Annual Revisions to the SUDAS Design Manual
2022 Edition

If you want to update your printed manual, please print this packet and follow the instructions below. The current edition of the manual, with the latest revisions fully incorporated, can be found on our website - www.iowasudas.org.

Please remove the old sheets and place the revised sheets in your manual. Some pages are completely new and do not replace an existing sheet. Also, some pages do not contain revisions, but are included due to changes on the other side of the sheet or a change in the page number. **PLEASE READ CAREFULLY - PAY ATTENTION TO THE SECTION NUMBER!** Included shading to help distinguish between chapters. Questions can be directed to Beth Richards, SUDAS Program Coordinator, at 515-294-2869 or brich@iastate.edu.

Chapter	***Section***	***pg #***	***Summary of Revision(s)***
Manual introductory info			Updated the Contributors and Acknowledgments page. *Note - if you want to replace the small business card for the spine of your manual, you can print a copy from our website.*
1	1D-2	ALL	Revised the "items to be specified" list based on corrections and SUDAS Specifications revisions.
	1D-3	ALL	Updated the "incidental or included items" list.
	1D-4	ALL	Updated the "bid item" list.
2	2C-3, G, 2, c	11-14	Changed concrete leg dimension from 6 inches to 12 inches. Changed CL to "(typical 12 inches)."
	2D-3, C, 1	3	Included additional elements for apron guards and safety grates.
	2E-1, E, 14	7-8	Included additional elements for apron guards and safety grates.
5	Tables 5C-1.03 and 5C-1.04	7-8	Updated rural (40 or less) backslope or parking values based on the 2011 Roadside Design Guide and updated source information.
	5C-2, O	15-16	Added discussion points about the length of cul-de-sacs from International Fire Code and ITE perspectives.
	5J-1, C	7-12	Expanded design information addressing crack and seat projects in urban areas.
10	ENTIRE CHAPTER	ALL	Updated the chapter based on current practices.
13	Table of Contents	ALL	Revised table of contents based on changes made in Chapter 13.
	13A-1 through 13A-5	ALL	Revised the traffic signal design sections based on guidance from the SUDAS Traffic Signal Committee.
	13B-2	ALL	Fixed header.

Contributors and Acknowledgments

In 2021, SUDAS staff held many meetings to accomplish the various revisions reflected in the 2022 versions of the SUDAS manuals. These revisions would not have been possible without the efforts of the SUDAS technical committee members. The SUDAS program's success is also due to the dedication of the district committees and Board of Directors. Keeping the SUDAS manuals current is an ongoing, cooperative effort, involving hundreds of people who volunteer their time and expertise. It is not possible to acknowledge each of these volunteers individually, but we appreciate them all.

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Items to be Specified on Plans or in Contract Documents

The SUDAS Specifications specify many items and methods that can be used for the construction of improvements. Following is a list of items in the SUDAS Specifications that are to be noted on the construction drawings and/or in the special provisions whenever there is to be a deviation from the standard requirements of the specifications. This information may include specifying pipe sizes and materials, who is responsible for providing compaction testing, as well as many others.

The project engineer should review the following list and the SUDAS Specifications to make sure all items that are necessary to construct the project are specified on the plans and/or in the special provisions. Please note - this list is not all-inclusive.

Section 2010 - Earthwork, Subgrade, and Subbase

2010, 1.08 D, 1, a	Specify whenever the depth of cut for stripping and salvaging topsoil is other than 8 inches.
2010, 1.08, E	Specify the class of excavation as Class 10, Class 12, or Class 13.
2010, 1.08, E, 1, b, 2)	When the truck count method is to be used for measuring Class 10 or Class 13 excavation, specify if the shrinkage factor is other than 1.35.
2010, 1.08, E, 4	Specify whenever stripping, salvaging, and spreading 8 inches of topsoil is NOT a pay item and is included in the payment of Class 10, Class 12, or Class 13 Excavation.
2010, 1.08, F, 1	Specify whenever below grade excavation (core out) will NOT be measured and paid as extra work.
2010, 1.08, J, 3	Specify whenever removal of pipe and conduits will include capping.
2010, 1.08, L	Specify when the Contractor is responsible for compaction testing.
2010, 2.01	Specify use of compost-amended or off-site topsoil if on-site topsoil is NOT to be used.
2010, 2.02, C, 3	Specify the limits of Class 13 excavation.
2010, 2.04, C, 5	Specify whenever Type 2 geogrid is to be used in lieu of Type 1.
2010, 3.02, C	Specify if 8 inches of off-site topsoil is not to be used.
2010, 3.03, F, 1	Specify the desired depth for removal of unsuitable or unstable materials.
2010, 3.04, D	Specify whenever Type A compaction is to be used in lieu of compaction with moisture and density control.

2010, 3.05	Specify whenever and where unsuitable soils will be allowed in the right-of-way.
2010, 3.06, A	Specify if granular stabilization materials or subgrade treatment is to be used in lieu of select subgrade materials.
2010, 3.07	Specify the type of subgrade treatment (lime, cement, fly ash, asphalt, geogrid, or geotextiles) to be used.
2010, 3.07, A, 1	Specify the depth and rate of incorporation of the subgrade treatment material (lime, cement, fly ash, or asphalt).
2010, 3.07, A, 2	Specify the areas requiring subgrade treatment.
2010, 3.08, B	Specify the type and depth of subbase.
2010, 3.09, A	Specify when the Contractor is responsible for compaction testing.
Figure 2010.102	Specify whenever Type A compaction is desired in lieu of compaction with moisture and density control.

Section 3010 - Trench Excavation and Backfill

3010, 1.08, F	Specify when the Contractor is responsible for trench compaction testing.
3010, 2.03, B	Specify whenever Class V material can be used as other than topsoil.
3010, 2.06, D	Specify if foamed cellular concrete may be substituted for flowable mortar.
3010, 3.05, A, 6	Specify if concrete, flowable mortar, CLSM, or foamed cellular concrete is to be used in lieu of other bedding materials.
3010, 3.05, B, 1, a	Specify if granular bedding material is to be used for pressure pipes.
Figure 3010.101	Specify when over-excavation and foundation stone will be required.
Figure 3010.105	Specify when and where to install a waterstop.

Section 3020 - Trenchless Construction

3020, 2.02, A	Specify the wall thickness of casing pipe. See Section 9C-1.
3020, 2.02, C	Specify inside diameter of casing pipe.
3020, 2.05, B	Specify where special fill materials will be used.
3020, 3.04, A, 2, b	Specify the installation deviation tolerances of casing pipe if different than those included.

3020, 3.04, A, 2, b, 2), b) Specify the minimum depth of pressurized pipe.

3020, 3.04, D	Specify when to fill the annular space between the carrier and casing pipe with flowable mortar, CLSM, or foamed cellular concrete.

Section 4010 - Sanitary Sewers

4010, 1.08, A, 1, c	Specify if a pipe lining is to be used.
4010, 1.08, A, 2, c	Specify if a pipe lining is to be used.
4010, 1.08, B, 1, c	Specify if a pipe lining is to be used.
4010, 1.08, B, 2, c	Specify if a pipe lining is to be used.
4010, 1.08, E	Specify the distance beyond the right-of-way line that the sanitary sewer service stub is to extend, if other than 10 feet.
4010, 1.08, H, 3	For removal of sanitary sewer, specify if capping is required.
4010, 2.01, A, 1	For solid wall PVC pipe, 8 inch to 15 inch, specify if SDR 35 may be used.
4010, 2.01, C, 2, a	For corrugated PVC, 8 inch to 10 inch, specify if a minimum pipe stiffness of 46 psi may be used.
4010, 2.02, A	Specify when joint restraints for ductile iron pipe force mains are required.
4010, 2.02, B	Specify when restrained joints are required for PVC force mains.
4010, 2.02, E, 2	Specify the color of plastic post used for tracer wire station.
4010, 3.02, B, 7	Specify the location for installation of wye or tee service fitting.
4010, 3.05, B, 2	Specify the location for any installation of a tracer wire station in addition to each end of the force main.
4010, 3.06, A	Specify the locations for installation of sanitary sewer service stub.
4010, 3.06, C	Specify the distance beyond the right-of-way line that the sanitary sewer service stub is to extend, if other than 10 feet.
4010, 3.06, C, 3	Specify the depth of sanitary sewer service stub at its termination, if other than 10 to 12 feet.
4010, 3.06, C, 5	Specify method of marking the end of the sanitary sewer service line.
4010, 3.08, B, 2	Specify when to fill an abandoned sanitary sewer with flowable mortar, foamed cellular concrete, or CLSM.
4010, 3.10	Specify where to provide sanitary sewer cleanouts.

Section 4020 - Storm Sewers

4020, 1.08, D, 3	Specify if capping is required for removal of storm sewer.
4020, 2.01, A, 3	Specify when to use a rubber O-ring or profile gasket in lieu of a tongue and groove joint wrapped with engineering fabric.

4020, 2.01, B, 3	Specify when to use a rubber O-ring or profile gasket in lieu of a tongue and groove joint wrapped with engineering fabric.
4020, 2.01, C, 3	Specify when to use a rubber O-ring or profile gasket in lieu of a tongue and groove joint wrapped with engineering fabric.
4020, 2.01, G, 1, d	Specify gage of corrugated metal pipe, if other than Iowa DOT Standard Road Plan DR-104.
4020, 2.01, I, 2	Specify gage of coated corrugated metal pipe, if other than Iowa DOT Standard Road Plan DR-104.
4020, 3.04, A	Specify any special linear trench drain installation requirements.
4020, 3.05, B, 2	Specify the use of a rubber O-ring or profile gasket.
4020, 3.06	Specify where to install pipe aprons, apron footings, and apron guards.
4020, 3.09, B, 2	Specify when to fill a line to be abandoned with flowable mortar, foamed cellular concrete, or CLSM.

Section 4030 - Pipe Culverts

4030, 2.01, C, 5	Specify gage of the structural plate culverts, if other than Iowa DOT Standard Road Plan DR-104.
4030, 3.02, A	Specify the locations to install pipe aprons.
4030, 3.02, B	Specify the locations to install apron footings.
4030, 3.02, E	Specify the locations to install apron guards.
Figure 4030.225	Specify when to extend the bottom cross bar through the apron.

Section 4040 - Subdrains and Footing Drains

4040, 1.08, A, 3	Specify the use of engineering fabric.
4040, 1.08, E	Specify the distance beyond the right-of-way that the storm sewer service stub is to extend, if other than 10 feet.
4040, 3.01, A, 1	Excavate trench and provide pipe bedding and backfill as shown on the figures. Install engineering fabric if specified in the contract documents.
4040, 3.02, B	Specify the use of engineering fabric.
4040, 3.03, A	Specify the locations to install footing drain service stubs.
4040, 3.03, C	Specify the distance beyond the right-of-way that the footing drain service stub is to extend, if other than 10 feet.

Figure 4040.231 For Type 1 subdrains, specify Case A, B, or C. For Type 2 subdrains, specify Case D or E and the pipe diameter. When using Case A or Case D, specify the distance from back of curb. For both types, specify when engineering fabric is to be used.

Figure 4040.232 Specify the type of subdrain cleanout to be used.

Figure 4040.233 Specify when to use a CMP outlet.

Section 4050 - Pipe Rehabilitation

4050, 1.07, B Specify if water will not be provided for cleaning and installation of cured-in-place pipe by the Jurisdiction at no cost.

4050, 1.08 Specify if bypass pumping is not included in the measurement and payment of other bid items. *Applies to C, 1, c; D, 3; E, 1, c; E, 2, c; F, 1, c; F, 2, c; F, 3, c; and F, 4, c.* {Note - 1.08, G is the bid item for bypass pumping}.

4050, 1.08, A, 1, c Specify if unit price will include disposal and associated costs for all debris removed from sewer.

4050, 1.08, E, 2, a Specify the length of service pipe to line.

4050, 2.01, C, 2 Specify if the CIPP structural requirements are not fully deteriorated conditions.

4050, 2.01, Table 4050.01 Specify the ovality reduction factor and height of soil above pipe.

4050, 2.02, B Specify the CIPP point repair liner length.

4050, 2.02, C Specify if the ovality is a value other than 2%.

4050, 2.03, A, 1 Specify the distance the tube should extend from the sewer main into the service.

4050, 2.03, B, 2 Specify the service liner length.

4050, 2.03, E, 1 Specify if the cured-in-place service liner should be designed following different assumptions than those described in Table 4050.02.

4050, 2.03, Table 4050.02 Specify the depth of cover for each service repair location.

4050, 2.04, C Specify when to provide a root deterrent chemical to control root regrowth.

4050, 2.07, B Specify the materials to use for pipe replacement.

4050, 3.01, A, 6 Specify if the Contractor is to pay for disposal fees.

4050, 3.05, B, 1 Specify the length of the CIPP service repair.

4050, 3.06, B, 2 Specify if the length of the service line grouting plug should be a length other than 18 inches.

4050, 3.07, C, 1 Specify the materials to use for the replacement pipe.

Section 4060 - Cleaning, Inspection, and Testing of Sewers

4060, 2.01, B, 3	Specify the type of recording media that will be used to record the inspection.
4060, 3.03, A, 1	Specify whenever video inspection of storm sewers is not desired.

Section 5010 - Pipe and Fittings

5010, 1.08, C	Specify whether measurement of fittings will be made by count or by weight.
5010, 2.01, A, 1, b	Specify the minimum wall thickness for PVC pipe sizes over 24 inches.
5010, 2.01, A, 2	Specify joint type for PVC pipe if other than push-on.
5010, 2.01, B, 1, b	Specify the minimum wall thickness for DIP sizes over 24 inches.
5010, 2.01, B, 4	Specify joint type for DIP if other than push-on.
5010, 2.04, C	Specify when thrust blocks will be used for pipe sizes greater than 16 inches in diameter.
5010, 2.07, B	Specify the materials to use for water service pipe and appurtenances.
5010, 3.01, A, 3	Specify the lines and grades to install pipe with fittings.
5010, 3.01, A, 8	For pipes larger than 16 inches, specify when concrete thrust blocks are required in addition to restrained joints.
5010, 3.06, E	Specify the locations to install ground rods if other than adjacent to connections to existing piping.
5010, 3.07, B	Specify where to construct utility line supports.
5010, 3.08	Specify when the change of piping material is to be on the inside of the structure wall.
5010, 3.10, A, 1	Specify the valves to close and the valve boxes to remove.
5010, 3.10, B, 1	Specify the valves to close and the valve boxes to remove.
5010, 3.11, A	Specify the valves to close.
Figure 5010.101	Specify when to use the alternate method of thrust blocks at dead ends.

Section 5011 - Fusible PVC and HDPE Pipe

5011, 2.01, A, 1, b	Specify the minimum wall thickness for fusible PVC pipe sizes over 24 inches.
5011, 2.01, B, 2, b	Specify the minimum wall thickness for fusible HDPE pipe sizes over 24 inches.
5011, 3.01, C, 2	Specify when the internal joint bead is to be ground and to what height if other than 0.1 inch.

Section 5020 - Valves, Fire Hydrants, and Appurtenances

5020, 1.08, I, 3	Specify if the fire hydrant assembly is to be delivered to the Contracting Authority.
5020, 1.08, J, 3	Specify if the valve is to be delivered to the Contracting Authority.
5020, 1.08, K, 3	Specify if the valve box is to be delivered to the Contracting Authority.
5020, 2.01, A, 2	Specify whenever the opening direction for valves is clockwise.
5020, 2.01, D, 7	Specify the locations to use tapping valve assemblies.
5020, 2.02, B	Specify allowable manufacturer(s) of fire hydrant assemblies.
5020, 2.02, C, 5	Specify whenever the opening direction for fire hydrant assemblies is clockwise.
5020, 2.02, C, 6	For fire hydrant assemblies, specify the operating nut, pumper nozzle, nozzle threads, and main valve nominal opening sizes.
5020, 2.03, A	Specify the type of flushing device (blowoff) to be used.
5020, 2.03, B, 2	Specify the allowable manufacturer(s) for valve boxes.
5020, 3.02	Specify where to install and how to construct flushing device (blowoff).
5020, 3.03, A	Specify where to place anchor tee and hydrant.
5020, 3.04, D	Specify if exterior of a new fire hydrant barrel section will be painted a color other than matching the existing fire hydrant.

Section 6010 - Structures for Sanitary and Storm Sewers

6010, 1.08, A, 3	Specify if a manhole lining is to be used.
6010, 2.05, B, 2, b	Specify the use of engineering fabric.
6010, 2.06, B	Specify when to use a concentric cone on sanitary sewer manholes.
6010, 2.11, B, 1	Specify if sanitary sewer manhole exterior is to be coated.
6010, 2.11, B, 2	Specify whenever sanitary sewer manhole lining is required.
6010, 2.13, A, 1	Specify if steps are to be provided in manholes or intakes less than or equal to 20 feet deep.
6010, 3.01, D	Specify if intake lids are NOT to be set to match the longitudinal slope of the adjacent street.
6010, 3.01, J	Specify the type of casting to use for manholes and intakes, except for intakes that have a specific casting type identified on the figures. Specify if casting frame is to be attached to the structure with bolts.

6010, 3.02, B, 2	Specify if reinforcing steel is to lap other than 36 diameters.
6010, 3.04, A, 1	Specify when to install casting extension rings.
6010, 3.04, B, 3	Specify when existing casting may be reinstalled for minor adjustment of existing manhole or intake.
6010, 3.04, C, 4	Specify when existing casting may be reinstalled for major adjustment of existing manhole or intake.
6010, 3.05, C, 1, a	Specify whenever a knockout opening is allowed in lieu of a cored opening.
6010, 3.05, C, 1, b	Specify if sanitary sewer service is NOT required to be maintained at all times when connecting a sanitary sewer to existing manhole or intake.
6010, 3.05, C, 3	Specify whenever a knockout opening is allowed in lieu of a cored opening.
6010, 3.07, A	Specify if removal of manhole or intake is other than to a minimum of 10 feet below top of subgrade in paved areas or 10 feet below finished grade in other areas.
6010, 3.07, B, 3	Specify when to fill abandoned pipe line with flowable mortar or controlled low strength material.
Figure 6010.501	Specify when Type Q grate is to be used in lieu of Type R.
Figure 6010.502	Specify when Type Q grate is to be used in lieu of Type R.
Figure 6010.603	Specify when Type Q grate is to be used in lieu of Type R.

Section 6020 - Rehabilitation of Existing Manholes

6020, 2.02, A	Specify the thickness of the in-situ manhole replacement wall.
6020, 2.02, C	Specify whenever the Contractor is required to provide a PVC or PE plastic liner for in-situ manhole replacement.
6020, 3.01, C	Specify when the use of a urethane chimney seal is allowed.
6020, 3.02, B, 3	Specify whenever a plastic liner is to be installed in an in-situ manhole replacement.

Section 6030 - Cleaning, Inspection, and Testing of Structures

6030, 3.04, A, 1	Specify when exfiltration testing is required for sanitary sewer manholes in lieu of vacuum testing.

Section 7010 - Portland Cement Concrete Pavement

7010, 2.01, E	Specify the use of an intermediate aggregate for concrete.

7010, 2.01, L, 2	Specify the type of performed expansion jointing filler or sealer to use if NOT using a resilient filler.
7010, 2.02, A, 1	Specify the type of Class C or Class M mix to use.
7010, 2.02, C, 2	Specify the type and amount of supplementary cementitious material in the mix.
7010, 3.01, C, 1, c	Specify the use of stringless paving.
7010, 3.02, I, 5, a	Specify when a textured finished surface other than an artificial turf or burlap drag is desired (i.e. surface tining).
7010, 3.02, I, 5, b	Specify when surface tining is required. *Note - longitudinal tining is listed as the default.*
7010, 3.02, J, 1, a	Specify when the use of a linseed oil solution is required.
7010, 3.02, K, 1, a	Specify the type and locations for construction of joints.
7010, 3.02, K, 2, i	Specify when to use wet sawing for dust control.
7010, 3.02, K, 3, a	Specify the location of longitudinal and transverse construction joints.
7010, 3.02, K, 4, a	Specify the location of expansion joints.
7010, 3.07, C, 2, a	Specify when the use of a profilograph for pavement smoothness is required.
Figure 7010.101	Specify when to use Detail D-1, D-2, or D-3.

Section 7011 - Portland Cement Concrete Overlays

7011, 2.01, L, 1	Specify the mass per unit area.
7011, 3.02, E, 3, a	Specify the high spots in the existing asphalt surface to be milled.

Section 7020 - Hot Mix Asphalt Pavement

7020, 1.08, A & B	Specify if measurement of HMA pavement is by ton or square yard.
7020, 1.08, C & D	Specify if measurement of HMA base widening is by ton or square yard.
7020, 3.05, B, 1	Specify when the use of profilograph for pavement smoothness is required.
7020, Table 7020.05	Specify if the field laboratory air voids target value is other than 4%.

Section 7021 - Hot Mix Asphalt Overlays

7021, 2.04, A	Specify the asphalt binder grade.
7021, 3.01, A	Specify the milling depth, cross-section, or profile.

Section 7030 - Sidewalks, Shared Use Paths, and Driveways

7030, 1.08, H, 2	Specify whether granular surfacing for driveways will be computed in square yards or tons.
7030, 1.08, I, 1	Specify whenever the Contractor will be responsible for concrete compression or HMA density testing.
7030, 2.03, A	Specify color and surface texture of clay brick pavers, or select from samples submitted by the Contractor.
7030, 2.03, B	If concrete pavers are to be used, specify the material requirements.
7030, 2.04, B	Specify the use of a pre-mixed high performance cold mix in lieu of an HMA setting bed.
7030, 2.06	Specify the use of colored cement for brick/paver joint filler.
7030, 3.01, A-C	Specify removal limits of sidewalks, shared use paths, driveways, bricks, and curbs.
7030. 3.01, E	Specify the locations to grind or saw existing curbs to install sidewalks, shared use paths, and driveways.
7030, 3.04	Specify the line and running slope to construct sidewalks and shared use paths. Specify the cross slope.
7030, 3.04, F, 2, a, 1)	Specify the spacing for transverse joints in shared use paths, if other than equal to the width of the shared use paths.
7030, 3.05	Specify the cross slope.
7030, 3.06, A, 2	Specify the cross-section and patterns to use for brick sidewalks with a concrete base.
7030, 3.11, A	Specify when testing will be the Contractor's responsibility.
Figure 7030.101	Specify the radius for commercial and industrial driveways. Specify when a 'B' joint is to be provided at the back of curb. Specify the driveway width. Specify when a 5 foot sidewalk is to be constructed through the driveway.
Figure 7030.102	Specify the radius for commercial and industrial driveways. Specify the driveway width. Specify when a 5 foot sidewalk is to be constructed through the driveway.
Figure 7030.104	Specify parking grading slope and property slope if different than 4:1.
Figure 7030.201	If a special grade is required for parking slopes, specify the grade. Specify the width of the sidewalk.
Figure 7030.202	Specify one of the curb details for Class A sidewalk.
Figure 7030.203	Specify the brick sidewalk pattern. Specify the jointing of the concrete base.
Figure 7030.205	Specify the use of a BT-3, KT-2, or expansion joint.

Section 7040 - Pavement Rehabilitation

7040, 1.08, K, 3	Specify the use of waterproof bonding material with pavement core replacement.
7040, 2.01, A, 1	Specify if patches are not constructed as standard patches.
7040, 2.01, A, 2	Specify the use of calcium chloride in high early strength patching.
7040, 2.01, B	Specify if an HMA mixture other than a minimum Low Traffic (LT) mixture is desired.
7040, 2.01, C, 5	Specify the use of soil sterilant for crack and joint filler material.
7040, 2.01, G	Specify if a subbase material other than modified subbase is desired.
7040, 2.01, K	Specify the length and diameter of epoxy coated dowel bars.
7040, 3.01, C	Specify the dimensions of full depth and partial depth patches.
7040, 3.01, F	Specify seeding or sodding the area outside the pavement.
7040, 3.02, A, 1	Specify when a second saw cut is required.
7040, 3.02, C, 6	Specify the locations of joints.
7040, 3.03, B, 2	Specify when to tool the joint.
7040, 3.04, J	Specify when pavement smoothness testing is required.
7040, 3.05, B	Specify the depth to mill the pavement area.
7040, 3.05, D	Specify if materials removed are not the property of the Contractor.
7040, 3.06, B, 3	Specify when to clean wet sawn joints.
7040, 3.06, C, 2	Specify the level to heat, handle, and apply joint filler material.
7040, 3.07, A, 3	Specify when to apply soil sterilant.
7040, 3.07, B, 2	For cracks wider than 1 inch, specify when to utilize additional methods to clean cracks of old crack filler.
7040, 3.07, C, 2	For cracks 1/4 inch to 1 inch in width, specify when to utilize additional methods to clean cracks of old crack filler.
Figure 7040.102	Specify the use of a ‘CD’ joint.
Figure 7040.105	Specify the use of filter fabric. Specify the type of subbase.

Section 7050 - Asphalt Stabilization

7050, 1.02	Specify the crown of the pavement.
7050, 2.01, B	Specify the type of aggregate required.
7050, 3.03, A	Specify the depth of existing roadway surface to reclaim, if other than 4 inches.
7050, 3.07	Specify the type of surface treatment to apply.

Section 7060 - Bituminous Seal Coat

7060, 1.08 A & B	Specify measurement of bituminous seal coat is in area or units.
7060, 2.01, A	Specify the cover aggregate size.
7060, 2.01, B	Specify bituminous material if different than CRS-2P.
7060, 3.02, A, 1	Specify when to patch and joint fill hard surfaced streets.
7060, 3.04, B	Specify the application rate for spreading binder bitumen, if other than shown in the table.
7060, 3.04, D	Specify the application rate for spreading cover aggregate, if other than shown in the table.
7060, 3.06, B, 2	Specify the rate for spreading binder bitumen for two course seal coats.
7060, 3.06, B, 3	Specify the size of aggregate and the rate for spreading cover aggregate for two course seal coats.
7060, 3.07	Specify if sweeping of rural pavements is <u>not</u> necessary.

Section 7070 - Emulsified Asphalt Slurry Seal

7070, 1.02, B	Specify the application of fine or coarse slurry mixtures.
7070, 2.01, B	Specify when to use crushed aggregates.
7070, 2.02, A	Specify the amount of asphalt emulsion to blend with the aggregate.
7070, 3.01, B, 1, b	Specify the width of slurry mixture application.
7070, 3.02, A	Specify when to complete pavement patches and joint or crack filling for surface preparation.
7070, 3.02, C	Specify if water flushing for surface preparation is <u>not</u> allowed.
7070, 3.03, C	Specify the rate of applying the slurry seal, if other than 10 to 18 pounds per square yard for fine aggregate and 15 to 22 pounds per square yard for coarse aggregate.

7070, 3.03, F	Specify when to apply a burlap drag.
7070, 3.05, E	Specify if strip slurry treatment is to be placed in two separate operations.

Section 7080 - Permeable Interlocking Pavers

7080, 2.02, A	Specify either slotted or perforated underdrain pipes.
7080, 2.02, B	Specify the size of collector pipe if other than 6 inch diameter is desired.
7080, 2.03, C	Specify the size of lateral pipe if other than 4 inch diameter is desired.
7080, 3.02, A	Specify the elevation and grade for the excavation area.
7080, 3.02, B	Specify the use and location of underdrains.
7080, 3.03, A	Specify the use of engineering fabric over completed subgrade.
7080, 3.04, A, 5	Specify cleanout locations.
7080, 3.04, A, 7	Specify the use of underdrain cleanout pipes and observation wells.
7080, 3.04, B, 1	Specify underdrain lateral pipe locations.
7080, 3.05, A	Specify the thickness of storage aggregate.
7080, 3.05, C	Specify the storage aggregate elevation.
7080, 3.06, C	Specify the need to proof roll the filter aggregate.
7080, 3.09	Specify the installation pattern of the pavers.

Section 7090 - Cold-in-Place Pavement Recycling

7090, 2.02	Specify the required strength of the recycled pavement section.
7090, 3.01, B, 1	Specify the width and depth to mill the existing pavement material.
7090, 3.01, B, 2	Specify the use of an asphalt foaming system.
7090, 3.08, C	Specify if the compacted recycled roadway does not have to be within 6 inches of the established centerline.

Section 7091 - Full Depth Reclamation

7091, 2.02	Specify the required strength of the reclaimed pavement section as specified in the contract documents.
7091, 3.01, B, 1	Specify the width and depth to reclaim.
7091, 3.01, B, 2	Specify the use of an asphalt foaming system.

7091, 3.05, A	Specify if multiple passes are required.
7091, 3.09, C	Specify if the compacted, reclaimed roadway does not have to be within 6 inches of the established centerline.
7091, 3.11	Specify when to complete microcracking.
7091, 3.12	Specify the use of an HMA interlayer.

Section 7092 - Crack and Seat Existing PCC Pavement

7092, 1.08, A, 3	Specify the use of vibration monitoring. Specify the crack and seat pattern.
7092, 1.08, G, 3	Specify if a new grate assembly is required to be furnished and installed. Specify if a new intake top is to be furnished and installed.
7092, 1.08, J, 3	Specify the rock interlayer thickness.
7092, 3.02, C	Specify if subdrains are to be installed.
7092, 3.05, A	Specify if use of existing intake grate assembly is allowed.
7092, 3.05, B	Specify if use of existing intake top is allowed.
7092, 3.09	Specify when notch and runout milling is required.

Section 8010 - Traffic Signals

8010, 1.08, B, 3	Specify if pedestrian equipment is required with temporary traffic signal.
8010, 1.08, C, 3	Specify the location to deliver removed traffic signal materials.
8010, 2.01, A, 1, a	Specify if cable hooks are NOT required.
8010, 2.01, A, 1, c	Specify if a message besides “TRAFFIC SIGNAL” will be required on the handhole cover.
8010, 2.01, B, 3, a, 2)	Specify solvent welded, socket type fittings for use other than PVC conduit and fittings.
8010, 2.01, C, 5, a	Specify the mode type, size, and number of fibers for fiber optic cable required.
8010, 2.01, C, 5, d	Specify the single-mode fiber attributes to follow.
8010, 2.01, C, 5, i	Specify which type of cable to use - dielectric without armoring or armored with corrugated steel tape armor.
8010, 2.01, C, 6, o	Specify the number of fibers to be included in the fiber distribution panel.
8010, 2.01, C, 6, s	Specify the use of fusion splice continuous fiber runs or branch circuit connections in splice enclosures.

8010, 2.02, B, 2, c	Specify the voice message to be used for accessible pedestrian signal push button stations.
8010, 2.02, D, 9	Specify the type of mounting for microwave vehicle detectors.
8010, 2.02, E	Specify the type of wireless magnetic sensor to use for pavement sensor, access points, base stations, and repeaters, if necessary.
8010, 2.03, A	Specify the use of traffic monitoring systems.
8010, 2.03, B	Specify the use of fiber optic hub cabinet.
8010, 2.03, C, 2, b	Specify the location to mount the antenna for a wireless interconnect network, if other than near the top of the signal pole nearest the controller cabinet.
8010, 2.04, A, 2, b	Specify dimensions and type of aluminum cabinet riser to be used.
8010, 2.04, A, 2, c	Specify the ATC cabinet voltage category.
8010, 2.04, A, 2, h	Specify accommodations of phasing and expansibility of cabinet back panel positions.
8010, 2.04, C	Specify the use of emergency vehicle preemption system.
8010, 2.05, A, 1, a	Specify the color of vehicle traffic signal head assembly housing.
8010, 2.05, A, 6, c	Specify the use of high visibility reflective tape on the backplate.
8010, 2.05, A, 7, a	Specify if the rigid mounting hardware should be a natural aluminum finish or match the pole color.
8010, 2.05, B, 1, a	Specify the color of pedestrian traffic signal head assembly housing.
8010, 2.05, B, 2, a	Specify the type of visor - egg crate or tunnel type.
8010, 2.05, C, 1, a	Specify the mast arm length and vertical pole height.
8010, 2.05, C, 1, f	Specify where to use a combination street lighting/signal pole. Specify if the luminaire arm is to be mounted somewhere other than the same vertical plane as the signal arm.
8010, 2.05, D, 1, a	Specify the vertical pole height of the traffic signal pedestal pole.
8010, 2.05, F, 3	Specify the street name sign dimensions, letter height and font, and sheeting.
8010, 3.01, B, 3, c	Specify if boring pits are allowed to be closer than 2 feet to the back of curb.
8010, 3.01, C, 6	Specify the length of fiber optic cable to coil.
8010, 3.01, C, 9, c	Specify if the conduit cables could be pulled through intermediate junction boxes, handholes, pull boxes, pole bases, or any conduit opening.

8010, 3.01, C, 9, g	Specify how much cable slack to provide in each handhole, junction box, and cabinet.
8010, 3.01, C, 9, h	Specify installation of fiber optic accessories.
8010, 3.01, D, 1	Specify the foundation excavation size, shape, and depth.
8010, 3.02, C	Specify the installation of video detection camera system.
8010, 3.03, A	Specify the installation of traffic monitoring system.
8010, 3.03, B	Specify the installation of fiber optic hub cabinet.
8010, 3.04, A, 1	Specify the installation of controller cabinet and auxiliary equipment.
8010, 3.04, B	Specify the installation of controller.
8010, 3.04, C	Specify the installation of UPS battery backup system.
8010, 3.04, D	Specify the installation of emergency vehicle preemption system.
8010, 3.06	Specify construction of temporary traffic signal.
8010, 3.11, C	Specify the removal and disposal of handholes and abandoned conduit.
8010, 3.11, F	Specify the location to deliver salvaged traffic signal material.
Figure 8010.104	Specify the length of rectangular detector loop.
Figure 8010.105	Specify the number of signals, signs, and spacing.

Section 8020 - Pavement Markings

8020, 3.02, A, 3, c	Specify lane widths.
8020, 3.02, B, 2	Specify if pavement surface will not be cleaned with a rotary broom or street sweeper.
8020, 3.02, D	Specify if pavement is to be grooved prior to placing marking tape.
8020, 3.02, G, 2	Specify when to place pavement markings in a groove cut into the pavement surface.

Section 8030 - Temporary Traffic Control

8030, 1.08, A, 3	Specify when to include portable dynamic message signs, temporary barrier rail, temporary flood lighting, and pilot cars in the traffic control lump sum bid item.
8030, 2.04, B	Specify if something other than precast concrete units are to be used for temporary barrier rail.
8030, 3.01, C	Specify the locations to place temporary barrier rail.

Figure 8030.117	Specify the use of auxiliary lighting or audible information devices.
Figure 8030.118	Specify the use of a crash cushion to separate the temporary sidewalk from vehicular traffic.
Figure 8030.119	Specify the use of auxiliary lighting or audible information devices.

Section 9010 - Seeding

9010, 2.01, B	Specify PLS, which shall not be less than the accumulated total.
9010, 2.02	Specify seed mixture in the contract documents.
9010, 2.03, A, 2	Specify if fertilizer is not to be applied for temporary conventional seeding.
9010, 3.01, A	Specify when aerial application of seed and fertilizer is desired.
9010, 3.01, M	Specify the use of a no-till attachment if desired.
9010, 3.04, E, 4, a	Specify if winter dormant seeding is required.
9010, 3.10, B	Specify when a warranty for seeding is required.

Section 9020 - Sodding

9020, 2.04	Specify when contractor is not to provide water and watering equipment.

Section 9030 - Plant Material and Planting

9030, 1.03, E	Specify when the contractor is to submit a schedule of unit prices for each size and variety of tree, shrub, and ground cover plant.
9030, 2.01, A, 4	Specify whenever plants in rows do not need to be matched in form or size.
9030, 2.01, E, 1	Specify where to use bare root plants.
9030, 3.05	Specify when tree drainage wells are needed.
9030, 3.08, A	Specify when tree wrapping is required.
9030, 3.12, B	Specify when a warranty for plants is required.
Figure 9030.102	Specify when tree wrapping is required.

Section 9040 - Erosion and Sediment Control

9040, 1.08, A, 1	Specify if the Contractor will be responsible for the SWPPP preparation.
9040, 1.08, A, 2	Specify if the Contractor will be responsible for the SWPPP management.
9040, 1.08, B	Specify thickness for compost blankets.

9040, 1.08, E, 1	Specify the width of temporary RECP.
9040, 1.08, I	Specify if level spreaders are not to be removed.
9040, 1.08, L, 1, c	Specify the use of anti-seep collars.
9040, 1.08, O	Specify measurement for stabilized construction entrance in square yards or tons.
9040, 2.02, B	Specify the use of filter berms or compost blankets.
9040, 2.03	Specify the use of filter material in areas other than filter socks and filter berms.
9040, 2.06, A	Specify diameter for open weave, degradable netting if other than 9 inches is required.
9040, 2.07, A, 2	Specify if using RECP for permeable check dam.
9040, 2.08, A	Specify length of pressure-treated timber for level spreaders.
9040, 2.11, A	Specify class of concrete if not Class C.
9040, 2.11, B	Specify riser diameter for sediment basin outlet structures.
9040, 2.11, C, 1	Specify the number, diameter, and elevation of the holes in the riser of the dewatering device in sediment basin outlet structures.
9040, 2.11, D	Specify barrel diameter of the sediment basin outlet structures.
9040, 2.11, E	Specify riser diameter for anti-vortex device.
9040, 3.02, D	Specify if weekly erosion and sediment control site inspections are not required as a part of SWPPP management.
9040, 3.05, B	Specify depth of compost blankets.
9040, 3.06, A	Specify when the filter berm is not to be installed along the contour.
9040, 3.06, C	Specify when a vegetated berm is required.
9040, 3.07, A, 1	Specify the size and length of filter sock.
9040, 3.07, A, 3	Specify when the filter sock is not to be installed along the contour.
9040, 3.07, B	Specify when to remove the filter sock.
9040, 3.08, A, 2	Specify if placement of seed and fertilizer is to be accomplished before installation of temporary rolled erosion control products.
9040, 3.08, A, 3	Specify if placement of seed and fertilizer is to be accomplished on the anchor trench.
9040, 3.08, B, 1	Specify if placement of seed and fertilizer is to be accomplished before installation of temporary rolled erosion control products.

9040, 3.09, B	Specify when to remove the wattle.
9040, 3.10, A, 2	Specify when to provide an RECP under the check dam.
9040, 3.10, D	Specify when to remove check dams.
9040, 3.12, C	Specify the excavated depth behind the level spreader.
9040, 3.12, E	Specify the minimum depth of depression before accumulated sediment is removed.
9040, 3.15, B, 1	Specify the number, diameter, and configuration of holes in the riser section of sediment basin outlet structures.
9040, 3.17	Specify the size and elevations of sediment traps.
9040, 3.18, A, 1	Specify when the silt fence material is not to be installed along the contour.
9040, 3.19, E	Specify when to install subgrade stabilization fabric prior to placing crushed stone.
9040, 3.19, F	Specify the thickness and dimensions of crushed stone for stabilized construction entrance.
Figure 9040.101	Specify if compost blankets are vegetated or unvegetated.
Figure 9040.102	Specify size of berm if slope is steeper than 3:1. Specify berm placement locations in uncompacted windrow perpendicular to the slope. Specify filter sock diameter.
Figure 9040.105	Specify diameter of wattle. Specify space between wattles.
Figure 9040.107	Specify height between engineering fabric and crest on the rock check dam.
Figure 9040.108	Specify total height of diversion.
Figure 9040.109	Specify excavated depression depth.
Figure 9040.110	Specify the rock thickness (T), width (W), and length (L) for rip rap apron for pipe outlet onto flat ground.
Figure 9040.111	Specify the rock thickness (T), width (W), and length (L) for rip rap apron for pipe outlet into channel.
Figure 9040.112	Specify diameter of pipe for temporary pipe slope drain. Specify A, B, and C anchoring options.
Figure 9040.113	Specify barrel length and diameter for sediment basin without emergency spillway. Specify when anti-seep collars are required.
Figure 9040.114	Specify barrel length and diameter for sediment basin with emergency spillway. Specify when anti-seep collars are required.

Figure 9040.115	Specify elevations and dimensions for sediment basin dewatering device. Specify perforation configurations. Specify diameter of discharge pipe barrel.
Figure 9040.116	Specify riser diameter for anti-vortex device.
Figure 9040.117	Specify when anti-seep collars are required.
Figure 9040.118	Specify width of sediment trap.
Figure 9040.119	Specify spacing of post installation for silt fence.

Section 9050 - Gabions and Revet Mattresses

9050, 1.08, A, 3	Specify PVC coating for gabions.
9050, 1.08, B, 3	Specify PVC coating for revet mattresses.
9050, 2.01	Specify when double twisted wire baskets are <u>not</u> required.
9050, 2.02	Specify when to use welded wire baskets.
9050, 2.05	Specify when to use anchor stakes. Specify the length of anchor stakes.
9050, 3.01, A	Specify when to cut and reshape the area behind a proposed gabion wall to allow for placement of the wall.
9050, 3.01, E	Specify the placement, compaction, and dimensions of granular subbase materials.
9050, 3.04, A	Specify special details of gabion wall installation including height, slope of wall, gabion setback, special backfill materials, and tieback requirements.

Section 9060 - Chain Link Fence

9060, 1.08, A, 3	Specify PVC coating for chain link fence.
9060, 1.08, B, 3	Specify the use of barbed wire for gates.
9060, 1.08, C, 3	Specify the type of barbed wire supporting arm.
9060, 2.01, D, 2	Specify the PVC coating color.
9060, 2.02, A, 2	Specify the nominal diameter of fence height for post use, if other than shown in the table.
9060, 2.05, A	Specify the type of arm configuration for barbed wire supporting arms.
9060, 2.07, A	Specify the type, height, and width of gates.
9060, 3.01, A	Specify fence location and height.
9060, 3.01, B, 2, a	Specify post holes dimensions.

9060, 3.01, B, 2, e	Specify the required brace-post assembly.
9060, 3.01, G	Specify when to use barbed wire.
9060, 3.01, G, 1	Specify the installation of barbed wire, if other than 3 parallel wires on each barbed wire supporting arm on the outside of the area being secured.
9060, 3.01, H	Specify the installation requirements for gates.
9060, 3.01, I, 1	Specify the installation of electrical grounds.
9060, 3.02	Specify when all fences, including posts and footings, are not to be removed from within work areas.
9060, 3.03, A	Specify the height of temporary fence.
Figure 9060.101	Specify the fence fabric width. Specify when to install fence on the roadway side of the right-of-way.
Figure 9060.103	Specify the length of the sidewalk.

Section 9070 - Landscape Retaining Walls

9070, 2.01, B	Specify the depth of limestone slabs, if other than 8 inches.
9070, 3.01, B	Specify the excavation line and grade.

Section 9071 - Segmental Block Retaining Walls

9071, 3.01, B	Specify the excavation line and grade.
9071, 3.02, B	Specify leveling pad materials.
9071, 3.02, C	Specify the elevation and orientation.
9071, 3.02, D, 1	Specify the use of subdrains.

Section 9072 - Combined Concrete Sidewalk and Retaining Wall

9072, 2.01, A, 3	Specify the type of expansion joint, if resilient filler is not desired.
9072, 3.01, B	Specify the excavation line and grade.
9072, 3.04	Specify the formation of rustications.

Section 9080 - Concrete Steps, Handrails, and Safety Rail

9080, 2.04, B	Specify when to galvanize handrail and safety rail.
9080, 2.04, C	Specify when to apply powder coat to steel, galvanized steel, or aluminum handrail and safety rail.

9080, 3.02, A, 1	Specify the length of rail.
Figure 9080.103	Specify the field painting of safety rail.

Section 10,010 - Demolition

10,010, 1.07, A	Specify when the use of explosives is allowed.
10,010, 3.08, D	Specify when the removal and disposal of all brush, shrubs, trees, logs, downed timber, and other yard waste on the site is not desired.
10,010, 3.08, E	Specify when the removal of all retaining walls is not desired.
10,010, 3.11	Specify what materials are required to be recycled from the demolition site.

Section 11,010 - Construction Survey

11,010, 1.02	Specify any additional items to be included in construction survey work.
11,010, 3.02, D	Specify if property limits are to be marked.
11,010, 3.04	Specify which land corners, property corners, permanent reference markers, and benchmarks are to be replaced.

Section 11,040 - Temporary Sidewalk Access

11,040, 3.02, A	Specify locations to construct temporary granular sidewalks.
11,040, 3.03, B	Specify locations to locate temporary longitudinal channelizing devices.
Figure 11,040.102	Specify when to install orange construction safety fence between the top of the bottom rail and the bottom of the top rail.

Incidental or Included Items

Items that are necessary to properly complete construction, including work and materials, and are not pay items. The following is a list of items in the SUDAS Specifications that are considered incidental to other work unless specified as a pay item on the plans or in the contract documents. Please note - this list is not all-inclusive.

Section 2010 - Earthwork, Subgrade, and Subbase

2010, 1.08, A, 3 — Clearing and Grubbing (by units)
Placement of backfill in area where roots have been removed, and removal and disposal of all materials.

2010, 1.08, B, 3 — Clearing and Grubbing (by area)
Removal and disposal of all materials and placement of backfill in area where roots have been removed.

2010, 1.08, D, 1, c — Topsoil, On-site
Stripping and stockpiling topsoil; preparing the topsoil placement area by tillage or ripping; re-spreading the topsoil; additional tillage to address compaction during placement; and removal of clods, roots, stones, and other undesirable materials.

2010, 1.08, D, 2, c — Topsoil, Compost-amended
Preparing the placement area by tillage or ripping and furnishing, transporting, placing, and incorporating compost.

2010, 1.08, D, 3, c — Topsoil, Off-site
Preparing the placement area by tillage or ripping; furnishing, transporting, and spreading the off-site topsoil; completing tillage to address compaction during placement; and removal of clods, roots, stones, and other undesirable materials.

2010, 1.08, E, 3 — Excavation, Class 10, Class 12, or Class 13

a. Site preparation for, and the construction of, embankment, fills, shoulder backfill, and backfill behind curbs.
b. Overhaul.
c. Finishing the soil surface, including roadways, shoulders, behind curbs, side ditches, slopes, and borrow pits.
d. Repair or replacement of any fences that have been unnecessarily damaged or removed.
e. Compaction testing, as specified in the contract documents.

2010, 1.08, F, 3 — Below Grade Excavation (Core Out)
Equipment, tools, labor, disposal of unsuitable materials, dewatering, drying, furnishing, and placement of foundation materials as required by the Engineer, compaction and finishing of the excavated area, and all incidental work as may be required.

2010, 1.08, G, 3 — Subgrade Preparation
Excavating, manipulating, replacing, compacting, and trimming to the proper grade.

2.01, 1.08, H, 3 — Granular Stabilization
Removal and disposal of unstable material and furnishing, hauling, placing, and compacting granular stabilization material.

2010, 1.08, I, 3 — Subgrade Treatment
Furnishing, placing, and incorporating the subgrade treatment material (cement, asphalt, fly ash, lime, geogrid, or geotextiles).

2010, 1.08, J, 3 — Subbase
Furnishing, placing, compacting, and trimming to the proper grade.

2010, 1.08, K, 1, c — Removal of Structures
Removal and disposal of structures.

2010, 1.08, K, 2, a, 3) — Removal of Known Box Culverts
Removal and disposal of known box culverts.

2010, 1.08, K, 2, c, 3) — Removal of Known Pipe Culverts
Removal and disposal of known pipe culverts.

2010, 1.08, K, 3, a, 3) — Removal of Known Pipes and Conduits
Removal, disposal, and plugging, if specified, of pipes and conduits.

Section 3010 - Trench Excavation and Backfill

3010, 1.08, A — General

1. Standard trench excavation.
2. Removal and disposal of unsuitable backfill material encountered during standard trench excavation.
3. Removal of abandoned private utilities encountered during trench excavation.
4. Furnishing and placing granular bedding material.
5. Placing and compacting backfill material.
6. Dewatering including, but not limited to, all equipment such as generators, pumps, rock for sump pits, discharge piping, and any extra excavation needed to facilitate dewatering according to stormwater regulations, as applicable.
7. Sheeting, shoring, and bracing.
8. Adjusting the moisture content of excavated backfill material to the range specified for placement and compaction.

3010, 1.08, C, 3 — Trench Foundation
Removal and disposal of over-excavated material required to stabilize trench foundation; and furnishing, hauling, and placing stabilization material.

3010, 1.08, D, 3 — Replacement of Unsuitable Backfill Material
Furnishing, hauling, and placing backfill material.

3010, 1.08, E, 3 Special Pipe Embedment or Encasement
Furnishing and placing all required special pipe embedment or encasement materials.

Section 3020 - Trenchless Construction

3020, 1.08 All items of work contained in this section are incidental to the underground utility pipe being installed and will not be paid for separately.

Section 4010 - Sanitary Sewers

4010, 1.08, A, 1, c Sanitary Sewer Gravity Main, Trenched
Trench excavation; dewatering; furnishing and installing pipe; pipe lining (if specified); furnishing, placing, and compacting bedding and backfill material; wyes and other fittings; pipe joints; pipe connections; testing; and inspection.

4010, 1.08, A, 2, c Sanitary Sewer Gravity Main, Trenchless
Furnishing and installing pipe; pipe lining (if specified); trenchless installation materials and equipment; pit excavation; dewatering; placing and compacting backfill material; pipe connections; testing; and inspection.

4010, 1.08, B, 1, c Sanitary Sewer Gravity Main with Casing Pipe, Trenched
Furnishing and installing both carrier pipe and casing pipe, pipe lining (if specified); trench excavation, dewatering, furnishing bedding material, placing bedding and backfill material, furnishing and installing annular space fill material, casing spacers, pipe connections, testing, and inspection.

4010, 1.08, B, 2, c Sanitary Sewer Gravity Main with Casing Pipe, Trenchless
Furnishing and installing both carrier pipe and casing pipe; pipe lining (if specified); trenchless installation materials and equipment; pit excavation; dewatering; and placing and compacting backfill material; casing spacers; furnishing and installing annular space fill material; pipe connections; testing; and inspection.

4010, 1.08, C, 1, c Sanitary Sewer Force Main, Trenched
Trench excavation; dewatering; furnishing and installing pipe; furnishing, placing, and compacting bedding and backfill; wyes and other fittings; pipe joints; testing; and inspection.

4010, 1.08, C, 2, c Sanitary Sewer Force Main, Trenchless
Furnishing and installing pipe; trenchless installation materials and equipment; pit excavation; dewatering; placing and compacting backfill material; pipe connections; testing; and inspection.

4010, 1.08, D, 1, c Sanitary Sewer Force Main with Casing Pipe, Trenched
Furnishing and installing both carrier pipe and casing pipe; trench excavation; dewatering; furnishing, placing, and compacting bedding and backfill material; furnishing and installing annular space fill material; casing spacers; pipe connections; testing; and inspection.

4010, 1.08, D, 2, c — Sanitary Sewer Force Main with Casing Pipe, Trenchless
Furnishing and installing both carrier pipe and casing pipe; trenchless installation materials and equipment; pit excavation; dewatering; placing and compacting backfill material; casing spacers; furnishing and installing annular space fill material; pipe connections; testing; and inspection.

4010, 1.08, E, 3 — Sanitary Sewer Service Stub
Trench excavation; furnishing and installing pipe; furnishing, placing, and compacting bedding and backfill material; tap; fittings; testing; and inspection.

4010, 1.08, F, 3 — Sanitary Sewer Service Relocation
Removal of existing pipe, trench excavation, furnishing new pipe and bedding material, placing and compacting bedding and backfill material, connection back to existing service, compaction, testing, and inspection.

4010, 1.08, G, 3 — Sewage Air Release Valve and Pit
Excavation; furnishing, placing, and compacting bedding and backfill material; and testing.

4010, 1.08, H, 3 — Removal of Sanitary Sewer
Removal, disposal, and capping (if specified) of pipe; and furnishing, placing, and compacting backfill material.

4010, 1.08, I, 3 — Sanitary Sewer Cleanout
Plug at the end of the main, fittings, riser pipe, cap with screw plug, casting, and concrete casting encasement.

4010, 1.08, K, 3 — Sanitary Sewer Abandonment, Plug
Trench excavation (if necessary), cutting pipe (if required), furnishing and placing plug materials, and placing and compacting backfill material.

4010, 1.08, L, 3 — Sanitary Sewer Abandonment, Fill and Plug
Trench excavation (if necessary), cutting pipe (if required), furnishing and placing pipe fill material, furnishing and placing plug materials, and placing and compacting backfill material.

Section 4020 - Storm Sewers

4020, 1.08, A, 1, c — Storm Sewer, Trenched
Trench excavation; dewatering; furnishing and installing pipe; furnishing, placing, and compacting bedding and backfill material; joint wrapping; wyes and other fittings; pipe joints; pipe connections; testing; and inspection.

4020, 1.08, A, 2, c — Storm Sewer, Trenchless
Furnishing and installing pipe; trenchless installation materials and equipment; pit excavation; dewatering; placing and compacting backfill material; pipe connections; testing; and inspection.

4020, 1.08, B, 1, c — Storm Sewer with Casing Pipe, Trenched
Furnishing and installing both carrier pipe and casing pipe; trench excavation; dewatering; furnishing, placing, and compacting bedding and backfill material; furnishing and installing annular space fill material; casing spacers; pipe connections; testing; and inspection.

4020, 1.08, B, 2, c — Storm Sewer with Casing Pipe, Trenchless
Furnishing and installing both carrier pipe and casing pipe; trenchless installation materials and equipment; pit excavation; dewatering; placing and compacting backfill material; casing spacers; furnishing and installing annular space fill material; pipe connections; testing; and inspection.

4020, 1.08, C, 3 — Linear Trench Drain
Furnishing and installing the linear trench drain including all appurtenances; furnishing and placement of PCC transition; furnishing, excavation, and backfill of discharge pipe; connection to manhole or intake, if required; installation of apron, if required.

4020, 1.08, D, 3 — Removal of Storm Sewer
Removal, disposal, and capping (if specified) of pipe; and furnishing, placing, and compacting backfill material.

4020, 1.08, F, 3 — Storm Sewer Abandonment, Plug
Trench excavation (if necessary), cutting pipe (if required), furnishing and placing plug materials, and placing and compacting backfill material.

4020, 1.08, G, 3 — Storm Sewer Abandonment, Fill and Plug
Trench excavation (if necessary), cutting pipe (if required), furnishing and placing pipe fill material, furnishing and placing plug materials, and placing and compacting backfill material.

Section 4030 - Pipe Culverts

4030, 1.08, A, 1, c — Pipe Culvert, Trenched
Trench excavation; dewatering; furnishing and installing pipe; furnishing, placing, and compacting bedding and backfill material; connectors; testing; and inspection.

4030, 1.08, A, 2, c — Pipe Culvert, Trenchless
Furnishing and installing pipe; trenchless installation materials and equipment; pit excavation, dewatering, and placing and compacting backfill material; pipe connections; testing; and inspection.

4030, 1.08, B, 3 — Pipe Apron
Trench excavation; dewatering; furnishing and installing pipe; furnishing, placing, and compacting bedding and backfill material; connectors; and other appurtenances.

4030, 1.08, C, 3 — Footings for Concrete Pipe Aprons
Excavation; dewatering; reinforcing steel; concrete; furnishing and installing apron; furnishing, placing and compacting bedding and backfill material.

Section 4040 - Subdrains and Footing Drain Collectors

4040, 1.08, A, 3 — Subdrain
Trench excavation, furnishing and placing bedding and backfill material, engineering fabric (when specified), connectors, and elbows and tees. The length of elbows and tees of the pipes installed will be included in the length of pipe measured.

4040, 1.08, B, 3 — Footing Drain Collector
Trench excavation, pipe, wyes, tap, fittings, and furnishing and placing bedding and backfill material.

4040, 1.08, D, 3 — Subdrain or Footing Drain Outlets and Connections
Pipe, non-shrink grout, coupling bands, and rodent guards for pipes 6 inches or smaller.

4040, 1.08, E, 3 — Storm Sewer Service Stub
Trench excavation, furnishing bedding material, placing bedding and backfill material, tap, fittings, and plugs.

Section 4050 - Pipe Rehabilitation

4050, 1.08, A, 1, c — Pre-Rehabilitation Cleaning and Inspection
Pre-cleaning CCTV inspection, light sewer cleaning, debris removal and transport, post cleaning CCTV inspection for Engineer review, and identification and logging of active service taps. If specified in the contract documents, unit price also includes disposal and associated costs for all debris removed from sewer.

4050, 1.08, A, 2, c — Additional Sewer Cleaning
Heavy sewer cleaning; root cutting; deposit cutting; and removing, transporting, disposing, paying associated costs for all debris removed from sewer, and post cleaning CCTV inspection for Engineer review.

4050, 1.08, B, 3 — Remove Protruding Service Connections
Removal of protruding service connections and debris removal.

4050, 1.08, C, 1, c — CIPP Main Lining
Furnishing and installing the liner and appurtenances, CCTV inspection immediately prior to lining, bypass pumping unless otherwise specified, sliding foil, post-lining CCTV inspection, and all costs associated with the public information and notification program.

4050, 1.08, C, 2, c — Building Sanitary Sewer Service Reinstatement
Reinstating sanitary sewer service connections, removal of debris, and coordination with service owners.

4050, 1.08, C, 3, c — CIPP End Seal
End seal and installation.

4050, 1.08, D, 3	CIPP Point Repair Furnishing and placing point repair liner, bypass pumping unless otherwise specified, sewer cleaning, removal of obstructions, debris removal, pipe preparation, and pre and post repair CCTV inspection.
4050, 1.08, E, 1, c	CIPP Service Pipe, Connection Furnishing and placing service connection liner, bypass pumping unless otherwise specified, documentation, and all costs associated with the public information and notification program.
4050, 1.08, E, 2, c	CIPP Service Repair, Partial Pipe Furnishing and installing service repair liner, bypass pumping unless otherwise specified, documentation, and all costs associated with the public information and notification program.
4050, 1.08, F, 1, c	Pressure Testing of Mainline Sewer Joints Bypass pumping unless otherwise specified, control testing, and documentation.
4050, 1.08, F, 2, c	Injection Grouting of Mainline Sewer Joints Bypass pumping unless otherwise specified, material testing, pressure testing after grouting, re-grouting of failed joints, and documentation. Unit price does not include the quantity of chemical grout used.
4050, 1.08, F, 3, c	Pressure Testing of Service Connections Bypass pumping unless otherwise specified, and documentation.
4050, 1.08, F, 4, c	Injection Grouting of Service Connections Bypass pumping unless otherwise specified, material testing, pressure testing after grouting, and documentation. Unit price does not include the quantity of chemical grout used.
4050, 1.08, F, 5, c	Chemical Grout Grout additives; root inhibitor; and supplying, mixing, and measurement of chemical grout.
4050, 1.08, G, 3	Bypass Pumping Development and submittal of the bypassing plan, all staffing, equipment, and appurtenances necessary to accomplish the approved bypassing plan, including reserve equipment.
4050, 1.08, H, 1, c	Spot Repairs (by Pipe Replacement) Uncovering and removing existing pipe and furnishing and placing bedding and backfill material for replacement pipe.
4050, 1.08, H, 2, c	Spot Repairs (by Linear Foot) Furnishing and installing replacement pipe and connections.

Section 4060 - Cleaning, Inspection, and Testing of Sewers

4060, 1.08	Cleaning, inspecting, and testing sanitary sewers, storm sewers, pipe culverts, and rehabilitated pipes (including video inspection) are incidental to other project costs and will not be paid for separately.

Section 5010 - Pipe and Fittings

5010, 1.08, A, 1, c — Water Main, Trenched
Trench excavation; dewatering; furnishing and installing pipe; furnishing, placing, and compacting bedding and backfill material; tracer system; testing; disinfection; and polyethylene wrap for ductile iron pipe and for fittings.

5010, 1.08, A, 2, c — Water Main, Trenchless
Furnishing and installing pipe; trenchless installation materials and equipment; pit excavation; dewatering; placing and compacting backfill material; tracer system; testing; and disinfection.

5010, 1.08, B, 1, c — Water Main with Casing Pipe, Trenched
Furnishing and installing both carrier pipe and casing pipe; trench excavation; dewatering; furnishing and installing pipe; furnishing, placing, and compacting bedding and backfill material; casing spacers; furnishing and installing annular space fill material; tracer system; testing; and disinfection.

5010, 1.08, B, 2, c — Water Main with Casing Pipe, Trenchless
Furnishing and installing both carrier pipe and casing pipe; trenchless installation materials and equipment; pit excavation; dewatering; placing and compacting backfill material; casing spacers; furnishing and installing annular space fill material; tracer system; testing; and disinfection.

5010, 1.08, C, 1, c — Fitting (by count)
Restrained joints and thrust blocks.

5010, 1.08, C, 2, c — Fitting (by weight)
Restrained joints and thrust blocks.

5010, 1.08, D, 3 — Water Service Stub (by each)
Water service corporation; service pipe; curb stop; stop box; trench excavation; dewatering; furnishing and installing pipe; furnishing, placing, and compacting bedding and backfill material; and installation of tracer wire system for non-metallic service pipe.

5010, 1.08, E, 1, c — Water Service Stub (by length), Water Service Pipe
Trench excavation; dewatering; furnishing and installing pipe; furnishing, placing, and compacting bedding and backfill material; and installation of tracer wire system for non-metallic service pipe.

5010, 1.08, F, 3 — Water Main Abandonment, Cap
Trench excavation (if necessary); closing valves; removing valve boxes; installing thrust blocks; cutting pipe; installing MJ caps; and furnishing, placing, and compacting backfill material.

5010, 1.08, G, 3 — Water Main Abandonment, Fill and Plug
Trench excavation (if necessary); closing valves; removing valve boxes; installing thrust blocks; cutting and removing the specified section of pipe; furnishing and pumping flowable material to fill the pipe to be abandoned; installing MJ caps; and furnishing, placing, and compacting backfill material.

5010, 1.08, H, 3 Water Main Removal
Trench excavation (if necessary); closing valves; installing thrust blocks; cutting pipe; installing MJ caps; removal and disposal of all valves and pipe specified for removal; furnishing, placing, and compacting backfill material.

Section 5011 - Fusible PVC and HDPE Pipe

5011, 1.08, A, 1, c Fusible Water Main, Trenched
Trench excavation, dewatering, furnishing bedding material, performing fusion jointing, placing bedding and backfill material, tracer system, testing, and disinfection.

5011, 1.08, A, 2, c Fusible Water Main, Trenchless
Furnishing and installing pipe; performing fusion jointing, trenchless installation materials and equipment; pit excavation, dewatering, and placing backfill material; tracer system; testing; and disinfection.

5011, 1.08, B, 1, c Water Main with Casing Pipe, Trenched
Furnishing and installing both fusible carrier pipe and casing pipe, performing fusion jointing, trench excavation, dewatering, furnishing bedding material, placing bedding and backfill material, casing spacers, furnishing and installing annular space fill material, tracer system, testing, and disinfection.

5011, 1.08, B, 2, c Water Main with Casing Pipe, Trenchless
Furnishing and installing both fusible carrier pipe and casing pipe; performing fusion jointing, trenchless installation materials and equipment; pit excavation, dewatering, and placing backfill material; casing spacers; furnishing and installing annular space fill material; tracer system; testing; and disinfection.

Section 5020 - Valves, Fire Hydrants, and Appurtenances

5020, 1.08, A, 3 Valve (Butterfly or Gate)
All components attached to the valve or required for its complete installation, including underground or above ground operator, square valve operating nut, valve box and cover, valve box extension, and valve stem extension.

5020, 1.08, B, 3 Tapping Valve Assembly
Tapping sleeve, tapping valve, the tap, valve box and cover, valve box extension, and valve stem extension.

5020, 1.08, C, 3 Fire Hydrant Assembly
The fire hydrant, barrel extensions sufficient to achieve proper bury depth of anchoring pipe and height of fire hydrant above finished grade, and components to connect the fire hydrant to the water main, including anchoring pipe, fittings, thrust blocks, pea gravel or porous backfill material, and fire hydrant gate valve and appurtenances, except tapping valve assembly if used.

5020, 1.08, D, 3 Alternate Fire Hydrant Assembly
The fire hydrant, barrel extensions sufficient to achieve proper bury depth of anchoring pipe and height of fire hydrant above finished grade, and components to connect the fire hydrant to the water main, including anchoring pipes, 90 degree bend; fittings, thrust blocks, pea gravel or porous backfill material, and fire hydrant gate valve and appurtenances, except tapping valve assembly if used.

5020, 1.08, F — Measurement and payment for minor adjustment of an existing valve box by raising or lowering the adjustable valve box is incidental.

5020, 1.08, H, 3 — Valve Box Replacement
Removal of existing valve box; excavation; furnishing and installing new valve box; backfill; compaction; and all other necessary appurtenances.

5020, 1.08, I, 3 — Fire Hydrant Adjustment
Removal and reinstallation of the existing fire hydrant; furnishing and installing the extension barrel section and stem; and all other necessary appurtenances.

5020, 1.08, J, 3 — Fire Hydrant Assembly Removal
Excavation, removal of the fire hydrant, hydrant valve, thrust block, delivery of the fire hydrant assembly to the Contracting Authority (if specified), capping of the pipe, backfill, compaction, and surface restoration to match the surrounding area.

5020, 1.08, K, 3 — Valve Removal
Excavation, removal of each valve, replacing the removed valve with pipe and connections if required or capping the former valve connection, delivery of the valve to the Contracting Authority (if specified), backfill, compaction, and surface restoration to match the surrounding area.

5020, 1.08, L, 3 — Valve Box Removal
Excavation, removal of each valve box, delivery of the valve box to the Contracting Authority (if specified), backfill, compaction, and surface restoration to match the surrounding area.

Section 5030 - Testing and Disinfection

5030, 1.08 — Testing and disinfection of water systems is incidental to the construction of pipe and fittings.

Section 6010 - Structures for Sanitary and Storm Sewers

6010, 1.08, A, 3 — Manhole
Excavation; furnishing and installing pipe; lining (if specified); furnishing, placing, and compacting bedding and backfill material; base; structural concrete; reinforcing steel; precast units (if used); concrete fillets; pipe connections; infiltration barriers (sanitary sewer manholes only); castings; and adjustment rings.

6010, 1.08, B, 3 — Intake
Excavation; furnishing and installing pipe; furnishing, placing, and compacting bedding and backfill material; base; structural concrete; reinforcing steel; precast units (if used); concrete fillets; pipe connections; castings; and adjustment rings.

6010, 1.08, C, 1, c — Internal Drop Connection
Cutting the hole and installing a flexible watertight connector, providing and installing the receiving bowl, flexible coupler between the bowl and the drop pipe, the PVC drop pipe, pipe brackets and bolts, the bottom elbow, repair of fillet if required, and a splash guard if required.

6010, 1.08, C, 2, c — External Drop Connection
The connection to the manhole and all pipe; fittings; concrete encasement; and furnishing, placing, and compacting bedding and backfill material.

6010, 1.08, E, 3 — Manhole or Intake Adjustment, Minor
Removing existing casting and existing adjustment rings, furnishing and installing adjustment rings, furnishing and installing new casting, and installing new infiltration barrier (sanitary sewer manholes only).

6010, 1.08, F, 3 — Manhole or Intake Adjustment, Major
Removal of existing casting, adjustment rings, top sections, and risers; excavation; concrete and reinforcing steel or precast sections; furnishing and installing new casting; installing new infiltration barrier (sanitary sewer manholes only); placing backfill material; and compaction.

6010, 1.08, G, 3 — Connection to Existing Manhole or Intake
Coring or cutting into the existing manhole or intake, pipe connectors, grout, and waterstop (when required).

6010, 1.08, H, 3 — Remove Manhole or Intake
Removal of casting, concrete, and reinforcement; plugging pipes; filling remaining structure with flowable mortar; and placing compacted fill over structure to finished grade.

Section 6020 - Rehabilitation of Existing Manholes

6020, 1.08, A, 1, c — Infiltration Barrier, Rubber Chimney Seal
All necessary compression or expansion bands and extension sleeves as necessary to complete chimney seal.

6020, 1.08, A, 2, c — Infiltration Barrier, Molded Shield
Sealant.

6020, 1.08, B, 3 — In-situ Manhole Replacement, Cast-in-place Concrete
Handling of sewer flows as required to properly complete the installation, invert overlay as recommended by the manufacturer, replacement of existing casting with a new casting, and testing the manhole upon completion.

6020, 1.08, C, 3 — In-situ Manhole Replacement, Cast-in-place Concrete with Plastic Liner
Handling of sewer flows as required to properly complete the installation, invert overlay as recommended by the manufacturer, replacement of existing casting with a new casting, sealing at the frame and cover, sealing pipe penetrations as recommended by the manufacturer, and testing the manhole upon completion.

6020, 1.08, D, 3 — Manhole Lining with Centrifugally Cast Cementitious Mortar Liner with Epoxy Seal
Handling of sewer flows during lining operations as required to properly complete the installation, and replacement of the existing casting with a new casting.

Section 6030 - Cleaning, Inspection, and Testing of Structures

6030, 1.08 Cleaning, inspection, and testing of structures are incidental to construction of structures and will not be paid for separately.

Section 7010 - Portland Cement Concrete Pavement

7010, 1.08, A, 3 Pavement, PCC
Final trimming of subgrade or subbase, integral curb, bars and reinforcement, joints and sealing, surface curing and pavement protection, safety fencing, concrete for rigid headers, boxouts for fixtures, and pavement smoothness testing.

7010, 1.08, E, 3 Curb and Gutter
Final subgrade/subbase preparation, bars and reinforcement, joints and sealing, surface curing and pavement protection, and boxouts for fixtures.

7010, 1.08, F, 3 Beam Curb
Final subgrade/subbase preparation, bars and reinforcement, joints and sealing, surface curing and pavement protection, and boxouts for fixtures.

7010, 1.08, G, 3 Concrete Median
Final subgrade/subbase preparation, bars and reinforcement, joints and sealing, surface curing and pavement protection, and boxouts for fixtures.

7010, 1.08, H, 3 PCC Railroad Crossing Approach
Excavation for modified subbase and subdrain, furnishing and installing subdrain, furnishing and installing subdrain outlet or connection to storm sewer, furnishing and installing porous backfill material, furnishing and installing fiber board barrier, furnishing and placing modified subbase material, furnishing and installing reinforcing steel and tie bars, furnishing and placing concrete, furnishing, placing, and compacting HMA.

7010, 1.08, I, 3 PCC Pavement Samples and Testing
Certified plant inspection, pavement thickness cores, profilograph pavement smoothness measurement (when required by the contract documents), and maturity testing.

7010, 1.08, K, 3 PCC Pavement Widening
Final subgrade/subbase preparation, integral curb, bars and reinforcement, joints and sealing, surface curing and pavement protection, safety fencing, concrete for rigid headers, boxouts for fixtures, and pavement smoothness.

Section 7011 - Portland Cement Concrete Overlays

7011, 1.08, A, 1, c PCC Overlay, Furnish Only
Furnishing the concrete mixture and delivery to the project site.

7011, 1.08, A, 2, c PCC Overlay, Place Only
Integral curb, bars and reinforcement, joints and sealing, finishing and texturing, surface curing and pavement protection, safety fencing, concrete for rigid headers, boxouts for fixtures, and pavement smoothness testing.

7011, 1.08, A, 3, c — Surface Preparation for Bonded PCC Overlay
Sandblasting, shot blasting, scarification, and surface cleaning.

7011, 1.08, A, 4, c — Surface Preparation for Unbonded PCC Overlay
Scarification and surface cleaning.

7011, 1.08, A, 5, c — HMA Separation Layer for Unbonded PCC Overlay
HMA mix, including asphalt binder.

7011, 1.08, A, 6, c — Geotextile Fabric Separation Layer for Unbonded PCC Overlay
Cleaning surface and furnishing, placing, and securing the geotextile fabric separation layer.

Section 7020 - Hot Mix Asphalt Pavement

7020, 1.08, A, 3 — Pavement, HMA (by ton)
Asphalt mix with asphalt binder, tack coats between layers, construction zone protection, and quality control.

7020, 1.08, B, 3 — Pavement, HMA (by square yard)
Asphalt mix with asphalt binder, tack coats between layers, construction zone protection, and quality control.

7020, 1.08, C, 3 — HMA Base Widening (by ton)
Asphalt mix with asphalt binder, tack coats between layers, construction zone protection, and quality control.

7020, 1.08, D, 3 — HMA Base Widening (by square yard)
Asphalt mix with asphalt binder, tack coats between layers, construction zone protection, and quality control.

7020, 1.08, E, 3 — HMA Railroad Crossing Approach
Excavation for modified subbase and subdrain, furnishing and installing subdrain, furnishing and installing subdrain outlet, furnishing and installing porous backfill material, furnishing and installing fiber board barrier, furnishing and placing modified subbase material, furnishing and applying tack coat, furnishing, placing, and compacting HMA.

7020, 1.08, I, 3 — HMA Pavement Samples and Testing
Certified plant inspection, pavement thickness cores, density analysis, profilograph pavement smoothness measurement (when required by the contract documents), and air void testing.

Section 7021 - Hot Mix Asphalt Overlays

7021, 1.08, A, 3 — HMA Overlay (by ton)
Asphalt mix with asphalt binder, tack coats between layers, construction zone protection, and quality control.

7021, 1.08, B, 3 — HMA Overlay (by square yard)
Asphalt mix with asphalt binder, tack coat, construction zone protection, and quality control.

Section 7030 - Sidewalks, Shared Use Paths, and Driveways

7030, 1.08, A, 3 — Removal of Sidewalk, Shared Use Path, or Driveway
Sawing, hauling, and disposal of materials removed.

7030, 1.08, B, 3 — Removal of Curb
Hauling and disposal of materials removed.

7030, 1.08, C, 3 — Shared Use Paths
Subgrade preparation, jointing, sampling, smoothness testing and correction, and testing.

7030, 1.08, D, 3 — Special Subgrade Preparation for Shared Use Paths
Water required to bring subgrade moisture content to within the required limits.

7030, 1.08, E, 3 — Sidewalk, PCC
Minor grade adjustments at driveways and other intersections, subgrade preparation, formwork, additional thickness at thickened edges, jointing, sampling, smoothness testing and correction, and testing.

7030, 1.08, F, 3 — Brick/Paver Sidewalk with Pavement Base
Subgrade preparation, pavement base, setting bed, neoprene asphalt adhesive for asphalt setting bed, setting the bricks/pavers, installing weep holes and associated materials, and sand/cement joint filler.

7030, 1.08, G, 3 — Detectable Warning
Steel bar supports and manufactured detectable warning panels.

7030, 1.08, H, 1, c — Driveway, Paved
Excavation, subgrade preparation, jointing, sampling, and testing.

7030, 1.08, H, 2, c — Driveway, Granular
Excavation and preparation of subgrade.

Section 7040 - Pavement Rehabilitation

7040, 1.08, A, 3 — Full Depth Patches
Sawing, removing, and disposing of existing pavement and reinforcing; restoring the subgrade; furnishing and installing tie bars and dowel bars; furnishing and placing the patch material, including the asphalt binder and tack coat; forming and constructing integral curb; surface curing and pavement protection; joint sawing and filling; and placing backfill and restoring disturbed surfaces.

7040, 1.08, B, 3 — Subbase Over-excavation
Removal of existing subbase or subgrade, disposal of materials removed, furnishing and placing subbase material, and any additional excavation required for subbase placement.

7040, 1.08, C, 3 — Partial Depth Patches
Sawing, removing, and disposing of existing pavement; furnishing tack coat or bonding agent; furnishing and placing the patch material; curing; joint filling (PCC patches only); placing backfill; and restoring disturbed surfaces.

7040, 1.08, D, 3	Crack and Joint Cleaning and Filling, Hot Pour Furnishing crack and joint filler material and routing, sawing, cleaning, and filling joints or cracks.
7040, 1.08, E, 1, c	Crack Cleaning and Filling, Emulsion Furnishing emulsified crack filler material, cleaning cracks, placing soil sterilant, and filling cracks.
7040, 1.08, E, 2, c	Hot Mix Asphalt for Crack Filling Cleaning, applying tack coat, and furnishing and placing HMA for crack filling.
7040, 1.08, F, 3	Diamond Grinding Diamond grinding pavement, testing for smoothness according to the contract documents, and removal of slurry and residue from the project site.
7040, 1.08, G, 3	Milling Milling pavement; furnishing water; and salvaging, stockpiling, and removing cuttings and debris.
7040, 1.08, H, 3	Pavement Removal Sawing, breaking, removing, and disposing of existing pavement and reinforcing steel.
7040, 1.08, I, 3	Curb and Gutter Removal Sawing, breaking, removing, and disposing of existing curb and gutter.
7040, 1.08, J, 3	Dowel Bar Retrofit Cutting the slots, preparing the slots, placing and grouting the bars, and curing the surface.
7040, 1.08, K	Core Hole Cutting and Replacement Cutting the core hole, vacuum excavation, furnishing and placing backfill material and pavement, or replacing the pavement core using waterproof bonding material, if specified.
7040, 1.08, L	Required sampling and testing for pavement repair and rehabilitation work is incidental to other project costs and will not be paid for separately.

Section 7050 - Asphalt Stabilization

7050, 1.08, A, 3	Asphalt Stabilization Furnishing and spreading imported material, applying and incorporating asphalt stabilization, blending of the materials, grading and compacting the blended materials, and final clean up.

Section 7060 - Bituminous Seal Coat

7060, 1.08, A, 3	Bituminous Seal Coat (by area) Surface preparation including protection of street fixtures; furnishing and placing of materials, including fillets at intersecting streets, driveways, and turnouts; and final clean up.

7060, 1.08, B, 1, c — Bituminous Seal Coat (by units), Cover Aggregate
Surface preparation including protection of street fixtures; furnishing and placing of materials, including fillets at intersecting streets, driveways, and turnouts; and final clean up.

7060, 1.08, B, 2, c — Bituminous Seal Coat (by units), Binder Bitumen
Furnishing and placing of materials, including fillets at intersecting streets, driveways, and turnouts; and final clean up.

Section 7070 - Emulsified Asphalt Slurry Seal

7070, 1.08, A, 3 — Emulsified Asphalt Slurry Seal (by area)
Surface preparation and furnishing and placing of materials, including fillets at intersecting streets, driveways, and turnouts.

7070, 1.08, B, 1, c — Emulsified Asphalt Slurry Seal (by units), Aggregate
Surface preparation and furnishing and placing of materials, including fillets at intersecting streets, driveways, and turnouts.

7070, 1.08, B, 2, c — Emulsified Asphalt Slurry Seal (by units), Asphalt Emulsion
Surface preparation and furnishing and placing of materials, including fillets at intersecting streets, driveways, and turnouts.

Section 7080 - Permeable Interlocking Pavers

7080, 1.08, B, 3 — Engineering Fabric
Placing and securing filter fabric and any overlapped areas.

7080, 1.08, C, 3 — Underdrain
Furnishing and placing pipe, cleanouts, observation wells, and pipe fittings.

7080, 1.08, D, 3 — Storage Aggregate
Furnishing, hauling, placing, and compacting storage aggregate.

7080, 1.08, E, 3 — Filter Aggregate
Furnishing, hauling, placing filter, and compacting aggregate.

7080, 1.08, F, 3 — Permeable Interlocking Pavers
Testing, furnishing and placing bedding course, furnishing and installing permeable interlocking pavers, furnishing and placing joint/opening fill material, refilling joint after 6 months, and pavement protection.

7080, 1.08, G, 3 — PCC Edge Restraint
Final trimming of subgrade or subbase, bars and reinforcement, joints and sealing, surface curing and pavement protection, safety fencing, and boxouts for fixtures.

Section 7090 - Cold-in-Place Pavement Recycling

7090, 1.08, A, 3 — Cold-in-Place Recycling
Milling and sizing of existing asphalt layers; protecting street fixtures; development of a job mix formula; adding and mixing recycling agents and additives, if required; supplying and incorporating water; compacting the reclaimed mix; shaping of the mix; completing secondary compaction, if required; removing any loose or excess material; and final clean up.

7090, 1.08, B, 3 — Bituminous Recycling Agents
Furnishing and placing of materials and mixing the agent into the recycled mix.

7090, 1.08, C, 3 — Chemical Recycling Additives
Furnishing and placing of materials and mixing the agent into the recycled mix.

Section 7091 - Full Depth Reclamation

7091, 1.08, A, 3 — Full Depth Reclamation
Pulverizing and sizing of existing asphalt layers; incorporating and mixing of existing underlying materials; protecting street fixtures; development of a job mix formula; adding and mixing stabilizing agents and additives, if required; compacting the reclaimed mix; shaping of the mix; removing any loose or excess material; curing; and final clean up.

7091, 1.08, B, 3 — Mechanical Stabilization Agents
Furnishing and placing of aggregate and blending of the aggregates.

7091, 1.08, C, 3 — Bituminous Stabilization Agents
Furnishing and placing of materials and mixing the agent into the reclaimed mix.

7091, 1.08, D, 3 — Chemical Stabilization Agents
Furnishing and placing of materials and mixing the agent into the reclaimed mix.

7091, 1.08, F, 3 — Interlayer for Cement Stabilized Base
Surface cleaning, furnishing, and placing of the specified interlayer.

Section 7092 - Crack and Seat Existing PCC Pavement

7092, 1.08, A, 3 — Crack and Seat of PCC Pavement
notifying adjacent properties, providing traffic control and no parking signs; vibration monitoring if specified; cracking and seating of the designated PCC pavement to the specified pattern; watering to verify crack pattern; protecting existing fixtures; cleaning of slab prior to overlay; and final project site cleanup.

7092, 1.08, B, 3 — Remove and Replace Curb and Gutter
Full depth sawing; removing and disposing removed materials; furnishing and compacting subgrade material to bring to the proper elevation; all form work required; concrete; placing new curb and gutter; and final cleanup and backfill placement behind the new curb.

7092, 1.08, C, 3 Full Depth Saw Cut
Providing a concrete saw or other cutting device that will result in a full depth vertical edge and severing all tie or reinforcing steel.

7092, 1.08, G, 3 Intake Adjustment, Major
Sawing all three sides of the boxout; removing and replacing the boxout; furnishing and installing a new grate assembly or, if specified, removing and re-setting the existing grate assembly; removing existing open-throat intake grate; adjusting intake walls; furnishing and installing new intake grate or, if specified, re-setting existing intake grate; and furnishing, placing, and compacting backfill.

7092, 1.08, H, 3 Joint Control Fabric
Cleaning and preparing the surface, furnishing, placing, and adhering joint control fabric prior to placing surface lift.

7092, 1.08, I, 3 Partial Depth Patch Removal
Provide equipment and removing all designated partial depth patches down to the base PCC, cleaning of the former patch area; and disposal of the patch material.

7092, 1.08, J, 3 Rock Interlayer
Furnishing and placing the rock interlayer to the thickness specified.

Section 8010 - Traffic Signals

8010, 1.08, B, 3 Temporary Traffic Signal
Furnishing, installing, maintaining, and removing poles; wiring; traffic signal control equipment including pedestrian equipment if specified; implement all modifications of signal timing, signal placement and display due to Contractor initiated changes in the construction staging plan established by the Contracting Authority; relocation of trailer mounted temporary traffic signal systems; placement in another physical location to address changes in construction staging; and all appurtenances.

8010, 1.08, C, 3 Traffic Signal Removal
Removal of poles, concrete pads, foundations, wiring, traffic signal cabinet and equipment, pedestrian signal equipment, and handholes; delivery of removed materials to the location specified in the contract documents; furnishing, placing, and compacting backfill in all excavations; and restoring disturbed surfaces.

Section 8020 - Pavement Markings

8020, 1.08, B, 3 Painted Pavement Markings, Solvent/Waterborne
Reflectorizing spheres, layout, surface preparation, and application of marking paint.

8020, 1.08, C, 3 Painted Pavement Markings, Durable
Layout, surface preparation, and application of marking paint.

8020, 1.08, D, 3 Painted Pavement Markings, High-Build
Layout, surface preparation, and application of marking paint.

8020, 1.08, E, 3 Permanent Tape Markings
Layout, surface preparation, and application of marking tape.

8020, 1.08, F, 3 — Wet, Retroreflective Removable Tape Markings
Layout, surface preparation, application, and removal.

8020, 1.08, G, 3 — Painted Symbols and Legends
Layout, surface preparation, and application of each symbol and legend.

8020, 1.08, H, 3 — Precut Symbols and Legends
Layout, surface preparation, and application of each symbol and legend.

8020, 1.08, I, 3 — Temporary Delineators
Installation and removal of delineators.

8020, 1.08, J, 3 — Raised Pavement Markers
Installation and removal of pavement markers.

8020, 1.08, K, 3 — Pavement Markings Removed
Pavement marking removal and waste material collection, removal, and disposal.

8020, 1.08, L, 3 — Symbols and Legends Removed
Symbol and legend marking removal and waste material collection, removal, and disposal.

8020, 1.08, M, 3 — Grooves Cut for Pavement Markings
Layout, cutting grooves, collection and disposal of removed material, and additional groove width and transition length beyond the pavement marking dimensions.

8020, 1.08, N, 3 — Grooves Cut for Symbols and Legends
Layout, cutting grooves, and collection and disposal of removed material.

Section 8030 - Temporary Traffic Control

8030, 1.08, A, 3 — Temporary Traffic Control
Installation, maintenance, and removal of temporary traffic control; total roadway closures with installation and removal of detour signing as shown in the contract documents; removal and reinstallation or covering of permanent traffic control devices that conflict with the temporary traffic control plan; monitoring and documenting traffic control conditions; and flaggers. When required in the contract documents, the following are also included in traffic control unless a separate bid item is provided: portable dynamic message signs, temporary barrier rail, temporary flood lighting, and pilot cars.

Section 9010 - Seeding

9010, 1.08, A, 1, c — Conventional Seeding, Seeding
Removal of rock and other debris from the area; repairing rills and washes; preparing the seedbed; furnishing and placing seed, including any treatment required; furnishing and placing fertilizer and mulch; and furnishing water and other care during the care period, unless these items are bid separately.

9010, 1.08, B, 3 Hydraulic Seeding, Seeding, Fertilizing, and Mulching
Removal of rock and other debris from the area; repairing rills and washes; preparing the seedbed; furnishing and placing seed, including any treatment required; furnishing and placing fertilizer and mulch; and furnishing water and other care during the care period, unless these items are bid separately.

9010, 1.08, C, 3 Pneumatic Seeding, Seeding, Fertilizing, and Mulching
Removal of rock and other debris from the area; repairing rills and washes; preparing the seedbed; furnishing and placing seed, including any treatment required; furnishing and placing fertilizer and mulch; and furnishing water and other care during the care period, unless these items are bid separately.

9010, 1.08, D, 3 Watering
Water, pumps, meters, equipment, water tanker/container, transportation, hoses, and sprinklers.

9010, 1.08, E, 3 Warranty
All work required to correct any defects in the original placement of the seeding for the period of time designated.

Section 9020 - Sodding

9020, 1.08, A, 3 Sod
Preparation of sod and sodbed, stakes, fertilizing, watering, maintenance, and clean-up. Also includes any necessary sod replacements during maintenance period.

Section 9030 - Plant Material and Planting

9030, 1.08, A, 3 Plants (by count)
Delivery; excavation; installation; watering; placing backfill material; mulching; tree protection; staking or guying; pre-emergent herbicide, if specified; maintenance during the establishment period; and replacements.

9030, 1.08, B, 3 Plants (by count), With Warranty
Delivery; excavation; installation; watering; placing backfill material; mulching; tree protection; staking or guying; pre-emergent herbicide, if specified; maintenance during the establishment and warranty periods; and replacements.

9030, 1.08, C, 3 Plants (by lump sum)
Delivery, excavation, installation, watering, placing backfill material, mulching, wrapping, staking or guying, herbicide, maintenance during the establishment period, and replacements.

9030, 1.08, D, 3 Plants (by lump sum), With Warranty
Delivery, excavation, installation, watering, placing backfill material, mulching, wrapping, staking or guying, herbicide, maintenance during the establishment and warranty period, and replacements.

9030, 1.08, E, 3 Tree Drainage Wells
Excavation, furnishing and placing rock, engineering fabric, and placing backfill material.

Section 9040 - Erosion and Sediment Control

9040, 1.07, C	When applicable, conduct all operations in compliance with the Iowa DNR NPDES General Permit No. 2. Labor, equipment, or materials not included as a bid item, but necessary to prevent stormwater contamination from construction related sources, are considered incidental. Incidental work related to compliance with the permit may include, but is not limited to: hazardous materials protection, fuel containment, waste disposal, and providing employee sanitary facilities.
9040, 1.08, A, 1, c	SWPPP Preparation Development of a SWPPP by the Contractor meeting local and state agency requirements, filing the required public notices, filing a Notice of Intent for coverage of the project under the Iowa DNR NPDES General Permit No. 2, and payment of associated NPDES permit fees.
9040, 1.08, A, 2, c	SWPPP Management All work required to comply with the administrative provisions of the Iowa DNR NPDES General Permit No. 2; including record keeping, documentation, updating the SWPPP, filing the Notice of Discontinuation, etc. Item also includes weekly inspections required to satisfy the provisions of General Permit No. 2, unless otherwise specified in the contract documents.
9040, 1.08, D, 1, c	Filter Socks, Installation Anchoring stakes.
9040, 1.08, D, 2, c	Filter Socks, Removal Restoration of the area to finished grade and off-site disposal of filter socks and accumulated sediment.
9040, 1.08, E, 3	Temporary RECP Excavation, staples, anchoring devices, and material for anchoring slots.
9040, 1.08, F, 1, c	Wattles, Installation Anchoring stakes.
9040, 1.08, F, 2, c	Wattles, Removal Restoration of the area to finished grade and off-site disposal of wattle and accumulated sediment.
9040, 1.08, G, 1, c	Check Dams, Rock Engineering fabric.
9040, 1.08, G, 2, a, 3)	Check Dams, Manufactured, Installation Anchoring stakes.
9040, 1.08, G, 2, b, 3)	Check Dams, Manufactured, Removal Restoration of the area to finished grade and off-site disposal of manufactured check dam and accumulated sediment.
9040, 1.08, H, 3	Temporary Earth Diversion Structures Removal of the structure upon completion of the project.

9040, 1.08, I, 3	Level Spreaders Maintaining the spreader during the period of construction and removal upon completion of the project, unless otherwise specified in the contract documents.
9040, 1.08, J, 3	Rip Rap Engineering fabric.
9040, 1.08, K, 3	Temporary Pipe Slope Drains Excavation, furnishing and installing pipe and pipe aprons, grading, and removal of the slope drain upon completion of the project.
9040, 1.08, L, 1, c	Sediment Basin, Outlet Structure Concrete base, dewatering device, anti-vortex device, outlet pipe, and anti-seep collars (if specified).
9040, 1.08, L, 2, c	Sediment Basin, Removal of Sediment Dewatering and removal and off-site disposal of accumulated sediment.
9040, 1.08, L, 3, c	Sediment Basin, Removal of Outlet Structure Dewatering and off-site disposal of the outlet structure, concrete base, emergency spillway, and accumulated sediment.
9040, 1.08, M, 1, c	Sediment Trap Outlet, Installation Engineering fabric.
9040, 1.08, M, 2, c	Sediment Trap Outlet, Removal of Sediment Dewatering and removal and off-site disposal of accumulated sediment.
9040, 1.08, M, 3, c	Sediment Trap Outlet, Removal of Device Dewatering and off-site disposal of sediment trap outlet and accumulated sediment.
9040, 1.08, N, 1, c	Silt Fence or Silt Fence Ditch Check, Installation Anchoring posts.
9040, 1.08, N, 2, c	Silt Fence or Silt Fence Ditch Check, Removal of Sediment Anchoring posts.
9040, 1.08, N, 3, c	Silt Fence or Silt Fence Ditch Check, Removal of Device Restoration of the area to finished grade and off-site disposal of fence, posts, and accumulated sediment.
9040, 1.08, O, 1, c	Stabilized Construction Entrance (by Square Yard) Subgrade stabilization fabric.
9040, 1.08, O, 2, c	Stabilized Construction Entrance (by Ton) Subgrade stabilization fabric.
9040, 1.08, P, 1, c	Dust Control, Water Furnishing, transporting, and distributing water to the haul road.
9040, 1.08, R, 3	Turf Reinforcement Mats (TRM) Excavation, staples, anchoring devices, and material for anchoring slots.

9040, 1.08, T, 1, c — Inlet Protection Device, Installation
Removal of the device upon completion of the project.

9040, 1.08, T, 2, c — Inlet Protection Device, Maintenance
Removal and off-site disposal of accumulated sediment.

9040, 1.08, U, 3 — Flow Transition Mat
Anchoring devices.

9040, 1.08, V, 3 — End of Season Temporary Erosion Control
Furnishing, placing, and maintaining the end of season temporary erosion control throughout the winter season.

Section 9050 - Gabions and Revet Mattresses

9050, 1.08, A, 3 — Gabions
Furnishing and assembling wire mesh baskets, PVC coating (if specified in the contract documents), fasteners, furnishing and placing gabion stone, engineering fabric, and anchor stakes.

9050, 1.08, B, 3 — Revet Mattresses
Furnishing and assembling wire mesh baskets, PVC coating (if specified in the contract documents), fasteners, furnishing and placing mattress stone, engineering fabric, and anchor stakes.

Section 9060 - Chain Link Fence

9060, 1.08, A, 3 — Chain Link Fence
Posts, fabric, rails, braces, truss rods, ties, tension wire, tension bands, tension bars, grounds, fittings, PVC coating (if specified in the contract documents), excavation of post holes, and concrete encasement of posts.

9060, 1.08, B, 3 — Gates
Gate rails, fabric, stretcher bars, braces, vertical stay, hinges, latches, keepers, drop bar lock, center gate stop, and barbed wire (if specified).

9060, 1.08, C, 3 — Barbed Wire
Furnishing and installing all necessary strands of barbed wire, anchors, and barbed wire supporting arms.

9060, 1.08, D, 3 — Removal and Reinstallation of Existing Fence
Removing vegetation; removing all fence fabric, appurtenances, posts, and gates; removal of concrete encasement from posts; storage of the removed fencing materials to prevent damage; reinstallation of the posts, gates, and fabric, including all appurtenances; and replacement of any fence parts that are not able to be salvaged and reinstalled. Replace items damaged from Contractor's operations with new materials, at no additional cost to the Contracting Authority.

9060, 1.08, E, 3 — Removal of Fence
Off-site disposal of fence (including posts, concrete encasement of posts, gates, grounds, and barbed wire) and placing and compacting backfill material in post holes.

9060, 1.08, F, 3 Temporary Fence
Furnishing, installing, and removing posts, fabric, ties, and fittings.

Section 9070 - Landscape Retaining Walls

9070, 1.08, A, 3 Modular Block Retaining Wall
Excavation, foundation preparation, furnishing and placing wall units, geogrid (if necessary), leveling pad, subdrain, porous backfill material for subdrain, engineering fabric for subdrain, granular backfill material, suitable backfill material, and shoring as necessary.

9070, 1.08, B, 3 Limestone Retaining Wall
Excavation, foundation preparation, furnishing and placing leveling pad, limestone, subdrain, porous backfill material for subdrain, engineering fabric for subdrain, suitable backfill material, and shoring as necessary.

9070, 1.08, C, 3 Landscape Timbers
Excavation, foundation preparation, furnishing and placing leveling pad, landscape timbers, spikes, reinforcing bar, subdrain, porous backfill material for subdrain, engineering fabric for subdrain, suitable backfill material, and shoring as necessary.

Section 9071 - Segmental Block Retaining Walls

9071, 1.08, A, 3 Segmented Block Retaining Wall
Design by a Licensed Professional Engineer in the State of Iowa, excavation, foundation preparation, furnishing and placing wall units, geogrid, leveling pad, subdrain, porous backfill material for subdrain, engineering fabric for subdrain, suitable backfill material, and shoring as necessary.

9071, 1.08, C, 3 Granular Backfill Material
Furnishing, transporting, placing, and compacting material.

Section 9072 - Combined Concrete Sidewalk and Retaining Walls

9072, 1.08, A, 3 Combined Concrete Sidewalk and Retaining Wall
Excavation; foundation preparation; furnishing and placing concrete and reinforcing steel; joint material; subdrain; porous backfill material; suitable backfill material; finishing disturbed areas; and shoring as necessary.

Section 9080 - Concrete Steps, Handrails, and Safety Rail

9080, 1.08, A, 3 Concrete Steps
Reinforcement, expansion joint material, and preparation of subgrade.

9080, 1.08, B, 3 Handrail
Posts, mounting hardware or concrete grout, and finishing (painted, galvanized, or powder coated).

9080, 1.08, C, 3 Safety Rail
Posts, pickets, mounting hardware, epoxy grout, and finishing (painted, galvanized, or powder coated).

Section 10,010 - Demolition

10,010, 1.08, A, 3 — Demolition Work
Removal of trees, brush, vegetation, buildings, building materials, contents of buildings, appliances, trash, rubbish, basement walls, foundations, sidewalks, steps, and driveways from the site; disconnection of utilities; furnishing and compaction of backfill material; furnishing and placing topsoil; finish grading of disturbed areas; placing and removing safety fencing; removal of fuel and septic tanks and cisterns; seeding; and payment of any permit or disposal fees.

10,010, 1.08, B, 3 — Plug or Abandon Well
Obtaining all permits; plug or abandon private wells according to local, state, and federal regulations.

Section 11,010 - Construction Survey

11,010, 1.08, A, 3 — Construction Survey
The costs of resetting project control points, re-staking, and any additional staking requested beyond the requirements of this section.

11,010, 1.08, B, 3 — Monument Preservation and Replacement
Property research and documentation, locating monuments prior to construction, replacement of disturbed monuments, and preparation and filing of the monument preservation certificate.

Section 11,020 - Mobilization

11,020, 1.07, B — When the proposal form does not include a bid item for mobilization, all costs incurred by the contractor for mobilization are incidental to other work and no separate payment will be made.

11,020, 1.08, A, 3 — Mobilization
The movement of personnel, equipment, and supplies to the project site; the establishment of offices, buildings, and other facilities necessary for the project; and bonding, permits, and other expenses incurred prior to construction.

Section 11,040 - Temporary Sidewalk Access

11,040, 1.08, A, 3 — Temporary Pedestrian Residential Access
Supplying and placing granular material, continuous maintenance of granular surface, removal of temporary granular sidewalk, and restoring disturbed surfaces to a condition equal to that which existed prior to construction.

11,040, 1.08, B, 3 — Temporary Granular Sidewalk
Excavation, grading, timber edging, supplying and placing granular material, continuous maintenance of granular surface, removal of temporary granular sidewalk, and restoring disturbed surfaces to a condition equal to that which existed prior to construction.

11,040, 1.08, C, 3 — Temporary Longitudinal Channelizing Device
Construction, placement, maintenance, and removal of the device.

Section 11,050 - Concrete Washout

11,050, 1.08, A, 3 Concrete Washout
Providing concrete washwater containment, collection, and disposal.

Bid Items

Below is a list of units of measurements/payment and the abbreviations used in the bid item list.

UNITS	Units of Measurement/Payment	UNITS	Units of Measurement/Payment
ACRE	Acres	SF	Square Feet
CY	Cubic Yards	SQ	Squares
EACH	Each	STA	Stations
LB	Pounds	SY	Square Yards
LF	Linear Feet	TON	Tons
LS	Lump Sum	UNIT	Units
MGAL	1,000 Gallons		

A. Standard Bid Items

The following is a list of suggested standard bid items based on the SUDAS Specifications. The four digits first mentioned in the item number below reference the SUDAS Specifications Section; measurement and payment descriptions are included in subsection 1.08. Please note, some of the items below require additional information, such as type, size, width, thickness, etc.

Item Number	Item Description	Unit
Section 2010 - Earthwork, Subgrade, and Subbase		
2010-A	Clearing and Grubbing	UNIT
2010-B	Clearing and Grubbing	ACRE
2010-C	Clearing and Grubbing	LS
2010-D-1	Topsoil, On-site	CY
2010-D-2	Topsoil, Compost-amended	CY
2010-D-3	Topsoil, Off-site	CY
2010-E	Excavation, Class 10, Class 12, or Class 13	CY
2010-G	Subgrade Preparation	SY
2010-H	Granular Stabilization	TON
2010-I	Subgrade Treatment, ____ (Type)	SY
2010-J	Subbase, ____ (Type)	SY
2010-K-1	Removal of Structure, ____ (Type)	EA
2010-K-2-a	Removal of Known Box Culvert, ____ (Type), ____ (Size)	LF
2010-K-2-c	Removal of Known Pipe Culvert, ____ (Type), ____ (Size)	LF
2010-K-3-a	Removal of Known Pipe and Conduit, ____ (Type), ____ (Size)	LF
2010-L-1	Filling and Plugging of Known Pipe Culverts, Pipes, and Conduits, ____ (Type), ____ (Size)	LF
2010-M	Compaction Testing	LS

Item Number	Item Description	Unit
Section 3010 - Trench Excavation and Backfill		
3010-B	Rock Excavation	CY
3010-C	Trench Foundation	TON
3010-D	Replacement of Unsuitable Backfill Material	CY
3010-E	Special Pipe Embedment or Encasement	LF
3010-F	Trench Compaction Testing	LS
Section 4010 - Sanitary Sewers		
4010-A-1	Sanitary Sewer Gravity Main, Trenched, ____ (Type), ____ (Size)	LF
4010-A-2	Sanitary Sewer Gravity Main, Trenchless, ____ (Type), ____ (Size)	LF
4010-B-1	Sanitary Sewer Gravity Main with Casing Pipe, Trenched, ___ (Type), ___ (Size)	LF
4010-B-2	Sanitary Sewer Gravity Main with Casing Pipe, Trenchless, ___ (Type), ___ (Size)	LF
4010-C-1	Sanitary Sewer Force Main, Trenched, ____ (Type), ____ (Size)	LF
4010-C-2	Sanitary Sewer Force Main, Trenchless, ____ (Type), ____ (Size)	LF
4010-D-1	Sanitary Sewer Force Main with Casing Pipe, Trenched, ____ (Type), ____ (Size)	LF
4010-D-2	Sanitary Sewer Force Main with Casing Pipe, Trenchless, ____ (Type), ____ (Size)	LF
4010-E	Sanitary Sewer Service Stub, ____ (Type), ____ (Size)	LF
4010-F	Sanitary Sewer Service Relocation	EA
4010-G	Sewage Air Release Valve and Pit	EA
4010-H	Removal of Sanitary Sewer, ____ (Type), ____ (Size)	LF
4010-I	Sanitary Sewer Cleanout	EA
4010-K	Sanitary Sewer Abandonment, Plug	EA
4010-L	Sanitary Sewer Abandonment, Fill and Plug	LF
Section 4020 - Storm Sewers		
4020-A-1	Storm Sewer, Trenched, ____ (Type), ____ (Size)	LF
4020-A-2	Storm Sewer, Trenchless, ____ (Type), ____ (Size)	LF
4020-B-1	Storm Sewer with Casing Pipe, Trenched, ____ (Type), ____ (Size)	LF
4020-B-2	Storm Sewer with Casing Pipe, Trenchless, ____ (Type), ____ (Size)	LF
4020-C	Linear Trench Drain	LF
4020-D	Removal of Storm Sewer, ____ (Type), ____ (Size)	LF
4020-F	Storm Sewer Abandonment, Plug	EA
4020-G	Storm Sewer Abandonment, Fill and Plug	LF
Section 4030 - Pipe Culverts		
4030-A-1	Pipe Culvert, Trenched, ____ (Type), ____ (Size)	LF
4030-A-2	Pipe Culvert, Trenchless, ____ (Type), ____ (Size)	LF
4030-B	Pipe Apron, ____ (Type), ____ (Size)	EA
4030-C	Footing for Concrete Pipe Apron, ____ (Type), ____ (Size)	EA
4030-D	Pipe Apron Guard	EA
Section 4040 - Subdrains and Footing Drain Collectors		
4040-A	Subdrain, ____ (Type), ____ (Size)	LF
4040-B	Footing Drain Collector, ____ (Type), ____ (Size)	LF
4040-C	Subdrain Cleanout, ____ (Type), ____ (Size)	EA

Item Number	Item Description	Unit
4040-C	Footing Drain Cleanout, ____ (Type), ____ (Size)	EA
4040-D	Subdrain Outlets and Connections, ____ (Type), ____ (Size)	EA
4040-D	Footing Drain Outlets and Connections, ____ (Type), ____ (Size)	EA
4040-E	Storm Sewer Service Stub, ____ (Type), ____ (Size)	LF
Section 4050 - Pipe Rehabilitation		
4050-A-1	Pre-Rehabilitation Cleaning and Inspection, ____ (Size)	LF
4050-A-2	Additional Sewer Cleaning	HOUR
4050-B	Remove Protruding Service Connections	EA
4050-C-1	CIPP Main Lining	LF
4050-C-2	Building Sanitary Sewer Service Reinstatement	EA
4050-C-3	CIPP End Seal	EA
4050-D	CIPP Point Repair, ____ (Size)	EA
4050-E-1	CIPP Service Pipe, Connection, ____ (Size)	EA
4050-E-2	CIPP Service Repair, Partial Pipe, ____ (Size)	EA
4050-F-1	Pressure Testing of Mainline Sewer Joints, ____ (Size)	EA
4050-F-2	Injection Grouting of Mainline Sewer Joints, ____ (Size)	EA
4050-F-3	Pressure Testing of Service Connections, ____ (Size)	EA
4050-F-4	Injection Grouting of Service Connections, ____ (Size)	EA
4050-F-5	Chemical Grout	EA
4050-G-3	Bypass Pumping	LS
4050-H-1	Spot Repairs by Pipe Replacement	EA
4050-H-2	Spot Repairs by Pipe Replacement	LF
Section 5010 - Pipe and Fittings		
5010-A-1	Water Main, Trenched, ____ (Type), ____ (Size)	LF
5010-A-2	Water Main, Trenchless, ____ (Type), ____ (Size)	LF
5010-B-1	Water Main with Casing Pipe, Trenched, ____ (Type), ____ (Size)	LF
5010-B-2	Water Main with Casing Pipe, Trenchless, ____ (Type), ____ (Size)	LF
5010-C-1	Fitting, ____ (Type), ____ (Size)	EA
5010-C-2	Fitting, ____ (Type), ____ (Size)	LB
5010-D	Water Service Stub, ____ (Type), ____ (Size)	EA
5010-E-1	Water Service Pipe, ____ (Type), ____ (Size)	LF
5010-E-2	Water Service Corporation, ____ (Type), ____ (Size)	EA
5010-E-3	Water Service Curb Stop and Box, ____ (Type), ____ (Size)	EA
5010-F	Water Main Abandonment, Cap, ____ (Size)	EA
5010-G	Water Main Abandonment, Fill and Plug, ____ (Size)	LF
5010-H	Water Main Removal, ____ (Size)	LF
Section 5011 - Fusible PVC and HDPE Pipe		
5011-A-1	Fusible Water Main, Trenched, ____ (Type), ____ (Size)	LF
5011-A-2	Fusible Water Main, Trenchless, ____ (Type), ____ (Size)	LF
5011-B-1	Water Main with Casing Pipe, Trenched, ____ (Type), ____ (Size)	LF
5011-B-2	Water Main with Casing Pipe, Trenchless, ____ (Type), ____ (Size)	LF

Item Number	Item Description	Unit
Section 5020 - Valves, Fire Hydrants, and Appurtenances		
5020-A	Valve, ____ (Type), ____ (Size)	EA
5020-B	Tapping Valve Assembly, ____ (Size)	EA
5020-C	Fire Hydrant Assembly	EA
5020-D	Alternate Fire Hydrant Assembly	EA
5020-E	Flushing Device (Blowoff), ____ (Size)	EA
5020-G	Valve Box Extension	EA
5020-H	Valve Box Replacement	EA
5020-I	Fire Hydrant Adjustment	EA
5020-J	Fire Hydrant Assembly Removal	EA
5020-K	Valve Removal	EA
5020-L	Valve Box Removal	EA
Section 6010 - Structures for Sanitary and Storm Sewers		
6010-A	Manhole, ____ (Type), ____ (Size)	EA
6010-B	Intake, ____ (Type), ____ (Size)	EA
6010-C-1	Internal Drop Connection	EA
6010-C-2	External Drop Connection	EA
6010-D	Casting Extension Ring	EA
6010-E	Manhole Adjustment, Minor	EA
6010-E	Intake Adjustment, Minor	EA
6010-F	Manhole Adjustment, Major	EA
6010-F	Intake Adjustment, Major	EA
6010-G	Connection to Existing Manhole	EA
6010-G	Connection to Existing Intake	EA
6010-H	Remove Manhole	EA
6010-H	Remove Intake	EA
Section 6020 - Rehabilitation of Existing Manholes		
6020-A	Infiltration Barrier, ____ (Type)	EA
6020-B	In-situ Manhole Replacement, Cast-in-place Concrete	VF
6020-C	In-situ Manhole Replacement, Cast-in-place Concrete with Plastic Liner	VF
6020-D	Manhole Lining with Centrifugally Cast Cementitious Mortar Liner with Epoxy Seal	VF
Section 7010 - Portland Cement Concrete Pavement		
7010-A	Pavement, PCC, ____ (Thickness)	SY
7010-E	Curb and Gutter, ____ (Width), ____ (Thickness)	LF
7010-F	Beam Curb	LF
7010-G	Concrete Median	SY
7010-H	PCC Railroad Crossing Approach	SY
7010-I	PCC Pavement Samples and Testing	LS
7010-K	PCC Pavement Widening, ____ (Thickness)	SY

Item Number	Item Description	Unit
Section 7011 - Portland Cement Concrete Overlays		
7011-A-1	PCC Overlay, Furnish Only	CY
7011-A-2	PCC Overlay, Place Only	SY
7011-A-3	Surface Preparation for Bonded PCC Overlay	SY
7011-A-4	Surface Preparation for Unbonded PCC Overlay	SY
7011-A-5	HMA Separation Layer for Unbonded PCC Overlay	SY
7011-A-6	Geotextile Fabric Separation Layer for Unbonded PCC Overlay	SY
Section 7020 - Hot Mix Asphalt Pavement		
7020-A	Pavement, HMA	TON
7020-B	Pavement, HMA, ____ (Thickness)	SY
7020-C	HMA Base Widening	TON
7020-D	HMA Base Widening, ____ (Thickness)	SY
7020-E	HMA Railroad Crossing Approach	SY
7020-I	HMA Pavement Samples and Testing	LS
Section 7021 - Hot Mix Asphalt Overlays		
7021-A	HMA Overlay	TON
7021-B	HMA Overlay, ____ (Thickness)	SY
Section 7030 - Sidewalks, Shared Use Paths, and Driveways		
7030-A	Removal of Sidewalk	SY
7030-A	Removal of Shared Use Path	SY
7030-A	Removal of Driveway	SY
7030-B	Removal of Curb	LF
7030-C	Shared Use Path, ____ (Type), ____ (Thickness)	SY
7030-D	Special Subgrade Preparation for Shared Use Path	SY
7030-E	Sidewalk, PCC, ____ (Thickness)	SY
7030-F	Brick/Paver Sidewalk with Pavement Base	SY
7030-G	Detectable Warnings	SF
7030-H-1	Driveway, Paved, ____ (Type), ____ (Thickness)	SY
7030-H-2	Driveway, Granular	SY or TON
7030-I	Sidewalk Assurance Testing	LS
7030-I	Shared Use Path Assurance Testing	LS
7030-I	Driveway Assurance Testing	LS
Section 7040 - Pavement Rehabilitation		
7040-A	Full Depth Patches	SY
7040-B	Subbase Over-excavation	TON
7040-C	Partial Depth Patches	SF
7040-D	Crack and Joint Cleaning and Filling, Hot Pour	LF
7040-E-1	Crack Cleaning and Filling, Emulsion	LF
7040-E-2	Hot Mix Asphalt for Crack Filling	TON
7040-F	Diamond Grinding	SY
7040-G	Milling	SY
7040-H	Pavement Removal	SY

Item Number	Item Description	Unit
7040-I	Curb and Gutter Removal	LF
7040-J	Dowel Bar Retrofit	EA
7040-K	Core Hole Cutting and Replacement	EA
Section 7050 - Asphalt Stabilization		
7050-A	Asphalt Stabilization	SY
Section 7060 - Bituminous Seal Coat		
7060-A	Bituminous Seal Coat	SY
7060-B-1	Cover Aggregate, ____ (Size)	TON
7060-B-2	Binder Bitumen	GAL
Section 7070 - Emulsified Asphalt Slurry Seal		
7070-A	Emulsified Asphalt Slurry Seal	SY
7070-B-1	Aggregate, ____ (Size)	TON
7070-B-2	Asphalt Emulsion	GAL
Section 7080 - Permeable Interlocking Pavers		
7080-B	Engineering Fabric	SY
7080-C	Underdrain, ____ (Type), ____ (Size)	LF
7080-D	Storage Aggregate	TON
7080-E	Filter Aggregate	TON
7080-F	Permeable Interlocking Pavers, ____ (Type)	SY
7080-G	PCC Edge Restraint, ____ (Type), ____ (Size)	LF
Section 7090 - Cold-in-Place Pavement Recycling		
7090-A	Cold-in-Place Recycling	SY
7090-B	Bituminous Recycling Agents	GAL
7090-C	Chemical Recycling Additives	TON
Section 7091 - Full Depth Reclamation		
7091-A	Full Depth Reclamation	SY
7091-B	Mechanical Stabilization Agents	TON
7091-C	Bituminous Stabilization Agents	GAL
7091-D	Chemical Stabilization Agents	TON
7091-E	Microcracking	SY
7091-F	Interlayer for Cement Stabilized Base, ____ (Type), ____ (Thickness)	SY
Section 7092 - Crack and Seat Existing PCC Pavement		
7092-A	Crack and Seat of PCC Pavement	SY
7092-B	Remove and Replace Curb and Gutter	LF
7092-C	Full Depth Saw Cut	LF
7092-G	Intake Adjustment, Major	EA
7092-H	Joint Control Fabric	LF
7092-I	Partial Depth Patch Removal	SF
7092-J	Rock Interlayer	TON

Item Number	Item Description	Unit
Section 8010 - Traffic Control		
8010-A	Traffic Signal	LS
8010-B	Temporary Traffic Signal	LS
8010-C	Traffic Signal Removal	LS
Section 8020 - Pavement Markings		
8020-B	Painted Pavement Markings, Solvent/Waterborne	STA
8020-C	Painted Pavement Markings, Durable	STA
8020-D	Painted Pavement Markings, High-Build	STA
8020-E	Permanent Tape Markings	STA
8020-F	Wet, Retroreflective Removable Tape Markings	STA
8020-G	Painted Symbols and Legends	EA
8020-H	Precut Symbols and Legends	EA
8020-I	Temporary Delineators	EA
8020-J	Raised Pavement Markers	EA
8020-K	Pavement Markings Removed	STA
8020-L	Symbols and Legends Removed	EA
8020-M	Grooves Cut for Pavement Markings	STA
8020-N	Grooves Cut for Symbols and Legends	EA
Section 8030 - Temporary Traffic Control		
8030-A	Temporary Traffic Control	LS
Section 9010 - Seeding		
9010-A	Conventional Seeding, Seeding, Fertilizing, and Mulching	AC
9010-B	Hydraulic Seeding, Seeding, Fertilizing, and Mulching	AC
9010-C	Pneumatic Seeding, Seeding, Fertilizing, and Mulching	AC
9010-D	Watering	MGAL
9010-E	Warranty	LS
Section 9020 - Sodding		
9020-A	Sod	SQ
Section 9030 - Plant Material and Planting		
9030-A	Plants, ____ (Type)	EA
9030-B	Plants with Warranty, ____ (Type)	EA
9030-C	Plants	LS
9030-D	Plants with Warranty	LS
9030-E	Tree Drainage Wells	EA
Section 9040 - Erosion and Sediment Control		
9040-A-1	SWPPP Preparation	LS
9040-A-2	SWPPP Management	LS
9040-B	Compost Blanket, ____ (Thickness)	SF
9040-C	Filter Berm, ____ (Size)	LF
9040-D-1	Filter Sock, ____ (Size)	LF
9040--D-2	Filter Sock, Removal	LF

Item Number	Item Description	Unit
9040-E-0	Temporary RECP, ____ (Type)	SY
9040-F-1	Wattle, ____ (Type), ____ (Size)	LF
9040-F-2	Wattle, Removal	LF
9040-G-1	Check Dam, Rock	TON
9040-G-2-a	Check Dam, Manufactured, ____ (Type), ____ (Size)	LF
9040-G-2-b	Check Dam, Manufactured, Removal, ____ (Type)	LF
9040-H-0	Temporary Earth Diversion Structure, ____ (Type), ____ (Size)	LF
9040-I-0	Level Spreader	LF
9040-J-0	Rip Rap, ____ (Type)	TON
9040-K-0	Temporary Pipe Slope Drain, ____ (Type), ____ (Size)	LF
9040-L-1	Sediment Basin, Outlet Structure, ____ (Size)	EA
9040-L-2	Sediment Basin, Removal of Sediment	EA
9040-L-3	Sediment Basin, Removal of Outlet Structure	EA
9040-M-1	Sediment Trap Outlet	TON
9040-M-2	Sediment Trap Outlet, Removal of Sediment	EA
9040-M-3	Sediment Trap Outlet, Removal of Device	EA
9040-N-1	Silt Fence or Silt Fence Ditch Check	LF
9040-N-2	Silt Fence or Silt Fence Ditch Check, Removal of Sediment	LF
9040-N-3	Silt Fence or Silt Fence Ditch Check, Removal of Device	LF
9040-O-1	Stabilized Construction Entrance	SY
9040-O-2	Stabilized Construction Entrance	TON
9040-P-1	Dust Control, Water	MGAL
9040-P-2	Dust Control, Product	SY
9040-Q-1	Erosion Control Mulching, Conventional	AC
9040-Q-2	Erosion Control Mulching, Hydromulching	AC
9040-R	Turf Reinforcement Mats, ____ (Type)	SQ
9040-S	Surface Roughening	SF
9040-T-1	Inlet Protection Device, ____ (Type)	EA
9040-T-2	Inlet Protection Device, Maintenance	EA
9040-U	Flow Transition Mat	SF
9040-V	End of Season Temporary Erosion Control	AC
Section 9050 - Gabions and Revet Mattresses		
9050-A	Gabions, ____ (Type)	CY
9050-B	Revet Mattresses, ____ (Type)	CY
Section 9060 - Chain Link Fence		
9060-A	Chain Link Fence, ____ (Type), ____ (Size)	LF
9060-B	Gates, ____ (Type), ____ (Size)	EA
9060-C	Barbed Wire, ____ (Type of Supporting Arm)	LF
9060-D	Removal and Reinstallation of Existing Fence, ____ (Type), ____ (Size)	LF
9060-E	Removal of Fence	LF
9060-F	Temporary Fence, ____ (Type), ____ (Size)	LF

Item Number	Item Description	Unit
Section 9070 - Landscape Retaining Walls		
9070-A	Modular Block Retaining Wall	SF
9070-B	Limestone Retaining Wall	SF
9070-C	Landscape Timbers	SF
Section 9071 - Segmental Block Retaining Walls		
9071-A	Segmental Block Retaining Wall	SF
9071-C	Granular Backfill Material	TON
Section 9072 - Combined Concrete Sidewalk and Retaining Wall		
9072-A	Combined Concrete Sidewalk and Retaining Wall	CY
Section 9080 - Concrete Steps, Handrails, and Safety Rail		
9080-A	Concrete Steps, ____ (Type)	SF
9080-B	Handrail, ____ (Type)	LF
9080-C	Safety Rail	LF
Section 10,010 - Demolition		
10,010-A	Demolition Work	LS
10,010-B	Plug or Abandon Well	EA
Section 11,010 - Construction Survey		
11,010-A	Construction Survey	LS
11,010-B	Monument Preservation and Replacement	LS
Section 11,020 - Mobilization		
11,020-A	Mobilization	LS
Section 11,030 - Temporary Services During Construction		
11,030-A	Maintenance of Postal Service	LS
11,030-B	Maintenance of Solid Waste Collection	LS
Section 11,040 - Temporary Sidewalk Access		
11,040-A	Temporary Pedestrian Residential Access	SY
11,040-B	Temporary Granular Sidewalk	SY
11,040-C	Temporary Longitudinal Channelizing Device	LF
Section 11,050 - Concrete Washout		
11,050-A	Concrete Washout	LS

B. Supplemental Bid Items

When a new bid item needs to be created, the following format is suggested:

1. If the bid item falls within a SUDAS Specifications Section, but is not identified in SUDAS, use the four digit section number, followed by 999, then a letter. For example, if you want to add a new bid item for sanitary sewers, use 4010-999-A.

2. If the bid item generally falls within a SUDAS Specifications Division (broader category), but is not identified as a particular SUDAS Specifications Section, use the division number, followed by 999, then a letter. For example, if you add pipe bursting and want the bid items organized with the other pipe items, use 4999-A. Or if a supplemental specifications section has been created, the first four digits should match the numbers used in the supplemental. In that instance, it is suggested to use the division number as the first digit, followed by a 9, and then the next numbers as you see fit.

3. If the bid item does not fall within a SUDAS Specifications Division or Section, use 0000, followed by 999, then a letter. For example, 0000-999-A.

4. When making modifications to a standard SUDAS bid item, be sure to address such modifications in the estimate reference notes.

$$Q_i = 0.67A_g(2gd)^{0.5} + 0.67hL(2gd_0)^{0.5}$$ **Equation 2C-3.18**

where:

A_g = Clear opening of the grate, ft^2
g = Gravitational constant = 32.16 ft/s^2
d = Depth at the curb, ft
H = Height of the open-throat orifice, ft
L = length of open-throat section, ft
d_0 = effective depth at the center of the open-throat orifice, ft

G. Storm Sewer Structure Requirements

1. **Manholes or Intakes:** Manholes or intakes are required under the following conditions:

   a. At the end of each sewer line.

   b. At all changes in pipe size, elevation and grade, or alignment, and at all bends.

   c. At all sewer pipe intersections, except where the size of the storm sewer conduit (54 inches diameter or greater pipe) eliminates the need for a manhole. Manholes are required for 54 inches or greater pipes when direct access is desired every 400 feet.

   d. At all sewer pipe intersections and at intervals not exceeding 400 feet. If owner has adequate cleaning equipment, the allowable spacing may be increased to 500 feet for sewers 24 inches and larger.

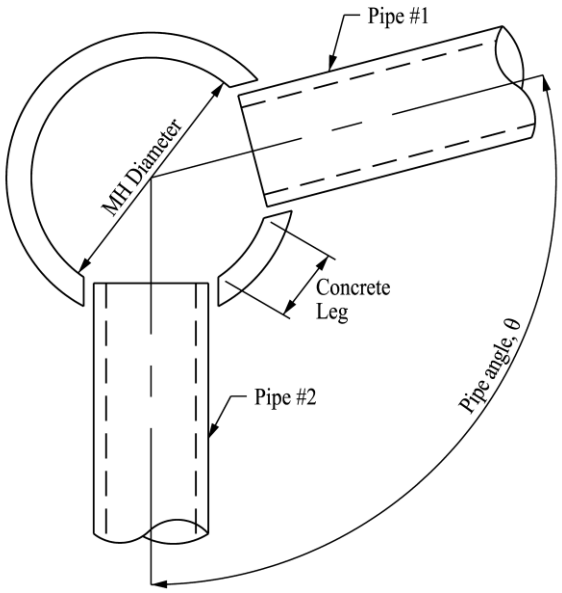
2. **Openings:**

   a. Standard: The minimum size for a manhole is 48 inches in diameter. Jurisdictions require concentric manholes, without built-in steps, with the manhole opening over the centerline of the pipe or on an offset not to exceed 12 inches. Some Jurisdictions may allow for eccentric manholes.

   b. Special: For square or rectangular manholes, the manhole openings should be over the centerline of the pipes or on an offset not to exceed 12 inches. The distance from the centerline of the manhole opening to the face of the inside manhole wall should not exceed 30 inches to better facilitate video inspection and maintenance equipment. This may require more than one manhole opening.

   c. Determining Diameters: When utilizing circular precast manholes, it is necessary to determine the diameter required to maintain the structural integrity of the manhole. As a general rule, a minimum concrete leg of 12 inches should remain between the manhole blockouts for adjacent pipes. Determining the required manhole diameter to provide this minimum distance may be done as follows:
      1) Determine the diameters of, and the angle between, the two pipes in question. If more than two pipes connect at the manhole, the adjacent pipes with the critical configuration (i.e. smallest angle and largest pipes) should be selected. If the critical configuration is not apparent, calculations may be required for all adjacent pipes.

Figure 2C-3.05: Manhole Sizing Requirements



2) Determine the blockout diameter. The blockout is the opening provided in the manhole for the pipe. Blockout dimensions are based on the outside diameter of the pipe. For storm sewer, a circular or doghouse type opening is provided with additional clearance to allow for the insertion of the pipe and sufficient space to accommodate placement of concrete grout in the opening. Typical blockout dimensions for various pipe sizes and materials are given in Table 2C-3.04 below.

Table 2C-3.04: Manhole Blockout Sizes

Pipe Diameter (inches)	**Manhole Blockout (inches)**		
	RCP	***PVC***	***DIP***
12	21	16	16
14	N/A	16	18
15	24	19	N/A
16	N/A	N/A	20
18	28	22	23
20	N/A	N/A	24
21	31	25	N/A
24	35	28	29
27	38	31	N/A
30	42	35	36
33	47	N/A	N/A
36	48	42	41
42	57	N/A	N/A
48	64	N/A	N/A
54	71	N/A	N/A
60	78	N/A	N/A

3) Determine the diameter of the manhole required to provide the minimum concrete leg dimension. This diameter may be calculated with the following equation:

$$MH_d = \frac{BO_1 + BO_2 + 2CL}{\theta \times \left(\pi/_{180}\right)}$$ **Equation 2C-3.19**

where:

MH_d = Manhole diameter, in
BO = Blockout diameter, in
CL = Minimum concrete leg length, in (typically 12 inches)
θ = Angle between pipe centerlines, degrees

4) Round the minimum manhole diameter calculated, up to the next standard manhole size (48 inches, 60 inches, 72 inches, 84 inches, 96 inches, 108 inches, or 120 inches).
5) Verify that the manhole diameter calculated is sufficient for the largest pipe diameter (See Table 2C-3.04).

Table 2C-3.04: Minimum Manhole Diameter Required for Pipe Size

Pipe Diameter (inches)	Minimum Manhole Diameter (inches)		
	RCP	***PVC***	***DIP***
8	N/A	48	48
10	N/A	48	48
12	48	48	48
14	N/A	N/A	48
15	48	48	N/A
16	N/A	N/A	48
18	48	48	48
20	N/A	N/A	48
21	48	48	N/A
24	48	48	48
27	*60	48	N/A
30	*60	*60	*60
33	*60	N/A	N/A
36	*60	*60	*60
42	*72		
48	*84		
54	*96		
60	*96		

*48 inch diameter Tee-section manhole may be used for pipes 27 inches and greater.

3. Intake/Manhole Combination: Intake/manhole combinations will be used when the size of the connecting pipes so indicate or when horizontal clearance is necessary behind the back of curb. The Engineer is encouraged to utilize intake/manhole combinations for storm sewers that are parallel to the street. This will prevent storm sewers from being installed under pavement; improving maintenance access without requiring pavement removal.

4. Cleanouts: Lamp holes or cleanout structures are required at the beginning of footing drains and subdrains in street right-of-way. Cleanouts may be allowed in place of a manhole at the end of lines that are less than 150 feet in length. Approval to use cleanouts is required.

5. Access Spacing: Storm sewer structures (manholes, intakes, combination intakes, or cleanouts) in street right-of-way must be located in areas that allow direct access by maintenance vehicles.

Areas outside the street right-of-way will be subject to the approval of the Jurisdictional Engineer.

a. Manhole Spacing: Manholes are to be spaced at intervals not exceeding 400 feet or at intervals not exceeding 500 feet when adequate cleaning equipment is available.

b. Intake Spacing: Locate street intakes upgrade from intersections, sidewalk ramps, and outside of intersection radii. At least one intake is to be installed at the low point of the street grade.

1) **First Intake:** An intake should be located no further than 500 feet from the street high point.
2) **Remaining Intakes:** To be spaced at a distance no greater than 400 feet, regardless of gutter flow capacity, in order to meet maintenance needs.

6. Invert Drop: When there is a change in pipe size at a structure, the invert of the smaller sewer must be raised to maintain the same energy gradient. An approximate method of doing this is to place the 0.8 depth point of both sewers at the same elevation. When there is a change in alignment between storm sewer of 45 degrees or greater, the suggested minimum manhole drop is 0.10 foot.

H. Manhole and Intake Standards

1. Manhole Standards to be Utilized:

Figure No.[1]	Description	Use	
		Main Pipe Size	***Depth Restrictions***
6010.401	Circular Storm Sewer Manhole	12" min. See table on Figure 6010.401 for max. pipe size	N/A
6010.402	Rectangular Storm Sewer Manhole	12" to 54"	8' max.
6010.403	Deep Well Rectangular Storm Sewer Manhole	12" to 72"	12' max.
6010.404	Rectangular Base/Circular Top Storm Sewer Manhole	12" to 96"	12' min. to 22' max.
6010.405	Tee-section Storm Sewer Manhole	12" or greater	N/A

[1] The figure numbers listed in this table refer to figures from the SUDAS Specifications.

2. Manhole Castings to be Utilized:

Figure No.[1]	Casting Type	Number of Pieces	Ring/ Cover	Bolted Frame	Bolted Cover (Floodable)	Gasket
6010.602	E	2	Fixed[2]	Yes	No	No
6010.602	F	3	Adjustable[3]	No	No	No

[1] The figure numbers listed in this table refer to figures from the SUDAS Specifications.
[2] Typically used with non-paved or flexible surfaces, including HMA, seal coat, gravel, and brick.
[3] Typically used with PCC surfaces, including castings in concrete boxouts.

C. Outlets

1. Where a storm sewer discharges into a natural channel or irrigation ditch, an outlet structure should be provided that will blend the storm sewer discharge into the natural channel flow in such a way as to prevent erosion of the bed or banks of the channel. As a minimum, all storm sewer pipes that outlet to drainageways will require flared end sections with apron guard or safety grates for pipe diameters 18 inches or larger. When treating the outlet end of a culvert using apron guards or safety grates, the inlet end must also be treated in some manner to prevent debris from intruding into or clogging the culvert. The presence of apron guards or safety grates may result in additional maintenance needs in order to prevent clogging. Storm sewers 30 inches in diameter or greater require a footing at the outlet. Footings may be required for pipe diameters less than 30 inches.

2. In an instance where the discharge velocity is high (higher than those outlined in Section 2F-2, Tables 2F-2.03 and 2F-2.04) or supercritical, prevention of erosion of the natural channel bed or banks in the vicinity of the outlet requires an energy dissipating structure, such as:
   - Rip rap
   - Concrete slab
   - Gabions
   - Headwalls and wing wall with stilling basins
   - Flow transition mats

3. Outlets should drain at a receiving drainageway or connect to an existing storm sewer. Outlets should not drain across sidewalks or directly to streets. Outlets should not be located on slopes without adequate erosion protection and means of conveyance between the outlet and receiving drainageway or storm sewer. Erosion protection on a slope that does not extend beyond the outlet is often inadequate, as runoff velocity will increase down grade of the outlet.

14. Horizontal Culvert Clearances:

a. Small culverts (30 inches in diameter or less) should use an end section or a sloped headwall. Apron guards or safety grates maybe needed in residential areas for pipe diameters 18 inches or greater.

b. Culverts greater than 30 inches in diameter should receive one of the following treatments:
   1) Extend to appropriate clear zone distance per AASHTO Roadside Design Guide
   2) When installing a safety grate or apron guards to prevent human entry, make sure to check the potential consequences of clogging and flooding.

15. Separation of Multi-pipe Culverts: In order to provide proper spacing between multi-pipe culverts, the following should be considered:

a. Without Aprons: If multi-pipe culverts are placed without aprons or footings, the distance between the centerline of each pipe should be 1 1/2 times the pipe diameter, but no less than 1 foot between the outside wall of each pipe. This separation allows room for compaction between the culverts. If a cutoff wall or barrier wall of low-permeability clay soil at least 2 feet thick is not available at the inlet and outlet to protect the pipe backfill, then consideration should be given to the use of flowable mortar as a means of pipe backfill.

b. With Curtain Walls: The distance between the centerline of each pipe culvert with curtain walls equals the diameter plus 2 feet (allows for proper reinforcement placement in the footing).

c. With Aprons: The separation between multi-pipe culverts with aprons is based on the distance need between aprons. This distance should be a minimum of 2 feet from the end of the apron for concrete and reinforcement placement to tie the aprons together. A preferable distance of 4 to 6 feet should be used when earth fill is used.

F. Pipe Material

1. RCP - Minimum strength Class III under all streets and entrance pavement and Class V under railroad tracks and pipes to be jacked.

2. Use of CMP and multi-plate gauge is at the discretion of the Jurisdictional Engineer.

G. Pipe Culvert Sizes

1. Entrance Pipes: Minimum 18 inches in diameter

2. Street or Roadway Pipe: Minimum 24 inches in diameter

H. Culvert Inlets

Selection of the type of inlet is an important part of the culvert design, particularly with inlet control. Hydraulic efficiency and cost can be significantly affected by inlet conditions. The inlet coefficient K_e is a measure of the hydraulic efficiency of the inlet, with lower values indicating greater efficiency. All the methods described in this chapter directly or indirectly use inlet coefficients. See Table 2E-1.01.

1. **Inlets with Headwalls:** Headwalls may be used for a variety of reasons:
   - Increasing the efficiency of the inlet
   - Providing embankment stability
   - Providing embankment protection against erosion
   - Providing protection from buoyancy
   - Shortening the length of the required structure

   The relative efficiency of the inlet depends on the pipe material. Headwalls are usually required for all metal culverts and where buoyancy protection is necessary. Corrugated metal pipe in a headwall is essentially square-edged with an inlet coefficient of approximately 0.5. For tongue-and-groove or bell-and-spigot concrete pipe, little increase in hydraulic efficiency is realized by adding a headwall.

2. **Wingwalls and Aprons:** Wingwalls are used where the side slopes of the channel adjacent to the entrance are unstable, or where the culvert is skewed to the normal channel flow. Little increase in hydraulic efficiency is realized with the use of normal wingwalls, regardless of the pipe material used and therefore, the use should be justified for other reasons. Wingwalls can be used to increase hydraulic efficiency if designed as a side-tapered inlet.

   If high headwater depths are to be encountered, or the approach velocity in the channel will cause scour, a short channel apron should be provided at the toe of the headwall. This apron should extend at least one pipe diameter upstream from the entrance, and the top of the apron should not protrude above the normal streambed elevation.

Note: For federal-aid projects, proposed design values that do not meet the "Acceptable" table may require design exceptions. Design exceptions will be considered on a project-by-project basis and must have concurrence of the Iowa DOT when applicable. For non-federal aid projects, the designer should contact the Jurisdiction to determine what level of documentation, if any, is required prior to utilizing design values that do not meet the "Acceptable" table.

Table 5C-1.02 Footnotes:

[1] Number of traffic lanes, turn lanes, intersection configuration, etc. should be designed to provide the specified LOS at the design year ADT.

[2] Width shown is for through lanes and turn lanes.

[3] Bridge width is measured as the clear width between curbs or railings. Minimum bridge width is based upon the width of the traveled way (lane widths) plus 3 feet clearance on each side; but no less than the curb-face to curb-face width of the approaching roadway. Minimum bridge widths do not include medians, turn lanes, parking, or sidewalks. At least one sidewalk should be extended across the bridge.

[4] The values shown are the clear width across the bridge between curbs or railings. Values are based upon the width of the traveled way (lane width) and include a 1 foot and 2 foot offset on each side for collectors and arterials respectively. Values do not include medians, turn lanes, parking, or sidewalks. In no case should the minimum clear width across the bridge be less than the width of the traveled way of the approach road.

[5] Vertical clearance includes a 0.5 foot allowance for future resurfacing. Vertical clearance of 14.5 feet on arterials is allowed only if an alternate route with 16 feet of clearance is available.

[6] Object setback does not apply to mailboxes constructed and installed according to US Postal Service regulations, including breakaway supports.

[7] Values shown are measured from the edge of the traveled way to the back of curb. Curb offset is not required for turn lanes. On roadways with an anticipated posted speed of 45 mph or greater, mountable curbs are required. For pavements with gutterline jointing, the curb offset should be equal to or greater than the distance between the back of curb and longitudinal gutterline joint.

[8] At locations where a 1.5 foot curb offset is used, an alternative intake boxout, with the intake set back a minimum of 6 inches from the curb line, must be used to prevent intake grates from encroaching into the traveled way.

[9] Some jurisdictions allow parking on both sides of the street. When this occurs, each jurisdiction will set their own standards to allow for proper clearances, including passage of large emergency vehicles.

[10] For low volume residential streets, two free flowing lanes are not required and a 26 foot roadway may be used where parking is allowed on one side only. For higher volume residential streets, which require two continuously free flowing traffic lanes, a 31foot roadway should be used.

[11] Some minimum roadway widths have been increased to match standard roadway widths. Unless approved by Jurisdiction, all two lane roadways must comply with standard widths of 26, 31, 34, or 37 feet.

[12] Median width is measured between the edges of the traveled way of the inside lanes and includes the curb offset on each side of the median. Values include a left turn lane with a 6 foot raised median as required to accommodate a pedestrian access route (refer to Chapter 12) through the median (crosswalk cut through). At locations where a crosswalk does not cut through the median, the widths shown can be reduced by 2 feet to provide a 4 foot raised median.

[13] The use of 3:1 foreslopes is allowed, as shown, but may require a wider clear zone as slopes steeper than 4:1 are not considered recoverable by errant vehicles.

[14] It is preferred to select a design speed that is at least 5 mph greater than the anticipated posted speed limit of the roadway. Selecting a design speed equal to the posted speed limit may also be acceptable and should be evaluated on a project by project basis, subject to approval of the Engineer

[15] Values for low design speed (<50 mph) assume no removal of crown (i.e. negative 2% superelevation on outside of curve). According to the AASHTO Green Book (Table 3-1 and 3-13b) for low volume roadways with 10 or less units beyond the curve and projected traffic volumes of less than 100 vehicles per day beyond the curve, the horizontal curve radius may be a minimum of 107 feet if at least 115 feet of stopping sight distance is provided or the radius may be a minimum of 50 feet if at least 80 feet of stopping sight distance is available. Radii for design speeds of 50 mph or greater are based upon a superelevation rate of 6%. For radii corresponding to other superelevation rates, refer to the AASHTO's "Green Book."

[16] Assumes stopping sight distance with 2 foot high object.

[17] Use only if roadway has continuous overhead lighting.

[18] A typical minimum grade is 0.5%, but a grade of 0.4% may be used in isolated areas where the pavement is accurately crowned and supported on firm subgrade.

[19] Maximum gradient may be steepened by 2% for short distances and for one way downgrades.

Table 5C-1.03: Preferred Clear Zone Distances for Rural and Urban Roadways

Design Speed mph	Design Traffic ADT	Foreslope			Backslope or Parking		
		6:1 or flatter	*5:1 to 4:1*	*3:1*	*6:1 or flatter*	*5:1 to 4:1*	*3:1*
		In feet from edge of traveled way					
Urban 40 or less	All	For low-speed urban roadways, refer to 5C-1, C, 1.					
Rural 40 or less	Under 750	10	10	*	10	10	10
	750 to 1,500	12	14	*	14	14	14
	1,500 to 6,000	14	16	*	16	16	16
	Over 6,000	16	18	*	18	18	18
Rural and Urban 45 to 50	Under 750	12	14	*	12	10	10
	750 to 1,500	16	20	*	16	14	12
	1,500 to 6,000	18	26	*	18	16	14
	Over 6,000	22	28	*	22	20	16
Rural and Urban 55	Under 750	14	18	*	12	12	10
	750 to 1,500	18	24	*	18	16	12
	1,500 to 6,000	22	30	*	22	18	16
	Over 6,000	24	32	*	24	22	18
Rural and Urban 60	Under 750	18	24	*	16	14	12
	750 to 1,500	24	32	*	22	18	14
	1,500 to 6,000	30	40	*	26	22	18
	Over 6,000	32	44	*	28	26	22

Source: Adapted from the *Roadside Design Guide*, 2011

Table 5C-1.04: Acceptable Clear Zone Distances for Rural and Urban Roadways

Design Speed mph	Design Traffic ADT	Foreslope			Backslope or Parking		
		6:1 or flatter	*5:1 to 4:1*	*3:1*	*6:1 or flatter*	*5:1 to 4:1*	*3:1*
		In feet from edge of traveled way					
Urban 40 or less	All	For low-speed urban roadways, refer to 5C-1, C, 1.					
Rural 40 or less	Under 750	7	7	*	7	7	7
	750 to 1,500	10	12	*	12	12	12
	1,500 to 6,000	12	14	*	14	14	14
	Over 6,000	14	16	*	16	16	16
Rural and Urban 45 to 50	Under 750	10	12	*	10	8	8
	750 to 1,500	14	16	*	14	12	10
	1,500 to 6,000	16	20	*	16	14	12
	Over 6,000	20	24	*	20	18	14
Rural and Urban 55	Under 750	12	14	*	10	10	8
	750 to 1,500	16	20	*	16	14	10
	1,500 to 6,000	20	24	*	20	16	14
	Over 6,000	22	26	*	22	20	16
Rural and Urban 60	Under 750	16	20	*	14	12	10
	750 to 1,500	20	26	*	20	16	12
	1,500 to 6,000	26	32	*	24	18	14
	Over 6,000	30	36	*	26	24	20

Source: Adapted from the *Roadside Design Guide*, 2011

* Foreslopes steeper than 4:1 are considered traversable, but not recoverable. An errant vehicle can safely travel across a 3:1 slope, but it is unlikely the driver would recover control of the vehicle before reaching the bottom of the slope; therefore, fixed objects should not be present on these slopes or at the toe of these slopes.

gutter, the curb offset should be equal to or greater than the width of the curb and gutter section. In addition, grates and special shaping for curb intakes and depressions for open-throat intakes should be located within the curb offset width and should not encroach into the lane.

2. **Curb and Gutter:** Typically, a curb and gutter cross-section should consists of a 6 inch high, 6 inch wide curb with a concrete gutter section. If the design speed is 40 mph or below, an 8 inch curb may be used for certain arterial and collector streets. For design speeds greater than 40 mph, a 1 foot wide, 6 inch high sloped curb with a minimum 2 foot gutter offset should be used.

N. Parking Lane

Where curbed sections are used, the curb offset width may be included as part of the parking lane.

1. Parking lanes are not allowed on arterial streets.

2. Although on-street parking may impede traffic flow, parallel parking may be allowed by the Jurisdiction on urban collectors where sufficient street width is available to provide parking lanes.

3. Parking lane width determinations should include consideration for the potential use of the lane as a through or turn lane for moving traffic either during peak hours or continuously. If this potential exists, additional parking width should be provided.

O. Cul-de-sacs

A local street open at one end only should have a cul-de-sac constructed at the closed-end. The 2018 International Fire Code stipulates a minimum cul-de-sac radius of 48 feet however some jurisdictions allow lesser radii due to the size of their fire apparatus. The minimum radius for cul-de-sacs is 45 feet, which may be increased in commercial areas or if significant truck traffic is anticipated. The border area around the cul-de-sac should be the same as the approach street. The transition radius with the approach street will be 50 feet for residential streets and 75 feet for commercial and industrial streets.

The length of a cul-de-sac determines how many people are impacted by maintenance operations, traffic accidents, and other incidences that may stop traffic flow. Many Iowa cities limit the length of a cul-de-sac to 500 to 600 feet. Studies indicate the longer the cul-de-sac, the higher the vehicular speeds along it. The 2018 edition of the International Fire Code recommends the length of the cul-de-sac be less than 750 feet unless additional steps such as intermediate turnarounds are implemented. ITE, the Urban Land Institute, and ASCE indicate cul-de-sacs should be less than 1,000 feet long or the length that generates less than 200 trips per day according to the adjacent land use. For single family dwellings that generate 8 to 10 trips per day, the 200 trips per day would be produced by about 20 parcels.

P. Shoulder Width

Shoulders accommodate stopped vehicles, emergency use, and provide lateral support of the subbase and pavement. In some cases, the shoulder can accommodate bicyclists. Where no curb and gutter is constructed a soil, granular, or paved shoulder will be provided.

Desirably, a vehicle stopped on the shoulder should clear the pavement edge by 2 feet. This preference has led to the adoption of 10 feet as the desirable shoulder width that should be provided along high volume facilities. In difficult terrain and on low volume highways, usable shoulders of this width may not be practical.

Where roadside barriers, walls, or other vertical elements are used, the graded shoulder should be wide enough that these vertical elements can be offset a minimum of 2 feet from the outer edge of the usable shoulder. It may be necessary to provide a graded shoulder wider than used elsewhere on the curved section of a roadway or to provide lateral support for guardrail posts and/or clear space for lateral dynamic deflection required by the particular barrier in use. On low volume roads, roadside barriers may be placed at the outer edge of the shoulder; however, a minimum of 4 feet should be provided from the traveled way to the barrier.

Q. Intersection Radii

Minimum curb return radii are shown in Table 5C-2.03 below. Where truck traffic is significant, curb return radii should be provided according to the current AASHTO "Green Book;" turning templates are used in this design. The Iowa DOT has an Iowa truck vehicle that can be used to check the proposed radii for truck routes.

Table 5C-2.03: Curb Return Radii Based Upon Roadway Classification

Roadway Classification	Arterial	Collector	Local - Commercial/ Industrial	Local - Residential
Arterial	Special*	Special*	30'	30'
Collector	Special*	30'	30'	25'
Local - Commercial/Industrial	30'	30'	25'	25'
Local - Residential	30'	30'	25'	25'

*Special design required. Use turning templates.

R. Pavement Thickness

Refer to Section 5F-1 for pavement thickness determination and design.

S. References

American Association of State Highway and Transportation Officials (AASHTO). *A Policy on Geometric Design of Highways and Streets* ("Green Book"). Washington, DC. 2004.

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Des Moines Area Metropolitan Planning Organization (MPO). *Des Moines Area Daily Directional Capacities At Level of Service D*. Des Moines. 2000.

The fabric is secured to the existing pavement with pneumatic hammers at approximately 6 feet spacing or through the use of adhesives. It is critical that the fabric is free of wrinkles and no more than three edges overlap at one location. The weight of the fabric is dependent on the thickness of the overlay. Recommended weights for nonwoven geotextile fabrics for unbonded concrete overlays are as follows:

Overlays $\leq$ 4 inches – 13.3 oz/yd^2
Overlays $\geq$ 5 inches – 14.7 oz/yd^2

Temperature of the surface upon which the overlay is to be placed is critical to minimize fast drying out and shrinkage cracks in the PCC overlay. One method to assist in keeping the surface cooler is to specify a fabric interlayer that is white or light colored for the hot, summer months. A black or dark fabric interlayer can be used in the cooler spring and fall months.

Specifications for the nonwoven geotextile separation layer are included in SUDAS Specifications Section 7011.

5. **Thickness Design:** There are several design procedures available for determining the thickness of concrete overlays. Designers should reference the *Guide to the Design of Concrete Overlays Using Existing Methodologies* (Torres et al. 2012) for recent guidance. This document provides guidance on the following design procedures, in addition to more recent software design. The following design methodologies are most common:
   - Bonded Concrete Overlays on Asphalt (BCOA) Thickness Designer (ACPA 2012)
   - Bonded Concrete Overlays on Asphalt ME (Vandenbossche 2013) for overlays on asphalt
   - Guide for Design of Pavement Structures 4th Edition (AASHTO 1993)
   - StreetPave (ACPA 2012)

   Table 10 from the *Guide to Concrete Overlays* provides a summary of typical design and software parameters.

6. **Construction:** Concrete overlays are constructed using conventional concrete paving equipment and procedures. Construction time for concrete overlays is significantly shorter than reconstruction due to the lack of earthwork required as well as the potential for the paving equipment to move faster due to the thinner layer. Payment for concrete overlays are typically based on square yards of concrete placement and cubic yards of concrete delivered to the site. Table 21 from the *Guide to Concrete Overlays* provides a detailed list of construction consideration items and how they relate to bonded and unbonded concrete overlays.

   Joints are one of the most critical elements for overlay construction. Timing of joint sawing is critical and because of the smaller joint spacing, the sawing operation is likely to determine daily production limits. Joint spacing requires special consideration based on the type of overlay and the type of underlying pavement.

   For bonded overlays over concrete pavement, the joints in the overlay need to match the joints in the underlying pavement. The joints should be cut full depth plus 1/2 inch for transverse joints and T/2 for longitudinal joints. The width of the transverse saw cut must be equal to or greater than the width of the crack at the bottom of the transverse joint in the existing pavement.

   The recommended joint pattern for bonded overlays over asphalt pavement should not exceed 1 1/2 times the overlay thickness. Transverse joints should be sawed to T/3 using conventional saws and not less than 1 1/4 inches using an early entry saw. Longitudinal joints should be cut to T/3.

For unbonded overlays, it is generally a good practice to mismatch joints or cracks to maximize load transfer from the underlying pavement. Slab dimensions (in feet) should not exceed 1 1/2 times the overlay thickness for overlays less than 6 inches thick, and should not exceed 2 times the thickness with an absolute maximum of 15 feet for overlays greater than 6 inches thick. Transverse saw cuts for conventional saws and longitudinal joints should be T/3. Transverse cuts for early entry saws should be at least 1 1/4 inches deep.

C. Asphalt Overlays

1. HMA Overlays:

a. Conventional: Conventional HMA overlays are typically 2 to 4 inches thick, placed in multiple lifts. Lift thickness varies but are typically 1 1/2 inches to 3 inches thick. The overlay is expected to improve rideability, surface friction, profile, crown, and cross slope. In addition, specific distress types of low severity cracking, raveling, roughness, low severity bleeding, and low severity block cracking are improved. HMA overlays rely on timely compaction to be successful. Typically, HMA overlays are dense-graded but may also be open-graded if a porous mix is desired.

In order for the aggregate in the HMA overlay to properly align itself during compaction and achieve required density, the nominal maximum aggregate size must be no larger than 1/3 the thickness of the overlay. For example, for a 1 1/2 inch thick asphalt lift, nominal aggregate size should be no larger than 1/2 inch. See SUDAS Specifications Section 7020.

b. Thin Lift: Sometimes called thinlays, thin lift overlays generally range from 3/4 inch to 1 1/2 inches thick. With the thin lift overlays, the nominal maximum aggregate size must be no larger than 1/3 the thickness of the overlay. The mix has more asphalt binder (approximately 8%) than a traditional mix in order to cover the surface area. The binder (PG 64-34E+) is formulated to be softer, which helps the mix be more durable and resistant to cracking than traditional mixes.

Because of its nature and the overlay being very thin, it is critical to have a sound underlying pavement for the thin lift overlay to perform properly. In addition to the condition of the underlying pavement, one of the biggest factors for success is cleanliness, especially if milling is involved.

In most cases, milling of the underlying pavement will help improve smoothness as well as remove defects that could reflect through the new thin lift overlay. Milling will roughen the surface, which should improve the bonding and thus the shear resistance. With or without milling, cleaning of the roadway is imperative. Any amount of dust will affect the tack coat. Due to the thin nature, tack failure will lead to debonding and slippage.

The smaller aggregate size used in thin lift overlays can present production and transport challenges. If the air temperatures are cooler and the transport distance long, the mix may lose heat quicker than standard mixes and thus workability and compaction can be compromised. Production temperatures may need to be greater for thin lift overlays because they cool more quickly. Production time for thin lift overlay mixes is generally slower than for standard mixes. Fine aggregates generally retain more moisture than coarse aggregates and thus require more drying time. In addition, the fine aggregates require more asphalt to fully coat the greater surface area they exhibit.

A uniformly applied tack coat is essential to the success of thin lift overlays. Raveling and slipping of the surface course at the interface with the existing pavement are problems when tack coats are insufficient or applied in streaks.

With the thin lift thickness, it is difficult to isolate the density of the overlay from the density of the underlying pavement. Thus, in most cases, a rolling pattern is established. To date, experience has shown that three passes with a vibratory steel-wheeled roller provides appropriate density.

As noted, the performance of thin lift overlays will depend on traffic, climate, underlying pavement quality, surface preparation, materials, and construction quality. In colder climates such as in Iowa, special attention needs to be paid to thermal cracking and damage created by snowplows.

c. Interlayers: HMA interlayers can be placed prior to the HMA overlay to minimize reflective cracking from the underlying pavement. An asphalt interlayer is a specially designed lift of HMA placed over a pavement and under an asphalt overlay. The asphalt interlayer is usually about 1 inch thick and uses a highly polymerized asphalt binder (PG 58-34E), fine aggregates, and a higher than normal asphalt cement content to develop a flexible layer. The interlayer will have the elasticity to resist and partially absorb the tension, shear, and bending exerted on the pavement. The asphalt interlayer assists in retarding reflective cracking of the HMA overlay caused by movement of the underlying pavement. The asphalt interlayer also helps keep additional moisture from penetrating through any cracks that are reflected and thus delaying any further deterioration of the pavement structure.

The condition of the underlying pavement is critical. If an underlying pavement has deteriorated or become unstable, it may be necessary to do removal and patching or placement of a leveling course with standard HMA prior to placement of the interlayer. Due to the higher cost, the asphalt interlayer should not be used as a leveling course.

2. Crack and Seat with Asphalt Overlay: Cracking and seating with asphalt overlay is considered a major rehabilitation. Crack and seat will typically reduce the occurrence and severity of reflection cracks in the asphalt surface overlay. The crack and seat process is best used on structurally good PCC pavements with limited panel movement. Installing a subdrain well in advance, up to a year prior, of the crack and seating operation will enhance the quality of the crack and seat operation because the more stable subgrade/subbase will assist in efficient pavement cracking. The subdrain will also provide improved subgrade support for the new pavement structure. The existing concrete is broken with a segmental type breaker to produce hairline cracks at approximately 1 1/2 to 3 foot spacing. The cracked slabs are then seated by use of a weighted roller to reestablish support between the underlying subbase or subgrade and the existing pavement. The roller is usually a rubber-tired piece of equipment with a minimum gross load of 30 tons. Some streets may not have adequate strength to support a heavy roller. The engineer may designate the use of a lighter roller.

Crack and Seat - Photo courtesy of Antigo Construction

In urban areas, a full depth saw cut along the curbline and also around manholes and utility fixtures, such as water valves, is required prior to conducting crack and seat operations. In addition, a guillotine style breaker should be used with caution where structures are near the roadway. Impacts from the large single breaker can vibrate structures and cause concerns for property and utility owners. A segmental breaker results in lower magnitude vibrations and is

recommended for crack and seat projects in urban areas. Informing the public about the project and especially the project schedule will help avoid potential problems. Assuring complete transverse cracking is critical with a segmental breaker. The breaking pattern with the segmental breaker must be varied to avoid developing continuous longitudinal cracks. Crack and seat activities typically produce earth-borne vibrations that are below the level necessary to cause damage, unless the source of the vibrations is very close (< 25 feet). Therefore, these lower intensity vibrations can be considered annoying and may cause people to believe that the building is being damaged, when in reality it is not being damaged. However, there are certain conditions such as close proximity to historical buildings or buildings that house historical or antique artifacts that may require special attention to avoid damaging the structure or the artifacts in the structure. The following steps should be taken as the project design is progressing:

a. Identify potential problem areas along the project including evaluating the potential for damage to underground utilities.
b. Determine what conditions exist and check for existing damage. Deteriorated sewer systems and aging water mains could be damaged by the vibrations.
c. If allowed by the property owners, take photos of existing conditions prior to construction commencing to establish a baseline.
d. If necessary, provide for monitoring and recording vibrations during the project construction.
e. Be ready to investigate concerns and respond to them.

3. **Modified Rubblization with Asphalt Overlay:** Modified rubblization blends the principles of crack and seat and full rubblization by cracking the roadway to approximately 12 inch to 18 inch pieces. Installation of a longitudinal subdrain prior to initiating the modified rubblization process is strongly recommended. Subdrains will enhance the success of the project because the more stable subgrade/subbase will assist in efficient pavement breaking and provide improved subgrade support for the new pavement structure. This process can be used when softer subgrades prevent use of full rubblization. Seating is accomplished with either a 35 ton rubber tired roller or a 10 ton vibratory roller. A 2 inch to 3 inch rock interlayer of 3/4 inch roadstone may be placed on the rubbilized concrete and rolled prior to placing the asphalt overlay if surface variations remain after initially rolling. The use of the interlayer provides a more stable work platform and enhances the overlay's ability to stop reflective cracking.

   Like rubblization, modified rubblization is not recommended for use in urban areas due to the potential for damage to underground utilities, adjacent properties, and structures.

4. **Rubblizing with Asphalt Overlay:** Rubblizing of an existing concrete pavement and placement of an asphalt overlay is an optional major rehabilitation method. This process includes breaking up the concrete pavement into small pieces and rolling it into place to produce a sound base, which prevents reflective cracking in the asphalt surface. Rubblizing a concrete pavement successfully is predicated on having a stable subgrade so the concrete material does not intermix with the subgrade. Installation of a longitudinal subdrain prior to initiating the rubblization process is recommended and will enhance the success of the project because the drier, more stable subgrade/subbase will assist in efficient pavement cracking. Rubblization has limited uses in areas of soft subgrades, which are often encountered in Iowa. If soft subgrades are encountered during a project, complete failure of the rubblization can result. In urban areas, care must be taken not to damage utilities with minimal cover, as well as the associate utility structures. Rubblization is generally not advised for urban roads. The final surface is an asphalt overlay.

Rubblizing - Photo courtesy of Antigo Construction

It may be necessary to work with the rubblizing contractor to establish a 100 to 200 foot test section as a means of determining the effectiveness of the rubblization. The goal is to break the existing PCC pavement into pieces with a nominal maximum size of 6 inches. In certain circumstances, the designer may allow larger pieces but they should not exceed 12 inches in size and should only be allowed for a limited area. It may be appropriate to require the contractor to excavate a test pit (4 feet by 4 feet) to assure that the PCC has been fractured throughout its entire thickness and that the bond between any steel and the concrete has been broken.

The displacement of the rubbilized pieces into the subgrade should be minimized. A steel drum vibratory roller having a minimum gross weight of 10 tons is required to compact the rubbilized pavement.

In areas of soft subgrade, it may be necessary to remove the pavement and patch with 2 inch limestone chokestone. Geogrid may be used under the patch rock to add additional support.

A 2 inch to 3 inch rock interlayer of 3/4 inch roadstone may be placed on the rubbilized concrete and rolled prior to placing the asphalt overlay if surface variations remain after rolling. The use of the interlayer provides a more stable work platform and enhances the overlay's ability to stop reflective cracking.

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Chapter 10 - Street Tree Criteria

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General Information

A. Concept

Trees along our streets, in our parks, in other public spaces, and on private property provide a wide range of benefits. They improve the air we breathe, beautify the environment, reduce energy consumption, and make communities more pleasant places to live and work. A street tree is any tree with a trunk located 50% or more within the land lying between property lines on either side of public streets, boulevards, and alleys, including public easements. With narrower rights-of-way and the increasing use of underground utilities, the available space within a public right-of-way to plant trees is diminishing. Consideration should be given to placement of trees outside of the public right-of-way on private property, which will still maintain the aesthetic and environmental advantages of trees. In addition, the placement outside of the public right-of-way will prevent future complications of sight distance, utility conflicts, and construction conflicts.

If trees are placed in the public right-of-way, the principal considerations in design of the placement of street trees are their relation to horizontal and vertical clear zones. No street tree should be placed in the horizontal clear zone or triangular sight distance as described in Chapter 5. The minimum vertical clearance for mature trees should be 14 feet above the street grade, 10 feet above recreational trails, and 8 feet above sidewalks. Special considerations must be given to clearances to overhead utility lines, driveways, traffic signs, and underground utilities. Permits may be required prior to planting.

B. Conditions

1. **Design Standards:**

   a. SUDAS Design Manual

   b. Recognized design publications for street trees

   c. In case of a conflict between the above design standards, the Jurisdictional Engineer should be contacted for clarification

2. **Construction Standards:** Use the most recent edition of the SUDAS Standard Specifications together with the latest contract supplementary information.

3. **Project Submittals:** If street trees are allowed by the Jurisdiction and if project submittals are required, a street tree planting layout showing the quantity, species/cultivar, and location of all trees must be submitted for review. This plan is to be approved by the Jurisdiction prior to the tree planting and a permit issued if the proposed trees are within the public right-of-way.

4. **Ownership:** If the tree is located in the public right-of-way or publicly owned property, Section 364.12 of the Iowa Code requires the Jurisdiction to remove deadwood or diseased trees. If the street tree(s) are located outside of public property or right-of-way, the responsibility and ownership is that of the landowner.

5. **Establishment and Warranty Periods:** The establishment period is 1 year after the installation has been accepted by the Engineer. Care and maintenance of all plants will be the responsibility of the Contractor during that time. The Engineer has the option to include an additional year, which is called the warranty period. If specified, the warranty period begins immediately after the establishment period and continues for another year. Check with the Jurisdiction for their requirements.

Street Tree Design

A. Area Requirement per Tree

At least 9 square feet of ground is required for each tree and the trunk of street trees should be no closer than 2.5 feet from impervious surface material.

B. Spacing

For planning purposes, the ideal spacing should be based on species and cultivar of tree selected. Trees should not be spaced closer than the size of their mature horizontal spread.

C. Location within Public Right-of-way

The following criteria are for the location of street trees that are located in the street right-of-way. Jurisdictions may require additional street right-of-way to provide clearances to underground or overhead utilities. The mature tree trunk size should be taken into account when placing the tree. The criterion does not include street trees located within medians. Special designs that meet the required clear zone must be used when locating trees within medians.

1. Minimum distance of 5 linear feet from water service stop boxes.

2. Minimum distance from the edge of the traveled way according to Chapter 5.

3. Minimum distance of 10 linear feet from hydrants, poles, transformers, telephone junction boxes, manholes, and driveway approaches.

4. Minimum distance from street lights of 25 linear feet or the width of spread of the mature tree, whichever is greater.

5. In central business districts where traffic speeds are low, a minimum distance of 3 feet from the back of curb should be used for street trees if a minimum distance of 8 feet exists for right-of-way from the back of curb.

6. No trees should be in the horizontal clear zone or triangular sight distance area. (See Chapter 5).

7. Do not plant street trees in any public right-of-way that has less than 12 feet from back of curb or edge of pavement to the property line on each side of the street.

8. All underground utilities or any other improvements, either private or public, will be located before excavation is done. Information on contacting Iowa One Call will be included in the contract documents. The Iowa One Call phone number is 811 or use iowaonecall.com for online ticketing.

D. Tree Size

Street trees should be a minimum of 1 1/2 inch diameter for ornamental and shade trees or as specified and measured at 6 inches above grade after planting unless smaller trees are allowed.

E. Selection of Trees

When selecting trees, care must be taken to consider site conditions; including above and below ground spatial and environmental conditions. It is also important to consider how selection(s) complement existing plant material to ensure a diverse, functional, and attractive tree canopy can be developed.

Some of these trees produce fruit or seed pods that can increase maintenance needs along walkways. Others need additional pruning to ensure proper clearance and a healthy leader or have shallow root systems. Consideration should be taken in the maintenance needs, site conditions, and diversity of trees selected. Consulting a licensed landscape architect or certified arborist prior to selecting trees is recommended.

Planting under overhead utility lines is not always feasible and make sure it is allowed by the local jurisdiction. When planting under overhead utility lines, proceed with caution and careful consideration to local jurisdiction requirements and mature tree height impacts.

Table 10B-1.01 offers tree species and cultivar selections for use as street trees along neighborhood and municipal streets. This table is not all-inclusive; other species or different varieties of the listed species may be used with approval of the jurisdiction. Not all these trees will work in every situation; it is important to take local site constraints into consideration. This table should be considered a starting point for individuals looking for well-adapted and pest resistant trees for Iowa communities. It is important to check with each jurisdiction since certain species listed may not be allowed or have quantity restrictions to increase local tree diversity. Monoculture planting of one species can have disease and pest impacts and should be avoided; some jurisdictions have specific guidelines for increasing tree diversity in their communities.

Table 10B-1.01: Selection of Trees

Common Name	Genus Name	Mature Shape	Mature Height (feet)	Mature Spread (feet)
Maples[3]				
Autumn Blaze Maple	Acer x freemanii 'Jeffersred'	Broad Oval	50	40
Firefall Maple	Acer x freemanii 'AF#1'	Seedless, Upright Oval	50	35
Marmo Maple	Acer x freemanii 'Marmo'	Seedless, Upright Oval	55	45
Sienna Glen Maple	Acer x freemanii 'Sienna'	Pyramidal	50	35
State Street Maple	Acer miyabei 'Morton'	Upright Oval	50	35
Rugged Ridge Maple	Acer miyabei 'JFS-KW3AMI'	Upright Oval	55	40
Greencolumn Maple[10]	Acer nigrum 'Greencolumn'	Upright Oval	60	25
Armstrong Gold Maple[4]	Acer rubrum 'JFS-KW78'	Narrow Upright	40	12
Red Sunset Maple[4]	Acer rubrum 'Franksred'	Upright Oval	45	35
Redpointe Maple[4]	Acer rubrum 'Frank Jr.'	Broad Pyramidal	35	30
Apollo Maple[10]	Acer saccharum 'Barrett Cole'	Narrow Upright	30	10
Fall Fiesta Maple[10]	Acer saccharum 'Bailsta'	Broad Oval	50	40
Sugar Maple 'Green Mountain'[10]	Acer saccharum 'Green Mountain'	Broad Oval	50	40
Three-Flower Maple[5]	Acer triflorum	Broad Oval	25	20
Serviceberry				
Autumn Brilliance Serviceberry (Single Stem Only)	Amelanchier x grandiflora 'Autumn Brilliance'	Upright Oval	25	15
Robin Hill Serviceberry (Single Stem)	Amelanchier x grandiflora 'Robin Hill'	Upright Oval	25	15
Cumulus Serviceberry (Single Stem)	Amelanchier laevis 'Cumulus'	Upright Oval	25	15
Hornbeam				
European Hornbeam[2, 5]	Carpinus betulus	Broad Oval	35	25
American Hornbeam[2, 5, 10]	Carpinus caroliniana	Broad Oval	25	20
Hackberry				
Chicagoland Hackberry[10]	Celtis occidentalis 'Chicagoland'	Upright Oval	50	40
Prairie Pride Hackberry[10]	Celtis occidentalis 'Prairie Pride'	Upright Oval	50	40
Prairie Sentinel Hackberry[10]	Celtis occidentalis 'JFS-KSU1'	Upright Oval	45	12
Yellowood, Cornelian Cherry and Filbert				
Yellowood[5,6]	Cladrastis kentukea	Upright Oval	50	40
Golden Glory Cornelian Cherry (Single Stem)	Cornus mas 'Golden Glory'	Broad Oval	22	18
Saffron Sentinel Cornelian Cherry[5] (Single Stem)	Cornus mas 'JFS-PN4Legacy'	Columnar	22	12
Turkish Filbert[5, 8, 9]	Corylus colurna	Pyramidal	40	25
Hawthorn				
Washington Hawthorn[5]	Crataegus phaenopyrum	Broad Oval	25	20
Winter King Green Hawthorn	Crataegus viridis 'Winter King'	Wide Vase Shaped	20	25

Table 10B-1.01: Selection of Trees (continued)

Common Name	Genus Name	Mature Shape	Mature Height (feet)	Mature Spread (feet)
Honeylocust				
Street Keeper Honeylocust[10]	Gleditsia triacanthos var. inermis 'Draves'	Narrow Upright	45	20
Northern Acclaim Honeylocust[10]	Gleditsia triacanthos var. inermis 'Harve'	Broad Pyramid	45	35
Skyline Honeylocust[10]	Gleditsia triacanthos var. inermis 'Skycole'	Broad Pyramid	45	35
Shademaster Honeylocust[10]	Gleditsia triacanthos var. inermis 'Shademaster'	Upright Vase Shape	50	35
Ginkgo				
Autumn Gold Ginkgo (Fruitless, Male)	Ginkgo biloba 'Autumn Gold'	Broad Conical	45	35
Magyar Ginkgo (Fruitless, Male)	Ginkgo biloba 'Magyar'	Pyramidal	50	30
Presidential Gold Ginkgo (Fruitless, Male)	Ginkgo biloba 'The President'	Broad Conical to Oval	50	40
Princeton Sentry Ginkgo (Fruitless, Male)	Ginkgo biloba 'Princeton Sentry'	Narrow Conical	45	25
Kentucky Coffeetree and Osage Orange				
Kentucky Coffeetree 'Espresso' (Seedless, Male)[10]	Gymnocladus dioicus 'Espresso'	Oval to Vase Shaped	60	40
White Shield Osage Orange (Fruitless, Thornless)[5]	Maclura pomifera 'White Shield'	Upright Spreading, Rounded	35	35
Crabapples				
Adirondack Crabapple[5]	Malus 'Adirondack'	Dense Upright	18	10
Ivory Spear Crabapple[5]	Malus 'JFS-KW214MX'	Narrow	18	7
Golden Raindrops Crabapple	Malus 'Schmidtcutleaf'	Upright, Vase Shaped	20	15
Marilee Crabapple	Malus 'Jarmin' PP 14337	Narrow Upright, Vase Shaped	24	10
Purple Prince Crabapple	Malus 'Purple Prince'	Rounded	20	20
Raspberry Spear Crabapple[5]	Malus 'JFS-KW213MX'	Narrow	20	8
Royal Raindrops Crabapple	Malus 'JFS-KW5'	Upright, Spreading	20	15
Ruby Dayze Crabapple[5]	Malus 'JFS-KW139MX'	Upright, Oval	22	16
Snow Crystal Crabapple[5]	Malus 'JFS KW218MX'	Pyramidal, Compact	15	12
Sparkling Sprite Crabapple[5]	Malus 'JFS-KW207' PP27954	Compact Dense Round	12	12
Black Gum, Ironwood, Planetree and Sargent Cherry				
Black Gum (Black Tupelo)[7]	Nyssa sylvatica	Pyramidal	35	20
American Hophornbeam (Ironwood)[2,5]	Ostrya virginiana	Upright Oval	22	16
Excamation Planetree[4]	Platanus x acerifolia 'Morton Circle'	Upright Pyramidal	55	35
Oak[4, 9]				
White Oak[10]	Quercus alba	Spreading	50	50
Swamp White Oak[1, 7, 10]	Quercus bicolor	Upright Spreading	75	60
Crimson Spire Oak	Quercus x bimundorum 'Crumschmidt'	Columnar	45	15
Prairie Stature Oak	Quercus x bimundorum 'Midwest'	Broad Pyramid	50	40
Scarlet Oak	Quercus coccinea	Round Open	50	40

Table 10B-1.01: Selection of Trees (continued)

Common Name	Genus Name	Mature Shape	Mature Height (feet)	Mature Spread (feet)
Shingle Oak[10]	Quercus imbricaria	Broad Oval	50	40
Burr Oak[10]	Quercus macrocarpa	Broad Open	55	45
Urban Pinnacle Oak[10]	Quercus macrocarpa 'JFS-KW3'	Narrow Pyramid	55	25
Chinkapin Oak	Quercus muehlenbergii	Round Open	45	45
Heritage Oak[5]	Quercus robur x macrocarpa	Broad Pyramid, Oval	60	40
Northern Red Oak[10]	Quercus rubra	Pyramidal to Round Open	60	60
Kindred Spirit Oak	Quercus x warei 'Nadler'	Tightly Columnar	30	6
Regal Prince Oak	Quercus x warei 'Long'	Narrow Oval	45	18
Tree Lilacs				
Ivory Silk Japanese Tree Lilac	Syringa reticulate 'Ivory Silk'	Oval, Rounded	25	20
Beijing Gold Peking Lilac	Syringa reticulate subsp. Pekinensis 'Zhang Zhiming'	Oval, Rounded	20	15
China Snow Peking Lilac	Syringa subsp. Pekinensis 'Morton'	Rounded	25	20
Great Wall Peking Lilac	Syringa subsp. Pekinensis 'WFH2'	Upright, Oval Habit	20	12
Summer Charm Peking Lilac	Syringa subsp. Pekinensis 'DTR 124'	Oval, Rounded	20	15
Bald-cypress				
Bald-cypress[7]	Taxodium distichum	Pyramidal	55	30
Linden				
Boulevard Linden[2, 3, 5, 10]	Tilia americana 'Boulevard'	Narrow Pyramid	50	25
American Sentry Linden[2, 3, 5, 10]	Tilia americana 'McKSentry'	Pyramidal	45	30
Redmond Linden[2, 3, 5, 10]	Tilia Americana 'Redmond'	Pyramidal	50	35
Harvest Gold Linden[2, 3, 5]	Tilia cordata x mongolica 'Harvest Gold'	Pyramidal	40	30
Glenleven Linden[2, 3, 5]	Tilia x flavescens 'Glenleven'	Pyramidal	50	30
Silver Linden[3, 5]	Tilia tomentosa	Pyramidal	45	35
Elms				
Jefferson Elm[10]	Ulmus americana 'Jefferson'	Vase-shaped	70	59
Princeton Elm[10]	Ulmus americana 'Princeton'	Vase-shaped	60	40
Prairie Expedition Elm[10]	Ulmus americana 'Lewis & Clark'	Broad Rounded	55	60
Accolade Elm	Ulmus 'Morton'	Vase-shaped	70	60
Triumph Elm	Ulmus 'Morton Glossy'	Upright Oval	55	45
New Horizon Elm	Ulmus 'New Horizon'	Upright Oval	55	40
Prospector Elm	Ulmus ' Prospector'	Vase-shaped	40	30
Discovery Elm	Ulmus 'Discovery'	Vase-shaped	50	40

[1] High PH sensitive.
[2] Salt intolerant.
[3] Restrictions of use may exist due to over planting or pests. Check with the local jurisdiction.
[4] Spring dig only. Fall quantities may be limited.
[5] May be limited quantities available.
[6] Susceptible to wind damage.
[7] Tolerant of wet soils.
[8] Not suitable for heavy clay sites.
[9] Fruit or nut litter may be a concern.
[10] Tree native to Iowa.

F. Trees NOT Recommended for Planting in the Public Right-of-Way

The species of trees listed in Table 10B-1.02 are not recommended for street tree use. Species may be used with approval of the jurisdiction. Conifers are generally inappropriate for use along city streets and therefore are not included in Table 10B-1.01. Table 10B-1.02 is a summary of species considered to be undesirable or invasive by many jurisdictions.

Table 10B-1.02: Trees Not Recommended

Siberian Elm*	Box Elder	Cotton-Bearing Cottonwood
Chinese Elm*	European Mountain Ash	White Poplar
Silver Maple*	Catalpa	Willows
Russian Olive	Tree of Heaven	Austrian Pine
Bolleana Poplar	Weeping Birch	Lombardy Poplar
Black Locust*	Autumn Olive	Ash
Mulberry		

* Some cultivars and hybrid varieties accepted; however, use caution and confirm it is acceptable with the local jurisdiction.

G. Guideline for Selection of Nursery Trees

If inspecting nursery stock prior to delivery to the project site, use the following criteria and the requirements of SUDAS Specifications Section 9030, 2.01 to evaluate the plant materials.

1. There should be no roots greater than 1/10 the trunk diameter circling more than one-third the way around in the top half of the root ball. Roots larger than this may be cut provided they are smaller than one-third the trunk diameter. There should be no kinked roots greater than 1/5 the trunk diameter. Roots larger than this can be cut provided they are less than one-third the trunk diameter.

2. Plants should be in a healthy, vigorous condition and essentially free of dead or broken branches, scars that are not completely healed, frost cracks, disfiguring knots, broken or abraded bark, redundant leaders or branches, rubbing branches or aberrations of any kind. Plants should not have multiple leaders, unless that is their natural form.

3. Ensure trees are rooted into the root ball so that soil or media remains intact and trunk and root ball move as one when lifted. The trunk should bend when gently pushed, not pivot at or below soil line.

4. The point where the top-most root in the root ball emerges from the trunk, called the root flare, should be visible at the soil surface.

5. Comply with ANSI Z60.1 for the relationship between caliper, height, and root ball size, as shown in Table 10B-1.02.

6. There should be one dominant leader more-or-less straight to the top of the tree with the largest branches spaced at least 6 inches apart. There can be a double leader in the top 10% of the tree.

7. The tree canopy should be symmetrical, free of large voids, and typical of the species or cultivar. Live crown ratio (distance from bottom of canopy to tree top/tree height) should be at least 60%.

8. Branches should be less than 2/3 the trunk diameter, free of bark inclusions, and more-or-less radially distributed around the trunk.

9. Trees greater than 1 1/2 inches caliper should be able to stand erect without a supporting stake.

10. Ensure the trunk and main branches are free of wounds (except for properly-made pruning wounds), damaged areas, conks, bleeding, and signs of insects or disease.

11. In areas near overhead utility lines, the mature height of the tree should be a minimum of 10 feet lower than the overhead lines.

12. If any of the above conditions are not met, trees may be rejected.

Table 10B-1.02: Caliper/Rootball/Height Relationship

Caliper (inches)	Average Height (feet)	Minimum Rootball Diameter (inches)
1	8 to 10	16
1 1/2	10 to 12	20
2	12 to 14	24
2 1/2	12 to 14	28
3	14 to 16	32
3 1/2	14 to 16	38
4	16 to 18	42

Source: American Standard for Nursery Stock (ANSI Z60.1), 2014

H. Staking of Trees

Depending on the size of the trees identified to be planted, the jurisdictional engineer should designate if staking is required. Generally, if plant stock is delivered with well developed root balls, and if properly planted, it will not require staking. In areas where damage due to deer is of a concern, trees can be protected by placing sturdy wood stakes or fence posts at 18 inch intervals around the tree. In some jurisdictions, staking of trees in the public right-of-way is not allowed.

References

The following references can be found from ISU Extension:

1. Shade Trees for Iowa - Ash Alternatives
2. Small-stature Trees for Iowa - Ash Alternatives
3. Establishing a Community Tree Program - Community Trees
4. Conifer Species for Iowa - Community Trees
5. Tips for Proper Planting of Containerized Trees
6. Care of Newly Planted Trees
7. Pruning Trees: Shade, Flowering, and Conifer - Sustainable Urban Landscapes
8. Trees and Construction
9. Yard and Garden: Planting Bare-root Trees
10. Community Tree Planting and Care Guide

Table of Contents

Chapter 13 - Traffic Control

13A Traffic Signals

13B Work Zone Traffic Control

Traffic Signal General Information

A. Introduction

The purpose of this chapter is to supplement SUDAS Specifications Section 8010 and to provide general guidance for traffic signal designs on roadways within Iowa. The information is provided as an overview for traffic signals design consideration.

B. Scope

There is no legal requirement to use the information within this chapter by local agencies. This document refers to a number of other resources available for the designer to be considered when designing a traffic control signal. The document loosely follows the format of the MUTCD, as published by The U.S. DOT, FHWA and as adopted or modified by the Iowa DOT. However, no attempt is made to re-print the content of the MUTCD herein. A variety of other technical resources are also noted for consideration by the designer.

By MUTCD definition, a traffic control signal is "any highway traffic signal by which traffic is alternately directed to stop and permitted to proceed" with highway traffic signal being defined as "a power-operated traffic control device by which traffic is warned or directed to take some specific action. These devices do not include power-operated signs, illuminated pavement markers, barricade warning lights, or steady-burning electric lamps." From an application standpoint traffic control signals are used to assign vehicular or pedestrian right-of-way.

The design for traffic control signals shall be in conformance with the current edition of the MUTCD as adopted or modified by the Iowa DOT. The following should be used as design standards as applicable to a project:

- MUTCD Part 4 Highway Traffic Signals
- Jurisdiction Design Standards and Construction Standards
- Iowa DOT and FHWA regarding the design of traffic control signals
- Institute of Transportation Engineers - "Manual of Traffic Signal Design," "Traffic Engineering Handbook," "Manual of Transportation Engineering Studies" and "Traffic Control Devices Handbook."
- "Signal Timing Manual", NCHRP Report 812
- Other standard references such as the National Electrical Code by the National Fire Protection Association (NFPA), and the National Electrical Manufacturers Association (NEMA) Standards Publications.

Other resources to consider and that are referenced within this document include:

- MnDOT Traffic Engineering Manual
- MnDOT Signal Design Manual
- MnDOT Lighting and Signal Certification Field Guide
- Ohio DOT Traffic Engineering Manual
- FHWA Automated Traffic Signal Performance Measures
- FHWA Adaptive Traffic Signal Control Website

Traffic Control Signal Needs Study

A. General

The MUTCD states that "A traffic control signal should not be installed unless an engineering study indicates that installing a traffic control signal will improve the overall safety and/or operation of the intersection." The first question that must be answered is whether a traffic control signal is justified or is the most effective treatment option. It is the responsibility of the Engineer or agency to make this determination with serious consideration given to MUTCD Section 4B.

B. Data Collection

The engineering study should be based upon current site and traffic data (vehicle, pedestrian, etc.) pertaining to the candidate location. The following studies may be helpful in assessing and demonstrating the need for a signal:

- Volume studies, including approach volumes, turning movements, and peak hour detail counts
- Pedestrian counts, including any unusual numbers of children, handicapped, and elderly
- Traffic gap studies
- Speed studies
- Crash studies
- Intersection delay studies

Procedures for completing various traffic studies are found in the ITE Manual of Transportation Engineering Studies.

MUTCD Section 4C.01 provides a detailed description of engineering study data which may be needed to conduct a warrant analysis.

C. Warrants

MUTCD Section 4C.01 "Studies and Factors for Justifying Traffic Control Signals" states, "An engineering study of traffic conditions, pedestrian characteristics, and physical characteristics of the location shall be performed to determine whether installation of a traffic control signal is justified at a particular location.

Ohio DOT's Traffic Engineering Manual Part 4-Signals provides additional guidance for consideration of the reduction of minor approach right turning volume for traffic signal warrants to account for minor approach lane configurations, the proportion of right turns to other traffic, and the conflicting through volumes on the major street.

Guidelines regarding the installation of pedestrian hybrid beacons (HAWK signals) are provided in MUTCD Chapter 4F. These guidelines consider vehicular and pedestrian crossing volumes, crosswalk length and traffic speeds.

Mn/DOT's Traffic Signal Design Manual Section 9-4.02.03 provides additional guidance for advance warning flashers consideration.

Traffic Signal Features

A. Traffic Control Signal Features

The MUTCD Chapter 4D Traffic Control Signal Features establishes traffic signal uniformity and serves as a critical resource for each traffic signal design. The features of traffic control signals of interest to road users are the location, design, and meaning of the signal indications. Uniformity in the design features that affect the traffic to be controlled, as set forth in the MUTCD, is especially important for reasonably safe and efficient traffic operations.

B. Pedestrian Control Features

The MUTCD Chapter 4E Pedestrian Control Features establishes pedestrian control uniformity and serves as a critical resource for each traffic signal design. Pedestrian signal heads provide special types of traffic signal indications exclusively intended for controlling pedestrian traffic. These signal indications consist of the illuminated symbols of a WALKING PERSON (symbolizing WALK), an UPRAISED HAND (symbolizing DONT WALK), and a countdown display.

C. Agency Specific Information

Agencies often have different design requirements in addition to those found in the MUTCD. Therefore, one of the first steps in the traffic signal design process is to learn the design requirements by meeting with agency staff and studying agency specific design manuals, specifications, and/or standard details. Field observations of existing traffic signals within an agency's jurisdiction can also provide insight to specific design requirements.

Determining agency specific design requirements prior to design can be challenging. It can be difficult to ask all the right questions, give all the necessary answers, and not overlook any details. More challenges can arise when staff is less experienced or a new working relationship is being established. Most design requirements that are overlooked will be caught during the design process or review process. However, taking steps to prevent design requirements from being overlooked will accelerate the design process and minimize costs by eliminating or reducing change orders. The following are some examples of design requirements that can vary between agencies.

- The MUTCD requires a maximum distance of 180 feet from the stop line to the 12 inch signal faces unless a near side supplemental signal face is used. A previous version required a maximum distance of 150 feet and some agencies continue to follow the old requirement.
- Some agencies center mast arm mounted signal heads over the lane line and others center them over the center of the lane.
- Certain agencies elect to install supplemental signal heads on the vertical shaft of the mast arm pole and others elect not to.
- Doghouse style five section heads are used for protected / permissive left turns by some agencies but not others.
- Protected / permissive left turn operation can vary. Some agencies configure left turn lane detection to call the protected phase only when two to three vehicles are queued, while other agencies always call the protected phase.
- Detector types, sizes, and layouts vary between agencies.

- The size and number of conduits, handholes, and wiring varies greatly among agencies.
- Some agencies share conduit between signal cable, street light power, and/or interconnect while others keep these cables in separate conduits.
- Some agencies choose to install emergency vehicle preemption.
- Some agencies choose to install traffic monitoring (PTZ) cameras.
- Signal wiring details vary among agencies.
- Some agencies use the "astro" type brackets to mount all signal heads and others do not use this on side of pole mounted heads. Bracketing and banding of all hardware (typically to the poles) varies greatly among agencies.
- Traffic signal cabinets, cabinet risers, and controller types and preferences vary greatly among agencies.
- Mounting heights for signal heads, street light luminaires, detection cameras, monitoring cameras, etc. vary greatly among agencies.
- Pedestrian signals may or may not include Assessible Pedestrian Signals (APS), with or without voice messages.
- Agencies use a variety of signal interconnect and communication systems including fiber optic cable, wireless systems, and GPS timeclocks.
- Pedestrian walking speed for crossing interval timing may vary.

D. Signal Design Criteria

Signal designers should coordinate with the agency regarding specific traffic signal elements to be included in a project. This is particularly important for a first project with a new agency. A list or memoranda regarding signal design criteria for review by and discussion with the agency early in the project development may be of significant benefit to both the engineer and agency. The following is a list of possible signal design criteria items to consider:

1. **General:** General nature of the signal project - new installation, replacement, minor modifications, or major modifications.

2. **Signal Phasing:**
   a. Phase numbering (Phase 2 southbound or major through movement)
   b. Left turn phasing for each approach (protected-only, protected-permissive, permissive-only, split-phase)
   c. Leading pedestrian interval
   d. Use of overlaps

3. **Signal Heads:**
   a. Based on proposed left turn phasing
   b. Overhead locations relative to lane lines
   c. Side-of-pole locations
   d. Head configurations, displays, color
   e. Pedestrian signal head type (1-section or 2-section)
   f. Head mounting hardware and bracket types
   g. Backplates, visors

4. **Poles:**
   a. Pole types (mast arm, combination mast-arm/ lighting, pedestal)
   b. Pole locations considering clear zone, sidewalk, utilities and right-of-way constraints
   c. Pole base types (T-base or anchor base)
   d. Luminaire mounting height for combination poles
   e. Special pole finishes (paint, powdercoat)
   f. Special pole handhole needs

5. **Detection:**
   a. Type of vehicle detection (video, pavement loops, microwave, other)
   b. Advance detection based on approach speeds
   c. Detection to accommodate Automated Traffic Signal Performance Measures
   d. Emergency Vehicle Preemption (EVP) detectors
   e. Pedestrian pushbuttons (APS or non-APS)
   f. Pushbutton locations per ADA and MUTCD guidance
   g. Special detection needs (bicycles)

6. **Controller/ Cabinet:**
   a. Controller type or model (NEMA, ATC, 2070)
   b. Cabinet type or model (TS1, TS2, ATC, 2070)
   c. Cabinet location
   d. Pad or pole-mounted cabinet
   e. Battery back-up (UPS)
   f. Cabinet riser height
   g. Meter location
   h. Misc. cabinet equipment

7. **Conduit and Wiring:**
   a. Conduit sizes and types
   b. Separate conduits for lighting, power and/or fiber optic cable
   c. Signal cable configurations (number of conductors)
   d. Lighting cable sizes
   e. Ground wire, tracer wire and pull tape
   f. Fiber optic cable configuration, routing, termination and splicing
   g. Misc. cables (video, EVP, Cat 5/6, etc.)

8. **Handholes:** Handhole types and locations, including whether to provide one near the controller, and for the ground rod near the foundation.

9. **Interconnect:**
   a. Need for coordinated signal operation
   b. Type of interconnect
   c. Modifications needed at adjacent signalized intersections

10. **Power Service:**
    a. Coordination with utility company
    b. Power source location and type (overhead or pad-mounted transformer)
    c. Meter requirements
    d. Metered or un-metered lighting

11. **Signs:**
    a. Street name signs
    b. Lane use signs
    c. Traffic signal signs
    d. Pedestrian pushbutton signs

12. **Construction Staging:**
    a. Potential need for temporary signals and/or detection
    b. Lane closures
    c. Special requirements

13. **Miscellaneous:**
    a. Potential need for AWF
    b. Construction schedule and anticipated pole and equipment lead times
    c. Supplemental specifications and/or plan notes as needed
    d. Signal turn-on procedure, possible portable dynamic message signs
    e. Luminaires for combination poles

E. Additional Information

In addition to typical vehicle and pedestrian signals, the MUTCD also provides guidance on the following types of traffic signals:

Chapter 4F Pedestrian Hybrid Beacons
Chapter 4G Traffic Control Signals and Hybrid Beacons for Emergency-Vehicle Access
Chapter 4H Traffic Control Signals for One-Lane, Two-Way Facilities
Chapter 4I Traffic Control Signals for Freeway Entrance Ramps
Chapter 4J Traffic Control for Movable Bridges
Chapter 4K Highway Traffic Signals at Toll Plazas
Chapter 4L Flashing Beacons
Chapter 4M Lane-Use Control Signals
Chapter 4N In-Roadway Lights

Traffic Signal Design Considerations

In addition to basic MUTCD requirements, the safe and efficient operation of a signalized intersection requires careful attention and balance of a number of design parameters. This section provides some reference resources for the traffic signal designer in consideration of these features.

A. Geometrics

The geometrics of an intersection are a critical consideration given the potential impact on intersection safety and performance. Geometrics directly impact sight distance, vehicle separation, operations, and capacity. As a result, intersection geometrics should always be considered whether dealing with existing, reconstructed, or new signalized intersections.

References are made to Signalized Intersections: Informational Guide, Second Edition, FHWA-SA-13-027, July 2013, which provides a single, comprehensive document with methods for evaluating the safety and operations of signalized intersections and tools to remedy deficiencies. The treatments in this guide range from low-cost measures such as improvements to signal timing and signage, to high-cost measures such as intersection reconstruction or grade separation. While some treatments apply only to higher volume intersections, much of this guide is applicable to signalized intersections of all volume levels.

1. **Basic Geometric Considerations:** The geometric design section of the Signalized Intersections: Informational Guide provides the following comments:

   Geometric design profoundly influences roadway safety; it shapes road user expectations and defines how to proceed through an intersection where many conflicts exist. In addition to safety, geometric design influences the operational performance for all road users. Minimizing impediments, reducing the need for lane changes and merge maneuvers, and minimizing the required distance to traverse an intersection all improve intersection safety and operational efficiency.

   All possible road users' (Chapter 2 of the guide) needs must be considered to achieve optimal safety and operational levels at an intersection. When road user groups' design objectives conflict, the practitioner must carefully examine the needs of each user, identify the tradeoffs associated with each element of geometric design, and make decisions with all road user groups in mind. For instance, practitioners may design corner radii to accommodate large vehicles. However, these larger radii could be detrimental to pedestrian safety due to the increase in walking distances and the increase in speed of turning vehicles.

   The geometric design chapter (Chapter 4 of the guide) addresses the following design topics to be considered when designing traffic signal controlled intersections:
   - 4.1 Number of Intersection Legs
   - 4.2 Channelization
   - 4.3 Horizontal and Vertical Alignment
   - 4.4 Corner Radius
   - 4.5 Sight Distance
   - 4.6 Pedestrian Treatments

- 4.7 Bicycle Facilities
- 4.8 Transit Facilities

2. Additional Sight-Distance Considerations:

a. Sight distance is a safety requirement that impacts intersection geometrics as fundamental as horizontal and vertical alignments. It is a design requirement that is discussed in detail as it relates to the visibility of traffic signal indications in the MUTCD. In addition to the sight distance requirements of the MUTCD, the AASHTO "Policy on Geometric Design of Highways and Streets 2018" states that at signalized intersections, the first vehicle stopped on one approach should be visible to the driver of the first vehicle stopped on each of the other approaches. It also states that left turning drivers need sufficient site distance to decide when to turn left across the lane(s) used by opposing traffic. This requires consideration of offset left turn lanes for permissive left turns to provide adequate left turn sight distance. If right turns are allowed on a red signal indication, the appropriate sight distance to the left of the right turning vehicle should be provided. See Chapter 9 - Intersections in the AASHTO "Policy on Geometric Design of Highways and Streets 2018" for additional sight distance information.

b. One sight distance issue that deserves additional consideration is the sight triangle and the sight obstructions found within it. Certain obstructions are obvious like structures near the street. Other obstructions are not always obvious or are installed after the traffic signal is designed and constructed. These obstructions seem to blend into the background. They are obstructions like entrance monuments, parked vehicles, special street name signs, business signs, and landscape vegetation that may not be a problem initially but become a problem as the plants reach maturity. Finally, be aware of the signal cabinet size and location including the height of the footing or cabinet riser so it does not become a sight obstruction.

c. Sight distance requirements are less restrictive at signalized intersections as drivers are required by law to obey the signal indications; however, there are instances when drivers do not obey traffic signals. A traffic signal should be designed to exceed minimum sight distance requirements when possible. Drivers are taught to drive defensively and providing additional sight distance will only aid drivers in collision avoidance.

3. Turn Lanes:

a. Traffic volumes, turning movement counts, and crash history are used to complete intersection capacity and safety analyses. The results of the analyses determine the need for and length of turn lanes. The turn lane information is used to properly design the geometrics of signalized intersection approaches.

b. Turn lane capacity issues often create safety problems. Left or right turning vehicle queues blocking through traffic create increased potential for rear-end crashes. Sideswipe potential also increases as traffic attempts to maneuver out of defacto turn lanes or around left turn queues blocking through lanes. High volumes of turning vehicles combined with high volumes of opposing vehicles significantly reduce the number and size of available gaps needed to complete turning maneuvers increasing the potential for right angle collisions. As a result, properly designed turn lanes improve safety as well as capacity.

c. The need for turn lanes, turn lane storage lengths, and other geometric or traffic control improvements should be determined based on traffic operations analyses of existing and projected design year peak hour traffic. Traffic engineers typically use traffic analysis and/or simulation software for these analyses.

B. Operational Characteristics

The behavior of the traffic at an intersection is another highly important element of signal design. The MnDOT Traffic Engineering Manual Section 9-7.03 notes the various elements that should be considered.

C. System (Arterial) Considerations

In many cases, an individual traffic control signal must be considered as part of a system, either as one of a series of signals along a linear route, or as one signal in a grid network. MnDOT Section 9-7.04 notes the elements to be considered. In addition, note the following:

Traffic actuated controllers are most often used. The actuated controller tends to reduce the number of stops and does not cut off platoons of vehicles. In the suburban environment, the arterial streets tend to be very wide, and traffic volumes are often significant. At intersections with low volumes of pedestrians crossing such as an arterial, an actuated controller tends to operate much more efficiently, as it is not necessary to time pedestrian intervals except when an actual demand exists.

A split is the relative percentage of green, yellow, and red clearance time allocated to each of the various phases at a single intersection. An offset is a system reference time, usually expressed in seconds but sometimes in percent of cycle length.

D. Signal Design Elements

The following publications provide a wide range of guidance in the design of traffic signals:

- Manual of Traffic Signal Design, Second Edition, ITE
- Traffic Control Devices Handbook, Second Edition, ITE
- Signalized Intersections: Informational Guide, Second Edition, FHWA
- Signal Timing Manual, NCHRP Report 812

Traffic signal designs should be based on project and intersection-specific design criteria (Section 13A-3, D). Key elements to consider and include in the design, as appropriate, include the following:

1. Signal Layout:

a. Pole locations considering clear zone requirements, existing and proposed utilities, signal head locations, mast arm lengths, lighting needs, elevation differences, pedestrian pushbutton locations, and right-of-way constraints.

b. Cabinet location considering proposed power service, signal interconnect, sight distance, and cabinet accessibility.

c. Signal head locations and configurations considering visibility and proposed phasing.

d. Handhole locations and conduit layout to minimize lengths of conduit runs. Consider providing a larger (Type III or IV) handhole near the signal cabinet and routing all signal conduits to the cabinet through this handhole.

e. Signing needs.

f. Stop line and advance detection.

g. Miscellaneous equipment (EVP, traffic monitoring camera, etc.)

2. **Conduit and Wiring:**

    a. Conduit sizes considering conduit fill percentage.

    b. Wiring quantities and configurations based on equipment needs.

    c. Fiber optic cable configuration, terminations, and splicing.

3. **Phasing and Timing:**

    a. Type of left turn phasing (protected-only, protected-permissive, permissive-only) for each approach.

    b. Possible right turn overlap for right turn lanes.

    c. Phasing sequence diagram.

    d. Recommended initial timings.

4. **Miscellaneous Items:**

    a. Traffic signal notes and supplemental specifications, as needed.

    b. Estimated traffic signal quantities.

    c. Specific equipment or materials requirements.

    d. Reference or include applicable SUDAS Specifications Section 8010 figures and/or special details needed.

E. Traffic Signal Operations

The following publications provide guidance regarding traffic signal timings and operations:

- Signal Timing Manual, NCHRP Report 812
- Guidelines for Timing Yellow and All-Red Intervals at Signalized Intersections, NCHRP Report 731

Traditionally, protected-only left turn phasing has been used for dual left turn lanes, due to safety concerns with permissive operation. However, protected-only left turn phasing can be inefficient, particularly during off-peak times. If protected-permissive or permissive-only left turn phasing is being considered, a traffic engineering study should be performed, including evaluation of the following:

- Operating speeds
- Possible sight distance obstructions (vehicles in opposing left turn lane(s), horizontal/vertical roadway geometry)
- Left turn and opposing through traffic volumes (vehicle mix - trucks)
- Left turn crossing distance
- Crash history
- Vehicle delays and queuing
- Potential pedestrian crossing conflicts
- Controller, cabinet and equipment flexibility and limitations

If protected-permissive or permissive-only operation is determined to be acceptable, flashing yellow arrow signal heads are required for separate signal faces per the MUTCD. Consideration should be given to providing this type of operation only during off-peak times.

To help jurisdictions better manage the variations in traffic volumes and operating speeds along signalized corridors, the use of automated traffic signal performance measures (ATSPMs) and/or adaptive traffic signal control (ATSC) could be considered.

The use of ATSPMs give agencies a better idea of how signal timing plans are performing throughout the day / week / month / year and provide the information needed to make adjustments to fine tune timing plans and coordination plans. New traffic signal controllers, or third party equipment added to existing traffic signal controllers, collect the real-time data needed to produce the performance reports. More information can be found on the FHWA ATSPM Website.

The data produced through the ATSPMs can be used to determine the potential need for an ATSC system, which utilizes much of the same data collected for ATSPMs and adjusts traffic signal plans or coordination plans automatically. ATSC systems can be useful for corridors in which traffic is more variable or unpredictable than what could be addressed with specific time-of-day timing and coordination plans. More information can be found on the FHWA ATSC Website.

F. Pedestrian Considerations

1. Geometrics:

a. Geometrics have a significant impact on pedestrian operations and safety at signalized intersections as alluded to in the previous section. Intersection skew, number of lanes, lane width, medians, islands, and curb returns all impact the distance pedestrians must travel to cross an intersection. As the distance to traverse an intersection approach increases, so does the signal timing that must be allocated to the pedestrian clearance interval. Long pedestrian clearance intervals have a negative impact on traffic capacity and operations. A pedestrian actuation will disrupt traffic signal coordination and require several cycles to bring a corridor back into coordination. However, large pedestrian volumes may dictate signal timing resulting in less than optimal conditions for vehicles. A traffic engineer must balance the priorities and safety of vehicles and pedestrians at signalized intersections.

b. Right turns present challenges for pedestrians. A driver of a vehicle turning right on red will be looking left for a gap in traffic. A pedestrian approaching from the right may have a walk indication. If the driver sees a gap but does not look back to the right, the pedestrian may not be seen by the driver resulting in a collision. As a result, a traffic engineer must decide whether to allow right turns on red.

c. Right turn lanes can present additional challenges for pedestrians, especially if the returns are large and channelize traffic with an island. The islands can channelize right turning vehicles away from the traffic signal indications creating difficulties signalizing the right turn movement. Pedestrian volume and safety are important considerations when considering and designing right turn lanes.

d. An additional geometric consideration as it relates to pedestrians is the pedestrian refuge. Right turn islands and medians often double as pedestrian refuges. If islands and medians are intended to be used as pedestrian refuges, they must be large enough to hold pedestrians and be ADA compliant. A traffic engineer must consider the likelihood that pedestrians will stop and get stranded in an island or median. On large approaches, it may be intended that pedestrians only cross a portion of the approach and stop in a median or island. As a result, a

traffic engineer must decide whether to install supplemental push buttons in the right turn island or median. If islands and medians are not intended to function as pedestrian refuges, they must be located so they do not obstruct the path of pedestrians.

2. **Visibility:** Visibility is important to the safe operation of the pedestrian indications. Pedestrian indications as well as the push buttons should be easily located by pedestrians. Consider where vehicles, especially large trucks, may stop so they do not obstruct the view of the pedestrian indications. This will require careful location of median noses, stop bars, crosswalks, and the pedestrian heads. Finally, make sure there are no obstructions in the returns that may prevent drivers and pedestrians from seeing one another such as the signal cabinet or vegetation.

3. **Special Considerations:** Circumstances often arise that require special considerations. For example, children may have difficulty understanding the meaning of pedestrian indications. Count down pedestrian heads may be easier for children to understand; therefore, have increased value in school zones. Count down pedestrian heads may also have added value on wide approaches. The flashing numbers can attract a person's eye and the numbers tell a pedestrian how much time they have to cross which has added value on very wide approaches. There may be a particular area within a city that has a high concentration of visually impaired. In this case, audible pedestrian indications may have added benefit. In many cases, some extra thought and minimal dollars can change a design from adequate to desirable.

4. **Americans with Disabilities Act:** The Americans with Disabilities Act (ADA) addresses several design requirements relating to pedestrians. ADA addresses design requirements for items such as sidewalk ramps, truncated domes, and pedestrian push buttons. These topics are addressed in detail in Chapter 12 - Sidewalks and Bicycle Facilities and other design guides such as the MUTCD and the AASHTO Policy on Geometric Design of Highways and Streets.

   a. **Accessible Pedestrian Signals (APS):** Evaluate each traffic signal project location to determine the need for accessible pedestrian signals, especially if the project location presents difficulties for individuals with visual disabilities. Some jurisdictions elect to provide APS for all new or modified signal installations. An engineering study should be completed that determines the needs for pedestrians with visual disabilities to safely cross the street. The study should consider the following factors:
      - Potential demand for accessible pedestrian signals
      - Requests for accessible pedestrian signals by individuals with visual disabilities
      - Traffic volumes when pedestrians are present, including low volumes or high right turn on red volumes
      - The complexity of the signal phasing, such as split phasing, protected turn phases, leading pedestrian intervals, and exclusive pedestrian phases
      - The complexity of the intersection geometry

      One tool that is available for evaluation of the need for APS and also prioritizing the order for installing APS equipment on crosswalks can be found at www.apsguide.org developed by the National Cooperative Highway Research Program (NCHRP).

      If APS are warranted, it is necessary to provide information to the pedestrian in non-visual formats. This will include audible tones and vibrotactile surfaces. Pedestrian push buttons should have locator tones for the visually impaired individual to be able to access the signal. Consistency throughout the pedestrian system is very important. Contact the Jurisdictional Engineer regarding the standards and equipment types that should be incorporated into the design of the accessible pedestrian signal system. New tones such as clicks, ticks, and other electronic sounds have replaced the cuckoos and chirping tones of past systems.

b. APS Design Elements: Refer to MUTCD Sections 4E.08 through 4E.13 and the following information.

1) Push Button Stations: An APS push button station is a weather-tight housing with a 2 inch diameter push button, a speaker, and a pedestrian sign. Braille signing, raised print or a tactile map of the crosswalk may also be provided. The push button has a vibrotactile arrow pointing in the direction of the crossing.

2) Location of Pedestrian Push Buttons: Push buttons (APS and non-APS) should be located adjacent to the sidewalk, between 1.5 and 6 feet from the edge of curb, shoulder, or pavement and no more than 5 feet from the outside crosswalk line (extended). Where physical constraints make the 6 feet maximum impractical, push buttons should be located no more than 10 feet from the edge of curb, shoulder, or pavement. Where two push buttons are provided on the same corner of the intersection, they should be separated by at least 10 feet. If the 10 feet separation is not feasible, audible speech walk messages are required for APS. Supplemental push button poles or posts will typically be needed to meet the above criteria. The MUTCD requires a pedestrian push button mounting height of approximately 3.5 feet above the sidewalk; keep in mind that the 3.5 feet is above the grade where the pedestrian would be when accessing the button. The push button should be located so pedestrians using the audible or vibrotactile indication can align themselves and prepare for the crossing while waiting close to the push button station and the crossing departure point.

It is common to see a narrow grass strip between the sidewalk and pole used to mount the push buttons or to only see sidewalk on one side of a pole containing multiple push buttons. It is difficult to impossible for a person in a wheelchair to reach the push button in cases like these since it often requires the person to struggle with one wheel in the grass and one on the sidewalk. As a result, sidewalks must be paved up to the pole used to mount the push buttons and be at a reasonable slope. There should also be sidewalk on each side of a pole that has a push button.

3) Locator Tone: APS push buttons have a locator tone to allow visually impaired individuals to access the signal. The locator tone should be audible 6 to 12 feet from the push button. The locator tone is active during the pedestrian clearance and "DON'T WALK" intervals.

4) Walk Indications:

- In addition to visual indications, APS include audible and vibrotactile walk indications. When at least 10 feet separation is provided between pedestrian push button stations, the audible walk indication is a percussive tone. If 10 feet separation is not provided, speech messages are required. The speech message should name the street to be crossed and indicate that the walk sign is on. For example: "Main. Walk sign is on to cross Main." Designations such as "Street" or "Avenue" should not be used unless necessary to avoid ambiguity at a particular location. If the traffic signal rests in WALK, the tone/message should be limited to 7 seconds and be recalled by a button press during the WALK interval, provided that the crossing time remaining is greater than the pedestrian change interval.
- The vibrotactile walk indication is provided by a high visual contrast tactile arrow on the push button that vibrates during the walk interval. The vibrotactile indication is particularly useful to individuals who have both visual and hearing impairments. The pedestrian must be able to place a hand on the device while being aligned and waiting to begin the crossing. The arrow should be aligned parallel to the direction of travel on the associated crosswalk.

c. APS System Options:

- Products currently in the marketplace involve use of 2-wire or 4-wire systems, indicating the number of wires between the push button station and the control unit (CU). The 2-wire system uses a central CU mounted in the controller cabinet, and may provide

Ethernet connectivity. Advantages of this system include minimal field wiring required on retrofit applications and central control of multiple crossings.

- The 4-wire system requires a separate CU mounted in the applicable pedestrian signal head for each push button station. In addition to the typical two wires between the push button and the controller cabinet, a 4-wire cable must be provided between the push button station and the CU. This system may be more cost effective for installations with only one or two crossings.

G. Driver and Pedestrian Expectations

Other traffic signal design considerations involve driver and pedestrian expectancy. A traffic engineer must look beyond the traffic signal being designed and consider the characteristics of the corridor and the attributes of the existing traffic signals along the corridor. For example, left turn phasing should be applied consistently and not switch between protected only and protected/ permissive without legitimate reasons. If pedestrian signal heads are used, they should be used consistently and not sporadically where one intersection uses the heads and the next intersection relies on vehicular signal heads to guide pedestrians. Traffic signal head style, placement, and orientation should be consistent along a corridor as well as sign type, size, and location. Intersections should not randomly switch between doghouse and vertical five section heads, center of lane and lane line placement, or vertical and horizontal signal head orientation. Consistently applied design criteria improve driver and pedestrian expectations which typically promote improved safety and operations. However, circumstances exist that may, at times, require changes to design criteria to increase vehicle and pedestrian safety and operations.

H. Future Development and Improvements

One of the biggest traffic signal design challenges is designing a traffic signal in an area that is under development or being redeveloped. Under these circumstances, much of the data needed for design is either unknown or unstable. Land uses are often modified and business prospects continually change often having significant impacts on existing and future traffic volumes. In addition, the rate at which traffic volumes will increase is difficult to determine. In such cases, the traffic signal designer must work closely with adjacent area land use planning agencies to work towards reasonable expectations for future travel demands and overall operations. It may be possible for anticipated future intersection improvements to be accommodated for within the design to significantly reduce the need to replace signal poles, mast arms, and foundations or add additional functionality to the traffic signal. These simple steps can build credibility with the public and add considerable efficiency to the traffic signal design and overall engineering process.

Traffic Signal Specifications Information

This section provides design information that complements and is organized similar to SUDAS Specifications Section 8010.

The information below provides selective guidance on the specifications.

A. Part 1 - General

1. **Submittals:** There are several key submittals required of the contractor following award of the project. These are described below.

   a. **Schedule of Unit Prices:**
      1) **Document:** Prepared by the traffic signal designer and included within the contract documents or provided to the contractor prior to construction.
      2) **Purpose:** Establish unit pricing for change order work if needed. Used to estimate partial payments.
      3) **Includes:** Identification of major traffic signal items along with an estimate of quantity and units of measurement. Two additional blank columns are provided (unit price, and unit extension).
      4) **Contractor Action:** Within 30 days after award, the contractor is required to submit a completed schedule of unit prices to the contracting authority.
      5) **Engineer Action:** Review the schedule in a timely manner. Check the appropriateness of each unit price, the accuracy of each unit extension calculation, and ensure that the grand total for all unit extensions matches the lump sum bid item for traffic signalization.

   b. **Material and Equipment List:**
      1) **Document:** Prepared by the traffic signal designer or contractor.
      2) **Purpose:** Contracting authority approval of materials and equipment for all major traffic signal items.
      3) **Includes:** Identification of major traffic signal items along with an estimate of quantity and units of measurement. Two additional blank columns are provided (manufacturers name and each item's model number).
      4) **Contractor Action:** Within 30 days after award, the contractor is required to submit a completed list of materials and equipment to the contracting authority for approval.
      5) **Engineer Action:** Review the list in a timely manner. Check the appropriateness of each identified manufacturer and model number. Upon acceptance, sign and date the list and provide a copy to the contractor.

   c. **Contractor Certification:**
      1) **Document:** Prepared by the contractor on company letterhead.
      2) **Purpose:** Contracting authority verification of contractor qualifications.
      3) **Includes:** Name, contact information, and certification of the Level II International Municipal Signal Association (IMSA) Certified Traffic Signal Technician(s) working on the project, along with a copy of their IMSA certificate.
      4) **Contractor Action:** Within 30 days after award, the contractor is required to submit the contractor certification to the contracting authority.

5) **Engineer Action:** Review the appropriateness of the information provided.

d. Shop Drawings:

1) **Document:** Prepared by the traffic signal pole supplier for the contractor.
2) **Purpose:** Contracting authority review of traffic signal poles, supports, and related hardware.
3) **Includes:** Shop drawing information detailing each traffic signal pole, accompanying parts, and necessary hardware.
4) **Contractor Action:** Within 30 days after award, submit shop drawings to the contracting authority for engineer review.
5) **Engineer Action:** Review the shop drawings in a timely manner. Check the appropriateness of each detail. Upon completion of the review, sign/initial and date the shop drawings and provide a copy to the contractor.

e. Catalog Cuts:

1) **Document:** Prepared by the traffic signal equipment supplier for the contractor.
2) **Purpose:** Contracting authority review of all items within the equipment and materials list as well as for supporting components.
3) **Includes:** Catalog cut information detailing the make, model number, manufacturer, and specific details for all traffic signal equipment.
4) **Contractor Action:** Within 30 days after award, submit catalog cuts to the contracting authority for engineer review.
5) **Engineer Action:** Review the catalog cuts in a timely manner. Check the appropriateness of each item. Upon completion of the review, sign/initial and date the catalog cut documents and provide a copy to the contractor.

2. **Measurement and Payment:** Traffic signal work is typically bid as a lump sum item of which no measurements are made. However, partial payments to the contractor are established through measuring or estimating installed quantities and applying these quantities to the appropriate unit price (see Schedule of Unit Prices above).

B. Part 2 - Products

1. **Underground:**

a. Handhole: Handholes are a critical component to traffic signal design. The designer should verify with the jurisdiction how handhole lids are to be labeled and whether cable hooks should be included in handholes (sometimes not included in fiber optic handholes).

Handholes can come in all shapes and sizes (see SUDAS Specifications Figure 8010.103) and must be specified by the Engineer.

The designer should ensure that the contract documents clearly distinguish between handhole types, sizes, and desired locations. Handholes are typically uniquely numbered on the contract documents.

b. Conduit: The SUDAS Specifications allow both steel and ~~PVC~~ flexible conduit. Steel conduit is typically used on all service risers and plastic PVC or HDPE is used at all other locations. A typical signal installation will use a variety of conduit sizes. Some jurisdictions may request a specific color for fiber optic conduit. When connecting HDPE conduit to PVC conduit, the designer should work with the Contractor to clarify the method or materials to be used.

The following is a conduit checklist to consider during signal design:

- Conduit size and cables listed.
- Correct symbol for in-place conduit.
- Correct symbol for proposed conduit.
- Check for conflict with in place underground utilities.
- Check if conduit fill is less than 40%.
- 3 inch minimum typical size conduit under all public traveled roadways.
- Possible spare conduit stub out of controller cabinet for future use, threaded and capped.
- Conduit runs for interconnect should be as straight as possible.
- No PVC above ground (for example: bridge crossings and wood pole systems).
- Size of bends and elbows in conduit according to National Electrical Code or UL guidelines.
- If conduit is suspended under a bridge, does the distance between supports conform to code, is a hanger detail given in plan, and are expansion fittings called for?

An online resource can be found through Chapter 11 - Conduits and Fittings from MnDOT's Lighting and Signal Certification Field Guide, which provides the designer with a photographic resource for considering conduit installation and features.

c. Wiring and Cable: Signalized intersections require a variety of standard wires and cables; however, the number, size, and quantity of extra conductors pulled can vary by agency. The designer should include sufficient details to ensure the clear identification of cable runs by conduit. The inspector should make sure all wires are terminated neatly and in an organized fashion. Cables for vehicle and pedestrian signal heads should be continuous from the pole base to the controller cabinet without splices in underground handholes. Video and emergency vehicle preemption cables should be continuous without splices from the unit to the controller cabinet. All plan terminology should be consistent for example:

- Cable callouts/symbols identifying the number of cables and the number and size of conductors (for example 1-12C#14, 2-5C#14, 2-2C#14, 1-1C#6 Ground, 1-1C#10 Tracer, etc.).
- Ped indications with separate 5/C #14 cables.
- Separate 2/C #14 detector lead-in cable for each group of loop detectors.
- Provide spares for future expansion of system, if necessary, and label them.

d. Foundations: Signalized intersections require footings or foundations for all poles, pad-mounted controller cabinets, and other service cabinets such as fiber optic hubs or electrical service panels. Cabinet footing details are shown on SUDAS Specifications Figure 8010.101. The designer should ensure that the plans reflect any desired future use spare conduit stubs out of the foundation.

Foundation size and depths vary according to pole style, mast-arm length, and pole loadings. The SUDAS Specifications provide figures for both pedestal poles and for mast-arm poles (SUDAS Specifications Figure 8010.102). SUDAS standard Type A mast arm pole foundation in soil designs (SUDAS Specifications Figure 8010.102 and Table 13A-5.01) are based on the following guidelines, parameters, and assumptions:

- Broms' method for lateral resistance (moment/shear design) per AASHTO *Standard Specifications for Structural Supports for Highway Signs, Luminaries, and Traffic Signals*, 6th Edition, 2013 (AASHTO LTS-6), with a safety factor of 2.86, which accounts for the possible under capacity of the soil strength (0.7) and the overload factor for the loadings (2.0).
- Alpha method for torsion design per FHWA-NHI-10-016 *Drilled Shafts: Construction Procedures and LRFD Design Methods*, May 2010, with a safety factor of 1.0.

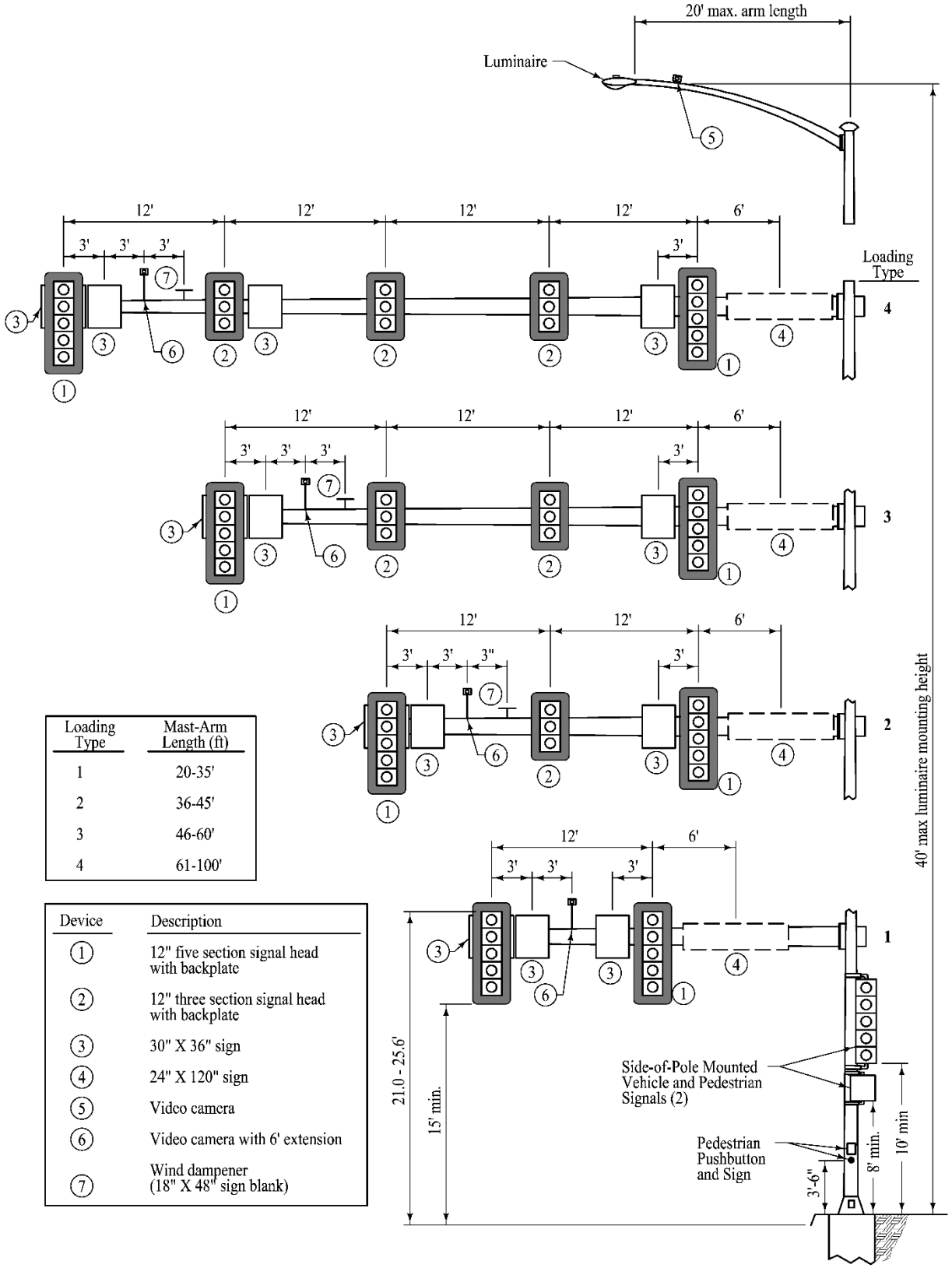
- Disturbed soil due to frost: 2.5 feet for moment/shear design, 5.0 feet for torsion design. Broms' method as presented in AASHTO LTS-6 includes an additional 1.5 diameters of foundation length to be added to the minimum foundation length required. The maximum value of 1.5 diameters or 2.5 feet shall be used when determining the disturbed soil for moment/shear design.
- Groundwater is present for moment/shear and torsion designs.
- Pole loadings as shown in Figure 13A-5.01, with poles designed per AASHTO LTS-6 specifications. Basic wind speed equals 90 mph with a 50 year mean recurrence interval and gust effect factor of 1.14 for strength design. Use Category II for fatigue design. Apply only natural wind gust loads (i.e. do not apply galloping loads, vortex shedding loads, or truck-induced gust loads) for fatigue design. Install vibration mitigation devices on all traffic signal pole mast arms over 60 feet in length as shown in the figures.
- Cohesive soils along the length of the foundation with an average blow count (N60) greater than or equal to 8, which equates to an average unconfined compressive strength (Qu) greater than or equal to 2.0 kips per square foot.
- Reinforced concrete design per AASHTO LTS-6 specifications.

For pole loading conditions greater than shown in Figure 13A-5.01, granular soils, or lower strength soils, special foundation designs will be required. Soil boring testing should be performed prior to construction to verify soil types and strengths if non-typical soils are suspected. If rock is anticipated at the project site and the designer intends to utilize the Type C mast arm pole foundation in rock or a Type B foundation (see SUDAS Specifications Figure 8010.102), determine rock quality through a subsurface investigation completed by a geotechnical engineer licensed in Iowa. If rock is encountered unexpectedly, the contractor may undertake a subsurface evaluation conducted by a geotechnical engineer licensed in Iowa to determine the quality of the rocks encountered. Based on that investigation, the Engineer may approve the use of a Type B or Type C foundation in rock if requested by the contractor.

Table 13A-5.01: Standard Mast Arm Pole Foundation Designs

Loading Type (Figure 13A-5.01)	Maximum Mast Arm Length (feet)
1	35
2	45
3	55
3	60
4	70
4	80
4	90
4	100

Figure 13A-5.01: Mast Arm Pole Loadings for Standard Foundation Designs



The designer should ensure that foundations:

- Are located in compliance with applicable clear zone requirements (unless breakaway pedestal poles)
- Do not conflict with pedestrian walkways or ramps
- Are at the proper finish grade elevation
- Avoid or minimize conflicts with existing or proposed utilities
- Provide acceptable pedestrian pushbutton locations per MUTCD guidance
- Are located to provide adequate visibility of signal heads

An online resource can be found through Chapter 10 - Foundations and Equipment Pads from MnDOT's Lighting and Signal Certification Field Guide, which provides the designer with a photographic resource for foundation types and installation details.

e. Bonding and Grounding: All traffic signal installations must be bonded and grounded according to the National Electrical Code.

Bonding is defined in the Code as the permanent joining of metallic parts required to be electrically connected. In a traffic signal, the term is used to describe the electrical and mechanical connection of conduit, metal poles, cabinets, and service equipment.

Grounding is defined in the Code as a conducting connection, whether intentional or accidental, between an electrical circuit or equipment and the earth, or to some conductive body that serves in place of earth.

The designer should ensure that the contract documents include sufficient notation for the traffic signalized intersection to be properly bonded and grounded. This includes placing ground rods at each traffic signal pole and at the controller as well as through use of bonding and grounding jumpers within the handholes.

An online resource can be found through Chapter 13 - Grounding and Bonding from MnDOT's Lighting and Signal Certification Field Guide, which provides the designer with a photographic resource for bonding and grounding details.

2. Detection: Detectors provide vehicle and pedestrian inputs to the traffic signal controller. Proper detector installation, operation, and maintenance is critical to the safe and efficient operation of any signalized intersection. An online resource to learn more about detection styles, modes, and typical layouts can be found within Chapter 9 - Traffic Signals from MnDOT's Traffic Engineering Manual. Since this document is a PDF, some of the information from this source is provided below.

Detector sizes and locations vary by agency and by location. SUDAS provides standard drawings for typical modified diamond and rectangular detector loops (SUDAS Specifications Figure 8010.104).

An online resource can be found through Chapter 15 - Vehicle Detection from Lighting and Signal Certification Field Guide, which provides the designer with a photographic resource for installation and mounting details.

a. Inductive Loop Vehicle Detector: A common type of vehicle detection device in use today is the inductive loop. This is a loop of wire imbedded in the pavement (saw cut in existing concrete or NMC loop in new concrete) carrying a small electrical current. When a large mass of ferrous metal passes over the loop, the magnetic field is disturbed and generates, or induces, a change in resonant frequency in the wire. This change in frequency is then recognized by the detector amplifier and signals the controller that a vehicle is present.

b. Pedestrian Push Button Detector: There are a number of ways to provide pedestrian actuation at a signalized intersection. The most common equipment used by far is the pedestrian pushbutton detector. Pressing the button provides a contact closure that actuates the call. There are plenty of examples of good and bad pedestrian pushbutton placement; however, part of the problem is getting the pedestrian to use the button. Specific information regarding pedestrian detectors can be found in the MUTCD Section 4E.08 Pedestrian Detectors.

An online resource can be found through Chapter 18 - Accessible Pedestrian Signal Push Buttons from MnDOT's Lighting and Signal Certification Field Guide, which provides the designer with a photographic resource for style, installation, and mounting details.

c. Video Detection Camera System: Vehicle detection by video cameras is a popular form of vehicle detection within Iowa. The rapid processing of video images provides the detection outputs to the controller. The designer should carefully consider the type of equipment necessary to provide video detection, the maintenance needs of this equipment, and the specific installation and mounting requirements necessary.

Designers should consider relevant manufacturer recommendations and other online resources.

d. Microwave/Radar Vehicle Detector: Microwave/radar detection is often used within Iowa during temporary signal control to provide simple, non-intrusive vehicle detection.

3. Communications: The designer may be required to provide supplemental specifications for these items given the highly proprietary nature of this equipment and the needs of the contracting agency. Generic specifications have been provided in the SUDAS Specifications.

4. Cabinet and Controller: The designer may be required to provide supplemental specifications for the controller, cabinet, and emergency vehicle pre-emption system given the highly proprietary nature of this equipment. Cabinet and controller options include TS1, TS2, ATC, and 2070. The need for controllers to collect high definition data should be considered. Generic specifications have been provided in the SUDAS Specifications; this section also includes references to UPS battery backup system and emergency vehicle preemption system. The designer should carefully consider the cabinet and mounting requirements of the battery back-up system.

An online resource can be found through Chapter 21 - Traffic Control Signal Cabinets from MnDOT's Lighting and Signal Certification Field Guide, which provides the designer with a photographic resource for style, installation, and mounting details.

5. Poles, Heads, and Signs:

a. Vehicle Traffic Signal Head Assembly: Vehicle signal heads must comply with MUTCD Chapter 4D.

An online resource can be found through Chapter 17 - Signal Heads and Luminaires from MnDOT's Lighting and Signal Certification Field Guide, which provides the designer with a photographic resource for style, installation, and mounting details.

b. Pedestrian Signal Head Assembly: Pedestrian vehicle signal heads must comply with Chapter 4E of the MUTCD.

c. Traffic Signal Poles and Mast Arms: Signalized intersections require poles and mast arms to achieve proper traffic signal and pedestrian head placement. The default is for the contractor to furnish one-piece poles and mast arms. The designer should include plan note information if two-piece poles and mast arms will be allowed. Mast arm details and typical loadings are shown on Figure 13A-5.01; additional mast arm details are shown SUDAS Specifications Figure 8010.105. The designer should ensure that the plan locations comply with all clear zone, sight restriction, and pedestrian criteria. Vertical clearance to overhead utility lines is a constant issue that designers should take note of during design. Although the minimum height from the pavement to the bottom of the signal housing is 15 feet, the designer should consider the street classification and the volume of large trucks in establishing the signal height above the pavement. However, the top of the signal housing cannot exceed 25.6 feet above the pavement. If the project being designed has specific requirements relative to the elevation of the end of the mast arm in relation to the connecting point on the vertical pole, include those requirements in the plans or special provisions of the contract documents.

An online resource can be found through Chapter 16 - Signal and Light Poles from MnDOT's Lighting and Signal Certification Field Guide, which provides the designer with a photographic resource for style, installation, and mounting details.

d. Traffic Signal Pedestal Poles: Pedestal poles are often used for pedestrian signals and pushbuttons, and are much easier to locate within a tight right-of-way. Pedestal pole details and typical head mounting information are shown on SUDAS Specifications Figure 8010.106.

e. Traffic Signs: The designer must ensure that all signs comply with Iowa DOT standards and the MUTCD.

C. Supplemental Requirements

A summary listing of items within SUDAS Specifications Section 8010 requiring supplemental requirements to be provided by the designer includes, but is not limited to, the following:

- Handholes - specify types, sizes, and lettering.
- Foundations - specify dimensions and any conduit stubs needed for future use.
- Communications - specify all traffic monitoring equipment along with any fiber optic equipment and materials.
- Cabinet, controller, battery backup, vehicle detection, pedestrian detection, PTZ camera, and emergency vehicle preemption - specify all relevant equipment.
- Traffic signal poles and mast arms - specify finish for pole.
- Traffic signs - specify sheeting, sign dimensions, street name sign letter series and sizes, and mounting requirements.

D. Temporary Traffic Signals

When a temporary traffic signal (SUDAS Specifications Figure 8010.107) is included in the work, the designer must address the following items:

- Type of vehicle detection equipment to include, if any.
- Type of emergency pre-emption equipment, if any.
- Number of signal heads for each direction.
- Signal control equipment, including pedestrian equipment if to be included.
- Basic signal timing and any modifications based on construction staging.
- Points for relocation of temporary traffic signal if a trailer mounted unit is specified.

Work Zone Set Up

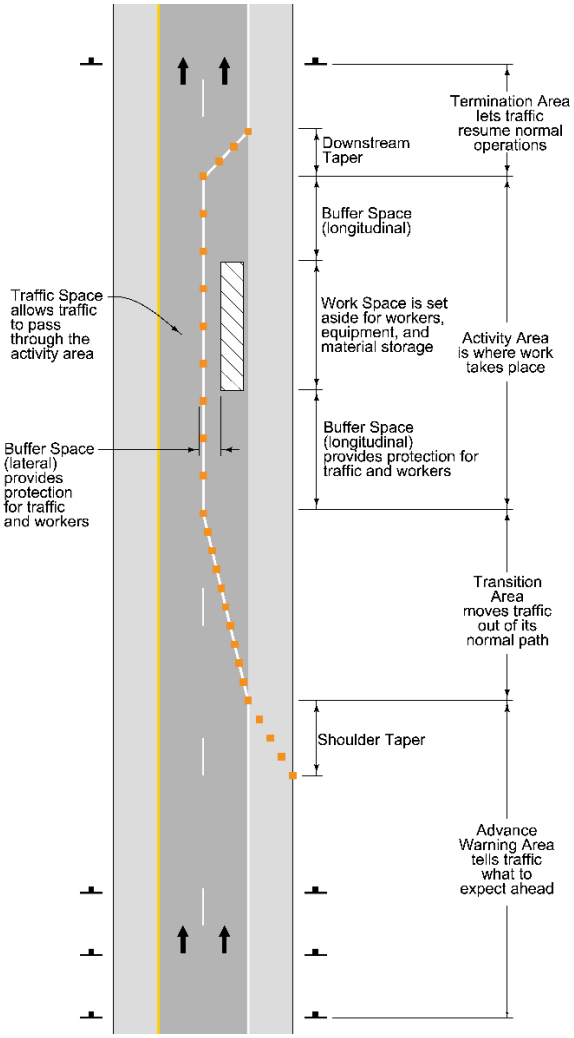
A. Major Elements

A typical work zone, designated with signs and various other traffic control devices, is defined as extending from the first advance warning sign or vehicle with amber, high-intensity, rotating, flashing, oscillating, or strobe light to an END ROAD WORK (G20-2) sign or other device beyond which traffic returns to normal paths.

Most work zones involving major traffic obstructions can be divided into four major areas:

- advance warning
- transition
- activity
- termination

Figure 13B-2.01: Work Zone Temporary Traffic Control - Major Elements



1. **Advance Warning Area:** Advance warning is crucial to safety, and every work zone should include this important feature. Without effective warning, road users cannot be expected to react properly. The advance warning area is that section of roadway where road users are informed about the activity ahead. Depending on the type of road, traffic volumes and speeds, and degree of obstruction, advance warning might consist of a
   - vehicle with amber, high-intensity, rotating, flashing, oscillating, or strobe light,
   - single sign, or
   - series of signs.

   Vehicle hazard lights may be used to supplement amber, high-intensity, rotating, flashing, oscillating, or strobe lights (hereinafter called vehicle warning lights), but they shall not be used alone. Flags may be used to call attention to the advanced warning signs

   When a series of signs is required, information is presented in this order:
   a. General information, such as ROAD WORK AHEAD (W20-1)
   b. Description of activity or obstruction, such as RIGHT LANE CLOSED AHEAD (W20-5R) or ONE LANE ROAD AHEAD (W20-4)
   c. Specific action, such as BE PREPARED TO STOP (W20-7b) or FLAGGER AHEAD (W20-7a)

2. **Transition Area:** In a transition area, traffic is directed from the normal, intended path to a new course, such as from one lane to another. To accomplish this, the MUTCD requires channelizing. Channelization, or redirection of traffic, is usually accomplished with tapers.

3. **Tapers:** Part 6 of the MUTCD discusses tapers in detail. Several types of tapers are available for work zones, depending on circumstances:
   - Merging tapers are used for lane closures on multi-lane roadways.
   - Shifting tapers divert traffic to alternate paths without closing lanes.
   - Shoulder tapers can be used to delineate shoulder closures.

   The recommended minimum length of all these taper types depends on the speed of approaching traffic and the width of the lane being closed. Lengths of merging tapers for various speeds are shown in Table 13B-2.01. Speed limit refers to the legally established and signed speed limit.

   Two other taper types do not depend on traffic speed or lane width:
   - one lane, two-way taper (used mostly for flagging or self-regulating)
   - downstream (termination) taper

   One hundred feet is the maximum recommended length for a one-lane, two-way taper, but a length of 50 feet can benefit flagging operations. Refer to the Iowa DOT's *Flagger's Handbook* for more details. At least 100 feet for each closed lane is recommended for a termination taper length. For merging taper lengths on multi-lane roadways, see Table 13B-2.01.

Table 13B-2.01: Merging Taper Lengths for Lane Closure*			
Speed Limit (mph)	**Taper Length (L) (ft)**	**Number of Devices**	**Spacing of Devices (ft)**
20	80	5	20
25	125	6	25
30	180	7	30
35	245	8	35
40	320	9	40
45	540	13	45
50	600	13	50
55	660	13	55

* This table does not apply to one lane, two-way (flagger) tapers.

4. **Channelizing Devices:** Several channelizing devices are available for use in tapers, including cones, verticals panels, drums, and barricades.

5. **Activity Area:** The activity area of many work zones can be divided into three main parts:

   a. **Buffer Space:** Buffer spaces are recommended wherever workers are exposed to high-speed moving traffic. Neither work activity nor storage of equipment, vehicles, or material should occur within a buffer space.

      1) **Longitudinal buffer spaces** are a safety protection for workers and road users. They give drivers space to recover in emergency situations. Like many other work zone dimensions, longitudinal buffer space is based largely on the traffic speed. Table 13B-2.02 includes buffer lengths for various traffic speeds and are applicable to all temporary traffic control situations. The length of the longitudinal buffer space used may need to be modified based on site conditions.

Table 13B-2.02: Longitudinal Buffer Space

Speed (mph)	Length (ft)
20-35	0-200
40	0-300
45	0-400
50	400
55	600

      2) **Lateral buffer spaces** are especially effective in high-speed and heavy traffic situations where maximum possible separation of workers from moving vehicles is desired. Flaggers are often beneficial in these circumstances as well.

   b. **Work Space:** The work space is that area closed to traffic where maintenance and construction activities are accomplished. This area can be occupied by equipment, materials, and workers and should be made as secure and safe as possible.

   c. **Traffic Space:** Motor vehicles and other road users occupy the traffic space, also known as the open lane. Workers and equipment should respect this area and not intrude or otherwise hamper free movement of traffic in the open lane.

4. **Termination Area**: The termination area begins at the end of the work space and extends to the END ROAD WORK (G20-2) sign, if posted. This sign is optional, but is recommended by the MUTCD. A downstream or termination taper (50 to 100 feet) may be installed in this area for traffic guidance.