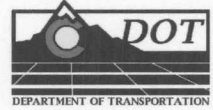


# STATE OF COLORADO

## DEPARTMENT OF TRANSPORTATION

Chief Engineer  
4201 E. Arkansas Ave. #262  
Denver, CO 80222  
(303) 757-9206  
(303) 757-9656 Fax



December 17, 2009

Ms. Karla Petty  
Federal Highway Administration  
12300 West Dakota Avenue, Suite 180  
Lakewood, Colorado 80228

RE: CDOT Pipe Material Selection Policy

Dear Ms. Petty,

On Tuesday December 15, 2009, the CDOT Pipe Material Selection Policy (attached) was signed as a Chief Engineer Policy. CDOT respectfully requests formal concurrence from the FHWA for the acceptance of this policy.

To comply with 23 CFR 635.411 (b), the Colorado Department of Transportation (CDOT) must implement Section 5514 of SAFETEA-LU, competitive bidding for pipe materials.

In June of 2009, a CDOT committee was formed to identify stakeholders and make recommendations to adopt a pipe material selection policy. Mr. Matt Greer of FHWA was a member of this committee, participated, and/or concurred with the content of the policy. This policy gives guidance to project engineers for the selection of pipe materials based on specific criteria, on projects administered by CDOT, including Local Agency projects. This policy as written will allow for competition in the usage of pipe materials and replaces all previous policies regarding the selection of pipe materials.

If you have any questions, please contact Scott Rees at 303-757-9233.

Sincerely,

A handwritten signature in cursive script that reads "Pamela Hutton".

Pam Hutton, P.E.  
Chief Engineer

A handwritten signature in cursive script that reads "Douglas Bennett".

FHWA concurrence

cc: Doug Bennett, Assistant Division Administrator, FHWA  
Rick Gabel, Staff Services  
Tim Aschenbrener, Project Development  
Matthew Greer, FHWA

# CDOT PIPE MATERIAL SELECTION POLICY

## **Implementation**

The CDOT Pipe Material Selection Policy has been developed by the Project Development Branch for approval by the Chief Engineer

These Procedures for Pipe Material Selection supersede and replace all previous procedures, guidelines, and policies regarding the selection of pipe materials used by CDOT.

These procedures also replace the CDOT Chief Engineer memo dated February 8, 1984, *Pipe to be Used in Storm Sewer*.

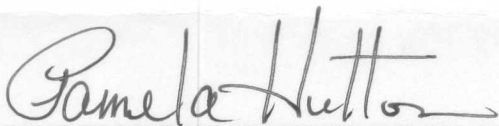
The Colorado Department of Transportation will adopt the content of this policy:

## **Recommended for Approval**



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Rick Gabel, Director of Staff Services



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Pam Hutton, Chief Engineer

# CDOT PIPE MATERIAL SELECTION POLICY

## **Introduction**

To comply with the provisions of the Final Rule published in 23 CFR 635.411 (b), the Colorado Department of Transportation (CDOT) must implement Section 5514 of Safe, Accountable, Flexible, Efficient Transportation Equity Act (SAFETEA-LU) which was published in the Federal Register on November 15, 2006. CDOT will follow its standard practices for the hydraulic and structural design of pipes. CDOT will adopt additional performance criteria that will be used to evaluate the acceptability of alternative pipe materials based on application, locale, and regional factors. This policy replaces all previous policies regarding the selection of pipe material for Storm Sewers, Cross Drains, Side Drains, and Under Drains. Under this policy, Project Managers will select the allowable pipe material options for each installation on a specific project. The Contractor will choose the final pipe material from the list of options provided in the Contract and as specified in applicable sections of the CDOT *Standard Specifications for Road and Bridge Construction*. *Any pipe that meets the corrosion and abrasion criteria in this policy and is installed per the plans and specifications is assumed to have a 50-year service life.*

## **Selection Considerations**

CDOT will evaluate the risk associated with the performance of the pipe materials. Risk will be considered to the extent that it is influenced by the pipe, other materials, or installation techniques as they are used in construction. Project design and material selection are based on balancing engineering requirements with budget constraints.

The CDOT Pipe Material Selection Policy identifies the specific engineering and performance criteria used to evaluate the acceptability of alternative pipe materials. CDOT will allow alternative pipe materials where appropriate. A record of the determination of abrasion and corrosion levels will be documented and maintained in the project design files.

Although a number of states have significant experience with the design and construction of alternative pipe materials, Colorado does not. CDOT will begin allowing the use of additional alternative materials only as it gains knowledge and expertise in their use, even if the product has been successfully used in other states. This approach will help avoid failures resulting from inappropriate use, inexperience, or improper construction techniques. When CDOT and FHWA agree that material selection policy revisions are appropriate, they will be implemented on a reasonable schedule. The evaluation periods for alternative materials used on experimental or pilot project installations will be as short as practicable.

## **Definitions**

Cross Drain – Also known as a Cross Culvert. These pipes usually convey flows from one side of the road to the other, and are open on each end.

Side Drain – A pipe under a driveway or a road approach to the mainline roadway.

Storm Sewer – A storm sewer is usually part of a system of pipes connecting inlets, manholes, or both to outfalls. An outfall is usually the pipe that discharges the collected water from the storm drain system. Storm drain systems are composed of lateral pipes and collector pipes. The laterals usually connect inlets to the collector which is conveyed to the outfall.

Subsurface Drain – The most common example is a French Drain. Subsurface drains collect ground water or relieve water pressure from a wall or structure and transport it to a location where it will not harm the roadway features, or where it can be conveyed by

## CDOT PIPE MATERIAL SELECTION POLICY

another system (i.e. a Storm Sewer). Note: Subsurface drains are not covered as a part of this policy.

Durability - Although structural condition is a very important element in the performance of pipes, durability problems are a common cause for replacement. Pipes are more likely to "wear away" than fail structurally. Durability is affected by two mechanisms: corrosion and abrasion. Each is discussed in the following sections.

Corrosion – Corrosion is the deterioration of material due to chemical or electrochemical reaction with the environment. Corrosion of pipe materials may occur in many different soils and waters. These soils and waters may contain acids, alkalis, dissolved salts, organics, industrial wastes or chemicals, mine drainage, sanitary effluents, and dissolved or free gases. However, pipe corrosion is generally related to water and the chemicals that have reacted to, become dissolved in, or been transported by the water.

Abrasion – Abrasion is the process of wearing down or grinding away the surface material of pipes, as water laden with sand, gravel, or stones flow through a pipe. Abrasive forces increase as the velocity of the water flowing through a pipe increases.

Alternative Materials – Alternative materials are the various pipe materials that will meet the project requirements. The alternative materials will be identified in the Contract, and the Contractor may select any one of them for use on the project.

# CDOT PIPE MATERIAL SELECTION POLICY

**Selection Process** – All decisions regarding pipe material type will be based on engineering practices and judgments. The Project Manager (PM) will consider such factors as durability, environmental considerations, soil conditions, fill heights, need for water tight joints, slopes of inverts, and hydraulic characteristics of pipe material inside surfaces.

Durability includes the potential for natural corrosive effects and abrasive flows [bed load]. Often corrosion and abrasion operate together to produce far greater deterioration than would result from either alone. Abrasion can accelerate corrosion by removing protective coatings and allowing water-borne chemicals to come into contact with corrodible pipe materials.

The Project Manager will specify on the plans or in the special provisions when water tight joints are required. Siphons, irrigation systems, and storm drain systems require water tight joints.

Due to material incompatibilities similar material, size, and type of pipe will be used for extensions of existing pipes and systems, unless conditions and engineering justifications merit otherwise.

**Step I: Determine Application** – In all cases, the Project Manager will use the latest version of CDOT's *Drainage Design Manual*. The pipe selection process begins when the Project Manager determines the location of the new pipe. The Project Manager will then determine and document the specific use of the pipe:

- Cross Drain
- Side Drain
- Storm Sewer

**Step II: Determine Abrasion Level** – An estimate of the potential for abrasion is required to determine acceptable pipe types and whether there is a need for invert protection. Four levels of abrasion are referred to in this guidance, and the following guidelines are established for each level:

- **Abrasion Level 1** – This level applies where the conditions are nonabrasive. Nonabrasive conditions exist in areas of no bed load and very low velocities. This is the level assumed for the soil side of drainage pipes. This is also the level assumed for the inverts of cross drains and side drains installed in typically dry drainages.
- **Abrasion Level 2** – This level applies where low abrasive conditions exist. Low abrasive conditions exist in areas of minor bed loads of sand and velocities of 5 fps or less.
- **Abrasion Level 3** – This level applies where moderately abrasive conditions exist. Moderately abrasive conditions exist in areas of moderate bed loads of sand and gravel and velocities between 5 fps and 15 fps.
- **Abrasion Level 4** – This level applies where severely abrasive conditions exist. Severely abrasive conditions exist in areas of heavy bed loads of sand, gravel, and rock and velocities exceeding 15 fps.

Abrasion levels are intended to help the Project Manager consider the impacts of bed-load wear on the invert of pipe materials. Sampling of the streambed materials is not required, but visual examination and documentation of the size of the materials in the stream bed and the average slope of the channel assist the Project Manager in determining the expected level of abrasion. Where existing pipes are in place in the



## **CDOT PIPE MATERIAL SELECTION POLICY**

same drainage, the conditions of their inverts should be documented and used as guidance. The expected stream velocity should be based upon 2-year flow and less.

The Project Manager will estimate and document the abrasive forces that will have an effect on the drain or sewer.

- Measure or calculate the velocity of the water based upon 2-year flow and less.
- Estimate the bed-loading as:
  - No bed load
  - Minor bed load – silt and sand
  - Moderate bed load – silt, sand, and gravel
  - Heavy bed load – silt, sand, gravel, and rock
- Determine whether the abrasion level is 1, 2, 3, or 4 as defined above.

**Step III: Determine Corrosion Level** – The station of each proposed pipe must be supplied to the appropriate Region Staff (Region). The Region will determine a sampling schedule to ensure that corrosive forces are adequately addressed. The Region will sample soil and water at these locations. The resulting sample testing information will be used in flow charts (Figures 1 and 2) to select appropriate material.

The Project Manager will document the following properties of the soil and water:

- Sulfate Levels
- Chloride Levels
- Resistivity
- pH
- Moisture Levels

This information will be obtained at all pipe locations supplied by the Project Manager and documented in the project records by the Project Manager. If the project is small enough, or the alluvium of the area is sufficiently homogeneous, a reduced sampling schedule will be acceptable as determined by the Region.

**Step IV: Selection of Pipe Material Type** – Use the flowcharts in this document to identify acceptable pipe material types. If metal pipe is determined to be an allowable material type as determined in Figure 1 of this document, use Table 2 to determine whether there are additional requirements for metal pipes.

**Step V: Verify Fill Height** – Check Fill Height tables in the Standard Plans. Determine if Project Special Provisions are required and/or if any other Standard Special Provisions are applicable.

**Step VI: Address Exceptions to This Policy** – All exceptions to this policy require a Justification letter and must be approved by the Chief Engineer and the FHWA.

**Step VII: Documentation** – All design decisions regarding pipe material type selection must be documented and a letter placed in the project file. A copy of all selection letters are to be sent the Area Engineer prior to final design decisions being made, for guidance and to verify consistency.

# CDOT PIPE MATERIAL SELECTION POLICY

**Table 1**  
**Guidelines for selection of corrosion resistance levels**

CR Level	SOIL			WATER		
	Sulfate	Chloride		Sulfate	Chloride	
	(SO <sub>4</sub> )	(Cl)	pH	(SO <sub>4</sub> )	(Cl)	pH
	% max	% max		ppm (max)	ppm (max)	
*CR 0	0.05	0.05	6.0-8.5	50	50	6.0-8.5
CR 1	0.10	0.10	6.0-8.5	150	150	6.0-8.5
CR 2	0.20	0.20	6.0-8.5	1,500	1,500	6.0-8.5
CR 3	0.50	0.50	6.0-8.5	5,000	5,000	6.0-8.5
CR 4	1.00	1.00	5.0-9.0	7,500	7,500	5.0-9.0
CR 5	2.00	2.00	5.0-9.0	10,000	10,000	5.0-9.0
CR 6	>2.00	>2.00	<5 or >9	>10,000	>10,000	<5 or >9

\*No special corrosion protection recommended when values are within these limits. Concrete pipe used when the pH of either the soil or water is less than 5 shall be coated in accordance with subsection 706.07. When needed, specify the coating in a special provision or plan note.

Table 1, above, and observations of field conditions of existing pipes are to be used as aids in the determination of a CR level.

**Table 2**  
**Minimum Pipe Thickness For Metal Pipes Based On The Resistivity And pH Of The Adjacent Soil**

SOIL SIDE		MINIMUM REQUIRED GAUGE THICKNESS FOR METAL PIPE MATERIAL
Resistivity, R (Ohm – cm)	pH	
≥1,500	5.0-9.0	0.052 in (18 Gauge) Aluminized Type 2
≥250	3.0-12.0	0.052 in (18 Gauge) Polymer Coated

A standard special provision [SSP] has been issued. The SSP revises Sections 603 and 624, and eliminates Section 617. In the rare instance a single type of pipe material is specified, use the appropriate Section 603 pay item. In the normal cases use the new Section 624 pay item for the Class of material allowed for the pipe. Attached are project special provision work sheets to assist Project Managers in specifying additional pipe requirements. Use the latest versions of the work sheets which can be found at:

<http://www.dot.state.co.us/DesignSupport/Construction/2005SpecsBook/Work%20Sheets/2005ws.htm>

# CDOT PIPE MATERIAL SELECTION POLICY

## STANDARD SPECIAL PROVISION



Revision of 603,  
617, and 624 01-08.c

## PROJECT SPECIAL PROVISION WORK SHEETS

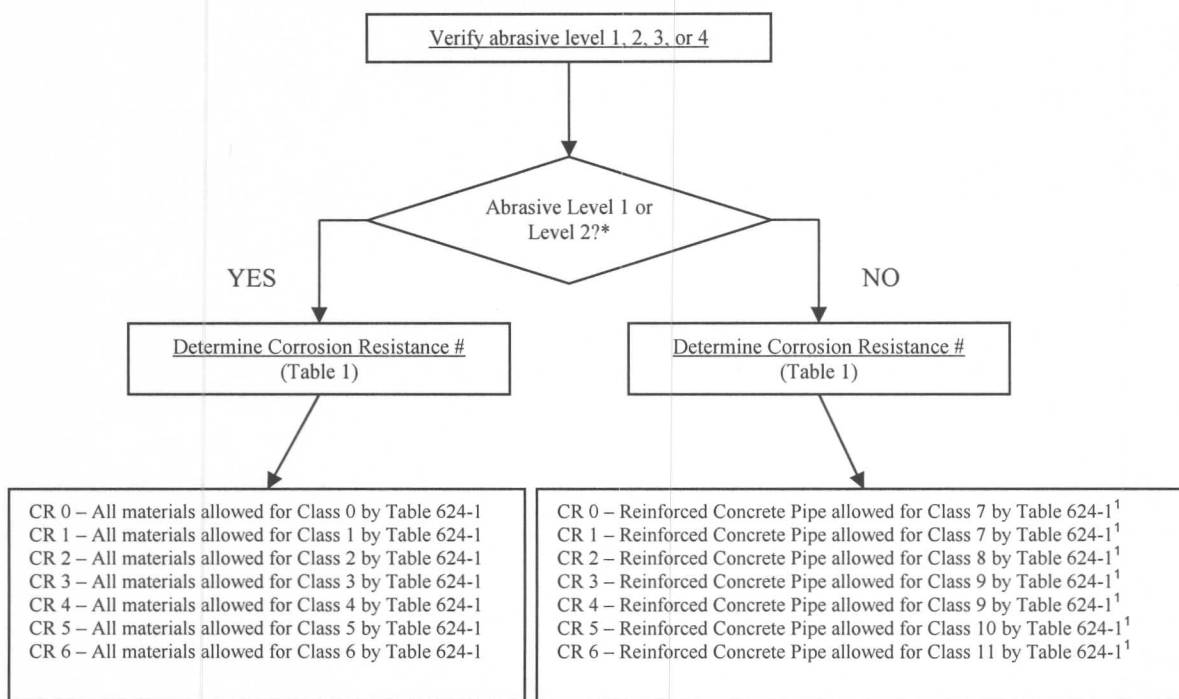


603 624  
worksheets.docx



# CDOT PIPE MATERIAL SELECTION POLICY

**Figure 1  
CROSS – DRAINS and SIDE – DRAINS**



\*Aluminum alloy pipe not allowed in environments with an Abrasion Level higher than 1.

<sup>1</sup> When concrete pipe is selected the sulfate content dictates the CR level. Cementitious requirements for Sulfate Protection Classes are listed in 601.04. A higher level of protection may be used. Concrete shall have a minimum compressive strength of 4,500 psi and a maximum water to cementitious ratio (w/cm) listed in 601.04. Concrete may be used when the pH and chlorides exceed the levels listed in Table 1

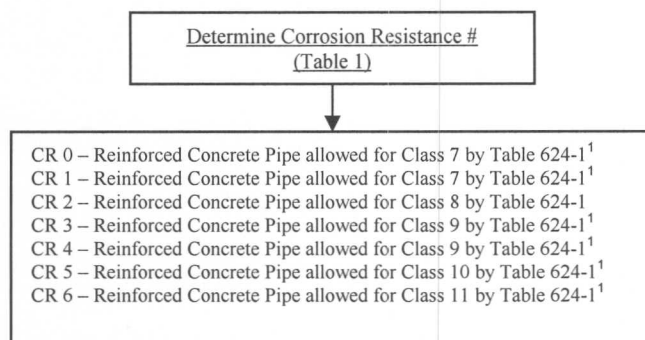
For Metal pipes, see “Minimum Pipe Thickness For Metal Pipes Based On The Resistivity And pH Of The Adjacent Soil” (Table 2) in this document.

When extending an existing pipe, the same size and type of material must be specified. If conditions are Abrasive level 1 or 2 **and** CR 0, specify material type from Section 603 pay items.

# CDOT PIPE MATERIAL SELECTION POLICY

**Figure 2**  
**STORM-SEWERS**

Storm-sewers are often inundated with water for a period of time. CDOT has observed that dissimilar materials (i.e. concrete to metal or plastics) when joined will often not form a water tight seal. Therefore, it is recommended that only reinforced concrete pipe (RCP) be used in storm sewers.



<sup>1</sup> – If abrasion level is 3 or 4, concrete shall have a minimum compressive strength of 4,500 psi. Cementitious requirements for Sulfate Protection Classes are listed in 601.04. A higher level of protection may be used. Concrete may be used when the pH and chlorides exceed the levels listed in Table 1

When extending an existing pipe, the same size and type of material must be specified. If conditions are Abrasive level 1 or 2 **and** CR 0, specify material type from Section 603 pay items.

# CDOT PIPE MATERIAL SELECTION POLICY

## TRIAL INSTALLATIONS & EVALUATION PROCESS

At any time, Manufacturers may request in writing to have materials not approved herein evaluated for a specific application. Requests for trial installations shall follow the requirements of P.D. 1401.1. Contact information for that procedure is given below:

Product Evaluation Coordinator  
Colorado Department of Transportation  
Materials and Geotechnical Branch  
4670 Holly Street, Unit A  
Denver, CO 80216  
303-398-6500

- Manufacturers will provide all of the materials, equipment and labor required for the pipe material to be evaluated at no cost to CDOT.
- The pipe material to be evaluated must meet applicable AASHTO and ASTM design and material standards.
- Manufacturers will be responsible for all coordination with the Contractor, and any additional cost incurred by the Contractor as a result of the trial installation.
- CDOT will determine a suitable location for the trial installation.
- During installation, the manufacturer shall have a representative at the installation site. The manufacturer will provide documentation to CDOT that the pipe material was designed and installed per all current and applicable AASHTO and CDOT design and installation standards.
- Trial installations shall perform satisfactorily for at least one year before conclusions regarding product performance are made.
- During the one year evaluation period, at a time chosen by CDOT, the manufacturer shall provide laser video inspection services on the trial installation utilizing an inspection contractor approved by CDOT.
- Based on the results of the laser video inspection, trial installations shall meet CDOT and AASHTO standards for deflection, joint separation, buckling, tearing, sagging and cracking.
- Monitoring may include research of the trial material in use in other states.
- If further evaluation is required beyond one year, the supplier will be notified of the justification for this evaluation extension.
- Upon successful completion of the monitoring period, CDOT's Materials Advisory Committee (MAC) will review the performance and determine the acceptability of the material for future inclusion into the CDOT Pipe Material Selection Policy.
- If changes to this policy, not including introduction of new materials, are requested, they will be evaluated through the following process:
  - The MAC will form a Pipe Material Task Force or Task Group to assist in evaluation of documentation concerning this type of change to the policy.
  - Documentation supporting the proposed change is to be submitted by the supplier to the Product Evaluation Coordinator (PEC) at the address above.
  - The PEC will compile all submitted documentation and submit it to the Pipe Material Task Force or Task Group.
  - The Pipe Material Task Force or Task Group will evaluate proposals as submitted and make recommendation to the MAC for voting.
  - These recommendations, if ratified by the MAC, will be further evaluated by affected committees if appropriate, and if fully accepted, incorporated into the policy.