CHAPTER 12: DRAINAGE

15" SAFETY APRON

The 15" CS Safety apron is not covered by Standard Plate 3128. Therefore, when using this size metal safety apron be sure to include a detail in the plan for it.

CASTING ASSEMBLY

There has been some confusion on when a casting assembly is paid for separately and when it is part of the structure.

Statewide when the removal of a structure is by the EACH it includes the removal of the casting. If the casting is to be salvaged then a pay item for the salvaging of the casting should be added.

When the removal is by the lin ft then follow the intent of the 2506 spec and pay for the casting separately. The tabs would show a remove structure and remove casting.

CHINOOK WINDS AND WINTER SNOWS

A combination which frequently results in hazardous winter conditions on shaded portions of roadways under bridges. Icing conditions are a danger in themselves, and they present further hazards during corrective maintenance operations. Paradoxically, they melt away maintenance funds. Potentially hazardous conditions and rising maintenance costs often can be prevented by thoughtful design. Hydraulics Engineers, request that designers place catch basins in such a manner so that runoff in gutters can be intercepted before it can flow under bridges to freeze in those shaded areas. This is a relatively simple design concept which, if employed wherever feasible, will not only reduce recurring maintenance cost, but may also prevent bodily harm and property damage. All surface design features should be carefully evaluated to minimize or prevent, where possible, the flow of water across pavement surfaces. This is especially important in the case of water from winter thaws. For example, snow and ice accumulations on raised islands thawing, and then freezing on the road surface, might be prevented by use of a drained, depressed island.

CLASSES FOR REINFORCED CONCRETE ARCH PIPE

Class IIA is the only class available for pipe arches with a nominal span less than 73 inches. Class IIA is designed for 0' to 8' of cover. For pipe arch sizes 73 in. or greater, Class IIA, IIIA and IVA are available. Refer to Standard Plate No. 3014 for further information.

CULVERT APRONS IN THE CLEAR ZONE

Several designers have shown confusion with when to use safety aprons and or grates. They

should refer to Chapter 8 of the Road Design Manual for this information.

It is recommended that ALL entrance culverts have safety aprons and/or grates within the clear zone.

CULVERT WORK

Whenever there is work to be done on a portion of a culvert, such as a lining or a salvage/install aprons, every effort should be made to bring the aprons up to current standards. A safety apron and/or grate may be needed to accomplish this. However the District does have the option of not bringing the aprons up to current standards. When deciding on whether to add safety features or not the District should investigate the risk, run off the road data, grading, right of way, safety concerns, etc.. If it is decided that the aprons are not going to have safety features a full explanation should be given and placed in the design file. There are a few locations that would still require safety features to be added. One such location would be a median culvert. If you have questions on a particular situations please contact the Project Design Services office.

DEWATERING

When DEWATERING is paid for in the plan a location should be referenced either as a note in the SEQ or in a TABULATION where this is needed and at least one of the following should be included…

- A detail/schematic of the dewatering.
- The flow/infiltration rates for each of the locations.
- Information included in the Special Provisions.

A good example of a table is as follows….

DEWATERING TABULATION						
STATION	INPLACE	EXISTING	NORMAL WATER	2-YEAR EVENT	2-YEAR EVENT	DRAINAGE AREA
TH 1	CULVERT	RESOURCE	DEPTH FEET	DEPTH FEET	FLOW CFS	ACRES
272+00	24" RCP	WETLAND	1.5	2.2	12	29
645+06	24" RCP	TRIBUTARY-DNR PROTECTED WATER	0.5	3.1	35	323
900+50	30" RCP	WETLAND	0.5	2	14	41
TH 2	CULVERT	RESOURCE	DEPTH FEET	DEPTH FEET	FLOW CFS	ACRES
174+81	48" RCP	TRIBUTARY	0.3	3.2	64	250
182-83	60" RCP	TRIBUTARY	1	2.1	40	186
47+96	60" RCP	TRIBUTARY	1	2	16	164

DRAINAGE FLOW ARROWS

Plans should contain drainage flow arrows on the plan sheets indicating the direction of flow for culverts, bridges, ditches, ditch breaks, etc..

DRAINAGE STRUCTURES ON ALTERNATE BID PLANS

When doing alternate bid plans the designer needs to pay attention to the drainage structures. How they are handled may be different in a bituminous plan versus a concrete plan. There have been some issues with the inlet pads not being accounted for on the alternate projects.

GRATES

The type of grate used with a catch basin does affect the amount of runoff intercepted along a curb and gutter. The location of the catch basin, whether on a slope or at a low point, also should be considered when choosing the type of grate to be used. The advantages and disadvantages of some of MnDOT grates are as follows:

Grate	Advantages	Disadvantages
Standard Plate 4154 (vane type) (Grate Casting 816)	1. Tends not to plug with debris. 2. Intercept large flow Depths on steep slopes with no flow across grate. Bicycle 3. safe when ~~installed~~ placed in correct position.	Has less capacity at low Points than parallel grate Std. Plate 4153.
Standard Plate 4152 (vane type) (Grate Casting 814)	1. Bicycle safe 2. Accommodates foot traffic Debris.	1. Tends to plug with debris 2. Water will tend to skip across grate with large with large flow depths on Steep slopes.

The above information indicates that the vane type grate (Standard Plate 4154-Grate Casting 816) should be used on grades. The parallel type grate (Standard Plate 4153 - Grate Casting 815) is recommended at low point except where bicycle traffic is expected. If the low point structures may have bicycle traffic, the vane grate (816) is recommended.

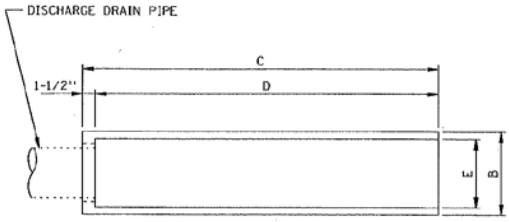
See Design Scene Chapter 3 – "ADA SAFETY GRATES, CURB BOXES, and HELPER STRUCTURES" for more information.

HEADWALLS (POLYETHYLENE OPTION)

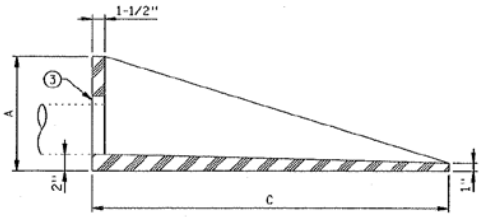
The headwall detail shown below shall be considered an unapproved standard detail to be used for headwalls for subsurface drains. The intent is to use Polyethylene (P.E.) as an option to the concrete headwall we currently use. Sub note CONCRETE HEADWALL pay item to read: THE CONTRACTOR HAS THE OPTION OF USING A POLYETHYLENE HEADWALL AS SHOWN ON SHEET ___.

This detail can be found on the internal website at “MnDOT A to Z”…”D”…”Design Details”…”HEADWALL”

Designers outside of MnDOT will need to contact their MnDOT project Manager to get a copy.



PLAN



SECTION

DIMENSIONS	4" DIA. PIPE	6" DIA. PIPE
A	11-3/4"	13-3/4"
B	7"	10"
C	36"	42-1/2"
D	34-1/2"	41"
E	5-1/2"	8-1/4"
F Δ	1 - 2"	1 - 2"
(1) G	5"	7"
APPROX. WT.	38 LBS.	45 LBS.

Δ WALL THICKNESS - SIDES, BOTTOM, AND END.

NOTES:

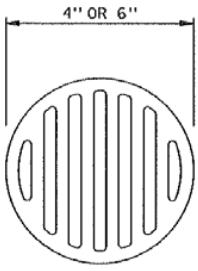
SEE PLANS FOR MORE INFORMATION.

HEADWALL TO BE RECYCLED HIGH DENSITY POLYETHYLENE, TENSILE: 3.2 k P.S.I. MINIMUM, FLEXURAL 100 k P.S.I. MINIMUM.

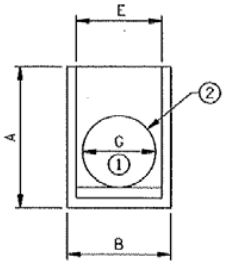
(1) HOLE SIZE TO ACCEPT ALL COMMONLY USED P.V.C. PIPE.

(2) P.V.C. GRATE FOR POLY APRON IS COMMERCIALLY AVAILABLE AS A FLOOR STRAINER. SHIELD IS FASTENED TO THE OUT FALL PIPE WITH 2 (TWO) NO. 10 X 1 INCH GALVANIZED SHEET METAL SCREWS. OPTION:
SCREENS OF 2 OR 3 MESH, 16 GAUGE OR HEAVIER HOT DIPPED GALVANIZED CARBON STEEL WIRE. FITS SNUGLY TO SIDES AND BOTTOM AND IS BENT TO FIT SECURELY TO THE BACK OF THE ENDWALL. ALLOWS FOR APPROXIMATELY 1-1/2" - 2" EXTENSION OF OUT FLOW PIPE.

(3) SEAL P.V.C. PIPE WITH SILICONE CAULK OR OTHER APPROVED MATERIAL



P.V.C. GRATE



END VIEW

INPLACE DRAINAGE STRUCTURES

On projects where inplace manholes or catch basins are likely to be either adjusted or

reconstructed, the following additional information is necessary from survey crews.

- Design or type of structure
- Cone Type A, B or C.
- Height of adjusting rings – if no rings, indicate this
- Height of casting

This information is also necessary when the design requires connecting new drainage structures to inplace structures. Please inform you District Surveys Engineer of these requirements.

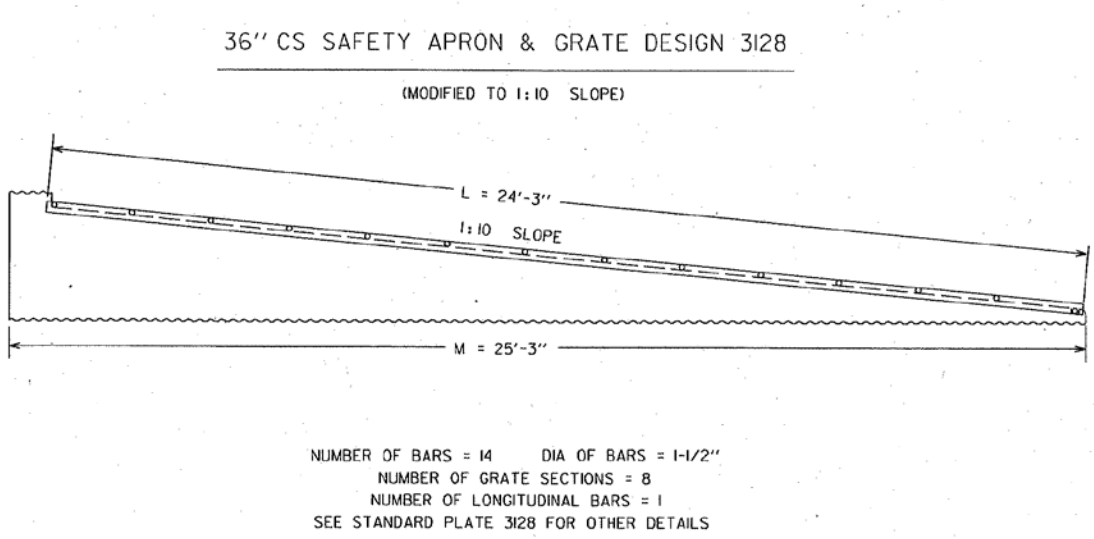
Also, during review of supplemental agreements, we noticed several agreements had to be processed due to the incorrect size of existing storm sewer pipes in the plan. A more careful check, especially those pipes that require extensions, is in order.

PARALLEL PIPES AND APRONS IN THE MEDIAN

Parallel pipes located in the median require safety aprons, must be grated, and the slope modified to a 1:10. The only apron design that must be used is Apron and Grate Design 3128. Standard Plate 3148 CANNOT be used for this application. If concrete pipe is used standard plate 3128 covers the connection to the concrete pipe. The plan must also include a design detail for the 1:10 apron.

These details can be found on the internal website at "MnDOT A to Z"…"D"…"Design Details"…"SAFEAPRN1_10B" or "SAFEAPRN1_10SM"

Designers outside of MnDOT will need to contact their MnDOT project Manager to get a copy.



PIPE BEDDING

There are now standard plan sheets available for Standard Culvert Bedding for Flexible Pipe (5-297.440), Standard Culvert Bedding for Rigid Pipe (5-297.441), and Standard Storm Sewer Bedding for Rigid and Flexible Pipe (5-297.442). These will be required to be used for plan let on or after June 28, 2019.

The design details will still need to be used for culverts with treatments and Box Culverts as these are not covered by the standard plan sheets.

When there are Storm Sewer Pipes items (2503) in the plan…

- Bedding, excavation and backfill do NOT need to be tabulated separately but are considered to be included in the cost of the storm sewer items.
- Include the Standard Plan sheet for Standard Storm Sewer Bedding for Rigid and Flexible Pipe (5-297.442) in the plan. These details should NOT need to be edited.

When there are Culvert items in the plan (2501) that…

- Require treatments, typically centerline culverts in areas prone to frost heave…
  - Payment for excavation, bedding, and special backfill quantities should be included in the SEQ and Tabulations (preferable the drainage tabulation).
  - Identify the treatment type in the Tabulations.
  - Include the detail in the plan from…MnDOT A to Z...go to "Design Details"…go to
    - "CULV BEDDING RIGID" if using concrete pipes.
    - "CULV BEDDING FLEX" if using metal and/or plastic pipes.
      - These details can be editing according to the District materials Engineers recommendations.
- Do NOT require treatments, typically centerline and side culverts for local roadways but do not typically apply to entrance culverts….
  - Payment for the bedding quantities should be included in the SEQ and Tabulations.
  - Excavation and backfill do NOT need to be tabulated separately but are considered to be included in the cost of the storm sewer items unless a special backfill is required. When special backfill is required backfill should be included in the SEQ and Tabulations.
  - Include the Standard Plan for
    - "STANDARD CULVERT BEDDING FOR RIGID PIPE (5-297.441)" if using concrete pipes.
    - "STANDARD CULVERT BEDDING FOR FLEXIBLE PIPE (5-297.440)" if using metal and/or plastic pipes.
      - Details are NOT modified unless an alternate bedding design is used.
- Are Entrance Culverts for agricultural, residential, or commercial entrances.
  - If placed with "Select grading material" as backfill then…
    - No detail is needed
    - No quantities need to be in the tabulations.
  - If specific bedding is required then…

- ✦ Payment for the bedding quantities should be included in the SEQ and Tabulations.
- ✦ Excavation and backfill do NOT need to be tabulated separately but are considered to be included in the cost of the culvert items.

❖ Include the detail in the plan from…MnDOT A to Z...go to "Design Details"…go to
- ❖ "STANDARD CULVERT BEDDING FOR RIGID PIPE (5-297.441)" if using concrete pipes.
- ❖ "STANDARD CULVERT BEDDING FOR FLEXIBLE PIPE (5-297.440)" if using metal and/or plastic pipes.
  - o Details are NOT modified unless an alternate bedding design is used.\

When there are Box Culvert items (2412) in the plan…

➢ Payment for excavation, bedding, and special backfill quantities should be included in the SEQ and Tabulations.

➢ Include the detail in the plan from… MnDOT A to Z...go to "Design Details"…go to "BOX CULV BEDDING"
- ❖ Details are NOT modified unless an alternate bedding design is used.

PIPE GAUGES

Standard Plate 3041. This plate allows a lighter gauge metal pipe above 36 in. diameter than Standard Plate 3040. Therefore, it is better not to show any gauge within a plan unless a heavier than standard gauge is required (lighter than standard are never used). When a heavier gauge is called for, it should be sub noted as below:

2501.503 42" CAS PIPE CULVERT 10 GAUGE (1)
(1) A 10 gauge is required per Standard Plate 3040 or a 12 gauge per Standard Plate 3041.

NOTE: (1) above is assuming that the gauge requirements are based on fill conditions only. If a heavier gauge is desired for velocity - durability reasons, note (1) above should state that regardless of which plate is used, a 10 gauge pipe is required.

PIPE LINING

There has been some confusion regarding pipe lining, hopefully this will clear it up...

Lining pipes must state the size of the pipe being lined….

➢ 2503.603 LINING SEWER PIPE__" by the LIN FT…grout is incidental unless otherwise noted.

➢ 2507.503 LINING CULVERT PIPE (__") by the LIN FT, when using this pay item they also need to include either…

- ❖ 2519.507 CLSM LOW DENSITY by the CU YD or
- ❖ 2519.507 CLSM HIGH DENSITY by the CU YD or

- If using cured in place pipe (CIPP) then pay for it as 2507.603 LINING CULVERT PIPE (__") SPECIAL by the LIN FT. Add a note stating it is Cured in Place Pipe (CIPP) because sometimes it is special but not because it is CIPP. A special provision is required for this and is being updated on a regular basis. Please contact the State Hydraulics Engineer for this write-up.

PLASTIC PIPE OPTION FOR STORM SEWER AND CULVERTS

There has been some confusion with this article given the latest Technical Memorandum 17-5- B-02 issued 4-25-2017.

How plastic pipe options are included in the plan has not changed as a result of this Technical Memorandum. Pay for them as the existing/previous article states. The major change for this is that when listing options the designer CAN now also include PP (polypropylene pipe), that qualified venders and products are listed on the Approved/Qualified Products list and that FHWA allows MnDOT autonomy on determining pipe materials use. While MnDOT continues to recommend consideration of alternative pipe material options where appropriate as a way to increase competition, designers may continue to specify a particular product to be used when professional engineering judgment determines that circumstances warrant. When this is the case the designer should keep written documentation on pipe material selection in the project file.

When giving plastic pipe as an option the plan should include the appropriate bedding detail.

- If using flexible pipe for storm sewer include Standard Plan sheet for *Standard Storm Sewer Bedding for Rigid and Flexible Pipe (5-297.442),*
- If giving flexible pipe as an option for centerline culvert where treatments are not used include Standard Plan sheet for *Standard Culvert Bedding for Flexible Pipe (without Treatments) (5-297.440).*
- Where flexible pipe is an option for centerline culverts where treatments are needed include Design Detail for *Culvert Bedding Flexible Pipe*. The designer should use these details not ones they created.

Plastic pipe should be used in accordance with Technical memorandum No. 17-05-B-02.

Storm Sewer

Storm Sewer (2503 items) Plastic pipe may be used as an option for pipes less than or equal to 48".

Example of how to show it in the plan:
2503.503 24" RC PIPE SEWER CLASS III (1) LIN FT 500
(1) Plastic pipe may be used as an option for 200 lin. ft.. See tabulations for locations.

Make sure the locations are shown in the drainage table.

Centerline Culvert
Plastic pipes may be used for centerline culverts as long as they meet the following requirements…

The maximum allowable diameter is 48" for use under unpaved roads or when ADT is less than 5000.

Centerline culverts shall have silt-tight joints unless designated as requiring watertight joints. A note should be in the plan when a watertight joint is required.

In order to make it clear which pipes shall have options, it is recommended that for each reach of pipe that the options should be noted in the drainage tabulation. On the Statement of Estimated Quantities the listed pay item will be reinforced concrete pipe. A note shall be provided on each appropriate pay item noting that: Plastic pipe may be used as an option.

Side Culvert
As with the storm sewer it is recommended that the tabulation for side culverts note those that will have options.

When giving the plastic pipe option they must use the generic pay items…
- 2501.602 X" SAFETY APRON by the EACH with the note…Apron material shall be the same as pipe material except that the apron for CP and PP pipe shall be CS.
- 2501.602 X" PIPE APRON by the EACH with the note… Apron material shall be the same as pipe material except that the apron for CP, PP, and CS pipe shall be GS.
- 2501.603 X" PIPE CULVERT by the LIN FT with the note…CS, CP, PP, RC may be used as acceptable pipe options. CS was used to determine the pipe lengths.

Other
Plastic pipe is dependent on soil interaction for support. Adequate compaction must be attainable for the pipe to perform satisfactorily. Areas of high groundwater or unusual soil conditions may not be suitable if compaction is not certain. Follow the design criteria in the Technical Memorandum which provide guidance on acceptable pipe sizes, cover requirements, allowable ADT for centerline culvert, and other considerations. Designers need to apply engineering judgment in such situations and limit the types of pipe materials allowed if site conditions may result in an unsuccessful installation.

STANDARD PLATE 3022

This standard plate is used for safety aprons up to and including 36 inches. Standard Plate 3022 shows two design options (No. 1 & No. 2). When using this plate the designer should indicate on the drainage tabulation which option was used to determine the length of pipes.

STANDARD PLATE 4134

Standard plate 4134, Curb Box Casting for Catch Basin (for Design B Curbs), was created specifically for use with 4" B curb. Some problems have occurred with this curb box. Input from the districts and the Bridge Hydraulics Section indicate that breakage has been caused by installation problems. Curb boxes are considered effective only at low-points and should normally not be used at structure locations on-grade. Proper field installation of curb boxes is important, but designers should avoid their use except at low-points. This is especially important when designing for 4" curb and gutter.

This box does not fit on our standard structures; therefore, when using this you need to place it on a structure with a 30" opening such as a Drainage Structure Design N or Drainage Structure Design 4020 or SD with a modified cover with larger hole.

WHAT IS IT?

There has been confusion for the situation when there is a culvert with a drainage structure (catch basin) as part of it.

The Road Design Manual Chapter 8(3) defines a

- Culvert as "a *conduit with open ends through which surface water flows transversely under one or more roadways. It may include intermediate median drains or junctioning conduits, but such junctioning conduits shall be classified as pipe culverts only if they consist of a single conduit with an open end.*"
- Storm Sewer as "*a conduit or interconnected complex of conduits that conveys storm water runoff. Water is admitted to the system primarily through drains and catch basins. An open-end conduit is classified as a storm drain if it connects to a system of conduits.*"

In other words…if it drains primarily from the roadway it is a storm sewer, if it drains primarily from the ditch it is a culvert.