NORTH DAKOTA
DEPARTMENT OF TRANSPORTATION

NDDOT Policy for the
Selection of Alternate Pipe Materials

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Prepared by

Office of Project Development

February 2008

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Introduction

A Final Rule to implement Section 5514 of the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users was published in the Federal Register on November 15, 2006. The Final Rule supports FHWA material selection policies for the competitive bidding principles in Section 112 of Title 23 U.S. Code.

To comply with the provisions of the Final Rule, (as stated in FHWA Memorandum titled, *Pipe Selection Final Rule,* dated November 30, 2006); the NDDOT is required to consider *"all available pipe products that are judged to be of satisfactory quality and equally acceptable on the basis of engineering and economic analyses*. *Where such products appear to be equal, alternative bidding practices must be used as required by 23 CFR 635.411(b). Where alternative products are determined to have different engineering and economic properties, contracting agencies may select a specific material or product based on the required engineering properties and/or life cycle cost criteria. In such cases, the State DOT should document its material selection decision on a project or program basis as appropriate."*

The North Dakota Department of Transportation (NDDOT) has standard practices for the hydraulic and structural design of pipes. The NDDOT will adopt additional performance criteria that will be used to evaluate the acceptability of alternate pipe materials based on application, local, and regional factors.

Risk is an important factor that will be considered in the evaluation of the acceptability of alternate pipe materials. Risk associated with the reliability of the pipe material will be mitigated by considering the manufacturer's product recommendations, AASHTO or ASTM specifications, and the experience of others. Risk associated with the installation process will be mitigated through adherence to design standards & specifications, and appropriate field inspection & testing practices.

Local or regional considerations, as they relate to engineering, cost, or performance criteria, will be used in evaluating the acceptability of alternate pipe materials and may be studied on a case by case basis where it is deemed appropriate.

This document serves as a general policy statement. It refers to the processes and procedures that identify the specific engineering, cost analysis, and performance criteria used to evaluate the acceptability of alternate pipe materials.

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It is NDDOT's practice to allow alternate pipe materials where they can be used. All pipe material will be considered to be "Pipe Conduit". The plans, specifications and bid documents for the project will identify all alternate pipe materials that, based on the results of the evaluation, are determined to be acceptable for the following general or specific applications. To qualify for selection, optional pipe materials must meet the following criteria:

- Provide adequate hydraulic capacity.
- Withstand forces of the weight of the fill over the pipe.
- Withstand forces of traffic loads and construction equipment during pipe installation and under post construction conditions.
- Withstand hydrostatic pressure to prevent fluid from leaking out of the pipe into the surrounding bed materials.
- Provide adequate service life in relation to the AASHTO Culvert Service Life Guidelines (Note 3 - Table 2).
- Withstand corrosion caused by the fluids conveyed by the pipe and the soil surrounding the pipe.
- Withstand abrasion from solids carried by the flow.
- Withstand fire and combustion.
- Be constructible within the constraints of the site.
- Consider local government preferences, but all construction projects shall comply with the requirements of the Final Rule.
- Fulfill the need for experimental installations and/or Materials & Research product review process.

Pipe Material

Table 1 lists references to the NDDOT *Standard Specifications for Road and Bridge Construction.* These pipe materials are considered as appropriate for Mainline Drainage, Approach Drainage, and Storm Drains; with the exception of Plastic Pipe which is not allowed in Mainline applications due to unacceptable risk.

For guidelines on the selection and use of alternate pipe materials for specific applications see Table 2. The list of factors to be considered is not intended to be all inclusive, therefore a proper engineering analysis is required for all installations. For large installations, the analysis should include installation cost comparisons.

Table 1 – Pipe Materials

Material	NDDOT Specifications
Concrete Pipe	714.02 & 830.01
Metal Pipe	714.02 & 830.02
Plastic Pipe	714.02 & 830.03

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New Materials

Pipe materials that the Department does not have a history with in drainage applications are generally not listed on Tables 1 and 2. However, the Department is willing to review new products to determine if the product could be suitable for highway use in the future.

Submitted products will be reviewed for specification requirements, product history, previous usage, constructability, and may be tested in the Department's materials laboratory. If a product or material is found to be acceptable, it may be utilized on specific projects or on an experimental basis.

Design Service Life

Design Service Life is typically defined as the period of service without a need for major repairs. Highway drainage structures are usually designed with the goal of providing some pre-selected minimum number of years of service life.

For metal pipes, this will normally be the period in years from installation until deterioration reaches the point of perforation of any point on the culvert. Reinforced concrete pipe design service life is typically the period from installation until reinforcing steel is exposed, or a crack signifying severe distress develops. Plastic pipe design service life may be considered at an end when excessive cracking, perforation, or deflection has occurred.

It is important to recognize that culverts are not assumed to be at or near the point of collapse at the end of their design service life. Rather, it is the period of little to no rehabilitative maintenance.

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Table 2 – Guidelines for Alternate Pipe Materials

Application	Factors to be Considered	Materials to be Considered	Notes
Mainline Drainage Design Service Life - 75 Years	- Hydraulic Capacity - Structural Capacity - Service Life - Soil / Water Corrosivity - Fill Height - Bed Load Abrasion - Resistance to Fire	- Concrete Pipe (Section 830.01) - Metal Pipe (Section 830.02)	1. The materials listed for each application in this table are a preliminary estimate of possible alternate materials. **Not all of the materials may be feasible in all situations and additional engineering criteria may require evaluation.** 2. Some materials may not have adequate hydraulic capacity, service life, corrosion and abrasion resistance, structural capacity, and resistance to fire damage. 3. The use of a specific pipe product may be used if documented properly in the Hydraulic Study in accordance with these guidelines, and the Culvert Service Life Guidelines located in Chapter 9; Appendix E of the AASHTO Model Drainage Manual will be utilized to the extent possible and in combination with 23 CFR 635.411 (b) when specifying pipe products on NDDOT projects. 4. To fully document the alternate pipe material selection, the following items should be included during the determination of Hydraulic and Structural Requirements as appropriate: a. A hydraulic analysis for each culvert or storm drain shall be completed. b. Determination if abrasion protection is required based on the channel bed material and estimated flow velocity. c. Review of regional corrosive soil maps to determine the applicable pipe materials, gauges, and coatings that provide an adequate service life for the application. d. Verification to determine that the minimum and maximum fill height for each alternate pipe material and shape is applicable to each crossing. e. Review of project scoping reports and District input to determine If ditch burning is anticipated near exposed pipe. If ditch burning is anticipated, plastic or coated metal pipe shall not be used without non-flammable end treatment. 5. The fill height tables for various pipes are located in the NDDOT Standard Drawings. These tables shall be used to determine the applicability of the various alternate pipe materials, shape, gauge, and wall thickness.
Approach Drainage Design Service Life - 40 Years	- Hydraulic Capacity - Structural Capacity - Service Life - Soil / Water Corrosivity - Fill Height - Bed Load Abrasion - Resistance to Fire	- Concrete Pipe (Section 830.01) - Metal Pipe (Section 830.02) - Plastic Pipe (Section 830.03)	
Pipe Extensions	- Review Remaining Pipe Service Life	- Mainline: • Match Existing Material - Approach: • Unlike Materials Acceptable	
Storm Drain Trunk Line and Laterals Design Service Life - 75 Years	- Hydraulic Capacity - Structural Capacity - Service Life - Soil / Water Corrosivity - Fill Height - Bed Load Abrasion - Water Tight Joints	- Concrete Pipe (Section 830.01) - Metal Pipe (Section 830.02) - Plastic Pipe (Section 830.03)	

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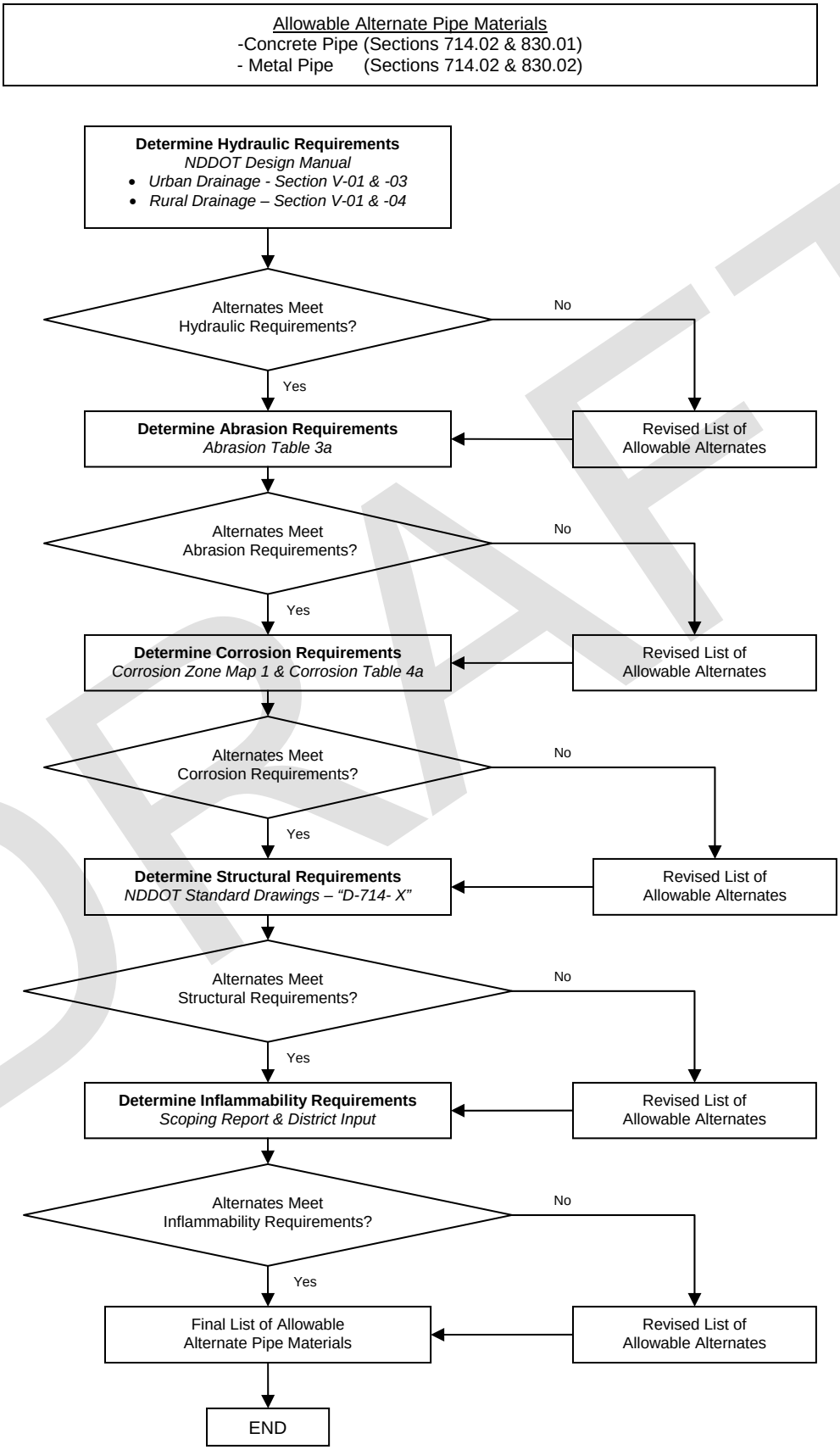
Pipe Material Evaluation Process

Mainline Drainage

(Design Service Life - 75 Years)



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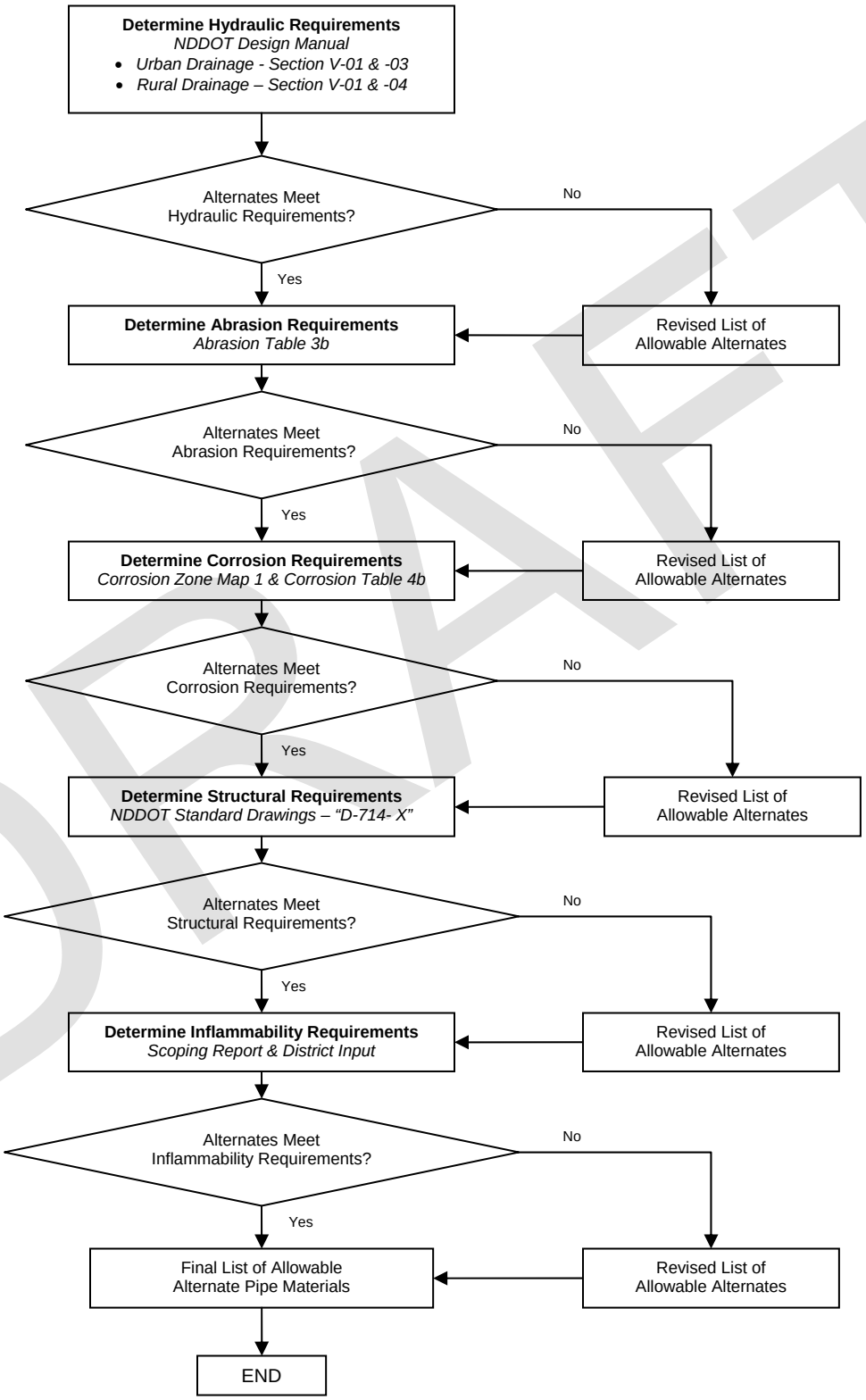
Approach Drainage

(Design Service Life - 40 Years)

Allowable Alternate Pipe Materials
-Concrete Pipe (Sections 714.02 & 830.01)
- Metal Pipe (Section 714.02 & 830.02)
- Plastic Pipe (Section 714.02 & 830.03)



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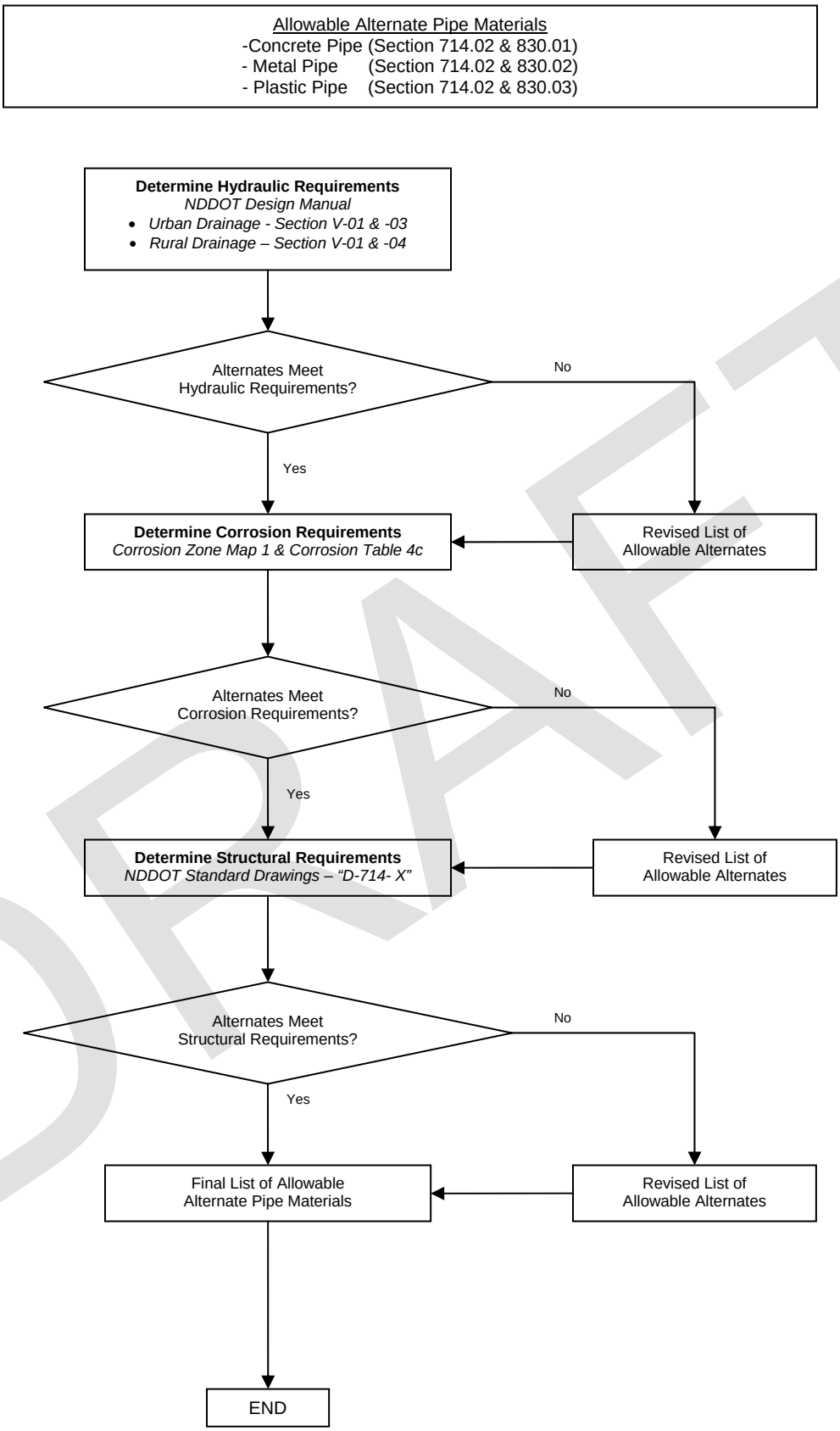
Storm Drain Trunk Line & Lateral Drainage

(Design Service Life - 75 Years)



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Abrasion Tables

Abrasion Table: 3a

Mainline Drainage

(Design Service Life - 75 Years)

Pipe Material	Abrasion Level				
	Level 1	Level 2	Level 3	Level 4	Level 5
Concrete Pipe (Section 830.01)	Y	Y	Y	Y	Y
Metal Pipe (Section 830.02)					
Zinc Coated Corrugated Steel	Y	Y			
Aluminum Coated Corrugated Steel (Type 2)	Y	Y	Y		
Polymeric Coated Steel (over Zinc or Aluminum Coated Steel)	Y	Y	Y	Y	
Structural Steel Plate Pipe (Zinc Coated)	Y	Y			
Aluminum Alloy Pipe	Y	Y	Y	Add 1 Gauge	Add 2 Gauges

Level 1 – No bedload – regardless of velocity.
Level 2 – Bedload of sand, gravel, and debris with velocities of 0 to 5 ft/s.
Level 3 – Bedload of sand, gravel, and debris with velocities of 5 to 10 ft/s.
Level 4 – Bedload of sand, gravel, and debris with velocities of 10 to 15 ft/s.
Level 5 – Bedload of sand, gravel, and debris with velocities greater than 15 ft/s.

Abrasion velocities based on a 2 year design frequency.

Source: National Corrugated Steel Pipe Association and West Virginia DOT Design Directive DD-503.

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Abrasion Table: 3b

Approach Drainage

(Design Service Life - 40 Years)

Pipe Material	Abrasion Level				
	Level 1	Level 2	Level 3	Level 4	Level 5
Concrete Pipe (Section 830.01)	Y	Y	Y	Y	Y
Metal Pipe (Section 830.02)					
Zinc Coated Corrugated Steel	Y	Y			
Aluminum Coated Corrugated Steel (Type 2)	Y	Y	Y		
Polymeric Coated Steel (over Zinc or Aluminum Coated Steel)	Y	Y	Y	Y	
Structural Steel Plate Pipe (Zinc Coated)	Y	Y			
Aluminum Alloy Pipe	Y	Y	Y	Add 1 Gauge	Add 2 Gauges
Plastic Pipe (Section 830.03)					
High-Density Polyethylene (HDPE)	Y	Y	Y	Y	Y

Level 1 – No bedload – regardless of velocity.
Level 2 – Bedload of sand, gravel, and debris with velocities of 0 to 5 ft/s.
Level 3 – Bedload of sand, gravel, and debris with velocities of 5 to 10 ft/s.
Level 4 – Bedload of sand, gravel, and debris with velocities of 10 to 15 ft/s.
Level 5 – Bedload of sand, gravel, and debris with velocities greater than 15 ft/s.

Abrasion velocities based on a 2 year design frequency.

Source: National Corrugated Steel Pipe Association and West Virginia DOT Design Directive DD-503.

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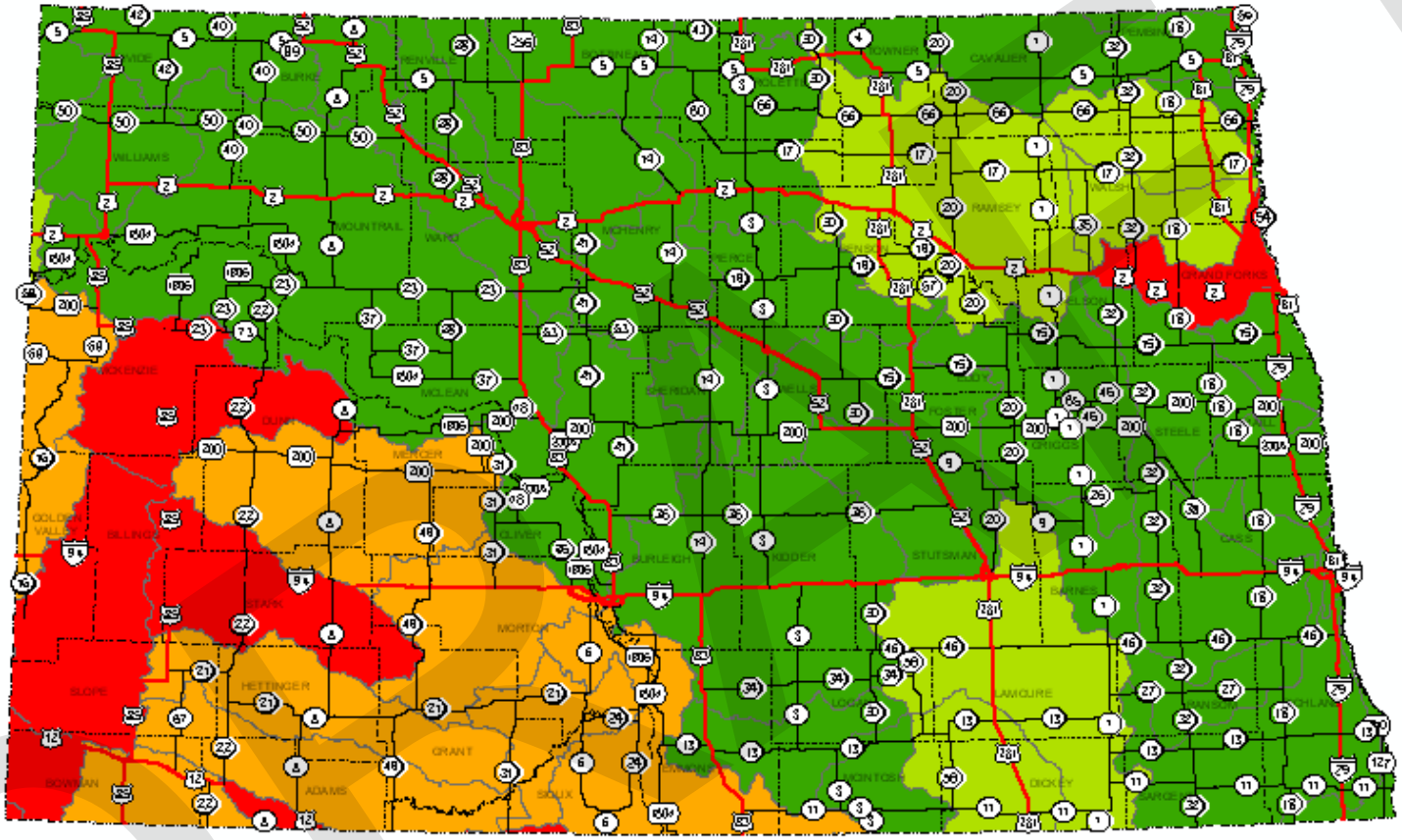
North Dakota Corrosion Zones

Based on Soil Resistivity (Map 1)



ZONE 1 (>750 ohms*cm)

ZONE 2 (500 – 750 ohms*cm)

ZONE 3 (350-500 ohms*cm)

ZONE 4 (<350 ohms*cm)

Data Source: United States Environmental Protection Agency's (EPA) Environmental Monitoring Assessment Program.

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Corrosion Tables

Corrosion Table: 4a

Mainline Drainage

(Design Service Life - 75 Years)

Pipe Material		Corrosion Zone			
		Zone 1	Zone 2	Zone 3	Zone 4
Concrete Pipe (Section 830.01)		Y	Y	Y	Y
Metal Pipe (Section 830.02)	Gauge				
Zinc Coated Corrugated Steel	16 ga.				
	14 ga.	Y			
	12 ga.	Y	Y	Y	
	10 ga.	Y	Y	Y	
	8 ga.	Y	Y	Y	Y
Aluminum Coated Corrugated Steel (Type 2)	16 ga.	Y			
	14 ga.	Y	Y		
	12 ga.	Y	Y	Y	Y
	10 ga.	Y	Y	Y	Y
	8 ga.	Y	Y	Y	Y
Polymeric Coated Steel (over Zinc or Aluminum Coated Steel)	16 ga.	Y	Y	Y	Y
	14 ga.	Y	Y	Y	Y
	12 ga.	Y	Y	Y	Y
	10 ga.	Y	Y	Y	Y
	8 ga.	Y	Y	Y	Y
Structural Steel Plate Pipe (Zinc Coated)	16 ga.				
	14 ga.	Y			
	12 ga.	Y	Y	Y	
	10 ga.	Y	Y	Y	
	8 ga.	Y	Y	Y	Y
Aluminum Alloy Pipe	16 ga.	Y	Y		
	14 ga.	Y	Y		
	12 ga.	Y	Y		
	10 ga.	Y	Y		
	8 ga.	Y	Y		

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Corrosion Table: 4b

Approach Drainage

(Design Service Life - 40 Years)

		Corrosion Zone			
Pipe Material		Zone 1	Zone 2	Zone 3	Zone 4
Concrete Pipe (Section 830.01)		Y	Y	Y	Y
Metal Pipe (Section 830.02)	Gauge				
Zinc Coated Corrugated Steel	16 ga.	Y	Y	Y	Y
	14 ga.	Y	Y	Y	Y
	12 ga.	Y	Y	Y	Y
	10 ga.	Y	Y	Y	Y
	8 ga.	Y	Y	Y	Y
Aluminum Coated Corrugated Steel (Type 2)	16 ga.	Y	Y	Y	Y
	14 ga.	Y	Y	Y	Y
	12 ga.	Y	Y	Y	Y
	10 ga.	Y	Y	Y	Y
	8 ga.	Y	Y	Y	Y
Polymeric Coated Steel (over Zinc or Aluminum Coated Steel)	16 ga.	Y	Y	Y	Y
	14 ga.	Y	Y	Y	Y
	12 ga.	Y	Y	Y	Y
	10 ga.	Y	Y	Y	Y
	8 ga.	Y	Y	Y	Y
Structural Steel Plate Pipe (Zinc Coated)	16 ga.	Y	Y	Y	Y
	14 ga.	Y	Y	Y	Y
	12 ga.	Y	Y	Y	Y
	10 ga.	Y	Y	Y	Y
	8 ga.	Y	Y	Y	Y
Aluminum Alloy Structural Plate Pipe	16 ga.	Y	Y	Y	Y
	14 ga.	Y	Y	Y	Y
	12 ga.	Y	Y	Y	Y
	10 ga.	Y	Y	Y	Y
	8 ga.	Y	Y	Y	Y
Plastic Pipe (Section 830.03)					
High-Density Polyethylene (HDPE)		Y	Y	Y	Y

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Corrosion Table: 4c

Storm Drain Trunk Line & Lateral Drainage

(Design Service Life - 75 Years)

		Corrosion Zone			
Pipe Material		Zone 1	Zone 2	Zone 3	Zone 4
Concrete Pipe (Section 830.01)		Y	Y	Y	Y
Metal Pipe (Section 830.02)	Gauge				
Zinc Coated Corrugated Steel	16 ga.				
	14 ga.	Y			
	12 ga.	Y	Y	Y	
	10 ga.	Y	Y	Y	
	8 ga.	Y	Y	Y	Y
Aluminum Coated Corrugated Steel (Type 2)	16 ga.	Y			
	14 ga.	Y	Y		
	12 ga.	Y	Y	Y	Y
	10 ga.	Y	Y	Y	Y
	8 ga.	Y	Y	Y	Y
Polymeric Coated Steel (over Zinc or Aluminum Coated Steel)	16 ga.	Y	Y	Y	Y
	14 ga.	Y	Y	Y	Y
	12 ga.	Y	Y	Y	Y
	10 ga.	Y	Y	Y	Y
	8 ga.	Y	Y	Y	Y
Structural Steel Plate Pipe (Zinc Coated)	16 ga.				
	14 ga.	Y			
	12 ga.	Y	Y	Y	
	10 ga.	Y	Y	Y	
	8 ga.	Y	Y	Y	Y
Aluminum Alloy Pipe	16 ga.	Y	Y		
	14 ga.	Y	Y		
	12 ga.	Y	Y		
	10 ga.	Y	Y		
	8 ga.	Y	Y		
Plastic Pipe (Section 830.03)					
Polyvinyl Chloride (PVC)		Y	Y	Y	Y
High-Density Polyethylene (HDPE)		Y	Y	Y	Y

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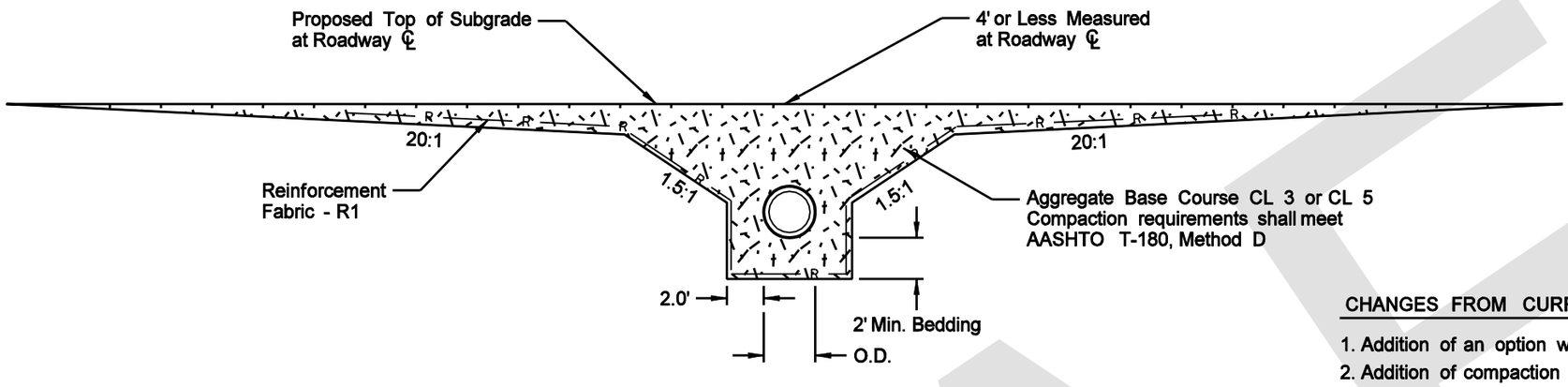
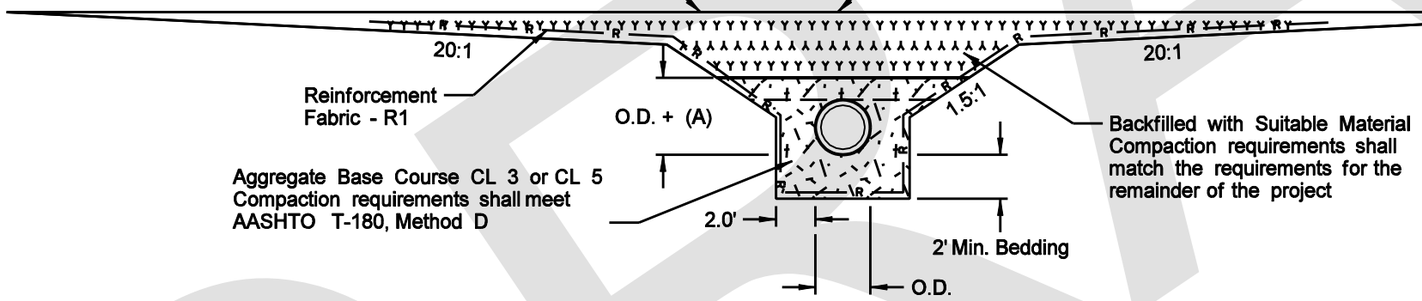


Existing Backfill Detail

CHANGES FROM CURRENT DETAIL

1. Addition of an option with some suitable backfill above the pipe
2. Addition of compaction requirements on the aggregate backfill
3. Addition of aggregate cover requirements, directly above the pipe



Suitable Backfill Detail

Aggregate Cover Requirements	
Pipe Material	Dimension (A)
Concrete	0 inches
Metal	12 inches

Mainline
Pipe Backfill Detail
for Pipes 4' and Less
Below the Proposed Base

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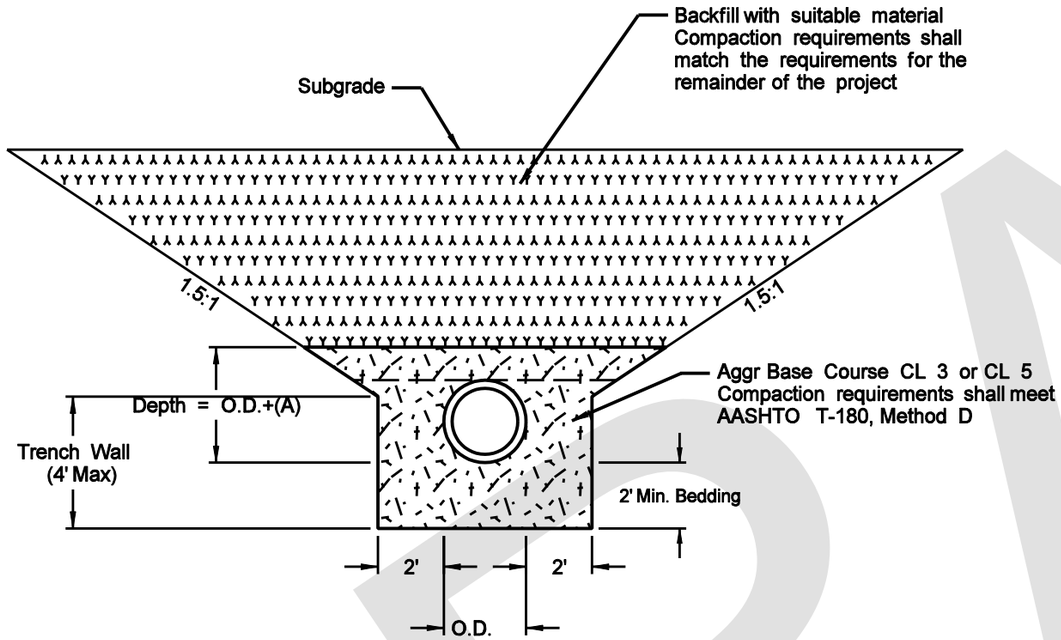
STATE	PROJECT NO.	SECTION NO.	SHEET NO.
ND	.	.	.



CHANGES FROM CURRENT DETAIL

1. Addition of compaction requirements on the suitable backfill
2. Addition of compaction requirement on the aggregate backfill
3. Addition of the aggregate cover requirements, directly above the pipe

Aggregate Cover Requirements	
Pipe Material	Dimension (A)
Concrete	0 inches
Metal	12 inches

Mainline
Pipe Backfill Detail
for Pipes Greater than
4 feet Below the Proposed Base

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