



ARIZONA DEPARTMENT OF TRANSPORTATION

**PUBLIC-PRIVATE PARTNERSHIP
DESIGN-BUILD-OPERATE-MAINTAIN AGREEMENT**

REQUEST FOR PROPOSALS

TECHNICAL PROVISIONS – TP ATTACHMENTS

For

I-17, Anthem Way TI to Jct. SR 69 (Cordes Junction)

**ADOT Project No. 17 MA 229 H6800 01C
Federal Project No. NHPP-017-A(228)S
Phoenix – Cordes Junction Highway**

October 28, 2021

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TP Attachment 110-1 – Project Description

1 **1 PROJECT DESCRIPTION**

2 The Interstate 17 (I-17) Anthem Way Traffic Interchange to Junction (Jct.) State Route 69 (SR 69)
3 (Cordes Junction) Project (Project) is located in the central Arizona from the north end of Maricopa
4 County into Yavapai County. The Selected Alternative in the Final Design Concept Report (DCR)
5 and Categorical Exclusion (CE) included adding one general purpose lane in each direction from
6 Anthem Way to Black Canyon City and two “flex lanes” or reversible lanes from Black Canyon
7 City to Sunset Point Rest Area, as shown in Figure 3-1. No improvements were identified between
8 Sunset Point and SR 69.

9 The Project will help address the congestion and travel delays currently experienced along the
10 corridor on weekends and holidays. I-17 is the only direct route connecting the Phoenix area with
11 northern Arizona, and the mountainous, federal forest land that flanks the highway offers no
12 reasonable alternate routes. The additional general purpose lanes will add capacity through the
13 segment that experiences the highest traffic volumes and worst congestion. The flex lanes will
14 add capacity through the mountainous grades in the direction with the highest volume, on different
15 days of the week. This region of I-17 is primarily recreational traffic and trucks. The recreational
16 traffic means that on Friday through Saturday there are a large number of people using this route
17 to get out of Phoenix for the weekend and on Sunday’s there are large numbers returning. The
18 flex lanes address this by creating two additional reversible lanes open to the direction of traffic
19 experiencing the highest volumes each day of the week.

20 The Project is led by the Arizona Department of Transportation (ADOT), in cooperation with
21 Central Yavapai Metropolitan Planning Organization (CYMPO), and Maricopa Association of
22 Governments (MAG). ADOT has undertaken certain planning and preliminary concept work
23 concerning the Project development, which is included in the Reference Information Documents
24 (RIDs).

25 **2 PROJECT STATUS**

26 ADOT has been moving forward with development of the Project for several years, using its own
27 personnel; retaining consultants; and engaging with stakeholders such as CYMPO, the municipal
28 planning organization for Yavapai County, and MAG, the municipal planning organization for
29 Maricopa County, Cities along the Project corridor, resource agencies, and the public.

30 On April 30, 2019, the Final Design Concept Report (DCR) for the Project was published. The
31 DCR includes 15% level-design plans for the additional general purpose lanes and the flex lanes.
32 An environmental review was concluded on August 6, 2019, identifying any environmental
33 considerations along the corridor. The Final DCR and the anticipated CE are included in the RIDs.

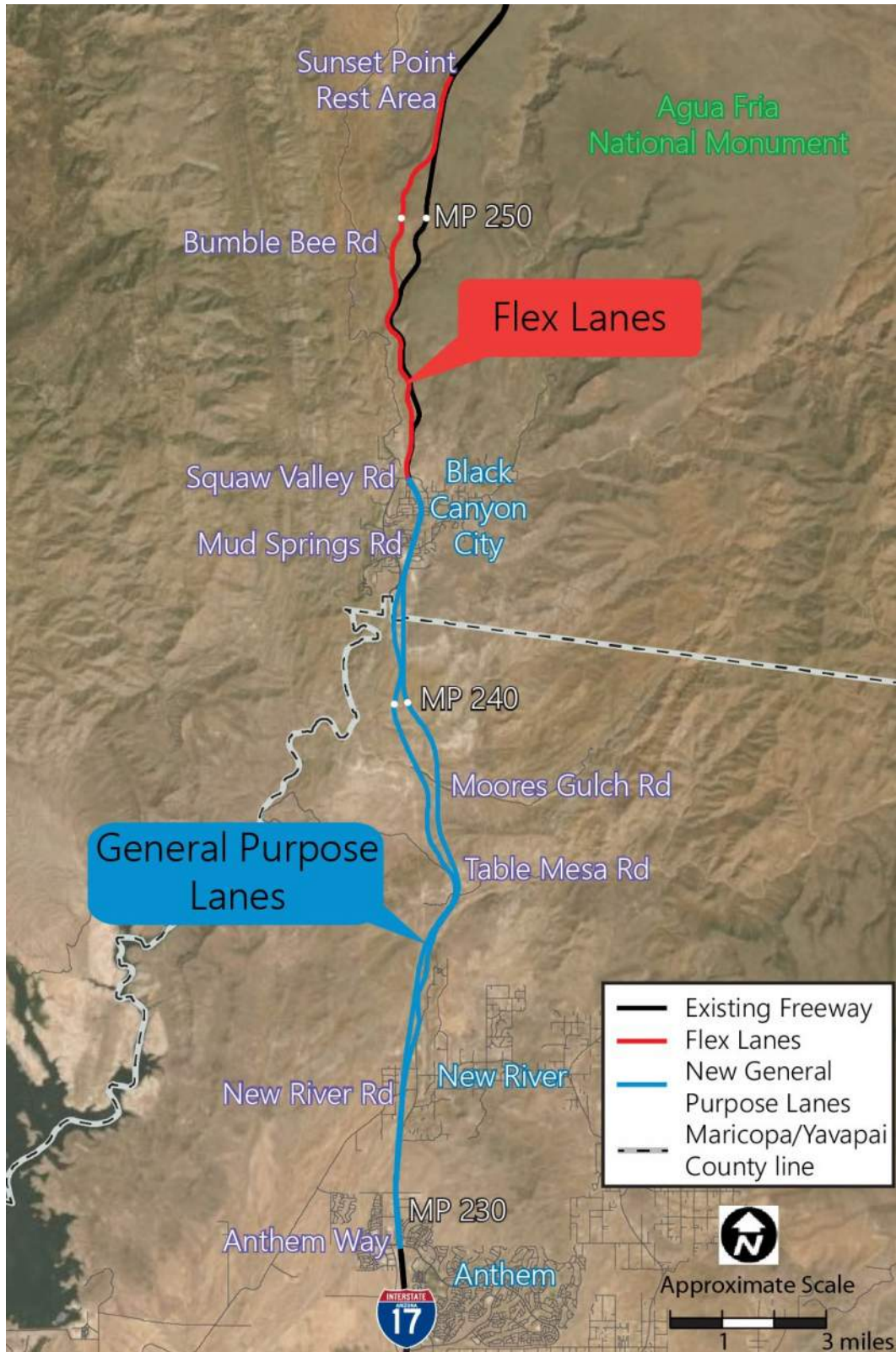
34 **3 GENERAL PROJECT IMPROVEMENTS**

35 The Project will add one general purpose lane to both the northbound and southbound alignments
36 of I-17 from Anthem Way (milepost [MP] 229) to Black Canyon City (MP 244), a distance of
37 approximately 15 miles. The Project also includes adding two flex lanes from Black Canyon City
38 (MP 244) to Sunset Point Rest Area (MP 252), a distance of approximately 8 miles. The flex lanes
39 will run adjacent to the existing southbound lanes. The flex lanes will require crossover ramps at
40 both the southern and northern termini. To accommodate the widening, ten bridges will need to
41 be widened and two will need to be replaced. The Project also includes converting five ramps
42 from taper type to parallel type ramps.

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Figure 3-1 Vicinity Map



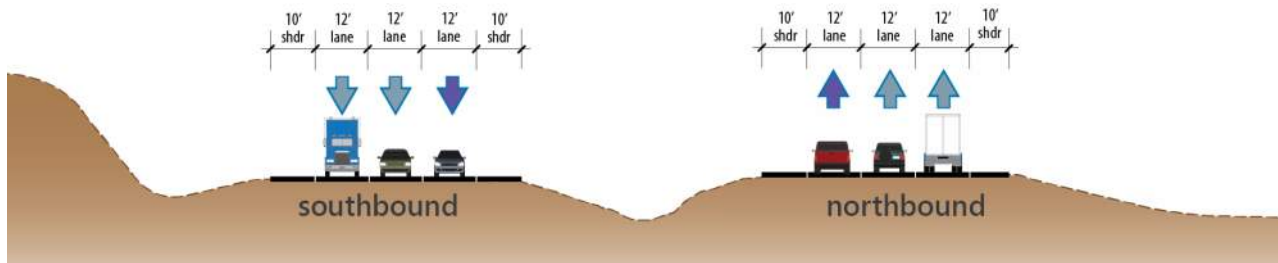
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1 The roadway typical section for the first segment consists of six-lanes with three general purpose
 2 lanes in each direction (see Figure 3-1). The roadway typical section for the flex lanes consists of
 3 six-lanes, with two general purpose lanes in both directions and two flex lanes on the inside of the
 4 southbound lanes (see Figure 3-2). Locating the two flex lanes on the outside of the
 5 southbound lanes in selected locations is not precluded. The flex lanes will be separated from the
 6 southbound lanes by a concrete median barrier. The freeway terrain is rolling between MP 229
 7 and MP 244 and is mountainous from MP 244 to MP 252.

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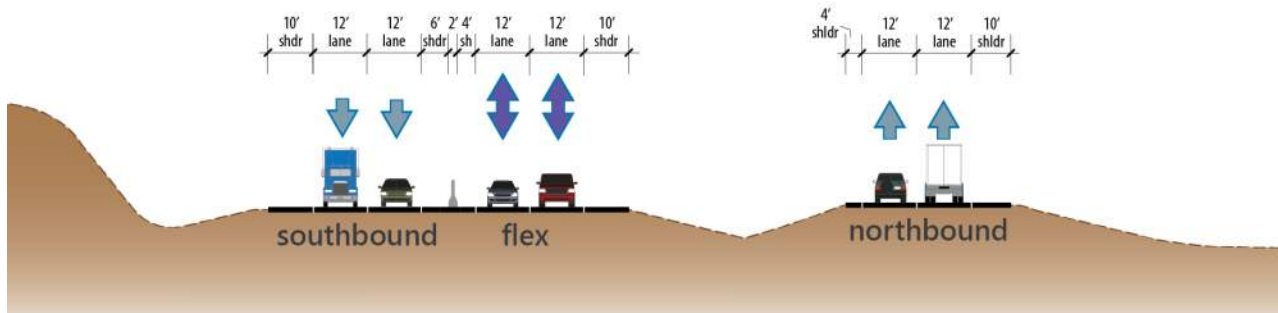
Figure 3-2
Typical Freeway Section MP 229 to MP 244



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Figure 3-3
Typical Freeway Section MP 244 to MP 252



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1 **TP Attachment 420-1 – Project Environmental Commitment Requirements**

TP Attachment 420-1

I-17 Anthem Way to SR 69 Revised Categorical Exclusion (CE) Environmental Commitments

The following table includes the Project-specific environmental commitments that were included in the I-17 Anthem Way to SR 69 (CE) dated May 26,2021, with minor modifications for clarification purposes. These Project environmental commitments within this TP Attachment shall supersede any previous environmental commitments that were provided in the RIDs. As it relates to these Technical Provisions, references to freeway, project, I-17 Anthem Way to SR 69 Project, mean the Project, and references to contractor mean Developer. Developer is responsible for performing and complying with all obligations of ADOT, except those obligations that are specifically identified below as being the obligations of ADOT.

ECR Number	Environmental Commitment Record Requirements	Description of ADOT-Retained Obligations
General		
GEN-1	The Engineer will contact the ADOT archaeologist (602.712.6371 or 602.712.7767) to schedule the preconstruction meeting or partnering meeting on a mutually agreeable date to ensure a qualified Environmental Planning representative will be available to attend the meeting.	None retained; all delegated to Developer
GEN-2	The contractor shall avoid all flagged, fenced, and otherwise designated sensitive resource areas within or adjacent to the project area.	None retained; all delegated to Developer
Biology		
BIO-1	Prior to construction activity, the contractor’s field personnel, including the project manager, assistant project manager, general superintendent, and project superintendent, shall review the attached ADOT Environmental Planning “Sonoran Desert Tortoise Awareness Program Handout,” become familiar with the identification and avoidance of the Sonoran desert tortoise, and follow the notification request, as applicable.	None retained; all delegated to Developer

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ECR Number	Environmental Commitment Record Requirements	Description of ADOT-Retained Obligations
BIO-2	<p>The contractor shall employ a qualified biologist with necessary scientific collecting permit(s) to conduct a pre-construction survey for the Sonoran desert tortoise.</p> <p>The contractor shall employ a qualified biologist to complete pre-construction surveys for Sonoran desert tortoises within 48 (forty-eight) hours prior to vegetation removal or construction in the areas that will be disturbed. Within 24 (twenty-four) hours of completing each survey, the contractor shall contact the Engineer to provide survey results.</p> <p>No construction including pre-construction ground disturbing activities shall begin until a qualified biologist has completed a survey for the presence of Sonoran desert tortoises or potential desert tortoise burrows.</p> <p>The Engineer will provide Sonoran desert tortoise survey results to the ADOT Environmental Planning biologist (email: bioteam@azdot.gov or phone: 602.712.7134/602.341.9331).</p>	None retained; all delegated to Developer

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ECR Number	Environmental Commitment Record Requirements	Description of ADOT-Retained Obligations
BIO-3	<p>The contractor shall require all on-site workers to check under their parked vehicles and equipment prior to driving to make sure there isn't a tortoise sheltering underneath the vehicle or piece of equipment. If a desert tortoise is found sheltering underneath a parked vehicle or piece of equipment, the tortoise shall be allowed to move out from under the vehicle on its own or be relocated following the current guidelines for Sonoran desert tortoise handling before the vehicle can be moved.</p> <p>If any Sonoran desert tortoises are encountered during construction, the contractor shall adhere to the attached Arizona Game and Fish Department "Guidelines for Handling Sonoran Desert Tortoises Encountered on Development Projects" revised September 22, 2014. If any tortoise is encountered during construction, the contractor shall notify the Engineer to report the encounter.</p> <p>The contractor shall report encounters with any Sonoran desert tortoise (live, injured, or dead) during construction to the Engineer using the attached Arizona Department of Transportation Sonoran Desert Tortoise Observation Form. The final form shall be sent to the Arizona Department of Transportation Environmental Planning biologist (email: bioteam@azdot.gov) within 24 (twenty-four) hours of the encounter. Photographs should be taken of tortoises encountered and included in the report, if possible.</p>	None retained; all delegated to Developer

<p>BIO-4</p>	<p>If clearing, grubbing, or tree/limb removal will occur between March 1 and August 31, the contractor shall employ a qualified biologist to conduct a migratory bird nest search of all vegetation within the 10 (ten) days prior to removal. Vegetation may be removed if it has been surveyed and no active bird nests are present. If active nests cannot be avoided, the contractor shall notify the Engineer to evaluate the situation. During the nonbreeding season (September 1 to February 28), vegetation removal is not subject to this restriction.</p> <p>The contractor shall not cause injury or death to swallows, including eggs and nestlings. If work will occur that will directly impact nesting swallows from February 1 to August 31 of any calendar year. the contractor shall adhere to the following:</p> <ul style="list-style-type: none"> • The contractor shall completely remove all existing swallow nests within 100 feet of work areas after August 31 but prior to February 1 to prevent swallows from reusing those nests. • The contractor shall implement exclusionary measures to prevent swallows from building new nests within areas directly impacted by construction activities. Exclusionary measures shall be implemented in all areas where swallows are likely to nest, and may include (a) continually removing nesting materials during early nest construction when eggs or nestlings are not present, (b) installing deterrent spike strips, and/or (c) installing polytetrafluoroethylene (Teflon) sheeting. • The contractor shall not disturb any active swallow nests (completed or partially completed nests that contain eggs or nestlings). If any active nest is discovered within 100 feet of construction activities, work shall stop and the Arizona Department of Transportation Environmental Planning biologist shall be contacted (602-712-7134 or 602-341-9331) to evaluate the potential for disturbance of nests. • The contractor shall monitor and maintain the effectiveness of exclusionary measures daily. Spike strips shall be maintained such that they remain in place. Teflon sheeting shall be reapplied as often as necessary to remain effective. <p>If swallow exclusion measures fail, the contractor shall:</p>	<p>None retained; all delegated to Developer.</p>
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ECR Number	Environmental Commitment Record Requirements	Description of ADOT-Retained Obligations
	<ul style="list-style-type: none"> • Inform the Engineer as soon as swallow nest building occurs and determine whether the area can be avoided until nests are no longer active; • Hire a qualified biologist to survey bird nests within 100 feet of construction areas and report to the Environmental Planning biologist (602.622.9622 or 602.712.6819) with the number of affected nests for each species of bird. The resume for the selected biologist shall be approved by the Engineer in coordination with the ADOT Biologist prior to conducting the survey. • Determine whether to wait for the nestlings to fledge or apply for a US Fish and Wildlife Service Migratory Bird Treaty Act Special Purpose permit from the USFWS Regional office in Albuquerque, New Mexico. • If the permit is approved, hire a wildlife rehabilitator licensed by USFWS to relocate and rehabilitate all affected eggs or nestlings. • Any costs incurred as a result of delays related to failure of swallow exclusion measures, including waiting until the nests are not active and/or time required to obtain a Migratory Bird Treaty Act relocation permit and the eggs or nestlings to be relocated from the work area shall be the contractor's responsibility. <p>The contractor shall remove all exclusionary measures after project completion to the satisfaction of the Engineer.</p>	

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ECR Number	Environmental Commitment Record Requirements	Description of ADOT-Retained Obligations
BIO-5	<p>If active bird nests are identified within the project limits, construction activities will avoid disturbing any active nest. Avoidance areas, if necessary, will be marked in the field with temporary fencing or T-posts with flagging by the approved biologist. The Engineer will confer with the approved biologist to determine the appropriate avoidance strategies until the nestlings have fledged from the nest and the nest is no longer active.</p> <p>If any active bird nests cannot be avoided by vegetation clearing or construction activities, the Engineer will contact the Arizona Department of Transportation Environmental Planning biologist (602.712.7134 or 602.622.9622) to evaluate the situation.</p>	None retained; all delegated to Developer.
BIO-6	The Arizona Department of Transportation Roadside Development Section will coordinate with the Bureau of Land Management regarding the removal of native plants on Bureau of Land Management lands.	ADOT retains this obligation.
BIO-7	Protected native plants within the project limits will be impacted by this project; therefore, the Arizona Department of Transportation Roadside Development Section will determine whether Arizona Department of Agriculture notification is needed. If notification is needed, the Arizona Department of Transportation Roadside Development Section will send the notification at least 60 (sixty) calendar days prior to the start of construction.	None retained; all delegated to Developer.
BIO-8	The Arizona Department of Transportation Roadside Development Section will provide special provisions for the control of noxious and invasive plant species during construction that may require treatment and control within the project limits.	None retained: all delegated to Developer. Requirements are identified in Section DR 450.2.4 of the Technical Provisions.

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ECR Number	Environmental Commitment Record Requirements	Description of ADOT-Retained Obligations
BIO-9	The contractor shall develop a Noxious and Invasive Plant Species Treatment and Control Plan in accordance with the requirements in the contract documents. Plants to be controlled shall include those listed in the state and federal noxious weed and the state invasive species lists in accordance with state and federal laws and executive orders. The plan and associated treatments shall include all areas within the project right-of-way and easements as shown on the project plans. The treatment and control plan shall be submitted to the Engineer for the Arizona Department of Transportation Construction Professional Landscape Architect for review and approval prior to implementation by the contractor.	None retained; all delegated to Developer, except ADOT retains reviewing and commenting on Developer's Plan as provided in Section DR 450.2.4 of the Technical Provisions.
BIO-10	Prior to the start of ground-disturbing activities and throughout the duration of construction and any landscape establishment period, the contractor shall arrange for and perform the control of noxious and invasive species in the project area.	None retained; all delegated to Developer.
BIO-11	To prevent the introduction of invasive species seeds, all earthmoving and hauling equipment shall be washed prior to entering the construction site and the contractor shall inspect all construction equipment and remove all attached debris, including plant parts, soil and mud, prior to the equipment entering the construction site.	None retained; all delegated to Developer.
BIO-12	To prevent invasive species seeds from leaving the site, the contractor shall inspect all construction and hauling equipment and remove all debris, including plant parts, soil and mud, prior to leaving the construction site.	None retained; all delegated to Developer.
BIO-13	All disturbed soils not paved that will not be landscaped or otherwise permanently stabilized by construction shall be seeded using species native to the project vicinity.	None retained; all delegated to Developer
Cultural		

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ECR Number	Environmental Commitment Record Requirements	Description of ADOT-Retained Obligations
CUL-1	The Engineer will contact the Arizona Department of Transportation Historic Preservation Team (ADOT HPT) (602.712.6371 or 602.712.7767) 14 (fourteen) days prior to construction to ensure that the terms and stipulations of the Programmatic Agreement Pursuant to Section 106 of the National Historic Preservation Act Regarding Implementation of Federal-aid Transportation Projects in the State of Arizona executed December 16, 2015, have been fulfilled.	None retained; all delegated to Developer.
CUL-2	The contractor shall contact the ADOT HPT (602.712.6371 or 602.712.7767) at least 10 (ten) business days prior to the start of ground-disturbing activities to arrange for a qualified archaeologist to flag and/or fence avoidance areas. The contractor shall avoid all flagged and otherwise designated sensitive areas within or adjacent to the Project area.	None retained; all delegated to Developer.
CUL-3	The contractor shall contact the ADOT HPT (602.712.6371 or 602.712.7767) at least 10 (ten) business days prior to the start of ground-disturbing activities to arrange for qualified personnel to monitor and be present during construction actions specific to excavation, rock work, earthwork, staging, and stockpiling.	None retained; all delegated to Developer.
CUL-4	No work will occur until the 2009 Section 106 Programmatic Agreement (PA) amendment is executed.	ADOT retains this obligation; Developer to confirm with ADOT that execution is complete.
CUL-5	No work will occur until the Historic Property Treatment Plan (HPTP) is approved in the course of Section 106 consultation.	None retained; Developer must comply with work restrictions. ADOT to confirm with Developer when completed.
CUL-6	No work or actions contrary to the approved HPTP will be undertaken or permitted.	None retained; Developer must comply with work restrictions.
CUL-7	No work will occur in buffered site areas until (a) archaeological mitigation in that area is completed, and (b) a preliminary (end-of-fieldwork) report has been approved via Section 106 consultation, or (c) in-field consultation takes place, as documented by the ADOT HPT in a memorandum.	Partially retained. ADOT HPT to complete items (a), (b), and (c) and confirm with Developer when completed. Developer to comply with work restriction in buffered site areas.

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ECR Number	Environmental Commitment Record Requirements	Description of ADOT-Retained Obligations
CUL-8	Should any deviation from the cultural resource standards or those set forth in the PA or HPTP occur, without prior written approval from the ADOT HPT, the contractor will bear fiscal responsibility for the completion of reasonable mitigation (e.g., damage assessment, documentation, consultation) as determined by the ADOT HPT through consultation with the land-managing agency and State Historic Preservation Office.	None retained; all delegated to Developer.
Hazardous Materials		
HZM-1	No work at Table Mesa Road, Moores Gulch Bridge southbound (Structure No. 339 with silver/orange girder/rocker paint) and northbound, Little Squaw Creek Bridge northbound, Mud Springs underpass, Rock Springs traffic interchange underpass southbound, Bumble Bee traffic interchange underpass northbound, northbound Interstate 17 off-ramp (milepost 252.5), Agua Fria National Monument access road (from Sunset Point traffic interchange), Sunset Point traffic interchange overpass northbound (milepost 252.5), Sunset Point frontage road (near milepost 252.5), and Bumble Bee Road at the traffic interchange underpass southbound will occur until the Lead-Based Paint Removal and Abatement Plan is approved and implemented (refer to attached list of Lead Based Paint and Asbestos-Containing Materials Detections).	All delegated to Developer with the exception of ADOT confirmation of abatement implementation and completion.

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ECR Number	Environmental Commitment Record Requirements	Description of ADOT-Retained Obligations
HZM-2	<p>An approved contractor shall develop and implement an approved Lead-Based Paint and Asbestos Abatement Plan for the removal of the lead-based paint and asbestos, Toxicity Characteristic Leaching Procedure testing of the generated waste stream, and proper disposal of the waste stream derived from the removal of lead-based paint and asbestos (refer to attached list of Lead-Based Paint and Asbestos-Containing Materials Detections). This shall also include the removal of Moores Gulch Bridges SB (Structure No. 339) silver/orange girder/rocker paint. The contractor shall select a lead abatement contractor that meets the qualification requirements specified in the special provisions and as approved by the Engineer. The contractor shall follow all applicable federal, state, and local codes and regulations, including “Arizona Department of Transportation Standard Specifications for Road and Bridge Construction” (2008 Edition), related to the treatment and handling of lead-based paint.</p> <p>No work (refer to attached list of Lead-Based Paint and Asbestos-Containing Materials Detections, including removal of Moores Gulch Bridges SB silver/orange girder/rocker paint) shall occur until the Lead-Based Paint and Asbestos Abatement Plan is approved by the Arizona Department of Transportation Environmental Planning hazardous materials coordinator and implemented.</p>	All delegated to Developer, except ADOT retains review and approval of the Plan and the ADOT Standard Specifications shall apply.
HZM-3	The contractor shall submit a Lead-Based Paint and Asbestos Abatement Plan for the removal of lead-based pain and asbestos (refer to attached list of Lead-Based Paint and Asbestos-Containing Materials Detections, including the Moores Gulch Bridges SB silver/orange girder/rocker paint) within the project limits to the Engineer and the Arizona Department of Transportation Environmental Planning hazardous materials coordinator (602.920.3882 or 602.712.7767) for review and approval at least 10 (ten) working days prior to work.	All delegated to Developer, except ADOT retains review and approval of the Plan.

Air Quality

TP Attachment 420-1

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ECR Number	Environmental Commitment Record Requirements	Description of ADOT-Retained Obligations
AQ-1	Visible fugitive dust emissions from paint removal shall be controlled through wet or dry (e.g., vacuum) means during the removal process. If the liquid waste stream generated by a waterblasting obliteration method passes the Toxicity Characteristic Leaching Process analysis, it may be used as a dust palliative or for compaction on the project. If the water is not used on the project, it shall be properly disposed of in accordance with all applicable federal, state, and local regulations.	None retained; all delegated to Developer.
AQ-2	The contractor shall not utilize any abrasive tools or methods for the removal of the cattle guards that would disturb the lead-based paint. This includes, but is not limited to, sawing, grinding, sanding, or heating. Woven straps (not linked chains) may be used to lift the cattle guard grate from the frame.	None retained; all delegated to Developer.
AQ-3	For milling activities, the roadway surface preceding the milling machine shall be kept sufficiently wet so as to prevent the generation of any visible fugitive dust particles but not so wet as to cause excess runoff from the roadway surface onto the roadway shoulder.	None retained; all delegated to Developer.
AQ-4	The contractor shall complete a National Standards for Hazardous Air Pollutants (NESHAP) notification for the work associated with Moores Gulch Bridge southbound (Structure No. 0339), Bumble Bee traffic interchange (TI) underpass southbound (Structure No. 1170), Bumble Bee TI overpass northbound (Structure No. 1171) and the temporary bridge, and submit to the Engineer, who shall submit it to the Arizona Department of Transportation environmental planning hazardous material coordinator (602.920.3882 or 602.712.7767) for a five (5) working day review and approval. Upon approval, the contractor shall file the notification with the Arizona Department of Environmental Quality at least ten (10) working days prior to the commencement of work associated with the Moores Gulch Bridge southbound (Structure No. 0339), Bumble Bee TI underpass southbound (Structure No. 1170), Bumble Bee TI overpass (OP) northbound (Structure No. 1171) and the temporary bridge.	All delegated to Developer, except ADOT retains review and approval of the Plan.

Water Resources

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ECR Number	Environmental Commitment Record Requirements	Description of ADOT-Retained Obligations
WRE-1	If any non-municipal water source is used by the contractor, the Engineer will forward the proof of the environmental clearance/permitting to Arizona Department of Transportation Environmental Planning (602.712.8858) upon receipt.	None retained; all delegated to Developer.
WRE-2	If any non-municipal water source is used by the contractor, for any reason, then the contractor shall be responsible for obtaining any environmental clearance and permitting needed. Proof of environmental clearance/permitting shall be given to the Engineer at least 1 day prior to using the water source.	None retained; all delegated to Developer.
Waters of the United States		
WUS-1	No work will occur within jurisdictional Waters of the United States until the appropriate Clean Water Act Section 401 and 404 permits are obtained.	None retained; all delegated to Developer, except as provided in DR 420.2.6.2.
Noise		
NOI-1	The contractor shall, at a minimum, address three noise barriers, as per the Final Noise Analysis Technical Report, May 2018, and the Table 60 of the Design Concept Report.	None retained; all delegated to Developer.
NOI-2	The contractor shall update noise analysis, produce corresponding sound wall design drawings, and submit to ADOT Environmental Planning for final review and approval.	None retained; all delegated to Developer.

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TP Attachment 430-1 – Utility Inventory

TP Attachment 430-1 Utility Inventory									
PLAN SHEET NO.	FACILITY TYPE / SIZE	FACILITY OWNER	OBSERVED ROADWAY/ PROJECT STATION	REASON FOR CONFLICT	*M / R	NEED ROW (Y/N)	PRIOR RIGHTS (Y/N)	BETTERMENTS REQUESTED TO BE INCLUDED IN STATE PROJECT	**REMARKS / FINAL DISPOSITION
	FO (1 1/4" inner duct)	AT&T	I-17 / Anthem Way Lt						
	FO (1 1/4" inner duct)	AT&T	I-17 / Sta 2011+50 (MP 238.96) Lt						
	FO (1 1/4" inner duct)	AT&T	I-17 / Sta 2052+50 (MP 239.69) Rt						
	FO (1 1/4" inner duct)	AT&T	I-17 / Sta 2057+00 to 2110+50 (MP 239.74 to 240.69) Rt						
	FO (1 1/4" inner duct)	AT&T	I-17 / Sta 2110+50 (MP 240.69) Rt						
	FO (1 1/4" inner duct)	AT&T	I-17 / Sta 2117+50 (MP 240.85) Lt						
	FO (1 1/4" inner duct)	AT&T	I-17 / 2117+50 to 2185+00 (MP 240.85 to 242.18) Lt						
	FO (1 1/4" inner duct)	AT&T	Rt 69 (Maggie Mine Road) (MP 244.5) Lt						
	FO (1 1/4" inner duct)	AT&T	Rt 69 (Crown King Rd) (MP 248.4 to 256.1)						
	FO (1 1/4" inner duct)	AT&T	Rt 69 (Crown King Rd) (NW to Cordes Jct)						
	OH Unk kV	APS	I-17 / Sta 1503+50 (MP 229.29) Rt to Sta 1502+50 (MP 229.24) Lt						
	OH Unk kV	APS	I-17 / Sta 1538+00 (MP 229.96)						
	OH Unk kV	APS	I-17 / Sta 1611+50 (MP 231.35)						
	OH Unk kV	APS	I-17 / Sta 1671+00 (MP 232.35)						Vertical clearance approximately 25'
	OH Unk kV	APS	I-17 / Sta 1863+50 Lt to Sta 1860+80 Rt (MP 236.09 and MP 236.04)						
	OH Unk kV	APS	I-17 / Sta 1883+00 Rt to 1883+50 Lt (MP 236.46 and MP 236.47)						Vertical clearance approximately 25'
	OH Unk kV	APS	I-17 / Sta 1991+55 Rt to 2007+47 Lt (MP 238.50 to MP 238.80)						
	OH Unk kV	APS	I-17 / Sta 2065 to Sta 2165+00 Lt						Pole potentially impacted by fill slope
	OH Unk kV	APS	I-17 / Sta 2202+00 Rt to Sta 2201+70 Lt (MP 242.77 and MP 242.76)						Vertical clearance approximately 25'
	OH Unk kV	APS	I-17 / Sta 2225+00 Rt to Sta 2223+80 Lt (MP 243.22 and MP 243.19)						
	OH Unk kV	APS	I-17 / Sta 2248+80 Rt to Sta 2248+50 Lt (MP 243.68 and MP 243.67)						
	OH Unk kV	APS	I-17 / Sta 2284+20 Rt to Sta 2283+70 Lt (MP 244.37 and MP 244.36)						
	OH Unk kV	APS	I-17 / Rt 69 (Maggie Mine Road) (MP 244.5)						
	OH Unk kV	APS	I-17 / Sta 2429+75 Lt						One pole 30' away from outside edge of pavement.

TP Attachment 430-1 Utility Inventory									
PLAN SHEET NO.	FACILITY TYPE / SIZE	FACILITY OWNER	OBSERVED ROADWAY/ PROJECT STATION	REASON FOR CONFLICT	*M / R	NEED ROW (Y/N)	PRIOR RIGHTS (Y/N)	BETTERMENTS REQUESTED TO BE INCLUDED IN STATE PROJECT	**REMARKS / FINAL DISPOSITION
	OH Unk kV	APS	I-17 / Bumble Bee TI (MP 248.4)						
	OH 345kV	WAPA	Table Mesa TI						
	OH 345kV	WAPA	I-17 / Sta 1881+00 Lt (MP 236.42) to Sta 1931+50 Rt (MP 237.36)						
	OH 345kV	WAPA	I-17 / Sta 1886+50 Lt (MP 236.52) and Sta 2040+00 Rt (MP 239.43)						
	OH 345kV	WAPA	I-17 / Sta 1965+00 to Sta 1976+20 Lt (MP 238.00 to MP 238.21)						
	OH 345kV	WAPA	I-17 / Sta 1995+00 Lt (MP 238.58)						
	OH 345kV	WAPA	I-17 / Sta 2198+00 Lt (MP 251.34)						
	OH 345kV	WAPA	I-17 / Sta 2236+00 Lt (MP 243.43)						
	OH 345kV	WAPA	I-17 / Sta 2103+50 Rt (MP 239.00)						
	OH 345kV	WAPA	I-17 / Sta 2195+00 Rt (MP 251.28)						
	OH 345kV	WAPA	I-17 / Sta 2367+00 Rt (MP 245.97)						
	OH 345kV	WAPA	I-17 / West of BCC TI (MP 244.5)						
	OH 345kV	WAPA	I-17 / Sta 2356+80 Lt (MP 245.88)						
	OH 345kV	WAPA	I-17 / Sta 2367+62 Rt (MP 246.11)						
	OH 345kV	WAPA	I-17 / Agua Fria National Monument Rt						
	OH 345kV	WAPA	I-17 / Sta 2950+02 Rt (MP 257.20)						
	OH 345kV	WAPA	I-17 / Sta 2998+04 Lt (MP 258.11)						
	20" gas pipe	El Paso Natural Gas	I-17 / Sta 2012+50 Lt (MP 238.91)						
	20" gas pipe	El Paso Natural Gas	I-17 / Sta 2054+00 Rt (MP 239.69)						
	20" gas pipe	El Paso Natural Gas	I-17 / Sta 2208+80 (MP 242.87) (south of Agua Fria River)						
	20" gas pipe	El Paso Natural Gas	I-17 / West of BCC TI (MP 244.5)						
	20" gas pipe	El Paso Natural Gas	I-17 / Sta 2430+00 Lt						
	20" gas pipe	El Paso Natural Gas	I-17 / 2920+90 Rt (MP 256.65)						
	20" gas pipe	El Paso Natural Gas	I-17 / Sta 2929+24 Lt (MP 256.81)						
	1 1/4" gas pipe	Southwest Gas	I-17 / Sta 1657+00 Lt (MP 232.20) and Sta 1656+00 Rt (MP 232.18)						
	Cable	Eagle West Cable	Aerial at Mud Springs						

TP Attachment 430-1 Utility Inventory									
PLAN SHEET NO.	FACILITY TYPE / SIZE	FACILITY OWNER	OBSERVED ROADWAY/ PROJECT STATION	REASON FOR CONFLICT	*M / R	NEED ROW (Y/N)	PRIOR RIGHTS (Y/N)	BETTERMENTS REQUESTED TO BE INCLUDED IN STATE PROJECT	**REMARKS / FINAL DISPOSITION
	42" gas pipe	Transwestern Pipeline Company	I-17 / Sta 2011+60 Lt (MP 238.90)						
	42" gas pipe	Transwestern Pipeline Company	I-17 / Sta 2051+50 Rt (MP 239.75)						
	42" gas pipe	Transwestern Pipeline Company	I-17 / West of BCC TI (MP 244.5)						
	4" water pipe (abandoned)	Black Canyon City Water Improvement District	I-17 / Sta 2205+00 (MP 242.83)						Line is adequately deep, valves should be located during final design
	2" water pipe	Black Canyon City Water Improvement District	I-17 / Sta 2216+50 (MP 243.02)						Line is adequately deep, valves should be located during final design
	4" water pipe	Black Canyon City Water Improvement District	I-17 / Sta 2232+00 (MP 243.35)						Line is adequately deep, valves should be located during final design
	6" water pipe	Black Canyon City Water Improvement District	I-17 / Sta 2233+00 (MP 243.37)						Line is adequately deep, valves should be located during final design

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TP Attachment 440-1 – Roadway Design Criteria

TP Attachment 440-1 Roadway Design Criteria	
Lane Width:	12 feet
Shoulder Width:	
Inside:	4 feet + 2 foot offset to barrier (2-lane section) 10 feet + 2 foot offset to barrier (3-lane section)
Outside:	10 feet + 2 foot offset to barrier
Barrier Side (Flex Lane including crossovers):	4 feet 10 feet + 2 foot offset to barrier
Median Side (Flex Lane including crossovers):	
Design Speed:	
Mainline:	
MP 229.0 – 244.5	75 MPH
MP 244.5 – 250.5	65 MPH
Flex Lanes including crossovers:	65 MPH
Ramp Exit at Mainline Gore:	
Taper-Type:	Mainline design speed minus 10 MPH
Parallel-Type:	Mainline design speed minus 5 MPH
Ramp Entrance:	Mainline design speed minus 10 MPH
Ramp Body:	50 MPH
Ramp Terminus:	35 MPH
Crossroad:	40 MPH but not less than design speed of crossroad approaches to the interchange
Design Vehicle:	WB-67

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TP Attachment 440-2 – Design Variances

TP Attachment 440-2 Design Variances	
Location	Variance
NB MP 233.80 to MP 234.00	600' spiral curve is 124' longer than maximum length of super elevation transition spiral in the RDG.
SB MP 246.40 to MP 246.56	400' spiral curve is 63' longer than maximum length of super elevation transition spiral in the RDG.
SB MP 246.72 to MP 246.81	400' spiral curve is 63' longer than maximum length of super elevation transition spiral in the RDG.
SB MP 247.24 to MP 247.45	400' spiral curve is 63' longer than maximum length of super elevation transition spiral in the RDG.
SB MP 247.60 to MP 247.92	400' spiral curve is 63' longer than maximum length of super elevation transition spiral in the RDG.
SB MP 249.23 to MP 249.35	450' spiral curve is 61' longer than maximum length of super elevation transition spiral in the RDG.
SB MP 249.58 to MP 249.69	400' spiral curve is 63' longer than maximum length of super elevation transition spiral in the RDG.
SB MP 249.85 to MP 249.89	400' spiral curve is 63' longer than maximum length of super elevation transition spiral in the RDG.
SB MP 250.04 to MP 250.08	400' spiral curve is 63' longer than maximum length of super elevation transition spiral in the RDG.
SB MP 250.23 to MP 250.36	400' spiral curve is 63' longer than maximum length of super elevation transition spiral in the RDG.
SB MP 237.0 to MP 240.8	Superelevation axis of rotation is 15' from existing HCL and PGL instead of coincident as stated in RDG.
NB MP 233.30 to MP 233.40	Widened pavement matches existing Ls=450.24', DOC=1°30'03", DS=75mph. Minimum required by RDG is 2°15' DOC for spiral curves at 75mph DS.
NB MP 233.80 to MP 234.00	Widened pavement matches existing Ls=600, DOC=2°00'00", DS=75mph. Minimum required by RDG is 2°15' DOC for spiral curves at 75mph DS.
NB MP 234.20 to MP 234.40	Widened pavement matches existing Ls=450', DOC=1°30'00", DS=75mph. Minimum required by RDG is 2°15' DOC for spiral curves at 75mph DS.
NB MP 234.69 to MP 234.88	Widened pavement matches existing Ls=225', DOC=0°45'00", DS=75mph. Minimum required by RDG is 2°15' DOC for spiral curves at 75mph DS.
NB MP 235.80 to MP 236.40	Widened pavement matches existing Ls=300', DOC=1°30'00", DS=75mph. Minimum required by RDG is 2°15' DOC for spiral curves at 75mph DS.
NB MP 243.51 to MP 244.02	Widened pavement matches existing Ls=300', DOC=1°28'45", DS=65mph. Minimum required by RDG is 2°45' DOC for spiral curves at 65mph DS.
NB MP 244.30 to MP 244.70	Widened pavement matches existing Ls=300', DOC=2°02'18", DS=65mph. Minimum required by RDG is 2°45' DOC for spiral curves at 65mph DS.
SB MP 235.80 to MP 236.40	Widened pavement matches existing Ls=300', DOC=2°00'00", DS=75mph. Minimum required by RDG is 2°15' DOC for spiral curves at 75mph DS.
SB MP 236.70 to MP 236.80	Widened pavement matches existing Ls=200', DOC=1°00'00", DS=75mph. Minimum required by RDG is 2°15' DOC for spiral curves at 75mph DS.
SB MP 236.90 to MP 237.00	Widened pavement matches existing Ls=200', DOC=1°00'00", DS=75mph. Minimum required by RDG is 2°15' DOC for spiral curves at 75mph DS.

TP Attachment 440-2 Design Variances	
Location	Variance
SB MP 237.70 to MP 237.80	Widened pavement matches existing Ls=300', DOC=1°00'00", DS=75mph. Minimum required by RDG is 2°15' DOC for spiral curves at 75mph DS.
SB MP 237.90 to MP 238.40	Widened pavement matches existing Ls=375', DOC=1°15'00", DS=75mph. Minimum required by RDG is 2°15' DOC for spiral curves at 75mph DS.
SB MP 243.50 to MP 244.00	Widened pavement matches existing Ls=300', DOC=1°31'17", DS=75mph. Minimum required by RDG is 2°15' DOC for spiral curves at 75mph DS.
SB MP 244.30 to MP 244.70	Widened pavement matches existing Ls=300', DOC=1°57'47", DS=75mph. Minimum required by RDG is 2°15' DOC for spiral curves at 75mph DS.
SB MP 244.81 to MP 245.13	Widened pavement matches existing Ls=300', DOC=1°12'00", DS=65mph. Minimum required by RDG is 2°45' DOC for spiral curves at 65mph DS.
SB MP 248.07 to MP 248.47	Widened pavement matches existing Ls=350', DOC=1°45'00", DS=65mph. Minimum required by RDG is 2°45' DOC for spiral curves at 65mph DS.
SB MP 251.05 to MP 251.38	Widened pavement matches existing Ls=400', DOC=2°00'00", DS=65mph. Minimum required by RDG is 2°45' DOC for spiral curves at 65mph DS.
NB MP 229.84, 1532+00.00	Grade Break of 0.2399%, which is 0.0399% higher than the maximum grade break without a vertical curve as stated in the RDG.
NB MP 234.65, 1788+00.00	Grade Break of 0.3239%, which is 0.1239% higher than the maximum grade break without a vertical curve as stated in the RDG.
SB MP 248.95, 2516+00.00	Grade Break of 0.5967%, which is 0.3967% higher than the maximum grade break without a vertical curve as stated in the RDG.
SB MP 249.76, 2567+00.00	Grade Break of 0.6739%, which is 0.4739% higher than the maximum grade break without a vertical curve as stated in the RDG.
SB MP 250.30, 2595+00.00	Grade Break of 0.4583%, which is 0.2583% higher than the maximum grade break without a vertical curve as stated in the RDG.

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TP Attachment 440-3 – Design Exceptions

**TP Attachment 440-3
Design Exceptions**

Location	Exception
MP 245.7 to MP 245.9, barrier side flex lane	Horizontal stopping sight distance is 155' less than the required 682'.
MP 246.29 to MP 246.56, barrier side flex lane	Horizontal stopping sight distance is 353' less than the required 728'
MP 247.15 to MP 247.55, barrier side flex lane	Horizontal stopping sight distance is 353' less than the required 728'
MP 247.99 to MP 248.42, barrier side flex lane	Horizontal stopping sight distance is 49' less than the required 612'
MP 249.54 to MP 249.57, barrier side flex lane	Horizontal stopping sight distance is 353' less than the required 728'
MP 249.79 to MP 249.92, barrier side flex lane	Horizontal stopping sight distance is 333' less than the required 728'
MP 250.27 to MP 250.39, barrier side flex lane	Horizontal stopping sight distance is 295' less than the required 728'
MP 250.97 to MP 251.37, barrier side flex lane	Horizontal stopping sight distance is 154' less than the required 682';
MP 246.22 to MP 246.37, existing inside lane	Horizontal stopping sight distance is 298' less than the required 728'
MP 246.73 to MP 246.96, existing inside lane	Horizontal stopping sight distance is 377' less than the required 728'
MP 247.10 to MP 247.22, existing inside lane	Horizontal stopping sight distance is 240' less than the required 728'
MP 247.61 to MP 248.05, existing inside lane	Horizontal stopping sight distance is 346' less than the required 728'
MP 249.23 to MP 249.48, existing inside lane	Horizontal stopping sight distance is 261' less than the required 682'
MP 249.71 to MP 249.93, existing inside lane	Horizontal stopping sight distance is 305' less than the required 728'
MP 250.10 to MP 250.34, existing inside lane	Horizontal stopping sight distance is 337' less than the required 728'
MP 250.73 to MP 251.01, existing inside lane	Horizontal stopping sight distance is 281' less than the required 728'
NB MP 232.00 to MP 232.20	Vertical stopping sight distance (grade adjusted crest vertical curve sight restriction) is 24' less than the required 832'
NB MP 232.80 to MP 233.00	Vertical stopping sight distance (grade adjusted crest vertical curve sight restriction) is 42' less than the required 837'
NB MP 237.20 to MP 237.50	Vertical stopping sight distance (grade adjusted crest vertical curve sight restriction) is 149' less than the required 905'
NB MP 240.00 to MP 240.40	Vertical stopping sight distance (grade adjusted crest vertical curve sight restriction) is 82' less than the required 869'
NB MP 242.20 to MP 242.30	Vertical stopping sight distance (grade adjusted crest vertical curve sight restriction) is 38' less than the required 842'
SB MP 232.00 to MP 232.20	Vertical stopping sight distance (grade adjusted crest vertical curve sight restriction) is 57' less than the required 866'
SB MP 233.50 to MP 233.70	Vertical stopping sight distance (grade adjusted crest vertical curve sight restriction) is 25' less than the required 835'
SB MP 234.90 to MP 235.10	Vertical stopping sight distance (grade adjusted crest vertical curve sight restriction) is 11' less than the required 860'
SB MP 235.70 to MP 236.00	Vertical stopping sight distance (grade adjusted crest vertical curve sight restriction) is 81' less than the required 866'

**TP Attachment 440-3
Design Exceptions**

Location	Exception
NB MP 233.30 to MP 233.40, 1032' curve length	Superelevation is 0.038'/ft less than the recommended 0.061'/ft
NB MP 233.80 to MP 234.00, 895' curve length	Superelevation is 0.025'/ft less than the recommended 0.079'/ft
NB MP 234.20 to MP 234.40, 688' curve length	Superelevation is 0.038'/ft less than the recommended 0.061'/ft
NB MP 234.70 to MP 234.90, 1025' curve length	Superelevation is 0.016'/ft less than the recommended 0.031'/ft
NB MP 235.20 to MP 235.30, 829' curve length	Superelevation is 0.038'/ft less than the recommended 0.061'/ft
NB MP 235.80 to MP 236.40, 3603' curve length	Superelevation is 0.032'/ft less than the recommended 0.061'/ft
NB MP 237.20 to MP 237.60, 2135' curve length	Superelevation is 0.026'/ft less than the recommended 0.041'/ft
NB MP 238.50 to MP 239.50, 5121' curve length	Superelevation is 0.016'/ft less than the recommended 0.031'/ft
NB MP 239.60 to MP 240.40, 3903' curve length	Superelevation is 0.026'/ft less than the recommended 0.041'/ft
NB MP 242.10 to MP 242.50, 1612' curve length	Superelevation is 0.026'/ft less than the recommended 0.041'/ft
NB MP 244.30 to MP 244.70, 1872' curve length	Superelevation is 0.048'/ft less than the recommended 0.063'/ft
SB MP 235.80 to MP 236.40, 3312' curve length	Superelevation is 0.060'/ft less than the recommended 0.079'/ft
SB MP 236.70 to MP 236.80, 524' curve length	Superelevation is 0.026'/ft less than the recommended 0.041'/ft
SB MP 236.90 to MP 237.00, 394' curve length	Superelevation is 0.026'/ft less than the recommended 0.041'/ft
SB MP 237.10 to MP 237.40, 2037' curve length	Superelevation is 0.038'/ft less than the recommended 0.061'/ft
SB MP 237.70 to MP 237.80, 658' curve length	Superelevation is 0.026'/ft less than the recommended 0.041'/ft
SB MP 237.90 to MP 238.40, 2200' curve length	Superelevation is 0.036'/ft less than the recommended 0.051'/ft
SB MP 239.70 to MP 240.00, 2379' curve length	Superelevation is 0.038'/ft less than the recommended 0.061'/ft
SB MP 240.60 to MP 240.80, 1479' curve length	Superelevation is 0.025'/ft less than the recommended 0.079'/ft
SB MP 240.90 to MP 241.80, 6590' curve length	Superelevation is 0.006'/ft less than the recommended 0.021'/ft
SB MP 243.50 to MP 244.00, 2594' curve length	Superelevation is 0.011'/ft less than the recommended 0.061'/ft
SB MP 244.30 to MP 244.70, 1956' curve length	Superelevation is 0.046'/ft less than the recommended 0.061'/ft
SB MP 244.81 to MP 245.13, 1107' curve length	Superelevation is 0.019'/ft less than the recommended 0.034'/ft
SB MP 252.21 to MP 253.08, 4532' curve length	Superelevation is 0.013'/ft less than the recommended 0.028'/ft
SB Flex Lanes MP 245.78 to MP 245.93, 609' curve length	Superelevation is 0.047'/ft less than the recommended 0.062'/ft

**TP Attachment 440-3
Design Exceptions**

Location	Exception
SB Flex Lanes MP 246.13 to MP 246.26, 702' curve length	Superelevation is 0.057'/ft less than the recommended 0.087'/ft
SB Flex Lanes MP 246.40 to MP 246.56, 812' curve length	Superelevation is 0.028'/ft less than the recommended 0.099'/ft
SB Flex Lanes MP 246.72 to MP 246.81, 483' curve length	Superelevation is 0.028'/ft less than the recommended 0.099'/ft
SB Flex Lanes MP 247.08 to MP 247.10, 69' curve length	Superelevation is 0.016'/ft less than the recommended 0.087'/ft
SB Flex Lanes MP 247.24 to MP 247.45, 1106' curve length	Superelevation is 0.028'/ft less than the recommended 0.099'/ft
SB Flex Lanes MP 247.60 to MP 247.92, 1652' curve length	Superelevation is 0.028'/ft less than the recommended 0.099'/ft
SB Flex Lanes MP 248.07 to MP 248.47, 2071' curve length	Superelevation is 0.040'/ft less than the recommended 0.055'/ft
SB Flex Lanes MP 248.75 to MP 248.94, 987' curve length	Superelevation is 0.018'/ft less than the recommended 0.033'/ft
SB Flex Lanes MP 249.23 to MP 249.35, 625' curve length	Superelevation is 0.057'/ft less than the recommended 0.087'/ft
SB Flex Lanes MP 249.58 to MP 249.69, 604' curve length	Superelevation is 0.028'/ft less than the recommended 0.099'/ft
SB Flex Lanes MP 249.85 to MP 249.89, 175' curve length	Superelevation is 0.028'/ft less than the recommended 0.099'/ft
SB Flex Lanes MP 250.04 to MP 250.08, 177' curve length	Superelevation is 0.028'/ft less than the recommended 0.099'/ft
SB Flex Lanes MP 250.23 to MP 250.36, 649' curve length	Superelevation is 0.028'/ft less than the recommended 0.099'/ft
SB Flex Lanes MP 250.50 to MP 250.57, 345' curve length	Superelevation is 0.016'/ft less than the recommended 0.087'/ft
SB Flex Lanes MP 250.72 to MP 250.91, 1008' curve length	Superelevation is 0.057'/ft less than the recommended 0.087'/ft
SB Flex Lanes MP 251.05 to MP 251.38, 1879' curve length	Superelevation is 0.064'/ft less than the recommended 0.079'/ft
NB MP 237.49 to MP 238.19, Rolling Terrain, 3871' long grade	Maximum grade is 1.0526% steeper than the max grade 4.000%
SB Flex Lanes MP 245.95 to MP 247.62, Mountain Terrain, 8796' long grade	Maximum grade is 0.7368% greater than the max grade 5.000%
SB Flex Lanes MP 248.78 to MP 249.18, Mountain Terrain, 2108' long grade	Maximum grade is 0.7143% greater than the max grade 5.000%
SB Flex Lanes MP 249.53 to MP 250.81, Mountain Terrain, 6793' long grade	Maximum grade is 1.1739% greater than the max grade 5.000%
NB MP 242.1, Rock Springs TI UP (Str # 00969)	Vertical clearance is 0'-1" less than the minimum 16'-0"
Table Mesa TI UP (Str # 01294)	Inside shoulder width is 5.5' less than the minimum of 10' shoulder + 2' offset to barrier
Table Mesa TI UP (Str # 01295)	Inside shoulder width is 5.5' less than the minimum of 10' shoulder + 2' offset to barrier

TP Attachment 440-4 – Guardrail Replacement

**TP Attachment 440-4
Guardrail Replacement**

I-17 Northbound	I-17 Southbound
Sta. 1508+91 to 1517+07 (Right)	Sta. 1578+93 to 1588+95 (Left)
Sta. 1612+55 to 1616+59 (Left) ¹	Sta. 1601+80 to 1609+82 (Left)
Sta. 1613+54 to 1616+85 (Right) ¹	Sta. 1856+40 to 1857+87 (Left) ¹
Sta. 1620+66 to 1625+28 (Right) ¹	Sta. 2210+66 to 2211+80 (Left)
Sta. 1857+87 to 1859+84 (Right) ¹	Sta. 2346+75 to 2365+17 (Left)
Sta. 2346+86 to 2367+70 (Left)	Sta. 2366+86 to 2392+11 (Left)
Sta. 2349+47 to 2358+28 (Right)	Sta. 2394+55 to 2425+53 (Left)
Sta. 2359+60 to 2377+60 (Right)	Sta. 2429+67 to 2445+67 (Left)
Sta. 2696+00 to 2709+96 (Right) ¹	Sta. 2453+11 to 2475+02 (Left)
Sta. 2696+55 to 2709+96 (Left) ¹	Sta. 2486+59 to 2494+18 (Left)
	Sta. 2497+49 to 2508+77 (Right)
	Sta. 2498+53 to 2510+85 (Left)
	Sta. 2514+12 to 2524+00 (Left)
	Sta. 2530+75 to 2567+03 (Left)
	Sta. 2623+16 to 2631+23 (Left)
	Sta. 2623+28 to 2632+83 (Right)
	Sta. 2700+55 to 2710+34 (Right) ¹
	Sta. 2702+08 to 2710+34 (Left) ¹
Bumble Bee Road	Bumble Bee Road Ramps
West side, all runs from the junction with SB Exit Ramp to the junction with the NB Entrance Ramp	SB Entrance Ramp (West side, all runs)
East side, all runs from the junction with the SB Exit Ramp to the junction with the NB Entrance Ramp.	SB Entrance Ramp (East side, all runs)
	SB Exit Ramp (West side, all runs)
	SB Exit Ramp (East side, all runs)

(Right) and (Left) are in direction of stationing.

¹ Requires modification to existing bridge barrier for three-beam guardrail transition.

TP Attachment 450-1 – Seed Mix

400 SEEDING

400.1 General Requirements

Developer shall seed all disturbed areas of the Project and any areas outlined in the SWPPP as proposed by Developer and approved by ADOT. Unless otherwise prohibited by an Environmental Approval, seeding is required to stabilize unpaved, disturbed dry area within the Waters of the U.S. Seeding area below the ordinary high-water mark (OHWM) shall exclude any definable low-flow channel.

Seeding shall be accomplished in two stages. The first stage shall consist of tillage; furnishing and applying compost, chemical fertilizer, and sulfur; furnishing and planting the contract-specified seed mix; and furnishing, applying, and affixing final mulch cover. The second stage, beginning after the first stage has been accepted by ADOT, and continuing through the Landscaping Establishment Period, shall consist of maintaining and stabilizing the seeded and mulched areas, and restoring damage and eroded areas.

Developer shall submit to ADOT for review and comment appropriate documentation, as specified below, a minimum of 30 days before the start of a scheduled seeding activity. No materials shall be delivered to the site until the documentation has been reviewed by ADOT.

1. Unless otherwise specified, Developer shall provide to ADOT certificates of compliance for all materials, conforming to the requirements of Section 106.05 of the ADOT Standard Specifications.
2. Developer shall provide tests from accredited laboratories for all materials, as specified herein. Should Developer perform its own testing, it shall provide such test results to ADOT.

400.2 Seed

The species, variety, and strain of seed (contract-specified seed) shall be as specific herein. The contract-specified seed shall be obtained from seed suppliers through harvesting of wildland collections, or field grown seeds.

A certificate of analysis for each seed species shall be furnished to ADOT at least four weeks prior to the seeding operation. No seed shall be furnished to or delivered to the Project until the certificates of analysis have been reviewed by ADOT. The certificates of analysis shall contain the following information for each seed sample: the test results of the Fifty States Noxious Weed list; all seeds including weed seeds listed; purity and germination; tetrazolium test results, when used; and any pathology found to be present. The sample testing, when available for the native plant species, shall use the rules for testing seeds published by the Association of Official Seed Analysts or the Society of Commercial Seed Technologists.

If the samples indicate species listed as noxious, restricted, or invasive, the lot will be rejected for use on the Project. The list of noxious, restricted or invasive species is located at the following website:

<http://www.azdot.gov/business/engineering-and-construction/roadway-engineering/roadside-development>

The seed must be delivered to the Project site unmixed in standard, sealed, undamaged containers for each seed species. Each container shall be labeled in accordance with the appropriate provisions of the Arizona Revised Statutes and the U.S. Department of Agriculture rules and regulations under the Federal Seed Act. Labels must indicate the scientific genus, species, subspecies/varieties or strains of seed, the percentage of germination, purity, weed content, and testing information. Unless otherwise approved by ADOT, the date of analysis for

Tetrazolium Test (TZ) must not be more than 15 months prior to the delivery date from a seed provider/supplier. A certificate of analysis from an accredited seed-testing laboratory, and conforming to Section 110 of the TPs, must accompany each container of seed.

Weed content of the contract-specified seed mix must not exceed 0.5 percent.

In addition to Federal Seed Act Regulations, unless otherwise approved by ADOT, the contamination of seed lots from the noxious/invasive plant species shown in Table 450-1, below, shall not be permitted.

Table 450-1 Noxious/Invasive Weeds Watch List For the Contaminated Seed Lots	
SCIENTIFIC NAME	COMMON NAME
<i>Amaranthus retroflexus</i>	Redroot Amaranth / Redroot Pigweed / Red-Rooted Pigweed / Rough Pigweed
<i>Bassia scoparia</i> (syn. <i>Kochia scoparia</i>)	Kochia / Fireweed
<i>Bothriochloa bladhii</i> (syn. <i>Andropogon bladhii</i> / <i>Andropogon caucasicus</i> / <i>Andropogon intermedius</i> / <i>Bothriochloa caucasica</i> / <i>Bothriochloa intermedia</i>)	Caucasian Bluestem
<i>Bothriochloa ischaemum</i>	Yellow Bluestem
<i>Brassica tournefortii</i>	Sahara Mustard / Mediterranean Mustard / Prickly Turnip
<i>Bromus tectorum</i>	Cheatgrass / Downy Brome / Broncoglass / Downy Chess / Soft Chess / Drooping Brome
<i>Cynodon dactylon</i> (syn. <i>Capriola dactylon</i>)	Bermudagrass / Devilgrass
<i>Cenchrus spinifex</i> (syn. <i>Cenchrus incertus</i> / <i>Cenchrus pauciflorus</i> / <i>Cenchrus parviceps</i>)	Field Sandbur / Coastal Sandbur / Common Sandbur
<i>Chorispura tenella</i>	Crossflower / Purple Mustard / Blue Mustard / Musk Mustard / Beanpodded Mustard / Tenella Mustard
<i>Eragrostis lehmanniana</i>	Lehmann Lovegrass
<i>Euphorbia esula</i>	Leafy Spurge / Green Spurge / Wolf's Milk
<i>Euphorbia prostrata</i> (syn. <i>Chamaesyce prostrata</i> / <i>Euphorbia chamaesyce</i>)	Prostrate Spurge / Prostrate Sandmat / Ground Spurge / Blue Weed
<i>Onopordum acanthium</i>	Scotch Thistle / Cotton Thistle
<i>Pennisetum ciliare</i> (syn. <i>Cenchrus ciliaris</i>)	Buffelgrass / African Foxtail Grass
<i>Salsola kali</i> subsp. <i>tragus</i> (syn. <i>Salsola iberica</i>)	Russian Thistle / Tumbleweed
<i>Setaria faberi</i>	Japanese Bristlegrass / Giant Foxtail
<i>Setaria pumila</i> (syn. <i>Chaetochloa glauca</i> / <i>Chaetochloa lutescens</i> / <i>Panicum glaucum</i> / <i>Setaria glauca</i>)	Yellow Foxtail / Pigeon Grass / Yellow Bristlegrass
<i>Setaria viridis</i>	Green Bristlegrass / Pigeon Grass / Wild Millet / Green Foxtail
<i>Solanum physalifolium</i> (syn. <i>Solanum physalifolium</i> / <i>Solanum sarachoides</i> / <i>Solanum villosum</i>)	Hoe Nightshade / Argentine Nightshade / Green Nightshade / Hairy Nightshade

Developer shall submit all seed tag labels and certificates of analysis from all seed to be used on the Project to ADOT for review.

Both Developer and the seed supplier shall store seed under dry conditions, at temperatures between 35°F and 120°F, and out of direct sunlight. Prior to using the seed, Developer and seed

supplier shall both provide a certification letter to ADOT verifying that the seed was stored as specified herein.

Legume seed shall be inoculated with appropriate bacteria cultures approved by ADOT, in accordance with the culture manufacturer's instructions.

Tetrazolium staining shall be acceptable to test for germination and hard seed. Cut or fill testing will not be allowed. Developer shall retest seeds with an expiration date past the acceptable test date or not meeting the specified conditions for storage.

Application rates of seed as specified are for pure live seed. Pure live seed is determined by multiplying the sum of the percent germination of seeds, including hard or dormant seeds, by the percent purity.

Seed mix species and the pure live seed rates are shown herein Tables 450-2 and 450-3 below.

Developer shall apply Seed Mix H1 (Table 450-2 below):

- Along roadway median zones;
- Along new shoulder build-up areas;
- On all unpaved disturbed soil areas within 30 feet of pavement edges along the median zone;
- To the unpaved disturbed dry areas within the Waters of the U.S. and ditches outside of the inlets and outlets of drainage facilities acceptable under the Environmental Approvals; and
- Below the OHWM of unpaved disturbed dry roadway median zone.

TABLE 450-2 Seed Mix H1- Medians, Recovery Areas, Ditches and Drainages		
Botanical Name	Common Name	PLS Rate (pounds per acre)
Aristida purpurea	Purple Threeawn	1
Baileya multiradiata	Desert Marigold	1.5
Bothriochloa barbinodis	Cane Beardgrass	1
Bouteloua curtipendula cv. Vaughn *	Sideoats Grama	2
Bouteloua barbada	Six Weeks Grama	1
Bouteloua gracilis cv. Hachita	Blue Grama	1
Bouteloua rothrockii	Rothrock's Grama	0.5
Castilleja exerta ssp. exerta	Purple Owl's Clover	0.1
Digitaria californica	Arizona Cottontop	0.75
Distichlis stricta	Desert Saltgrass	1
Dyssodia pentachaeta	Golden Dyssodia	1

TABLE 450-2 Seed Mix H1- Medians, Recovery Areas, Ditches and Drainages		
Botanical Name	Common Name	PLS Rate (pounds per acre)
Encelia farinosa	Incienso Brittlebush	1
Encelia frutescens	Button Brittlebush	0.75
Erigonium fasciculatum var. poliofolium	Flattop Buckwheat	.75
Eschscholtzia mexicana	Mexican Poppy	2
Gaillardia aristata	Blanket Flower	1
Gaillardia pulchella	Firewheel	0.75
Glandularia goodingii	Gooding Verbena	0.75
Hilaria berlanderi	Curly Mesquitegrass	3.5
Kallstroemia grandiflora	Arizona Poppy	0.5
Lesquerella gordonii	Gordon's Bladderpod	1.5
Lupinus sparsiflorus	Desert Lupine	1.5
Lupinus succulentus	Arroyo Lupine	3
Phacelia crenulata	Arizona Desert Bluebell	1
Psilostrophe cooperi	Paper Flower	0.5
Penstemon eatonii	Firecracker Penstemon	1
Penstemon parryii	Parry Penstemon	0.75
Plantago ovata	Desert Indian Wheat	2
Salvia columbariae	Desert Chia	1
Senna covesii	Desert Senna	3
Sphaeralcea ambigua	Desert Globemallow	1
Sporobolus airoides	Alkali Sacaton	0.75
Sporobolus cryptandrus	Sand Dropseed	0.2

Developer shall apply Seed Mix H2 (Table 450-3 below) to all unpaved disturbed soil areas not covered under Seed Mix H1. Developer shall not apply Seed Mix H2:

- Within the traffic clear zone/recovery area as defined in ADOT Roadway Design Guidelines;

- Within 20 feet behind guardrails/barrier walls;
- Within 20 feet of the inlets and outlets of drainage facilities;
- To the dry flow paths of the inlets and outlets of drainage facilities; or
- Within/along median zone, where Seed Mix H1 is used.

Seed Mix H2 shall be applicable along the definable edge above the OHWM for unpaved disturbed construction areas. Seed Mix H2 shall promote functional landscape ecological restoration of project site.

TABLE 450-3 Seed Mix H2 – Tall Background Mix		
Botanical Name	Common Name	PLS Rate (pounds per acre)
<i>Atriplex canescens</i>	Fourwing Saltbush	0.2
<i>Acacia greggii</i>	Catclaw Acacia	1
<i>Atriplex lentiformis</i>	Quail Bush	0.1
<i>Aristida purpurea</i>	Purple Threeawn	2
<i>Atriplex polycarpa</i>	Desert Saltbush	0.25
<i>Baileya multiradiata</i>	Desert Marigold	0.5
<i>Bothriochloa barbinodis</i>	Cane Beardgrass	1
<i>Bouteloua curtipendula</i> cv. Vaughn *	Sideoats Grama	3
<i>Bouteloua gracilis</i> cv. Hachita	Blue Grama	1
<i>Calliandra eriophylla</i>	Fairy Duster	1.5
<i>Cercidium floridum</i>	Blue Palo Verde	0.5
<i>Cercidium microphyllum</i>	Foothills Palo Verde	0.5
<i>Chilopsis linearis</i>	Desert Willow	1
<i>Celtis pallida</i>	Desert Hackberry	0.5
<i>Distichlis stricta</i>	Desert Saltgrass	0.75
<i>Encelia farinosa</i>	Inciense Brittlebush	1
<i>Encelia frutescens</i>	Button Brittlebush	0.5
<i>Ericameria laricifolia</i>	Turpentine Bush	1
<i>Eschscholtzia mexicana</i>	Mexican Poppy	0.5
<i>Ephedra nevadensis</i>	Nevada Mormon Tea	2.5

TABLE 450-3 Seed Mix H2 – Tall Background Mix		
Botanical Name	Common Name	PLS Rate (pounds per acre)
Hilaria berlanderi	Curly Mesquitegrass	1
Larrea tridentata	Creosote Bush	0.5
Lesquerella gordonii	Gordon's Bladderpod	1.5
Lupinus sparsiflorus	Desert Lupine	1
Lupinus succulentus	Arroyo Lupine	3
Lycium exsertum	Arizona Desert Thorn	0.5
Muhlenbergia porteri	Bush Muhly	0.2
Olneya tesota	Desert Ironwood	3
Phacelia crenulata	Arizona Desert Bluebell	1
Psilostrophe cooperi	Paper Flower	0.2
Prosopis pubescens	Screwbean Mesquite	1
Plantago ovata	Desert Indian Wheat	0.8
Salvia columbariae	Desert Chia	1
Senna covesii	Desert Senna	3
Simmondsia chinensis	Jojoba	5
Sphaeralcea ambigua	Desert Globemallow	0.5
Sporobolus airoides	Alkali Sacaton	0.5
Sporobolus cryptandrus	Sand Dropseed	0.2
Zinnia acerosa	Desert Zinnia	0.2

400.2.1 Seed Substitution

No substitution of the contract-specified seed will be allowed unless evidence is submitted documenting that Developer has made a diligent effort to obtain the contract-specified seed from either seed suppliers or collectors, and that the contract-specified seed will not become available prior to the time specified for seeding in the Project Schedule.

Should a substitution of the contract-specified seed be requested, Developer shall request such Deviation as outlined in Section 8.2.5 of the Agreement. The alternate seed will only be allowed when there is an insufficient quantity of the contract-specified seed for the areas to be seeded as called for herein or as required for erosion control. Developer shall obtain and apply the alternate seed, as required, to all such remaining areas. The alternate seed will only be allowed until such

time that contract-specified seed meeting the availability requirements specified herein can be provided.

400.3 Tacking Agent

Tacking agent shall be a naturally occurring organic compound and shall be non-toxic. The tacking agent shall be a product typically used for binding soil and mulch in seeding or erosion control operations. Approved types shall consist of mucilage or gum by dry weight as active ingredient obtained from guar or plantago. The tacking agent shall be labeled indicating the type and mucilage purity.

Developer shall have the tacking agent swell volume tested by an approved testing laboratory using the USP method. The standard swell volume shall be considered as 30 milliliters per gram. Material shall have a swell volume of at least 24 milliliters per gram. Developer shall furnish to ADOT certified laboratory test results for homogenous consistency for each shipment of tacking agent to be used on Project areas. Tacking agent rates shall be adjusted to compensate for swell volume variation. Material tested with lesser swell volume shall have the tacking agent rate increased by the same percentage of decrease in swell volume from the standard 30 milliliters per gram. Material tested with greater volume may reduce tacking agent rates by the same percentage of increase in swell volume from the standard 30 milliliters per gram. Tacking agent shall be pure material without starches, bentonite, or other compounds that would alter the swell volume test results of mucilage, or the effectiveness of the tacking.

400.4 Thermally-Refined Wood Fiber

Wood cellulose fiber mulch shall conform to the requirements of Section 805-2.03 of the ADOT Standard Specifications, except as modified herein, and shall be from thermo-mechanically processed wood, processed to contain no growth germination inhibiting factors. The mulch shall be from virgin wood manufactured and processed so the fibers will remain in uniform suspension in water under agitation to form homogenous slurry. Paper products will not be considered as virgin wood. The thermally-refined wood fiber mulch shall have the properties shown in Table 450-4 below:

Table 450-4 Thermally-Refined Wood Fiber Properties	
Virgin Wood Cellulose Fiber	90% min.
Recycled Cellulose Fiber	10% max.
Ash Content	0.8% +/- 0.3%
pH	4.5 +/-1.0
Water Holding Capacity	10:1 (water:fiber) min.

400.5 Weed Free Straw Mulch

400.5.1 General Requirements

Straw mulch including barley straw shall conform to the requirements of Section 805-2.03 of the ADOT Standard Specifications, except as modified herein, and shall be from the current season's crop. A letter of certification from the supplier shall be required stating that the straw was baled less than 12 months from the delivery date.

All straw, including hydraulically applied straw, shall be free from noxious weeds in compliance with the standards and procedures of the North American Weed Management Association (NAWMA) or the Arizona Crop Improvement Association (ACIA). Developer shall provide documentation, including a transit certificate, and appropriate labels and/or marking twine, from

the ACIA or NAWMA that straw materials to be used for mulch are free of noxious weeds. The straw shall be accompanied by the certification, labels and/or marking twine at the time of delivery to the Project site. Straw delivered to the Project without such information will be rejected, and Developer shall promptly remove it from the Site.

Rye straw and oat straw will not be acceptable.

400.5.2 Weed Free Straw Mulch for Hydraulic Application

Hydraulically applied straw mulch shall be wheat, barley, or rice straw processed to various particle sizes, mixed with water, and tacking material, and applied as a non-clogging slurry using a hydroseeder. A minimum of 70 percent of the wheat, barley, or rice straw in the mix shall be not less than 1/2 inch ± 1/4 inch in length. Straw particles may be longer provided that the particles can be used with the selected hydroseeder without clogging. Hydraulically applied straw mulch, as furnished by the manufacturer, may contain up to ten percent paper or cotton materials in dry weight.

Hydraulically applied straw mulch shall also contain 20 percent of wood fiber in dry weight. The combined dry weight percentage of paper, cotton, and wood fiber materials together shall be not less than 15 percent nor more than 30 percent of the hydraulically applied straw mulch.

The date of installation of hydraulically applied straw mulch cover shall be less than 12 months from the date of production. The date of production of hydraulically applied straw mulch material shall be presented for verification to ADOT. All hydraulically applied straw mulch material shall also meet the requirements of [Section 400.5.1 above](#).

400.6 Slow-release Chemical Fertilizer and Sulfur

Chemical fertilizer must conform to the requirements of [Section 805-2.06](#) of the ADOT Standard Specifications and must be the kind hereafter specified. Fertilizer must be composed of a mixture of one part sulfur-coated urea 25-4-8, one part monoammonium phosphate 11-5-20, and one part methylene urea 38-0-0. The sulfur-coated urea, a blended fertilizer 25-4-8, must have approximately 80 percent of the nitrogen defined as slow release, and contain five percent Iron, ten percent sulfur and trace amounts of zinc and manganese. The result must be a 24-18-2 chemical blended fertilizer, as specified herein.

In addition to the fertilizer mixture, agricultural sulfur compounds, comprised of between 80 percent and 96 percent sulfur, shall be applied at the rate specified in [Section 400.9.2 below](#). Chemical fertilizer and sulfur shall not be applied for the seeding area below the OHWM.

400.7 Water

Water must be free of oil, acid, salts, or other substances which are harmful to plants. Developer shall test all non-potable water for its suitability for seeding/planting with the water related concerns of salinity, pathogens, and contaminants. Developer shall submit to ADOT the water quality results within two Business Days after obtaining the results. Developer shall consider *An Arizona Guide to Water Quality and Uses* (weblink <https://wrrc.arizona.edu/guide-water-quality-uses>). Figure 8, Water Quality and Uses Triangle as a reference for testing result evaluation.

400.8 Compost

Compost in bulk or furnished in containers or bags must consist of composted organic vegetative materials, and may contain worm castings. Developer shall not use or add animal manures or city biosolids in the compost. Prior to being furnished on the Project, Developer shall cause compost samples to be tested for the specified microbiological and nutrient conditions, including maturity and stability, by a testing laboratory approved for testing of organic materials. Developer shall

submit to ADOT the official lab test results not later than 15 days prior to use of the compost. The date of the official lab test results must be within nine months before use of the compost.

Compost material shall be dark brown in color with the parent material composted and no longer visible. The structure shall be a mixture of fine and medium size particles and humus crumbs. The maximum particle size shall be within the capacity of Developer’s equipment for application to the constructed slopes. The odor shall be that of rich humus with no ammonia or anaerobic odors.

Bulk compost shall also meet the requirements of Table 450-5 below:

Table 450-5 Bulk Compost Requirements	
Cation Exchange Capacity (CEC)	Greater than 45 meq/100 g
Carbon: Nitrogen Ratio (C:N)	Less than 20:1
pH (of extract)	5.0– 8.5
Organic Matter Content	Greater than 30%
Total Nitrogen (not added)	Greater than 1%
Micronutrients (added)	S, Ca, Mg, Na, Fe, Al, Mn, Cu, Zn, B
Maturity Index	Greater than 50% on Maturity Index at a 10:1 ratio
Stability Indicator, CO ₂ Evolution: Biologically Available C (BAC)	Less than 4mg CO ₂ -C/g OM/day is desirable. From 4 through 8mg CO ₂ -C/g OM/day is acceptable. Greater than 8mg CO ₂ -C/g OM/day is <u>not</u> acceptable.
The CEC lab testing method shall refer to EPA9081 at the web link: https://www.epa.gov/sites/production/files/2015-12/documents/9081.pdf	

Bulk compost is preferred and shall be applied to areas designated for seeding at the specified rate of 15 cubic yards per acre prior to final tillage for incorporation into the soil seedbed. Bulk compost shall be used in all areas where equipment can be operated for final tillage in order to incorporate into the soil seedbed.

Developer shall measure and document the volume of bulk compost and promptly deliver such information to ADOT for verification.

In areas where bulk compost cannot be applied by broadcast methods, Developer shall apply compost hydraulically. The choice between bulk compost and hydraulically applied compost shall be evaluated and reviewed by the Engineer of Record according to specific Project conditions. Determination of such areas shall be subject to ADOT’s prior review and comment. Hydraulically applied compost shall be applied at the rate of 3,000 pounds per acre to mini-benched slopes or on other required areas for incorporation into the soil seedbed. For seeding areas 3:1 and flatter where bulk compost cannot be employed, hydraulically applied compost shall be utilized at the rate of 3,000 pounds per acre. Hydraulically applied compost may also be combined with soil amendments and fertilizer in the same slurry. Seed shall be employed separately after the implementation of hydraulically applied compost and prior to the final mulch cover.

Developer shall measure and document the weight of hydraulically applied compost and promptly deliver such information to ADOT for verification.

Hydraulically applied compost shall meet the requirements of Table 450-6 below:

Table 450-6 Hydraulically Applied Compost Requirements	
Cation Exchange Capacity (CEC)	Greater than 55 meq/100 g*
Carbon:Nitrogen Ratio (C:N)	Less than 20:1
PH (of extract)	5.0 – 8.5
Organic Matter Content	Greater than 35%
Total Nitrogen (not added)	Greater than 1%
Micronutrients (added)	S, Ca, Mg, Na, Fe, Al, Mn, Cu, Zn, B
Stability Indicator, CO ₂ Evolution: Biologically Available C (BAC)	Less than 4mg CO ₂ -C/g OM/day is desirable.
	From 4 through 8mg CO ₂ -C/g OM/day is acceptable.
	Greater than 8mg CO ₂ -C/g OM/day is <u>not</u> acceptable.
Moisture Content by Weight	From 25% through 35%
The CEC lab testing method shall refer to EPA9081 at the web link: https://www.epa.gov/sites/production/files/2015-12/documents/9081.pdf	
* When CEC is from 50 meq/100 g through 55 meq/100 g, in order to be approved, Developer may add 100 pounds additional Hydraulically Applied Compost per acre to compensate for the lower-than-standard CEC value.	

Compost shall not be applied for the seeding area below the OHVM.

400.9 Construction

400.9.1 Seeding Operations

ADOT and Developer shall determine a 1-acre sample demonstrative area to be seeded and mulched with compliant materials prior to applying seed to the remainder of the Project. Both regular straw mulch and hydraulically applied straw mulch shall be applied to the sample demonstrative area, as determined during on-site pre-activity seeding construction meeting. Both straw mulches shall be representative of the materials proposed for use on the Project. If the seeding and mulching procedures, as well as outcomes are acceptable to ADOT, Developer shall begin seeding operations as specified herein. Developer shall conduct and promptly submit to ADOT photographic documentation of 0.5-acre sample demonstrative seeded/mulched area. The photographic documentation shall be the comparative standard representation (mandatory visual reference) for seeding acceptance as stated in [Section 400.9.6 below](#).

Developer shall notify ADOT at least two Days prior to commencing any phase of seeding operations for the remainder of the Project.

The equipment and methods used to distribute seeding materials must provide an even and uniform application of seed, mulch, and other materials at the specified rates.

It is Developer's responsibility to furnish all suitable equipment for soil tillage, seeding, and mulching incidental to the work in this Section.

Unless specified otherwise in the TPs, Developer shall not perform seeding operations on undisturbed soil outside the clearing and grubbing limits of the Project or on steep rock cuts.

Developer shall coordinate the seeding operations with the grading operations to determine mobilization frequency as embankment and cut slopes are finished throughout the duration of the Project. Developer shall perform seeding only during suitable weather and soil conditions (soil-water and soil-temperature regimes) for tillage and placement of materials. Developer shall not

perform seeding operations when wind exceeds ten miles per hour or conditions would prevent uniform application of materials or would carry seeding materials into areas not designated for seeding.

Seeding shall be accomplished within 14 Days after slopes and disturbed areas have been completed. Seeding operations shall comply with the applicable portions of Section 203 of the ADOT Standard Specifications.

Frequent mobilizations may be required to accomplish seeding as specified herein.

400.9.2 Tillage

Developer shall provide thorough soil cultivation to the depth specified below. It is Developer's responsibility to furnish all suitable equipment for soil tillage incidental to this work item.

For areas too steep to be prepared for seeding after the slope has been completed, as determined by ADOT, tillage shall be accomplished as the slope is being constructed. On slope areas, all tillage shall be horizontal and parallel to the contours of the areas involved in order to create a roughened surface condition. All seeded areas suitable for tillage shall be pre-tilled to promote on-site stormwater infiltration and alleviate stormwater surface runoffs, as a part of stormwater volume reduction approaches. All areas which are eroded shall be restored to the specified condition, grade, and slope prior to seeding.

Except as specified herein, slopes shall be constructed in accordance with Section 203-3.03(B) of the ADOT Standard Specifications. Cut slopes flatter than 3:1 (horizontal to vertical) shall be tilled to a minimum 12 inches in depth, and fill slopes flatter than 3:1 shall be tilled to a minimum 6 inches in depth. All slopes steeper than 3:1, and areas which could potentially be affected by underground utilities, shall be tilled to a minimum 6 inches in depth, and left in a roughened surface condition as they are constructed.

Tillage shall be a minimum of two inches in depth for the first ten feet from the toe of AC wedge or from the outside edge of curb and gutter.

Care shall be taken during the seeding operations to prevent damage to existing trees and shrubs in the seeding area in accordance with the requirements of Section 107.11 of the ADOT Standard Specifications.

Tillage may require passing the equipment over the area several times to provide thorough soil cultivation. Furrows from tillage shall be no more than 12 inches apart. No work shall be done when the moisture content of the soil is unfavorable to tillage.

All competitive vegetation shall be uprooted prior to seeding and the soil shall be left in a friable roughened surface condition. Invasive and non-native weed species shall be eradicated. In clear zones, rocks over four inches in any direction must be removed, prior to seeding.

Regardless of the method of seeding application, all areas prepared with tilling shall have chemical fertilizer and soil amendments (sulfur and compost) uniformly applied and incorporated (disked) into the soil prior to final tillage and seeding.

Chemical fertilizer and sulfur shall be applied at the rate of 200 pounds each per acre. Bulk compost shall be applied at the rate of 15 cubic yards per acre.

Slopes 3:1 and flatter shall have fertilizer, sulfur, and compost tilled/disked into a minimum of the top four inches of the surface. Slopes steeper than 3:1 shall have fertilizer, sulfur, and compost uniformly broadcast for incorporation into the soil. Unless otherwise operated together with hydraulically applied compost for the approved locations, fertilizer and sulfur shall not be applied hydraulically to areas for seeding.

For mini-benched slopes, fertilizer, compost, and sulfur shall be applied at the specified rates with no tillage or incorporation.

Seeding shall not initiate until all tillage areas and/or mini-benched slopes are accomplished in compliance with requirements.

400.9.3 Seeding

400.9.3.1 General Requirements

Drill seeding with straw mulch shall be considered as the preferred method of seed application when practicable. Drill seeding shall be used for all areas with slopes of 3:1 or less.

Hydroseeding shall be the alternative method for seed distribution for slopes in excess of 3:1, and where drill seeding is not practicable or suitable for soil conditions and seed types, as determined by Developer.

Seeds not suitable for drill seeding and hydroseeding methods shall be broadcast manually. Areas to be seeded manually shall be completed after the final soil tillage and prior to any drill or hydroseeding.

Final straw mulch cover or hydraulically applied straw mulch cover shall be applied on all seeded areas, as specified below, within 24 hours of seed application. Seeding application shall be accomplished prior to installation of straw mulch cover or hydraulically applied straw mulch cover. Combining the seed application process with the mulching process will not be acceptable. Developer shall install final straw mulch cover or hydraulically applied final straw mulch cover to minimize raindrop splash erosion and wind erosion/dust, as close as possible at the source of disturbance to protect all seeded areas. Thermally-refined wood fiber shall not be utilized solely as final mulch cover to protect all seeded areas.

Seeding areas shall not be watered after planting.

400.9.3.2 Drill Method

After the tillage and incorporation of fertilizer, sulfur and compost is completed and accepted by ADOT, Developer shall plant seed with a drill seeder capable of accurately metering the specific seed mix. Use of a drill seeder shall not damage the prepared seedbed and shall provide a soil cover over the planted seed.

Developer shall plant seed shall be planted approximately 1/4-inch deep, with a maximum depth of 1/2-inch. The distance between the furrows produced using the drill process shall not be more than eight inches. If the furrow openers on the drill exceed eight inches, the area shall be drilled twice. Seeding shall be done with grass seeding equipment with double disc openers, depth bands, packer wheels or drag chains, rate control attachments, seed boxes with agitators and separate boxes for small seed. Seed of different sizes shall be sowed from at least two separate boxes adjusted or set to provide the planting rate as specified.

400.9.3.3 Hydroseed Method

Developer shall hydroseed areas and seed types not suitable for drill-seeding, as determined by Developer. Developer shall apply the contract-specified seed in a slurry containing 200 pounds of thermally-refined wood fiber and a minimum of 40 pounds tacking agent per acre. Seed shall not be in the slurry for more than 30 minutes. Hydroseeded areas shall have 100 percent coverage from all directions. Developer also shall mulch hydroseeded areas as specified in Section 400.9.4 or Section 400.9.5 within 24 hours of application of the seed.

400.9.3.4 Manual Application

Developer shall broadcast manually applied seeds evenly to produce uniform distribution over the seeded areas.

400.9.4 Applying Straw Mulch

400.9.4.1 General Requirements

Within 24 hours after each area is planted, Developer shall apply straw mulch uniformly at the minimum rate of 2 1/2 tons per acre for areas to be crimped and tacked, and minimum two tons per acre for tacked-only areas. Except for edge of pavement build-up areas, Developer shall apply straw mulch to all seeded areas.

During seeding and mulching operations, Developer shall exercise care to prevent drift and displacement of materials. Developer shall promptly remove mulch material which is placed upon trees and shrubs, roadways, structures, and upon any areas where mulching is not specified, or which is placed in excessive depths on mulching areas. Mulch materials which are deposited in a matted condition must be loosened and uniformly spread to the specified depth over the mulching areas. Developer shall immediately correct any unevenness in materials. In addition, Developer shall minimize production of dust or other airborne particulate matter during application of straw mulch.

Except as specified in the next paragraph, Developer shall immediately affix straw mulch applied to seeded areas by crimping and tacking after application. No mulch shall be applied to seeding areas which cannot be crimped and/or tacked by the end of each Day. Developer shall correct any drifting or displacement of mulch before crimping and/or tacking.

Crimping shall not be required for areas that are steeper than 3:1, for drill seeded or hydroseeded areas with rocky conditions, or for other areas deemed unsuitable by ADOT for crimping. Straw mulch applied to such areas shall only be tacked, as specified below.

Prior to the application of a tacking agent, Developer shall place protective covering on all structures and objects where stains would be objectionable. Developer shall take all necessary precautions to protect the traveling public and vehicles from damage due to drifting spray.

400.9.4.2 Anchorage by Crimping

Except as specified above in Section 400.9.4.1, crimping is required for all straw mulched areas. Developer shall anchor straw mulch into the soil with a heavy disc. Discs shall be flat and serrated, with at least 1/4-inch thickness having dull edges, and spaced no more than 9 inches apart. Straw mulch must be anchored to a depth of at least two inches and must not be covered with an excessive amount of soil. Developer shall perform anchoring operations across the slopes where practical, with no more than two passes of the anchoring equipment. Immediately following the crimping operation, Developer shall tack the crimped area as specified below.

400.9.4.3 Anchorage by Tacking

Developer shall anchor straw mulch by tacking, using a slurry consisting of a minimum of 150 pounds of tacking agent, 500 pounds of thermally refined wood fiber mulch, and 300 gallons of water per acre. Developer may increase the quantities of components to ensure the stability of the straw mulch to provide erosion control.

400.9.5 Hydraulically Applied Straw Mulch with Tacking Agent

Areas seeded but not practical for straw mulch, as determined by ADOT, shall have hydraulically applied straw mulch with tacking agent applied at the variable rates shown in the Table 450-7 below.

Table 450-7 Hydraulically Applied Straw Mulch with Tacking Agent Rates			
Slope (H:V)	Hydraulically Applied Straw Mulch (pounds per acre – dry weight)	Tacking Agent (pounds pure mucilage per acre – dry weight)	Thermally-Refined Wood Fiber (pounds per acre – dry weight)
Flat to 6:1	2,000	150	400
From greater than 6:1 to 3:1	2,500	150	500
Greater than 3:1	3,000	200	600
Erosive Soil Slopes or Highly Erosive Areas*	3,500	250	700
* As determined by ADOT			

Developer shall submit a batch (tank) mix quantity schedule for mulch application to ADOT for review and comment prior to mixing hydraulically applied straw mulch, thermally-refined wood fiber, and tacking agent in a slurry. Developer shall monitor batch mixing and coverage throughout the seeding operations. Developer shall coordinate the mixing and application operations with ADOT in advance of all mixing. Developer shall not mix fertilizer or seed into any slurry for temporary erosion control mulch application.

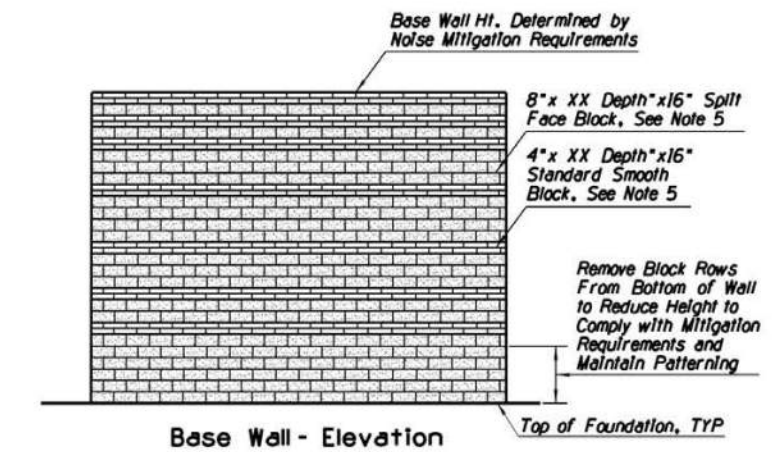
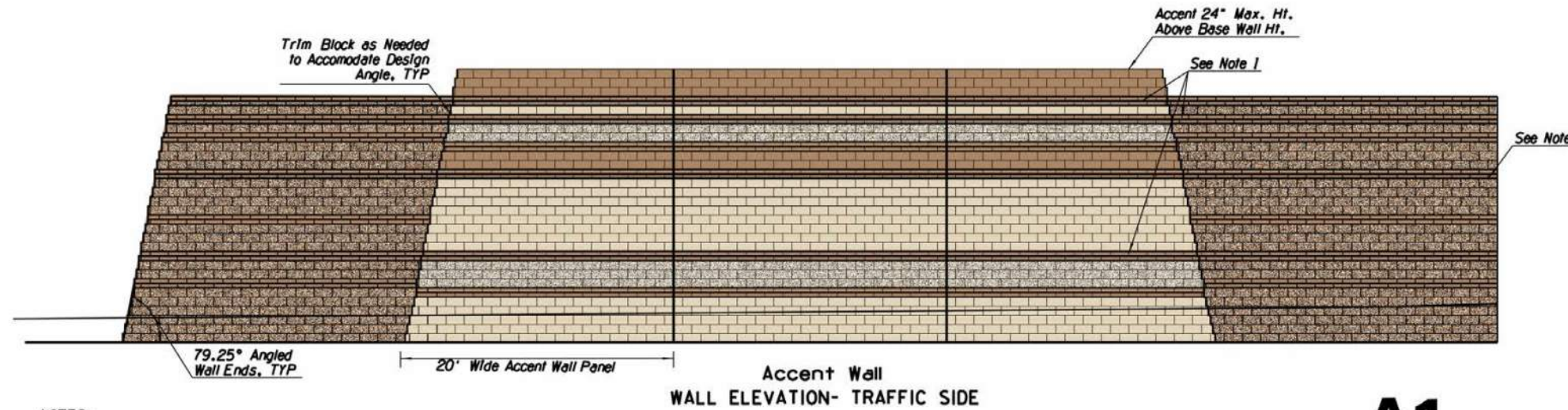
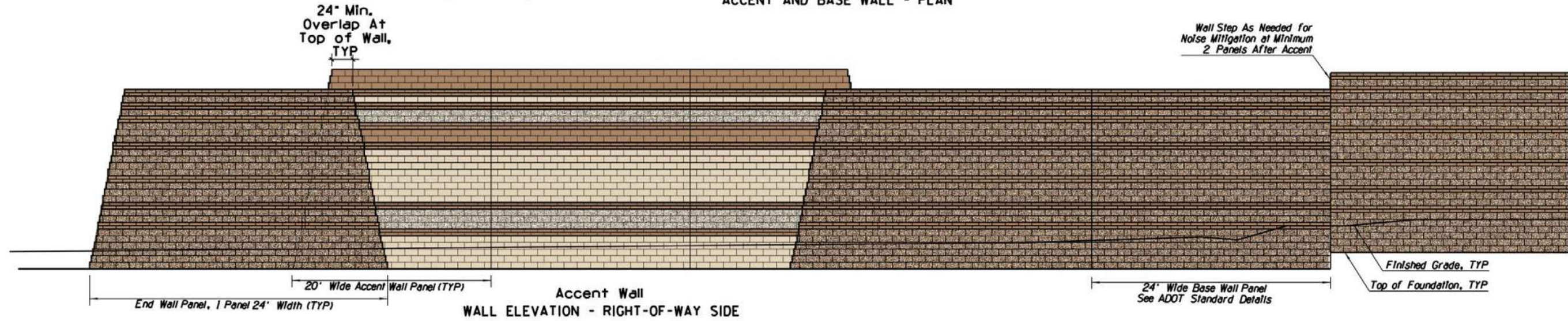
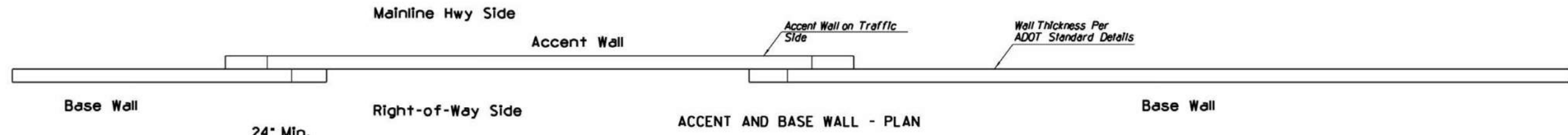
400.9.6 Seeding Acceptance

After application, ADOT will inspect seeded areas or sub-areas for conformance to the contract requirements. Developer shall correct, to the satisfaction of ADOT, any areas not conforming to the specifications.

Developer shall maintain and stabilize each area or sub-area, including edge of pavement build-up areas, through the Landscaping Establishment Period after application of the seeding and mulching materials. Developer shall promptly re-seed, re-mulch and re-tack any areas that are damaged from erosion or have less than 90 percent of remaining final mulch cover. ADOT will assess the seeded area in comparison to the pre-established 1-acre sample demonstrative area for seeding to determine the necessity of re-seeding, re-mulching, and retacking.

Attachment 450-2: Aesthetic Concept

F.H.W.A. REGION	STATE	PROJECT NO.	SHEET NO.	TOTAL SHEETS	RECORD DRAWING
9	ARIZ.	017 MA(229)			



NOTES:

1. 4" Block Patterns Aligned Between Accent and Base Wall Pattern in 3 Locations Shown in Elevation.
2. Block Pattern on Accent are Conceptual; Finishes, Color, and Pattern May Vary Using 4" and 8" Block to Achieve Geological Strata Theme.
3. Use Spillface and Standard Smooth Finish Block on All Exposed Sides of the Wall to Create Geological Strata Theme on Walls.
4. See TPs for Detail Submittal Requirements.
5. Block Depth, Shown as XX in Details, Shall be Determined by Structural Requirements.
6. See Engineering Details for Wall and Foundation Design.
7. Materials Shown are CMU Block. Developer May Construct Walls From Other Materials As Long As the Final Design Rustication Closely Resembles the Depths, Finish Surfaces, and Textures as Shown in These Details.
8. Block Rustication Patterns, Textures, and Paint on All Exposed Sides and Extend 2-Foot Below Finished Grade or to Top of Foundation.
9. Accent and Base Wall Shall Have a Gap to Account for Wall Deflection Without Contact. Coordinate with Structures in Final Design for Gap Size.
10. Accent Wall and Adjacent Base Wall Panels (1 on Each Side of Accent at Minimum) Shall be Placed on a Single Continuous Modified Foundation.
11. Accents Occur at Each End of Noise Walls Only. Retaining Wall Rustication Shall Resemble the Base Wall Detail A2 in Depth, Finish Surfaces, and Textures.
12. Paint: Base Color Shall be a Single Color with a Flat Finish Corridor-Wide. Accent Colors are the Base Color in a Gloss Finish and One Accent Color in a Gloss Finish.

DETAIL A1 NTS
WALL LAYOUT DETAILS

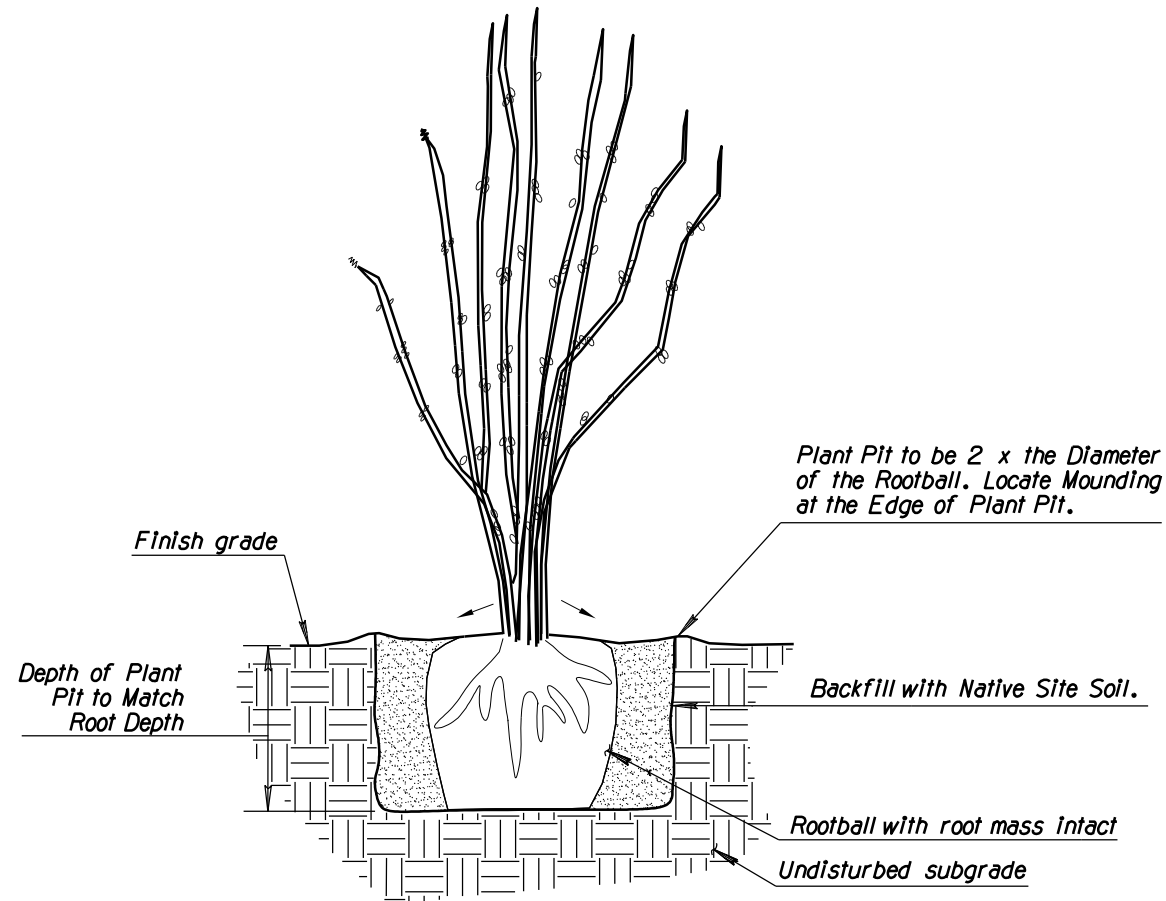
- Base Wall Color (Flat) Accent Wall Colors (Gloss)
- | | | | |
|---------|------------------|------------------|------------------|
| Color 1 | Textures | Color 2 /Color 1 | Textures |
| | Smooth Block | | Smooth Block |
| | Split Face Block | | Split Face Block |

DETAIL A2 NTS
BASE WALL BLOCK LAYOUT

DESIGN	NAME	DATE	ARIZONA DEPARTMENT OF TRANSPORTATION INFRASTRUCTURE DELIVERY AND OPERATIONS DIVISION ROADWAY DESIGN SECTION	PRELIMINARY
DRAWN	STAFF	3/21		
CHECKED	ECC	3/21		
corral design group, inc.			Aesthetics Concept	
ROUTE	LOCATION	1-17 ANTHEM WAY TRAFFIC INTERCHANGE TO JCT. 69 (CORDES JUNCTION) PROJECT		
TRACS NO. H6800 01D	017 MA(229)		Review NOT FOR CONSTRUCTION OR RECORDING	
			DWG NO. <u> OF </u>	

Attachment 450-3: Landscape Detail

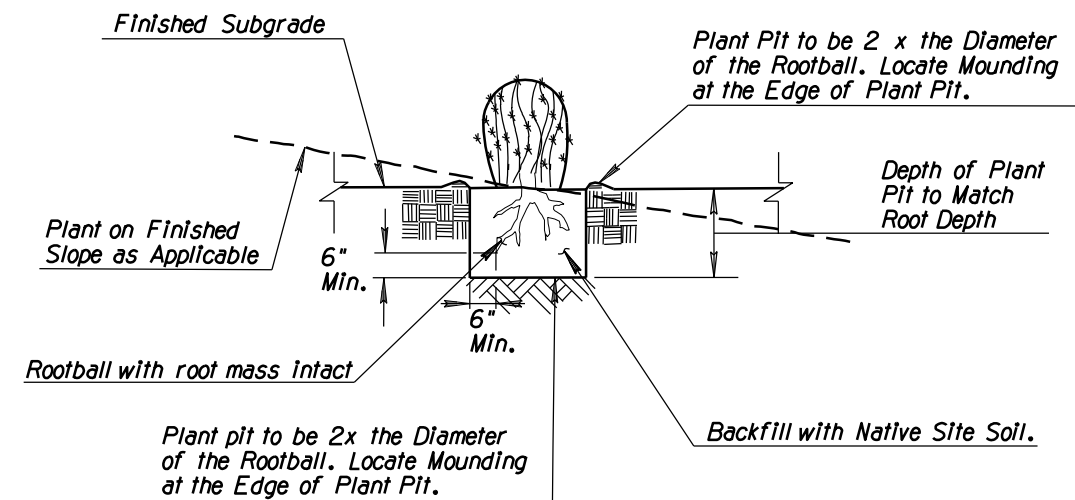
F.H.W.A. REGION	STATE	PROJECT NO.	SHEET NO.	TOTAL SHEETS	RECORD DRAWING
9	ARIZ.	017 MA(229)			




DETAIL L3 NTS
OCOTILLO PLANTING ON LEVEL GROUND

GENERAL NOTES:

1. Root Prune All Shredded or Damaged Roots. Ensure All Wounds to the Root System are Clean Cut Before Planting.
2. Apply Dusting Sulfer to All Roots Below Grade.
3. Bare Roots Shall Not be Out of the Ground for More Than Five Days Before Replanting.
4. Roughen Bottom And Sides of Plant Pit Prior to Setting.
5. Rootball to be placed on undisturbed soil. Top of Rootball to be at finished grade.
6. Basins shall be omitted when plants are to be planted on slopes exceeding 6:1.
7. Water Thoroughly at the Time of Transplanting to Remove Air Pockets and Assure Proper Compaction.
8. Native Backfill Shall be Free of Rocks and Debris 6" or Larger.



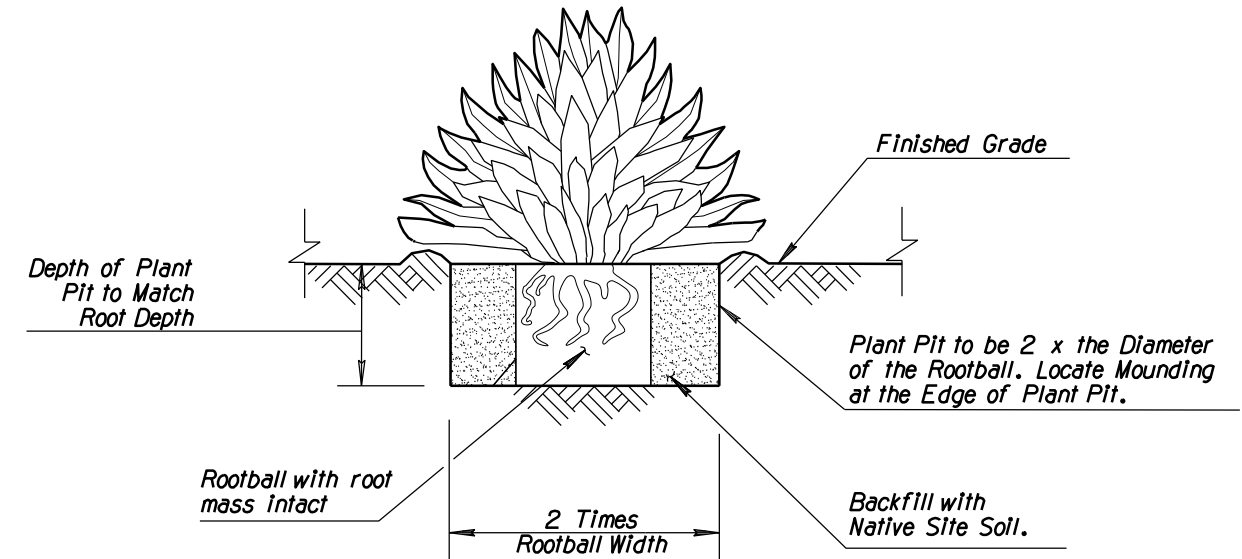
DETAIL L4 NTS
BARREL CACTUS PLANTING DETAIL

DESIGN	NAME	DATE	ARIZONA DEPARTMENT OF TRANSPORTATION INFRASTRUCTURE DELIVERY AND OPERATIONS DIVISION ROADWAY DESIGN SECTION	PRELIMINARY
XXX		6/21	LANDSCAPE DETAILS	Review NOT FOR CONSTRUCTION OR RECORDING
STAFF		6/21		
ECC		6/21		
corral design group, inc. 			I-17 ANTHEM WAY TRAFFIC INTERCHANGE TO JCT. 69 (CORDES JUNCTION) PROJECT	DWG NO. LS-01.03
ROUTE	LOCATION			
I-17			TRACS NO. H6800 01D	017 MA(229)
				OF

F.H.W.A. REGION	STATE	PROJECT NO.	SHEET NO.	TOTAL SHEETS	RECORD DRAWING
9	ARIZ.	017 MA(229)			

SAGUARO, AGAVE, AND YUCCA PLANTING NOTES:

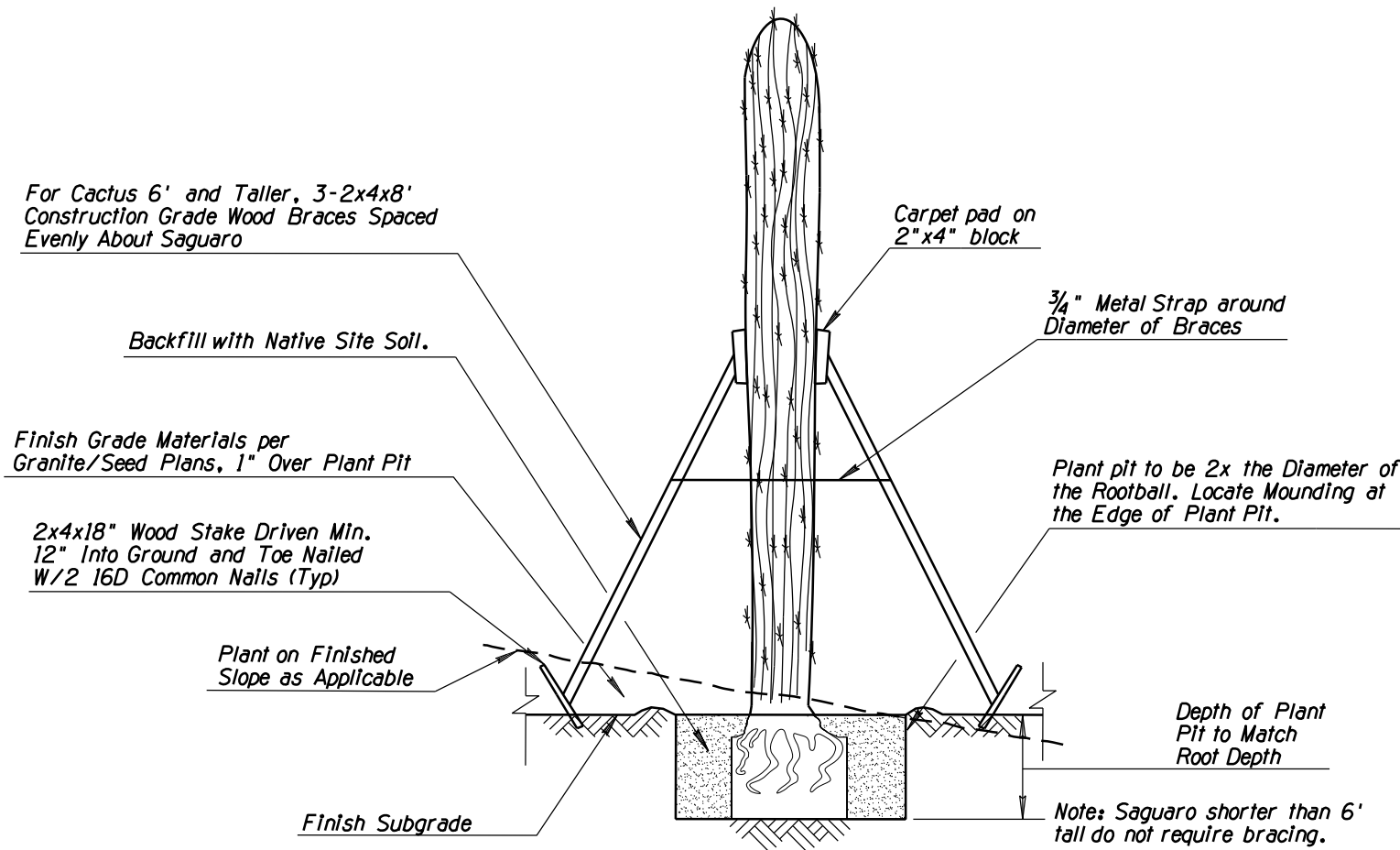
1. Treat all surface wounds with bactericide.
2. Plant pit shall be 6" min. wider than the extent of the several lateral roots.
3. Cut through taproot to provide a flat base with dia. sufficient to support the weight of the unsupported Saguaro.
4. Backfill pit with 6" layers of rodded, compacted, moist, site soil.
5. Planting depth shall be the depth at which plant was grown or deeper but the tapering of the root collar must be visible.
6. Ensure surface water cannot stand against the root collar.
7. All Saguaro placement shall match original orientation with south side facing south.
8. Saguaro are specified by height. A variety of heights may be acceptable provided the average is not less than that specified.
9. Do not water for three weeks following planting.
10. Native Backfill Shall be Free of Rocks and Debris 6" or Larger.



DETAIL L6 NTS
AGAVE/YUCCA PLANTING DETAIL

GENERAL NOTES:

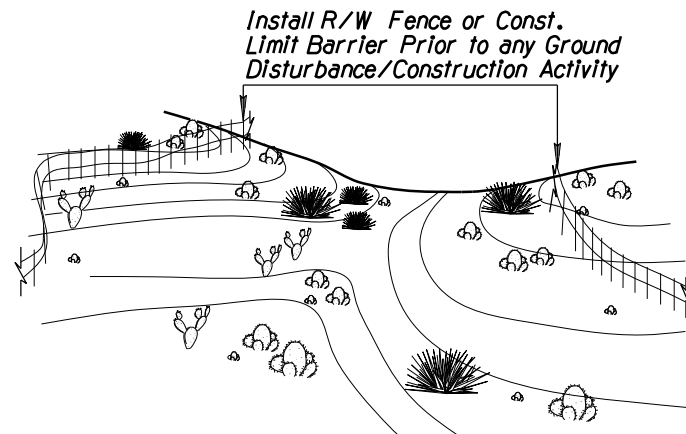
1. Root Prune All Shredded or Damaged Roots. Ensure All Wounds to the Root System are Clean Cut Before Planting.
2. Apply Dusting Sulfer to All Roots Below Grade.
3. Bare Roots Shall Not be Out of the Ground for More Than Five Days Before Replanting.
4. Roughen Bottom And Sides of Plant Pit Prior to Setting.
5. Rootball to be placed on undisturbed soil. Top of Rootball to be at finished grade.
6. Basins shall be Omitted when Plants are to be Planted on Slopes Exceeding 6:1.
7. Native Backfill Shall be Free of Rocks and Debris 6" or Larger.



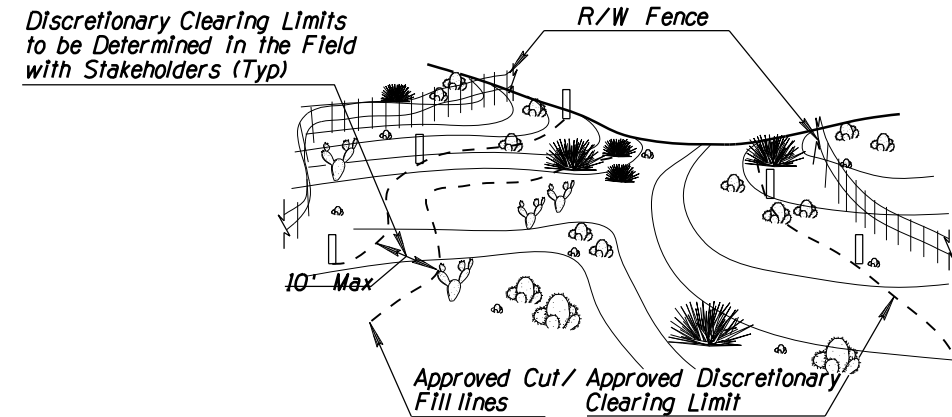
DETAIL L5 NTS
SAGUARO PLANTING

DESIGN	XXX	DATE	6/21	ARIZONA DEPARTMENT OF TRANSPORTATION INFRASTRUCTURE DELIVERY AND OPERATIONS DIVISION ROADWAY DESIGN SECTION	PRELIMINARY Review NOT FOR CONSTRUCTION OR RECORDING DWG NO. LS-01.04
DRAWN	STAFF	DATE	6/21		
CHECKED	ECC	DATE	6/21		
corral design group, inc.				LANDSCAPE DETAILS	
ROUTE	1-17	LOCATION	I-17 ANTHEM WAY TRAFFIC INTERCHANGE TO JCT. 69 (CORDES JUNCTION) PROJECT		
TRACS NO. H6800 01D			017 MA(229)		OF

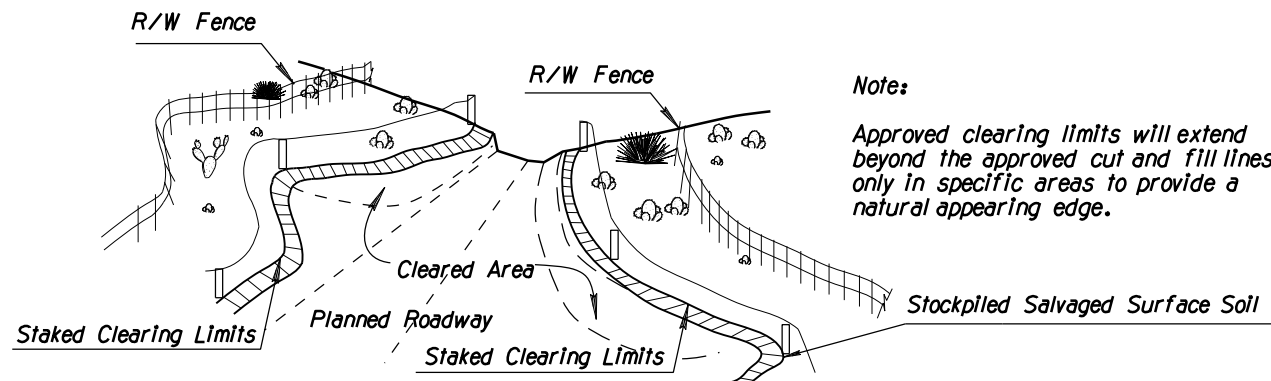
F.H.W.A. REGION	STATE	PROJECT NO.	SHEET NO.	TOTAL SHEETS	RECORD DRAWING
9	ARIZ.	017 MA(229)			



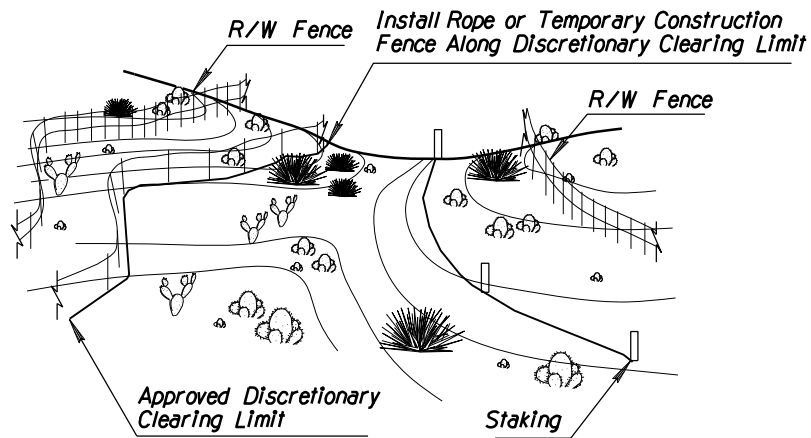
EXISTING TOPOGRAPHY / VEGETATION - STEP 1



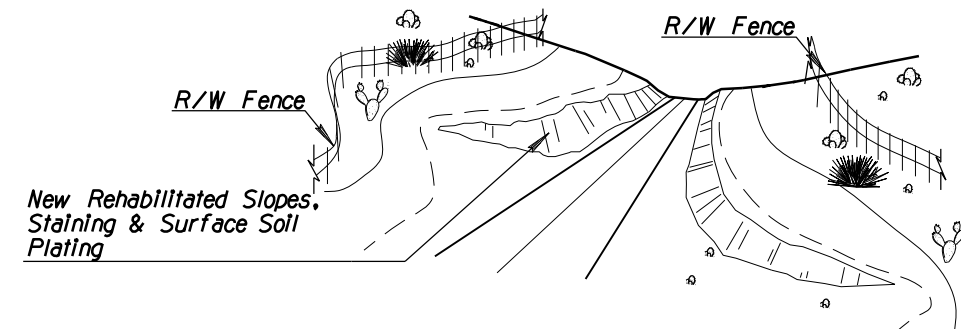
INITIAL DISCRETIONARY CLEARING - STEP 2 APPROVAL



MASS CLEARING BETWEEN APPROVED CLEARING LIMITS - STEP 4



INSTALLATION OF TEMPORARY CLEARING LIMIT DEMARCATION - STEP 3



FINAL DISCRETIONARY CLEARING / REVEGETATION - STEP 5

DETAIL L7

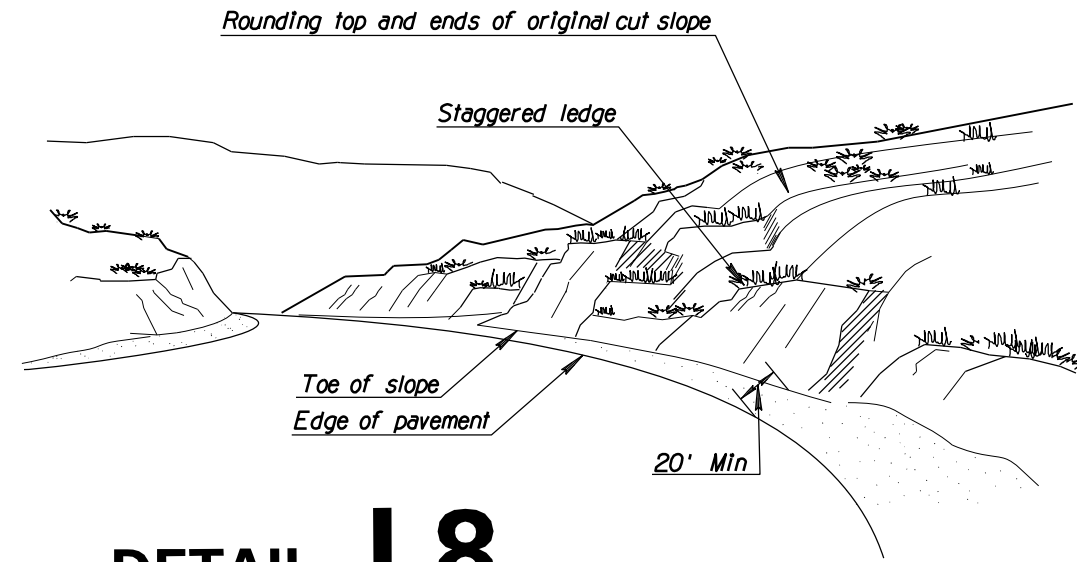
NTS

CLEARING LIMIT DETAIL

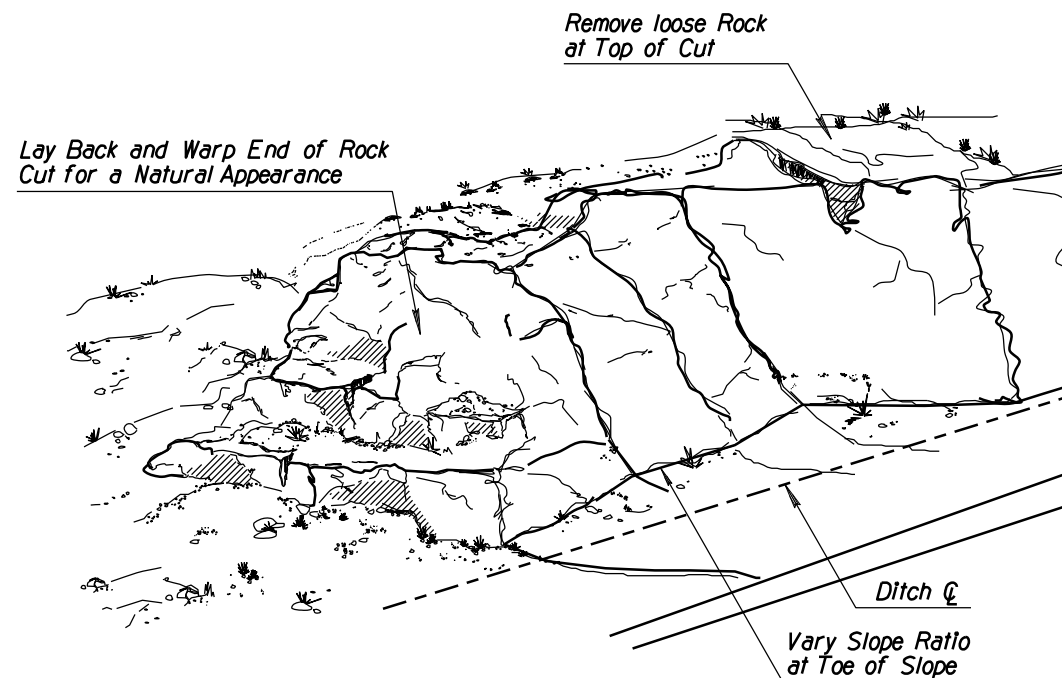
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DRAWN	STAFF	DATE	3/21		
CHECKED	ECC	DATE	3/21		
corral design group, inc.				LANDSCAPE DETAILS	
ROUTE	1-17	LOCATION	1-17 ANTHEM WAY TRAFFIC INTERCHANGE TO JCT. 69 (CORDES JUNCTION) PROJECT		
TRACS NO. H6800 01D			017 MA(229)		OF

SURVEY NO. FINISHED PLANS. DATE. REVISIONS. LOCATION. DATE. FINISHED PLANS. SURVEY NO.

F.H.W.A. REGION	STATE	PROJECT NO.	SHEET NO.	TOTAL SHEETS	RECORD DRAWING
9	ARIZ.	017 MA(229)			



DETAIL L8_{NTS}
CONCEPT SKETCH OF STAGGERED LEDGES



DETAIL L10_{NTS}
CONCEPT OF SLOPE WARPING OF FRACTURED ROCK SOIL-END OF CUT/FILL TRANSITIONS

Rounding At Top Of Slope Rounding Shall Occur In Both Fractured Rock And Soil Conditions - See Slope Rounding Detail L2-4, This Sheet

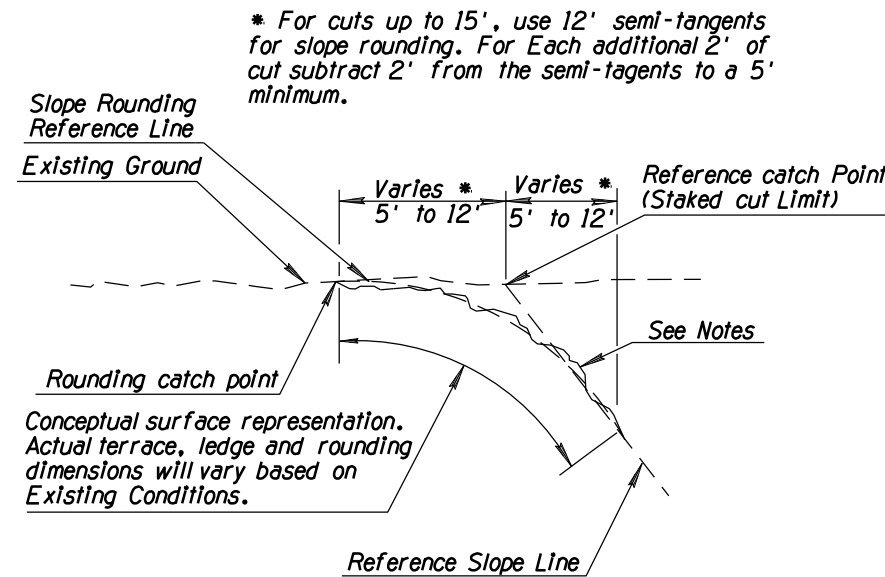
Return In-Situ Surface Soil to top of Rounded and Warped Cuts and rake and blend into existing soils

Ends Of Slope Laid Back

NOTE:

Except in unfractured rock, or as directed by the GEC, the intersection of roadway cut slopes with the ground surfaces shall be rounded or laid back.

DETAIL L9_{NTS}
LAID BACK ENDS CONCEPT

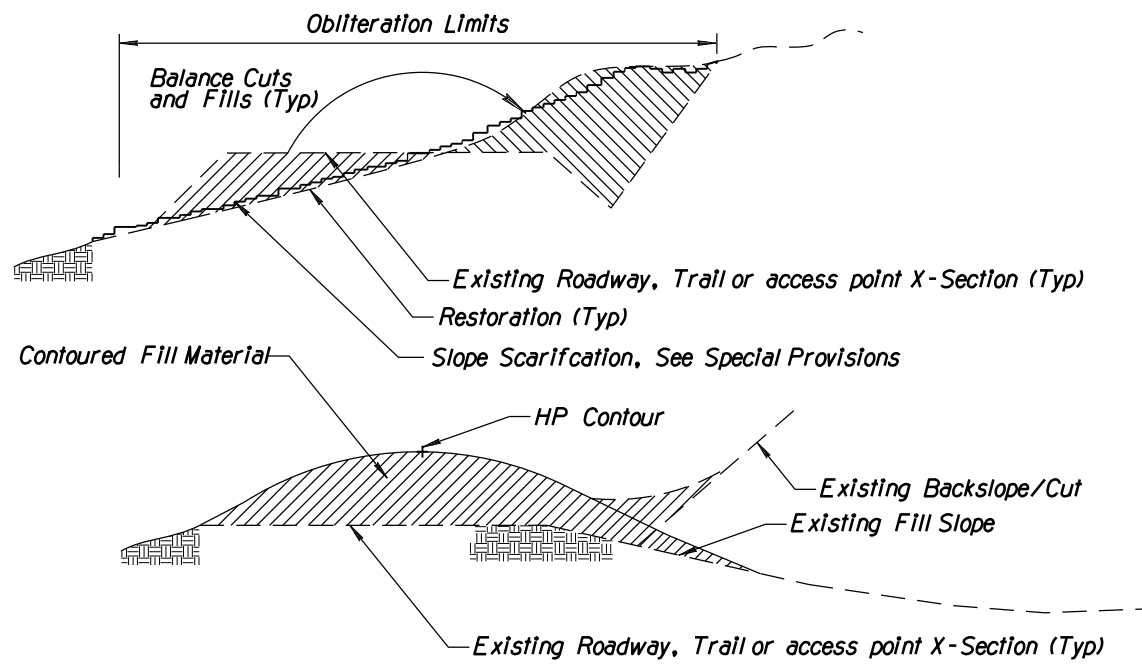


DETAIL L11_{NTS}
SLOPE ROUNDING

1. Rounding shall occur in all cuts, both soil and rock conditions, except as superseded by Contour Grading Plans.
2. Except as directed by the GEC, the intersection of roadway cut slopes with the existing ground surfaces shall be rounded or laid back.
3. The final location of the slope rounding catch point will be determined in the field during the staking of the clearing limits.
4. The rounded slope shall be irregular and uneven as dictated by natural fracturing, weathering and soil development to create a broken surface appearance.
5. Rounded areas shall be scaled to remove detached rock separated by open fractures.
6. Up to 30% of the rounded surface may project from the rounding profile if the areas are consistent with aesthetic objectives and are stable as determined by the GEC.
7. Rounding in rock cuts shall contain terraces, ledges, humps, rounds, wedges, dips, etc. as dictated by natural fracturing, weathering, and soil development to create a broken surface appearance.
8. Staggered ledges to be located on slopes where loose or dislodged rock material does not provide potential for launching of rock into roadway, as directed by the GEC.
9. Excessive smoothing of finish grade is not required on rock cuts. Slopes can maintain natural appearing staggered ledges and fracturing.
10. Slope Rounding is not required on unfractured 1:1 or steeper rock cuts and where limited R/W exists at top of slope cuts.

DESIGN	XXX	DATE	3/21	ARIZONA DEPARTMENT OF TRANSPORTATION INFRASTRUCTURE DELIVERY AND OPERATIONS DIVISION ROADWAY DESIGN SECTION	PRELIMINARY Review NOT FOR CONSTRUCTION OR RECORDING DWG NO. LS-01.06
DRAWN	STAFF	DATE	3/21		
CHECKED	ECC	DATE	3/21		
corral design group, inc.				LANDSCAPE DETAILS	
ROUTE	1-17	LOCATION	I-17 ANTHEM WAY TRAFFIC INTERCHANGE TO JCT. 69 (CORDES JUNCTION) PROJECT		
TRACS NO. H6800 01D			017 MA(229)		

F.H.W.A. REGION	STATE	PROJECT NO.	SHEET NO.	TOTAL SHEETS	RECORD DRAWING
9	ARIZ.	017 MA(229)			



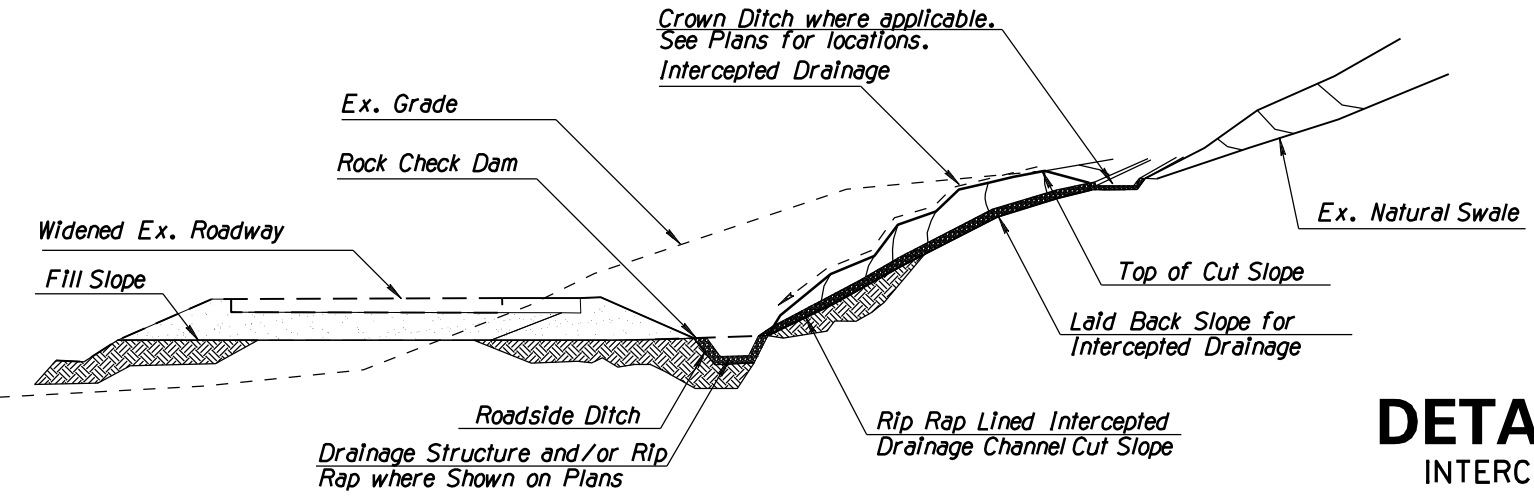
TYPICAL OBLITERATION SECTIONS

NOTES:

1. Contractor has the option to stockpile salvage surface soils at top of cut or bottom of fill or stockpile offsite. If salvage surface soil remains onsite the stockpile must remain within the determined disturbance areas as shown on the plans throughout the construction phase.
2. Obliteration limits may vary outside existing disturbed areas to create more natural appearing contours.
3. Remove pavement and existing aggregate base as required. Fill remaining void with acceptable native material.
4. Grade obliteration limits with undulating contours for a more natural appearance.
5. Scarify to a depth of 12".
6. Apply salvaged surface soil as specified in special provisions.

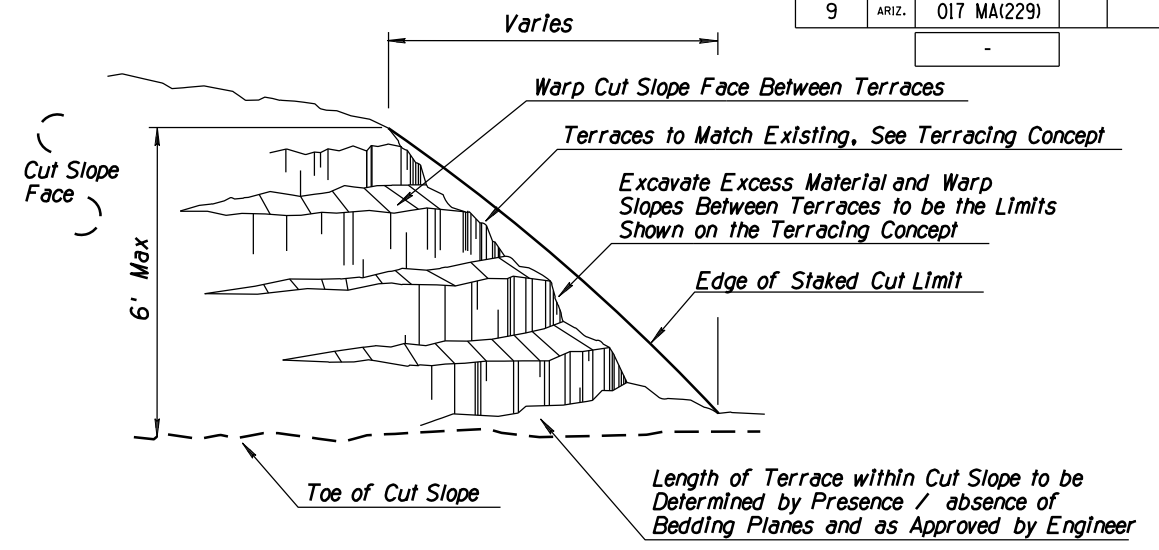
DETAIL L12

ROADWAY OBLITERATION (CONCEPTS)



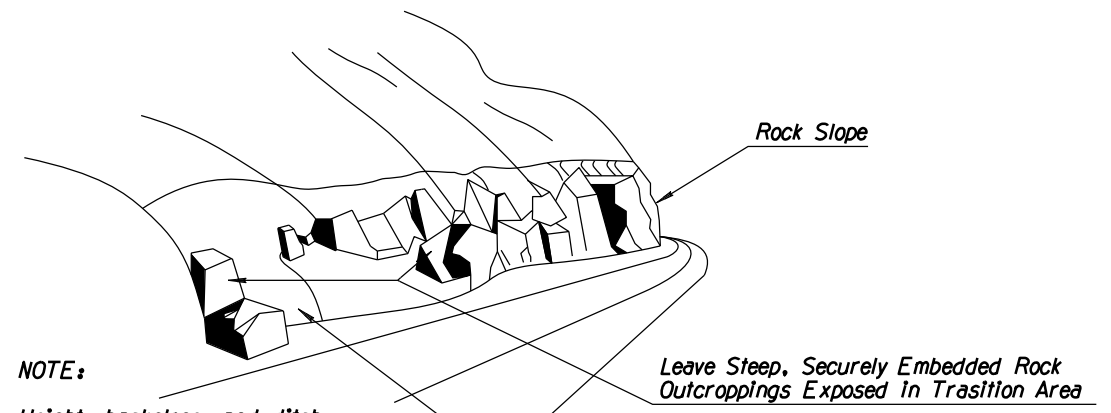
DETAIL L15

INTERCEPTED DRAINAGE



DETAIL L13

TERRACING



NOTE:

Height, backslope, and ditch transition dimensions vary. Step toe of slope back to expose natural jointing patterns. Refer to slope mitigation summary.

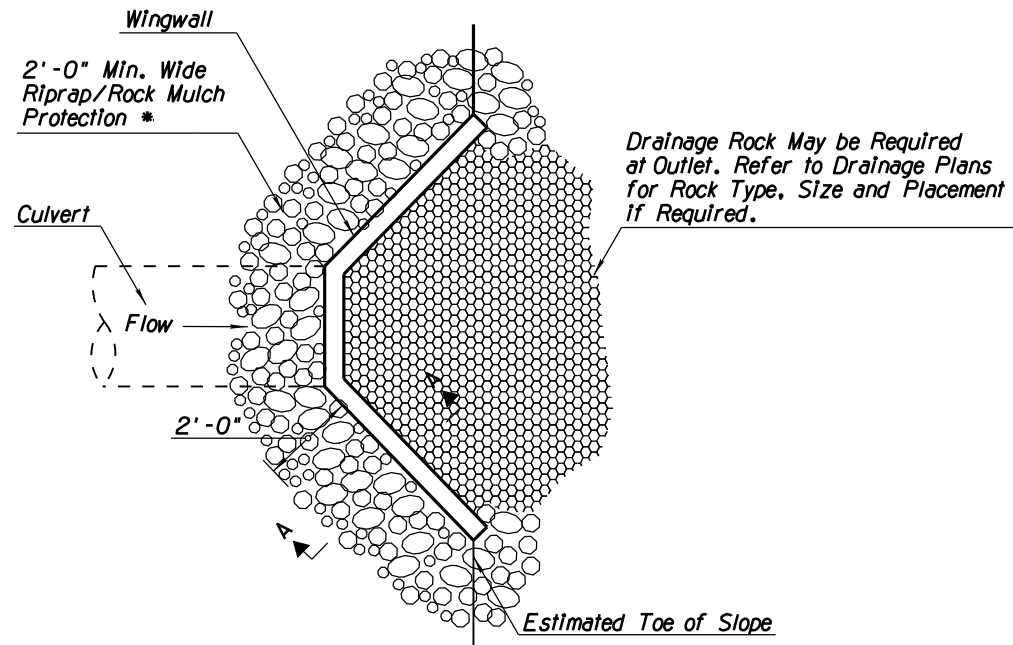
Do Not Oversteepen Soil or Conglomerate to Meet Rock Slope

DETAIL L14

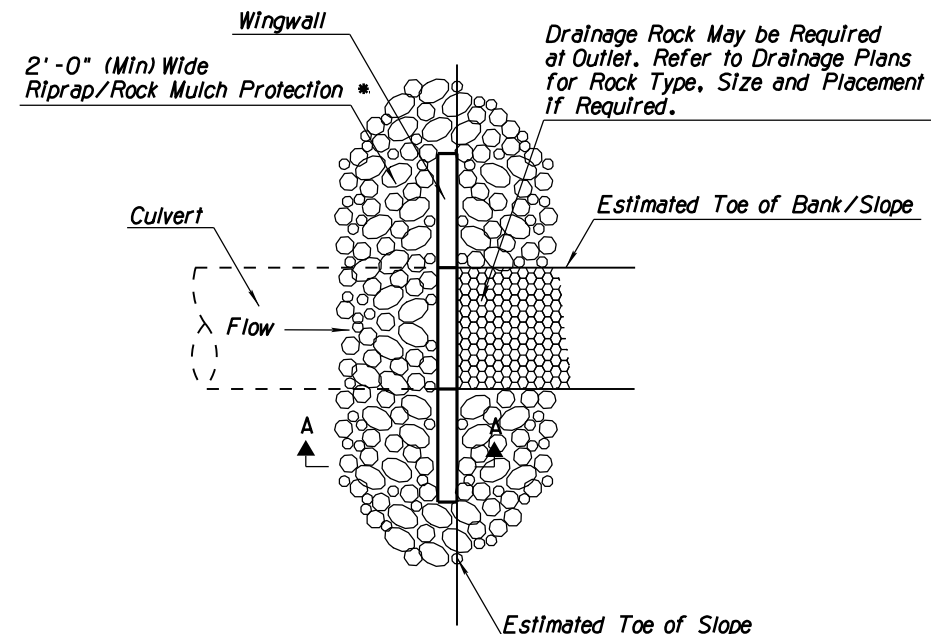
CONGLOMERATE CUT / ROCK TRANSITION

DESIGN	XXX	DATE	3/21	ARIZONA DEPARTMENT OF TRANSPORTATION INFRASTRUCTURE DELIVERY AND OPERATIONS DIVISION ROADWAY DESIGN SECTION	PRELIMINARY Review NOT FOR CONSTRUCTION OR RECORDING DWG NO. LS-01.07
DRAWN	STAFF	DATE	3/21		
CHECKED	ECC	DATE	3/21		
corral design group, inc.				LANDSCAPE DETAILS	
ROUTE	1-17	LOCATION	1-17 ANTHEM WAY TRAFFIC INTERCHANGE TO JCT. 69 (CORDES JUNCTION) PROJECT		
TRACS NO. H6800 01D			017 MA(229)		

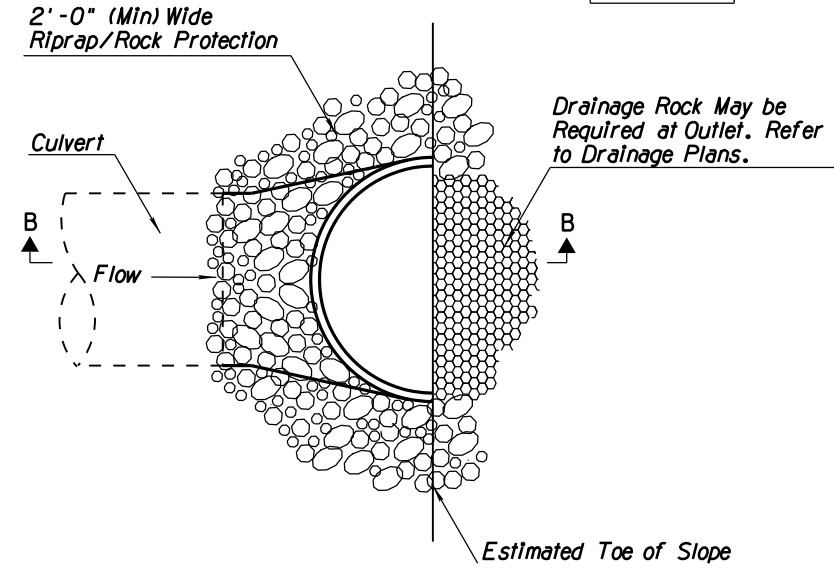
F.H.W.A. REGION	STATE	PROJECT NO.	SHEET NO.	TOTAL SHEETS	RECORD DRAWING
9	ARIZ.	017 MA(229)			



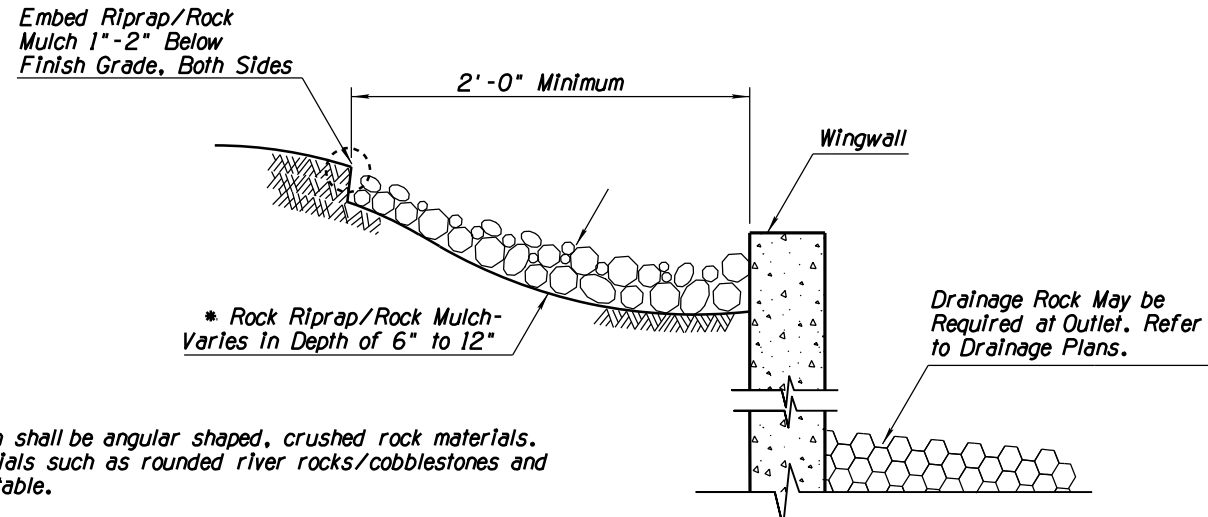
ANGLED HEADWALL
PLAN VIEW (NTS)



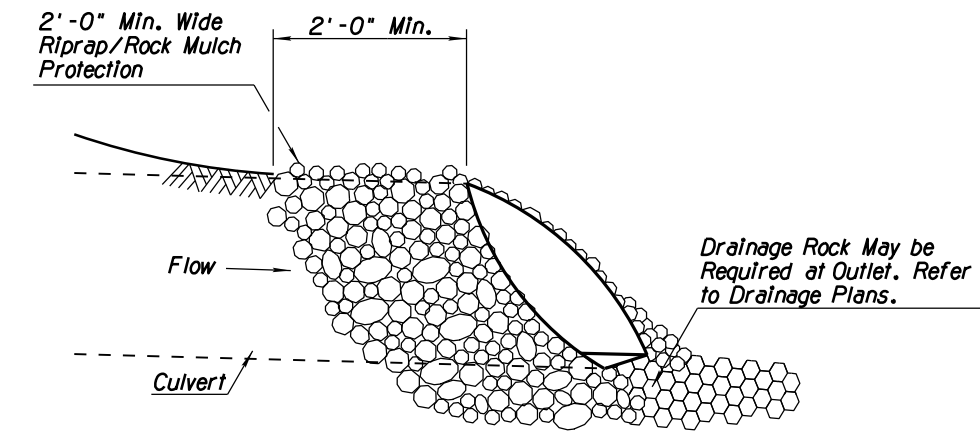
FLUSH HEADWALL
PLAN VIEW (NTS)



FLARED END
PLAN VIEW (NTS)



WINGWALL
SECTION A-A (NTS)



FLARED END
SECTION B-B (NTS)

NOTES:

1. Rock Riprap/Rock Mulch shall be angular shaped, crushed rock materials. Natural river-run materials such as rounded river rocks/cobblestones and pebbles are NOT acceptable.
2. Rock Riprap/Rock Mulch within the traffic Clear Zone shall conform to the requirements of Section 810-2.03 Sieve Size Gradation C, and Section 913 of the ADOT Standard Specifications.
3. Embed rock within traffic recovery area/clear zone into the finished grade so that any portion of the rock above the grade will be less than 4" in height.
4. The installation and maintenance of Rock Protection shall not negatively impact traffic safety, nor the designed function of roadway or bridge drainage facilities. Rock Protection shall be installed and maintained to carry the stormwater of at least 2-year, 24-hour events.
5. Make field adjustments and corrections of Rock Protection immediately if it is causing flooding, erosion, and/or affecting roadway safety.
6. Make field adjustments and corrections to ensure NO sensitive biological resources (native species / habitats) will be adversely impacted.

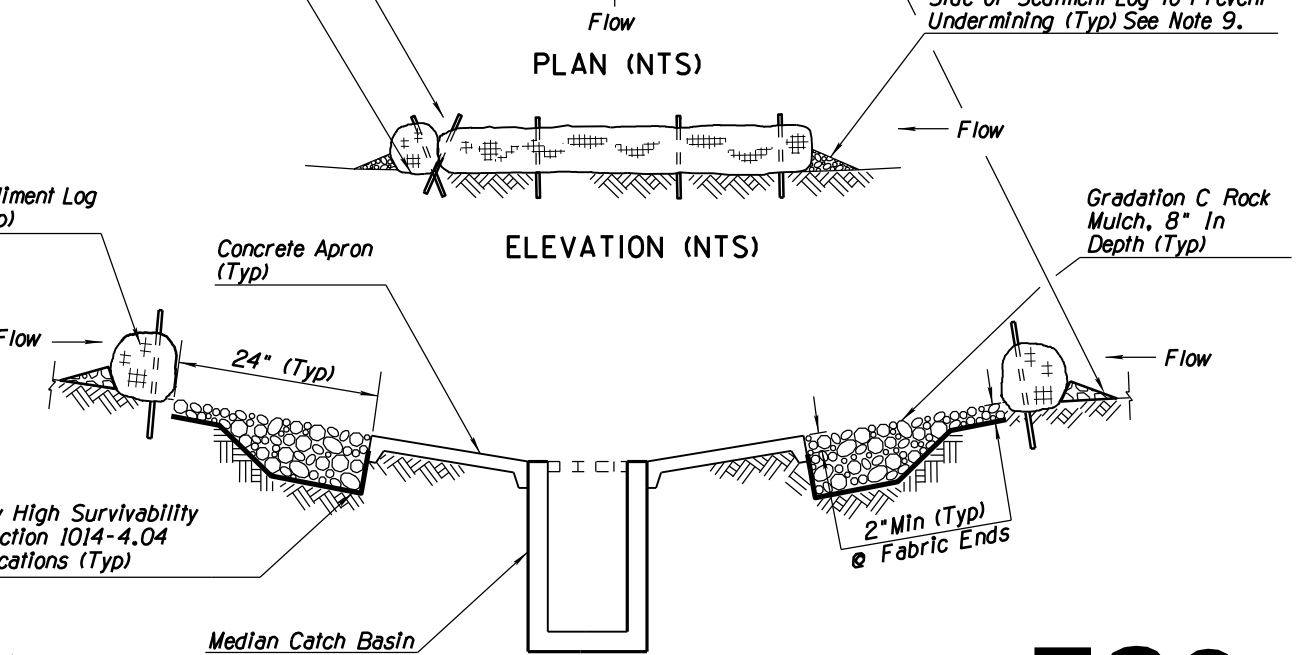
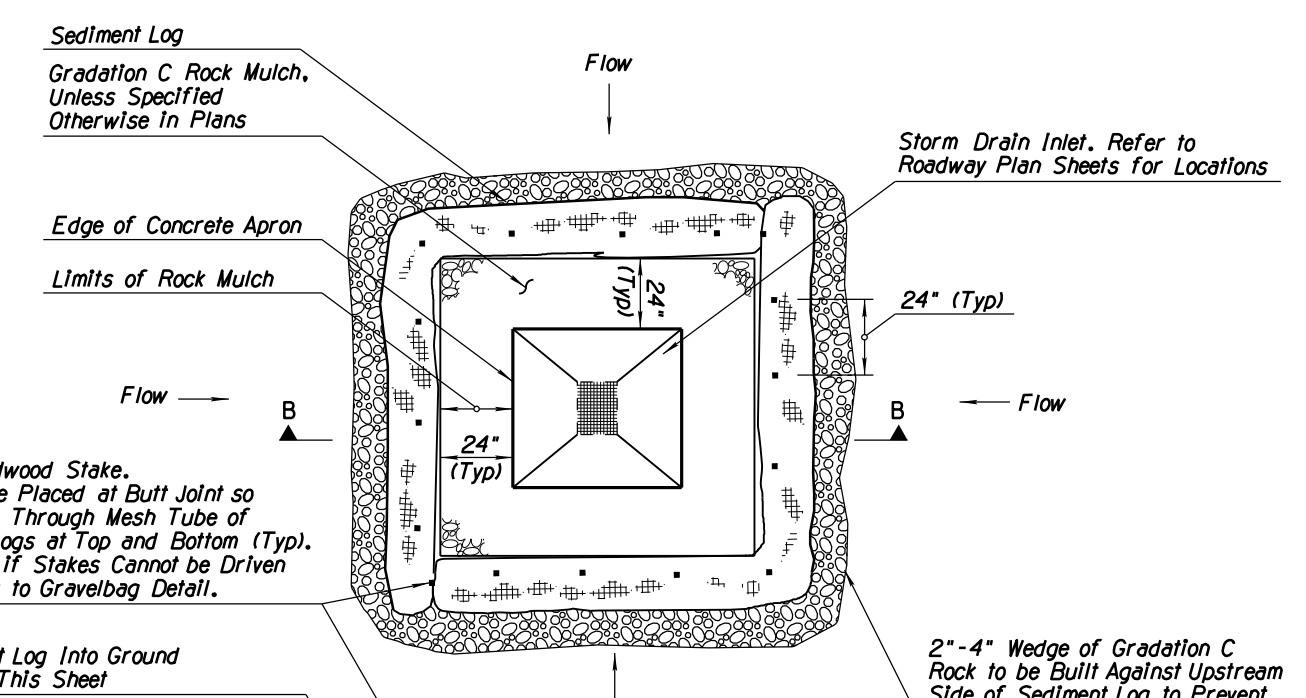
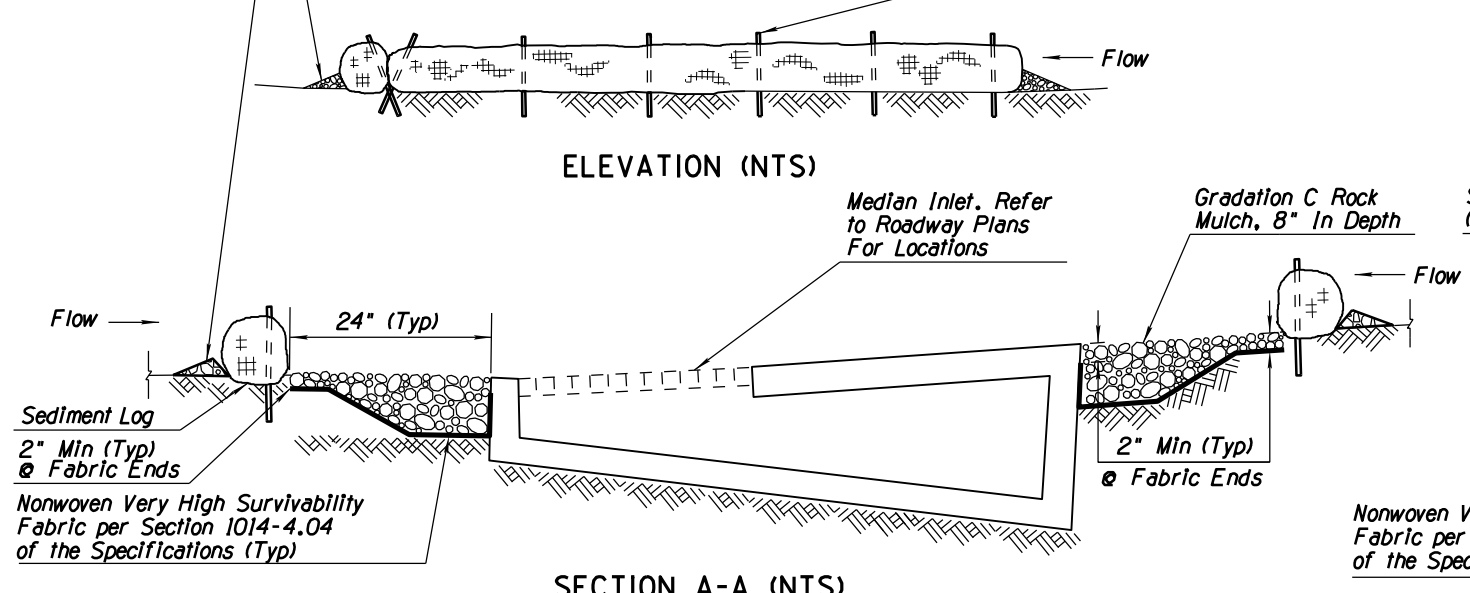
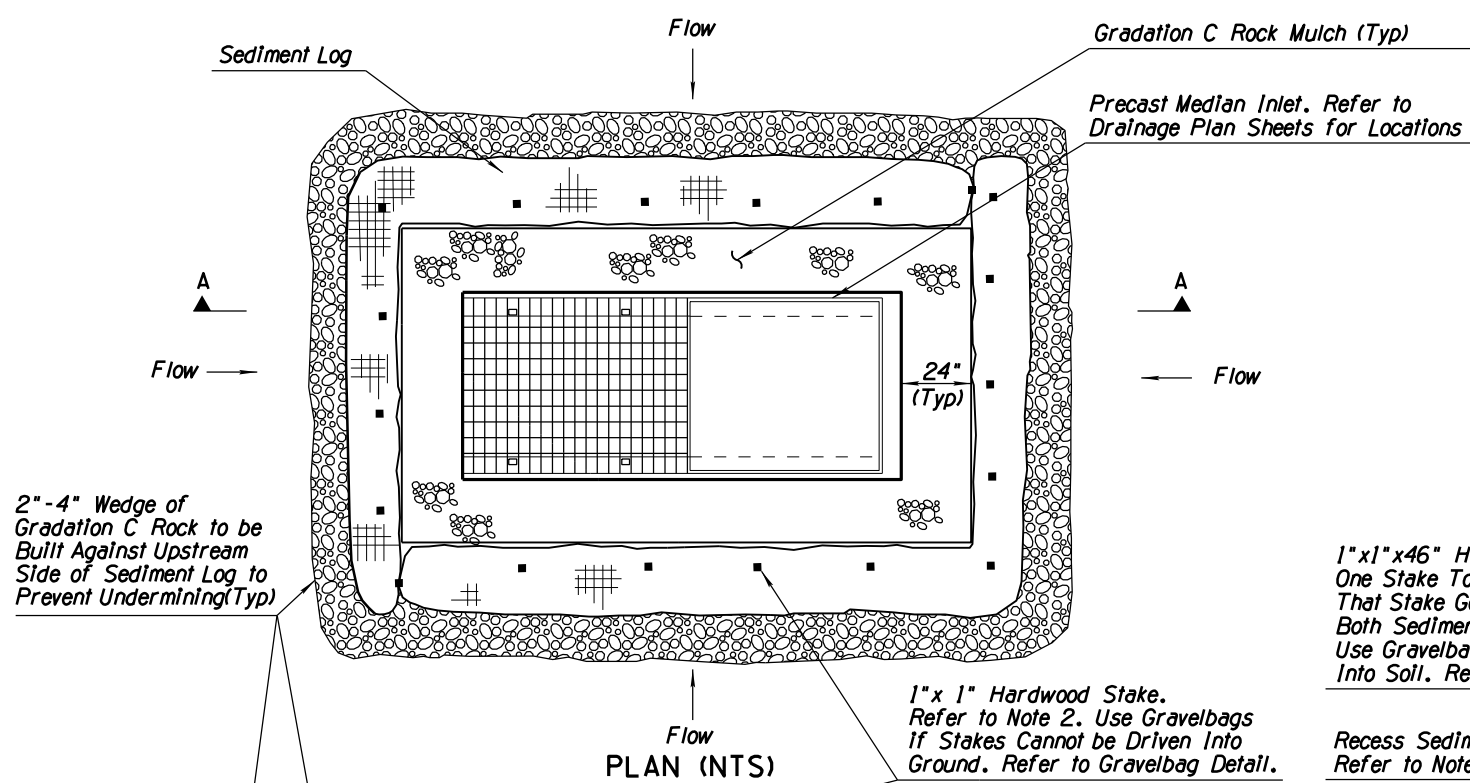
* Rock protection shall be installed behind applicable box culvert headwall/wingwall where called out in the plans and approved by the Engineer.

DETAIL ES1

ROCK PROTECTION FOR INLETS,
OUTLETS AND HEADWALL TRANSITION

DESIGN	XXX	DATE	5/21	ARIZONA DEPARTMENT OF TRANSPORTATION INFRASTRUCTURE DELIVERY AND OPERATIONS DIVISION ROADWAY DESIGN SECTION	PRELIMINARY
DRAWN	STAFF	DATE	5/21		
CHECKED	ECC	DATE	5/21		
corral design group, inc.				AZPDES SWPPP INDEX SHEET	Review NOT FOR CONSTRUCTION OR RECORDING
ROUTE	1-17	LOCATION	I-17 ANTHEM WAY TRAFFIC INTERCHANGE TO JCT. 69 (CORDES JUNCTION) PROJECT		DWG NO. EC-02.01
TRACS NO. H6800 01D			017 MA(229)		OF

F.H.W.A. REGION	STATE	PROJECT NO.	SHEET NO.	TOTAL SHEETS	RECORD DRAWING
9	ARIZ.	017 MA(229)			



NOTES:

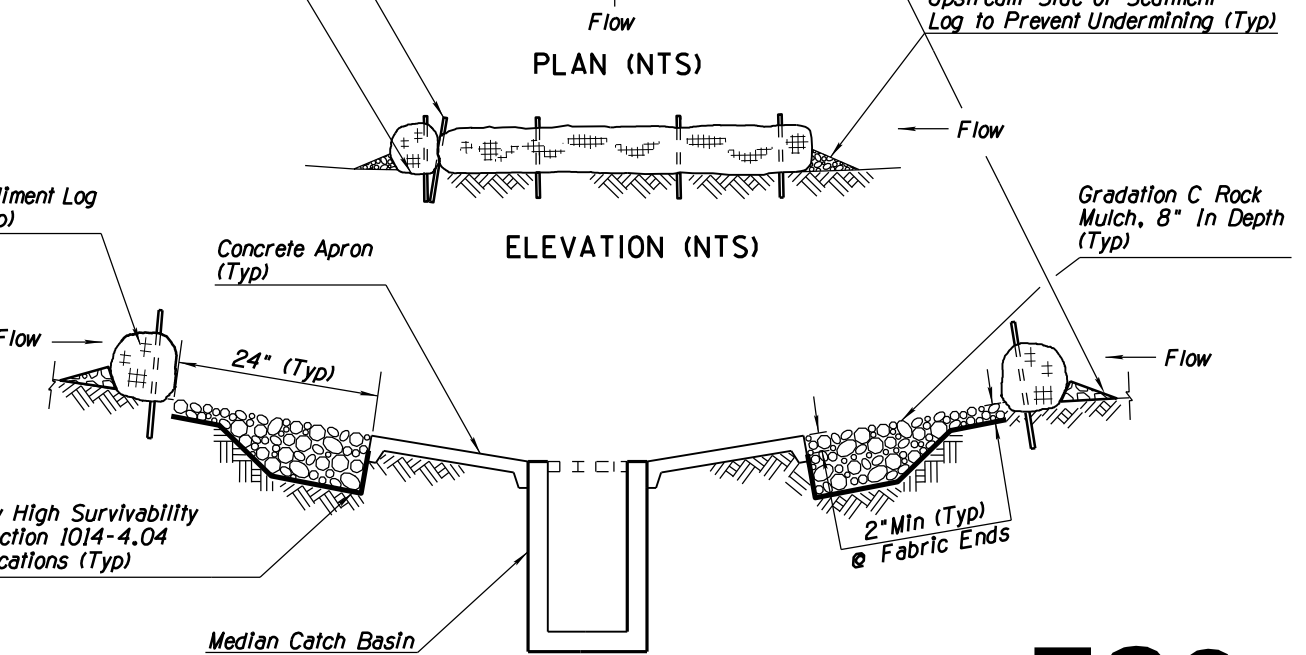
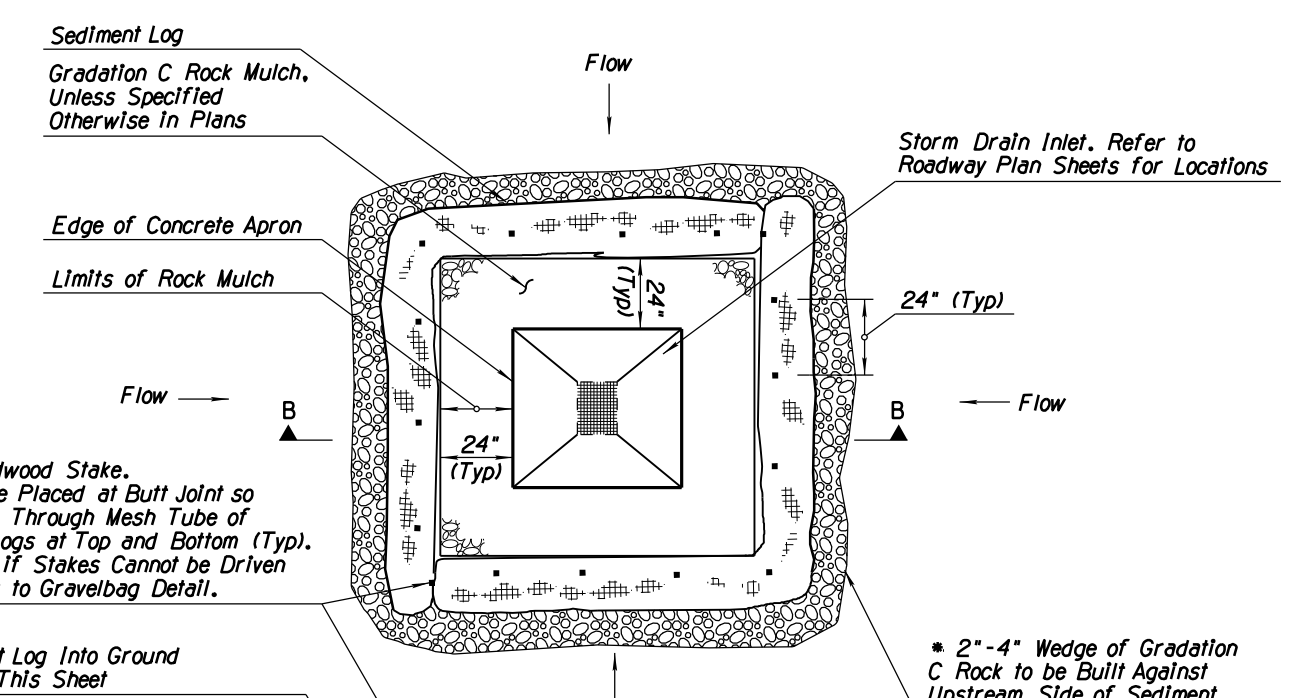
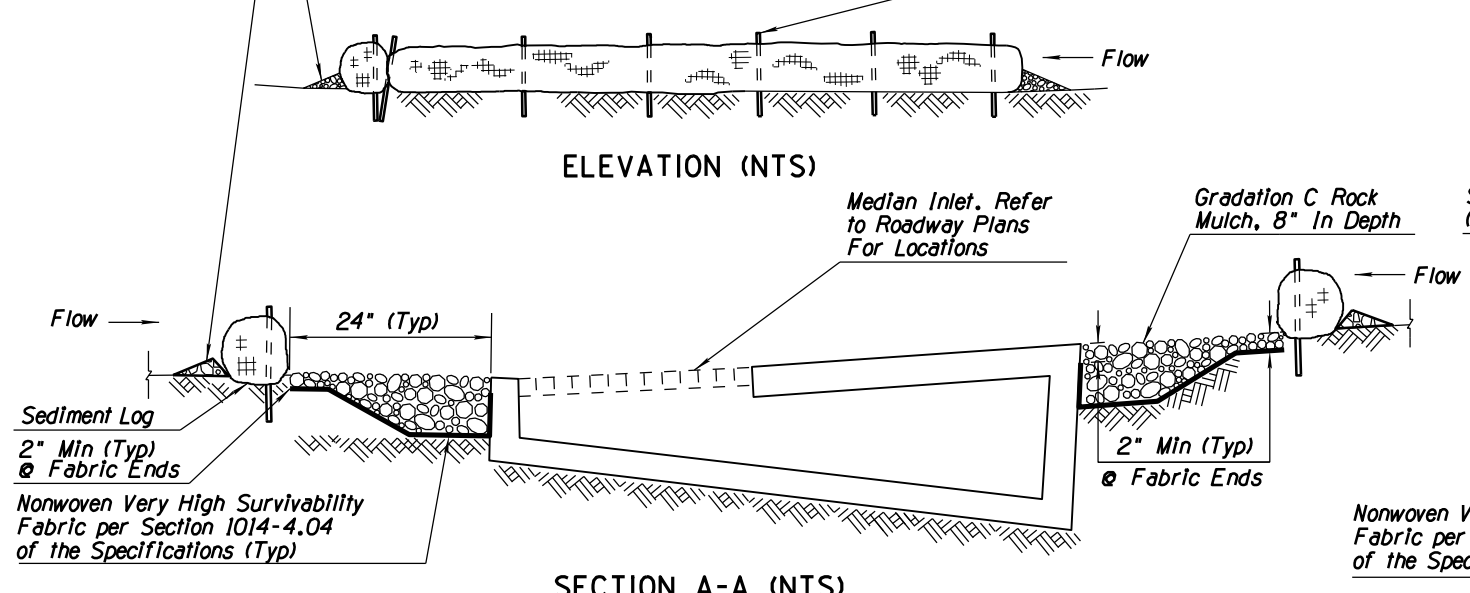
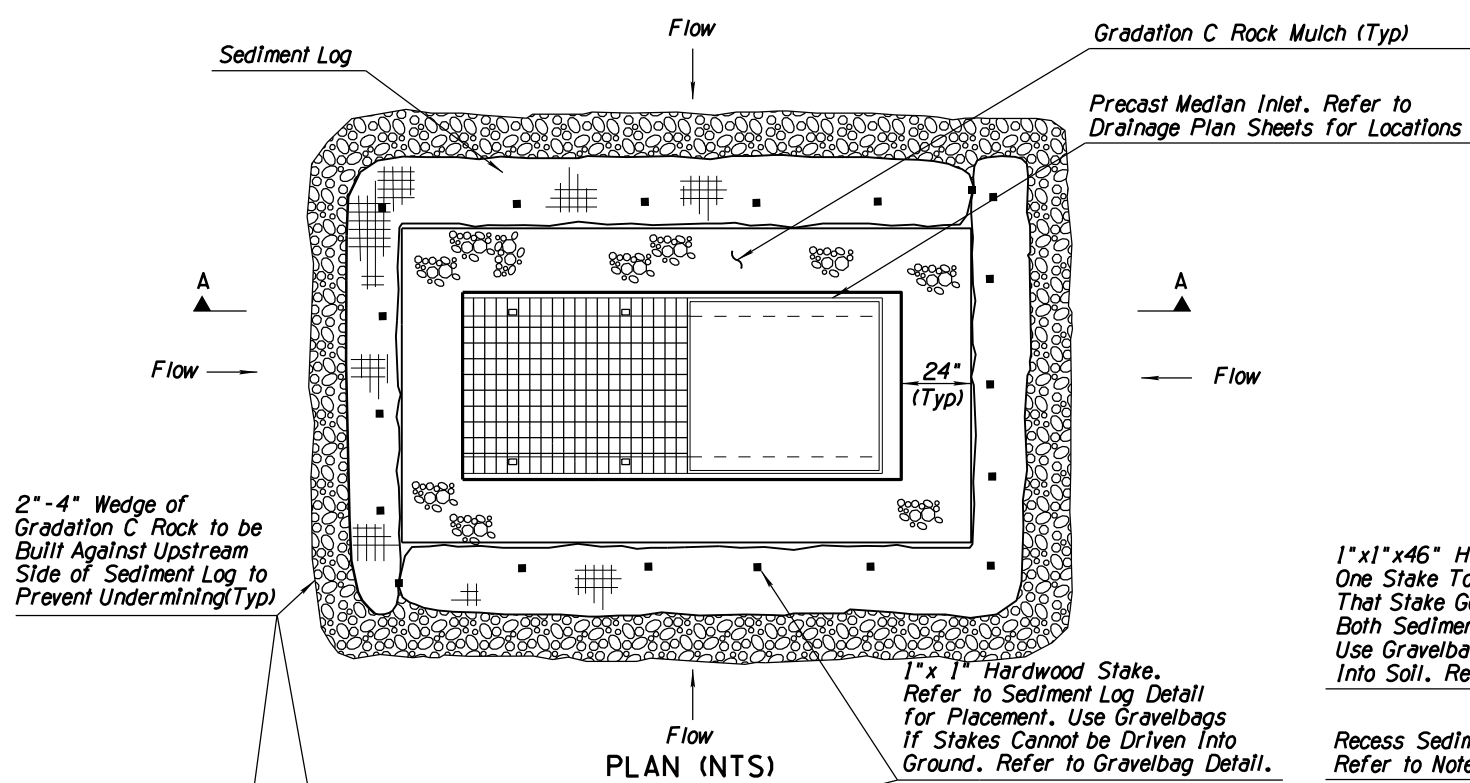
- Sediment logs shall be located as indicated on plans or as directed by the Engineer. They shall be selected, installed, and maintained per manufacturer's specifications and good engineering practices. Log shall be installed perpendicular to the flow of water. Continuous contact between the bottom of the log and the ground is mandatory.
- Stake log with 1"x 1"x 46" Min. hardwood stakes 24" on center. The stake shall be placed through the downstream side only. It is necessary for the stakes to grab one or two inches of netting. Do not drive stake through center of log. The stakes must be driven into the ground 24". Stakes at corners shall be placed in an "X" pattern.
- Make sure no gaps exist between subgrade and sediment log. Runoff must not pass under sediment log. May require subgrade preparation as directed by Engineer.
- Repair any rills or gullies promptly.
- Remove Sediment Log and stakes once construction activities are complete. Dispose of sediment logs and trapped sediment material and fill trench created by sediment log.
- Refer to Roadway and Drainage Plans and Details for Locations of Inlets and Catch Basins.
- Make field adjustments and corrections of Inlet Protection CM/BMP immediately if it is causing flooding, erosion, and/or affecting roadway safety.
- Make field adjustments and corrections to ensure NO sensitive biological resources (native species / habitats) will be adversely impacted.
- Construct Rock Wedge with angular-shaped Gradation C Rock Mulch as defined in Section 810-2.03 of the Specifications and project Special Provisions. Natural river-run materials such as rounded river rocks/cobblestones and pebbles are NOT acceptable.

DETAIL ES2

DRAIN INLET PROTECTION

DESIGN	XXX	DATE	5/21	ARIZONA DEPARTMENT OF TRANSPORTATION INFRASTRUCTURE DELIVERY AND OPERATIONS DIVISION ROADWAY DESIGN SECTION	PRELIMINARY
DRAWN	STAFF	DATE	5/21		
CHECKED	ECC	DATE	5/21		
corral design group, inc.				EROSION CONTROL SUMMARY	Review NOT FOR CONSTRUCTION OR RECORDING
ROUTE	1-17	LOCATION	1-17 ANTHEM WAY TRAFFIC INTERCHANGE TO JCT. 69 (CORDES JUNCTION) PROJECT	DWG NO.	
TRACS NO. H6800 OID			017 MA(229)		OF

F.H.W.A. REGION	STATE	PROJECT NO.	SHEET NO.	TOTAL SHEETS	RECORD DRAWING
9	ARIZ.	017 MA(229)			



NOTES:

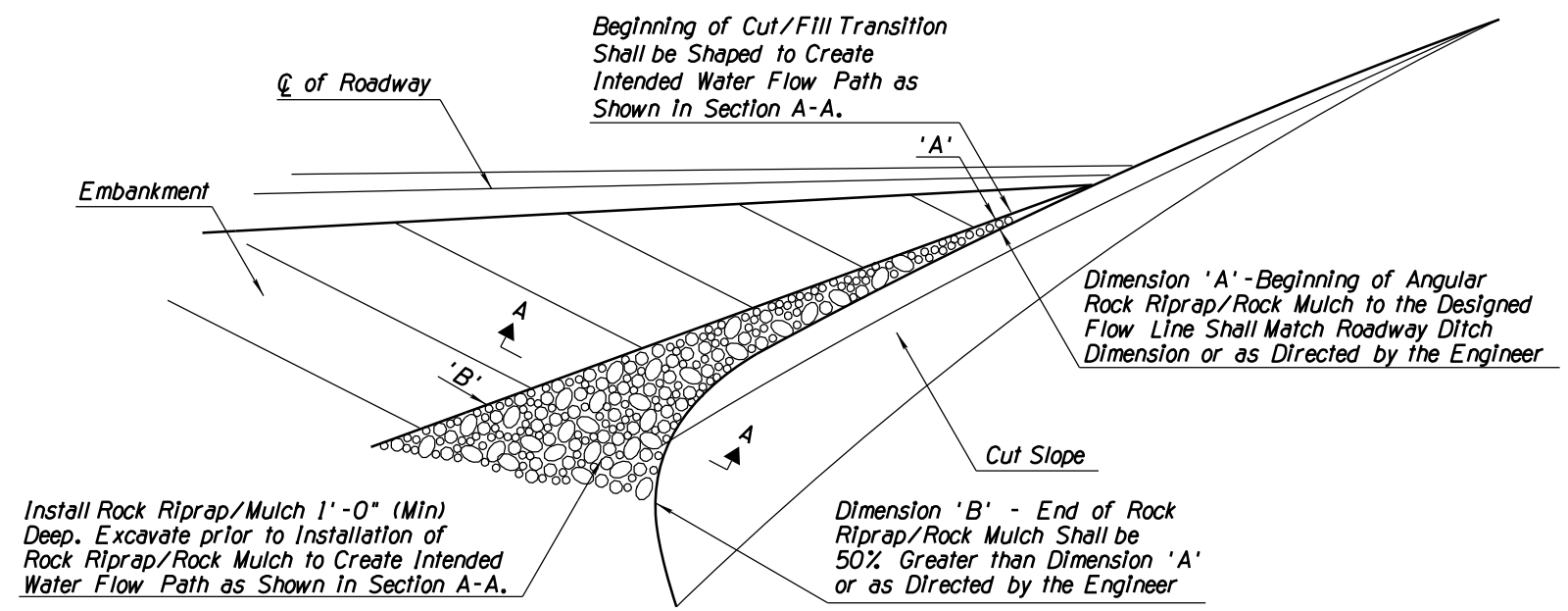
- Sediment logs shall be located as indicated on plans or as directed by the Engineer. They shall be selected, installed, and maintained per manufacturer's specifications and good engineering practices. Log shall be installed perpendicular to the flow of water. Continuous contact between the bottom of the log and the ground is mandatory.
- Stake log with 1"x1"x46" Min. hardwood stakes 24" on center. The stake shall be placed through the downstream side only. It is necessary for the stakes to grab one or two inches of netting. Do not drive stake through center of log. The stakes must be driven into the ground 24". Stakes at corners shall be placed in an "X" pattern.
- Make sure no gaps exist between subgrade and sediment log. Runoff must not pass under sediment log. May require subgrade preparation as directed by Engineer.
- Repair any rills or gullies promptly.
- Remove Sediment Log and stakes once construction activities are complete. Dispose of sediment logs and trapped sediment material and fill trench created by sediment log.
- Refer to Roadway and Drainage Plans and Details for Locations of Inlets and Catch Basins.
- Make field adjustments and corrections of Inlet Protection CM/BMP immediately if it is causing flooding, erosion, and/or affecting roadway safety.
- Make field adjustments and corrections to ensure NO sensitive biological resources (native species / habitats) will be adversely impacted.
- * Construct Rock Wedge with angular-shaped Gradation C Rock Mulch as defined in Section 810-2.03 of the Specifications and project special provisions. Natural river-run materials such as rounded river rocks/cobblestones and pebbles are NOT acceptable.

DETAIL ES2

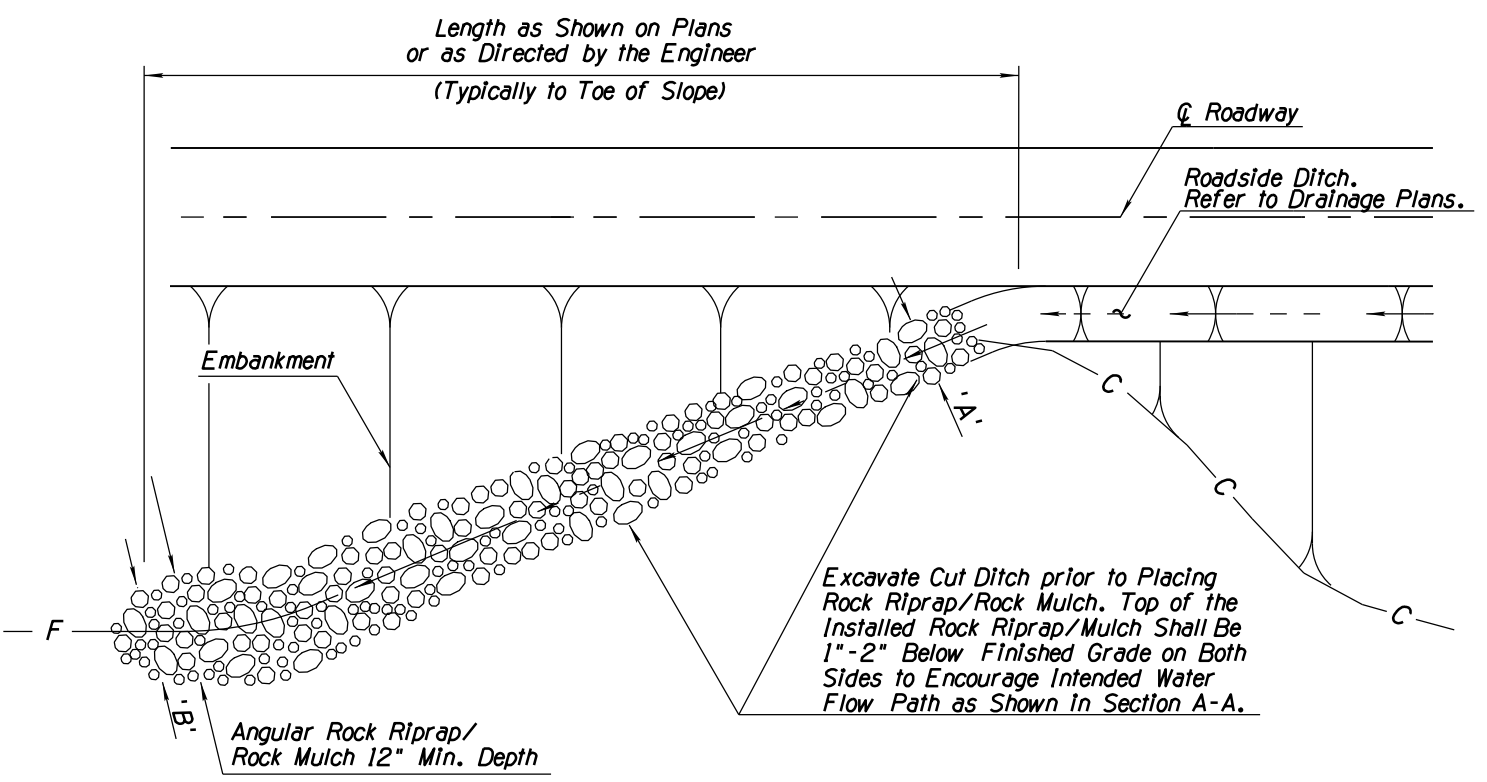
DRAIN INLET PROTECTION

DESIGN	XXX	DATE	3/21	ARIZONA DEPARTMENT OF TRANSPORTATION INFRASTRUCTURE DELIVERY AND OPERATIONS DIVISION ROADWAY DESIGN SECTION	PRELIMINARY
DRAWN	STAFF	DATE	3/21		
CHECKED	ECC	DATE	3/21		
corral design group, inc.				EROSION CONTROL SUMMARY	Review NOT FOR CONSTRUCTION OR RECORDING
ROUTE	1-17	LOCATION	I-17 ANTHEM WAY TRAFFIC INTERCHANGE TO JCT. 69 (CORDES JUNCTION) PROJECT		DWG NO. EC-02.02
TRACS NO. H6800 OID			017 MA(229)		OF

F.H.W.A. REGION	STATE	PROJECT NO.	SHEET NO.	TOTAL SHEETS	RECORD DRAWING
9	ARIZ.	017 MA(229)			

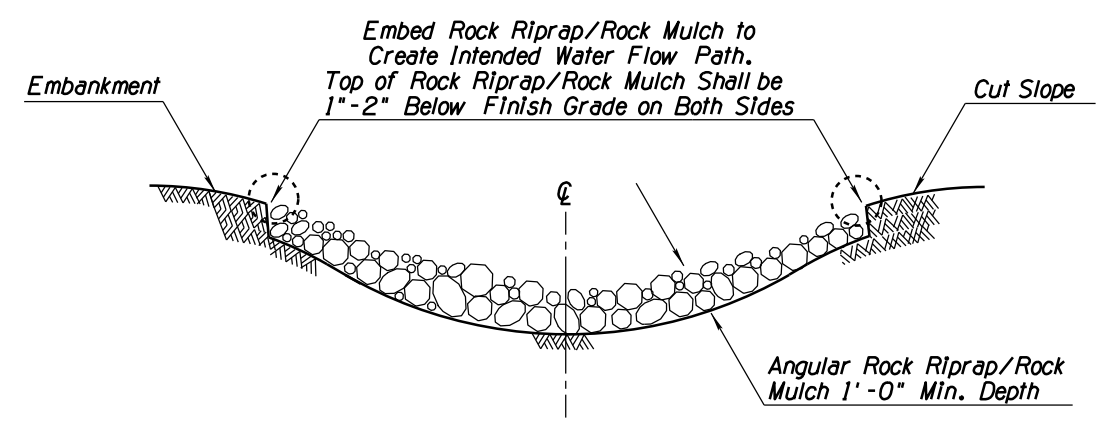


ROCK RIPRAP/ROCK MULCH FLOW PATH PERSPECTIVE (NTS)



ROCK RIPRAP/ROCK MULCH FLOW PATH PLAN VIEW (NTS)

NOTE:
Cut and fill transition shall be placed as shown on plans. Field adjust per direction of Engineer.



ROCK RIPRAP/ROCK MULCH FLOW PATH EMBEDMENT SECTION A-A (NTS)

NOTES:

1. Rock Riprap/Rock Mulch shall be angular shaped, crushed rock materials. Natural river-run materials such as rounded river rocks/cobblestones and pebbles are NOT acceptable.
2. Rock Riprap/Rock Mulch within the traffic Clear Zone/Recovery Area shall conform to the requirements of Section 810-2.03 Sieve Size Gradation A and/or Gradation C, and Section 913 of the Specifications and project special provisions.
3. Install Rock Riprap/Rock Mulch to a minimum depth of 12" for Channel Lining and Cut/Fill Transition. Excavate round surface to a depth that the top of Rock is 1"-2" below the grade of the ditch to encourage Intended Flow Path as shown in Section A-A.
4. Embed any rock into the finished grade so that any portion of the Rock is less than 4" above grade, within traffic recovery area/clear zone.
5. The installation and maintenance of Rock Protection shall not negatively impact traffic safety, nor the designed function of roadway or bridge drainage facilities. Rock Protection shall be installed and maintained to carry the stormwater of at least 2-year, 24-hour events.
6. Make field adjustments and corrections of Rock Protection immediately if it is causing flooding, erosion, and/or affecting roadway safety.
7. Make field adjustments to ensure the top surface of Rock Riprap/Rock Mulch is graded lower than the surrounding finished grade to collect surface stormwater runoff and concentrated flow.
8. Make field adjustments and corrections to ensure NO sensitive biological resources (native species / habitats) will be adversely impacted.

DETAIL ES3

ROCK PROTECTION FOR CUT & FILL TRANSITION AND CHANNEL LINING

DESIGN	XXX	DATE	3/21	ARIZONA DEPARTMENT OF TRANSPORTATION INFRASTRUCTURE DELIVERY AND OPERATIONS DIVISION ROADWAY DESIGN SECTION	PRELIMINARY Review NOT FOR CONSTRUCTION OR RECORDING DWG NO. EC-02.03
DRAWN	STAFF	DATE	3/21		
CHECKED	ECC	DATE	3/21		
corral design group, inc.				EROSION CONTROL DETAILS	
ROUTE	1-17	LOCATION	1-17 ANTHEM WAY TRAFFIC INTERCHANGE TO JCT. 69 (CORDES JUNCTION) PROJECT		
TRACS NO.	H6800 01D		017 MA(229)		OF

TP Attachment 455-1 – MSE Wall Specification

*** Note to designer: Appendix X includes figure 929-2.03(A) and is located at the bottom of this spec ***

*** It shall be included in the appendix list for the project's specifications document ***

(929MSEW, 10/1/20)

SECTION 929 MECHANICALLY STABILIZED EARTH (MSE) WALLS: of the Standard Specifications is modified to add:

929-1 Description:

929-1.01 General:

The work under this section consists of designing, furnishing all materials and constructing Mechanically Stabilized Earth (MSE) retaining walls in accordance with these specifications and in compliance with the lines and grades, dimensions and details shown on the project plans and as directed by the Engineer.

The contractor shall provide the MSE wall designer with a complete set of project plans and specifications and shall ensure that the wall design is compatible with all other project features that can impact the design and construction of the wall.

The terms used in this specification for identification of various entities responsible for MSE wall designs are defined in Table 929-1:

TABLE 929-1	
Term	Entity Responsibilities
Wall Manufacturer/Supplier	The entity contractually retained by the contractor to provide materials and construction support services for an accepted MSE wall system as identified in Subsection 929-1.03.
Wall Designer	The entity contractually retained by the contractor to provide internal design of an accepted MSE wall system as identified in Subsection 929-1.03. The Wall Designer is also responsible for evaluating certain aspects of external stability as discussed herein using the geotechnical information provided by the Geotechnical Engineer. The Wall Designer may be a representative of the Wall Manufacturer/Supplier.

TABLE 929-1

Term	Entity Responsibilities
	<p>Internal design includes evaluation of compound stability, which is defined as a failure mode passing through the reinforced soil mass and the retained fill and/or foundation. Geotechnical properties for the retained fill and foundation are to be obtained from the Geotechnical Engineer.</p> <p>The aspects of external stability as discussed below for Geotechnical Engineer that are the responsibility of the Wall Designer to evaluate are as follows:</p> <ol style="list-style-type: none"> (1) Verify the bearing pressures do not exceed the bearing resistance of the foundation soils shown on the bearing resistance charts provided by the Geotechnical Engineer. (2) Estimate the settlements along the length of the accepted MSE wall system, as identified in Subsection 929-1.03, using the Service I limit state settlement curves shown on the bearing resistance charts provided by the Geotechnical Engineer. (3) Evaluate limited eccentricity and sliding of the accepted MSE wall system, as identified in Subsection 929-1.03, using the geotechnical properties for the retained fill and foundation material provided by the Geotechnical Engineer.
<p align="center">Geotechnical Engineer</p>	<p>The entity responsible to evaluate or provide geotechnical information needed for the Wall Designer to evaluate certain aspects of external stability of the accepted MSE wall system as identified in Subsection 929-1.03. External stability includes the analysis of:</p> <ol style="list-style-type: none"> 1. Bearing Capacity 2. Settlement (short term and post construction) 3. Limited Eccentricity 4. Sliding 5. Global slope stability <p>The bearing capacity and settlement (short term) shall be evaluated by the Geotechnical Engineer and provided to the Wall Designer in the form of a bearing resistance</p>

TABLE 929-1	
Term	Entity Responsibilities
	<p>chart developed in accordance with ADOT SF-1 (2010) Memorandum (3). Bearing resistance charts shall be developed for each boring advanced along the length of the proposed MSE walls.</p> <p>Long-term settlements (post construction) shall be evaluated by the Geotechnical Engineer and provided to the Wall Designer so that the Wall Designer can account for such settlements in their design.</p> <p>Geotechnical properties of the retained fill and foundation material shall be provided by the Geotechnical Engineer to the Wall Designer to allow the Wall Designer to evaluate limited eccentricity and sliding of the accepted MSE wall system, as identified in Subsection 929-1.03.</p>
<p>Notes:</p> <p>(1) For design build (DB)/ CMAR/ P3 projects, both the Wall Designer and Geotechnical Engineer shall be contractually retained by the contractor to provide the responsibilities defined herein.</p> <p>(2) The geotechnical properties for the retained fill provided by the Geotechnical Engineer to the Wall Designer are minimum properties based on global stability analysis performed by the Geotechnical Engineer, and the Wall Designer may elect to use material exceeding those minimum property values for design. In such case, the geotechnical properties used by the Wall Designer exceeding those provided by the Geotechnical Engineer shall become the required geotechnical properties for the retained fill during construction.</p> <p>(3) ADOT SF-1 (2010): Development of Factored Bearing Resistance Chart by a Geotechnical Engineer for Use by a Bridge Engineer to Size Spread Footings on Soils for Service and Strength Limit States Based on Load and Resistance Factor Design (LRFD) Methodology, Memorandum from N. H. Wetz and J. D. Wilson to J. Lawson, Dated March 19, 2008 (Revision 1).</p>	

929-1.02 Certifications:

(A) Certification of Review of Geotechnical Report(s):

The contractor shall be responsible to review all available geotechnical investigation reports, and the contractor’s signature on the proposal form shall certify that this review has been performed

and that this specification and any relevant geotechnical information has been provided to the firms designing and supplying the MSE wall.

The geotechnical investigation reports are available on the Contracts and Specifications Section current advertisement website.

(B) Certification of Design Parameters:

See Subsection 929-2.01 herein specified.

(C) Certification of Materials:

See Subsections 929-3.04, 929-3.06 and 929-3.09 herein specified.

929-1.03 Accepted Systems:

The contractor shall select one of the appropriate ADOT pre-approved earth retaining systems to be constructed for the MSE walls designated on the plans.

Pre-approved systems are listed on the ADOT Bridge Group website:

<https://azdot.gov/business/engineering-and-construction/bridge/guidelines/geotech-services>

The features of the system(s) furnished, including design and configuration of precast elements, fasteners, connections, soil reinforcements, joint fillers, geotextile filter, and other necessary components shall be those that meet the requirements of Subsection 929-2.

Heights and lengths of earth retaining MSE walls may vary from, but shall not be less than, those shown on the plans. The height and length to be used for any system shall be the minimum for that system that will effectively retain the earth behind the wall for the loading conditions and the contours, profile, or slope lines shown on the plans, in accordance with all relevant internal and external stability design criteria.

929-1.04 Unlisted Systems Acceptance Process:

If the contractor elects to use an earth retaining systems not listed on the ADOT Bridge Group website, the approval process for such systems is as follows:

- (1) No consideration will be given to a request for approval of an unlisted system prior to contract award. After award, and in time to allow for consideration without delaying work, the contractor shall submit a written request for approval of a new system.
- (2) If the contractor wishes to propose multiple systems, separate written requests shall be submitted for each system. All requests must be received within the timeframes specified herein.
- (3) The contractor's progress schedule shall indicate when the proposed system is to be used on the project. The schedule shall include time for the Department to evaluate the proposed system and shall demonstrate that there will be no impacts to the critical path. If, in the opinion of the Engineer, the schedule shows that the evaluation and approval timeframe of the proposed system is not reasonable, the Department will not consider the proposed system.
- (4) A request for the use of an unlisted system shall include all information necessary to determine that a system is an equal, including samples for testing, if required. Unlisted systems will not be entertained as Value Engineering (VE) Proposals.
- (5) The Department will evaluate the information submitted, perform tests when necessary and make comparisons. The Engineer will then make the final decision as to whether the proposed system is an equal. The Department will neither be liable for any delay in acting upon any request nor for any failure to approve a request pursuant to the use of an unlisted system.
- (6) The Department will review the contractor's request for the use of an unlisted system within 45 days of the contractor's submittal and inform the contractor in writing if the request is rejected, approved, or if the Department will take additional time for evaluation. Any additional information needed to evaluate the proposed system shall be submitted in a timely manner. Untimely submittals of additional information shall result in rejection of the proposed system.
- (7) The contractor shall not be entitled to additional compensation or an extension of contract time resulting from the Department's acceptance or rejection of a proposed system. Bid prices shall not to be based on the anticipated approval of a proposed system.

929-1.05

Manufacturer's Field Representative:

The manufacturer's field representative performing the work described in this specification shall have, in the past three years, successfully installed at least four MSE retaining walls of heights, lengths and complexity similar to those shown on the plans and meeting the tolerances specified herein. The manufacturer's field representative may make field changes subject to the approval of the Engineer. Any such changes shall be documented in writing within 24 hours of the approved changes. This written document shall be sealed by the manufacturer's design engineer, who is registered as a Civil Engineer in the State of Arizona.

929-1.06 MSE Pre-Activity Meeting:

A pre-activity meeting will be scheduled prior to commencement of MSE wall construction activity. As a minimum, this meeting shall be attended by the Engineer, contractor (including wall construction crew chiefs), the MSE wall sub-contractor, MSE wall manufacturer's and MSE Wall designer's representatives. No wall construction activity shall be performed until the contractor's final submittals have been approved as having satisfactorily resolved all review comments and the pre-activity meeting has been held.

929-1.07 Wall Aesthetics:

Wall aesthetics shall be as specified in the project plans and special provisions.

929-2 Submittals (Working Drawings and Design):

929-2.01 Submittals:

The submittals required shall include working drawings, construction procedures, supporting design calculations, verification of experience, and a transmittal letter. The transmittal letter shall only list the documents included in the submittal. No technical information shall be included in the transmittal letter.

Working drawings and calculations shall be signed and sealed by a Professional Engineer, who is registered as a Civil Engineer in the State of Arizona. The MSE wall designer/supplier shall document on the working drawings all assumptions made in the design. The following statement shall be included near the P.E. seal on the first sheet of the working drawings: "All design assumptions are validated through notes or details on these drawings".

Working drawings, design calculations, and MSE wall supplier's construction procedures modified as necessary by the contractor and wall designer for site-specific conditions shall be submitted to the Engineer for review. The Engineer shall have 15 calendar days after receiving the submittal to finish a review. The revised package shall be resubmitted to the Engineer for review. The Engineer shall have 5 calendar days to complete this review. This review process shall be repeated until the entire submittal is accepted by the Engineer.

The Department assumes no responsibility for errors or omissions in the working drawings. Acceptance of the final working drawings submitted by the contractor shall not relieve the contractor of any responsibility under the contract for the successful completion of the work.

Construction of the wall shall not commence until the contractor receives a written Notification to Proceed (NTP) from the Engineer. The NTP will be issued once the complete wall package (drawings, calculations, and construction procedures) is accepted. Fabrication of any of the wall components before the NTP shall be at the sole risk of the contractor.

929-2.02 Working Drawings:

The contractor shall submit complete working drawings and specifications for each installation of the system in accordance with the requirements of Subsection 105.03 as modified herein.

Working drawings shall include the following at a minimum:

- (1) Layout of the wall including plan and elevation views;
- (2) All design parameters and assumptions including design life;
- (3) Existing ground elevations and utilities impacted by the wall shall be field verified by the contractor for each location;
- (4) Complete details of all elements and component parts required for the proper construction of the system at each location and any required accommodations for drainage systems, foundation subgrades or other facilities shown on the contract documents;
- (5) The working drawing submittal shall clearly detail any special design requirements. These special design requirements may include, but are not limited to; structural frames to place reinforcements around obstructions such as deep foundations and storm drain crossings, drainage systems within the reinforced backfill, placement sequence of drainage and unit core fill with respect to reinforced (structure) fill behind a wall face using modular block facing units, guardrail post installation, scour protection, foundation subgrade modification, all corner details (acute, obtuse and 90 degrees), slip joints, connection details of MSE walls with other cast-in-place structures, wedges, shims and other devices such as clamps and bracing to establish and maintain vertical and horizontal wall facing alignments;
- (6) A complete listing of components and materials specifications; and

- (7) Other site-specific or project specific information required by the contract.

929-2.03 MSE Wall Design:

(A) General:

The working drawings shall be supplemented with all design calculations for the particular installation as required herein.

The proposed design shall satisfy the design parameters shown on the project plans and listed in these specifications, and comply with the design requirements of the following documents:

- FHWA (2009), "Design and Construction of Mechanically Stabilized Earth Walls and Reinforced Soil Slopes; Publication No. FHWA-NHI-10-024 and FHWA-NHI-10-025; Authors: Berg, R. R., Christopher, B. R., and Samtani, N. C.
- AASHTO (2017), "AASHTO LRFD Bridge Design Specifications", 8th Edition, including latest Interims.

All references made to AASHTO (2017) herein shall mean "AASHTO LRFD Bridge Design Specifications", 8th Edition, including latest Interims.

Maximum reinforcement loads shall be calculated using the "Simplified Method" as presented in AASHTO (2017) and as per the requirements specified herein. No other design method will be allowed.

Sample analyses and hand-calculations shall be submitted, if requested by the Engineer, to verify the output from software used by the MSE wall designer. Sample analyses and hand calculations shall be required for complex walls having geometries and loading conditions that are not readily amenable to computer analysis. Failure modes, including circular, non-circular, and multi-part wedge shall be analyzed for compound stability to verify the most critical failure case (slip surface with lowest factor of safety) within each section of the wall where the length of the reinforcement changes. For compound stability, all potential slip surfaces for each failure mode passing through all Three Search Zones shown in Appendix X shall be analyzed to determine the most critical failure case. Each failure mode shall be analyzed individually and not be forced to mimic the results of other failure modes. The compound stability analyses are required for all wall geometries including walls with level ground in front of wall and level backfill behind wall. Global stability requirements are contained in the MSE wall design summary plan sheet.

The contractor and wall designer shall identify the specific locations on working drawing plan and profiles based on subgrade evaluation and at other key locations to control the deformation along

the wall. The soil reinforcement attached to the slip joints shall be oriented perpendicular to the slip joint panels and shall be the full design length. Special connection and compaction details shall be provided on the working drawings.

At all corners formed by two MSE walls, the leveling pad along the shorter wall forming the corner shall be at the same elevation as the leveling pad for the taller wall for a distance of at least 80 percent of the height of the taller wall or a distance of 10 feet, whichever is greater.

Unless otherwise specified in the contract, all structures shall be designed to conform to the requirements shown in Table 929-2 and other requirements specified herein.

TABLE 929-2			
DESIGN PARAMETERS			
Description	Limit State	Value	Note
1. Design Life	All limit states	75 Years	
2. Effective (Drained) Friction Angle			
a. Retained Backfill	All limit states	(Project specific as detailed in the MSE wall design summary sheet)	1
b. Reinforced Backfill	All limit states	34° ,110 pcf	1
3. Length of soil reinforcement, B	All limit states	0.7H min or 8-ft whichever is more	2
4. Limiting eccentricity	Strength (all)	B/3 (soil), 0.45B (rock)	
	Service I	B/6 (soil), B/4 (rock)	
5. Coefficient of Sliding Friction	Strength (all)	$\tan[\min(\phi_r, \phi_f, \phi_i)]$	3
6. Resistance factors			
a. Sliding	Strength (all)	1.0	4
b. Bearing	Strength (all)	0.65	5
c. Overall (slope) stability			
I. Deep Seated Stability	Service I	0.65	6
II. Compound Stability	Service I	0.65	6
d. Pullout resistance			
I. Static	Strength (all)	0.90	7
II. Combined static/earthquake	Strength (all)	1.20	7

e. Tensile resistance of metallic reinforcements and connectors			
I. Static			
- Strip reinforcement	Strength (all)	0.75	8
- Grid reinforcement	Strength (all)	0.65	8,9
II. Combined static/earthquake			
- Strip reinforcement	Strength (all)	1.00	8
- Grid reinforcement	Strength (all)	0.85	8,9
f. Tensile resistance of geosynthetic reinforcements and connectors			
I. Static	Strength (all)	0.90	
II. Combined static/earthquake	Strength (all)	1.20	
Notes:			
1	Retained backfill requirements shall be project specific as noted on the MSE wall summary plan sheet developed by the Geotechnical Engineer.		
2	H is the design height of the wall and is defined as the difference in elevation between the finished grade at top of wall and the top of leveling pad. The top of the leveling pad shall always be below the minimum embedment reference line as indicated on the plans for that location. The length of the soil reinforcement, B, is measured from the backface of the wall facing unit. In case of grid type reinforcements the length of the soil reinforcement is measured from the backface of the wall to the last full transverse member. For modular block facing units, the total length of the reinforcement, BT, as measured from the front face of the wall is the length B as defined above plus the width of the modular block unit (the horizontal dimension of the block unit measured perpendicular to the wall face). Depending on the configuration of the reinforcements and properties of the various actual fills selected by the contractor, the minimum length of the reinforcement may need to be increased to satisfy the required resistance factors for compound stability analyses.		
3	ϕ_r = friction angle of reinforced wall fill. ϕ_f = friction angle of foundation soil (As reported on the MSE wall design summary plan sheet). ϕ_I = friction angle of the interface between reinforcement and soil for cases of sheet reinforcement such as geotextiles.		

	All friction angles are effective (drained) friction angles. Refer to the MSE wall design summary plan sheet for friction angle and unit weight of foundation soil.
4	Passive resistance shall not be considered in evaluation of sliding resistance.
5	For all limit states, the design loading for the MSE retaining wall system shall not exceed the factored general and local bearing resistances specified in the Geotechnical Report(s).
6	For earthquake loading condition, a resistance factor of 0.90 shall be used.
7	Live load due to vehicular traffic shall be included in the computations to determine the maximum tensile forces in reinforcement layers, but shall be neglected in the computations for pullout resistance. Intensity of live load shall be considered as a uniform surcharge using the equivalent height of soil in accordance with Section Article 3.11.6.4 of AASHTO (2017).
8	Apply to gross cross-section less sacrificial area. For sections with holes, reduce gross area in accordance with Article 6.8.3 of AASHTO (2017) and apply to net section less sacrificial area.
9	Applies to grid reinforcements connected to a rigid facing element, e.g., a concrete panel or block. For grid reinforcements connected to a flexible facing mat or which are continuous with the facing mat, use the resistance factor for strip reinforcements.
1 0	Unless otherwise specified, all resistance factors shall be taken as 1.0 when investigating an extreme event limit state.

(B) Subsurface Drainage Systems:

Walls shall be provided with subsurface drainage measures as shown on the project plans and specifications. As a minimum, an underdrain system shall be provided for leading subsurface and surface water away from the backfill and outside the limits of the wall. Geocomposite drains, if used for subsurface drainage, shall be in accordance with Subsection 203-5.02 and 203-5.03(C) of the specifications.

The Wall Designer is responsible for drainage measures within the reinforced backfill. Drainage measures outside the MSE wall backfill shall be designed by the project civil designer.

(C) Obstructions in Backfill:

(1) General:

Where obstructions, such as deep foundations or storm drains crossings, are located in the reinforced backfill zone, cutting of reinforcements to avoid obstructions shall not be permitted. A minimum offset of one diameter but not less than 3 feet shall be maintained between the face of

any pipe crossings and the back face of MSE retaining wall panels. A minimum clearance of 3 feet shall be maintained between the face of any other obstruction and the back face of MSE retaining wall panels.

(2) Horizontal Deflection of Reinforcements:

In the horizontal plane at a reinforcing level, a deviation up to 15 degrees from normal to the face of the wall may be allowed for strip reinforcement and bolted connection. This deviation is herein referred to as the splay angle. Grid reinforcements may not be splayed, unless connection has been specifically fabricated to accommodate a splay and connection detail has been approved by the Department. If used, the splay in grid reinforcements is limited to five degrees. For obstructions that cannot be accommodated with splayed reinforcement, structural frames and connections shall be required, and shall be designed in accordance with Section 10 (“Steel Structures”) of AASHTO (2017) for the maximum tension in the reinforcements. The structural frame design shall be such that bending moments are not generated in the soil reinforcement or the connection at the wall face. The design, along with supporting calculations, shall be included in the working drawings.

(3) Vertical Deflection of Reinforcements:

Vertical deflection of the reinforcement to avoid obstructions such as utilities along the wall face shall be limited to a maximum of 15 degrees from normal to face of wall. Bends in the reinforcement shall be smooth and gradual to ensure that galvanization remains intact.

(D) Hydrostatic Pressures:

As determined by the Engineer and/or as noted on the plans, for walls potentially subject to inundation, such as those located adjacent to rivers, canals, detention basins or retention basins, a minimum hydrostatic pressure equal to three feet shall be applied at the high-water level for the design flood event. Effective unit weights shall be used in the calculations for internal and external stability beginning at levels just below the equivalent surface of the pressure head line. Where the wall is influenced by water fluctuations, the wall shall be designed for rapid drawdown conditions which could result in differential hydrostatic pressure greater than 3 feet. As an alternative to designing for rapid drawdown conditions, Size 57 coarse aggregate, as specified in AASHTO M 43, shall be provided as reinforced backfill for the full length of the wall and to the maximum height of submergence of the wall. Separation fabric shall be class I needle-punched polypropylene non-woven geotextile with the highest permittivity shown in AASHTO M 288. The fabric shall be provided at the interface of the Size 57 coarse aggregate and reinforced backfill above it, and at the interface of the retained backfill behind it. Adjoining sections of separation fabric shall be overlapped by a minimum of 12 inches.

(E) Acute Angle Corners:

Wall corners with an included angle of less than 70 degrees shall be designed for bin-type lateral pressures for the extent of the wall where the full length of the reinforcement cannot be installed without encountering a wall face. Acute angle corner structures shall not be stand-alone separate structures. Computations shall be provided that demonstrate deformation compatibility between the acute angle corner structure and the rest of the MSE wall. Full-height vertical slip joints shall be provided at the acute angle corner and after the last column of panels where full length of the reinforcements can be placed. The soil reinforcement attached to the slip joints shall be oriented perpendicular to the slip joint panels and shall be the full design length. Special connection and compaction details shall be provided on the working drawings.

(F) Slip Joints:

For walls with precast concrete panels, vertical slip joints shall be included in the wall face at the following locations and as shown on the plans, whichever is more stringent:

- (1) Boundaries of limits where differential settlement exceeds 1/100.
- (2) All locations where a wall height changes by more than 5 feet.
- (3) All corners within an MSE wall.
- (4) Each side of a stiff element such as a reinforced concrete box culvert (RCBC), abutment wing walls, or any other wall face penetration larger than 5 feet.
- (5) Each side of a drilled shaft foundation constructed prior to and within 8 feet of the face of wall. Approximate locations of slip joints are shown on the project plans.

(G) Spacing of Metallic Reinforcement for Flexible Face Wall Systems:

For permanent walls, vertical and horizontal spacing of metallic reinforcements for flexible face (welded wire or similar) wall systems shall not exceed 18 inches. The stiffness of the facing and spacing of reinforcements shall be such that the maximum local deformation between soil reinforcement layers shall be limited to less than 1½ inches. Facing elements shall not yield in bending and tension.

For temporary walls, i.e., walls with less than 36 months service life, the contractor may adjust the stiffness of the facing and spacing of the reinforcements such that the local deformation between the reinforcement is within the elastic range in bending and tension, and the overall geometry meets the line and grade requirements for the temporary walls.

(H) Soil Reinforcement for Modular Block Wall (MBW) Systems:

The soil reinforcement lengths and percent coverage at a given reinforcement level shall be in accordance with the plans. All soil reinforcement shall be positively connected to the modular block facing units by a connection that is capable of resisting 100 percent of the maximum tension in the soil reinforcements at any level within the wall. Detailed documentation for connection strength shall be submitted as noted in Subsection 929-3.09. The vertical spacing of the soil reinforcement for walls with modular block facing units shall be as follows:

- (1) The first (bottom) layer of soil reinforcement shall be no further than 16 inches above the top of the leveling pad.
- (2) The last (top) layer of soil reinforcement shall be no further than 20 inches on the average below the top of the uppermost MBW unit.
- (3) The maximum vertical spacing between layers of adjacent soil reinforcement shall not exceed 24 inches. For walls deriving any part of their connection capacity by friction the maximum vertical spacing of the reinforcement shall be limited to two times the block depth (front face to back face) to assure construction and long-term stability. The top row of reinforcement shall be placed at a depth no more than two times the block height from the top of finished grade.

(I) Initial Batter of Wall:

The initial batter of the wall, both during construction and upon completion, shall be within the vertical and horizontal alignment tolerances included in this specification. The initial batter of the wall at the start of construction and the means and methods necessary to achieve the batter shall be provided on the working drawings. Subject to Engineer's approval, the initial batter may be modified at the start of construction by the manufacturer's field representative based on the evaluation of the backfill material selected by the contractor. Any such changes shall be documented in writing within 24 hours of the approved changes. This written document shall be sealed by the manufacturer's design engineer who is registered as a Civil Engineer in the State of Arizona. Details of the wedges or shims or other devices, such as clamps and external bracing used to achieve or maintain the wall batter, shall be as shown on the working drawings and/or accompanying construction manual. Permanent shims shall comply with the design life criteria, and shall maintain the design stress levels required for the walls.

929-3 Material Requirements:

929-3.01 Precast Concrete Elements:

Precast concrete elements shall conform to the requirements for precast minor structures in Sections 601 and 1006. The concrete shall be Class S with minimum design strength of 4,000 pounds per square inch. The mix design shall conform to the requirements of Subsection 1006-

3.

Prior to casting, all embedded components shall be set in place to the dimensions and tolerances designated in the plans and specifications. Rustication for wall aesthetics shall be in accordance with project plans, special provisions, and applicable requirements of Sections 601, 610, 1002 and 1006.

(A) Concrete Testing and Inspection:

Precast concrete elements shall be subjected to compressive strength testing in accordance with Subsection 1006-7, and inspected for surface conditions and dimensional tolerances in accordance with Subsections 601-3.05 and 601-4.02 respectively. Panels delivered to the site without the ADOT acceptance stamp will be rejected.

(B) Casting:

Precast concrete face panels shall be cast on a horizontal surface with the front face of the panel at the bottom of the form. Connection hardware shall be set in the rear face. The concrete in each precast concrete panel shall be placed without interruption and shall be consolidated by deploying an approved vibrator, supplemented by such hand tamping as may be necessary to force the concrete into the corner of the forms, and to eliminate the formation of stone pockets or cleavage planes. Form release agents as specified in Subsection 601-3.02(C)(1) shall be used on all form faces for all casting operations.

The contractor shall advise the Engineer of the starting date for concrete panel casting at least 14 calendar days prior to beginning the operation if the casting operation is within the State of Arizona, or 21 calendar days if the casting operation is outside the State of Arizona.

(C) Finish:

(1) Non-Exposed Surfaces:

Rear faces of precast concrete panels shall receive a Class I finish in accordance with Subsection 6013.05.

(2) Exposed Surfaces:

The type of finish required on exposed surfaces shall be as shown in the plans.

(a) Exposed Aggregate Finish:

- (i) Prior to placing concrete, a set retardant shall be applied to the casting forms in accordance with the manufacturer's instructions.
- (ii) After removal from the forms and after the concrete has set sufficiently to prevent its dislodging, the aggregate shall be exposed by a combination of brushing and washing with clear water. The depth of exposure shall be between $\frac{3}{8}$ inch and $\frac{1}{2}$ inch.
- (iii) An acrylic resin sealer consisting of 80 percent thinner and 20 percent acrylic solids by weight shall be applied to the exposed aggregate surface at a rate of 1 gallon per 250 square feet.

(b) Concrete Panel Finish:

Concrete panel finish shall be in accordance with Subsection 601-3.05.

(D) Tolerances:

Precast concrete elements shall comply with Subsection 601-4.02(B)(1) and 601-4.02(B)(4). Connection device placement shall be within $\pm \frac{3}{8}$ inch of the dimensions shown on the drawings. Panel squareness as determined by the difference between the two diagonals shall not exceed $\frac{1}{2}$ inch.

(E) Identification and Markings:

The date of manufacture, the production lot number, and the piece mark shall be inscribed on a non-exposed surface of each element.

(F) Handling, Storage, and Shipping:

All panels shall be handled, stored, and shipped in such a manner to eliminate the dangers of chipping, discoloration, cracks, fractures, and excessive bending stresses. Panels in storage shall be supported in firm blocking to protect panel connection devices and the exposed exterior finish. Storing and shipping shall be in accordance with the manufacturer's recommendations.

(G) Compressive Strength:

Precast concrete elements shall not be shipped or placed in the wall until a compressive strength of 3,400 pounds per square inch has been attained. The facing elements shall be cast on a flat

and level area and shall be fully supported until a compressive strength of 1,000 pounds per square inch has been attained.

(H) Precast Concrete Panel Joints:

(1) General:

Where the wall wraps around an inside corner, a corner block panel shall be provided with flange extensions that will allow for differential movement without exposing the panel joints. The back face of vertical and horizontal joints shall be covered with geotextile filter. Joint filler, bearing pads, and geotextile filter shall be as recommended by the wall manufacturer and shall meet the requirements shown on the approved working drawings.

If required, as indicated on the plans, flexible open-cell polyurethane foam strips shall be used for filler for vertical joints between panels, and in horizontal joints where pads are used.

All joints between panels on the back side of the wall shall be covered with a geotextile meeting the requirements for filtration applications as specified by AASHTO M 288. The minimum width shall be foot.

(2) Bearing Pads:

All horizontal and diagonal joints between panels shall include bearing pads. Bearing pads shall meet or exceed the following material requirements:

- (a) Preformed EPDM (Ethylene Propylene Diene Monomer) rubber pads conforming to ASTM D2000 Grade 2, Type A, Class A with a Durometer Hardness of 70.
- (b) Preformed HDPE (High Density Polyethylene) pads with a minimum density of 0.946 grams per cubic centimeter in accordance with ASTM D1505.

The stiffness (axial and lateral), size, and number of bearing pads shall be determined such that the final joint opening shall be $\frac{3}{4}$ inches within $-\frac{1}{8}$ inch unless otherwise shown on the plans. The MSE wall designer shall submit substantiating calculations verifying the stiffness (axial and lateral), size, and number of bearing pads assuming, as a minimum, a vertical loading at a given joint equal to 2.5 times the weight of facing panels directly above that level. As part of the substantiating calculations, the MSE wall designer shall submit results of certified laboratory tests in the form of vertical load-vertical strain and vertical load-lateral strain curves for the specific bearing pads proposed by the MSE wall designer. The vertical load-vertical strain curve shall extend beyond the first yield point of the proposed bearing pad.

929-3.02 Steel Components:

Steel components shall conform to the applicable requirements of Sections 605 and 1003.

(A) Galvanization:

Soil reinforcement steel shall be hot-dip galvanized in accordance with AASHTO M 111 (ASTM A123). Connection hardware steel can be galvanized by hot-dipping or other means, provided the method satisfies the requirements of AASHTO M 111 (ASTM A123). A minimum galvanization coating of 2.0 oz./ft² (605 g/m²) or 3.4 mils (85 μm) thickness is required. Soil reinforcement steel shall be adequately supported while lifting and placing such that the galvanization remains intact. Steel members with damaged (peeled) galvanization shall be repaired according to ASTM A780 and as specified in approved working drawings, at no additional cost to the Department.

(B) Metallic Reinforcing Strips and Tie Strips:

Reinforcing strips shall be hot-rolled from bars to the required shape and dimensions. The strips' physical and mechanical properties shall conform to the requirements of ASTM A572, Grade 65 minimum.

Tie strips shall be shop fabricated of hot-rolled steel conforming to the requirements of ASTM A1101, Grade 50 minimum. The minimum bending radius of the tie strips shall be 3/8 inch. Galvanization shall be applied after the strips are fabricated, inclusive of punch holes for bolts as shown on approved drawings.

(C) Metallic Reinforcing Mesh:

Reinforcing mesh shall be shop fabricated of cold-drawn steel wire conforming to the requirements of AASHTO M 32, and shall be welded into the finished mesh fabric in accordance with AASHTO M 55. Galvanization shall be applied after the mesh is fabricated. A minimum galvanization coating of 2.0 oz./ft² (605 g/m²) or 3.4 mils (85 μm) thickness is required.

(D) Connector Pins:

Connector pins and mat bars shall be fabricated and connected to the soil reinforcement mats as shown in the approved working drawings. Connector bars shall be fabricated of cold drawn steel wire conforming to the requirements of AASHTO M 32.

(E) Welded Wire Fabric:

All welded wire fabric shall conform to the requirements of AASHTO M 32, AASHTO M 55, and the approved working drawings. Welded wire fabric shall be galvanized in conformance with the requirements of ASTM A123.

(F) Fasteners:

Connection hardware shall conform to the requirements shown in the approved working drawings. Connection hardware shall be cast in the precast concrete panels such that all connectors are in alignment and able to transfer full and even load to the soil reinforcement. Once the reinforcement is connected to the panel, the amount of slack shall not exceed $\frac{1}{8}$ inch between the connector and the reinforcement during field installation. Fasteners shall be galvanized and conform to the requirements of AASHTO M 164 or equivalent.

929-3.03 Geosynthetic Reinforcement:

Geosynthetic soil reinforcement shall be limited to geosynthetics manufactured from polypropylene, high density polyethylene, and polyester. Geosynthetic reinforcement shall be evaluated through the NTPEP REGEO (National Transportation Product Evaluation Program – Geosynthetic Reinforcements) for installation damage reduction factor RF_{ID} and creep reduction factor RF_{CR} . The geogrid shall be a regular network of integrally connected polymer tensile elements, with aperture geometry sufficient to permit significant mechanical interlock with the surrounding soil. Geogrid structure shall be dimensionally stable and able to retain its geometry under manufacture, transport, and installation. Geosynthetic reinforcements other than geogrids may be utilized if an independent evaluation has been performed through NTPEP REGEO.

The nominal long-term tensile design strength (T-AL) of specific geosynthetic material shall meet or exceed the creep and durability reduction factors required by the wall manufacturer, as well as those required by AASHTO (2017). The wall designer may not select installation damage reduction factor RF_{ID} and creep reduction factor RF_{CR} to be less than the results obtained through the NTPEP REGEO program.

929-3.04 Certificate of Analysis for Soil Reinforcements:

The contractor shall furnish the Engineer with a Certificate of Analysis conforming to the requirements of Subsection 106.05 for all materials.

For geosynthetics, the Certificate of Analysis shall verify that the supplied geosynthetic is the type approved by the Engineer and as measured in full accordance with all test methods and standards specified herein. The manufacturer's certificate shall state that the furnished geosynthetics meet the requirements of the specifications, as evaluated by the NTPEP REGEO program.

For metallic wall reinforcement, a mill test report containing the ultimate tensile strength for the soil reinforcement shall be included in the certification. For metallic wall reinforcement, a mill test report containing the galvanization coverage shall be included in the certification. For metallic mesh wall reinforcement, a mill test report containing the ultimate weld strength for the soil reinforcement shall be included in the certification.

929-3.05 Reinforced and Retained Backfill Material:

(A) General:

Reinforced backfill material shall be free of shale, organic matter, mica, gypsum, smectite, montmorillonite, or other soft poor durability particles. No salvaged material, such as asphaltic concrete millings or Portland Cement Concrete rubble, etc., will be allowed.

Retained backfill material shall be project specific as noted on the MSE wall summary plan sheet developed by the Geotechnical Engineer.

(B) Soundness:

The reinforced backfill material shall have a soundness loss of 30 percent or less when tested in accordance with AASHTO T 104 using a magnesium sulfate solution with test duration of four cycles. Alternatively, the material shall have a soundness loss of 15 percent or less when tested in accordance with AASHTO T 104 using a sodium sulfate solution with test duration of five cycles. Aggregate sources with recent testing data within the past year may submit previous testing results for soundness determination.

(C) Gradation and Fractured Coarse Aggregates:

Gradations will be determined by Arizona Test Method 201 and shall be in accordance with Table 929-3, unless otherwise specified.

Material retained on the #4 and larger sieves must have a minimum of 50 percent particles with two or more mechanically induced crushed faces when tested by Arizona Test Method 212.

Table 929-3	
BACKFILL GRADATION REQUIREMENTS	
Sieve Size	Percent Passing
1 ½ inch	100

1 inch	95-100
½ inch	25-60
No. 4	0 - 10
No. 8	0 - 5

(D) Separation Fabric:

A class I needle-punched polypropylene non-woven separation geotextile fabric, meeting the minimum requirements for filtration applications specified in AASHTO M 288 and Subsection 1014-4 shall encapsulate the rock backfill. Adjoining sections of separation fabric shall be overlapped by a minimum of 12 inches.

(E) Limits of Reinforced Backfill:

For all walls, except back-to-back walls, the reinforced backfill shall extend to at least 2 feet beyond the free end of the reinforcement. For back-to-back walls wherein the free ends of the reinforcement of the two walls are spaced apart less than or equal to one-half the design height of the taller wall, reinforced wall fill shall be used for the space between the free ends of the reinforcements as well. The design height of the wall is defined as the difference in elevation between the top of coping and the top of leveling pad. The top of the leveling pad shall always be below the minimum embedment reference line as indicated on the plans for the location under consideration.

929-3.06 Certificate of Analysis for Reinforced Backfill Materials:

At least three weeks prior to construction of the MSE wall, the contractor shall furnish the Engineer with an 80 pound representative sample of the reinforced backfill material, and a Certificate of Analysis conforming to the requirements of Subsection 106.05 certifying that the reinforced backfill material comply with the requirements specified herein. During construction, the reinforced backfill material shall be sampled and tested by the contractor for acceptance and quality control testing in accordance with the requirements stated in Table 929-4. A new sample and Certificate of Analysis shall be provided any time the reinforced backfill material changes as noted in Table 929-4.

Table 929-4	
Sampling Frequency for Reinforced Backfill Material	
Test	Frequency
Gradation (Arizona Test Method 201), Plasticity Index (AASHTO T 90)	One per 500 CY

Fractured Coarse Aggregate Particles (ARIZ 212)	At production facility
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929-3.07 Cast-in-Place Concrete:

Cast-in-place concrete shall conform to the requirements of Sections 601 and 1006. Unless otherwise approved, all cast-in-place concrete shall be Class S with a minimum compressive strength of 4,000 pounds per square inch.

929-3.08 Modular Block (Segmental) Facing Units:

This section covers dry cast hollow and solid wet cast concrete masonry structural retaining wall units, machine made from Portland cement, water, and suitable mineral aggregates. The units are intended for use as facing units in the construction of mortarless, modular block walls (MBW) also known as segmental retaining walls (SRW). Metallic or geosynthetic reinforcement specified in Section 929-3.02 and 929-3.03, respectively, may be used as soil reinforcement in the reinforced (structure) backfill zone.

(A) Casting:

Cementitious material in the modular block facing unit shall be Portland cement conforming to the requirements of ASTM C150. If fly ash is used it shall not exceed 20 percent by weight of the total cement content, and shall conform to ASTM C618. Aggregates used in concrete blocks shall conform to ASTM C33 for normal weight concrete aggregate. Efflorescence control agent shall be used in concrete mix design to prevent efflorescence on the block.

The contractor shall advise the Engineer of the starting date for concrete panel casting at least 14 calendar days prior to beginning the operation if the casting operation is within the State of Arizona, or 21 calendar days if the casting operation is outside the State of Arizona.

(B) Physical Requirements:

At the time of delivery to the work site, the modular block facing units shall conform to the following physical requirements:

- (1) Minimum required compressive strength of 4,000 psi (average 3 coupons)
- (2) Minimum required compressive strength of 3,500 psi (individual coupon)
- (3) Minimum oven dry unit weight of 125 pcf

- (4) Maximum water absorption of 5 percent after 24 hours
- (5) Maximum number of blocks per lot of 2,000. Tests on blocks shall be submitted at the frequency of one set per lot.

Acceptance of the concrete block, with respect to compressive strength, water absorption and unit weight, will be determined on a lot basis. The lot shall be randomly sampled and tested in accordance with ASTM C140. As no additional expense to the Department, the manufacturer shall perform the tests at an ADOT approved laboratory and submit the results to the Engineer for approval. Compressive strength test specimens shall be cored or shall conform to the sawcut coupon provisions of ASTM C140. Block lots represented by test coupons that do not reach an average compressive strength of 4,000 psi will be rejected.

(C) Freeze-Thaw Durability:

In areas above 3000 feet, where repeated freezing and thawing under saturated conditions occur, the units shall be tested to demonstrate freeze-thaw durability in accordance with Test Method ASTM C1262. Freeze-thaw durability shall be based on tests from five specimens made with the same materials, concrete mix design, manufacturing process, and curing method, conducted not more than 18 months prior to delivery. Specimens used for absorption testing shall not subsequently be used for freeze-thaw testing. Specimens shall comply with either or both of the following acceptance criteria depending on the severity of the project location as determined by the Department:

- (1) The weight loss of four out of five specimens at the conclusion of 150 cycles shall not exceed 1 percent of its initial weight when tested in water.
- (2) The weight loss of each of four out of the five test specimens at the conclusion of 50 cycles shall not exceed 1.5 percent of its initial mass when tested in a saline (3 percent sodium chloride by weight) solution.

(D) Tolerances for Modular Block Dimensions:

Modular blocks shall be manufactured within the following tolerances:

- (1) The length and width of each individual block shall be within $\pm \frac{1}{8}$ inch of the specified dimension. Hollow units shall have a minimum wall thickness of $1\frac{1}{4}$ inches.
- (2) The height of each individual block shall be within $\pm \frac{1}{16}$ inch of the specified dimension.

- (3) When a broken (split) face finish is required, the dimension of the front face shall be within ± 1.0 inch of the theoretical dimension of the unit.

(E) Finish and Appearance:

Units that indicate imperfect molding, honeycomb or open texture concrete and color variation on front face of block due to excess form oil or other reasons shall be rejected. All units shall be visually efflorescence free. All units shall be sound and free of cracks or other defects that would interfere with the proper placing of the unit or significantly impair the strength or permanence of the construction. Minor cracks (e.g. no greater than 1/50 inch in width and no longer than 25 percent of the unit height) incidental to the usual method of manufacture or minor chipping resulting from shipment and delivery, are not grounds for rejection.

The exposed faces shall be free of chips, cracks or other imperfections when viewed from a distance of 30 feet under diffused lighting. Up to 5 percent of a shipment may contain slight cracks or small chips not larger than 1.0 inch.

Color and finish shall be as shown on the plans and shall be erected with a running bond configuration.

(F) Pins:

If pins are required to align modular block facing units, they shall consist of a non-degrading polymer or hot-dipped galvanized steel and be made for the express use with the modular block units supplied. Connecting pins shall be capable of holding the geogrid in the proper design position during backfilling.

(G) Cap Units and Adhesive:

The cap unit connection to the block unit immediately under it shall be of a positive interlocking type and not frictional. Cap units shall be cast to or attached to the top of modular block facing units in strict accordance with the requirements of the manufacturer of the blocks and the adhesive. The surface of the block units under the cap units shall be clear of all debris and standing water before the approved adhesive is placed. The contractor shall provide the owner in writing an acceptable 10-year warranty that the integrity of the materials used to attach the cap blocks will preclude separation and displacement of the cap blocks for the warranty period.

(H) Unit (Core) Fill:

Unit (core) fill is defined as free draining, coarse grained material that is placed within the empty cores of the modular block facing units. Unit (core) fill shall be a crushed stone or granular fill.

929-3.09 Certificate of Analysis for Modular Block Connection

For modular block facing units, a certification shall be provided with detailed calculations according to AASHTO (2017) and the results of laboratory test results performed in accordance with Section A.3 in Appendix A of FHWA NHI-00-043, dated March 2001 (“Mechanically Stabilized Earth Walls and Reinforced Soil Slopes”). Such certification shall demonstrate that all connections, including block-to-reinforcement and block-to-block connections, and all related components meet or exceed the current AASHTO 75 year design life requirements and are capable of resisting 100 percent of the maximum tension in the soil reinforcements at any level within the wall. Long-term connection testing for extensible reinforcements is also required. The effect of wall batter and normal pressures representative of the full range of wall configurations and heights shall be incorporated in the tests.

929-4 Construction Requirements:

929-4.01 Excavation:

The contractor shall ensure that temporary slopes are safe during the period of wall construction, and shall adhere to all applicable local, state, and federal regulations. During construction of the MSE walls, the contractor shall design, construct, maintain, and when called for, remove temporary excavation support systems (shoring). Temporary excavation support systems may be left in place if approved by the Engineer. The back slope of the excavation shall be benched. Where shoring is required, the contractor shall submit to the Engineer the shoring design, and a plan outlining construction and removal procedures for review and approval prior to proceeding with the work. Shoring plans shall be prepared and submitted as part of the working drawings, as specified in Subsection 105.03, and shall bear the seal and signature of a licensed Professional Civil or Structural Engineer, registered in the State of Arizona. All shoring design shall include appropriate input and review by the contractor’s Professional Engineer.

929-4.02 Foundation Preparation:

(A) General:

In the absence of specific ground improvement requirements in the plans and special provisions, the following applies:

The foundation for the reinforced and retained wall fill shall be graded level for the entire area of the base of such backfills, plus an additional 12 inches on all sides, or to the limits shown in the plans.

If soil reinforcement components are to be positioned on native soil, the top 1 foot of native soil shall meet the requirements of the reinforced backfill material specified in Subsection 929-3.05.

If soil reinforcement components are to be positioned on native rock mass, the rock mass shall be classified as at least Class II rock mass in accordance with Subsection 10.4.6.4 of AASHTO LRFD Bridge Design Specifications, 6th edition (2012).

(B) Proof-Rolling:

Proof-rolling shall be performed to evaluate the stability and uniformity of the subgrades on which retaining wall structures will be constructed. Proof-rolling shall be performed on the entire areas at the following locations and at other locations shown on the project plans:

- (1) At the bottom of the overexcavation and recompaction zones if specified;
- (2) At the bottom of the overexcavation and replacement zones if specified;
- (3) At the base of all retaining walls;
- (4) At the base of all concrete box culverts;
- (5) At the top of native soil layers that have been scarified, moisture conditioned and recompacted (if different from the bottom of the overexcavation and recompaction or overexcavation and replacement zones).

The proof-rolling shall be done immediately after subgrade compaction while the moisture content of the subgrade soil is near optimum or at the moisture content that achieved the required compaction.

If proof-rolling is performed after installation of pipe underdrains, do not use the proof-roller within 1.5 feet of the underdrains. Proof-rolling shall be performed with a pneumatic tired tandem axle roller with at least 3 wheels on each axle, a gross weight of 25 tons (50 kips) (This weight shall be determined on a project by project bases, depending on the soils and purpose of the proof-rolling), a minimum tire pressure of 75 psi and a minimum rolling width of 75 inches. A Caterpillar PS-300B (or PF-300B), Ingersoll-Rand PT-240R, BOMAG BW24R, Dynapac CP271 or equipment with equivalent capabilities shall be used for proof-rolling. The use of water trucks, scrapers, or other equipment for proof-rolling of the subgrades is not allowed.

Proof-rolling equipment shall be operated at a speed between 1.5 to 3 miles per hour or slower as required by the Engineer to permit measurements of ruts and/or pumping deformations.

Proof-rolling shall be carried out in two directions at right angles to each other with no more than 24 inches between tire tracks of adjacent passes. In cases where proof-rolling perpendicular to the wall alignment is not possible due to space constraints, proof-rolling shall be performed parallel to the wall with minimum 6-inches overlap between the tracks of adjacent passes. The contractor shall operate the proof-roller in a pattern that readily allows for the recording of deformation data and complete coverage of the subgrade.

The following actions shall be taken based on the results of the proof-rolling activity:

If rutting is less than $\frac{1}{4}$ inch; the grade is acceptable.

If rutting is greater than $\frac{1}{4}$ inch and less than $1\frac{1}{2}$ inches; the grade needs to be scarified and re-compacted.

If rutting is greater than $1\frac{1}{2}$ inches; the compacted area shall be removed and reconstructed.

If pumping (deformation which rebounds or materials are squeezed out of wheel's path) is greater than 1 inch; remediate as directed by the Engineer.

The contractor is responsible for maintaining the condition of the approved proof-rolled soils throughout the duration of the retaining MSE wall construction. Wall construction shall not commence until the subgrade has been approved by the Engineer.

929-4.03 Concrete Leveling Pad:

Leveling pads shall be constructed of unreinforced concrete as shown on the working drawings. Gravel leveling pads shall not be allowed. As a minimum, the concrete for leveling pads shall meet the requirements of Section 922. The elevation of the top of leveling pad shall be within $\frac{1}{8}$ inch from the design elevation when measured by a straightedge over any 10-foot run of the leveling pad.

The minimum width of the leveling pad shall be the width of the facing unit plus 8 inches. The centerline of the leveling pad shall be within $\frac{1}{2}$ inch from design location. When the facing units are centered on the leveling pad, the leveling pad shall extend approximately 4 inches beyond the limits of the facing unit as measured in the direction perpendicular to the face of the wall.

Cast-in-place leveling pads shall be cured for a minimum of 24 hours before placement of wall facing units. A geotextile shall be applied over the back of the area of any openings between the facing units and leveling pad steps. The geotextile shall extend a minimum of 6 inches beyond the edges of the opening. The opening shall be filled with concrete, conforming to Section 1006, or shall be concurrently backfilled on both sides with soil.

929-4.04 Subsurface Drainage:

Prior to wall erection, the contractor shall install a subsurface drainage system as shown on the working drawings.

929-4.05 Wall Erection:

(A) General:

Walls shall be erected in accordance with the manufacturer's written instructions. The contractor shall be responsible for ensuring that a field representative from the manufacturer is available at the site during construction of the initial 10-foot height of the full length of wall, and as called upon thereafter by the Engineer, to assist the contractor and Engineer at no additional cost to the Department. All temporary construction aids (e.g., wedges, clamps, etc.) shall be in accordance with the manufacturer's recommendations.

(B) Placement Tolerances for Walls with Rigid (Precast) Facing:

For walls with rigid facing, such as precast concrete panels, the panels shall be placed such that their final position is vertical or battered as shown on the working drawings. As wall fill material is placed, the panels shall be maintained in the correct vertical alignment by means of temporary wedges, clamps, or bracing as recommended by the manufacturer. A minimum of two, but not more than three, rows of panel wedges shall remain in place at all times during wall erection. Wedges shall be removed from lower rows as panel erection progresses, so as to prevent chipping or cracking of concrete panels. The contractor shall repair any damage to erected concrete panels as directed by the Engineer and to the Engineer's satisfaction. No external wedges in front of the wall shall remain in place when the wall is complete.

Erection of walls with rigid facing shall be in accordance with the following tolerances:

- (1) Vertical and horizontal alignment of the wall face shall not vary by more than $\frac{3}{4}$ inch when measured along a 10 foot straightedge.
- (2) The overall vertical tolerance (plumbness) of the finished wall shall not exceed $\frac{1}{2}$ inch per 10 feet of wall height. Negative (outward leaning) batter is not acceptable.
- (3) The maximum permissible out-of-plane offset at any panel joint shall not exceed $\frac{3}{8}$ inch.

- (4) The final horizontal and vertical joint gaps between adjacent facing panel units shall be within $-\frac{1}{8}$ inch and $\pm\frac{1}{4}$ inch, respectively, of the design final joint opening per the approved calculations required in Subsection 929-3.01(H).

Wall sections not conforming to these tolerances shall be reconstructed at no additional cost to the Department.

(C) Placement Tolerances for Permanent Walls with Flexible Facing:

Erection of permanent walls with flexible facing (such as welded wire mesh) shall be in accordance with the following tolerances:

- (1) Vertical and horizontal alignment of the wall face shall not vary by more than 2 inches when measured along a 10-foot straightedge, or as shown in the plans and specifications.
- (2) The overall vertical tolerance (plumbness) of the wall shall not exceed 1 inch per 10 feet of wall height. Negative (outward leaning) batter is not acceptable.
- (3) The offset limit between consecutive rows of facing shall not exceed 1 inch from planned offset.

Wall sections not conforming to these tolerances shall be reconstructed at no additional cost to the Department.

(D) Placement Tolerances for Modular Block Units:

Erection of walls with Modular Block Units shall be as per the following requirements:

- (1) Vertical and horizontal alignment of the wall face shall not vary by more than $\frac{3}{4}$ of an inch when measured along a 10-foot straightedge.
- (2) Overall vertical tolerance (plumbness) of the wall shall not exceed $1\frac{1}{4}$ inch per 10 feet of wall height from the final wall batter. Negative (outward leaning) batter is not acceptable.
- (3) The first row of units shall be level from unit-to-unit and from front-to-back. Use the tail of the units for alignment and measurement.
- (4) All units shall be laid snugly together and parallel to the straight or curved line of the wall face.

- (5) Unless otherwise noted, all blocks shall be dry-stacked and placed with each block evenly spanning the joint in the row below (running bond). Shimming or grinding shall control the elevations of any two adjacent blocks within 1/16 of an inch.
- (6) The top of blocks shall be checked with a straight edge bubble level that is at least 3 feet long. Any high points identified by the straight edge shall be ground flat. Block front to back tilting shall be checked frequently; however correction by shimming shall be done no later than 3 completed courses.

Wall sections not conforming to these tolerances shall be reconstructed at no additional cost to the Department.

(E) Placement of Metallic Reinforcement Elements:

Metallic reinforcement elements shall be placed normal (perpendicular) to the face of the wall, unless otherwise shown on the approved plans. All reinforcement shall be structurally connected to the wall face.

At each level of the soil reinforcement, the reinforced wall fill material shall be roughly leveled and compacted before placing the next layer of reinforcement. The reinforcement shall bear uniformly on the compacted reinforced soil from the connection to the wall to the free end of the reinforcing elements. The reinforcement placement elevation shall be at the connection elevation to 2 inches higher than the connection elevation.

For geosynthetic reinforcement where overlapping of reinforcing may occur, such as at corners, reinforcing connections to panels shall be adjusted to maintain at least 6 inches of vertical separation between overlapping reinforcement.

(F) Placement of Geotextile Fabric:

All joints between precast concrete panels shall be covered with geotextile fabric on the back side of the wall. Adhesive shall be applied to panels only. Adhesive shall not be applied to geotextile fabric or within 2 inches of a joint. The contractor shall provide geotextile fabric having a minimum width of 12 inches, and shall overlap the fabric a minimum of 4 inches. For modular block walls, the placement of the geotextile fabric shall be in accordance with the plans.

(G) Joint Pads and Fillers:

The contractor shall install joint pads and fillers as shown on the working drawings.

(H) Placement of Geosynthetic Reinforcement:

Geosynthetic reinforcement shall be installed in accordance with the manufacturer's site-specific wall erection instructions.

The geosynthetic reinforcement shall be rolled out with the stronger direction perpendicular to the wall face. The reinforcement shall be continuous for their full length. Joints parallel to the wall shall not be permitted, except as shown on the working drawings.

Reinforcement coverage shall be 100 percent of embedment area unless otherwise shown in the working drawings. Adjacent sections of geosynthetic reinforcement need not be overlapped except when exposed in a wrap-around face system, at which time the reinforcement rolls shall be overlapped or mechanically connected per the manufacturer's requirements.

Geosynthetic reinforcement shall be placed to lay flat and pulled tight prior to backfilling. After a layer of geosynthetic reinforcement has been placed, suitable means, such as pins or small piles of soil, shall be used to hold the geosynthetic reinforcement in position until the subsequent soil layer can be placed.

During construction, the surface of the fill shall be kept approximately horizontal. Geosynthetic reinforcement shall be placed directly on the compacted horizontal fill surface. The reinforcement shall bear uniformly on the compacted reinforced soil from the connection to the wall to the free end of the reinforcing elements. The reinforcement placement elevation shall be at the connection elevation to 2 inches higher than the connection elevation.

929-4.06 Reinforced Wall Fill Placement:

(A) General:

Reinforced wall fill placement shall closely follow erection of each course of facing panels. Backfill shall be placed in such a manner to avoid damage or disturbance of the wall materials, misalignment of facing panels, or damage to soil reinforcement or facing members. The contractor shall place backfill to the level of the connection and in such a manner as to ensure that no voids exist directly beneath reinforcing elements.

For walls with modular block facing units, the backfill shall not be advanced more than the height of a modular block unit until the drainage fill, core fill and all fill in all openings within the blocks at that level have been placed. The filled units shall be swept clean of all debris before installing the next level of units and/or placing the geogrid materials.

For walls with flexible facing with gabion style facing, the rock near the wall face shall be hand-placed in accordance with the recommendations of the wall manufacturer.

The maximum lift thickness before compaction shall not exceed 12 inches.

For geosynthetic reinforcements, the fill shall be spread by moving the machinery parallel to or away from the wall facing and in such a manner that the geogrid remains taut. Construction equipment shall not operate directly on the geogrid. A minimum fill thickness of ~~six~~ 6 inches over the geogrid shall be required prior to operation of vehicles. Sudden braking and sharp turning shall be avoided.

For metallic reinforcements, the fill shall be spread by moving the machinery parallel to or away from the wall facing and in such a manner that the steel reinforcement remains normal to the face of the wall. Construction equipment shall not operate directly on the steel reinforcement. A minimum fill thickness of 3 inches over the steel reinforcement shall be required prior to operation of vehicles. Sudden braking and sharp turning shall be avoided.

Wall materials which are damaged during backfill placement shall be removed and replaced by the contractor, at no additional cost to the Department. The contractor may submit alternative corrective procedures to the Engineer for consideration. Proposed alternative corrective procedures shall have the concurrence of the MSE wall supplier and designer, in writing, prior to submission to the Engineer for consideration. All corrective actions shall be at no additional cost to the Department.

(B) Compaction:

Reinforced wall fill compaction requires a minimum of 2 roller passes of a vibratory roller having a minimum dynamic force of 6,000 pounds impact per vibration, and a minimum frequency of 1,000 vibrations per minute.

The vibratory roller shall be operated at speeds less than 3 feet per second.

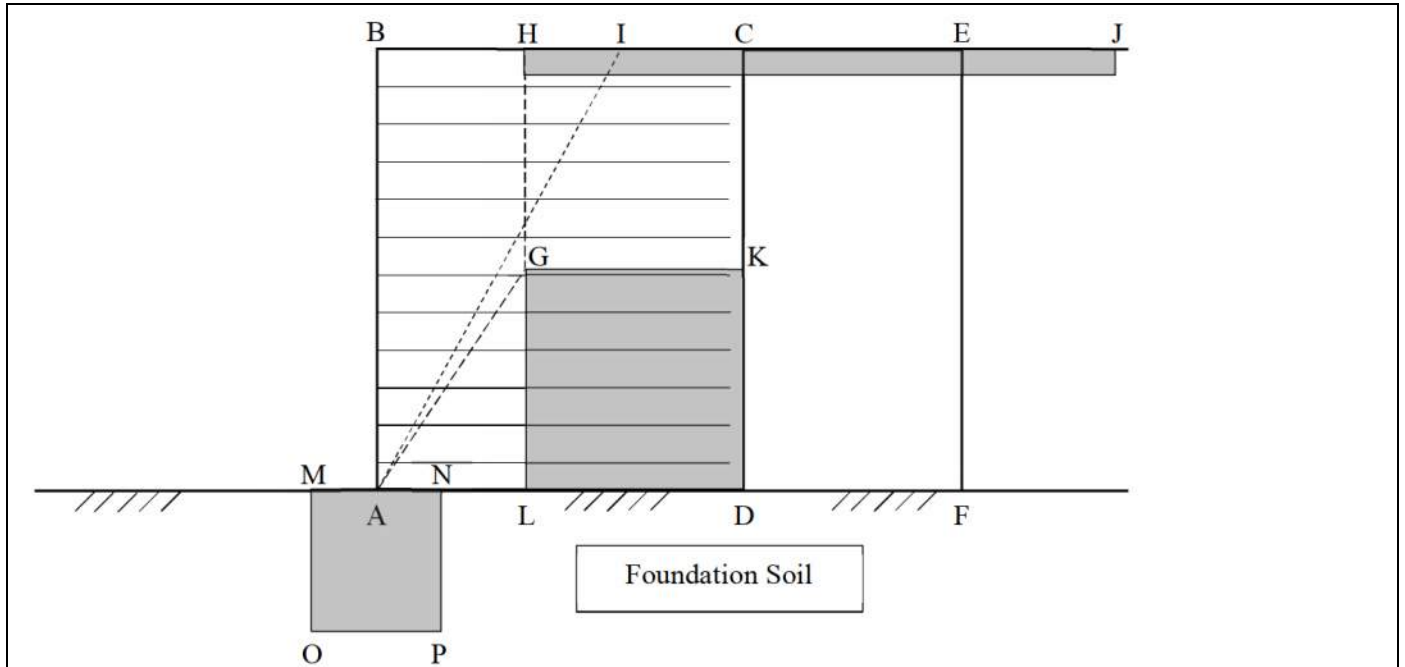
Backfill within 3 feet of the wall face shall be compacted utilizing a hand operated vibratory plate.

Retained backfill shall be compacted and tested per section 203-10.03 (Embankment Construction Requirements) which require 100 percent of the maximum density for an additional 50 feet beyond the limits of approach slabs.

(C) Protection of the Work:

The contractor shall not allow surface runoff from adjacent areas to enter the wall construction site at any time during construction operations. In addition, at the end of each day's operation, the contractor shall slope the last lift of backfill away from the wall facing so that runoff is directed away from the structure. If the subgrade is damaged due to water or otherwise, such that it does not meet the requirements of Subsection 929-4.02, then as directed by the Engineer, the contractor shall rework and repair the damaged subgrade at no additional expense to the Department. The criteria in Subsection 929-4.02 shall be used to judge the adequacy of the repair. Rework and repair shall extend to a depth where undamaged work is encountered.

*** This will become an Appendix to the project's specifications, not a Figure in this specification ***



Where:

AB = Wall Height = h , where A is at the Bottom of the Leveling Pad and B is at the Top of the Wall

ABCD = Reinforced Soil Zone

DCEF = Retained Soil Zone

To the Right of Plane EF = Common Embankment Fill

AGH = Failure Surface for Internal Stability Design of MSE Walls with Inextensible Reinforcements

AI = Failure Surface for Internal Stability Design of MSE Walls with Extensible Reinforcements

OMNP = Search Zone 1 (Search Area At and Below the Toe of the MSE Wall).

Search Zone Limits:

Search Zone Height (OM = NP) = A Minimum of $h/2$ or 5 feet, whichever is Greater

Search Zone Width (MN = OP) = A Minimum of 10 feet Centered Around Point A

LGKD = Search Zone 2 (Search Area in Reinforced Soil Zone of the MSE Wall).

Search Zone Limits:

Search Zone Height (LG = KD) = A Minimum of $h/2$

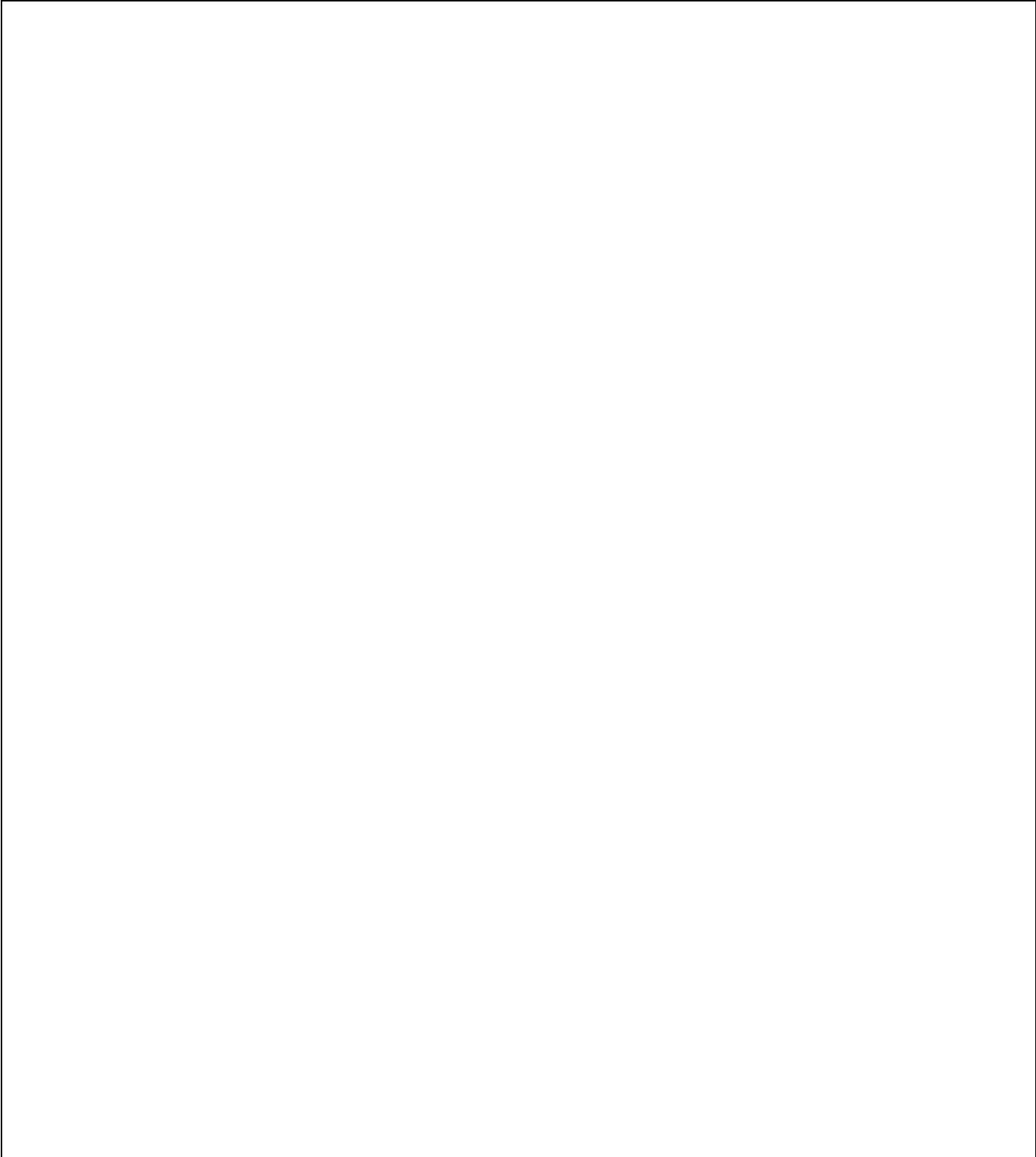
Search Zone Width (GK = LD) = A Minimum of the Reinforcement Length within the Resistance Zone of the Reinforced Soil Zone at the Middle Elevation of the Wall Height (i.e., the Reinforcement Length Beyond the Failure Surface for Internal Stability Design at the Middle Elevation of the Wall Height)

HJ or IJ = Search Zone 3 (Search Area Near the Top of the MSE Wall). HJ is Applicable to Inextensible Reinforcements. IJ is Applicable to Extensible Reinforcements.

Search Zone Limits:

Search Zone Width (HJ or IJ) = A Minimum Distance Beyond the Reinforced Soil Zone

Equivalent to the Wall Height, h

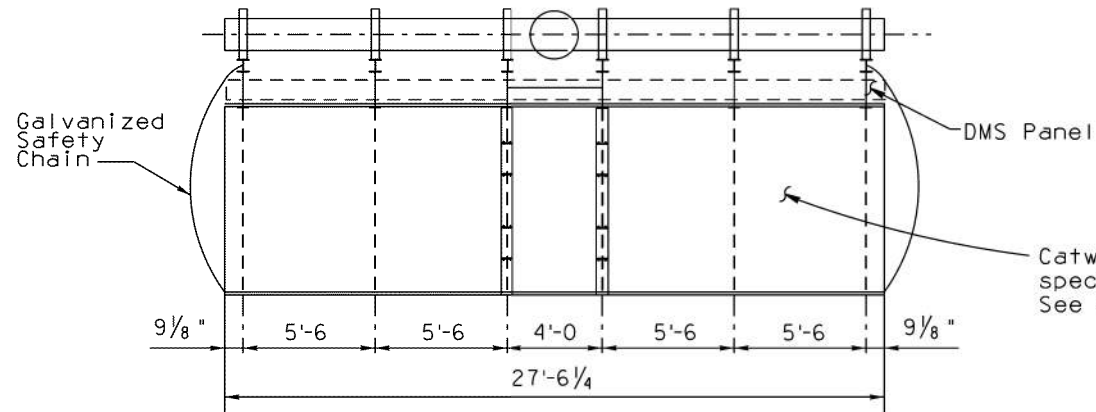


Appendix X

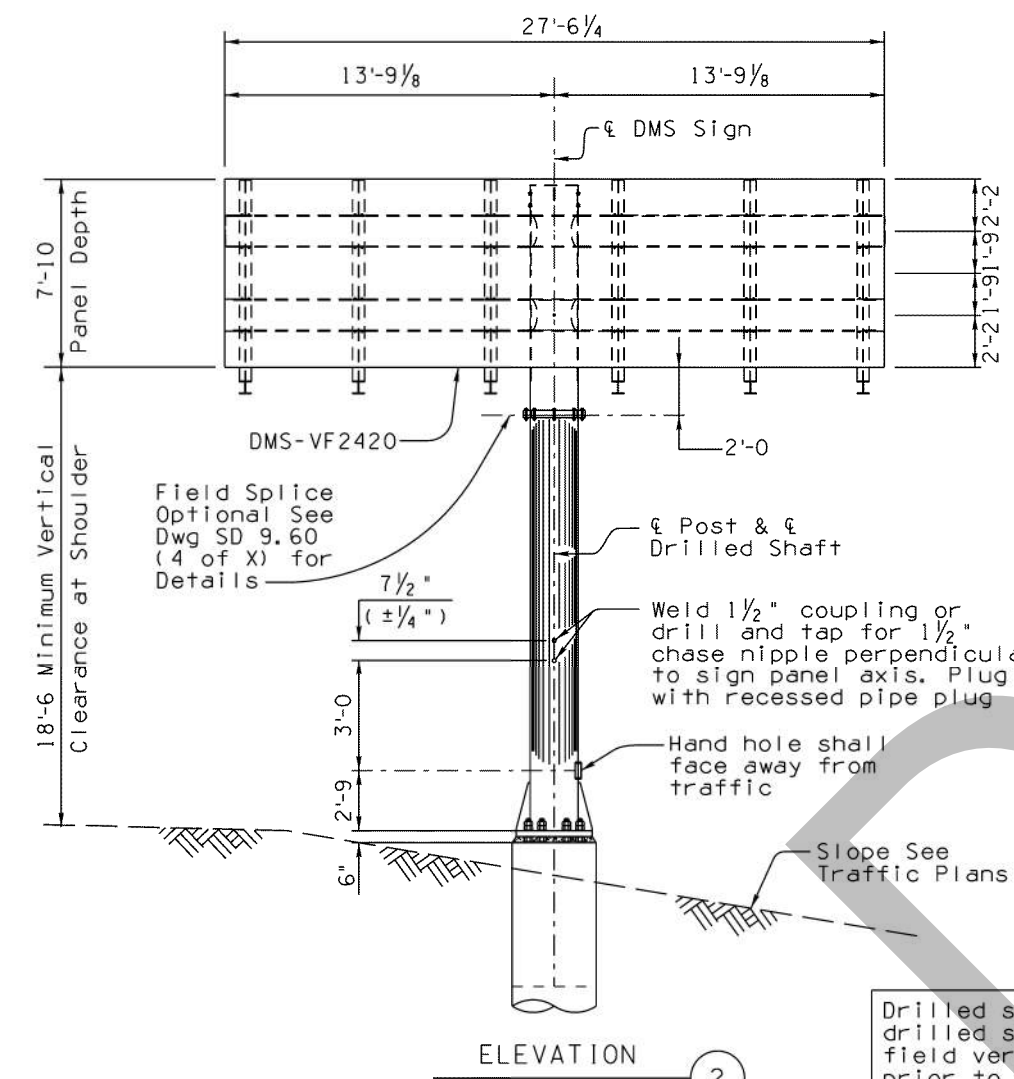
MSE Wall Compound Stability Search Zone Locations to Verify the Most Critical Failure Case for an MSE Wall with Level Backfill.

TP Attachment 455-2 – DMS Butterfly Structure Detail

Note to Designer: The information presented in this Standard Drawing has been prepared in accordance with recognized engineering principles and is for general use. It should not be used for specific application without competent professional examination and verification of its suitability and applicability by a licensed professional engineer. Contents within the inner border line shall not be altered.



PLAN 1



ELEVATION 2

Drilled shaft location and top of drilled shaft elevation shall be field verified by the Contractor prior to fabrication of post.

DMS CABINET DESCRIPTION

VF - 2420 96 X 400 - 20 - RGB
 Front Panel Depth = 7'-10
 Top Cabinet Width = 11"
 Length = 27'-6 1/4
 Weight = 2290 lbs.

NOTES:

See Traffic Plans for the Sign Structure Location.
 Catwalk optional. See Traffic Plans.
 If catwalk is omitted, the W6 X 20 Mounting post shall be cut off 1'-2 from the Bottom.

PAY ITEM NOTES:

Pay Item for butterfly sign structure foundation includes the drilled shaft, the formed pedestal on drilled shaft, and the anchor bolt assembly.
 Pay Item 6060152 SIGN STRUCTURE (BUTTERFLY DMS) Measure: Each
 Pay Item 6060152 SIGN STRUCTURE (FOUNDATION FOR BUTTERFLY DMS) Measure: Each

GENERAL NOTES:

Construction Specification - Arizona Department of Transportation Standard Specifications for Road and Bridge Construction, Edition, of 2008.

Design Specifications - AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals, Sixth Edition of 2013.

Standard Specifications for Highway Bridges 17th Edition - 2002.

Wind Loading: 90 MPH Velocity.

DMS - TYPE I

All concrete shall be Class "S".

Reinforcing steel shall conform to ASTM Specification A615 (Grade 60).

Structural Steel shall conform to ASTM Specification A36 unless noted otherwise.

Stresses:

Class "S" concrete f'c = 3500 psi
 Grade 60 reinforcing steel fs = 24000 psi
 Structural steel Fy = 35000 psi

All bolts shall conform to ASTM Specification A325. All bolts, nuts and washers shall be galvanized in accordance with the requirements of ASTM A153. All other steel shall be galvanized after fabrication in accordance with ASTM A123.

All Tubular Structural Frame Pipes shall be welded or seamless steel pipes and shall conform to ASTM specifications:

A53,	Grade B,	Type E or S
A252,	Grade 2,	Type E or S
A106,	Grade B,	Type S only
API 5L,	Grade B,	Type E or S
API 5LX,	Grade X42,	Type E or S

Prior to erecting any portion of the Sign Structure, the Contractor shall provide the Engineer an erection plan for review and approval.

Dimensions shall not be scaled from drawings.

WELDING NOTES:

Welding of structural tubing shall conform to the requirements of the American Welding Society (AWS), Structural Welding Code D1.1, latest edition.

All other welding shall conform to the requirements of the American Welding Society, AWS/AASHTO/AWS D1.5, Bridge Welding Code, latest edition.

All welding shall be continuous unless noted otherwise.

All butt welds shall be full penetration using prequalified welding procedures, and shall be tested by ultrasonic testing.

All butt welds shall be ground flush, full width.

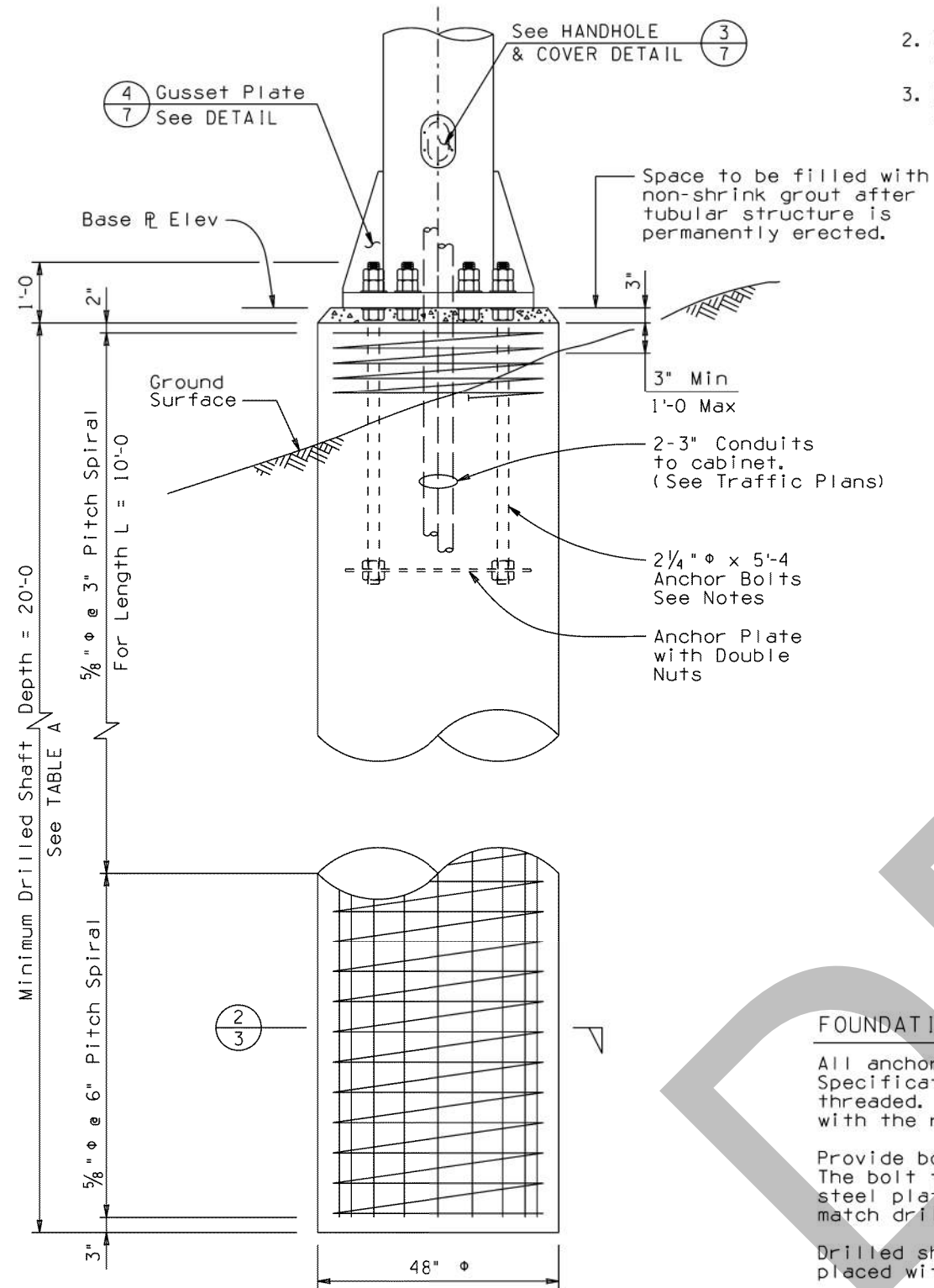
Grinding striations shall be parallel to length of member.

BUTTERFLY SIGN STRUCTURE		POST PIPE DATA			MAST ARM PIPE DATA			
Maximum DMS Dimensions	Max DMS Weight	Pipe Nominal Diameter (IN)	Pipe Wall Thickness (IN)	Max Post Height (FT) "L"	Pipe Nominal Diameter (IN)	Pipe Wall Thickness (IN)	Mast Arm Length (FT)	Mast Arm Spacing (FT)
27'-6 1/4 W x 7'-10 H x 11" D	2290 Lbs	24.0	0.50	Varies	16.0	0.50	Varies	3'-6

STANDARDS ENGINEER A. ALZUBI	ARIZONA DEPARTMENT OF TRANSPORTATION INFRASTRUCTURE DELIVERY AND OPERATIONS DIVISION BRIDGE GROUP STANDARD DRAWING	
RECOMMENDED FOR APPROVAL GROUP MANAGER D. EBERHART	DYNAMIC MESSAGE SIGN BUTTERFLY PLAN AND ELEVATION	DRAWING NO. SD 9,60 1 of 7
APPROVED STANDARDS COMMITTEE APPROVED FOR DISTRIBUTION	01/21 DATE	

PRIOR DISTRIBUTION DATE

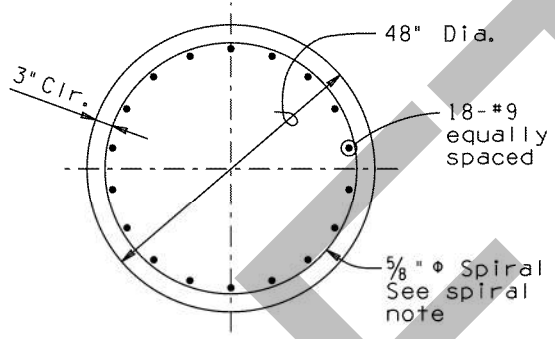
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DRILLED SHAFT ELEVATION (1)

NOTES:

1. Provide 2 Hardened Steel washers, 2 Hex nuts and one leveling nut for each bolt. At final position of post, all top and bottom nuts of anchor bolts shall be snug tightened against base plate.
2. Gusset plates shall be placed perpendicular to base plate and post face, and shall be centered between anchor bolt holes.
3. Base Plate, Post, and Gusset plates welds shall be as shown in Details 1 and 2 on Sheet S-9.60 (7 of X)



SECTION (2)

TABLE A	
Max. Slope	'X'
8:1	0'
6:1	1'
4:1	2'
2:1	4'
1 1/2:1	5'
1:1	8'

Drilled Shaft Depth shall be adjusted for ground slope. Add a value of 'X' in TABLE A to the minimum Drilled Shaft depth to obtain the total length of shaft.

FOUNDATION NOTES:

All anchor bolts shall conform to ASTM F1554 Grade 55 Specifications. The upper 1'-2 and lower 6" shall be threaded. The upper 1'-8 shall be galvanized in accordance with the requirements of ASTM A153.

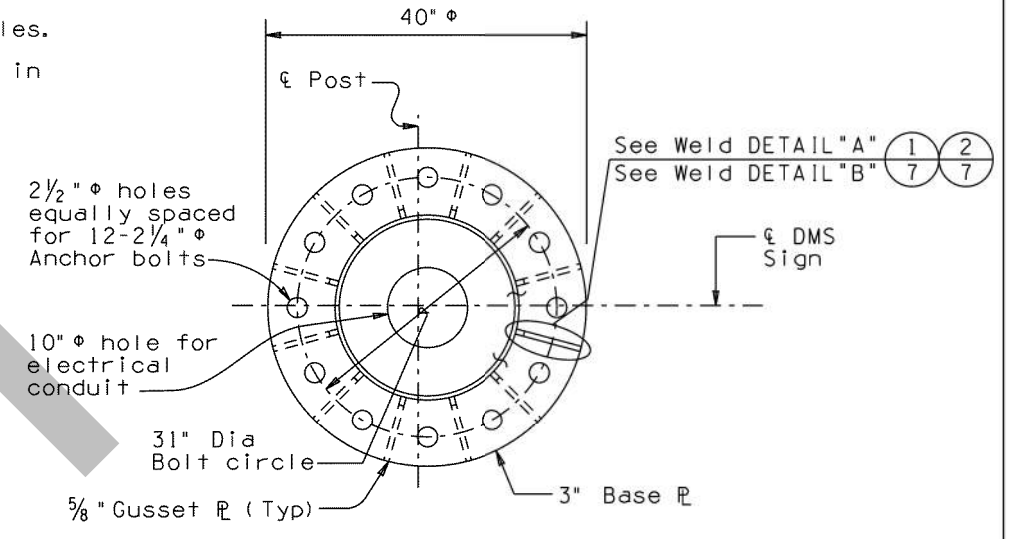
Provide bolt template during installation of anchor bolts. The bolt template shall be fabricated of 1/4" thick (Min.) steel plate, similar to anchor plate details, and shall be match drilled to each base plate.

Drilled shaft concrete shall be class S, and shall be placed within undisturbed material or compacted embankment.

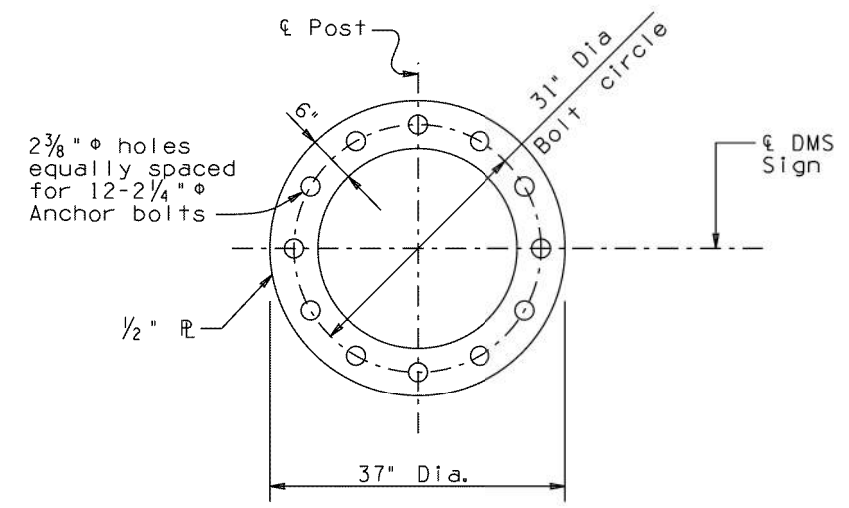
Top of drilled shaft shall be formed to 1'-0 below ground surface. Compacted backfill shall be in place prior to erecting post.

SPIRAL NOTE:

The 5/8" diameter spiral shall be cold drawn steel wire conforming to AASHTO M32 except minimum Tensile Strength = 60,000 psi. Lap 1 1/2 turns at top and bottom of spiral.



3" BASE PLATE DETAILS (3)

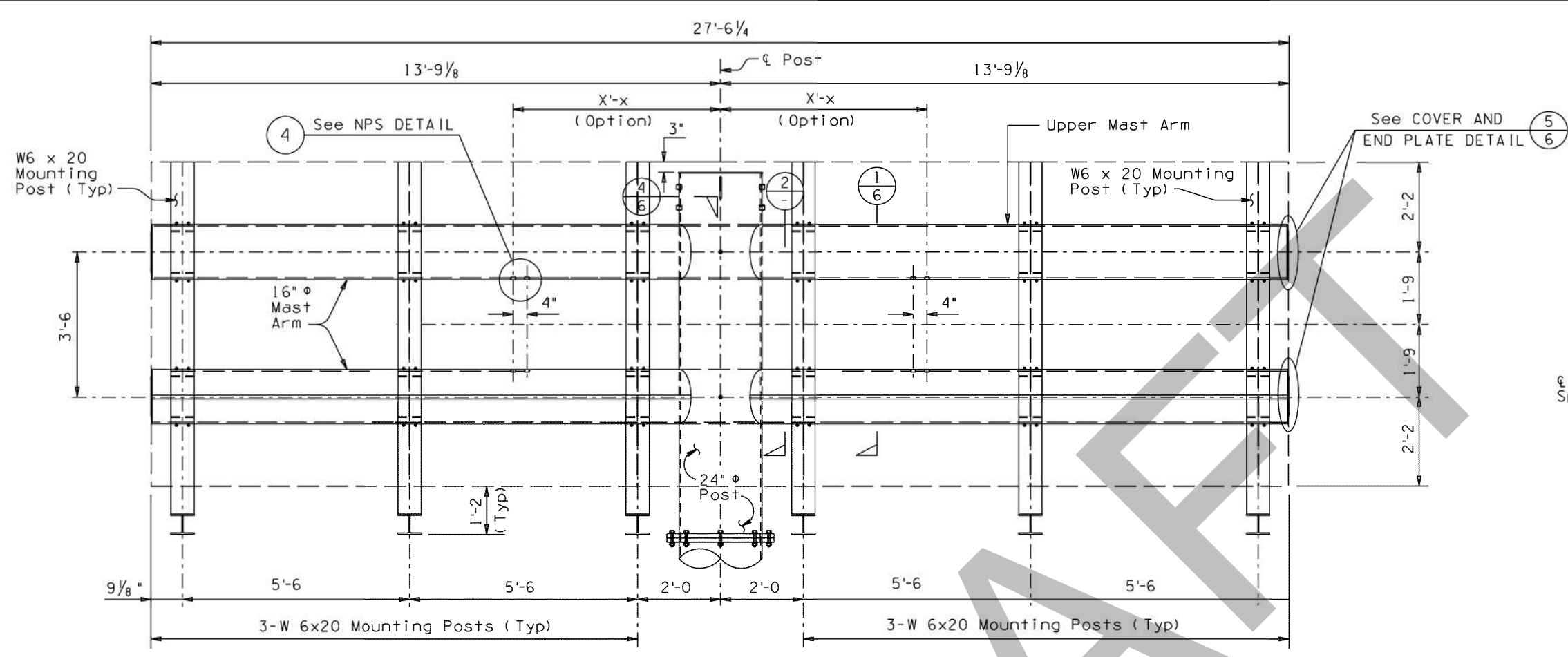


1/2" ANCHOR PLATE DETAILS (4)

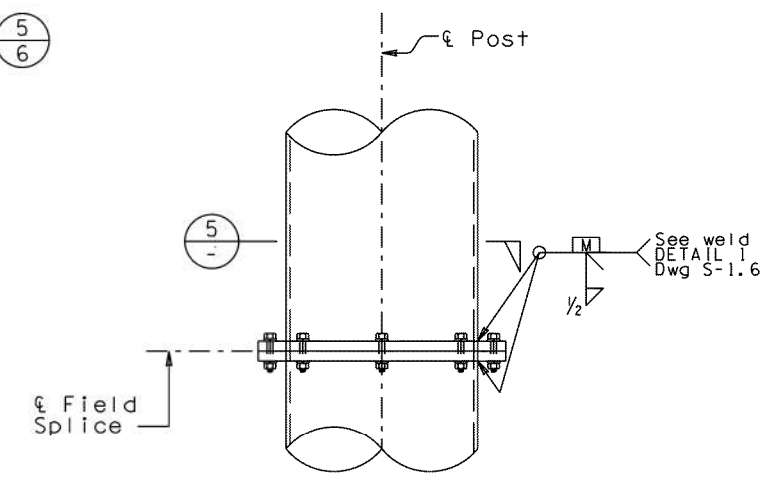
STANDARDS ENGINEER A. ALZUBI	ARIZONA DEPARTMENT OF TRANSPORTATION INFRASTRUCTURE DELIVERY AND OPERATIONS DIVISION BRIDGE GROUP STANDARD DRAWING	
RECOMMENDED FOR APPROVAL GROUP MANAGER D. EBERHART	DYNAMIC MESSAGE SIGN BUTTERFLY FOUNDATION DETAILS	DRAWING NO. SD 9.60 2 of 7
APPROVED STANDARDS COMMITTEE APPROVED FOR DISTRIBUTION	01/21 DATE	

PRIOR DISTRIBUTION DATE

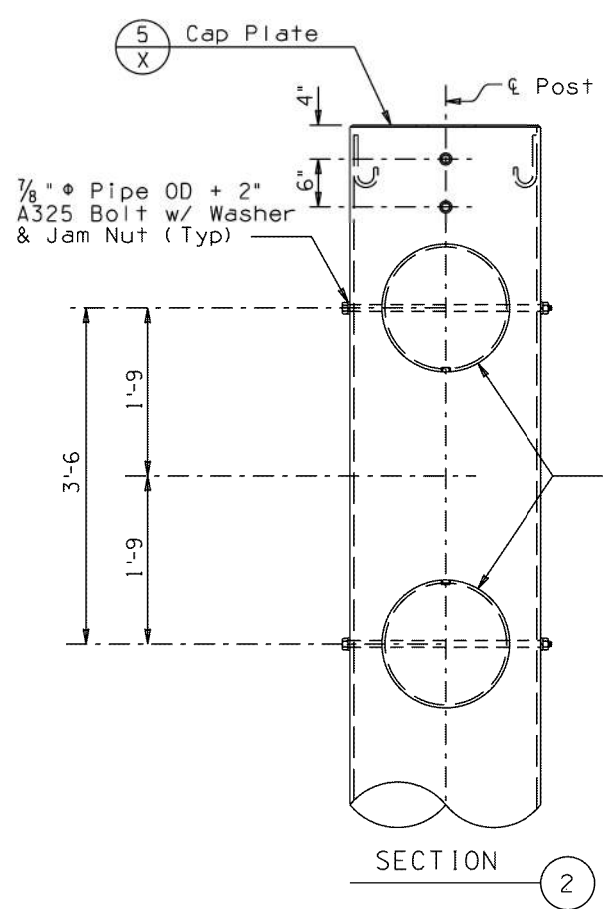
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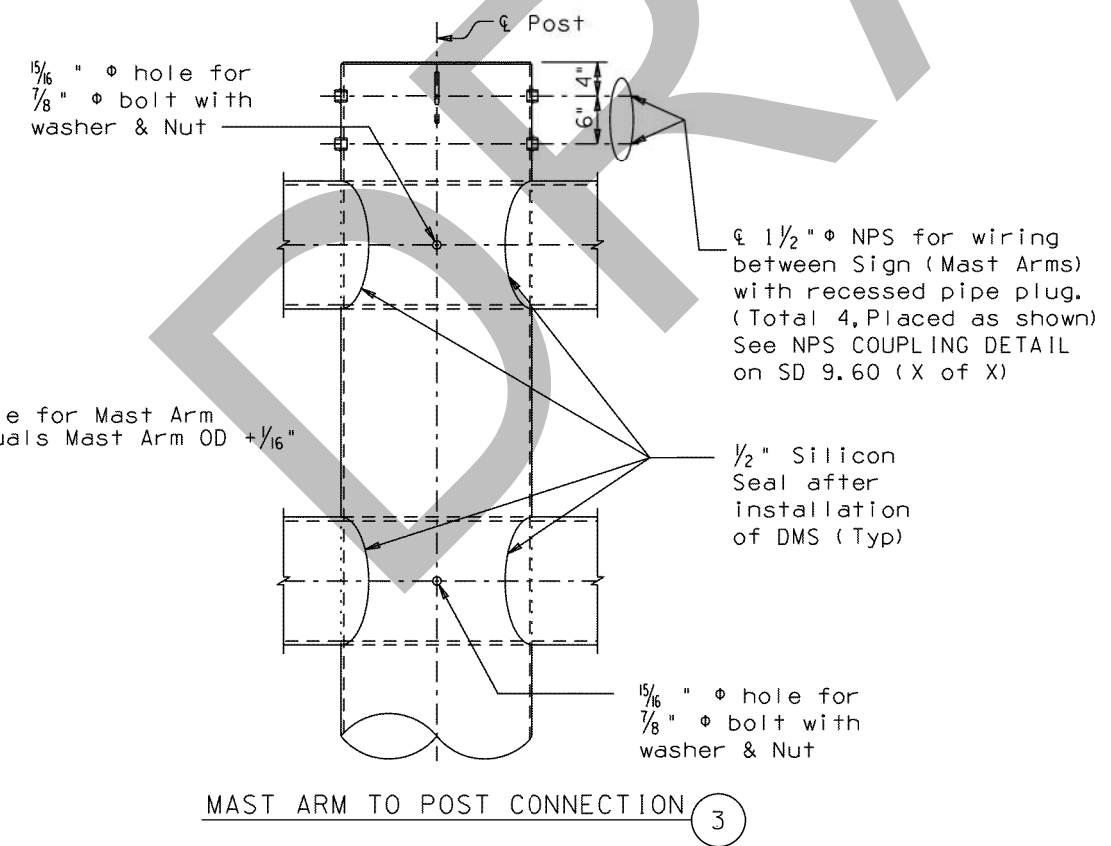
ELEVATION (MONOTUBE ASSEMBLY) 1



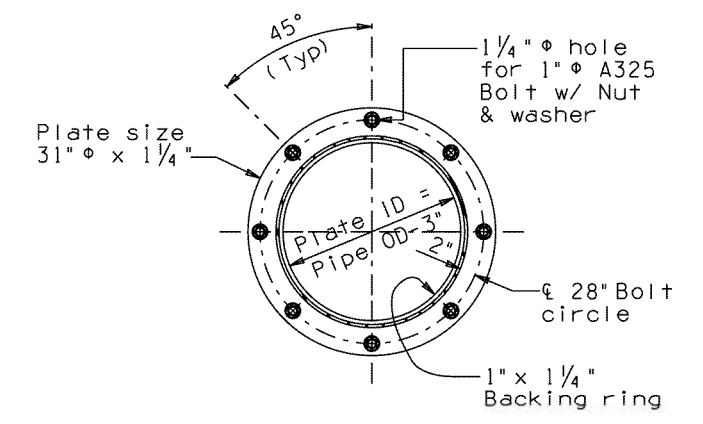
OPTIONAL FIELD SPLICE DETAIL 1



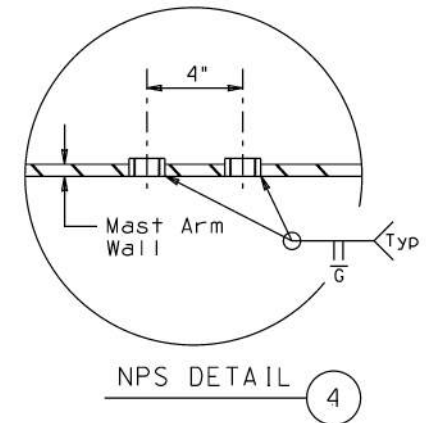
SECTION 2



MAST ARM TO POST CONNECTION 3



SECTION 5



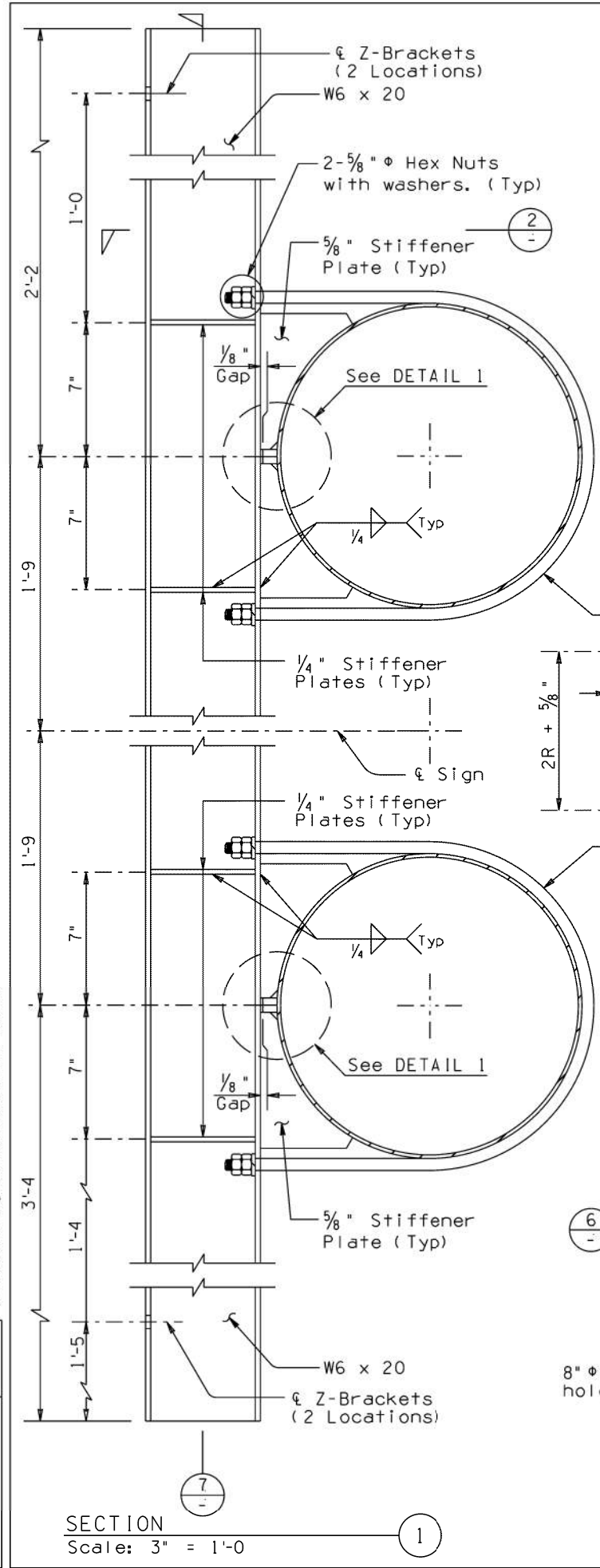
NPS DETAIL 4

NPS NOTE:
 Flush mount 2-1/2" NPS for wiring between both sign Mast Arms as shown. (Optional)

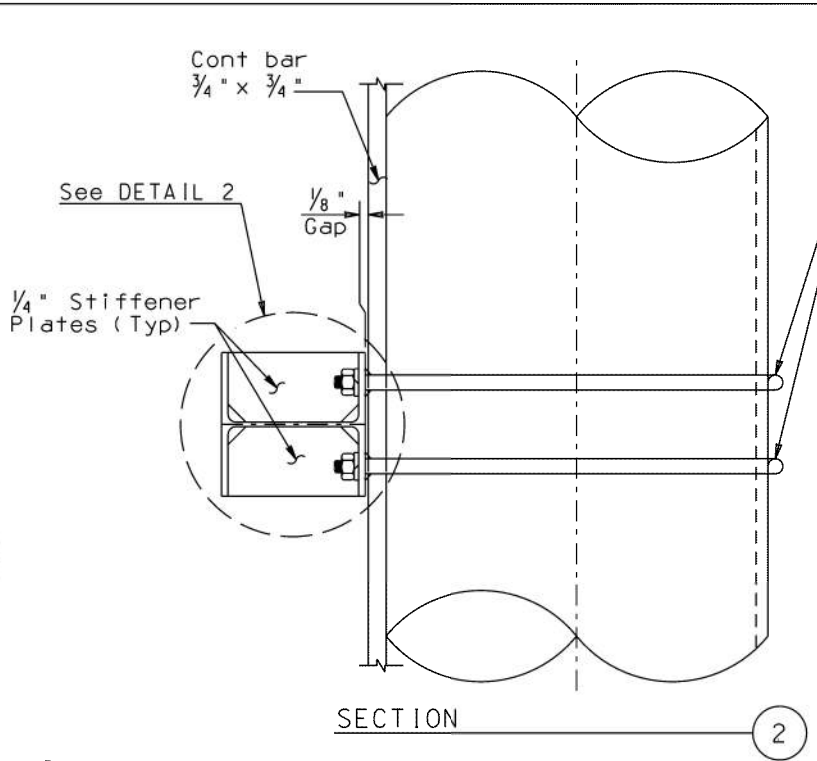
STANDARDS ENGINEER A. ALZUBI RECOMMENDED FOR APPROVAL GROUP MANAGER D. EBERHART APPROVED STANDARDS COMMITTEE APPROVED FOR DISTRIBUTION	ARIZONA DEPARTMENT OF TRANSPORTATION INFRASTRUCTURE DELIVERY AND OPERATIONS DIVISION BRIDGE GROUP STANDARD DRAWING DYNAMIC MESSAGE SIGN BUTTERFLY DMS SIGN MONOTUBE ASSEMBLY	DRAWING NO. SD 9.60 3 of 7
DATE: DI/21		

PRIOR DISTRIBUTION DATE

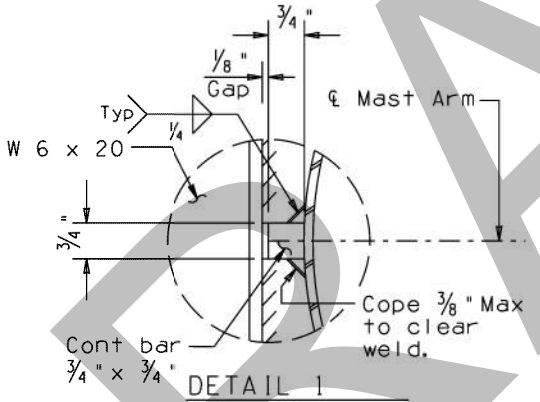
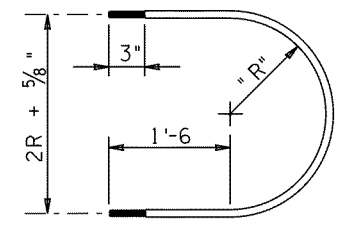
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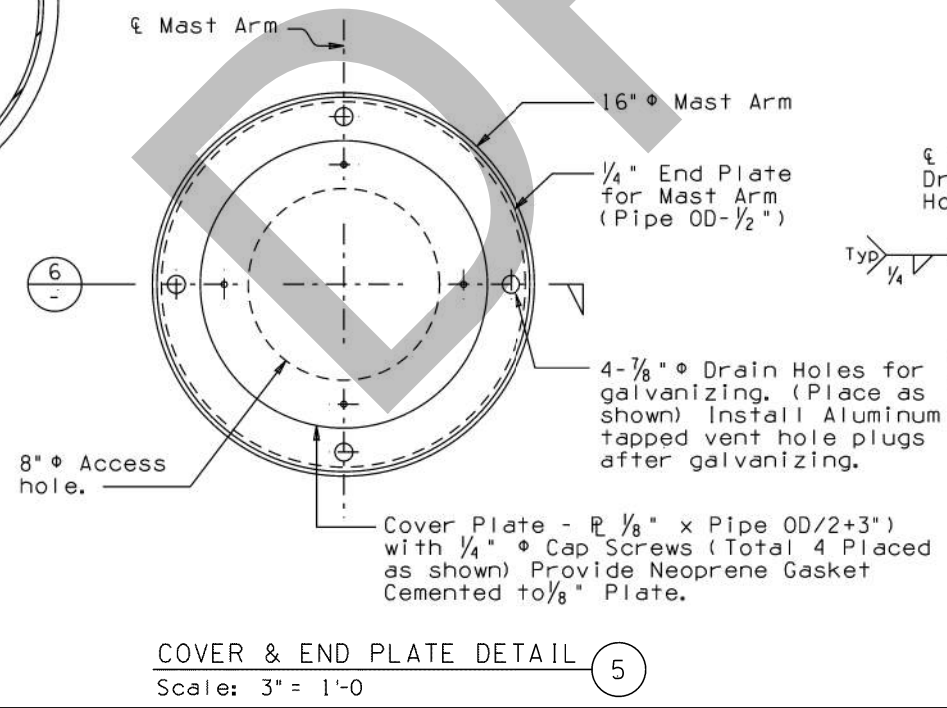
SECTION 1
Scale: 3" = 1'-0"



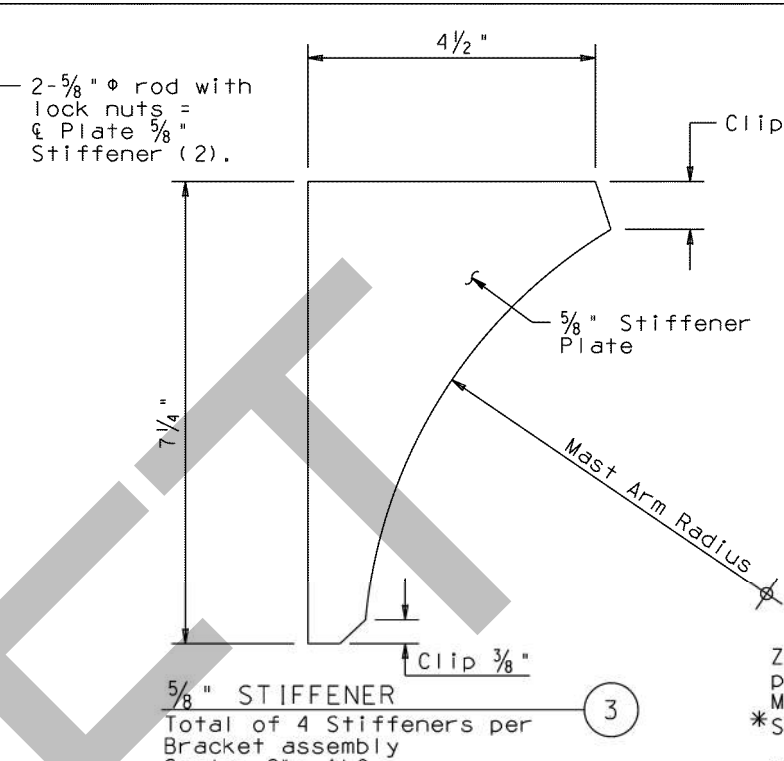
SECTION 2



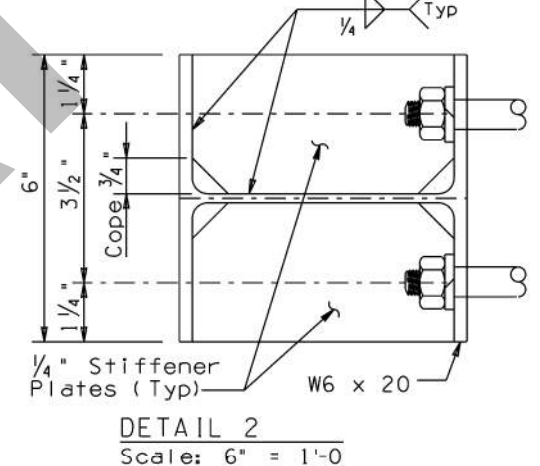
DETAIL 1



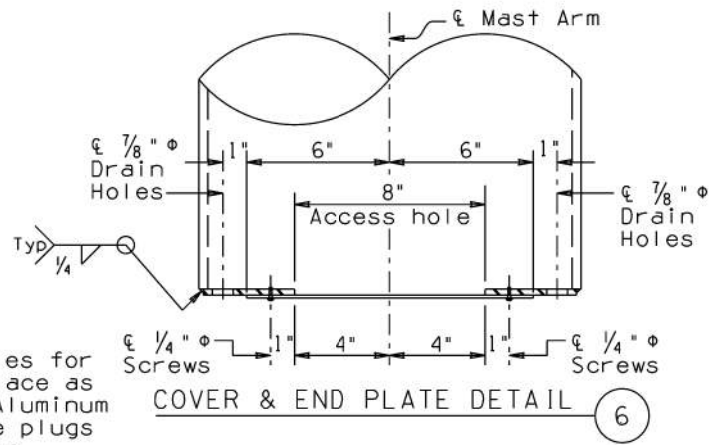
COVER & END PLATE DETAIL 5
Scale: 3" = 1'-0"



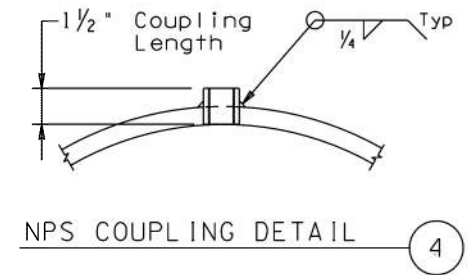
SECTION 3
5/8" STIFFENER
Total of 4 Stiffeners per Bracket assembly
Scale: 2" = 1'-0"



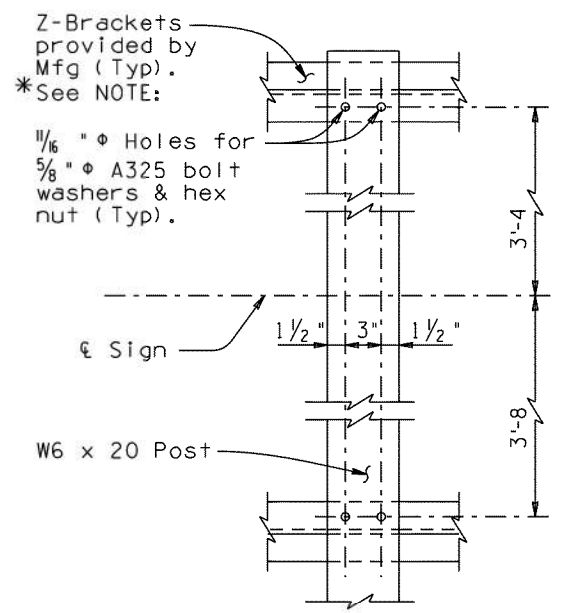
DETAIL 2
Scale: 6" = 1'-0"



COVER & END PLATE DETAIL 6



NPS COUPLING DETAIL 4



Z-Brackets provided by Mfg (Typ).
* See NOTE:

1/8" Holes for 5/8" A325 bolt washers & hex nut (Typ).

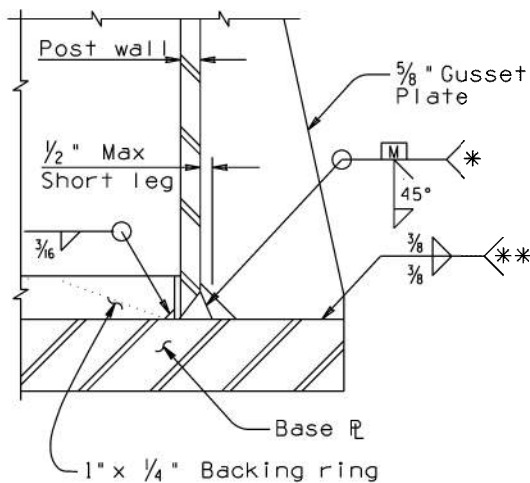
SECTION 7

***Z-Bracket NOTE:**
Barrier Tape shall be used at any point of contact between aluminum Z-Mounting Brackets (provided by manufacturer) and Steel Sign Supports. The Contractor shall supply Tape based on Manufacturer's recommendations, and shall be submitted to the Engineer for approval.

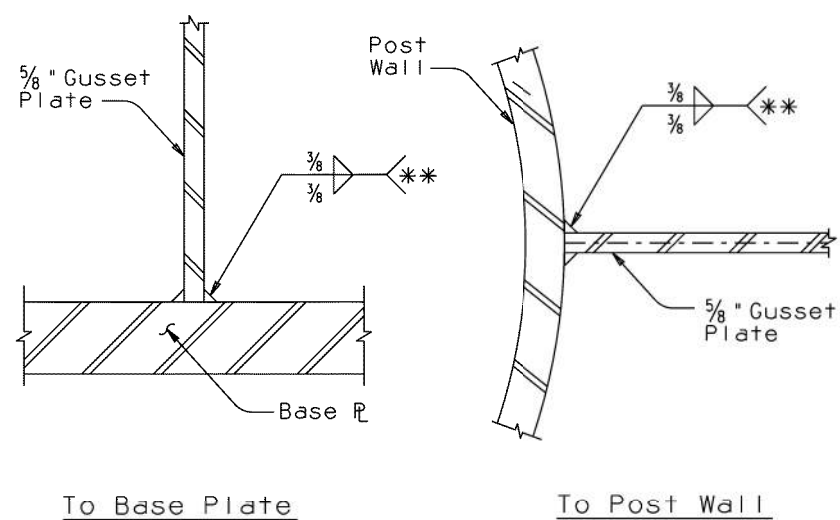
STANDARDS ENGINEER A. ALZUBI	ARIZONA DEPARTMENT OF TRANSPORTATION INFRASTRUCTURE DELIVERY AND OPERATIONS DIVISION BRIDGE GROUP STANDARD DRAWING
RECOMMENDED FOR APPROVAL GROUP MANAGER D. EBERHART	
APPROVED STANDARDS COMMITTEE APPROVED FOR DISTRIBUTION	DYNAMIC MESSAGE SIGN BUTTERFLY DMS SIGN MAST ARM DETAILS
DI/21 DATE	DRAWING NO. SD 9.60 4 of 7

* Preheat per AWS requirements

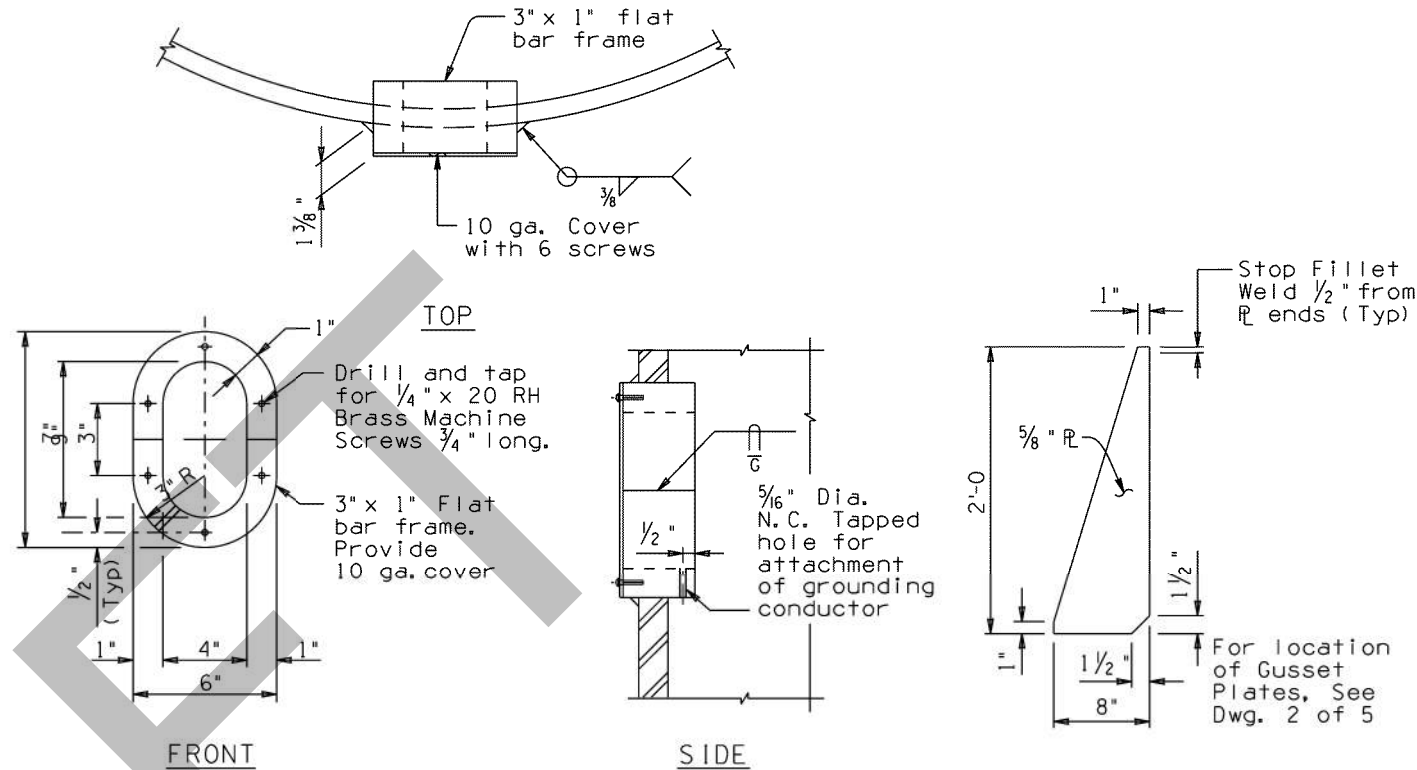
** Stop fillet weld 1/2" from R ends



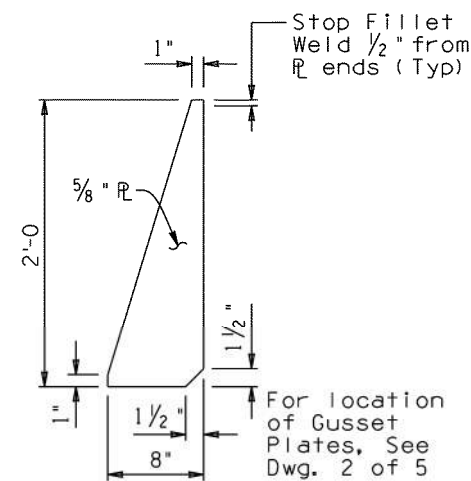
DETAIL A
POST TO BASE PLATE WELDING ①



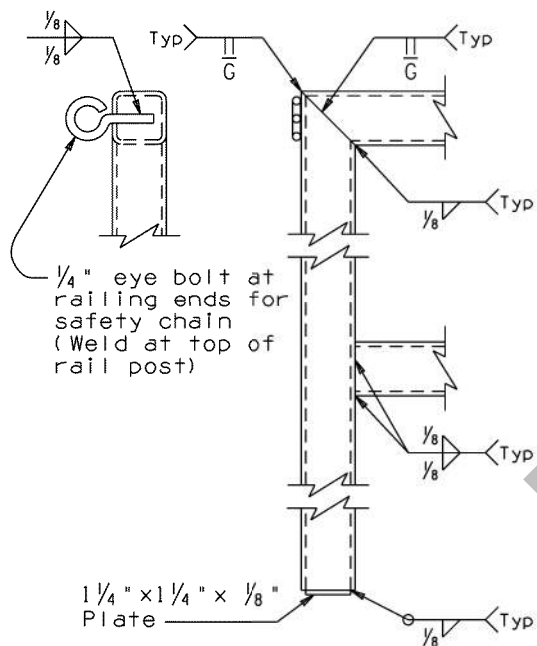
DETAIL B
GUSSET PLATE WELDING ②



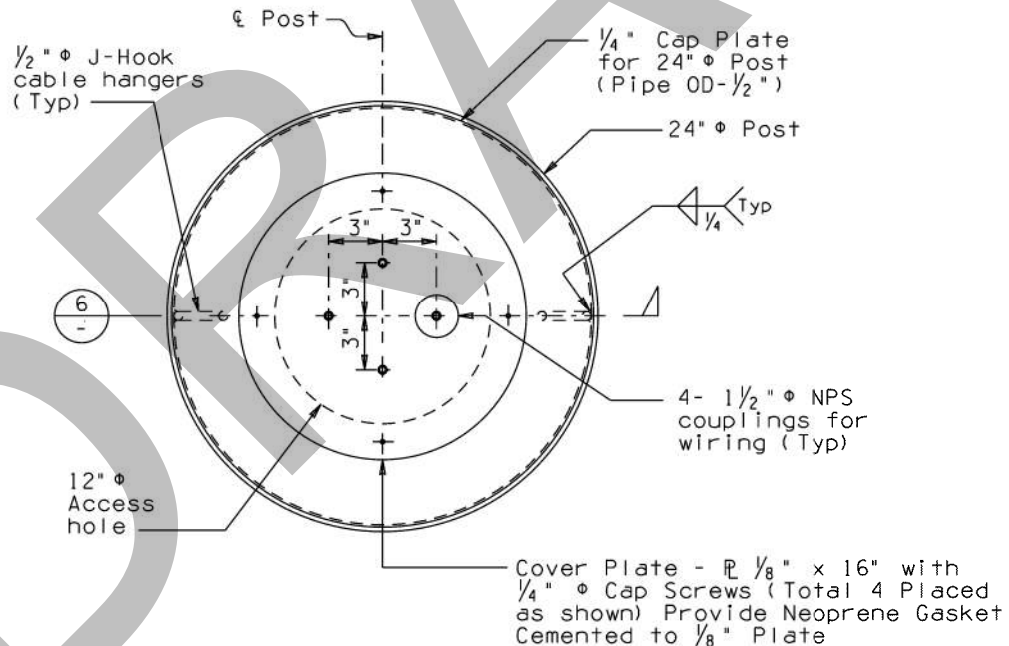
HANDHOLE & COVER DETAILS ③



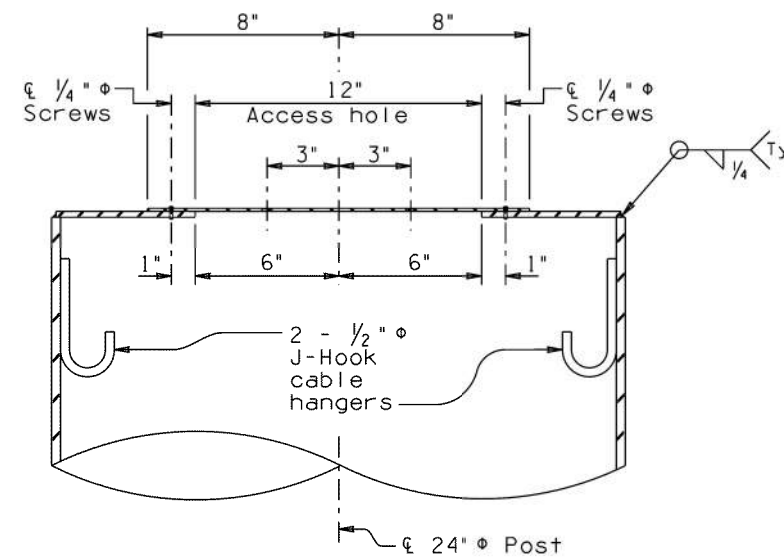
GUSSET PLATE DETAIL ④



HANDRAIL WELD DETAILS



CAP PLATE DETAIL ⑤



CAP PLATE SECTION DETAIL ⑥

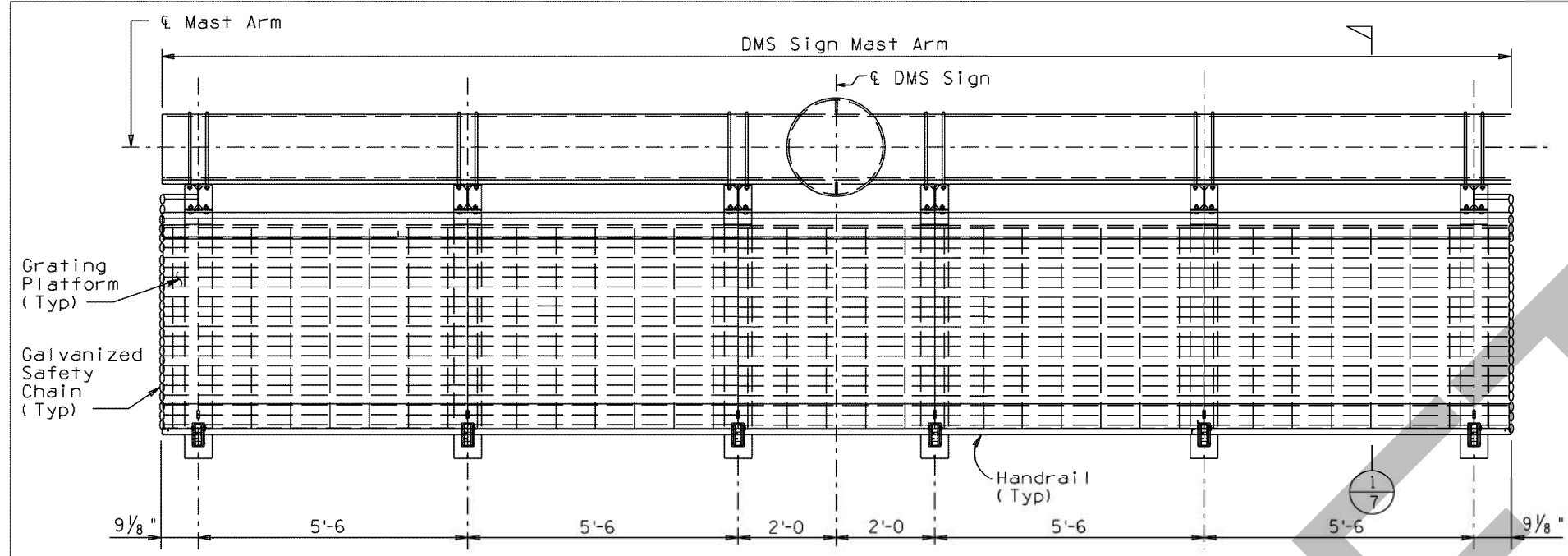
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PRIOR DISTRIBUTION DATE

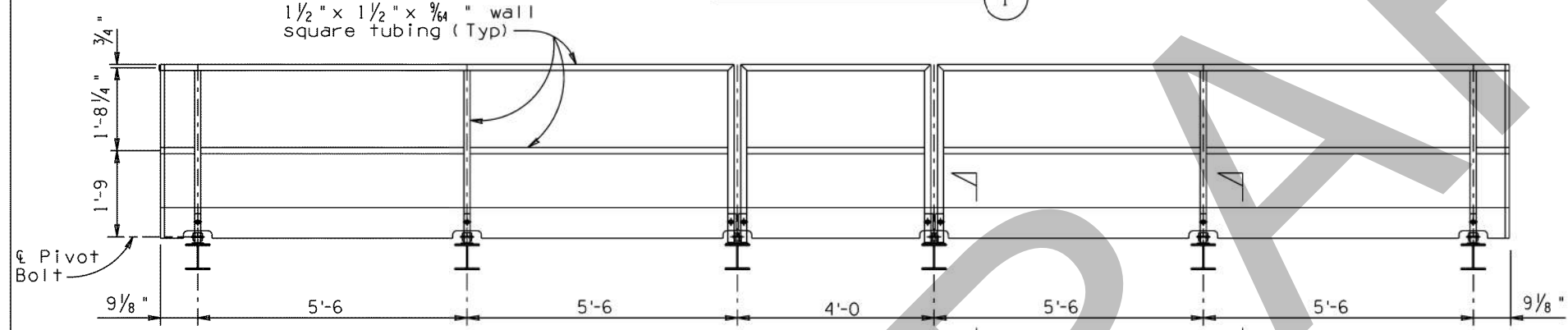
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RECOMMENDED FOR APPROVAL GROUP MANAGER D. EBERHART	
APPROVED STANDARDS COMMITTEE APPROVED FOR DISTRIBUTION 01/21 DATE	DYNAMIC MESSAGE SIGN BUTTERFLY MISCELLANEOUS DETAILS

DRAWING NO. SD 9.60 5 of 7

Note to Designer: The information presented in this Standard Drawing has been prepared in accordance with recognized engineering principles and is for general use. It should not be used for specific application without competent professional examination and verification of its suitability and applicability by a licensed professional engineer. Contents within the inner border line shall not be altered.

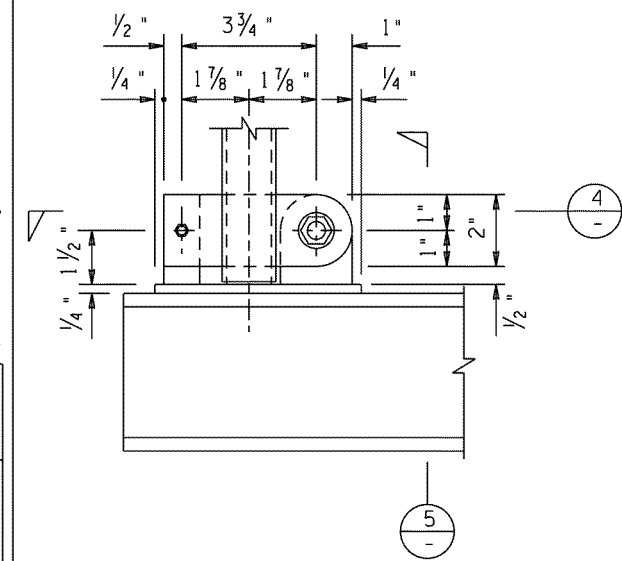


CATWALK PLAN VIEW (1)

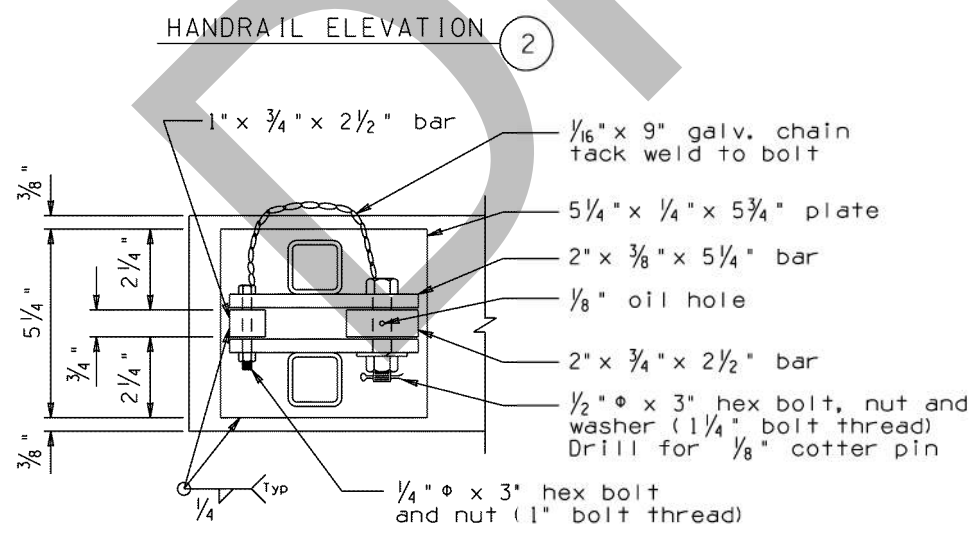


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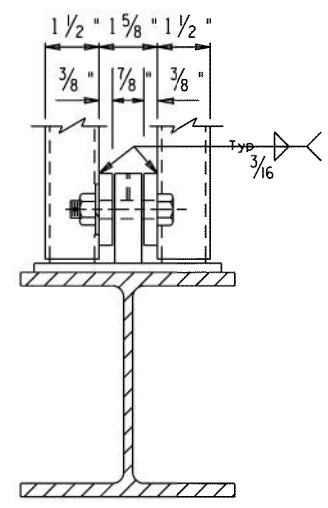
NOTE:
 Provide 5/8" ϕ holes for 1/2" ϕ pivot bolts and 3/8" ϕ holes for 1/4" ϕ lock bolts



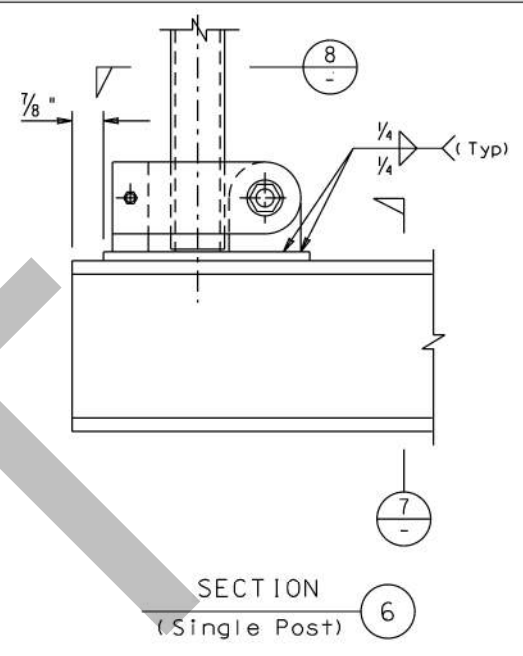
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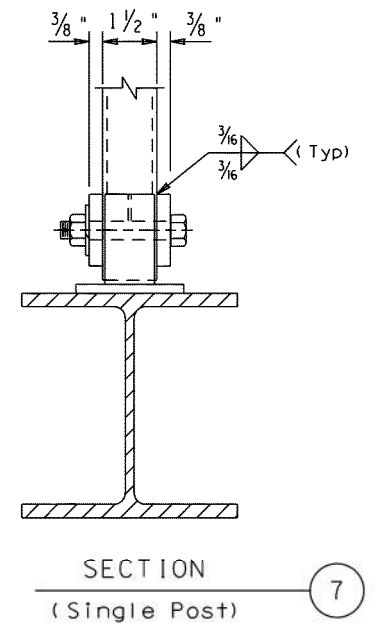
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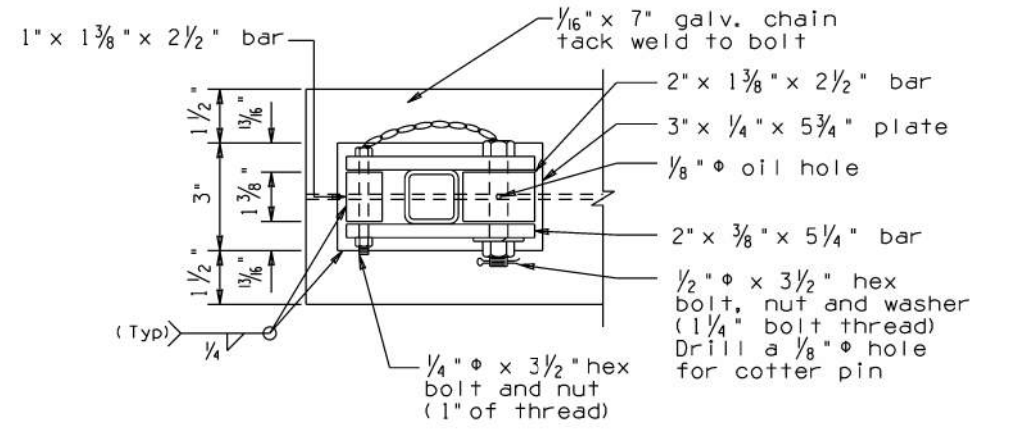
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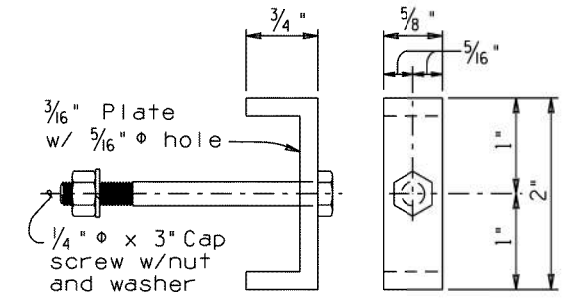
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SECTION (8) (Single Post)



SECTION (8) (Single Post)



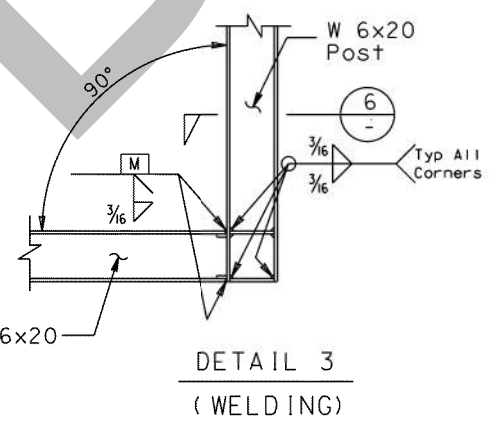
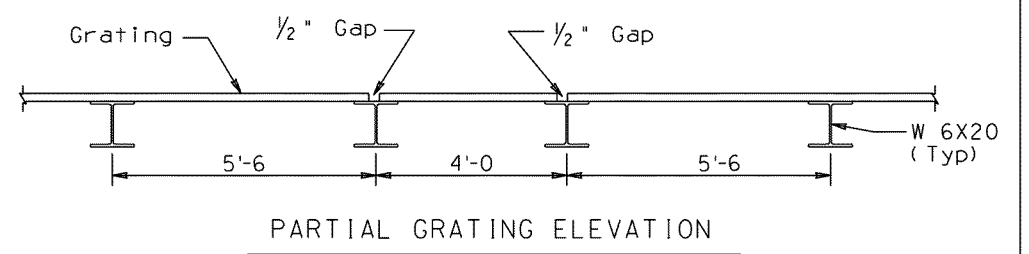
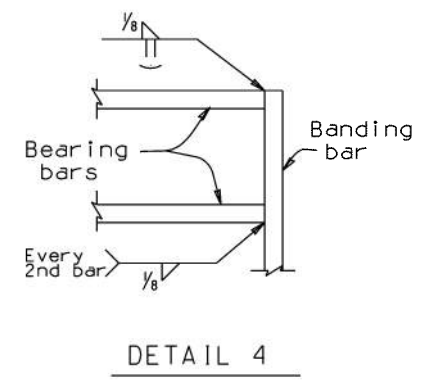
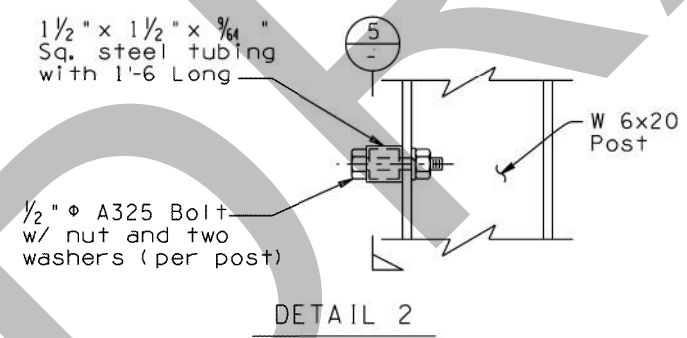
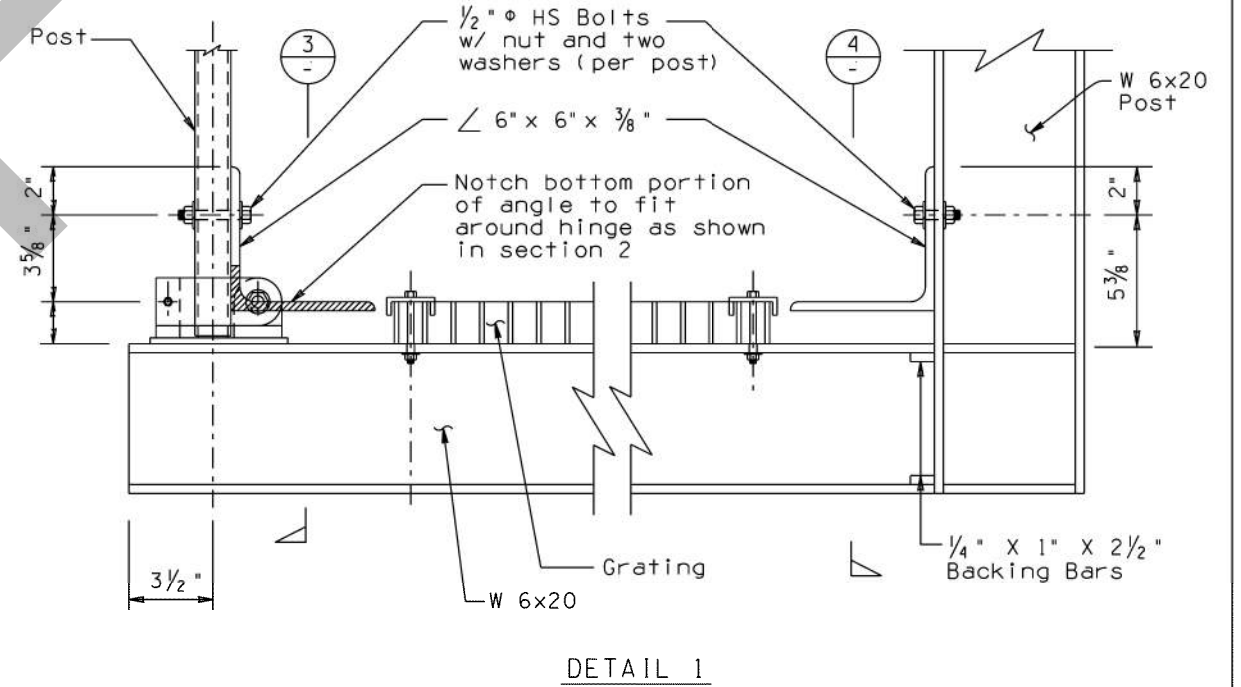
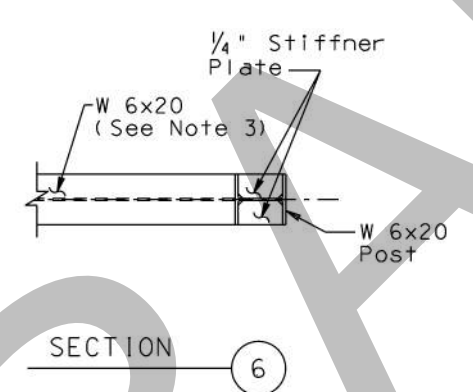
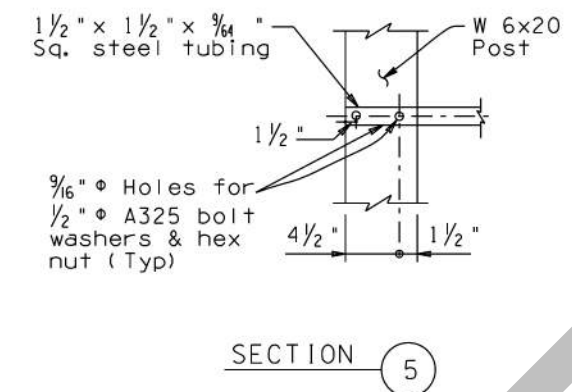
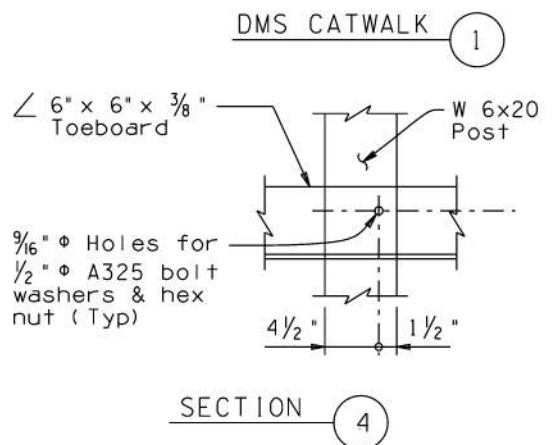
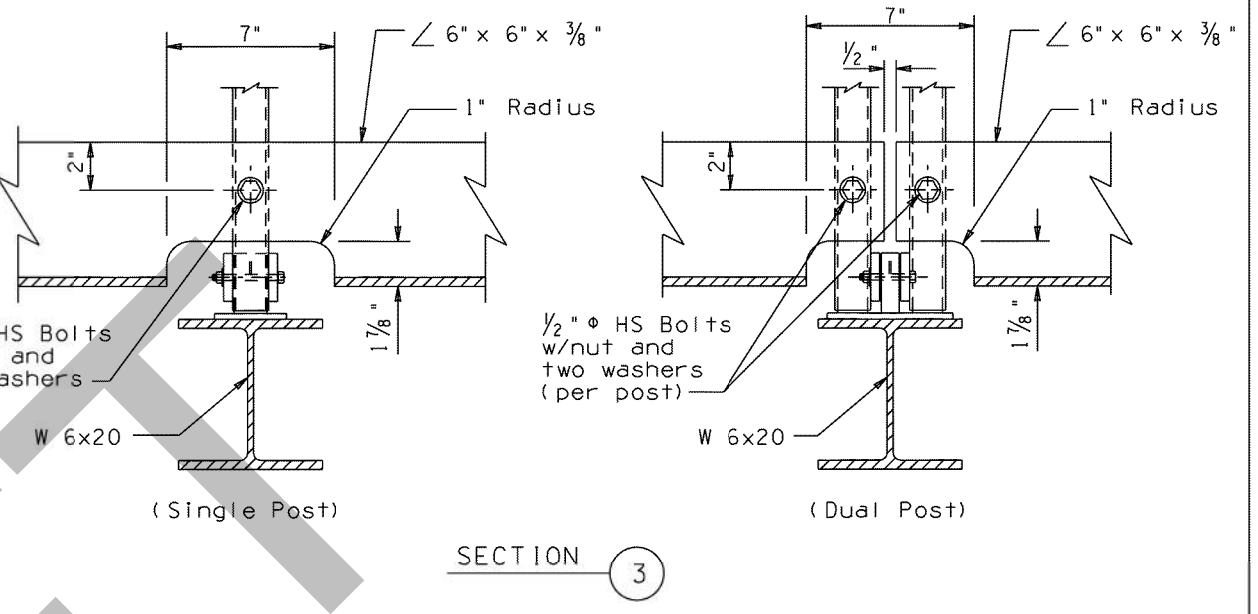
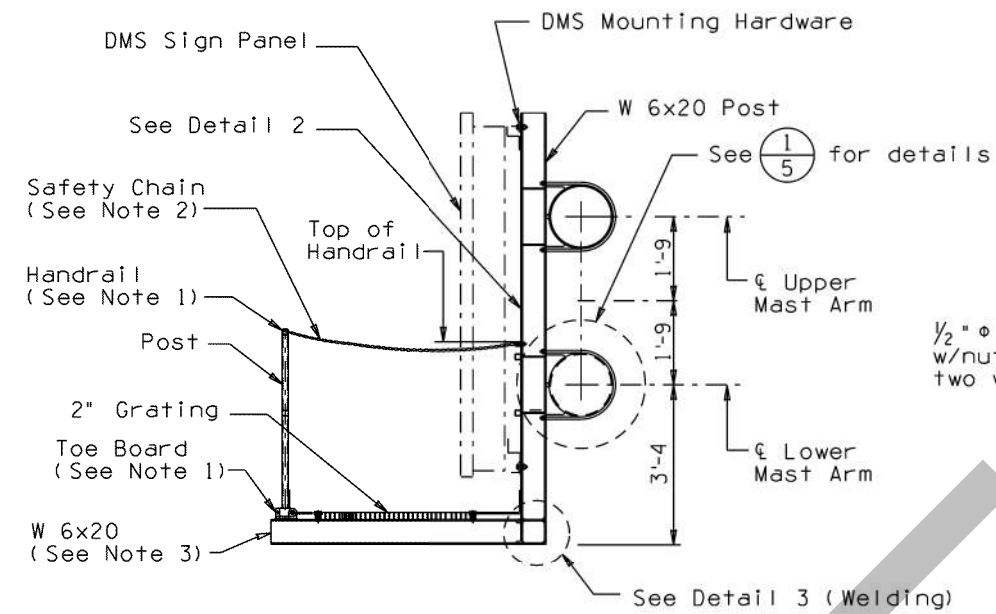
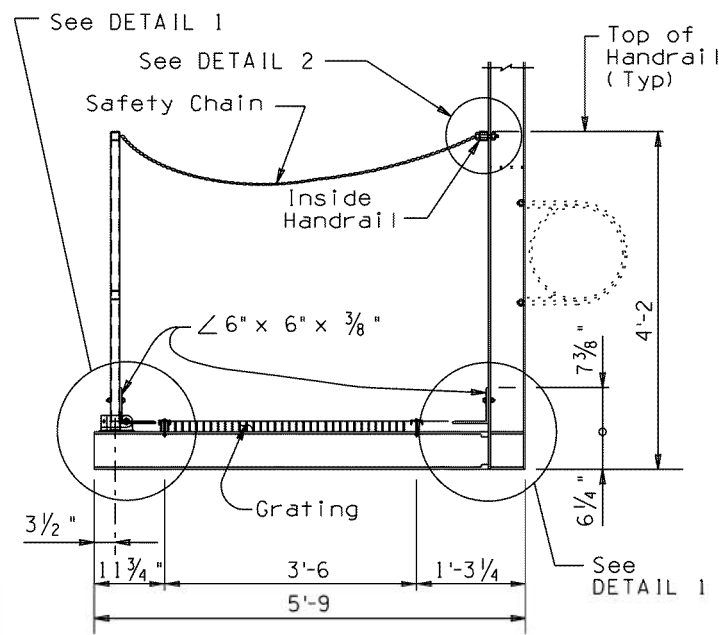
DETAIL 5 GRATING CLIP

STANDARDS ENGINEER
 A. ALZUBI
 RECOMMENDED FOR APPROVAL
 GROUP MANAGER
 D. EBERHART
 APPROVED
 STANDARDS COMMITTEE APPROVED FOR DISTRIBUTION 01/21 DATE

ARIZONA DEPARTMENT OF TRANSPORTATION
 INFRASTRUCTURE DELIVERY AND OPERATIONS DIVISION
BRIDGE GROUP STANDARD DRAWING
 DYNAMIC MESSAGE SIGN
 BUTTERFLY
 CATWALK ASSEMBLY AND HANDRAIL
 DRAWING NO.
 SD 9.60
 6 of 7

PRIOR DISTRIBUTION DATE

Note to Designer: The information presented in this Standard Drawing has been prepared in accordance with recognized engineering principles and is for general use. It should not be used for specific application without competent professional examination and verification of its suitability and applicability by a licensed professional engineer. Contents within the inner border line shall not be altered.



NOTES:

Welded grating shall meet the standard requirements of ANSI/NAAMM MGB 531-00. Grating shall be 2" x 3/16" bearing bars at 1 3/16" centers and cross bars at 4" centers.

All grating shall have 2" x 3/16" banding bars at both ends.

Weld bearing bars to banding bars with 1/8" fillet weld, one side every second bar and as shown in Detail 3.

All grating to be straight and true after fabrication. Grating shall be galvanized.

See Table for grating dimensions.

The Field splice surface shall be in full contact without gaps prior to the bolts being snug tightened and fully tensioned. The contact surface is the area defined by a 1 3/8" radius around each bolt.

3/16" galvanized safety chain with 1- 1/4" snap hook at end of catwalks.

Omit horizontal W 6x20, backing bars and stiffeners when Catwalk is specifically omitted on Traffic Plans.

STANDARDS ENGINEER A. ALZUBI	ARIZONA DEPARTMENT OF TRANSPORTATION INFRASTRUCTURE DELIVERY AND OPERATIONS DIVISION BRIDGE GROUP STANDARD DRAWING	
RECOMMENDED FOR APPROVAL GROUP MANAGER D. EBERHART	DYNAMIC MESSAGE SIGN BUTTERFLY CATWALK DETAILS	
APPROVED STANDARDS COMMITTEE APPROVED FOR DISTRIBUTION DATE 01/21	DRAWING NO. SD 9.60 7 of 7	

1 **TP Attachment 455-3 – Bridge Repair (Penetrating Deck Sealer – Methacrylate)**
2

1 **ITEM 9240139 – BRIDGE REPAIR (PENETRATING DECK SEALER –**
2 **METHACRYLATE)**

3
4 **1.0 Description:**

5
6 The work under this Item shall consists of furnishing and applying a methacrylate
7 penetrating crack seal material (hereinafter called sealant material) on the entire bridge
8 deck, approach slabs, and anchor slabs in accordance with the requirements of the
9 project plans, the manufacturer’s recommendations, and the requirements of these
10 specifications.

11
12 **2.0 Materials:**

13
14 **2.1 High Molecular Weight Methacrylate:**

15
16 The penetrating crack sealer material shall be a two-component, low viscosity, 100%
17 solids, high molecular weight methacrylate (HMWM) penetrating crack sealer conforming
18 to the physical and performance requirements shown in Table 1.

19

Table 1: Material Requirements of High Molecular Weight (HMW) Crack Sealers	
Viscosity, ASTM D2196	25 cP (or less)
Tack Free Time in the field	< 400 minutes (6.67 hours)
Dry Slant Shear, ASTM C882	1500 psi minimum
Compressive Yield Strength, ASTM D695	2500 psi 2-day minimum
Tensile Strength, ASTM D638	1500 psi minimum
Tensile Elongation, ASTM D638	3% minimum

20
21 The contractor shall review and follow all of the manufacturer’s recommendations on how
22 to use and mix the products.

23
24 **2.2 Broadcast Sand:**

25
26 Provide a commercial-quality, dry-blast sand for a skid resistance surface. The size of the
27 sand shall be such that 95% or more shall pass the No. 8 sieve, and 95% or more shall
28 be retained on the No. 20 sieve.

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3.0 Safety and Construction Requirements:

The application of sealant material shall not begin until the completion of the bridge deck repair work and the bridge deck has cured.

Prior to start of the work, the contractor shall submit a safety plan for use of the penetrating crack sealers. The plan shall identify personnel that have been trained by the manufacturer in the handling, transport, and mixing of the penetrating crack sealer. Personnel who have not been certified by the manufacturer shall not handle, transport, or mix the material. Non-certified personnel may apply the crack sealer only while a certified person is present. The manufacturer certification shall be for personnel that have completed training including the following topics:

1. Compliance with pertinent OSHA and other federal, state, and local regulations governing the use of the equipment, the handling of materials, the methods for preventing the occurrence of hazardous conditions, and accidents.
2. Proper handling, storage, and waste disposal methods to eliminate fire, reactivity and explosion hazards and protect personnel from injury caused by exposure to and contact with the components of the material.
3. Use of effective protective clothing, especially aprons, gloves, goggles, respirators, emergency devices, and adequate ventilation in storage areas.
4. Training in safe work habits, first aid procedures, effective measures for coping with emergencies, and accidents.

The safety plan shall identify the location of storage, the method of transporting the material to the project location, the proposed mixing location, and the mixing procedure to be used at the project site.

The safety plan shall identify processes and precautions used to protect the public. This may include controlling temperatures for storage of the product, protective clothing, equipment used in the handling and application of the material, the transportation procedures, the transportation routes, safety protection plan in the event of a spill, fire, or required clean-up, and maintaining sound safety practices.

1 The Engineer will review the safety plan for use of the penetrating crack sealer products
2 and will either approve it or return it to the contractor for corrections no more than 10
3 working days after receipt. The contractor shall then modify the safety plan, if necessary,
4 and resubmit to the Engineer within five working days. The contractor shall allow five
5 working days for each subsequent review. The contractor shall not commence work until
6 the safety plan has been approved. No increase in contract time will be granted for the
7 contractor's failure to provide acceptable submittals of the safety plan.

8
9 The contractor shall follow the approved safety plan. If it is determined by the Engineer
10 that the measures taken by the contractor are inadequate to provide for public safety, the
11 contractor shall revise his operation. No further work shall be performed associated with
12 the penetrating crack sealer until the public safety measures are adequate and, if
13 required, a revised safety plan has been approved.

14
15 Application equipment shall be as recommended by the manufacturer. The spray
16 equipment, tanks, hose, brooms, rollers, coaters, squeegees etc. shall be thoroughly
17 cleaned, free of foreign matter, oil residue and water prior to applying the penetrating
18 crack sealer to the bridge deck.

19
20 Surfaces, which are to be treated, shall meet the manufacturer's requirements for surface
21 condition prior to application. Sealing shall not be done until all concrete repairs and any
22 other corrective actions needed have been completed and the repaired concrete has
23 cured. The contractor shall furnish the Engineer with written instructions for surface
24 preparation requirements and a representative of the manufacturer shall be present to
25 assure that the surface condition meets the manufacturer's requirements.

26
27 At a minimum, the surface shall be thoroughly cleaned to remove dust, dirt, oil, wax,
28 curing components, efflorescence, laitance, coatings, and other foreign materials. The
29 manufacturer or manufacturer's representative shall approve the use of chemicals and
30 other cleaning compounds to facilitate removal of these foreign materials before use. The
31 penetrating crack sealer treatment shall be applied within 48 hours following surface
32 preparation.

33
34 Cleaning equipment shall be fitted with suitable traps, filters, drip pans and other devices
35 to prevent oil and other foreign material from being deposited on the concrete surface.

36
37 The concrete surface and ambient temperature during application should be in the range
38 of 50 degrees F to 90 degrees F unless otherwise approved by the Engineer or as
39 specified by the manufacturer. The application temperature may affect the curing
40 properties of the materials.

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The sealer shall be applied at the application rate specified by the manufacturer. The material should be spread evenly across the surface of the concrete in a manner to prevent puddles or excessive concentrations of material in small areas. If the applicator is unable to complete the entire application continuously, the location where the application was stopped shall be noted and clearly marked.

When applying the treatment, the contractor shall protect the adjoining surfaces of the structure that are not to be sealed by masking them off or by other means.

A system approved by the Engineer shall be used to provide a watertight seal for existing bridge joints and bridge drainage systems. Care shall be taken to not damage the water tight systems, during construction operations.

Broadcast sand shall be applied following the placement of a penetrating crack sealer on the bridge decks, approach slabs, and anchor slabs. Broadcast sand shall be applied within the period of time and at the rate recommended by the manufacturer. If there is no manufacturer recommended period of time for application of broadcast sand; the sand shall be applied within 20 minutes of penetrating crack sealer placement. If there is no manufacturer recommended application rate for broadcast sand; the rate of application shall be 2 pounds per square yard. If the sand does not adhere to the sealer, an additional application shall be made. All non-adhered sand shall be removed from the bridge deck, approach slabs, and anchor slabs by power sweeping. All non-adhered sand shall be removed from the bridge deck joints by vacuuming the joints.

Vehicular traffic shall only be allowed on the treated deck after meeting manufacturer's requirements and upon approval by the Engineer.

Areas of penetrating crack sealer not applied according to the manufacturer's recommendations or the specifications shall be removed and replaced at no cost to the Department.

4.0 Method of Measurement:

Bridge Repair (Penetrating Deck Sealer - Methacrylate) will be measured by the square yard of bridge deck covered with sealant material.

5.0 Basis of Payment:

1 The accepted quantities of Bridge Repair (Penetrating Deck Sealer - Methacrylate),
2 measured as provided above, will be paid for at the contract unit price per square yard,
3 which price shall be full compensation for the work, complete in place, as shown on the
4 project plans, as specified herein, and as directed by the Engineer.

5

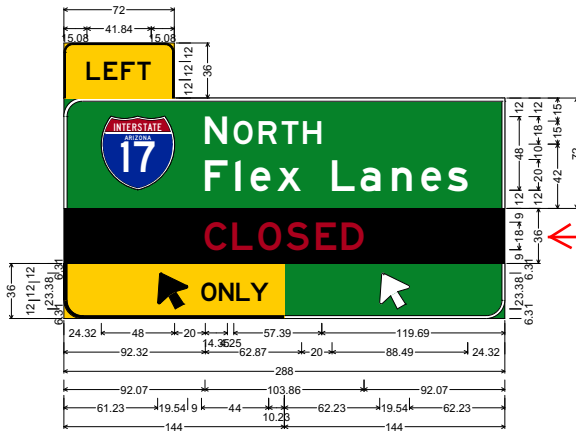
6 No additional payment will be made for the development and preparation of the program
7 for public safety associated with the use of the sealant material, the cost being considered
8 as included in the price of the contract item.

9

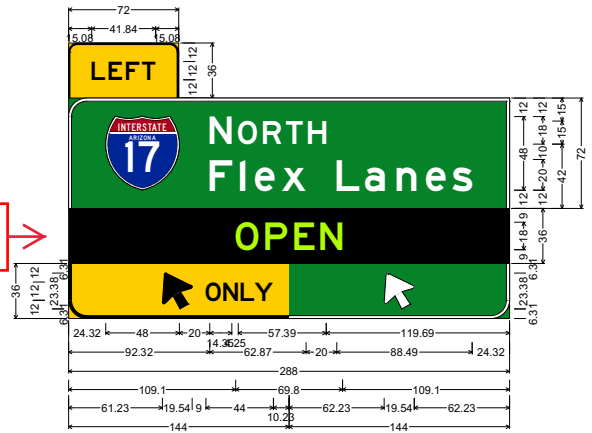
10 No additional payment will be made for broadcast sand, the cost being considered as
11 included in the price of the contract, regardless of how many applications the contractor
12 applies in order for the sand to adhere to the sealer.

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TP Attachment 460-1 – Flex Lanes Guide Signs Format

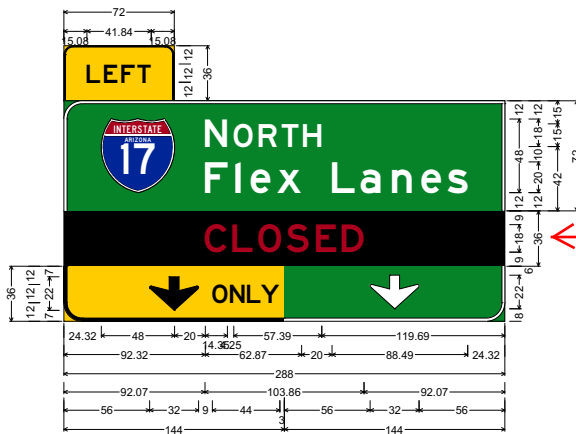


LED Message Board

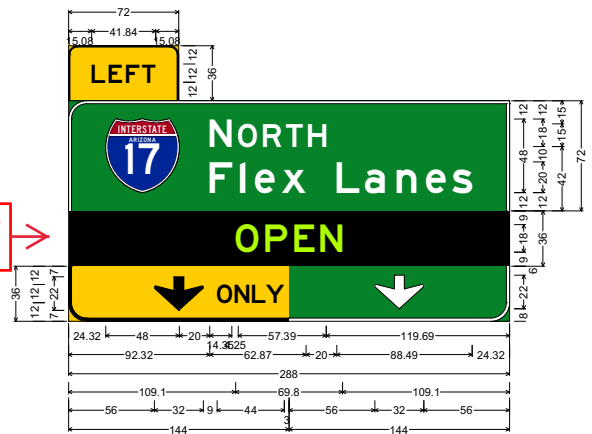


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 State Name 17 M1-2a; "NORTH", E; "Flex Lanes", E;
 No border, None on, Black;
 "CLOSED" Red, E;
 12.00" Radius, 2.00" Border, Black on, Yellow;
 Arrow 16-20 Type B - 120'; "ONLY", E specified length;
 12.00" Radius, 2.00" Border, White on, Green;
 Arrow 16-20 Type B - 120';

E1-5aP (freeway);
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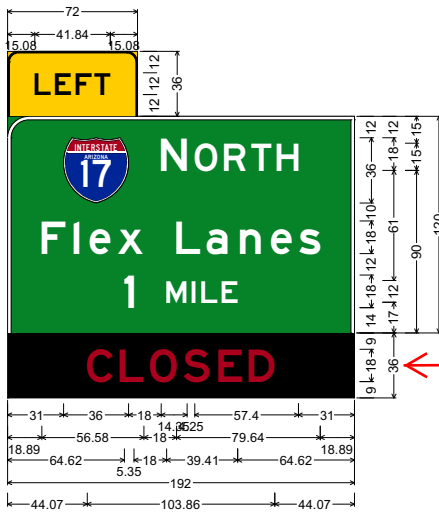


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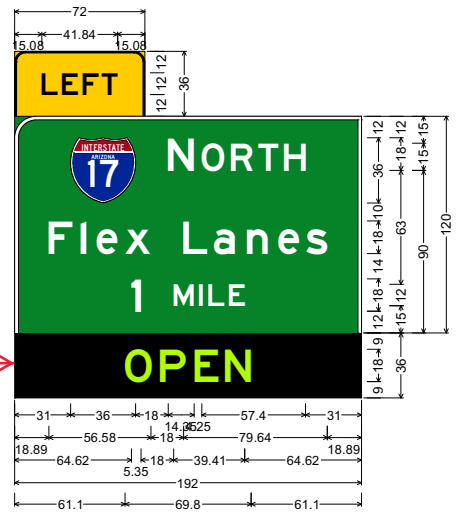
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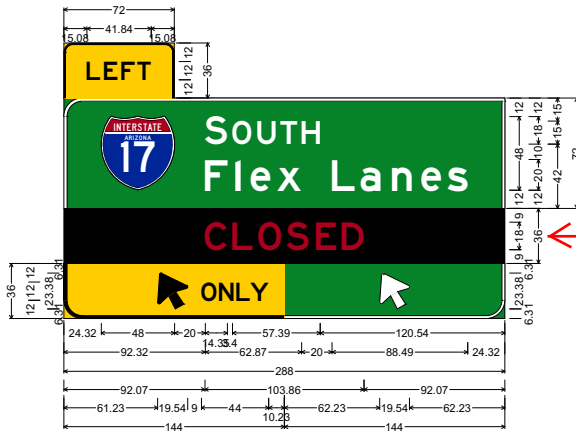


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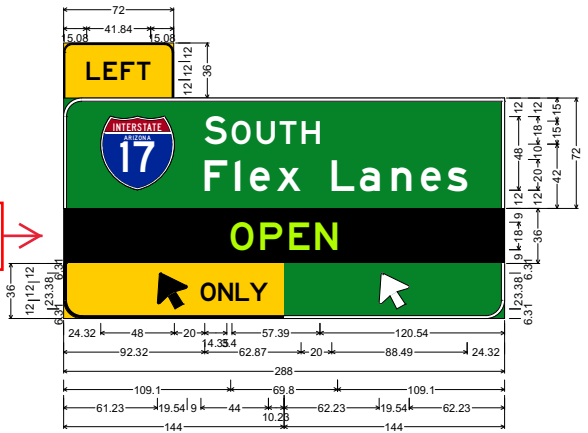
LED Message Board



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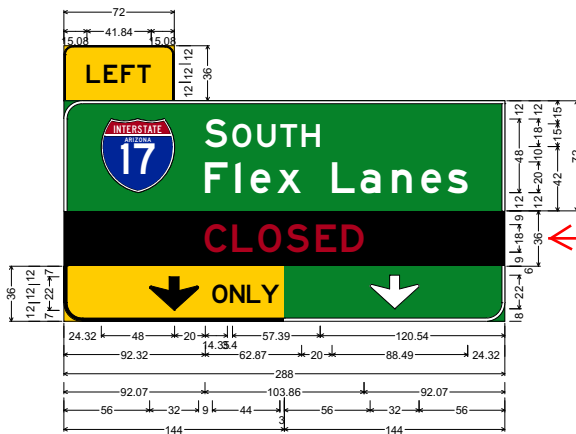


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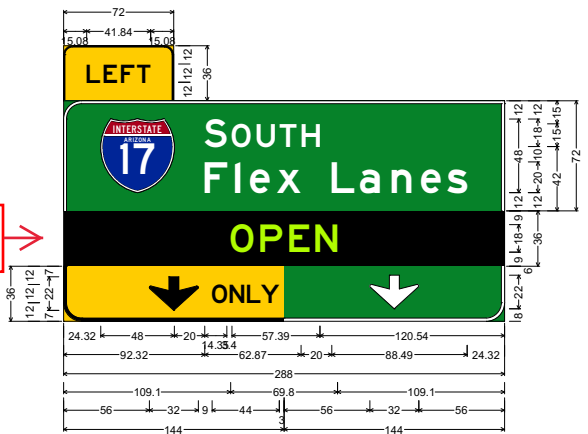


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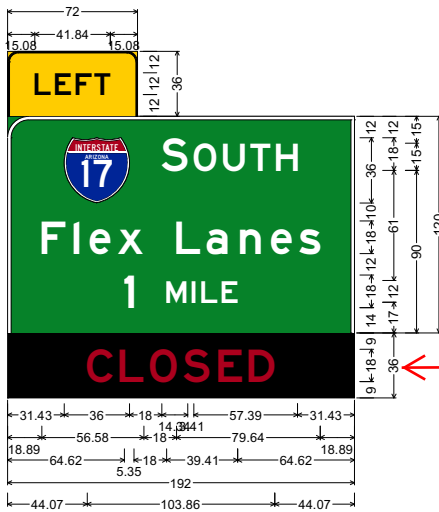


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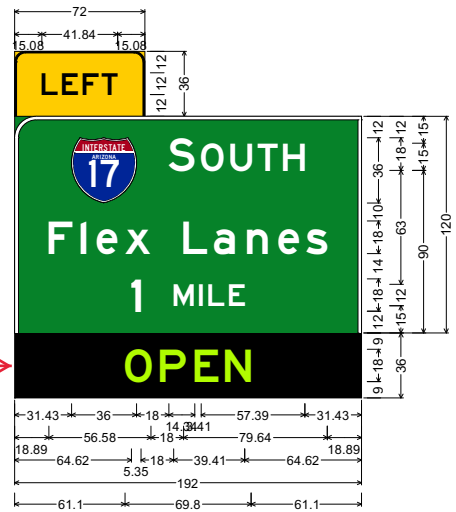
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 Down Arrow 13.33-16-20" - 270"; "ONLY", E specified length;
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 E1-101a (freeway);
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 State Name 17 M1-2a; "SOUTH", E; "Flex Lanes", E;
 "1", E; "MILE", E;
 No border, None on, Black;
 "CLOSED" Red, E;

LED Message Board



E1-5aP (freeway);
 6.00" Radius, 1.00" Border, Black on, Yellow;
 "LEFT", E;
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 12.00" Radius, 2.00" Border, White on, Green;
 State Name 17 M1-2a; "SOUTH", E; "Flex Lanes", E;
 "1", E; "MILE", E;
 No border, None on, Black;
 "OPEN" Bright yellow green, E;

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TP Attachment 466-1 – ITS Technical Specifications

1 **SECTION 738 GENERAL REQUIREMENTS:**

2 **738-1 Description:**

3 It is the purpose of this section to provide general information necessary for completion of the
4 Work on the elements of Intelligent Transportation Systems (ITS) in accordance with the
5 referenced TPs, standard drawings, details shown on the RFC plans, and requirements of these
6 Specifications.

7 ITS generally include; dynamic message sign systems, detection/wrong way detection systems,
8 closed circuit television camera systems, Flex Lane gate systems, Flex Lanes Guide Signs, fiber
9 optic communications and network infrastructure dedicated to supporting these systems.

10 All ITS components and appurtenances shall be complete, functional, have successfully passed
11 any specified testing and training procedures, and in operating condition at the time of
12 acceptance and no later than Project Substantial Completion or, to the extent applicable, South
13 Segment Substantial Completion.

14 **(A) ITS MATERIAL SUBMITTAL:**

15 Developer shall submit to ADOT for its approval a list of materials to be used for the ITS. The
16 material submittal shall be clear and contain all items to be supplied on the project by Developer.
17 The material submittal shall contain an index of the items included in the material submittal
18 package. The material submittal shall include adequate details to allow ADOT to procure
19 replacements of materials used on the project. The model, variations, accessories, and options
20 shall be clearly indicated. Material designations used by ADOT shall be noted on the material list.
21 The materials shall be identified by the contract project number, catalog part number, catalog cut,
22 shop drawings for equipment, trade name, and schedules for other pertinent information. The
23 material submittal shall include Certificates of Compliance for all materials conforming to the
24 requirements of Section 106.05 of the Standard Specifications.

25 ADOT approval is required before ordering or installing materials. Developer work schedule shall
26 include at least 10 Days for ADOT inspection and testing of any materials that have not been
27 previously used by ADOT.

28 **(B) ACCESS TO ADOT TRAFFIC OPERATIONS CENTER (TOC):**

29 Developer shall do no work within the Traffic Operation Center (TOC). All interface cabling (i.e.,
30 video or data) that may be required in the TOC will be furnished and installed by ADOT personnel.

31 **(C) ITS DEVICE STAKING:**

32 Developer shall survey and stake the locations of the cabinet foundations, DMS structure
33 foundations, CCTV pole, and Flex Lanes Guide Signs foundations according to the RFC Plans in
34 the presence of ADOT personnel or designated representative. Developer shall give a minimum
35 of two Days advanced notice to ADOT prior to staking the locations.

36 **(D) TRACER WIRE:**

37 Magnetic detection for underground facilities shall meet the requirements of Stored Specifications
38 104MAGDET.

39 **738-2 ABBREVIATIONS:**

40 CCTV Closed circuit television

1	dB	Decibels – a logarithmic ratio of input and output power or voltage
2	DIN	Deutsches Institut für Normung
3	DMS	Dynamic Message Sign
4	GIS	Geographic Information System
5	HDPE	High Density Polyethylene
6	Hz	Hertz
7	IEEE	Institute of Electrical and Electronics Engineers.
8	ISO	International Standards Organization
9	ITS	Intelligent Transportation System
10	kVA	Kilo-Volt-Amperes
11	LED	Light-emitting diode
12	mA	Milli-amp, equivalent to 1/1,000 Amp MOV Metal oxide varistor
13	mV	Milli-Volt, equivalent to 1/1,000 of a Volt NEC National Electrical Code
14	NICET	National Institute for Certification in Engineering Technologies
15	NSPS	National Society of Professional Surveyors
16	NTCIP	National Transportation Communications for ITS Protocol
17	TP	Network Time Protocol
18	NTSC	National Television Systems Committee
19	PPI	Plastic Pipe Institute
20	OTDR	Optical Time-Domain Reflectometer
21	Ps	Pico-second, equivalent to 1 trillionth of a second
22	RAM	Random Access Memory
23	RMS	Root Mean Square
24	ROM	Read-Only Memory
25	SAT	System Acceptance Test
26	SMFO	Single-Mode Fiber-Optic
27	SMTP	Simple Mail Transfer Protocol
28	SNMP	Simple Network Management Protocol
29	SSPC	Society for Protective Coatings
30	SST	Subsystem Acceptance Test
31	TIA	Telecommunications Industry Association
32	TOC	Traffic Operations Center
33	VAC	Volts, Alternating Current

1 VDC Volts, Direct Current

1 **SECTION 740 STRUCTURAL SUPPORTS AND FOUNDATIONS FOR ITS**
2 **ELEMENTS:**

3 **740-1 Description:**

4 The work under this item includes furnishing equipment, material, labor and accessories needed
5 to furnish and install structural supports and foundations for ITS elements including CCTV,
6 camera lowering systems, wrong way detection poles and DMS sign structures.

7 **740-2 MATERIALS:**

8 Materials shall be in accordance with the requirements of Subsection 606-2 and Section 609
9 Drilled Shaft Foundations of the Standard Specifications.

10 Concrete for the foundations shall conform to the requirements of Section 1006 of the Standard
11 Specifications. Reinforcing steel and wire mesh shall conform to the requirements of Section 1003
12 of the Standard Specifications and to the requirements of ASTM A 615. Unless otherwise
13 specified, steel bars meeting the requirements of ASTM A 706 may be substituted for ASTM A
14 615 steel bars. When ASTM A 706 bars are used, tack welding of the reinforcement will not be
15 permitted unless approved in writing by ADOT. Reinforcing steel wire shall conform to the
16 requirements of ASTM A 82.

17 ITS structural elements and foundations shall conform to the requirements of Section 609 of the
18 ADOT Standard Specifications.

19 **(A) SHOP DRAWINGS:**

20 The shop drawings shall detail connection of the DMS to the support structure and list materials,
21 lengths of support members, flexible conduit routing, catwalk dimensions and connections,
22 handrail, grating, cable connections, and other features required for successful erection,
23 installation, and operation of the DMS. The shop drawings shall specifically identify the bolt torque
24 values. The shop drawing shall show the lane configuration, shoulder width, the location of the
25 DMS and location and elevation of the DMS panel and structural supports in relation to the high
26 point of the roadway including shoulders.

27 **(B) POLE SHAFTS:**

28 Pole shafts shall be constructed of a uniformly tapered, one or two-piece round tubular pole,
29 conforming to the ITS Standard Drawings. CCTV poles shall provide a means of routing the CCTV
30 cables inside the pole. CCTV poles shall be designed to accommodate a CCTV camera
31 assembly, electrical hardware, mounting hardware, lowering device, pole-mounted cabinet, and
32 enclosures. Threaded couplings to support pole-mounted equipment shall be factory-installed.
33 Field-modifications to CCTV poles will not be accepted.

34 CCTV Poles shall be constructed of material conforming to ASTM A595, Grade A or ASTM A572,
35 Grade 55 or better. Drilled shafts shall be used to support CCTV structures. CCTV poles shall be
36 designed for a minimum effective wind area of two square feet for CCTV & Assembly and shall
37 be designed for a one-inch maximum deflection at the top of the pole under a 30 mile per hour
38 non-gust wind speed.

39 The CCTV pole hand hole shall be reinforced with a minimum 2-inch wide hot rolled steel rim. The
40 nominal outside dimension of the hand hole shall be 6 inches x 27 inches. The hand hole shall have
41 a tapped hole for mounting the portable winch for the CCTV lowering system. The hand hole shall
42 be positioned on the CCTV pole so that it is not in conflict with the CCTV pole-mounted cabinet and

1 associated 1-inch mogul elbow. The hand hole shall be positioned so that the CCTV camera is not
2 directly above the user when operating the CCTV lowering system.

3 Prior to pole fabrication, Developer shall provide the material submittal for each type of pole for
4 approval. The material submittal shall include material specifications and structural calculations
5 showing stresses and deflections in accordance with this TP Attachment 466-1, Sections 604 and
6 731 of the ADOT Standard Specifications, the ITS Standard Drawings, and the RFC Plans.
7 Drawings and calculations shall be prepared, signed and sealed by a Civil or Structural Engineer
8 registered in the State of Arizona.

9 **(C) BASE PLATES:**

10 Base plates shall be fabricated from structural steel plates conforming to the minimum strength
11 requirements of ASTM A36. Exposed surfaces shall be finished smooth and exposed edges shall
12 be neatly rounded to a 1/8-inch radius. Pole bases shall be galvanized in accordance with ASTM
13 A123.

14 **(D) NON-SHRINK GROUT:**

15 Non-shrink grout shall conform to the requirements of the ADOT Approved Products List.

16 **(E) CCTV CAMERA LOWERING SYSTEM:**

17 The CCTV camera lowering system shall be compatible with Bosch model MIC-7522-Z30W and
18 orientation of camera, resulting in a correctly-orientated camera image. The CCTV camera lowering system
19 shall not obscure the CCTV cameras range of vision. The CCTV camera lowering system shall
20 be designed to support and lower/raise CCTV camera systems weighing up to 100 pounds. External
21 components shall be made of corrosion resistant materials, powder coated, galvanized, or
22 otherwise protected from the environment. Moving parts of the CCTV camera lowering system
23 shall be corrosion resistant, self-lubricating and sealed, rated for a minimum of 10,000 lowering and lifting
24 operations. If offered by the manufacturer, the conductor interface mechanism which receives the
25 movable portion of the lowering device shall be the heavy-duty version.

26 Developer shall supply and install grommets, connectors, nipples, necessary hardware, a cable
27 from the CCTV cabinet to the lowering device, and a cable from the lowering device to the CCTV
28 camera assembly. Cables shall be outdoor rated, and contain shielded communication conductors
29 and five auxiliary conductors, 14 AWG, or larger. Conductors within the cables shall be stranded.

30 The CCTV camera lowering system shall be equipped with a self-aligning locking mechanism which
31 securely holds the movable portion of the CCTV camera lowering device when the CCTV camera is in
32 use. When in the locked position, all weight shall be removed from the lowering cable. The locking
33 components shall be made of metal.

34 The CCTV camera lowering system shall include a junction box between the CCTV camera and the
35 movable portion of the lowering device to facilitate the connection of CCTV camera power, video,
36 and camera control. The junction box shall be water resistant and in accordance with NEMA 3R
37 requirements.

38 Electrical connections shall be suited for operation at 120 VAC with a current carrying capacity
39 not less than 15 Amperes. The electrical connectors shall contain a minimum of 14 contacts
40 including a ground. Data contacts shall be designed to handle 1V peak to peak NTSC video, RS-
41 232 and RS-485 control, and Ethernet communication signals.

1 The CCTV camera lowering system shall be operated from the ground by the use of a portable
2 lowering tool. The tool shall consist of a lightweight metal frame and winch assembly operated by
3 a variable speed electric drill motor or hand crank. The CCTV camera lowering system shall
4 include clutches and brakes to prevent the free-fall of the CCTV camera and over tensioning of
5 the lowering device cable. The lowering tool shall have the appropriate gearing to facilitate using
6 a hand crank for lowering and raising the CCTV camera. The CCTV camera lowering system
7 shall incorporate a field adjustable counterweight system to minimize the amount of effort required
8 to raise the CCTV camera. One lowering tool for the project shall be provided to ADOT.

9 **(F) CCTV POLE FOUNDATION:**

10 CCTV Pole Foundations shall be drilled shaft in accordance with Section 609 of the Standard
11 Specifications. Excavation and backfill shall conform to the requirements of Subsection 203-5.03
12 of the Standard Specifications.

13 Anchor bolts shall conform to the requirements of ASTM F1554 Grade 55. The upper 12 inches of
14 the bolts shall be hot dip galvanized in accordance with ASTM A153. The strength of the nuts shall
15 be equal to or exceed the proof load of the bolts.

16 Concrete for foundations shall be Class S and shall have a required 28-day compressive
17 strength of 3,500 pounds per square inch.

18 Developer shall provide the material submittal for each type of foundation including material
19 specifications and reinforcing drawings per ADOT ITS Standard Details or RFC Foundation
20 Details.

21 **740-3 CONSTRUCTION REQUIREMENTS:**

22 Prior to fabrication of sign structures, Developer shall perform a field survey of the foundation and
23 roadway elevation to determine support structure dimensions to ensure proper mounting height
24 of the DMS and vertical clearance requirements.

25 ITS structures shall be constructed in accordance with the requirements of Section 609 of the
26 Standard Specifications, and Subsection 606-3 of the Standard Specifications and the RFC
27 Plans.

28 Developer shall form a 1/4-inch weep hole in the grout at the base of the pole which allows
29 drainage of water that may accumulate inside the structure.

30 **(A) FOUNDATIONS:**

31 ITS structure foundations shall be constructed in accordance with the requirements of Section
32 609 and Subsection 606-3 of the ADOT Standard Specifications and the RFC Plans.

33 Developer shall use drilled shaft method per Section 609 of the ADOT Standard Specifications.

34 Excavation shall be performed to avoid damage to pavement, landscaping, and other
35 improvements. Excavated material shall be placed in a position that will not impact traffic, and
36 drainage. If existing concrete is damaged by Developer, the entire section, between expansion
37 joints, shall be removed and reconstructed.

38 Surplus excavated material shall be removed and properly disposed of by Developer.

39 Excavation and backfill shall conform to the requirements of Subsection 203-5 of the ADOT
40 Standard Specifications. At the end of each working period, excavations shall be barricaded or
41 covered, or both, to provide safe passage for vehicular traffic.

1 Concrete shall be placed in holes which have been augured against undisturbed earth. If the
2 material in the bottom of the hole is not firm and stable, it shall be compacted, or treated as
3 directed by Developer's Geotechnical Engineer. The walls and the bottoms of the hole shall be
4 adequately moistened prior to placing the concrete.

5 If the soil is not stable and a hole cannot be augured, casings shall be used of the proper size
6 and dimensions, and shall be rigid and securely braced. The casing and the bottom of the hole
7 shall be adequately moistened prior to placing the concrete.

8 Anchor bolts and conduit stubs shall be placed and held in proper alignment, position, and height
9 during the placing and vibrating of concrete. Foundations shall set for a minimum of 7 Days prior
10 to pole installation.

11 DMS support structures shall be bonded to form a continuous grounding system in accordance
12 with Subsection 732-3.03 of the ADOT Standard Specifications. The coil ground shall be covered
13 with native soil prior to placing concrete. A ground resistance test shall be performed in
14 accordance with the ground rod testing method specified in Subsection 732-3.03 of the ADOT
15 Standard Specifications.

16 Developer shall protect existing lighting poles, conduit, conductors, irrigation, landscape,
17 aesthetic, storm drains, utilities and other elements from damage.

18 **(B) POLE SHAFTS:**

19 Developer shall bond and ground CCTV poles in accordance with Subsection 732-3.03 of the
20 ADOT Standard Specifications and as shown in the ITS Standard Drawings. CCTV poles shall
21 be bonded to form a continuous grounding system.

22 Poles shall be vertically plumb with camera equipment installed. Once the pole installation is
23 complete, the open space between the base plate and foundation shall be grouted. Grout shall
24 be mixed, handled and placed in accordance with the manufacturer's recommendations.

25 If field-repair of galvanizing is allowed by ADOT, it shall be by the hot-stick method.

26 Developer shall obtain an FAA determination for any new CCTV Pole which meet the requirements
27 for construction or alteration requiring notice (77.13) in the Code of Federal Aviation Regulations,
28 part 77. Developer shall not incorporate such new CCTV poles unless and until approved by the
29 FAA.

30 CCTV camera pole foundations shall be set flush with the finished grade where there is no curb
31 or sidewalk, except in sloped areas.

32

1 **SECTION 741 ELECTRICAL UNDERGROUND EQUIPMENT FOR ITS**

2 **741-1 Description:**

3 The work under these items includes furnishing and installing electrical underground equipment
4 including conduit, innerduct and pull boxes for ITS elements, as shown on the RFC Plans and in
5 these Specifications.

6 **741-2 MATERIALS:**

7 Polyvinyl Chloride (PVC) conduit, Rigid Metallic Conduit (RMC), and Flexible Metal Conduit shall
8 conform to Subsection 732-2.02 of the Standard Specifications. Intermediate Metal Conduit (IMC)
9 is not allowed for ITS applications. Conduit runs which enter pole and cabinet foundations shall
10 consist of PVC.

11 Conduit bends, fittings, expansion couplings, sweeps, and other accessories shall be of the same
12 material as the conduit.

13 Conduit elbows for new or future fiber optic cable shall have a minimum radius of 36 inches. Other
14 conduit elbows shall have a minimum radius of 24 inches.

15 **(A) HDPE CONDUIT:**

16 Developer may propose substituting HDPE conduit which meets these specifications in place of
17 direct-buried PVC conduit.

18 HDPE conduit and fittings shall comply with ASTM D 2241 and ASTM-F2160-01. HDPE conduit
19 shall have a minimum rating of SDR 11. HDPE innerducts shall have a minimum rating of SDR

20 13.5. It shall have a cell classification of PE334470C (for black conduit) and PE334470E (for
21 colored conduit) in accordance with ASTM 3350: Standard Specification for Polyethylene Pipe
22 and Fittings Materials. The polyethylene base resin shall meet the density requirement and melt
23 index properties described herein. The density shall not be less than 0.940 and not more than
24 0.955 g/cm³ in accordance with ASTM D 1505: Standard Test Method for Density of Plastics by
25 the Density-Gradient Technique. The range for the melt index shall be between 0.05 to 0.5g/10
26 minutes in accordance with ASTM D 1238: Standard Test Method for Melt Flow Rates of
27 Thermoplastics by Extrusion Plastometer. The HDPE conduit shall have a minimum Flexural
28 Modulus, of 80,000 psi, in accordance with ASTM D 790 and a minimum tensile strength at yield
29 of 3,000 psi, in accordance with ASTM D-638. Additives to the base resin shall be included to
30 provide heat stabilization, oxidation prevention and ultraviolet (UV) protection. It shall utilize
31 carbon black in the range of 2 to 3 percent for long term protection against UV degradation. The
32 minimum protection period shall be one year from date of manufacture in unprotected, outdoor
33 storage in accordance with ASTM D 1603: Standard Test Method for Carbon Black in Olefin
34 Plastics.

35 Developer shall submit data sheets and a Certificate of Compliance letter from the HDPE conduit
36 manufacturer stating that the product meets these requirements per Section 106.05 of the ADOT
37 Standard Specifications.

38 **(B) INNERDUCT:**

39 Innerduct shall be smooth HDPE. The number of innerducts per conduit and sizes shall be as
40 called for in the Section DR 466.3.3.1 of the TPs and the RFC Plans. Innerduct color shall be
41 orange from the factory unless otherwise specified. The innerduct shall be furnished in one
42 continuous length with no factory installed splices or couplings, and of lengths sufficient to
43 complete runs between pull boxes without splicing.

1 **(C) CONDUIT WARNING TAPE:**

2 Conduit warning tape shall be a minimum four-mil composite reinforced thermoplastic, with a
3 minimum width of 3 inches and minimum length of 5 feet. Warning tape shall be highly resistant
4 to alkalis, acids, and other destructive agents found in the soil.

5 Warning tape shall have a continuous printed message warning of the location of underground
6 conduits. The message shall be in permanent ink specifically formulated for prolonged
7 underground use and shall bear the words, "CAUTION - ELECTRIC LINE BURIED BELOW" or
8 "CAUTION – COMMUNICATION CABLE BURIED BELOW" in black letters on a red background
9 for electric conduits or orange background for communication conduits. Where both electric and
10 communications conduits are in a single trench, both warning tapes, as described above, shall be
11 provided.

12 **(D) DETECTABLE PULL TAPE:**

13 Detectable pull tape shall be constructed of fiber and have an embedded #22 AWG conductor.
14 The tape shall be low-stretch and moisture-resistant. The tape shall have nominal pull strength of
15 2,500 pounds. The tape shall include distance markings at intervals not to exceed 2 feet.

16 **(E) NO. 7 ITS PULL BOXES:**

17 No. 7 ITS pull boxes shall be precast, polymer concrete, fiberglass reinforced, with ANSI Tier 22 rating
18 for both the box and lid. Concrete pull boxes and lids shall not be used. Steel pull box lids shall not
19 to be used unless H20 traffic loading is required.

20 No. 7 ITS pull boxes shall be 24 inches in depth and consist of a single-piece box unit. Stacked
21 units shall not be used unless otherwise specified.

22 Pull box lids shall bear the words "ADOT FMS" unless otherwise specified. Markings shall be
23 clearly defined and placed parallel to the long side of the cover. No. 7 pull boxes letter height shall
24 be a minimum of 1 inch and recessed into the lid.

25 Pull box lids shall have a locking mechanism approved by ADOT.

26 Developer shall provide a Certificate of Compliance that the pull boxes furnished and installed
27 are in conformance with Section 106.05 of the ADOT Standard Specifications.

28 **(F) NO. 9 PULL BOXES:**

29 No. 9 pull boxes shall be fabricated of concrete and provide conduit access ports on the four sides
30 as shown in the ITS Standard Drawings.

31 No. 9 pull box lids shall have a square, hinged lid that opens a full 180 degrees. Lid opening shall
32 be spring-assisted from both the open and closed positions using a torsion bar lift system. Lids
33 shall lock down with at least one stainless steel security type penta-head bolt that shall be captive
34 to the lid. Lids shall have padlock cavity with a spring-loaded cover and lock-down bolt that leaves
35 no part of the padlock exposed.

36 No. 9 pull boxes shall be furnished with galvanized and slotted C-channel struts embedded in the
37 concrete walls of the pull box, with an 18-hole rack mounted to each slotted C-channel strut, and
38 ½ inch spring nuts and bolts and one cable hook per rack.

39 Pull box lids shall bear the words "ADOT FMS" unless otherwise specified. Markings shall be
40 clearly defined and placed parallel to the long side of the cover. Letter height for No. 9 pull boxes
41 shall be 4 inches.

1 Pull box lids shall have a locking mechanism approved by ADOT.
2 Developer shall provide a Certificate of Compliance that the pull boxes furnished and installed are
3 in conformance with Section 106.05 of the ADOT Standard Specifications.

4 **(G) METAL JUNCTION BOXES:**

5 Metal junction boxes and covers installed in concrete structures shall be fabricated from a
6 minimum of 16-gauge type 304 stainless steel. Seams shall be continuously welded and conform
7 to the RFC Details and Project Specifications.

8 A neoprene gasket with a thickness of 1/8 inch shall fit between the pull box and cover. The cover
9 shall fit securely and be held in place with a minimum of four stainless steel machine screws.

10 Developer shall furnish materials that meet the requirements of Section 732-2 for conduit and pull
11 boxes, except as modified by this TP Attachment 466-1.

12 **741-3 CONSTRUCTION REQUIREMENTS:**

13 Construction Requirements shall conform to Section 732, unless otherwise specified in the ITS
14 Standard Drawings, on the RFC plans, or this TP Attachment 466-1.

15 **741-3.01 CONDUIT:**

16 Conduit installation shall conform to Subsection 732-3.01 of the ADOT Standard Specifications
17 with the following exceptions.

18 **(A) CONDUIT ROUTING:**

19 Conduit shown on the plans indicates the intended path and conduit shall be placed in accordance
20 with the lines, grades, details and dimensions shown on the RFC Plans, the ADOT Standard
21 Specifications and this TP Attachment 466-1. The conduit path shall be modified as necessary,
22 to avoid obstacles, conflicts and obstructions, to facilitate future maintenance, or to conform to
23 appropriate codes and specifications. Final conduit locations shall be documented in the record
24 drawings.

25 The contactor shall restore, repair, or replace, damaged or contaminated vegetation, landscaping
26 features, decomposed granite, irrigation facilities, walkways, utilities, and other items resulting
27 from ITS construction activities.

28 Developer shall take special precautions prior to work in the vicinity of irrigation lines. Small
29 irrigation lines are typically not Blue Staked, but shall be repaired or replaced if damaged during
30 construction by Developer.

31 Excavations shall be in accordance with the Project Safety Management Plan.

32 **(B) CONDUIT SIZE:**

33 Conduit sizes shall be as indicated on RFC plans and in conformance with the TPs.

34 **(C) CONDUIT BEND RADIUS AND DEFLECTION:**

35 Except for factory bends, conduit bends shall have a radius of not less than that specified in the
36 NEC. Conduit shall be bent without crimping or flattening, using the longest radius practicable.
37 Communications conduits shall not deflect more than 1 inch per foot (1:12) vertically or horizontally. This
38 is equivalent to a minimum radius of 6 feet. If the 1:12 requirement cannot be achieved, elbow fittings of 11
39 1/4, 22 1/2, 30 or 45 degrees, with a minimum radius of 12 times the conduit diameter shall be used. If

1 90-degree cumulative turns are required, they must be made of individual elbows with a minimum
2 radius of 36 inches for new or future fiber optic cable.

3 **(D) CONDUIT FITTINGS:**

4 New runs of conduit must be continuous from pull box to pull box. HDPE conduit must not be
5 joined to PVC conduit in the length of the run.

6 If joining segments of HDPE conduit is called for on the plans, Developer shall utilize non-
7 corrosive, sit-tight, water-tight couplings. Heat fusion, electrofusion fittings and mechanical
8 connections will be permitted if the HDPE conduit and joining device manufacturer's
9 recommendations are followed and the internal diameter of the HDPE conduit is not reduced.
10 Extrusion welding and hot gas welding to join HDPE conduits is not permitted. Upon completion
11 of joining HDPE conduit sections and setting the pull boxes, Developer shall clean the HDPE
12 conduit with compressed air. Developer shall demonstrate that the conduit was not deformed
13 during installation by pulling a cleaning mandrel or ball mandrel with a diameter of 80 percent of
14 the HDPE inside diameter. If the mandrel passes through the HDPE, Developer shall install the
15 pull tape in accordance with Section 732 of the ADOT Standard Specifications. If the mandrel
16 encounters a deformity in the HDPE conduit, Developer shall replace the entire segment of HDPE
17 between pull boxes with new HDPE.

18 Conduit plugs, caps, or sealing fittings for sealing empty conduit and occupied conduit must be
19 durable, easily removable, reusable, and produce a watertight seal. Plugs, caps, and sealing
20 fittings must be designed for the diameter of the conduit and cable, must cause no damage to the
21 cable when installed, and must have a rope tie on the inside end for connection of a pull rope.
22 Plugs that seal conduits containing fiber optic cable must be of the split design to allow installation
23 and removal around in-place cables.

24 **(E) CONDUIT DEPTH:**

25 Conduits must have a minimum cover depth of 30 inches. Backfill compaction shall be in
26 accordance with Subsection 203-5.03(B)(4) of the ADOT Standard Specifications. When conduit
27 cannot be installed at the required minimum depths, it must be encased in Class B concrete, in
28 accordance with Section 1006 of the ADOT Standard Specifications.

29 **(F) CONDUIT IN TRENCHES:**

30 Immediately after conduit work, including installation, mandrelling, or cable or pull tape
31 installations, Developer shall seal the conduit to prevent the intrusion of water, mud, gravel,
32 vermin, etc. Taping the ends of the conduit is not allowed.

33 Unoccupied conduits on which work is performed, including those extending beyond the end of
34 capped conduit, must be sealed with a water-tight, corrosion-proof, removable, reusable, and
35 vermin resistant conduit plug or cap.

36 Occupied conduits on which work is performed **must** be sealed with a conduit cap. The conduit
37 cap **must** be water-tight, corrosion-proof, removable, and vermin resistant.

38 Occupied innerduct on which work is performed extending beyond the end of the capped conduit
39 **must** be sealed with an innerduct cap. The innerduct cap **must** be water-tight, corrosion-proof,
40 removable, and vermin resistant.

1 New innerducts and existing empty innerducts to be utilized **must** have a plug pulled through to
2 demonstrate that the innerduct integrity and continuity is appropriate for use with no breaks or
3 debris.

4 New innerducts and existing empty innerducts to be utilized **must** have a means to secure the
5 ends of the innerduct to prevent the innerduct from retracting into the conduit.

6 Developer shall cut a three inch “Y” into the face of the curb directly over conduit located under
7 rolled or vertical curbs.

8 Developer shall place warning tape in trenches in which new PVC or trenched HDPE conduit is
9 placed. Warning tape is not required in conduit segments where trenchless methods are used for
10 installation. Warning tape **must** be buried at a depth of six to eight inches below the finished grade. No
11 additional compensation will be provided to restore landscape or add decomposed granite at disturbed
12 areas.

13 **(G) CONDUIT BY TRENCHLESS METHODS:**

14 New conduit to be installed under existing pavement, curbs and gutters, sidewalks, established
15 landscaping or decomposed granite not otherwise impacted by construction, and at other
16 locations specifically indicated in the RFC Submittals, must be installed by horizontal directional
17 boring (HDB) or horizontal directional drilling (HDD) methods. Open cutting and trenching existing
18 pavement to remain is not allowed.

19 Prior to beginning trenchless installation methods, Developer shall complete the necessary
20 potholing, and submit the proposed profile to ADOT. The profile of installed conduit must be such
21 that the allowable bend radiuses are not exceeded. Developer shall perform installation in
22 accordance with Good Industry Practice.

23 Developer’s installation process shall utilize the “walkover” locating system or other ADOT
24 approved equivalent, for determining the installation profile. The installation equipment **must**
25 register the depth, angle, rotation and directional data. At the surface, Developer shall use
26 equipment to gather the data and relay the information to the equipment operator.

27 Excavation and backfill of excavated pits **must** be in accordance with the requirements of
28 Subsection 203-5.03 (A) and (B) of the ADOT Standard Specifications.

29 When enlargement of an installation hole is necessary, the hole must be at least 25 percent larger
30 than the conduit to be installed. Pulling equipment such as grips, pulling eyes, and other
31 attachment hardware external to the conduit will be permitted as long as a wooden dowel is placed
32 inside the conduit to prevent it from collapsing at the point of attachment when pull tension is at
33 its peak. A swivel must be used with pulling hardware when pulling back the conduit into the
34 installation path. Drilling fluid must be pumped down the hole to provide lubrication for the conduit
35 as it is pulled in. The pulling tension for installing conduit into the installation path **must** not exceed
36 75 percent of the conduit manufacturer’s tensile strength rating in order to prevent the conduit
37 from “necking down” or deforming.

38 Developer shall submit final installation profiles to ADOT within 72 hours of completion of the bore
39 shot. All bore shot installation profiles shall be compiled into the Record Drawings.

40 **(H) DETECTABLE PULL TAPE:**

41 Developer shall install detectable pull tape in new and existing empty conduits and innerducts.
42 Detectable pull tape in conduits shall terminate at the end of the conduit with a minimum of 2 feet

1 of coiled slack in the pull box. Detectable pull tape traveling through conduit that terminates in a
2 pull box, shall have its wire ends connected together to allow for a continuous locating signal to
3 be used for the entire conduit run.

4 **(I) CONDUITS EMBEDDED IN OR ATTACHED TO STRUCTURES:**

5 Attaching or embedding conduit in a structure shall be approved by ADOT and shown on the RFC
6 plans. Conduit within a structural member shall be installed in accordance with the National Electrical
7 Code.

8 Conduit installed within open bridge cells or attached to structures shall be rigid metal conduit
9 (RMC). RMC shall be painted to match the exterior color of the structure when located on the
10 exterior of the structure. Painting may require pre-treatment of the RMC.

11 Intermediate junction boxes shall be used in RMC runs over 1,000 feet in length. Intermediate
12 junction boxes shall be evenly spaced at a maximum spacing of 1,000 feet.

13 Expansion couplings shall be installed in conduit runs which cross an expansion joint in a structure.
14 Expansion couplings shall be as shown in the ITS Standard Drawings or RFC Plans as approved
15 by ADOT. A minimum of 3 feet shall separate a conduit expansion coupling and the pipe sleeve
16 where the conduit enters a structure. Expansion couplings on adjacent conduits shall be staggered to
17 keep conduit runs as straight as possible. Where bonding is not continuous, expansion couplings
18 shall be provided with a #6 AWG bonding jumper conductor with enough slack to accommodate
19 the range of expansion of the coupling.

20 Where it is not possible to use expansion couplings, sleeves of sufficient size shall be installed to
21 provide a minimum 1/2-inch clearance between the conduit and the inside wall of the sleeve. The
22 sleeve shall be discontinuous at the expansion joints. The coupling sleeve shall not be exposed
23 to the elements and shall be protected by a steel plate recessed within the barrier at the expansion
24 joint.

25 **(J) CONDUIT CLEANING:**

26 Developer shall clean existing conduit, no more than one week prior to installation of cables or
27 conductors. For PVC conduit, a metal-disc mandrel with an outer diameter not less than 90
28 percent of the conduit's inside diameter shall be pulled through the conduit. For HDPE conduit, a
29 ball mandrel with an outer diameter not less than 80 percent of the conduit's inside diameter shall
30 be pulled through the conduit. Prior to pulling the mandrel through the conduit, the conduit shall
31 be brushed or swabbed.

32 **(K) UTILITY CONDUITS:**

33 Installation of conduit for underground utility service shall conform to the utility company
34 requirements, local codes and TP Attachment 466-1.

35 **(L) CONDUIT ENTERING PULL BOXES:**

36 Conduit entering pull boxes shall be installed in accordance with the ITS Standard Drawings.
37 Conduit ends shall be capped with conduit end cap or plug fittings until wiring or cabling is
38 installed. When end caps or plugs are removed, Developer shall install bell end fittings or bell end
39 shape integral to the conduit as approved by ADOT. Bell ends shall be installed prior to the
40 installation of the conductors or cables. Insulated grounding bushings shall be used on steel
41 conduit ends as approved by ADOT.

1 RMC conduits terminating in a No. 7 ITS Pull Box shall have a coupling to convert to PVC prior
2 to the underground elbow.

3 New HDPE conduits terminating in a No. 9 pull box shall run directly into the conduit port hole of
4 the pull box wall and be cut flush with the inside face of the pull box. The void between the outside
5 of the conduit and inside of conduit port hole shall be sealed with a sealant as approved by ADOT.

6 **(M) INNERDUCT:**

7 Innerduct shall be installed in conduit as shown on the plans. Innerduct shall not be pulled or
8 dragged on the ground or pavement. Developer shall ensure that the tensile load on the innerduct
9 does not exceed the allowed maximum by using a break-away technique and/or a pulley system
10 with numeric readout which includes a means of alerting the installer when the pulling tension
11 approaches the manufacturer's maximum pulling tension.

12 Developer shall ensure that the innerduct is protected from sharp edges and excessive bends.
13 Developer shall not cause the innerduct to violate the minimum bending radius for which the
14 innerduct was designed. Developer shall be responsible for damage of innerduct and shall
15 remove and install new innerduct.

16 During pulling, the innerduct shall be continuously lubricated as it enters the conduit. Pre-
17 lubrication may be necessary per manufacturers requirements. The lubricant used shall be
18 compatible with the innerduct material. The manufacturer's recommended pulling speed and
19 pulling tension shall not be exceeded.

20 Innerduct shall be anchored at pull boxes to keep innerduct from retracting into the conduits,
21 beyond the exposed conduit end, in a manner approved by ADOT.

22 Newly installed empty innerduct shall contain detectable pull tape from pull box to pull box. Each
23 pull tape shall terminate at the end of the innerduct with a minimum of 2 feet of coiled slack in
24 each pull box.

25 **(N) CATHODIC PROTECTION:**

26 Prior to trenching, Developer shall verify the existence of cathodic protection in existing utilities
27 and shall maintain existing cathodic protection and test stations.

28

29 **(O) CONDUIT AT REMOVED PULL BOXES:**

30 At pull boxes to be removed, where existing HDPE conduit has a HDPE-to-PVC coupling, a new
31 No. 9 pull box shall be installed in place of the coupling or the coupling and PVC components
32 shall be removed and the conduit shall be spliced with matching HDPE conduit and HDPE-to-
33 HDPE coupling as approved by ADOT, resulting in a continuous all-HDPE segment.

34 **(P) CONDUIT RECONDITIONING**

35 Developer shall not recondition existing conduit. Existing damaged conduit intended to remain
36 shall be replaced with new conduit of the same material as the entire conduit run from pull box to
37 pull box.

38 **741-3.02 PULL BOXES**

39 Prior to installation, pull boxes shall be field located, to avoid drainage swales, slopes steeper
40 than 2:1, maintenance vehicle pathways, utility easements, and other areas of conflict.

1 Developer shall be responsible for restoring the surrounding surface conditions back to their
2 original condition if not intended to be modified by the Project.

3 When a new pull box occupies the same location as an existing pull box, the existing bricks, stone
4 sump and felt paper shall be replaced with new. In instances where an existing 12-inch depth pull
5 box is replaced by a 24-inch depth pull box, Developer shall adjust the existing conduits, as
6 necessary, to allow the conduit to enter the bottom of the box in conformance with the ITS
7 Standard Drawings, the project plans and specifications.

8 Compaction around pull boxes shall not cause the sides to deflect or the box or lid to crack or
9 become dented. Developer shall replace cracked, broken, chipped or damaged pull boxes and
10 lids.

11 Removable caps shall be placed on unused conduits within pull boxes.

12 **(A) NO. 9 PULL BOXES:**

13 When installing a No. 9 pull box, Developer shall only lift the pull box and covers using the lifting
14 hardware installed for that purpose. The lid shall be oriented such that the lid hinge lies along
15 the side of the pull box farthest from the roadway.

16 Existing No. 9 pull boxes for ITS conduits co-located with lighting conduits, shall have the lighting
17 conductors removed, conduit rerouted around the No. 9 pull box, and lighting conductors
18 reinstalled and terminated, matching existing. Lighting conductor splicing shall occur only in a
19 new adjacent lighting pull boxes. No lighting conductors or conduits shall pass through a No. 9
20 pull box to remain.

21 **(B) PULL BOX RECONDITIONING**

22 Developer shall not recondition existing pull boxes. Existing damaged pull boxes intended to
23 remain shall be replaced with new pull boxes.

24 Existing No. 9 pull boxes that do not have existing grounding shall have new a ground rod,
25 grounding lugs, and grounding conductor furnished and installed in accordance with the ITS
26 Standard Drawings. Grounding shall meet the requirements of Subsection 732-3.03 of the ADOT
27 Standard Specifications.

28 Pull box work identified as part of the facilities inventory shall be completed prior to work on fiber
29 optic cable or conductor installation.

30

1 **SECTION 742 FIBER OPTIC CABLE AND EQUIPMENT**

2 **742- 1 Description:**

3 The work under these items includes furnishing and installing fiber optic cables, fiber optic splice
 4 closures, Small Form-Factor Pluggable (SFP) transceiver modules with a fiber optic patch cable,
 5 rack-mounted fiber optic patch panels and Ethernet switches.

6 **742- 2 MATERIALS:**

7 **(A) Fiber Optic Cable:**

8 Developer shall furnish and install Single Mode Fiber Optic (SMFO) communication cables to
 9 provide a communications subsystem.

10 Fiber optic cable shall be of loose tube construction, filled with a water-blocking material, and
 11 constructed by a certified ISO 9001 or 9002 manufacturer. Fiber optic cable shall be dielectric
 12 and comply with the requirements of REA PE-90, except as modified by the following
 13 requirements:
 14

Cladding diameter:	125 ± 1.0 μm
Core-to-cladding offset:	≤0.8 μm
Cladding non-circularity:	≤1.0 percent
Maximum attenuation:	≤0.35 dB/km at 1310 nm, ≤0.25 dB/km at 1550 nm
Microbend attenuation (1 turn, 1.25-inch dia.):	≤0.5 dB at 1550 nm
Microbend attenuation (100 turns, 3' dia.):	≤0.05 dB at 1310 nm
Mode-field diameter (matched cladding):	9.3 ± 0.5 μm at 1310 nm; 10.5 ± 1.0 μm at 1550 nm
Maximum chromatic dispersion:	≤3.2 ps/(nm x km) from 1285 nm to 1330 nm and <18 ps/(nm x km) at 1550 nm

Fiber polarization mode dispersion:	$\leq 0.5 \text{ ps}/(\text{km})^{1/2}$
Fiber coating:	Dual layered, UV cured acrylate
Coating diameter:	$245 \mu\text{m} \pm 10 \mu\text{m}$
Minimum storage temperature range:	-40 to 158 degrees Fahrenheit
Minimum operating temperature range:	-40 to 158 degrees Fahrenheit

1 Buffer tubes shall be filled with a dry water-blocking material that provides for an efficient and
2 craft-friendly cable preparation. Buffer tubes shall be stranded around a central member using
3 the reverse oscillation or "S-Z", stranding process. Filler rods shall be used in the fiber optic cable
4 to lend symmetry to the cable section.

5 The fiber optic cable shall have a central strength member designed to prevent buckling of the
6 cable.

7 The fiber optic cable shall utilize a dry water-blocking material to block the migration of moisture in
8 the cable interstices.

9 The fiber optic cable shall have tensile strength members designed to minimize cable elongation
10 due to installation forces and temperature variation. The fiber optic cable shall withstand a 600
11 lbf (pound-force) maximum installation tensile load and a long term installed maximum tensile
12 load of 200 lbf.

13 The fiber optic cable jacket shall be constructed of a high or medium density polyethylene (HDPE or
14 MDPE) jacket that has been applied directly over the tensile strength members and water-
15 blocking material. The jacket shall have at least one ripcord designed for easy sheath removal.
16 The cable shall be wound on the reel in such a manner as to provide access to both ends of the
17 cable to enable testing to be performed while the cable is on the reel.

18 The cable shall be capable of withstanding total immersion in water with natural mineral and salt
19 contents, and wasp/hornet spray without damage or decrease in function.

20 Conductor and cable tagging shall conform to the requirements of Subsection 732-2.01 (A) (2) of
21 the Standard Specifications, unless otherwise specified. Tags shall have the capability of being
22 moved along the conductor or cable during future alterations.

23 Developer shall provide a Certificate of Compliance that the fiber optic cables furnished and
24 installed are in conformance with these Specifications. This certification shall be in two parts:

- 25 1. Certificate of Compliance from the fiber optic cable manufacturer that the
26 cable is in conformance with the Rural Electrification Administration (REA)
27 Bulletin PE-90 (where applicable) and these specifications.
- 28 2. Certificate of Compliance from Developer that the communication cable

1 subsystem has been installed and spliced in accordance with the fiber
2 optic cable and fiber optic splice closure manufacturer's
3 recommendations, and the RFC Plans and Project Special Provisions
4 for Construction.

5 **(B) FIBER OPTIC SPLICE CLOSURES:**

6 Fiber optic splice closures shall be either shell design or cylindrical, butt-end style, corrosion
7 resistant, watertight, and meet the requirements of CR-771-CORE. Underground splice closures
8 shall seal, bond, anchor, and provide efficient routing, storage, organization, and protection for
9 fiber optic cable and splices.

10 The splice closure shall provide an internal configuration and end cap with a minimum of two
11 express ports for entry and exit of backbone cable and a minimum of four additional ports for
12 distribution and branch cables.

13 Splice closures shall be designed to accommodate heat-shrink fusion splice trays in sufficient
14 quantities to perform the required number of splices. At a minimum, the splice closure shall
15 accommodate 144 splices, unless otherwise specified. Splice closures shall be supplied with the
16 maximum number of fusion splice trays.

17 Splice closures shall have a reliable dual-seal design with both the cable jackets and core tubes
18 sealed, without the use of water-blocking material. The splice closures shall be capable of being
19 opened and completely resealed without loss of performance.

20 The splice closure minimum dimensions shall be at least 29 inches long by 10 inches wide.

21 **(C) FIBER OPTIC PATCH PANEL**

22 The patch panels installed in the field shall be factory terminated and have protective covers for
23 all unused connectors. Patch panels shall be manufactured with LC-type connectors required to
24 match pre-installed connectors on jumper fiber optic cables. Branch 12-SMFO cable shall be pre-
25 installed on the patch panel by manufacturer and have the required length including needed slack
26 to reach each splice location. Branch cable shall be supplied with the splicing end protected by the
27 manufacturer with secure dust-proof cap ready to be spliced into each splice closure.

28 **(D) FIBER OPTIC PATCH AND SPLICE MODULE**

29 The fiber patch and splice module shall accommodate 12 single-mode fibers with LC type
30 connectors from the patch cables and the branch cable. Patch cables shall be included with the
31 fiber patch panel. The fiber patch panel shall be compatible with plenum-rated loose tube fiber
32 and provide protection of the buffer tube and individual fibers. The panel shall be capable of
33 securing the cable to the housing to prevent any damage due to movement.

34 **742-3 CONSTRUCTION REQUIREMENTS:**

35 Construction shall conform to Section 732 of the ADOT Standard Specifications, the ITS Standard
36 Drawings, the RFC Plans, and these specifications.

37 **(A) CONDUIT CLEANING:**

38 Developer shall clean new and existing conduits, no more than one week prior to installation of
39 fiber optic cable. Conduit cleaning is not required where existing cables, conductors, or innerducts
40 within a conduit will not be removed.

1 For PVC conduit, a metal-disc mandrel with an outer diameter not less than 90 percent of the
2 conduit's inside diameter shall be pulled through the conduit. For HDPE conduit, a ball mandrel
3 with an outer diameter not less than 80 percent of the conduit's inside diameter shall be pulled
4 through the conduit. Prior to pulling the mandrel through the conduit, the conduit shall be brushed or
5 swabbed.

6 **(B) FIBER OPTIC CABLE INSTALLATION:**

7 Developer shall visually inspect fiber optic cable upon delivery and prior to installation. Prior to
8 installation, damaged cable shall successfully pass OTDR testing, as specified herein. Damaged
9 cable shall be replaced by Developer.

10 No fiber optic cable shall be installed until the conduit, pull boxes, and cabinets through which
11 fiber optic cables will pass or terminate have been approved for fiber optic cable installation.

12 Developer shall not cause the cable to violate the minimum bending radius specified by the cable
13 manufacturer. In the event Developer violates the minimum bending radius, the entire length of
14 cable from the previous splice point shall be removed from the project and a new cable shall be
15 installed.

16 Developer shall ensure that the cable is protected from dragging or scraping. Cable shall not drag
17 on the ground or pavement and shall be guided into conduits or innerduct to avoid contact with
18 sharp edges. Fiber optic cables shall be pulled through conduit or innerduct with a device
19 designed to provide a firm hold on the exterior covering and the central strength member of the
20 cable.

21 Developer shall supply documentation identifying the manufacturer's recommendation for
22 maximum pulling tension and speed, and these values shall not be exceeded. Developer shall
23 have this documentation on site during each fiber optic cable installation pull. Developer shall use
24 a break-away tension limiter set below the tensile load limit of the cable and a system that
25 provides a means of alerting the installer when the tension approaches the tensile load limit.

26 During pulling, the cable shall be lubricated at each pull box. The lubricant used shall be
27 compatible with the cable jacket and meet the cable manufacturer's recommendations. Liquid
28 detergent shall not be used. Developer shall use a pre-lubrication or continuous lubrication
29 method. Lubricant quantity for each pull shall be as follows:

30
$$Q = 0.0008 \times D \times L$$

31 Where:

Q = is the lubricant quantity, in gallons

D = is the conduit diameter, in inches

L = is the length of the pull, in feet

32 Developer shall record the "foot marking" of installed fiber optic cable at the entrance and exit
33 point of No. 9 pull boxes in a Fiber-Optic Cable Installation Sequential Report. The report shall be
34 provided to ADOT in electronic spreadsheet format prior to final acceptance.

35 **(C) FIBER OPTIC PATCH PANEL:**

36 The factory terminated patch panels shall be mounted on the cabinet walls. They will be secured to
37 controller cabinets so as to avoid water, dust entry or accidental damage to the branch fiber optic

1 cable. Branch fiber optic cable shall directly connect into patch panels inside controller cabinets
2 and shall be factory installed on the patch panel. Patch panel shall be installed first in controller
3 cabinet followed by pulling and splicing of the branch fiber optic cable. All connectors on patch
4 panels shall be factory tested and labeled to insure proper installation. All unused connectors shall
5 be sealed by the manufacturer supplied plugs. Pulling of the cable shall comply with general
6 requirements for pulling fiber optic cable in conduits according to this TP Attachment 466-1.

7 Cables shall be routed to the panel to prevent damage. Developer shall install ultra-polished LC
8 connectors with metal inserts in a composite housing on each branch cable fiber and connect
9 fibers to the panel in the fiber order. The LC connectors for the cable may be fusion pre-polished
10 pigtails or hot melt field-polished connectors. No dry crimp connectors will be acceptable.

11 **(D) FIBER OPTIC PATCH AND SPLICE MODULE:**

12 The fiber optic patch and splice module shall be mounted vertically on the DIN rail, near the right
13 end. Space for air circulation shall be provided for adjacent equipment also mounted on the DIN
14 rail. Cables shall be routed to the panel to prevent damage. Developer shall install ultra-polished
15 LC connectors with metal inserts in a composite housing on each branch cable fiber and connect
16 fibers to the panel in the fiber order. The LC connectors for the cable may be fusion pre-polished
17 pigtails or hot melt field-polished connectors. No dry crimp connectors will be acceptable.

18 **(E) CABLE SLACK & COILING:**

19 Unless a greater distance is specified, No. 9 pull boxes with splice closures shall have 50 feet of
20 cable slack provided between the splice closure and the wall of the pull box where the cable
21 enters/exits the pull box, allowing the splice closure to be removed up to 50 feet from the pull box.
22 No. 9 pull boxes without splice closures shall provide a minimum of 100 feet of slack in each cable
23 passing through the pull box, unless otherwise specified.

24 Cable slack shall be loosely coiled into a circular shape and attached to the rack and hook system
25 integral to the wall of the No. 9 pull box with industry standard nylon cable ties. Cables shall be
26 coiled independently from one another and secured with separate cable ties for each coil. Cable
27 ties shall be tightened to prevent cable slippage, but shall not deform or damage the cable sheath.

28 **(F) SPLICES:**

29 Developer shall perform fusion splicing of fiber optic cable at the locations shown in the RFC
30 plans. Splices shall be prepared in accordance with the manufacturer's recommendations.
31 Splicing shall be conducted only at node buildings, specified pull boxes, and connector housing
32 units as shown on the RFC Plans and described in the Project Special Provisions for Construction.
33 Fiber optic cable shall be continuous between splice points.

34 Developer shall install splice closures in a manner such that trunk line cable entries on the same
35 side of the end cap allowing future branch fiber optic cables to be installed without disturbing the
36 trunk line seals.

37 Where Developer is splicing to existing fiber optic cable, Developer shall take care not to disturb
38 existing splices. Existing splices that are damaged shall be repaired immediately by Developer.

39 **(G) CONNECTORS:**

40 Branch fiber optic cables, typically between a cabinet and a splice closure on the trunk line, shall
41 be connectorized in accordance with the manufacturer's recommendations. Connectors shall be

1 installed to meet requirements of the ITS Design Guide, ITS Standard Drawings, as indicated on
2 the RFC Plans, and in these specifications.

3 Trunk line fiber optic cables shall not be connectorized.

4 **(H) TAGGING:**

5 Tags shall be installed on conductors and cables inside pull boxes near the pull box entrance and
6 exit, and inside cabinets. Tags shall be labeled with the following fields, as applicable:

7 Field 1: Responsible Agency (applicable only if agency is other than ADOT)

Example Legends	Application
ADOT	Arizona Department of Transportation
Sun Corridor	ADOT Broadband Initiative for I-17

8

9 Field 2: Description

Example Legends	Application
SMFO144	144-strand single mode fiber optic cable
SMFO12	12-strand single mode fiber optic cable
AWG6	American Wire Gauge 6
LOOP 1U	lane 1 upstream loop detector (other loop designations per Standard Drawing FM-5.01)
CCTV	CCTV device cable
DMS	DMS device cable

10 Field 3: Termination

Example Legends	Application
-----------------	-------------

TO NODE 15	fiber optic trunk line or power to a node
TO SB TRUNK LINE	fiber optic branch to southbound trunk line
TO CAB 2124532	fiber optic or power to a cabinet
TO LC 2124528	power to a load center
TO NB DMS	Power or control cable to northbound DMS

1 A continuous cable passing through a pull box shall have two tags which will be the same except
2 with different Termination descriptions. A pull box with a trunk line fiber optic cable spliced with a
3 branch fiber optic cable shall have three tags, two on the trunk line fiber optic cable and one on
4 the branch fiber optic cable. Multiple power conductors that go to one load center shall be bundled
5 together and have one tag that indicates the load center cabinet number in the Termination field.
6 Multiple power conductors that go to different cabinets shall be bundled and tagged in conductor
7 pairs according to the cabinet they go to.

8 Tagging shall be recorded by Developer in a Record Drawing Cable Schedule and include the
9 distance marking on the fiber optic cable at the entrance to a pull box, cabinet, or other termination
10 point. The as-built Cable Schedules within the ITS Plans shall be provided to ADOT with the Final
11 Complied Documentation.

12 **(I) TEST REQUIREMENTS:**

13 Fiber optic cable shall successfully pass the following tests, demonstrating acceptable attenuation
14 and connectivity. Developer shall make corrective actions for unacceptable. Failed splices and
15 connections shall be remade and re-tested for compliance. Developer shall replace cable in its
16 entirety that is not compliant with these specifications.

17 Each fiber optic strand shall introduce less than 0.35 dB/km of attenuation at 1310 nm and 0.25
18 dB/km of attenuation at 1550 nm.

19 Each splice between two newfibers shall introduce less than 0.1 dB of attenuation. Each splice
20 between one new and one existing, or two existing fibers, shall introduce less than 0.3 dB of
21 attenuation.

22 Each fiber connector shall introduce less than 0.5 dB of attenuation. Connectors exceeding this
23 limit shall be replaced until this requirement is met.

24 **(1) POWER METER TEST:**

25 Power meter tests shall be conducted by Developer after installation of the fiber optic cable,
26 splicing, and installation of fiber optic pigtailed and breakouts.

27 Power Meter Tests shall be performed on each fiber strand terminated with connectors utilized in
28 circuits, in accordance with Method A.3 of TIA/EIA-526-7 – “Measurement of Optical Power Loss

1 of Installed Single-Mode Fiber Cable Plant.” Testing shall be conducted at the cable ends in one
2 direction using 1310 nm wavelength.

3 Developer shall use the Power Meter Test Form provided at:

4 [https://www.azdot.gov/business/engineering-and-construction/systems-technology/its-](https://www.azdot.gov/business/engineering-and-construction/systems-technology/its-references)
5 [references](https://www.azdot.gov/business/engineering-and-construction/systems-technology/its-references) and submit a complete and organized set of forms in electronic PDF format to ADOT.

6 **(2) OTDR TEST:**

7 OTDR testing shall be conducted by Developer after successful completion of the power meter
8 test.

9 OTDR tests shall be performed in accordance with EIA/TIA-455-8 for all fibers, including new
10 fibers, dark fibers, and existing fibers in splice enclosures that Developer works in. Developer
11 shall test each fiber in both directions at 1310 nm and 1550 nm using a launch cable of a length
12 recommended by the OTDR manufacturer.

13 Developer shall use the OTDR Test Form provided at:

14 [https://www.azdot.gov/business/engineering-and-construction/systems-technology/its-](https://www.azdot.gov/business/engineering-and-construction/systems-technology/its-references)
15 [references](https://www.azdot.gov/business/engineering-and-construction/systems-technology/its-references) and submit a complete and organized set of forms in electronic PDF format to ADOT.

16 Developer shall submit OTDR traces which clearly annotate the location of each loss event and
17 identify the allowable loss and measured loss.

18 Developer shall coordinate with ADOT to install the SFP module and fiber optic patch cable and
19 reconfigure the existing switches to accommodate the new fiber optic communications channels
20 being established for this project.

21 The Fiber Patch Panel shall be rack mounted at a location designated ADOT. Cables shall be
22 routed to the panel to prevent damage. Developer shall install ultra-polished LC connectors with
23 metal inserts in a composite housing on all 144 fibers and connect fibers to the panel in the fiber
24 order. The LC connectors for the cable may be fusion pre-polished pigtailed or hot melt field-
25 polished connectors. No dry crimp connectors will be accepted.

26 Minimum qualifications for Developer personnel performing installation and testing of the
27 Ethernet Switches shall be:

- 28 • Three years' experience in installation, testing and maintenance of Ethernet network
29 equipment.
- 30 • Performed two installations where Ethernet Switches were deployed and the network
31 has remained in continuous satisfactory operation for at least two years.

32 Developer shall provide documentation indicating the names of the individuals performing the
33 work, company they work for, contact information, relevant experience and the amount of time
34 spent on each project, and any other supporting information to ADOT for approval at least 60
35 Days prior to the start of Ethernet switch installation.

36 Developer shall request the IP address, VLANs, host name, and other configuration settings from
37 ADOT at least 30 Days prior to installing the Ethernet Switches. The host name shall include the
38 cabinet ID number, device type (DMS, CCTV, Ramp Meter), and location description.

39 Ethernet switches shall be physically labeled with the IP address, device type (DMS, CCTV, Ramp
40 Meter), and location description.

- 1 Ethernet switches shall be mounted vertically, in the middle of the DIN rail. The power supply
- 2 shall be mounted to the left of the Ethernet switch leaving space for air circulation.
- 3 Wires and cables shall be neatly installed and secured using common practices and standards.
- 4 Developer shall provide service loops at connection points. Components shall be installed in a
- 5 manner where parts are readily accessible for inspection and maintenance.
- 6

1 **SECTION 743 CONTROL CABINET ASSEMBLIES AND FOUNDATION**

2 **743-1 Description:**

3 The work under this item includes furnishing and installing control cabinets, as shown on the plans
4 and in these Specifications.

5 The work under these items includes furnishing and installing control cabinet foundations, as
6 shown on the plans and in this TP Attachment 466-1.

7 The work under this item includes furnishing and installing transformer cabinet foundations, as
8 shown on the plans and in this TP Attachment 466-1.

9 **743-2 MATERIALS:**

10 The ITS cabinets shall be the type indicated on the RFC Plans. Overall appearance and
11 dimensions shall be as shown in the ITS Standard Drawings unless otherwise specified.

12 Developer shall provide complete wiring diagrams and schematics for ITS cabinet assemblies for
13 ADOT testing. The diagram shall show the specific loop detector field wire terminals for each loop
14 detector. An electronic copy and one set of 11" x 17" prints shall be provided with each ITS cabinet
15 assembly. The wiring diagram shall illustrate circuits and components in detail. Components shall
16 be identified by name or number so as to be clearly noted in the drawings. Material submittals
17 shall conform to the general requirements of this TP Attachment 466-1 and the TPs.

18 **743-2.01 STANDARD EQUIPMENT:**

19 ITS Cabinets Assemblies shall be furnished with the following items.

20 **(A) GENERAL:**

21 Bolts, nuts, washers, screws, hinges, and hinge pins shall be stainless steel, unless otherwise
22 specified.

23 Units of equipment shall be enclosed in a sheet metal case with a protective finish. The case shall
24 be designed to provide convenient access to the entire interior assembly and permit the removal
25 of printed circuit boards or modules without the use of special tools.

26 Module and printed circuit assemblies shall incorporate plug-in techniques and be easily
27 replaceable. A guide or track shall be provided for each module and assembly. Assemblies shall
28 be mechanically secured so as to retain the assemblies in their proper position under conditions of
29 shock and vibration when the unit is mounted in a roadside cabinet.

30 Assemblies shall be provided with two guides for each plug-in printed circuit board. The guides
31 shall extend to within 0.75 inch from the face of either the socket or connector. Connectors and
32 printed circuit cards shall be keyed to prevent accidental insertion of the wrong connector or card.

33 The manufacturer's model number, serial number, functional variation circuit issue or revision
34 number, and date of shipment (month and year) shall appear in an easily visible location on each
35 equipment unit and module supplied.

36 Units having the same model number shall be electrically and mechanically interchangeable.

37 **(B) CABINET HOUSING:**

38 Cabinet housings shall be ventilated NEMA 3 weather resistant with the top of the enclosure
39 crowned, to prevent standing water. Overall appearance and dimensions shall be as shown on

1 the RFC Plans and conform to the ITS Standard Drawings. The outside surface of the cabinet
2 shall have a smooth, uniform, natural, unpainted aluminum finish.

3 The enclosure, doors, two lifting eyes, gasket channels and supports welded to the enclosure and
4 doors shall be fabricated of 0.125-inch minimum thickness 5052-H32 sheet aluminum. Bolted-on
5 supports shall be either the same material and thickness as the enclosure, or shall be 0.105-inch
6 thick (minimum) steel. The side panels and filter shell shall be fabricated of 0.080- inch minimum
7 thickness sheet aluminum.

8 Each cabinet shall be provided with two lifting eyes. Each lifting eye opening shall have a
9 minimum diameter of 0.75 inch. Each lifting eye shall be able to support a load of 1,000 pounds.

10 Exterior seams for the enclosure and doors shall be continuously welded. Welds shall be neatly
11 formed and free of cracks, blow holes, and other irregularities. Edges shall be filed to a minimum
12 radius of 0.03125 inch. Exterior cabinet welds shall be accomplished by the gas Tungsten arc
13 Tungsten Inert Gas (TIG) process only. For the TIG process, the ER5356 (AlMg-5) 5%
14 Magnesium, Aluminum alloy welding rod, conforming to AWS A5.10 requirements shall be used
15 for welding on aluminum. Procedures, welders, and welding operators shall conform to the
16 requirements and practices in AWS B3.0 and C5.6 for aluminum. Internal cabinet welds shall be
17 done by either the gas metal arc Metal Inert Gas MIG (also known as Gas Metal Arc Welding
18 (GMAW) or the gas tungsten arc TIG process.

19 An anodic coating shall be applied to aluminum surfaces after the surface has been cleaned and
20 etched. The cleaning and etching procedure shall be to immerse in inhibited alkaline cleaner
21 at 159.8 degrees Fahrenheit for 5 minutes (in a mix of 6 to 8 ounces per gallon to distilled water)
22 then rinsed in cold water and etched in a sodium solution at 150.8 degrees Fahrenheit for 5
23 minutes (0.5 ounce sodium fluoride, plus five ounces of sodium hydroxide mix per gallon to
24 distilled water). The surface shall again be rinsed in cold water and then degreased in a 50
25 percent, by volume, nitric acid solution at 68 degrees Fahrenheit for 2 minutes. Finally, the surface
26 shall be rinsed in cold water.

27 The anodic coating shall conform to MIL-A-8625F (Anodic Coatings for Aluminum and Aluminum
28 Alloys) for Type II, Class I Coating except the outer housing surface coating shall have a 0.0007-
29 inch minimum thickness and a 0.952 ounces per square inch minimum coating weight. The anodic
30 coating shall be sealed in a 5 percent aqueous solution of nickel acetate (pH 5.0 to 6.5) for 15
31 minutes at 210.2 degrees Fahrenheit.

32 The enclosure door frames shall be double-flanged on all four sides, and shall have strikers to
33 hold tension on and form a firm seal between the door gasket and the frame. The dimension
34 between the door edge and the enclosure external surface when the door is closed and locked
35 shall be 0.156 ± 0.08 inch.

36 Gaskets shall be provided on door openings and shall be dust-tight. Gaskets shall be 0.25-inch
37 minimum thickness, closed-cell neoprene or silicone, and shall be permanently bonded to the
38 metal. If neoprene is used, the mating surface of the gasket shall be covered with a silicone
39 lubricant to prevent sticking to the mating metal surface. A gasket top channel shall be provided
40 to support the top gasket on the door to prevent gasket gravitational fatigue.

41 No bolts shall protrude through the cabinet top or walls. Inside and outside edges of the cabinet
42 shall be free of burrs.

43 Cabinet housing shall have single front and rear doors, each equipped with a lock. The handles
44 shall have provisions for padlocking in the closed position. Each handle shall be 0.75-inch

1 minimum diameter stainless steel with a minimum 0.50-inch shank. The padlocking attachment
2 shall be placed at 4 inches from the handle shank center to clear the lock and key. An additional
3 4-inch minimum gripping length shall be provided.

4 The latching mechanism shall be a 3-point draw-roller type. The center catches and push-rods
5 shall be cadmium plated, Type II Class 1. Rollers shall have a minimum diameter of 0.75 inch
6 with nylon wheels and steel ball bearings. The push rods shall be turned edgewise at the outward
7 supports and have a cross-section of 0.25-inch thick by 0.75 inch wide, minimum. The center
8 catch shall be fabricated from 0.140-inch steel, minimum.

9 When the door is closed and latched, the door shall be locked. The lock and lock support shall be
10 rigidly mounted on the door. In the locked position, the bolt throw shall extend a minimum of
11 0.25 inch into the latch-cam area. A seal shall be provided to prevent dust or water entry through
12 the lock opening.

13 Locks shall be consistent and compatible with current ADOT ITS cabinet maintenance keys. The
14 key shall be removable only in the locked position. One key shall be furnished with each lock. All
15 parts of the locking mechanism shall be stainless steel. Locks shall have rectangular spring-
16 loaded bolts. Bolts shall have a 0.281-inch throw and shall be 0.75 inches wide by 0.75 inches
17 thick (tolerance is +/- 0.035 inches).

18 The rear door shall be provided with louvered vents. The louvered vent depth shall be a maximum
19 of 0.25 inch. A removable, reusable air filter shall be housed behind the door vents. The filter shall
20 cover the vent opening area. A filter shell that fits over the filter and provides mechanical support
21 for the filter shall be furnished. The shell shall be louvered to direct the incoming air downward.
22 The shell sides and top shall be bent a minimum of 0.25 inch to contain the filter. The filter resident
23 in its shell shall be held firmly in place with a bottom bracket and a spring-loaded upper clamp.
24 No incoming air shall bypass the filter. The bottom filter bracket shall be formed into a waterproof
25 sump with drain holes to the outside of the housing. The filter shall be 16 inches wide x 12 inches
26 high x 0.875-inch thick, and compatible with the cabinet the filter is serving. The intake (including
27 filter with shell) and exhaust areas shall pass a minimum of 100 cubic feet of air per minute.

28 Two-bolts per leaf hinge shall be provided to bolt the enclosure to the door. The housing shall
29 have 4 hinges. Each hinge shall be 3.5-inch minimum length and have a fixed pin. The pin ends
30 shall be welded to the hinge and ground smooth. The pins and bolts shall be covered by the door
31 edge and not accessible when the door is closed.

32 Front and rear doors shall be provided with catches to hold the doors open at both 90 and 180
33 ± 10 degrees. The catch minimum diameter shall be either 0.375 inch for plated steel or aluminum
34 rods or 0.25 inch for stainless steel. The catches shall hold the door open at 90 degrees in a 60
35 mile per hour wind acting at an angle perpendicular to the plane of the door.

36 Developer shall furnish and install pressure-sensitive, permanent identification decals on load
37 center cabinets, as shown in the ITS Standard Drawings. The decals shall be 3- inch tall, Series
38 C, Gothic letters and shall be top-grade, glass-beaded, reflective black letters on a silver or
39 chrome background.

40 **(C) CAGE SUPPORT ASSEMBLY:**

41 A standard EIA 19-inch rack cage shall be installed inside the housing for mounting of the
42 controller unit and cabinet accessories.

1 The EIA rack portion of the cage shall consist of two pairs of continuous, adjustable equipment
2 mounting angles. The angle nominal thickness shall be either 0.1345-inch plated steel or 0.105
3 stainless steel. The angles shall be tapped with holes having 10-32 threads with EIA universal
4 spacing.

5 The angle shall comply with standard EIA RS-310-D and shall be supported at the top and bottom
6 by either welded or bolted support angles to form a cage.

7 The cage bottom support mounting angles shall be provided on either side, level with the bottom
8 edge of the door opening for horizontal support and bolt attachment. Side cage supports shall be
9 provided for the upper cage bolt attachments. Spacer brackets between the side cage supports
10 and the cage shall be either 0.188-inch aluminum or 0.105-inch steel.

11 Clearance between angles for mounting assemblies shall be 17.75 inches.

12 Two steel supporting angles extending from the front to the back rails shall be supplied to support
13 the controller unit. The angles shall be designed to support a minimum of 50 pounds each. The
14 horizontal side of each angle shall be a minimum 3 inches wide. The angles shall be vertically
15 adjustable.

16 As part of the controller support brackets, a 1.5-inch rack mounted drawer shall be provided within
17 a 1.75-inch space. The rack mounted drawer shall have a hinged top cover. The drawer shall
18 store documents and miscellaneous equipment up to 50 pounds in weight when extended out
19 from the cage. When fully extended, the drawer shall lock in place and shall require manual
20 release of spring pins on each of two sides to allow the drawer to be retracted into the cage.

21 The cage shall be bolted to the cabinet at four points on both top and bottom, using the housing
22 cage supports and associated spacer brackets, and shall be centered within the cabinet.

23 Aluminum side panels shall be provided in the cabinet as shown in the ADOT ITS Standard
24 Drawings. They shall be bolted to the support cage.

25 **(D) ELECTRICAL REQUIREMENTS:**

26 Circuits shall be functionally operational with regard to the following parameters:

27	Power source frequency:	60 ± 3 Hz
28	Applied Line Voltage:	90 to 135 VAC, single-phase
29	Ambient temperature:	-35 to +165 degrees Fahrenheit
30	Humidity:	5 to 95 percent, non-condensing

31 The surfaces of circuit boards shall be sealed to protect against moisture.

32 Circuits shall commence operation at or below 90 VAC, as the applied voltage is increased at a
33 rate of 2 ± 0.5 VAC per second.

34 Equipment shall be unaffected by transient voltages normally experienced in commercial power
35 lines.

36 Equipment shall be capable of normal operation following opening and closing of contacts in
37 series with the applied voltage at a rate of 30 openings and closings per minute for a period of 2
38 minutes.

39 Live electrical circuitry shall be isolated by a dead front panel fabricated from 14-gage sheet steel.
40 The dead front panels shall be hinged on one side and securely fastened on the other with bolts.

1 Switches, breakers and other components shall have openings to operate from the front of the
2 panel.

3 **(E) CABINET WIRING:**

4 Conductors used in cabinet wiring shall terminate with properly sized non-insulated (if used for
5 DC logic only) or clear insulated spring-spade type terminals except when soldered to a through-
6 panel solder lug on the rear side of the terminal block or as specified otherwise. Crimp-style
7 connectors shall be applied with a power tool that prevents opening of the handles until the crimp is
8 completed.

9 Cable connectors shall have cable hoods or shields and strain relief clamps.

10 Pin and socket connectors shall use identical contact insertion tools, contact extraction tools, and
11 contact crimping tools. Pin diameter shall be 0.062 inches.

12 Conductors between the service terminal AC- and Equipment Ground, and their associated bus,
13 the equipment ground bus conductor to Power Distribution Assembly, and cage rail, AC- Bus to
14 Power Distribution Assembly shall be 8 AWG or larger.

15 Conductors, unless otherwise specified, shall be 22 AWG or larger, with a minimum of 19 copper
16 strands. Conductors shall conform to Military Specification MIL-W-16878D, Type B, or better. The
17 insulation shall have a minimum thickness of 10 mils and shall be nylon jacketed polyvinyl
18 chloride, except that conductors 14 AWG and larger may have Type THHN insulation (without
19 nylon jacket), and shall be stranded with minimum of seven copper strands.

20 Field conductors shall be tagged in the control cabinet in accordance with these Specifications.

21 Conductors shall conform to the following color-code requirements:

22 The grounded conductors of AC circuits shall be identified by a solid white or solid gray
23 color;

24 The equipment grounding conductors shall be identified by a solid green color or by a
25 continuous green color with one or more yellow stripes;

26 The DC logic ground conductors shall be identified by a continuous white color with a
27 red stripe;

28 The ungrounded AC+ conductors shall be identified by a solid black or continuous black
29 with colored stripe; and

30 The logic ungrounded conductors shall be identified by a color not specified above.

31 Wiring harnesses shall be routed to minimize crosstalk and electrical interference.

32 The C1 connector wire harness shall be a minimum of 4 feet in length and shall have adequate
33 length to allow the C1P connector to properly connect the controller unit to the cabinet while the
34 unit is mounted in the cabinet and while the unit is sitting on the cabinet drawer.

35 Wiring containing AC shall be routed and bundled separately or shielded separately from logic
36 voltage control circuits.

37 Cabling shall be routed to prevent conductors from being in contact with metal edges.

38 Cabling shall be arranged so that removable assemblies can be removed without disturbing
39 conductors not associated with that assembly.

1 The DC logic ground shall be electrically isolated within the cabinet from the AC neutral and the
2 equipment ground by at least 500 Megohms at 250 VDC.

3 The cabinet power supply DC ground shall be connected to the DC logic ground bus using a No.
4 14 AWG or larger stranded copper wire.

5 With the power line surge protector disconnected, the AC neutral and the equipment ground shall
6 be electrically isolated by at least 500 Megohms at 250 VDC.

7 **(F) CIRCUIT BREAKERS:**

8 Circuit breakers shall be trip-free type with medium trip delay characteristics. Multi-pole circuit
9 breakers shall be the common-trip type. Circuit breakers shall be UL 489 approved. The trip and
10 frame size shall be plainly marked on the breaker by the manufacturer, and the Amperes rating
11 shall be marked and visible from the front of the breaker. Breakers shall be quick-make, quick-
12 break on either manual or automatic operation. Contacts shall be silver alloy enclosed in an arc
13 quenching chamber. Overload tripping shall not be influenced by an ambient temperature range of
14 from 0.4 to 122 degrees Fahrenheit. Minimum interrupting capacity shall be 5,000 Amperes RMS
15 when the breaker is secondary to a UL approved fuse or primary circuit breaker, and both breakers
16 in concert provide the rated capacity. For circuit breakers 80 Amperes and above, the minimum
17 interrupting capacity shall be 10,000 Amperes RMS.

18 **(G) FUSES:**

19 Fuses shall be 3AG Slow Blow type, and reside in a fuse holder. Fuse size rating shall be labeled
20 on the chassis or beside the holder. Fuses shall be easily accessible and removable without the
21 use of tools.

22 **(H) POWER LINE SURGE PROTECTOR:**

23 A power line surge protector shall be furnished and installed as part of the cabinet. The power
24 line surge protector shall consist of a hardware base and replaceable protection module with LED
25 failure indicators, conforming to the following requirements:

Operating Voltage	120 VAC
Clamping Voltage	340 VAC
Operating Current	15 Amps
Peak Surge Current	32.5 kA/Phase, 45.5 kA/Total
Operating Frequency	60 ± 3 Hz
EMI Attenuation	50 dB Typ.

Modes of Protection	L-N, L-G, N-G
Status Indicators	Power On, MOVs Functional
Temperature range:	-40 to + 185 degrees Fahrenheit
Maximum Dimensions:	3.125 inches wide x 7.125 inches long x 3.5 inches high

1 Typical radio interference noise suppression shall be 10 dB at 10kHz, 50 dB at 100kHz, and 90
2 dB at 1 MHz.

3 Power line surge protection shall be provided to enable equipment to withstand (non-disruptive)
4 and operate normally following the discharge of a 25 microfarad capacitor charged to ± 2,000
5 Volts, applied directly across the incoming AC line at a rate of once every 10 seconds, for a
6 maximum of 50 occurrences, with the equipment operating between 27 to 109 degrees
7 Fahrenheit and at 108 to 132 VAC.

8 Equipment shall withstand (non-disruptive) and operate normally when one discharge pulse of
9 ± 300 Volts is synchronously added to its incoming AC power line and moved uniformly over the
10 full wave across 360 degrees or stay at any point of line cycle once every second, with the
11 equipment operating between 27 to 109 degrees Fahrenheit and at 108 to 132 VAC. Peak noise
12 power shall be 5 kilowatts with a pulse rise time of 500 nanoseconds.

13 **(I) DIN RAIL SHELF:**

14 A 4U DIN rail shelf shall be included and capable of supporting power supplies, an Ethernet
15 Switch, a patch and splice module, power supplies, and other cabinet accessories.

16 **(J) VENTILATION FAN:**

17 Cabinets shall be equipped with two electric fans with ball or roller bearings and each with
18 capacity of 100 cubic feet of free air flow per minute. Fans shall be mounted within the interior of
19 the cabinet and vented.

20 Fans shall be thermostatically controlled and shall be manually adjustable to turn on between 32-
21 and 140-degrees Fahrenheit, with a differential between automatic turn on and off of not more
22 than 20 degrees Fahrenheit. It shall be possible to manually adjust the on/off temperature set point
23 in 20-degree Fahrenheit increments. Each fan circuit shall be protected at 125 percent of the fan
24 motor current rating.

25 **(K) LIGHTING:**

26 The cabinets shall contain two LED light fixtures. The fixtures shall be mounted on the inside top of
27 the cabinet near the front edge and rear edge of the roof so that the front or rear of the control
28 equipment will be illuminated when the corresponding door is open. A door-actuated, refrigerator-
29 type, normally-closed, durable push-button type switch shall automatically turn the appropriate
30 light fixture on and off when the front or rear door is opened and closed.

31 **743-2.02 CABINET ACCESSORIES:**

32 ITS Cabinet Assemblies shall be provided with the cabinet accessories as required.

1 **(A) MODEL 2070 CONTROLLERS**

2 Controllers shall be Intelight model 2070LC, model number INT YCT-2070LC(S), and where
3 appropriate, shall include Intelight Maxtime ramp metering software and licensing, model INT
4 YSW-RAMPMT, factory-loaded onto the controller. Each controller shall also be provided with
5 one Intelight Maxview central system license, model number INT YSW-MV-LICENSE. The
6 Maxview licenses shall be provided to ADOT in the form of one license key from Intelight for the
7 project by email to systemstechnologygroup@azdot.gov. The Developer shall submit the
8 Purchase Order (PO) to ADOT indicating the location for each Intelight controller.

9 **(B) INDUCTIVE LOOP DETECTOR CARDS:**

10 Detector cards shall provide two inductive loop detector channels for detecting vehicles and
11 actuating Model 2070 controllers. Control buttons and channel indicators shall be mounted on the
12 front panel. Detector cards shall have a front panel indicator to provide visual indication of
13 detection strength for each channel. The detector card front panel shall be provided with a handle to
14 facilitate insertion and removal. Detector cards of the same type shall be interchangeable.
15 Detector cards shall be in full compliance with the environmental requirements of the most current
16 NEMA standard.

17 Indicator lights and character displays shall have a 45-degree cone of visibility from an axis
18 perpendicular to the front panel. They shall be readily visible at a radius of up to 4 feet within the
19 cone of visibility when they are subjected to 9,000 foot-candles of white light (equivalent to bright
20 sunlight) at 45 degrees to the front panel. The front panel shall provide a separate indicator for
21 Detect and Fault for each channel.

22 Detector cards shall mate and be fully functional with the input file via a 44 terminal, double row,
23 edge connector having terminal spacing of 0.156 inch.

24 Detector cards shall draw no more than 100 mA from the + 24 ± 6 VDC cabinet power supply and
25 shall be insensitive to 700 mV RMS ripple on the incoming + 24 VDC line.

26 Detector card outputs shall be opto-isolated, open collector, NPN transistor and shall sink up to
27 50 mA at 30 VDC. The output shall be compatible with the controller unit's inputs.

28 Component parts and test points shall be clearly identified by permanent marking of circuit
29 references on the printed circuit board.

30 Each loop input channel shall be galvanically isolated, through the use of separate isolation-
31 transformers, from each other and the internal circuitry of the detector.

32 Detector channels shall function properly with an external surge protector installed on the loop
33 circuit.

34 Internal surge protection, provided on loop detector input terminals, shall enable the detector to
35 withstand a discharge of a 10 microfarad capacitor charged to ± 1,000 Volts directly across the
36 loop detector input pins with no loop load present and enable the detector to withstand a discharge
37 of a 10 microfarad capacitor charged to ± 2,000 Volts directly across either the detector input pins
38 or from loop input pins to equipment ground. The detector input pins shall have a dummy resistive
39 load attached equal to 5.0 Ohms for test purposes.

40 Optically-isolated solid state output devices shall be rated to hold off 50 VDC at 20 mA ON current
41 with a maximum 1.5-Volt drop across the output terminals. Isolation shall be at least 1,000 VAC
42 RMS.

1 Detector cards shall have a remote reset circuit which, when activated by an external ground level
2 signal greater than 15 microseconds, shall cause presence detections to be reset.

3 Detector channels shall be sequentially scanned to eliminate crosstalk between loops connected to
4 the same unit.

5 Detector channels shall automatically self-tune to any loop system inductance from 20 to 500
6 microhenries within 1 second after application or interruption of voltage.

7 At a minimum, each channel shall include the modes "PRESENCE," "PULSE," and "OFF". "OFF"
8 shall disable the output and indicator, and shall disable the channel excitation circuit to assist in
9 determining the offending channel when crosstalk is present.

10 "PULSE" shall provide a single 125 ± 25 ms output pulse in response to all types of licensed motor
11 vehicles when traveling over a 6 x 6-foot rectangular loop at 10 miles per hour and shall detect
12 successive vehicles traveling over the same rectangular loop at speeds of 10 to 60 miles per hour
13 with a minimum 1-second headway. Selection of pulse mode shall clear the presence indication
14 on the associated channel.

15 "PRESENSE" shall output a pulse that is directly related to the duration that a vehicle is detected
16 by the loop system. In presence mode, the detector channel shall be capable of detecting a
17 motorcycle and hold the output for at least 4 minutes when the motorcycle is stopped over one
18 loop of a series-connected loop system having four 6 x 6-foot loops with 1,000 feet of lead-in and
19 a Q factor greater than 5. The detector channel shall hold the output for at least 15 minutes when
20 the test is repeated using a standard automobile on the same loop system configuration.

21 The time delay between a vehicle entering the detection zone and the occurrence of the detection
22 output shall be 10 ms or less at the midpoint sensitivity setting. The time delay between a vehicle
23 leaving the detection zone and the detection output turning off shall be 10 ms or less at the
24 midpoint sensitivity setting.

25 For test purposes, a negative inductance change shall be applied for a minimum of 100 ms and a
26 maximum of 600 ms. When the difference in the durations of the inductance change and the
27 corresponding ground true output are averaged over 10 trials, the average difference (algebraic)
28 shall not exceed the specified threshold.

29 To test for vehicle presence, the delay time between when an inductance change is applied and
30 the time it takes for the output to respond, averaged over 10 trials, shall not exceed the specified
31 threshold.

32 To test for vehicle absence, the delay time between when an inductance change is removed and
33 the time it takes for the output to respond, averaged over 10 trials, shall not exceed the specified
34 threshold. To test recovery time, the above two tests shall be repeated in sequence 10 times with
35 a delay of not more than 100 ms between the beginning of each two-stage sequence.

36 Detector channels shall have a range of selectable sensitivities that ensures detection of all types
37 of licensed motor vehicles (including motorcycles) without detecting moving or stopped vehicles
38 further than 36 inches away from a three-turn, 6 x 6-foot loop with 50 feet, 500 feet, and 1,000 feet
39 of lead-in cable.

40 Detector channels shall be continuously monitored for open circuit, short circuit, and changes in
41 inductance indicating a loop fault condition. A loop fault of one channel shall have no adverse
42 effect on the operation of the other channel. Specific fault conditions shall be indicated by a unique
43 sequence of flashes by the fault indicator light. The fault indicator light shall display a previous

1 fault condition. Detector channels shall re-tune instantly and resume detection following a
2 momentary open circuit condition. During an open circuit condition, the channel shall provide a
3 continuous output that is not resettable as long as the open circuit exists, except when the channel
4 is off.

5 **(C) LOOP DETECTOR SURGE PROTECTORS:**

6 Loop detector surge protectors shall be provided in existing and new cabinets with new loop
7 terminations. Loop detector surge protectors shall have three spade lugs for connection to a
8 terminal strip, with 7/16-inch spacing, and conform to the following minimum performance
9 requirements:

10 (1) Peak Surge Current:

- 11 a. 8 x 20 µsec Differential Mode: 400 A
- 12 b. 8 x 20 µsec Common Mode: 1,000 A

13 (2) Life Expectancy (Occurrences):

- 14 a. 8 x 20µsec (200A): 500
- 15 b. 10 x 700µsec (100A): 100

16 (3) Response Time: Less than 5 ns

17 (4) Input Capacitance: 35 pF

18 (5) Clamping Voltage (After Breakover): 150 V

19 (6) Operating Temperature: Up to 185 degrees Fahrenheit

20 **(D) POWER DISTRIBUTION ASSEMBLY NO. 4:**

21 The power distribution assembly No. 4 (PDA4) shall perform the following functions:

22 Receive the 120 VAC power source and distribute it to the various cabinet functions through
23 separate circuit breakers.

24 Provide, via the Model 206 power supply module, a + 24 VDC power source for the operation of
25 various cabinet accessories.

26 Provide, via a Model 204 flasher unit, a means of flashing external signal indications.
27 Provide a switch pack load bay with inputs from the controller and outputs to field circuits.

28 The PDA4 shall include four 15 Amp circuit breakers. The rating of each breaker shall be shown
29 on the face of the breaker or handle. Breaker function (EQPT, CCTV, SIG GATES, REC) shall
30 be labeled on the front panel as shown on the ITS Standard Drawings.

31 The PDA4 shall have three duplex receptacles. Each receptacle shall accept both standard two-
32 prong non-grounded and standard three-prong grounded plugs.

33 Receptacle No. 1 (REC1) and receptacle No. 2 (REC2) shall have ground-fault circuit interruption,
34 as defined in the NEC. Circuit interruption shall occur in the presence of 6 mA or more ground-
35 fault current and shall not occur on less than 4 mA ground-fault current.

1 The 120 VAC supplies to the two outlets of receptacle No. 3 (REC3A and REC3B) shall be
2 separate. The rear panel of the PDA shall be etched to label REC3A as "CONTROLLER" and
3 REC3B as "AUX".

4 Terminal blocks shall have 10-32 thread terminal screws.

5 The PDA4 shall provide for the mounting and connection of four Model 200 switch packs. The
6 PDA4 shall have a maximum depth of 10.5-inches.

7 **(E) MODEL 206 POWER SUPPLY MODULE:**

8 The Model 206 Power Supply Module shall supply + 24 VDC to the input files and other devices in
9 the cabinet. It shall be furnished as a part of the PDA4.

10 The power supply shall be of ferro-resonant design, having no active components, and
11 conforming to the following requirements:

12 Line regulation shall be 2 percent from 90 to 135 VAC at 60 Hz, plus an additional 1.6 percent for
13 each 1.0 percent of frequency deviation.

14 Load regulation shall be 5 percent from 1 to 5 Amperes, with a maximum temperature rise of 86
15 degrees Fahrenheit, above ambient.

16 Design voltage shall be + 24 ± 0.5 VDC at full load, 86 degrees Fahrenheit, 115 VAC incoming
17 voltage.

18 Full load current shall be 5 Amperes, minimum.

19 Ripple noise shall be no greater than 2 Volts peak-to-peak and 500 mV RMS at full load.

20 Power source shall be 90 to 135 VAC.

21 Efficiency, at full load, shall be 80 percent, minimum. Circuit capacitors shall be rated for 40 Volts,
22 minimum.

23 The front panel shall include AC and DC fuses, power ON light, and test points for monitoring the
24 output voltages.

25 The assembly, including terminals, shall be protected to prevent accidental contact with energized
26 parts.

27 The module chassis shall be vented. Its top and sides shall be open. When resident in the power
28 distribution assembly, the module shall be held firmly in place by a stud screw, an assembly
29 connector support panel, and a wing-nut.

30 Two 0.5 Ohm, 10-Watt (minimum) wire-wound power resistors, each with a 0.2 microhenry
31 maximum inductance, shall be provided; one on the AC+ power line and one on the AC- line.

32 Three MOV surge arrestors rated for 20 Joules minimum, shall be supplied between AC+ and
33 equipment ground, AC- and equipment ground, and between AC+ and AC-. A 0.68-microFarad
34 capacitor shall be placed across AC+ and AC- between the two power resistors and the MOVs.

35 **(F) INPUT FILE:**

36 Developer shall furnish and install input files for cabinets used for detection applications, as shown
37 in the ADOT ITS Standard Drawings. The input file racks shall provide card slots for the loop
38 detector cards. Each input file rack shall have a maximum depth of 8.5 inches and shall mate with
39 and support up to 14 two-channel detector sensor or isolator cards. The file shall provide a PCB

1 22/44S connector centered vertically for each two-channel card slot. The input file shall be
2 provided with labels identifying the detectors associated with each slot. Terminal blocks shall be
3 provided with a terminal screw size of 8-32 with locking star washers.

4 **(G) REMOTE MANAGEMENT POWER STRIP:**

5 A remote management power strip shall be included in the cabinets.

6 The remote management power strip shall be a non-surge protected power strip rated for an
7 operating temperature range of -34 to 74 degrees Celsius (-30 to 165 degrees Fahrenheit) and
8 an operating current of 15 Amps. The power strip shall have a minimum of 4 NEMA 5-20R power
9 outlets, and be rack-mounted with a recess for plug and cord clearance. The power strip shall
10 provide IP network accessibility and support NTP, SNMP, and SMTP protocols. A web interface
11 shall provide status and control of each of the receptacles separately. The system shall be
12 capable of providing email alerts, event log, and scheduling with momentary power cycling.

13 **(H) DETECTION CABINETS:**

14 The Detection Cabinets shall be furnished and installed in accordance with the ITS Standard
15 Drawings and in these Specifications. At location where the number of lanes exceed that as
16 shown in the ITS Standard Drawings, the Developer shall coordinate with the cabinet
17 manufacturer to ensure the cabinets are pre-wired to accommodate loops and detectors for all
18 lanes of traffic.

19 Detection Cabinets shall be provided with the following cabinet accessories:

- 20 Model 2070 Controller
- 21 Inductive Loop Detector Cards
- 22 Loop Detector Surge Protector
- 23 Power Distribution Assembly (PDA) No. 4
- 24 Model 206 Power Supply Module
- 25 Input Files "I"
- 26 and "J"

27 Additional cabinet accessories shall be furnished and installed when specified on the RFC plans
28 and shall include a Remote Management Power Strip.

29 Detection Cabinets shall be capable of operating without a conflict monitor.

30 Locking star washers shall be included on each terminal block mounting screw. Each terminal of
31 each double-sided terminal block shall contain two terminal screws with a removable shorting bar
32 between the terminal screws. The shorting bar shall be suitable for 22 AWG through 14 AWG wire,
33 and PV 18-6F-M lugs. A removable shorting bar shall be installed between the terminal screws.
34 The terminal number assigned to each terminal shall be clearly and permanently indicated on a
35 marking strip placed on or adjacent to the terminal block.

36 The main circuit breaker box shall contain the following:

- 37 120 VAC, 30 Ampere, socket-mounted, double-pole, single-throw heavy duty relay and
- 38 socket to serve as the signal power interrupt relay

1 30 Ampere single-pole
2 breaker Power line surge
3 protection device

4 The circuit breaker box shall have nominal dimensions of 10 inches high x 8 inches wide x 4
5 inches deep. The main circuit breaker shall accommodate service wire as large as No. 2 AWG.
6 The electrical service conductors shall be contained in a flexible conduit as described in the NEC.
7 This conduit shall enclose the service from the entrance conduit to the circuit breaker box. It shall
8 be long enough to be dressed neatly and attached to the side panel.

9 The flexible conduit shall be equipped with a coupling and a reducer, if necessary, to enable its
10 attachment to the service entrance conduit. Conduit shall extend approximately 6 inches into the
11 service entrance conduit.

12 **(I) CCTV CABINETS:**

13 CCTV Cabinets shall be furnished with pole-mounting hardware. CCTV cabinets shall be provided
14 with one exhaust fan. CCTV Cabinet shall be provided with a power distribution panel including
15 the following:

- 16 30 Ampere main circuit breaker
- 17 20 Ampere circuit breaker for the cabinet equipment receptacle
- 18 20 Ampere circuit breakers for GFCI convenience receptacle
- 19 One standard three-wire 20 Ampere duplex outlet
- 20 One GFCI three-wire 20 Ampere duplex outlet
- 21 Power line surge protection device

22 Additional cabinet accessories shall be furnished and installed when specified on the RFC plans
23 and shall include a Remote Management Power Strip.

24 For CCTV cabinets powered by solar power/battery systems in areas where AC power is not
25 readily available, the 20 Ampere duplex outlet and the 20 Ampere GFCI outlet may be omitted
26 provided the inverter has sufficient connections to provide power to all CCTV equipment
27 components, the network switch, the remote management power strip and any other devices in
28 the CCTV cabinet.

29 **743-3 CONSTRUCTION REQUIREMENTS:**

30 Developer shall install wire, cable, connectors, and other incidental materials necessary to
31 connect equipment to be incorporated in, or connected to the work through the foundation, to the
32 cabinet, to form a fully functional system which meets the requirements of Subsection 731-

33 3.01 of the Standard Specifications. Installation shall include:

- 34 Grounding the cabinet to the ground system, using bare, solid 8 AWG soft-drawn copper
35 wire;
- 36 Grounding the transformer, if it is on the same foundation as the control cabinet;
- 37 Connecting the cabinet to the power source;
- 38 Completing fiber optic splices and terminations within the cabinet, as required;

1 Furnishing and installing necessary mounting hardware (pole-mount, if applicable to
2 specific cabinet type and location).

3 Developer shall supply Certificates of Compliance for each ITS cabinet and each accessory within
4 a control cabinet at the time of delivery of the ITS cabinet assembly for the following:

5 Acceptance testing of each supplied component

6 Physical and functional testing of each module

7 A minimum of 100-hour burn-in of each module

8 A minimum of 24 hours of operation of each cabinet

9 **743-3.01 CABINET FOUNDATIONS**

10 Foundations shall conform to the requirements of Subsection 731-3.01 of the ADOT Standard
11 Specifications. Foundations shall include conduit, conduit fittings and elbows, anchor bolts,
12 conductors, connectors, ground rods, grounding conductors, grounding lugs, and other incidental
13 materials necessary to connect equipment incorporated in, or connected through the foundation,
14 to the cabinet, to form a fully functional system.

15 If the cabinet will be located on a slope steeper than 3:1, the foundation shall be offset from the
16 pull box along the mainline conduit or other structure so that their locations do not lie on a line
17 perpendicular to the roadway.

18 Foundations shall be monolithic with the exposed surfaces formed and finished to present a neat,
19 smooth appearance. The bottom of each foundation shall rest on undisturbed earth and the top
20 shall be level. Adjacent concrete maintenance pads shall also meet these requirements.

21 Forms for the concrete shall be rigid and securely braced in place. Templates shall be used to
22 properly position and hold in place conduit, anchor bolts, and the ground rod. Immediately prior
23 to pouring the concrete, both forms and the earth shall be thoroughly moistened. The concrete
24 shall be allowed to cure at least 12 hours and shall be hardened sufficiently to prevent damage
25 before the forms are removed. Developer shall backfill and build slope in accordance with the
26 RFC Plans and restore the landscaping in areas with no new landscaping.

27 Grounding shall meet the requirements of Subsection 732-3.03 of the ADOT Standard
28 Specifications. Cabinet foundations shall have a copper clad steel ground rod with a minimum
29 diameter of 5/8 inch. The ground rod shall be driven into place through a sleeve in the foundation.
30 The ground rod shall be installed so that it extends into the surrounding undisturbed earth a
31 minimum of 9 feet. The ground rod shall extend approximately 3 inches above the foundation. The
32 ground rod shall be connected to the grounding system using ground clamps on the rod and an
33 approved lug connector in the cabinet. The cabinet shall be grounded with an 8 AWG solid copper
34 wire.

35 If Developer prefers to use an electrolytic grounding system, it shall be 100 percent self-
36 activating, sealed, and maintenance free. The electrolytic grounding system shall be UL listed
37 with a minimum life rating of 30 years. The electrolytic grounding system shall hygroscopically
38 extract moisture from the air to activate the electrolytic process without additions of chemicals or
39 water. The electrolytic grounding system shall not use hazardous material.

40 Concrete shall be 3,000 pound per square inch Class S concrete conforming to the requirements of
41 Section 1006. Anchor bolts shall conform to the requirements of Section 606-2.05 and 1004-

1 Grounding conductors shall conform to the requirements of Subsection 732-2.01.

2 **743-3.02 CABINETS:**

3 Field wires and power service cables shall be wired to the cabinets as shown in the ITS Standard
4 Drawings and on the RFC Plans. Developer shall connect the cabinet and its accessories to the
5 various field devices to be controlled, to form a fully functional system.

6 Removable caps shall be placed on unused conduits within the cabinet.

7 Wire and cable terminations shall only be made at recessed-screw barrier type terminal blocks,
8 unless otherwise specifically noted. No in-line or butt splices shall be made other than at terminal
9 blocks.

10 Control cabinet equipment shall be mounted on the cage mounting rails as shown in the ITS
11 Standard Drawings, unless otherwise specified.

12 Equipment, housings, metal conduit, and cabinets (exposed metal, non-current carrying parts)
13 shall be grounded and bonded in accordance with Subsection 732-3.03 of the ADOT Standard
14 Specifications and NEC Article 250. The cabinet's ground resistance shall be 25 Ohms or less.

15 Grounding conductors and bonding jumpers shall be connected by exothermic welding, UL listed
16 pressure connectors, UL listed clamps, or other approved UL listed means. Connection devices or
17 fittings that depend solely on soldering shall not be used. Sheet metal screws shall not be used
18 to connect grounding conductors to enclosures.

19 On two-door cabinets, the DIN rail shall be attached to the vertical rails serving the "back side" of
20 the cabinet. The "front side" of the cabinet is the side from which controller face and keyboard are
21 viewed. On single-door cabinets, the location for mounting the DIN rail shelf will be as specified
22 by ADOT, to meet specific site equipment space requirements.

23 Developer shall furnish and install silicone caulking, or other sealant as approved by ADOT,
24 around the base of the cabinet to form a watertight and dust-proof seal.

25 **743-3.02 CABINET ACCESSORIES:**

26 Detector cards and switch packs shall be installed in the appropriate slots in the control cabinet.

27 **(A) MODEL 2070 CONTROLLERS:**

28 Developer shall securely mount the controller unit in the cabinet by firmly attaching it to the cabinet
29 rack with screws. After Developer establishes communications to the controller, ADOT will
30 configure the controller software settings. Developer shall allow a minimum of 10 Days for ADOT
31 to configure the controller software settings.

32 Controllers shall be delivered to ADOT TSMO YM PM02 Basement at 2302 W Durango Street,
33 Phoenix, Arizona 85009 for programming and testing of controllers. The Developer shall notify
34 ADOT TSMO at least 2 Business Days prior to the scheduled delivery of the controllers.

35 **(B) INDUCTIVE LOOP DETECTOR CARDS:**

36 Developer shall set the loop detector card to the following
37 parameters: Mainline Channels:

38 Mode: Short Presence

1 Frequency Level (levels 1, 2, 3, and 4 correspond to low, medium low, medium high,
 2 and high, respectively):

U: 1	2U: 3	3U: 2	4U: 4	5U: 1	6U: 3	7U: 2	8U: 4
1D: 2	2D: 4	3D: 1	4D: 3	5D: 2	6D: 4	7D: 1	8D: 3

3
 4 Sensitivity (set to provide the following call strengths observed under normal
 5 traffic): No vehicle: 0
 6 High Vehicles (Semi-truck, 4x4): 4
 7 Mid-sized Vehicles (car, SUV, small pick-up
 8 truck): 5 Low Vehicles (sports car): 6

9 Entrance Ramp
 10 Channels:
 11 Mode: Long
 12 Presence

13 Frequency Level (levels 1, 2, 3, and 4 correspond to low, medium low, medium high,
 14 and high, respectively):

ELI: 1	ELQ: 1	ERO: 4
ELO: 2	ERI: 3	ERQ: 2

15
 16 Sensitivity (set to provide the following call strengths observed under normal
 17 traffic): No vehicle: 0
 18 High Vehicles (Semi-truck, 4x4): 4
 19 Mid-sized Vehicles (car, SUV, small pick-up
 20 truck): 5 Low Vehicles (sports car): 6

21 **(C) REMOTE MANAGEMENT POWER STRIP:**

22 Remote management power strips shall be horizontally rack mounted below the DIN rail
 23 shelf, leaving a single space gap between the DIN rail shelf and the remote management power
 24 strip.

25 **743-3.03 ITS CABINET ASSEMBLY TESTING REQUIREMENTS:**

26 ITS cabinet assemblies shall successfully pass the following tests, demonstrating that they operate
 27 properly when assembled and connected to the equipment they serve. Developer shall make
 28 corrective actions for equipment failing a test.

29 **(A) STAND-ALONE TEST:**

1 Developer shall perform the stand-alone test under normal traffic conditions and after the ITS
2 cabinet assembly is complete and loop lead-in cables have been connected to the loop detector
3 card.

4 **(1) ITS CABINET ASSEMBLY TEST**

5 Developer shall use the ITS Cabinet Assembly Test Form provided at:

6 [https://www.azdot.gov/business/engineering-and-construction/systems-technology/its-](https://www.azdot.gov/business/engineering-and-construction/systems-technology/its-references)
7 [references](https://www.azdot.gov/business/engineering-and-construction/systems-technology/its-references) and submit a complete and organized set of forms in electronic PDF format to ADOT.

8 **(2) TRAFFIC VOLUME AND SPEED TEST**

9 Developer shall test the accuracy of the volume data collected by the controller for each loop
10 detector. The controller shall provide volumes accurate between 95 to 105 percent. Accuracy
11 shall be evaluated comparing 20-second volume data reported by the controller to a manual
12 vehicle count during a 15-minute period, or 100 vehicles passing over the loop, whichever comes
13 first. Developer shall record 20-second controller volume and 1-minute manual count volume on
14 the Traffic Volume and Speed Test Form provided at:
15 [https://www.azdot.gov/business/engineering-and-construction/systems-technology/its-](https://www.azdot.gov/business/engineering-and-construction/systems-technology/its-references)
16 [references](https://www.azdot.gov/business/engineering-and-construction/systems-technology/its-references) and submit a complete and organized set of forms in electronic PDF format to ADOT.
17 ADOT will add Intelight menu commands to see line speeds.

18 Developer shall perform the following loop detector speed calibration and test for each mainline
19 lane:

- 20 1. Set the trap distance to 18 feet in the controller.
- 21 2. Determine the actual speed using a certified radar gun or a vehicle with a
22 calibrated speedometer. If using a vehicle, drive the vehicle past the detector
23 station at a constant maximum safe and legal speed and record the Actual
24 Speed. If using radar, collect radar speeds as vehicles pass over the loops. The
25 person collecting the speeds shall be positioned to collect radar speeds as near
26 to head-on as possible, speeds shall not be collected at an angle exceeding 15
27 degrees from the line of travel of the vehicle.
- 28
- 29 3. Record the actual speed
- 30 4. Record the speed measured by the controller
- 31 5. Perform the following calculation:
32
$$\text{New Trap Distance (ft)} = \text{Current Trap Distance (ft)} \times \frac{\text{Controller Speed (mph)}}{\text{Actual Speed (mph)}}$$

33
- 34 6. Set the trap distance in the controller to the New Trap Distance.
- 35 7. Repeat the previous steps as necessary until the controller indicates accurate
36 speeds to ADOT's satisfaction.
- 37 8. Record the final calibrated speed trap distance on the Traffic Volume and
38 Speed Test Form provided at:

1 [https://www.azdot.gov/business/engineering-and-construction/systems-technology/its-](https://www.azdot.gov/business/engineering-and-construction/systems-technology/its-references)
2 [references](https://www.azdot.gov/business/engineering-and-construction/systems-technology/its-references) and submit a complete and organized set of forms in electronic PDF format
3 to ADOT.

4 (3) ETHERNET SWITCH TEST

5 Developer shall use the Ethernet Switch Test Form provided at:

6 [https://www.azdot.gov/business/engineering-and-construction/systems-technology/its-](https://www.azdot.gov/business/engineering-and-construction/systems-technology/its-references)
7 [references](https://www.azdot.gov/business/engineering-and-construction/systems-technology/its-references) and submit a complete and organized set of forms in electronic PDF format to ADOT.

8 (B) SUBSYSTEM TEST (SST):

9 ADOT, with the support of Developer, will conduct the subsystem test on the ITS cabinets and
10 communications system to verify that communications circuits (Developer-installed and existing
11 equipment and connections) are properly configured and operate without failure and without
12 adversely affecting the existing system. The SST shall start on a Monday, Tuesday, or
13 Wednesday and shall be conducted for 3 consecutive days.

14 A communication failure to detection or ramp meter cabinet shall include receiving traffic data for
15 less than 4,104 of the 4,320 (95 percent) 20-second intervals in a day.

16 Developer shall repair or replace components that fail the SST and the test shall be restarted on a
17 Monday, Tuesday, or Wednesday and be conducted for 3 consecutive days. Developer shall
18 supply test equipment requested by ADOT to troubleshoot the system.

19 (C) SYSTEM ACCEPTANCE TEST (SAT):

20 Upon successful completion of subsystem testing, the SAT shall be started. The SAT shall consist
21 of a 30 consecutive day period of operation without failure of all Developer-supplied and approved
22 relocated equipment. Developer shall ensure that all equipment is ready for testing prior to
23 submission for ADOT's testing and acceptance.

24 The SAT shall not start without providing the required ITS documentation and delivering red lines
25 identified in Section 751 of this TP Attachment 466-1 to ADOT. GPS data shall be submitted and
26 approved by ADOT prior to beginning the SAT for the periods specified in the ITS Record
27 Documentation item.

28 The purpose of the SAT is to demonstrate that the total system, consisting of hardware, software,
29 communications, materials and construction, is properly installed, is free from defects and
30 problems, exhibits stable and reliable performance, and complies with contract documents.

31 During the SAT, Developer shall maintain equipment in an operable condition and ADOT
32 personnel shall be provided access to the equipment. Developer shall identify, isolate, diagnose,
33 and troubleshoot system problems and inconsistencies. Developer shall provide test equipment
34 and labor needed to test, isolate and correct equipment deficiencies found during the SAT.
35 Developer technical personnel having industry standard certification in the field of the design and
36 construction of each system component shall be available on site within 48 hours of notification
37 of a problem. Developer, in conjunction with ADOT, shall formulate possible solutions and shall
38 implement corrections required in Developer-supplied equipment.

39 During the SAT, Developer shall record test failures on the System Acceptance Test Failure Log
40 provided at:

1 [https://www.azdot.gov/business/engineering-and-construction/systems-technology/its-](https://www.azdot.gov/business/engineering-and-construction/systems-technology/its-references)
2 [references](https://www.azdot.gov/business/engineering-and-construction/systems-technology/its-references) and immediately submit the form to ADOT. After the repair has been completed, an
3 updated form shall be submitted to ADOT. Documentation errors, omissions, and changes
4 occurring prior to, and during, the SAT shall be corrected and resubmitted before the SAT is
5 completed.

6 (1) SAT MINOR FAILURE

7 In the event of a minor failure during the SAT, the test clock shall stop until the system is repaired.
8 Upon completion of the repair, testing shall resume with 24 hours added to the remaining test
9 time of the system. The following constitutes a minor failure:

- 10 • Failure to communicate to a controller.
- 11 • Failure to receive traffic data for less than 4,104 of the 4,320 (95 percent) 20-
12 second intervals in a day.

13 (2) SAT MAJOR FAILURE

14 In the event of a major failure during the SAT, the test clock shall stop until the system is repaired.
15 Upon completion of the repair, testing shall resume with the test clock reset to day zero. The
16 following constitute a major failure:

- 17 • Third failure to communicate to an individual controller.
- 18 • Third failure to receive traffic data from an individual controller for less than
19 4,104 of the 4,320 (95 percent) 20-second intervals in a day.
- 20 • Failure to correct an issue within 4 hours of being notified by ADOT.

21 Equipment lists and equipment submittals shall conform to the general requirements of these
22 Specifications.

1 **SECTION 744 LOAD CENTERS, TRANSFORMERS AND FOUNDATION**

2 **744-1 Description:**

3 The work under this item includes furnishing and installing load center cabinets, load center
4 cabinet foundations and modifying existing load center cabinets for ITS applications.

5 **744-2 MATERIALS:**

6 Load center cabinets shall meet the requirements of Subsection 736-2.03 of the ADOT Standard
7 Specifications as modified by this TP Attachment 466-1. Electrical service risers, riser strapping,
8 meter socket and service-side enclosure shall meet the requirements of the electrical service
9 provider. Electrical components shall be UL listed.

10 Type II load center cabinets shall conform with ADOT ITS Standard Drawing FM-3.18. Type IV load
11 center cabinets shall conform with ADOT ITS Standard Drawings FM-3.19 and FM- 3.20.

12 Load center cabinets shall include circuit breakers, internal wiring, meter socket, electrical service
13 riser, transformer, and other incidental materials. Photoelectric lighting controls shall be omitted.
14 There shall be no shelves in the interior of the cabinet.

15 The cabinet and door shall be constructed from 5052-H32 sheet aluminum alloy with a thickness of
16 0.125-inches. Welds shall be neatly formed and free of cracks, blow holes, and other irregularities.
17 Inside and outside edges of the cabinet shall be free of burrs. The cabinet shall have a sloped top
18 to prevent the accumulation of water. The outside surface of the cabinet shall have a smooth,
19 uniform, natural, aluminum finish. The doors shall have signs stating "Danger High Voltage".

20 The door opening(s) shall be double flanged on all four sides to increase strength around
21 openings and keep dirt and liquids from entering the enclosure when the door is opened. A two-
22 position door restraint on each door shall be provided, to hold the door open at 90 degrees in a
23 60-mph wind acting at an angle perpendicular to the plane of the door. The restraint shall hold the
24 door open at 90 ±10 degrees and at 180 ±10 degrees. The door shall be furnished with a gasket
25 that satisfies the physical properties as found in UL508 Table 21.1 and shall form a weather tight
26 seal between the cabinet and door.

27 Door hinges shall be continuous and welded to the inside of the door and cabinet and bolted to
28 the outside of the cabinet and door using twenty 0.125-inch stainless steel carriage bolts and
29 nylon insert lock nuts. The hinges shall be made of 0.093-inch thick aluminum and shall have a
30 3-inch open width with a 0.25-inch diameter stainless steel hinge pin. The hinge pin shall be
31 capped top and bottom by weld to render it tamper proof.

32 The latching mechanism shall be a 3-point draw roller type. The center catch and push- rods shall
33 be cadmium plated, Type II Class 1. Push-rods shall be turned edgewise at the outward supports
34 and shall be 0.25-inch by 0.75-inch steel, minimum. Rollers shall have a minimum diameter of
35 0.75-inches and shall be made of nylon. The center catch shall be fabricated from 0.140-inch
36 steel, minimum.

37 A stainless-steel handle with a 0.75-inch diameter shank shall be furnished. The latching handle
38 shall have a provision for padlocking in the closed position. The lock shall be consistent and
39 compatible with current ADOT maintenance keys. The key shall be removable only in the locked
40 position. One key shall be furnished with each lock. All parts of the locking mechanism shall be
41 stainless steel. The locks shall have rectangular spring-loaded bolts.

1 A cabinet exhaust fan meeting the requirements of Subsection 734-2.03 (D) shall be mounted on
2 top.

3 Load center cabinets shall have a dead front panel to isolate all live electrical circuitry. The panel
4 shall be fabricated from 14-gage sheet steel. The dead front panels shall be hinged on one side
5 and securely fastened on the other with bolts. Switches, breakers and other components shall
6 have openings to operate from the front panel.

7 All electrical components in the load center assembly shall be UL listed.

8 Switches, breakers and other components shall have openings to operate from the front panel.

9 Foundations shall conform to the requirements of Subsection 731-3.01 of the ADOT Standard
10 Specifications and this TP Attachment 466-1. Foundations shall include conduit, conduit fittings
11 and elbows, anchor bolts, conductors, connectors, ground rods, grounding conductors,
12 grounding lugs, and other incidental materials necessary to connect equipment incorporated in,
13 or connected through the foundation, to the cabinet, to form a fully functional system.

14 Concrete shall be 3,000 pound per square inch Class S concrete conforming to the requirements
15 of Section 1006 of the ADOT Standard Specifications. Anchor bolts shall conform to the
16 requirements of Section 606-2.05 and 1004-4 of the ADOT Standard Specifications. Grounding
17 conductors shall conform to the requirements of Subsection 734-3.03 of the ADOT Standard
18 Specifications.

19 **(A) CABINETS:**

20 The enclosure shall be a NEMA 3 single door ventilated cabinet. Overall appearance and
21 dimensions shall be as shown in the ITS Standard Drawings.

22 Cabinets shall be designed for mounting on a concrete foundation using anchor bolts of size and
23 placement as shown in the ITS Standard Drawings.

24 The cabinet and door shall be constructed from 5052-H32 sheet aluminum alloy with a thickness of
25 0.125-inches. All welds shall be neatly formed and free of cracks, blow holes, and other
26 irregularities. All inside and outside edges of the cabinet shall be free of burrs. The cabinet shall
27 be designed with a sloped top to prevent the accumulation of water on its top surface. The outside
28 surface of the cabinet shall have a smooth, uniform, natural, aluminum finish. The doors shall have
29 signs stating "Danger High Voltage".

30 The door opening shall be double flanged on all four sides to increase strength around openings
31 and keep dirt and liquids from entering the enclosure when the door is opened. A two-position
32 door restraint on each door shall be provided, to hold the door open at 90 degrees in a 60-mph
33 wind acting at an angle perpendicular to the plane of the door. The restraint shall hold the door
34 open at 90 ±10 degrees and at 180 ±10 degrees. The door shall be furnished with a gasket that
35 satisfies the physical properties as found in UL508 Table 21.1 and shall form a weather tight seal
36 between the cabinet and door.

37 Door hinges shall be continuous and welded to the inside of the door and cabinet and bolted to
38 the outside of the cabinet and door using twenty 0.125-inch stainless steel carriage bolts and
39 nylon insert lock nuts. The hinges shall be made of 0.093-inch thick aluminum and shall have a
40 3-inch open width with a 0.25-inch diameter stainless steel hinge pin. The hinge pin shall be
41 capped top and bottom by weld to render it tamper proof.

1 The latching mechanism shall be a 3-point draw roller type. The center catch and push- rods shall
2 be cadmium plated, Type II Class 1. Push-rods shall be turned edgewise at the outward supports
3 and shall be 0.25-inch by 0.75-inch steel, minimum. Rollers shall have a minimum diameter of
4 0.75-inches and shall be made of nylon. The center catch shall be fabricated from 0.140-inch
5 steel, minimum.

6 A stainless-steel handle with a 0.75-inch diameter shank shall be furnished. The latching handle
7 shall have a provision for padlocking in the closed position. The lock shall be consistent and
8 compatible with current ADOT maintenance keys. The key shall be removable only in the locked
9 position. One key shall be furnished with each lock. All parts of the locking mechanism shall be
10 stainless steel. The locks shall have rectangular spring-loaded bolts.

11 Cabinet ventilation shall be provided by louvered vents in the front door with a removable pleated
12 paper air filter. The filter shall cover the vents and shall be held firmly in place with bottom and
13 top brackets and a spring-loaded upper clamp. Exhaust air shall be vented out between the top
14 of the cabinet and the door. The exhaust area shall be screened with a material having a
15 maximum hole diameter of 0.125 inches.

16 A 12-gauge steel plate or panel board shall be attached with six 3/8-inch mounting studs welded to
17 the back wall of the cabinet for mounting the transformer. Appropriately sized carriage or lag bolts
18 shall be used to attach the transformer at the top and bottom. The transformer shall be mounted
19 4 inches from the top of the plate and centered from side to side.

20 **(B) TRANSFORMER:**

21 Transformers shall be new. Transformers shall conform to paragraphs 2.1.3 and 2.1.5 in Section
22 2 of the current NEMA Standards Publication TR-1-2013, and to other applicable NEMA
23 standards (i.e., NEMA ST 20), UL (i.e., UL-506), and EIA.

24 Transformers of the same type shall be identical and interchangeable. The transformer overall
25 dimensions, physical outlines, and mounting hole dimensions shall be shown on the RFC Plans
26 as approved by ADOT. Transformers shall be single-phase, dry type units. The transformer
27 primary and secondary voltages shall be as shown on the project plans. The mass of the
28 transformer shall not exceed 250 pounds and shall be wall mounted. The transformer shall be
29 labeled either “step-up” or “step-down” and the incoming (primary winding) and outgoing
30 (secondary winding) voltages shall be clearly identified on the exterior. Transformers shall be of
31 low-noise and sound levels shall not exceed 40 dB for transformers rated below 10 kVA, and shall
32 not exceed 45 dB for transformers rated 10 kVA and higher. Transformers shall be provided with
33 two 2 ½ percent taps above nominal voltage (Full Capacity Above Nominal - FCAN) and four 2 ½
34 percent taps below (Full Capacity Below Nominal - FCBN).

35 The core volume shall allow operation at 10 percent above rated primary voltage at no load,
36 without exceeding a temperature rise of 207 degrees Fahrenheit. All core laminations shall be
37 oxide or varnish coated, annealed, free of burrs, and properly assembled to reduce noise and
38 ensure efficient operation of the transformer.

39 Coil conductors shall be continuous with terminations brazed or welded without auxiliary flux
40 material. The entire core and coil assembly shall be impregnated with varnish and cured to seal
41 out moisture. Coils shall be protected with an outer layer of glass tape or similar quality insulation.
42 Coils shall incorporate an electrostatic shield located between primary and secondary windings.

1 **744 - 3 CONSTRUCTION REQUIREMENTS:**

2 Developer shall coordinate with the electrical service provider, local Governmental Entity and
3 ADOT to identify service locations, determine electrical service addresses, comply with electrical
4 service provider requirements, and verify electrical service provider approval of the load center
5 cabinet equipment and installation methods proposed.

6 The load center cabinet shall be installed at locations as shown on the RFC Plans. Removable
7 caps shall be placed on unused conduits within the cabinet.

8 Developer shall furnish and install silicone caulking, or other approved sealant around the base
9 of the cabinet to form a watertight and dust-proof seal.

10 Developer shall furnish and install pressure-sensitive, permanent identification decals on load
11 center cabinets, as shown in the ITS Standard Drawings. The decals shall be 3- inch tall, Series
12 C, Gothic letters and shall be engineer-grade, glass-beaded, reflective black letters on a silver or
13 chrome background.

14 Existing load center cabinets to remain shall remain in service for items and devices served in the
15 existing condition.

16 Developer shall install wire, cable, connectors, and other incidental materials necessary to
17 connect equipment to be incorporated in, or connected to the work through the foundation, to the
18 cabinet, to form a fully functional system.

19 If the cabinet will be located on a slope steeper than 3:1, the foundation shall be offset a minimum of
20 5 feet from the pull box along the mainline conduit or other structure so that their locations do not
21 lie on a line perpendicular to the roadway.

22 Foundations shall be monolithic with the exposed surfaces formed and finished to present a neat,
23 smooth appearance. The bottom of each foundation shall rest on undisturbed earth and the top
24 shall be level. Adjacent concrete maintenance pads as shown on the ITS Standard Drawings shall
25 also meet these requirements.

26 Forms for the concrete shall be rigid and securely braced in place. Templates shall be used to
27 properly position and hold in place conduit, anchor bolts, and the ground rod. Immediately prior
28 to pouring the concrete, both forms and the earth shall be thoroughly moistened. The concrete
29 shall be allowed to cure at least 12 hours or as specified for class provided, whichever is longer, to
30 prevent damage before the forms are removed. Developer shall backfill and build slope in
31 accordance with the plans and restore the landscaping.

32 Grounding shall meet the requirements of Subsection 734-3.03 of the ADOT Standard
33 Specifications. Cabinet foundations shall have a copper clad steel ground rod with a minimum
34 diameter of 5/8 inch. The ground rod shall be driven into place through a sleeve in the foundation.
35 The ground rod shall be installed so that it extends into the surrounding undisturbed earth a
36 minimum of 9 feet. The ground rod shall extend approximately 3 inches above the foundation. The
37 ground rod shall be connected to the grounding system using ground clamps on the rod and an
38 approved lug connector in the cabinet. The cabinet shall be grounded with a 8 AWG solid copper
39 wire.

40 If Developer prefers to use an electrolytic grounding system, it shall be 100 percent self-
41 activating, sealed, and maintenance free. The electrolytic grounding system shall be UL listed
42 with a minimum life rating of 30 years. The electrolytic grounding system shall hygroscopically

- 1 extract moisture from the air to activate the electrolytic process without additions of chemicals or
- 2 water. The electrolytic grounding system shall not use hazardous material.
- 3 The transformer cabinet assembly shall be installed at design locations as shown on the RFC
- 4 Plans, and as approved by ADOT.
- 5 Developer shall measure the secondary voltage after installation. If the secondary voltage is found
- 6 to be more than 3 percent above or under nominal operating voltage during loaded and unloaded
- 7 conditions, Developer shall connect to the appropriate taps on the transformer to supply output
- 8 voltage within 3 percent of nominal voltage under loaded and unloaded conditions.
- 9 Removable caps shall be placed on unused conduits within the cabinet.
- 10 Developer shall furnish and install silicone caulking, or other approved sealant around the base
- 11 of the cabinet to form a watertight and dust-proof seal.
- 12

1 **SECTION 745 ELECTRICAL CONDUCTORS FOR ITS**

2 **745-1 Description:**

3 The work under these items shall consist of furnishing and installing electrical conductors for ITS
 4 elements at the locations designated on the RFC Plans and in accordance with the details shown
 5 on the RFC Plans and the requirements of this TP Attachment 466-1.

6 **745-2 MATERIALS:**

7 Electrical conductors shall conform to Section 732 of the ADOT Standard Specifications, unless
 8 otherwise specified. Conductors shall conform to the requirements of the following table, unless
 9 otherwise specified.

CONDUCTOR TABLE						
CIRCUIT	FUNCTION	INSULATION		CONDUCTOR		
		COLOR	TYPE	Minimum Thick. (MILS)	Minimum Gauge (AWG)	TYPE
Common	Common Lead	White	THW	45/60	AS	AS
Spares	Unused Leads	Varies	Varies		AS	AS
Detection	Detector Roadway Loops, Saw Cut	Black, in Orange Tubing	PE in PVC or PE Tubing	15 31	#14 Stranded	IMSA 51-7

CONDUCTOR TABLE						
CIRCUIT	FUNCTION	INSULATION		CONDUCTOR		
		COLOR	TYPE	Minimum Thick. (MILS)	Minimum Gauge (AWG)	TYPE
Detection	Detector Roadway Loops, Pre-formed	Black, in Orange Tubing	TFFN in PVC or PP Tubing	AS	#16 Stranded	
Detection	Loop Detector Lead-In Cable	Black/ Natural	PE Alum/ Mylar Tape Shield		#14	IMSA 50-2
	Service Service Common Bond	Black White Green or Bare	THW THW THW	AS AS AS	AS AS AS	
<p>Legend:</p> <p>AS = As Specified; PP = Polypropylene; STP = Stranded Twisted Pair; S4C = Stranded 4 Conductor</p>						

1 Conductor and cable tagging shall conform to the requirements of Subsection 732-2.01 (A) (2) of
2 the ADOT Standard Specifications, unless otherwise specified. Tags shall have the capability of
3 being moved along the conductor or cable during future alterations.

4 **745-3 CONSTRUCTION REQUIREMENTS:**

5 Wiring procedures for conductors and cables shall conform to the requirements of Subsection
6 732-3.02 of the ADOT Standard Specifications, unless otherwise specified.

7 Electrical conductors that are left un-terminated shall be made waterproof.

8 Bonding and grounding shall conform to Subsection 734-3.03 of the ADOT Standard Specifications
9 and the requirements of the plans and these Specifications.

10 Metal enclosures, cabinets, pedestals, poles, metal pull box lids, metal conduit, and metal cable
11 sheaths shall be bonded to form a continuously grounded system. Non-metal portions of the
12 system such as PVC or HDPE conduit shall have a bare copper bond wire or a green insulated
13 copper bond wire installed with suitable connections to form a continuously grounded system.

14 Cables, conductors, pull tape, and innerducts within the same conduit or innerduct shall be
15 installed at the same time.

16 Where cables or conductors are to be installed in conduit with existing cables or conductors that
17 will remain, Developer shall disconnect, remove, reinstall, reconnect and test the existing cables
18 and conductors in accordance with the testing requirements of the applicable device being
19 connected or as determined by ADOT. Developer shall be responsible for damage to existing
20 cables or conductors caused by this operation. Existing cables or conductors shall be considered in
21 good condition unless Developer demonstrates otherwise to ADOT as part of the ITS Inventory and
22 prior to ITS Work.

23 Excess cable length within No. 9 pull boxes shall be loosely coiled into a circular shape and
24 attached to the rack and hook system integral to the wall of the No. 9 pull box with industry
25 standard nylon cable ties. Cables shall be coiled independently from one another and secured
26 with separate cable ties for each coil. Cable ties shall be tightened to prevent cable slippage, but
27 shall not deform or damage the cable sheath.

28 Tags shall be installed on conductors and cables inside pull boxes near the pull box entrance and
29 exit, inside cabinets and enclosures. Tags shall be labeled with the following fields, as applicable:

30 Tag Field 1: Responsible Agency (use only if agency is not ADOT)

Examples:	Applications:
ADOT	Arizona Department of Transportation
Sun Corridor	ADOT Broadband Initiative for I-17

1 Tag Field 2: Description

Examples:	Applications:
SMFO144 SMFO12	144-strand single mode fiber optic cable 12-strand single mode fiber optic cable
AWG6	American Wire Gauge 6
LOOP 1U	lane 1 upstream loop detector (other loop designations per Standard Drawing FM-5.01)
CCTV	CCTV cable
DMS	DMS cable

2 Tag Field 3: Termination

Examples:	Applications:
NODE 15	to node 15
SB TRUNK LINE	fiber optic branch to trunk line on SB side
CAB 2124532	to cabinet #2124532
LC 2124538	to load center #2124538
NB DMS	to northbound DMS

3

4 A continuous cable passing through a pull box shall have two tags which will be the same except
 5 with different termination descriptions. Multiple power conductors that go to one load center shall
 6 be bundled together and have one tag that indicates the load center cabinet number in the
 7 termination field. Multiple power conductors that go to different cabinets shall be bundled and
 8 tagged in conductor pairs according to the cabinet they go to.

- 1 Tagging shall be recorded by Developer in a Record Drawing Cable Schedule and include the
2 distance marking on the cable at the entrance to a pull box, cabinet, or other termination point.
3 The Record Drawing Cable Schedule shall be provided to ADOT with the ITS Final Compiled
4 Documentation.
- 5 Cables and conductors to be removed shall be identified and marked at intermediate pull boxes
6 for ADOT approval prior to removal. After ADOT approval, cables and conductors to be removed
7 shall be cut at intermediate pull boxes prior to removal. Conduits to remain empty for future use
8 shall have detectable pull tape installed.
- 9 At least 10 Days prior to disconnecting existing conductors or cables, Developer shall submit a
10 schedule for disconnection, removal, reinstallation, reconnection, and testing for ADOT approval.
11
12

1 **SECTION 746 LOOP DETECTION**

2 **746-1 Description:**

3 The work under these items includes furnishing, installing and testing loop detectors and loop
4 detector lead in cables, as shown on the RFC Plans and in this TP Attachment 700-4.

5 **746-2 MATERIALS:**

6 All work shall conform to Section 735 of the ADOT Standard Specifications, the ITS Standard
7 Drawings, the RFC Plans, and this TP Attachment 700-4.

8 Developer shall furnish Certificates of Compliance for loop detector materials which shall include
9 certification that the batches furnished were manufactured under the same conditions as the
10 batches tested.

11 **(A) LOOP WIRE:**

12 Loop detector lead-in cable shall be 14 AWG conforming to IMSA 50-2. Loop detector wire shall
13 be 14 AWG HDPE polyethylene insulated conductors conforming to IMSA 51-7.

14 **(B) HIGH TEMPERATURE BACKER ROD:**

15 High Temperature backer rod shall be a round foam material rated to withstand a minimum
16 temperature of 400 degrees Fahrenheit. The diameter of the backer rod shall be sized according to
17 the width of the saw cut as follows:

Saw Cut Width (inches)	Backer Rod Diameter (inches)
1/4	3/8
3/8	1/2
1/2	5/8
3/4	7/8
7/8	1
1	1 1/4
1 1/8	1 1/2

1 5/8	2
-------	---

1 **(C) LOOP SLOT SEALANT:**

2 Developer shall furnish and install loop slot sealant, depending on the pavement surface to be
3 sealed, to seal the loop slots and surface hole of the home run conduit. Loop slot sealants shall
4 be a flexible encapsulant designed for sealing and protecting loop detector wires installed in saw
5 cuts. Developer shall provide the expiration date of the sealant with the material submittal.

6 **(1) TWO-PART EPOXY FILLER SEALANT:**

7 Two-part epoxy joint filler sealant shall be a 100-percent solids, flexible, two-component, solvent
8 free, epoxy resin/hardener system for use as a saw cut sealant in asphaltic concrete pavements
9 and Portland cement concrete pavements.

10 Materials shall comply with the requirements of Subsection 1015-1 of the ADOT Standard
11 Specifications.

12 The epoxy system shall be specifically designed for the intended application according to the
13 product literature provided by the manufacturer.

14 The epoxy system shall be of sufficient strength and hardness to withstand stress and abrasion
15 from vehicular traffic, while remaining flexible enough to provide stress relief under thermal
16 movement and protect the loop wire from moisture penetration. It shall also be moisture
17 insensitive to allow effective application to damp pavements. No standing water is permitted on
18 the surfaces to which the epoxy system is to be applied.

19 The epoxy system shall be designed to enable vehicular traffic to pass over properly filled saw
20 cuts immediately after installation without tracking or stringing of the material.

21 Properly installed and cured epoxy systems shall exhibit resistance to the effects of weather,
22 motor oils, gasoline, anti-freeze solution, brake fluid, deicing chemicals, and salt in such a manner
23 that the performance of the loop detector wire is not adversely affected.

24 The epoxy system shall be designed for roadway installation when the surface temperature is a
25 minimum of 40 degrees F and rising. The cured epoxy system shall be temperature stable and
26 exhibit no degradation in performance throughout the ambient pavement temperature ranges
27 experienced within the State of Arizona.

28 The components of the epoxy system shall have a minimum shelf life of 12 months in original
29 unopened, undamaged containers, when stored in a cool dry environment, as recommended by
30 the manufacturer.

31 The epoxy system shall meet the following requirements:

Property	Test Method	Requirements
Mixing Ratio; Part A to Part B	-	1 to 1 by volume

Viscosity, centipoises	ASTM D 2393-86	4000 to 8000
Pot Life, minutes	ASTM C 881	12 to 20
Cure Time, minutes	ASTM C 679	60 maximum, Tack Free
Hardness (Shore D)	ASTM D 2240	35 to 65
Tensile Elongation, percent	ASTM D 638	50 minimum
Water Absorption, percent (24 hrs.)	ASTM D 570	1 maximum
3 percent Salt Water Absorption, percent (24 hrs.)	-	0.03 to 0.20
Oil Absorption, percent (24 hrs.)	ASTM D 471	0.01 to 0.02
Gasoline Absorption, percent (24 hrs.)	-	0.05 to 0.90

(2) ONE-PART ELASTOMERIC SEALANT:

- 1
2 One-part elastomeric sealant may be used to seal saw cuts in Portland cement concrete
3 pavement and lean concrete base.
- 4 The sealant shall provide compressive yield strength to withstand normal vehicular traffic as well
5 as sufficient flexibility to withstand normal movement in concrete pavements, while protecting the
6 loop wire from moisture penetration.
- 7 The encapsulant shall be a one-part elastomeric compound requiring no mixing, measuring or
8 application of heat prior to or during its installation.
- 9 The encapsulant shall, within its stated shelf life in original undamaged packaging, cure only in
10 the presence of moisture. The rate of cure will, therefore, depend upon temperature and relative
11 humidity at the time of installation. Cool dry weather will slow curing whereas warm, humid
12 weather will accelerate curing. The encapsulant shall have a minimum 12-month shelf life in
13 undamaged original containers when stored in a cool, dry environment.
- 14 The encapsulant shall form a surface skin allowing exposure to vehicular traffic within 30 minutes at
15 75 degrees F without tracking or stringing of the material, and completely cure to a tough, rubber-
16 like consistency within 2 to 7 Days after installation.

- 1 Properly installed and cured encapsulant shall exhibit resistance to effects of weather, vehicular
 2 abrasion, motor oils, gasoline, anti-freeze solution, brake fluid, deicing chemicals and salt
 3 normally encountered, in such a manner that the performance of the loop detector wire is not
 4 adversely affected.
- 5 The cured encapsulant shall be temperature stable and exhibit no degradation in performance
 6 throughout the ambient pavement temperature ranges experienced within the State of Arizona.
- 7 The encapsulant shall exhibit minimal shrinkage during or after its installation, and in no manner
 8 affect the performance characteristics of the material.
- 9 The encapsulant shall be designed to permit clean-up of material and application equipment, prior
 10 to curing of the encapsulant, with a suitable non-flammable solvent. Should encapsulant material
 11 be allowed to cure in the application nozzle, it shall be able to be pulled out as a solid plug.
- 12 The encapsulant shall be designed for roadway installation when the surface temperature is
 13 between 40 and 140 degrees F.
- 14 The encapsulant shall have the following physical properties in its uncured and cured states.

Uncured (Wet) Encapsulant		
Property	Requirement	Test Procedures
Weight	10.1 ± 0.3 pounds/gallon	A. Weight/Gallon
Total Solids by Weight	75 – 85 percent	B. Determination of Non-Volatile Content
Viscosity	10,000 - 85,000 centipoise	C. Dynamic Viscosity
Drying Time	Touch: 24 hrs. maximum Complete: 30 hrs. maximum	D. Tack-Free Time
Cured Encapsulant		
Property	Requirement	Test Procedure
Hardness (Indentation)	65 – 85	E. Rex hardness

Tensile Strength	500 psi minimum	F. Tensile & Elongation
Elongation	300 percent minimum	

1 **(3) HOT APPLIED RUBBERIZED SEALANT:**

2 Hot applied rubberized sealant may be used to seal saw cuts in asphaltic concrete and in lean
3 concrete base. It shall be suitable for use as a sealant for loop detector saw cuts and be non-
4 tracking under traffic. At application temperatures, the sealant shall be a thin, free flowing fluid
5 which penetrates saw cuts and self-levels permitting uniform application. The sealant shall be
6 melted and applied to pavements using a pressure feed melter unit. Pour pot application is not
7 acceptable. The sealant shall be a relatively stiff sealant but shall remain flexible at low pavement
8 surface temperatures. The test results shall conform to the following specifications for the loop
9 detector sealant.

Test	Specification
Penetration: 125 degrees Fahrenheit, 50g, 5s	50 maximum
Penetration: 77 degrees Fahrenheit, 100g, 5s	10 – 25
Softening Point:	210 degrees Fahrenheit minimum
Ductility: 77 degrees Fahrenheit	15 cm minimum
Mandrel Bend: 0 degrees Fahrenheit, 90 degrees Arc, 10s, 3/4-inch diameter	Pass 2 of 3
Recommended Pour Temp:	380 degrees Fahrenheit
Safe Heating Temp:	420 degrees Fahrenheit
Test	Specification
Brookfield Viscosity: 400 degrees Fahrenheit	7,500 centipoise max.

Unit Weight:	8.5 pounds per gallon
Coverage; 1/2 by 1/2-inch crack	11.0 pounds per 100 feet

1 Materials shall conform to ADOT Standard Drawings T.S. 6-3 and T.S. 6-4.

2 **746-3 CONSTRUCTION REQUIREMENTS:**

3 Construction of loop detectors shall conform to the ITS Standard Drawings and project plans.
 4 Loop detectors shall not be placed within 6 feet of an adjacent operational loop. The installation
 5 of the detectors shall be such that the operation shall not be affected by temperature changes,
 6 water, ice, rain, snow, chemicals, or electromagnetic noise. Loop detectors shall be installed prior
 7 to chip seal or friction course for asphaltic concrete pavements or Portland cement concrete
 8 pavements.

9 **(A) SAW CUT LOOPS:**

10 Prior to installing the loop wire or lead-in cable, Developer shall saw cut the slots and install
 11 associated conduit and pull boxes. New loop detectors shall not be cut in the exact same location
 12 as an existing loop detector. Developer shall use clean water to prevent blowing dust while cutting
 13 the slots. Developer shall flush the slots, vacuum water out of the slots and from the roadway,
 14 and then blow the loop slots with oil free compressed air to dry them and free them from debris,
 15 taking necessary safety precautions to avoid flying debris from coming into contact with personnel
 16 or vehicles. Debris shall be disposed of in accordance with Section 107.11 of the ADOT Standard
 17 Specifications. Developer shall take precautions to keep materials from entering the storm drains.
 18 The slots shall be thoroughly cleaned to allow sealant to adhere to the sides of the slot.

19 Developer shall install the loop wire in the slots without damage to the insulation. Turns of loop
 20 wire shall be installed in the same slot. The loop detector wire shall consist of one continuous
 21 wire from the pull box, through the loop, and back to the pull box. The top of the upper loop
 22 detector wire shall be a minimum of 1 ½ inches below the top of PCCP or Asphalt. Friction course,
 23 if present, is not included in the measurement. If the loop detector is installed in reinforced
 24 concrete, or is at least 2-inches below the roadway surface, Developer shall install four turns of
 25 the loop. The loop detector wire pair shall be twisted together 3 times per foot from the corner of
 26 the loop in the roadway to the pull box.

27 After the loop wire is installed, Developer shall install high temperature backer rod in the saw cut.
 28 The backer rod shall be continuous and completely shield the entire length of the loop detector
 29 wire from the loop slot sealant.

30 Developer shall seal the slots with loop slot sealant. Developer shall ensure that the slots are
 31 clean and dry with no residue remaining at the time of sealing. Developer shall seal the home run
 32 conduit stub out with loop slot sealant. During the sealing operation, the ambient air temperature
 33 shall be within the application range specified by the sealant manufacturer. The sealant shall be
 34 installed in accordance with the ITS Standard Drawings and in a manner that will fill the slot to its
 35 full depth. Developer shall strike off and remove excess sealant and remove it from the site.

36 **(B) PRE-FORMED LOOPS**

1 Pre-formed loops shall be installed in accordance with the ITS Standard Drawings, the RFC Plans
2 and these Specifications.

3 **(C) LEAD-IN CABLE:**

4 Developer shall install lead-in cable between the control cabinet and the nearest pull box adjacent
5 to the loop detector. Developer shall leave 5 feet of coiled slack in the pull box. Lead-in cables shall
6 be unspliced from the loop detector wire to the control cabinet. One lead-in cable shall be
7 provided, per loop, unless otherwise specified. Lead-in cables shall be tagged in the control
8 cabinet and in pull boxes in accordance with this TP Attachment 466-1.

9 Developer shall solder splice the loop wire to its associated lead-in cable and provide a watertight
10 seal in the pull box. Developer shall connect the lead-in cable to the appropriate loop detector
11 channel in the control cabinet. Spade lugs installed on the loop lead-in cable in the control cabinet
12 shall be crimped and soldered. Solder shall be resin core solder with 60 percent tin and 40 percent
13 lead. Lead-in cables that are not terminated within 1 Day of installation shall have unterminated
14 ends waterproofed.

15 **(D) LOOP DETECTOR TEST REQUIREMENTS:**

16 The following tests shall be performed by Developer in the presence of an ADOT Representative.
17 Developer shall provide traffic control for testing of loop detectors . Developer shall use the Loop
18 Detector Test Form provided at:

19 [https://www.azdot.gov/business/engineering-and-construction/systems-technology/its-](https://www.azdot.gov/business/engineering-and-construction/systems-technology/its-references)
20 [references](https://www.azdot.gov/business/engineering-and-construction/systems-technology/its-references) and submit a complete and organized set of forms in electronic PDF format to ADOT
21 for review and comment..

22 **(1) LOOP DETECTOR WIRES ONLY:**

23 The following tests shall be performed at the pull box on loop detector wire that is disconnected
24 from the loop lead-in cable.

25 **(A) EXISTING LOOP DETECTORS:**

26 The following tests shall be performed during the facilities inventory on existing loop detectors to
27 be utilized by the project. Testing of existing loop detectors shall be completed prior to other
28 construction activities requiring traffic control. Testing of existing loop detectors shall be
29 accomplished by cutting off the existing lead-in cable splice or waterproofed ends of the loop wire,
30 testing, and resplicing to the existing loop lead-in cable or waterproofing the ends of loop wire of
31 successfully tested loop detectors. Loop detector wire shall not be tested by skinning the
32 insulation. Developer shall install new loop lead-in cable tags where existing tags are missing or
33 do not meet the requirements of these Specifications. Developer shall replace loop detectors and
34 lead-in cables damaged during testing.

35 Developer shall install new saw cut loop detectors where existing loop detectors to be utilized by
36 the project do not exist or do not pass testing. If a single loop detector within a pair of existing loop
37 detectors (trap) does not pass testing, Developer shall replace both loop detectors.

38 **(B) NEW LOOP DETECTORS:**

39 The following tests shall be performed twice for each new loop detector, before the loop slot
40 sealant has been poured and after the loop slot sealant has hardened. Developer shall replace
41 or repair loop detector components until the loop detection successfully passes testing.

1 **(I) RESISTANCE TO GROUND TEST:**

2 The resistance to ground shall be measured with a Megohmmeter (Megger) connected between
3 the loop wire and the nearest reliable electrical ground, such as a meter, metal pole, fire hydrant, or
4 to a metal rod driven 3 feet into the ground. The resistance to ground shall be at least 100
5 megohms at 500 VDC.

6 **(II) SERIES RESISTANCE TEST:**

7 The series resistance, measured by an ohmmeter, shall be between 0.1 and 0.8 Ohms for a 6 x
8 6-foot loop, and less than 10 Ohms for other sizes of loops.

9 **(III) INDUCTANCE TEST:**

10 The inductance of a loop, measured with an inductance tester, shall be between the following
11 limits:

6' X 6' loop, 3 turns	50 to 100 µH
6' X 6' loop, 4 turns	100 to 155 µH
6 'X 6' loop, 5 turns	200 to 260 µH
6 'X 20' loop, 2 turns	55 to 105 µH
6 'X 20' loop, 3 turns	125 to 180 µH

12 **(2) LOOP DETECTORS SPLICED TO LEAD-IN CABLE:**

13 After the preceding tests have been passed, the following tests shall be performed at the control
14 cabinet on the loop lead-in cables. The tests shall be performed with the loop lead-in cable spliced
15 to the loop detector wire and with the with loop lead-in cable disconnected from the loop detector
16 card. The tests shall be performed twice for each loop, once with the splice between the loop
17 detector wire and the loop lead-in cable dry, and once with the splice submerged in water, and
18 has been submerged for at least 1 minute.

19 **(A) RESISTANCE TO GROUND TEST:**

20 Utilizing a Megger, Developer shall verify that the insulation resistance to ground of each lead-in
21 conductor is at least 10 megohms at 500 VDC.

22 **(B) INDUCTANCE TEST:**

23 The inductance of a loop detector plus the lead-in cable, measured with an inductance tester,
24 shall be between 50 to 490 µH.

25 Active loop detection within the project limits shall be tested after work is complete which may
26 damage loop detection, such as milling of pavement. Developer shall provide traffic control for
27 testing of loop detectors. Developer shall submit a Loop Detection Test Plan including traffic

1 control plans for review and approval by ADOT. If active loop detection is not shown on the plans,
 2 Developer shall coordinate with ADOT to identify active loop detection locations. The test plan
 3 shall list active loops to be tested which may include loop detection at entrance ramps, freeway
 4 mainline, and in freeway-to-freeway ramps. Inactive loop detection shall not be tested.
 5 Developer shall be accompanied by ADOT personnel during testing.

6 **(3) LOOP DETECTORS SPLICED TO LEAD-IN CABLE:**

7 The following tests shall be performed by Developer at the control cabinet on the loop lead-in
 8 cables in the presence of ADOT personnel. The tests shall be performed with the loop lead-in
 9 cable spliced to the loop detector wire and with the with loop lead-in cable disconnected from the
 10 loop detector card. After the test is complete, Developer shall reconnect the lead-in cable to return
 11 the loop detection system to its previous state.

12 **(A) INDUCTANCE TEST:**

13 Utilizing a Megger, Developer shall verify that the insulation resistance to ground of each lead-in
 14 conductor is at least 10 megohms at 500 VDC.
 15 The inductance of a loop detector plus the lead-in cable, measured with an inductance tester,
 16 shall be between 50 to 490 μ H.

17 **(4) LOOP DETECTOR WIRES ONLY:**

18 The following tests shall be performed if the preceding test failed in order to isolate whether the
 19 loop detector or lead-in cable caused the test to fail. The following tests shall be performed at the
 20 pull box on loop detector wire that is disconnected from the loop lead-in cable. After the test is
 21 complete, Developer shall solder splice the loop wire to its associated lead-in cable and provide
 22 a watertight seal using a factory-filled silicon wire nut in the pull box to return the loop detection
 23 system to its previous state.

24 **(A) RESISTANCE TO GROUND TEST:**

25 The resistance to ground shall be measured with a Megohmmeter (Megger) connected between
 26 the loop wire and the nearest reliable electrical ground, such as a metal pole, fire hydrant, or to a
 27 metal rod driven 3 feet into the ground. The resistance to ground shall be at least 100 megohms at
 28 500 VDC.

29 **(B) SERIES RESISTANCE TEST:**

30 The series resistance, measured by an ohmmeter, shall be between 0.1 and 0.8 ohms for a 6' x
 31 6' loop, and less than 10 ohms for other sizes of loops.

32 **(C) INDUCTANCE TEST:**

33 The inductance of a loop, measured with an inductance tester, shall be between the following
 34 limits:

6' X 6' loop, 3 turns	50 to 100 μ H
6' X 6' loop, 4 turns	100 to 155 μ H

6 'X 6' loop, 5 turns	200 to 260 μ H
6 'X 20' loop, 2 turns	55 to 105 μ H
6 'X 20' loop, 3 turns	125 to 180 μ H

- 1 Developer shall prepare a written report detailing the results of the loop detector testing and
- 2 submit the report to ADOT for approval.
- 3 Developer shall use the Loop Detector Test Form provided at:
- 4 [https://www.azdot.gov/business/engineering-and-construction/systems-technology/its-](https://www.azdot.gov/business/engineering-and-construction/systems-technology/its-references)
- 5 [references](https://www.azdot.gov/business/engineering-and-construction/systems-technology/its-references) and submit a complete and organized set of forms in electronic PDF format to the
- 6 Engineer. Developer shall identify loop detectors failing to pass and the component causing the
- 7 failure which typically will be the loop detector, splice, or lead-in cable. Repairs identified by
- 8 Developer are subject to approval by the Engineer.
- 9 Damage to loop detection during construction activities which could have been reasonably
- 10 avoided by Developer shall be replaced. Developer shall replace loop detectors and lead-in
- 11 cables damaged during testing.
- 12 Developer shall install new loop lead-in cable tags where existing tags are missing or do not meet
- 13 the requirements of these specifications.
- 14 Developer shall install new saw cut loop detectors where existing loop detectors do not pass
- 15 testing. If a single loop detector within a pair of existing loop detectors (trap) does not pass testing,
- 16 Developer shall replace both loop detectors. New loop detection shall be tested in accordance
- 17 with the loop detection specifications.
- 18 Developer shall install the new loop at locations designated on the RFC plans. Developer shall
- 19 maintain a distance of at least 5 feet offset for the new loop from the existing non-functional loop.
- 20

1 **SECTION 750 CCTV FIELD EQUIPMENT**

2 **750-1 Description:**

3 The work under this item shall include furnishing and installing Closed Circuit Television (CCTV)
4 cameras.

5 **750-2 MATERIALS:**

6 CCTV cameras shall be Bosch model MIC-7522-Z30W.

7 **750-3 CONSTRUCTION REQUIREMENTS:**

8 Developer shall mount the CCTV Camera to the CCTV lowering device in accordance with the
9 requirements of the CCTV camera manufacturer, lowering device manufacturer.

10 Conductors and cables shall be routed inside the CCTV pole. No cables or conductors shall be
11 exposed, including at the base of the tilt/pan drive and at the entrance to the CCTV cabinet.

12 Developer shall program the camera with camera ID information, and preset positions. Developer
13 shall coordinate with ADOT to obtain information for programming of the CCTV cameras prior to
14 testing.

15 **750-4 TEST REQUIREMENTS**

16 CCTV camera components will be subject to testing and monitoring to determine conformance
17 with this TP Attachment 466-1 and to ensure proper operation of the equipment and system.

18 Developer shall provide traffic control for the CCTV testing.

19 **(A) STAND-ALONE TESTS:**

20 Developer shall test the following stand-alone (non-network) functional operations of the CCTV
21 system:

- 22 • Control of focus, optical zoom, digital zoom, iris, pan, and tilt
- 23 • Response to automatic preset positioning commands
- 24 • Display of Camera ID information
- 25 • Presence and quality of video signal during bright sunlight and night conditions
- 26 • Lowering device functions properly

27 For testing purposes, "bright sunlight" conditions shall be defined as occurring between 10:00 AM
28 and 2:00 PM, on a cloudless day. "Night" conditions shall be defined as occurring between one
29 hour after sundown and one hour before sunrise with the moon no more than one-quarter full.

30 Developer shall use the CCTV Test Form provided at:

31 [https://www.azdot.gov/business/engineering-and-construction/systems-technology/its-](https://www.azdot.gov/business/engineering-and-construction/systems-technology/its-references)
32 [references](https://www.azdot.gov/business/engineering-and-construction/systems-technology/its-references) and submit a complete and organized set of forms in electronic PDF format to ADOT.

33 **(B) SUBSYSTEM TEST (SST):**

34 ADOT, with the support of Developer, shall conduct the subsystem test on the CCTV and
35 communications system to verify that communications circuits (Developer installed equipment as
36 well as connections to existing) have been properly configured and operate without failure and

1 without adversely affecting the existing system. The SST shall start on a Monday, Tuesday, or
2 Wednesday and be conducted for 3 consecutive days.

3 Developer shall replace components that fail the SST and the test shall be restarted on a Monday,
4 Tuesday, or Wednesday and be conducted for 3 consecutive days. Developer shall supply test
5 equipment requested by ADOT for troubleshooting the system.

6 The CCTV SST test shall verify the following:

- 7 • Transmission of high-quality video images to the TOC
- 8 • Transmission of control signals to camera
- 9 • Positioning of camera from the TOC control panels
- 10 • Response to automatic preset positioning commands from the
11 TOC
- 12 • Priority and partitioning of commands
- 13 • Generation of text, date, and time on monitors

14 If the video is does not meet the requirements of the test, Developer shall perform video resolution
15 and signal-to-noise ratio testing, in which case Developer shall submit a test procedure to ADOT
16 for approval, prior to the testing.

17 **(C) SYSTEM ACCEPTANCE TEST (SAT):**

18 Upon successful completion of the subsystem test, the SAT shall be started. The SAT shall consist of
19 a 30 consecutive day period of operation by ADOT without failure of all Developer-supplied and
20 approved relocated equipment. GPS data shall be submitted and approved prior to beginning the
21 SAT for the periods specified in the ITS Record Documentation item.

22 The purpose of the SAT is to demonstrate that the total system, consisting of hardware, software,
23 communications, materials and construction, is properly installed, is free from defects and identified
24 problems, exhibits stable and reliable performance, and completely complies with contract
25 documents.

26 During the SAT, Developer shall ensure that equipment is maintained in operable condition. ADOT
27 personnel shall be provided access to equipment during this period for purposes of verifying its
28 operation. Developer shall identify, isolate, diagnose and troubleshoot system problems and
29 inconsistencies. Developer, in conjunction with ADOT, shall formulate possible solutions and shall
30 implement corrections required in Developer supplied equipment.

31 Developer shall provide traffic control, bucket truck, test equipment, and labor needed to test,
32 isolate and correct equipment deficiencies found during the SAT. Developer technical personnel
33 having industry standard certification in the field the design and construction of each system
34 component shall be available on site within 48 hours of notification of a problem.

35 During the SAT, Developer shall record test failures on the System Acceptance Test Failure Log
36 provided at:

37 [https://www.azdot.gov/business/engineering-and-construction/systems-technology/its-
38 references](https://www.azdot.gov/business/engineering-and-construction/systems-technology/its-references) and immediately submit the form to ADOT for review and comment. After the repair has
39 been completed, an updated form shall be submitted to ADOT for review and comment.

1 System documentation errors, omissions and changes occurring prior to and during the SAT shall
2 be corrected and resubmitted before system acceptance can be completed.

3 **(1) SAT MINOR FAILURE**

4 In the event of a minor failure during the SAT, the test clock shall stop until the system is repaired.
5 At the completion of the repair, the testing shall recommence with 24 hours added to the remaining
6 test time of the system. The following constitute minor failures:

- 7
 - Failure to receive acceptable CCTV video image at TOC or loss of CCTV control.

8 **(2) SAT MAJOR FAILURE**

9 In the event of a major failure during the SAT, the test clock shall stop until the system is repaired.
10 At the completion of the repair, the testing shall recommence with the test clock reset to day zero.
11 The following constitute major failures:

- 12
 - Third failure of the equipment, if determined that failures were caused by faulty
13 installation by Developer.
 - Third failure to receive acceptable CCTV video image at TOC or loss of CCTV
14 control of an individual CCTV.
 - Failure to correct an issue within 4 hours of being notified by ADOT.

17

1 **SECTION 751 ITS RECORD DOCUMENTATION:**

2 **751-1 Description:**

3 The work under this item shall include maintaining a complete set of ITS record documentation
4 for installation of new, or modifications to existing ITS equipment.

5 **751-2 CONSTRUCTION REQUIREMENTS:**

6

7 **751-2.01 In-Progress Documentation:**

8 In-progress documentation shall be kept current within 14 Days of ITS Work being performed
9 through Substantial Completion. In-progress documentation shall be provided to ADOT prior to
10 initiation of the required System Acceptance Test (SAT) for that device. In-progress
11 documentation shall include:

- 12 • Construction Plans
- 13 • Operation Manuals
- 14 • Maintenance Manuals
- 15 • Equipment Assembly Drawings
- 16 • Cabinet and Rack Wiring Diagrams
- 17 • Electrical Schematics, Wiring and Logic Diagrams
- 18 • System Connection Diagrams
- 19 • Fiber Optic Assignments
- 20 • Splice Closure Diagrams
- 21 • Software Documentation
- 22 • Fiber Management Recording
- 23 • Communications and Operating Protocols
- 24 • Shop Drawings
- 25 • Certificates of Compliance
- 26 • Warranties
- 27 • Parts Lists
- 28 • Bore profile of conduits installed by directional drilling

29 Fiber Management Recording shall be in a format compatible with ADOT's fiber management
30 software. Acceptable manuals shall contain technical operations, maintenance, and
31 troubleshooting information. Advertising brochures and catalog cuts are not acceptable for
32 manuals.

1 **751-2.02 ITS FINAL COMPILED DOCUMENTATION:**

2 Final acceptance of work in accordance with Contract Documents will not be made until the ITS
3 Final Compiled Documentation has been submitted and has been approved by ADOT.

4 Developer shall furnish one copy of the ITS Final Compiled Documentation in electronic PDF
5 format, and one printed copy bound in loose-leaf 3-ring binders, grouped logically with printed
6 label tabs.

7 Developer shall provide one cabinet wiring diagram and fiber optic splice diagram for each control
8 cabinet, labeled with the location name and cabinet number, provided in a weatherproof holder
9 mounted within each control cabinet.

10 One print of the fiber optic cable connection and splice diagram shall be provided in a
11 weatherproof holder mounted in the pull box with the splice.

12 Software source code shall be submitted electronically in a format compatible with ADOT's
13 computer system.

14 Final documentation shall consist of the following documents.

15 **(A) RECORD DRAWINGS:**

16 The record drawings shall include lateral offset dimensions of conduit referenced from back of
17 curb, edge of pavement, barrier, guard rail, bridge wall, or other fixed landmark. The dimensions
18 shall be provided at for new conduit at angle points and tangent sections.

19 **(B) GPS DATA:**

20 GPS data of new and existing to remain ITS equipment within the project limits shall be collected
21 by an Arizona Registered Land Surveyor, regardless if the equipment was affected by
22 construction. GPS data shall be high-precision corrected, collected with accuracy within 12
23 inches or less. Developer shall submit a transmittal letter stamped by the surveyor, certifying the
24 accuracy of the GPS survey data. The GPS survey data shall be submitted to ADOT in an Excel
25 spreadsheet with different worksheet tabs for each ITS equipment type listed below.

26 The GPS survey data for control cabinet foundations for CCTV, DMS, ramp meters, detectors,
27 and traffic signals shall be submitted to ADOT at least 45 Days prior to the start of the system
28 acceptance testing to allow ADOT to integrate the equipment into ADOT's software. The
29 remaining GPS survey data shall be submitted at least 15 Days prior to the start of the system
30 acceptance testing.

31 The following ITS equipment types and fields shall be collected:

32 Cabinets:

- 33 • Coordinates at center of front door
- 34 • FMS Cabinet Identification Number
- 35 • MU Cabinet number
- 36 • Type: CCTV, DMS, Detector, Wrong Way Detection, Gate
- 37 • Route Number: I-17
- 38 • Route direction: NB, SB

- 1 Load Center Cabinets:
- 2 • Coordinates at center of front door
 - 3 • FMS Cabinet Identification Number
 - 4 • MU Cabinet number
 - 5 • Type: FMS Load Center
 - 6 • Route Number: I-17
 - 7 • Route direction: NB, SB
 - 8 • Street Address:
 - 9 • Utility Name: APS, SRP, etc.
- 10 Node Buildings:
- 11 • Coordinates at center of front door
 - 12 • Node Number:
 - 13 • Route Number: L-101, I-17,
 - 14 • Route direction: NB, SB, WB, EB
- 15 Dynamic Message Signs:
- 16 • Coordinates of support foundation on the right side
 - 17 • DMS ID
 - 18 • DMS Manufacturer
 - 19 • Vertical clearance above the roadway measured at the left edge of the catwalk,
 - 20 catwalk at the right edge line, and center of DMS sign.
 - 21 • Route Number: I-17
 - 22 • Route direction: NB, SB
- 23 Flex Lane Gates:
- 24 • Coordinates of gate foundation (one point for each gate)
 - 25 • Route Number: I-17
 - 26 • Route direction: NB, SB
- 27 Mainline Detection:
- 28 • Coordinates in the center of the mainline or flex lane, centered between loop pairs
 - 29 (one point for all loops)
 - 30 • Station ID
 - 31 • Loop Size: 6x6

- 1 • Route Number: I-17
- 2 • Route direction: NB, SB

3 CCTV Poles:

- 4 • Coordinates of pole foundation
- 5 • CCTV ID
- 6 • Route Number: I-17
- 7 • Route direction: NB, SB

8 Pull Boxes:

- 9 • Coordinates in the center of pull box
- 10 • Pull box ID
- 11 • Type: 7, 7X, 9
- 12 • Route Number: I-17
- 13 • Route direction: NB, SB

14 **(C) OPERATION MANUALS:**

15 Manuals containing a general description and detailed operation and installation instructions shall
16 be provided for each type and model of ITS equipment.

17 **(D) MAINTENANCE MANUALS:**

18 Manual containing detailed preventive maintenance and troubleshooting procedures shall be
19 provided for each type or model of ITS equipment. Step-by-step field and bench trouble-shooting
20 procedures shall be included, including normative waveforms and test wattages as applicable. A
21 detailed parts list shall be included. For each part, its circuit or pictorial identification shall be
22 shown, as well as rating information and a manufacturer and associated model or part number.

23 The list shall include cross-references to part numbers of other manufacturers who make the same
24 replacement part.

25 **(E) EQUIPMENT ASSEMBLY DRAWINGS:**

26 A drawing showing the physical location and identification shall be for each different electronic
27 unit and each different subassembly of electronic units. Equipment assembly drawings shall be
28 included in the maintenance manual.

29 **(F) CABINET AND RACK WIRING DIAGRAMS:**

30 In addition to the diagram stored in the field cabinet, a wiring diagram shall be provided for each
31 type of cabinet, equipment rack, and junction box containing wire terminals identified by location.
32 The wiring diagram shall depict actual, installed conditions.

33 **(G) SYSTEM CONNECTION DIAGRAMS:**

34 Connection diagrams for the entire ITS system, including block diagrams, terminal numbers, IP
35 addresses, and conductor color codes shall be cross-referenced to correlate with plan's wiring
36 diagrams. The diagram shall include conduits, pull boxes, detectors, etc.

1 **(H) FIBER OPTIC SPLICES AND SPLICE CLOSURES:**

2 Developer shall provide documentation identifying the location and fiber color codes for each field
3 splice performed by Developer. In addition to storing a drawing in each control cabinet, a fiber
4 assignment drawing shall be provided to ADOT for each splice closure throughout the project.

5 **(I) CONFIGURATION INFORMATION:**

6 Developer shall provide final configuration information for Developer-installed equipment.
7 Configuration information shall include configuration parameters, location, make and model
8 number, serial number, date of installation, vendor, vendor contact information, and warranty
9 expiration date.

10

1 **SECTION 753 DYNAMIC MESSAGE SIGNS**

2 **753-1 Description:**

3 The work under this item shall include furnishing and installing dynamic message signs (DMS).

4 **753-2 MATERIALS:**

5 The DMS shall be: Daktronics model number VF2420-96X400-20-RGB.

6 A DMS manufacturer’s warranty shall be provided for a period of 2 years starting upon successful
7 completion of the stand-alone test and shall be in accordance with Section 106.13.

8 The DMS sign shall include manufacturer-supplied power and control cables between the DMS
9 and sign controller, and a manufacturer-supplied control cabinet including the following
10 accessories:

- 11 • Sign Controller
- 12 • Pullout Drawer
- 13 • EIA Equipment Rack
- 14 • Ventilation System
- 15 • Cabinet lighting
- 16 • Main power supply and distribution system
- 17 • Photo Sensor Control

18 Developer shall furnish and install UV-rated flexible metal conduit between the DMS support
19 structure and the DMS sign case. Developer shall furnish and install one 8 AWG green bond
20 conductor between the DMS case and control cabinet conforming to Subsection 732-2.01 of the
21 ADOT Standard Specifications. Wiring and grounding shall conform to Section 732-3.03 of the
22 ADOT Standard Specifications. All conductors used for power with DMS shall be copper.
23 Aluminum wire shall not be used for DMS.

24 Developer shall submit shop drawings for each DMS installation conforming to the requirements in
25 the DMS sign structure bid item.

26 **753-3 CONSTRUCTION REQUIREMENTS:**

27 The control cabinets shall be ground mounted. Developer shall furnish and install silicone
28 caulking, or other approved sealant around the base of the cabinet to form a watertight and dust-
29 proof seal with the foundation.

30 Developer shall mount communication equipment such as the Ethernet switch, switch power
31 supply, and patch and splice module on the DIN rail shelf leaving a minimum of 5 inches of space
32 for air circulation between devices. Developer shall integrate the communication equipment and
33 DMS sign controller with ADOT’s network.

34 Developer shall install the control and power cables between the DMS and the sign controller in
35 accordance with DMS supplier’s recommended routing and installation methods. The power
36 cables shall be terminated by Developer and the control cables shall be left disconnected.

1 Developer shall arrange, coordinate and provide, for a DMS supplier's field technician to be on-
2 site to field-commission the sign, and initial set-up and testing. The DMS supplier's field technician
3 will terminate and connect the control cables between the DMS and the sign controller during the
4 stand-alone test.

5 Removable caps shall be placed on unused conduits within the cabinet.

6 Developer shall record on the plans the vertical clearance above the highest point of pavement
7 and the lowest component of the DMS sign and mounting hardware.

8 If the DMS will not be operational within 14 consecutive days of installation, Developer shall install
9 ADOT-furnished 36-inch by 36-inch static sign facing traffic with the message "SIGN UNDER
10 TEST". The sign shall be mounted on the vertical member of the DMS support structure with
11 Developer-furnished steel strap or banding. Mounting of the sign by drilling into the support
12 structure is not allowed. Developer shall remove the sign and mounting hardware upon final
13 acceptance. The sign shall be returned to ADOT after removal. Sign mounting hardware shall
14 become the property of Developer.

15 Developer shall furnish and install pressure-sensitive, permanent identification decals on the DMS
16 control cabinet, as shown in ADOT ITS Standard Drawings FM-3.13. The decals shall be 3-inch
17 tall, Series C, Gothic letters and shall be top-grade, glass-beaded, reflective black letters on a
18 silver or chrome background.

19 **753-4 TESTING REQUIREMENTS:**

20 **(A) Stand-Alone Test:**

21 After Developer has successfully energized all DMS assemblies on the project, the DMS Supplier
22 Testing will be performed by the DMS supplier's field technician. The DMS supplier's field
23 technician will terminate and connect the control cables between the DMS and the sign controller
24 and test functionality of the DMS system.

25 Developer shall schedule the stand-alone test with ADOT and the DMS supplier at least 4 weeks
26 prior to the desired test date. Developer shall provide the DMS supplier the DMS serial numbers,
27 cabinet serial numbers, and installed locations and mileposts. All DMS assemblies within the
28 project shall be ready for DMS Supplier Testing so Developer's DMS supplier may sequentially
29 perform testing on all DMS assemblies within the project. Developer shall work with the DMS
30 supplier's field technician to troubleshoot and make repairs to the DMS system. Developer shall
31 provide traffic control and a bucket truck with an operator for use by the DMS supplier's field
32 technician during testing.

33 The DMS supplier shall use their standard test form and submit a complete and organized set of
34 forms in electronic PDF format to ADOT for review and comment.

35 **(B) SUBSYSTEM TEST (SST):**

36 After successful completion of the above tests, ADOT, with the support of Developer, shall
37 conduct the subsystem test verifying that communication to the sign controller is properly
38 configured and operate without failure or adversely affecting the existing system. The SST shall
39 start on a Monday, Tuesday, or Wednesday and be conducted for 3 consecutive days.

40 Developer shall replace components that fail the SST and the test shall be restarted on a Monday,
41 Tuesday, or Wednesday and be conducted for 3 consecutive days. Developer shall supply test
42 equipment requested by ADOT to troubleshoot the system.

1 Developer shall provide traffic control and a bucket truck with an operator for use by the DMS
2 supplier's field technician during the subsystem test. Traffic control will be measured and paid for
3 under their respective traffic control items.

4 **(C) SYSTEM ACCEPTANCE TEST (SAT):**

5 Upon successful completion of the subsystem test, the SAT shall be started. The SAT shall
6 consist of a 30-day period of operation without failure of DMS equipment. GPS data shall be
7 submitted and approved prior to beginning the SAT as per the requirements of Section 116 of the
8 TPs.

9 The purpose of the SAT is to demonstrate that the total system, consisting of hardware, software,
10 communications, materials, and construction, is properly installed, is free from defects and
11 identified problems, exhibits stable and reliable performance, and complies with contract
12 documents.

13 During the SAT, Developer shall ensure that equipment is maintained in operable condition.
14 ADOT personnel shall be provided with access to equipment during the SAT for purposes of
15 verifying operation. Developer shall identify, isolate, diagnose and troubleshoot system problems
16 and inconsistencies. Developer, in conjunction with ADOT, shall formulate possible solutions and
17 shall implement corrections required in Developer-supplied equipment. Developer shall provide
18 test equipment and labor needed to test, isolate and correct equipment deficiencies found during
19 the SAT. Developer technical personnel having industry standard certification in the field of the
20 design and construction of each system component shall be available on site within 48 hours of
21 notification of a problem.

22 During the SAT, Developer shall record test failures on the System Acceptance Test Failure Log
23 provided at:

24 [https://www.azdot.gov/business/engineering-and-construction/systems-technology/its-](https://www.azdot.gov/business/engineering-and-construction/systems-technology/its-references)
25 [references](https://www.azdot.gov/business/engineering-and-construction/systems-technology/its-references) and immediately submit the form to ADOT. After the repair has been completed, an
26 updated form shall be submitted to ADOT. Documentation errors, omissions, and changes
27 occurring prior to, and during, the SAT shall be corrected and resubmitted before the SAT is
28 completed.

29 **(1) SAT MINOR FAILURE:**

30 In the event of a minor failure during the SAT, the test clock shall stop until the system is repaired. At
31 the completion of the repair, the testing shall recommence with 24 hours added to the remaining
32 test time of the system. The following constitute minor failures:

- 33 • Failure of Developer-furnished equipment.
- 34 • Failure of an entire communications circuit.
- 35 • Failure to communicate to a DMS or an attached confidence camera.

36 **(2) SAT MAJOR FAILURE**

37 In the event of a major failure during the SAT, the test clock shall stop until the system is repaired. At
38 the completion of the repair, the testing shall recommence with the test clock reset to day zero.
39 The following constitute major failures:

- 40 • Failure of Developer-furnished equipment, if determined that failures were
41 caused by faulty installation by Developer.

- 1 • Failure of an entire communications circuit for more than 15 minutes within a
- 2 24-hour period.
- 3 • Failure to communicate to an individual DMS.
- 4 • Failure to correct an issue within 4 hours of being notified by ADOT.
- 5
- 6

1 **SECTION 754 7 WAY MULTI-DUCT FOR ADOT BROADBAND INITIATIVE**

2 **754-1 Description:**

3 The work under this item shall consist of furnishing and installing 7-Way Multi-Duct for the
4 ADOT Broadband Initiative to replace conduit and fiber that is impacted by outside
5 widening within the project limits. The Developer is required to install new 7-Way Multi-
6 Duct for the entire distance between adjacent No. 9 pull boxes where any portion of the
7 7 Way Multi-Duct is impacted by construction.

8 **754-2 Materials:**

9 **(A) 7-Way Multi-Duct:**

10 The 7-Way Multi-Duct materials shall be the following with no substitutions allowed:

- 11 (1) Dura Line Corporation FuturePath® Armored with Orange
12 HDPE - 0.110-in Sheath (Armored), 7-way x 12.7/10 mm
13 Micro-ducts, No Ripcords, No Tracer Wire, ADDD1035:
 - 14 (a) Micro-ducts Colors: Blue, Brown, Green, Grey, Orange, Red &
15 White
 - 16 (b) Dura-Line Part Numbers:
 - 17 (i) 10010249 (3250' on an 83" reel)
 - 18 (ii) 10010241(5000' on a 90" reel)
- 19 (2) When installed within 3" conduit, the Dura Line Corporation
20 FuturePath® is not required to be armored.
- 21 (3) Straight Couplers: Dura Line Corporation 12.7mm, Part
22 Number 20001832
- 23 (4) MicroDuct/MicroCable Sealing End Cap
 - 24 (a) Dura-Line Part Number 20001931 (12.7/10mm Sealing End
25 Cap)
 - 26 (b) Other Dura-Line products needed to fit proposed fiber optic
27 cables
- 28 (5) MicroDuct End Cap
 - 29 (a) Dura-Line Part Number 20001482 (12.7mm End Cap)
- 30 (6) Sealing Voids in FuturePath® Located Between the
31 MicroDucts and Oversheath
 - 32 (a) Per Dura-Line TECHNICAL BULLETIN: DCEB-08008 called
33 FuturePath® - Recommended Void Sealing Methods

1 The 7-Way Multi-Duct shall be furnished in one continuous length, with no couplings or
2 splicing outside pull boxes, and of lengths sufficient to complete runs between No.9 Pull
3 Boxes.

4 **(B) Conduit Warning Tape:**

5 Conduit warning tape shall be a minimum four-mil composite reinforced thermoplastic,
6 with a minimum width of 3 inches and minimum length of 5 feet. Warning tape shall be
7 highly resistant to alkalis, acids, and other destructive agents found in the soil.

8 Warning tape shall have a continuous printed message warning of the location of
9 underground conduits. The message shall be in permanent ink specifically formulated for
10 prolonged underground use and shall bear the words, "CAUTION - ELECTRIC LINE
11 BURIED BELOW" or "CAUTION – COMMUNICATION CABLE BURIED BELOW" in black
12 letters on a red background for electric conduits or orange background for communication
13 conduits. Where both electric and communications conduits are in a single trench, both
14 warning tapes, as described above, shall be provided.

15 **(C) Detectable Pull Tape:**

16 Detectable pull tape shall be constructed of fiber and have an embedded No. 22 AWG
17 conductor. The tape shall be low-stretch and moisture-resistant. The tape shall have
18 nominal pull strength of 2,500 pounds. The tape shall include distance markings at
19 intervals not to exceed 2 feet.

20 **(D) Plugs and Caps:**

21 All plugs or caps used on the ends of occupied and unoccupied conduits, innerducts, and
22 microducts shall be corrosion-proof, removable, reusable, water-tight, and vermin
23 resistant end treatment recommended by the manufacturer to prevent intrusion of water,
24 mud, gravel, rodents, etc. Duct tape or similar material shall not be used for sealing
25 conduit ends.

26 The 7-Way Multi-Duct shall be capped and sealed in the following areas:

- 27 (1) Between each microduct and microcable
28 (2) With an end cap for any exposed unoccupied microducts
29 (3) Voids in 7-Way Multi-Duct located between the microducts and
30 oversheath
31 (4) Around 7-Way Multi-Duct when placed into a conduit or sleeve

32 **(E) Fiber Utility Markers:**

33 Fiber Utility Markers shall be constructed of a fiberglass composite material designed to
34 stand up to vehicular impacts and controlled ditch burns with an outward protruding rib
35 on each end to protect the decal on the front side (i.e., traffic facing side) from vehicle
36 impacts and a rib in the center of the back side to add strength for driving into hard soil
37 conditions. The decal on the Fiber Utility Marker shall have text saying "CAUTION" and

1 "FIBER OPTIC CABLE BURIED BELOW". Fiber Utility Markers shall be a minimum of
2 3.75 inches wide and 72 inches in length.

3 **(F) Cement-Treated Slurry Backfill:**

4 In areas where trenching occurs in existing or new asphalt pavement, the trench shall be
5 backfilled to the top of pavement subgrade with a cement-treated slurry bedding material
6 conforming to the requirements of Subsections 501-3.02(A)(3), 501-3.02(B)(3) and 501-
7 3.02(C)(3) of the specifications except as specified herein.

8 Cement-treated slurry backfill shall be rapid setting such that it may be paved on after 1-
9 hour of set time. No paving above the cement-treated slurry backfill shall be commenced
10 until 1 hour after the cement-treated slurry have been placed.

11 **(G) Asphaltic Concrete:**

12 Asphaltic concrete shall conform to the requirements of Subsection 409-2 of the ADOT
13 Standard specifications.

14 **754-3 Construction Requirements:**

15 Construction Requirements shall conform to Section 732, unless otherwise specified on
16 the RFC plans, or the specifications. No conduit trenches shall be left open after the work
17 shift. All conduit trenches shall be compacted and backfilled prior to leaving the
18 construction site.

19 Conduit installation shall conform to Subsection 732-3.01 with the following exceptions.
20 Exact conduit route to be verified with the Engineer prior to placement to account for field
21 conditions. All conduit, communication and electrical cable shall be installed according to
22 National Electric Code requirements and manufacturer's recommendations. The
23 Developer shall note that existing conduit may be encased in concrete or slurry material.

24 Work may include horizontal directional drilling, horizontal directional boring, excavating,
25 backfilling, compacting, warning tape, detectable pull tape, connectors and fittings,
26 locating existing conduit, removing and reinstalling existing signage, and restoration of
27 the surface to existing condition, including the replacement of pavement striping, concrete
28 slabs, decomposed granite, irrigation and other landscaping items where appropriate,
29 and/or at the locations designated on the RFC plans.

30 Open trenching and plow trenching shall be backfilled, compacted and regraded to meet
31 pre-disturbance condition within one day following the installation of the conduit.

32 A three inch "Y" shall be cut into the face of the curb directly over conduit located under
33 rolled or vertical curbs.

34 **(A) Conduit Routing and Underground Obstructions:**

35 The RFC Submittal shall indicate the intended path of conduit, and Developer shall place
36 conduit in accordance with the lines, grades, details and dimensions shown on the RFC
37 Submittal, unless otherwise approved by ADOT. The conduit path shall be staked for
38 review and approval of ADOT three Business Days prior to excavation and installation.

1 The conduit path shall be modified as necessary, with the approval of ADOT, to avoid
2 obstacles and obstructions, to facilitate future maintenance, or to conform to appropriate
3 codes and specifications. Final conduit locations shall be documented in the Record
4 Drawings.

5 Developer shall remove and reinstall existing signage as a result of construction activities.

6 Developer shall restore, repair, or replace, as necessary, vegetation, landscaping
7 features, decomposed granite, irrigation facilities, walkways, utilities, and other items
8 damaged or contaminated as a result of construction activities.

9 Developer shall contact ADOT 48 hours prior to work in the vicinity of irrigation lines.
10 Irrigation lines might not be Blue-Staked, but shall be repaired or replaced if damaged
11 during construction.

12 Developer shall not leave Excavations shall not be left open overnight and shall be
13 backfilled with appropriate material unless a plan has been submitted to and approved by
14 the Engineer allowing for open excavation. Safety devices used for the protection of
15 excavations will not be considered as traffic control items. The cost of these safety
16 devices is considered as included in the price of these items.

17 **(B) Conduit Ends and Connections:**

18 New runs of 7-Way Multi-Duct and HDPE conduit shall be continuous from pull box to pull
19 box. HDPE conduit shall not be joined to PVC conduit in the length of the run.

20 If joining segments of HDPE conduit is called for on the plans or required by the Engineer,
21 the Developer shall utilize non-corrosive, sit-tight, water-tight couplings. Heat fusion,
22 electrofusion fittings and mechanical connections will be permitted if the HDPE conduit
23 and joining device manufacturer's recommendations are followed and the internal
24 diameter of the HDPE conduit is not reduced. Extrusion welding and hot gas welding to
25 join HDPE conduits is not permitted. Upon completion of joining HDPE conduit sections
26 and setting the pull boxes, the Developer shall clean the HDPE conduit with compressed
27 air. The Developer shall demonstrate that the conduit was not deformed during installation
28 by pulling a cleaning mandrel or ball mandrel with a diameter of 80 percent of the HDPE
29 inside diameter. If the mandrel passes through the HDPE, the Developer shall install the
30 pull tape in accordance with Section 732. If the mandrel encounters a deformity in the
31 HDPE conduit, the Developer shall replace the entire segment of HDPE between pull
32 boxes with new HDPE at no additional cost to the Department.

33 **(C) Conduit Depth:**

34 Conduits shall have a minimum cover depth of 30 inches, or as indicated in the project
35 plans. Backfill compaction shall be in accordance with Subsection 203-5.03 (B) (4). When
36 conduit cannot be installed at the required minimum depths, it shall be encased in cement
37 slurry (1/2 sack) up to 4 inches above the conduit, or as indicated in the RFC plans.

38 The Developer shall record the cover depth, on the record drawing, for all conduit runs
39 that do not have a minimum cover depth of 30 inches by marking the beginning and end
40 points of the area that does not have this minimum cover depth. The Developer shall

1 record the actual depth and location of the point that has the lowest cover depth between
2 these beginning and end points.

3 Refer to Section (F) of these Construction Requirements for installing Fiber Utility Markers
4 at a more frequent spacing in areas that do not have a minimum cover depth of 30 inches.

5 **(D) Conduit in Trenches:**

6 Conduit installation methods identified in the RFC plans as “Plowing”, “Trench Off
7 Shoulder”, “Trench In Shoulder – Asphalt”, and “Trench In Shoulder – PCCP” may be
8 completed by a different installation method, if approved in advance by the Engineer as
9 a means of facilitating installation or mitigating potential damage to existing surface and
10 subsurface elements. If approved by the Engineer the substitution of a different
11 installation method for the original method of installation specified in the plans shall be
12 paid for at the original method of installation bid price of the conduit item.

13 Conduit installed by direct plowing shall include a vibratory plow, and conduit feeder tube
14 to displace the soil and install the conduit at the required depth. In locations where pre-
15 ripping is performed the use of a non-vibratory plow is allowed. The Developer shall use
16 the appropriate plowing equipment based on the field soil conditions and the conduit
17 depth.

18 Open trenching and plow trenching shall be backfilled, compacted and regraded to meet
19 pre-disturbance condition within a day following the installation of the conduit.

20 The Developer shall place detectable warning tape in trenches in which new 7-Way Multi-
21 Duct conduit is placed by plow and trench methods. Warning tape is not required in conduit
22 segments where trenchless methods (e.g., direction drill and bore) are used for installation
23 except direct plow method. Warning tape shall be buried at a depth of 6 to 8 inches below
24 the finished grade.

25 The Developer shall place fiber utility markers at a 500-foot maximum spacing along the
26 7-Way Multi-Duct trench/plow path outside the shoulder, at No. 9 PB, and at beginning,
27 center, and end points of where the conduit bends. When 7-Way Multi-Duct conduit
28 depth/cover is less than 30 inches the markers shall be installed at a 50-foot maximum
29 spacing along the trench/plow line outside the shoulder, and at the beginning and end
30 point of the shallow depth/cover area.

31 Immediately after conduit work including, installation, mandrelling, or cable or pull tape
32 installations, the conduit shall be sealed to prevent the intrusion of water, mud, gravel,
33 vermin, etc. Taping the ends of the conduit is not allowed.

34 Conduits entering into pull boxes shall be plugged or capped to prevent intrusion of water,
35 mud, gravel and rodents. Plugs or caps shall be used on the following:

- 36 (1) Unoccupied and occupied microducts on which work is
37 performed extending beyond the end of the capped HDPE
38 Armor Oversheath.

1 In areas where trenching occurs in existing asphalt pavement, the Developer shall sawcut
2 and remove the existing asphaltic concrete pavement prior to trenching. Removed
3 asphaltic concrete shall become the property of the Developer and shall be removed from
4 the project site and disposed of per local ordinances.

5 Following installation of the conduit, the Developer shall backfill the trench with a cement-
6 treated slurry backfill as specified herein. No paving above the cement-treated slurry
7 backfill shall be commenced until 1 hour after the cement-treated slurry have been placed.

8
9 The Developer shall pave the trench with asphaltic concrete in accordance with the details
10 shown on the project plans and in accordance with the requirements of Subsection 409-
11 3 of the specifications.

12 **(E) Conduit by Trenchless Methods:**

13 New conduit to be installed under existing pavement, curbs and gutters, sidewalks,
14 established landscaping or decomposed granite not otherwise impacted by construction,
15 and at other locations specifically indicated on the RFC plans as “Boring Under
16 Pavement”, shall be installed by Horizontal Directional Boring (HDB) or Horizontal
17 Directional Drilling (HDD) methods. Use of either method is allowed, subject to approval
18 of the Engineer.

19 Conduit installation methods identified in the RFC plans as “Boring Under Pavement” may
20 be completed by trenching or plowing methods, if approved in advance by the Engineer
21 as a means of facilitating installation or mitigating potential damage to existing surface
22 and subsurface elements. If approved by the Engineer, the substitution of trenching or
23 plowing methods for the original trenchless method of installation specified in the plans
24 shall be paid for at the original trenchless method of installation bid price of the conduit
25 item.

26 Prior to beginning trenchless installation methods, the Developer shall complete the
27 necessary potholing, and submit the proposed profile to the Engineer for approval.
28 Installation shall be performed in accordance with industry standards and as directed by
29 the Engineer.

30 The Developer’s installation process shall utilize the “walkover” locating system or other
31 Engineer approved equivalent, for determining the installation profile. The installation
32 equipment shall register the depth, angle, rotation and directional data. At the surface,
33 equipment shall be used to gather the data and relay the information to the equipment
34 operator.

35 Excavation and backfill of excavated pits shall be in accordance with the requirements of
36 Subsection 203-5.03 (A) and (B).

37 When enlargement of an installation hole is necessary, the hole shall be at least 25
38 percent larger than the conduit to be installed, unless otherwise specified by the Engineer.
39 Pulling equipment such as grips, pulling eyes, and other attachment hardware external to
40 the conduit will be permitted as long as a wooden dowel is placed inside the conduit to

1 prevent it from collapsing at the point of attachment when pull tension is at its peak. The
2 use of the wooden dowel inside the conduit is not required for the 7-Way Multi-Duct
3 material. A swivel shall be used with pulling hardware when pulling back the conduit into
4 the installation path. Drilling fluid shall be pumped down the hole to provide lubrication for
5 the conduit as it is pulled in. The pulling tension for installing conduit into the installation
6 path shall not exceed 75 percent of the conduit manufacturer's tensile strength rating in
7 order to prevent the conduit from "necking down" or deforming.

8 The Developer shall place fiber utility markers at a 500-foot maximum spacing along the
9 trenchless area 7-Way Multi-Duct is installed outside the shoulder, at No. 9 PB, at
10 beginning, center, and end points where the 7-Way Multi-Duct path bends or changes
11 direction, and at the beginning and end of roadway crossings. When 7-Way Multi-Duct
12 conduit depth/cover is less than 30 inches the markers shall be installed at a 50-foot
13 maximum spacing along the trenchless path outside the shoulder, and at the beginning
14 and end point of the shallow depth/cover area.

15 Final installation profiles shall be submitted to the Engineer.

16 **(F) Fiber Utility Markers:**

17 Fiber utility marker shall be installed as described in Construction Requirements section
18 (D)

19 Conduit in Trenches, section (E) Conduit by Trenchless Methods above, and a fiber utility
20 marker shall be installed at each No. 9 pull box location. The Developer shall provide each
21 ADOT Maintenance District, within the project limits, two sets of fiber utility marker
22 installation tools, including a Post Driver, Post Puller, and Pilot Hole Driver tools.

23 **(G) Detectable Pull Tape:**

24 The Developer shall install detectable pull tape in new and existing empty conduits and
25 innerducts, except for in 7-Way Multi-Ducts. The steel armor strength member within the
26 7-Way Multi-Duct shall be used to detect its path with a locating signal.

27 Detectable pull tape in conduits shall terminate at the end of the conduit with a minimum
28 of 2 feet of coiled slack in the pull box. Detectable pull tape traveling through conduit that
29 terminates in a pull box, shall have its wire ends connected together to allow for a
30 continuous locating signal to be used for the entire conduit run.

31 **(H) Conduit Cleaning:**

32 The Developer shall clean conduit, no more than one week prior to installation of cables
33 or conductors. For PVC conduit, a metal-disc mandrel with an outer diameter not less
34 than 90 percent of the conduit's inside diameter shall be pulled through the conduit. For
35 HDPE conduit, a ball mandrel with an outer diameter not less than 80 percent of the
36 conduit's inside diameter shall be pulled through the conduit. Prior to pulling the mandrel
37 through the conduit, the conduit shall be brushed or swabbed if required by the Engineer.

38 **(I) Conduit Entering Pull Boxes:**

1 Conduit entering pull boxes shall be installed in accordance with the details shown on the
2 project plans and the ITS Standard Drawings FM-2.03, FM-2.04 and FM-2.06. Conduit
3 ends shall be capped with conduit end cap or plug fittings until wiring or cabling is
4 installed. When end caps or plugs are removed, the Developer shall install bell end fittings
5 or approved bell end shape integral to the conduit. Bell ends shall be installed prior to the
6 installation of the conductors or cables. Approved insulated grounding bushings shall be
7 used on steel conduit ends.

8 New HDPE conduits terminating in a No. 9 pull box shall run directly into the conduit port
9 hole of the pull box wall and be cut flush with the inside face of the pull box. The void
10 between the outside of the conduit and inside of conduit port hole shall be sealed with an
11 approved sealant.

12 **(J) Cathodic Protection:**

13 Prior to trenching, the Developer shall verify the existence of cathodic protection in
14 existing utilities and take all possible precautions to maintain existing cathodic protection.

15 **(K) 7-Way Multi-Duct**

16 The 7-Way Multi-Duct shall be installed in one continuous length, between No.9 pull
17 boxes, with no couplings or splicing outside the pull boxes.

18 Six of the seven micro-ducts (colors: Blue, Brown, Green, Grey, Red & White) shall be
19 installed in one continuous length through the No.9 pull boxes. A straight coupler for each
20 micro-duct is permitted within the No.9 pull box to achieve the continuous lengths.

21 The Orange micro-duct shall be cut within each No.9 pull box, leaving a minimum length
22 of 2 feet inside the pull box with 1 foot or more accessible from each side of the pull box.

23 The Developer shall bond the steel armor strength member of the 7-Way Multi-Duct, at
24 each exposed end within the No.9 pull boxes, to the ground rod within the pull box.

25 **(L) Rigid Metal Conduit and Bridge Attachments**

26 Developer shall install conduits from the top of the bridge and access to the river/wash
27 will not be allowed.

28 Conduit either within an open bridge cell or attached to structures shall be rigid metal
29 conduit (RMC). The Developer shall attach rigid metal conduit on the bridge structure per
30 ADOT ITS Standard Drawing FM-1.05, FM-1.07, and FM-1.08.

31 Developer shall install expansion couplings when crossing expansion joints, junction
32 boxes as necessary to limit the total number of conduit bends between pull points to under

33 360 degrees, and provide 45 deg conduit bend fitting when necessary. Expansion
34 couplings, junction boxes, and 45 deg conduit bend fitting shall be installed per Detail 4
35 in the Plans.

36 Where required for aesthetic reasons RMC shall be painted to match the color of the
37 existing bridge structure. Painting may require pre-treatment of the RMC and will be done
38 at the direction of the Engineer.

1 **(M) Incorporation of Existing Conduit or Innerduct, Empty or**
2 **Occupied:**

3 Existing underground conduit to be incorporated into a new system shall be cleaned and
4 blown out with compressed air.

5 Where cables are to be installed in conduit with existing cables or wires that will remain,
6 the Developer shall disconnect, remove, reinstall, and reconnect the existing cables and
7 wires as determined by the Engineer, to facilitate the installation of the new cable.

8 Two weeks prior to disconnecting any existing cables, the Developer shall submit a
9 schedule, for approval by the Engineer, with the timeframes of when the existing cables
10 are to be disconnected.

11 The Developer shall be responsible for any damage to the existing cables or wires caused
12 by this operation. Existing wires and cables shall be considered in good condition unless
13 the Developer demonstrates to the contrary to the Engineer, prior to commencing removal
14 of any cable or conductor from the conduit(s).

15 No more than one week prior to installation of cable or conductors, all new and existing
16 conduits in which cable or conductors are to be installed shall be cleared/cleaned by
17 pulling through a metal-disc mandrel with a diameter of 90 percent of the conduit inside
18 diameter for PVC conduit, or a ball mandrel with a diameter of 80 percent of the conduit
19 inside diameter for HDPE. The conduit may be brushed or swabbed, if deemed
20 necessary, prior to pulling the mandrel through the conduit.

21 Where indicated on the plans, the Developer shall remove and dispose of existing cables
22 and/or conductors in existing conduits. Prior to their removal, all cables and/or conductors
23 to be removed shall be identified and marked at all intermediate pull boxes. These cables
24 and/or conductors shall be cut at all intermediate pull boxes before being removed.
25 Conduits to remain empty for future use shall have a detectable pull tape installed.

26 Where multiple cables, conductors, pull tape, and/or new innerducts are required to be
27 installed in the same conduit, all the materials shall be installed at the same time.

28 **SECTION 755 NODE AND NETWORK SWITCH FROM ADOT BROADBAND**
29 **INITIATIVE**

30 The following information is provided from the ADOT Broadband Initiative Project. The
31 Developer is required to design the communications for the GPL and Flex Lanes to be
32 integrated with the communications equipment provided by the ADOT Broadband
33 Initiative. All field devices shall be connected to communications running between the
34 node at Sunset Point and Node 15 at I-17/SR 101.

35 The Developer shall furnish and install any additional equipment at the nodes to facilitate
36 the communication.

37 **755-1 Description:**

38 The contractor shall furnish, install, and test, backbone communications equipment in
39 Node Building(s).

1 **755-2 Materials:**

2 Provide node buildings that consists of a Layer-3 10-Gigabit Ethernet Backbone switch,
3 Node-to-Node SFP+ Transceiver Modules and Optical Attenuators, Node-to-ITS Device
4 SFP Transceiver Modules and Optical Attenuators, 144-Port Fiber Termination Panels
5 and Patch Cords, and GigE Switch.

6 **(A) Layer-3 10-Gigabit Ethernet Backbone Switch:**

7 Provide a high-performance and 10-Gigabit Ethernet Backbone Switch supporting
8 standard Open System Interconnection (OSI) Layer 3 functionality that is compatible with
9 ADOT's current Layer 3 switch network and Network Management System (NMS) server.
10 Provide Ethernet Backbone Switch supporting direct connectivity to existing networks
11 configured in ring and mesh fault tolerant topologies enabling applications to operate
12 reliably and with low latency, and all associated software licenses.

13 The Ethernet Backbone Switch shall be as follows:

- 14 (1) Approved Product Configuration:
- 15 (a) Ruckus ICX 7450-48F Switch (includes 48×100/1000
 - 16 Mbps SFP ports)
 - 17 (b) One Ruckus ICX7400-4X10GF Module (4-
 - 18 port 1/10 GbE SFP/SFP+)
 - 19 (c) License for Advanced IPv4/v6 Layer 3 routing (OSPF,
 - 20 BGP, VRRP, PIM, PBR, VRF, etc.)
- 21 (2) Environmental
- 22 (a) Operating temperature: -5°C to 50°C/23°F to 122°F
 - 23 (b) Storage temperature: -40°C to 70°C/-40°F to 158°F
 - 24 (c) Operating relative humidity: 10% to 90% at 50°C, non-
 - 25 condensing
 - 26 (d) Non-operating relative humidity: 5% to 95% at 70°C,
 - 27 non- condensing
 - 28 (e) Operating altitude: 10,000 ft. (3,000 m) maximum
 - 29 (f) Storage altitude: 39,000 ft. (12,000 m) maximum
 - 30 (g) Vibration: IEC 68-2-36, IEC 68-2-6
 - 31 (h) Shock and drop: IEC 68-2-27, IEC 68-2-32
- 32 (3) High Availability
- 33 (a) Redundant hot-swappable power supplies
 - 34 (b) Hot-swappable fan trays
 - 35 (c) Layer 3 VRRP/VRRP-E protocol redundancy

- 1 (d) Real-time state synchronization across the stack
- 2 (e) Hitless failover and switchover from master to standby
- 3 stack controller
- 4 (f) Hot insertion and removal of stacked units
- 5 (g) Layer 2 VSRP switch redundancy
- 6 (h) In Service Software Update (ISSU)
- 7 (4) Layer 3 IP routing
- 8 (a) IPv4 and IPv6 static routes
- 9 (b) RIP v1/v2, RIPng
- 10 (c) ECMP
- 11 (d) Port-based Access Control Lists
- 12 (e) Layer 3/Layer 4 ACLs
- 13 (f) Host routes
- 14 (g) Virtual Interfaces
- 15 (h) Routed Interfaces
- 16 (i) Route-only Support
- 17 (j) Routing Between Directly Connected Subnets
- 18 (k) IPv4 and IPv6 dynamic routes
- 19 (l) OSPF v2, OSPF v3 (IPv6)
- 20 (m) PIM-SM, PIM-SSM, PIM-DM, PIM passive (IPv4/IPv6
- 21 multicast routing functionality)
- 22 (n) PBR
- 23 (o) Virtual Route Redundancy Protocol VRRP v3 (IPv6)
- 24 (p) VRRP-E (IPv4, IPv6)
- 25 (q) BGP4, BGP4+ (IPv6)
- 26 (r) GRE
- 27 (s) IPv6 over IPv4 tunnels
- 28 (t) VRF (IPv4 and IPv6)
- 29 (u) MSDP
- 30 (5) Layer 2 switching
- 31 (a) 802.1s Multiple Spanning Tree
- 32 (b) 802.1x Authentication

- 1 (c) Auto MDI/MDIX
- 2 (d) BPDU Guard, Root Guard
- 3 (e) Dual-Mode VLANs
- 4 (f) MAC-based VLANs, Dynamic MAC-based VLAN activation
- 5 (g) Dynamic Voice VLAN Assignment
- 6 (h) Dynamic VLAN Assignment
- 7 (i) Fast Port Span
- 8 (j) GVRP: GARP VLAN Registration Protocol
- 9 (k) IGMP Snooping (v1/v2/v3)
- 10 (l) IGMP Proxy for Static Groups
- 11 (m) IGMP v2/v3 Fast Leave
- 12 (n) Inter-Packet Gap (IPG) adjustment
- 13 (o) Link Fault Signaling (LFS)
- 14 (p) MAC Address Filtering
- 15 (q) MAC Learning Disable
- 16 (r) MLD Snooping (v1/v2)
- 17 (s) Multi-device Authentication
- 18 (t) Per-VLAN Spanning Tree (PVST/PVST+/PVRST)
- 19 (u) Mirroring - Port-based, ACL-based, MAC Filter-based,
20 and VLAN- based
- 21 (v) PIM-SM v2 Snooping
- 22 (w) Port Loop Detection
- 23 (x) Private VLAN
- 24 (y) Remote Fault Notification (RFN)
- 25 (z) Single-instance Spanning Tree
- 26 (aa) Trunk Groups (static, LACP)
- 27 (bb) Uni-Directional Link Detection (UDLD)
- 28 (cc) Metro-Ring Protocol (MRP) (v1, v2)
- 29 (dd) Virtual Switch Redundancy Protocol (VSRP)
- 30 (ee) Q-in-Q and selective Q-in-Q
- 31 (ff) VLAN Mapping

- 1 (gg) Topology Groups
- 2 (6) Quality of Service (QoS)
- 3 (a) ACL Mapping and Marking of ToS/DSCP (CoS)
- 4 (b) ACL Mapping and Marking of 802.1p
- 5 (c) ACL Mapping to Priority Queue
- 6 (d) Classifying and Limiting Flows Based on TCP Flags
- 7 (e) DiffServ Support
- 8 (f) Honoring DSCP and 802.1p (CoS)
- 9 (g) MAC Address Mapping to Priority Queue
- 10 (h) Priority Queue Management using Weighted Round
- 11 Robin (WRR), Strict Priority (SP), and a combination
- 12 of WRR and SP
- 13 (i) Priority Flow Control
- 14 (7) Traffic management
- 15 (a) ACL-based inbound rate limiting and traffic policies
- 16 (b) Broadcast, multicast, and unknown unicast rate limiting
- 17 (c) Inbound rate limiting per port
- 18 (d) Outbound rate limiting per port and per queue
- 19 (8) Security
- 20 (a) IPsec 128/256 AES-GCM (with service module)
- 21 (b) MACsec
- 22 (c) 802.1X Authentication
- 23 (d) MAC Authentication
- 24 (e) Flexible authentication
- 25 (f) Web authentication
- 26 (g) DHCP snooping
- 27 (h) Dynamic ARP inspection
- 28 (i) Neighbor Discovery (ND) Inspection
- 29 (j) Bi-level Access Mode (Standard- and EXEC-level)
- 30 (k) EAP pass-through support
- 31 (l) IEEE 802.1X username export in sFlow
- 32 (m) Protection against Denial of Service (DoS) attacks

- 1 (n) Authentication, Authorization, and Accounting (AAA)
- 2 (o) MAC Address Locking MAC Port Security
- 3 (p) Advanced Encryption Standard (AES) with SSHv2
- 4 (q) RADIUS/TACACS/TACACS+
- 5 (r) Secure Copy (SCP)
- 6 (s) Secure Shell (SSHv2)
- 7 (t) Protected Ports
- 8 (u) Local Username/Password
- 9 (v) Change of Authorization (CoA) RFC 5176
- 10 (w) RFC Conformance for Encryption:
- 11 (x) RFC 5996 Internet Key Exchange Protocol Version 2 (IKEv2)
- 12 (y) RFC 4303 IP Encapsulating Security Payload (ESP)
- 13 (z) RFC 6379 Suite B Cryptographic Suites for IPsec
- 14 (Suite-B-GCM- 256 and Suite-B-GCM-128)
- 15 (aa) RFC 5903 Elliptic Curve Groups Modulo a Prime (ECP
- 16 Groups) for IKEv2
- 17 (bb) RFC 4868 Using HMAC-SHA-256, HMAC-SHA-384,
- 18 and HMAC- SHA-512 with IPsec
- 19 (cc) RFC 4754 IKEv2 Authentication Using the Elliptic
- 20 Curve Digital Signature Algorithm (ECDSA)
- 21 (dd) RFC 4106 The use of Galois/Counter Mode (GCM) in
- 22 IPsec Encapsulating Security Payload (ESP)SP800-
- 23 56A Recommendation for Pair-Wise Key
- 24 Establishment Schemes Using Discrete Logarithm
- 25 Cryptography
- 26 (ee) Encrypted Syslog (RFC 5425)
- 27 (ff) RADSEC (RFC 6614)
- 28 (9) SDN features
- 29 (a) OpenFlow v1.0 and v1.3
- 30 (b) OpenFlow with hybrid port mode
- 31 (c) Operates with OpenDaylight SDN Controllers and the
- 32 applications running on the controller
- 33 (10) IEEE standards compliance
- 34 (a) 802.1AB LLDP

- 1 (b) 802.1D MAC Bridging
- 2 (c) 802.1p Mapping to Priority Queue
- 3 (d) 802.1s Multiple Spanning Tree (MST)
- 4 (e) 802.1w Rapid Reconfiguration of Spanning Tree
- 5 (f) 802.1x Port-based Network Access Control (PNAC)
- 6 (g) 802.3 Carrier Sense Multiple Access/Collision Detect
- 7 ion (CSMA/CD)
- 8 (h) 802.3ab 1000BASE-T
- 9 (i) 802.1 AX-2008 Link Aggregation
- 10 (j) 802.3ae 10 Gigabit Ethernet
- 11 (k) 802.3af Power over Ethernet
- 12 (l) 802.3at Power over Ethernet Plus
- 13 (m) 802.3u 100Base-TX
- 14 (n) 802.3x Full duplex and Flow Control
- 15 (o) 802.3z 1000Base-SX/LX
- 16 (p) 802.3 MAU MIB (RFC 2239)
- 17 (q) 802.3ba 40 and 100 Gbps Ethernet
- 18 (r) 802.1AE-MACsec (with license)
- 19 (s) 802.3az Energy Efficient Ethernet
- 20 (t) 802.1Q VLAN Tagging
- 21 (u) 802.1BR Bridge Port Extension
- 22 (11) Network and Device Management
- 23 (a) DHCP Auto Configuration
- 24 (b) Configuration Logging
- 25 (c) Digital Optical Monitoring
- 26 (d) Display Log Messages on Multiple Terminals
- 27 (e) Embedded Web Management (HTTP/HTTPS)
- 28 (f) Embedded DHCP Server
- 29 (g) Industry-standard Command Line Interface (CLI)
- 30 (h) Ruckus SmartZone, Ruckus Unleashed
- 31 (i) Key-based activation of optional software features

- 1 (j) USB file management and storage
- 2 (k) Macro for batch execution
- 3 (l) Out-of-band Ethernet Management
- 4 (m) ERSPAN support for remote traffic monitoring
- 5 (n) RSPAN
- 6 (o) TFTP
- 7 (p) TELNET Client and Server
- 8 (q) Bootp
- 9 (r) SNMPv1/v2c
- 10 (s) DHCP Server and DHCP Relay
- 11 (t) SNMPv3 Intro to Framework
- 12 (u) Architecture for Describing SNMP Framework
- 13 (v) SNMP Message Processing and Dispatching
- 14 (w) SNMPv3 Applications
- 15 (x) SNMPv3 User-based Security Model
- 16 (y) SNMP View-based Access Control Model SNMP
- 17 (z) sFlow
- 18 (aa) NTP Network Time Protocol
- 19 (bb) Multiple Syslog Servers
- 20 (cc) SCP
- 21 (dd) Virtual Cable Tester (VCT)

22 **(B) Node-to-Node SFP+ Transceiver Modules and Optical**
 23 **Attenuators:**

24 The Layer 3 10-Gigabit Ethernet Backbone Switch shall be provided with a minimum of
 25 two (2) Small Form Factor Plus (SFP+) Transceiver Modules and associated Optical
 26 Attenuators as necessary to support Node Building to Node Building communications.

- 27 (1) SFP+ Transceiver Modules:
- 28 (a) The SFP+ transceiver modules shall support:
 - 29 • a minimum distance of 80 km (50 miles)
 - 30 (b) a Transmit (Tx) Power of 0~5 dBm
 - 31 (c) a receiver sensitivity of -24 dBm or less (i.e., a greater
 - 32 negative number)

- 1 (d) a data rate of 10 Gigabit per second (Gbps) or more
- 2 (e) a 1550 nm Wavelength
- 3 (f) a LC Duplex type connector

4 (2) Optical Attenuator Requirements:

5 When transmit distance is less than 80km, provide an appropriate optical attenuator on
 6 each end of the fiber path according to the transmit distance as follows to assure the
 7 transceivers work:

- 8 (a) ≤ 50 km transmit distance = 2 dB attenuator
- 9 (b) ≤ 40 km transmit distance = 5 dB attenuator
- 10 (c) ≤ 30 km transmit distance = 7 dB attenuator
- 11 (d) ≤ 20 km transmit distance = 10 dB attenuator
- 12 (e) ≤ 15 km transmit distance = 11 dB attenuator
- 13 (f) ≤ 10 km transmit distance = 12 dB attenuator
- 14 (g) ≤ 1 km transmit distance = 15 dB attenuator

15 (C) **100/1000Base-T SFP Modules:**

16 The Layer 3 10-Gigabit Ethernet Backbone Switch shall be provided with a minimum of
 17 eight (8) Small Form Factor (SFP) Modules supporting 100/1000BaseT RJ-45
 18 connections to Ethernet devices located within the Node Building.

19	(D)	Node-to-			
20	ITS	Device	SFP	Transceiver	Modules ^[OBJ]
21			^[OBJ]	Attenuators:	

22 The Layer 3 10-Gigabit Ethernet Backbone Switch shall be provided with Small Form
 23 Factor (SFP) Transceiver Modules and associated Optical Attenuators as necessary to
 24 support Node Building to ITS Device Location communications.

- 25 (1) SFP Transceiver Module Requirements:
- 26 (2) SFP transceiver modules

27 shall support:

- 28 (a) a minimum distance = actual fiber path distance based on
 29 OTDR results
- 30 (b) a minimum Data rate = 1 Gigabit per second (Gbps)
- 31 (c) a 1550 nm Wavelength
- 32 (d) a LC Duplex type connector

33 (3) Optical Attenuator Requirements:

34 When transmit distance is less than the minimum distance supported by the SFP

1 Transceiver Module provide an appropriate optical attenuator on each end of the fiber
2 path.

3 **(E) 144-Port Fiber Termination Panels and Patch Cords:**

4 Each 144-Port Fiber Termination Panel shall be provided with the following:

- 5 (1) Splice Trays supporting up to 144 fusion splices.
- 6 (2) 144 Single-Mode Fiber Pigtails. Each Single-Mode Fiber Pigtail
7 shall be provided with:
 - 8 (a) a factory pre-terminated ST connector on one end
 - 9 (b) a 9/125 micron single-mode fiber cable with a jacket color
10 matching the color of the fiber strand within the 144-fiber
11 trunkline cable being terminated.
 - 12 (c) a fusion splice to a fiber strand within the 144-fiber trunkline
13 cable with a maximum acceptable splice attenuation of 0.10 dB.
- 14 (3) Connector Panels. Each connector panel shall be provided
15 with:
 - 16 (a) 12 couplers with ST connectors on each end.
 - 17 (b) Port numbers (1 through 12) imprinted on the front side of the
18 connector panel next to each coupler.
- 19 (4) Housing shall occupy no more than 4 RU of vertical space and
20 be provided with standard EIA 19-inch rack mounting provisions.
21 Each housing shall be provided with:
 - 22 (a) 12 Connector Panels with connector panel labels (A through L)
23 imprinted at the top and bottom of each connector panels.
 - 24 (b) Fiber Assignment Table with associated port numbers (1
25 through
26 12) and connector panel labels (A through L) clearly printed on
27 the table next to the 144 open spaces where the associated fiber
28 path description is manually written.
- 29 (5) Single Mode Fiber Patch Cords shall be provided between the
30 SFP/SFP+ transceiver modules and the associated ports within
31 the Fiber Optic Cable Termination Panels. Each Patch Cord shall
32 be a duplex type (i.e., 2 fiber strands) 9/125 micron single-mode
33 fiber cable with a yellow color jacket and the following factory
34 pre- terminated connectors:
 - 35 (a) LC Duplex type connector on one end
 - 36 (b) Two ST connectors on the other end

1 (6) Maximum acceptable attenuation per connector shall be 0.5 dB
2 per ANSI/TIA-568-C.3 specification.

3 **755-3 Construction Requirements:**

4 The contractor shall contact ADOT TTG staff to obtain IP addresses for all Ethernet based
5 equipment.

6 The contractor shall configure all contractor furnished network equipment in accordance
7 with an ADOT approved IP Addressing plan. The contractor shall coordinate with the
8 Engineer on switch configuration information, (i.e. IP addresses, VLANs etc.) 45 days
9 prior to installing Ethernet Switches.

10 The contractor shall interconnect the single node assembly equipment per the
11 manufacturer's instructions using the electrical and optical cables furnished by the
12 contractor.

13 **(A) Single Node Assembly Locations**

14 (1) At the Mcguireville Rest Area Node Building, the contractor
15 shall furnish and install the following equipment:

16 (a) Two (2) Layer-3 10-Gigabit Ethernet Backbone Switches with:

17 (i) Two (2) Node-to-Node SFP+ Transceiver Modules for
18 connection to both switches at the Sunset Point Node
19 Building.

20 (ii) Two (2) Node-to-Node SFP+ Transceiver Modules for
21 connection to both switches at the I-40 & I-17 Node
22 Building.

23 (iii) Optical Attenuators, as necessary.

24 (b) Two (2) 144-Port Fiber Termination Panels with Patch Cords.

25 (2) At the Sunset Point Node Building, the contractor shall furnish
26 and install the following equipment:

27 (a) Two (2) Layer-3 10-Gigabit Ethernet Backbone Switches with:

28 (i) Two (2) Node-to-Node SFP+ Transceiver Modules for
29 connection to both switches at the Mcguireville Rest Area
30 Node Building.

31 (ii) Two (2) Node-to-Node SFP+ Transceiver Modules for
32 connection to both switches at Node 20 (Loop 303 & Lake
33 Pleasant Pkwy).

34 (iii) Two (2) Node-to-Node SFP+ Transceiver Modules for
35 connection to both switches at Node 15 (Loop 101 & I-
36 17).Optical Attenuators, as necessary.

37 (b) Two (2) 144-Port Fiber Termination Panels with Patch Cords.

- 1 (c) Power Distribution Assembly upgrade comprised of the
2 following:
3 (i) Add a 30A single poles breaker to the existing power
4 distribution panel and update power panel circuit table to
5 say "ADOT Active Equipment Rack".
6 (ii) Provide a 3kVA rack mounted UPS within the ADOT
7 Active equipment Rack.
8 (iii) Provide three 10 AWG conductors (Hot, Neutral and
9 Ground) from the existing power panel to the new rack
10 mounted UPS.
11 (iv) Provide rack mounted power distribution switch connected
12 to the 3kVA rack mounted UPS.

13 **(B) Single Node Assembly Upgrade Locations**

- 14 (1) At Node 20 (Loop 303 & Lake Pleasant Pkwy), the contractor
15 shall furnish and install the following equipment:
16 (a) Add the following to the existing Layer-3 10-Gigabit Ethernet
17 Backbone Switches for connecting both existing switches to the
18 Sunset Point Node Building switches:
19 (i) Two (2) Node-to-Node SFP+ Transceiver Modules
20 (ii) Optical Attenuators, as necessary
21 (2) At Node 15 (Loop 101 & I-17 Node Building), the contractor
22 shall furnish and install the following equipment:
23 (a) Two (2) 144-Port Fiber Termination Panels with Patch Cords
24 (b) Add the following to the existing Layer-3 10-Gigabit Ethernet
25 Backbone Switches for connecting both existing switches to the
26 Sunset Point Node Building switches:
27 (i) Two (2) Node-to-Node SFP+ Transceiver Modules
28 (ii) Optical Attenuators, as necessary
29 (3) At Node 3/4 (I-10 & I-17 Node Building), the contractor shall
30 furnish and install the following equipment:
31 (a) Two (2) 144-Port Fiber Termination Panels with Patch Cords

32 **(C) Cabling:**

33 All cables shall be neatly routed and bundled in cable trays. Strain relief shall be utilized
34 where necessary per the manufacturer recommended installation procedures.

35 Each and every cable shall be labeled on each end of the cable near the connector with
36 an Engineer approved label and labeling method.

1 **(D) Acceptance Testing:**

2 (1) Subsystem Test (SST):

3 The purpose of the Subsystem Test Procedure is to verify that contractor-furnished and
4 installed equipment (CCTV, DMS, WWD, and Node Building Devices) is fully functional
5 and operating per the specification's requirements for a period of 72 hours of time without
6 failure.

7 The SST shall verify that for a 72-hour period the installed equipment function without any
8 failures of the node communications system. The main purpose of this test is to verify that
9 when the final condition is complete, no existing ITS operational systems will be adversely
10 affected.

11 During the 72-hour subsystem test all installed equipment function will be verified
12 acceptable to the Engineer. This will be a subjective test that the passing of which is solely
13 up to the discretion of the Engineer. If the communication to any installed equipment fails
14 more than 1 percent of the time in any 15-minute period, the test has failed. If any installed
15 equipment fails during this test, the contractor shall troubleshoot the system and the test
16 rerun for the full 72-hour period.

17 (2) System Acceptance Test (SAT):

18 After successful completion of the SST, the installed equipment configurations will be
19 moved over to the associated operational servers at the TOC, and the SAT may
20 commence.

21 The 30-day SAT shall be run using the ADOT supplied test procedure.

22 **(E) Training Requirements:**

23 In the event the contractor submits Single Node Assembly equipment, which is not
24 currently in use by ADOT, the contractor shall arrange for and provide a training course
25 for the equipment components. The course shall be of adequate duration to cover the
26 subject matter and shall have an instructor competent in the technical aspects of the
27 equipment installed in the Node Building(s). The training course shall provide training and
28 training materials for up to 12 Engineering and Maintenance personnel.

29 The contractor shall submit a syllabus, training materials and a schedule for the Single
30 Node Assembly equipment training course to the Engineer for review and approval 45
31 days prior to the proposed start of training. The Engineer will notify the contractor of
32 acceptability within 30 days of submittal. The contractor shall schedule the training no
33 sooner than 14 days from receipt of the approved syllabus unless otherwise noted in the
34 approval. Training materials shall include the course outline, material describing the
35 course, and operations and maintenance manuals with any additional information needed
36 to adequately describe the subject being taught. Training materials shall not be
37 copyrighted.

TP Attachment 470-1 – ROW Acquisition Status Report

TP Attachment 470-1 ROW Acquisition Status Report					
No.	Owner	Type	Area (SF)	Station	Est. Date Available to Developer
1	ASLD	New ROW	15,650	1880+00 (NB)	1/15/22
2	ASLD	New ROW	8,960	1945+00 (NB)	1/15/22
3	ASLD	New ROW	2,340	1950+00 (NB)	1/15/22
4	BLM	New ROW	11,930	1965+00 (SB)	1/15/22
5	ASLD	New ROW	6,330	1970+00 (NB)	1/15/22
6	ASLD	New ROW	13,911	1979+00 (NB)	1/15/22
7	ASLD	New ROW	26,440	1990+00 (NB)	1/15/22
8	BLM	New ROW	49,510	2020+00 (NB)	1/15/22
9	BLM	New ROW	14,440	2033+00 (NB)	1/15/22
10	BLM	New ROW	27,600	2050+00 (NB)	1/15/22
11	The Conservation Fund	New ROW	20,110	2060+00 (SB)	2/25/22
12	BLM	New ROW	38,160	2062+00 (NB)	1/15/22
13	BLM	New ROW	63,770	2085+00 (NB)	1/15/22
14	ASLD	New ROW	115,893	2293+00 (NB)	1/15/22
15	BLM	New ROW	141,990	2423+00 (SB)	1/15/22
16	BLM	New ROW	518,160	2435+00 (SB)	1/15/22
17	BLM	New ROW	677,620	2460+00 (SB)	1/15/22
18	BLM	New ROW	9,670	2489+00 (SB)	1/15/22
19	BLM	New ROW	4,450	2493+00 (SB)	1/15/22
20	BLM	New ROW	13,200	2567+00 (SB)	1/15/22
21	BLM	New ROW	66,300	2585+00 (SB)	1/15/22
22	BLM	New ROW	4,830	2598+00 (SB)	1/15/22
23	BLM	New ROW	118,930	2627+00 (SB)	1/15/22

TP Attachment 500-1 – Maintenance Table

TP Attachment 500-1 Maintenance Table								
Ref.	Element	Performance Requirement	Repair Response		Inspection Method	Inspection Frequency	Measurement Record	Target
			Temporary ¹	Permanent ²				
1 – Public Appearance								
1.1	Graffiti	Maintain all surfaces within the O&M Limits free of graffiti.	N/A	24 hours for profanity, areas visible to travelling public and for specific call outs; and 1 week for other graffiti discovered in the course of maintenance activities.	Visual	None	No graffiti within the O&M Limits.	100%.
1.2	Landscaping	Remove damaged or dead vegetation planted by Developer. During the landscape establishment period, replacements must occur as required in Section DR 450.3.4 of the TPs. This performance requirement applies (a) throughout the Project, but (b) only during the landscape establishment period.	NA	4 weeks	Visual	Monthly during landscape establishment period; None afterwards	New plants: No dead or damaged plants within the Project. Salvaged plants: No more than 20% dead or damaged plants within the Project.	100% of applicable Measurement Record
2 –Pavement								
2.1	Delamination of AR-ACFC	All roadways have a smooth surface course.	2 hours for distress that presents a safety hazard to motorists on mainline lanes and transition ramps even if Measurement Record is satisfied.	1 year	By ADOT	Annually	Repair when: 5 or more delamination areas, of 1 foot length or greater in any direction, within any 1 mile section per direction	100%
2.2	Potholes	All roadways have a smooth surface course.	2 hours for distress that presents a safety hazard to motorists on mainline lanes and transition ramps even if Measurement Record is satisfied.	1 year	By ADOT	Annually	Repair when: 5 or more potholes, of 1 inch depth or greater and a 1 foot length or greater in any direction, within any 1 mile section per direction.	100%
2.3	Base Failures	All roadways have a smooth surface course.	2 hours for distress that presents a safety hazard to motorists on mainline lanes and transition ramps even if Measurement Record is satisfied.	1 year	By ADOT	Annually	Repair when: any base and/or subgrade failure occurs.	100%
2.4	Settlement/ Heave/ Distortion	All roadways have a smooth surface course.	2 hours for distress that presents a safety hazard to motorists on mainline lanes and transition ramps even if Measurement Record is satisfied.	1 year	By ADOT	Annually	Repair when: surface deviations reach/exceed 1-1/2 inches in a length of 50 feet.	100%
					By ADOT	Annually	Repair when: surface deviations exceed 1/2 inch between adjacent slabs or structural sections.	100%

TP Attachment 500-1 Maintenance Table								
Ref.	Element	Performance Requirement	Repair Response		Inspection Method	Inspection Frequency	Measurement Record	Target
			Temporary ¹	Permanent ²				
2.5	Joints	All roadways have a smooth surface course.	2 hours for distress that presents a safety hazard to motorists on mainline lanes and transition ramps even if Measurement Record is satisfied.	1 year	By ADOT	Annually	Repair when: joint separations between concrete pavement and adjacent asphaltic concrete pavement exceed 1/2 inch in width.	100%
							Repair when: concrete pavement joints exceed 1/2 inch in width.	100%
2.6	Pavement ride	All roadways have a smooth surface course.	30 days	1 year	By ADOT	End of year two and year four of the O&M Period	Repair when: mainline lanes and ramps, 0.1 mile average IRI greater than or equal to 85 inches/mile.	100%
2.7	Ruts	All roadways have a smooth surface course.	2 hours for distress that presents a safety hazard to motorists on mainline lanes and transition ramps even if Measurement Record is satisfied.	6 months	By ADOT	Annually	Repair when: average rut depth of any 1 mile section is greater than 1/2 inch.	100%
							Repair when: any rut depth is greater than 1 inch.	100%
2.8	Cracks	Maintain cracks so they are sealed and watertight.	2 hours for distress that presents a safety hazard to motorists on mainline lanes and transition ramps even if Measurement Record is satisfied.	1 year	By ADOT	Annually	Clean and seal cracks when: any individual crack is 1/2 inch wide or wider.	100%
2.9	Skid Resistance	Maintain skid resistance to required level.	2 hours for distress that presents a safety hazard to motorists on mainline lanes and transition ramps even if Measurement Record is satisfied.	6 months	By ADOT	Annually	Repair when: skid resistance throughout any 1 mile section is less than or equal to 30.	100%
3 – Curb and Gutter								
3.1	Curb and gutter	Concrete curbs and gutters must not be displaced or damaged.	N/A	1 year	Visual; and physical measurement if visual inspection reveals displacement or damage.	Every other year	Inspection records and physical measurements showing compliance.	90% per mile for curb and gutter
4 – Safety and Security								
4.1	Safety Barriers, attenuators, barrier end treatments, and safety railing	All barriers, median barrier gates, guard rail / bridge rail transitions, guard rail end treatments, and attenuators must be functional with no damage that impairs their ability to perform.	2 hours to install safety measures	1 week for attenuators and barrier end treatments; and 30 days for other failures.	Visual	Annually	Inspection records showing compliance.	100%

TP Attachment 500-1 Maintenance Table								
Ref.	Element	Performance Requirement	Repair Response		Inspection Method	Inspection Frequency	Measurement Record	Target
			Temporary ¹	Permanent ²				
4.2	Signage and delineators	All signs and delineators function as designed, unauthorized signs are removed, obsolete signs are removed or replaced.	2 hours for safety critical signs (regulatory and warning); and 1 week for other signs.	6 weeks for signs 25 square feet or larger, and 2 weeks for other signs	Visual day and night	Annually	Inspection records showing compliance.	100%
4.3	Lighting	Luminaires are illuminated, function as designed. Electrical supply is maintained from point of service provider.	48 hours for restoration of electrical supply and N/A for street lighting luminaires	1 month	Visual	Annually	Percent of luminaires functioning.	90%
							Instance of 3 or more consecutive luminaires not functioning.	0
5 – Structures								
5.1	Bumble Bee TI SB Bridge	FHWA mandated inspections – these inspections are not delegated. ADOT will perform the required inspections. Developer shall carry out temporary and permanent repairs as indicated in the inspection reports	2 hours for conditions that affect life safety; and 1 week or as indicated in bridge inspection report for other issues.	6 months or as indicated in bridge inspection reports.	By ADOT	Every other year	Bridges with no condition rating below 7	100%
		<p>Bridge components:</p> <p>Substructures and superstructures are free of undesirable vegetation, debris, blocked drains, weep holes, defects in joint sealants, defects in pedestrian protection measures, settlement, scour, concrete spalls, and impact damage.</p> <p>Expansion joints are free of dirt, debris, vegetation, and defects in joint seals.</p> <p>The deck drainage system is free of all obstructions and operates as intended.</p> <p>Cover plates are secure and free of damage.</p> <p>Bearing pads and bearing seats are clean.</p> <p>Approach slab and anchor slab joints are free of dirt, debris, vegetation, defects in joint seals.</p>	2 hours for conditions that affect life safety; and 1 month for other issues.	6 months	Visual	Annually	No visually apparent defects	100%
5.2	Retaining walls	Mechanically stabilized earth and other types of retaining walls must be free from impact damage and dislocation, must drain properly, must have no loose components, and must not have exposed reinforcing.	2 hours for conditions that affect life safety; and 30 days for other conditions.	6 months	Visual	Annually	Inspection records showing compliance	100%
5.3	Sign and lighting supports	Sign and lighting supports must be structurally sound, must have no loose hardware or anchorages, and must be properly positioned and aligned.	2 hours for conditions that affect life safety; and 1 week for other conditions.	3 months	Visual	Annually	Inspection records showing compliance	100%
6 – Ponding/Flooding, Drainage and Slopes								
6.1	Ponding and flooding	Roadway must be free from standing water within 30 minutes after the end of a 50 year storm event	2 hours	1 month	Visual	Monthly and after storm event in compliance with SWPPP requirements	No areas of standing water within travel lanes. Areas of standing water on shoulders are less than 50 square yards in extent.	100%

TP Attachment 500-1 Maintenance Table								
Ref.	Element	Performance Requirement	Repair Response		Inspection Method	Inspection Frequency	Measurement Record	Target
			Temporary ¹	Permanent ²				
6.2	Slopes	Maintain cut and fill slopes at design configuration without slope failures or erosion. Remove erosion debris from roadway.	2 hours for failures that affect or threaten travelled way; and 1 month for other issues.	6 months	Visual	Annually	Erosion of materials or slope failures.	0
6.3	Rocks in Catchment Area	Rock catchment areas must work as designed. Fencing and barriers for rock catchment areas must be free from damage affecting structural integrity.	N/A	1 month	Visual	Monthly	Rocks confined to catchment areas. Inspection records show no structural damage to fencing and barriers.	0
7 – ITS and Flex Lanes Elements								
7.1	Cameras	Cameras, including CCTV and Flex Lanes cameras, are operating and functioning as designed. Electrical supply is maintained	24 hours for restoration of electrical supply or communications; N/A for cameras	72 hours	Visual	Monthly	Inspection records showing compliance.	100%
7.2					Visual	Monthly	Inspection records showing compliance.	100%
7.3	Flex Lanes Guide Signs	Signs are operating and functioning as designed. Electrical supply is maintained from point of service provider.	24 hours for restoration of electrical supply or communications; 24 hours to install portable message sign to replace LED message board;	2 weeks for repairs	Visual	Monthly	Inspection records showing compliance.	100%
7.4	Flex Lane Gates	Gates controlling access to the Flex Lanes are operating and functioning as designed with no damage that impairs their ability to perform.	2 hours to install safety measures	48 hours	Visual	Monthly	Inspection records showing compliance.	100%
7.5	Vehicle Arresting Barriers	VAB controlling access to the Flex Lanes are operating and functioning as designed with no damage that impairs their ability to perform.	2 hours to install safety measures	48 hours	Visual	Monthly	Inspection records showing compliance.	100%
7.6	Fiber	The network including fiber optic communications, ethernet switches, and power conductors to field devices are functioning as designed and providing necessary communication for Flex Lanes System operations.	24 hours for restoration of fiber communications, switches, or electrical supply	72 hours	Visual	Monthly	Inspection records showing compliance.	100%
7.7	Loop Detectors	Detectors are operating and accurately recording and transmitting vehicle volume, speed, and occupancy in both the northbound and southbound directions of the Flex Lanes.	7 days	1 month	Visual	Monthly	Inspection records showing compliance.	100%
7.8								
7.9	Battery Backup	Battery backup must have a minimum runtime of 72 hours.	24 hours	72 hours	Visual	Monthly	Inspection records showing compliance.	100%
7.10	Flex Lanes Controllers	Must communicate with the TOC and operate elements designated in Section DR 466.3.35 of the TPs.	24 hours	72 hours	Visual	Monthly	Inspection records showing compliance.	100%
7.11	Roadside Network Communications System	Network needs to be functioning and communicating with the TOC.	24 hours	72 hours	Visual	Monthly	Inspection records showing compliance.	100%
7.12	Software	Software is compatible with existing ADOT system and operational at all times.	24 hours	72 hours if bugs are discovered	Visual	Monthly	Inspection records showing compliance.	100%

TP Attachment 500-1 Maintenance Table								
Ref.	Element	Performance Requirement	Repair Response		Inspection Method	Inspection Frequency	Measurement Record	Target
			Temporary ¹	Permanent ²				
Note: 1. A temporary repair response requires a safety remedy or repair that protects the public and, as necessary, other Elements. A temporary repair response is not necessarily required to have the durability, aesthetic finish, or, to some extent, the full function of the Element as initially designed. 2. A permanent repair response requires a remedy or repair that restores the Element at issue to a condition of full functionality, durability and appearance as initially designed.								

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