accordance with the approved RWP (AM003)."
4/16/2026 (AM003)	Section 2.4.2 Title: Revised with "Transportation of G-RAM/LLRW to Government G-RAM/LLRW Storage Unit" 3rd sentence: Revise with "At the end of the screening activities, arrangements must be made for transportation to the Government G-RAM/LLRW storage unit through the Navy RASO, and the items must be managed through the proper LLRW route (AM003)."

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Table 1. G-RAM/LLRW PWS Base and Optional Bid Schedule and Assumptions 3

FIGURE

Figure 1. Location Map: IRP Site 78A, FTA 3 2

ABBREVIATION AND ACRONYMS

AAFB	Andersen Air Force Base
AOI	Area of Interest
FTA	Firefighter Training Area
G-RAM	General Radioactive Material
HAZWOPER	Hazardous Waste Operations and Emergency Response
IRP	Installation Restoration Program
JRM	Joint Region Marianas
LLRW	Low-Level Radioactive Waste
NAVFAC	Naval Facilities Engineering Systems Command
NAVSEADET	Naval Sea Systems Command Detachment
NRC	Nuclear Regulatory Commission
PPE	Personal Protective Equipment
PFAS	perfluoroalkyl and polyfluoroalkyl substances
PWS	Performance Work Statement
RASO	Radiological Affairs Support Office
RWP	Radiation Work Plan
RSO	Radiation Safety Officer

G-RAM/LLRW PERFORMANCE WORK STATEMENT (PWS)

FOR

FY2024 MCAF PROJECT P-012 / AJJY183012, NORTH AIRCRAFT PARKING RAMP

JOINT REGION MARIANAS, ANDERSEN AIR FORCE BASE, GUAM

SECTION 1 INTRODUCTION

The project site includes an Installation Restoration Program (IRP) Site, Site 78A, Firefighter Training Area (FTA) 3. Site 78A has been identified as a General Radioactive Material (G-RAM)/Low-Level Radioactive Waste (LLRW) Area of Interest (AOI) requiring further site evaluation. Conduct G-RAM/LLRW screening for the areas to be disturbed within the IRP Site. The Contractor will be responsible for handling, packaging, storage, and disposal of G-RAM/LLRW if discovered. At or prior to contract completion, the Government will provide direction for the final disposal of the G-RAM/LLRW at the Government G-RAM/LLRW storage unit (AM003). Retain qualified workers and subcontractors until the radiation hazard is mitigated or eliminated. Coordinate with the Naval Sea Systems Command Detachment (NAVSEADET) Radiological Affairs Support Office (RASO) through the Contracting Officer on G-RAM/LLRW management, handling, packaging, storage, transportation, and disposal. Provide monitoring and engineering and administrative hazard mitigation measures to protect workers, site users, and the environment. The mitigation measures must include the following but are not limited: hazard communication, monitoring, and engineering controls, including erosion and dust controls, wearing appropriate Personal Protective Equipment (PPE), and decontamination. Comply with applicable federal and Guam regulations and project requirements including the following specification sections.

- 01 35 29.13 HEALTH, SAFETY, AND EMERGENCY RESPONSE PROCEDURES FOR CONTAMINATED SITES
- 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS
- 02 61 13 EXCAVATION AND HANDLING OF CONTAMINATED MATERIAL
- 02 81 00 TRANSPORTATION AND DISPOSAL OF HAZARDOUS MATERIALS

Section 1.1 Background: IRP Site 78A, Firefighter Training Area (FTA) 3

1.1.1 Site Description and Operational History

Site 78A occupies approximately 10 acres north of North Field on Andersen AFB Main Base. The site is located north of Marianas Boulevard, approximately 1,800 feet east of the intersection of 5th Street and Marianas Boulevard. The area was used for firefighter training between 1955 and 1973. The first investigation at Site 78A was performed in 1994. This was a site reconnaissance without any sampling. Based on the information obtained during the initial site reconnaissance, additional field investigation was recommended for the site. In 2000, as part of the Phase I remedial action, Site 78A was revisited and a number of potential sources of contamination were identified, including a 135-foot diameter burn pit with a 1-foot-high soil berm, a cleared area surrounding the burn pit, a metal-framed rusting structure, and approximately fifty 55-gallon drums. Of the 50 drums, 5 were still intact and contained fluids, while the remaining drums were in a rusty or deteriorated condition. The drum labels indicated that the drums contained lube oil, hydraulic oil, and fuel oil. A follow-up Phase II remedial action investigation was completed at Site 78A in 2003. The Phase II remedial action included site reconnaissance, a geophysical survey, a soil gas survey, and surface and subsurface soil sampling. During the 2010 remedial investigation, several areas of empty drums were identified on the eastern boundary of the site. In addition, a 2-inch underground drain line was discovered and traced to approximately 200 feet of the northwest portion of the former fire training burn pit. The 5 intact 55-gallon drums observed during the Phase I remedial action were not observed during the RI site reconnaissance. The fate of these drums is unknown. Following the remedial investigation, the 2014 Record of Decision (ROD) indicated No Further Action (NFA) for Site 78A. However, the IRP Site 78A is reopening due to confirmed presence of perfluoroalkyl and polyfluoroalkyl substances (PFAS)-contaminated soil and potential presence of G-RAM.

1.1.2 Current Site Status

This section describes observations based on the 2023 preliminary assessment site visit. The site was grass-covered and relatively flat. A large depression was observed on the eastern side of the site and mounds of rubble with burned and rusted metal were located in several locations around the perimeter of the cleared area. Debris included drums and what appeared to be to vehicle and aircraft parts.

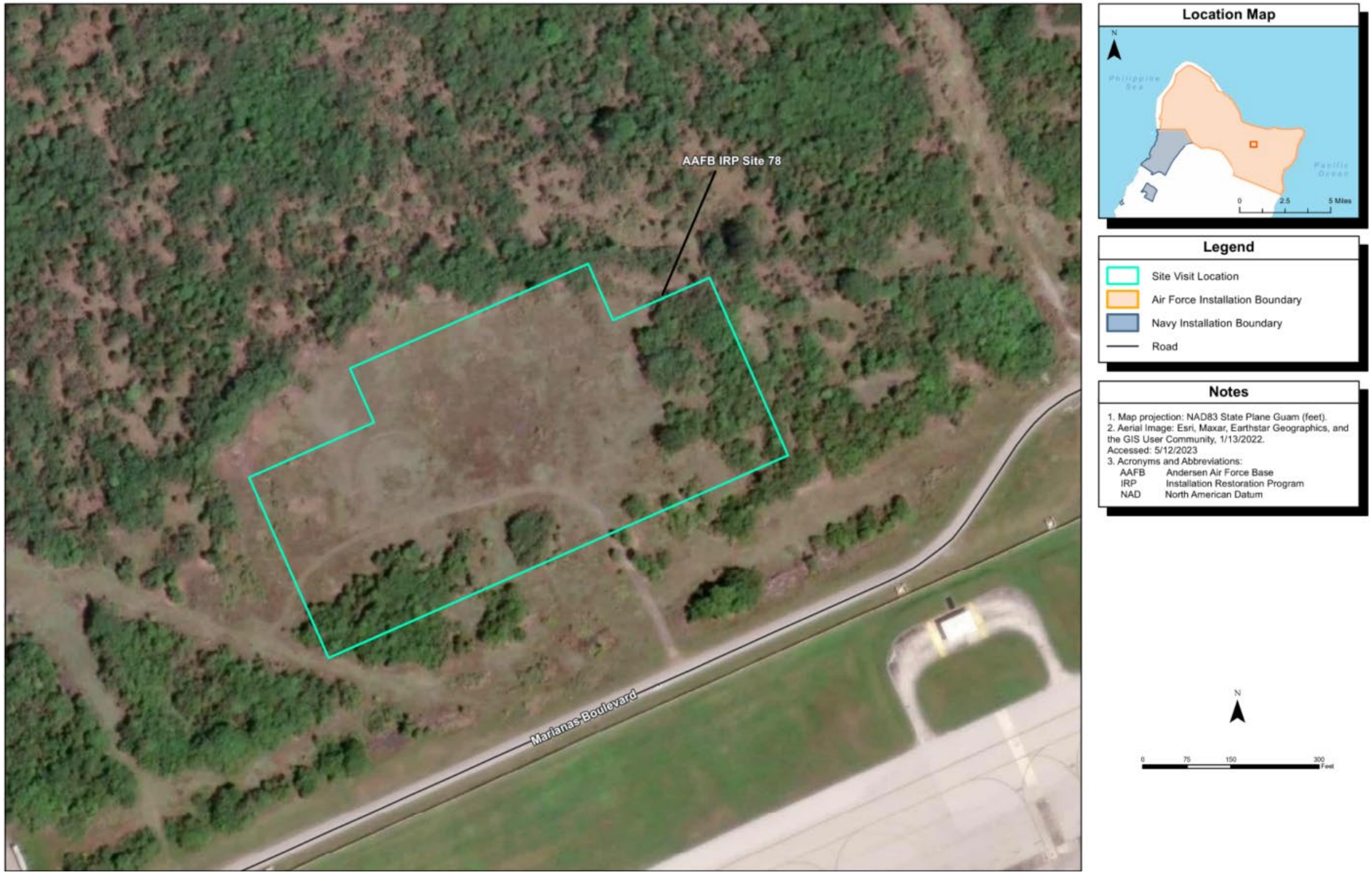

Figure 1. Location Map: IRP Site 78A, FTA 3

1.1.2.1 Potential or Former Historical Radiological Use

There are no documented radiological disposal activities at Site 78A; however, due to the timeframe of firefighting activities, there is potential that vehicles or aircraft containing radioluminescent components or other G-RAM-containing materials were used for firefighter training. Those materials may still be present onsite.

1.1.2.2 Historical Radiological Investigations

There are no records of historical radiological investigations for Site 78A. During the 2023 preliminary assessment site visit, the field team was equipped with a Ludlum Model 19 Exposure Rate Meter. Exposure rates observed around the perimeter of the site did not exceed notification levels. Measurements were made for health and safety purposes only; a detailed radiation survey was not conducted. Actions were taken to avoid any high exposure rates, so the rates detected may not be the highest within Site 78A.

Section 1.2 P-012 Project Potential Exposure Pathways and Worker Protection

Site 78A is considered an Area of Interest (AOI). While no direct impacts have been identified, historical firefighter training practices include the use of out-of-service aircraft that may have contained radioluminescent components or other G-RAM-containing materials. The preliminary Radionuclides of Potential Concern include cesium-137, radium-226, thorium-232, strontium-90, and uranium-238.

Currently, the site is covered with soil and vegetation with waste visible on the ground surface. The vegetative cover at the site reduces exposure to fugitive dust. However, the IRP site will be disturbed as part of the P-012 project. Various intrusive activities will be required including but are not limited to vegetation clearance, grubbing, grading, soil excavation/trenching, stockpiling, backfilling. The intrusive activities that disturb the soil and vegetation cover could result in possible exposure pathways to potentially radioactive soil and airborne material.

Abandoned debris may contain G-RAM due to the timeframe of firefighting activities based on historical firefighter training practices. Surface debris remains in the form of rusted metal. Debris may also be buried under soil and vegetation. Intrusive activities that uncover debris could result in possible exposure pathways to potentially radioactive material. Thus, there is risk of exposure to the construction workers authorized to be on the site. Provide monitoring and engineering and administrative hazard mitigation measures to protect workers and the environment. The mitigation measures must include the following but are not limited: hazard communication, monitoring, and engineering controls, including erosion and dust controls, wearing appropriate PPE, decontamination.

Section 1.3 G-RAM/LLRW PWS Base and Optional Bid Schedule and Assumptions

Table 1 presents assumptions for the Base and Optional Bid Schedule.

Table 1. G-RAM/LLRW PWS Base and Optional Bid Schedule and Assumptions

Tasks	P-012 Bid Assumptions
Section 2.1 Qualifications and Training	**Base Bid**
Section 2.2 Radiation Work Plan (RWP)	**Base Bid**
Section 2.3 G-RAM/LLRW Screening, Monitoring, Contamination Control and Decontamination	**Base Bid**. The G-RAM/LLRW screening areas will be limited to IRP Site 78A where the area will be disturbed by the project only.
Section 2.4 G-RAM/LLRW Handling, Storage, Packaging, Transportation, and Disposal	**Base Bid**. Assume discovering five (5) cubic yards of G-RAM/LLRW and other impacted materials, including soil, for the bid purposes. As part of this task, provide screening, monitoring, contamination control, and decontamination to manage discovered G-RAM, LLRW, and other impacted materials in accordance with the approved RWP. At or prior to contract completion, the Government will provide direction for the final disposal of the G-RAM/LLRW at the Government G-RAM/LLRW storage unit (AM003).
Section 2.5 G-RAM/LLRW Closure Report	**Base Bid**

SECTION 2 PROJECT REQUIREMENTS

Section 2.1 Qualifications and Training

The Contractor must retain qualified workers and subcontractors.

2.1.1 Radiation Safety Officer (RSO)

Retain a Radiation Safety Officer (RSO) to ensure the safe use, handling, and management of G-RAM, LLRW, radioactive materials, and radiation-producing equipment. The RSO must develop and implement radiation safety programs, monitor radiation levels, and ensure compliance with all relevant regulations. The RSO or other qualified designee must be onsite during the construction activities, including screening, managing, handling, packaging, and storage of G-RAM/LLRW until the G-RAM/LLRW leaves the project site for a designated disposal facility. The RSO must produce documentation of qualification to serve as the Radiation Safety Officer. Examples include professional certification of completion certification of 40-Hour Radiation Safety Officer Training.

2.1.2 NRC Licensed Service Provider

Retain a Nuclear Regulatory Commission (NRC) licensed service provider(s) to conduct G-RAM screening, packaging, storage, and transportation. Submit Qualification of NRC Licensed Service Provider.

2.1.3 Key Personnel Qualification: G-RAM/LLRW Management

Provide key personnel with a minimum of 3 years of G-RAM/LLRW experience. Include the site foreman, quality control personnel, and supervisory engineering and technical staff. Perform all G-RAM/LLRW work under the supervision of NRC license procedures and .

2.1.4 Training and Medical Surveillance Program for Construction Workers

The P-012 Project site includes the potential for encountering G-RAM and areas contaminated with Perfluoroalkyl and polyfluoroalkyl substances (PFAS), heavy metals, and other contaminants. All personnel performing duties with potential for exposure to onsite contaminants must have 40-hour Hazardous Waste Operations and Emergency Response (HAZWOPER) training, hazard communication, and job-specific health and safety training. After concerns or risks related to onsite contaminants are eliminated or mitigated, HAZWOPER-trained personnel will not be required. Job-specific training for G-RAM/LLRW must include the following:

- Site specific procedures for handling and storing radioactive materials;
- Health and safety hazards associated with exposure to the radioactive material that will be cleaned up or otherwise handled and the purpose and function of protective devices and precautions used to minimize exposure;
- Elements of the Accident Prevention Plan/Site Health and Safety Plan (APP/SSHP) and company specific procedures intended to provide protection from G-RAM/LLRW radiation exposure;
- Worker responsibility to report any unsafe acts which might result in exposure to G-RAM/LLRW;
- Appropriate worker response procedures to events that may result in worker exposure to G-RAM/LLRW;
- Personal protective equipment (PPE) requirements;
- Worker rights and responsibilities with respect to G-RAM/LLRW exposure.
- Applicable conditions of the contractor's NRC license and other project/contract requirements.

Comply with all requirements of 29 CFR 1910.120/29 CFR 1926.65 medical surveillance program and EM 385-1-1, Safety and Health Requirements Manual for workers performing cleanup operations and who will be exposed to contaminants. Identify required PPE.

Section 2.2 Radiation Work Plan (RWP)

Submit a Radiation Work Plan (RWP) within 45 calendar days after notice to proceed. Do not perform work at the IRP site,

except for site inspections and surveys, until the RWP is approved. Prepare the Draft and Final RWP for Government review. Allow 30 calendar days for Government review. No adjustment for time or money will be made if resubmittals of the work plan are required due to deficiencies in the plan. No construction or digging will be permitted without approval of the final RWP. At a minimum, include the following in the RWP:

1) Introduction (Site Background; Project Objectives; Project SOW)
2) Radiation Screening Requirements (Personnel and Responsibilities; Radiation Protection Plan; Radiological Posting Requirements; Radiation Detection Instruments; Inventory of Radioactive Materials)
3) Instrumentation (Survey Instruments; Daily Instrument Performance Checks; Radiation Detectors)
4) Screening/Survey Implementation and Procedures (Background Measurements; Site Screening Level; Personnel Surveys; Truck Surveys; Contamination Control; Characterization of Recovered Radioactive Material; G-RAM/LLRW Preparation, Management, and Shipping; Removal Plan; Final Status Survey)
5) Decontamination, Dismantling, and Disposition
6) Radioactive Materials Management, Transportation, and Disposal (DoD Coordination Procedures)
7) Documentation and Record Management
8) Closure Report

Section 2.3 G-RAM/LLRW Screening, Monitoring, Contamination Control, and Decontamination

Conduct G-RAM/LLRW screening for the areas to be disturbed within the IRP Site. Radiation screening and monitoring activities will include the following:

2.3.1. Background Radiation and Site Screening Level

Background measurements must be established prior to initiating radiation monitoring and radiological screening surveys. Determine the Site Screening Level for the Radiation Scan/Surveys. Submit a report for Site Screening Level describing the survey activities and findings. Obtain approval of the Site Screening Level from the Government.

2.3.2 Radiological Work Permit (RWP)

If exposures are expected to result in a dose in excess of 100 millirem total effective dose equivalent, a RWP must be issued to ensure that individuals observe the proper precautions while work is being performed in any area where hazards exist due to radiation, contamination, and/or airborne radioactivity. The RSO must develop, approve, and continually revise the RWP.

2.3.3 Radiation Screening/Surveys

Conduct gamma scan surveys of newly exposed excavation surfaces, waste piles/debris, and trucks with excavated materials/soils.

If the screening results discover elevated count rates above the Site Screening Level, and is determined to originate from something other than a natural material (e.g., gravel) or other common material (e.g., porcelain), to the extent practical, the G-RAM/LLRW must be removed, packaged in a plastic bag, bucket, or drum, and transported to the storage unit (e.g., Conex box or lockable storage container) established by the Contractor. The location of the storage unit must be approved by the AAFB RSO.

Trucks carrying excavated materials off-site must be surveyed. Before conducting the survey, the truck must be wiped to ensure there is no loose radioactive contamination. The truck surveys must include, at a minimum, gamma exposure rate measurements using a gamma exposure rate meter of the truck cab and nine other select contact points around the exterior of the truck. The measurements of the truck survey must be recorded on a survey form, and the truck must be identified by using either one or a combination of the cab number, truck number, cab license plate, and/or trailer license plate. If no measurement exceeds the Site Screening Level, then the truck can be released. As an alternative, dose rates can be taken as described and those points surveyed with an alpha/beta scintillation detector.

2.3.4 Personal Exposure Monitoring

Conduct periodic site dose rate surveys (e.g., start and end of workday, during an excavation event) and record observations.

2.3.5 Personnel Contamination Surveys and Contamination Surveys of Common Areas, Wastes, and Equipment

Prior to leaving the G-RAM/LLRW AOI or work area, personnel and small tools and items brought in and out of the work area must be surveyed ("frisked") by the site RSO or designated person. The personnel "frisk" will include, at a minimum, the hands, the bottoms of shoes, and any other contact point with potentially contaminated soil or material. If surveys measure contamination above background, the location of the elevated activity must be wiped down with a moist disposable towel until measurements of the area are indistinguishable from background.

2.3.6 Contamination Control and Decontamination

Control contamination and provide decontamination. Develop and implement the plans/procedure on site control and decontamination.

Section 2.4 G-RAM/LLRW Handling, Storage, Packaging, Transportation, and Disposal

The Contractor will be responsible for handling, temporary storage, packaging, and transportation to the designated Government G-RAM/LLRW storage unit if G-RAM/LLRW is discovered. At or prior to contract completion, the Government will provide direction for the final disposal of the G-RAM/LLRW at the Government G-RAM/LLRW storage unit (AM003). The tasks will include all necessary activities to conduct the work including personal exposure monitoring (Section 2.3.4); Personnel Contamination Surveys and Contamination Surveys of Common Areas, Wastes, and Equipment (Section 2.3.5); and Contamination Control and Decontamination (Section 2.3.6).

2.4.1 Discovered G-RAM, LLRW, and Impacted Soil

Segregate, identify, recover, and transport all G-RAM encountered during the screening and survey to the designated secure storage unit. Once suspected G-RAM is identified, notify the discovery to AAFB RSO and Navy RASO within 24 hours.

Place discovered G-RAM/LLRW in a plastic bag, then, containerize in a 55 gallon covered drum or equivalent container. Establish onsite storage units (e.g., Conex box or lockable storage container) to temporarily store discovered G-RAM/LLRW until disposal of the G-RAM/LLRW at the Government G-RAM/LLRW storage unit, in accordance with the approved RWP (AM003). Provide a label with a description of the contents and note on the label "TO BE DISPOSED AFTER APPROVAL FROM RASO". Apply the label to the exterior surface of the cover and site of the drum(s). Characterize all recovered G-RAM. Provide a Weekly G-RAM/LLRW Inventory Report including photography, labeling, and characterization. Provide the following data in the plastic bag and drum label:

- Activity:
- Contract No.:
- Material/Content:
- Isotope and Quantity (if known):

2.4.2 Transportation of G-RAM/LLRW to Government G-RAM/LLRW Storage Unit

All G-RAM/LLRW found must be securely stored in a storage unit at a designated secure site. Photographs and inventory of the items must be forwarded for further review by the AAFB RSO and Navy RASO. At the end of the screening activities, arrangements must be made for transportation to the Government G-RAM/LLRW storage unit through the Navy RASO, and the items must be managed through the proper LLRW route (AM003).

2.4.3 Final Status Survey of G-RAM/LLRW Storage Container/Unit

After the coordination and final disposal of G-RAM/LLRW that was stored in the storage unit, the RSO must direct a Final Status Survey of the storage container before its demobilization. The purpose of the Final Status Survey is to ensure that the storage unit is free of contamination and is acceptable to be released for unrestricted use. Submit a Final G-RAM/LLRW Status Survey Report. The following activities need to be completed before demobilization:

- Document verification that the storage unit is empty.
- A final clearance radiation survey of all storage unit areas, equipment, and tools to ensure that no contamination is present.
- The final clearance radiation survey that is documented in a survey form. The findings must be reported to the RSO, Navy Remedial Program Manager (RPM), AAFB RSO, and Navy RASO.
- Returning of all personnel radiation dosimetry badges to the site safety and health officer.

Section 2.5 G-RAM/LLRW Closure Report

Following the completion of all screening and disposal activities, submit a closure report. The closure report must include, at a minimum, a summary of the activities completed, radiation survey and screening results, and a RAM (e.g., G-RAM commodities) list along with associated characterization. At a minimum, the final report will include the following documentation:

1) Background measurements
2) Survey forms documenting periodic walk-around dose rate surveys
3) Gamma scan survey forms of newly exposed excavation surfaces
4) Gamma scan survey forms of piles (e.g., debris piles)
5) Gamma scan survey forms of trucks with excavated soils
6) Survey forms documenting periodic contamination surveys and surveys of equipment release from the work site
7) G-RAM/LLRW inventory and characterization survey results
8) G-RAM/LLRW disposal records
9) Photographs of RAM recovered
10) Survey forms documenting results of the storage unit Final Status Survey
11) Instrument daily response check data forms
12) Instrument calibration records

SECTION 02 81 00

TRANSPORTATION AND DISPOSAL OF HAZARDOUS MATERIALS
08/25

PART 1 GENERAL

1.1 REFERENCES

The publications 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.

INTERNATIONAL AIR TRANSPORT ASSOCIATION (IATA)

IATA DGR	(2025) Dangerous Goods Regulations - Edition 66

INTERNATIONAL MARITIME DANGEROUS GOODS (IMDG)

IMDG DGR	(2024) Dangerous Goods Regulations - 42nd Amendment

U.S. ARMY CORPS OF ENGINEERS (USACE)

EP 415-1-266	(2000) Construction -- Resident Engineer Management Guide (REMG) for Hazardous, Toxic, and Radioactive Waste (HTRW) Projects

U.S. DEPARTMENT OF TRANSPORTATION (DOT)

DOT 4500.9R	Defense Transportation Regulation, Part 2, Cargo Movement, Chapter 204, Hazardous Material

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

40 CFR 61	National Emission Standards for Hazardous Air Pollutants
40 CFR 261	Identification and Listing of Hazardous Waste
40 CFR 262	Standards Applicable to Generators of Hazardous Waste
40 CFR 263	Standards Applicable to Transporters of Hazardous Waste
40 CFR 264	Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities
40 CFR 265	Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities

40 CFR 266	Standards for the Management of Specific Hazardous Wastes and Specific Types of Hazardous Waste Management Facilities
40 CFR 268	Land Disposal Restrictions
40 CFR 270	EPA Administered Permit Programs: The Hazardous Waste Permit Program
40 CFR 279	Standards for the Management of Used Oil
40 CFR 300	National Oil and Hazardous Substances Pollution Contingency Plan
40 CFR 302	Designation, Reportable Quantities, and Notification
40 CFR 761	Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions
49 CFR 107	Hazardous Materials Program Procedures
49 CFR 171	General Information, Regulations, and Definitions
49 CFR 172	Hazardous Materials Table, Special Provisions, Hazardous Materials Communications, Emergency Response Information, and Training Requirements
49 CFR 173	Shippers - General Requirements for Shipments and Packagings
49 CFR 175	Carriage by Aircraft
49 CFR 176	Carriage by Vessel
49 CFR 178	Specifications for Packagings

1.2 DEFINITIONS

1.2.1 Hazardous Material

A substance or material which has been determined by the Secretary of Transportation to be capable of posing an unreasonable risk to health, safety, and property when transported in commerce, and which has been so designated pursuant to the Hazardous Materials Transportation Act, 49 U.S.C. Appendix Section 5101 et seq. The term includes materials designated as hazardous materials under the provisions of 49 CFR 172, Sections .101 and .102 and materials which meet the defining criteria for hazard classes and divisions in 49 CFR 173. EPA designated hazardous wastes are also hazardous materials.

1.2.2 Hazardous Waste

A waste which meets criteria established in Resource Conservation and Recovery Act (RCRA) or specified by the EPA in 40 CFR 261 or which has been designated as hazardous by a RCRA authorized state program.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Packaging Notifications

Hazardous Waste Management Plan; G

Onsite Hazardous Waste Management; G

Notices of Non-Compliance and Notices of Violation

SD-06 Test Reports

Recordkeeping; G

Exception Report; G

Spill Response

SD-07 Certificates

Transportation and Disposal Coordinator; G

Training; G

Pipeline Hazardous Materials Safety Administration Certification

Shipping Documents and Packagings Certification; G

Security Plan

Certificates of Disposal

Waste Minimization

1.4 QUALITY ASSURANCE

1.4.1 Transportation and Disposal Coordinator

Designate, by position and title, one person to act as the Transportation and Disposal Coordinator (TDC) for this contract. The TDC serves as the single point of contact for all environmental regulatory matters and has overall responsibility for total environmental compliance at the site including, but not limited to, accurate identification and classification of hazardous waste and hazardous materials; determination of proper shipping names; identification of marking, labeling, packaging and placarding requirements; completion of waste profiles, hazardous waste manifests, asbestos waste shipment records, PCB manifests, bill of ladings, exception and discrepancy reports; and all other environmental documentation in security of hazardous waste and hazardous materials. The TDC must have, at a minimum, one year of specialized experience in the management and transportation of hazardous waste and have been Department

of Transportation certified under 49 CFR 172, Subpart H, IATA Certification for shipments via air, and IMDG Certification for shipments via vessel.

1.4.2 Training

Hazardous materials/waste employees must be trained, tested, and certified to safely and effectively carry out their assigned duties in accordance with Section 01 35 26 GOVERNMENTAL SAFETY REQUIREMENTS and Section 01 35 29.13 HEALTH, SAFETY, AND EMERGENCY RESPONSE PROCEDURES FOR CONTAMINATED SITES. Employees transporting hazardous materials or preparing hazardous materials for transportation, including samples, must be trained, tested, and certified in accordance with 49 CFR 172, Subpart H, including security awareness and any applicable security plans. Hazardous material employees must also be trained in accordance with IATA DGR when shipping hazardous materials by air and IMDG DGR when shipping hazardous materials by water. Employees must be trained, tested, and certified in accordance with 49 CFR 172, Subpart H to determine that shipments do not constitute DOT regulated hazardous materials. Provide certifications for training in accordance with requirements provided in DOT 4500.9R.

1.4.3 Pipeline Hazardous Materials Safety Administration Certification

The hazardous materials transporter and offeror must possess a current certificate of registration issued by the Pipeline Hazardous Materials Safety Administration, when required by 49 CFR 107, Subpart G and unless an exemption applies. Submit copies of the certificates or written statements certifying exemption from these requirements.

1.4.4 Laws and Regulations Requirements

Comply with Federal, state, and local laws and regulations which are applicable. These requirements are amended frequently and compliance with amendments is required as they become effective. Notify the Contracting Officer immediately if compliance exceeds the scope of work or conflicts with specific requirements of the contract.

PART 2 PRODUCTS

2.1 MATERIALS

Provide all the materials required for the packaging, labeling, marking, placarding and transportation of hazardous wastes and hazardous materials in conformance with Department of Transportation standards, IATA DGR, IMDG DGR, and EP 415-1-266. Details must not be construed as establishing the limits of the Contractor's responsibility.

2.1.1 Packagings

Provide bulk and non-bulk containers for packaging hazardous materials/wastes consistent with the authorizations referenced in the Hazardous Materials Table in 49 CFR 172, Section 101, Column 8. Bulk and non-bulk packaging must meet the corresponding specifications in 49 CFR 173 referenced in the Hazardous Materials Table, 49 CFR 172, Section 101. Packaging must conform to the general packaging requirements of Subpart B of 49 CFR 173, to the requirements of 49 CFR 178 at the specified packing group performance level, to the requirements of special provisions of column 7 of the Hazardous Materials Table in 49 CFR 172, Section 101, and

be compatible with the material to be packaged as required by 49 CFR 173. Also provide other packaging related materials such as materials used to cushion or fill voids in overpacked containers. The hazardous materials being packaged must not react dangerously with, decompose or ignite the sorbent packaging materials. Additionally, sorbents used to treat free liquids to be disposed of in landfills must be non-biodegradable as specified in 40 CFR 264, Section 314. In addition, packaging notifications must be provided to the Government in accordance with 49 CFR 172, Section 178.2(c) regarding type and dimensions of closures, including gaskets, needed to satisfy performance test requirements.

2.1.2 Markings

Provide markings for each hazardous material/waste package, freight container, and transport vehicle consistent with the requirements of 49 CFR 172, Subpart D; 40 CFR 262, Section 32 (for hazardous waste); 49 CFR 175 (for transport by aircraft); and IATA DGR Section 7; 49 CFR 176 for transport by vessel; IMDG DGR Part 5, Chapters 5.2; 40 CFR 761, Section 45 (for PCBs); 40 CFR 61, Section 149(d) (for asbestos); and EP 415-1-266 (for FUSRAP radionuclides). Markings must withstand a 180 day exposure to conditions reasonably expected to be encountered during container storage and transportation, without deterioration or substantial color change.

2.1.3 Labeling

Provide primary and subsidiary labels for hazardous materials/wastes consistent with the requirements in the Hazardous Materials Table in 49 CFR 172, Section 101, Column 6. Provide labels meeting design specifications required by 49 CFR 172, Subpart E including size, shape, color, printing, and symbol requirements. Labeling must meet 49 CFR 175 (for transport by aircraft) and IATA DGR Section 7, 49 CFR 176 for transport by vessel and IMDG DGR Section 5.3. Labels must be durable weather resistant and withstanding a 180 day exposure to conditions reasonably expected to be encountered during container storage and transportation, without deterioration or substantial color change.

2.1.4 Placards

For each offsite shipment of hazardous material/waste, provide primary and subsidiary placards consistent with the requirements of 49 CFR 172, Subpart F and IMDG DGR Section 5.3. Provide placards for each side and each end of bulk packaging, freight containers, transport vehicles, and rail cars requiring such placarding. Placards may be plastic, metal, or other material capable of withstanding, without deterioration, a 30 day exposure to open weather conditions and must meet design requirements specified in 49 CFR 172, Subpart F and IMDG DGR Section 5.3.

2.1.5 Spill Response Materials

Provide spill response materials including, but not limited to, containers, adsorbent, shovels, and personal protective equipment. Spill response materials must be available at all times when hazardous materials/wastes are being handled or transported, must be compatible with the type of material being handled, and must include a sufficient volume of materials to contain the contents of the spill.

2.2 EQUIPMENT AND TOOLS

Provide appropriate equipment and tools necessary to handle hazardous materials and hazardous wastes in a safe and environmentally sound manner.

PART 3 EXECUTION

3.1 HAZARDOUS WASTE MANAGEMENT PLAN

Prepare a Hazardous Waste Management Plan detailing the manner in which hazardous wastes must be managed and describing the types and volumes of hazardous wastes anticipated to be managed. The Hazardous Waste Management Plan must be consistent with identified environmental controls described in 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS and 01 74 19 CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL. Address both onsite and offsite hazardous waste management. Describe the methods to be used to ensure accurate piece counts or weights of shipments; describe waste minimization methods; identify and describe facilities to be used for treatment, storage, and disposal (TSD); identify areas onsite where hazardous wastes are to be handled; and identify whether transfer facilities are to be used; and if so, how the wastes must be tracked to ultimate disposal. Submit the plan to the Contracting Officer for approval prior to start of work. Provide waste inspections as required by federal, state and local hazardous waste regulations. Submit written documentation of weekly hazardous waste inspections on a monthly basis.

3.2 ONSITE HAZARDOUS WASTE MANAGEMENT

Coordinate the onsite management of all hazardous materials and waste with the installation environmental function and the Contracting Officer. These paragraphs apply to Government owned waste only. Ensure compliance with Federal, state, and local hazardous waste laws and regulations and verifying those requirements when preparing reports, waste shipment records, hazardous waste manifests, or other documents. Identify hazardous wastes using criteria set forth in 40 CFR 261 or applicable state and local laws, regulations, and ordinances. Comply with generator requirements in 40 CFR 262 and applicable state or local law or regulations when accumulating hazardous waste onsite. Separate hazardous or otherwise regulated wastes from materials that are eligible for recycling or reclamation to the greatest extent practicable in accordance with Section 01 74 19 CONSTRUCTION WASTE MANGEMENT AND DISPOSAL.

Restrict onsite accumulation times to applicable time frames referenced in 40 CFR 262, Section 16, 17 and 18 based upon waste generator status, and applicable Guam or local law or regulation. Accumulation start dates commence when waste is placed into the container, unless accumulating in a Satellite Accumulation Area (SAA); then requirements of 40 CFR 262, Section 15 and state and local regulations must be followed. For waste accumulated in an SAA, the accumulation start date commences when the container exceeds the SAA volume limits and is moved to a Central Accumulation Area. Only use containers in good condition and compatible with the waste to be stored. Ensure containers are closed except when adding or removing waste, or temporary venting is necessary to support equipment operation or prevent hazardous pressure buildup. Immediately mark all hazardous waste containers with the words "hazardous waste" and other information required by 40 CFR 262, Section 32 and applicable state or local law or regulation as soon as the waste is containerized. Place additional markings on containers of "unknowns" designating the date sampled, and the suspected hazard. Inspect containers for signs of

deterioration and for responding to any spills or leaks. Inspect all hazardous waste areas weekly and provide written documentation of the inspection. For hazardous waste tank systems, perform daily inspections in accordance with 40 CFR 265 and provide written documentation of the inspections. Include date and time of inspection, name of individual conducting the inspection, problems noted, and corrective actions taken on the inspection logs.

3.2.1 Hazardous Waste Classification

Identify, in consultation with the Contracting Officer, all federal and Guam waste codes applicable to each hazardous waste stream based on requirements in 40 CFR 261 or applicable state or local law or regulation. Also identify applicable treatment standards in 40 CFR 268 and land disposal restrictions and make a determination as to whether or not the waste meets or exceeds the standards. Submit waste profiles, analyses, classification and treatment standards information to Contracting Officer for review and approval.

3.2.2 Packaging, Labeling, and Marking

Package, label, and mark hazardous materials/wastes using the specified materials and in accordance with the referenced authorizations. Mark each container of hazardous waste of 110 gallons or less with the following:

"HAZARDOUS WASTE - Federal Law Prohibits Improper Disposal.
If found, contact the nearest police or public safety authority or the U.S. Environmental Protection Agency.

1) Generator's name: _____
2) Manifest Document Number (or applicable labels required by RCRA authorized state programs): _____".
3) RCRA characterization (toxic, reactive, corrosive, ignitable): _____
4) DOT shipping name and Emergency Response Guide (ERG)#: _____

3.3 OFFSITE HAZARDOUS WASTE MANAGEMENT

Coordinate the off-site transfer of all hazardous materials and waste with the installation environmental function and the Contracting Officer. Use RCRA Subtitle C permitted facilities which meet the requirements of 40 CFR 264 or facilities operating under interim status which meet the requirements of 40 CFR 265 or 40 CFR 300 Section 440 for CERCLA sites. Do not use offsite treatment, storage, and disposal facilities with significant RCRA violations or compliance problems (such as facilities known to be releasing hazardous constituents into ground water, surface water, soil, or air). Submit Notices of Non-Compliance and Notices of Violation by a Federal, state, or local regulatory agency issued to the Contractor in relation to any work performed under this contract. Immediately provide copies of such notices to the Contracting Officer. Also furnish relevant documents regarding the incident and any information requested by the Contracting Officer, and coordinate its response to the notice with the Contracting Officer or the designated representative prior to submission to the notifying authority. Also furnish a copy to the Contracting Officer of all documents submitted to the regulatory authority, including the final reply to the notice, and all other materials, until the matter is resolved.

3.3.1 Treatment, Storage, and Disposal Facility and Transporter

Provide the Contracting Officer with EPA ID numbers, names, locations, and telephone numbers of TSD facilities and transporters. This information must be contained in the Hazardous Waste Management Plan and be approved by the Contracting Officer prior to waste disposal.

3.3.2 Facility Status Information

Facilities receiving hazardous waste must be permitted in accordance with 40 CFR 270 or operating under interim status in accordance with 40 CFR 265 requirements, or permitted by a state authorized by the Environmental Protection Agency to administer the RCRA permit program. Additionally, for waste generated at CERCLA sites, prior to using a TSD Facility, contact the EPA Regional Offsite Coordinator in accordance with 40 CFR 300, Section 440, to determine the facility's status, and document all information necessary to satisfy the requirements of the EPA Offsite policy and submit this information to the Contracting Officer in the Hazardous Waste Management Plan.

3.3.3 Shipping Documents and Packagings Certification

Prior to shipment of any hazardous material offsite and a minimum of 14 days prior to anticipated pickup, provide for review written certification to the Contracting Officer that hazardous materials have been properly packaged, labeled, and marked in accordance with Department of Transportation, IATA, IMDG, and EPA or authorized state requirements. Furnish designated receiving facility packaging assurances not later than 35 days after acceptance of the shipment. The Contractor's TDC must also provide written certification regarding waste minimization efforts documenting that efforts have been taken to reduce the volume and toxicity of waste to the degree economically practicable and that the method of treatment, storage, or disposal selected minimizes threats to human health and the environment.

3.3.4 Transportation

Prior to conducting hazardous materials activities, the Contractor responsible for pre-transportation activities must either certify to the Government that a Security Plan is in place which meets the requirements of 49 CFR 172, Subpart I IATA DGR Section 1.7, IMDG DGR Section 1.4 or in the event that the types or amounts of hazardous materials are excluded from the security planning requirements, a written statement to that effect detailing the basis for the exception. Use Uniform Hazardous Waste manifests for transporting hazardous wastes as required by 40 CFR 263 or applicable state or local law or regulation. Transportation must comply with all requirements in the Department of Transportation referenced regulations in the 49 CFR series. Prepare uniform hazardous waste manifests for each shipment of hazardous waste shipped offsite. Complete manifests using instructions in 40 CFR 262, Subpart B and applicable state or local law or regulation. Submit manifests and waste profiles to Contracting Officer for review and approval. Prepare land disposal restriction notifications as required by 40 CFR 268 for each shipment of hazardous waste. Submit notifications with the manifest to the Contracting Officer for review and approval. In accordance with DOT 4500.9R, inspect motor vehicles used to transport hazardous materials in accordance the 49 CFR and DOT safety regulations and complete DDForm 626, Motor Vehicle Inspection.

3.3.5 Treatment and Disposal of Hazardous Wastes

Coordinate any off site shipments of hazardous materials or hazardous wastes with the installation environmental function. Initial, or satellite hazardous waste accumulation is limited to 55 gallons (or 1 quart of acutely hazardous waste). Once a waste stream exceeds 55 gallons, it must be transferred to an on-site 90 day (180 day small quantity generator) accumulation area, or 270 days if the designated disposal facility is more than 200 miles away, or a permitted hazardous waste treatment, storage or disposal facility within three days. Ship hazardous wastes only to facilities which are properly permitted to accept the hazardous waste or operating under interim status. Ensure wastes are treated to meet land disposal treatment standards in 40 CFR 268 prior to land disposal. Propose TSD facilities via submission of the Hazardous Waste Management Plan, subject to the approval of the Contracting Officer. Submit Certificates of Disposal documenting the ultimate disposal, destruction or placement of hazardous wastes, CERCLA remediation waste, polychlorinated biphenyls (PCBs), ~~G-RAM/LLRW,~~ and asbestos within 180 days of initial shipment. Receipt of these certificates are required for final payment.

3.4 RADIOACTIVE MATERIALS MANAGEMENT

Consult with the Contracting Officer and RASO, to evaluate, prior to shipment of any material offsite, whether the material is regulated as a hazardous waste or a DOT hazardous material in addition to being regulated as a radioactive material. Management of radioactive materials/wastes must comply with Nuclear Regulatory Commission (NRC), DOT, and federal and state regulations governing management and transport. Perform the evaluation to determine proper shipping descriptions, marking requirements, and other criteria, as described below.

3.4.1 Identification of Proper Shipping Names

Use 49 CFR 172, Section .101 to identify proper shipping names for each hazardous material (including hazardous wastes and radioactive materials) to be shipped offsite. Submit proper shipping names to the Contracting Officer in the form of draft shipping documents for review and approval.

3.4.2 Packaging, Labeling, and Marking

Packaging, labeling and marking of radioactive materials must be in accordance with 49 CFR 172, and all nuclear regulatory commission (NRC) requirements and all state and local regulations.

3.4.3 Shipping Documents

Ensure that each shipment of radioactive and hazardous materials sent offsite is accompanied by properly completed shipping documents. This includes shipments of samples that may potentially meet the definition of a Department of Transportation regulated hazardous material.

3.4.3.1 Other Hazardous Material Shipment Documents

Prepare a bill of lading or dangerous goods declaration for air shipments for each shipment of hazardous material which is not a regulated hazardous waste requiring a hazardous waste manifest which fulfills the shipping paper requirements. Satisfy the requirements of 49 CFR 172, Subpart C, and 40 CFR 279 if shipping used oil and applicable state or local law or

regulation, and submit to the Contracting Officer for review and approval. For laboratory samples and treatability study samples, prepare bills of lading or dangerous goods declaration and other documentation as necessary to satisfy conditions of the sample exclusions in 40 CFR 261, Section 4(d) and (e) and any applicable state or local law or regulation. Bill of ladings or dangerous goods declarations requiring shipper's certifications must be signed by the Contractor.

3.5 SPECIAL REQUIREMENTS FOR ASBESTOS WASTES

If work involves asbestos containing wastes, manage these wastes in accordance with specification Section 02 82 00 ASBESTOS REMEDIATION.

3.5.1 Asbestos Waste Shipment Documents

Prepare waste shipment records, as required by 40 CFR 61, for shipments of asbestos. Submit waste shipment records to the Contracting Officer for review and approval.

3.6 PCB WASTE SHIPMENT DOCUMENTS

Prepare hazardous waste manifests for each shipment of PCB waste shipped offsite. Complete manifests using instructions in 40 CFR 761, Sections 207 and 208 and other applicable requirements. Submit documents to Contracting Officer for review and approval.

3.7 WASTE MINIMIZATION

Minimize the generation of hazardous waste to the maximum extent practicable and take all necessary precautions to avoid mixing clean and contaminated wastes. Identify and evaluate recycling and reclamation options as alternatives to land disposal. Requirements of 40 CFR 266 apply to: hazardous wastes recycled in a manner constituting disposal; hazardous waste burned for energy recovery; lead-acid battery recycling; and hazardous wastes with economically recoverable precious metals. Submit written certification that waste minimization efforts have been undertaken to reduce the volume and toxicity of waste to the degree economically practicable and that the method of treatment, storage, or disposal selected minimizes threats to human health and the environment. Exclude hazardous waste (whether recycled, reclaimed, or sent to landfill) from waste reduction calculations in accordance with Section 01 74 19 CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL.

3.8 RECORDKEEPING

Maintain adequate records to support information provided to the Contracting Officer regarding exception reports, annual reports, and biennial reports; maintain hazardous waste, PCB waste and asbestos waste shipment records for a minimum of 3 years from the date of shipment or any longer period required by applicable law or regulation or other provision of this contract; and maintain bill of ladings for a minimum of 2 years from the date of shipment or longer period required by applicable law or regulation or other provision of this contract. Submit information necessary to file state annual or EPA biennial reports for hazardous waste transported, treated, stored, or disposed of under this contract and in accordance with federal and state regulatory requirements. Do not forward these data directly to the regulatory agency but to the Contracting Officer at the specified time. Submit the information necessary for filing of the formal reports in the form and format required by the

governing Federal or state regulatory agency. A cover letter must accompany the data to include the contract number, Contractor name, and project location. In the event that a manifest copy documenting receipt of hazardous waste at the treatment storage and disposal facility is not received within 45 to 60 days days of shipment initiation based on the generator status, or that a manifest copy documenting receipt of PCB waste at the designated facility is not received within 35 days of shipment initiation, prepare and submit an exception report to the Contracting Officer within 60 days of shipment initiation. Exception reports must also comply with applicable state regulations.

3.9 SPILL RESPONSE

In the event of a spill or release of a hazardous substance (as designated in 40 CFR 302), or pollutant or contaminant, or oil (as governed by the Oil Pollution Act (OPA), 33 U.S.C. 2701 et seq.), notify the Contracting Officer immediately. Direction from the Contracting Officer concerning a spill or release is not considered a change under the contract. If the spill exceeds a reporting threshold, follow the pre-established procedures for immediate reporting to the Contracting Officer. Comply with applicable requirements of Federal, state, or local laws or regulations regarding any spill incident. Transporters must comply with 49 CFR 171 Section 15 for reporting of spills and releases during tranport.

3.10 EMERGENCY CONTACTS

Comply with the emergency contact provisions in 49 CFR 172, Section 604. When shipping hazardous materials, provide a 24 hr emergency response contact and phone number of a person knowledgeable about the hazardous materials being shipped and who has comprehensive emergency response and incident mitigation information for that material, or has immediate access to a person who possesses such knowledge and information. Monitor the phone on a 24 hour basis at all times when the hazardous materials are in transportation, including during storage incidental to transportation. Ensure that information regarding this emergency contact and phone number are placed on all hazardous material shipping documents. Designate an emergency coordinator and post the following information at areas in which hazardous wastes are managed:

a. The name of the emergency coordinator.

b. Phone number through which the emergency coordinator can be contacted on a 24 hour basis.

c. The telephone number of the local fire department.

d. The location of fire extinguishers and spill control materials.

Attachment A SAMPLE OFF-SITE POLICY CERTIFICATION MEMO	
Project/Contract #:	
Waste Stream:	
Primary TSD Facility, EPA ID # and Location:	
Alter. TSD Facility, EPA ID # and Location:	
EPA Region	Contact
I	888-372-7341 or (617) 918-1111
II	(212) 637-3660
III	800-438-2474 or 215-814-5000
IV	800-241-1754 or 404-562-9900
V	(800) 621-8431 or 312-353-2000
VI	800-887-6063 or 214-665-2210
VII	800-223-0425 or (913) 551-7003
VIII	(800) 227-8917 or (303) 312-6312
IX	(866) EPA-WEST or (415) 947-8000
X	800-424-4372 or (206) 553-1200
EPA representative contacted:	
EPA representative phone number:	
Date contacted:	
Comment:	
The above EPA representative was contacted on _____. As of that date the above sites were considered acceptable in accordance with the Off-Site Policy in 40 CFR 300 Section 440.	
Date:	Signature:
Phone number:	

-- End of Section --

SECTION 03 30 00

CAST-IN-PLACE CONCRETE
02/19, CHG 10: 08/25

PART 1 GENERAL

1.1 REFERENCES

The publications 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.

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 117	(2010; R 2015) Specifications for Tolerances for Concrete Construction and Materials and Commentary
ACI 121R	(2008) Guide for Concrete Construction Quality Systems in Conformance with ISO 9001
ACI 301	(2020) Specifications for Structural Concrete
ACI 302.1R	(2015) Guide for Concrete Floor and Slab Construction
ACI 304.2R	(2017) Guide to Placing Concrete by Pumping Methods
ACI 304R	(2000; R 2009) Guide for Measuring, Mixing, Transporting, and Placing Concrete
ACI 305.1	(2014) Specification for Hot Weather Concreting
ACI 305R	(2020) Guide to Hot Weather Concreting
ACI 306R	(2016) Guide to Cold Weather Concreting
ACI MNL-2	(2019; 11th Edition) ACI Manual of Concrete Inspection
ACI MNL-15	(2020) Field Reference Manual: Specifications for Concrete Construction ACI 301-20 with Selected ACI References
ACI SPEC 308.1	>(2023) External Curing of Cast-in-Place Concrete - Specification

AMERICAN WELDING SOCIETY (AWS)

AWS D1.4/D1.4M	(2018) Structural Welding Code - Reinforcing Steel

ASTM INTERNATIONAL (ASTM)

ASTM A184/A184M	(2024) Standard Specification for Welded Deformed Steel Bar Mats for Concrete Reinforcement
ASTM A615/A615M	(2024) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A706/A706M	(2024) Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement
ASTM A780/A780M	(2020) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM A934/A934M	(2022) Standard Specification for Epoxy-Coated Prefabricated Steel Reinforcing Bars
ASTM A1022/A1022M	(2016b) Standard Specification for Deformed and Plain Stainless Steel Wire and Welded Wire for Concrete Reinforcement
ASTM A1060/A1060M	(2016b) Standard Specification for Zinc-Coated (Galvanized) Steel Welded Wire Reinforcement, Plain and Deformed, for Concrete
ASTM A1064/A1064M	(2024) Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
ASTM C31/C31M	(2025a) Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C33/C33M	(2024a) Standard Specification for Concrete Aggregates
ASTM C39/C39M	(2024) Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C42/C42M	(2020) Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
ASTM C78/C78M	(2022) Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading)
ASTM C94/C94M	(2025) Standard Specification for Ready-Mixed Concrete
ASTM C136/C136M	(2019) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates

ASTM C143/C143M	(2020) Standard Test Method for Slump of Hydraulic-Cement Concrete
ASTM C150/C150M	(2024) Standard Specification for Portland Cement
ASTM C172/C172M	(2017) Standard Practice for Sampling Freshly Mixed Concrete
ASTM C173/C173M	(2024a) Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
ASTM C231/C231M	(2024) Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C260/C260M	(2024) Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C311/C311M	(2025) Standard Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use in Portland-Cement Concrete
ASTM C494/C494M	(2024) Standard Specification for Chemical Admixtures for Concrete
ASTM C595/C595M	(2024) Standard Specification for Blended Hydraulic Cements
ASTM C618	(2025a) Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C803/C803M	(2023) Standard Test Method for Penetration Resistance of Hardened Concrete
ASTM C873/C873M	(2015) Standard Test Method for Compressive Strength of Concrete Cylinders Cast in Place in Cylindrical Molds
ASTM C900	(2015) Standard Test Method for Pullout Strength of Hardened Concrete
ASTM C920	(2018; R 2024) Standard Specification for Elastomeric Joint Sealants
ASTM C989/C989M	(2024) Standard Specification for Slag Cement for Use in Concrete and Mortars
ASTM C1012/C1012M	(2024) Standard Test Method for Length Change of Hydraulic-Cement Mortars Exposed to a Sulfate Solution
ASTM C1016	(2014; R 2022) Standard Test Method for Determination of Water Absorption of Sealant Backing (Joint Filler) Material

ASTM C1074	(2019; E 2021) Standard Practice for Estimating Concrete Strength by the Maturity Method
ASTM C1077	(2024) Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation
ASTM C1107/C1107M	(2020) Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
ASTM C1157/C1157M	(2023) Standard Performance Specification for Hydraulic Cement
ASTM C1218/C1218M	(2020c) Standard Test Method for Water-Soluble Chloride in Mortar and Concrete
ASTM C1260	(2023) Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)
ASTM C1293	(2008; R 2015) Standard Test Method for Determination of Length Change of Concrete Due to Alkali-Silica Reaction
ASTM C1567	(2025) Standard Test Method for Determining the Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method)
ASTM C1602/C1602M	(2022) Standard Specification for Mixing Water Used in Production of Hydraulic Cement Concrete
ASTM C1778	(2023) Standard Guide for Reducing the Risk of Deleterious Alkali-Aggregate Reaction in Concrete
ASTM D471	(2016a; R 2021) Standard Test Method for Rubber Property - Effect of Liquids
ASTM D789	(2015) Determination of Relative Viscosity and Moisture Content of Polyamide (PA)
ASTM D1751	(2018) Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
ASTM D1752	(2018) Standard Specification for Preformed Sponge Rubber, Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction
ASTM D2628	(1991; R 2016) Standard Specification for

	Preformed Polychloroprene Elastomeric Joint Seals for Concrete Pavements
ASTM D2835	(1989; R 2017) Standard Specification for Lubricant for Installation of Preformed Compression Seals in Concrete Pavements
ASTM D5759	(2012; R 2020) Characterization of Coal Fly Ash and Clean Coal Combustion Fly Ash for Potential Uses
ASTM D6690	(2021) Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements
ASTM E96/E96M	(2024a) Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials
ASTM E329	(2023) Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection
ASTM E1643	(2018a) Standard Practice for Selection, Design, Installation, and Inspection of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs
ASTM E1745	(2017; R 2023) Standard Specification for Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs

COMPOSITE PANEL ASSOCIATION (CPA)

ANSI/CPA A135.4	(2012; R2020) Basic Hardboard

CONCRETE REINFORCING STEEL INSTITUTE (CRSI)

CRSI RB4.1	(2016) Supports for Reinforcement Used in Concrete
CRSI SP0001-31-DL-I	(2024) Manual of Standard Practice

FOREST STEWARDSHIP COUNCIL (FSC)

FSC STD 01 001	(2015) Principles and Criteria for Forest Stewardship

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)

NIST PS 1	(2009) DOC Voluntary Product Standard PS 1-07, Structural Plywood

U.S. ARMY CORPS OF ENGINEERS (USACE)

COE CRD-C 104	(1980) Method of Calculation of the Fineness Modulus of Aggregate

1.2 DEFINITIONS

a. "Cementitious material" as used herein includes all portland cement, pozzolan, fly ash, and slag cement.

b. "Exposed to public view" means situated so that it can be seen from eye level from a public location after completion of the building. A public location is accessible to persons not responsible for operation or maintenance of the building.

c. "Chemical admixtures" are materials in the form of powder or fluids that are added to the concrete to give it certain characteristics not obtainable with plain concrete mixes.

d. "Supplementary cementing materials" (SCM) include coal fly ash, slag cement, natural or calcined pozzolans, and ultra-fine coal ash when used in such proportions to replace the portland cement that result in improvement to sustainability and durability and reduced cost.

e. "Design strength" (f'c) is the specified compressive strength of concrete at time(s) specified in this section to meet structural design criteria.

f. "Mass Concrete" is any concrete system that approaches a maximum temperature of 158 degrees F within the first 72 hours of placement. In addition, it includes all concrete elements with a section thickness of 3 feet or more regardless of temperature.

g. "Mixture proportioning" is the process of designing concrete mixture proportions to enable it to meet the strength, service life and constructability requirements of the project while minimizing the initial and life-cycle cost.

h. "Mixture proportions" are the masses or volumes of individual ingredients used to make a unit measure (cubic meter or cubic yard) of concrete.

i. "Pozzolan" is a siliceous or siliceous and aluminous material, which in itself possesses little or no cementitious value but will, in finely divided form and in the presence of moisture, chemically react with calcium hydroxide at ordinary temperatures to form compounds possessing cementitious properties.

j. "Workability (or consistence)" is the ability of a fresh (plastic) concrete mix to fill the form/mould properly with the desired work (vibration) and without reducing the concrete's quality. Workability depends on water content, chemical admixtures, aggregate (shape and size distribution), cementitious content and age (level of hydration).

1.3 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Concrete Curing Plan

Quality Control Program; G

Quality Control Personnel Certifications; G

Quality Control Organizational Chart

Laboratory Accreditation; G

Maturity Method Data

SD-02 Shop Drawings

Reinforcing Steel; G

SD-03 Product Data

Joint Sealants; G

Joint Filler; G

Formwork Materials

Recycled Aggregate Materials; G

Cementitious Materials; G

Vapor Retarder; G

Concrete Curing Materials; G

Reinforcement; G

Liquid Chemical Floor Hardeners and Sealers

Admixtures; G

Mechanical Reinforcing Bar Connectors; G

Waterstops; G

Biodegradable Form Release Agent

Pumping Concrete; G

Nonshrink Grout; G

SD-05 Design Data

Construction and Movement Joints Locations and Details; G

Concrete Mix Design; G

SD-06 Test Reports

Concrete Mix Design; G

Fly Ash; G

Pozzolan; G

Slag Cement; G

Aggregates; G

Portland Cement; G

Blended Cements; G

Compressive Strength Tests; G

Slump Tests

Water

SD-07 Certificates

Reinforcing Bars

Welder Qualifications

VOC Content for Form Release Agents, Curing Compounds, and Concrete Penetrating Sealers

Safety Data Sheets

Forest Stewardship Council (FSC) Certification

Field Testing Technician and Testing Agency

SD-08 Manufacturer's Instructions

Liquid Chemical Floor Hardeners and Sealers

Joint Sealants; S

Curing Compound

1.4 MODIFICATION OF REFERENCES

Accomplish work in accordance with ACI publications except as modified herein. Consider the advisory or recommended provisions to be mandatory. Interpret reference to the "Building Official," the "Structural Engineer," and the "Architect/Engineer" to mean the Contracting Officer.

1.5 DELIVERY, STORAGE, AND HANDLING

Follow ACI 301, ACI 304R and ASTM A934/A934M requirements and recommendations. Do not deliver concrete until vapor retarder, forms, reinforcement, embedded items, and chamfer strips are in place and ready for concrete placement. Do not store concrete curing compounds or sealers in occupied spaces.

1.5.1 Reinforcement

Store reinforcement of different sizes and shapes in separate piles or racks raised above the ground to avoid excessive rusting. Protect from contaminants such as grease, oil, and dirt. Ensure bar sizes can be

accurately identified after bundles are broken and tags removed.

1.6 QUALITY ASSURANCE

1.6.1 Design Data

1.6.1.1 Concrete Mix Design

Sixty days minimum prior to concrete placement, submit a mix design for each strength and type of concrete. Submit all documentation required in ACI 301 Section 4 and as specified in this section. Submit a complete list of materials including type; brand; source and amount of cement, supplementary cementitious materials, and admixtures; and applicable reference specifications. Submit mill test and all other test for cement, supplementary cementitious materials, aggregates, and admixtures. Provide documentation of maximum nominal aggregate size, gradation analysis, percentage retained and passing sieve, and a graph of percentage retained verses sieve size. Provide mix proportion data using at least three different water-cementitious material ratios for each type of mixture, which produce a range of strength encompassing those required for each type of concrete required. If source material changes, resubmit mix proportion data using revised source material. Provide only materials that have been proven by trial mix studies to meet the requirements of this specification, unless otherwise approved in writing by the Contracting Officer. Indicate clearly in the submittal where each mix design is used when more than one mix design is submitted. Resubmit data on concrete components if the qualities or source of components changes. Required average strength can be documented by field experience if field strength test data are available and represent a single group of at least 10 consecutive strength tests for one mixture, using materials and conditions similar to those expected for work, and encompassing a period of not less than 45 days. The average of field strength tests must equal or exceed fcr'. Changes in materials, conditions, and proportions within the test record must not have been more closely restricted than those for the proposed work. Test records must not be more than 24 months old. Obtain mix design approval from the contracting officer prior to concrete placement.

1.6.2 Shop Drawings

1.6.2.1 Reinforcing Steel

Indicate bending diagrams, assembly diagrams, splicing and laps of bars, shapes, dimensions, and details of bar reinforcing, accessories, and concrete cover. Do not scale dimensions from structural drawings to determine lengths of reinforcing bars. Reproductions of contract drawings are unacceptable.

1.6.3 Control Submittals

1.6.3.1 Concrete Curing Plan

Submit proposed materials, methods and duration for curing concrete elements in accordance with ACI SPEC 308.1.

1.6.3.2 Pumping Concrete

Submit proposed materials and methods for pumping concrete. Include mix designs, pumping equipment including type of pump and size and material

for pipe, and maximum length and height concrete is to be pumped.

1.6.3.3 VOC Content for form release agents, curing compounds, and concrete penetrating sealers

Submit certification for the form release agent, curing compounds, and concrete penetrating sealers that indicate the VOC content of each product.

1.6.3.4 Safety Data Sheets

Submit Safety Data Sheets (SDS) for all materials that are regulated for hazardous health effects. SDS must be readily accessible during each work shift to employees when they are at the construction site.

1.6.4 Test Reports

1.6.4.1 Fly Ash and Pozzolan

Submit test results in accordance with ASTM C618 for fly ash and pozzolan. Submit test results performed within 6 months of submittal date.

1.6.4.2 Slag Cement

Submit test results in accordance with ASTM C989/C989M for slag cement. Submit test results performed within 6 months of submittal date.

1.6.4.3 Aggregates

Submit test results in accordance with ASTM C33/C33M, and ASTM C1293 or ASTM C1567 as required in the paragraph titled ALKALI-AGGREGATE REACTION.

1.6.5 Quality Control Program

Develop and submit for approval a concrete quality control program in accordance with the guidelines of ACI 121R and as specified herein. Include approved laboratories. Provide direct oversight for the concrete qualification program inclusive of associated sampling and testing. Provide all quality control reports to the Contracting Officer, Quality Manager and Concrete Supplier. Maintain a copy of ACI MNL-15 and CRSI SP0001-31-DL-I at project site.

1.6.6 Quality Control Personnel Certifications

Submit for approval the responsibilities of the various quality control personnel, including the names and qualifications of the individuals in those positions and a quality control organizational chart defining the quality control hierarchy and the responsibility of the various positions. Quality control personnel must be employed by the Contractor.

Submit American Concrete Institute certification for the following:

a. CQC personnel responsible for inspection of concrete operations.

b. Lead Foreman or Journeyman of the Concrete Placing, Finishing, and Curing Crews.

c. Field Testing Technicians: ACI Concrete Field Testing Technician, Grade I.

1.6.6.1 Quality Manager Qualifications

Holds a current license as a professional engineer in a U.S. state or territory with experience on at least five similar projects. Evidence of extraordinary proven experience may be considered by the Contracting Officer as sufficient to act as the Quality Manager.

1.6.6.2 Field Testing Technician and Testing Agency

Submit data on qualifications of proposed testing agency and technicians for approval by the Contracting Officer prior to performing testing on concrete.

a. Work on concrete under this contract must be performed by an ACI Concrete Field Testing Technician Grade 1 qualified in accordance with ACI MNL-2 or equivalent. Equivalent certification programs must include requirements for written and performance examinations as stipulated in ACI MNL-2.

b. Testing agencies that perform testing services on reinforcing steel must meet the requirements of ASTM E329.

c. Testing agencies that perform testing services on concrete materials must meet the requirements of ASTM C1077.

1.6.7 Laboratory Qualifications for Concrete Qualification Testing

The concrete testing laboratory must have the necessary equipment and experience to accomplish required testing. The laboratory must meet the requirements of ASTM C1077 and be accredited by a nationally recognized independent authority for ASTM C1077 laboratory evaluation; including International Accreditation Service (IAS), Cement and Concrete Reference Laboratory (CCRL), National Voluntary Laboratory Accreditation Program (NVLAP), Construction Materials Engineering Council (CMEC), American Association for Laboratory Accreditation (A2LA), and AASHTO Accreditation Program (AAP).

1.6.8 Laboratory Accreditation

Laboratory and testing facilities are provided by and at the expense of the Contractor. The laboratories performing the tests must be accredited in accordance with ASTM C1077, including ASTM C78/C78M and ASTM C1260. The accreditation must be current and must include the required test methods, as specified. Furthermore, comply with the following requirements:

a. Aggregate Testing and Mix Proportioning: Studies performed by an accredited laboratory and under the direction of a registered professional engineer in a U.S. state or territory competent in concrete materials who is competent in concrete materials and must sign all reports and designs.

b. Acceptance Testing: Furnish all materials, labor, and facilities required for molding, curing, testing, and protecting test specimens at the site and in the laboratory. Furnish and maintain boxes or other facilities suitable for storing and curing the specimens at the site while in the mold within the temperature range stipulated by ASTM C31/C31M.

c. Contractor Quality Control: All sampling and testing must be performed by an approved, onsite, independent, accredited laboratory.

1.7 ENVIRONMENTAL REQUIREMENTS

Provide space ventilation according to material manufacturer recommendations, at a minimum, during and following installation of concrete curing compound and sealer. Maintain one of the following ventilation conditions during the curing period or for 72 hours after installation:

a. Supply 100 percent outside air 24 hours a day.

b. Supply airflow at a rate of 6 air changes per hour, when outside temperatures are between 55 degrees F and 84 degrees F and humidity is between 30 percent and 60 percent.

c. Supply airflow at a rate of 1.5 air changes per hour, when outside air conditions are not within the range stipulated above.

1.7.1 Submittals for Environmental Performance

a. Provide data indication the percentage of post-industrial pozzolan (fly ash, slag cement) cement substitution as a percentage of the full product composite by weight.

b. Provide data indicating the percentage of post-industrial and post-consumer recycled content aggregate.

c. Provide product data indicating the percentage of post-consumer recycled steel content in each type of steel reinforcement as a percentage of the full product composite by weight.

d. Provide product data stating the location where all products were manufactured

e. For projects using FSC certified formwork, provide chain-of-custody documentation for all certified wood products.

f. For projects using reusable formwork, provide data showing how formwork is reused.

g. Provide SDS product information data showing that form release agents meet any environmental performance goals such as using vegetable and soy based products.

h. Provide SDS product information data showing that concrete adhesives meet any environmental performance goals including low emitting, low volatile organic compound products.

1.8 SUSTAINABLE DESIGN REQUIREMENTS

1.8.1 Forest Stewardship Council (FSC) Certification

Use FSC-certified wood where specified. Provide letter of certification signed by lumber supplier. Indicate compliance with FSC STD 01 001 and identify certifying organization. Submit FSC certification numbers; identify each certified product on a line-item basis. Submit copies of invoices bearing the FSC certification numbers.

1.9 QUALIFICATIONS FOR WELDING WORK

Welding procedures must be in accordance with AWS D1.4/D1.4M.

Verify that Welder qualifications are in accordance with AWS D1.4/D1.4M for welding of reinforcement or under an equivalent qualification test approved in advance. Welders are permitted to do only the type of welding for which each is specifically qualified.

PART 2 PRODUCTS

2.1 FORMWORK MATERIALS

a. Form-facing material in contact with concrete must be lumber, plywood, tempered concrete-form-grade hardboard, metal, plastic, or treated paper that creates specified appearance and texture of concrete surface. Submit product information on proposed form-facing materials if different from that specified herein.

b. Design formwork, shores, reshores, and backshores to support loads transmitted to them and to comply with applicable building code requirements.

c. Design formwork and shoring for load redistribution resulting from stressing of post-tensioned reinforcement. Ensure that formwork allows movement resulting from application of prestressing force.

d. Design formwork to withstand pressure resulting from placement and vibration of concrete and to maintain specified tolerances.

e. Design formwork to accommodate waterstop materials in joints at locations indicated in Contract Documents.

f. Provide temporary openings in formwork if needed to facilitate cleaning and inspection.

g. Design formwork joints to inhibit leakage of mortar.

h. Limit deflection of facing materials for concrete surfaces exposed to view to 1/240 of center-to-center spacing of facing supports.

i. Do not use earth cuts as forms for vertical or sloping surfaces.

j. Submit product information on proposed form-facing materials if different from that specified herein.

2.1.1 Wood Forms

Provide lumber that is square edged or tongue-and-groove boards, free of raised grain, knotholes, or other surface defects. Provide plywood that complies with NIST PS 1, B-B concrete form panels or better or ANSI/CPA A135.4, hardboard for smooth form lining. Submit data verifying that composite wood products contain no urea formaldehyde resins. Virgin wood used must be FSC-certified.

2.1.1.1 Concrete Form Plywood (Standard Rough)

Provide plywood that conforms to NIST PS 1, B-B, concrete form, not less

than 5/8-inch thick.

2.1.1.2 Overlaid Concrete Form Plywood (Standard Smooth)

Provide plywood that conforms to NIST PS 1, B-B, high density form overlay, not less than 5/8-inch thick.

2.1.2 Plastic Forms

Provide plastic forms that contain a minimum of 50 percent post-consumer recycled content, or a minimum of 50 percent post-industrial recycled content.

2.1.3 Steel Forms

Provide steel form surfaces that do not contain irregularities, dents, or sags.

2.2 FORMWORK ACCESSORIES

a. Use commercially manufactured formwork accessories, including ties and hangers.

b. Form ties and accessories must not reduce the effective cover of the reinforcement.

2.2.1 Form Ties

a. Use form ties with ends or end fasteners that can be removed without damage to concrete.

b. For secondary containment structures (including, but not limited to, fuel pits and vaults) and other structures indicated in Contract Documents, use form ties with integral water barrier plates or other acceptable positive water barriers in walls.

c. The breakback distance for ferrous ties must be at least 2 in. for Surface Finish-2.0 or Surface Finish-3.0, as defined in ACI 301.

d. Submit manufacturer's data sheet on form ties.

2.2.2 Waterstops

Submit manufacturer's data sheet on waterstop materials and splices.

2.2.2.1 Fuel Resistant Waterstop

Waterstop must be made of synthetic rubber, thermoplastic elastometric rubber, or other suitable compound material. Waterstop must be able to withstand long-term exposure to jet fuel Type Jet-A, JP-8 and diesel fuel without failure or permanent deterioration and must be tested in accordance with ASTM D471. Submit certification by the product manufacturer of the fuel resistance of the waterstop. Unless indicated otherwise, waterstops must be a minimum of 3/16 inch by 6 inches wide ribbed-style with centerbulb. Only manufacturer's shop-fabricated splice sections must be used for waterstop splices at corners intersections and angular joints.

2.2.3 Biodegradable Form Release Agent

a. Provide form release agent that is colorless, biodegradable, and rapeseed oil-based or soy oil-based or water-based, with a low (maximum of 55 grams/liter (g/l)) VOC content.

b. Provide product that does not bond with, stain, or adversely affect concrete surfaces and does not impair subsequent treatments of concrete surfaces.

c. Provide form release agent that reduces formwork moisture absorption, and does not contain diesel fuel, petroleum-based lubricating oils, waxes, or kerosene. Submit documentation indicating type of biobased material in product and biobased content. Indicate relative dollar value of biobased content products to total dollar value of products included in project.

d. Submit manufacturer's product data on formwork release agent for use on each form-facing material.

2.2.4 Chamfer Materials

Use lumber materials with dimensions of 3/4 x 3/4 in.

2.2.5 Construction and Movement Joints Locations and Details

a. Submit details and locations of construction joints in accordance with the requirements herein.

b. Locate construction joints within middle one-third of spans of slabs, beams, and girders. If a beam intersects a girder within the middle one-third of girder span, the distance between the construction joint in the girder and the edge of the beam must be at least twice the width of the larger member.

c. For members with post-tensioning tendons, locate construction joints where tendons pass through centroid of concrete section.

d. Locate construction joints in walls and columns at underside of slabs, beams, or girders and at tops of footings or slabs.

e. Make construction joints perpendicular to main reinforcement.

f. Provide movement joints where indicated in Contract Documents or in accepted alternate locations.

g. Submit location and detail of movement joints if different from those indicated in Contract Documents.

h. Submit manufacturer's data sheet on expansion joint materials.

i. Provide keyways where indicated in Contract Documents. Longitudinal keyways indicated in Contract Documents must be at least 1-1/2 in. deep, measured perpendicular to the plane of the joint, unless indicated otherwise.

2.2.6 Other Embedded items

Use sleeves, inserts, anchors, and other embedded items of material and

design indicated in Contract Documents.

2.3 CONCRETE MATERIALS

2.3.1 Cementitious Materials

2.3.1.1 Portland Cement

a. Unless otherwise specified, provide cement that conforms to ASTM C150/C150M Type II/V where in contact with earth ~~and Type I/II elsewhere~~. Where ASTM C150/C150M Type II/V cement is not available, ASTM C150/C150M Type I/II cement may be used. Provide ASTM C150/C150M Type I/II cement elsewhere.

b. Use one brand and type of cement for formed concrete having exposed-to-view finished surfaces.

c. For portland cement manufactured in a kiln fueled by hazardous waste, maintain a record of source for each batch. Supplier must certify that the hazardous waste is neutralized by the manufacturing process and that no additional pollutants are discharged.

d. Submit information along with evidence demonstrating compliance with referenced standards. Include types of cementitious materials, manufacturing locations, shipping locations, and certificates showing compliance.

e. Store cementitious materials and keep dry and free from contaminants.

2.3.1.2 Blended Cements

a. Conform to ASTM C595/C595M Type IP IS .

b. Slag cement added to the Type IS or Type IT blended cements must meet ASTM C989/C989M.

c. The pozzolan added to the Type IP or Type IT blended cements must meet ASTM C618 Class F, and interground with the cement clinker. The manufacturer must state in writing that the amount of pozzolan in the finished cement will not vary more than plus or minus 5 mass percent of the finished cement from lot-to-lot or within a lot. The percentage and type of pozzolan used in the blend must not change from that submitted for the aggregate evaluation and mixture proportioning.

2.3.1.3 Fly Ash

a. ASTM C618, Class F, except that the maximum allowable loss on ignition must not exceed 6 percent.

b. If fly ash is used it must range from 15 to 20 percent by weight of cementitious material, provided the fly ash does not reduce the amount of cement in the concrete mix below the minimum requirements of local building codes. Do not use fly ash when it cannot meet the minimum level. Report the chemical analysis of the fly ash in accordance with ASTM C311/C311M. Evaluate and classify fly ash in accordance with ASTM D5759.

2.3.1.4 Slag Cement

ASTM C989/C989M, Grade 120.

2.3.1.5 Other Supplementary Cementitious Materials

Natural pozzolan must be raw or calcined and conform to ASTM C618, Class N, including the optional requirement for uniformity.

Ultra Fine Fly Ash (UFFA) and Ultra Fine Pozzolan (UFP) must conform to ASTM C618, Class F or N, and the following additional requirements:

a. The strength activity index at 28 days of age at least 95 percent of the control specimens.

b. The average particle size not exceed 6 microns.

c. The sum of SiO2 plus Al2O3 plus Fe2O3 greater than 77 percent.

2.3.2 Water

a. Water or ice must comply with the requirements of ASTM C1602/C1602M.

b. Minimize the amount of water in the mix. Improve workability by adjusting the grading of the aggregate and using admixture rather than by adding water.

c. Provide water potable water; free from injurious amounts of oils, acids, alkalis, salts, organic materials, or other substances deleterious to concrete.

d. Protect mixing water and ice from contamination during storage and delivery.

e. Submit test report showing water complies with ASTM C1602/C1602M.

2.3.3 Aggregate

2.3.3.1 Normal-Weight Aggregate

a. Conform to ASTM C33/C33M.

b. Obtain aggregates used in concrete from the same sources and have the same size range as aggregates used in concrete represented by submitted field test records or used in trial mixtures.

c. Provide sand that is at least 50 percent natural sand.

d. Store and handle aggregate in a manner that will avoid segregation and prevents contamination by other materials or other sizes of aggregates. Store aggregates in locations that will permit them to drain freely. Do not use aggregates that contain frozen lumps.

e. Submit types, pit or quarry locations, producers' names, aggregate supplier statement of compliance with ASTM C33/C33M, and ASTM C1293 expansion data not more than 18 months old.

2.3.3.2 Recycled Aggregate Materials

Use a minimum of 25 percent recycled aggregate, depending on local availability and conforming to requirements of the mix design. Recycled aggregate to include: recovered glass recovered concrete recovered porcelain recovered stone that meets the aggregate requirements specified. Submit recycled material request with the aggregate certification submittals and do not use until approved by the Contracting Officer.

2.3.4 Admixtures

a. Chemical admixtures must conform to ASTM C494/C494M.

b. Air-entraining admixtures must conform to ASTM C260/C260M.

c. Do not use calcium chloride admixtures.

d. Use a corrosion-inhibiting admixture for all concrete, except ductbanks and sidewalks.

e. Viscosity modifying admixtures (VMA) must conform to ASTM C494/C494M, Type S.

f. Crystalline Waterproofing Admixture: Hydrophilic crystalline concrete admixture to provide permanently waterproof concrete. The admixture reacts chemically with water and un-hydrated cement particles to form insoluble microscopic needle-shaped crystals that fill capillary pores and self-seal micro-cracks in the concrete and block the pathways for water and waterborne contaminants. Include in all concrete for secondary containment structures (pits and vaults).

g. Admixtures used in concrete must be the same as those used in the concrete represented by submitted field test records or used in trial mixtures.

h. Protect stored admixtures against contamination, evaporation, or damage.

i. To ensure uniform distribution of constituents, provide agitating equipment for admixtures used in the form of suspensions or unstable solutions. Protect liquid admixtures from freezing and from temperature changes that would adversely affect their characteristics.

j. Submit types, brand names, producers' names, manufacturer's technical data sheets, and certificates showing compliance with standards required herein.

2.4 MISCELLANEOUS MATERIALS

2.4.1 Concrete Curing Materials

Provide concrete curing material in accordance with ACI 301 Section 5 and ACI SPEC 308.1 Section 2. Submit product data for concrete curing compound
s. Submit manufactures instructions for placement of curing compound.

2.4.2 Nonshrink Grout

Nonmetallic, nonshrink grout in accordance with ASTM C1107/C1107M with

minimum compressive strength of 6,000 psi at 28 days.

2.4.3 Floor Finish Materials

2.4.3.1 Liquid Chemical Floor Hardeners and Sealers

a. Hardener must be a colorless aqueous solution containing a blend of inorganic silicate or siliconate material and proprietary components combined with a wetting agent; that penetrates, hardens, and densifies concrete surfaces. Submit manufactures instructions for placement of liquid chemical floor hardener.

b. Use concrete penetrating sealers with a low (maximum 100 grams/liter, less water and less exempt compounds) VOC content. Submit manufactures instructions for placement of sealers.

2.4.4 Expansion/Contraction Joint Filler

ASTM D1751 or ASTM D1752 Type I or Type II. Provide material 1/2 inch thick, unless otherwise indicated. Use only ASTM D1752 Type II cork material in the areas with possible exposure to fuel.

2.4.5 Joint Sealants

Submit manufacturer's product data, indicating VOC content.

2.4.5.1 Horizontal Surfaces, 3 Percent Slope, Maximum

ASTM D6690 or ASTM C920, Type M, Class 25, Use T. Fuel resistant for surfaces subjected to exposure to fuel.

2.4.5.2 Vertical Surfaces Greater Than 3 Percent Slope

ASTM C920, Type M, Grade NS, Class 25, Use T or NT. FS SS-S-200, no sag, gray color for fuel resistant application.

2.4.5.3 Backer Rod

Provide backer rod material that is a compressible, non-shrinking, non-staining, non-absorbing material, nonreactive with the joint sealant. The material must have a melting point at least 3 degrees C greater than the pouring temperature of the sealant being used when tested in accordance with ASTM D789. The material must have a water absorption of not more than 5 percent of the sample weight when tested in accordance with ASTM C1016. Use material that is 25 plus or minus 5 percent larger in diameter than the nominal width of the crack. Foam material must be closed-cell type.

2.4.5.4 Preformed Polychloroprene Elastomeric Type

ASTM D2628.

2.4.5.5 Lubricant for Preformed Compression Seals

ASTM D2835.

2.4.6 Vapor Retarder

ASTM E1745 Class A B polyethylene sheeting, minimum 15 mil thickness or

other equivalent material with a maximum permeance rating of 0.04 perms per ASTM E96/E96M.

Consider plastic vapor retarders and adhesives with a high recycled content, low toxicity low VOC (Volatile Organic Compounds) levels.

2.5 CONCRETE MIX DESIGN

2.5.1 Properties and Requirements

a. Use materials and material combinations listed in this section and the contract documents.

b. Cementitious material content must be adequate for concrete to satisfy the specified requirements for strength, w/cm, durability, and finishability described in this section and the contract documents.

c. Selected target slump must meet the requirements of this section, the contract documents, and must not exceed 9 in. Concrete must not show visible signs of segregation.

d. Enforce the target slump for the duration of the project. Determine the slump by ASTM C143/C143M. Slump tolerances must meet the requirements of ACI 117.

e. The nominal maximum size of coarse aggregate for a mixture must not exceed three-fourths of the minimum clear spacing between reinforcement, one-fifth of the narrowest dimension between sides of forms, or one-third of the thickness of slabs or toppings.

f. Concrete must be air entrained for members assigned to Exposure Class F1, F2, or F3, with the total air content in accordance with the requirements of the paragraph titled DURABILITY.

g. Measure air content at the point of delivery in accordance with ASTM C173/C173M or ASTM C231/C231M.

h. Concrete for slabs to receive a hard-troweled finish must not contain an air-entraining admixture or have a total air content greater than 3 percent.

i. Concrete properties and requirements for each portion of the structure are specified in the table below. Refer to the paragraph titled DURABILITY for more details on exposure categories and their requirements.

	Minimum *f'c* psi	**Exposure Categories^**	**Miscellaneous Requirements**
Footings, mat slabs and drilled piers	5000 at 28 days	S0 ; C2; W2; F0	Nominal maximum aggregate size must be 1 in. Maximum slump: 8 in, with 2 to 4 in verified slump prior to adding water-reducing or plasticizing admixture

	Minimum $f'c$ psi	Exposure Categories^	Miscellaneous Requirements
Columns, walls, and elevated slabs	5000 at 28 days	S0 ; C2; W2; F0	Nominal maximum aggregate size must be 3/4 in. Maximum slump: 8 in, with 2 to 4 in verified slump prior to adding water-reducing or plasticizing admixture Maximum w/cm: 0.40
Sidewalks, curbs and gutters, electrical ductbanks	3500 at 28 days	S0 ; C1 ; W0 ; F0	Nominal maximum aggregate size must be 1 in. Maximum slump: 8 in, with 2 to 4 in verified slump prior to adding water-reducing or plasticizing admixture Maximum w/cm: 0.50
Unreinforced concrete	2500 at 28 days	S0 ; C1 ; W0 ; F0	Nominal maximum aggregate size must be 1 in Maximum w/cm: 0.60

2.5.2 Durability

2.5.2.1 Alkali-Aggregate Reaction

Do not use any aggregate susceptible to alkali-carbonate reaction (ACR). Use one of the three options below for qualifying concrete mixtures to reduce the potential of alkali-silica reaction (ASR):

a. For each aggregate used in concrete, the expansion result determined in accordance with ASTM C1293 must not exceed 0.04 percent at one year.

b. For each aggregate used in concrete, the expansion result of the aggregate and cementitious materials combination determined in accordance with ASTM C1567 must not exceed 0.10 percent at an age of 16 days.

c. Alkali content in concrete (LBA) must not exceed 4 pounds per cubic yard for moderately reactive aggregate or 3 pounds per cubic yard for highly reactive aggregate. Determine reactivity by testing in accordance with ASTM C1293 and categorize in accordance with ASTM C1778. Alkali content is calculated as follows:
LBA = (cement content, pounds per cubic yard) × (equivalent alkali content of portland cement in percent/100 percent)

2.5.2.2 Freezing and Thawing Resistance

a. Provide concrete meeting the following requirements based on exposure class assigned to members for freezing-and-thawing exposure in

Contract Documents:

Exposure class	Maximum *w/cm*	Minimum *f'c*, psi	Air content	Additional Requirements
F0	N/A	2500	N/A	

2.5.2.3 Corrosion and Chloride Content

a. Provide concrete meeting the requirements of the following table based on the exposure class assigned to members requiring protection against reinforcement corrosion in Contract Documents.

b. Submit documentation verifying compliance with specified requirements.

c. Determine water-soluble chloride ion content contributed from constituents including water, aggregates, cementitious materials, and admixtures for the concrete mixture by ASTM C1218/C1218M at age between 28 and 42 days.

d. The maximum water-soluble chloride ion (Cl-) content in concrete, percent by mass of cement is as follows:

Exposure class	Maximum *w/cm*	Minimum f'c, psi	Maximum water-soluble chloride ion (CL-) content in concrete, percent by mass of cement
Reinforced concrete			
C0	N/A	2500	1.00
C1	N/A	2500	0.30
C2	0.4	5000	0.15

2.5.2.4 Sulfate Resistance

a. Provide concrete meeting the requirements of the following table based on the exposure class assigned to members for sulfate exposure.

Exposure class	Maximum w/cm	Minimum f'c, psi	Required cementitious materials-types			Calcium chloride admixture
			ASTM C150/C150M	ASTM C595/C595M	ASTM C1157/C1157M	
S0	N/A	2500	N/A	N/A	N/A	No restrictions

* For seawater exposure, other types of portland cements with tricalcium aluminate (C3A) contents up to 10 percent are acceptable if the w/cm does not exceed 0.40.

** The amount of the specific source of the pozzolan or slag cement to be used must be at least the amount determined by test or service record to improve sulfate resistance when used in concrete containing Type V cement. Alternatively, the amount of the specific source of the pozzolan or slag used must not be less than the amount tested in accordance with ASTM C1012/C1012M and meeting the requirements maximum expansion requirements listed herein.

*** If Type V cement is used as the sole cementitious material, the

optional sulfate requirement of 0.040 percent maximum expansion in ASTM C150/C150M is required.

^ Other available types of cement, such as Type III or Type I, are acceptable in exposure classes S1 or S2 if the C3A contents are less than 8 or 5 percent, respectively.

b. Alternative combinations of cementitious materials of those listed in this paragraph are acceptable if they meet the maximum expansion requirements listed in the following table:

Exposure class	Maximum expansion when tested using ASTM C1012/C1012M		
	At 6 months	At 12 months	At 18 months
S1	0.10 percent	N/A	N/A
S2	0.05 percent	0.10 percent^	N/A
S3	N/A	N/A	0.10 percent

^The 12-month expansion limit applies only when the measured expansion exceeds the 6-month maximum expansion limit.

2.5.2.5 Concrete Temperature

The temperature of concrete as delivered must not exceed 95 degrees F .

2.5.2.6 Concrete Permeability

a. Provide concrete meeting the requirements of the following table based on exposure class assigned to members requiring low permeability in the Contract Documents.

Exposure class	Maximum *w/cm*	Minimum f'c, psi	Additional minimum requirements
W0	N/A	2500	None
W1	0.5	4000	None
W2	0.50	4000	None

b. Submit documentation verifying compliance with specified requirements.

2.5.3 Trial Mixtures

In accordance with ACI 301.

2.5.4 Ready-Mix Concrete

Provide concrete that meets the requirements of ASTM C94/C94M.

Ready-mixed concrete manufacturer must provide duplicate delivery tickets

with each load of concrete delivered. Provide delivery tickets with the following information in addition to that required by ASTM C94/C94M:

a. Type and brand cement

b. Cement and supplementary cementitious materials content in 94-pound bags per cubic yard of concrete

c. Maximum size of aggregate

d. Amount and brand name of admixtures

e. Total water content expressed by water cementitious material ratio

2.6 REINFORCEMENT

Shop Fabricate reinforcing bars to conform to shapes and dimensions indicated for reinforcement, and as follows:

a. Bend reinforcement cold. Reinforcement must be bent cold in the shop to shapes as indicated. Rebending of a reinforcing bar that has been bent incorrectly is not permitted. Bending must be in accordance with the standard approved practice and by approved machine methods. Provide hooks and bends that are in accordance with the Contract Documents. Fabricate reinforcement in accordance with fabricating tolerances of ACI 117.

b. Submit manufacturer's certified test report for reinforcement.

c. Submit placing drawings showing fabrication dimensions and placement locations of reinforcement and reinforcement supports. Indicate locations of splices, lengths of lap splices, and details of mechanical and welded splices.

d. Submit request with locations and details of splices not indicated in Contract Documents.

e. Submit request to place column dowels without using templates.

f. Submit request for field cutting, including location and type of bar to be cut and reason field cutting is required.

Deliver reinforcing bars bundled, tagged, and marked. Tags must be metal with bar size, length, mark, and other information pressed in by machine. Marks must correspond with those used on the placing drawings.

2.6.1 Reinforcing Bars

a. Deformed, except spirals, load-transfer dowels, and welded wire reinforcement, which may be plain.

b. ASTM A615/A615M with the bars marked S, Grade 60. Provide reinforcing bars that contain a minimum of 50 percent recycled content. See Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING for cumulative total recycled content requirements.

c. Reinforcing bars may contain post-consumer or post-industrial recycled content.

d. Submit mill certificates for reinforcing bars.

2.6.1.1 Bar Mats

a. Conform to ASTM A184/A184M.

b. If coated bar mats are required, repair damaged coating as required in the paragraph titled GALVANIZED REINFORCING BARS EPOXY-COATED REINFORCING BARS and DUAL-COATED REINFORCING BARS.

2.6.2 Mechanical Reinforcing Bar Connectors

a. Provide 125 percent minimum yield strength of the reinforcement bar.

b. Mechanical splices for galvanized reinforcing bars must be galvanized or coated with dielectric material.

c. Mechanical splices used with epoxy-coated or dual-coated reinforcing bars must be coated with dielectric material.

d. Submit data on mechanical splices demonstrating compliance with this paragraph.

2.6.3 Wire

a. Provide wire reinforcement that contains a minimum of50 percent recycled content.See Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING for cumulative total recycled content requirements. Wire reinforcement may contain post-consumer or post-industrial recycled content. Provide flat sheets of welded wire reinforcement for slabs and toppings.

b. Plain or deformed steel wire must conform to ASTM A1064/A1064M.

c. Stainless steel wire must conform to ASTM A1022/A1022M.

2.6.4 Welded Wire Reinforcement

a. Use welded wire reinforcement specified in Contract Documents and conforming to one or more of the specifications given herein.

b. Plain welded wire reinforcement must conform to ASTM A1064/A1064M, with welded intersections spaced no greater than 12 in. apart in direction of principal reinforcement.

c. Deformed welded wire reinforcement must conform to ASTM A1064/A1064M, with welded intersections spaced no greater than 16 in. apart in direction of principal reinforcement.

d. Zinc-coated (galvanized) welded wire reinforcement must conform to ASTM A1060/A1060M. Repair coating damage incurred during shipment, storage, handling, and placing of zinc-coated (galvanized) welded wire reinforcement in accordance with ASTM A780/A780M. If damaged area exceeds 2 percent of surface area in each linear foot of each wire or welded wire reinforcement, the sheet containing the damaged area must not be used. The 2 percent limit on damaged coating area includes repaired areas damaged before shipment as required by ASTM A1060/A1060M.

2.6.5 Reinforcing Bar Supports

a. Provide reinforcement support types within structure as required by Contract Documents. Conform to CRSI RB4.1. Submit description of reinforcement supports and materials for fastening coated reinforcement if not in conformance with CRSI RB4.1.

b. Do not use precast concrete blocks as bar support or spacers in walls or elevated slabs.

c. Legs of supports in contact with formwork may be hot-dip galvanized, or plastic coated after fabrication, or stainless-steel bar supports.

2.6.6 Dowels for Load Transfer in Floors

Provide greased dowels for load transfer in floors of the type, design, weight, and dimensions indicated. Provide dowel bars that are plain-billet steel conforming to ASTM A615/A615M, Grade 50.

2.6.7 Welding

a. Provide weldable reinforcing bars that conform to ASTM A706/A706M, Grade 60 (420), including Supplement S1.

b. Comply with AWS D1.4/D1.4M unless otherwise specified. Do not tack weld reinforcing bars.

c. Welded assemblies of steel reinforcement produced under factory conditions, such as welded wire reinforcement, bar mats, and deformed bar anchors, are allowed.

PART 3 EXECUTION

3.1 EXAMINATION

a. Do not begin installation until substrates have been properly constructed; verify that substrates are level.

b. If substrate preparation is the responsibility of another installer, notify Contracting Officer of unsatisfactory preparation before processing.

c. Check field dimensions before beginning installation. If dimensions vary too much from design dimensions for proper installation, notify Contracting Officer and wait for instructions before beginning installation.

3.2 PREPARATION

Determine quantity of concrete needed and minimize the production of excess concrete. Designate locations or uses for potential excess concrete before the concrete is poured.

3.2.1 General

a. Surfaces against which concrete is to be placed must be free of debris, loose material, standing water, snow, ice, and other deleterious substances before start of concrete placing.

b. Remove standing water without washing over freshly deposited concrete. Divert flow of water through side drains provided for such purpose.

3.2.2 Subgrade Under Foundations and Footings

a. When subgrade material is semi-porous and dry, sprinkle subgrade surface with water as required to eliminate suction at the time concrete is deposited, or seal subgrade surface by covering surface with specified vapor retarder.

b. When subgrade material is porous, seal subgrade surface by covering surface with specified vapor retarder.

3.2.3 Subgrade Under Slabs on Ground

a. Before construction of slabs on ground, have underground work on pipes and conduits completed and approved.

b. Clean previously constructed subgrade or fill of foreign materials.

c. Finish surface of capillary water barrier under interior slabs on ground must not show deviation in excess of 1/4 inch when tested with a 10-foot straightedge parallel with and at right angles to building lines.

d. Finished surface of subgrade or fill under exterior slabs on ground must not be more than 0.02-foot above or 0.10-foot below elevation indicated.

3.2.4 Edge Forms and Screed Strips for Slabs

a. Set edge forms or bulkheads and intermediate screed strips for slabs to obtain indicated elevations and contours in finished slab surface, strong enough to support vibrating bridge screeds or roller pipe screeds if nature of specified slab finish requires use of such equipment.

b. Align concrete surface to elevation of screed strips by use of strike-off templates or approved compacting-type screeds.

3.2.5 Reinforcement and Other Embedded Items

a. Secure reinforcement, joint materials, and other embedded materials in position, inspected, and approved before start of concrete placing.

b. When concrete is placed, reinforcement must be free of materials deleterious to bond. Reinforcement with rust, mill scale, or a combination of both will be considered satisfactory, provided minimum nominal dimensions, nominal weight, and minimum average height of deformations of a hand-wire-brushed test specimen are not less than applicable ASTM specification requirements.

3.3 FORMS

a. Provide forms, shoring, and scaffolding for concrete placement. Set forms mortar-tight and true to line and grade.

b. Chamfer above grade exposed joints, edges, and external corners of concrete 0.75 inch. Place chamfer strips in corners of formwork to

produce beveled edges on permanently exposed surfaces.

c. Provide formwork with clean-out openings to permit inspection and removal of debris.

d. Inspect formwork and remove foreign material before concrete is placed.

e. At construction joints, lap form-facing materials over the concrete of previous placement. Ensure formwork is placed against hardened concrete so offsets at construction joints conform to specified tolerances.

f. Provide positive means of adjustment (such as wedges or jacks) of shores and struts. Do not make adjustments in formwork after concrete has reached initial setting. Brace formwork to resist lateral deflection and lateral instability.

g. Fasten form wedges in place after final adjustment of forms and before concrete placement.

h. Provide anchoring and bracing to control upward and lateral movement of formwork system.

i. Construct formwork for openings to facilitate removal and to produce opening dimensions as specified and within tolerances.

j. Provide runways for moving equipment. Support runways directly on formwork or structural members. Do not support runways on reinforcement. Loading applied by runways must not exceed capacity of formwork or structural members.

k. Position and support expansion joint materials, waterstops, and other embedded items to prevent displacement. Fill voids in sleeves, inserts, and anchor slots temporarily with removable material to prevent concrete entry into voids.

l. Clean surfaces of formwork and embedded materials of mortar, grout, and foreign materials before concrete placement.

3.3.1 Coating

a. Cover formwork surfaces with an acceptable material that inhibits bond with concrete.

b. If formwork release agent is used, apply to formwork surfaces in accordance with manufacturer's recommendations before placing reinforcement. Remove excess release agent on formwork prior to concrete placement.

c. Do not allow formwork release agent to contact reinforcement or hardened concrete against which fresh concrete is to be placed.

3.3.2 Reuse

a. Reuse forms providing the structural integrity of concrete and the aesthetics of exposed concrete are not compromised.

b. Wood forms must not be clogged with paste and must be capable of absorbing high water-cementitious material ratio paste.

c. Remove leaked mortar from formwork joints before reuse.

3.3.3 Forms for Standard Rough Form Finish

Provide formwork in accordance with ACI 301 Section 5 with a surface finish, SF-1.0, for formed surfaces that are to be concealed by other construction.

3.3.4 Forms for Standard Smooth Form Finish

Provide formwork in accordance with ACI 301 Section 5 with a surface finish, SF-3.0, for formed surfaces that are exposed to view and surfaces to receive dampproof coating.

3.3.5 Form Ties

a. For post-tensioned structures, do not remove formwork supports until stressing records have been accepted by the Contracting Officer.

b. After ends or end fasteners of form ties have been removed, repair tie holes in accordance with ACI 301 Section 5 requirements.

3.3.6 Tolerances for Form Construction

a. Construct formwork so concrete surfaces conform to tolerances in ACI 117.

b. Position and secure sleeves, inserts, anchors, and other embedded items such that embedded items are positioned within ACI 117 tolerances.

c. To maintain specified elevation and thickness within tolerances, install formwork to compensate for deflection and anticipated settlement in formwork during concrete placement. Set formwork and intermediate screed strips for slabs to produce designated elevation, camber, and contour of finished surface before formwork removal. If specified finish requires use of vibrating screeds or roller pipe screeds, ensure that edge forms and screed strips are strong enough to support such equipment.

3.3.7 Removal of Forms and Supports

a. If vertical formed surfaces require finishing, remove forms as soon as removal operations will not damage concrete.

b. Remove top forms on sloping surfaces of concrete as soon as removal will not allow concrete to sag. Perform repairs and finishing operations required. If forms are removed before end of specified curing period, provide curing and protection.

c. Do not damage concrete during removal of vertical formwork for columns, walls, and sides of beams. Perform needed repair and finishing operations required on vertical surfaces. If forms are removed before end of specified curing period, provide curing and protection.

d. Form-facing material and horizontal facing support members may be removed before in-place concrete reaches specified compressive

strength if shores and other supports are designed to allow facing removal without deflection of supported slab or member.

3.3.8 Strength of Concrete Required for Removal of Formwork

If removal of formwork, reshoring, or backshoring is based on concrete reaching a specified in-place strength, mold and field-cure cylinders in accordance with ASTM C31/C31M. Test cylinders in accordance with ASTM C39/C39M. Alternatively, use one or more of the methods listed herein to evaluate in-place concrete strength for formwork removal.

a. Tests of cast-in-place cylinders in accordance with ASTM C873/C873M. This option is limited to slabs with concrete depths from 5 to 12 in.

b. Penetration resistance in accordance with ASTM C803/C803M.

c. Pullout strength in accordance with ASTM C900.

d. Maturity method in accordance with ASTM C1074. Submit maturity method data using project materials and concrete mix proportions used on the project to demonstrate the correlation between maturity and compressive strength of laboratory cured test specimens to the Contracting Officer.

3.4 WATERSTOP INSTALLATION AND SPLICES

a. Provide waterstops in construction joints as indicated.

b. Install formwork to accommodate waterstop materials. Locate waterstops in joints where indicated in Contract Documents. Minimize number of splices in waterstop. Splice waterstops in accordance with manufacturer's written instructions. Install only factory-manufactured premolded mitered corners and intersections. Field splices are only allowed along straight sections and must be made by therman fusion.

c. Install waterstops to form a continuous diaphragm in each joint. Make adequate provisions to support and protect waterstops during progress of work. Protect waterstops protruding from joints from damage.

3.4.1 Fuel Resistant Waterstop

Shop made fittings using a machine specifically designed to mechanically weld the waterstop. Use a portable power saw to miter or straight cut the ends to be joined to ensure good alignment and contact between joined surfaces. Maintain continuity of the characteristic features of the cross section of the waterstop (for example ribs, tabular center axis, and protrusions) across the splice.

Miter cut ends to be joined with sharp knife or shears. The ends must be thermally fused. Install and secure in place prior to concrete placement in accordance to manufacturer's written recommendations.

3.5 PLACING REINFORCEMENT AND MISCELLANEOUS MATERIALS

a. Unless otherwise specified, place reinforcement and miscellaneous materials in accordance to ACI 301. Provide bars, welded wire reinforcement, wire ties, supports, and other devices necessary to install and secure reinforcement.

b. Reinforcement must not have rust, scale, oil, grease, clay, or foreign substances that would reduce the bond. Rusting of reinforcement is a basis of rejection if the effective cross-sectional area or the nominal weight per unit length has been reduced. Remove loose rust prior to placing steel. Tack welding is prohibited.

c. Nonprestressed cast-in-place concrete members must have concrete cover for reinforcement given in the following table:

Concrete Exposure	Member	Reinforcement	Specified cover, in.
Cast against and permanently in contact with ground	All	All	3
Exposed to weather or in contact with ground	All	No. 6 through No. 18 bars	2
		No. 5 bar, W31 or D31 wire, and smaller	2
Not exposed to weather or in contact with ground	Slabs, joists, and walls	No. 14 and No. 18 bars	2
		No. 11 bar and smaller	2
	Beams, columns, pedestals, and tension ties	Primary reinforcement, stirrups, ties, spirals, and hoops	2

3.5.1 General

Provide details of reinforcement that are in accordance with the Contract Documents.

3.5.2 Vapor Retarder

a. Install in accordance with ASTM E1643. Provide beneath the on-grade concrete floor slab. Use the greatest widths and lengths practicable to eliminate joints wherever possible. Lap joints a minimum of 12 inches and tape.

b. Remove torn, punctured, or damaged vapor retarder material and provide with new vapor retarder prior to placing concrete. Concrete placement must not damage vapor retarder material.

3.5.3 Reinforcement Supports

Provide reinforcement support in accordance with CRSI RB4.1 and ACI 301 Section 3 requirements. Do not use precast concrete blocks as bar support or spacers in walls or elevated slabs.

3.5.4 Splicing

As indicated in the Contract Documents. For splices not indicated follow ACI 301. Do not splice at points of maximum stress. Overlap welded wire reinforcement the spacing of the cross wires, plus 2 inches.

3.5.5 Future Bonding

Plug exposed, threaded, mechanical reinforcement bar connectors with a greased bolt. Provide bolt threads that match the connector. Countersink the connector in the concrete. Caulk the depression after the bolt is installed.

3.5.6 Setting Miscellaneous Material

Place and secure anchors and bolts, pipe sleeves, conduits, and other such items in position before concrete placement and support against displacement. Plumb anchor bolts and check location and elevation. Temporarily fill voids in sleeves with readily removable material to prevent the entry of concrete.

3.5.7 Inspection of Reinforcement

Inspect and verify proper reinforcement grade, shape, cross section and condition. Do not use reinforcement with the following defects:

a. Bar lengths, depths, and bends beyond specified fabrication tolerances.

b. Bends or kinks not indicated on drawings or approved shop drawings.

c. Bars with reduced cross section due to rusting or other cause.

3.5.8 Placing Reinforcement

Place reinforcement in accordance with ACI 301.

For slabs on grade (over earth or over capillary water barrier) and for footing reinforcement, support bars or welded wire reinforcement on precast concrete blocks, spaced at intervals required by size of reinforcement, to keep reinforcement the minimum height specified above the underside of slab or footing.

Precast concrete units must be wedge shaped, not larger than 3-1/2 by 3-1/2 inches, and of thickness equal to that indicated for concrete protection of reinforcement. Provide precast units that have cast-in galvanized tie wire hooked for anchorage and blend with concrete surfaces after finishing is completed.

For bars or welded wire fabric not supported direct on earth, supports must be of plastic-coated steel or stainless steel protected bar supports. Do not use precast concrete blocks to support bars or welded wire fabrics in elevated horizontal structures (i.e., slabs, beams, etc.) or vertical

structures (i.e., columns, walls, etc.).

Provide reinforcement that is supported and secured together to prevent displacement by construction loads or by placing of wet concrete, and as follows:

a. Provide supports for reinforcing bars that are sufficient in number and have sufficient strength to carry the reinforcement they support, and in accordance with ACI 301 and CRSI SP0001-31-DL-I. Do not use supports to support runways for concrete conveying equipment and similar construction loads.

b. Equip supports on ground and similar surfaces with sand-plates.

c. Support welded wire reinforcement as required for reinforcing bars.

d. Secure reinforcements to supports by means of tie wire. Provide black, soft iron wire, not less than 16 gage.

e. Accurately place reinforcement, securely tie at intersections, and hold in position during placing of concrete by spacers, chairs, or other approved supports. Point wire-tie ends away from the form. Unless otherwise indicated, numbers, type, and spacing of supports must conform to the Contract Documents.

f. Bending of reinforcing bars partially embedded in concrete is permitted only as specified in the Contract Documents and upon approval from the Contracting Officer.

3.5.9 Spacing of Reinforcing Bars

a. As indicated in the Contract Documents.

b. Reinforcing bars may be relocated to avoid interference with other reinforcement, or with conduit, pipe, or other embedded items. If any reinforcing bar is moved a distance exceeding one bar diameter or specified placing tolerance, resulting rearrangement of reinforcement is subject to preapproval by the Contracting Officer.

3.5.10 Concrete Protection for Reinforcement

In accordance with the Contract Documents.

3.5.11 Welding

In accordance with AWS D1.4/D1.4M.

3.6 BATCHING, MEASURING, MIXING, AND TRANSPORTING CONCRETE

In accordance with ASTM C94/C94M, ACI 301, ACI 302.1R and ACI 304R, except as modified herein. Utilize batching equipment such that the concrete ingredients are consistently measured within the following tolerances: 1 percent for cement and water, 2 percent for aggregate, and 3 percent for admixtures. Furnish mandatory batch ticket information for each load of ready mix concrete.

3.6.1 Measuring

Make measurements at intervals as specified in paragraphs SAMPLING and

TESTING.

3.6.2 Mixing

a. Mix concrete in accordance with ASTM C94/C94M, ACI 301 and ACI 304R.

b. Machine mix concrete. Begin mixing within 30 minutes after the cement has been added to the aggregates. Place concrete within 90 minutes of either addition of mixing water to cement and aggregates or addition of cement to aggregates. If discharge is acceptable after more than 90 minutes the air content, slump, and concrete temperature must be tested and must be within the specified limits. A retarder must be used to facilitate placing and finishing when concrete temperature is 85 degrees F or greater.

c. If the entrained air content falls below the specified limit, add a sufficient quantity of admixture, within the manufacturer's recommended dosage, to bring the entrained air content within the specified limits. Dissolve admixtures in the mixing water and mix in the drum to uniformly distribute the admixture throughout the batch. Do not reconstitute concrete that has begun to solidify.

3.6.3 Transporting

Transport concrete from the mixer to the forms as rapidly as practicable. Prevent segregation or loss of ingredients. Clean transporting equipment thoroughly before each batch. Do not use aluminum pipe or chutes. Remove concrete which has segregated in transporting and dispose of as directed.

3.7 PLACING CONCRETE

Place concrete in accordance with ACI 301 Section 5. Place concrete within 15 minutes of discharge into non-agitating equipment.

3.7.1 Footing Placement

Concrete for footings may be placed in excavations without forms upon inspection and approval by the Contracting Officer. Excavation width must be a minimum of 4 inches greater than indicated.

3.7.2 Pumping

ACI 304R and ACI 304.2R. Pumping must not result in separation or loss of materials nor cause interruptions sufficient to permit loss of plasticity between successive increments. Loss of slump in pumping equipment must not exceed 2 inches at discharge/placement. Do not convey concrete through pipe made of aluminum or aluminum alloy. Avoid rapid changes in pipe sizes. Limit maximum size of course aggregate to 33 percent of the diameter of the pipe. Limit maximum size of well-rounded aggregate to 40 percent of the pipe diameter. Take samples for testing at both the point of delivery to the pump and at the discharge end.

3.7.3 Hot Weather

Meet the requirements of ACI 305.1 unless otherwise specified. Maintain required concrete temperature using Figure 4.2 in ACI 305R to prevent the evaporation rate from exceeding 0.2 pound of water per square foot of exposed concrete per hour. Cool ingredients before mixing or use other suitable means to control concrete temperature and prevent rapid drying of

newly placed concrete. Shade the fresh concrete as soon as possible after placing. Start curing when the surface of the fresh concrete is sufficiently hard to permit curing without damage. Provide water hoses, pipes, spraying equipment, and water hauling equipment, where job site is remote to water source, to maintain a moist concrete surface throughout the curing period. Provide burlap cover or other suitable, permeable material with fog spray or continuous wetting of the concrete when weather conditions prevent the use of either liquid membrane curing compound or impervious sheets. For vertical surfaces, protect forms from direct sunlight and add water to top of structure once concrete is set.

3.7.4 Bonding

Roughen and clean surfaces of set concrete at joints of laitance, coatings, loose particles, and foreign matter. Roughen surfaces in a manner that exposes the aggregate uniformly and does not leave laitance, loosened particles of aggregate, nor damaged concrete at the surface.

Use bonding agent is required, obtain bonding of fresh concrete that has set as follows:

a. At joints between footings and walls or columns, between walls or columns and the beams or slabs they support, and elsewhere unless otherwise specified; dampen but do not saturate roughened and cleaned surface of set concrete immediately prior to placing fresh concrete.

b. At joints in exposed-to-view work; at vertical joints in walls; at joints near midpoint of span in girders, beams, supported slabs, other structural members; in work designed to contain liquids; dampen but do not saturate the roughened and cleaned surface of set concrete and cover with a cement grout coating.

c. Provide cement grout that consists of equal parts of portland cement and fine aggregate by weight with not more than 6 gallons of water per sack of cement. Apply cement grout with a stiff broom or brush to a minimum thickness of 1/16 inch. Deposit fresh concrete before cement grout has attained its initial set.

3.8 WASTE MANAGEMENT

Provide as specified in the Waste Management Plan and as follows.

3.8.1 Mixing Equipment

Before concrete pours, designate on-site area to be paved later in project for cleaning out concrete mixing trucks. Minimize water used to wash equipment.

3.8.2 Hardened, Cured Waste Concrete

Crush and reuse hardened, cured waste concrete as fill or as a base course for pavement. Use hardened, cured waste concrete as aggregate in concrete mix if approved by Contracting Officer.

3.8.3 Reinforcing Steel

Collect reinforcing steel and place in designated area for recycling.

3.8.4 Other Waste

Identify concrete manufacturer's or supplier's policy for collection or return of construction waste, unused material, deconstruction waste, and/or packaging material. Return excess cement to supplier. Institute deconstruction and construction waste separation and recycling for use in manufacturer's programs. When such a program is not available, seek local recyclers to reclaim the materials.

3.9 SURFACE FINISHES EXCEPT FLOOR, SLAB, AND PAVEMENT FINISHES

3.9.1 Defects

Repair surface defects in accordance with ACI 301 Section 5.

3.9.2 Not Against Forms (Top of Walls)

Finish surfaces not otherwise specified with wood floats to even surfaces. Match adjacent finishes.

3.9.3 Formed Surfaces

3.9.3.1 Tolerances

Tolerances in accordance with ACI 117 and as indicated.

3.9.3.2 As-Cast Rough Form

Provide for surfaces not exposed to public view or surface not to receive dampproof coating a surface finish SF-1.0. Patch holes and defects in accordance with ACI 301.

3.9.3.3 Standard Smooth Finish

Provide for surfaces exposed to public view or surface not to receive dampproof coating a surface finish SF-3.0. Patch holes and defects in accordance with ACI 301.

3.10 FLOOR, SLAB, AND PAVEMENT FINISHES AND MISCELLANEOUS CONSTRUCTION

In accordance with ACI 301 and ACI 302.1R, unless otherwise specified. Slope floors uniformly to drains where drains are provided. Where straightedge measurements are specified, provide straightedge.

3.10.1 Finish

Place, consolidate, and immediately strike off concrete to obtain proper contour, grade, and elevation before bleedwater appears. Permit concrete to attain a set sufficient for floating and supporting the weight of the finisher and equipment. If bleedwater is present prior to floating the surface, drag the excess water off or remove by absorption with porous materials. Do not use dry cement to absorb bleedwater. Do no use grate tampers ("jitterbugs").

3.10.1.1 Scratched

Use for surfaces intended to receive bonded applied cementitious applications. Finish concrete in accordance with ACI 301 Section 5 for a scratched finish.

3.10.1.2 Floated

Use for exterior slabs where not otherwise specified. Finish concrete in accordance with ACI 301 Section 5 for a floated finish.

3.10.1.3 Steel Troweled

Use for floors intended as walking surfaces. Finish concrete in accordance with ACI 301 Section 5 for a steel troweled finish.

3.10.1.4 Broomed

Use on surfaces of exterior walks, platforms, patios, and ramps, unless otherwise indicated. Finish concrete in accordance with ACI 301 Section 5 for a broomed finish.

3.10.1.5 Pavement

Screed the concrete with a template advanced with a combined longitudinal and crosswise motion. Maintain a slight surplus of concrete ahead of the template. After screeding, float the concrete longitudinally. Use a straightedge to check slope and flatness; correct and refloat as necessary. Obtain final finish by belting. Lay belt flat on the concrete surface and advance with a sawing motion; continue until a uniform but gritty nonslip surface is obtained. Round edges and joints with an edger having a radius of 1/8 inch.

3.10.1.6 Chemical-Hardener Treatment

Apply liquid-chemical floor hardener where indicated after curing and drying concrete surface. Dilute liquid hardener with water and apply in three coats. Apply first coat at one-third strength, second coat one-half strength, and third coat two-thirds strength. Apply each coat evenly and allow to dry 24 hours between coats.

Apply approved proprietary chemical hardeners in accordance with manufacturer's printed directions.

3.10.2 Concrete Walks

Provide 4 inches thick minimum. Provide contraction joints spaced every 5 linear feet unless otherwise indicated. Cut contraction joints 1 inch deep, or one fourth the slab thickness whichever is deeper, with a jointing tool after the surface has been finished. Provide 0.5 inch thick transverse expansion joints at changes in direction where sidewalk abuts curb, steps, rigid pavement, or other similar structures; space expansion joints every 50 feet maximum. Give walks a broomed finish. Unless indicated otherwise, provide a transverse slope of 1/48. Limit variation in cross section to 1/4 inch in 5 feet.

3.10.3 Pits and Trenches

Place bottoms and walls monolithically or provide waterstops and keys.

3.10.4 Curbs

Provide contraction joints spaced every 10 feet maximum unless otherwise indicated. Cut contraction joints 3/4 inch deep with a jointing tool

after the surface has been finished. Provide expansion joints 1/2 inch thick and spaced every 100 feet maximum unless otherwise indicated. Perform pavement finish.

3.10.5 Splash Blocks

Provide at outlets of downspouts emptying at grade. Splash blocks may be precast concrete, 24 inches long, 12 inches wide and 4 inches thick, unless otherwise indicated, with smooth-finished countersunk dishes sloped to drain away from the building.

3.11 JOINTS

3.11.1 Construction Joints

Make and locate joints not indicated so as not to impair strength and appearance of the structure, as approved. Make joints perpendicular to main reinforcement. Continue and develop reinforcement across construction joints. Locate construction joints as follows:

3.11.1.1 Construction Joints for Constructability Purposes

a. In walls, at top of footing; at top of slabs on ground; at top and bottom of door and window openings or where required to conform to architectural details; and at underside of deepest beam or girder framing into wall.

b. In columns or piers, at top of footing; at top of slabs on ground; and at underside of deepest beam or girder framing into column or pier.

c. Near midpoint of spans for supported slabs, beams, and girders unless a beam intersects a girder at the center, in which case construction joints in girder must offset a distance equal to twice the width of the beam. Make transfer of shear through construction joint by use of inclined reinforcement.

Provide keyways at least 1-1/2-inches deep in construction joints in walls and slabs and between walls and footings; approved bulkheads may be used for slabs.

3.11.2 Isolation Joints in Slabs on Ground

a. Provide joints at points of contact between slabs on ground and vertical surfaces, such as column pedestals, foundation walls, grade beams, and elsewhere as indicated.

b. Fill joints with premolded joint filler strips 1/2 inch thick, extending full slab depth. Install filler strips at proper level below finish floor elevation with a slightly tapered, dress-and-oiled wood strip temporarily secured to top of filler strip to form a groove not less than 3/4 inch in depth where joint is sealed with sealing compound and not less than 1/4 inch in depth where joint sealing is not required. Remove wood strip after concrete has set. Clean groove of foreign matter and loose particles after surface has dried.

3.11.3 Contraction Joints in Slabs on Ground

a. Provide joints to form panels as indicated.

b. Under and on exact line of each control joint, cut 50 percent of welded wire reinforcement before placing concrete.

c. Sawcut contraction joints into slab on ground in accordance with ACI 301 Section 5.

3.11.4 Sealing Joints in Slabs on Ground

a. Seal contraction and control joints which are to receive finish flooring material with joint sealing compound after concrete curing period. Slightly underfill groove with joint sealing compound to prevent extrusion of compound. Remove excess material as soon after sealing as possible.

b. Leave sealed groove ready to receive filling material that is provided as part of finish floor covering work.

3.12 CURING AND PROTECTION

Curing and protection in accordance with ACI 301 Section 5, unless otherwise specified. Begin curing immediately following form removal. Avoid damage to concrete from vibration created by blasting, pile driving, movement of equipment in the vicinity, disturbance of formwork or protruding reinforcement, and any other activity resulting in ground vibrations. Protect concrete from injurious action by sun, rain, flowing water, frost, mechanical injury, tire marks, and oil stains. Do not allow concrete to dry out from time of placement until the expiration of the specified curing period. Do not use membrane-forming compound on surfaces where appearance would be objectionable, on any surface to be painted, where coverings are to be bonded to the concrete, or on concrete to which other concrete is to be bonded. If forms are removed prior to the expiration of the curing period, provide another curing procedure specified herein for the remaining portion of the curing period. Provide moist curing for those areas receiving liquid chemical sealer, hardener, or epoxy coating. Allow curing compound/sealer installations to cure prior to the installation of materials that adsorb VOCs.

3.12.1 Curing Periods

ACI 301 Section 5, except 10 days for vault bottom slab, vault walls, retaining walls, or pavement. Begin curing immediately after placement. Protect concrete from premature drying, excessively hot temperatures, and mechanical injury; and maintain minimal moisture loss at a relatively constant temperature for the period necessary for hydration of the cement and hardening of the concrete. The materials and methods of curing are subject to approval by the Contracting Officer.

3.12.2 Curing Formed Surfaces

Accomplish curing of formed surfaces, including undersurfaces of girders, beams, supported slabs, and other similar surfaces by moist curing with forms in place for full curing period or until forms are removed. If forms are removed before end of curing period, accomplish final curing of formed surfaces by any of the curing methods specified above, as applicable.

3.12.3 Curing Unformed Surfaces

a. Accomplish initial curing of unformed surfaces, such as monolithic

slabs, floor topping, and other flat surfaces, by membrane curing.

b. Accomplish final curing of unformed surfaces by any of curing methods specified, as applicable.

c. Accomplish final curing of concrete surfaces to receive liquid floor hardener of finish flooring by moisture-retaining cover curing.

3.12.4 Temperature of Concrete During Curing

When temperature of atmosphere is 41 degrees F and below, maintain temperature of concrete at not less than 55 degrees F throughout concrete curing period or 45 degrees F when the curing period is measured by maturity. When necessary, make arrangements before start of concrete placing for heating, covering, insulation, or housing as required to maintain specified temperature and moisture conditions for concrete during curing period.

When the temperature of atmosphere is 80 degrees F and above or during other climatic conditions which cause too rapid drying of concrete, make arrangements before start of concrete placing for installation of wind breaks, of shading, and for fog spraying, wet sprinkling, or moisture-retaining covering of light color as required to protect concrete during curing period.

Changes in temperature of concrete must be uniform and not exceed 5 degrees F in any one hour nor 49 degrees F in any 24-hour period.

3.12.5 Protection from Mechanical Injury

During curing period, protect concrete from damaging mechanical disturbances, particularly load stresses, heavy shock, and excessive vibration and from damage caused by rain or running water.

3.12.6 Protection After Curing

Protect finished concrete surfaces from damage by construction operations.

3.13 FIELD QUALITY CONTROL

3.13.1 Aggregate Testing

3.13.1.1 Fine Aggregate

At least once during each shift when the concrete plant is operating, there must be one sieve analysis and fineness modulus determination in accordance with ASTM C136/C136M and COE CRD-C 104 for the fine aggregate or for each fine aggregate if it is batched in more than one size or classification. The location at which samples are taken may be selected by the Contractor as the most advantageous for control. However, the Contractor is responsible for delivering fine aggregate to the mixer within specification limits. When the amount passing on any sieve is outside the specification limits, immediately resample and retest the fine aggregate. If there is another failure on any sieve, immediately report the fact to the Contracting Officer, stop concreting, and take immediate steps to correct the grading.

3.13.1.2 Coarse Aggregate

At least once during each shift in which the concrete plant is operating, provide a sieve analysis in accordance with ASTM C136/C136M for each size of coarse aggregate. The location at which samples are taken may be selected by the Contractor as the most advantageous for production control. However, the Contractor is responsible for delivering the aggregate to the mixer within specification limits. A test record of samples of aggregate taken at the same locations must show the results of the current test as well as the average results of the five most recent tests including the current test. The Contractor may adopt limits for control coarser than the specification limits for samples taken other than as delivered to the mixer to allow for degradation during handling. When the amount passing any sieve is outside the specification limits, immediately resample and retest the coarse aggregate. If the second sample fails on any sieve, report that fact to the Contracting Officer. Where two consecutive averages of 5 tests are outside specification limits, the operation will be considered out of control and reported to the Contracting Officer. Stop concreting and take immediate steps to correct the grading.

3.13.2 Concrete Sampling

ASTM C172/C172M. Collect samples of fresh concrete to perform tests specified. ASTM C31/C31M for making test specimens.

3.13.3 Concrete Testing

3.13.3.1 Slump Tests

ASTM C143/C143M. Take concrete samples during concrete placement/discharge. The maximum slump may be increased as specified with the addition of an approved admixture provided that the water-cementitious material ratio is not exceeded. Perform tests at commencement of concrete placement, when test cylinders are made, and for each 20 cubic yards (maximum) of concrete. If the measured slump at point of delivery is greater than specified, a check test will be performed on a new sample from point of delivery. If the check test fails, concrete is considered to have failed to meet the requirements of this specification. If the measured slump is less than specified, adjustments will be permitted in accordance with ASTM C94/C94M. If the test of slump of the adjusted mixture fails, concrete is considered to have failed to meet the requirements of this specification.

3.13.3.2 Temperature Tests

Test the concrete delivered and the concrete in the forms. Perform tests in hot or cold weather conditions (below 50 degrees F and above 80 degrees F) for each batch (minimum) or every 20 cubic yards (maximum) of concrete, until the specified temperature is obtained, and whenever test cylinders and slump tests are made.

3.13.3.3 Compressive Strength Tests

ASTM C39/C39M. Make six 6 inch by 12 inch or nine 4 inch by 8 inch test cylinders for each set of tests in accordance with ASTM C31/C31M, ASTM C172/C172M and applicable requirements of ACI 305R and ACI 306R. Take precautions to prevent evaporation and loss of water from the specimen. Test two 6 inch by 12 inch or three 4 inch by 8 inch cylinders

at 7 days, two 6 inch by 12 inch or three 4 inch by 8 inch cylinders at 28 days, and hold two 6 inch by 12 inch or three 4 inch by 8 inch cylinders in reserve. Take samples for strength tests for each concrete mixture placed each day not less than once a day, nor less than once for each 150 cubic yards of concrete, nor less than once for each 5000 square feet of surface area for slabs or walls. For the entire project, take no less than five sets of samples and perform strength tests for each mix design of concrete placed. Each strength test result must be the average of two 6 inch by 12 inch or three 4 inch by 8 inch cylinders from the same concrete sample tested at 28 days . Concrete compressive tests must meet the requirements of this section, the Contract Document, and ACI 301.

3.13.3.4 Strength of Concrete Structure

The strength of the concrete structure will be considered to be deficient if any of the following conditions are identified:

a. Failure to meet compressive strength tests as evaluated.

b. Reinforcement not conforming to requirements specified.

c. Concrete which differs from required dimensions or location in such a manner as to reduce strength.

d. Concrete curing and protection of concrete against extremes of temperature during curing, not conforming to requirements specified.

e. Concrete subjected to damaging mechanical disturbances, particularly load stresses, heavy shock, and excessive vibration.

f. Poor workmanship likely to result in deficient strength.

Where the strength of the concrete structure is considered deficient submit a mitigation or remediation plan for review and approval by the Contracting Officer.

3.13.3.5 Non-Conforming Materials

Factors that indicate that there are non-conforming materials include (but not limited to) excessive compressive strength, inadequate compressive strength, excessive slump, excessive voids and honeycombing, concrete delivery records that indicate excessive time between mixing and placement, or excessive water was added to the mixture during delivery and placement. Any of these indicators alone are sufficient reason for the Contracting Officer to request additional sampling and testing.

Conduct investigations into non-conforming materials at the Contractor's expense. The Contractor is responsible for the investigation and must make written recommendations to adequately mitigate or remediate the non-conforming material. The Contracting Officer may accept, accept with reduced payment, require mitigation, or require removal and replacement of non-conforming material at no additional cost to the Government.

3.13.3.6 Testing Concrete Structure for Strength

When there is evidence that strength of concrete structure in place does not meet specification requirements or there are non-conforming materials, make cores drilled from hardened concrete for compressive strength determination in accordance with ASTM C42/C42M, and as follows:

a. Take at least three representative cores from each member or area of concrete-in-place that is considered potentially deficient. Location of cores will be determined by the Contracting Officer.

b. Test cores after moisture conditioning in accordance with ASTM C42/C42M if concrete they represent is more than superficially wet under service.

c. Air dry cores, (60 to 80 degrees F with relative humidity less than 60 percent) for 7 days before test and test dry if concrete they represent is dry under service conditions.

d. Strength of cores from each member or area are considered satisfactory if their average compressive strength is equal to or greater than 85 percent of the design compressive strength, and if no single core strength is less than 75 percent of the design compressive strength. Additional testing of cores extracted from locations represented by erratic core strength results will be permitted only when approved by the Contracting Officer.

Fill core holes solid with patching mortar and finished to match adjacent concrete surfaces.

Correct concrete work that is found inadequate by core tests in a manner approved by the Contracting Officer.

3.14 REPAIR, REHABILITATION AND REMOVAL

Before the Contracting Officer accepts the structure, inspect the structure for cracks, damage and substandard concrete placements that may adversely affect the service life of the structure. Prepare a report documenting these defects which includes recommendations for repair, removal or remediation and submit to the Contracting Officer for approval before any corrective work is accomplished.

3.14.1 Crack Repair

Prior to final acceptance, document all cracks in excess of 0.02 inches wide or surface not to receive dampproof coating and repair. Submit the proposed method and materials to repair the cracks to the Contracting Officer for approval. Address the amount of movement expected in the crack due to temperature changes and loading.

3.14.2 Repair of Weak Surfaces

Weak surfaces are defined as mortar-rich, rain-damaged, uncured, or containing exposed voids or deleterious materials. Concrete surfaces with weak surfaces less than 1/4 inch thick must be diamond ground to remove the weak surface. Surfaces containing weak surfaces greater than 1/4 inch thick must be removed and replaced or mitigated in a manner acceptable to the Contracting Officer.

3.14.3 Failure of Quality Assurance Test Results

Proposed mitigation efforts must be approved by the Contracting Officer prior to proceeding.

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SECTION 26 56 20

AIRFIELD AND HELIPORT LIGHTING AND VISUAL NAVIGATION AIDS
02/19

PART 1 GENERAL

1.1 REFERENCES

The publications 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.

ASTM INTERNATIONAL (ASTM)

ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C2	(2023) National Electrical Safety Code

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1; TIA 25-2) National Electrical Code
NFPA 70B	(2023) Recommended Practice for Electrical Equipment Maintenance

U.S. FEDERAL AVIATION ADMINISTRATION (FAA)

FAA AC 70/7460-1	(2016; Rev L; Change 2) Obstruction Marking and Lighting
FAA AC 150/5345-7	(2013; Rev F) Specification for L-824 Underground Electrical Cable for Airport Lighting Circuits
FAA AC 150/5345-26	(2021; Rev E) FAA Specification for L-823 Plug and Receptacle, Cable Connectors
FAA AC 150/5345-42	(2019; Rev J) Specification for Airport Light Bases, Transformer Housings, Junction Boxes and Accessories
FAA AC 150/5345-43	(2019; Rev J) Specification for Obstruction Lighting Equipment
FAA AC 150/5345-44	(2015; Rev K; Errata 2022) Specification for Runway and Taxiway Signs

FAA AC 150/5345-46	(2016; Rev E; Errata 1 2023) Specification for Runway and Taxiway Light Fixtures
FAA AC 150/5345-47	(2005; Rev B) Specification for Series to Series Isolation Transformers for Airport Lighting Systems
FAA AC 150/5345-53	(2012; Rev D) Airport Lighting Equipment Certification Program
FAA E-2519	(1972; Rev A) Types I and II
FAA FO 6850.19	(1978) Frangible Coupling

UL SOLUTIONS (UL)

UL 797	(2007; Reprint Apr 2023) UL Standard for Safety Electrical Metallic Tubing -- Steel
UL Electrical Construction	(2012) Electrical Construction Equipment Directory

1.2 SYSTEM DESCRIPTION

Provide airfield lighting and visual navigation aids as indicated.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Protection plan; G

Training; G

SD-02 Shop Drawings

Lighting and visual navigation aids; G

Composite drawings showing coordination of work of one trade with that of other trades and with structural and architectural elements of the work. Provide sufficient detail to show overall dimensions of related items, clearances, and relative locations of work in allotted spaces. Indicate where conflicts or clearance problems exist between the various trades.

Posted instructions; G

SD-03 Product Data

When equipment or materials are specified to conform to the standards or publications and requirements of AASHTO, ANSI, ASTM, AEIC, ETL, IEEE, IES, NEMA, NFPA, or UL, or to an FAA, FS, or MS, include proof that the items furnished under this section conform to the specified requirements. The label or listing in

UL Electrical Construction or ETL or the manufacturer's certification or published catalog specification data statement that the items comply with applicable specifications, standards, or publications and with the manufacturer's standards will be acceptable evidence of such compliance. Provide manufacturer prepared certificates when the manufacturer's published data or drawings do not indicate conformance with other requirements of these specifications.

Taxiway edge lights; G

Guidance signs; G

Obstruction lighting; G

Light bases, each type; G

Isolation transformers; G

Constant current regulators, each size; G

Frangible couplings; G

Materials and equipment; G

SD-06 Test Reports

Visual inspection; G

Progress testing for series lighting circuits; G

Counterpoise system test and inspection; G

Operating test; G

Distribution conductors, 600-volt class; G

Electrical acceptance tests; G

Low-voltage continuity tests; G

High-voltage insulation resistance tests; G

Constant current regulators, each size; G

SD-07 Certificates

Qualifications of contractor; G

Certified documentation of qualifications, as specified.

Special tools; G

List of special tools and test equipment required for installation, maintenance and testing of the products supplied by the Contractor. Items to be listed include, but are not limited to, the following:

Crimping tool; G

Cable penciler

List of parts; G

A list of parts and components for the system by manufacturer's name, part number, nomenclature, and stock level required for maintenance and repair necessary to ensure continued operation with minimal delays.

SD-08 Manufacturer's Instructions

Posted instructions; G

Submit proposed disgrams, instructions, and other sheets prior to posting.

SD-10 Operation and Maintenance Data

Constant current regulators, Data Package 5; G

Maintenance and repair instructions; G

Instructions necessary to check out, troubleshoot, repair, and replace components of the systems, as specified.

Posted operations and maintenance instructions

Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

SD-11 Closeout Submittals

As-built drawings

1.4 QUALITY CONTROL

1.4.1 Regulatory Requirements

In each standard referred to herein, consider the advisory provisions to be mandatory, as though the word "must" has been substituted for "shall" or "should" wherever it appears. Interpret references in these standards to "authority having jurisdiction," or words of similar meaning, to mean Contracting Officer.

1.4.1.1 Code Compliance

Comply with the requirements and recommendations of NFPA 70 and IEEE C2 and local codes where required.

1.4.2 Standard Products

a. Use only approved equipment listed in FAA AC 150/5345-53 with addendum for the date of delivery the exception of Air Force threshold lights and Army heliport fixture colors and intensities. Inspect wire and cable for date of manufacture. Materials must be certified and listed as FAA AC 150/5345-53D "Approved Airport Lighting Equipment". Do not use wire and cable manufactured more than one year before delivery to job site.

b. Provide materials and equipment listed by FAA, UL, or ETL, when such equipment is listed or approved. Do not use askarel, tetrachlorethylene and insulating liquids containing polychlorinated biphenyls (PCBs) in equipment.

c. Material and equipment must be a standard product of a manufacturer regularly engaged in the manufacture of the product and essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening.

d. Where two or more items of the same class of equipment are required, provide products of a single manufacturer; however, the component parts of the item need not be products of the same manufacturer unless stated in this section.

1.4.3 Qualifications of Contractor

a. Provide documentation that the aviation lighting equipment contractor and installation electricians are experienced in installing, testing and maintaining aviation lighting systems of a similar complexity. Similar complexity, in increasing complexity, are the following: elevated edge lights and signs, in-pavement lights, and approach light systems. Include a list of government projects and 3 years of experience in constructing similar projects. Include written certification that systems have performed satisfactorily for not less than 18 months. Provide a list of airfield lighting schools or seminars attended in the last 5 years.

b. Submit certification containing the names and the qualifications of persons recommended to perform the splicing and termination of medium-voltage cables approved for installation under this contract. Indicate that any person recommended to perform actual splicing and termination has been adequately trained in the proper techniques and has had at least 3 recent years of experience in splicing and terminating the same or similar types of cables approved for installation. Any person recommended by the Contractor may be required to perform a dummy or practice splice and termination, in the presence of the Contracting Officer, before being approved as a qualified installer of medium-voltage power or series lighting cables. If that additional requirement is imposed, provide short sections of the approved types of cables with the approved type of splice and termination kits, and detailed manufacturer's instruction for the proper splicing and termination of the approved cable types.

1.4.4 Protection Plan

Submit detailed procedures to prevent damage to existing facilities or infrastructures. If damage does occur, the procedures must address repair and replacement of damaged property at the Contractor's expense.

1.4.5 Prevention of Corrosion

1.4.5.1 Metallic Materials

Protect metallic materials against corrosion as specified. Do not use aluminum in contact with earth or concrete. Do not use aluminum conductors.

1.4.5.2 Ferrous Metal Hardware

Ferrous metal hardware must be hot-dip galvanized in accordance with ASTM A123/A123M and ASTM A153/A153M.

1.5 DELIVERY, STORAGE, AND HANDLING

The Contractor must deliver, store and secure all airfield lighting materials an equipment in accordance with the manufacturers' requirements.

1.6 PROJECT/SITE CONDITIONS

Items furnished under this section must be specifically suitable for the following unusual service conditions:

1.6.1 Altitude

Any equipment must be suitable for operation up to an altitude of 10,000 feet.

1.6.2 Other

Material or equipment to be installed underground; in handholes, manholes, or underground vaults; or in light bases, must be suitable for submerged operation.

1.6.3 Existing Airfield Lighting Systems

Existing airfield lighting systems must remain in operating condition and interruptions must be held to a minimum. Where interruptions are necessary, they must be scheduled as approved in writing by the Contracting Officer. Prior to the scheduled time for each interruptions, all necessary materials and a sufficient labor force must be assembled to permit completing the work within the scheduled time interval. Under no circumstances must any of the existing airfield lighting circuits be left inoperative without making provisions for suitable temporary connections in the affected area or areas. All airfield lighting circuits covered under this Contract must be replaced in such a manner that they will be operational at dusk each day. The Contractor must submit to the Contracting Officer a plan for outages and maintaining lighting and lighting control.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

Provide airfield lighting and visual navigation aids as indicated on contract drawings.

2.2 TAXIWAY LIGHTING SYSTEMS

Include edge lights, and all associated equipment, power supplies and controls, mounting devices, and interconnecting wiring to provide complete systems. If LED fixtures are used, provide fixtures that are compatible with the associated constant current regulators.

2.2.1 Taxiway Edge Lights

FAA AC 150/5345-46, Type ~~L-852E(L)~~L-852T(L) LED, Class 2 for semiflush

taxiway edge lights with blue filter.

2.3 AIRFIELD GUIDANCE SIGN SYSTEMS

2.3.1 General

Provide guidance signs compatible with all L-828/L-829 regulators.

2.3.2 Photometric Requirements

Guidance signs must meet FAA minimum luminance requirements.

2.3.3 Taxiway Guidance Signs

FAA AC 150/5345-44, Type L-858Y(L) LED for information. Provide signs of the size and with the information indicated. Sign must operate on a multistep 6.6 amp circuit.

2.4 OBSTRUCTION LIGHTING AND MARKING

2.4.1 Obstruction Lights

Mark obstructions on or near the airfield and/or lighted as indicated. Use obstruction marker lights emitting aviation red steady burning light. Use multiple-socket assembly FAA AC 150/5345-43, Type L-810 light fixtures. For multiple flashing lights on a circuit, flash the lights in unison. Use double-unit type obstruction marker lights as indicated. Energize the obstruction lights multiple circuits as indicated.

Do not use LED-based obstruction lights on military facilities.

2.5 LIGHT BASES

FAA AC 150/5345-42 Type L-868 . Use Stainless Steel bases, Class 1B, Size B as indicated or as required to accommodate the fixture or device installed. Provide base plates, cover plates, and adapter plates to accommodate various sizes of fixtures.

Furnish each base with internal and external one-hole ground lugs for attaching ground or counterpoise cables.

Furnish each base with a 4 foot braided, #6 AWG equivalent ground strap with one-hole lug compression fittings. Utilize straps made for the purpose of grounding the light fixture to the base can interior grounding lug.

2.6 ISOLATION TRANSFORMERS

2.6.1 Encapsulated Isolation Transformers

FAA AC 150/5345-47, Type (G) L-830. Provide each transformer with rating as indicated. Insulation Level Primary voltage rating 5000 volts RMS, Secondary 600 V RMS. Operating Temperature range minus 131 degrees F to plus 149 degrees F. Resistant to UV exposure and ozone. Suitable for areas contaminated with oils, aircraft fuels, soil acids, alkalis, and deicing fluids. Compatible with FAA Style 2 and Style 9 connectors.

2.7 MATERIALS AND HARDWARE

2.7.1 Wire and Cable

Use copper conductors installed in conduit. Do not provide or install wire and cable manufactured more than one year before delivery to the job site.

2.7.1.1 Conductor Sizes

Conductor size conforming to American Wire Gage (AWG) or metric trade size. Use stranded conductors for sizes larger #8 AWG. Unless otherwise indicated #8 AWG and smaller may be solid or stranded.

2.7.1.2 Wire and Cable for Series Lighting Circuits

a. FAA AC 150/5345-7, Type L-824 for crosslinked polyethylene Type C5000-volt cable. Use unshielded cable for series airfield and heliport lighting.

2.7.1.3 Cable Tags

Install cable tags for each cable or wire at duct entrances entering or leaving manholes, handholes, and at each terminal within the lighting vault, and in all base cans. Use stainless steel, bronze or copper strip cable tags, approximately 1/16 inch thick or hard plastic 1/8 inch thick suitable for immersion in salt water and impervious to petroleum products. Use sufficient material length for imprinting the legend on one line using raised letters. Permanently mark or stamped with letters not less than 1/4 inch in height as indicated. Two-color laminated plastic is acceptable. When providing plastic tags utilize white colored with markings of black color to provide contrast so that identification can be easily read. Use nylon or stainless steel ties must be of a type that will not deteriorate when exposed to water with a high saline content and to petroleum products.

2.7.1.4 Cable Connectors and Splices

FAA AC 150/5345-26, Item L-823 for connections and splices appropriate for FAA Type L-824 cable.

2.7.2 Conduit, Conduit Fittings, and Boxes

2.7.2.1 Outlet Boxes for use with RMC, EMT, of LFMC

See 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION.

2.7.2.2 Plastic Duct for Concrete Encasement

Provide as specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION.

2.7.2.3 Plastic Conduit for Direct Burial

Provide as specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION.

2.7.2.4 High Density Polyethylene (HDPE) Electrical Conduit for Directional Bore

Provide as specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION.

2.7.2.5 Frangible Couplings and Adapters

FAA FO 6850.19 and FAA E-2519. Provide upper section of frangible coupling with one of the following:

a. Unthreaded for slip-fitter connections.

b. 2-13/32 inch 16N-1A modified thread for nut and compression ring to secure 2 inch EMT.

c. 2 inch 11-1/2-N.P.T. (tapered) with 7/32 inch nominal wall thickness to accept rigid conduit coupling.

d. Frangible Couplings for specialized applications as approved.

e. Electrical Metallic Tubing UL 797, where indicated for use with frangible couplings and adapters.

2.7.3 Electrical Tape

Provide as specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION.

2.7.4 Ground Rods

As specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION.

2.7.5 Bolts and Hardware

2.7.5.1 Locking Type Washers

Use locking washers of the two-piece wedge-lock design to prevent damage to the fixture. Do not use split-ring, serrated or star type lock washers.

2.7.5.2 Anti-Seize Compound

Use anti-seize compounds for elevated light fixtures with stainless steel bolts but not for ceramic-metallic/fluorocarbon polymer coated bolts for in-pavement light fixtures. Use as recommended by the fixture manufacturer to provide the required clamping force except as indicated in Part 3 of this specification.

2.7.5.3 Ceramic-Metallic/Fluorocarbon Polymer Coated Bolts

Ceramic-metallic/fluorocarbon polymer coated bolts must be used for in-pavement light fixtures or may be used where recommended by the fixture manufacturer in lieu of using an anti-seize compound.

2.7.5.4 Stainless Steel Bolts for Elevated Fixtures

Use anti-seize lubricating compound.

2.7.6 Manufacturer's Nameplates

Provide on each item of equipment a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

2.7.7 Field Fabricated Nameplates

Provide field fabricated nameplates as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

2.8 ACCESSORIES

2.8.1 Special Tools

List of special tools and test equipment required for installation, maintenance of testing of the products supplied by the Contractor. Items to be listed include, but are not limited to, the following:

4-Jack Positioning Jig, used to install the light base to ensure correct orientation and leveling of in-pavement fixtures.

Crimping Tool

Cable Penciler

Elevated Light Level

2.9 EXISTING CONTROL SYSTEM

The Contractor must update the display for the existing Airfield Lighting Control System to show new apron and connector taxiways. The existing control system manufacturer is Crouse-Hinds.

PART 3 EXECUTION

3.1 LIGHT FIXTURE INSTALLATION REQUIREMENTS

3.1.1 Existing Airfield Lighting Systems

Existing airfield lighting systems must remain in operating condition and interruptions must be held to a minimum. Where interruptions are necessary, they must be scheduled as approved in writing by the Contracting Officer. Prior to the scheduled time for each interruption, all necessary materials and a sufficient labor force must be assembled to permit completing the work within the scheduled time interval. Under no circumstances must any of the existing airfield lighting circuits be left inoperative without making provisions for suitable temporary connections in the affected area or areas. All airfield lighting circuits covered under this Contract must be replaced in such a manner that they will be operational at dusk each day. The Contractor must submit to the Contracting Officer a plan for outages and maintaining lighting and lighting control.

3.1.2 General Installation Requirements

Conform to IEEE C2, NFPA 70, NFPA 70B, and requirements specified herein. Circuits installed underground must conform to the requirements of Section

33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION, except as required herein. Steel conduits installed underground must be installed and protected from corrosion in conformance with the requirements of Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Electrical metallic tubing (EMT) must not be installed underground or encased in concrete. Except as covered herein, perform excavation, trenching, and backfilling in accordance with the requirements of Section 31 00 00 EARTHWORK and Section 32 11 23.23 BASE COURSE DRAINAGE LAYERS.

3.1.3 Airfield Light Fixture Installation

Use 2-part locking type washers for the installation of all airfield light fixtures. Tighten bolts to washer manufacturers recommended torque based on bolt type used. Use only adjustable torque limiting tools.

Where stainless steel bolts are used for elevated fixture installation use an anti-seize lubricating compound.

Where ceramic-metallic/fluorocarbon polymer coated bolts are used for in-pavement fixture installation do not use anti-seize lubricating compounds.

3.1.4 Light Base Installation

3.1.4.1 Installation in Concrete Bed

Where light base can is partially embedded in concrete with jig or holding devices, leave device in place for minimum 24 hours. Let base can set for an additional 48 hours before remaining concrete is placed to the top of the light base.

3.1.5 In-Pavement Airfield

Remove water, debris, and other foreign substances prior to installing in-pavement light base and light. Use a 4-jack positioning jig, obtained from the L-868 base manufacturer, to install the light base to ensure correct orientation and leveling. The individual setting the jig must fully understand reference marks that are provided by the surveyor. Check azimuth by survey before the concrete anchor is placed and again before paving. Do not place the near light base edge closer than two feet from a planned pavement joint. If conflict occurs, immediately notify the Contracting Officer Representative of the conflict.

3.1.5.1 In-Pavement Light Installation

For in-pavement installations, pavement around the light base must be level with the surrounding pavement; dished or mounded pavement near the light base is not acceptable.

3.1.6 Light Fixture Installation Tolerances

	IN-PAVEMENT	ELEVATED
ELEVATION (relative to finished pavement surface)	+0 inch, -1/16 inch (fixture edge on low side in snow areas or on high side in non-snow areas)	+1/4 inch, -0 inch
AZMUTH (*) (w/respect to line parallel to RW/TW centerline)	+/- 1/2 degree	+/- 1/2 degree
LEVEL	+/- 1/2 degree	+/- 1/2 degree
STATIONING (in line parallel to RW/TW centerline)	+/- 2 inch	+/- 2 inch
OFFSET (perpendicular to RW/TW centerline)	+/- 1/4 inch	+/- 1/4 inch

(*)For omni-directional fixtures the Azimuth does not apply.

3.1.7 Isolation Transformers

Conform to FAA AC 150/5345-26 for transformer lead connections. Plug transformer secondary connectors directly into a mating connector on the transformer secondary leads. During installation, cover mating surfaces of connectors until connected and clean when plugged together. At joint where connectors come together, install heat shrinkable tubing with waterproof sealant or with two half-lapped layers of tape over the entire joint. Joint must prevent entrapment of air which might subsequently loosen the joint.

3.2 CABLES

3.2.1 Cable Installation

In addition to the requirements of Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION, use kit type connectors to splice 5 kV single-conductor series lighting cables. During installation, keep mating surfaces of connectors covered until connected and clean when plugged together. At joint where connectors come together, install heat shrinkable tubing with waterproof sealant. Alternately, provide two half lapped layers of tape over the entire joint. Joint must prevent entrapment of air which might subsequently loosen the joint.

3.2.2 Airfield 5kV Series Lighting Cables

3.2.2.1 Connectors

Use kit type connectors to splice 5 kV single-conductor series lighting cables. During installation and prior to covering with earth, cover mating surfaces of connectors until connected and clean when plugged together. At joint where connectors come together, install heat shrinkable tubing with waterproof sealant with two half-lapped layers of tape over the entire joint. Joint must prevent entrapment of air which might subsequently loosen the joint.

3.2.2.2 Crimping Tool

Use only splice kit manufacturer's crimping tool on splice connectors for all primary and secondary airfield cable splices. Crimping tool must have an embossed die with gauge marks for gauge of cable being used.

3.2.2.3 Cable Penciler

Airfield cable insulation must only be removed using cabling penciler made specifically for airfield cable.

3.2.3 Cable Markers

Provide cable markers or tags for each cable at duct entrances entering or leaving manholes or handholes and at each termination within the lighting vault. Provide not less than two tags per cable in in each manhole or handhole, one near each duct entrance hole. Immediately after cable installation, permanently attached tags to cables and wires so that they cannot be accidentally detached.

3.3 COUNTERPOISE

Install counterpoise above multiple conduits/duct banks for airfield lighting cables, with the intent being to provide a complete cone of protection over the airfield lighting cables. When multiple conduits and/or duct banks for airfield cable are installed in the same trench, the number and location of counterpoise conductors above the conduits must be adequate to provide a cone of protection measured 22 1/2 degrees each side of vertical. Install one continuous length of conductor, except where distance exceeds the length usually supplied. Install the counterpoise approximately 6 inches above single duct lines that are not adjacent to pavement. Where trenches or duct lines intersect, electrically interconnect the counterpoise wires. Connect the counterpoise conductor to a ground rod at every 2,000feet of cable run, at lighting vault(s) (but not to vault equipment), and at feeder connection to light circuit(s). Install the counterpoise conductor in a separate duct under roads, railroads and paved areas, above the highest duct containing electrical or communications circuits.

For in-pavement light fixtures, provide counterpoise ground rods at maximum 2,000 foot spacing.

3.4 SAFETY (EQUIPMENT) GROUNDING SYSTEM

The purpose of the safety ground is to protect personnel from possible contact with an energized light base that may result from a shorted power cable or isolation transformer. Install and connect a #16 AWG conductor

by one of the following methods from base to a ground rod

a. Connect each fixture base to a dedicated ground rod located outside the base on the side opposite the counterpoise.

Connect the safety ground conductor to ground rods by exothermic welding and bolted connections. A safety ground is not required for in-pavement fixture bases where a counterpoise is connected to the exterior ground lug. In all cases connect the light fixture, whether in-pavement or elevated, to the base interior ground lug by means of a braided ground strap specified in paragraph "Light Bases".

3.5 DUCT LINES

Duct lines as required in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION and as indicated. Ducts must be installed in trench for 24 hours before trench is backfilled to allow ducts to reach final ground temperature.

3.6 MARKING AND LIGHTING OF AIRWAY OBSTRUCTIONS

Mark and light all towers, poles, smokestacks, buildings of certain shapes and sizes, and other obstructions in accordance with FAA AC 70/7460-1 and as indicated.

3.6.1 Obstruction Marker Lights

Install obstruction marker lights on radio towers, elevated water tanks, smokestacks, buildings, and similar structures with 1 inch zinc-coated rigid steel conduit stems using standard tees and elbows, except that lowering devices, when required, must be installed in accordance with equipment manufacturer's recommendations.

3.7 APPLICATION

3.7.1 Exothermic Welding

Utilize only personnel who are experienced in and regularly engaged in this type of work to make these connections. Prior to any installations in the field, provide documentation that the welding kits, materials and procedures to be used for welded connections are satisfactory. Comply with the manufacturer's recommendations and the following:

a. Remove all slag from welds.

b. The light fixture base cans should be provided with internal and external one-hole ground lugs that are coated with hot dipped galvanizing, the same as the rest of the base cans. The external ground lug should be bolted to a separate ground lug that is exothermically welded to a #4 AWG stranded bare copper grounding cable. That is connected to a ground rod for Air Force or Army projects or the counterpoise for Navy projects.

c. All direct buried welds must be thoroughly coated 6 mil of 3M "Scotchkote", or approved equivalent, or coated with coal tar bitumastic material to prevent surface exposure to corrosive soil or moisture.

3.7.2 Field Fabricated Nameplate Mounting

Provide number, location, and letter designation of nameplates as indicated. Fasten nameplates to the device with a minimum of two sheet-metal screws or two rivets.

3.7.3 Equipment for Silicone Sealant

Equipment for silicone sealant must be air-powered pump, components, and hoses as recommended by the sealant manufacturer. Hoses and seals must be lined to prevent moisture penetration and withstand pumping pressures. Equipment must be free of contamination from previously used other type sealant.

3.7.4 Concrete

Concrete used in underground structures, such as manholes, handholes, pull boxes and foundations must have minimum 28-day strength of 4000 psi. Similar structures in areas where freeze/thaw conditions are common, must have minimum 28-day strength of 4500 psi. Concrete used for non-structural items, such as equipment pads, must have minimum 28-day strength of 2000 psi.

3.7.5 Grounding

Ground non-current carrying metallic parts associated with electrical equipment as specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION.

3.8 FIELD QUALITY CONTROL

Notify the Contracting Officer five working days prior to each test. Correct all deficiencies and repeat tests. Field test reports must be written, signed and provided as each circuit or installation item is completed. Include resistance-to-ground and resistance between conductors field tests, and continuity measurements for each circuit. For each series circuit measure the input voltage and output current of the constant current regulator at each intensity. For multiple circuits measure the input and output voltage of the transformer for each intensity setting. Provide report documenting the visual inspection of the lights operation markings appearance installed fixtures or units.

3.8.1 Visual Inspection

Inspection reports must be prepared and provided as each stage of installation is completed. Identify the activity by contract number, location, quantity of material placed, and compliance with requirements.

3.8.2 Operating Test

Upon completion of tests, show by demonstration in service that circuits, control equipment, and lights covered by the contract are in good operating condition. Operate each switch in the control tower lighting panels so that each switch position is engaged at least twice. During this process, observe lights and associated equipment to determine that each switch controls properly corresponding circuit. Provide telephone or radio communication between the operator and the observers. Repeat tests from the alternate control station, from the remote control points, and again from the local control switches on the regulators. Test each

lighting circuit by operating the lamps at maximum brightness for not less than 30 minutes. Visually examine at the beginning and at the end of this test to ensure that the correct number of lights are burning at full brightness. Conduct one day and one night operating test for the Contracting Officer.

Provide performance test reports, upon completion and testing of the installed system, in booklet form showing all field tests performed to adjust each component and all field tests performed to provide compliance with the specified performance criteria. For each test, indicate the final position of controls.

3.8.3 Distribution Conductors, 600-Volt Class

Using an instrument which applies a voltage of approximately 500 volts providing a direct reading in resistance, performing testing to verify that no short circuits or accidental grounds exist.

3.8.4 Counterpoise System Test and Inspection

At accessible locations, visually inspect counterpoise system to ensure continuity of counterpoise system. Test continuity of counterpoise system to the vault grounding system in manhole closest to the vault.

3.8.5 Progress Testing for Series Lighting Circuits

Conduct a megger test on each section of circuit or progressive combinations of sections as they are installed. Test each section or progressive combination of sections with a megohmmeter providing a voltage of approximately 1000 volts, a direct reading in resistance. Document all results. Eliminate faults found by these tests, and re-test before proceeding with the circuit installation.

3.8.6 Electrical Acceptance Tests

Perform acceptance tests for series and multiple airfield and heliport lighting circuits only on complete lighting circuits. Each series and multiple lighting circuit must receive a high voltage insulation test. Check that cable insulation resistance to ground is not less than 50 megohms per FAA-C-1391, Installation and Splicing of Underground Cable.

3.8.7 Low-Voltage Continuity Tests

Test each series circuit for electrical continuity. Eliminate faults indicated by this test and perform retest before proceeding with the high-voltage insulation resistance test.

3.8.8 High-Voltage Insulation Resistance Tests

Subject each series lighting circuit to a high-voltage insulation resistance test by measurement of the insulation leakage current with a suitable high-voltage test instrument which has a steady, filtered direct current output voltage and limited current. High-voltage tester must include an accurate voltmeter and microammeter for reading voltage applied to the circuit and resultant insulation leakage current. Do not exceed voltage test values specified below.

a. Test Procedure: Disconnect both leads from regulator output terminals and support so that air gaps of at least 3 inches or as defined by

FAA AC 150/5345-7 Table 1 exists between bare conductors and ground. Clean and dry cable sheaths for a distance of 1 feet from ends of cables and exposed insulation at ends of cables. Connect ends of both conductors of the circuit together and to high-voltage terminals of test equipment, and test voltage applied as specified in the following tabulation between conductors and ground for a period of 5 minutes.

Test Voltage, DC		
	First Test on New Circuits	Test on Existing Circuits
High Intensity Series Lighting Circuits (5,000 volt leads, 500 and 200 watt transformers)	9000	5000
Medium Intensity Series Lighting Circuits (5,000 volt leads, 30/45 watt transformers)	6000	3000
600-Volt Circuits	900	600

When additions are made to existing circuits, test only new sections in accordance with "First Test on New Circuits" in table above. To ensure reliable operation, test complete circuit at reduced voltages indicated above.

b. Leakage Current: Measure and record insulation leakage current for each circuit after a 1 minute application of the test voltage. If leakage current exceeds values specified below, sectionalize the circuit and retest, and repair or replace defective parts. Leakage current limits include allowances for the normal number of connectors and splices for each circuit as follows:

1. Three microamperes for each 1000 feet of cable.

2. Two microamperes for each isolation transformer.

3. If measured value of insulation leakage current exceeds calculated value, sectionalize the circuit and test as specified for each section. Repair or replace defective components until repeated tests indicate an acceptable value of leakage current for the entire circuit.

c. Resistance Values versus Cable Length

An alternate test procedure for circuit validation is to use a megohmeter. Use 5000V test for new circuits and 3000V test for existing circuits. If the minimum resistance values are not achieved then use the leakage current test indicated above.

Circuit Length in Feet Meters	Minimum Resistance to Ground (Megohms)
10,000	50
10,000-20,000	40
>20,000	30

3.9 PHOTOMETRIC TESTING

3.9.1 Constant Current Regulators

3.9.1.1 Visual Examination

Examine each constant current regulator to ensure that porcelain bushings are not cracked, no shipping damage has occurred, internal and external connections are correct, switches and relays operate freely and are not tied or blocked, fuses, if required, are correct, and oil level of oil-filled regulators is correct. Remove relay panel covers only for this examination; it is not necessary to open the main tank of oil-filled regulators. Accomplish the instructions on the plates attached to the regulators. Replace covers tightly after completing examinations and tests.

3.9.1.2 Electrical Tests

Ensure that supply voltage and input tap correspond. With load disconnected, energize regulator and observe the open circuit protector to ensure that it de-energizes the regulator within 3 seconds. After testing circuits for open connections and grounds and after determining that lamps are good and in place, apply circuit load to the regulator and measure the voltage and current simultaneously on brightness taps. Voltmeter and ammeter must have an accuracy of plus or minus one percent. Record readings and make readings during the day and night in order to obtain the average supply voltage. Output current on each brightness tap must be within plus or minus 2 percent of the nameplate values after making necessary correction in the supply voltage. Late model regulators have automatic supply voltage correction in lieu of input taps, and output current does not change as supply voltage varies. When output current on tap 5 deviates from nameplate value by more than 2 percent, and regulator is not overloaded, check internal adjustment as described on regulator instruction plate. Since adjustment may be rather delicate, allow a deviation of up to plus or minus 5 percent on taps 1 through 4 before attempting to readjust the regulator.

3.10 CLOSEOUT ACTIVITIES

3.10.1 Demonstration

After completion of installations and the above tests, circuits, control equipment, and lights covered by the contract must be demonstrated to be in acceptable operating condition. Each switch in the control tower lighting panels must be operated so that each switch position is engaged at least twice. During this process, lights and associated equipment must be observed to determine that each switch properly controls the corresponding circuit. Telephone or radio communication must be provided

between the operator and the observer. Tests must be repeated from the alternate control station, from the remote control points, and again from the local control switches on the regulators. Each lighting circuit must be tested by operating the lamps at maximum brightness for not less than 30 minutes. At the beginning and at the end of this test the correct number of lights must be observed to be burning at full brightness. One day and one night operating test must be conducted for the Contracting Officer.

3.10.2 Training

Submit requirements of training four weeks before training is scheduled to begin. Submit information describing training to be provided, training aids to be used, samples of training materials, and schedules; instructions necessary to checkout, troubleshoot, repair, and replace components of the systems, including integrated electrical and mechanical schematics and diagrams and diagnostic techniques necessary to enable operation and troubleshooting after acceptance of the system.

a. Provide training on the proper operation and maintenance procedures for the system. Submit a list of special tools and test equipment required for maintenance and testing of the products supplied by the Contractor.

b. Submit six copies of operation for the equipment furnished. One complete set must be furnished prior to performance testing and the remainder must be furnished upon acceptance. Operating manuals must detail the step-by-step procedures required for system startup, operation, and shutdown. Operating manuals must include the manufacturer's name, model number, parts list, and brief description of all equipment and their basic operating features.

c. Submit six copies of maintenance manuals listing routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guides. Maintenance manuals must include conduit and equipment layout and simplified wiring and control diagrams of the system as installed.

3.10.3 As-Built Drawings

Submit as-built drawings that provide current factual information including deviations from, and amendments to the drawings and changes in the work, concealed and visible, as instructed. The as-built drawings must show installations with respect to fixed installations not associated with the systems specified herein. Cable and wire must be accurately identified as to direct-burial or in conduit and must locate the connection and routing to and away from bases, housings, and boxes.

3.10.4 Posted Instructions

Submit a typed copy of the proposed posted instructions showing wiring, control diagrams, complete layout and operating instructions explaining preventive maintenance procedures, methods of checking the system for normal safe operation, and procedures for safely starting and stopping the system.

3.11 MAINTENANCE

3.11.1 List of Parts

A list of parts and components for the system by manufacturer's name, part number, nomenclature, and stock level required for maintenance and repair necessary to ensure continued operation with minimal delays.

3.11.2 Maintenance and Repair Instructions

Instructions necessary to check out, troubleshoot, repair, and replace components of the systems, as specified.

3.11.3 Posted Operations and Maintenance Instructions

Submit proposed diagrams, instructions, and other sheets prior to posting.

3.12 SCHEDULES

Refer to Section 01 35 13 SPECIAL PROJECT PROCEDURES for construction outage plan requirements.

-- End of Section --

SECTION 31 00 00

EARTHWORK
08/23

PART 1 GENERAL

1.1 REFERENCES

The publications 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.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO T 180	(2017) Standard Method of Test for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop
AASHTO T 85	(2025) Standard Method of Test for Specific Gravity and Absorption of Course Aggregate
AASHTO T 210	(2025) Standard Method of Test for Aggregate Durability Index

ASTM INTERNATIONAL (ASTM)

ASTM C33/C33M	(2024a) Standard Specification for Concrete Aggregates
ASTM C117	(2023) Standard Test Method for Materials Finer than 75-um (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C136/C136M	(2019) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C144	(2018) Standard Specification for Aggregate for Masonry Mortar
ASTM D1140	(2017) Standard Test Methods for Determining the Amount of Material Finer than 75-µm (No. 200) Sieve in Soils by Washing
ASTM D1557	(2012; E 2015) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3) (2700 kN-m/m3)
ASTM D1883	(2021) Standard Test Method for California Bearing Ratio (CBR) of Laboratory-Compacted Soils
ASTM D2321	(2020) Standard Practice for Underground

	Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications
ASTM D2453	(2015; R 2020; E 2020) Standard Test Method for Shrinkage and Tenacity of Oil- and Resin-Base Caulking Compounds
ASTM D2487	(2017; E 2020) Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D2974	(2020; E 2020) Moisture, Ash, and Organic Matter of Peat and Other Organic Soils
ASTM D3740	(2019) Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction
ASTM D3786/D3786M	(2018; R 2023) Standard Test Method for Bursting Strength of Textile Fabrics—Diaphragm Bursting Strength Tester Method
ASTM D4253	(2016; E 2019) Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table
ASTM D4254	(2016) Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density
ASTM D4318	(2017; E 2018) Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D4533	(2011; R 2023) Trapezoid Tearing Strength of Geotextiles
ASTM D4632/D4632M	(2015a; R2023) Grab Breaking Load and Elongation of Geotextiles
ASTM D4829	(2021) Standard Test Method for Expansion Index of Soils
ASTM D4833/D4833M	(2007; R 2020) Standard Test Method for Index Puncture Resistance of Geomembranes and Related Products
ASTM D6431	(2018) Standard Guide for Using the Direct Current Resistivity Method for Subsurface Site Characterization
ASTM D6938	(2017a) Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

ASTM G57	(2020) Standard Test Method for Measurement of Soil Resistivity Using the Wenner Four-Electrode Method

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1	(2024) Safety and Occupational Health (SOH) Requirements

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

EPA 600/4-79/020	(1983) Methods for Chemical Analysis of Water and Wastes
EPA SW-846.3-3	(1999, Third Edition, Update III-A) Test Methods for Evaluating Solid Waste: Physical/Chemical Methods

1.2 DEFINITIONS

1.2.1 Structural Fill

Soil material placed to support buildings, walls, pads, and other similar facilities.

1.2.2 Embankment Fill

Soil material placed to construct embankment.

1.2.3 Porous Fill

Free-draining material placed for subsurface drainage, as a capillary break, or another specific purpose.

1.2.4 Topsoil

Surface layer of primarily organic soil capable of supporting vegetation growth.

1.2.5 Utility Bedding Material

Fill placed to directly support pipes, conduits, cables, and appurtenant structures. Bedding may also be used to provide a cushion between utilities and bedrock, obstacles, obstructions and other unyielding materials.

1.2.6 Flowable Fill

Fill placed in a plastic or liquid form that flows to near its final placement location with limited assistance and subsequently cures or solidifies to provide a stable or impermeable barrier.

1.2.7 Satisfactory Materials

Satisfactory materials for fill and backfill, and/or any in-situ soils to remain in place comprise any materials classified by ASTM D2487 as GW, GP, GM, GP-GM, GW-GM, SW, SP, SM, SW-SM, and SP-SM. In situ soils defined as CH, CL, MH, ML, CL-ML must be removed in their entirely; however they can be reconditioned and reused in landscape and non-loaded areas only and not

under structures and pavements. Maximum particle size to be no greater than 3 inches in any dimension.

1.2.8 Unsatisfactory Materials

Materials which do not comply with the requirements for satisfactory materials are unsatisfactory. Unsatisfactory materials also include man-made fills; trash; refuse; backfills from previous construction; roots and other organic matter or frozen material. Notify the Contracting Officer when encountering any contaminated materials. Perform testing, for classifying high organic content materials in accordance with ASTM D2974. High organic content material are considered unsatisfactory, except for use as topsoil.

1.2.9 Cohesionless Materials

Cohesionless materials include materials classified in ASTM D2487 as GW, GP, SW, and SP. Materials classified as GM, SM, GP-GM, GW-GM, SP-SM and SW-SM will be identified as cohesionless only when the fines are nonplastic. Perform testing, required for classifying materials, in accordance with ASTM D4318, ASTM C117, ASTM C136/C136M and ASTM D1140.

1.2.10 Cohesive Materials

Cohesive materials include materials classified as GC, SC, ML, CL, MH, and CH. Materials classified as GM, SM, GP-GM, GW-GM, SP-SM and SW-SM will be identified as cohesive only when the fines are plastic. Perform testing, required for classifying materials, in accordance with ASTM D4318, ASTM C117, ASTM C136/C136M and ASTM D1140.

1.2.11 Hard/Unyielding Materials

Hard/Unyielding materials comprise weathered rock, dense consolidated deposits, or conglomerate materials which are not included in the definition of "rock" with stones greater than 3 inch in any dimension or as defined by the pipe manufacturer, whichever is smaller. These materials usually require the use of heavy excavation equipment, ripper teeth, or jack hammers for removal. Boulder size and smaller hard materials are present on the site.

1.2.12 Unstable Material

Unstable materials are too weak to adequately support the utility pipe, conduit, equipment, or appurtenant structure. Satisfactory material may become unstable due to ineffective drainage, dewatering, becoming frozen, excessive loading.

1.2.13 Expansive Soils

Expansive soils are defined as soils that have an expansion index greater than 20 when tested in accordance with ASTM D4829.

1.2.14 Rock

Solid homogeneous interlocking crystalline material with firmly cemented, laminated, or foliated masses or conglomerate deposits, neither of which can be removed without systematic drilling and blasting, drilling and the use of expansion jacks or feather wedges, or the use of backhoe-mounted pneumatic hole punchers or rock breakers; also large boulders, buried

masonry, or concrete other than pavement exceeding 1/2 cubic yard in volume. Removal of hard material will not be considered rock excavation because of intermittent drilling that is performed merely to increase production. Shallow bedrock is expected to be encountered across most of the site, anticipate most excavation will be in rock.

1.2.15 Capillary Water Barrier

A layer of clean, poorly graded crushed rock, stone, or natural or manufactured sand or gravel having a high porosity which is placed beneath a building slab with or without a vapor barrier to cut off the capillary flow of pore water to the area immediately below a slab.

1.2.16 Degree of Compaction (Proctor)

Degree of compaction required, except as noted in the second sentence, is expressed as a percentage of the maximum density obtained by the test procedure presented in ASTM D1557 abbreviated as a percent of laboratory maximum density. Since ASTM D1557 applies only to soils that have 30 percent or less by weight of their particles retained on the 3/4 inch sieve, express the degree of compaction for material having more than 30 percent by weight of their particles retained on the 3/4 inch sieve as a percentage of the maximum density in accordance with AASHTO T 180-21 paragraph 1.5, Note 1.

1.2.17 Degree of Compaction (Relative Density)

Degree of compaction required for soils with less than 5 percent passing the No. 200 sieve, is expressed as a relative percentage of the maximum index density/dry unit weight and minimum index density/dry unit weight, obtained by the test procedures in accordance with ASTM D4253 and ASTM D4254, respectively, abbreviated as a percent of laboratory relative density.

1.2.18 Borrow

Soil brought to the project site from an external location for the purposes of project construction.

1.2.19 Subgrade

Earth materials directly below foundations and directly below granular base materials in building slab and pavement areas including shoulders.

1.2.20 Sand Filter Fill

Soil material placed above geotextile-encapsulated crushed stone for karst feature repairs as shown on the drawings.

1.3 SUBSURFACE DATA

Subsurface soil boring logs are shown in project plans. These data represent available subsurface information; however, variations may exist between boring locations.

1.4 CRITERIA FOR BIDDING

Base bids on the following criteria:

a. Surface elevations are as indicated.

b. Pipes or other artificial obstructions, except those indicated, will not be encountered.

c. Subsurface conditions and ground water elevations indicated by the boring log were those existing at the time subsurface investigations were made and do not necessarily represent subsurface and ground water elevation at the time of construction.

d. Material character is indicated by the boring logs.

e. Hard materials and rock will be encountered as indicated in boring logs.

1.5 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Excavation and Trenching Plan; G

Borrow Plan; G

Dewatering Work Plan; G

Disposition of Surplus Materials; G

Preconstruction Meeting; G

SD-06 Test Reports

Material Test Report; G

Borrow Site Testing; G

Pipe Inspection Report; G

Geotechnical Evaluation Report; G

Subsurface Extents of Karst Features Report; G

Karst Feature Repair Methodology and Hydrogeologic Assessment Report; G

1.6 QUALITY CONTROL

1.6.1 Geotechnical Engineer

Provide a Professional Geotechnical Engineer to provide inspection of excavations and soil/groundwater conditions throughout construction. The Geotechnical Engineer is responsible for performing pre-construction and periodic site visits throughout construction to assess site conditions. The Geotechnical Engineer must visit the site within two weeks of earthwork operations beginning and a minimum of every two months

thereafter or whenever earthwork operations begin in a new area or when subsurface conditions change. The Geotechnical Engineer or their representative is responsible for preparing and updating the Excavation and Trenching Plan and Dewatering Work Plan as construction progresses to reflect changing conditions and submit an updated plan if necessary. Submit a monthly Geotechnical Evaluation report, informing the Contractor and Contracting Officer of the status of the plan and an accounting of the Contractor's adherence to the plan addressing any present or potential problems. The Contractor is responsible for arranging meetings with the Geotechnical Engineer and Contracting Officer throughout the contract duration.

1.6.2 Geotechnical Field Representative

Provide a Geotechnical Field Representative to inspect, monitor, sample, and performing field testing. The Geotechnical Representative qualifications need to have or be a current National Institute for Certification in Engineering Technologies (NICET) Level II minimum certification in Construction Materials Testing Soils and certified by ACI per Section 03 30 00 CAST-IN-PLACE CONCRETE, paragraph FIELD TESTING TECHNICIAN AND TESTING AGENCY; be one of the following; Geologist-in-Training; an Engineer-in-Training; a Registered Geologist; or a Professional Engineer.

The Geotechnical Field Representative must have a minimum of 5 years of experience in site development, mass grading and foundation construction with similar subsurface materials for this Contract. If the Geotechnical Engineer is not able to be on-site to perform their role, the Geotechnical Field Representative can perform the on-site duties of the Geotechnical Engineer provided they are in direct contact with the Geotechnical Engineer while performing these functions. The role of the Geotechnical Field Representative in no way eliminates the requirement of the Geotechnical Engineer to perform site visits as specified in paragraph GEOTECHNICAL ENGINEER. The Geotechnical Field Representative must be present for all earthwork activities when the Geotechnical Engineer is not on site.

1.6.3 Lab Validation

Perform testing by a Corps validated commercial testing laboratory or Contractor established testing laboratory meeting the requirements of Section 01 45 00 (or similar number) entitled QUALITY CONTROL and approved by the Contracting Officer. Submit testing laboratory validation for the testing to be performed. Do not permit work requiring testing until testing facilities have been inspected, Corps validated and approved by the Contracting Officer.

1.6.4 Preconstruction Meeting

Conduct a preconstruction meeting at the jobsite at least five business days prior to the start of earthwork operations on the project. The preconstruction meeting is to be arranged by the Contractor and is to follow the written agenda submitted prior to the meeting. The purpose of this meeting is to review the requirements of this specification and the associated plans. The following individuals must be in attendance at this meeting: Contractor's Project Manager and Project Superintendent, earthwork subcontractor's Project Manager and Site Foreman, Contractor's Geotechnical Engineer and Testing Agency, Government Geotechnical Engineer and Civil Engineer, and Government Construction Manager and Engineering

Technician.

The minutes of this meeting are to be recorded by the Contractor and published via email within 48 hours to all attendees. The minutes must be re-published within 48 hours via email pending any subsequent comments from the attendees.

PART 2 PRODUCTS

2.1 SOIL MATERIALS

2.1.1 Structural Fill

Materials classified as GW, GP, GM, GW-GM, or GP-GM in accordance with ASTM D2487. Select material type appropriate for the intended purpose. Only GW or GP may be used beneath airfield pavements.

2.1.2 Embankment Fill

Materials classified as GW, GP, GM, GC, GW-GM, GW-GC, GP-GM, GP-GC, GC-GM, SW, SP, SM, SW-SM, SC, SW-SC, SP-SM, SP-SC, ML, MH, CL, or CH in accordance with ASTM D2487. Select material type appropriate for the intended purpose. Embankment fill beneath airfield pavements and proposed structures must not include cohesive material such as ML, MH, CL or CH. Only GW or GP may be used beneath airfield pavements. Other fill material utilized outside airfield pavement embankment must have a plasticity index not more than 12 percent and a liquid limit not greater than 35 percent, and containing no more than 25 percent passing a number 200 sieve, but with adequate sand content for dense compaction. Only cohesionless fill may be incorporated into embankments beneath structures.

2.1.3 Porous Fill

Materials containing less than 5 percent passing the No. 200 sieve. Provide the gradation as appropriate for the intended purpose.

2.1.4 Topsoil

Material suitable for topsoil obtained from excavations is defined as: Natural, friable soil representative of productive, well-drained soils in the area, free of subsoil, stumps, rocks larger than one inch diameter, brush, weeds, toxic substances, and other material detrimental to plant growth.

2.1.5 Utility Bedding Material

Except as specified otherwise in the individual piping section, provide bedding for buried piping in accordance with ASTM D2321. Install bedding for plastic piping to spring line of pipe. Utility bedding material may include the following:

Pipe bedding material for exterior coated steel pipe must be clean, sand conforming to ASTM C144 (masonry aggregate) or ASTM C33/C33M (fine concrete aggregate) with not more than 5 percent by weight passing the No. 200 sieve. Resistivity tests for sand backfill must verify the sand has an average wet resistivity greater than 10,000 ohm-cm as determined by ASTM G57.

Sieve	ASTM C33 Percent Passing	ASTM C144 Percent Passing
3/8 inch	100	---
No. 4	95 to 100	100
No. 8	80 to 100	95 to 100
No. 16	50 to 85	70 to 100
No. 30	25 to 60	40 to 75
No. 50	10 to 30	10 to 35
No. 100	2 to 10	2 to 15
No. 200	---	0 to 5

2.1.5.1 Class I

Angular, 0.25 to 1.5 inch, graded stone, including a number of fill materials that have regional significance such as coral, slag, cinders, crushed stone, and crushed shells.

2.1.5.2 Class II

Coarse sands and gravels with maximum particle size of 1.5 inch, 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.

2.1.5.3 Gravel and Crushed Stone

Clean, coarsely graded natural gravel, crushed stone or a combination thereof or having a classification of GW, GP in accordance with ASTM D2487 for bedding. Do not exceed maximum particle size of 3 inches.

2.1.6 Durable Stone

Hard, durable, angular rock that is resistant to weathering and water action and free of organic or other unsuitable materials. Do not use shale, rock with shale seams, or other fissile or fissured rock that may break into smaller pieces in the process of handling and placing. Durable stone must conform to the following:

a. Apparent Specific Gravity, AASHTO T 85: 2.5 min.

b. Absorption, AASHTO T 85: 4.2percent max.

c. Coarse Durability Index, AASHTO T 210: 50 min.

2.1.7 2.1.7 Sand Filter Fill

Sand having particle sizes that range from fine sand to coarse sand, with less than 2 percent fines, and having a classification of SP or SW in accordance with ASTM D2487.

2.2 BURIED WARNING AND IDENTIFICATION MARKERS

Provide 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 inches minimum width, color coded as specified 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. Provide permanent color and printing, 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
Gray	Compressed Air

2.2.1 Warning Tape for Metallic Piping

Provide acid and alkali-resistant polyethylene plastic tape conforming to the width, color, and printing requirements specified above, with a minimum thickness of 0.003 inch and a minimum strength of 1500 psi lengthwise, and 1250 psi crosswise, with a maximum 350 percent elongation.

2.2.2 Detectable Warning Tape for Non-Metallic Piping

Provide polyethylene plastic tape conforming to the width, color, and printing requirements specified above, with a minimum thickness of 0.004 inch, and a minimum strength of 1500 psi lengthwise and 1250 psi crosswise. Manufacture tape with integral wires, foil backing, or other means of enabling detection by a metal detector when tape is buried up to 3 feet deep. Encase metallic element of the tape in a protective jacket or provide with other means of corrosion protection.

2.2.3 Detection Wire for Non-Metallic Piping

Insulate a single strand, solid copper detection wire with a minimum of 12 AWG.

2.3 MATERIAL FOR RIP-RAP

Provide bedding material filter fabric and rock conforming to these requirements for construction indicated.

2.3.1 Bedding Material

Provide bedding material consisting of sand, gravel, or crushed rock, well graded, or poorly graded with a maximum particle size of 2 inches. Compose material of tough, durable particles. Allow fines passing the No. 200 standard sieve with a plasticity index less than 6.

2.3.2 Rock

Provide rock fragments which ensure permanence in the structure and the environment in which it is to be used. Use rock fragments free from cracks, seams, and other defects that would increase the risk of deterioration from natural causes. Provide fragments sized such that no individual fragment exceeds a weight of 150 pounds and that no more than 10 percent of the mixture, by weight, consists of fragments weighing 2 pounds or less each. Provide rock with a minimum specific gravity of 2.50. Do not permit the inclusion of more than trace 1 percent quantities of dirt, sand, clay and rock fines.

2.4 BORROW

Provide borrow materials from sources located within and/or outside of Government property meeting the requirements of paragraph STRUCTURAL FILL, EMBANKMENT, FILL TOPSOIL. Borrow materials must be free of organic content, according to ASTM D2974.

PART 3 EXECUTION

3.1 PROTECTION

Perform all work specified in accordance with applicable requirements of the Corps of Engineers publication EM 385-1-1 Safety and Health Requirements Manual. Provide a Geotechnical Engineer to monitor construction activities and to prepare necessary work plans and reports; see paragraph QUALITY CONTROL.

Use equipment of type and size appropriate for the site conditions (soil character and moisture content). Maintenance of exposed subgrades and fills is the responsibility of the Contractor. The Contractor is required to prevent damage by ineffective drainage, dewatering, and heavy loads and equipment by implementing precautionary measures. Repair or replace any defects or damage.

3.1.1 Underground Utilities

Location of the existing utilities indicated is approximate. Physically verify the location and elevation of the existing utilities indicated prior to starting construction. The Contractor is responsible for protecting utilities from damage during construction.

3.1.2 Drainage and Dewatering

Provide for the collection and disposal of surface and subsurface water encountered during construction.

3.1.2.1 Drainage

Provide for the collection and disposal of surface and subsurface water encountered during construction. Construct storm drainage features

(ponds/basins) at the earliest stages of site development, and throughout construction grade the construction area to provide positive surface water runoff away from the construction activity and/or provide temporary ditches, swales, and other drainage features and equipment as required to keep soils from becoming unstable, prevent erosion, or undermining of foundations. Remove unstable material from working platforms for equipment operation and soil support for subsequent construction features and provide new material as specified herein. It is the responsibility of the Contractor to assess the site conditions to employ necessary measures to permit construction to proceed.

3.1.2.2 Dewatering

Control groundwater flowing toward or into excavations 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 are not allowed within 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. Perform control measures 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, maintain the water level continuously, at least 3 feet below the working level. Submit a Dewatering Work Plan outlining procedures for accomplishing dewatering work.

3.1.3 Shoring and Sheeting

Submit an Excavation and Trenching Plan to stabilize features, prevent undermining or unintended horizontal and vertical movement of adjacent structures, and prevent slippage or movement in banks or slopes adjacent to the excavation. Submit drawings and calculations, certified by a registered professional engineer, describing the methods for shoring and sheeting of excavations. Drawings to include material sizes and types, arrangement of members, and the sequence and method of installation and removal. Calculations are to include data and references used.

3.1.4 Protection of Graded Surfaces

Protect newly backfilled, graded, and topsoiled areas from traffic, erosion, and settlements that may occur. Repair or reestablish damaged grades, elevations, or slopes.

3.2 BORROW

Select borrow material to meet the requirements and conditions of the fill or embankment for which it is to be used. Obtain borrow material selected by the Contractor from approved private sources. Submit a Borrow Plan that includes materials to be excavated, stockpile locations, proposed slopes, drainage, and closure. Unless otherwise provided in the contract, the Contractor is responsible for obtaining 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 from the owners.

3.2.1 Government Furnished Borrow Area(s)

3.2.1.1 Drainage of Borrow Excavations

Provide adequate drainage of borrow area. Ensure that borrow operations result in minimum detrimental effects on natural environmental conditions.

3.2.2 Contractor Furnished Borrow Area(s)

Obtain approved borrow materials from approved offsite sources. If a borrow source is selected that is not a commercial entity from which soil material is directly purchased, submit a Borrow Plan that includes the borrow source location, geotechnical test results showing the fill material meets the Contract requirements, environmental test results in accordance with paragraph ENVIRONMENTAL REQUIREMENTS FOR OFF-SITE SOIL, and any Federal, State, and local permits required for excavation and reclamation of the borrow area.

3.2.3 Environmental Requirements for Off-Site Soil

Test offsite soils brought in for use as backfill for Total Petroleum Hydrocarbons (TPH), Benzene, Toluene, Ethyl Benzene, and Xylene (BTEX) and full Toxicity Characteristic Leaching Procedure (TCLP) including ignitability, corrosivity and reactivity. Backfill may not contain concentrations above appropriate State and EPA criteria, and for hazardous waste characteristics. Determine TPH concentrations by using EPA 600/4-79/020 Method 418.1. Determine BTEX concentrations by using EPA SW-846.3-3 Method 5030/8020/8260B. Perform TCLP in accordance with EPA SW-846.3-3 Method 1311. Perform hazardous waste characteristic tests for ignitability, corrosivity, and reactivity in accordance with accepted standard methods. Perform PCB testing in accordance with accepted standard methods for sampling and analysis of bulk solid samples. Provide borrow site testing for petroleum hydrocarbons and BTEX from a grab sample of material from the area most likely to be contaminated at the borrow site (as indicated by visual or olfactory evidence), with at least one test from each borrow site. Provide borrow site testing for hazardous waste characteristics (TPH, BTEX and TCLP) from a composite sample of material, collected in accordance with standard soil sampling techniques. Do not bring borrow material to project site until Borrow Plan containing environmental test results has been received and approved by the Contracting Officer. Supplier certified or representative testing by the contractor must be supplemented by production sampling prior to delivery to the site for every 150,000 cubic yards delivered.

3.3 SURFACE PREPARATION

3.3.1 Clearing and Grubbing

Clear and grub as specified in Section 31 11 00 CLEARING AND GRUBBING.

Remove trees, stumps, logs, shrubs, brush and vegetation and other items that would interfere with construction operations. Remove stumps entirely. Grub out matted roots and roots over 3 inches in diameter to at least 18 inches below existing surface.

3.3.2 Stripping

Strip site where indicated on the plans. Strip existing surface materials to a depth of 4 inches below the existing ground surface in areas

designated as Clear and Grub on the plans. Strip existing surficial soils to a depth of 4 inches in all other areas. Strip in all areas within the planned limits of disturbance. All stripped materials not suitable for reuse as topsoil will be wasted in specified disposal area. Screen all stripped soils to remove roots and organic materials prior disposal.

3.3.3 Electrical Resistivity Tomography (ERT)

The Contractor must engage a geophysicist or geotechnical engineering firm meeting the requirements of ASTM D3740 that is familiar with ERT testing methods in accordance with ASTM D6431. The firm must provide a project geophysicist, QC geophysicist, and geophysical survey team leader for the project. The QC geophysicist and geophysical team leader must be present during all ERT work. The QC geophysicist must review the ERT tests results produced by the geophysical team leader. The project geophysicist must be present at the beginning of the ERT work to coordinate the areas where ERT work will be done with the Contracting Officer, and to provide general supervision of the ERT work at the start of the project. The project geophysicist must be present on-site as needed and as requested by the Contracting Officer, and must otherwise be available for remote work related to the ERT testing and review of the ERT testing. ERT testing must be performed where shown on the drawings, and in additional areas approved by the Contracting Officer. After site stripping is completed, the exposed area must be evaluated using ASTM D6431 with probe spacing sufficient to evaluate the potential karst features from the ground surface up to 60 feet below the existing subgrade. Perform ERT testing using a 100-ft grid-based pattern. To evaluate the area, individual parallel arrays must have a horizontal spacing no greater than 100 feet, with arrays positioned perpendicular to these and at the same spacing. ERT testing must extend 100-feet beyond the perimeter of the testing areas identified on the drawings, and in additional areas approved by the Contracting Officer. ERT testing in additional areas that are approved by the Contracting Officer must be done for sinkhole throat widths of greater than 6 feet.

GPS coordinates must be provided by the ERT testing firm for all ERT test arrays, with coordinates being provided for the ends of each straight line segment along each individual ERT test array. The locations of each ERT test must be shown on a map of the site plan. The Contractor's hydrogeologist/geotechnical engineer must provide GPS coordinates for the approximate center point of the throat of all encountered sinkholes requiring repair. The Contractor's hydrogeologist/geotechnical engineer must provide GPS coordinates of the perimeter of the sinkhole throat for sinkholes with throat widths greater than 6-feet in width. The QC geophysicist must review the raw data to check for anomalies and errors due to poor electrode contact or environmental noise. For each array, two-dimensional plots of the resistivity with depth along the array must be provided with suspect karst features noted. A report of these ERT test results entitled "Subsurface Extents of Karst Features Report" must must be prepared and submitted to the Contractor's hydrogeologist/geotechnical engineer, and must include the locations, depths, and extents of the karst features and supporting data. A draft report of the ERT data must be provided within 2 days of each day of completed field testing summarizing the results for a single day of testing. A final report of ERT testing must be provided within 7 days of the completion of all testing. For karst features with throat widths greater than 6 feet, the Contractor's hydrogeologist/geotechnical engineer will prepare a Karst Feature Repair Methodology and Hydrogeologic Assessment Report based on the Karst Features Report, and will submit these reports to the Contracting Officer,

DOR, and GEPA for review. The Karst Feature Repair Methodology and Hydrogeologic Assessment Report must include the Zone type as shown on the Karst Features project drawings at the location of the sinkhole, in addition to the locations, depths, extents of the karst features, photographs ans measurements of the encountered sinkhole, means and methods for the repair's construction, and must include a hydrogeologic assessment(s) and report in accordance with GEPA Regulation 22, Div 2, Ch 10, Section 10107, para F. Upon review of the Karst Feature Repair Methodology and Hydrogeologic Assessment Report, a repair method will be issued to the Contractor by the Contracting Officer indicating the backfill requirements. Contractor must not backfill suspect areas without permission of the Contracting Officer. The approximate locations of potential karst features are provided on drawing BB126. Existing ERT data is provided on drawings BB121 to BB125. The data provided on the identified sheets is for informational purposes only.

3.3.4 Proof Rolling

Perform proof rolling on exposed subgrade that is unfrozen and free of surface water (wet conditions resulting from rainfall). Perform proof rolling under the full time observation of the Geotechnical Field Representative. Notify the Contracting Officer a minimum of three days prior to proof rolling. Perform proof rolling in the presence of the Contracting Officer.

After stripping, excavating, and rough grading to the planned elevation, proof roll the existing subgrade of all building, pavement and embankment locations with six passes of a loaded tandem axle dump truck. Operate the truck in a systematic manner to ensure the number of passes over all areas, and at speeds between 2.5 to 3.5 miles per hour. Subgrade materials that exhibit excessive deflection and/or rutting during proof rolling need to be scarified, aerated, and re-compacted to specified density at plus or minus 3 percent of optimum moisture content prior to being considered for remedial action by the Contracting Officer. When proof rolling under buildings, the building subgrade is considered to extend 5 feet beyond the building lines, and make one-half of the passes with the roller in a direction perpendicular to the other passes. A 15 ton pneumatic-tired or smooth drum roller may be used instead of a loaded tandem axle dump truck for proof rolling.

3.3.5 Stockpiling Operations

Place and grade stockpiles of satisfactory as specified. Keep stockpiles in a neat and well drained condition, giving due consideration to drainage at all times. Clear, grub, and seal by rubber-tired equipment, the ground surface at stockpile locations; separately stockpile excavated satisfactory and unsatisfactory materials. Protect stockpiles of satisfactory materials from contamination which may destroy the quality and fitness of the stockpiled material. Do not create stockpiles that could obstruct the flow of any stream, endanger a partly finished structure, impair the efficiency or appearance of any structure, or be detrimental to the completed work in any way. If the Contractor fails to protect the stockpiles, and any material becomes unsatisfactory, remove and replace such material with satisfactory material from approved sources.

3.4 EXCAVATION

Excavate to contours, elevation, and dimensions indicated. Excavate soil disturbed or weakened by Contractor's operations, and soils softened or

made unstable for subsequent construction due to exposure to weather. Use material removed from excavations meeting the specified requirements in the construction of fills, embankments, subgrades, shoulders, bedding (as backfill), and for similar purposes to minimize surplus material and to minimize additional material to brought on site. Do not excavate below indicated depths except to remove unstable material as determined by the Geotechnical Field Representative and confirmed by the Contracting Officer. Remove and replace excavations below the grades shown with appropriate materials as specified.

3.4.1 Ditches, Gutters, and Channel Changes

Finish excavation of ditches, gutters, and channel changes by cutting accurately to the cross sections, grades, and elevations shown. Do not excavate below grades shown. Backfill excessive excavation as directed by the Contracting Officer, with satisfactory, compacted, material or with suitable stone or cobble to grades shown. Dispose excavated material as shown or as directed. Do not allow material to be deposited within 4 feet from edge of a ditch. Maintain excavations free from detrimental quantities of leaves, brush, sticks, trash, and other debris until final acceptance of the work.

3.4.2 Trench Excavation Requirements

Excavate the trench as recommended by the manufacturer of the pipe to be installed. Slope trench walls below the top of the pipe, or make vertical, and of such width as recommended by the manufacturer. Provide vertical trench walls where no manufacturer installation instructions are available. Do not exceed the trench width of 24 inches below the top pipe plus pipe outside diameter (O.D.) for pipes of less than 24 inches inside diameter, and do not exceed 36 inches plus pipe outside diameter for pipe sizes larger than 24 inches inside diameter. Where recommended trench widths are exceeded, provide redesign, stronger pipe, or special installation procedures. The Contractor is responsible for the cost of redesign, stronger pipe, or special installation procedures without any additional cost to the Government.

3.4.2.1 Bottom Preparation

Grade the bottoms of trenches accurately to provide uniform bearing and support for the bottom quadrant of each section of the pipe. Excavate bell holes to the necessary size at each joint or coupling to eliminate point bearing. Remove stones of 3 inch or greater in any dimension, or as recommended by the pipe manufacturer, whichever is smaller, to avoid point bearing.

3.4.2.2 Removal of Unyielding Material

Where unyielding material is encountered in the bottom of the trench, remove such material 4 inch below the required grade and replaced with suitable materials as provided in paragraph FILLING AND COMPACTION.

3.4.2.3 Removal of Unstable Material

Where unstable material is encountered in the bottom of the trench, remove such material to the depth directed and replace it to the proper grade with suitable material as provided in paragraph FILLING AND COMPACTION. When removal of unstable material is required due to the Contractor's fault or neglect in performing the work, the Contractor is responsible for

excavating the resulting material and replacing it without additional cost to the Government.

3.4.2.4 Excavation for Appurtenances

Provide excavation for manholes, catch-basins, inlets, or similar structures sufficient to leave at least 12 inches clear between the outer structure surfaces and the face of the excavation or support members and of sufficient size to permit the placement and removal of forms for the full length and width of structure footings and foundations as shown.

3.4.2.5 Gas Distribution

Excavate trenches to a depth that will provide a minimum 18 inches of cover in rock excavation and a minimum 24 inches of cover in other excavation.

3.4.2.6 Water Lines

Excavate trenches to a depth that provides a minimum cover of 3 feet from the existing ground surface, or from the indicated finished grade, whichever is lower, to the top of the pipe.

3.4.3 Underground Utilities

Perform work adjacent to utilities as indicated. Excavation made with power-driven equipment is not permitted within 2 feet of known utility or subsurface construction. For work immediately adjacent to or for excavations exposing a utility or other buried obstruction, excavate by hand. Start hand excavation on each side of the indicated obstruction and continue until the obstruction is uncovered or until clearance for the new grade is assured. Support uncovered lines or other existing work affected by the contract excavation until approval for backfill is granted by the Contracting Officer. Report damage to utility lines or subsurface construction immediately to the Contracting Officer.

3.4.4 Structural Excavation

Following general excavation and rough grading activities, excavate the entire building footprint area and at least 5 feet beyond, to the deeper of 4 feet below existing grade or 3 feet below bottom of footings. Scarify the exposed surface to a depth of 4 to 6 inches, moisture-condition, and compact to at least 100 percent of laboratory maximum density. For new pavement areas including exterior concrete pads, over-excavate granular soils including GW and GP to a minimum of 12 inches below bottom of new pavement/pad base course, scarify, moisture-condition, and compact to at least 100 percent. For all other soils, excavate a minimum of 36 inches below bottom of new pavement/pad base course, and replace with structural fill, moisture-condition, and compact to at least 100 percent of the laboratory maximum density. Cohesive soils must not be placed beneath structures or pavements.

Make excavations to the lines, grades, and elevations shown, or as directed. Provide trenches and foundation pits of sufficient size to permit the placement and removal of forms for the full length and width of structure footings and foundations as shown. Clean rock or other hard foundation material of loose debris and cut to a firm, level, stepped, or serrated surface. Remove loose disintegrated rock and thin strata.

Footing subgrades must be inspected by the Geotechnical Field Representative prior to placing reinforcement and concrete. Following inspection by the Geotechnical Field Representative, the Contracting Officer must be notified prior to proceeding with Concrete placement.

When intact hard rock is encountered, terminate excavation at the bottom of footing elevation shown on the plans. If the subgrade can be scarified, scarify as described above. Level the excavated rock subgrade with a minimum 1 inch thick lean concrete or sand-cement grout with a minimum 28 day unconfined compressive strength of 1,500 psi. Determine if a mixed soil-rock subgrade condition exists. Pothole a maximum spacing of 50 feet and where a mixed soil and rock subgrade is observed. Excavate soil or weak, broken rock to a depth of 3 feet below subgrade. Replace these areas with structural fill.

3.4.5 Rock Excavation and Blasting

Excavate rock encountered in the cut section to a depth of 6 inches below finished grade and replace with satisfactory material. Blasting will not be permitted.

3.5 SUBGRADE PREPARATION

3.5.1 General Requirements

Shape subgrade to line, grade, and cross section as indicated. Remove unsatisfactory and unstable material in surfaces to receive fill or in excavated areas, as determined by proof rolling, and replaced with satisfactory materials. Do not place material on surfaces that are muddy, or otherwise containing unstable material. Scarify the surface to a depth of 4 inches prior to placing fill. Step or bench sloped surfaces steeper than 1 vertical to 4 horizontal prior to scarifying. Place 4 inches of loose fill and blend with scarified material. When subgrade is part fill and part excavation or natural ground, scarify to a depth of 8 inches. Perform probing and grouting beneath structures as shown on the plans prior to the placement of structural fill. Perform probing and grouting according to Section 31 33 10 FOUNDATION DRILLING AND GROUTING IN ROCK.

3.5.2 Subgrade for Structures, Spread Footings, and Concrete Slabs

Do not excavate below depth shown for structures, spread footings, and concrete slabs. If over excavation occurs, compact disturbed material to at least 100 percent of ASTM D1557. After final rolling, the surface of the subgrade for buildings and pavements must not show deviations greater than 0.05 foot when tested with a 12-foot straightedge applied both parallel and at right angles to the centerline of the area.

3.5.3 Subgrade for Pavements

Compact top 12 inches of subgrade for pavements to at least 100 percent of ASTM D1557. After final rolling, the surface of the subgrade for buildings and pavements must not show deviations greater than 0.05 foot when tested with a 12-foot straightedge applied both parallel and at right angles to the centerline of the area.

3.5.4 Subgrade for Shoulders

Compact the upper 16 inches of subgrade for shoulders to at least 100 percent of ASTM D1557 for the depth below the surface of shoulder shown.

3.5.5 Subgrade for Airfield Pavements

Compact top 12 inches of subgrade, to at least 100 percent of ASTM D1557. After final rolling, the surface of the subgrade for buildings and pavements must not show deviations greater than 0.05 foot when tested with a12-foot straightedge applied both parallel and at right angles to the centerline of the area.

3.6 FILLING AND COMPACTION

Prepare ground surface on which backfill is to be placed and provide compaction requirements for backfill materials in conformance with the applicable portions of paragraphs for SUBGRADE PREPARATION. Do not place material on surfaces that are muddy. Finish compaction by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, or other approved equipment well suited to the soil being compacted. Moisten material as necessary to plus or minus 3 percent of optimum moisture. Fill and backfill to contours, elevations, and dimensions indicated. Compact and test each lift before placing overlaying lift.

3.6.1 Trench Backfill

Backfill trenches to the grade shown. Do not backfill the trench until all specified tests are performed.

3.6.1.1 Replacement of Unyielding Material

Replace unyielding material removed from the bottom of the trench with satisfactory material or initial backfill material.

3.6.1.2 Replacement of Unstable Material

Replace unstable material removed from the bottom of the trench or excavation with satisfactory material placed in layers not exceeding 6 inches loose thickness.

3.6.1.3 Bedding and Initial Backfill

Provide bedding of the type and thickness shown. Place initial backfill material and compact it with approved tampers to a height of at least one foot above the utility pipe or conduit. Bring up the backfill evenly on both sides of the pipe for the full length of the pipe. Take care to ensure thorough compaction of the fill under the haunches of the pipe. Except where shown or when specified otherwise in the individual piping section, provide bedding for buried piping in accordance with PART 2 paragraph UTILITY BEDDING MATERIAL. Compact backfill to top of pipe to 95 percent of ASTM D1557 maximum density. Provide plastic piping with bedding to spring line of pipe.

3.6.1.4 Final Backfill

Do not begin backfill until construction below finish grade has been approved, underground utilities systems have been inspected, tested and approved, forms removed, and the excavation cleaned of trash and debris. Bring backfill to indicated finish grade. Where pipe is coated or wrapped for protection against corrosion, the backfill material up to an elevation 2 feet above sewer lines and one foot above other utility lines need to be free from stones larger than one inch in any dimension. Heavy equipment

for spreading and compacting backfill are not to be operated closer to foundation or retaining walls than a distance equal to the height of backfill above the top of footing; compact remaining area in layers not more than 4 inches in compacted thickness with power-driven hand tampers suitable for the material being compacted. Place backfill carefully around pipes or tanks to avoid damage to coatings, wrappings, or tanks. Do not place backfill against foundation walls prior to 7 days after completion of the walls. As far as practicable, bring backfill up evenly on each side of the wall and sloped to drain away from the wall. Cohesive soils must not be placed beneath structures or pavements.

Fill the remainder of the trench, except for special materials for buildings, airfields and pavements with satisfactory material. Place backfill material and compact as follows:

3.6.1.4.1 Buildings, Airfields and Pavements

Place backfill up to the required elevation as specified. Do not permit water flooding or jetting methods of compaction. Compact as specified for Structural Fill. Subgrade materials placed within 3 feet of the final subgrade elevation below pavements must be tested to confirm that a minimum CBR value of 20 has been achieved in accordance with ASTM D1883.

3.6.1.4.2 Turfed or Seeded Areas and Miscellaneous Areas

Deposit backfill in layers of a maximum of 8 inches loose thickness, and compact it to 90 percent maximum density for cohesive soils and 90 percent maximum density for cohesionless soils. Do not permit compaction by water flooding or jetting. Apply this requirement to all other areas not specifically designated above.

3.6.1.5 Electrical Distribution System

Provide a minimum cover of 24 inches from the finished grade to direct burial cable and conduit or duct line, unless otherwise indicated.

3.6.1.6 Displacement of Features

After other required tests have been performed and the trench backfill compacted to the finished grade surface, inspect the pipe to determine whether unexpected or damaging displacement has occurred. Conduct walk-through inspection of pipe sizes larger than 48 inches. Inspect pipes smaller than 48 inches using remote methods using closed circuit television, sonar, or hybrid that can provide a 360-degree inspection of the pipe. Prepare and submit a pipe inspection report consisting of digital video or photos. If, in the judgment of the Contracting Officer, the interior of the pipe shows poor alignment or any other defects that would cause improper functioning of the system, replace or repair the defects as directed at no additional cost to the Government.

3.6.1.7 Buried Tape And Detection Wire

3.6.1.7.1 Buried Warning and Identification Tape

Provide buried utility lines with utility identification tape. Bury tape 12 inches below finished grade; under pavements and slabs, bury tape 6 inches below top of subgrade.

3.6.1.7.2 Buried Detection Wire

Bury detection wire directly above non-metallic piping at a distance not to exceed 12 inches above the top of pipe. Extend the wire continuously and unbroken, from manhole to manhole. Terminate the ends of the wire inside the manholes at each end of the pipe, with a minimum of 3 feet of wire, coiled, remaining accessible in each manhole. Furnish insulated wire over its entire length. Install wires at 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, terminate the wire in the valve pit at the pump station end of the pipe.

3.6.2 Structural Fill Placement

Place fill and backfill beneath and adjacent to structures in successive horizontal layers of loose material not more than 8 inches in depth, or in loose layers not more than 4 inches in depth when using hand-operated compaction equipment. Do not place over wet materials. Compact to at least 100 percent of laboratory maximum density for cohesionless materials, except as otherwise specified. Perform compaction in such a manner as to prevent wedging action or eccentric loading upon or other damage to the structure. Moisture condition fill and backfill material to within range of plus 2 or minus 2 percent of optimum moisture content at the time of compaction.

3.6.3 Backfill for Appurtenances

After the manhole, catchbasin, inlet, or similar structure has been constructed, place backfill in such a manner that the structure is not be damaged by the shock of falling earth. Deposit the backfill material, compact it as specified for final backfill, and bring up the backfill evenly on all sides of the structure to prevent eccentric loading and excessive stress.

3.6.4 Compaction

3.6.4.1 General Site

Compact underneath areas designated for vegetation and areas outside the 5 foot line of the paved area or structure to at least 85 percent of ASTM D1557.

3.6.4.2 Adjacent Areas

Compact areas within 5 feet of structures to at least 95 percent of ASTM D1557.

3.6.5 Backfill for Karst Repairs

Perform karst mitigation where shown on Karst Features Plan and perform as shown on Karst Features Detail. Zone 2 repairs requiring geotextile placement must meet the following requirements for a Class A Filter Geotextile:

Geotextile Strength Requirements for Drains		
Strength Type	Test Method	Class A
Grab Tensile	ASTM D4632/D4632M	180
Seam	ASTM D4632/D4632M	160
Puncture	ASTM D4833/D4833M	80
Burst	ASTM D3786/D3786M	290
Trapezoid Tear	ASTM D4533	50

3.7 EMBANKMENTS

3.7.1 Earth Embankments

Construct earth embankments from satisfactory materials free of organic or frozen material and rocks with any dimension greater than 3 inches. Place the material in successive horizontal layers of loose material not more than 8 inches in depth. Spread each layer uniformly on a soil surface that has been moistened or aerated as necessary and scarified or otherwise broken up so that the fill will bond with the surface on which it is placed. After spreading, plow, disk, or otherwise break up each layer; moisten or aerate as necessary; thoroughly mix; and compact to at least 100 percent laboratory maximum density for cohesionless materials beneath structures and 95 percent laboratory maximum density for cohesionless materials not beneath structures. Cohesive materials are not permitted under structures or pavements and must only be placed in turf/green and miscellaneous fill areas. The cohesive materials in these areas must be compacted to a minimum of 90 percent of the laboratory Proctor. Backfill and fill material are to be within the range of minus 3 to plus 3 percent of optimum moisture.

Compaction requirements for the upper portion of earth embankments forming subgrade for pavements are identical with those requirements specified in paragraph SUBGRADE PREPARATION. Finish compaction by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, vibratory compactors, or other approved equipment.

3.8 RIP-RAP CONSTRUCTION

Construct rip-rap on bedding material in the areas indicated. Trim and dress indicated areas to conform to cross sections, lines and grades shown within a tolerance of 0.1 foot.

3.8.1 Bedding Placement

Spread bedding material uniformly to a thickness of at least 3 inches on prepared subgrade as indicated.

3.8.2 Stone Placement

Place rock for rip-rap on prepared bedding material to produce a well graded mass with the minimum practicable percentage of voids in

conformance with lines and grades indicated. Distribute larger rock fragments, with dimensions extending the full depth of the rip-rap throughout the entire mass and eliminate "pockets" of small rock fragments. Rearrange individual pieces by mechanical equipment or by hand as necessary to obtain the distribution of fragment sizes specified above.

3.9 FINISHING/FINISH OPERATIONS

During construction, keep embankments and excavations shaped and drained. Maintain ditches and drains along subgrade to drain effectively at all times. Do not disturb the finished subgrade by traffic or other operation. Protect and maintain the finished subgrade in a satisfactory condition until ballast, subbase, base, or pavement is placed. Do not permit the storage or stockpiling of materials on finished subgrade. Do not lay subbase, base course, ballast, or pavement until the subgrade has been checked and approved, and in no case place subbase, base, surfacing, pavement, or ballast on a muddy, spongy, frozen or otherwise unstable subgrade.

Finish the surface of excavations, embankments, and subgrades to a smooth and compact surface in accordance with the lines, grades, and cross sections or elevations shown. Provide the degree of finish for graded areas within 0.1 foot of the grades and elevations indicated except as indicated for subgrades specified in paragraph SUBGRADE PREPARATION. Finish gutters and ditches in a manner that will result in effective drainage. Finish the surface of areas to be turfed to a smoothness suitable for the application of turfing materials. Repair graded, topsoiled, or backfilled areas prior to acceptance of the work, and re-established grades to the required elevations and slopes.

3.9.1 Capillary Water Barrier

Place a capillary water barrier under concrete floor and area-way slabs grade directly on the subgrade and compact with a minimum of two passes of a hand-operated plate-type vibratory compactor.

3.9.2 Grading Around Structures

Construct areas within 5 feet outside of each building and structure line true-to-grade, shape to drain, and maintain free of trash and debris until final inspection has been completed and the work has been accepted.

3.9.3 Grading

Finish grades as indicated within one-tenth of one foot. Grade areas to drain water away from structures. Maintain areas free of trash and debris. For existing grades that will remain but which were disturbed by Contractor's operations, grade as directed.

3.9.4 Topsoil and Seed

Provide as specified in Section 32 92 19 SEEDING.

On areas to receive topsoil, prepare the compacted subgrade soil to a 2 inches depth for bonding of topsoil with subsoil. Spread topsoil evenly to a thickness of 4 inch and grade to the elevations and slopes shown. Do not spread topsoil when frozen or excessively wet or dry. Keep topsoil separate from other excavated materials, brush, litter, objectionable weeds, roots, stones larger than 2 inches in diameter, and other materials

that would interfere with planting and maintenance operations. Remove from the site any surplus of topsoil from excavations and gradings. Obtain material required for topsoil in excess of that produced by excavation within the grading limits from offsite areas.

3.10 DISPOSITION OF SURPLUS MATERIAL

Remove from Government property all surplus or other soil material not required or not suitable for filling or backfilling, along with brush, refuse, stumps, roots, and timber. Properly disposed of in accordance with all applicable laws and regulations. Prepare plan for Disposition of Surplus Materials to include permissions document to dispose of nonsalable products.

3.11 TESTING

Perform testing as indicated in Table 1. Submit Material Test Reports within 24 hours of tests being completed. The material test reports must include a plan showing test identification, elevation, location, coordinates, and a table of the results and action taken for non-conforming items. When test results indicate that compaction is not as specified, the material must be removed, replaced, and recompacted to meet specification requirements. Tests on recompacted areas must be performed to determine conformance with specification requirements.

MATERIAL TESTED	PROCTOR TYPE	MIN PERCENT DRY DENSITY	MOUISTURE CONTENT RANGE	FREQUENCY OF TESTING*
Structural Fill (Granular)	Modified (ASTM D1557)	100 percent	-2 to + 2 percent >95 percent saturated	1 per 1,000 cy of fill placed per ASTM D6938
Random Fill (non-load bearing)	Modified (ASTM D1557)	90 percent	-3 to + 3 percent	1 per 3,000 cy of fill placed per ASTM D6938
Utility Trench Backfill/Wall Backfill	Modified (ASTM D1557)	90 percent	-2 to + 2 percent	1 per 200 cy of fill placed per ASTM D6938

*Minimum of 1 test per lift
A minimum of one density test is required per footing or slab.
Test per ASTM D2453 and ASTM D4254 for relative density for soils with less than 5 percent passing the No. 200 Sieve at the same frequency as shown above per ASTM D6938.

Material	Test Type	Frequency of Test
Embankments beneath structures, fills, backfills, borrow, and subgrade	Modified Proctor (ASTM D1557)	1 per 5,000 CY or material change
	CBR - Field or Laboratory (ASTM D1883)	1 per 5,000 CY or material change
	Gradation (ASTM C136/C136M)	1 per 1,000 CY or material change
	Atterberg Limits (ASTM D4318)	1 per 1,000 CY or material change
	Organic Content (ASTM D2974)	1 representative test per 200 lineal feet of embankment
Native Soil Subgrades other than beneath structures or pavement	Modified Proctor (ASTM D1557)	1 per 10,000 CY or material change
	Gradation (ASTM C136/C136M)	1 per 3,000 CY or material change
	Atterberg Limits (ASTM D4318)	1 per 3,000 CY or material change
	Organic Content (ASTM D2974)	1 representative test per 200 lineal feet of embankment
Utility Trench Backfill	Modified Proctor (ASTM D1557)	1 per 1,000 CY or material change
	Gradation (ASTM C136/C136M)	1 per 500 CY or material change
	Atterberg Limits (ASTM D4318)	1 per 500 CY or material change
	Organic Content (ASTM D2974)	1 representative test per 200 lineal feet of embankment

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SECTION 32 12 16.16

ROAD-MIX ASPHALT PAVING
11/20

PART 1 GENERAL

1.1 PERCENT PAYMENT

1.1.1 Method of Measurement

Measurement of the quantity of hot-mix warm-mix asphalt pavement, per ton placed and accepted, will be made for the purposes of assessing the pay factors stipulated below.

1.1.2 Basis of Payment

The measured quantity of hot-mixed warm-mixed asphalt pavement will be paid for and included in the lump sum contract price. If less than 100 percent payment is due based on the pay factors stipulated in paragraph PERCENT PAYMENT, a unit price of $915.00 per ton will be used for purposes of calculating the payment reduction.

1.1.3 Lot Pay Factor

The lot pay factor is determined by taking the lowest computed pay factor based on either laboratory air voids, in-place density, smoothness, or grade (each discussed below). Remove and replace lots when the lowest computed pay factor requires rejection. At the end of the project calculate the average pay factor for all lots. If this average lot pay factor exceeds 95.0 percent and no individual lot has a pay factor less than 75.0 percent, then the percent payment for the entire project will be 100 percent of the unit bid price. If the average lot pay factor is less than 95.0 percent, then each lot will be paid for at the unit price multiplied by the lot's pay factor. For any lots which are less than 2,000 tons, a weighted lot pay factor will be used to calculate the average lot pay factor. When work on a lot is required to be terminated before all four sublots are completed, the results from the completed sublots will be analyzed to determine the percent payment for the lot following the same procedures and requirements for full lots but with fewer or more test results as determined in paragraph PAVEMENT LOTS.

1.1.4 Payment Adjustment for Laboratory Air Voids

Laboratory air void calculations for each lot will use the average theoretical maximum density values obtained for the lot. Determine the average TMD in accordance with paragraph THEORETICAL MAXIMUM DENSITY (TMD). The mean absolute deviation of the laboratory air void contents (one from each sublot) from the JMF air void content will be evaluated as shown in the example below and a pay factor will be determined from Table 1. When 0 percent payment is determined, remove and replace the rejected lot at least 4 inches into the cold (existing) lane adjacent to the longitudinal joint.

Table 1. Pay Factor Based on Laboratory Air Voids	
Mean Absolute Deviation of Lab Air Voids from JMF	Pay Factor, percent
0.60 or less	100
0.61 - 0.80	98
0.81 - 1.00	95
1.01 - 1.20	90
Above 1.20	reject (0)

1.1.4.1 Pay Factor Example for Laboratory Air Voids

An example of the computation of mean absolute deviation for laboratory air voids is as follows: Assume that the laboratory air voids are determined from 4 sublots where one set of laboratory compacted specimens is from a single sublot. The laboratory air voids for the 4 sublots are determined to be 3.5, 3.0, 4.0, and 3.7. Assume that the target air voids from the JMF is 4.0. The mean absolute deviation is then:

Mean Absolute Deviation = (|3.5 - 4.0| + |3.0 - 4.0| + |4.0 - 4.0| + |3.7 - 4.0|)/4

Mean Absolute Deviation = (0.5 + 1.0 + 0.0 + 0.3)/4 = (1.8)/4 = 0.45

The mean absolute deviation for laboratory air voids is determined to be 0.45. It can be seen from Table 1 that the lot's pay factor based on laboratory air voids is 100 percent.

1.1.5 Payment Adjustment for In-place Densities

The average in-place mat and joint densities are expressed as a percentage of the average theoretical maximum density (TMD) for the lot. Determine the average TMD in accordance with paragraph THEORETICAL MAXIMUM DENSITY (TMD). The average in-place mat density and joint density for a lot are determined and compared with Table 2 to calculate a single pay factor per lot. Use the following process to determine the single pay factor for in-place density:

a. Step 1: Determine the pay factors for mat density and joint density using Table 2.

b. Step 2: Determine ratio of joint area to mat area. The area associated with the joint is considered to be 10 feet wide times the length of completed longitudinal construction joint in the lot. This joint area will not exceed the total lot size. The length of joint to be considered will be that length where a new lane has been placed against an adjacent lane of asphalt pavement, either an adjacent freshly paved lane or one paved at any time previously.

c. Step 3: Compute the weighted pay factor for the joint using the formula in the example below.

d. Step 4: Compare weighted pay factor for joint density to pay factor

for mat density and select the smaller. This selected pay factor is the pay factor based on density for the lot.

When 0 percent payment is determined for mat density, remove and replace the rejected lot at least 4 inches into the cold (existing) lane adjacent to the longitudinal joint. When 0 percent payment is determined for joint density, remove and replace the rejected longitudinal joint with a 10 feet wide paving lane that is centered over the joint.

Table 2. Pay Factor Based on In-place Density

Average Mat Density (4 Cores) (Percent of TMD)	Pay Factor, Percent	Average Joint Density (4 Cores) (Percent of TMD)
93.0 - 96.0	100.0	91.5 or above
92.9	100.0	91.4
92.8 or 96.1	99.9	91.3
92.7	99.8	91.2
92.6 or 96.2	99.6	91.1
92.5	99.4	91.0
92.4 or 96.3	99.1	90.9
92.3	98.7	90.8
92.2 or 96.4	98.3	90.7
92.1	97.8	90.6
92.0 or 96.5	97.3	90.5
91.9	96.3	90.4
91.8 or 96.6	94.1	90.3
91.7	92.2	90.2
91.6 or 96.7	90.3	90.1
91.5	87.9	90.0
91.4 or 96.8	85.7	89.9
91.3	83.3	89.8
91.2 or 96.9	80.6	89.7
91.1	78.0	89.6
91.0 or 97.0	75.0	89.5
below 91.0, above 97.0	0.0 (reject)	below 89.5

1.1.5.1 Pay Factor Example for In-place Density

An example of the computation of a pay factor (in I-P units only) based on in-place density, is as follows: Assume the following test results for field density made on the lot: (1) Average mat density = 92.2 percent (of lab TMD). (2) Average joint density = 90.5 percent (of lab TMD). (3) Total area of lot = 30,000 square feet. (4) Length of completed longitudinal construction joint = 2,000 feet.

a. Step 1: Determine pay factor based on mat density and on joint

density, using Table 2:

Mat density of 92.2 percent = 98.3 pay factor.

Joint density of 90.5 percent = 97.3 pay factor.

b. Step 2: Determine ratio of joint area to mat area. Multiply the length of completed longitudinal construction joint by the specified 10 foot width and divide by the mat area (total paved area in the lot).

Ratio = Ratio of joint area to mat area

Ratio = (2,000 feet x 10 feet)/30,000 square feet

Ratio = 0.6667

c. Step 3: Weighted pay factor (wpf) for joint is determined as indicated below:

wpf = joint pay factor + (100 - joint pay factor) x (1 - ratio)

wpf = 97.3 + (100-97.3) x (1-0.6667) = 98.2 percent

d. Step 4: Compare weighted pay factor for joint density to pay factor for mat density and select the smaller:

Pay factor for mat density: 98.3 percent.

Weighted pay factor for joint density: 98.2 percent

Selected pay factor: 98.2 percent

1.1.6 Payment Adjustment for Smoothness (Final Wearing Surface Only)

Profilograph Testing. Record the location and data from all profilograph measurements. When the Profile Index of a lot exceeds the tolerance specified in paragraph SMOOTHNESS REQUIREMENTS by 1.0 inch per mile, but less than 2.0 inches per mile, after any reduction of high spots or removal and replacement, the computed pay factor for that lot based on surface smoothness will be 95 percent. When the Profile Index exceeds the tolerance by 2.0 inches per mile, but less than 3.0 inches per mile, the computed pay factor will be 90 percent. When the Profile Index exceeds the tolerance by 3.0 inches per mile, but less than 4.0 inches per mile, the computed pay factor will be 75 percent. Remove and replace the lot when the Profile Index exceeds the tolerance by 4.0 inches per mile or more, at no additional cost to the Government. Regardless of the above, correct any small individual area with surface deviation which exceeds the tolerance given above by more than 5.0 inches per mile or more, by grinding to meet the specification requirements above or remove and replace at no additional cost to the Government.

1.1.7 Payment Adjustment for Plan Grade

When more than 5 percent of all measurements made within a lot are outside the 0.05 foot tolerance, the pay factor based on grade for that lot will be 95 percent. For individual locations where the grade exceeds 0.075 foot tolerance, remove the surface lift full depth and replace the lift with asphalt pavement to meet specification requirements at no additional cost to the Government. High spots can be diamond ground as an alternative to

remove and replace in order to meet grade requirements for the lot and at individual locations.

1.2 PAYMENT

1.2.1 Method of Measurement

Measurement of the quantity of hot-mix warm-mix asphalt pavement per lot will be made for the purposes of assessing acceptance stipulated in paragraph ACCEPTANCE.

1.2.2 Basis of Payment

The measured quantity of hot-mixed warm-mixed asphalt pavement will be paid for and included in the lump sum contract price.

1.3 REFERENCES

The publications 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.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 156	(2013; R 2017) Standard Specification for Requirements for Mixing Plants for Hot-Mixed, Hot-Laid Bituminous Paving Mixtures
AASHTO T 304	(2011; R 2015) Standard Method of Test for Uncompacted Void Content of Fine Aggregate
AASHTO T 329	(2015) Standard Test Method for Moisture Content of Hot Mix Asphalt (HMA) by Oven Method

ASPHALT INSTITUTE (AI)

AI MS-2	(2015) Asphalt Mix Design Methods

ASTM INTERNATIONAL (ASTM)

ASTM C29/C29M	(2023) Standard Test Method for Bulk Density ("Unit Weight") and Voids in Aggregate
ASTM C88	(2018) Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM C117	(2023) Standard Test Method for Materials Finer than 75-um (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C127	(2015) Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate

ASTM C128	(2022) Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Fine Aggregate
ASTM C131/C131M	(2020) Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C136/C136M	(2019) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C142/C142M	(2017; R 2023) Standard Test Method for Clay Lumps and Friable Particles in Aggregates
ASTM C566	(2013) Standard Test Method for Total Evaporable Moisture Content of Aggregate by Drying
ASTM D75/D75M	(2019) Standard Practice for Sampling Aggregates
ASTM D242/D242M	(2009; R 2014) Mineral Filler for Bituminous Paving Mixtures
ASTM D979/D979M	(2015) Sampling Bituminous Paving Mixtures
ASTM D2041/D2041M	(2011) Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures
ASTM D2172/D2172M	(2017; E 2018) Standard Test Methods for Quantitative Extraction of Asphalt Binder from Asphalt Mixtures
ASTM D2419	(2014) Sand Equivalent Value of Soils and Fine Aggregate
ASTM D2726/D2726M	(2019) Standard Test Method for Bulk Specific Gravity and Density of Non-Absorptive Compacted Bituminous Mixtures
ASTM D3203/D3203M	(2017) Standard Test Method for Percent Air Voids in Compacted Asphalt Mixtures
ASTM D3665	(2012; R 2017) Standard Practice for Random Sampling of Construction Materials
ASTM D3666	(2016) Standard Specification for Minimum Requirements for Agencies Testing and Inspecting Road and Paving Materials
ASTM D4791	(2019) Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate
ASTM D4867/D4867M	(2009; R 2014) Effect of Moisture on

	Asphalt Concrete Paving Mixtures
ASTM D5361/D5361M	(2016) Standard Practice for Sampling Compacted Asphalt Mixtures for Laboratory Testing
ASTM D5444	(2015) Mechanical Size Analysis of Extracted Aggregate
ASTM D5821	(2013; R 2017) Standard Test Method for Determining the Percentage of Fractured Particles in Coarse Aggregate
ASTM D6307	(2019) Standard Test Method for Asphalt Content of Asphalt Mixture by Ignition Method
ASTM D6373	(2023) Standard Specification for Performance Graded Asphalt Binder
ASTM D6926	(2020) Standard Practice for Preparation of Asphalt Mixture Specimens Using Marshall Apparatus
ASTM D6927	(2015) Standard Test Method for Marshall Stability and Flow of Bituminous Mixtures
ASTM E1274	(2018); R 2024 Standard Test Method for Measuring Pavement Roughness Using a Profilograph

1.4 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Placement Plan; G

SD-03 Product Data

Diamond Grinding Plan; G

Mix Design; G

Contractor Quality Control; G

SD-04 Samples

Aggregates

Asphalt Cement Binder

Warm-mix Additive

SD-06 Test Reports

Aggregates; G

QC Monitoring

SD-07 Certificates

Asphalt Cement Binder; G

Laboratory Accreditation and Validation

Warm-mix Additive

1.5 ACCEPTANCE

1.5.1 Acceptability of Work

Acquire the services of an independent commercial laboratory to perform acceptance testing. Acceptance of the plant produced mix and in-place requirements will be on a lot to lot basis. The materials and the pavement itself will be accepted on the basis of production testing. The Government may make check tests from split samples to validate the results of the production testing. Testing performed by the Government does not reduce the required testing of the independent commercial laboratory. Split samples will be taken for Government testing to reduce the variability between the independent commercial laboratory and the Government's test results. When the difference between the independent commercial laboratory and the Government's test results for split samples exceed the acceptable range of two results for multilaboratory precision for the appropriate test method (i.e. ASTM) then at least one of the laboratories is determined to be in error. An evaluation of procedures and equipment in both laboratories will be made to determine the cause(s) for the differences. Develop steps to correct procedures and equipment to bring multilaboratory precision to within acceptable limits.

1.5.2 Acceptance Requirements

Provide all sampling and testing required for acceptance and payment adjustment. Where appropriate, adjustments in percent payment acceptance for individual lots of asphalt pavement will be made based on laboratory air voids, in-place density, smoothness, and grade in accordance with the following paragraphs. Surface smoothness and grade determinations will be made on the lot as a whole. Exceptions or adjustments to this will be made in situations where the mix within one lot is placed as part of both the intermediate and surface courses, thus smoothness and grade measurements for the entire lot cannot be made.

1.5.3 Pavement Lots

A standard lot for all requirements is equal to one day's production or 2,000 tons, whichever is smaller. Divide each lot into four equal sublots in order to evaluate laboratory air voids and in-place density. When operational conditions cause a lot to be terminated before the specified four sublots have been completed, use the following procedure to adjust the lot size and number of tests for the lot. Where three sublots have been completed, they constitute a lot. Where one or two sublots have been completed, incorporate them into the next lot and the total number of sublots (i.e. 5 or 6 sublots) is used for acceptance criteria. Include partial lots at the end of asphalt production into the previous lot.

Complete and report all theoretical maximum density, laboratory air voids, and in-place density testing within 24 hours after construction of each lot.

1.5.4 Sublot Sampling

Take one mixture sample for each sublot in accordance with ASTM D979/D979M from a random truck or another location for determining theoretical maximum density, laboratory air voids, any additional testing the Government desires, and Contractor Quality Control. All samples will be selected randomly, using commonly recognized methods of assuring randomness conforming to ASTM D3665 and employing tables of random numbers or computer programs.

1.5.5 Additional Sampling and Testing

The Government reserves the right to direct additional samples and tests for any area which appears to deviate from the specification requirements. The cost of any additional testing will be paid for by the Government. Testing in these areas will be treated as a separate lot. Payment Acceptance will be made for the quantity of asphalt pavement represented by these tests in accordance with the provisions of this section.

1.5.6 Theoretical Maximum Density (TMD)

Measure theoretical maximum density one time for each sublot in accordance with ASTM D2041/D2041M for purposes of calculating laboratory air voids and determining in-place density. The average TMD for each lot will be determined as the average TMD of the random sublot samples. When the TMD on both sides of a longitudinal joint is different, the average of these two TMD values will be used as the TMD needed to calculate the percent joint density.

1.5.7 Laboratory Air Voids

Prepare one set of laboratory compacted specimens for each sublot in accordance with ASTM D6926 using the hand-held hammer for the Marshall Method. Provide three test specimens prepared from the same sample for each set of laboratory compacted specimens. Compact the specimens within 2 hours of the time the mixture was loaded into trucks at the asphalt plant. Do not reheat samples prior to compaction. Provide insulated containers as necessary to maintain the sample temperature. Measure the bulk density of laboratory compacted specimens in accordance with ASTM D2726/D2726M. Determine laboratory air voids from one set (three laboratory compacted specimens) for each sublot sample in accordance with ASTM D3203/D3203M.

1.5.7.1 Tolerance

Provide laboratory air voids with a mean absolute deviation of 1.00 percent or less from the JMF for each lot. Remove and replace lots that do not meet the laboratory air voids requirement at least 4 inches into the cold (existing) lane adjacent to the longitudinal joint, at no additional cost to the Government. The mean absolute deviation of the laboratory air void contents from the JMF air void content will be evaluated as shown in the example below.

1.5.7.2 Calculating Laboratory Air Voids

Laboratory air void calculations for each lot will use the average theoretical maximum density values obtained for the lot. Determine the average TMD in accordance with paragraph THEORETICAL MAXIMUM DENSITY (TMD). The mean absolute deviation of the laboratory air void contents (one from each sublot) from the JMF air void content will be evaluated as in the following example:

Assume that the laboratory air voids are determined from 4 sublots where one set of laboratory compacted specimens is from a single sublot. The laboratory air voids for the 4 sublots are determined to be 3.5, 3.0, 4.0, and 3.7. Assume that the target air voids from the JMF is 4.0. The mean absolute deviation is then:

Mean Absolute Deviation = (|3.5 - 4.0| + |3.0 - 4.0| + |4.0 - 4.0| + |3.7 - 4.0|)/4

Mean Absolute Deviation = (0.5 + 1.0 + 0.0 + 0.3)/4 = (1.8)/4 = 0.45

The mean absolute deviation for laboratory air voids is determined to be 0.45. It can be seen that 0.45 is less than 1.00 percent. The lot is acceptable for laboratory air voids.

1.5.8 In-place Density

Obtain one random 4 inch or 6 inch diameter core from the mat and joint of each sublot in accordance with ASTM D5361/D5361M for determining in-place density. Cut samples neatly with a diamond core drill bit. Obtain random cores that are the full thickness of the layer being placed. Select core locations randomly using the procedures contained in ASTM D3665. Locate cores for mat density no closer than 12 inches from a transverse or longitudinal joint including the pavement edge. Center all cores for joint density on the joint. Discard samples that are clearly defective as a result of sampling and take an additional random core. When the random core is less than 1 inch thick, it will not be included in the analysis. In this case, obtain another random core sample. Clean and tack coat dry core holes before filling with asphalt mixture. Fill all core holes with asphalt mixture and compact using a standard Marshall hammer to the density specified. Provide all tools, labor, and materials for cutting samples, cleaning, and filling the cored pavement. Measure in-place density in accordance with ASTM D2726/D2726M using each core obtained from the mat and joint.

1.5.8.1 Tolerance

Provide a minimum in-place mat density of 93.0 percent and a minimum in-place joint density of 90.0 percent for each lot. The average in-place mat and joint densities are expressed as a percentage of the average theoretical maximum density (TMD) for the lot. Determine the average TMD in accordance with paragraph THEORETICAL MAXIMUM DENSITY (TMD). Remove and replace lots that do not meet the in-place mat density requirement at least 4 inches into the cold (existing) lane adjacent to the longitudinal joint, at no additional cost to the Government. Remove and replace the longitudinal joint when the lot does not meet the in-place joint density, at no additional cost to the Government. Use a 10 feet wide paving lane that is centered over the joint.

1.5.9 Surface Smoothness

Use a straightedge and profilograph for measuring surface smoothness. Use the profilograph method for all longitudinal testing, except for paving lanes less than 0.25 miles in length. Use the straightedge method for transverse testing, for longitudinal testing where the length of each pavement lane is less than 0.25 miles, and at the ends of the paving limits for the project. Smoothness requirements do not apply over crowns or grade breaks. Maintain detailed notes of the testing results and provide a copy to the Government immediately after each day's testing.

1.5.9.1 Smoothness Requirements

1.5.9.1.1 Straightedge Testing

Provide finished surfaces of the pavements with no abrupt change of 1/4 inch or more when checked with an approved 12 foot straightedge. Remove and replace surface lift lots when the surface smoothness exceeds 3/8 inch, at no additional cost to the Government. High spots can be diamond ground as an alternative to remove and replace in order to meet surface smoothness requirements at individual locations.

1.5.9.1.2 Profilograph Testing

Provide finished surfaces with a Profile Index not greater than 9 inches per mile when tested with an approved California-type profilograph. Remove and replace the lot when the Profile Index exceeds the tolerance by 4.0 inches per mile or more, at no additional cost to the Government. Correct any small individual area with surface deviation which exceeds the tolerance given above by more than 5.0 inches per mile or more by diamond grinding to meet the specification requirements above or remove and replace at no additional cost to the Government.

1.5.9.2 Testing Method

After the final rolling, but not later than 24 hours after placement, test the surface of the pavement in each entire lot in a manner to reveal surface irregularities exceeding the tolerances specified above. If any pavement areas are diamond ground, retest these areas immediately after diamond grinding. The maximum area allowed to be corrected by diamond grinding is 10 percent of the total area of the lot. Test the entire area of the pavement with a profilograph. Check a number of random locations along with any observed suspicious locations primarily at transverse and longitudinal joints with the straightedge.

1.5.9.2.1 Straightedge Testing

Use the straightedge to measure abrupt changes in surface smoothness. Hold the straightedge in contact with the pavement surface and measure the maximum distance between the straightedge and the pavement surface. Determine the amount of surface irregularity by placing the freestanding (unleveled) straightedge on the pavement surface and allowing it to rest upon the two highest spots covered by its length, and measuring the maximum gap between the straightedge and the pavement surface in the area between these two high points.

1.5.9.2.2 Profilograph Testing

Perform profilograph testing using an approved California profilograph and

procedures described in ASTM E1274. Provide equipment that utilizes electronic recording and automatic computerized reduction of data to indicate "must-grind" bumps and the Profile Index for the pavement. Use a "blanking band" that is 0.2 inch wide and the "bump template" spanning 1 inch with an offset of 0.4 inch. Provide profilograph operated by an approved, factory-trained operator on the alignments specified above. Provide a copy of the reduced tapes to the Government at the end of each day's testing.

1.5.9.2.3 Bumps ("Must Grind" Areas)

Reduce any bumps ("must grind" areas) shown on the profilograph trace which exceed 0.4 inch in height by diamond grinding until they do not exceed 0.3 inch when retested. Taper diamond grinding in all directions to provide smooth transitions to areas not requiring diamond grinding. The following will not be permitted: (1) skin patching for correcting low areas, (2) planing or milling for correcting high areas. Perform additional profilograph testing in all areas corrected by diamond grinding.

1.5.10 Plan Grade

Provide a final wearing surface of pavement conforming to the elevations and cross sections shown and not vary more than 0.05 foot from the plan grade established and approved at site of work. Within 5 working days after completion of a particular lot incorporating the final wearing course, test the final wearing surface of the pavement for conformance with specified plan grade requirements. Match finished surfaces at juncture with other pavements with finished surfaces of abutting pavements. Deviation from the plan elevation will not be permitted in areas of pavements where closer conformance with planned elevation is required for the proper functioning of drainage and other appurtenant structures involved. For roads, the grade will be determined by running lines of levels along the centerline at intervals of 25 feet or less longitudinally to determine the elevation of the completed pavement surface. Measure transverse grades at appropriate intervals. For parking lots, the grade will be determined by running lines of levels at intervals of 25 feet or less longitudinally and transversely to determine the elevation of the completed pavement surface. Diamond grinding can be used to remove high spots to meet grade requirements. Skin patching for correcting low areas or planing or milling for correcting high areas will not be permitted. Maintain detailed notes of the results of the testing and provide a copy to the Government immediately after each day's testing. Remove and replace surface lift lots when individual locations exceed 0.05 foot tolerance, at no additional cost to the Government. High spots can be diamond ground as an alternative to remove and replace in order to meet plan grade requirements at individual locations.

1.5.11 Laboratory Accreditation and Validation

Provide laboratories used to develop the Job Mix Formula (JMF), perform acceptance testing, and Contractor Quality Control testing that meet the requirements of ASTM D3666. Provide laboratories with a masonry saw having a diamond blade for trimming pavement cores and samples. Perform all required test methods by an accredited laboratory. Schedule and provide payment for laboratory inspections. Additional payment or a time extension due to failure to acquire the required laboratory accreditation is not allowed. Submit a certificate of compliance signed by the manager of the laboratory stating that it meets these requirements to the Government prior to the start of construction. At a minimum, include the

following certifications:

a. Qualifications of personnel; laboratory manager, supervising technician, and testing technicians.

b. A listing of equipment to be used in developing the job mix.

c. A copy of the laboratory's quality control system.

1.6 ENVIRONMENTAL REQUIREMENTS

Do not place the asphalt mixture upon a wet surface or when the surface temperature of the underlying course is less than specified in Table 3 Table 1. The temperature requirements may be waived by the Government, if requested; however, meet all other requirements including compaction.

Table 3. Table 1. Surface Temperature Limitations of Underlying Course

Mat Thickness, inches	Degrees F
3 or greater	40
Less than 3	45

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

Perform the work consisting of pavement courses composed of mineral aggregate and asphalt material heated and mixed in a central mixing plant and placed on a prepared course. Provide asphalt pavement designed and constructed in accordance with this section conforming to the lines, grades, thicknesses, and typical cross sections shown on the drawings. Construct each course to the depth, section, or elevation required by the drawings and rolled, finished, and approved before the placement of the next course. Submit proposed Placement Plan indicating lane widths and longitudinal joints for each course or lift.

2.1.1 Asphalt Mixing Plant

Provide plants used for the preparation of asphalt mixture conforming to the requirements of AASHTO M 156 with the following changes:

2.1.1.1 Truck Scales

Weigh the asphalt mixture on approved scales, or on certified public scales at no additional expense to the Government. Inspect and seal scales at least annually by an approved calibration laboratory.

2.1.1.2 Inspection of Plant

Provide access to the Government at all times, to all areas of the plant for checking adequacy of equipment; inspecting operation of the plant; verifying weights, proportions, and material properties; checking the temperatures maintained in the preparation of the mixtures and for taking samples. Provide assistance as requested, for the Government to procure any desired samples.

2.1.1.3 Storage bins

The asphalt mixture can be stored in non-insulated storage bins for a period of time not exceeding 3 hours. The asphalt mixture can be stored in insulated storage bins for a period of time not exceeding 8 hours. Provide the mix drawn from bins that meets the same requirements as mix loaded directly into trucks.

2.1.2 Hauling Equipment

Provide trucks used for hauling asphalt mixture that have tight, clean, and smooth metal beds. To prevent the mixture from adhering to them, lightly coat the truck beds with a minimum amount of paraffin oil, lime solution, or other approved material. Do not use petroleum based products as a release agent. Provide each truck with a suitable cover to protect the mixture from adverse weather, contamination, and loss of material during hauling. When necessary due to long haul distance and cold weather, provide insulated truck beds with covers (tarps) that are securely fastened.

2.1.3 Material Transfer Vehicle (MTV)

Provide Material Transfer Vehicle for placement of the asphalt mixture. Transfer the material from the hauling equipment to the paver using a self-propelled, material transfer vehicle with a swing conveyor that is capable of delivering material to the paver without making contact with the paver. Provide MTV capable to move back and forth between the hauling equipment and the paver providing material transfer to the paver, while allowing the paver to operate at a constant speed. Provide Material Transfer Vehicle with remixing and storage capability to prevent physical and thermal segregation.

2.1.4 Asphalt Pavers

Provide mechanical spreading and finishing equipment consisting of a self-powered paver, capable of spreading and finishing the mixture to the specified line, grade, and cross section. Provide paver screed capable of laying a uniform mixture to meet the specified thickness, smoothness, and grade without physical or temperature segregation, the full width of the material being placed. Provide a paver with a vibrating screed to be used during all placement.

2.1.4.1 Receiving Hopper

Provide paver with a receiving hopper of sufficient capacity to permit a uniform spreading operation and a distribution system to place the mixture uniformly in front of the screed without segregation. Provide a screed that effectively produces a finished surface of the required evenness and texture without tearing, shoving, or gouging the mixture.

2.1.4.2 Automatic Grade Controls

Provide a paver equipped with a control system capable of maintaining the specified screed elevation. One of three methods can be used to control grade: stringline, laser, or computerized elevations along with GPS. For multiple layers it is acceptable to control the grade in the underlying layer and control the grade of the surface layer by applying a constant thickness over the underlying layer which has been placed to the desired

grade. Slope control can also be used to control the grade of the surface for roads, but is not acceptable for wide pavements such as parking lots. Provide transverse slope controller capable of maintaining the screed at the desired slope within plus or minus 0.1 percent. A ski-type device of not less than 30 ft can be used to provide improved smoothness. Use a shoe on one side of the paver to match an existing paved surface to provide a smooth joint.

2.1.5 Rollers

Provide rollers in good condition and operate at slow speeds to avoid displacement of the asphalt mixture. Provide sufficient number, type, and weight of rollers to compact the mixture to the required density while it is still in a workable condition. Do not use equipment which causes excessive crushing of the aggregate.

2.1.6 Diamond Grinding

Those performing diamond grinding are required to have a minimum of three years experience in diamond grinding. In areas not meeting the specified limits for surface smoothness and plan grade, reduce high areas to attain the required smoothness and grade, except as depth is limited below. Reduce high areas by diamond grinding the asphalt pavement with approved equipment. Perform diamond grinding by sawing with saw blades impregnated with an industrial diamond abrasive. Assemble the saw blades in a cutting head mounted on a machine designed specifically for diamond grinding that produces the required texture and smoothness level without damage to the asphalt pavement or joint faces. Provide diamond grinding equipment with saw blades that are 1/8-inch wide, a minimum of 60 blades per 12 inches of cutting head width, and capable of cutting a path a minimum of 3 feet wide. Diamond grinding equipment that causes raveling, fracturing of aggregate, or disturbance to the underlying material will not be allowed. The maximum area corrected by diamond grinding the surface of the asphalt pavement is 10 percent of the total area of any lot. The maximum depth of diamond grinding is 1/2 inch. Provide diamond grinding machine equipped to flush and vacuum the pavement surface. Dispose of all debris from diamond grinding operations off Government property. Prior to diamond grinding, submit a Diamond Grinding Plan for review and approval. At a minimum, include the daily reports for the deficient areas, the location and extent of deficiencies, corrective actions, and equipment. Remove and replace all pavement areas requiring plan grade or surface smoothness corrections in excess of the limits specified.

Prior to production diamond grinding operations, perform a test section at the approved location, consisting of a minimum of two adjacent passes with a minimum length of 40 feet to allow evaluation of the finish and transition between adjacent passes. Production diamond grinding operations cannot be performed prior to approval.

2.2 AGGREGATES

Notify the Government at least 7 days before sampling aggregates. Obtain samples in accordance with ASTM D75/D75M that are representative of the materials to be used for the project. Provide aggregates consisting of crushed stone, crushed gravel, crushed slag, screenings, natural sand, and mineral filler as required. The portion of material retained on the No. 4 sieve is coarse aggregate. The portion of material passing the No. 4 sieve and retained on the No. 200 sieve is fine aggregate. The portion passing the No. 200 sieve is defined as mineral filler. Submit sufficient

materials to produce 200 pounds of blended mixture for mix design verification. Submit all aggregate test results and samples to the Government at least 14 days prior to start of construction. Perform job aggregate testing no earlier than 6 months before contract award.

2.2.1 Coarse Aggregate

Provide coarse aggregate consisting of sound, tough, durable particles, free from films of material that would prevent thorough coating and bonding with the asphalt material and free from organic matter and other deleterious substances. Provide coarse aggregate particles meeting the following requirements:

a. The percentage of loss not greater than 40 percent after 500 revolutions when tested in accordance with ASTM C131/C131M.

b. The sodium sulfate soundness loss not exceeding 12 percent, or the magnesium sulfate soundness loss not exceeding 18 percent after five cycles when tested in accordance with ASTM C88.

c. At least 75 percent by weight of coarse aggregate containing two or more fractured faces when tested in accordance with ASTM D5821 with fractured faces produced by crushing.

d. The particle shape essentially cubical and the aggregate containing not more than 10 percent, by weight, of flat and elongated particles (5:1 ratio of length to thickness) when tested in accordance with ASTM D4791, Method B.

e. Slag consisting of air-cooled, blast furnace slag with a compacted weight of not less than 75 lb/cu ft when tested in accordance with ASTM C29/C29M.

f. Clay lumps and friable particles not exceeding 0.3 percent, by weight, when tested in accordance with ASTM C142/C142M.

2.2.2 Fine Aggregate

Provide fine aggregate consisting of clean, sound, tough, durable particles. Provide aggregate particles that are free from coatings of clay, silt, or any objectionable material, contain no clay balls, and meet the following requirements:

a. Quantity of natural sand (noncrushed material) added to the aggregate blend not exceeding 15 percent by weight of total aggregate.

b. Individual fine aggregate sources with a sand equivalent value greater than 45 when tested in accordance with ASTM D2419.

c. Fine aggregate portion of the blended aggregate with an uncompacted void content greater than 45.0 percent when tested in accordance with AASHTO T 304 Method A.

d. Clay lumps and friable particles not exceeding 0.3 percent, by weight, when tested in accordance with ASTM C142/C142M.

2.2.3 Mineral Filler

Provide mineral filler consisting of a nonplastic material meeting the

requirements of ASTM D242/D242M.

2.2.4 Aggregate Gradation

Provide a combined aggregate gradation that conforms to gradations specified in Table 4 Table 2, when tested in accordance with ASTM C136/C136M and ASTM C117, and does not vary from the low limit on one sieve to the high limit on the adjacent sieve or vice versa, but grades uniformly from coarse to fine. Provide a JMF within the specification limits; however, the gradation can exceed the limits when the allowable deviation from the JMF shown in Tables 6 and 7 Tables 4 and 5 are applied.

Table 4. Table 2. Aggregate Gradations

Sieve Size, inch	Gradation 2 Percent Passing by Mass
1	---
3/4	100
1/2	90-100
3/8	69-89
No. 4	53-73
No. 8	38-60
No. 16	26-48
No. 30	18-38
No. 50	11-27
No. 100	6-18
No. 200	3-6

2.3 ASPHALT CEMENT BINDER

Provide asphalt cement binder that conforms to ASTM D6373 Performance Grade (PG) 70-10. Provide test data indicating grade certification by the supplier at the time of delivery of each load to the mix plant. When warm-mix asphalt technology involves additives, grade the asphalt binder with the asphalt binder additive included. Submit copies of these certifications to the Government. The supplier is defined as the last source of any modification to the binder. The Government may sample and test the binder at the mix plant at any time before or during mix production.

2.4 MIX DESIGN

The mix design must be designed to meet the specs before it is processed through the plant. The baghouse must not be used to remove fines to meet specified gradations. The baghouses are intended to keep the plant from generating a large cloud of dust when under production, not to modify the gradation. Develop the mix design. Perform Job Mix formula (JMF) and aggregates testing no earlier than 6 months before contract award. Provide asphalt mixture composed of well-graded aggregate, mineral filler if required, and asphalt material. Provide aggregate fractions sized, handled in separate size groups, and combined in such proportions that the

resulting mixture meets the grading requirements of Table 4 Table 2. Do not produce asphalt pavement for payment acceptance until a JMF has been approved. Design the asphalt mixture using 50 or 75 blows with the Marshall hand-held hammer procedures contained in AI MS-2 and the criteria shown in Table 5 Table 3. Use laboratory compaction temperatures for Polymer Modified Asphalts as recommended by the asphalt binder manufacturer. Determine the Tensile Strength Ratio (TSR) of the composite mixture in accordance with ASTM D4867/D4867M. Compact the TSR specimens to an air void content of 7 percent plus or minus 1 percent. If the Tensile Strength Ratio (TSR) of the composite mixture is less than 75, reject the aggregates or treat the asphalt mixture with an anti-stripping agent. Add a sufficient amount of anti-stripping agent to produce a TSR of not less than 75. If an antistrip agent is required, provide it at no additional cost to the Government. Provide sufficient materials to produce 200 pound of blended mixture to the Government for verification of mix design at least 14 days prior to construction of test section.

2.4.1 JMF Requirements

Submit the proposed JMF in writing, for approval, at least 14 days prior to the start of the test section including, as a minimum:

a. Percent passing each sieve size.

b. Percent of asphalt cement.

c. Percent of each aggregate and mineral filler to be used.

d. Asphalt performance grade.

e. Number of blows of hammer per side of molded specimen.

f. Laboratory mixing temperature.

g. Laboratory compaction temperature.

h. Temperature-viscosity relationship of the asphalt cement

i. Plot of the combined gradation on the 0.45 power gradation chart, stating the nominal maximum size.

j. Graphical plots and summary tabulation of Marshall stability, flow, air voids, voids in the mineral aggregate, and unit weight versus asphalt content as shown in AI MS-2. Include summary tabulation that includes individual specimen data for each specimen tested.

k. Specific gravity and absorption of each aggregate.

l. Percent natural sand.

m. Percent particles with two or more fractured faces (in coarse aggregate).

n. Fine aggregate angularity.

o. Percent flat or elongated particles in coarse aggregate.

p. Tensile Strength Ratio and wet/dry specimen test results.

q. Antistrip agent (if required).

r. List of all modifiers.

s. Warm-mix additive or process.

Table 5. Table 3. Mix Design Criteria

Test Property	Marshall (50 Blows)	Marshall (75 Blows)
Stability, pounds, minimum (NA for Superpave)	1000(1)	1800(1)
Flow, 0.01 inch, (NA for Superpave)	8-18	8-16
Air voids, percent	3-5	3-5
Minimum Percent Voids in Mineral Aggregate (VMA)(2)		
Gradation 1	13.0	13.0
Gradation 2	14.0	14.0
Gradation 3	15.0	15.0
TSR, minimum percent	75	75

(1) This is a minimum requirement. Provide significantly higher average during construction to ensure compliance with the specifications.

(2) Calculate VMA in accordance with AI MS-2, based on ASTM C127 and ASTM C128 bulk specific gravity for the aggregate.

2.4.2 Adjustments to JMF

The JMF for each mixture is in effect until a new formula is approved in writing by the Government. Should a change in sources of any materials be made, perform a new mix design and a new JMF approved before the new material is used. Make minor adjustments within the specification limits to the JMF to optimize mix volumetric properties. Adjustments to the original JMF are limited to plus or minus 4 percent on the No. 4 and coarser sieves; plus or minus 3 percent on the No. 8 to No. 50 sieves; and plus or minus 1 percent on the No. 100 sieve and No. 200 sieve. Asphalt content adjustments are limited to plus or minus 0.40 from the original JMF. If adjustments are needed that exceed these limits, develop a new mix design.

PART 3 EXECUTION

3.1 CONTRACTOR QUALITY CONTROL

3.1.1 General Quality Control Requirements

Submit the Quality Control Plan. Do not produce hot-mix warm-mix asphalt for payment acceptance until the quality control plan has been approved. In the quality control plan, address all elements which affect the quality of the pavement including, but not limited to:

a. Mix Design and unique JMF identification code

b. Aggregate Grading

c. Quality of Materials

d. Stockpile Management and procedures to prevent contamination

e. Mixing and Transportation

f. Mixture Volumetrics

g. Moisture Content of Mixtures

h. Placing and Compaction

i. Joints

j. Surface Smoothness

k. Truck bed release agent

m. Correlation of mechanical hammer to hand hammer. Determine the number of blows of the mechanical hammer required to provide the same density of the JMF as provided by the hand hammer. Use the average of three specimens per trial blow application.

3.1.2 Testing Laboratory

Provide a fully equipped asphalt laboratory located at the plant or job site that is equipped with heating and air conditioning units to maintain a temperature of 75 plus or minus 5 degrees F. Provide laboratory facilities that are kept clean and all equipment maintained in proper working condition. Provide the Government with unrestricted access to inspect the laboratory facility, to witness quality control activities, and to perform any check testing desired. The Government will advise in writing of any noted deficiencies concerning the laboratory facility, equipment, supplies, or testing personnel and procedures. When the deficiencies are serious enough to adversely affect test results, immediately suspend the incorporation of the materials into the work. Incorporation of the materials into the work will not be permitted to resume until the deficiencies are corrected.

3.1.3 Quality Control Testing

Perform all quality control tests applicable to these specifications and as set forth in the Quality Control Program. Use the independent commercial laboratory for acceptance testing in paragraph ACCEPTANCE. Use

in-house capabilities or the independent commercial laboratory for quality control testing. Required elements of the testing program include, but are not limited to tests for the control of asphalt content, aggregate gradation, aggregate moisture, moisture in the asphalt mixture, temperatures, VMA, Marshall stability, flow, and in-place density. Develop a Quality Control Testing Plan as part of the Quality Control Program.

3.1.3.1 Asphalt Content

Determine asphalt content a minimum of twice per lot (a lot is defined in paragraph PAVEMENT LOTS) using the ignition method in accordance with ASTM D6307. Use the extraction method in accordance with ASTM D2172/D2172M if the correction factor for the ignition method in ASTM D6307 is greater than 1.0. The asphalt content for the lot will be determined by averaging the test results.

3.1.3.2 Aggregate Properties

Determine aggregate gradations a minimum of twice per lot from mechanical analysis of extracted aggregate in accordance with ASTM D5444, ASTM C136/C136M, and ASTM C117. Determine the specific gravity of each aggregate size grouping for each 20,000 tons in accordance with ASTM C127 or ASTM C128. Determine fractured faces for gravel sources for each 20,000 tons in accordance with ASTM D5821. Determine the uncompacted void content of natural sand, manufactured sand, and blended aggregate for each 20,000 tons in accordance with AASHTO T 304 Method A.

3.1.3.3 Moisture Content of Aggregate

Determine the moisture content of aggregate used for production a minimum of once per lot in accordance with ASTM C566.

3.1.3.4 Moisture Content of Asphalt Mixture

Determine the moisture content of the asphalt mixture at least once per lot in accordance with AASHTO T 329.

3.1.3.5 Temperatures

Check temperatures at least four times per lot, at necessary locations to determine the temperature at the dryer, the asphalt cement binder in the storage tank, the asphalt mixture at the plant, and the asphalt mixture at the job site.

3.1.3.6 VMA, Marshall Stability, and Flow

Obtain mixture samples at least four times per lot. Calculate the VMA of each specimen in accordance with AI MS-2 based on ASTM C127 and ASTM C128 bulk specific gravity for the aggregate, as well as the Marshall stability and flow, as described in ASTM D6927. Provide VMA within the limits of Table 5 Table 3.

3.1.3.7 In-Place Density

Conduct any necessary testing to ensure the specified density is achieved. A nuclear gauge or other non-destructive testing device can be used to monitor pavement density.

3.1.3.8 Additional Testing

Perform any additional testing deemed necessary to control the process.

3.1.3.9 QC Monitoring

Submit all QC test results to the Government on a daily basis as the tests are performed. The Government reserves the right to monitor any of the Contractor's quality control testing and to perform duplicate testing as a check to the Contractor's quality control testing.

3.1.4 Sampling

When directed by the Government, sample and test any material which appears to not meet specification requirements unless such material is voluntarily removed and replaced or deficiencies corrected. Perform all sampling in accordance with standard procedures specified.

3.1.5 Control Charts

For process control, establish and maintain linear control charts on both individual samples and the running average of last four samples for the parameters listed in Table 6 Table 4, as a minimum. Post the control charts as directed by the Government and maintain current at all times. Identify the following on the control charts: the project number, the test parameter being plotted, the individual sample numbers, the Action and Suspension Limits listed in Table 6 Table 4 applicable to the test parameter being plotted, and the test results. Also show target values (JMF) on the control charts as indicators of central tendency for the cumulative percent passing, asphalt content, and laboratory air voids parameters. When the test results exceed either applicable Action Limit, take immediate steps to bring the process back in control. When the test results exceed either applicable Suspension Limit, halt production until the problem is solved. When the Suspension Limit is exceeded for individual values or running average values, the Government has the option to require removal and replacement of the material represented by the samples or to leave in place and base acceptance on mixture volumetric properties and in place density. Use the control charts as part of the process control system for identifying trends so that potential problems can be corrected before they occur. Make decisions concerning mix modifications based on analysis of the results provided in the control charts. In the Quality Control Plan, indicate the appropriate action to be taken to bring the process into control when certain parameters exceed their Action Limits.

Table 6. Table 4. Action and Suspension Limits for the Parameters to be Plotted on Individual and Running Average Control Charts

	Individual Samples		Running Average of	
Parameter to be Plotted	Action Limit	Suspension Limit	Action Limit	Suspension Limit
No. 4 sieve, Cumulative percent passing, deviation for JMF target; plus or minus values	6	8	4	5

Table 6. Table 4. Action and Suspension Limits for the Parameters to be Plotted on Individual and Running Average Control Charts

	Individual Samples		Running Average of	
Parameter to be Plotted	Action Limit	Suspension Limit	Action Limit	Suspension Limit
No. 30 sieve, Cumulative percent passing, deviation for JMF target; plus or minus values	4	6	3	4
No. 200 sieve, Cumulative percent passing, deviation for JMF target; plus or minus values	1.4	2.0	1.1	1.5
Asphalt content, percent deviation from JMF target; plus or minus value	0.4	0.5	0.2	0.3
Stability, pounds (minimum) (NA for Superpave)				
75 Blow JMF	1800	1700	1900	1800
50 Blow JMF	1000	900	1100	1000
Flow, 0.01 inch (NA for Superpave)				
75 Blow JMF	8 min.	7 min.	9 min.	8 min.
	16 max.	17 max.	15 max.	16 max.
50 Blow JMF	8 min.	7 min.	9 min.	8 min.
	18 max.	19 max.	17 max.	18 max.
Laboratory Air Voids, percent deviation from JMF target value	No specific action and suspension limits set since this parameter is used for acceptance			
In-place Mat Density, percent of TMD	No specific action and suspension limits set since this parameter is used for acceptance			
In-place Joint Density, percent of TMD	No specific action and suspension limits set since this parameter is used for acceptance			
VMA				
Gradation 2	14.5	14.0	14.3	14.0

3.2 PREPARATION OF ASPHALT BINDER MATERIAL

Heat the asphalt cement material while avoiding local overheating. Provide a continuous supply of the asphalt material to the mixer at a uniform temperature. Maintain the temperature of the asphalt delivered to the mixer to provide a suitable viscosity for adequate coating of the aggregate particles. For hot-mix, do not heat unmodified asphalt to a temperature exceeding 325 degrees F when added to the aggregate. Do not heat modified asphalt to a temperature exceeding 350 degrees F when added to the aggregate. For warm-mix, do not heat asphalt binder to a temperature exceeding 270 degrees F when added to the aggregate.

3.3 PREPARATION OF MINERAL AGGREGATE

Heat and dry the aggregate prior to mixing. Provide a rate of heating and a maximum temperature that does not damage the aggregates. Do not heat the aggregate to a temperature exceeding 350 degrees F when the asphalt binder is added. Maintain the temperature no lower than is required to obtain complete coating and uniform distribution on the aggregate particles and to provide a mixture of satisfactory workability.

3.4 PREPARATION OF ASPHALT MIXTURE

Weigh or meter the aggregates and the asphalt cement and introduce into the mixer the amount specified by the JMF. Mix the combined materials until the aggregate obtains a uniform coating of asphalt binder and is thoroughly distributed throughout the mixture. The moisture content of all asphalt mixture upon discharge from the plant is not to exceed 0.5 percent by total weight of mixture as measured by AASHTO T 329.

3.5 PREPARATION OF THE UNDERLYING SURFACE

Immediately before placing the asphalt mixture, clean the underlying course of dust and debris. Apply a prime coat or tack coat in accordance with Section 32 12 13 BITUMINOUS TACK AND PRIME COATS.

3.6 TEST SECTION

Prior to full production, place a test section for each JMF used. Construct a test section 250 to 500 feet long and two paver passes wide with a longitudinal cold joint. Do not place the second lane of test section until the temperature of pavement edge is less than 175 degrees F. Construct the test section with the same depth as the course which it represents. Ensure the underlying grade or pavement structure upon which the test section is to be constructed is the same or very similar to underlying layer for the project. Use the same equipment and procedures in construction of the test section as on the remainder of the course represented by the test section. Construct the test section as part of the project pavement, as approved by the Government.

3.6.1 Sampling and Testing for Test Section

Obtain one sample at the plant from a random truck. Compact three specimens and test for laboratory air voids as well as the Marshall stability and flow. Test a portion of the same sample for theoretical maximum density (TMD), aggregate gradation, asphalt content, and TSR. Adjust the compactive effort as required to provide TSR specimens with an air void content of 7 plus or minus 1 percent. Obtain four randomly selected cores from each finished pavement mat (eight total), four from the longitudinal joint, and test for density. Perform random sampling in accordance with procedures contained in ASTM D3665. Construction may continue provided the test results are within the tolerances or exceed the minimum values shown in Table 7 Table 5. If all test results meet the specified requirements, the test section may remain as part of the project pavement. If test results exceed the tolerances shown, remove and replace the test section and construct another test section at no additional cost to the Government.

Table 7. Table 5. Test Section Requirements for Material and Mixture Properties

Property	Specification Limit
Aggregate Gradation-Percent Passing (Individual Test Result)	
No. 4 and larger	JMF plus or minus 8
No. 8, No. 16, No. 30, and No. 50	JMF plus or minus 6
No. 100 and No. 200	JMF plus or minus 2.0
Asphalt Content, Percent (Individual Test Result)	JMF plus or minus 0.5
Laboratory Air Voids, Percent (Average of 3 specimens)	JMF plus or minus 1.0
VMA, Percent (Average of 3 specimens)	See Table 5 Table 3
Tensile Strength Ratio (TSR) (At 7 percent plus/minus 1 percent air void content)	75 percent minimum
Conditioned Strength	60 psi minimum
Mat Density, Percent of TMD (Average of 4 Random Cores)	92.0 - 96.0 93.0 minimum
Joint Density, Percent of TMD (Average of 4 Random Cores)	89.5 minimum 90.0 minimum
Stability, pounds (Average of 3 specimens) (for Marshall only)	1000 minimum for 50 blows 1800 minimum for 75 blows
Flow, 0.01 inch (Average of 3 specimens) (for Marshall only with non-modified asphalt)	8 - 18 for 50 blows 8 - 16 for 75 blows

3.6.2 Additional Test Sections

If the initial test section should prove to be unacceptable, make the necessary adjustments to the JMF, plant operation, placing procedures, and rolling procedures before beginning construction of a second test section. Construct and evaluate additional test sections, as required, for conformance to the specifications. Full production paving is not allowed until an acceptable section has been constructed and accepted.

3.7 TRANSPORTING AND PLACING

3.7.1 Transporting

Transport asphalt mixture from the mixing plant to the site in clean,

tight vehicles. Schedule deliveries so that placing and compacting of mixture is uniform with minimum stopping and starting of the paver. Provide adequate artificial lighting for night placements. Hauling over freshly placed material will not be permitted until the material has been compacted as specified, and allowed to cool to 140 degrees F.

3.7.2 Placing

Place the mix in lifts of adequate thickness and compact at a temperature suitable for obtaining density, surface smoothness, and other specified requirements. Upon arrival, place the mixture to the full width by an asphalt paver; strike off in a uniform layer of such depth that, when the work is completed, the required thickness is obtained and the surface conforms to the grade and contour indicated. Do not broadcast waste mixture onto the mat or recycle into the paver hopper. Collect waste mixture and dispose off site. Regulate the speed of the paver to eliminate pulling and tearing of the asphalt mat. Begin placement of the mixture along the centerline of a crowned section or on the high side of areas with a one-way slope. Place the mixture in consecutive adjacent strips having a minimum width of 10 feet. Offset the longitudinal joint in one course from the longitudinal joint in the course immediately below by at least 1 foot; however, locate the joint in the surface course at the centerline of the pavement. Offset transverse joints in one course by at least 10 feet from transverse joints in the previous course. Offset transverse joints in adjacent lanes a minimum of 10 feet. On isolated areas where irregularities or unavoidable obstacles make the use of mechanical spreading and finishing equipment impractical, the mixture can be spread and luted by hand tools.

3.8 COMPACTION OF MIXTURE

3.8.1 General

a. After placing, thoroughly and uniformly compact the mixture by rolling. Compact the surface as soon as possible without causing displacement, cracking, or shoving. Determine the sequence of rolling operations and the type of rollers used with the exception that application of more than three passes with a vibratory roller in the vibrating mode is prohibited. Maintain the speed of the roller, at all times, sufficiently slow to avoid displacement of the asphalt mixture and to be effective in compaction. Correct at once any displacement occurring as a result of reversing the direction of the roller, or from any other cause.

b. Furnish sufficient rollers to handle the output of the plant. Continue rolling until the surface is of uniform texture, true to grade and cross section, and the required field density is obtained. To prevent adhesion of the mixture to the roller, keep the wheels properly moistened, but excessive water is not permitted. In areas not accessible to the roller, thoroughly compact the mixture with hand tampers or small compactors. Remove the full depth of any mixture that becomes loose and broken, mixed with dirt, contains check-cracking, or is in any way defective. Replace with fresh asphalt mixture and immediately compact to conform to the surrounding area. Perform this work at no expense to the Government. Skin patching is not allowed.

3.8.2 Segregation

The Government can sample and test any material that looks deficient. When the in-place material appears to be segregated, the Government has the option to sample the material and have it tested and compared to the aggregate gradation, asphalt content, and in-place density requirements in Table 7 Table 5. If the material fails to meet these specification requirements, remove and replace the extent of the segregated material the full depth of the layer of asphalt mixture at no additional cost to the Government. When segregation occurs in the mat, take appropriate action to correct the process so that additional segregation does not occur.

3.9 JOINTS

Construct joints to ensure a continuous bond between the courses and to obtain the required density. Provide all joints with the same texture as other sections of the course and meet the requirements for smoothness and grade.

3.9.1 Transverse Joints

Do not pass the roller over the unprotected end of the freshly laid mixture, except when necessary to form a transverse joint. When necessary to form a transverse joint, construct by means of placing a bulkhead or by tapering the course. Utilize a dry saw cut on the transverse joint full depth and width on a straight line to expose a vertical face prior to placing the adjacent lane. Remove the cutback material from the project. In both methods, provide a light tack coat of asphalt material to all contact surfaces before placing any fresh mixture against the joint.

3.9.2 Longitudinal Joints

Provide a joint that meets density and smoothness requirements for joints and has uniform texture. Cut back longitudinal joints which are irregular, damaged, uncompacted, cold (less than 175 degrees F at the time of placing adjacent lanes), or otherwise defective, a maximum of 3 inches from the top of the course with a cutting wheel to expose a clean, sound, near vertical surface for the full depth of the course. Remove all cutback material from the project. Provide a light tack coat of asphalt material to all contact surfaces prior to placing any fresh mixture against the joint.

-- End of Section --

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SECTION 33 11 00

WATER UTILITY DISTRIBUTION PIPING
08/24

PART 1 GENERAL

1.1 REFERENCES

The publications 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.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B18.2.2	(2022) Nuts for General Applications: Machine Screw Nuts, and Hex, Square, Hex Flange, and Coupling Nuts (Inch Series)

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C104/A21.4	(2022) Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
AWWA C110/A21.10	(2021) Ductile-Iron and Gray-Iron Fittings
AWWA C111/A21.11	(2023) Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C153/A21.53	(2019) Ductile-Iron Compact Fittings for Water Service
AWWA C219	(2023) Bolted Sleeve-Type Couplings for Plain-End Pipe
AWWA C500	(2019) Metal-Seated Gate Valves for Water Supply Service
AWWA C503	(2021) Wet-Barrel Fire Hydrants
AWWA C509	(2023) Resilient-Seated Gate Valves for Water Supply Service
AWWA C512	(2015) Air-Release, Air/Vacuum, and Combination Air Valves for Water and Wastewater Service
AWWA C515	(2020) Reduced-Wall, Resilient-Seated Gate Valves for Water Supply Service
AWWA C550	(2024) Protective Interior Coatings for Valves and Hydrants
AWWA C600	(2023) Installation of Ductile-Iron Mains and Their Appurtenances
AWWA C605	(2021) Underground Installation of Polyvinyl Chloride (PVC) and Molecularly

	Oriented Polyvinyl Chloride (PVCO) Pressure Pipe and Fittings
AWWA C651	(2023) Standard for Disinfecting Water Mains
AWWA C655	(2018) Field Dechlorination
AWWA C800	(2021) Underground Service Line Valves and Fittings
AWWA C900	(2022) Polyvinyl Chloride (PVC) Pressure Pipe, and Fabricated Fittings, 4 In. Through 60 In. (100 mm Through 1,500 mm)
AWWA C909	(2022) Molecularly Oriented Polyvinyl Chloride (PVCO) Pressure Pipe, 4 In. (100 mm) and Larger
AWWA M9	(2008; Errata 2013) Manual: Concrete Pressure Pipe
AWWA M23	(2020) Manual: PVC Pipe - Design and Installation - Third Edition

ASTM INTERNATIONAL (ASTM)

ASTM A307	(2023) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM A536	(2024) Standard Specification for Ductile Iron Castings
ASTM A563/A563M	(2024) Standard Specification for Carbon and Alloy Steel Nuts (Inch and Metric)
ASTM C94/C94M	(2025) Standard Specification for Ready-Mixed Concrete
ASTM D1784	(2020) Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D2774	(2021a) Standard Practice for Underground Installation of Thermoplastic Pressure Piping
ASTM D3139	(2019) Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
ASTM F402	(2018) Standard Practice for Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermoplastic Pipe and Fittings
ASTM F477	(2014; R 2021) Standard Specification for Elastomeric Seals (Gaskets) for Joining

	Plastic Pipe
ASTM F1483	(2023) Standard Specification for Oriented Poly(Vinyl Chloride), PVCO, Pressure Pipe

FOUNDATION FOR CROSS-CONNECTION CONTROL AND HYDRAULIC RESEARCH (FCCCHR)

FCCCHR Manual	(10th Edition) Manual of Cross-Connection Control

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 8678	(1998) Cup Head Square Neck Bolts with Small Head and Short Neck-Product Grade B

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 24	(2025) Standard for the Installation of Private Fire Service Mains and Their Appurtenances
NFPA 1961	(2020) Standard on Fire Hose

NSF INTERNATIONAL (NSF)

NSF/ANSI/CAN 61	(2024) Drinking Water System Components - Health Effects

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-600-01	(2016; with Change 6, 2021) Fire Protection Engineering for Facilities

UL SOLUTIONS (UL)

UL 246	(2011; Reprint Jul 2020) UL Standard for Safety Hydrants for Fire-Protection Service
UL 262	(2004; Reprint Jul 2023) Gate Valves for Fire-Protection Service

1.2 DEFINITIONS

1.2.1 Water Transmission Mains

Water transmission mains include water piping having diameters greater than 14 inch, specific materials, methods of joining and any appurtenances deemed necessary for a satisfactory system.

1.2.2 Water Mains

Water mains include water piping having diameters 4 through 14 inch, specific materials, methods of joining and any appurtenances deemed necessary for a satisfactory system.

1.2.3 Additional Definitions

For additional definitions refer to the definitions in the applicable

referenced standard.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Connections; G

SD-03 Product Data

Pipe, Fittings, Joints and Couplings; G

Valves; G

Valve Boxes; G

Fire Hydrants; G

Pipe Restraint; G

Tapping Sleeves; G

Disinfection Procedures; G

SD-06 Test Reports

Backflow Preventer Tests; G

Bacteriological Samples; G

Hydrostatic Sewer Test

Leakage Test

Hydrostatic Test

SD-07 Certificates

Pipe, Fittings, Joints and Couplings

Lining for Fittings

Valves

Fire Hydrants

SD-08 Manufacturer's Instructions

PVC Piping

PVCO Piping

1.4 QUALITY CONTROL

1.4.1 Regulatory Requirements

Use NSF/ANSI/CAN 61 materials for potable water systems to comply with lead free content requirements as defined by the U.S. Safe Drinking Water Act effective January 2014 and January 2022.

Comply with NFPA 24 for materials, installation, and testing of fire main piping and components.

1.5 DELIVERY, STORAGE, AND HANDLING

1.5.1 Delivery and Storage

Inspect materials delivered to site for required pipe markings and damage. Unload and store with minimum handling and in accordance with manufacturer's instructions to prevent cuts, scratches and other damage. Store materials on site in enclosures or under protective covering. Store plastic piping, jointing materials and rubber gaskets under cover out of direct sunlight. Do not store materials directly on the ground. Keep inside of pipes, fittings, valves, fire hydrants, and other accessories free of dirt and debris or other contaminates.

1.5.2 Handling

Handle pipe, fittings, valves, fire hydrants, and other accessories in accordance with applicable AWWA standard, manufacturer's instructions and in a manner to ensure delivery to the trench in sound undamaged condition. Avoid injury to coatings and linings on pipe and fittings; make repairs if coatings or linings are damaged. Do not place other material, hooks, or pipe inside a pipe or fitting after the coating has been applied. Inspect the pipe for defects before installation. Carry, do not drag pipe to the trench. Use of pinch bars and tongs for aligning or turning pipe will be permitted only on the bare ends of the pipe. Clean the interior of pipe and accessories of foreign matter before being lowered into the trench and keep them clean during laying operations by plugging. Replace defective material without additional expense to the Government. Store rubber gaskets, not immediately installed, under cover or out of direct sunlight.

Handle PVC and PVCO pipe, fittings, and accessories in accordance with AWWA C605.

PART 2 PRODUCTS

2.1 MATERIALS

All materials are intended for potable water use unless otherwise indicated.

Provide all materials in accordance with AWWA C800 and as indicated herein. Provide valves and fittings with pressure ratings equivalent to the pressure ratings of the pipe.

2.1.1 Pipe, Fittings, Joints And Couplings

Submit manufacturer's standard drawings or catalog cuts, except submit both drawings and cuts for push-on joints. Include information concerning

gaskets with submittal for joints and couplings.

2.1.1.1 Plastic Piping

2.1.1.1.1 PVC and PVCO Piping

2.1.1.1.1.1 PVC Piping

AWWA C900 plain end or gasket bell end pipe meeting or exceeding ASTM D1784 cell class 12454, with a minimum Pressure Class 165 (DR25), with ductile iron outside diameter (DIOD).

2.1.1.1.1.2 PVCO Piping

AWWA C909, ASTM F1483 plain end or gasket bell end pipe meeting or exceeding ASTM D1784 cell class 12454, Pressure Class 165 PVCO pressure pipe, with ductile iron outside diameter (DIOD).

2.1.1.1.1.3 Fittings for PVC and PVCO Pipe

Ductile iron fittings, AWWA C110/A21.10 or compact fittings in accordance with AWWA C153/A21.53, with cement-mortar lining for fittings, AWWA C104/A21.4, standard thickness. Fittings with push-on joint ends are to conform to the same requirements as fittings with mechanical-joint ends, except for the factory modified bell design compatible for use with PVC pipe as specified.

2.1.1.1.1.4 Joints and Jointing Material for PVC and PVCO Piping

a. Push-on joints: Use jointing material in accordance with ASTM D3139 and AWWA C111/A21.11 between pipes, pipes and metal fittings, valves, and other accessories or compression-type joints/mechanical joints. Provide each joint connection with an elastomeric gasket compatible for the bell or coupling used. Gaskets for push-on joints for pipe, ASTM F477. Gaskets for push-on joints and compression-type joints/mechanical joints for joint connections between pipe and metal fittings, valves, and other accessories, AWWA C111/A21.11, respectively, for push-on joints and mechanical joints.

b. Mechanical Joint: Use mechanically coupled joints having a sleeve-type mechanical coupling, as specified in the paragraph SLEEVE-TYPE MECHANICAL COUPLINGS, as an optional jointing method for plain-end PVC pipe, subject to the limitations specified for mechanically coupled joints using a sleeve-type mechanical coupling as specified for compression-type joints in ASTM D3139. Provide jointing material in accordance with AWWA C111/A21.11 between pipe and sleeve-type mechanical couplings.

2.1.2 Valves

Provide a protective interior coating in accordance with AWWA C550.

2.1.2.1 Gate Valves 3 Inch Size and Larger on Buried Piping

AWWA C500, AWWA C509, AWWA C515, or UL 262 and:

a. AWWA C500: nonrising stem type with double-disc gate and mechanical-joint ends or push-on joint ends compatible for the adjoining pipe.

b. AWWA C509 or AWWA C515: nonrising stem type with mechanical-joint ends

c. UL 262: inside-screw type with operating nut, double-disc or split-wedge type gate, designed for a hydraulic working pressure of 175 psi, and have mechanical-joint ends or push-on joint ends as appropriate for the pipe to which it is joined.

Match materials for UL 262 gate valves to the reference standards specified in AWWA C500. Gate valves open by counterclockwise rotation of the valve stem. Stuffing boxes have 0-ring stem seals. Stuffing boxes are bolted and constructed so as to permit easy removal of parts for repair. Use gate valves with special ends for connection to sleeve-type mechanical coupling in lieu of mechanical-joint ends and push-on joint ends. Provide valve ends and gaskets for connection to sleeve-type mechanical couplings that conform to the requirements specified for the joint or coupling. Provide AWWA C500 6 inch, 8 inch and 12 inch gate valves with gearing. Provide all valves from one manufacturer.

2.1.2.2 Air Release, Air/Vacuum, and Combination Air Valves

Provide AWWA C512 air release and combination air valves that release air and prevent the formation of a vacuum. Provide valves with an iron body, lead-free bronze trim and stainless steel float that automatically releases air when the lines are being filled with water and admits air into the line when water is being withdrawn in excess of the inflow.

2.1.2.3 Valve Boxes

Provide a valve box for each gate valve on buried piping. Construct adjustable valve boxes manufactured from cast iron of a size compatible for the valve on which it is used. Cast the word "WATER" on the lid. The minimum diameter of the shaft of the box is shown on plans.

2.1.2.4 Valve Pits

Construct the valve pits at locations indicated or as required above and in accordance with the details shown.

2.1.3 Fire Hydrants and Hose Houses

2.1.3.1 Fire Hydrants

Provide fire hydrants where indicated. Paint fire hydrants with at least one coat of primer and two coats of enamel paint. Paint barrel and bonnet colors in accordance with UFC 3-600-01. Stencil fire hydrant number and main size on the fire hydrant barrel using black stencil paint.

2.1.3.1.1 Wet-Barrel Type Fire Hydrants

Provide ~~Dry~~Wet-barrel type fire hydrants, ~~AWWA C502~~AWWA C503 or UL 246, "Wet Barrel" with 6 inch inlet, one 4 1/2 inch pumper connection, and two 2 1/2 inch hose connections. Individually valve pumper connection and hose connections with independent nozzle gate valves.

Provide mechanical-joint or push-on joint end, except where flanged end is indicated; with end matching requirements as specified in AWWA C503 or UL 246 for size and shape of operating nut, cap nuts, and threads on hose and pumper connections.

2.1.3.2 Fire Hydrant Hose Houses

Provide hose houses matching the requirements of NFPA 24 at each fire hydrant indicated on the drawings to have a fire hydrant hose house.

2.1.3.2.1 Additional Equipment

Provide the following equipment, in addition to that listed in NFPA 24, Hose Houses and Equipment, with each hose house:

a. 200 feet of 2-1/2 inch woven jacketed, rubber lined hose matching the requirements of NFPA 1961 with a minimum service test pressure of 300 psi; 100 feet of 1-1/2 inch woven jacketed, rubber lined hose matching the requirements of NFPA 1961 with a minimum service test pressure of 300 psi;

b. One gated 2-1/2 by 1-1/2 by 1-1/2 inch wye;

c. One playpipe for 2-1/2 inch hose with 1 inch shutoff nozzle tip;

d. One playpipe for 1-1/2 inch hose with 1/2 inch shutoff nozzle or combination nozzle;

e. Two adapter fittings, 2-1/2 to 1-1/2 inch;

f. Two spanners for 1-1/2 inch hose.

2.2 ACCESSORIES

2.2.1 Pipe Restraint

2.2.1.1 Thrust Blocks

Use ASTM C94/C94M concrete having a minimum compressive strength of 2,500 psi at 28 days.

2.2.2 Tapping Sleeves

Provide cast gray, ductile, malleable iron or stainless steel, split-sleeve type tapping sleeves of the sizes indicated for connection to existing main with flanged or grooved outlet, and with bolts, follower rings and gaskets on each end of the sleeve. Utilize similar metals for bolts, nuts, and washers to minimize the possibility of galvanic corrosion. Provide dielectric gaskets where dissimilar metals adjoin. Provide a tapping sleeve assembly with a maximum working pressure of 150 psi. Provide bolts with square heads and hexagonal nuts. Longitudinal gaskets and mechanical joints with gaskets as recommended by the manufacturer of the sleeve. When using grooved mechanical tee, utilize an upper housing with full locating collar for rigid positioning which engages a machine-cut hole in pipe, encasing an elastomeric gasket which conforms to the pipe outside diameter around the hole and a lower housing with positioning lugs, secured together during assembly by nuts and bolts as specified, pre-torqued to 50 foot-pound.

2.2.3 Sleeve-Type Mechanical Couplings

Use AWWA C219 couplings to join plain-end piping by compression of a ring gasket at each end of the adjoining pipe sections. The coupling consists

of one middle ring flared or beveled at each end to provide a gasket seat; two follower rings; two resilient tapered rubber gaskets; and bolts and nuts to draw the follower rings toward each other to compress the gaskets. Provide true circular middle ring and the follower rings sections free from irregularities, flat spots, and surface defects; provide for confinement and compression of the gaskets. For PVC pipe, use ASTM A536 ductile iron. Use gaskets for resistance to set after installation and to meet the requirements specified for gaskets for mechanical joint in AWWA C111/A21.11. Provide track-head type bolts ASTM A307, Grade A, with ASTM A563/A563M, Grade A nuts or round-head square-neck type ISO 8678 bolts with ASME B18.2.2 hex nuts. Provide 5/8 inch diameter bolts. Minimum number of bolts for each coupling is 3 for 3 inch pipe, 5 for 6 inch pipe, and 6 for 8 inch pipe. Shape bolt holes in follower rings to hold fast to the necks of the bolts used. Do not use mechanically coupled joints using a sleeve-type mechanical coupling as an optional method of jointing except where pipeline is adequately anchored to resist tension pull across the joint. Provide a tight flexible joint with mechanical couplings under reasonable conditions, such as pipe movements caused by expansion, contraction, slight settling or shifting in the ground, minor variations in trench gradients, and traffic vibrations. Match coupling strength to that of the adjoining pipeline.

2.2.4 Insulating Joints

Provide a rubber-gasketed insulating joint or dielectric coupling between pipe of dissimilar metals which will effectively prevent metal-to-metal contact between adjacent sections of piping.

2.2.5 Dielectric Fittings

Install dielectric fittings between threaded ferrous and nonferrous metallic pipe, fittings and valves, except where corporation stops join mains to prevent metal-to-metal contact of dissimilar metallic piping elements and compatible with the indicated working pressure.

2.2.6 Tracer Wire for Nonmetallic Piping

Provide a continuous bare copper or aluminum wire not less than 0.10 inch in diameter in sufficient length over each separate run of nonmetallic pipe.

PART 3 EXECUTION

3.1 PREPARATION

3.1.1 Connections to Existing System

Perform all connections to the existing water system in the presence of the Contracting Officer.

3.1.2 Operation of Existing Valves

Do not operate valves within or directly connected to the existing water system unless expressly directed to do so by the Contracting Officer.

3.1.3 Earthwork

Perform earthwork operations in accordance with Section 31 00 00 EARTHWORK.

3.2 INSTALLATION

Install all materials in accordance with the applicable reference standard, manufacturers instructions and as indicated herein.

3.2.1 Piping

3.2.1.1 General Requirements

Install pipe, fittings, joints and couplings in accordance with the applicable referenced standard, the manufacturer's instructions and as specified herein.

3.2.1.1.1 Termination of Water Lines

Terminate the work covered by this section at a point approximately 5 feet from the building, unless otherwise indicated.

Do not lay water lines in the same trench with gas lines, fuel lines, electric wiring, or any other utility. Do not install copper tubing in the same trench with ferrous piping materials. Where nonferrous metallic pipe (i.e., copper tubing) crosses any ferrous piping, provide a minimum vertical separation of 12 inches between pipes.

3.2.1.1.2 Pipe Laying and Jointing

Remove fins and burrs from pipe and fittings. Before placing in position, clean pipe, fittings, valves, and accessories, and maintain in a clean condition. Provide proper facilities for lowering sections of pipe into trenches. Under no circumstances is it permissible to drop or dump pipe, fittings, valves, or other water line material into trenches. Cut pipe cleanly, squarely, and accurately to the length established at the site and work into place without springing or forcing. Inspect pipe and fittings prior to backfilling and repair as required. Replace a pipe or fitting that does not allow sufficient space for installation of jointing material. Blocking or wedging between bells and spigots is not permitted. Lay bell-and-spigot pipe with the bell end pointing in the direction of laying. Grade the pipeline in straight lines; avoid the formation of dips and low points. Support pipe at the design elevation and grade. Secure firm, uniform support. Wood support blocking is not permitted. Lay pipe so that the full length of each section of pipe and each fitting rests solidly on the pipe bedding; excavate recesses to accommodate bells, joints, and couplings. Provide anchors and supports for fastening work into place. Make provision for expansion and contraction of pipelines. Keep trenches free of water until joints have been assembled. At the end of each work day, close open ends of pipe temporarily with wood blocks or bulkheads. Do not lay pipe when conditions of trench or weather prevent installation. Provide a minimum of 3 feet depth of cover over top of pipe.

3.2.1.1.3 Tracer Wire

Install a continuous length of tracer wire for the full length of each run of nonmetallic pipe. Attach wire to top of pipe in such manner that it will not be displaced during construction operations.

3.2.1.1.4 Connections to Existing Water Lines

Make connections to existing water lines after coordination with the

facility and with a minimum interruption of service on the existing line. Make connections to existing lines under pressure in accordance with the recommended procedures of the manufacturer of the pipe being tapped and as indicated.

3.2.1.1.5 Sewer Manholes

No water piping is to pass through or come in contact with any part of a sewer manhole.

3.2.1.1.6 Water Piping Parallel With Sewer Piping

a. Normal Conditions: Lay water piping at least 10 feet horizontally from sewer or sewer manhole whenever possible. Measure the distance from outside edge to outside edge of pipe or outside edge of manhole. When local conditions prevent horizontal separation install water piping in a separate trench with the bottom of the water piping at least 18 inchesabove the top of the sewer piping.

b. Unusual Conditions: When local conditions prevent vertical separation, construct sewer piping of AWWA compliant ductile iron water piping and perform hydrostatic sewer test, without leakage, prior to backfilling. When local conditions prevent vertical separation, test the sewer manhole in place to ensure watertight construction.

3.2.1.1.7 Water Piping Crossing Sewer Piping

a. Normal Conditions: Provide a separation of at least 18 inches between the bottom of the water piping and the top of the sewer piping in cases where water piping crosses above sewer piping.

b. Unusual Conditions: When local conditions prevent a vertical separation described above, construct sewer piping passing over or under water piping of AWWA compliant ductile iron water piping and perform hydrostatic sewer test, without leakage, prior to backfilling. Construct sewer crossing with a minimum 20 feet length of the AWWA compliant ductile iron water piping, centered at the point of the crossing so that joints are equidistant and as far as possible from the water piping. Protect water piping passing under sewer piping by providing a vertical separation of at least 18 inches between the bottom of the sewer piping and the top of the water piping; adequate structural support for the sewer piping to prevent excessive deflection of the joints and the settling on or damage to the water piping.

3.2.1.1.8 Penetrations

Provide ductile-iron or Schedule 40 steel wall sleeves for pipe passing through walls of valve pits and structures. Fill annular space between walls and sleeves with rich cement mortar. Fill annular space between pipe and sleeves with mastic.

3.2.1.2 PVC and PVCO Water Main Pipe

Unless otherwise specified, install pipe and fittings in accordance with the paragraph GENERAL REQUIREMENTS and with the requirements of AWWA C605 for laying of pipe, joining PVC pipe to fittings and accessories, setting of fire hydrants, valves, and fittings; and with the recommendations for pipe joint assembly and appurtenance installation in AWWA M23, Chapter 7,

"Installation in Trenches and Embankments."

a. Jointing: Make push-on joints with the elastomeric gaskets specified for this type joint, using either elastomeric-gasket bell-end pipe or elastomeric-gasket couplings. For pipe-to-pipe push-on joint connections, use only pipe with push-on joint ends having factory-made bevel; for push-on joint connections to metal fittings, valves, and other accessories, cut spigot end of pipe off square and re-bevel pipe end to a bevel approximately the same as that on ductile-iron pipe used for the same type of joint. Use a lubricant recommended by the pipe manufacturer for push-on joints. Assemble push-on joints for pipe-to-pipe joint connections in accordance with the requirements of AWWA C605 for laying the pipe and the recommendations in AWWA M23, Chapter 7, "Installation in Trenches and Embankments," for pipe joint assembly. Assemble push-on joints for connection to fittings, valves, and other accessories in accordance with the requirements of AWWA C605 for joining PVC pipe to fittings and accessories and with the requirements of AWWA C600 for joint assembly. Make compression-type joints/mechanical joints with the gaskets, glands, bolts, nuts, and internal stiffeners previously specified for this type joint; assemble in accordance with the requirements of AWWA C605 for joining PVC pipe to fittings and accessories, with the requirements of AWWA C600 for joint assembly, and with the recommendations of Appendix A to AWWA C111/A21.11. Cut off spigot end of pipe for compression-type joint/mechanical-joint connections and do not re-bevel. Assemble joints made with sleeve-type mechanical couplings in accordance with the recommendations of the coupling manufacturer using internal stiffeners as previously specified for compression-type joints.

b. Joint Offset: Construct joint offset in accordance AWWA C605. Do not exceed the minimum longitudinal bending as indicated by AWWA C605.

c. Fittings: Install in accordance with AWWA C605.

3.2.1.3 Plastic Service Piping

Install pipe and fittings in accordance with the paragraph GENERAL REQUIREMENTS and with the applicable requirements of ASTM D2774, unless otherwise specified. Handle solvent cements used to join plastic piping in accordance with ASTM F402.

3.2.1.3.1 Jointing

Make plastic pipe joints to other pipe materials in accordance with the recommendations of the plastic pipe manufacturer.

3.2.1.3.2 Plastic Pipe Connections to Appurtenances

Connect plastic service lines to corporation stops and gate valves in accordance with the recommendations of the plastic pipe manufacturer.

3.2.2 Disinfection

Prior to disinfection, provide disinfection procedures, proposed neutralization and disposal methods of waste water from disinfection as part of the disinfection submittal. Disinfect new water piping and existing water piping affected by Contractor's operations in accordance with AWWA C651. Ensure a free chlorine residual of not less than 10 parts per million after 24 hour holding period and prior to performing

bacteriological tests.

3.2.3 Flushing

Perform bacteriological tests prior to flushing. Flush solution from the systems with domestic water until maximum residual chlorine content is within the range of 0.2 to 0.5 parts per million, the residual chlorine content of the distribution system, or acceptable for domestic use. Use AWWA C655 neutralizing chemicals.

3.2.4 Pipe Restraint

3.2.4.1 Concrete Thrust Blocks

Install concrete thrust blocks where indicated.

3.2.5 Valves

3.2.5.1 Gate Valves

Install gate valves, AWWA C500 and UL 262, in accordance with the requirements of AWWA C600 for valve-and-fitting installation and with the recommendations of the Appendix ("Installation, Operation, and Maintenance of Gate Valves") to AWWA C500. Install gate valves, AWWA C509 or AWWA C515, in accordance with the requirements of AWWA C600 for valve-and-fitting installation and with the recommendations of the Appendix ("Installation, Operation, and Maintenance of Gate Valves") to AWWA C509 or AWWA C515. Install gate valves on PVC and PVCO water mains in accordance with the recommendations for appurtenance installation in AWWA M23, Chapter 7, "Installation." Make and assemble joints to gate valves as specified for making and assembling the same type joints between pipe and fittings.

3.2.5.2 Air Release, Air/Vacuum, and Combination Air Valves

Install pressure vacuum assemblies of type, size, and capacity indicated. Include valves and test cocks. Install according to the requirements of plumbing and health department and authorities having jurisdiction. Do not install pressure vacuum breaker assemblies in vault or other space subject to flooding.

3.2.6 Blowoff Valve Assemblies

Install blowoff valve assemblies as indicated on the drawings or in accordance with the manufactures recommendations. Install discharge fitting on the end of riser pipe to direct the flow of water so as to minimize damage to surrounding areas.

3.2.7 Fire Hydrants

Install fire hydrants in accordance with AWWA C600 for fire hydrant installation and as indicated. Make and assemble joints as specified for making and assembling the same type joints between pipe and fittings. Install fire hydrants with the 4 1/2 inch connections facing the adjacent paved surface. If there are two paved adjacent surfaces, install fire hydrants with the 4 1/2 inch connection facing the paved surface where the connecting main is located.

3.3 FIELD QUALITY CONTROL

3.3.1 Tests

Notify the Contracting Officer a minimum of five days in advance of hydrostatic testing. Coordinate the proposed method for disposal of waste water from hydrostatic testing. Perform field tests, and provide labor, equipment, and incidentals required for testing, except that water needed for field tests will be furnished as set forth in paragraph AVAILABILITY AND USE OF UTILITY SERVICES in Section 01 50 00 TEMPORARY CONSTRUCTION FACILITIES AND CONTROLS. Provide documentation that all items of work have been constructed in accordance with the Contract documents.

3.3.1.1 Hydrostatic Test

Test the water system in accordance with the applicable AWWA standard specified below.Test PVC and PVCO plastic water systems made with PVC pipe in accordance with the requirements of AWWA C605 for pressure and leakage tests. The amount of leakage on pipelines made of PVC water main pipe is not to exceed the amounts given in AWWA C605, except that at joints made with sleeve-type mechanical couplings, no leakage will be allowed. Test concrete water mains in accordance with the recommendations in AWWA M9, "Hydrostatic Testing and Disinfection of Mains." The amount of leakage on concrete pipelines is not to exceed 20 gallons per 24 hours per inch of pipe diameter per mile of pipeline. Do not backfill utility trench or begin testing on any section of a pipeline where concrete thrust blocks have been provided until at least 7 days after placing of the concrete.

3.3.1.2 Hydrostatic Sewer Test

The hydrostatic pressure sewer test will be performed in accordance with the applicable AWWA standard for the piping material or AWWA C600.

3.3.1.3 Leakage Test

For leakage test, use a hydrostatic pressure not less than the maximum working pressure of the system. Leakage test may be performed at the same time and at the same test pressure as the pressure test.

3.3.1.4 Bacteriological Testing

Perform bacteriological tests in accordance with AWWA C651 Option A. Analyze samples by a certified laboratory, and submit the results of the bacteriological samples.

3.3.1.5 Backflow Preventer Tests

After installation conduct Backflow Preventer Tests and provide test reports verifying that the installation meets the FCCCHR Manual Standards.

3.3.1.6 Special Testing Requirements for Fire Service

Test water mains and water service lines providing fire service or water and fire service in accordance with NFPA 24. The additional water added to the system must not exceed the limits given in NFPA 24

3.3.1.7 Tracer Wire Continuity Test

Test tracer wire for continuity after service connections have been

completed and prior to final pavement or restoration. Verify that tracer wire is locatable with electronic utility locating equipment. Repair breaks or separations and re-test for continuity.

3.4 SYSTEM STARTUP

Water mains and appurtenances must be completely installed, disinfected, flushed, and satisfactory bacteriological sample results received prior to permanent connections being made to the active distribution system. Obtain approval by the Contracting Officer prior to the new water piping being placed into service.

3.5 CLEANUP

Upon completion of the installation of water lines and appurtenances, remove all debris and surplus materials resulting from the work.

-- End of Section --

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SECTION 33 52 43.13

AVIATION FUEL PIPING
08/18, CHG 1: 02/21

PART 1 GENERAL

1.1 REFERENCES

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.

AMERICAN PETROLEUM INSTITUTE (API)

API RP 1110	(2013; R 2018) Recommended Practice for the Pressure Testing of Steel Pipelines for the Transportation of Gas, Petroleum Gas, Hazardous Liquids, Highly Volatile Liquids, or Carbon Dioxide
API STD 608	(2012) Metal Ball Valves - Flanged, Threaded, And Welding End
API Spec 6D	(June 2018, 4th Ed; Errata 1 July 2018; Errata 2 August 2018) Specification for Pipeline and Piping Valves
API Std 607	(2016) Fire Test for Quarter-turn Valves and Valves Equipped with Non-metallic Seats

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B1.1	(2024) Unified Inch Screw Threads (UN, UNR, and UNJ Thread Form)
ASME B16.5	(2020) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B16.9	(2018) Factory-Made Wrought Buttwelding Fittings
ASME B16.11	(2022) Forged Fittings, Socket-Welding and Threaded
ASME B16.21	(2021) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B18.2.1	(2012; R 2021) Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series)
ASME B18.2.2	(2022) Nuts for General Applications: Machine Screw Nuts, and Hex, Square, Hex Flange, and Coupling Nuts (Inch Series)

ASME B31.3	(2024) Process Piping
ASME BPVC SEC VIII D1	(2023) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1

AMERICAN WELDING SOCIETY (AWS)

AWS A5.9/A5.9M	(2022) Welding Consumables-Wire Electrodes, Strip Electrodes, Wires, and Rods for Arc Welding of Stainless and Heat Resisting Steels- Classification

ASTM INTERNATIONAL (ASTM)

ASTM A182/A182M	(2024) Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service
ASTM A193/A193M	(2024a) Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service and Other Special Purpose Applications
ASTM A194/A194M	(2024) Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both
ASTM A269/A269M	(2024) Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service
ASTM A312/A312M	(2022a) Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes
ASTM A358/A358M	(2024) Standard Specification for Electric-Fusion-Welded Austenitic Chromium-Nickel Stainless Steel Pipe for High-Temperature Service and General Applications
ASTM A403/A403M	(2022b) Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings
ASTM A961/A961M	(2024) Standard Specification for Common Requirements for Steel Flanges, Forged Fittings, Valves, and Parts for Piping Applications
ASTM D229	(2019) Standard Test Methods for Rigid Sheet and Plate Materials Used for Electrical Insulation
ASTM D1655	(2018a) Standard Specification for Aviation Turbine Fuels

ASTM F436	(2011) Hardened Steel Washers

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C62.41	(1991; R 1995) Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-58	(2018) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 30	(2024) Flammable and Combustible Liquids Code

SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

SAE J514	(2012) Hydraulic Tube Fittings

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-STD-101	(2014; Rev C) Color Code for Pipelines and for Compressed Gas Cylinders
MIL-STD-161	(2025; Rev J) Identification Methods for Bulk Petroleum Products Systems Including Hydrocarbon Missile Fuels

1.2 ADMINISTRATIVE REQUIREMENTS

Design conditions must be as specified in Section 33 52 43.11 AVIATION FUEL MECHANICAL EQUIPMENT. Submit Operation and Maintenance Manuals for the equipment items or systems listed below. Refer to Section 01 78 23.33 OPERATION AND MAINTENANCE MANUALS FOR AVIATION FUEL SYSTEMS for the information to be submitted for various type of equipment and systems.

Manual Valves
Strainers
Protective Coatings
Isolating Gasket Kits
Gaskets

1.3 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Contractor Qualifications; G

SD-03 Product Data

Stainless Steel Piping; G

Protective Coatings for Buried Stainless Steel Piping; G

Fittings; G

Isolating Gasket Kits; G

Flange Protectors; G

Lightning Surge Arrester; G

Nuts and Bolts; G

Gaskets; G.

Ball Valves; G.

Plug (Double Block and Bleed) Valves; G

Thermal Relief Valves; G

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Refer to Section 01 78 23.33 OPERATION AND MAINTENANCE MANUALS FOR AVIATION FUEL SYSTEMS for the information to be submitted for various types of aviation fueling equipment and systems.

1.4 QUALITY ASSURANCE

1.4.1 Design Data

1.4.1.1 Pipeline Inventory

Fuel system volume must be calculated using as constructed pipe lengths, internal diameters, fittings, and components.

1.4.2 Contractor Qualifications

Each installation Contractor must have successfully completed at least 3 projects of the similar scope and the same size or larger within the last 6 years. Each installation Contractor must demonstrate specific installation experience in regard to the specific system installation to be performed. Each installation Contractor must have taken, if applicable, manufacturer's training courses on the installation of piping and must meet the licensing requirements in the state. Submit a letter listing prior projects, the date of construction, a point of contact for each prior project, the scope of work of each prior project, and a detailed list of work performed. Provide in the letter evidence of prior manufacturer's training and state licensing.

PART 2 PRODUCTS

2.1 TYPES OF FUEL HANDLED

2.1.1 Properties of F-24 Turbine Fuel

Jet Fuel system components must be suitable for use with F-24 turbine fuel (Jet A with additives FSII, CI/LI, and SDA); specific gravity of 0.81 at 60 degrees F; Reid vapor pressure less than 0.05 psi; flash point of 100 degrees F; viscosity 1.62 cSt at 60 degrees F; ASTM D1655.

2.2 MATERIALS AND EQUIPMENT

Pipe and fittings in contact with fuel must be stainless steel, interior epoxy coated carbon steel, or carbon steel as indicated on the drawings. No zinc coated metals, brass, bronze or other copper bearing alloys must be used in contact with the fuel. Identification of piping must be in accordance with MIL-STD-161 and as detailed on the drawings, unless specified otherwise. Flow arrows, at a minimum, must be provided adjacent each product labeling location. Flow arrows must be sized based on the requirements of MIL-STD-101. Material for manual valves must be as specified hereinafter.

2.2.1 Stainless Steel Piping

a. Piping 2-1/2-Inches and Larger:

(1) ASTM A358/A358M, Grade 304L, Class 1 or Class 3 with supplementary requirements of S1, S2 and S3, or ASTM A312/A312M Type 304L, seamless (only). Any agreements between the purchaser and the manufacturer or supplier as referenced in the applicable ASTM must include the Contracting Officer as a party to the agreement. All piping welds will receive 100 percent radiographic inspection, 100 percent liquid penetrant inspection, 100 percent visual inspection and all tests as required by the applicable ASTM Standard. Piping must be provided with a nominal wall thickness as shown in Table A for ASTM A358/A358M with the deviation from the nominal wall thickness less than 0.01-inch. ASTM A312/A312M seamless piping must be provided with a minimum schedule 10S wall thickness.

TABLE A

Nominal Pipe Size	Nominal (Average) Pipe O.D.	Wall Thickness(tn)
16 inches	16.000 inches	0.312 inch
14 inches	14.000 inches	0.312 inch
12 inches	12.750 inches	0.250 inch
10 inches	10.750 inches	0.250 inch
8 inches	8.625 inches	0.250 inch
6 inches	6.625 inches	0.219 inch
4 inches	4.500 inches	0.219 inch
2.5 inches	2.875 inches	0.156 inch

(2) Pipe Ends: All Piping must be provided with beveled ends per Chapter V, ASME B31.3, and must be shipped with the ends capped.

(3) Factory Testing and Inspection Records: Per Table K341.3.2 of Chapter IX of ASME B31.3, visual, radiographic and liquid penetrant tests must be performed for each section of piping provided as all sections are subjected to cyclic conditions. All

testing and inspections records must be submitted to the Contracting Officer and must indicate the pipe mark and installed location of each piping section on the project site. Observation by the Contracting Officer of the manufacturers and the fields testing and inspection procedures must be allowed under this contract. Pipe certification along with pipe markings must be submitted before the pipe arrives on the job site.

(4) Provide a qualified inspector in accordance with Chapter VI of ASME B31.3. to act as the owner's inspector (for the Government) at the pipe manufacturer's facility in addition to the manufacturer's inspector.

(5) Submit Quality Assurance Plan for the welding, inspecting and testing of the welded seam pipe.

b. Piping 2-inches and Smaller: Schedule 80 ASTM A312/A312M seamless Type 304L for threaded piping and schedule 40 (unless otherwise indicated) ASTM A312/A312M seamless Type 304L for welded piping.

c. Stainless Steel Control Tubing: Seamless, fully annealed tubing conforming to ASTM A269/A269M, Grade TP316, Rockwell hardness B80 or less. Wall thickness for 1/2-inch tubing to be 0.049-inch.

d. Welding Electrodes (Factory Fabrication): E308L conforming to AWS A5.9/A5.9M.

2.2.2 External Protective Coatings for Buried Steel Piping

2.2.2.1 Protective Coatings for Buried Stainless Steel Piping

a. New pipe and fittings must be factory coated fusion bonded epoxy (FBE) in accordance with Section 33 52 80 LIQUID FUELS PIPELINE COATING SYSTEM.

b. Field joints and repairs must be fusion bonded epoxy (FBE) in accordance with Section 33 52 80 LIQUID FUELS PIPELINE COATING SYSTEM.

c. Field joints and repairs in tight spots (valve pits, etc. when heaters are too big) must be liquid epoxy in accordance with Section 33 52 80 LIQUID FUELS PIPELINE COATING SYSTEM.

d. Existing systems must match existing coating system and must be in accordance with Section 33 52 80 LIQUID FUELS PIPELINE COATING SYSTEM.

2.2.3 Fittings

2.2.3.1 General

Welding ells, caps, tees, reducers, etc., must be of materials compatible for welding to the pipe line in which they are installed, and wall thickness, pressure and temperature ratings of the fittings must be not less than the adjoining pipe line. Unless otherwise required by the conditions of installation, all elbows must be the long radius type. Miter joints are not acceptable. Make odd angle offsets with pipe bends or elbows cut to the proper angle. Butt weld fittings must be factory-made wrought fittings manufactured by forging or shaping. Fabricated fittings will not be permitted. Welding branch fittings must

be insert type suitable for radiographic inspections specified herein, unless indicated otherwise on the drawings.

2.2.3.2 Stainless Steel Fittings

a. Fittings 2.5 Inches and Larger: Butt weld stainless steel conforming to ASTM A403/A403M, Class WP, Type 304L, seamless or welded, and ASME B16.9 of the same minimum wall thickness as the adjoining pipe. Welded fittings must be tested and inspected the same as the welded seam pipe and meet the same requirements as for the pipe. Elbows located between the pig launcher and the receiver, must have a radius 3 times the pipe diameter (3D bends). Tees with branches 6-inches and larger, must have guide bars as detailed on the drawings.

b. Fittings 2-Inches and Smaller: Forged Type 304 or 304L (socket welded or if indicated on drawings, threaded), 3,000-pound W.O.G. conforming to ASTM A182/A182M and ASME B16.11. Threaded fittings must only be used for above grade applications. Underground and in pits low point drain pipe and high point vent pipe must be butt welded.

c. Unions. Conforming to ASTM A312/A312M, Grade 304 or 316.

d. Flanges. 150 pound weld neck, forged Type 304 stainless steel flanges conforming to ASTM A182/A182M and ASME B16.5, except flanges that are to be connected to the fueling/defueling pumps must be 300-pound. For flanges 2" and smaller located in contained pumphouses, contained truck offloads, contained truck fill stands, and other visibly contained areas the fitting may be forged (socket welded), 900 kg 3,000-pound W.O.G., conforming to ASTM A182/A182M and ASME B16.11. In pits, vaults, on PRV piping for pipeline routes, and other uncontained locations the connection must be butt welded. Flanges to be 1/16-inch raised-face with phonographic finish, except where required otherwise to match equipment furnished. Match flange face to valves or equipment furnished. Flanges must be subjected to the Supplementary Requirements S56, Liquid Penetrant Examination as outlined in ASTM A961/A961M. Detectable flaws will not be acceptable.

e. Stainless Steel Tube Fittings. Flareless, 316 stainless steel fittings conforming to SAE J514.

f. Fabricated Bends. Where indicated, provide fabricated bends with a centerline radius equal to 3 times the nominal pipe diameter (3D bends). 3D bends must have a 1 foot long straight section on each side of the bend (from tangent points), to prevent ovality at the weld joints. Field bending of pipe is not permitted. 3D bends must be fabricated of stainless steel pipe that complies with paragraph STAINLESS STEEL PIPING of this section.

2.2.3.3 Isolating Gasket Kits (Insulating) for Flanges

Provide ASTM D229 electrical insulating material of 1,000 ohms minimum resistance or 500 Volts per Mil (VPM) minimum dielectric strength; material must be resistant to the effects of aviation hydrocarbon fuels. Provide full face insulating gaskets between flanges with fluoroelastomer (FKM), commonly referred to as Viton, O-ring sealing surfaces. Provide full surface 0.03-inch thick wall thickness, spiral-wound mylar insulating sleeves between the bolts and the holes in flanges; bolts may have reduced shanks of a diameter not less than the diameter at the root of threads. Provide 0.125-inch thick high-strength

phenolic insulating washers next to flanges and provide flat circular stainless steel washers over insulating washers and under bolt heads and nuts. Provide bolts 0.5-inch longer than standard length to compensate for the thicker insulating gaskets and the washers under bolt heads and nuts. Above grade flanges separated by electrically isolating gasket kits must be provided with weatherproof lightning surge arrester devices. The surge arrester must bolt across flanges separated by insulating gasket kits per detail on contract drawings. The arrestor must have the following features:

a. Weatherproof NEMA 6P enclosure.
b. Bidirectional and bipolar protection.
c. Constructed of solid state components, no lights, fuses or relays and used without required maintenance or replacement.
d. Withstand unlimited number of surges at 50,000 Amperes.
e. Maximum clamping voltage of 700 Volts based on a IEEE C62.41 8x20 microsecond wave form at 50,000 Amperes peak measured at the device terminals (zero lead length).
f. A UL listed arrester for installation in Class 1, Division 1 or Class 1, Division 2, Group D, hazardous areas.

Install the mounting bracket and leads on the flange side of the bolt insulating sleeve and washer, and size in accordance with this schedule:

Line Size	Bolt Size
2 inch	5/8 inch
2.5 inch	5/8 inch
3 inch	5/8 inch
4 inch	5/8 inch
6 inch	3/4 inch
8 inch	3/4 inch
10 inch	7/8 inch
12 inch	7/8 inch
14 inch	1 inch
16 inch	1 inch

Note: Make allowance for the 1/32-inch thickness of the insulating sleeve around the bolts when sizing the mounting lugs.

2.2.3.4 Flange Protectors

Protectors shall protect the bolts, studs, nuts, and gaskets of a flanged end connection from corrosion or damage due to exposure to the environment. Protectors must be weather and ultraviolet (UP) resistant. Protectors must allow for quick and easy removal and re-installation by maintenance personnel. Provide grease filled bolt caps. Corrosion prevention grease shall be non-expansive and designed for the service. Provide protectors that allow for visual inspection of the flange gasket without requiring removal. Provide protectors with grease fittings which allow the injection of grease into the flange cavity. Only provide in low point drain pits, high point vent pits, and isolation valve vaults.

2.2.4 Nuts and Bolts

Bolts and nuts for pipe flanges, flanged fittings, valves and accessories must conform to ASME B18.2.1 and ASME B18.2.2, except as otherwise specified. Bolts must be of sufficient length to obtain full bearing on the nuts and must project no more than three full threads beyond the nuts with the bolts tightened to the required torque. Bolts must be regular hexagonal bolts conforming to ASME B18.2.1 with material conforming to ASTM A193/A193M, Class 2, Grade B8, stainless steel, when connections are made where a stainless steel flange is involved, and Grade B7, chromium molybdenum alloy, when only carbon steel flanges are involved. Bolts must be threaded in accordance with ASME B1.1, Class 2A fit, Coarse Thread Series, for sizes one inch and smaller and Eight-Pitch Thread Series for sizes larger than one inch. Nuts must conform to ASME B18.2.2, hexagonal, heavy series with material conforming to ASTM A194/A194M, Grade 8, stainless steel for stainless steel bolts, and Grade 7, chromium molybdenum allow for chromium molybdenum alloy bolts. Nuts must be threaded in accordance with ASME B1.1, Class 2B fit, Coarse Thread Series for sizes one inch and smaller and Eight-Pitch Thread Series for sizes larger than one inch. Provide washers under bolt heads and nuts. Use chromium molybdenum alloy washers dimensioned to ASTM F436 flat circular for chromium molybdenum bolts. Stainless steel washer dimensioned in accordance with ASTM F436 flat circular, use material the same as the bolt. Use torque wrenches to tighten all flange bolts to the torque recommended by the gasket manufacturer. Tight in the pattern recommended by the gasket manufacturer. Use anti-seize compound on stainless steel bolts.

2.2.5 Gaskets

ASME B16.21, composition ring, using a Buna-N, polytetrafluoroethylene (PTFE), or a protein and glycerin binder, 0.1250-inch thick. Gaskets must be resistant to the effects of aviation hydrocarbon fuels and manufactured of fire-resistant materials. Full-face gaskets must be used for flat-face flanged joints. Ring gaskets must be used for raised-face flanged joints. Gaskets must be of one piece factory cut.

2.2.6 Relief and Drain System Piping

Pressure relief valve discharge lines and drain lines to the product recovery tank must be Schedule 40 ASTM A312/A312M seamless Type 304L Stainless Steel. See Gaskets specified herein before.

2.2.7 Relief and Drain System Protective Coating

Pipe must be factory coated as specified herein before for steel piping.

2.2.8 Stainless Steel Field Applied Protective Coatings

The field joints and fittings of all underground piping must be coated in accordance with Section 33 52 80 LIQUID FUELS PIPELINE COATING SYSTEMS, Para 2.2 (Field Applied External Pipe Coating).

2.2.9 Threaded Joints

Threaded joints, if indicated on the drawings, must be made tight with manufacturer recommended PTFE tape or a mixture of graphite and oil, inert filler and oil, or with a graphite compound, applied with a brush to the

male threads. Not more than three threads must show on made up joints. Threaded joints, mechanical couplings and flanges will not be permitted in buried piping. Threaded joints must not get welded.

2.2.10 Welded Joints

Welded joints in steel pipe must be as specified in Part 3.

2.3 MANUAL VALVES

All portions of a valve coming in contact with fuel in stainless steel pipe lines or epoxy lined carbon steel pipe lines must be of noncorrosive material. Valves in stainless steel pipe lines or epoxy lined carbon steel pipe lines must be Type 304 or Type 316 stainless steel or carbon steel internally plated with chromium or nickel or internally electroless nickel plated. Valves in unlined carbon steel pipelines must have carbon steel body. Stem and trim must be stainless steel for all valves. Manually operated valves 6 inches and larger must be worm-gear operated and valves smaller than 6 inches must be lever operated or handwheel operated. Valves smaller than 2 inches must have lever-type handles. Handles installed more than 6 feet above finished floor must have chain operators. Valve indicators installed higher than 5 feet must have a position indicator visible from ground level. Sprocket wheel for chain operator must be aluminum. Valves in the isolation pits in fuel piping between the pig launchers and the pig receivers must be full bore, piggable, double block and bleed type. The full bore piggable valves at the launcher and the receiver must be ball type.

2.3.1 Ball Valves

Ball valves must be fire tested and qualified in accordance with the requirements of API Std 607 and API STD 608. Seal material for the fire test must be graphite, seal material for the project must be as as indicated below. Ball valves must be nonlubricated valves that operate from fully open to fully closed with 90 degree rotation of the ball. Valves 2 inches and larger must conform to applicable construction and dimension requirements of API Spec 6D, ANSI Class 150 and must have flanged ends. Valves smaller than 2 inches must be ANSI class 150 valves with flanged ends, unless noted otherwise. The balls in valves 10 inches full port and 12 inch regular port and larger must have trunnion type support bearings. Except as otherwise specified, reduced port or full port valves may be provided at the Contractor's option. All 1-inch ball valves associated with thermal relief assemblies shall be full port. Balls must be solid, not hollow cavity.

2.3.1.1 Materials

Ball must be stainless steel. Ball valves must have polytetrafluoroethylene (TFM) or fluoroelastomer (FKM), commonly referred to as Viton seats, body seals and stem seals. Valves 4 inches and smaller must have a locking mechanism.

2.3.2 Plug (Double Block and Bleed) Valves

API Spec 6D, ANSI Class 150, non-lubricated, resilient, double seated, trunnion mounted, tapered lift plug capable of two-way shutoff. Valve must have tapered plug of steel or ductile iron with chrome or nickel plating and plug supported on upper and lower trunnions. Sealing slips must be steel or ductile iron, with Viton seals which are held in place by

dovetail connections. Valve design must permit sealing slips to be replaced from the bottom with the valve mounted in the piping. Valves must operate from fully open to fully closed by rotation of the handwheel to lift and turn the plug. Valves must have weatherproof operators with mechanical position indicators. Indicator shaft must be stainless steel. Minimum bore size must be not less than 65 percent of the internal cross sectional area of a pipe of the same nominal diameter unless bore height of plug equals the nominal pipe diameter and manufacturer can show equal or better flow characteristics of the reduced bore size design. Full port plug valves in distribution piping must be provided with a 1/2-inch threaded body drain. Provide full port (piggable) double block and bleed plug valves where indicated on the mechanical drawings.

2.3.2.1 Valve Operation

Rotation of the handwheel toward open must lift the plug without wiping the seals and retract the sealing slips so that during rotation of the plug clearance is maintained between the sealing slips and the valve body. Rotation of the handwheel toward closed must lower the plug after the sealing slips are aligned with the valve body and force the sealing slips against the valve body for positive closure. When valve is closed, the slips must form a secondary fire-safe metal-to-metal seat on both sides of the resilient seal. Plug valves located in Isolation Valve Pits or vaults must be provided with handwheel extensions.

2.3.2.2 Relief Valves

ANSI Class 150. Provide plug valves with automatic thermal relief valves to relieve the pressure build up in the internal body cavity when the plug valve is closed. Relief valves must open at 25 psi differential pressure and must discharge to the throat of, and to the upstream side, of the plug valve.

2.3.2.3 Bleed Valves

ANSI Class 150, stainless steel body valve. Provide manually operated bleed valves that can be opened to verify that the plug valves are not leaking when in the closed position.

2.4 THERMAL RELIEF VALVES

Relief valves must be the fully enclosed, spring loaded, angle pattern, single port, hydraulically operated type with plain caps, and must be labeled in accordance with ASME BPVC SEC VIII D1 (GPM). Valve stems must be fully guided between the closed and fully opened positions. The valves must be factory-set to open at 225 psi unless otherwise indicated on the drawings. Operating pressure must be adjustable by means of an enclosed adjusting screw. The valves must have a minimum capacity of 20 GPM at 10 percent overpressure. Valves must have a replaceable seat. Relief valves that do not relieve to a zone of atmospheric pressure or tank must be a balanced (non-ASME) type relief or regulator valve.

2.4.1 Valve Materials

Valves must have carbon steel bodies (stainless steel on SS pipelines) and bonnets with stainless steel springs and trim. Valves must be Class 150 flanged end connections.

2.5 PIPING ACCESSORIES

2.5.1 Pipe Sleeves

Pipe sleeves must be installed where indicated and at all points where the piping passes through concrete construction. Such sleeves must be of sufficient inside diameter to provide a minimum clear distance between the pipe and the sleeve of 1/2-inch. Sleeves through concrete pits or slabs must be GR TP316L Schedule 40S stainless steel pipe, unless indicated otherwise. Each sleeve must extend through the respective pit wall or slab and must be provided with a Buna-N casing seal (Viton when exposed to sunlight). Sleeves where piping passes under roads or piping indicated to be double walled must be standard weight carbon steel pipe with a protective coating as previously specified. Alignment of the sleeve and piping must be such that the pipe is accurately centered within the sleeve by a nonconductive centering element. The sleeve must be securely anchored to prevent dislocation. Closure of space between the pipe and the pipe sleeve must be by means of a mechanically adjustable segmented elastomeric seal. The seal must be installed so as to be flush.

2.5.2 Strainers

2.5.2.1 Cone Type

Strainer must be stainless steel type 304 or 316, 100 mesh screen with the ratio of net open area of strainer to the area of the connecting pipe must be not less than three to one at the pump suction, and 5/32-inch perforations and suitable for bi-directional flow at the inlet to the hydrant pit control valves.Pump suction strainer must have a 100 mesh screen with not less than 300 percent open area (ratio of the strainer open area to the cross section of pipe). Hydrant pit control valve strainer must be the basket type, have 5/32 inch perforations, suitable for bidirectional flow, and have a minimum 200 percent open area.

2.5.3 Pipe Supports

2.5.3.1 General

Pipe supports must conform to MSS SP-58. Supports must be provided at the indicated locations. Steel support structures shall be hot-dipped galvanized unless otherwise noted on the Structural drawings. A PTFE pad must be installed between the pipe and any steel structure to prevent metal to metal contact.

2.5.3.2 Adjustable Pipe Supports

Adjustable pipe supports must consist of a cast iron saddle and a threaded nipple connected to a carbon steel pipe by means of a special reducer conforming to MSS SP-58. The supports must be provided with PTFE insulation strips.

2.5.3.3 Low Friction Supports

Low friction supports must be self-lubricating antifriction element composed of reinforced PTFE. Units must be factory designed and manufactured.

2.5.3.4 Concrete and Grout

Concrete and grout for anchors and supports must comply with SECTION 03 30 00 CAST-IN-PLACE CONCRETE.

2.5.4 Pigging Accessories

2.5.4.1 Closure Door

The closure must be hinged, swing bolted closure of the same material as the pipe and for a Class 150 system. Gasket must be nitrile. Eye bolts must be pinned to lugs on the hub.

2.5.4.2 Signaler

The pig signaler must be mechanical flag type with manual reset, and be located on the pig launcher and the pig receiver. Material in contact with the fuel must be stainless steel. Units must be suitable for removal and installation under line pressure of 275 psig. Signaler must be capable of withstanding line pressure of a Class 150 system.

PART 3 EXECUTION

3.1 VERIFICATION OF DIMENSIONS

After becoming familiar with details of the work, verify dimensions in the field, and advise the Contracting Officer of any discrepancy before performing any work.

3.2 CLEANING OF PIPING

Keep the interior and ends of all new piping, affected by construction operations, thoroughly cleaned of foreign matter and water before and after being installed. Piping systems must be kept clean during installation by means of plugs or other approved methods. When work is not in progress, open ends of piping and fittings must be closed so that no water or other foreign substance will enter the pipes or fittings. Piping must be inspected before placing into position. The interior of each length of pipe must be cleaned after welding insuring that the interior of the piping is free of foreign matter when it is connected into the system.

3.3 TRENCHING AND BACKFILLING

Trenching and backfilling must conform to , and the following bedding and backfill requirements. The pipe must be laid in a bed of sand 6 inches deep, compacted in accordance with Section 31 00 00 EARTHWORK, paragraph "Backfilling and Compaction". Sand must meet the requirements of Section 31 00 00 EARTHWORK, paragraph "Select Granular Material". The full length of each section of pipe without any protective covering must be excavated to permit installation of the protective covering. Pipe that has the grade or joint disturbed after laying, must be taken up and relaid. Pipe must not be laid in water or when the trench or weather conditions are unsuitable for such work. After testing and application of protective covering to joints, sand backfill must be placed and compacted around the pipe or protective coating to a depth of 1 foot above top of pipe. The remainder of the backfill must be the same as for other types of pipe.

3.4 PIPING LAYOUT REQUIREMENTS

3.4.1 Pipe Fabrication

Fabricate piping to measurements established on the project site and position into place without springing or forcing. Make provisions for absorbing expansion and contraction without undue stress in any part of the system. The use of flexible hoses in permanently mounted pump suction and discharge lines as a method of compensating for piping misalignment is not acceptable.

3.4.2 Interferences and Measurements

Provide offsets, fittings, and accessories required to eliminate interferences and to match actual equipment connection locations and arrangements. Verify measurements before commencing work. Submit discrepancies for clarification before proceeding with the installations to the Contracting Officer.

3.4.3 Space and Access

Keep piping, control tubing, which is not detailed close to structures and columns so as to take up a minimum amount of space. Ensure that access is provided for maintenance of equipment, valves and gauges.

3.4.4 Location

Do not place unions in locations that will be inaccessible after the completion of the work. Place unions on each side of equipment.

3.4.5 Piping and Equipment

Provide anchors where required to absorb or transmit thrust or eliminate vibration or pulsation. Provide hangers and supports near each change of direction. Select support components which do not restrict the movement of the pipe due to thermal expansion. Space hangers uniformly and arrange symmetrically.

3.4.6 Structural Support

Provide supplementary or intermediate steel or other structural members as required for transmission of loads to members forming part of the supporting structure. Piping must not be supported from other piping.

3.4.7 Grade

Where profiles of piping lines are shown on the drawings, grade the line uniformly between changes in slope or direction. Maintain gradient to within ± 1/4-inch over the entire length of pipe. When backfilling has been completed to the top of the pipe, the pipe must be surveyed at each joint, and logged by station number. Submit to the Contracting Officer for approval the survey final elevations before backfilling can continue.

3.4.8 Size Changes

Make changes in pipe size with reducing fittings. Do not use bushings. In lieu of welding reducing outlet tees for piping 2 inches and larger, welding branches suitable for 100 percent radiographic inspection may be used. Do not use weldolets unless specifically called out (labeled) on

the drawings.

3.4.9 Direction Changes

Make changes in direction of pipes with long radius fittings. Provide special fittings when required. Do not make miter welds. Make odd-angle offsets with pipe bends or elbows cut to the proper angle.

3.5 WELDING

3.5.1 General

All joints, unless indicated otherwise, in stainless steel piping systems must be welded. Welding of fuel pipe joints must comply with Section 33 52 23.15 SERVICE PIPING WELDING.

3.6 INSTALLATION

3.6.1 Precautions

Take special care to ensure that the protective coating on buried pipe is not damaged during installation and that the completed system is free of rocks, sand, dirt, water, weld slag, and foreign objects including construction debris. Take the following steps to ensure these conditions.

a. Coated pipe must be handled only with canvas or nylon slings or padded clamps. Any coating damaged by improper handling or storage must be repaired as specified.

b. Pipe brought to the site must be stored on blocks or horses at least 18 inches above the ground and adequately supported to prevent sagging. Padded blocks or horses must be used for coated pipe. The method and height of storing coated pipe must be in accordance with the coating manufacturer's instructions. Pipe ends must be protected and capped against weather at all times, except to accommodate immediate installation.

c. Visual inspection must be made of the inside of each length of pipe to ensure that it is clear and clean prior to installation.

d. The open ends of the pipe system must be closed at the end of each day's work or when work is not in progress by use of expansion plugs and must not be opened until the work is resumed.

e. A swab, with a leather or canvas belt disc to fit the inside diameter of pipe, must be pulled through each length of pipe after welding in place.

f. Obstruction remaining in the pipe after completion of the system must be removed at the expense of the Contractor.

g. Plasma cutters and torches are not to be used to make penetrations in the pipe or to cut pipe.

h. After installation and backfill of the hydrant loop is complete and before fuel is put in the pipe, the pipe will be cleaned using foam swabs and poly coated wire brush pigs and compressed dry gas, residual humidity of not over 20 percent. Ten flights of a combination of swab and brush pigs must be run. During this, low point drains and high

point vents must be blown clean.

3.6.2 Protective Coatings for Buried Stainless Steel Piping

Refer to Section 33 52 80 LIQUID FUELS PIPELINE COATING SYSTEM.

3.7 INSTALLATION OF UNDERGROUND PIPE

Underground fuel pipelines must be pitched as shown on the drawings. Where not indicated they must be pitched a minimum of 2 inches per 100 feet. Branch lines to the hydrant pits must slope up to the pit. Two-inch pipe size valved drain connections must be provided at all low points and 1-1/2-inch pipe size valved outlet vent connections must be provided at all high points. Vent and drain lines must terminate in male cam-type locking end connectors with matching female dust covers and installed in pits. The pipe must have cover as shown on the drawings. Drain lines must be installed at the slopes indicated.

3.7.1 Pipe Assembly

Pipe must be strung parallel and adjacent to or above a trench. The pipe must be supported on padded skids during welding and inspection of joints. Protective coating must be inspected and repaired prior to lowering the pipe into the trench. The pipe must be lowered using only canvas or nylon slings. The sling must be dug from underneath the pipe after placements and must not be pulled from underneath the pipe while in contact with it. Care must be taken to prevent damage to the pipe, welded joints or coating and any such damage must be repaired as directed by the Contracting Officer. Pressure testing of the pipe must be done after it has been placed in final position in the trench.

3.7.2 Warning Tapes in Earth Trenches

For the purpose of early warning and identification of buried pipes outside of building walls during future trenching or other excavation, continuous identification tapes must be provided in the trench. Provide metallic core or metallic-faced, acid- and alkali-resistant, polyethylene plastic warning tape manufactured for the purpose of early warning and identification of utilities buried below the tape. Tape must be at least 3 inches in width. Color of tape must be as standard with the manufacturer with respect to the type of utility buried below the tape. Tape must have lettering at least 1 inch high with warning and identification imprinted in bold black letters continuously over the entire tape length with not less than the following identification on the tape: BURIED JET FUEL PIPING BELOW. Tape must be installed in accordance with the printed recommendations of the tape manufacturer, as modified herein. Tapes must be buried at a depth of 6 inches from the top of the subgrade or 12 inches below the top surface of earth. Provide permanent color and printing, unaffected by moisture or soil.

3.7.3 Clearances

Install pipe to be clear of contact with other pipes, pipe sleeves, casings, reinforcing steel, conduits, cables, or other metallic structures. Where pipes cross other pipes or structures with a separation of less than 6 inches, install an insulating separator. Protect the pipe from contact with a 12-inch square by 1 inch thick bituminous-impregnated cane fiber board.

3.7.4 Protective Coating

When the protective coating on pipe is damaged, the Contracting Officer must be notified and must inspect the pipe before the coating is patched. If the damage to the pipe is deeper than 0.050-inch, the damage must be repaired by welding in accordance with paragraph "WELDING". If the pipe is dented, out of round or damaged to the point that welding will not make it good as new, the length of pipe must be rejected.

3.8 TESTING

Piping must be tested by pneumatic and hydrostatic pressure. Testing must comply with applicable requirements of ASME B31.3, NFPA 30 and the requirements specified herein. Hydrostatic testing must be performed using fuel as the liquid. Water must not be introduced into the system for testing. Pneumatic and hydrostatic testing must be performed only after welding inspection has been completed.

3.8.1 Pneumatic Test

Piping to be installed underground must not receive field applied protective covering at the joints or be covered by backfill until the piping has passed the pneumatic test described herein. To facilitate the tests, isolate various sections of the piping system and test each one separately. Where such sections terminate at flanged valve points, the line must be closed by means of blind flanges in lieu of relying on the valve. Furnish tapped flanges that can be attached to the end of the section of line being tested, and that will permit a direct connection between the piping and the air compressor and/or pressurizing pump. No taps in the permanent line will be permitted. Furnish all necessary equipment for testing; all gauges must be subject to testing and approval of the Contracting Officer. The air used for pneumatic testing must have a dew point of no more than 41 degrees F. Provide dehumidifying equipment on the suction or discharge side of the air compressor used to provide air for testing. Pressurizing pump must not exceed 10 cfm.

3.8.1.1 Pneumatic Test Procedure

Special safety measures, including the wearing of face mask, must be taken during testing under pressure. Only authorized personnel must be permitted in the area during testing. The pneumatic test pressure must be applied in increments. A preliminary 25 psig test must be applied. Examine joints with soap solution. Leaks revealed by this test must be repaired. The full test pressure must then be applied. Unless otherwise directed by the Contracting Officer, all piping must be tested at a pressure of 50 psig for not less than 2 hours, during which time there must be no drop in pressure, only pressure rises with temperature. The pressure source must be disconnected during the final test period. Any leaks revealed by the test must be repaired and the test repeated.

3.8.1.2 Hydrostatic Test

Upon completion of pneumatic testing and after backfilling, hydrostatically test each piping system with fuel at 415 psig in accordance with ASME B31.3 and API RP 1110, with no leakage or reduction in gauge pressure for four hours. Furnish electricity, instruments, connecting devices, and personnel for test. Fuel must be furnished by the Government. Equipment which is not rated by the manufacturer for the test pressure must be removed prior to testing. Defects in work must be

corrected at the Contractor's expense, and the test repeated until the work is proven to be in compliance with the Contract requirements.

3.8.2 Performance Testing

After the system is completed (including pneumatic and hydrostatic testing) the fuel system must be cleaned and performance tested as specified in Section 33 08 53 AVIATION FUEL DISTRIBUTION SYSTEM START UP. All control valves, both manual and automatic, must be checked for leaks (any area wetted with fuel) and proper operation and adjusted, repaired or replaced to correct any defects.

3.9 PIPELINE PIGGING VERIFICATION

3.9.1 Pipeline Internal Inspection Operations

3.9.1.1 General

The following pigs will be propelled through the pipeline with product in order to inspect the pipeline: 5 pound density foam swab, combination poly scraper-magnetic, stainless steel wire brush, and aluminum plate gauge. Tracking devices must be used on all pigs. At a minimum, the sequence of pig runs must be as follows: 1) foam swab for proving and cleaning, 2) wire brush for cleaning, 3) scraper-magnetic for cleaning, 4) aluminum plate gauge for gauging internal anomalies, 5) scraper-magnetic for cleaning, 6) wire brush for cleaning, 7) scraper-magnetic for cleaning, 8) foam swab for cleaning, (Note: the number of pig flights of each type of cleaning pigs must be determined by the amount and type of debris removed. The conclusion of the cleaning process must be when debris recovered is only that from the pigs themselves. This determination will be determined by the project's system supplier and the Contracting Officer).

3.9.1.2 Preparatory Work

The Government will bring to the attention of the Contractor all statutes, rules and regulations relevant to the performance of the work on the site (on Government property) and will also provide the Contractor with a copy of its own site regulations (if any). Provide the pigging vendors with all-available pipeline records and drawings.

3.9.1.3 Pig Load And Launch

The pig must be loaded into the pig launcher by the Contractor. The method of loading and lodging the front pig cup into the launcher must not involve the use of uncontrolled mechanical force applied to the rear of the pig. A temporary pig launcher and receiver must be provided by the Contractor to pig the new hydrant loop.

3.9.1.4 Pipeline Operation During Pigging

All pig runs to the new hydrant loop must be made with the line packed with product. The temporary pumps will be used to propel the pig. The temporary pig traps will be used for pig launch and retrieval.

3.9.1.5 Brush and Gauging Survey

Run a brush pig at least as often as previously indicated. The brush pig must be designed and provided by the geometry/ultrasonic pig vendor.

Additional runs may be required based upon the amount of debris found in the pipeline. The onsite geometry/ultrasonic pig vendor's personnel and COR must determine if additional runs are required. Immediately following the brush pig run and immediately prior to the geometry/ultrasonic survey, run, as a minimum, a single batching pig fitted with a gauge plate equal to 90 percent of the pipeline normal inside diameter. The plate is to be a segmented aluminum disk of 1/8 inch thickness. The plate gauge pig must also include a tracker and tracking equipment. Track the pig assembly above ground during the operation.

3.9.1.6 Lost Pig

The Contractor is responsible for a lost pig, finding the pig, retrieval of the pig, and all repairs, radiographs to the pipeline system and the pig.

-- End of Section --

SECTION 33 52 80

LIQUID FUELS PIPELINE COATING SYSTEMS
08/22

PART 1 GENERAL

1.1 REFERENCES

The publications 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.

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C210	(2015) Standard for Liquid Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines
AWWA C213	(2022) Fusion-Bonded Epoxy Coatings and Linings for Steel Water Pipe and Fittings

ASTM INTERNATIONAL (ASTM)

ASTM D3276	(2015; E 2016) Standard Guide for Painting Inspectors (Metal Substrates)
ASTM D3335	(1985a; R 2020) Low Concentrations of Lead, Cadmium, and Cobalt in Paint by Atomic Absorption Spectroscopy
ASTM D3718	(1985a; R 2015) Low Concentrations of Chromium in Paint by Atomic Absorption Spectroscopy
ASTM D3925	(2002; R 2015) Sampling Liquid Paints and Related Pigmented Coatings
ASTM D4285	(1983; R 2018) Indicating Oil or Water in Compressed Air
ASTM D4417	(2021) Standard Test Methods for Field Measurement of Surface Profile of Blast Cleaned Steel

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 8502-3	(2017) Preparation of Steel Substrates Before Application of Paints and Related Products - Tests for the Assessment of Surface Cleanliness - Part 3: Assessment of Dust on Steel Surfaces Prepared for Painting (Pressure-Sensitive Tape Method)
ISO 9001	(2015) Quality Management Systems-Requirements

NACE INTERNATIONAL (NACE)

NACE RP0402	(2002) Field-Applied Fusion-Bonded Epoxy (FBE) Pipe Coating Systems for Girth Weld Joints: Application, Performance, and Quality Control

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC AB 1	(2015; E 2017) Mineral and Slag Abrasives
SSPC AB 2	(2015; E 2016) Cleanliness of Recycled Ferrous Metallic Abrasive
SSPC AB 3	(2023; R 2023) Ferrous Metallic Abrasive
SSPC Guide 6	(2021) Guide for Containing Surface Preparation Debris Generated During Paint Removal Operations
SSPC Guide 12	(2023) Guide for Illumination of Industrial Painting Projects
SSPC PA 1	(2024) Shop, Field, and Maintenance Coating of Metals
SSPC PA 2	(2015; E 2018) Procedure for Determining Conformance to Dry Coating Thickness Requirements
SSPC QP 1	(2019) Standard Procedure for Evaluating the Qualifications of Industrial/Marine Painting Contractors (Field Application to Complex Industrial Steel Structures and Other Metal Components)
SSPC QP 3	(2010) Standard Procedure for Evaluating Qualifications of Shop Painting Applicators
SSPC QP 5	(2022) Standard Procedure for Evaluating the Qualifications of Coating and Lining Inspection Companies
SSPC QS 1	(2015) Standard Procedure for Evaluating a Contractor's Advanced Quality Management System
SSPC SP 1	(2015) Solvent Cleaning
SSPC SP 17	(2019) Thorough Abrasive Blast Cleaning of Non-Ferrous Metals
SSPC VIS 1	(2002; E 2004) Guide and Reference Photographs for Steel Surfaces Prepared by Dry Abrasive Blast Cleaning

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910-SUBPART Z	Toxic and Hazardous Substances

29 CFR 1910.134	Respiratory Protection
29 CFR 1910.1000	Air Contaminants
29 CFR 1926.59	Hazard Communication

1.2 SYSTEM DESCRIPTION

This section specifies the requirements for exterior coating of below ground and buried carbon steel and stainless steel liquid fuel pipelines. The exterior coating system for buried pipelines is a fusion bonded epoxy (FBE) system. Fusion bonded epoxy coating is specified for the interior of carbon steel aviation fuel pipe to protect fuel iron contamination.

1.3 DEFINITIONS

Definitions are generally provided throughout this Section in the paragraphs where used and denoted by capital letters. The following definition is used throughout this Section:

a. INDEPENDENT THIRD-PARTY - Impartial third-party not a part or affiliated with Contractor or subcontractor principal or subsidiary businesses, and not a materials supplier.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" classification. Submittals not having a "G" classification are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Contract Errors, Omissions, and Other Discrepancies

Corrective Action Procedures

Corrective Action Request (CAR) Form

Coatings Work Plan

Inspection Report Forms

SD-03 Product Data

External Pipe Coating

Internal Pipe Coating

Field-Applied External Pipe Coating

SD-05, Design Data

Containment System

SD-06 Test Reports

Inspection Report Forms

Daily Inspection Reports

Coatings Qualification Test Reports

Non-Metallic Abrasive Qualification Test Reports

Coating Field Test Reports

Abrasive Field Test Reports

SD-07 Certificates

Contract Errors, Omissions, And Other Discrepancies

Corrective Action Procedures

Coatings Work Plan

Qualifications of Certified Industrial Hygienist (CIH)

Qualifications of Pipe Coating Shop

Qualifications of Certified Protective Coatings Specialist (PCS)

Qualifications of Coatings Inspection Company

Qualifications of Quality Assurance Coatings Inspector

Qualifications of Coatings Contractors for Field Coating

Qualifications of Individuals Performing Abrasive Blasting for Field Coating

Qualifications of Individuals Performing Coating Application for Field Coating

Qualifications of Testing Laboratory for Coatings

Qualifications of Testing Laboratory for Abrasive

Coating Materials Certificate of Conformance

Non-Metallic Abrasive Certificate of Conformance

SD-08 Manufacturer's Instructions

Coating System Instructions

SD-11 Closeout Submittals

Disposal of Used Abrasive Shop Applied Coating

Disposal of Used Abrasive Field Applied Coating

Inspection Logbook

Corrective Action Log; G

1.5 QUALITY ASSURANCE

1.5.1 Contract Errors, Omissions, and Other Discrepancies

Submit all errors, omissions, and other discrepancies in contract documents to the Contracting Officer within 30 days of contract award for all work covered in this Section, other than the work that will not be uncovered until a later date. All such discrepancies must be addressed and resolved, and the Coatings Work Plan modified, prior to beginning the Initial and Follow-Up phases of work. Discrepancies that become apparent only after work is uncovered must be identified at the earliest discoverable time and submitted for resolution. Schedule time (float) must be built into the project schedule at those points where old work is to be uncovered or where access is not available during the first 30 days after award, to allow for resolution of contract discrepancies.

1.5.2 Corrective Action (CA)

CA must be included in the Contractor Quality Control Plan as outlined in Section 01 45 00 QUALITY CONTROL.

1.5.2.1 Corrective Action Procedures

Develop procedures for determining the root cause of each non-compliance, developing a plan to eliminate the root cause so that the non-compliance does not recur, and following up to ensure that the root cause was eliminated.

1.5.2.2 Corrective Action Request (CAR) Form

Develop Corrective Action Request (CAR) forms for initiating CA and for tracking and documenting each step. The CAR should be included with the Corrective Action Procedures. A CAR must be initiated by either the Contractor or the Contracting Officer. The Protective Coatings Specialist (PCS) must approve each CAR at the root cause identification stage, the plan for elimination stage, and the close out stage after verification that the root cause has been eliminated.

1.5.2.3 Corrective Action Log

When a CAR is initiated, Contractor must take action to identify and eliminate the root cause of each non-compliance so as to prevent recurrence. These actions must apply to non-compliance in the work, and to non-compliance in the Quality Control (QC) System. Corrective actions must be appropriate to the effects of the non-compliance encountered. The corrective action must be documented in a report that is serialized and tracked in the Corrective Action Log until project completion and its acceptance by the Contracting Officer. All corrective action reports must be retained in project records. The Corrective Action Log, showing status of each CAR, must be submitted to the Contracting Officer monthly.

1.5.3 Coatings Work Plan

This work plan must be considered as part of the Contractor Quality Control Plan as outlined in Section 01 45 00 QUALITY CONTROL.

The Coatings Work Plan must be submitted and approved by the PCS prior to mobilization. The Coatings Work Plan must explain in detail all procedures including, but not limited to, all sequential processes,

quality control for each process, quality assurance for each process, and safety considerations. Subsections must include at least the following:

a. Purpose;

b. Introduction;

c. Safety, fire, and health information;

d. Contractor and worker qualifications with certifications;

e. Project management organization and documents;

f. Timeline in a Gantt chart;

g. Project document references;

h. Reference to all applicable standards (e.g., AMPP, NACE, SSPC, ISO, and ASTM);

i. Coatings manufacturer's supporting documentation;

j. Descriptions and explanations of any exceptions from the coating manufacturer (including those specific to stainless steel piping;

k. Coating and blasting equipment, model names, and, if applicable, calibration dates;

l. Containment design and/or details;

m. Environmental testing;

n. Material delivery, storage, and handling details;

o. Surface preparation;

p. Pre-application test panel validation for field-applied external coating as outlined in SURFACE STANDARD;

q. Coating materials, mixing, application, recoat windows, and coating curing times, if applicable;

r. Coating repairs and rework;

s. Non-conformance;

t. Spent material handling and effluent discharge containment and disposal;

u. Inspection test plan (as outlined in FIELD INSPECTION, and including inspection hold points, both Quality Assurance and Coating Contractor QC Coatings Inspector's responsibilities, and daily documentation and delivery);

v. Instruments and test kits;

w. Warranty (in writing, signed by the Contractor and the coating manufacturer's representative);

x. Demobilization;

y. PCS and PM approval;

1.5.4 Design Data

1.5.4.1 Containment System for Field Coating

Submit complete design drawings and calculations for the scaffolding and containment system, including an analysis of the loads which will be added to the structure by the containment system and waste materials. A registered engineer must approve calculations and scaffold system design.

1.5.5 Test Reports

1.5.5.1 Coatings Qualification Test Reports

Submit test results from an INDEPENDENT THIRD-PARTY laboratory of representative samples of each coating material. U.S. Department of Defense laboratories are considered to be INDEPENDENT THIRD-PARTY laboratories. Samples must have been tested within the last three years. The purpose of qualification testing is to pre-qualify the coatings used on buried pipe. Provide qualification testing results for exterior coatings used for repairs or girth welds on buried pipe in conformance with NACE RP0402. Provide qualification testing results for shop applied exterior coatings for buried pipe in conformance with AWWA C213.

Qualification testing must be based on all required production verification testing required by NACE RP0402. For AWWA C213, provide test reports for production verification testing described in paragraph OPTIONAL EPOXY PERFORMANCE TESTING OF COATED PIPE of AWWA C213, including cross-section porosity, interface porosity, thermal analysis (DSC), permanent strain (bendability), and interfacial contamination. Perform production verification testing on a minimum of one pipe joint in the first half hour of production each day, and on a minimum of one pipe joint in the last half hour of production each day. Perform additional testing as required to segregate any non-compliant material.

1.5.5.2 Non-Metallic Abrasive Qualification Test Reports

Submit results for abrasive as required in paragraph 4 REQUIREMENTS of SSPC AB 1. Submit test results from an INDEPENDENT THIRD-PARTY laboratory of representative samples of each abrasive to be used on the jobsite. Samples must have been tested within the last three years. Note that this testing is for the purpose of pre-qualifying the abrasive.

1.5.6 Qualifications

The qualifications specified in this Section must be met throughout the duration of this contract. Personnel and corporate entities must provide proof of active certification to all qualifications specified in this Section. Work must not be provided by personnel and corporate entities unless all specified qualifications are met.

1.5.6.1 Qualifications of Certified Industrial Hygienist (CIH)

Submit name, address, telephone number, fax number, and e-mail address of the INDEPENDENT THIRD-PARTY CIH. Submit documentation that the hygienist is certified by the American Board of Industrial Hygiene in comprehensive

practice, including certification number and date of certification/recertification. The CIH must remain certified during the entire project, and the Contracting Officer must be notified of any change in certification status within 10 days of the change. If a CIH's certification expires, the hygienist will not be allowed to perform any hygienist functions, and all hygienist work must stop, until the certification is reissued or another CIH is approved. Requests for extension of time for any delay to the completion of the project due to an inactive certification will not be considered and liquidated damages will apply. Provide evidence of experience with hazards involved in industrial coating application work.

1.5.6.2 Qualifications of Pipe Coating Shop

Each shop that applies coatings to pipe must be certified to SSPC QP 3 prior to contract award and must remain certified while accomplishing any surface preparation or coating application. If a shop's certification expires, the firm will not be allowed to perform any work until the certification is reissued. Requests for extension of time for any delay to the completion of the project due to an inactive certification will not be considered and liquidated damages will apply. Notify the Contracting Officer of any change in the shop's certification status within 10 days of the change. If a shop's qualification expires, the shop will not be allowed to perform any coatings related functions until the qualification is reissued. Requests for extension of time for any delay to the completion of the project due to an inactive qualification will not be considered and liquidated damages will apply. Notify the Contracting Officer of all scheduled and unannounced on-site audits from AMPP and furnish a copy of all audit reports.

For shops located outside the United States, Guam, and Puerto Rico, the certifications for the shop (SSPC QP 3) can be substituted if the coatings Contractor meets all of the below requirements:

a. ISO 9001 certified;

b. Eight years of experience with industrial coatings;

c. Evidence of recent work that has Contractor Performance Assessment Report System (CPARS) ratings, and/or other quality/performance ratings, that are equivalent to, or exceed, "Above Average";

d. Evidence of an INDEPENDENT THIRD-PARTY audit from AMPP demonstrating equivalency to SSPC QP 3 within the last two years.

The shop must be certified to ISO 9001 prior to contract award and must remain so certified for the duration of the project. Notify the Contracting Officer of any change in the shop's certification status within 10 days of the change. If a Contractor's qualification expires, the shop will not be allowed to perform any coatings related functions until the qualification is reissued. Requests for extension of time for any delay to the completion of the project due to an inactive qualification will not be considered and liquidated damages will apply. Notify the Contracting Officer of all scheduled and unannounced on-site inspections from the ISO certifying organization and furnish a copy of all inspection reports.

1.5.6.3 Qualifications of Certified Protective Coatings Specialist (PCS)

Submit name, address, telephone number, fax number, and e-mail address of the INDEPENDENT THIRD-PARTY PCS. Submit documentation that the PCS is certified by the Association for Materials Protection and Performance (AMPP) (formerly SSPC: The Society for Protective Coatings (SSPC)), including certification number and date of certification/recertification. If the PCS is employed by the same coatings inspection company to which the Quality Assurance Coatings Inspector is employed, this does not violate the INDEPENDENT THIRD-PARTY requirements. The PCS must be an INDEPENDENT THIRD-PARTY to the pipe coating shop. The PCS must remain certified during the entire project, and the Contracting Officer must be notified of any change in certification status within 10 days of the change. If a PCS's certification expires, the PCS will not be allowed to perform any PCS functions, and all coatings work must stop, until the certification is reissued or another PCS is approved. Requests for extension of time for any delay to the completion of the project due to an inactive certification will not be considered and liquidated damages will apply. The PCS must not be the designated Quality Assurance Coatings Inspector. The PCS's responsibilities are outlined in PROTECTIVE COATINGS SPECIALIST (PCS).

1.5.6.4 Qualifications of Coatings Inspection Company

Submit documentation that the selected quality assurance coatings inspection company is accredited by AMPP to the requirements of SSPC QP 5 prior to contract award. The coatings inspection company that is submitted and approved, must remain and cannot be changed through completion of the contract. The coatings inspection company must remain SSPC QP 5 certified for the duration of the coatings work. If a coatings inspection company's certification expires, the firm will not be allowed to perform any inspection functions, and all surface preparation and coating application work must stop, until the certification is reissued. Requests for extension of time for any delay to the completion of the project due to an inactive certification will not be considered and liquidated damages will apply. Notify the Contracting Officer of any change in the coatings inspection company certification status within 10 days of the change. Notify the Contracting Officer of all scheduled and unannounced on-site audits from AMPP and furnish a copy of all audit reports. The coatings inspection company must not engage in any activities that may conflict with their independence of judgment and integrity in relation to their inspection activities. In particular, they must not be engaged in the manufacture, supply, application, surface preparation, purchase, or maintenance of the applied coating in this project.

1.5.6.5 Qualifications of Quality Assurance Coatings Inspector

Submit documentation that each Quality Assurance Coatings Inspector is employed by the SSPC QP 5 company and is qualified to a minimum certification of NACE CIP Level II. Each inspector must remain employed by the coatings inspection company while performing any coatings inspection functions. The Quality Assurance Coatings Inspector's responsibilities are outlined in QUALITY ASSURANCE COATINGS INSPECTOR'S FIELD RESPONSIBILITIES. The roles of the Quality Assurance Coatings Inspector are in addition to, and distinct from, the role of the QC Coatings Inspector employed by the coatings Contractor and the Coatings Inspector for Shop Coating.

1.5.6.6 Qualifications of Coatings Contractors for Field Coating

All Contractors and Subcontractors that perform surface preparation or coatings application must be certified to SSPC QP 1 and SSPC QS 1 prior to contract award and must remain certified while accomplishing any surface preparation or coating application. If a Contractor's or Subcontractor's certification expires, the firm will not be allowed to perform any work until the certification is reissued. Requests for extension of time for any delay to the completion of the project due to an inactive certification will not be considered and liquidated damages will apply. Notify the Contracting Officer of any change in Contractor certification status within 10 days of the change. If a Contractor's qualification expires, the Contractor will not be allowed to perform any coatings related functions until the qualification is reissued. Requests for extension of time for any delay to the completion of the project due to an inactive qualification will not be considered and liquidated damages will apply. Notify the Contracting Officer of all scheduled and unannounced on-site audits from AMPP and furnish a copy of all audit reports.

For projects located outside the United States, Guam, and Puerto Rico, the certifications for the coatings Contractor (SSPC QP 1 and SSPC QS 1) can be substituted if the coatings Contractor meets all of the below requirements:

a. ISO 9001 certified;

b. Eight years of experience with industrial coatings;

c. Evidence of recent work that has Contractor Performance Assessment Report System (CPARS) ratings, and/or other quality/performance ratings, that are equivalent to, or exceed, "Above Average";

d. Evidence of an INDEPENDENT THIRD-PARTY audit from AMPP demonstrating equivalency to SSPC QP 1 and SSPC QS 1 within the last two years.

The coatings Contractors and coatings Subcontractors must be certified to ISO 9001 prior to contract award and must remain so certified for the duration of the project. Notify the Contracting Officer of any change in Contractor certification status within 10 days of the change. If a Contractor's qualification expires, the Contractor will not be allowed to perform any coatings related functions until the qualification is reissued. Requests for extension of time for any delay to the completion of the project due to an inactive qualification will not be considered and liquidated damages will apply. Notify the Contracting Officer of all scheduled and unannounced on-site inspections from the ISO certifying organization and furnish a copy of all inspection reports.

1.5.6.7 Qualifications of Individuals Performing Abrasive Blasting for Field Coating

Submit name, address, and telephone number of each person that will be performing abrasive blasting. All individuals performing abrasive blasting must be certified by AMPP to the SSPC C7 Dry Abrasive Blaster Qualification Program or CAS Coating Application Specialist Level 2 Certification Program (Interim Status), and must remain certified during the entire period of abrasive blasting. The Contracting Officer must be notified of any change in qualification status within 10 days of the change. If a blaster's qualification expires, the blaster will not be allowed to perform any blasting functions until the qualification is

reissued. Requests for extension of time for any delay to the completion of the project due to an inactive qualification will not be considered and liquidated damages will apply.

This requirement applies to all manual abrasive blasting performed in shop and field locations. This requirement does not apply to automated abrasive blasting performed in the shop.

1.5.6.8 Qualifications of Individuals Performing Coating Application for Field Coating

Submit name, address, telephone number, and evidence of certification of each person that will be performing coatings application by any method. All individuals performing coatings application must be certified by AMPP to the SSPC CAS Coating Application Specialist Level 2 Certification Program (Interim Status) or SSPC C12 Spray Application Program. Each applicator must remain certified during the entire period of coatings application, and the Contracting Officer must be notified of any change in qualification status within 10 days of the change. If an applicator's qualification expires, the applicator will not be allowed to perform any coatings application functions until the qualification is reissued. Requests for extension of time for any delay to the completion of the project due to an inactive qualification will not be considered and liquidated damages will apply.

1.5.6.9 Qualifications of Testing Laboratory for Coatings

Submit name, address, telephone number, fax number, and e-mail address of the INDEPENDENT THIRD-PARTY laboratory or laboratories selected to perform testing of coating samples for qualification testing and for field sample testing for compliance with this Section. Submit documentation that the laboratory is regularly engaged in testing of paint samples for conformance with specifications and that the employees performing testing are qualified.

1.5.6.10 Qualifications of Testing Laboratory for Abrasive

Submit name, address, telephone number, fax number, and e-mail address of the INDEPENDENT THIRD-PARTY laboratory or laboratories selected to perform testing of abrasive for compliance with this section. Submit documentation that the laboratory has experience in testing samples of abrasive for conformance with specifications and that the employees performing testing are qualified.

1.5.6.11 Coating Materials Certificate of Conformance

Provide manufacturer's certification of conformance to NACE RP0402 for exterior coatings used for repairs or girth welds on buried pipe. Provide manufacturer's certification of conformance to AWWA C213 for shop applied exterior coatings for buried pipe.

1.5.6.12 Non-Metallic Abrasive Certificate of Conformance

Provide manufacturer's certification that the materials are currently in conformance with SSPC AB 1 and as modified in this Section, and have been tested within the last three years.

1.5.7 QA and QC Personnel

1.5.7.1 QC Manager

The QC Manager is as defined in Section 01 45 00 QUALITY CONTROL.

1.5.7.2 Protective Coatings Specialist (PCS)

The PCS must be considered a QC Specialist and must report to the QC Manager, as specified in Section 01 45 00 QUALITY CONTROL. The PCS must approve all submittals prior to submission to the QC Manager for approval or submission to the government for approval.

The PCS's responsibilities include, but are not limited to, the following:

a. Obtain, review, and understand all project documentation including, but not limited to, this Section, project program, Coatings Work Plan, inspection and testing plan (ITP), and all submittals before the project starts, during the project, and all coatings related re-work;

b. Attend all pre-job coatings meetings (in-person, phone, or virtually);

c. Attend pre-final coatings walk-through (mandatory) and attend final coatings walk-through (as required).

1.5.7.3 Quality Assurance Coatings Inspector

The Quality Assurance Coatings Inspector must be considered a QC Specialist and must report to the QC Manager, as specified in Section 01 45 00 QUALITY CONTROL. The Quality Assurance Coatings Inspector must be present during all pre-preparation testing, surface preparation, coating application, initial cure of the coating system, during all coating repair work, and during completion activities. The Quality Assurance Coatings Inspector must provide complete documentation of conditions and occurrences on the job site, and be aware of conditions and occurrences that are potentially detrimental to the coating system. The responsibilities of the Quality Assurance Coatings Inspector are defined in QUALITY ASSURANCE COATING INSPECTOR'S RESPONSIBILITIES. These responsibilities are separate and distinct from the responsibilities of the Coatings Contractor QC Coatings Inspector and Coatings Inspector for Shop Coating.

1.5.7.4 Coatings Inspector for Shop Coating

The coatings inspector must be the shop Quality Manager or appropriate designee. The coatings inspector must be considered a QC Specialist and must report to the prime Contractor's QC Manager, as specified in Section 01 45 00 QUALITY CONTROL. The coatings inspector must be present during all pre-preparation testing, surface preparation, coating application, initial cure of the coating system, and during all coating repair work required of the shop. The coatings inspector must provide complete documentation of conditions and occurrences on the job site, and be aware of conditions and occurrences that are potentially detrimental to the coating system.

1.5.7.5 Coatings Contractor QC Coatings Inspector

The Coatings Contractor QC Coatings Inspector must stop non-compliant work. The responsibilities of the Coatings Contractor QC Coatings

Inspector are defined in COATINGS CONTRACTOR QC COATINGS INSPECTOR'S RESPONSIBILITIES. These responsibilities are separate and distinct from the responsibilities of the Quality Assurance Coatings Inspector.

1.5.8 Pre-Application Meeting for Field Coating

After approval of submittals, but prior to the initiation of coatings work, Contractor representatives, including at a minimum, project superintendent, QC manager, paint foreman, Quality Assurance Coatings Inspector, and PCS must have a pre-application coating preparatory meeting. This meeting must be in addition to the pre-construction conference. Specific items addressed must include: corrective action requirements and procedures, coatings work plan, safety plan, coordination with other Sections, inspection standards, inspection requirements and tools, test procedures, environmental control system, safety plan, and test logs. Notify Contracting Officer at least ten days prior to meeting.

1.6 PRODUCT DATA

1.6.1 Coating System Instructions

Submit manufacturer's printed instructions, including detailed mixing and application procedures, number and types of coats required, minimum and maximum application temperatures, and curing procedures of all coating materials. Include Safety Data Sheets (SDS) for materials to be used at the job site in accordance with 29 CFR 1926.59.

1.7 DELIVERY AND STORAGE

Ship, store, and handle materials in accordance with SSPC PA 1, applicable standards, and as modified in this Section. Maintain temperature in storage spaces between 40 and 75 degrees F, and air temperature more than 5 degrees F above the dew-point at all times. Inspect materials for damage and return non-compliant materials to manufacturer. Remove materials with expired shelf life from government property immediately and notify the Contracting Officer.

If materials are approaching shelf life expiration and an extension is desired, samples must be sent to the manufacturer, along with complete records of storage conditions, with a request for shelf life extension. If the manufacturer finds the samples and storage data suitable for shelf life extension, the manufacturer must issue an extension, referencing the product evaluation and the review of storage records. Products must not be extended longer than allowed in the product specification.

1.8 COATING HAZARDS

Ensure that employees are trained in all aspects of the safety plan. Specified coatings may have potential health hazards if ingested or improperly handled. The coating manufacturer's written safety precautions must be followed throughout mixing, application, and curing of the coatings. During cleaning, cleanup, surface preparation, and paint application phases, ensure that employees are protected from toxic and hazardous chemical agents which exceed concentrations in 29 CFR 1910.1000. Comply with respiratory protection requirements in 29 CFR 1910.134. The CIH must approve work procedures and personal protective equipment.

1.9 JOB SITE REFERENCES - SHOP

Make available to the Contracting Officer a copy of each standard to which the shop will be applying coatings under this Section.

1.10 JOB SITE REFERENCES - FIELD

Make available to the Contracting Officer a copy of each standard to which field coatings will be applied to under this Section, and an SSPC Certified Contractor Evaluation Form at the job site.

PART 2 PRODUCTS

2.1 SHOP-APPLIED COATING FOR BURIED PIPING

2.1.1 External Pipe Coating

For carbon steel, FBE coating: AWWA C213. For stainless steel, FBE coating: AWWA C213.

2.1.2 Internal Pipe Coating (Lining)

For carbon steel, FBE coating: AWWA C213. A certification must be provided from the coating manufacturer stating that the coating system is suitable for immersion service in aviation fuel.

2.2 FIELD-APPLIED EXTERNAL PIPE COATING

All coating materials used to coat external girth welds or repair existing coating must be from the same manufacture as the shop applied coating. Use one or more of the following repair methods, as modified herein, to repair shop applied coatings and coat external girth welds:

a. Fusion-Bonded Epoxy (FBE) Coating: NACE RP0402, coating material to be same as applied to pipe in shop

b. Liquid-Epoxy Coating System: AWWA C210

2.3 COATING FIELD SAMPLE COLLECTION AND SHIPPING KIT

Provide a kit for each sample to be collected. For FBE coatings, each kit must contain: a one quart can for the dry/powder; dipping cups for sampling; a shipping box sized for the samples to be shipped; and packing material. For liquid coatings, each kit must contain: a one quart can for the base of each liquid coatings material; one appropriately sized can for the activator of each liquid coatings material; dipping cups for each component to be sampled; a shipping box sized for the samples to be shipped; and packing material. Mark cans for the appropriate components (powder, base, or activator), including manufacturer's name, address, batch numbers, batch size shipped to the project site, and date of manufacture. Provide shipping documents, including either pre-paid shipping or a shipping number that can be used by the QC Manager to arrange pickup, addressed to the INDEPENDENT THIRD-PARTY coating testing laboratory.

2.4 ABRASIVE FIELD SAMPLE COLLECTION AND SHIPPING KIT

Provide a kit for each sample to be collected. Each kit must contain: one suitable plastic bag or container for each sample to be collected. Mark

containers with manufacturer's name, address, batch number, batch size, and date of manufacture. Provide shipping documents, including either pre-paid shipping label or a shipping number that can be used by the QC Manager to arrange pickup, addressed to the approved coating testing laboratory.

2.5 INSPECTION TEST KITS

2.5.1 Test Kit for Measuring Chloride, Sulfate, and Nitrate Ions on Steel and Coated Surfaces

Provide test kits that meet the following requirements:

a. Contains all materials, supplies, tools, and instructions for field testing and on-site quantitative evaluation of chloride, sulfate, and nitrate ions;

b. Extract solution is acidic, factory pre-measured, pre-packaged, and of uniform concentration;

c. Components and solutions are mercury free and environmentally friendly;

d. Contains new materials and solutions for each test extraction;

e. Contains an extraction test container (vessel, sleeve, cell) creates a sealed, encapsulated environment during salt ion extraction;

f. Contains a test extract container is suitable for testing the following steel surfaces: horizontal (up/down configuration), vertical, flat, curved, smooth, pitted, and rough;

g. All salt ion concentrations are directly measured in micrograms per square centimeter.

2.5.2 Test Kit for Measuring Chlorides in Abrasives

Provide test kits that meet all of the following requirements:

a. Be a completely self-contained test kit with all materials, supplies, tools, and instructions to take tests and identify results;

b. Use identifiable, consistent, factory pre-measured test extract solution;

c. Provide for testing equal volumes of abrasive and test solution;

d. Provide for taking direct measurements of the chloride ion in parts per million (PPM), without using conversion charts or tables;

e. Provide all new components for extraction and titration for each test;

f. Provide a factory sealed titration device for each test;

g. Use the extract sampling container as the titration container.

2.5.3 Test Kit for Identifying Amine Blush on Epoxy Surfaces

Provide test kits that meet all of the following requirements:

a. Be a completely self-contained field test kit with all materials, supplies, tools, and instructions to perform tests and indicate the presence of unreacted amines;

b. Use an identifiable, consistent, uniform, pre-packaged, factory pre-measured indicating solution;

c. Contains no mercury or lead and is environmentally friendly;

d. Contains a solution of an unreacted amine for the purpose of "self checking" the indicator solution.

2.6 ABRASIVE

Use abrasive that is specifically selected to provide a sharp, angular profile to the specified depth. Abrasive must meet all requirements of this Section each time that it is placed in the blast pot. The referenced abrasive specifications have maximum limits for soluble salts contamination; however, this maximum level of contamination does not guarantee that contamination will not be transferred to the steel surface during abrasive blasting. Other factors, such as on-site handling and recycling, can allow contamination of abrasive that can be transferred to the steel surface. Contractors are cautioned to verify that the chosen abrasive, along with work and storage processes, allow the final surface cleanliness requirements to be achieved. Successful testing of contamination in abrasive does not negate the final acceptance testing of steel surfaces.

Non-ferrous abrasives must be used for abrasive blasting stainless steel piping.

Abrasive material must contain a maximum of one percent by weight of any toxic substance listed in either Table Z-1, Z-2, or Z-3 of 29 CFR 1910-SUBPART Z, with the exception of inert or nuisance dust materials, arsenic, beryllium, cadmium, cobalt, lead, mercury, rhodium, silver, tellurium, thallium, and uranium.

Gross gamma radioactivity must not exceed 5 picocuries per gram.

2.6.1 Non-Metallic Abrasive

Non-metallic abrasive must be graded to the appropriate surface profile range and must conform to the chemical and physical properties of SSPC AB 1, Class A except that:

a. The maximum allowable chromium and cadmium content of the work mix must be less than 0.1 percent by weight when tested in accordance with ASTM D3718 for chromium and ASTM D3335 for cadmium.

b. Must contain less than 7 PPM chlorides when tested with the kit provided in paragraph TEST KIT FOR MEASURING CHLORIDES IN ABRASIVES. Modify the requirements of SSPC AB 1 to substitute requirement for one chloride test for each "CONDUCTIVITY TEST" required in SSPC AB 1 (one random sample per 50 bags of abrasive or three random samples from each shipment, if abrasive is delivered in bulk).

PART 3 EXECUTION

Perform all work, rework, and repair in accordance with approved procedures in the Coatings Work Plan. The Coatings Work Plan must be submitted and approved by the PCS prior to mobilization in accordance with the paragraph entitled COATINGS WORK PLAN.

3.1 FIELD SAMPLE COLLECTION AND TESTING

Sample and test materials delivered to the jobsite as required in the subsequent subparagraphs. Notify Contracting Officer three days in advance of sampling. The QC Manager, and either the PCS or the Quality Assurance Coatings Inspector, must witness all sampling.

3.1.1 Coating Field Sample Collection

All coatings/resins applied in the shop and in the field require one sample to be collected from each coating type used. This sample must be collected and set aside for the duration of the project, and must be tested if unforeseen coatings issues arise or if testing is requested by the Contracting Officer.

Field applied coatings require a random field sample from each lot of coating material used on-site in accordance with ASTM D3925. Each random sample must be tested. Utilize sample collection kits as outlined in the paragraph entitled COATING FIELD SAMPLE COLLECTION AND SHIPPING KIT. For powder based coatings, collect a one quart sample from each lot by random selection. For two component liquid coatings, obtain a one quart sample of each base material, and proportional samples of each activator based on mix ratio, by random selection from sealed containers from each lot. Prior to sampling, mix contents of each sealed container to ensure uniformity. As an alternative to collecting small samples from kits, entire kits may be randomly selected and shipped to the THIRD-PARTY INDEPENDENT laboratory, observing all requirements for witnessing and traceability. For purposes of quality conformance inspection, a lot is defined as that quantity of materials from a single, uniform batch produced and offered for delivery at one time. A batch is defined as that quantity of material processed by the manufacturer at one time and identified by number on the label. Identify samples by designated name, specification number, batch number, project contract number, sample date, intended use, and quantity involved. The QC manager will take possession of the packaged samples, contact the shipping company to arrange for pickup, and ship one complete sample of each material in question (including powder or base and activator) with all batch information to the INDEPENDENT THIRD-PARTY laboratory for testing as required in paragraph COATING FIELD TESTING REPORTS.

3.1.2 Abrasive Field Sample Collection

Utilize the sample collection kits as required in paragraph ABRASIVE FIELD SAMPLE COLLECTION AND SHIPPING KIT to obtain samples from each lot of abrasive delivered to site using the sampling techniques and schedule of one sample per every 50 bags for ferrous metallic abrasive, paragraph 4 REQUIREMENTS FOR RECYCLED WORK MIX ABRASIVES of SSPC AB 2 for recycled ferrous metallic abrasives, or paragraph 5.3 SAMPLING FOR QUALITY CONTROL TESTS of SSPC AB 1 for non-metallic abrasives.

For purposes of quality conformance inspection, a lot must consist of all abrasive materials of the same type from a single, uniform batch produced

and offered for delivery at one time. The addition of any substance to a batch must constitute a new lot. Identify samples by designated name, specification number, lot number, project contract number, sample date, intended use, and quantity involved. The QC manager will take possession of the packaged samples, contact the shipping company to arrange for pickup, and relinquish the samples only to the shipping representative for shipment to the approved INDEPENDENT THIRD-PARTY laboratory for testing required in paragraph ABRASIVE SAMPLE TEST REPORTS.

3.1.3 Coating Field Test Reports

Submit test results for each sample that requires testing in the paragraph COATINGS FIELD SAMPLE COLLECTION. Test samples of coating material for compliance with requirements of NACE RP0402. Reject entire batch represented by samples that fail one or more tests, select new lots, and test samples.

3.1.4 Abrasive Field Test Reports

Submit test results for each lot of abrasive delivered to the jobsite. Test samples of ferrous metallic abrasive to the requirements of paragraph 5.2 TEST PARAMETERS of SSPC AB 3, excluding paragraph 5.2.4 DURABILITY. Test samples of recycled ferrous metallic abrasives to the requirements of paragraph 4 REQUIREMENTS FOR RECYCLED WORK MIX ABRASIVES of SSPC AB 2. Test samples of non-metallic abrasive to the requirements of paragraph 5.3 SAMPLING FOR QUALITY CONTROL TESTS of SSPC AB 1. Reject entire lot represented by samples that fail one or more tests, select new lots, and test samples.

3.2 LIGHTING

Provide lighting for all work areas as prescribed in SSPC Guide 12.

3.3 ENVIRONMENTAL CONDITIONS

3.3.1 Automated Monitoring Requirements for Shop Applied Coating

Provide continuous monitoring of temperature, relative humidity, and dew point data at pertinent points in the shop, during surface preparation, coating application, and initial cure. This data does not suffice for documentation of conformity to surface conditions during application and cure of coating. Locate sensors to provide pertinent data for the surface preparation and coating application being performed, as well as the temperature extremes on the structure. Describe the location plan in the Coatings Work Plan. Monitor any heating, cooling, or dehumidification equipment used. Provide monitoring equipment to perform as follows:

a. Data is collected in 15-minute increments, and available for download (on-site) in a standard database format. Contractor must collect these data and make available to the Contracting Officer and QC Manager;

b. Monitoring equipment must have backup power such that data collection will be uninterrupted during the entire period of the dehumidification requirement;

c. Monitoring equipment must have capability to measure interior and exterior dry bulb temperature (DB), relative humidity (RH), and dewpoint temperature (DP).

There is no requirement for connectivity of the monitoring system to control the dehumidification equipment; therefore, any combination of equipment having the required functionality will be accepted.

3.3.2 Containment for Field Coating

Design and provide a containment system for the capture, containment, collection, storage, and disposal of the waste materials generated by the work under this Section, to meet the requirements of SSPC Guide 6, Class 3. Vapor concentrations must be kept at or below 10 percent of Lower Explosive Limit (LEL) at all times. Containment may be designed as fixed containment for complete structure or portable containment for sections of structure; however, containment must remain in any one place from beginning of abrasive blasting through initial cure of coating. Waste materials covered by this paragraph must not include any material or residue from removal of coatings containing lead, chromium, cadmium, PCB, or any other hazardous material.

It is the Contractors responsibility to insure the feasibility and workability of the containment system. The Contractor must perform their operations and work schedule in a manner as to minimize leakage of the containment system. The containment system must be properly maintained and must not deviate from the approved drawings. If the containment system fails to function satisfactorily, the Contractor must suspend all operations, except those required to minimize adverse impact on the environment or government property. Operations must not resume until modifications have been made to correct the cause of the failure.

3.3.3 Automated Monitoring Requirements for Field Coating

Provide continuous monitoring of temperature, relative humidity, and dew point data at pertinent points on the structure, during surface preparation, coating application, and initial cure. This data does not suffice for documentation of conformity to surface conditions during application and cure of coating. Locate sensors to provide pertinent data for the surface preparation and coating application being performed, as well as the temperature extremes on the structure. Describe the location plan, including required moves, in the Coatings Work Plan. Monitor any heating, cooling, or dehumidification equipment used. Provide monitoring equipment to perform as follows:

a. Data is collected in the field unit in 15-minute increments, and available for download (on-site) in a standard database format. Contractor must collect these data and make available to the Contracting Officer, Quality Assurance Coatings Inspector, and QC Manager;

b. Monitoring equipment must have backup power such that data collection will be uninterrupted during the entire period of the dehumidification requirement;

c. Monitoring equipment must have capability to measure surface temperatures at a minimum of four locations anywhere on a structure, regardless of the size of the structure;

d. Monitoring equipment must have capability to measure interior and exterior dry bulb temperature (DB), relative humidity (RH), and dewpoint temperature (DP).

There is no requirement for connectivity of the monitoring system to control the dehumidification equipment; therefore, any combination of equipment having the required functionality will be accepted.

3.4 SHOP APPLIED COATING OF BURIED PIPING

3.4.1 Surface Preparation for Shop Applied Coating

Prepare exterior steel surfaces in accordance with AWWA C213.

3.4.1.1 Abrasive Blasting Equipment for Shop Applied Coating of Buried Piping

Confirm that air supply for abrasive blasting is free of oil and moisture when tested in accordance with ASTM D4285. Test air quality at each startup, but in no case, less often than every five operating hours.

3.4.1.2 Contamination Evaluation of Abrasive for Shop Applied Coating of Buried Piping

Test abrasive for salt contamination and oil contamination as required SSPC AB 1 for non-metallic abrasives, SSPC AB 2 for recycled ferrous abrasives, and SSPC AB 3 for ferrous metallic abrasives. Modify the schedule of testing to be daily, at startup, and every five operating hours thereafter.

3.4.1.3 Pre-Preparation Testing for Surface Contamination for Shop Applied Coating of Buried Piping

3.4.1.3.1 Pre-Preparation Testing for Oil and Grease Contamination for Shop Applied Coating of Buried Piping

Inspect all surfaces for oil or grease contamination using two or more of the following inspection techniques:

1) VISUAL INSPECTION - Observe surface for evidence of dirt or oil.

2) WATER BREAK TEST - Spray atomized mist of distilled water onto surface and observe for water beading. If water wets surface rather than beading up, surface can be considered free of oil or grease contamination. Beading of water (water forms droplets) is evidence of oil or grease contamination.

3) CLOTH RUB TEST - Rub a clean, white, lint-free, cotton cloth onto surface and observe for discoloration. To confirm oil or grease contamination in lightly stained areas, a non-staining solvent may be used to aid in oil or grease extraction. Any visible discoloration is evidence of oil or grease contamination.

Reject oil or grease contaminated surfaces, clean in accordance with SSPC SP 1, and recheck for contamination until surfaces are free of oil and grease.

3.4.1.3.2 Pre-Preparation Testing for Soluble Salts Contamination for Shop Applied Coating of Buried Piping

Test each lot of pipe for soluble salt contamination on the external surfaces using the test kit described in paragraph TEST KIT FOR MEASURING CHLORIDE, SULFATE, AND NITRATE IONS ON STEEL AND COATED SURFACES. For

pipes with an outer diameter (OD) of less than 6 inches, one test per 20 lineal feet is required. For pipes with an OD of more than 6 inches, three tests per 100 square feet must be taken, with a minimum of one test per section of pipe. Label all test tubes and retain for test verification. Reject and wash surfaces of the entire lot if one or more readings greater than 3 micrograms per square centimeter of chlorides or 10 micrograms per square centimeter of sulfates or 5 micrograms per square centimeter of nitrates is measured.

Effective washing and removal of soluble salts will require removal of any barrier to the steel surface, including rust or mill scale. This procedure may necessitate combinations of wet abrasive blasting, high pressure water rinsing, and cleaning using a solution of water and soluble salt remover. The soluble salt remover must be acidic, biodegradable, non-toxic, non-corrosive, and after application, will not interfere with primer adhesion. Use potable water, or potable water modified with soluble salt remover, for all washing or wet abrasive blasting. Additional testing is required when there are delays between testing and preparation or testing and coating application. Test methods and equipment used in this phase must be included in the Coatings Work Plan.

This phase is required because pre-preparation testing and washing are generally more advantageous than attempting to remove soluble salt contamination after abrasive blasting. Soluble salt testing is also required in paragraph PRE-APPLICATION TESTING FOR SOLUBLE SALTS CONTAMINATION as a final acceptance test of prepared surfaces after abrasive blasting. Successful completion of pre-preparation testing and washing does not negate the requirement for pre-application testing.

3.4.1.4 Abrasive Blasting External Surfaces for Shop Applied Coating of Buried Piping

For stainless steel, prepare surfaces in accordance with SSPC SP 17. The surface profile must be in accordance with the coating manufacturer's recommended range. Non-ferrous abrasives must be used. The surface profile must be in accordance with AWWA C213 and measured in accordance with ASTM D4417, Method A and Method C. The appearance of the surface after blasting must have the appearance of a Sand or Grit comparator. A rounded profile shape or peened surface is not acceptable. Measure profile at a rate of three measurements per lot at the beginning of the day.

After completion of abrasive blasting, stainless steel pipe must be re-passivated prior to shop applied coating.

3.4.1.5 Disposal of Used Abrasive for Shop Applied Coating of Buried Piping

Provide Disposal of Used Abrasive Shop Applied Coating, in accordance with Federal, State, and Local mandated regulations.

3.4.1.6 Pre-Application Testing for Surface Contamination for Shop Applied Coating of Buried Piping

3.4.1.6.1 Pre-Application Testing for Oil and Grease Contamination for Shop Applied Coating of Buried Piping

Ensure surfaces are free of contamination as described in paragraph PRE-PREPARATION TESTING FOR OIL AND GREASE CONTAMINATION FOR SHOP APPLIED COATING OF BURIED PIPING, except that only questionable areas need be

checked for beading of water misted onto surface.

3.4.1.6.2 Pre-Application Testing for Surface Cleanliness for Shop Applied Coating of Buried Piping

Apply coatings to dust free surfaces. To test surfaces, use ISO 8502-3. Use a kit that is compliant with ISO 8502-3. A rating of 2 or better must be achieved for acceptance. If a test does not result in a rating of 2 or better, reject contaminated surfaces, clean by vacuum cleaning, and retest. Test surfaces at rate of one test per joint or repair area where application will be performed. Provide two additional tests for each failed test or questionable test. Document test results in the Daily Inspection Report and attach tape to the Inspection Logbook.

Ferrous abrasives may become magnetized and difficult to remove from the steel substrate. If ferrous abrasives are used, additional visual inspection must be performed to ensure no surface contamination by the abrasive is present.

3.4.2 Mixing and Application of Shop Applied Coating of Buried Piping

3.4.2.1 Mixing Liquid Epoxy Coatings

Mix materials as stated in coating system instructions. Mix materials in same temperature and humidity conditions specified in paragraph DELIVERY AND STORAGE. Allow mixed material to stand for the required induction time.

Apply mixed products within stated pot life for each product. Stop applying when material becomes difficult to apply in a smooth, uniform wet film. Do not add solvent to extend pot life. Add all required solvent, if allowable by the coating manufacturer, at time of mixing.

3.4.2.2 External Pipe Shop Applied Coating Application

Apply coatings in accordance with SSPC PA 1 and as specified in AWWA C213. Apply coatings to surfaces that meet all stated surface preparation requirements.

For the application of AWWA C213, the DFT must be a minimum of 15 mils and maximum of 20 mils. The coating thickness must not exceed the manufacturers recommendations.

The coating thickness must not exceed the manufacturers recommendations.

3.4.2.3 Internal Pipe Coating Application

For the application of AWWA C213, the DFT must be a minimum of 12 mils. The coating thickness must not exceed the manufacturers recommendations.

3.4.2.4 Holiday Testing and Shop Repair

Perform holiday testing on all shop-applied, externally coated areas and repair as outlined in AWWA C213.

3.5 FIELD REPAIRS TO EXTERNAL COATING OF BURIED PIPING

Field repairs must only be performed when repairing shop applied coatings in the field and coating external girth welds.

3.5.1 Surface Preparation for Field Coating of Buried Piping

Block or suspended pipeline at a height that will allow the blast nozzle to be perpendicular to the surface being blasted, and at the proper standoff distance, at all times.

3.5.1.1 Abrasive Blasting Equipment for Field Coating of Buried Piping

Use abrasive blasting equipment of conventional air, force-feed, or pressure type. Maintain a minimum pressure of 95 psig at nozzle. Confirm that air supply for abrasive blasting is free of oil and moisture when tested in accordance with ASTM D4285. Test air quality at each startup, but in no case, less often than every five operating hours.

3.5.1.2 Contamination Evaluation of Abrasive for Field Coating of Buried Piping

Test abrasive for salt contamination and oil contamination as required SSPC AB 1 for non-ferrous abrasives, SSPC AB 2 for recycled ferrous abrasives, and SSPC AB 3 for ferrous abrasives. Modify the schedule of testing to be daily, at startup, and every five operating hours thereafter.

3.5.1.3 Surface Standard

Inspect surfaces to be coated, and select plate with similar properties and surface characteristics for use as a surface standard. Blast clean one or more one foot square steel panels in the manner specified in paragraph ABRASIVE BLASTING FOR FIELD COATING OF BURIED PIPING. Record blast nozzle type and size, air pressure at nozzle and compressor, distance of nozzle from panel, and angle of blast to establish procedures for blast cleaning. Measure surface profile in accordance with ASTM D4417, Method C. When the surface standard complies with all specified requirements, seal with a clearcoat protectant. Use the surface standard for comparison to abrasive blasted surfaces throughout the course of work.

After completion of abrasive blasting, stainless steel pipe must be re-passivated prior to field coating repairs.

3.5.1.4 Pre-Preparation Testing for Surface Contamination for Field Coating of Buried Piping

3.5.1.4.1 Pre-Preparation Testing for Oil and Grease Contamination for Field Coating of Buried Piping

Inspect all surfaces for oil or grease contamination using two or more of the following inspection techniques:

1) VISUAL INSPECTION - Observe surface for evidence of dirt or oil.

2) WATER BREAK TEST - Spray atomized mist of distilled water onto surface and observe for water beading. If water wets surface rather than beading up, surface can be considered free of oil or grease contamination. Beading of water (water forms droplets) is evidence of oil or grease contamination.

3) CLOTH RUB TEST - Rub a clean, white, lint-free, cotton cloth onto surface and observe for discoloration. To confirm oil or grease contamination in lightly stained areas, a non-staining solvent may be

used to aid in oil or grease extraction. Any visible discoloration is evidence of oil or grease contamination.

Reject oil or grease contaminated surfaces, clean using a water based pH neutral degreaser in accordance with SSPC SP 1, and recheck for contamination until surfaces are free of oil and grease.

3.5.1.4.2 Pre-Preparation Testing for Soluble Salts Contamination for Field Coating of Buried Piping

Prior to abrasive blasting, test all exposed girth welds and areas to be recoated for soluble salt contamination using the test kit described in paragraph TEST KIT FOR MEASURING CHLORIDE, SULFATE, AND NITRATE IONS ON STEEL AND COATED SURFACES. Label all test tubes and retain for test verification. Reject and wash surfaces if one or more readings greater than 3 micrograms per square centimeter of chlorides or 10 micrograms per square centimeter of sulfates or 5 micrograms per square centimeter of nitrates is measured.

Effective washing and removal of soluble salts will require removal of any barrier to the steel surface, including rust. This procedure may necessitate combinations of wet abrasive blasting, high pressure water rinsing, and cleaning using a solution of water and soluble salts remover. The soluble salts remover must be acidic, biodegradable, non-toxic, non-corrosive, and after application, will not interfere with coating adhesion. Delays between testing and preparation, or testing and coating application, may allow for the formation of new contamination. Use potable water, or potable water modified with soluble salt remover, for all washing or wet abrasive blasting. Test methods and equipment used in this phase must be included in the Coatings Work Plan.

This phase is required because pre-preparation testing and washing are generally more advantageous than attempting to remove soluble salt contamination after abrasive blasting. Soluble salt testing is also required in paragraph PRE-APPLICATION TESTING FOR SOLUBLE SALTS CONTAMINATION FOR FIELD COATING OF BURIED PIPING as a final acceptance test of prepared surfaces after abrasive blasting. Successful completion of pre-preparation testing and washing does not negate the requirement for pre-application testing.

3.5.1.5 Abrasive Blasting for Field Coating of Buried Piping

For stainless steel, prepare girth welds and repairs to bare steel to SSPC SP 17 immediately prior to coating application. Verify that prepared surfaces comply with SSPC VIS 1 at time of coating application. All other surfaces must be prepared in accordance with the appropriate coating standard referenced herein. The surface profile must be in accordance with the coating manufacturer's recommended range. Measure the surface profile in accordance with ASTM D4417, Method A and Method C. The appearance of the surface after blasting must have the appearance of a Sand or Grit comparator. A rounded profile shape or peened surface is not acceptable. For pipes with an outer diameter (OD) of less than6 inches, one test per 20 lineal feet is required. For pipes with an OD of more than 6 inches, three tests per 100 square feet must be taken, with a minimum of one test per section of pipe. Internal lining must not be used for stainless steel piping. Non-ferrous abrasive must be used. When surfaces are re-blasted for any reason, retest profile as specified. Following abrasive blasting, remove dust and debris by vacuum cleaning. Dust and debris tend to collect at welds, plate overlaps, and surface

irregularities. Do not attempt to wipe surface clean.

3.5.1.6 Disposal of Used Abrasive for Field Coating of Buried Piping

Provide Disposal of Used Abrasive Field Applied Coating off Government property in accordance with Federal, State, and Local mandated regulations.

3.5.1.7 Pre-Application Testing for Surface Contamination for Field Coating of Buried Piping

3.5.1.7.1 Pre-Application Testing for Oil and Grease Contamination for Field Coating of Buried Piping

Ensure surfaces are free of contamination as described in paragraph PRE-PREPARATION TESTING FOR OIL AND GREASE CONTAMINATION FOR FIELD COATING OF BURIED PIPING, except that only questionable areas need to be checked for beading of water misted onto surface.

3.5.1.7.2 Pre-Application Testing for Soluble Salts Contamination for Field Coating of Buried Piping

Test surfaces for soluble salts using the test kit described in paragraph TEST KIT FOR MEASURING CHLORIDE, SULFATE, AND NITRATE IONS ON STEEL AND COATED SURFACES, test girth welds and areas to be recoated for soluble salts. Label all test tubes and retain for test verification. One or more readings greater than 3 micrograms per square centimeter of chlorides or 10 micrograms per square centimeter of sulfates or 5 micrograms per square centimeter of nitrates is evidence of soluble salt contamination. Reject contaminated surfaces, wash as required in paragraph PRE-PREPARATION TESTING FOR SOLUBLE SALTS CONTAMINATION FOR FIELD COATING OF BURIED PIPING, allow to dry, and re-test, and re-wash until all required tests show allowable results. Re-blast tested areas using vacuum equipped blast equipment.

3.5.1.7.3 Pre-Application Testing for Surface Cleanliness for Field Coating of Buried Piping

Apply coatings to dust free surfaces. To test surfaces, use ISO 8502-3. Use a kit that is compliant with ISO 8502-3. A rating of 2 or better must be achieved for acceptance. If a test does not result in a rating of 2 or better, reject contaminated surfaces, clean by vacuum cleaning, and retest. Test surfaces at rate of one test per joint or repair area where application will be performed. Provide two additional tests for each failed test or questionable test. Document test results in the Daily Inspection Reports and attach tape to the Inspection Logbook.

Ferrous abrasives may become magnetized and difficult to remove from the steel substrate. If ferrous abrasives are used, additional visual inspection must be performed to ensure no surface contamination by the abrasive is present.

3.5.2 Coating Mixing and Application for Field Coating of Buried Piping

3.5.2.1 Mixing Coating Materials for Field Coating of Buried Piping

a. Mix and apply coating materials in accordance with the approved coating system instructions, which may differ for each product. Do not mix partial kits unless standardized measuring cups are utilized. Do not alter mix ratios. Mix materials in same temperature and

humidity conditions specified in paragraph DELIVERY AND STORAGE. Allow mixed material to stand for the required induction time. All mixing processes must be witnessed by the Quality Assurance Coatings Inspector.

b. Apply mixed products within stated pot life for each product. Stop applying when material becomes difficult to apply in a smooth, uniform wet film. Do not add solvent to extend pot life. Add all required solvent at time of mixing, as allowable per the coating system instructions.

c. If coating materials are not liquid materials (i.e., powder or extrusion materials), this paragraph may not apply. Follow the recommended instructions per the approved coating system instructions.

3.5.2.2 Application Conditions and Recoat Windows for Field Coating of Buried Piping

The application condition requirements for coatings are time and temperature sensitive. Plan coating application to ensure that specified temperature, humidity, and condensation conditions are met. If conditions do not allow for proper application of the coating materials, use appropriate means of controlling air and surface temperatures, as required. Partial or total enclosures, insulation, heating, cooling, or other appropriate measures may be required to control conditions to allow for orderly application of all required coats.

Maintain air and steel surface temperature within the range allowable by the approved coating system instructions during application and initial cure. Maintain steel surface temperature more than 5 degrees F above the dew-point of the ambient air for the same period. These conditions may require environmental controls through containment.

3.5.2.3 Coating Application for Field Coating of Buried Piping

Apply coatings in accordance with SSPC PA 1 and as specified in AWWA C210, NACE RP0402. Apply coatings to surfaces that meet all stated surface preparation requirements.

3.5.2.4 Holiday Testing and Field Repair

Perform holiday testing on all field coated areas and repair as outlined in AWWA C210, NACE RP0402.

3.5.3 Final Inspection of Pipeline Prior to Burial

Verify that all surfaces of the pipeline are holiday-free at time of placement of backfill over pipe. Use holiday inspection requirements and acceptance criteria of the standards applicable to the coatings being tested.

3.5.4 Final Cleanup

Following completion of the work, remove debris, equipment, and materials from the site. Remove all foreign matter such as blast media, dust, dirt, debris, grease, and oils. Wipe all dry to handle coated surfaces with damp lint-free cloth. Remove temporary connections to Government- or Contractor-furnished water and electrical services. Restore existing facilities in and around the work areas to their original condition.

3.6 FIELD AND SHOP QUALITY CONTROL

For marking of surfaces, use chalk for marking bare steel and water based markers for marking coated surfaces. Remove marks prior to coating. Do not use any wax or grease based markers, or any other markers that leave a residue or stain.

3.6.1 Inspection

3.6.1.1 Inspection Requirements

a. Perform inspections in accordance with ASTM D3276 and the approved Coatings Work Plan.

b. Provide all tools and instruments required to perform the required testing, as well as any tools or instruments that the inspector considers necessary to perform the required inspections and tests. Document each inspection and test, including required hold points and other required inspections and tests, as well as those inspections and tests deemed prudent from on-site evaluation to document a particular process or condition, as follows:

(1) Location or area;

(2) Purpose (required or special);

(3) Method;

(4) Criteria for evaluation;

(5) Results;

(6) Determination of compliance;

(7) List of required rework;

(8) Observations.

c. Collect and record environmental conditions as described in ASTM D3276 on a 24 hour basis, as follows:

(1) During surface preparation, every hour, or when changes occur;

(2) During coating application and the first four days of initial cure, every hour, or when changes occur;

(3) Note location, time, and temperature of the highest and lowest surface temperatures each day;

(4) Use a non-contact thermometer to locate temperature extremes, then verify with contact thermometers.

d. Data collected on environmental conditions in AUTOMATED MONITORING REQUIREMENTS may be used for overnight data; however, the data must be constantly verified as to location of sensors and validity of data with respect to the coating work being accomplished.

e. Document all equipment used in inspections and testing, including

manufacturer, model number, serial number, last calibration date and future calibration date, and results of on-site calibration performed. Work documented using data from equipment found to be out of calibration must be considered as non-compliant since last calibration or calibration check, as required.

f. Document Contractors compliance with the Coatings Work Plan.

3.6.1.2 Inspection Report Forms

Develop project-specific report forms as required to report measurements, test results, and observations being complete and conforming to contract requirements. This includes all direct requirements of the contract documents and indirect requirements of referenced documents. Show acceptance criteria with each requirement and indication of conformity of each inspected item. The data may be in any format, but must be legible and presented so that entered data can be quickly compared to the appropriate requirement.

3.6.1.3 Daily Inspection Reports

Submit one copy of daily inspection report completed each day when performing work under this Section, to the Contracting Officer. Note all non-compliance issues, and all issues that were reported for rework in accordance with QC procedures of Section 01 45 00 QUALITY CONTROL. Each report must be signed by the Quality Assurance Coatings Inspector and the QC Manager. Submit report within 24 hours of date recorded on the report.

3.6.1.4 Inspection Logbook

A continuous record of all activity related to this Section must be maintained in an Inspection Logbook on a daily basis. The logbook must be hard or spiral-bound book or digital program with consecutively numbered pages, and must be used to record all information provided in the Daily Inspection Reports, as well as other pertinent observations and information. Submit the original Inspection Logbook to the Contracting Officer upon completion of the project and prior to final payment.

3.6.1.5 Inspection Equipment

All equipment must be in good condition, operational within its design range, and calibrated as required by the specified standard for use of each device.

3.6.2 Coatings Contractor QC Coatings Inspector's Responsibilities

The Coatings Contractor QC Coatings Inspector responsibilities include complete documentation of all daily inspection and production activities for the entire coatings project as outlined in the Coatings Work Plan, project program, and this Section. This includes, but is not limited to, the following:

a. Attending and documenting the pre-job meeting and acquiring the project program, inspection and testing plan (ITP), schedule, and a list of who will receive the QC daily inspection reports;

b. Performing a project site walk-through with the Quality Assurance Evaluator (QAE) or asset owner, Coatings Contractor QC, QC Manager, and Quality Assurance Coatings Inspector, inspecting at least the

following:

(1) Asset(s) to be coated;

(2) Equipment and placement of equipment;

(3) Materials delivery and storage;

(4) Facility operational requirements during the project.

c. Perform all daily and hold point inspections including, but not limited to, the following:

(1) Check equipment, including blotter test to verify compressed air cleanliness;

(2) Perform non-visible contaminants testing (in accordance with PRE-PREPARATION TESTING FOR SOLUBLE SALT CONTAMINATION FOR SHOP APPLIED COATING OF BURIED PIPING, PRE-APPLICATION TESTING FOR SOLUBLE SALT CONTAMINATION FOR SHOP APPLIED COATING OF BURIED PIPING, PRE-PREPARATION TESTING FOR SOLUBLE SALT CONTAMINATION FOR FIELD COATING OF BURIED PIPING, and PRE-APPLICATION TESTING FOR SOLUBLE SALT CONTAMINATION FOR FIELD COATING OF BURIED PIPING);

(3) Perform visible contaminants testing (in accordance with PRE-PREPARATION TESTING FOR OIL AND GREASE CONTAMINATION FOR SHOP APPLIED COATING OF BURIED PIPING, PRE-APPLICATION TESTING FOR OIL AND GREASE CONTAMINATION FOR SHOP APPLIED COATING OF BURIED PIPING, PRE-PREPARATION TESTING FOR OIL AND GREASE CONTAMINATION FOR FIELD COATING OF BURIED PIPING, and PRE-APPLICATION TESTING FOR OIL AND GREASE CONTAMINATION FOR FIELD COATING OF BURIED PIPING);

(4) Obtain environmental readings;

(5) Perform abrasive testing per SSPC AB 1, SSPC AB 2, or SSPC AB 3;

(6) Perform surface preparation monitoring and testing;

(7) Perform surface cleanliness testing;

(8) Perform dust quantity testing;

(9) Record materials storage documentation (record all coatings and abrasive materials information, batch numbers, segregation, and storage temperature);

(10) Witness all coatings materials mixing and record mix materials temperatures, with verification of time of coatings pot life;

(11) Verify, witness, and record application method;

(12) Perform random wet film thickness (WFT) readings;

(13) Perform inspection of coatings application;

(14) Obtain dry film thickness (DFT) readings per SSPC PA 2;

(15) Perform holiday testing in accordance with HOLIDAY TESTING AND

SHOP REPAIR and HOLIDAY TESTING AND FIELD REPAIR;

(16) Label asset identification (label stickers);

(17) Write Correction Action Reports (CAR), if needed;

(18) Write Non-Conformance Reports (NCR), if needed.

d. Writing a daily detailed summary of the work shift inspections, testing, and the day's events, including any meetings and prevalent conversations. The final daily report must include a project summary that must be part of the daily coatings inspection report.

e. The Coatings Contractor QC Coatings Inspector must stop all non-compliant work.

3.6.3 Quality Assurance Coatings Inspector's Responsibilities

The Quality Assurance Coatings Inspector's responsibilities include complete documentation of all on-site work associated with the coatings project. These responsibilities include, but are not limited to, the following:

a. Attending and documenting the pre-job meeting and acquiring the project program, inspection and testing plan (ITP), schedule, and a list of who will receive the QC daily inspection reports;

b. Performing a project site walk-through with the Quality Assurance Evaluator (QAE) or asset owner, prime Contractor, and coatings Contractor (QC Coatings Inspector and QC Manager), inspecting at least the following:

(1) Asset(s) to be coated;

(2) Equipment and placement of equipment;

(3) Materials delivery and storage;

(4) Facility operational requirements during the project.

c. Verifying all daily and hold point inspections performed by the Coatings Contractor QC Coatings Inspector or QC Manager by performing mirror inspections including, but not limited to, the following:

(1) Verify equipment check, including blotter test to verify compressed air cleanliness;

(2) Verify visible contaminants testing;

(3) Take environmental readings;

(4) Perform surface preparation monitoring and testing;

(5) Perform surface cleanliness testing;

(6) Perform dust quantity test;

(7) Record materials storage documentation (record all coating and abrasive information, batch numbers, segregation, and storage

temperature);

(8) Witness all coatings materials mixing and record mix materials temperatures, with verification of time of coatings pot life;

(9) Verify, witness, and record application method;

(10) Inspect coatings application;

(11) Perform dry film thickness (DFT) readings per SSPC PA 2;

(12) Inspect asset identification (label stickers);

(13) Write Correction Action Reports (CAR), if needed;

(14) Write Non-Conformance Reports (NCR), if needed.

d. The following testing is witnessed by the Quality Assurance Coatings Inspector and performed by the Coatings Contractor QC Coatings Inspector or QC Manager:

(1) Wet film thickness (WFT) readings by coatings applicator(s);

(2) Non-visible contaminants testing for chlorides, sulfates, and nitrates (CSN);

(3) Abrasive testing per SSPC AB 1, SSPC AB 2, or SSPC AB 3;

(4) Holiday testing.

e. Writing a daily detailed summary of the work shift inspections, testing, and the day's events, including any meetings and prevalent conversations. The final daily report must include a project summary that will be part of the last daily coatings inspection report.

3.7 PROJECT IDENTIFICATION

At the completion of the work, affix pertinent coating data on structure at a location that is readily accessible and visible from the ground. Use either stencils or nameplates. The following list generally describes the pertinent coating data, but should be modified as required to describe the coating systems.

Date coated/accepted: _____/_____

Project Number: _____

Contractor: _____

Address: _____

Coating System

Manufacturer: _____

Surface Prep: SSPC SP ____ Profile: _____

Primer: _____ Thickness: ____

Intermediate: _____ Thickness: ____

Topcoat: _____ Thickness: ____

Total Thickness: _____

3.7.1 Stencils

Use stencils on piping 8 in or larger. Use stencils with 3/4- to one-inch Helvetica style letters and acrylic stencil paint of contrasting color.

3.7.2 Nameplates

Use nameplates for piping smaller than 8 inches. Construct plates of stainless steel. Install nameplates in prominent locations with nonferrous screws, nonferrous bolts, or permanent adhesive. Minimum size of nameplates must be one by 2.5 in. Lettering must be the normal block style with a minimum 0.25 in height. Accurately align all lettering on nameplates.

-- End of Section --

SECTION 33 71 02

UNDERGROUND ELECTRICAL DISTRIBUTION
08/21

PART 1 GENERAL

1.1 REFERENCES

The publications 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.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO HB-17	(2002; Errata 2003; Errata 2005, 17th Edition) Standard Specifications for Highway Bridges

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 318M	(2019; Errata 2022) Building Code Requirements for Structural Concrete & Commentary
ACI SP-66	(2004) ACI Detailing Manual

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2025) Structural Welding Code - Steel

ASSOCIATION OF EDISON ILLUMINATING COMPANIES (AEIC)

AEIC CS8	(2013) Specification for Extruded Dielectric Shielded Power Cables Rated 5 Through 46 kV

ASTM INTERNATIONAL (ASTM)

ASTM A48/A48M	(2022) Standard Specification for Gray Iron Castings
ASTM B1	(2013) Standard Specification for Hard-Drawn Copper Wire
ASTM B3	(2013; R 2024) Standard Specification for Soft or Annealed Copper Wire
ASTM B8	(2023) Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
ASTM B496	(2016; R 2021) Standard Specification for Compact Round Concentric-Lay-Stranded Copper Conductors

ASTM C32	(2023) Standard Specification for Sewer and Manhole Brick (Made from Clay or Shale)
ASTM C309	(2019) Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C478	(2018) Standard Specification for Circular Precast Reinforced Concrete Manhole Sections
ASTM C857	(2016) Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures
ASTM C990	(2009; R 2019) Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants
ASTM F2160	(2022a) Standard Specification for Solid Wall High Density Polyethylene (HDPE) Conduit Based on Controlled Outside Diameter (OD)

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 48	(2020) Test Procedures and Requirements for Alternating-Current Cable Terminations Used on Shielded Cables Having Laminated Insulation Rated 2.5 kV through 765 kV or Extruded Insulation Rated 2.5 kV through 500 kV
IEEE 81	(2012) Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System
IEEE 386	(2016) Separable Insulated Connector Systems for Power Distribution Systems Rated 2.5 kV through 35 kV
IEEE 400.2	(2013) Guide for Field Testing of Shielded Power Cable Systems Using Very Low Frequency (VLF)
IEEE 404	(2012) Standard for Extruded and Laminated Dielectric Shielded Cable Joints Rated 2500 V to 500,000 V
IEEE C2	(2023) National Electrical Safety Code
IEEE C37.20.3	(2013) Standard for Metal-Enclosed Interrupter Switchgear
IEEE Stds Dictionary	(2009) IEEE Standards Dictionary: Glossary of Terms & Definitions

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2025) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI C119.1	(2023) Electric Connectors - Sealed Insulated Underground Connector Systems Rated 600 Volts
NEMA C119.4	(2011) Electric Connectors - Connectors for Use Between Aluminum-to-Aluminum or Aluminum-to-Copper Conductors Designed for Normal Operation at or Below 93 Degrees C and Copper-to-Copper Conductors Designed for Normal Operation at or Below 100 Degrees C
NEMA RN 1	(2005; R 2013) Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit
NEMA TC 2	(2020) Standard for Electrical Polyvinyl Chloride (PVC) Conduit
NEMA TC 3	(2021) Polyvinyl Chloride (PVC) Fittings for Use With Rigid PVC Conduit and Tubing
NEMA TC 7	(2021) Smooth-Wall Coilable and Straight Electrical Polyethylene Conduit
NEMA TC 9	(2020) Standard for Fittings for Polyvinyl Chloride (PVC) Plastic Utilities Duct for Underground Installation
NEMA WC 70	(2021) Power Cable Rated 2000 Volts or Less for the Distribution of Electrical Energy
NEMA WC 74/ICEA S-93-639	(2022) 5-46 kV Shielded Power Cable for Use in the Transmission and Distribution of Electric Energy

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1; TIA 25-2) National Electrical Code

SOCIETY OF CABLE TELECOMMUNICATIONS ENGINEERS (SCTE)

ANSI/SCTE 77	(2013) Specification for Underground Enclosure Integrity

TELECOMMUNICATIONS INDUSTRY ASSOCIATION (TIA)

TIA-758	(2012b) Customer-Owned Outside Plant Telecommunications Infrastructure Standard

U.S. DEPARTMENT OF AGRICULTURE (USDA)

RUS Bull 1751F-644	(2002) Underground Plant Construction

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

CID A-A-60005	(Basic; Notice 2) Frames, Covers, Gratings, Steps, Sump And Catch Basin, Manhole

UL SOLUTIONS (UL)

UL 6	(2022) UL Standard for Safety Electrical Rigid Metal Conduit-Steel
UL 44	(2018; Reprint May 2021) UL Standard for Safety Thermoset-Insulated Wires and Cables
UL 83	(2017; Reprint Mar 2020) UL Standard for Safety Thermoplastic-Insulated Wires and Cables
UL 94	(2023; Reprint Jan 2024) UL Standard for Safety Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
UL 467	(2022) UL Standard for Safety Grounding and Bonding Equipment
UL 486A-486B	(2018; Reprint Jul 2023) UL Standard for Safety Wire Connectors
UL 510	(2020; Dec 2022) UL Standard for Safety Polyvinyl Chloride, Polyethylene and Rubber Insulating Tape
UL 514B	(2012; Reprint Mar 2024) UL Standard for Safety Conduit, Tubing and Cable Fittings
UL 651	(2011; Reprint May 2022) UL Standard for Safety Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings
UL 854	(2020; Reprint Jul 2024) Standard for Service-Entrance Cables
UL 1072	(2006; Reprint May 2024) Medium-Voltage Power Cables

1.2 RELATED REQUIREMENTS

Section 26 08 00 APPARATUS INSPECTION AND TESTING applies to this section, with the additions and modifications specified herein.

1.3 DEFINITIONS

a. Unless otherwise specified or indicated, electrical and electronics

terms used in these specifications, and on the drawings, are as defined in IEEE Stds Dictionary.

b. In the text of this section, the words conduit and duct are used interchangeably and have the same meaning.

c. In the text of this section, "medium voltage cable splices," and "medium voltage cable joints" are used interchangeably and have the same meaning.

d. Underground structures subject to aircraft loading are indicated on the drawings.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Precast Underground Structures; G

SD-03 Product Data

Medium Voltage Cable; G

Medium Voltage Cable Joints; G

Medium Voltage Cable Terminations; G

Precast Concrete Structures; G

Sealing Material

Pulling-In Irons

Manhole Frames and Covers; G

Handhole Frames and Covers; G

Frames and Covers for Airfield Facilities; G

Ductile Iron Frames and Covers for Airfield Facilities; G

Composite/Fiberglass Handholes; G

Cable Supports (racks, arms and insulators); G

SD-06 Test Reports

Medium Voltage Cable Qualification and Production Tests; G

Field Acceptance Checks and Tests; G

Arc-proofing Test for cable fireproofing tape; G

Cable Installation Plan and Procedure; G

Six copies of the information described below in 8-1/2 by 11 inch binders having a minimum of three rings from which material may readily be removed and replaced, including a separate section for each cable pull. Separate sections by heavy plastic dividers with tabs, with all data sheets signed and dated by the person supervising the pull.

a. Site layout drawing with cable pulls numerically identified.

b. A list of equipment used, with calibration certifications. The manufacturer and quantity of lubricant used on pull.

c. The cable manufacturer and type of cable.

d. The dates of cable pulls, time of day, and ambient temperature.

e. The length of cable pull and calculated cable pulling tensions.

f. The actual cable pulling tensions encountered during pull.

SD-07 Certificates

Cable splicer/terminator; G

Cable Installer Qualifications; G

Directional Boring Certificate of Conformance; G

1.5 QUALITY ASSURANCE

1.5.1 Precast Underground Structures

Submittal required for each type used. Provide calculations and drawings for precast manholes and handholes bearing the seal of a registered professional engineer including:

a. Material description (i.e., f'c and Fy)

b. Manufacturer's printed assembly and installation instructions

c. Design calculations

d. Reinforcing shop drawings in accordance with ACI SP-66

e. Plans and elevations showing opening and pulling-in iron locations and details

1.5.2 Certificate of Competency for Cable Splicer/Terminator

Submit certification of the qualification of the cable splicer/terminator for approval, 30 days before splices or terminations are to be made in medium voltage (5 kV to 35 kV) cables. Include the training, and experience of the individual on the specific type and classification of cable to be provided under this contract. Indicate that the individual has had three or more years recent experience splicing and terminating medium voltage cables. List a minimum of three splices/terminations that

have been in operation for more than one year. In addition, the individual may be required to perform a dummy or practice splice/termination in the presence of the Contracting Officer, before being approved as a qualified cable splicer. If that additional requirement is imposed, the Contractor must provide short sections of the approved types of cables along with the approved type of splice/termination kit, and detailed manufacturer's instructions for the cable to be spliced. The Contracting Officer reserves the right to require additional proof of competency or to reject the individual and call for certification of an alternate cable splicer.

1.5.3 Cable Installer Qualifications

Provide at least one onsite person in a supervisory position with a documentable level of competency and experience to supervise all cable pulling operations. Provide a resume showing the cable installers' experience in the last three years, including a list of references complete with points of contact, addresses and telephone numbers. Cable installer must demonstrate experience with a minimum of three medium voltage cable installations. The Contracting Officer reserves the right to require additional proof of competency or to reject the individual and call for an alternate qualified cable installer.

1.5.4 Directional Boring Certificate of Conformance

Provide certification of compliance with the registered Professional Engineer's design requirements for each directional bore, including: HDPE conduit size and type, bend radius, elevation changes, vertical and horizontal path deviations, conductor size and type and any conductor derating due to depth of conduit. Record location and depth of all directional-bore installed HDPE conduits using Global Positioning System (GPS) recording means with "resource grade" accuracy.

1.5.5 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "must" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Equipment, materials, installation, and workmanship must be in accordance with the mandatory and advisory provisions of IEEE C2 and NFPA 70 unless more stringent requirements are specified or indicated.

1.5.6 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Products must have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year period must include applications of equipment and materials under similar circumstances and of similar size. The product must have been for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period. Where two or more items of the same class of equipment are required, these items must be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

1.5.6.1 Alternative Qualifications

Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

1.5.6.2 Material and Equipment Manufacturing Date

Products manufactured more than 3 years prior to date of delivery to site are not acceptable, unless specified otherwise.

PART 2 PRODUCTS

2.1 CONDUIT, DUCTS, AND FITTINGS

2.1.1 Rigid Metal Conduit

UL 6.

2.1.1.1 Rigid Metallic Conduit, PVC Coated

NEMA RN 1, Type A40, except that hardness must be nominal 85 Shore A durometer, dielectric strength must be minimum 400 volts per mil at 60 Hz, and tensile strength must be minimum 3500 psi.

2.1.2 Plastic Duct for Concrete Encasement

Provide Type EPC-40 per UL 651 and NEMA TC 2, as indicated.

2.1.3 High Density Polyethylene (HDPE) Electrical Conduit for Directional Boring

Smoothwall, approved/listed for directional boring, minimum Schedule 80, ASTM F2160, NEMA TC 7.

2.1.4 Duct Sealant

UL 94, Class HBF. Provide high-expansion urethane foam duct sealant that expands and hardens to form a closed, chemically and water resistant, rigid structure. Sealant must be compatible with common cable and wire jackets and capable of adhering to metals, plastics and concrete. Sealant must be capable of curing in temperature ranges of 35 degrees F to 95 degrees F. Cured sealant must withstand temperature ranges of -20 degrees F to 200 degrees F without loss of function.

2.1.5 Fittings

2.1.5.1 Metal Fittings

UL 514B.

2.1.5.2 PVC Conduit Fittings

UL 514B, UL 651 and NEMA TC 3.

2.1.5.3 PVC Duct Fittings

NEMA TC 9.

2.2 LOW VOLTAGE INSULATED CONDUCTORS AND CABLES

Insulated conductors must be rated 600 volts and conform to the requirements of NFPA 70, including listing requirements, or in accordance with NEMA WC 70. Wires and cables manufactured more than 24 months prior to date of delivery to the site are not acceptable. Service entrance conductors must conform to UL 854, type USE.

2.2.1 Conductor Types

Cable and duct sizes indicated are for copper conductors and THHN/THWN unless otherwise noted. Conductors No. 10 AWG and smaller must be solid. Conductors No. 8 AWG and larger must be stranded.

2.2.2 Conductor Material

Unless specified or indicated otherwise or required by NFPA 70, wires in conduit, other than service entrance, must be 600-volt, Type THWN/THHN conforming to UL 83 or Type XHHW RHW conforming to UL 44. Copper conductors must be annealed copper complying with ASTM B3 and ASTM B8.

2.2.3 Jackets

Provide multiconductor cables with an overall PVC outer jacket.

2.2.4 Cable Marking

Insulated conductors must have the date of manufacture and other identification imprinted on the outer surface of each cable at regular intervals throughout the cable length.

Identify each cable by means of a fiber, laminated plastic, or non-ferrous metal tags in each manhole, handhole, junction box, and each terminal. Each tag must contain the following information; cable type, conductor size, circuit number, circuit voltage, cable destination and phase identification.

Color code conductors. Provide conductor identification within each enclosure where a tap, splice, or termination is made. Conductor identification must be by color-coded insulated conductors, plastic-coated self-sticking printed markers, colored nylon cable ties and plates, heat shrink type sleeves,or colored electrical tape. Properly identify control circuit terminations. Color must be green for grounding conductors and white for neutrals; except where neutrals of more than one system are installed in same raceway or box, other neutrals may be white with a different colored (not green) stripe for each. Color of ungrounded conductors in different voltage systems are as follows:

a. 208/120 volt, three-phase

    (1) Phase A - black

    (2) Phase B - red

    (3) Phase C - blue

b. 480/277 volt, three-phase

(1) Phase A - brown

(2) Phase B - orange

(3) Phase C - yellow

2.3 LOW VOLTAGE WIRE CONNECTORS AND TERMINALS

Provide a uniform compression over the entire conductor contact surface. Use solderless terminal lugs on stranded conductors.

a. For use with copper conductors: UL 486A-486B.

2.4 LOW VOLTAGE SPLICES

Provide splices in conductors with a compression connector on the conductor and by insulating and waterproofing using one of the following methods which are suitable for continuous submersion in water and comply with ANSI C119.1.

2.4.1 Heat Shrinkable Splice

Provide heat shrinkable splice insulation by means of a thermoplastic adhesive sealant material applied in accordance with the manufacturer's written instructions.

2.4.2 Cold Shrink Rubber Splice

Provide a cold-shrink rubber splice which consists of EPDM rubber tube which has been factory stretched onto a spiraled core which is removed during splice installation. The installation must not require heat or flame, or any additional materials such as covering or adhesive. It must be designed for use with inline compression type connectors, or indoor, outdoor, direct-burial or submerged locations.

2.5 MEDIUM VOLTAGE CABLE

Cable (conductor) sizes are designated by American Wire Gauge (AWG) and Thousand Circular Mils (Kcmil). Conductor and conduit sizes indicated are for copper conductors unless otherwise noted. Insulated conductors must have the date of manufacture and other identification imprinted on the outer surface of each cable at regular intervals throughout cable length. Wires and cables manufactured more than 24 months prior to date of delivery to the site are not acceptable. Provide single conductor type cables unless otherwise indicated.

2.5.1 Cable Configuration

Provide Type MV cable, conforming to NEMA WC 74/ICEA S-93-639 and UL 1072. Provide cables manufactured for use in duct applications as indicated. Cable must be rated 15 kV as indicated with 133 percent insulation level.

2.5.2 Conductor Material

Provide concentric-lay-stranded, Class B compact round conductors. Provide soft drawn copper cables complying with ASTM B3 and ASTM B8 for regular concentric and compressed stranding or ASTM B496 for compact stranding.

2.5.3 Insulation

Provide tree-retardant cross-linked thermosetting polyethylene (XLP) insulation conforming to the requirements of NEMA WC 74/ICEA S-93-639 and AEIC CS8.

2.5.4 Shielding

Cables rated for 2 kV and above must have a semiconducting conductor shield, a semiconducting insulation shield, and an overall copper tape shield for each phase.

2.5.5 Neutrals

Neutral conductors must be copper, employing the same insulation and jacket materials as phase conductors, except that a 600-volt insulation rating is acceptable.

2.5.6 Jackets

Provide cables with a PVC jacket.

2.6 MEDIUM VOLTAGE CABLE TERMINATIONS

IEEE 48 Class 1; of the molded elastomer, prestretched elastomer, or heat-shrinkable elastomer. Acceptable elastomers are track-resistant silicone rubber or track-resistant ethylene propylene compounds, such as ethylene propylene rubber or ethylene propylene diene monomer. Separable insulated connectors may be used for apparatus terminations, when such apparatus is provided with suitable bushings. Provide terminations, where required, with mounting brackets suitable for the intended installation and with grounding provisions for the cable shielding, metallic sheath, or armor. Provide terminations in a kit, including: skirts, stress control terminator, ground clamp, connectors, lugs, and complete instructions for assembly and installation. Terminations must be the product of one manufacturer, suitable for the type, diameter, insulation class and level, and materials of the cable terminated. Do not use separate parts of copper or copper alloy in contact with aluminum alloy parts in the construction or installation of the terminator.

2.6.1 Cold-Shrink Type

Terminator must be a one-piece design, utilizing the manufacturer's latest technology, where high-dielectric constant (capacitive) stress control is integrated within a skirted insulator made of silicone rubber. Termination must not require heat or flame for installation. Termination kit must contain all necessary materials (except for the lugs). Design termination for installation in low or highly contaminated indoor and outdoor locations and must resist ultraviolet rays and oxidative decomposition.

2.6.2 Heat Shrinkable Type

Terminator must consist of a uniform cross section heat shrinkable polymeric construction stress relief tubing and environmentally sealed outer covering that is nontracking, resists heavy atmospheric contaminants, ultra violet rays and oxidative decomposition. Provide heat shrinkable sheds or skirts of the same material. Design termination for installation in low or highly contaminated indoor or outdoor locations.

2.6.3 Separable Insulated Connector Type

IEEE 386. Provide connector with steel reinforced hook-stick eye, grounding eye, test point, and arc-quenching contact material. Provide connectors of the loadbreak or deadbreak type as indicated, of suitable construction for the application and the type of cable connected, and that include cable shield adaptors. Provide external clamping points and test points. Do no use separable connectors in manholes/handholes.

a. 200 Ampere loadbreak connector ratings: Voltage: 15 kV, 95 kV BIL. Short time rating: 10,000 rms symmetrical amperes.

b. 600 Ampere deadbreak connector ratings: Voltage: 15 kV, 95 kV BIL. Short time rating: 25,000 rms symmetrical amperes. Connectors must have 200 ampere bushing interface as indicated.

c. Provide one set of three grounding elbows and one set of three feed-thru inserts. Deliver grounding elbows and feed-thru inserts to the Contracting Officer.

2.7 MEDIUM VOLTAGE CABLE JOINTS

Provide joints (splices) in accordance with IEEE 404 suitable for the rated voltage, insulation level, insulation type, and construction of the cable. Joints must be certified by the manufacturer for waterproof, submersible applications. Upon request, supply manufacturer's design qualification test report in accordance with IEEE 404. Connectors for joint must be tin-plated electrolytic copper, having ends tapered and having center stops to equalize cable insertion.

2.7.1 Heat-Shrinkable Joint

Consists of a uniform cross-section heat-shrinkable polymeric construction with a linear stress relief system, a high dielectric strength insulating material, and an integrally bonded outer conductor layer for shielding. Replace original cable jacket with a heavy-wall heat-shrinkable sleeve with hot-melt adhesive coating.

2.7.2 Cold-Shrink Rubber-Type Joint

Joint must be of a cold shrink design that does not require any heat source for its installation. Splice insulation and jacket must be of a one-piece factory formed cold shrink sleeve made of black EPDM rubber. Splice should be packaged three splices per kit, including complete installation instructions.

2.8 TELECOMMUNICATIONS CABLING

Provide telecommunications cabling in accordance with Section 33 82 00 TELECOMMUNICATIONS OUTSIDE PLANT (OSP).

2.9 TAPE

2.9.1 Insulating Tape

UL 510, plastic insulating tape, capable of performing in a continuous temperature environment of 80 degrees C.

2.9.2 Buried Warning and Identification Tape

Provide detectable tape in accordance with Section 31 00 00 EARTHWORK.

2.9.3 Fireproofing Tape

Provide tape composed of a flexible, conformable, unsupported intumescent elastomer. Tape must be not less than .030 inch thick, noncorrosive to cable sheath, self-extinguishing, noncombustible, adhesive-free, and must not deteriorate when subjected to oil, water, gases, salt water, sewage, and fungus.

2.10 PULL ROPE

Plastic or flat pull line (bull line) having a minimum tensile strength of 200 pounds.

2.11 GROUNDING AND BONDING

2.11.1 Driven Ground Rods

Provide copper-clad steel ground rods conforming to UL 467 not less than 3/4 inch in diameter by 10 feet in length.

2.11.2 Grounding Conductors

Stranded-bare copper conductors must conform to ASTM B8, Class B, soft-drawn unless otherwise indicated. Solid-bare copper conductors must conform to ASTM B1 for sizes No. 8 and smaller. Insulated conductors must be of the same material as phase conductors and green color-coded, except that conductors must be rated no more than 600 volts. Aluminum is not acceptable.

2.12 CAST-IN-PLACE CONCRETE

Provide concrete in accordance with Section 03 30 00 CAST-IN-PLACE CONCRETE. In addition, provide concrete for encasement of underground ducts with ~~3000~~3500 psi minimum 28-day compressive strength. Concrete associated with electrical work for other than encasement of underground ducts must be 4000 psi minimum 28-day compressive strength unless specified otherwise.

2.13 UNDERGROUND STRUCTURES

Provide precast concrete underground structures or standard type cast-in-place manhole types as indicated, conforming to ASTM C857 and ASTM C478. Top, walls, and bottom must consist of reinforced concrete. Walls and bottom must be of monolithic concrete construction. Locate duct entrances and windows near the corners of structures to facilitate cable racking. Covers must fit the frames without undue play. Form steel and iron to shape and size with sharp lines and angles. Castings must be free from warp and blow holes that may impair strength or appearance. Exposed metal must have a smooth finish and sharp lines and arises. Provide necessary lugs, rabbets, and brackets. Set pulling-in irons and other built-in items in place before depositing concrete. Install a pulling-in iron in the wall opposite each duct line entrance. Cable racks, including rack arms and insulators, must be adequate to accommodate the cable.

2.13.1 Cast-In-Place Concrete Structures

Concrete must conform to Section 03 30 00 CAST-IN-PLACE CONCRETE. Construct walls on a footing of cast-in-place concrete except that precast concrete base sections may be used for precast concrete manhole risers. Concrete block is not allowed in areas subject to aircraft loading.

2.13.2 Precast Concrete Structures, Risers and Tops

Precast concrete underground structures may be provided in lieu of cast-in-place subject to the requirements specified below. Precast units must be the product of a manufacturer regularly engaged in the manufacture of precast concrete products, including precast manholes.

2.13.2.1 General

Precast concrete structures must have the same accessories and facilities as required for cast-in-place structures. Likewise, precast structures must have plan area and clear heights not less than those of cast-in-place structures. Concrete materials and methods of construction must be the same as for cast-in-place concrete construction, as modified herein. Slope in floor may be omitted provided precast sections are poured in reinforced steel forms. Concrete for precast work must have a 28-day compressive strength of not less than 4000 psi. Structures may be precast to the design and details indicated for cast-in-place construction, precast monolithically and placed as a unit, or structures may be assembled sections, designed and produced by the manufacturer in accordance with the requirements specified. Structures must be identified with the manufacturer's name embedded in or otherwise permanently attached to an interior wall face.

2.13.2.2 Design for Precast Structures

ACI 318M. In the absence of detailed on-site soil information, design for the following soil parameters/site conditions:

a. Angle of Internal Friction (phi) = 30 degrees

b. Unit Weight of Soil (Dry) = 110 pcf, (Saturated) = 130 pcf

c. Coefficient of Lateral Earth Pressure (Ka) = 0.33

d. Ground Water Level = 3 feet below ground elevation

e. Vertical design loads must include full dead, superimposed dead, and live loads including a 30 percent magnification factor for impact. Live loads must consider all types and magnitudes of vehicular (automotive, industrial, or aircraft) traffic to be encountered. The minimum design vertical load must be for H20 highway loading per AASHTO HB-17.

f. Horizontal design loads must include full geostatic and hydrostatic pressures for the soil parameters, water table, and depth of installation to be encountered. Also, horizontal loads imposed by adjacent structure foundations, and horizontal load components of vertical design loads, including impact, must be considered, along with a pulling-in iron design load of 6000 pounds.

g. Each structural component must be designed for the load combination and positioning resulting in the maximum shear and moment for that particular component.

h. Design must also consider the live loads induced in the handling, installation, and backfilling of the manholes. Provide lifting devices to ensure structural integrity during handling and installation.

2.13.2.3 Construction

Provide a uniform thickness for structure top, bottom, and wall not less than 6 inches. Thin-walled knock-out panels for designed or future duct bank entrances are not permitted. Provide quantity, size, and location of duct bank entrance windows as directed, and cast completely open by the precaster. Size of windows must exceed the nominal duct bank envelope dimensions by at least 12 inches vertically and horizontally to preclude in-field window modifications made necessary by duct bank misalignment. However, the sides of precast windows must be a minimum of 6 inches from the inside surface of adjacent walls, floors, or ceilings. Form the perimeter of precast window openings to have a keyed or inward flared surface to provide a positive interlock with the mating duct bank envelope. Provide welded wire fabric reinforcing through window openings for in-field cutting and flaring into duct bank envelopes. Provide additional reinforcing steel comprised of at least two No. 4 bars around window openings. Provide drain sumps a minimum of 12 inches in diameter and 4 inches deep for precast structures.

2.13.2.4 Joints

Provide tongue-and-groove joints on mating edges of precast components. Shiplap joints are not allowed. Design joints to firmly interlock adjoining components and to provide waterproof junctions and adequate shear transfer. Seal joints watertight using preformed plastic strip conforming to ASTM C990. Install sealing material in strict accordance with the sealant manufacturer's printed instructions. Provide waterproofing at conduit/duct entrances into structures, and where access frame meets the top slab, provide continuous grout seal.

2.13.3 Manhole Frames and Covers

Provide cast iron frames and covers for manholes conforming to CID A-A-60005. Cast the words "ELECTRIC" or "TELECOMMUNICATIONS" in the top face of power and telecommunications manhole covers, respectively.

2.13.4 Handhole Frames and Covers

Frames and covers of steel must be welded by qualified welders in accordance with standard commercial practice. Provide rolled-steel floor plate covers having an approved antislip surface. Hinges must be of stainless steel with bronze hinge pin, 5 by 5 inches by approximately 3/16 inch thick, without screw holes, and must be for full surface application by fillet welding. Hinges must have nonremovable pins and five knuckles. The surfaces of plates under hinges must be true after the removal of raised antislip surface, by grinding or other approved method.

2.13.5 Frames and Covers for Airfield Facilities

Fabricate frames and covers for airfield use of standard commercial grade

steel welded by qualified welders in accordance with AWS D1.1/D1.1M. Provide rolled steel floor plate covers having an approved anti-slip surface. Steel frames and covers must be hot dipped galvanized after fabrication.

2.13.6 Ductile Iron Frames and Covers for Airfield Facilities

At the Contractor's option, ductile iron covers and frames designed for a minimum proof load of 100,000 pounds may be provided in lieu of the steel frames and covers indicated. Covers must be of the same material as the frames (i.e. ductile iron frame with ductile iron cover, galvanized steel frame with galvanized steel cover). Perform proof loading in accordance with CID A-A-60005 and ASTM A48/A48M. Proof loads must be physically stamped into the cover. Provide the Contracting Officer copies of previous proof load test results performed on the same frames and covers as proposed for this contract. Modify the top of the structure to accept the ductile iron structure in lieu of the steel structure indicated. The finished structure must be level and non-rocking, with the top flush with the surrounding pavement.

2.13.7 Brick for Manhole Collar

Provide sewer and manhole brick conforming to ASTM C32, Grade MS.

2.13.8 Composite/Fiberglass Handholes and Covers

ANSI/SCTE 77. Provide handholes and covers of polymer concrete, reinforced with heavy weave fiberglass with a design load (Tier rating) appropriate for or greater than the intended use. All covers are required to have the Tier level rating embossed on the surface which must not exceed the design load of the box.

2.14 CABLE SUPPORTS (RACKS, ARMS, AND INSULATORS)

Zinc coat the metal portion of racks and arms after fabrication.

2.14.1 Cable Rack Stanchions

The wall bracket or stanchion must be 4 inches by approximately 1-1/2 inch by 3/16 inch channel steel, or 4 inches by approximately 1 inch glass-reinforced nylon with recessed bolt mounting holes, 48 inches long (minimum) in manholes. Space slots for mounting cable rack arms at 8 inch intervals.

2.14.2 Rack Arms

Cable rack arms must be steel or malleable iron or glass reinforced nylon and must be of the removable type. Rack arm length must be a minimum of 8 inches and a maximum of 12 inches.

2.14.3 Insulators

Insulators for metal rack arms must be dry-process glazed porcelain. Insulators are not required for nylon arms.

2.15 CABLE TAGS IN MANHOLES

Provide polyethylene tags for each power cable located in manholes. Do not provide handwritten letters. The first position on the power cable

tag denotes the voltage. The second through sixth positions on the tag identifies the circuit. The next to last position denotes the phase of the circuit and include the Greek "phi" symbol. The last position denotes the cable size. As an example, a tag could have the following designation: "11.5 NAS 1-8(Phase A)500," denoting that the tagged cable is on the 11.5kV system circuit number NAS 1-8, underground, Phase A, sized at 500 kcmil.

2.15.1 Polyethylene Cable Tags

Provide tags of polyethylene having an average tensile strength of 3250 pounds per square inch; and that are 0.08 inch thick (minimum), non-corrosive non-conductive; resistive to acids, alkalis, organic solvents, and salt water; and distortion resistant to 170 degrees F. Provide 0.05 inch (minimum) thick black polyethylene tag holder. Provide a one-piece nylon, self-locking tie at each end of the cable tag, having a minimum loop tensile strength of 175 pounds and black block letters, numbers, and symbols one inch high on a yellow background. Letters, numbers, and symbols must not fall off or change positions regardless of the cable tags' orientation.

2.16 MEDIUM VOLTAGE ABOVE GROUND CABLE TERMINATING CABINETS

Cable terminating cabinets must be hook-stick operable, deadfront construction conforming to the requirements of IEEE C37.20.3, Category A. Provide cabinets with 600 A. dead-break junctions and elbow-type separable dead-break connectors, cable parking stands, and grounding lugs. Provide cable terminating equipment in conformance with IEEE 386.

Ratings at 60 Hz must be:

Nominal voltage (kV)	13.8kV
Rated maximum voltage (kV)	15
Rated continuous current (A)	600
One-second short-time current-carrying capacity (kA)	10kA
BIL (kV)	95 kV

2.17 LOW VOLTAGE ABOVE GROUND TERMINATION PEDESTAL

Provide copolymer polypropylene, low voltage above ground termination pedestal manufactured through an injection molding process. Pedestals must resist fertilizers, salt air environments and ultra-violet radiation. Pedestal top must be imprinted with a "WARNING" and "ELECTRIC" identification. Pedestal must contain four lay-in six port connectors, NEMA C119.4, Class "A", dual rated for aluminum or copper, and capable of terminating conductors ranging from 10 AWG to 500 kcmil. Protect each connector with a clear, hard lexan (plastic) cover. Provide pedestal with rust-free material and stainless steel hardware that is lockable.

2.18 SOURCE QUALITY CONTROL

2.18.1 Arc-Proofing Test for Cable Fireproofing Tape

Manufacturer must test one sample assembly consisting of a straight lead tube 12 inches long with a 2 1/2 inch outside diameter, and a 1/8 inch thick wall, and covered with one-half lap layer of arc and fireproofing tape per manufacturer's instructions. The arc and fireproofing tape must withstand extreme temperature of a high-current fault arc 13,000 degrees K for 70 cycles as determined by using an argon directed plasma jet capable of constantly producing and maintaining an arc temperature of 13,000 degrees K. Temperature (13,000 degrees K) of the ignited arc between the cathode and anode must be obtained from a dc power source of 305 (plus or minus 5) amperes and 20 (plus or minus 1) volts. Direct the arc toward the sample assembly accurately positioned 5 (plus or minus 1) millimeters downstream in the plasma from the anode orifice by fixed flow rate of argon gas (0.18 g per second). Test each sample assembly at three unrelated points. Start time for tests must be taken from recorded peak current when the specimen is exposed to the full test temperature. Surface heat on the specimen prior to that time must be minimal. The end point is established when the plasma or conductive arc penetrates the protective tape and strikes the lead tube. Submittals for arc-proofing tape must indicate that the test has been performed and passed by the manufacturer.

2.18.2 Medium Voltage Cable Qualification and Production Tests

Results of AEIC CS8 qualification and production tests as applicable for each type of medium voltage cable.

PART 3 EXECUTION

3.1 INSTALLATION

Install equipment and devices in accordance with the manufacturer's published instructions and with the requirements and recommendations of NFPA 70 and IEEE C2 as applicable. In addition to these requirements, install telecommunications in accordance with TIA-758 and RUS Bull 1751F-644.

3.2 CABLE INSPECTION

Inspect each cable reel for correct storage positions, signs of physical damage, and broken end seals prior to installation. If end seal is broken, remove moisture from cable prior to installation in accordance with the cable manufacturer's recommendations.

3.3 CABLE INSTALLATION PLAN AND PROCEDURE

Obtain from the manufacturer an installation manual or set of instructions which addresses such aspects as cable construction, insulation type, cable diameter, bending radius, cable temperature limits for installation, lubricants, coefficient of friction, conduit cleaning, storage procedures, moisture seals, testing for and purging moisture, maximum allowable pulling tension, and maximum allowable sidewall bearing pressure. Perform pulling calculations and prepare a pulling plan and submit along with the manufacturer's instructions in accordance with SUBMITTALS. Install cable strictly in accordance with the cable manufacturer's recommendations and the approved installation plan.

Calculations and pulling plan must include:

a. Site layout drawing with cable pulls identified in numeric order of expected pulling sequence and direction of cable pull.

b. List of cable installation equipment.

c. Lubricant manufacturer's application instructions.

d. Procedure for resealing cable ends to prevent moisture from entering cable.

e. Cable pulling tension calculations of all cable pulls.

f. Cable percentage conduit fill.

g. Cable sidewall bearing pressure.

h. Cable minimum bend radius and minimum diameter of pulling wheels used.

i. Cable jam ratio.

j. Maximum allowable pulling tension on each different type and size of conductor.

k. Maximum allowable pulling tension on pulling device.

3.4 UNDERGROUND FEEDERS SUPPLYING BUILDINGS

Terminate underground feeders supplying building at a point 5 feet outside the building and projections thereof, except that conductors must be continuous to the terminating point indicated. Coordinate connections of the feeders to the service entrance equipment with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Provide PVC, Type EPC-40 conduit from the supply equipment to a point 5 feet outside the building and projections thereof. Protect ends of underground conduit with plastic plugs until connections are made.

Encase the underground portion of the conduit in a concrete envelope and bury as specified for underground duct with concrete encasement.

3.5 UNDERGROUND STRUCTURE CONSTRUCTION

Provide standard type cast-in-place construction as specified herein and as indicated, or precast construction as specified herein. Horizontal concrete surfaces of floors must have a smooth trowel finish. Cure concrete by applying two coats of white pigmented membrane forming-curing compound in strict accordance with the manufacturer's printed instructions, except that precast concrete may be steam cured. Curing compound must conform to ASTM C309. Locate duct entrances and windows in the center of end walls (shorter) and near the corners of sidewalls (longer) to facilitate cable racking and splicing. Covers for underground structures must fit the frames without undue play. Form steel and iron to shape and size with sharp lines and angles. Castings must be free from warp and blow holes that may impair strength or appearance. Exposed metal must have a smooth finish and sharp lines and arises. Provide necessary lugs, rabbets, and brackets. Set pulling-in irons and other built-in items in place before depositing concrete. Manhole locations, as

indicated, are approximate. Coordinate exact manhole locations with other utilities and finished grading and paving.

3.5.1 Cast-In-Place Concrete Structures

Construct walls on a footing of cast-in-place concrete except that precast concrete base sections may be used for precast concrete manhole risers.

3.5.2 Precast Concrete Construction

Set commercial precast structures on 6 inches of level, 90 percent compacted granular fill, 3/4 inch to 1 inch size, extending 12 inches beyond the structure on each side. Compact granular fill by a minimum of four passes with a plate type vibrator. Installation must additionally conform to the manufacturer's instructions.

3.5.3 Pulling-In Irons

Provide steel bars bent as indicated, and cast in the walls and floors. Alternatively, pipe sleeves may be precast into the walls and floors where required to accept U-bolts or other types of pulling-in devices possessing the strengths and clearances stated herein. The final installation of pulling-in devices must be made permanent. Cover and seal exterior projections of thru-wall type pulling-in devices with an appropriate protective coating. In the floor, locate the irons a minimum of 6 inches from the edge of the sump, and in the walls, locate the irons within 6 inches of the projected center of the duct bank pattern or precast window in the opposite wall. However, the pulling-in iron must not be located within 6 inches of an adjacent interior surface, or duct or precast window located within the same wall as the iron. If a pulling-in iron cannot be located directly opposite the corresponding duct bank or precast window due to this clearance limitation, locate the iron directly above or below the projected center of the duct bank pattern or precast window the minimum distance required to preserve the 6 inch clearance previously stated. In the case of directly opposing precast windows, pulling-in irons consisting of a 3 foot length of No. 5 reinforcing bar, formed into a hairpin, may be cast-in-place within the precast windows simultaneously with the end of the corresponding duct bank envelope. Irons installed in this manner must be positioned directly in line with, or when not possible, directly above or below the projected center of the duct bank pattern entering the opposite wall, while maintaining a minimum clear distance of 3 inches from any edge of the cast-in-place duct bank envelope or any individual duct. Pulling-in irons must have a clear projection into the structure of approximately 4 inches and must be designed to withstand a minimum pulling-in load of 6000 pounds. Hot-dip galvanize irons after fabrication.

3.5.4 Cable Racks, Arms and Insulators

Cable racks, arms and insulators must be sufficient to accommodate the cables. Space racks in power manholes not more than 3 feet apart, and provide each manhole wall with a minimum of two racks. Space racks in signal manholes not more than 16 1/2 inches apart with the end rack being no further than 12 inches from the adjacent wall. Methods of anchoring cable racks are as follows:

a. Provide a 5/8 inch diameter by 5 inch long anchor bolt with 3 inch foot cast in structure wall with 2 inch protrusion of threaded portion of bolt into structure. Provide 5/8 inch steel square head nut on

each anchor bolt. Coat threads of anchor bolts with suitable coating immediately prior to installing nuts.

b. Provide concrete channel insert with a minimum load rating of 800 pounds per foot. Insert channel must be steel of the same length as "vertical rack channel;" and cast flush in structure wall. Provide 5/8 inch steel nuts in channel insert to receive 5/8 inch diameter by 3 inch long steel, square head anchor bolts.

c. Provide concrete "spot insert" at each anchor bolt location, cast flush in structure wall. Each insert must have minimum 800 pound load rating. Provide 5/8 inch diameter by 3 inch long steel, square head anchor bolt at each anchor point. Coat threads of anchor bolts with suitable coating immediately prior to installing bolts.

3.5.5 Field Painting

Clean cast-iron frames and covers not buried in concrete or masonry of mortar, rust, grease, dirt and other deleterious materials, and coat with bituminous paint.

3.6 UNDERGROUND CONDUIT AND DUCT SYSTEMS

3.6.1 Requirements

Run conduit in straight lines except where a change of direction is necessary. Provide numbers and sizes of ducts as indicated. Provide a 4/0 AWG bare copper grounding conductor above medium-voltage distribution duct banks. Bond bare copper grounding conductor to ground rings (loops) in all manholes and to ground rings (loops) at all equipment slabs (pads). Route grounding conductor into manholes with the duct bank (sleeving is not required). Ducts must have a continuous slope downward toward underground structures and away from buildings, laid with a minimum slope of 4 inches per 100 feet. Depending on the contour of the finished grade, the high-point may be at a terminal, a manhole, a handhole, or between manholes or handholes. Terminate all PVC conduit end points in utility holes, switching cabinets, transform handholes and buildings with end bells. The bell end of the conduits that enter manholes and handholes must be flush with the wall.

Perform changes in ductbank direction as follows:

a. Short-radius manufactured 90-degree duct bends may be used only for pole or equipment risers, unless specifically indicated as acceptable.

b. The minimum manufactured bend radius must be 18 inches for ducts of less than 3 inch diameter, and 36 inches for ducts 3 inches or greater in diameter.

c. As an exception to the bend radius required above, provide field manufactured longsweep bends having a minimum radius of 25 feet for a change of direction of more than 5 degrees, either horizontally or vertically, using a combination of curved and straight sections. Maximum manufactured curved sections allowed for use in field manufactured longsweep bend: 30 degrees.

3.6.2 Treatment

Keep ducts clean of concrete, dirt, or foreign substances during

construction. Make field cuts requiring tapers with proper tools and match factory tapers. Use a coupling recommended by the duct manufacturer whenever an existing duct is connected to a duct of different material or shape. Store ducts to avoid warping and deterioration with ends sufficiently plugged to prevent entry of any water or solid substances. Thoroughly clean ducts before being laid. Store plastic ducts on a flat surface and protected from the direct rays of the sun.

3.6.3 Conduit Cleaning

As each conduit run is completed, for conduit sizes 3 inches and larger, draw a flexible testing mandrel approximately 12 inches long with a diameter less than the inside diameter of the conduit through the conduit. After which, draw a stiff bristle brush through until conduit is clear of particles of earth, sand and gravel; then immediately install conduit plugs. For conduit sizes less than 3 inches, draw a stiff bristle brush through until conduit is clear of particles of earth, sand and gravel; then immediately install conduit plugs.

3.6.4 Jacking and Drilling Under Roads and Structures

Conduits to be installed under existing paved areas which are not to be disturbed, and under roads and railroad tracks, must be zinc-coated, rigid steel, jacked into place. Where ducts are jacked under existing pavement, install rigid steel conduit because of its strength. To protect the corrosion-resistant conduit coating, predrilling or installing conduit inside a larger iron pipe sleeve (jack-and-sleeve) is required. For crossings of existing railroads and airfield pavements greater than 50 feet in length, the predrilling method or the jack-and-sleeve method will be used. Separators or spacing blocks must be made of steel, concrete, plastic, or a combination of these materials placed not farther apart than 4 feet on centers.

3.6.5 Galvanized Conduit Concrete Penetrations

Galvanized conduits which penetrate concrete (slabs, pavement, and walls) in wet locations must be PVC coated and extend from at least 2 inches within the concrete to the first coupling or fitting outside the concrete (minimum of 6 inches from penetration).

3.6.6 Multiple Conduits

Separate multiple conduits by a minimum distance of 3 inches, except that light and power conduits must be separated from control, signal, and telephone conduits by a minimum distance of 12 inches. Stagger the joints of the conduits by rows (horizontally) and layers (vertically) to strengthen the conduit assembly. Provide plastic duct spacers that interlock vertically and horizontally. Spacer assembly must consist of base spacers, intermediate spacers, ties, and locking device on top to provide a completely enclosed and locked-in conduit assembly. Install spacers per manufacturer's instructions, but provide a minimum of two spacer assemblies per 10 feet of conduit assembly.

3.6.7 Conduit Plugs and Pull Rope

Provide new conduit indicated as being unused or empty with plugs on each end. Plugs must contain a weephole or screen to allow water drainage. Provide a plastic pull rope having 3 feet of slack at each end of unused or empty conduits.

3.6.8 Conduit and Duct Without Concrete Encasement

3.6.8.1 Encasement Under Roads and Structures

Under roads, paved areas, and railroad tracks, install conduits in concrete encasement of rectangular cross-section providing a minimum of 3 inch concrete cover around ducts. Extend concrete encasement at least 5 feet beyond the edges of paved areas and roads, and 12 feet beyond the rails on each side of railroad tracks. Depths to top of the concrete envelope must be not less than 24 inches below finished grade.

3.6.8.2 Directional Boring

HDPE conduits must be installed below the frostline and as specified herein.

3.6.9 Duct Encased in Concrete

Construct underground duct lines of individual conduits encased in concrete. Depths to top of the concrete envelope must be not less than 18 inches below finished grade, except under roads and pavement, concrete envelope must be not less than 24 inches below finished grade. Do not mix different kinds of conduit in any one duct bank. Concrete encasement surrounding the bank must be rectangular in cross-section and provide at least 3 inches of concrete cover for ducts. Separate conduits by a minimum concrete thickness of 3 inches. Before pouring concrete, anchor duct bank assemblies, prevent floating during concrete pouring by driving reinforcing rods adjacent to duct spacer assemblies and attaching the rods to the spacer assembly. Provide color, type and depth of warning tape as specified in Section 31 00 00 EARTHWORK.

3.6.9.1 Connections to Manholes

Duct bank envelopes connecting to underground structures must be flared to have enlarged cross-section at the manhole entrance to provide additional shear strength. Dimensions of the flared cross-section must be larger than the corresponding manhole opening dimensions by no less than 12 inches in each direction. Perimeter of the duct bank opening in the underground structure must be flared toward the inside or keyed to provide a positive interlock between the duct bank and the wall of the structure. Use vibrators when this portion of the encasement is poured to assure a seal between the envelope and the wall of the structure.

3.6.9.2 Connections to Existing Underground Structures

For duct bank connections to existing structures, break the structure wall out to the dimensions required and preserve steel in the structure wall. Cut steel and bend out to tie into the reinforcing of the duct bank envelope. Chip the perimeter surface of the duct bank opening to form a key or flared surface, providing a positive connection with the duct bank envelope.

3.6.9.3 Connections to Existing Concrete Pads

For duct bank connections to concrete pads, break an opening in the pad out to the dimensions required and preserve steel in pad. Cut the steel and bend out to tie into the reinforcing of the duct bank envelope. Chip out the opening in the pad to form a key for the duct bank envelope.

3.6.9.4 Connections to Existing Ducts

Where connections to existing duct banks are indicated, excavate the banks to the maximum depth necessary. Cut off the banks and remove loose concrete from the conduits before new concrete-encased ducts are installed. Provide a reinforced concrete collar, poured monolithically with the new duct bank, to take the shear at the joint of the duct banks. Remove existing cables which constitute interference with the work.

3.6.9.5 Partially Completed Duct Banks

During construction wherever a construction joint is necessary in a duct bank, prevent debris such as mud, and, and dirt from entering ducts by providing suitable conduit plugs. Fit concrete envelope of a partially completed duct bank with reinforcing steel extending a minimum of 2 feet back into the envelope and a minimum of 2 feet beyond the end of the envelope. Provide one No. 4 bar in each corner, 3 inches from the edge of the envelope. Secure corner bars with two No. 3 ties, spaced approximately one foot apart. Restrain reinforcing assembly from moving during concrete pouring.

3.6.9.6 Removal of Ducts

Where duct lines are removed from existing underground structures, close the openings to waterproof the structure. Chip out the wall opening to provide a key for the new section of wall.

3.6.10 Duct Sealing

Seal all electrical penetrations for radon mitigation, maintaining integrity of the vapor barrier, and to prevent infiltration of air, insects, and vermin.

3.7 CABLE PULLING

Test existing duct lines with a mandrel and thoroughly swab out to remove foreign material before pulling cables. Pull cables down grade with the feed-in point at the manhole or buildings of the highest elevation. Use flexible cable feeds to convey cables through manhole opening and into duct runs. Do not exceed the specified cable bending radii when installing cable under any conditions, including turnups into switches, transformers, switchgear, switchboards, and other enclosures. Cable with tape shield must have a bending radius not less than 12 times the overall diameter of the completed cable. If basket-grip type cable-pulling devices are used to pull cable in place, cut off the section of cable under the grip before splicing and terminating.

3.7.1 Cable Lubricants

Use lubricants that are specifically recommended by the cable manufacturer for assisting in pulling jacketed cables.

3.8 CABLES IN UNDERGROUND STRUCTURES

Do not install cables utilizing the shortest path between penetrations, but route along those walls providing the longest route and the maximum spare cable lengths. Form cables to closely parallel walls, not to interfere with duct entrances, and support on brackets and cable

insulators. Support cable splices in underground structures by racks on each side of the splice. Locate splices to prevent cyclic bending in the spliced sheath. Install cables at middle and bottom of cable racks, leaving top space open for future cables, except as otherwise indicated for existing installations. Provide one spare three-insulator rack arm for each cable rack in each underground structure.

3.8.1 Cable Tag Installation

Install cable tags in each manhole as specified, including each splice. Tag wire and cable provided by this contract. Install cable tags over the fireproofing, if any, and locate the tags so that they are clearly visible without disturbing any cabling or wiring in the manholes.

3.9 CONDUCTORS INSTALLED IN PARALLEL

Group conductors such that each conduit of a parallel run contains one Phase A conductor, one Phase B conductor, one Phase C conductor, and one neutral conductor.

3.10 LOW VOLTAGE CABLE SPLICING AND TERMINATING

Make terminations and splices with materials and methods as indicated or specified herein and as designated by the written instructions of the manufacturer. Do not allow the cables to be moved until after the splicing material has completely set. Make splices in underground distribution systems only in accessible locations such as manholes, handholes, or aboveground termination pedestals.

3.11 MEDIUM VOLTAGE CABLE TERMINATIONS

Make terminations in accordance with the written instruction of the termination kit manufacturer.

3.12 MEDIUM VOLTAGE CABLE JOINTS

Provide power cable joints (splices) suitable for continuous immersion in water. Make joints only in accessible locations in manholes or handholes by using materials and methods in accordance with the written instructions of the joint kit manufacturer.

3.12.1 Joints in Shielded Cables

Cover the joined area with metallic tape, or material like the original cable shield and connect it to the cable shield on each side of the splice. Provide a bare copper ground connection brought out in a watertight manner and grounded to the manhole grounding loop as part of the splice installation. Ground conductors, connections, and rods must be as specified elsewhere in this section. Wire must be trained to the sides of the enclosure to prevent interference with the working area.

3.13 CABLE END CAPS

Cable ends must be sealed at all times with coated heat shrinkable end caps. Cables ends must be sealed when the cable is delivered to the job site, while the cable is stored and during installation of the cable. The caps must remain in place until the cable is spliced or terminated. Sealing compounds and tape are not acceptable substitutes for heat shrinkable end caps. Cable which is not sealed in the specified manner at

all times will be rejected.

3.14 FIREPROOFING OF CABLES IN UNDERGROUND STRUCTURES

Fireproof (arc proof) wire and cables which will carry current at 2200 volts or more in underground structures.

3.14.1 Fireproofing Tape

Tightly wrap strips of fireproofing tape around each cable spirally in half-lapped wrapping. Install tape in accordance with manufacturer's instructions.

3.15 GROUNDING SYSTEMS

NFPA 70 and IEEE C2, except provide grounding systems with a resistance to solid earth ground not exceeding 5 ohms.

3.15.1 Grounding Electrodes

Provide cone pointed driven ground rods driven or drilled full depth plus 12 inches, installed to provide an earth ground of the appropriate value for the particular equipment being grounded.
If the specified ground resistance is not met, provide an additional ground rod in accordance with the requirements of NFPA 70 (placed not less than 6 feet from the first rod). Should the resultant (combined) resistance exceed the specified resistance, measured not less than 48 hours after rainfall, notify the Contracting Officer immediately. Contractor must drill a mininum 1 foot diameter hole and fill with conductive soil to install ground rod where refusal occurs during standard hammer drill installation.

3.15.2 Grounding Connections

Make grounding connections which are buried or otherwise normally inaccessible, by exothermic weld or compression connector.

a. Make exothermic welds strictly in accordance with the weld manufacturer's written recommendations. Welds which are "puffed up" or which show convex surfaces indicating improper cleaning are not acceptable. Mechanical connectors are not required at exothermic welds.

b. Make compression connections using a hydraulic compression tool to provide the correct circumferential pressure. Tools and dies must be as recommended by the manufacturer. An embossing die code or other standard method must provide visible indication that a connector has been adequately compressed on the ground wire.

3.15.3 Grounding Conductors

Provide bare grounding conductors, except where installed in conduit with associated phase conductors. Ground cable sheaths, cable shields, conduit, and equipment with No. 6 AWG. Ground other noncurrent-carrying metal parts and equipment frames of metal-enclosed equipment. Ground metallic frames and covers of handholes and pull boxes with a braided, copper ground strap with equivalent ampacity of No. 6 AWG.

3.15.4 Ground Cable Crossing Expansion Joints

Protect ground cables crossing expansion joints or similar separations in structures and pavements by use of approved devices or methods of installation which provide the necessary slack in the cable across the joint to permit movement. Use stranded or other approved flexible copper cable across such separations.

3.15.5 Manhole Grounding

Loop a 4/0 AWG grounding conductor around the interior perimeter, approximately 12 inches above finished floor. Secure the conductor to the manhole walls at intervals not exceeding 36 inches. Connect the conductor to the manhole grounding electrode with 4/0 AWG conductor. Connect all incoming 4/0 grounding conductors to the ground loop adjacent to the point of entry into the manhole. Bond the ground loop to all cable shields, metal cable racks, and other metal equipment with a minimum 6 AWG conductor.

3.15.6 Fence Grounding

Provide grounding for fences with a ground rod at each fixed gate post and at each corner post. Drive ground rods until the top is 12 inches below grade. Attach a No. 4 AWG copper conductor, by exothermic weld to the ground rods and extend underground to the immediate vicinity of fence post. Lace the conductor vertically into 12 inches of fence mesh and fasten by two approved bronze compression fittings, one to bond wire to post and the other to bond wire to fence. Bond each gate section to its gatepost by a 1/8 by one inch flexible braided copper strap and ground post clamps. Clamps must be of the anti-electrolysis type.

3.16 EXCAVATING, BACKFILLING, AND COMPACTING

Provide in accordance with NFPA 70 and Section 31 00 00 EARTHWORK.

3.16.1 Reconditioning of Surfaces

3.16.1.1 Unpaved Surfaces

Restore to their original elevation and condition unpaved surfaces disturbed during installation of duct. Preserve sod and topsoil removed during excavation and reinstall after backfilling is completed. Replace sod that is damaged by sod of quality equal to that removed. When the surface is disturbed in a newly seeded area, re-seed the restored surface with the same quantity and formula of seed as that used in the original seeding, and provide topsoiling, fertilizing, liming, seeding, sodding, sprigging, or mulching. Provide work in accordance with Section 32 92 19 SEEDING.

3.16.1.2 Paving Repairs

Where trenches, pits, or other excavations are made in existing roadways and other areas of pavement where surface treatment of any kind exists, restore such surface treatment or pavement the same thickness and in the same kind as previously existed, except as otherwise specified, and to match and tie into the adjacent and surrounding existing surfaces.

3.17 CAST-IN-PLACE CONCRETE

Provide concrete in accordance with Section 03 30 00 CAST-IN-PLACE CONCRETE.

3.17.1 Concrete Slabs (Pads) for Equipment

Unless otherwise indicated, the slab must be at least 8 inches thick, reinforced with a 6 by 6 - W2.9 by W2.9 mesh, placed uniformly 4 inches from the top of the slab. Place slab on a 6 inch thick, well-compacted gravel base. Top of concrete slab must be approximately 4 inches above finished grade with gradual slope for drainage. Edges above grade must have 1/2 inch chamfer. Slab must be of adequate size to project at least 8 inches beyond the equipment.

Stub up conduits, with bushings, 2 inches into cable wells in the concrete pad. Coordinate dimensions of cable wells with transformer cable training areas.

3.17.2 Sealing

When the installation is complete, seal all conduit and other entries into the equipment enclosure with an approved sealing compound. Seals must be of sufficient strength and durability to protect all energized live parts of the equipment from rodents, insects, or other foreign matter.

3.18 FIELD QUALITY CONTROL

3.18.1 Performance of Field Acceptance Checks and Tests

Perform in accordance with the manufacturer's recommendations, and include the following visual and mechanical inspections and electrical tests, performed in accordance with NETA ATS.

3.18.1.1 Medium Voltage Cables

Perform tests after installation of cable, splices, and terminators and before terminating to equipment or splicing to existing circuits.

a. Visual and Mechanical Inspection

(1) Inspect exposed cable sections for physical damage.

(2) Verify that cable is supplied and connected in accordance with contract plans and specifications.

(3) Inspect for proper shield grounding, cable support, and cable termination.

(4) Verify that cable bends are not less than ICEA or manufacturer's minimum allowable bending radius.

(5) Inspect for proper fireproofing.

(6) Visually inspect jacket and insulation condition.

(7) Inspect for proper phase identification and arrangement.

b. Electrical Tests

(1) Perform a shield continuity test on each power cable by ohmmeter method. Record ohmic value, resistance values in excess of 10 ohms per 1000 feet of cable must be investigated and justified.

(2) Perform acceptance test on new cables before the new cables are connected to existing cables and placed into service, including terminations and joints. Perform maintenance test on complete cable system after the new cables are connected to existing cables and placed into service, including existing cable, terminations, and joints. Tests must be very low frequency (VLF) alternating voltage withstand tests in accordance with IEEE 400.2. VLF test frequency must be 0.05 Hz minimum for a duration of 60 minutes using a sinusoidal waveform. Test voltages must be as follows:

CABLE RATING AC TEST VOLTAGE for ACCEPTANCE TESTING	
5 kV	10kV rms(peak)
8 kV	13kV rms(peak)
15 kV	20kV rms(peak)
25 kV	31kV rms(peak)
35 kV	44kV rms(peak)

CABLE RATING AC TEST VOLTAGE for MAINTENANCE TESTING	
5 kV	7kV rms(peak)
8 kV	10kV rms(peak)
15 kV	16kV rms(peak)
25 kV	23kV rms(peak)
35 kV	33kV rms(peak)

3.18.1.2 Low Voltage Cables, 600-Volt

Perform tests after installation of cable, splices and terminations and before terminating to equipment or splicing to existing circuits.

a. Visual and Mechanical Inspection

(1) Inspect exposed cable sections for physical damage.

(2) Verify that cable is supplied and connected in accordance with contract plans and specifications.

(3) Verify tightness of accessible bolted electrical connections.

(4) Inspect compression-applied connectors for correct cable match and

indentation.

(5) Visually inspect jacket and insulation condition.

(6) Inspect for proper phase identification and arrangement.

b. Electrical Tests

(1) Perform insulation resistance tests on wiring No. 6 AWG and larger diameter using instrument which applies voltage of approximately 1000 volts dc for one minute.

(2) Perform continuity tests to insure correct cable connection.

3.18.1.3 Grounding System

a. Visual and mechanical inspection

Inspect ground system for compliance with contract plans and specifications.

b. Electrical tests

Perform ground-impedance measurements utilizing the fall-of-potential method in accordance with IEEE 81. On systems consisting of interconnected ground rods, perform tests after interconnections are complete. On systems consisting of a single ground rod perform tests before any wire is connected. Take measurements in normally dry weather, not less than 48 hours after rainfall. Use a portable ground resistance tester in accordance with manufacturer's instructions to test each ground or group of grounds. The instrument must be equipped with a meter reading directly in ohms or fractions thereof to indicate the ground value of the ground rod or grounding systems under test. Provide site diagram indicating location of test probes with associated distances, and provide a plot of resistance vs. distance.

3.18.2 Follow-Up Verification

Upon completion of acceptance checks and tests, show by demonstration in service that circuits and devices are in good operating condition and properly performing the intended function. As an exception to requirements stated elsewhere in the contract, the Contracting Officer must be given 5 working days advance notice of the dates and times of checking and testing.

.... -- End of Section --

SECTION 33 82 00

TELECOMMUNICATIONS OUTSIDE PLANT (OSP)
04/06

PART 1 GENERAL

1.1 REFERENCES

The publications 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.

ASTM INTERNATIONAL (ASTM)

ASTM B1	(2013) Standard Specification for Hard-Drawn Copper Wire
ASTM B8	(2023) Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
ASTM D709	(2017) Standard Specification for Laminated Thermosetting Materials
ASTM D1557	(2012; E 2015) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3) (2700 kN-m/m3)

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 100	(2000; Archived) The Authoritative Dictionary of IEEE Standards Terms
IEEE C2	(2023) National Electrical Safety Code

INSULATED CABLE ENGINEERS ASSOCIATION (ICEA)

ICEA S-84-608	(2012) Broadband Twisted Pair Telecommunication Cable Filled, Polyolefin Insulated, Copper Conductors Technical Requirements
ICEA S-87-640	(2023) Optical Fiber Outside Plant Communications Cable; 4th Edition
ICEA S-98-688	(2012) Broadband Twisted Pair Telecommunication Cable, Aircore, Polyolefin Insulated, Copper Conductors Technical Requirements

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI C62.61	(1993) American National Standard for Gas Tube Surge Arresters on Wire Line Telephone Circuits

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1; TIA 25-2) National Electrical Code

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC SP 6/NACE No.3	(2007) Commercial Blast Cleaning

TELECOMMUNICATIONS INDUSTRY ASSOCIATION (TIA)

TIA-455-107-A	(1999) FOTP-107 Determination of Component Reflectance or Link/System Return Loss using a Loss Test Set
TIA-455-204-A	(2013) FOTP-204 Measurement of Bandwidth on Multimode Fiber
TIA-455-C	(2014) General Requirements for Standard Test Procedure for Optic Fibers, Cables, Transducers, Sensors, Connecting and Terminating Devices, and Other Fiber Optic Components
TIA-472D000-B	(2007) Standard for Optical Fiber Outside Plant Communications Cable
TIA-455-78-B	(2020c) FOTP-78 Optical Fibres - Part 1-40: Measurement Methods and Test Procedures - Attenuation
TIA-492CAAA	(1998; R 2002) Detail Specification for Class IVa Dispersion-Unshifted Single-Mode Optical Fibers
TIA-492E000	(1996; R 2002) Sectional Specification for Class IVd Nonzero-Dispersion Single-Mode Optical Fibers for the 1550 nm Window
TIA-526-7-A	(2015) OFSTP-7 Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant
TIA-526-14-C	(2015) OFSTP-14A Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant
TIA-568.1-D	(2015; Add 1 2018) Commercial Building Telecommunications Infrastructure Standard
TIA-568.2-D	(2018) Balanced Twisted-Pair Telecommunications Cabling and Components Standards
TIA-568.3-D	(2016; Add 1 2019) Optical Fiber Cabling Components Standard
TIA-569-E	(2019) Telecommunications Pathways and Spaces

TIA-590-A	(1997) Standard for Physical Location and Protection of Below Ground Fiber Optic Cable Plant
TIA-598-D	(2014; Add 1 2018; Add 2 2018) Optical Fiber Cable Color Coding
TIA-606-C	(2017) Administration Standard for the Telecommunications Cabling Infrastructure
TIA-607-D	(2019) Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises
TIA-758-B	(2012) Customer-Owned Outside Plant Telecommunications Infrastructure Standard

U.S. DEPARTMENT OF AGRICULTURE (USDA)

RUS 1755	Telecommunications Standards and Specifications for Materials, Equipment and Construction
RUS Bull 345-50	(1979) Trunk Carrier Systems (PE-60)
RUS Bull 345-65	(1985) Shield Bonding Connectors (PE-65)
RUS Bull 345-72	(1985) Filled Splice Closures (PE-74)
RUS Bull 345-83	(1979; Rev Oct 1982) Gas Tube Surge Arrestors (PE-80)
RUS Bull 1751F-630	(1996) Design of Aerial Plant
RUS Bull 1751F-640	(1995) Design of Buried Plant, Physical Considerations
RUS Bull 1751F-643	(2002) Underground Plant Design
RUS Bull 1751F-815	(1979) Electrical Protection of Outside Plant
RUS Bull 1753F-201	(1997) Acceptance Tests of Telecommunications Plant (PC-4)
RUS Bull 1753F-401	(1995) Splicing Copper and Fiber Optic Cables (PC-2)

UL SOLUTIONS (UL)

UL 83	(2017; Reprint Mar 2020) UL Standard for Safety Thermoplastic-Insulated Wires and Cables
UL 497	(2001; Reprint Jul 2022) UL Standard for Safety Protectors for Paired Conductor Communication Circuits

UL 510	(2020; Dec 2022) UL Standard for Safety Polyvinyl Chloride, Polyethylene and Rubber Insulating Tape

1.2 DEFINITIONS

Unless otherwise specified or indicated, electrical and electronics terms used in this specification shall be as defined in TIA-568.1-D, TIA-568.2-D, TIA-568.3-D, TIA-569-E, TIA-606-C, and IEEE 100 and herein.

1.2.1 Campus Distributor (CD)

A distributor from which the campus backbone cabling emanates. (International expression for main cross-connect - (MC).)

1.2.2 Entrance Facility (EF) (Telecommunications)

An entrance to the building for both private and public network service cables (including antennae) including the entrance point at the building wall and continuing to the entrance room or space.

1.2.3 Entrance Room (ER) (Telecommunications)

A centralized space for telecommunications equipment that serves the occupants of a building. Equipment housed therein is considered distinct from a telecommunications room because of the nature of its complexity.

1.2.4 Building Distributor (BD)

A distributor in which the building backbone cables terminate and at which connections to the campus backbone cables may be made. (International expression for intermediate cross-connect - (IC).)

1.2.5 Pathway

A physical infrastructure utilized for the placement and routing of telecommunications cable.

1.3 SYSTEM DESCRIPTION

The telecommunications outside plant consists of cable, conduit, manholes, poles, etc. required to provide signal paths from the closest point of presence to the new facility, including free standing frames or backboards, interconnecting hardware, terminating cables, lightning and surge protection modules at the entrance facility. The work consists of providing, testing and making operational cabling, interconnecting hardware and lightning and surge protection necessary to form a complete outside plant telecommunications system for continuous use.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Telecommunications Outside Plant; G

Telecommunications Entrance Facility Drawings; G

In addition to Section 01 33 00 SUBMITTAL PROCEDURES, provide shop drawings in accordance with paragraph SHOP DRAWINGS.

Existing Telecommunications System Survey; G

SD-03 Product Data

Wire and Cable; G

Cable Splices, and Connectors; G

Closures; G

Building Protector Assemblies; G

Protector Modules; G

Cross-Connect Terminal Cabinets; G

Spare Parts; G

Submittals must include the manufacturer's name, trade name, place of manufacture, and catalog model or number. Submittals must also include applicable federal, military, industry, and technical society publication references. Should manufacturer's data require supplemental information for clarification, the supplemental information must be submitted as specified in paragraph REGULATORY REQUIREMENTS and as required for certificates in Section 01 33 00 SUBMITTAL PROCEDURES.

Original submittals must clearly indicate on product sheet which product, option and/or accessory is being proposed if multiple products, options or accessories are available. Selected product, option or accessory must be highlighted in a contrasting color from the product sheet to indicate its selection.

Resubmittals must clearly indicate on product sheet which product, option or accessory is being proposed if multiple products, options or accessories are available. Selected product, option or accessory must be highlighted in a contrasting color from the product sheet to indicate its selection. Resubmittals must also be clouded to clearly indicate to the reviewer what selections have changed from the original submittal.

Failure to indicate specific product information as outlined above will require corrected submission of product data by Contractor.

SD-06 Test Reports

Pre-installation Tests; G

Acceptance Tests; G

Outside Plant Test Plan; G

SD-07 Certificates

Telecommunications Contractor Qualifications; G

Key Personnel Qualifications; G

Minimum Manufacturer's Qualifications; G

SD-08 Manufacturer's Instructions

Building Protector Assembly Installation; G

Cable Tensions; G

Fiber Optic Splices; G

Submit instructions prior to installation.

SD-09 Manufacturer's Field Reports

Factory Reel Test Data; G

SD-10 Operation and Maintenance Data

Telecommunications Outside Plant (OSP), Data Package 5; G

Commercial off-the-shelf manuals must be provided for operation, installation, configuration, and maintenance of products provided as a part of the telecommunications outside plant (OSP). Submit operations and maintenance data in accordance with Section 01 78 23, OPERATION AND MAINTENANCE DATA and as specified herein not later than 2 months prior to the date of beneficial occupancy. In addition to requirements of Data package 5, include the requirements of paragraphs TELECOMMUNICATIONS OUTSIDE PLANT SHOP DRAWINGS and TELECOMMUNICATIONS ENTRANCE FACILITY DRAWINGS.

SD-11 Closeout Submittals

Record Documentation; G

In addition to other requirements, provide in accordance with paragraph RECORD DOCUMENTATION.

1.5 QUALITY ASSURANCE

1.5.1 Shop Drawings

Include wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown to ensure a coordinated installation. Wiring diagrams must identify circuit terminals and indicate the internal wiring for each item of equipment and the interconnection between each item of equipment. Drawings must indicate adequate clearance for operation, maintenance, and replacement of operating equipment devices. Submittals must include the nameplate data, size, and capacity. Submittals must also include applicable federal, military, industry, and technical society publication references.

1.5.1.1 Telecommunications Outside Plant Shop Drawings

Provide Outside Plant Design in accordance with TIA-758-B, RUS Bull 1751F-630 for aerial system design, and RUS Bull 1751F-643 for underground system design. Provide T0 shop drawings that show the physical and logical connections from the perspective of an entire campus, such as actual building locations, exterior pathways and campus backbone cabling on plan view drawings, major system nodes, and related connections on the logical system drawings in accordance with TIA-606-C. Drawings must include wiring and schematic diagrams for fiber optic and copper cabling and splices, copper conductor gauge and pair count, fiber pair count and type, pathway duct and innerduct arrangement, associated construction materials, and any details required to demonstrate that cable system has been coordinated and will properly support the switching and transmission system identified in specification and drawings. Provide Registered Communications Distribution Designer (RCDD) approved drawings of the telecommunications outside plant. The telecommunications outside plant (OSP) shop drawings must be included in the operation and maintenance manuals.

1.5.1.2 Telecommunications Entrance Facility Drawings

Provide T3 drawings for EF Telecommunications in accordance with TIA-606-C that include telecommunications entrance facility plan views, pathway layout (cable tray, racks, ladder-racks, etc.), mechanical/electrical layout, and cabinet, backboard and wall elevations. Drawings must show layout of applicable equipment including incoming cable stub or connector blocks, building protector assembly, outgoing cable connector blocks, patch panels and equipment spaces and cabinet/racks. Drawings must include a complete list of equipment and material, equipment rack details, proposed layout and anchorage of equipment and appurtenances, and equipment relationship to other parts of the work including clearance for maintenance and operation. Drawings may also be an enlargement of a congested area of T1 or T2 drawings. The telecommunications entrance facility shop drawings must be included in the operation and maintenance manuals.

1.5.1.3 Existing Telecommunications System Survey

Locate and verify existing telecommunications systems within the identified areas prior to starting work. The survey must include a review of maintenance holes, handholes, ductbanks, fiber optic and copper cabling. Provide drawings that show discrepancies between survey information and design drawings.

1.5.2 Telecommunications Qualifications

Work under this section must be performed by and the equipment must be provided by the approved telecommunications contractor and key personnel. Qualifications must be provided for: the telecommunications system contractor, the telecommunications system installer, the supervisor (if different from the installer), and the cable splicing and terminating personnel. A minimum of 30 days prior to installation, submit documentation of the experience of the telecommunications contractor and of the key personnel.

1.5.2.1 Telecommunications Contractor Qualifications

The telecommunications contractor must be a firm which is regularly and

professionally engaged in the business of the applications, installation, and testing of the specified telecommunications systems and equipment. The telecommunications contractor must demonstrate experience in providing successful telecommunications systems that include outside plant and broadband cabling within the past 3 years. Submit documentation for a minimum of three and a maximum of five successful telecommunication system installations for the telecommunications contractor. Each of the key personnel must demonstrate experience in providing successful telecommunications systems in accordance with TIA-758-B within the past 3 years.

1.5.2.2 Key Personnel Qualifications

Provide key personnel who are regularly and professionally engaged in the business of the application, installation and testing of the specified telecommunications systems and equipment. There may be one key person or more key persons proposed for this solicitation depending upon how many of the key roles each has successfully provided. Each of the key personnel must demonstrate experience in providing successful telecommunications systems within the past 3 years.

Cable splicing and terminating personnel assigned to the installation of this system or any of its components must have training in the proper techniques and have a minimum of 3 years experience in splicing and terminating the specified cables. Modular splices must be performed by factory certified personnel or under direct supervision of factory trained personnel for products used.

Supervisors and installers assigned to the installation of this system or any of its components must have factory or factory approved certification from each equipment manufacturer indicating that they are qualified to install and test the provided products.

Submit documentation for a minimum of three and a maximum of five successful telecommunication system installations for each of the key personnel. Documentation for each key person must include at least two successful system installations provided that are equivalent in system size and in construction complexity to the telecommunications system proposed for this solicitation. Include specific experience in installing and testing telecommunications outside plant systems, including broadband cabling, and provide the names and locations of at least two project installations successfully completed using optical fiber and copper telecommunications cabling systems. All of the existing telecommunications system installations offered by the key persons as successful experience must have been in successful full-time service for at least 18 months prior to the issuance date for this solicitation. Provide the name and role of the key person, the title, location, and completed installation date of the referenced project, the referenced project owner point of contact information including name, organization, title, and telephone number, and generally, the referenced project description including system size and construction complexity.

Indicate that all key persons are currently employed by the telecommunications contractor, or have a commitment to the telecommunications contractor to work on this project. All key persons must be employed by the telecommunications contractor at the date of issuance of this solicitation, or if not, have a commitment to the telecommunications contractor to work on this project by the date that the bid was due to the Contracting Officer.

Note that only the key personnel approved by the Contracting Officer in the successful proposal must do work on this solicitation's telecommunications system. Key personnel must function in the same roles in this contract, as they functioned in the offered successful experience. Any substitutions for the telecommunications contractor's key personnel requires approval from The Contracting Officer.

1.5.2.3 Minimum Manufacturer's Qualifications

Cabling, equipment and hardware manufacturers must have a minimum of 3 years experience in the manufacturing, assembly, and factory testing of components which comply with, TIA-568.1-D, TIA-568.2-D and TIA-568.3-D. In addition, cabling manufacturers must have a minimum of 3 years experience in the manufacturing and factory testing of cabling which comply with ICEA S-87-640, ICEA S-98-688, and ICEA S-84-608.

1.5.3 Outside Plant Test Plan

Prepare and provide a complete and detailed test plan for field tests of the outside plant including a complete list of test equipment for the copper conductor and optical fiber cables, components, and accessories for approval by the Contracting Officer. Include a cut-over plan with procedures and schedules for relocation of facility station numbers without interrupting service to any active location. Submit the plan at least 30 days prior to tests for Contracting Officer approval. Provide outside plant testing and performance measurement criteria in accordance with TIA-568.1-D and RUS Bull 1753F-201. Include procedures for certification, validation, and testing that includes fiber optic link performance criteria.

1.5.4 Standard Products

Provide materials and equipment that are standard products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship and must be the manufacturer's latest standard design that has been in satisfactory commercial or industrial use for at least 2 years prior to bid opening. The 2-year period must include applications of equipment and materials under similar circumstances and of similar size. The product must have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period. Products supplied must be specifically designed and manufactured for use with outside plant telecommunications systems. Where two or more items of the same class of equipment are required, these items must be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

1.5.4.1 Alternative Qualifications

Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is provided.

1.5.4.2 Material and Equipment Manufacturing Date

Products manufactured more than 3 years prior to date of delivery to site must not be used, unless specified otherwise.

1.5.5 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "must" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Equipment, materials, installation, and workmanship must be in accordance with the mandatory and advisory provisions of NFPA 70 unless more stringent requirements are specified or indicated.

1.5.5.1 Independent Testing Organization Certificate

In lieu of the label or listing, submit a certificate from an independent testing organization, competent to perform testing, and approved by the Contracting Officer. The certificate must state that the item has been tested in accordance with the specified organization's test methods and that the item complies with the specified organization's reference standard.

1.6 DELIVERY, STORAGE, AND HANDLING

Ship cable on reels in 1000 feet length with a minimum overage of 10 percent. Radius of the reel drum must not be smaller than the minimum bend radius of the cable. Wind cable on the reel so that unwinding can be done without kinking the cable. Two meters of cable at both ends of the cable must be accessible for testing. Attach permanent label on each reel showing length, cable identification number, cable size, cable type, and date of manufacture. Provide water resistant label and the indelible writing on the labels. Apply end seals to each end of the cables to prevent moisture from entering the cable. Reels with cable must be suitable for outside storage conditions when temperature ranges from minus 40 degrees C to plus 65 degrees C, with relative humidity from 0 to 100 percent. Equipment, other than cable, delivered and placed in storage must be stored with protection from weather, humidity and temperature variation, dirt and dust, or other contaminants in accordance with manufacturer's requirements.

1.7 MAINTENANCE

1.7.1 Record Documentation

Provide the activity responsible for telecommunications system maintenance and administration a single complete and accurate set of record documentation for the entire telecommunications system with respect to this project.

Provide T5 drawings including documentation on cables and termination hardware in accordance with TIA-606-C. T5 drawings must include schedules to show information for cut-overs and cable plant management, patch panel layouts, cross-connect information and connecting terminal layout as a minimum. T5 drawings must be provided on electronic media using Windows based computer cable management software. A licensed copy of the cable management software including documentation, must be provided. Provide the following T5 drawing documentation as a minimum:

a. Cables - A record of installed cable must be provided in accordance with TIA-606-C. The cable records must include the required data

fields for each cable and complete end-to-end circuit report for each complete circuit from the assigned outlet to the entry facility in accordance with TIA-606-C. Include manufacture date of cable with submittal.

b. Termination Hardware - Provide a record of installed patch panels, cross-connect points, campus distributor and terminating block arrangements and type in accordance with TIA-606-C. Documentation must include the required data fields as a minimum in accordance with TIA-606-C.

1.7.2 Spare Parts

In addition to the requirements of Section 01 78 23 OPERATION AND MAINTENANCE DATA, provide a complete list of parts and supplies, with current unit prices and source of supply, and a list of spare parts recommended for stocking. Spare parts must be provided no later than the start of field testing.

1.8 WARRANTY

The equipment items must be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

Products supplied must be specifically designed and manufactured for use with outside plant telecommunications systems.

2.2 TELECOMMUNICATIONS ENTRANCE FACILITY

2.2.1 Building Protector Assemblies

Provide self-contained 5 pin solid state unit supplied with a field cable stub factory connected to protector socket blocks to terminate and accept protector modules for pairs as indicated on plans of outside cable. Building protector assembly must have interconnecting hardware for connection to interior cabling at full capacity. Provide manufacturers instructions for building protector assembly installation.

2.2.2 Protector Modules

Provide in accordance with UL 497 three-electrode gas tube or solid state type 5 pin rated for the application. Provide gas tube protection modules in accordance with RUS Bull 345-83 and must be heavy duty, A>10kA, B>400, C>65A where A is the maximum single impulse discharge current, B is the impulse life and C is the AC discharge current in accordance with ANSI C62.61. The gas modules must shunt high voltage to ground, fail short, and be equipped with an external spark gap and heat coils in accordance with UL 497. Provide the number of surge protection modules equal to the number of pairs of exterior cable of the building protector assembly.

2.3 CLOSURES

2.3.1 Copper Conductor Closures

2.3.1.1 Underground Cable Closures

a. In vault or manhole: Provide underground closure suitable to house a straight, butt, and branch splice in a protective housing into which can be poured an encapsulating compound. Closure must be of suitable thermoplastic, thermoset, or stainless steel material supplying structural strength necessary to pass the mechanical and electrical requirements in a vault or manhole environment. Encapsulating compound must be reenterable and must not alter the chemical stability of the closure. Provide filled splice cases in accordance with RUS Bull 345-72.

2.3.2 Fiber Optic Closures

2.3.2.1 In Vault or Manhole

Provide underground closure suitable to house splice organizer in a protective housing into which can be poured an encapsulating compound. Closure must be of thermoplastic, thermoset, or stainless steel material supplying structural strength necessary to pass the mechanical and electrical requirements in a vault or manhole environment. Encapsulating compound must be reenterable and must not alter the chemical stability of the closure.

2.4 PAD MOUNTED CROSS-CONNECT TERMINAL CABINETS

Provide in accordance with RUS 1755.910 and the following:

a. Constructed of 14 gauge steel.

b. Equipped with a double set of hinged doors with closed-cell foam weatherstripping. Doors must be locked and contain a marker as indicated.

c. Equipped with spool spindle bracket, mounting frames, binding post log, jumpering instruction label, and load coil mounting provisions.

d. Complete with cross connect modules to terminate number of pairs as indicated.

e. Sized as indicated.

2.5 CABLE SPLICES, AND CONNECTORS

2.5.1 Copper Cable Splices

Provide multipair, in-line splices of a moisture resistant, three-wire insulation displacement connector held rigidly in place to assure maximum continuity in accordance with RUS Bull 1753F-401. Cables greater than 25 pairs must be spliced using multipair splicing connectors, which accommodate 25 pairs of conductors at a time. Provide correct connector size to accommodate the cable gauge of the supplied cable.

2.5.2 Copper Cable Splice Connector

Provide splice connectors with a polycarbonate body and cap and a tin-plated brass contact element. Connector must accommodate 22 to 26 AWG solid wire with a maximum insulation diameter of 0.065 inch. Fill connector with sealant grease to make a moisture resistant connection, in accordance with RUS Bull 1753F-401.

2.5.3 Fiber Optic Cable Splices

Provide fiber optic cable splices and splicing materials for fusion methods at locations shown on the construction drawings. The splice insertion loss must be 0.3 dB maximum when measured in accordance with TIA-455-78-B using an Optical Time Domain Reflectometer (OTDR). Splices must be designed for a return loss of 40.0 db max for single mode fiber when tested in accordance with TIA-455-107-A. Physically protect each fiber optic splice by a splice kit specially designed for the splice.

2.5.4 Fiber Optic Splice Organizer

Provide splice organizer suitable for housing fiber optic splices in a neat and orderly fashion. Splice organizer must allow for a minimum of 3 feet of fiber for each fiber within the cable to be neatly stored without kinks or twists. Splice organizer must accommodate individual strain relief for each splice and allow for future maintenance or modification, without damage to the cable or splices. Provide splice organizer hardware, such as splice trays, protective glass shelves, and shield bond connectors in a splice organizer kit.

2.5.5 Shield Connectors

Provide connectors with a stable, low-impedance electrical connection between the cable shield and the bonding conductor in accordance with RUS Bull 345-65.

2.6 CONDUIT

Provide conduit as specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION.

2.7 PLASTIC INSULATING TAPE

UL 510.

2.8 WIRE AND CABLE

2.8.1 Copper Conductor Cable

Solid copper conductors, covered with an extruded solid insulating compound. Insulated conductors must be twisted into pairs which are then stranded or oscillated to form a cylindrical core. For special high frequency applications, the cable core must be separated into compartments. Cable must be completed by the application of a suitable core wrapping material, a corrugated copper or plastic coated aluminum shield, and an overall extruded jacket. Telecommunications contractor must verify distances between splice points prior to ordering cable in specific cut lengths. Gauge of conductor must determine the range of numbers of pairs specified; 19 gauge (6 to 400 pairs), 22 gauge (6 to 1200 pairs), 24 gauge (6 to 2100 pairs), and 26 gauge (6 to 3000 pairs).

Copper conductor must conform to the following:

2.8.1.1 Underground

Provide filled cable meeting the requirements of ICEA S-84-608 and RUS 1755.390 RUS 1755.890.

2.8.1.2 Screen

Provide screen-compartmental core cable filled cable meeting the requirements of ICEA S-84-608 and RUS 1755.390.

2.8.2 Fiber Optic Cable

Provide single-mode, 8/125-um, 0.10 aperture 1310 nm fiber optic cable in accordance with TIA-492CAAA single-mode, 8/125-um, 0.10 aperture 1550 nm fiber optic cable in accordance with TIA-492E000, TIA-472D000-B, and ICEA S-87-640 including any special requirements made necessary by a specialized design. Provide optical fibers as indicated. Fiber optic cable must be single-armored and specifically designed for outside use with loose buffer construction. Provide fiber optic color code in accordance with TIA-598-D

2.8.2.1 Strength Members

Provide central, non-metallic strength members with sufficient tensile strength for installation and residual rated loads to meet the applicable performance requirements in accordance with ICEA S-87-640. The strength member is included to serve as a cable core foundation to reduce strain on the fibers, and must not serve as a pulling strength member.

2.8.2.2 Shielding or Other Metallic Covering

Provide copper, copper alloy or copper and steel laminate dual tape covering or shield in accordance with ICEA S-87-640.

2.8.2.3 Performance Requirements

Provide fiber optic cable with optical and mechanical performance requirements in accordance with ICEA S-87-640.

2.8.3 Grounding and Bonding Conductors

Provide grounding and bonding conductors in accordance with RUS 1755.200, TIA-607-D, IEEE C2, and NFPA 70. Solid bare copper wire meeting the requirements of ASTM B1 for sizes No. 8 AWG and smaller and stranded bare copper wire meeting the requirements of ASTM B8, for sizes No. 6 AWG and larger. Insulated conductors must have 600-volt, Type TW insulation meeting the requirements of UL 83.

2.9 T-SPAN LINE TREATMENT REPEATERS

Provide as indicated. Repeaters must be pedestal mounted with non-pressurized housings, sized as indicated and must meet the requirements of RUS Bull 345-50.

2.10 CABLE TAGS IN MANHOLES, HANDHOLES, AND VAULTS

Provide tags for each telecommunications cable or wire located in

manholes, handholes, and vaults. Cable tags must be stainless steel and labeled in accordance with TIA-606-C. Handwritten labeling is unacceptable.

2.10.1 Stainless Steel

Provide stainless steel, cable tags 1 5/8 inches in diameter 1/16 inch thick minimum, and circular in shape. Tags must be die stamped with numbers, letters, and symbols not less than 0.25 inch high and approximately 0.015 inch deep in normal block style.

2.10.2 Polyethylene Cable Tags

Provide tags of polyethylene that have an average tensile strength of 3250 pounds per square inch; and that are 0.08 inch thick (minimum), non-corrosive non-conductive; resistive to acids, alkalis, organic solvents, and salt water; and distortion resistant to 170 degrees F. Provide 0.05 inch (minimum) thick black polyethylene tag holder. Provide a one-piece nylon, self-locking tie at each end of the cable tag. Ties must have a minimum loop tensile strength of 175 pounds. The cable tags must have black block letters, numbers, and symbols one inch high on a yellow background. Letters, numbers, and symbols must not fall off or change positions regardless of the cable tags' orientation.

2.11 BURIED WARNING AND IDENTIFICATION TAPE

Provide fiber optic media marking and protection in accordance with TIA-590-A. Provide color, type and depth of tape as specified in paragraph BURIED WARNING AND IDENTIFICATION TAPE in Section 31 00 00 EARTHWORK.

2.12 GROUNDING BRAID

Provide grounding braid that provides low electrical impedance connections for dependable shield bonding in accordance with RUS 1755.200. Braid must be made from flat tin-plated copper.

2.13 MANUFACTURER'S NAMEPLATE

Each item of equipment must have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

2.14 FIELD FABRICATED NAMEPLATES

Provide laminated plastic nameplates in accordance with ASTM D709 for each patch panel, protector assembly, rack, cabinet and other equipment or as indicated on the drawings. Each nameplate inscription must identify the function and, when applicable, the position. Nameplates must be melamine plastic, 0.125 inch thick, white with black center core. Surface must be matte finish. Corners must be square. Accurately align lettering and engrave into the core. Minimum size of nameplates must be one by 2.5 inches. Lettering must be a minimum of 0.25 inch high normal block style.

2.15 TESTS, INSPECTIONS, AND VERIFICATIONS

2.15.1 Factory Reel Test Data

Test 100 percent OTDR test of FO media at the factory in accordance with TIA-568.1-D and TIA-568.3-D. Use TIA-526-7-A for single mode fiber and TIA-526-14-C Method B for multi mode fiber measurements. Calibrate OTDR to show anomalies of 0.2 dB minimum. Enhanced performance filled OSP copper cables, referred to as Broadband Outside Plant (BBOSP), must meet the requirements of ICEA S-84-608. Enhanced performance air core OSP copper cables must meet the requirements of ICEA S-98-688. Submit test reports, including manufacture date for each cable reel and receive approval before delivery of cable to the project site.

PART 3 EXECUTION

3.1 INSTALLATION

Install all system components and appurtenances in accordance with manufacturer's instructions IEEE C2, NFPA 70, and as indicated. Provide all necessary interconnections, services, and adjustments required for a complete and operable telecommunications system.

3.1.1 Contractor Damage

Promptly repair indicated utility lines or systems damaged during site preparation and construction. Damages to lines or systems not indicated, which are caused by Contractor operations, must be treated as "Changes" under the terms of the Contract Clauses. When Contractor is advised in writing of the location of a nonindicated line or system, such notice must provide that portion of the line or system with "indicated" status in determining liability for damages. In every event, immediately notify the Contracting Officer of damage.

3.1.2 Cable Inspection and Repair

Handle cable and wire provided in the construction of this project with care. Inspect cable reels for cuts, nicks or other damage. Damaged cable must be replaced or repaired to the satisfaction of the Contracting Officer. Reel wraps must remain intact on the reel until the cable is ready for placement.

3.1.3 Direct Burial System

Installation must be in accordance with RUS Bull 1751F-640. Under railroad tracks, paved areas, and roadways install cable in conduit encased in concrete. Slope ducts to drain. Excavate trenches by hand or mechanical trenching equipment. Provide a minimum cable cover of 24 inches below finished grade. Trenches must be not less than 6 inches wide and in straight lines between cable markers. Do not use cable plows. Bends in trenches must have a radius of not less than 36 inches. Where two or more cables are laid parallel in the same trench, space laterally at least 3 inches apart. When rock is encountered, remove it to a depth of at least 3 inches below the cable and fill the space with sand or clean earth free from particles larger than 1/4 inch. Do not unreel and pull cables into the trench from one end. Cable may be unreeled on grade and lifted into position. Provide color, type and depth of warning tape as specified in paragraph BURIED WARNING AND IDENTIFICATION TAPE in Section 31 00 00 EARTHWORK.

3.1.3.1 Cable Placement

a. Separate cables crossing other cables or metal piping from the other cables or pipe by not less than 3 inches of well tamped earth. Do not install circuits for communications under or above traffic signal loops.

b. Cables must be in one piece without splices between connections except where the distance exceeds the lengths in which the cable is furnished.

c. Avoid bends in cables of small radii and twists that might cause damage. Do not bend cable and wire in a radius less than 10 times the outside diameter of the cable or wire.

d. Leave a horizontal slack of approximately 3 feet in the ground on each end of cable runs, on each side of connection boxes, and at points where connections are brought aboveground. Where cable is brought aboveground, leave additional slack to make necessary connections.

3.1.3.2 Identification Markers

Provide a marker at each change of direction of the cable, over the ends of ducts or conduits which are installed under paved areas and roadways and over each splice. Identification markers must be of concrete, approximately 20 inches square by 6 inches thick.

3.1.3.3 Backfill for Rocky Soil

When placing cable in a trench in rocky soil, the cable must be cushioned by a fill of sand or selected soil at least 2 inches thick on the floor of the trench before placing the cable or wire. The backfill for at least 4 inches above the wire or cable must be free from stones, rocks, or other hard or sharp materials which might damage the cable or wire. If the buried cable is placed less than 24 inches in depth, a protective cover of concrete must be used.

3.1.4 Cable Protection

Provide direct burial cable protection in accordance with NFPA 70 and as specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION. Galvanized conduits which penetrate concrete (slabs, pavement, and walls) must be PVC coated and must extend from the first coupling or fitting outside either side of the concrete minimum of 6 inches per 12 inches burial depth beyond the edge of the surface where cable protection is required; all conduits must be sealed on each end. Where additional protection is required, cable may be placed in galvanized iron pipe (GIP) sized on a maximum fill of 40 percent of cross-sectional area, or in concrete encased 4 inches PVC pipe. Conduit may be installed by jacking or trenching. Trenches must be backfilled with earth and mechanically tamped at 6 inches lift so that the earth is restored to the same density, grade and vegetation as adjacent undisturbed material.

3.1.4.1 Cable End Caps

Cable ends must be sealed at all times with coated heat shrinkable end caps. Cables ends must be sealed when the cable is delivered to the job site, while the cable is stored and during installation of the cable. The caps must remain in place until the cable is spliced or terminated.

Sealing compounds and tape are not acceptable substitutes for heat shrinkable end caps. Cable which is not sealed in the specified manner at all times will be rejected.

3.1.5 Underground Duct

Provide underground duct and connections to existing manholes, handholes, concrete pads, and existing ducts as specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION with any additional requirements as specified herein.

3.1.6 Reconditioning of Surfaces

Provide reconditioning of surfaces as specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION.

3.1.7 Penetrations

Caulk and seal cable access penetrations in walls, ceilings and other parts of the building. Seal openings around electrical penetrations through fire resistance-rated wall, partitions, floors, or ceilings ~~in accordance with Section 07 84 00 FIRESTOPPING~~.

3.1.8 Cable Pulling

Test duct lines with a mandrel and swab out to remove foreign material before the pulling of cables. Avoid damage to cables in setting up pulling apparatus or in placing tools or hardware. Do not step on cables when entering or leaving the manhole. Do not place cables in ducts other than those shown without prior written approval of the Contracting Officer. Roll cable reels in the direction indicated by the arrows painted on the reel flanges. Set up cable reels on the same side of the manhole as the conduit section in which the cable is to be placed. Level the reel and bring into proper alignment with the conduit section so that the cable pays off from the top of the reel in a long smooth bend into the duct without twisting. Under no circumstances must the cable be paid off from the bottom of a reel. Check the equipment set up prior to beginning the cable pulling to avoid an interruption once pulling has started. Use a cable feeder guide of suitable dimensions between cable reel and face of duct to protect cable and guide cable into the duct as it is paid off the reel. As cable is paid off the reel, lubricate and inspect cable for sheath defects. When defects are noticed, stop pulling operations and notify the Contracting Officer to determine required corrective action. Cable pulling must also be stopped when reel binds or does not pay off freely. Rectify cause of binding before resuming pulling operations. Provide cable lubricants recommended by the cable manufacturer. Avoid bends in cables of small radii and twists that might cause damage. Do not bend cable and wire in a radius less than 10 times the outside diameter of the cable or wire.

3.1.8.1 Cable Tensions

Obtain from the cable manufacturer and provide to the Contracting Officer, the maximum allowable pulling tension. This tension must not be exceeded.

3.1.8.2 Pulling Eyes

Equip cables 1.25 inches in diameter and larger with cable manufacturer's factory installed pulling-in eyes. Provide cables with diameter smaller

than 1.25 inches with heat shrinkable type end caps or seals on cable ends when using cable pulling grips. Rings to prevent grip from slipping must not be beaten into the cable sheath. Use a swivel of 3/4 inch links between pulling-in eyes or grips and pulling strand.

3.1.8.3 Installation of Cables in Manholes, Handholes, and Vaults

Do not install cables utilizing the shortest route, but route along those walls providing the longest route and the maximum spare cable lengths. Form cables to closely parallel walls, not to interfere with duct entrances, and support cables on brackets and cable insulators at a maximum of 4 feet. In existing manholes, handholes, and vaults where new ducts are to be terminated, or where new cables are to be installed, modify the existing installation of cables, cable supports, and grounding as required with cables arranged and supported as specified for new cables. Identify each cable with corrosion-resistant embossed metal tags.

3.1.9 Aerial Cable Installation

Where physical obstructions make it necessary to pull distribution wire along the line from a stationary reel, use cable stringing blocks to support wire during placing and tensioning operations. Do not place ladders, cable coils, and other equipment on or against the distribution wire. Wire must be sagged in accordance with the data shown. Protect cable installed outside of building less than 8 feet above finished grade against physical damage.

3.1.9.1 Figure 8 Distribution Wire

Perform spiraling of the wire within 24 hours of the tensioning operation. Perform spiraling operations at alternate poles with the approximate length of the spiral being 15 feet. Do not remove insulation from support members except at bonding and grounding points and at points where ends of support members are terminated in splicing and dead-end devices. Ground support wire at poles to the pole ground.

3.1.9.2 Suspension Strand

Place suspension strand as indicated. Tension in accordance with the data indicated. When tensioning strand, loosen cable suspension clamps enough to allow free movement of the strand. Place suspension strand on the road side of the pole line. In tangent construction, point the lip of the suspension strand clamp toward the pole. At angles in the line, point the suspension strand clamp lip away from the load. In level construction place the suspension strand clamp in such a manner that it will hold the strand below the through-bolt. At points where there is an up-pull on the strand, place clamp so that it will support strand above the through-bolt. Make suspension strand electrically continuous throughout its entire length, bond to other bare cables suspension strands and connect to pole ground at each pole.

3.1.9.3 Aerial Cable

Keep cable ends sealed at all times using cable end caps. Take cable from reel only as it is placed. During placing operations, do not bend cables in a radius less than 10 times the outside diameter of cable. Place temporary supports sufficiently close together and properly tension the cable where necessary to prevent excessive bending. In those instances where spiraling of cabling is involved, accomplish mounting of enclosures

for purposes of loading, splicing, and distribution after the spiraling operation has been completed.

3.1.10 Cable Splicing

3.1.10.1 Copper Conductor Splices

Perform splicing in accordance with requirements of RUS Bull 1753F-401 except that direct buried splices and twisted and soldered splices are not allowed. Exception does not apply for pairs assigned for carrier application.

3.1.10.2 Fiber Optic Splices

Fiber optic splicing must be in accordance with manufacturer's recommendation and must exhibit an insertion loss not greater than 0.2 dB for fusion splices.

3.1.11 Surge Protection

All cables and conductors, except fiber optic cable, which serve as communication lines through off-premise lines, must have surge protection installed at each end which meet the requirements of RUS Bull 1751F-815.

3.1.12 Grounding

Provide grounding and bonding in accordance with RUS 1755.200, TIA-607-D, IEEE C2, and NFPA 70. Ground exposed noncurrent carrying metallic parts of telephone equipment, cable sheaths, cable splices, and terminals.

3.1.12.1 Primary Bonding Busbar (PBB)

The PBB is the hub of the basic telecommunications grounding system providing a common point of connection for ground from outside cable, CD, and equipment. Establish a PBB for connection point for cable stub shields to connector blocks and CD protector assemblies as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

3.1.12.2 Incoming Cable Shields

Shields must not be bonded across the splice to the cable stubs. Ground shields of incoming cables in the EF Telecommunications to the PBB.

3.1.12.3 Campus Distributor Grounding

a. Protection assemblies: Mount CD protector assemblies directly on the telecommunications backboard. Connect assemblies mounted on each vertical frame with No. 6 AWG copper conductor to provide a low resistance path to PBB.

b. PBB connection: Connect PBB to Secondary Bonding Busbar (SBB) with copper conductor with a total resistance of less than 0.01 ohms.

3.1.13 Cut-Over

All necessary transfers and cut-overs, must be accomplished by the telecommunications contractor.

3.2 LABELING

3.2.1 Labels

Provide labeling for new cabling and termination hardware located within the facility in accordance with TIA-606-C. Handwritten labeling is unacceptable. Stenciled lettering for cable and termination hardware must be provided using laser printer.

3.2.2 Cable Tag Installation

Install cable tags for each telecommunications cable or wire located in manholes, handholes, and vaults including each splice. Tag new wire and cable provided under this contract and existing wire and cable which are indicated to have splices and terminations provided by this contract. The labeling of telecommunications cable tag identifiers must be in accordance with TIA-606-C. Do not provide handwritten letters. Install cable tags so that they are clearly visible without disturbing any cabling or wiring in the manholes, handholes, and vaults.

3.2.3 Termination Hardware

Label patch panels, distribution panels, connector blocks and protection modules using color coded labels with identifiers in accordance with TIA-606-C.

3.3 FIELD APPLIED PAINTING

Provide ferrous metallic enclosure finishes in accordance with the following procedures. Ensure that surfaces are dry and clean when the coating is applied. Coat joints and crevices. Prior to assembly, paint surfaces which will be concealed or inaccessible after assembly. Apply primer and finish coat in accordance with the manufacturer's recommendations. Provide ferrous metallic enclosure finishes as specified in Section 09 90 00 PAINTS AND COATINGS.

3.3.1 Cleaning

Clean surfaces in accordance with SSPC SP 6/NACE No.3.

3.3.2 Priming

Prime with a two component polyamide epoxy primer which has a bisphenol-A base, a minimum of 60 percent solids by volume, and an ability to build up a minimum dry film thickness on a vertical surface of 5.0 mils. Apply in two coats to a total dry film thickness of 5 to 8 mils.

3.3.3 Finish Coat

Finish with a two component urethane consisting of saturated polyester polyol resin mixed with aliphatic isocyanate which has a minimum of 50 percent solids by volume. Apply to a minimum dry film thickness of 2 to 3 mils. Color must be the manufacturer's standard.

3.4 FIELD FABRICATED NAMEPLATE MOUNTING

Provide number, location, and letter designation of nameplates as indicated. Fasten nameplates to the device with a minimum of two sheet-metal screws or two rivets.

3.5 FIELD QUALITY CONTROL

Provide the Contracting Officer 10 working days notice prior to each test. Provide labor, equipment, and incidentals required for testing. Correct defective material and workmanship disclosed as the results of the tests. Furnish a signed copy of the test results to the Contracting Officer within 3 working days after the tests for each segment of construction are completed. Perform testing as construction progresses and do not wait until all construction is complete before starting field tests.

3.5.1 Pre-Installation Tests

Perform the following tests on cable at the job site before it is removed from the cable reel. For cables with factory installed pulling eyes, these tests must be performed at the factory and certified test results must accompany the cable.

3.5.1.1 Cable Capacitance

Perform capacitance tests on at least 10 percent of the pairs within a cable to determine if cable capacitance is within the limits specified.

3.5.1.2 Loop Resistance

Perform DC-loop resistance on at least 10 percent of the pairs within a cable to determine if DC-loop resistance is within the manufacturer's calculated resistance.

3.5.1.3 Pre-Installation Test Results

Provide results of pre-installation tests to the Contracting Officer at least 5 working days before installation is to start. Results must indicate reel number of the cable, manufacturer, size of cable, pairs tested, and recorded readings. When pre-installation tests indicate that cable does not meet specifications, remove cable from the job site.

3.5.2 Acceptance Tests

Perform acceptance testing in accordance with RUS Bull 1753F-201 and as further specified in this section. Provide personnel, equipment, instrumentation, and supplies necessary to perform required testing. Notification of any planned testing must be given to the Contracting Officer at least 14 days prior to any test unless specified otherwise. Testing must not proceed until after the Contractor has received written Contracting Officer's approval of the test plans as specified. Test plans must define the tests required to ensure that the system meets technical, operational, and performance specifications. The test plans must define milestones for the tests, equipment, personnel, facilities, and supplies required. The test plans must identify the capabilities and functions to be tested. Provide test reports in booklet form showing all field tests performed, upon completion and testing of the installed system. Measurements must be tabulated on a pair by pair or strand by strand basis.

3.5.2.1 Copper Conductor Cable

Perform the following acceptance tests in accordance with TIA-758-B:

a. Wire map (pin to pin continuity)

b. Continuity to remote end

c. Crossed pairs

d. Reversed pairs

e. Split pairs

f. Shorts between two or more conductors

3.5.2.2 Fiber Optic Cable

Test fiber optic cable in accordance with TIA-455-C and as further specified in this section. Two optical tests must be performed on all optical fibers: Optical Time Domain Reflectometry (OTDR) Test, and Attenuation Test. In addition, a Bandwidth Test must be performed on all multimode optical fibers. These tests must be performed on the completed end-to-end spans which include the near-end pre-connectorized single fiber cable assembly, outside plant as specified, and the far-end pre-connectorized single fiber cable assembly.

a. OTDR Test: The OTDR test must be used to determine the adequacy of the cable installations by showing any irregularities, such as discontinuities, micro-bendings or improper splices for the cable span under test. Hard copy fiber signature records must be obtained from the OTDR for each fiber in each span and must be included in the test results. The OTDR test must be measured in both directions. A reference length of fiber, 66 feet minimum, used as the delay line must be placed before the new end connector and after the far end patch panel connectors for inspection of connector signature. Conduct OTDR test and provide calculation or interpretation of results in accordance with TIA-526-7-A for single-mode fiber and TIA-526-14-C for multimode fiber. Splice losses must not exceed 0.3 db.

b. Attenuation Test: End-to-end attenuation measurements must be made on all fibers, in both directions, using a 850 1300 1310 1550 nanometer light source at one end and the optical power meter on the other end to verify that the cable system attenuation requirements are met in accordance with TIA-455-78-B for multimode and TIA-526-7-A for single-mode fiber optic cables. The measurement method must be in accordance with TIA-455-78-B. Attenuation losses must not exceed 0.5 db/km at 1310 nm and 1550 nm for single-mode fiber. Attenuation losses must not exceed 5.0 db/km at 850 nm and 1.5 db/km at 1300 nm for multimode fiber.

c. Bandwidth Test: The end-to-end bandwidth of all multimode fiber span links must be measured by the frequency domain method. The bandwidth must be measured in both directions on all fibers. The bandwidth measurements must be in accordance with TIA-455-204-A.

3.5.3 Soil Density Tests

a. Determine soil-density relationships for compaction of backfill material in accordance with ASTM D1557, Method D.

b. Determine soil-density relationships as specified for soil tests in Section 31 00 00 EARTHWORK.

-- End of Section --