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Material Testing Rates for Low-Volume Roads

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June 2012

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Final Report 2012-17



Your Destination...Our Priority



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TABLE OF CONTENTS

CHAPTER 1 INTRODUCTION	1
CHAPTER 2 MNDOT SURVEY.....	2
CHAPTER 3 MNDOT AUDIT	7
CHAPTER 4 RISK ANALYSIS.....	8
CHAPTER 5 CONCLUSIONS.....	10
APPENDIX A - UPDATED SCHEDULE OF MATERIALS CONTROL	

LIST OF TABLES

Table 4.1 LIMS Testing Summary (2010).....	8
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LIST OF FIGURES

Figure 2.1 Responses from MnDOT Districts	2
Figure 2.2 Survey Categories.....	2
Figure 2.3 Critical Inspection	3
Figure 2.4 Time Required for Inspection.....	4
Figure 2.5 Safety Risk.....	5
Figure 2.6 Process to Eliminate	6

EXECUTIVE SUMMARY

This research project updated the Schedule of Materials Control (SMC) for the State Aid to Local Transportation (SALT) division of the Minnesota Department of Transportation (MnDOT). The process included a survey, an audit review, a risk analysis evaluation and finally, the creation of a revised SMC specific to the needs of the state aid division.

A SALT SMC survey elicited responses from 33 field inspectors, 56 project engineers and 8 contractors. Comments addressed a perceived need for a simpler SMC for smaller jobs, which are completed in a matter of days. Respondents commented that testing results are likely to be unusable for the small jobs, since it could take longer to get test results back than it takes to complete the job. Comments also clearly addressed the frustration of required inspections and testing even though the products came from certified, qualified or approved sources. The required time to inspect low-cost and low-risk areas and materials on the job were noted by multiple respondents.

MnDOT Office of Audit's annual audit of compliance with specific single audit compliance requirements for the year ended June 30, 2009, was reviewed. The recommendations included specific instructions to SALT to "implement a plan to ensure cities and counties perform the following actions," essentially, instructions to follow the MnDOT Schedule of Materials Control. The annual audit results also brought an awareness of the financial impact of the MnDOT Schedule of Materials Control. The requirements of MnDOT's Schedule of Materials Control and the MnDOT audit process demonstrate the need to either follow the published guidelines or change the guidelines to more accurately reflect the necessary requirements.

Pass/fail rates and costs of testing for several material items were reviewed to evaluate the risk associated with changing various materials testing requirements. The asphalt cement failure rate was less than 1%, with the average cost of discovery factored at \$25,000. The asphalt emulsion failure rate was 1.8%, giving a factored cost around \$2,000 per failure.

The projects undertaken by the state aid division are typically smaller in size and shorter in duration than the projects managed by the Construction and Innovative Contracting (OCIC) division of MnDOT. The smaller project scope and shorter timeline of state aid projects has been shown to warrant a SALT SMC.

CHAPTER 1 INTRODUCTION

The Transportation Research Board holds a standing committee on low-volume roads and hosts a conference every four years dedicated to the issues of work on low-volume roads. It is widely recognized that the issues facing construction managers on low-volume road projects are quite different from issues faced on roads which carry more traffic with both higher vehicle counts and higher weights. The 9th International Conference on low-volume roads was held in Austin, TX in 2007. In a TRB published paper, Ann Johnson, P.E., summarized “Current Issues Facing Low-Volume Road Managers.” She divided the issues into New Materials and Preservations/Management and Planning, Design and Safety. Each section of her paper contained summaries of six separate “hot topics” discussed at the conference. A common theme throughout is a lack of guidelines and documentation for research and experiments on low-volume roads.

MnDOT has a long history of using different requirements for different types of roads. For instance, Test Cell 32, constructed at the MnRoad test facility in 2000, was designed to study the behavior of a thin, low-cost pavement to be used on low-volume roads. This less expensive mix design is one example of how traditional standards for building roads may be modified, depending on the planned use.

One of the issues not addressed in Johnson’s review is the ripple effect changes in the MnDOT Schedule of Materials (SMC) may have on counties, cities and townships. Currently, the local government entities must follow the same guidelines as MnDOT, without the ability to know when testing fees will be charged until the jobs are in process. Examples include testing charges for asphalt binder and asphalt plant inspections. Both tests are periodic and, if quantities are small, may or may not be incurred. Information obtained from engineers at the Transportation Department of Dakota County was used to validate areas of uncertainty for the counties, cities and townships.

Requirements to test materials have proven to be effective over time, as demonstrated by the quality of roads in the state of Minnesota. However, quality inspection, as quoted in the 1925 Minnesota Highway Department manual states, “Good inspection may add several thousand dollars to the value of the road without adding materially to its cost.” One issue with the current method of materials control is that testing requirements have been prioritized over inspection responsibilities. Testing requirements are relatively easy to measure, a simple checkbox will suffice. Inspection responsibilities require analysis and understanding of conditions, which are more difficult to both report and justify.

One of the challenges for creation of a State Aid for Local Transportation (SALT) Schedule of Materials Control (SMC) for low-volume roads was the definition of where the new guidelines apply. Low-volume roads have a variety of definitions. The consensus of the Technical Advisory Panel (TAP) in this study was to allow application of the SALT SMC on State Aid Projects only with Average Daily Traffic (ADT) fewer than 1500 vehicles, including construction and maintenance of off street trails. The established challenge was to create a set of guidelines that would minimize the costs of construction and maintenance for low-volume roads without creating unnecessary risks.

CHAPTER 2 MNDOT SURVEY

Task 1 of the current Schedule of Materials Control for low-volume roads study was an online survey conducted in November 2010. In all, 80 people completed the online survey. An identical paper and pencil survey was also conducted during the same time period with 18 additional respondents. Of the total responding to the survey, 33 were field inspectors, 56 were project engineers and 8 were contractors. The respondents were scattered across the State of Minnesota, as reflected in the data from Table 1.

Q2: Which MNDOT district are you most associated with?

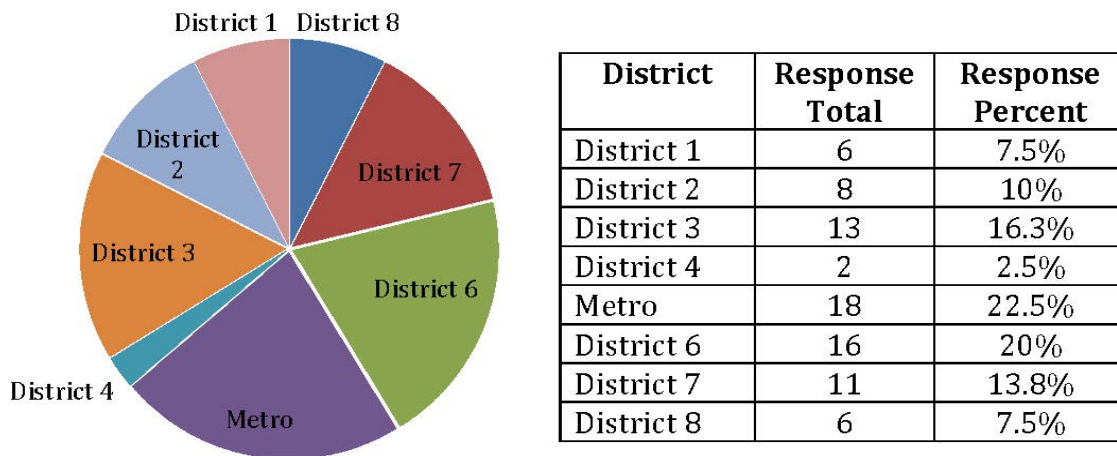


Figure 2.1 Responses from MnDOT Districts

The survey divided the Schedule of Materials Control into nine categories, based loosely on current divisions of the MnDOT SMC. Table 2 lists the categories that were used in the survey.

Mainline Paving
Ancillary Paving
Structural Concrete
Miscellaneous Concrete
Erosion Control
Grading and Base
Landscaping
Metallic
Pipe

Figure 2.2 Survey Categories

Each respondent was asked to rank order the significance of the categories in several ways. The first question asked to rank order by critical inspection. Table 3 contains the results from the 98 total respondents. Mainline paving, structural concrete and grading and base ranked highest in

need of inspection. The categories of Landscaping and Metallic (guardrail, fencing, etc.) scored lowest. Ancillary paving, miscellaneous concrete and erosion control all scored significantly lower than the three items with highest scores on the survey. Comments from the respondents included concern for the requirement to test items that were under warranty, had already been approved, certified, qualified or have been tested by the manufacturer. It was also a concern that there was significant time required for tasks that had a low cost and low safety risk if there was a failure.

Q3: Consider your role at the agency, please rank order the following categories according to their critical inspection

Overall

The table below displays the mean score for each category. **Mainline Paving, Structural Concrete, and Grading & Base** appear to be the most critical. **Landscaping and Metallic** appear to be the least critical.

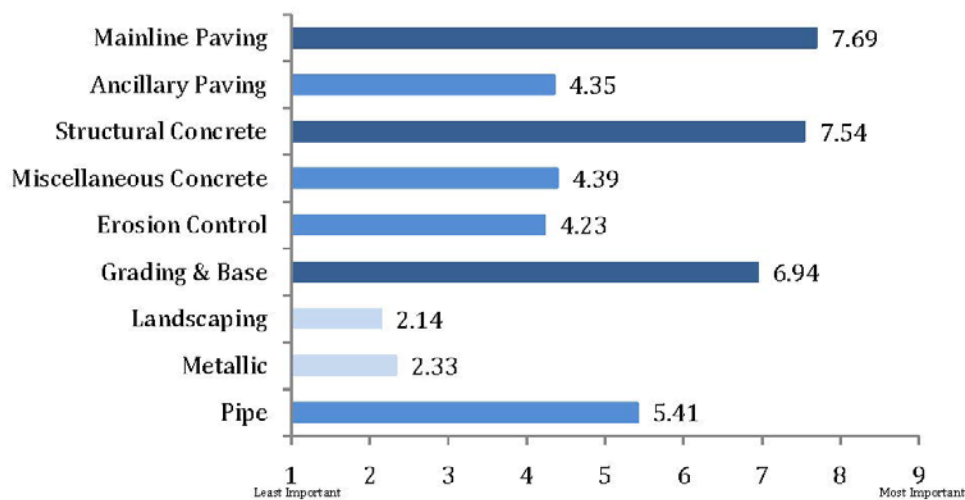


Figure 2.3 Critical Inspection

With the reality of budget constraints already apparent and efficient use of time at a premium, the time needed to perform inspections is a significant concern. Question four of the survey, with data shown in Table 4, asked about time commitment in order to fulfill the requirements of the SMC. Comments from respondents focused on the return on investment for their time. Spending valuable time on low risk tasks may decrease the amount of available time necessary for critical tasks.

Q5: Consider your role at the agency, please rank order the following categories in terms of time taken to administer the inspection

Overall

The table below displays the mean score for each category. **Mainline Paving**, **Structural Concrete**, and **Grading & Base** appear to be taking the most time to administer the inspection. **Landscaping** and **Metallic** appear to be taking the least time to administer the inspection.

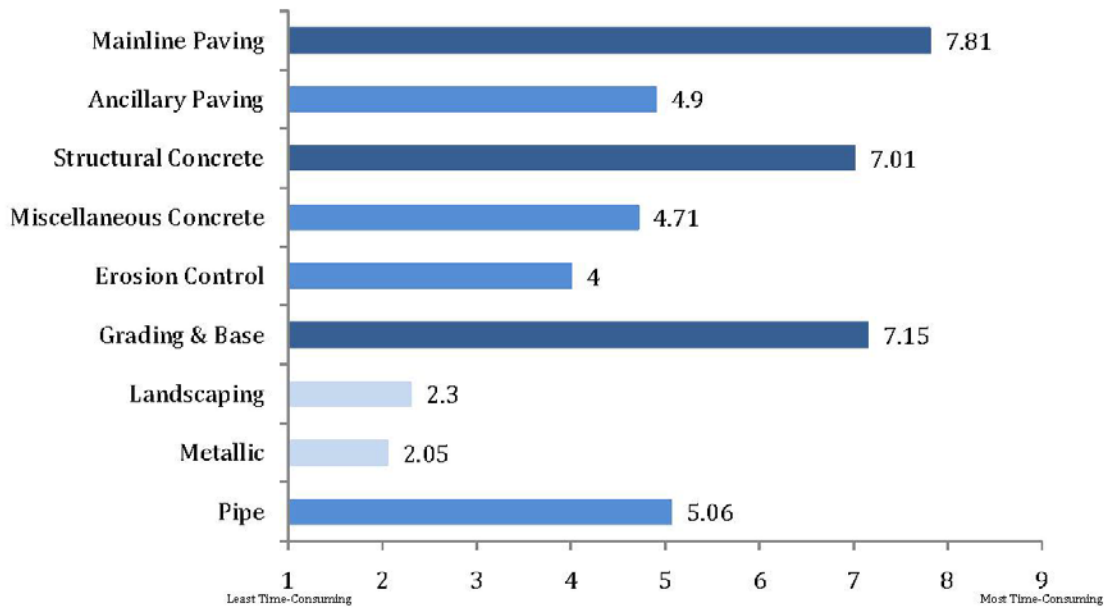


Figure 2.4 Time Required for Inspection

Safety of the traveling public is a primary motivation behind testing and inspection as roads are being built. Survey respondents were asked to rank order the nine categories for safety risks if inspections were not performed. Structural concrete had the highest score, meaning inspection in that category was the most critical to address safety risks. Landscaping and erosion control scored lowest, with safety risks not a major concern. Table 5 shows the safety risk results.

Q6: Consider your role at the agency, please rank order the following categories in terms of increase safety risk if the step wasn't performed

Overall

The table below displays the mean score for each category. **Mainline Paving**, **Structural Concrete**, and **Grading & Base** appear to have the highest safety risk if the inspection wasn't administered. **Landscaping** and **Erosion Control** appear to have the lowest safety risk if the inspection wasn't administered.

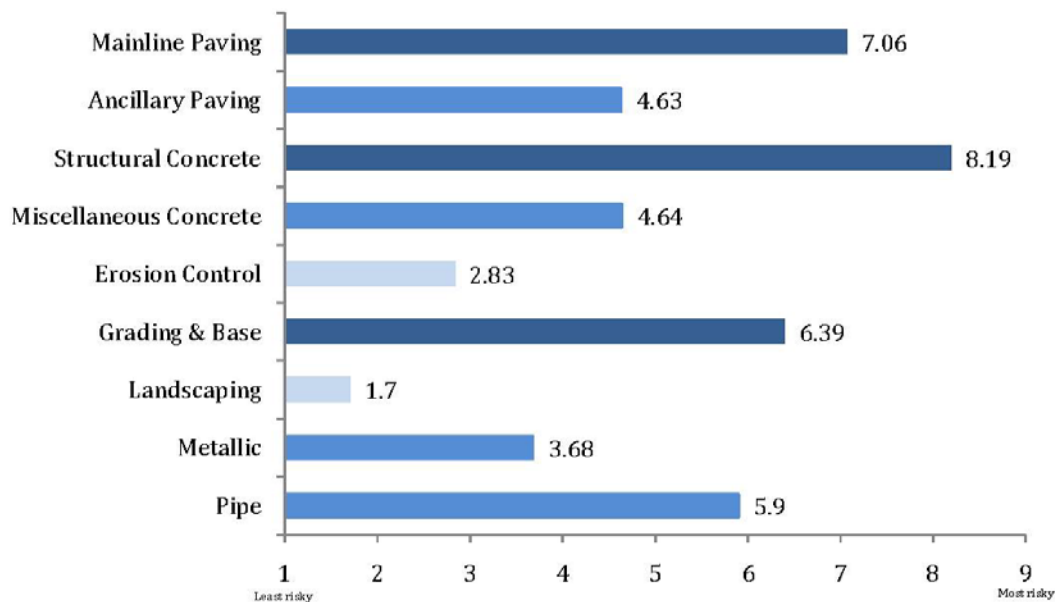


Figure 2.5 Safety Risk

The final question of the survey asked which step in the inspection process could be skipped. Overwhelmingly, landscaping and erosion control were steps selected as least important and would be skipped if possible. Table 6 shows the results of the question. Comments from respondents included the need to simplify the process of using approved/certified products and the suggestion to incorporate warranty periods, a process already used, to assure quality products in place of up-front testing.

Q7: If you could skip any step in the materials control process, which would you skip?

Overall

The table below displays the response frequency for each category. **Landscaping** and **Erosion Control** appear to have the highest number of respondents who think that these steps can be skipped. **Structural Concrete**, **Mainline Paving**, **Pipe**, and **Grading & Base** appear to have the lowest number of people who think these steps can be skipped.

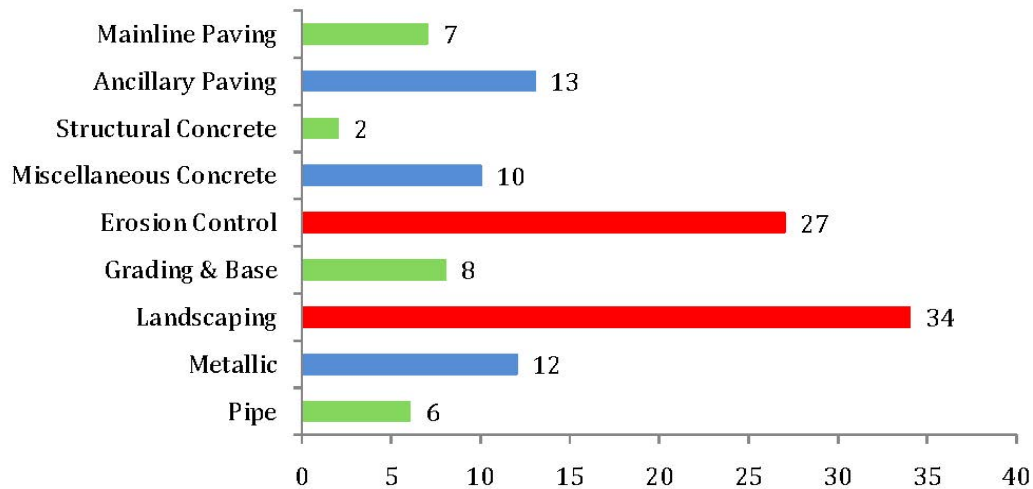


Figure 2.6 Process to Eliminate

Results of the survey clearly suggest that landscaping and erosion control categories are the least critical and could be skipped if the regulations allowed. Responses also clearly showed that mainline paving and structural concrete were critical items to inspect. Comments addressed a perceived need for a simpler SMC for smaller jobs, which are completed in a matter of days. Testing results are likely to be unusable for the small jobs, since it may take longer to get test results back than it takes to complete the job. Comments, solicited from the respondents, clearly addressed the frustration of required inspections and testing even though the products came from certified, qualified or approved sources. The required time to inspect low-cost and low-risk areas and materials on the job were noted by multiple respondents. It was also suggested by multiple respondents that producers, manufacturers and contractors need to shoulder more of the responsibility for quality, through increased penalties and a higher standard for “remove and replace” rather than taking a simple deduction.

CHAPTER 3 MNDOT AUDIT

Results from the MnDOT Office of Audit's annual audit of compliance with specific Single Audit Compliance Requirements for the year ended June 30, 2009 were published in a memo dated December 22, 2009. A total of 9 MnDOT Trunk Highway projects and 9 local agency projects were audited. With respect to the concerns discussed in the report, results of the audit indicated MnDOT and State Aid substantially complied with applicable Project requirements.

One area noted in the audit that included State Aid for Local Transportation was grading and base. Recommendations put forth by the auditors included the need to complete and submit grading and base reporting as required. Reporting included completion of necessary Quality Assurance testing, Quality Control testing, Certification of Aggregates and the Materials Certification Exceptions Summary. Recommendations from the auditors also included taking actions necessary to train responsible project personnel and then hold the responsible person accountable.

A second area noted included testing for concrete and bituminous items. The requirements for core testing, coarse aggregate testing, air entraining agents, water reducers, companion samples and more were noted in the recommendations. The recommendations included specific instructions to State Aid to "implement a plan to ensure cities and counties perform the following actions," essentially, instructions to follow the MnDOT Schedule of Materials Control.

The annual audit results also brought an awareness of the financial impact of the MnDOT Schedule of Materials Control. In the event that the Auditor determined the specified processes (testing, sampling, inspection) for a various item on a project were not adhered to, and depending on the degree of noncompliance, the federal funding of said item may be questioned (referred to as a 'Questioned Cost'). From this point, a panel consisting of MnDOT personnel and local agency representatives would be tasked with reviewing each Questioned Cost and determining whether or not the subject item/material met the intent of the Project Specifications. Depending upon the information collected and presented for each Questioned Cost, and the professional judgment of the panel, all, a portion of, or none of the federal funding would be removed from the project. If federal funds are pulled from the project budget, MnDOT and/or the local agency was then faced with withholding funds from or assessing deduct to contractors, or finding funding for said portion of the project via other avenues.

The requirements of the MnDOT Schedule of Materials Control and the MnDOT audit process demonstrate the need to either follow the published guidelines or change the guidelines to more accurately reflect the necessary requirements.

CHAPTER 4 RISK ANALYSIS

Pass/Fail rates and costs of testing for several material items were reviewed to evaluate the risk associated with changing various materials testing requirements. MnDOT's Lab Information Management System (LIMS) program was the primary source of testing information utilized during the study. Table 7 summarizes the testing results for Asphalt Cement, Asphalt Emulsion, Cement, Curing Compound, Concrete Additives, Epoxy paints, Geotextiles, Fly Ash, Fencing, Fasteners, Glass Beads, Guardrail, Joint Filler, Liquid Chloride, Sign Posts, Soil Fertility and Traffic Tape.

Table 4.1 LIMS Testing Summary (2010)

2010 testing	Asphalt Cement	Asphalt Emulsion	Cement	Curing Compound	Concrete Additives	Epoxy Paints	Geotextiles	Flyash	Fencing ^B
Samples submitted - total	588	271	421	91	995	955	242	502	339
Test results reported	588	271	125 ^A	5 ^A	995	430 ^A	242	135 ^A	319
Local samples submitted	302 / 51 %	104 / 38 %	63 / 50 %	7 / 8 %	227 / 27 %	106 / 11 %	82 / 34 %	152 / 30 %	184 / 58 %
DOT samples submitted	286 / 49 %	167 / 62 %	62 / 50 %	84 / 92 %	768 / 73 %	849 / 89 %	160 / 66 %	350 / 70 %	135 / 42 %
Local sample failures	3 / .5%	5 / 1.8%	0	0	8 / .8 %	0	1 / .4 %	0	46 / 14 %
Dot sample failures	6 / 1.0%	4 / 1.5%	0	0	12 / 1.2 %	3 / .7 %	9 / 3.4 %	1 / .7 %	70 / 22 %
Cost to Local Agency	\$75,814.08	\$11,351.60	\$4,830.21	\$171.36	\$4,492.33	\$2,934.08	\$6,514.08	\$12,293.76	\$11,536.80
									\$129,938.30
	Fasteners ^C	Glass Beads	Guardrail	Joint Filler	Liquid Chloride	Sign Posts	Soil Fertility	Traffic Tape	
Samples submitted - total	100	340	66	174	99	48	85	75	
Test results reported	58	340	27	172	99	48	?	66	
Local samples submitted	31 / 53 %	72 / 21 %	^D 8 / 30 %	9 / 5 %	31 / 31 %	^E 30 / 62 %	35 / 41%	12 / 19 %	
DOT samples submitted	27 / 47 %	268 / 79 %	19 / 70%	163 / 95 %	68 / 69 %	18 / 38 %	50 / 59 %	54 / 81 %	
Local sample failures	1 / 1.7 %	3 / .9%	0	0	4 / 4 %	8 / 17%	?	0	
Dot sample failures	19 / 32.8%	2 / .6 %	0	?	2 / 2 %	3 / 6 %	?	0	
Cost to Local Agency	\$2,154.50	\$2,091.60	\$556.00	\$1,035.54	\$1,066.40	\$5,088.60	\$3,781.40	\$476.76	\$16,250.80
									\$146,189.10

^ASamples are submitted to the Maplewood Lab and are entered into LIMS (Lab Information Management System). Some final test results were not linked back into LIMS.

^BFencing had failures with plastic coating thickness on hog rings, etc...

^CFasteners had failures with buy america screws for noise wall construction

^D Guardrail, 8 samples from 1 county - Redwood

^ESign post failure were black enamel posts submitted (needs to be galv) and thinner gauge metal

The failure rate for asphalt cement is less than 1%. The three local sample failures average a cost over \$25,000.00 per discovery. The cost to repair or replace asphalt cement would be substantially less than the costs incurred by mandating testing of asphalt cement across all local projects. The asphalt emulsion failure rate is 1.8%, giving a factored cost of around \$2,000 per failure. Fencing item failures that are notable include coating that was thicker than the specification required as well as coatings that were tested on hog rings and other miscellaneous parts. The failure rates for fasteners were based on missing documentation required by the "Buy America" standard. All of the guardrail failures were from one county and the sign post failures were submitted as black enamel rather than galvanized.

None of the failures would cause safety concerns to the traveling public. The costs associated with established testing guidelines for the categories listed in Table 7 totaled over \$146,000 in the year 2010. Based on these findings, a new SALT SMC for low-volume roads was developed

to address the construction project risks Local Agencies encounter. Minnesota State University, Mankato recommends that State Aid for Local Transportation adopt the following 2012 SALT Schedule of Materials Control for low-volume roads.

CHAPTER 5 CONCLUSIONS

Requirements to test materials have proven to be effective over time, as demonstrated by the quality of roads in the state of Minnesota. However, quality inspection, as quoted in the 1925 Minnesota Highway Department manual states, “Good inspection may add several thousand dollars to the value of the road without adding materially to its cost.” One issue with the current method of materials control is that testing requirements have been prioritized over inspection responsibilities. Testing requirements are relatively easy to measure, a simple checkbox will suffice. Inspection responsibilities require analysis and understanding of conditions, which are more difficult to both report and justify.

The MnDOT Materials Control Schedule (MCS) is designed to standardize testing and inspection of projects under the control of MnDOT. The projects undertaken by the State Aid division are typically smaller in size and shorter in duration than the projects managed by the Construction and Innovative Contracting (OCIC) division of MnDOT. The smaller project scope and shorter timeline of state aid projects has been shown to warrant a different set of guidelines.

The 2012 SALT SMC for low-volume roads guidelines have been reviewed by the MnDOT personnel and local agency representatives. Feedback from MnDOT, local agency representatives and the construction industry through the Technical Advisory Panel was catalogued and the Authors have modified the 2012 SALT SMC for low-volume roads based on the input received. The 2012 SALT SMC for low-volume roads will standardize testing on local agency projects in the same manner that the MnDOT MCS has for Trunk Highway Projects.

APPENDIX A

UPDATED SCHEDULE OF MATERIALS CONTROL

12/2/2011

2012 SALT* Schedule of Materials Control - Low Volume

*MnDOT Office of State Aid for Local Transportation

1603.2 SAMPLING AND TESTING - SPECIAL PROVISIONS

The first sentence of the first paragraph is hereby deleted and replaced with the following:

"Sampling and testing of materials for all Low Volume State Aid Projects will be in accordance with the MnDOT - SALT Schedule of Materials Control - Low Volume". Low volume is determined as actual average daily traffic (ADT) of 1500 or less and off system trails. The Schedule of Materials Control - Low Volume serves as a guide for material testing with allowable acceptance "as directed by the Engineer" detailed in Specification 1501.1a - Authority of the Engineer.

These testing rates are a minimum and additional tests may be taken at the Engineer's discretion. A minimal testing rate does not always ensure a quality product; field observations and attention to detail is crucial. Materials not listed on an approved products list may be sampled and tested as directed by the Engineer. Materials listed on a Qualified Products list may be accepted or tested at the discretion of the Engineer. Sample sizes and testing rates for projects greater than 1500 ADT are detailed in the current MnDOT Schedule of Materials Control.

[The current MnDOT Schedule of Materials Control.](#)

Definitions

Approved

Products are 'approved' when they have been found to routinely meet all applicable standards and specifications. The product is placed on the list based upon established successful manufacturer's quality control and warranties, but the listing may expire or require periodic renewal to verify the product has not changed over time. The approval process for the individual product should specify any expiration requirement.

Qualified

Products are considered 'Qualified' when they are predicted to meet all applicable standards and specifications, but random sample testing is required to verify specific product lots meet specifications prior to usage. These products are generally considered to be "qualified" but not approved until tested for compliance. Successfully tested product lots are considered to be "approved". The approval process for the individual product should specify any further testing requirements for the product.

2012 SALT Schedule of Materials Control - Low Volume
Materials Acceptance Summary - Project _____

[illegible]

* Items not included on the Approved Product List or the Manufacturer's Certifications have not been received are hereby accepted by the Engineer. Materials on a Qualified Products list which have not been tested at the discretion of the Engineer are hereby accepted.

signed: _____

2012 SALT - Schedule of Materials Control - Low Volume

CERTIFIED READY-MIX CONCRETE 1 of 2

The Prime Contractor is responsible to assure that all ready-mix concrete used is produced by a certified ready-mix plant. The Certified Ready Mix Program requirements are detailed in Specification 2461.4D7 and the current MnDOT Schedule of Materials Control. The Engineer shall review the suppliers ready-mix certification program for compliance.

Test Type	Spec. No.	Minimum Required Agency Acceptance Testing
Gradation	3126 3137	Coarse and Fine: 1 per 200 yd ³ or as directed by the Engineer.
Aggregate Quality	3126 3137	As directed by the Engineer.
Coarse Aggregate Testing, 200 sieve	3137	As directed by the Engineer.
Air Content *	2461	Test first load each day per mix, then 1 test per 100 yd ³
Slump *		Test first load each day per mix, then 1 test per 100 yd ³ , slump test not required for slip form placement.
Temperature		Record temperature each time air content, slump or strength test specimen is performed/fabricated.
Compressive Strength		Test first load each day per mix, then 1 test per 100 yd ³ , Minimum of 1 per day if production is more than 50 yd ³ .

* The first load of concrete for any pour must have passing air content and slump prior to placement.

[No Sampling required for materials on the Approved Products List](#)

Only materials on the Approved Products List, Qualified Products List, or from a certified source are allowed for the following items.

CURING MATERIALS
JOINT MATERIALS

CEMENTITIOUS MATERIALS
ADMIXTURE FOR CONCRETE

Additional Resources

[Concrete Manual](#)
[Concrete Tests](#)

[Concrete Materials & Testing](#)
[The Certified Ready-Mix Program](#)

Small quantity is 20 yd³ or less/day with no gradation testing or plant monitoring required.

The testing rates shown in the Schedule of Materials Control - Low Volume are minimums. All samples shall be taken in a random manner using an appropriate number generator. Take as many tests as necessary to ensure quality concrete. It is recommended that the Agency Plant Monitor be present during critical pours, such as superstructure or paving concrete (ie. 3Y33, 3Y36, 3Y46, 3A21).

If any field test fails, reject the concrete or if the Producer makes adjustments to the load to meet requirements, record the adjustments on the Certificate of Compliance and Weekly Concrete Report. Retest the load and record the adjusted test results. Make sure the next load is tested, before it gets into the work. If batching adjustments are made at the plant, test the adjusted load, before it gets into the work. Continue to test the concrete when test results are inconsistent or marginal.

MnDOT - SALT Schedule of Materials Control - Low Volume

CERTIFIED READY-MIX CONCRETE 2 of 2

Material not meeting requirements shall not knowingly be placed in the work. If failing concrete inadvertently gets placed in the work, use either the Mn/DOT Standard Specifications for Construction or the Schedule of Price Reductions for Concrete to address penalties. It is recommended that the Agency representative continually monitor the progress of all concrete pours. (It is not a recommended practice to only perform minimum testing requirements and leave the project.)

Gradation Sample Size: 25 lb. for 3/4" Plus Coarse Aggregate
15 lb. for 3/4" Minus Coarse Aggregate
10 lb. for CA-70 and Sand

Quality Sample Size: 50 lb. 3/4" plus Coarse Aggregate
30 lb. 3/4" minus Coarse Aggregate
30 lb. Fine Aggregate

Moisture Sample Size: 1.1 lb. Fine Aggregate
4.4 lb. Coarse Aggregate

Testing rates for the following items are detailed in the current Mn/DOT Schedule of Materials Control.

PAVING CONCRETE SUPPLIED BY A PAVING PLANT

PAVING CONCRETE SUPPLIED BY A CERTIFIED READY-MIX PLANT

LOW SLUMP CONCRETE FOR BRIDGE DECK OVERLAYS

CONCRETE PAVEMENT REPAIR (CPR) FOR CONCRETE NOT SUPPLIED BY CERTIFIED READY-MIX

DOWEL BAR RETROFIT MATERIAL

CONTROLLED LOW STRENGTH MATERIAL (CLSM) OR CELLULAR CONCRETE

CONCRETE CONSTRUCTION MATERIALS: Refer to Metallic Materials and Metal Products for sampling requirements for concrete reinforcement.

2012 SALT - Schedule of Materials Control - Low Volume Bituminous Quality Management

The Contractor shall provide and maintain a quality control program as detailed in Specification 2360.2.G. The Engineer shall review the quality control program for compliance.

	Type of Test	Spec Section *	Contractor - QC Testing Rates	Agency - QA Testing Rates	
Production Start-Up Testing Rates for the 1st 2000 tons **	Bulk Specific Gravity	2360.2.G.7.b	1 per 500 tons 55 lb sample 3 full cylinder molds	1 Verification Mixture Sample per day, all QA samples are from a split (QC/QA) sample.	
	Maximum Specific Gravity	2360.2.G.7.c			
	Air Voids (calculated)	2360.2.G.7.d			
	Asphalt Content	2360.2.G.7.a			
	Adj. Asphalt Film Thickness (AFT)	2360.2.E.7.e			
	Gradation	2360.2.G.7.f			
	Fines to Effective Asphalt Ratio calc'd	2360.2.G.7.a/f	1 per 1000 tons		
	Coarse Aggregate Angularity (CAA)	2360.2.G.7.g			
	Fine Aggregate Angularity (FAA)	2360.2.G.7.h			
	Added AC/Total AC Ratio (calc'd)	2360.2.G.7.a			
Production Testing Rates	Bulk Specific Gravity	2360.2.G.7.b	1 per 1000 tons 55 lb sample 3 full cylinder molds	1 Verification Mixture Sample per day/ mix type, submit companion to the QC - CAA & FAA test results.	
	Maximum Specific Gravity	2360.2.G.7.c			
	Air Voids (calculated)	2360.2.G.7.d			
	Asphalt Content	2360.2.G.7.a			
	Adj. Asphalt Film Thickness (AFT)	2360.2.E.7.e			
	Gradation (minimum of 1 per day)	2360.2.G.7.f			
	Added AC/Total AC Ratio (calculated)	2360.2.G.7.a			
	Coarse Aggregate Angularity (CAA)	2360.2.G.7.g	NOTE 1		
	Fine Aggregate Angularity (FAA)	2360.2.G.7.h	NOTE 2		
	TSR	2360.2.G.7.i	When directed by the Materials Engineer		
	Aggregate Specific Gravity	2360.2.G.7.j	As directed by the Engineer		
	Mixture Moisture Content	2360.2.G.7.k	NOTE 3		
	Asphalt Binder	2360.2.G.7.l	NOTE 4		
	Asphalt Emulsion	3151	NOTE 4		
	Compaction / Density Requirements	2360.3.D	Review special provisions		

Review the requirements of 2360.2.E Mixture Design prior to production start-up.

* Review Special Provisions & 2360.2.G Mixture Quality Management.

** The testing rates apply only to mixtures that have not been tested on previous projects. Mixtures from previous years should use the start-up testing rates.

NOTE 1: 2 tests/day for a minimum of 2 days, then 1 per day if CAA is met. If CAA > 8% of requirement, 1 sample/day but test 1/week.

NOTE 2: 2 tests/day for a minimum of 2 days, then 1 per day if FAA is met. If FAA > 5% of requirement, 1 sample/day but test 1/week.

NOTE 3: Shall be a Certified Supplier - NO SAMPLES - See [Asphalt Binder Certified Supplier List](#)

NOTE 4: Shall be a Certified Supplier - NO SAMPLES - See [Asphalt Emulsion Certified Supplier List](#)

Testing rates for the following items are detailed in the current Mn/DOT Schedule of Materials Control.

Bituminous Seal Coat	Otta Seal
Ultra Thin Bonded Wearing Course (UTBWC)	Permeable Asphalt Stabilized Relief Course (PASSRC)
Micro Surfacing	Permeable Asphalt Stabilized Base (PASB)

2012 SALT - Schedule of Materials Control - Low Volume

GRADING AND BASE CONSTRUCTION ITEMS 1 of 2

The Contractor is responsible for maintaining a gradation control program as detailed in Specification 2211.

	Material Type	Const. Spec.	Mat'l Spec.*	Minimum Req'd Agency Acceptance Testing	Lab Sample
GRADATION TESTING (See Notes 2 & 3)	Aggregate Surfacing	2118	3138	275 yd ³ to < 2,200 yd ³ (CV) = 1/550 yd ³ 2,200 yd ³ to 5,500 yd ³ (CV) = 4 tests/Lot 500 Tons to < 4000 Tons = 1/1000 Tons 4000 Tons to < 10,000 Tons = 4 tests/Lot	1/source 30 lb
	Aggregate Base	2211			
	Aggregate Shoulders	2221			
	Stabilizing Agg.	2105	3149		
	Open Graded Aggregate Base (OGAB)	2211	*	1/550 yd ³ (CV) or 1/1000 Tons	1/source 30 lb
	Granular Borrow	2105	3149	1/20,000 yd ³ (CV)	1/source 30 lb
	Select Gran. Borrow				
	Full Depth Reclamation	2331	*	1/12,000 yd ² or as directed by Engineer	None
	Granular Filter	2511	3601	1/ source or as directed by Engineer	1/source 150 lb
	Granular Backfill	2451	3149		1/source 30 lb
	Aggregate Backfill				
	Granular Bedding				
	Aggregate Bedding				
	Coarse Filter				
	Fine Filter	2502	1/source 30 lb		
Sand Cover	2206				
MOISTURE- DENSITY TEST (PROCTOR)	<i>(Req'd for Specified Density)</i>		3138	1/25,000 cubic yards per source	1 sample minimum 25 lb
	Aggregate Base	2211			
	Aggregate Shoulders	2221			
	Embankment Soil; Excavation & Borrow	2105	3149	1 per major soil	2 sample minimum 25 lb
RELATIVE DENSITY TEST (SAND CONE)	<i>(Req'd for Specified Density)</i>		3138	1/1,000 yd ³ (CV)	None
	Aggregate Base	2211			
	Aggregate Shoulders	2221			
	Embankment Soil; Excavation & Borrow	2105	3149	1/4,000yd ³ (CV)	
Penetration Index Method (DCP)	Aggregate Base	2211	3138	1 DCP tests/500 yd ³ (CV)	None
	Aggregate Shoulders	2221			
	Full Depth Reclamation	2331	2331 *	1 DCP tests/3,000 yd ²	
	Fine Filter Aggregate (Edge Drains)	2502	2331 *	Special Provisions	
Penetrati on Index (Mod. DCP)	Aggregate Base	2211	3138	1 DCP tests/500 yd ³ (CV)	None
	Aggregate Shoulders	2221			
	Granular Borrow Select Granular Borrow	2105	3149	1 DCP tests/2,000 yd ³ (CV)	

2012 SALT - Schedule of Materials Control - Low Volume
GRADING AND BASE CONSTRUCTION ITEMS 2 of 2

	Material Type	Const. Spec.	Mat'l Spec.*	Minimum Req'd Agency Acceptance Testing	Lab Sample
Relative Moisture	<i>(Req'd for Specified Density)</i>				
	Aggregate Base	2211	3138	1/1,000 yd ³ or 10 tests whichever is less or as directed by the Engineer	None
	Aggregate Shoulders	2221			
	Embankment Soil; Excavation & Borrow	2105	3149	1/10,000 yd ³ (CV)	
Moisture Content (Dry Wt.)	<i>(Required for Quality Compaction, Penetration Index Method, & Modified Penetration Method)</i>				
	Aggregate Base	2211	3138	1/1,000 yd ³ or 10 tests whichever is less or as directed by the Engineer	None
	Aggregate Shoulders	2221			
Percent Crushing	Particle Count (note 1)	2105 2118 2211 2221	3138 3149 *	1/ source or as directed by Engineer, (req'd for class 5, class 6, stabilizing aggregate & aggregate bedding).	None
Quality	Aggregate Quality Tests	2105 2118 2206 2211 2221 2451 2502	3138 3149 *	1/ source or as directed by Engineer	1/source 30lb

* Always review the project Special Provisions for modifications.

Laboratory Companion Samples:

1. Samples are not required for 1,000 tons or less.
2. Include the laboratory companion with the first field sample.
3. Include the field sample results with the laboratory sample.
4. Laboratories with AMRL Accreditation are not required to submit laboratory companion samples.
5. Carbonate aggregate materials require 50 lb samples for the laboratory testing.

NOTE 1: Percent crushing test is not required for materials meeting class A or class B in 3137.2B or 3139.2A2.

NOTE 2: Submit a laboratory companion to the first Acceptance Gradation sample for a bituminous extraction, see 3138.2A2a(a). Full Depth Reclamation samples are not required.

NOTE 3: Documentation of testing locations is at the discretion of the Engineer.

Samples are not required for less than 500 tons (275 yd³).

To convert from volume to weight use the following: 1 ton = 0.55 yd³ (CV)

[Click here for testing procedures in the Grading & Base Manual.](#)

[Forms and worksheets at the Grading & Base Website.](#)

[Gradation worksheets at the SALT Construction Website](#)

2012 SALT - Schedule of Materials Control - Low Volume

LANDSCAPING AND EROSION CONTROL ITEMS

Kind of Material	Spec. No.	Minimum Required Acceptance Testing (Field Testing Rate)
Manufactured Topsoil Borrow, Salvaged Topsoil (stockpiled)	3877.2	As directed by the Engineer
Plant Stock & Landscape Materials	3861 and 2571.2A1	Certificate of Compliance, Nursery stock certificate registered with Mn Dept. of Agriculture. Out of state products subject to pest quarantines must accompanied by documentation certifying all products are free of regulated pests.
Erosion Control Blanket	3885	Visual Inspection and Check approved products or approved vendors list - As directed by the Engineer.
Erosion Control Netting	3883	
Silt Fence	3886	
Erosion Stabilization Mat	3885	
Flotation Silt Curtain	3887	Accepted, based on manufacturers certification of compliance. Check weight of fabric.
Filter Logs	3897	None
Flocculants	3898	Obtain copy of Certificate of Compliance and MSDS
Fertilizer	3881	Obtain copy of invoice of blended material stating analysis.
Agricultural Lime	3879	Contractor must supply amount of ENP (Equivalent Neutralizing Power) for each shipment.
Mulch - Type 3	3882	Certified Weed Free (Certified sources only) Check for Certified Vendor tag from Minnesota Crop Improvement Association (MCIA).
Mulch - Type 6 - Woodchips		All wood chips supplied by a supplier outside the Emerald Ash Borer quarantine area or have an Emerald Ash Borer Compliance Agreement with the MDA
Seeds	3876	(Certified Vendors Only) (Mixes 100-299) Check for Certified Vendor tag from Minnesota Crop Improvement Association (MCIA).
Native Seed		(Mixes 300-399) certified seed only. Check for Certified Vendor tag from Minnesota Crop Improvement Association (MCIA).
Sod	3878	Visual Inspection - Check approved products list - As directed by the Engineer. Check for Certified Vendor tag from Minnesota Crop Improvement Association (MCIA) for salt tolerant sod.
Compost (from Certified Source)	3890	
Compost (from Non-Certified Source)		Visual Inspection - As directed by the Engineer.
Hydraulic Soil Stabilizer	3884	Check Approved/Qualified Products List - As directed by the Engineer.

2012 SALT - Schedule of Materials Control - Low Volume

CHEMICAL ITEMS

Kind of Material	Spec. No.	Minimum Required Acceptance Testing (Field Testing Rate)
Asphalt Plank	3204	Visual Inspection - As directed by the Engineer.
Calcium Chloride	3911	Review the percentage required as per specification.
Magnesium Chloride	3912	
Hot-Pour Crack Sealant (for Crack Sealing/Filling)	3719 3723 3725	Retain Certification of Compliance
Waterproofing Materials		
Membrane Waterproofing System	3757	Visual Inspection - Check qualified products list.
Waterproofing Materials - Three Ply System		
Asphalt Primer	3165	Visual Inspection - As directed by the Engineer.
Waterproofing Asphalt	3166	
Fabric	3201	
Paints		
Waterborne Latex - Traffic Paint	3591	Visual Inspection - Check qualified products list - retain Certificate of Compliance.
Epoxy Traffic Paint	3590	
Traffic Marking Paint	Special Provisions	
Non-Traffic Striping Paints	3500 Series	Retain Certification of Compliance
Bridge Structural Steel Paint	3520	Visual Inspection - Check approved products list - retain Certificate of Compliance.
Exterior Masonry Paint	3584	
Noise Wall Stain	Special Provisions	
Drop-on Glass Beads	3592	Visual Inspection - Check qualified products list. Retain Certificate of Compliance.
Pavement Marking Tape	3354	Visual Inspection - Check qualified products list. Retain Certificate of Compliance.
	3355	
	Special Provisions	
Signs and Markers	3352	Visual Inspection - Check qualified products list.

2012 SALT - Schedule of Materials Control - Low Volume
Metals 1 of 2

Kind of Material	Spec. No.	Minimum Required Acceptance Testing (Field Testing Rate)*
Guard Rail		
Fittings - Splicers, Bolts, etc.	3381	Visual Inspection - Materials shall be approved before use. Call MnDOT inspector at 218-846-3613 to see if material has been approved.
Structural Plate Beam	3382	
Steel Posts		
Steel Sign Posts	3401	Visual Inspection - As directed by the Engineer. Retain Certificate of Compliance in Project file.
Fence Posts, Brace Bars, Rails and others	3403	Visual Inspection - As directed by the Engineer. Retain Certificate of Compliance and certified mill analysis in project file.
	3406	
	3379	
Fence		
Barbed Wire	3376	Visual Inspection Retain Certification of Compliance, As directed by the Engineer.
Woven Wire		
Chain Link Fabric		
Components: cup, cap, nut, bolt, end clamp, tension band, truss rod tightener, hog ring, tie wire, tension stretcher bar, truss rod, clamp & tension wire		
Gates	3379	
Pipe		
Water Pipe and other Piping Materials	3364, 3365, 3366 & Special Provisions	Visual Inspection - As directed by the Engineer.
Reinforcing Steel - Inspected by MnDOT & will be charged back to the Local Agency.		
Uncoated Bars	3301	Retain Certificate of Compliance & Certified Mill Analysis
Epoxy Coated Bars	3301	For Epoxy-Coated bars, steel will be tagged "Inspected" when it has been sampled and tested by Mn/DOT prior to shipment, and it will be tagged "Sampled" when testing has not been completed prior to shipment. If the Epoxy-Coated bars are not tagged "Sampled" or "Inspected", submit samples, Certificate of Compliance, and Certified Mill Analysis for testing. Maintain original Certificate of Compliance and Certified Mill Analysis in project file.
Spirals	3305	
Stainless Steel Bars	Special Provisions	Visual Inspection Testing as directed by the Engineer. Certified Mill Test Reports to be kept in file.

**2012 - SALT Schedule of Materials Control - Low Volume
Metals 2 of 2**

Kind of Material	Spec. No.	Minimum Required Acceptance Testing (Field Testing Rate)*
Reinforcing Steel - Inspected by MnDOT & will be charged back to the Local Agency.		
Steel Fabric	3303	Visual Inspection - Retain Certificate of Compliance.
Dowel Bars	3302	
Castings		
Drainage and Electrical Castings	3321	Visual Inspection - Check approved foundries list.
	2471	
	2565	
Anchor Rods (Cast in Place) and Structural Fasteners	3385	Visual Inspection - Testing as directed by the Engineer, (see Notes below)
	3391	
Notes: Manufacturer must have one yearly passing test from the Department for each anchor rod or bolt type. Prior to installation, obtain copy of Mn/DOT passing test report from supplier. Specs 3385.2 A, B, & C require anchor rod markings per ASTM F 1554 S3. The end of each anchor bolt intended to project from the concrete must be die stamped with the grade identification as follows: Grade 36 = AB36, Grade 55 = AB55, Grade 105 = AB105.		
Anchorages (Drilled In)	Special Provisions	Visual Inspection - Check qualified products list.
Structural Steel Inspected by MnDOT & will be charged back to the Local Agency.		
Steel Bridge - Beams, Girders, Diaphragms, etc.	2471	Structural Metals Inspection Tag and field inspection for damage/defects, check dimensions for contract compliance. Review approved products list as directed by the Engineer. Note: Structural metals products will be inspected at the plant and will be shipped with a Structural Metals Inspection Tag. An inspection confirmation report will be completed by Structural Metals Inspection staff and sent to the field personnel. Only approved suppliers are allowed to supply Structural Metals products. A list of approved suppliers can be found on the Bridge Office web site: http://www.dot.state.mn.us/bridge/
Concrete Girders-Diaphragms and sole plates		
Expansion Joints		
Steel Bearings		
Railing-Structural tube and ornamental		
Drainage Systems		
Protection Angles		
Overhead Sign structures	2564	
	2471	
High Mast Lighting Structures	2545	
	2471	
Monotube Signal Structures	2565	
	2471	

* Check domestic steel requirement under 1601 Special Provision.

2012 SALT - Schedule of Materials Control - Low Volume
Geosynthetics, Pipe, Tile, Precast/Prestressed Concrete 1 of 2

Kind of Material	Spec. No.	Minimum Required Acceptance Testing (Field Testing Rate)
Corrugated Metal Products		
Culvert Pipe Underdrains Erosion control Structures	3225 thru 3229, 3351,	Visual Inspection: Check for good construction, workmanship, finish requirements and shipping
Structural Plate	3231	Visual Inspection: Invoice shall include notation that material described is in accordance with fabricator's Certificate and Guarantee
Aluminum Structural Plate	3233	
REMARKS: Retain the Certificate of Compliance and certified mill analysis in project file.		
Pipe		
Clay Pipe	3251	Visual Inspection
Reinforced Concrete Pipe and Arches, Precast Cattle Pass Units, Sectional Manhole Units	3236	Field Inspection: Check for damage and defects. Check dimensions and class as required.
Non-Reinforced Concrete Pipe	3253	
Drain Tile (Clay or Concrete)	3276	Visual Inspection - Acceptance as directed by the Engineer.
Thermoplastic (TP) Pipe ABS and PVC	3245	Obtain Certificate of compliance. Check for approved marking printed on pipe. Field Inspect for damage or defects.
Corrugated Polyethylene Pipe	3278	Check for markings (AASHTO M 252) Certificate of Compliance. Field Inspect for damage or defects.
Corrugated Polyethylene Pipe - Dual Wall 12"-48"	3247	Visual Inspection - Check approved products list. Obtain Certificate of Compliance.
Precast/Prestressed Concrete Structures - Inspected by MnDOT & will be charged back to the Local Agency.		
Reinforced Precast Box Culvert	3238	Field Inspection: Check for damage and defects. Check dimensions as required. Check for the "MnDOT" stamp and signature on the certification document.
Precast/Prestressed Concrete Structure (beams, posts, etc.)	2405	
Manholes and Catch Basins (Construction)	2506 3622	
Pipe Joint Sealer		
Sewer Joint Sealing Compound	3724	Visual Inspection - Acceptance as directed by the Engineer.

2012 - SALT Schedule of Materials Control - Low Volume
Geosynthetics, Pipe, Tile, Precast/Prestressed Concrete 2 of 2

Kind of Material	Spec. No.	Minimum Required Acceptance Testing (Field Testing Rate)
Preformed Plastic Sealer for Pipe	3726 Type b	Visual Inspection - Acceptance as directed by the Engineer.
Bituminous Mastic Joint Sealer for Pipe	3728	
EPS Geofoam	Special Provisions	Visual Inspection - Acceptance as directed by the Engineer. Check for yellow aged material, uniformity and dimensions.
Geotextile Fabric and Geogrid Reinforcement	3733 and Special Provisions	Geotextile Materials are tested on a on-going basis. Call the Maplewood lab regarding material acceptance, 651-366-5451.
Silt Fence	3886	Visual Inspection - Check approved products list.

2012 SALT - Schedule of Materials Control - Low Volume

ELECTRICAL AND SIGNAL EQUIPMENT ITEMS 1 of 2

Kind of Material	Spec. No.	Minimum Required Acceptance Testing (Field Testing Rate)
Lighting Standards (Aluminum or Steel)	3811	Visual Inspection - Obtain Certificate of Compliance. The Fabricator will submit "Certificate of Compliance", on a per project basis, to the Project Engineer.
Hand Holes (Precast, PVC, and LLDPE)	2545	Visual Inspection - Check approved/qualified products list. Traffic signal and street lighting projects require handholes to be listed on the Mn/DOT Signals Approved Products List (APL). For cast iron frame and cover: see Metals - Drainage and Electrical Castings
	2550	
	2565	
Foundation	2545	Check Contract Documents and Special Provisions.
Conduit and Fittings		
Metallic	3801	Visual Inspection - Conduit shall be labeled as being listed by a National Recognized Testing Laboratory (NRTL). For traffic signal and street lighting projects, specific requirements are contained in the Special Provisions for each project.
	3802	
	3803	
Non-Metallic (Rigid and HDPE)	Special Provisions	
Anchor Rods and Bolts (Cast in Place)	3385	Visual Inspection - Manufacturer must have one yearly passing test from the Department for each anchor rod or bolt type. Prior to installation, obtain copy of Mn/DOT passing test report from supplier. Specs 3385.2 A, B, & C require anchor rod markings per ASTM F 1554 S3. The end of each anchor bolt intended to project from the concrete must be die stamped with the grade identification as follows: Grade 36 = AB36, Grade 55 = AB55, Grade 105 = AB105.
Anchorages (Drilled In)	Special Provision	Visual Inspection - Check qualified products list.
Miscellaneous Hardware	2545	Visual Inspection - Check approved products list. Will carry "Inspected" tag if sampled and tested prior to shipment. No sample necessary if "Inspected". Do not use if not tested. Field sample at sampling rate for laboratory testing. For traffic signal and street light lighting projects, various miscellaneous hardware is required to be listed on the Mn/DOT Signals and Lighting Approved Products Lists (APL). The Contract documents indicate, which items must be on the Signals and/or Lighting APL.
	2565	

MnDOT - SALT Schedule of Materials Control - Low Volume

ELECTRICAL AND SIGNAL EQUIPMENT ITEMS 2 of 2

Kind of Material	Spec. No.	Minimum Required Acceptance Testing (Field Testing Rate)
Cable and Conductors		
Power Conductors	3815.2B1	Visual Inspection - Make certain the conductors are the type specified. Submit Field Inspection report showing type and quantities used. Shall be labeled as being listed by a National Recognized Testing Laboratory (NRTL) and type where applicable.
Loop Detector Conductors (No Tubing)	3815.2B2 (a)	
Electrical Cables and Single Conductors with Jacket	3815.2B2(b)	Visual Inspection - Usually inspected at the distributor. Documentation showing project number, reel number(s), & Mn/DOT test number(s) will be included with each project shipment. If such documentation is not received from Contractor, submit sample for testing along with material certification from manufacturer. Do not use if not tested. Pre-inspected materials will not be tagged; an inspection report will be sent by the Mn/DOT inspector for each shipment. Project inspectors should verify that the shipping documents agree with this inspection report. Call Steve Grover at 651-366-5540 or Cindy Schellack at 651-366-5543 with questions. For traffic signal and street lighting projects, the Special Provisions for each project contain electrical cable and conductor specifications.
	3815.2B3	
	3815.2B5	
	3815.2C1 thru .2C8	
	3815.2C14	
Ground Rods	Special Provisions	Visual Inspection - Check approved products list. Shall be labeled as being listed by a National Recognized Testing Laboratory (NRTL). Detail materials on Materials Acceptance Summary.
	2545	
	2565	
Luminaires and Lamps	3810	Visual Inspection - Check approved products list. Traffic signal and street lighting projects require luminaires and lamps to be listed on the Mn/DOT Lighting Approved/Qualified Products List (APL). The conductors shall be labeled as being listed by a National Recognized Testing Laboratory (NRTL) and type, where applicable.
Electrical Systems		Electrical Systems are to be reported as a "System" using the LIGHTING, SIGNAL AND TRAFFIC RECORDER INSPECTION REPORT. To be certified by the Project Engineer.
Traffic Signal Systems	2565	Traffic Signal Systems are to be reported as a "System" using the LIGHTING, SIGNAL AND TRAFFIC RECORDER INSPECTION REPORT. To be certified by the Project Engineer.

2012 SALT - Schedule of Materials Control - Low Volume

Brick, Stone and Masonry Units

Kind of Material	Spec. No.	Minimum Required Acceptance Testing (Field Testing Rate)
Brick		
Sewer (clay) and Building	3612 to 3615	Visual Inspection - Acceptance as directed by the Engineer.
Sewer (Concrete)	3616	Visual Inspection - Acceptance as directed by the Engineer. Air entrainment required. Obtain air content statement from supplier.
Concrete Masonry Units		
Sewer Construction	3621	Visual Inspection - Acceptance as directed by the Engineer. Air entrainment required. Obtain air content statement from supplier.
Modular Block Retaining Walls	Review Current Special Provisions	Visual Inspection - Note: All lots of block upon delivery shall have Manufacturer or Independent laboratory test results to verify passing both compression and freeze-thaw requirements. * Wall units and cap units are considered separate block types.
Reinforced Concrete Cribbing	3661	Visual Inspection - Acceptance as directed by the Engineer. Will be stamped when inspected prior to shipment.
Stone for Masonry or Rip-Rap	3601 and Special Provisions	Visual Inspection - Acceptance as directed by the Engineer.
REMARKS: Each source shall be approved by Project Engineer or Supervisor for quality, prior to use. For questions on quality, contact District Materials or Geology Unit.		