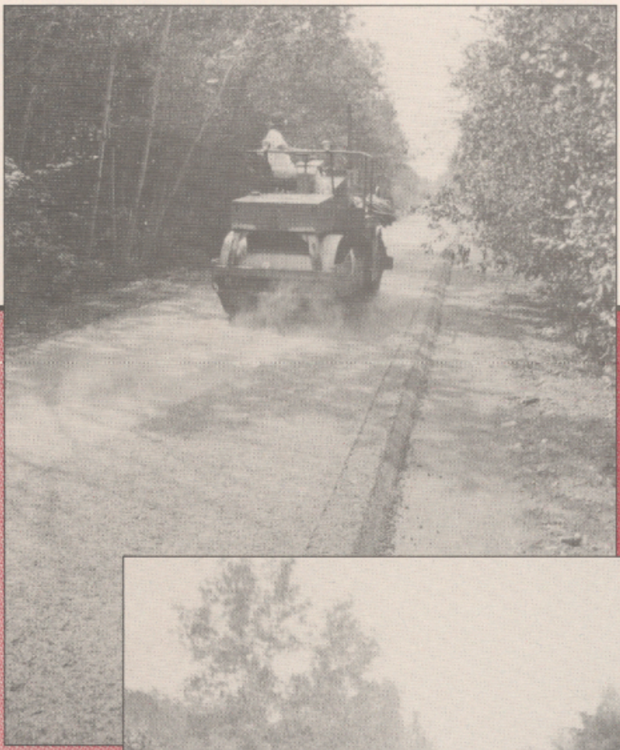
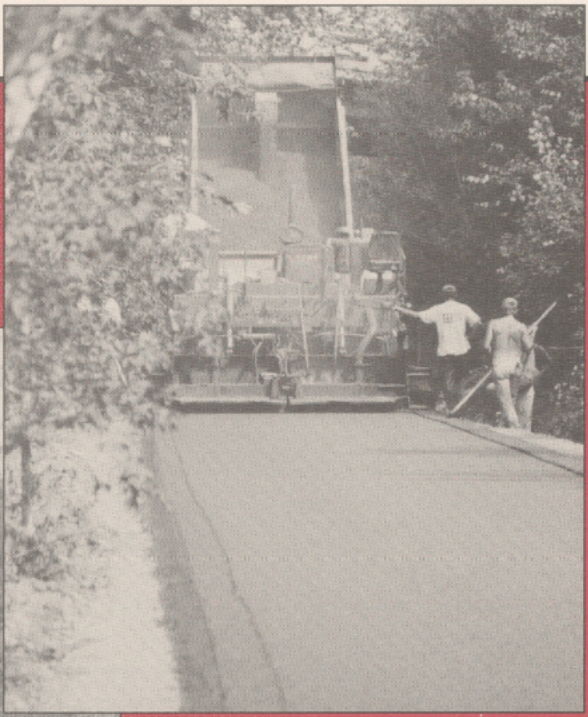
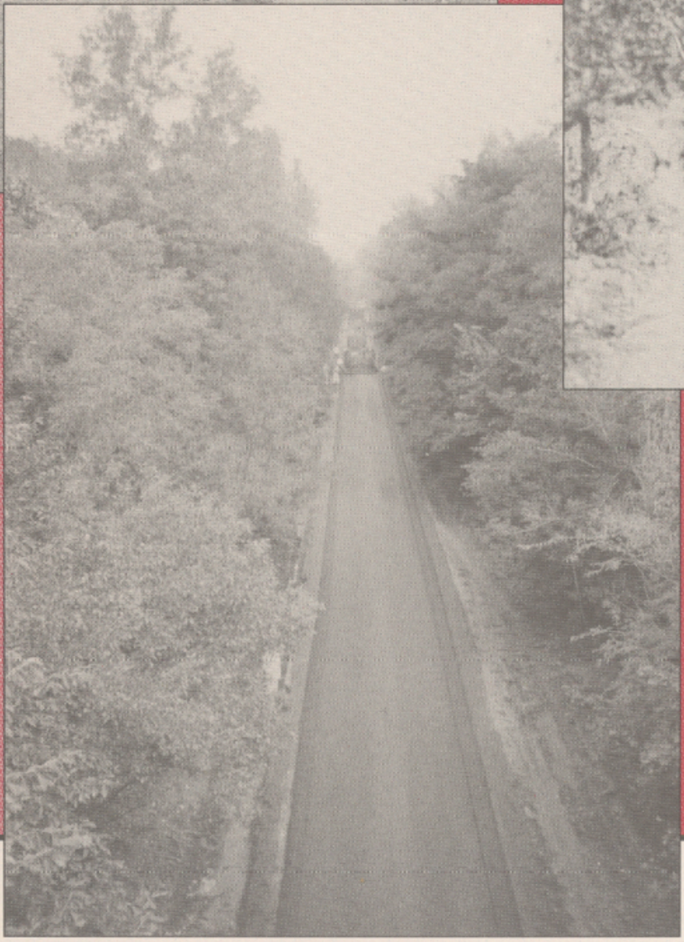
91-06

Waste Tire and Shingle Scrap/Bituminous Paving Test Sections







on the Willard Munger Recreational Trail Gateway Segment

Interim Report

A Cooperative Study Performed by
Minnesota Pollution Control Agency
Minnesota Department Of Natural Resources
Minnesota Department of Transportation

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The need to reduce our states dependence on land fills resulted in a unique cooperative venture by three state agencies. A partnership was forged between the Minnesota Pollution Control Agency (MPCA), the Minnesota Department of Natural Resources (DNR) and the Minnesota Department of Transportation (Mn/DOT) to investigate the use of recycled tire rubber and processed asphalt shingle scrap. The result is a two mile section of the Willard Munger Recreational Trail in St. Paul, constructed with asphalt paving mixtures which contain varying percentages of recycled tire rubber and shingle scrap.

Special bituminous mix designs were formulated using 3% rubber, 6% rubber, 3% rubber with 6% shingles and 9% shingles. The mixtures containing rubber did not exhibit acceptable mix characteristic values under present Mn/DOT bituminous specifications. The shingle-only mix met specifications and yielded an economic advantage of decreasing the asphalt cement demand of the mix.

Conventional mixing and paving equipment was utilized for construction. This application appears to be a viable alternative containing rubber increased from 35% to 50% over the cost of the conventional mixture. Since the use of shingle scrap was negotiated by the private companies involved, no comparable cost data is available.

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Waste Tires
Shingle Scrap
Bicycle Trail

b.Identifiers/Open-Ended Terms

c.COSATI Field/Group

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Waste Tire and Shingle Scrap/Bituminous Paving Test Sections

on the

Willard Munger Recreational Trail Gateway Segment

Interim Report

Construction Report by
Curtis M. Turgeon
Research Project Engineer
Minnesota Department of Transportation

A Cooperative Study Performed by
Minnesota Pollution Control Agency
Minnesota Department Of Natural Resources
Minnesota Department of Transportation

ABSTRACT

The need to reduce our states dependence on land fills resulted in a unique cooperative venture by three state agencies. A partnership was forged between the Minnesota Pollution Control Agency (MPCA), the Minnesota Department of Natural Resources (DNR) and the Minnesota Department of Transportation (Mn/DOT) to investigate the use of recycled tire rubber and processed asphalt shingle scrap. The result is a two mile section of the Willard Munger Recreational Trail in St. Paul constructed with asphalt paving mixtures which contain varying percentages of recycled tire rubber and shingle scrap.

Special bituminous mix designs were formulated using 3% rubber, 6% rubber, 3% rubber with 6% shingles and 9% shingles. The mixtures containing rubber did not exhibit acceptable mix characteristic values under present Mn/DOT bituminous specifications. The shingle-only mix met specifications and yielded an economic advantage of decreasing the asphalt cement demand of the mix.

Conventional mixing and paving equipment was utilized for construction. This application appears to be a viable alternative to landfilling these materials. However, costs for the mixtures containing rubber increased from 35% to 50% over the cost of the conventional mixture. Since the use of shingle scrap was negotiated by the private companies involved, no comparable cost data is available.

ACKNOWLEDGEMENTS

The author would like to acknowledge the contributions of the following individuals and their organizations. An immense amount of cooperation and coordination was required to implement this concept.

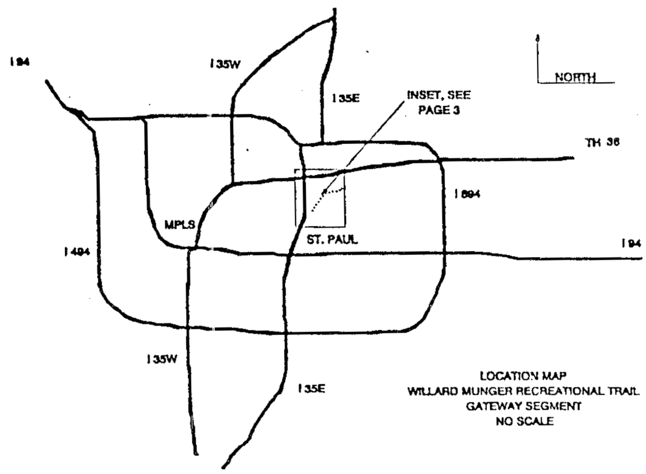
Tom Ask, Bituminous Roadways Inc.
Robert Englestad and Jerry Buehler, Trash Depot Inc.
Roland Doerr, Certainteed Shingles Inc.
Mike McCormick, J.L. Shiely Inc.
David Omann and Jim Omann, Omann Brothers Inc.
Frank Wallner, MPCA
Tim Peterson, MDNR
Greg Murray MDNR
Tom Danger MDNR
Rick Walkosz, Mn/DOT
Roger Olson Mn/DOT
Doug Schwartz, Mn/DOT

CONTENTS

Background.

The need to reduce our states dependence on land fills resulted in a unique cooperative venture by three state agencies. A partnership was forged between the Minnesota Pollution Control Agency (MPCA), the Minnesota Department of Natural Resources (DNR) and the Minnesota Department of Transportation (Mn/DOT) to investigate the use of recycled tire rubber and processed asphalt shingle scrap. The result is a two mile section of the Willard Munger Recreational Trail in St. Paul constructed with asphalt paving mixtures which contain varying percentages of recycled tire rubber and shingle scrap.

The location of the Gateway Segment, which contains the test sections, is shown in Figure 1. The test sections contain the following proportions of waste materials:

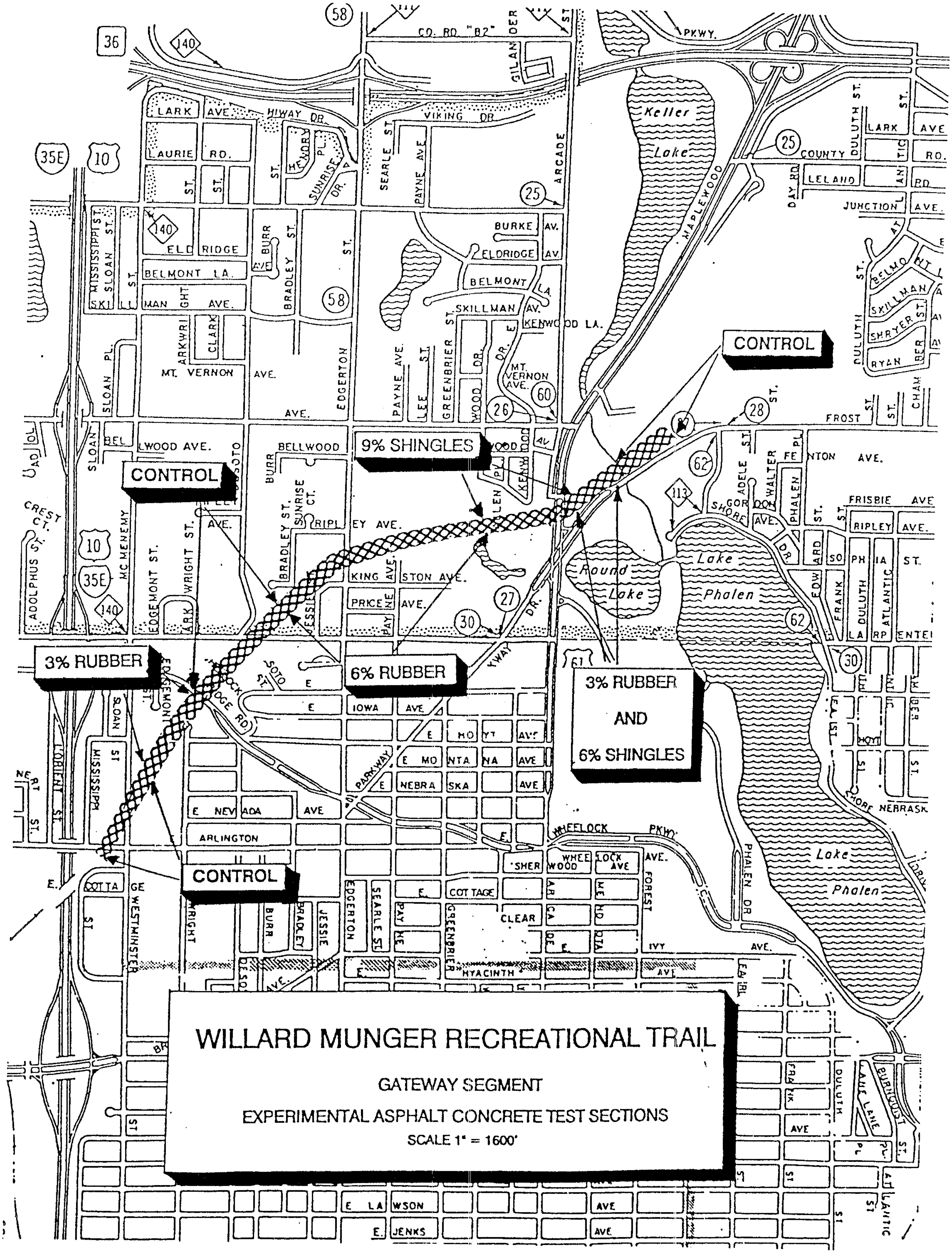


- 3% Rubber
- 6% Rubber
- 3% Rubber and 6% Shingle Scrap
- 9% Shingle Scrap

(Percent by weight of the mineral aggregates.) Asphalt mixture utilizing only standard aggregates was also used as a control mix for comparison purposes. Locations of the test and control sections are shown on the following page.

Since 1985, when the landfilling of waste tires became illegal, there have been ongoing efforts to find viable markets for waste tire products. Presently, most of Minnesota's waste tires are shredded and consumed as industrial boiler fuel. The use of ground tire rubber in asphalt paving mixes is not new. Past experiences by Mn/DOT and other agency's had shown them to be constructable. However, highway experiences demonstrated less room for error when placing rubber mixtures and, when errors occurred, catastrophic failures ensued. Rubber mixtures also require a higher percentage of asphalt cement. Since asphalt cement is by far the most expensive ingredient in an asphalt paving mixture, higher asphalt demand equates to a significant rise in construction cost.

The concern over potential failures led to the concept of testing the mixtures on recreational trails instead of on highway construction. Using the trail allowed a more bold approach in formulating the mixture designs since reconstruction of failed test sections would not pose the traffic control problems and other costs associated with highway testing. However, the trail pavement is subjected to exactly the same mixing, paving and, most importantly, environmental factors common to all asphalt paving.


WILLARD MUNGER RECREATIONAL TRAIL
GATEWAY SEGMENT
EXPERIMENTAL ASPHALT CONCRETE TEST SECTIONS
SCALE 1" = 1600'
CONTROL
9% SHINGLES
CONTROL
3% RUBBER
6% RUBBER
3% RUBBER
AND
6% SHINGLES
CONTROL
Keller Lake
Round Lake
Lake Phalen
Lake Phalen

The use of shingle scrap was identified as a means to reduce the mixtures asphalt demand and make the use of rubber more economical. Organic and fiberglass shingles, the two types presently produced in the United States, contain approximately 30% and 19% asphalt cement, respectively. Ends of runs, samples, off color shingles and tabs create approximately 5% waste during the manufacturing process. This waste is presently landfilled. It is important to note that the shingle scrap was obtained directly from a shingle manufacturing plant. It did not include waste removed during reroof construction. While utilization of reroof waste has merit, problems with uniformity, removal of nails and material separation preclude its use at this time.

Laboratory Bituminous Mix Design.

Previous studies and background testing had shown that mixes containing ground rubber display lower Marshall stability (a standard measure of resistance to deformation or strength) and higher air void content than conventional mixtures. Upon awarding the contract to the low bidder, Bituminous Roadways, samples of standard aggregates were obtained from their stockpiles. It is essential that the actual aggregates to be used on any bituminous project are used in the trial mix testing.

The DNR specifications called for the use of standard Mn/DOT mix type 2341. Trail mix lab work performed in the Mn/DOT Central Lab yielded the following mix designs.

% Agg	% Rubber	% Shingles	% Asphalt	Stab. lbs.	% Air Voids
100	0	0	5.0	1560	4.2
97	3	0	6.5	192	5.7
93	6	0	7.7	50	9.1
91	3	6	5.9	408	5.3
91	0	9	3.0	2464	3.3

% Aggregate + %Rubber + % Shingles = 100% weight of dry mineral materials.

% Asphalt = % by weight of total mixture (asphalt cement and mineral materials)

Some stability and air void data was interpolated from actual test results. Quantities shown are for comparison purposes only.

Mix design sheets are in Appendix A of this report.

The Mn/DOT bituminous specification type 2341 for 1990 required a minimum Marshall stability of 1000 lbs. and a maximum of 3000 lbs with a targeted air void content of 4.0.

All mixes contained the same combination of natural aggregates. The control mix met type 2341 gradation requirements but was formulated to be on the coarser side of the tolerances. Experience with other aggregates had shown that when rubber is added, relatively coarser aggregates yield higher stabilities. It is theorized that larger stones maintain better aggregate interlock as the smaller less dense rubber particles fill the gaps. Even with this slight beneficial influence, rubber-only mixtures exhibited extremely low stability values.

The stability values for the rubber and shingle mix were somewhat better, but still failed to meet specification. A notable decrease in asphalt demand, 0.6 percent, was also demonstrated.
The shingle-only mix met specification and demonstrated a significantly higher Marshall stability than the control mixture. The angular granules and relatively hard asphalt cement contributed by the shingle scrap are potential sources of this increase in stability. The decrease of 2.0 percent in asphalt demand displayed has important potential economic benefits.

Pre-Construction.

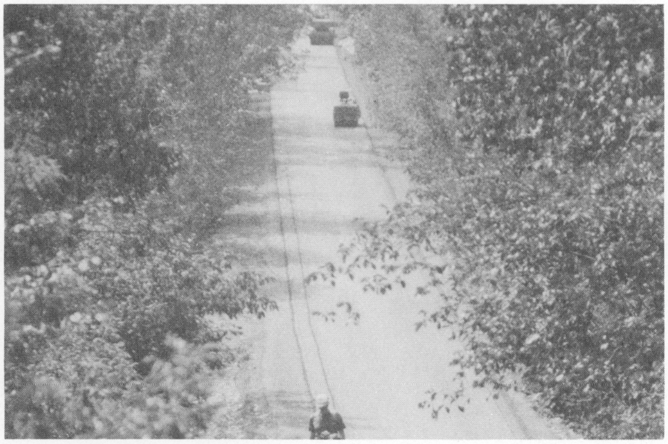
A great deal of planning was required to bring together the information and materials to make this project work. The DNR prepared the plans and specifications, with assistance from Mn/DOT. The MPCA contracted with the Trash Depot Inc of Moorhead, Minnesota to produce and deliver the ground rubber. The use of shingle scrap was coordinated by the J.L. Shiely Company. This including locating a shingle scrap source; Certainteed Inc of Shakopee, Mn; selecting a processor/grinder, the Omann Brothers of St. Michael, Mn; and working with the paving contractor, Bituminous Roadways. Performing the mix design testing was provided by Mn/DOT.

Construction.

This section of trail was placed on abandoned Soo Line Rail Road right of way. The inplace track bed was reshaped as needed and a 4" thick crushed concrete base was placed and compacted.

A batch-type plant was use to prepare the mixture. All waste materials were introduce through the plant's recycled asphalt pavement inlet. No recycled asphalt pavement was utilized on this project. Higher mixing temperatures (30-40 degrees F higher than the normal 290 F) and slightly longer mixing times were utilized to foster better rubber/aggregate coating. Since only one inlet was available for waste product introduction, premixing of the rubber and shingles for the rubber-shingle mix was required. This was accomplished with a front-end-loader and truck scale. The contractors versatility and previous experience with rubber athletic tracks led to relatively smooth production with few unexpected plant problems.

The weather during construction was hot and humid with clear skies and highs in the 90's F. The 12 foot wide, 2.5 inch thick mat was place in one paver pass. A steel wheeled roller provided compaction with a second smaller steel wheeled roller creating the finished surface. The use of pneumatic tired roller was no recommended due to potential rubber pickup problems. A few 2-3 inch diameter clumps of shredded shingles appeared during paving. While the clumps posed only a minor problem, a process to break up or remove them should be adopted.



Performance.

The surface texture immediately after construction was somewhat open and porous. Much of this was due to the coarse natural aggregate gradation used in hopes of gaining stability. It appears that what little was gained in stability was sacrificed in terms of surface texture.

Shortly after construction some loss of rubber particles from the surface occurred. As yet, this phenomenon has been minimal and has not significantly effected the surface texture.

While the shingle-only mixture also exhibited a relatively open surface texture due to the coarse natural aggregates, it is performing satisfactorily to date.

Laboratory Analysis.

Core sample were taken from each test section. The following parameters were evaluated in the Mn/DOT lab.

Mix Type	Density (Bulk) lbs/cu.ft	Split Tensile Strength psi. avg. / range	Inplace Air Voids (Rice)	%AC	AC PEN
Control	141.7	70 / 64-76	9.0	5.3	52
3% Rubber	128.8	42 / 28-50	12.6	6.3	76
6% Rubber	122.7	30 / 29-31	13.0	7.8	111
3% Rubber 6% Shingles	129.6	40 / 34-48	12.6	7.3	55
9% Shingles	130.5	37 / 31-48	16.1	5.4	34

%AC = Percent of extracted asphalt cement by weight mix.
AC PEN = Penetration of recovered asphalt at 77 F.

(Penetration is a relative measure of the stiffness of the asphalt cement. The term "recovered" refers to the process of washing the asphalt from the aggregate with a solvent. The asphalt and solvent are then separated and the asphalt is tested.)

One should exercise discretion when comparing the above data since the tests are formulated for standard asphalt-aggregate mixtures.

The control mix exhibited relatively standard results. The tensile strength is somewhat low but this may be due to the coarseness of the aggregates. The grade of asphalt cement used was 120-150, which means its penetration prior to mixing fell between 120 and 150. The heat applied during mixing causes the asphalt to stiffen, hence the recovered (after mixing and placement) penetration of 52.

The rubber-only mixtures have in general lower densities, lower tensile strengths, higher air voids and have asphalt contents close to the prescribed contents in the mix design formulation. The penetration values seem to indicate some resistance to the normal asphalt hardening due to heating and mixing. The rubber may be soaking up and "hiding" the asphalt from the heat. However the rubber may be reacting with the solvent in the extraction/recovery process and tainting the results. Further studying is needed to clarify this point and what effect it has on mix properties.

The rubber-shingle mix yielded results similar to the rubber-only mixes with the notable exception of the recovered penetration. The asphalt cement contributed by the shingles is relatively hard. (low penetration) Therefore the combination of the standard asphalt and shingle asphalt creates a harder binder.

The effect of the stiff shingle asphalt is more apparent in the shingle-only mix. The penetration of the shingle-only mix is lower than the control mix. Stiffer binders can be more susceptible to low temperature cracking. Cracking of the shingle-only mix should be monitored closely. Inplace air voids are higher than expected as well. The stiffness of the asphalt cement may also inhibit compaction.

Cost.

Precise costs are difficult to establish due to the wide variety of organizations contributing to the project. The MPCA contract, which included purchase and delivery of the ground rubber, yielded the following totals:

Tons of rubber delivered:	38.0
Price per ton:	$ 125.00
Total Contract:	$4,750.00

The unit prices in the DNR contract for mixing and placing the control and rubber mixes were as follows:

Control mix	$ 3.60 /sq yd
3% Rubber	$ 4.40 /sq yd
6% Rubber	$ 4.50 /sq yd

When the rubber purchase and delivery is factored into the mixing and placing costs the total costs become:

Control mix	$ 3.60 /sq yd
35 Rubber	$ 4.85 /sq yd
6% Rubber	$ 5.41 /sq yd

One can see that the total cost for the rubber mixtures is 35% to 50% higher than the control mix.

The concept of using shingle scrap developed after the above contracts were awarded. All cost for transport, processing, mixing and placing were negotiated between the private companies involved. All materials and processing were provided to the State at no cost. It is possible that the savings from the decrease in asphalt demand would offset any handling or processing costs. Depending upon the price of asphalt cement, shingle scrap use may actually decrease the bituminous mixes total cost.

Conclusions.

1. This project has shown bituminous trail construction with two waste products, ground tire rubber and shredded shingle waste, to be a viable alternative to landfill disposal.

2. Laboratory characteristics of bituminous mixtures containing

ground tire rubber did not favorably compare to the control mix or to the Mn/DOT specifications. Rubber mixtures exhibited high air void contents, low Marshall stabilities and high asphalt cement demand.

3. Improved Marshall stability can be achieved by using a coarser natural aggregate gradation. Unfortunately this causes the pavement surface to be open or porous in appearance.

4. Ground shingle scrap effectively reduced asphalt demand and increased Marshall stability.

5. Analysis of core test section samples removed after construction displayed low density, low tensile strength and high air voids when compared to the control mix. Mixes containing rubber had higher recovered asphalt penetration and mixes containing shingles had lower recovered asphalt penetrations when compared to the control mix.

6. The total cost for using the 3% and 6% rubber-only mixes was 35% and 50% higher, respectively, than the control mix. No expense for the use of shingles was born by the State, therefore these costs are not reported.

Recommendations.

1. The test sections should continue to be monitored for surface abrasion, cracking and general performance.

2. The natural aggregate selection and mix design process for rubber bituminous mixes for trails should focus equally on standard laboratory data (Marshall stability, air void content, asphalt demand) and potential surface texture/porosity.

3. A cost comparison/analysis should be undertaken to determine if this is a cost effective/competitive means of waste tire disposal.

4. Further testing on the use of shingle scrap in bituminous mixes is warranted.

APPENDIX A

BITUMINOUS TRIAL MIX RESULTS

EXTRACTION AND GRADATION RESULTS

Mn/DOT TP-24450-03 (1-90)

BITUMINOUS PAVING RECOMMENDATION # 0-

Minnesota Department of Transportation
Materials and Research Laboratory
1400 Gervais Avenue
Maplewood, MN 55109

Date: 8/23/90
Phone: 612-779-5614
FAX: 612-779-5580

To: ______________________, Engineer, ______________________

The mix design for Spec. 2340 Special, Mixture Type 41S is hereby approved for this project as follows:

S.P. / S.A.P. | 9 | | | | | | – | | | (1 2 … 11) | | | J O B - M I X (12 … 20) FORMULA

Begin with test number:

	Card	Test number	
For Base	(Card 1)	4 1 B B 0 0 1	21–27
For Binder	(Card 2)	4 1 B I 0 0 1	21–27
For Leveling	(Card 3)	4 1 L V 0 0 1	21–27
For Wearing	(Card 4)	4 1 W E 0 0 1	21–27
For Shoulders	(Card 5)	S H	21–27

Formula (Percent pass)	Sieve Size		Working Range		
100	1 1/2"	33	100	100	38
100	3/4"	39	100	100	44
100	5/8"	45	100	100	50
95	1/2"	51	89	100	56
80	3/8"	57	74	86	62
49	#4	63	43	55	68
40	#10	69	36	44	74
23	#40	75	19	27	80
4.3	#200	81	2.	6.	86
5.0 Target (New)	% A. C.		4.8 Min.	5.3 Max.	

Use 120/150 penetration grade asphalt.

Trial Mix No. 0-90190 indicates a Marshall Density of 148.0 PCF at 50 blows per side.

Proportions	Source of Material	BA or BR#
10 %	Solberg-Nininger (Coarse)	0-90392
60 %	Bituminous Roadways (Fines)	0-90393
30 %	Shiely-Larson (½" Rock)	0-90394
%		0-
%		0-

Remarks: Obtain 60# sample of Plant Mix from behind paver. Send to Maplewood Lab for Testing c/o R. Walkosz/C. Turgeon.

Approved by:

Assistant Bituminous Engineer

cc:
Dist. Mat'ls Engr. (Dist.) (2)
Bituminous Office (3)
Ft. Snelling (3)
Contractor

InDOT TP 24303A(1-88)

Sheet __ of __ T.M. No. 0-90190

Specification No. 415 Previous Mix No.

		AB No.	Source	Proportion
Project No.	9PR 1008 0303			
Location	Ramsey T.H. No.	90392	Solberg-Nininger	10
Additive	%	393	Bit. Rdwys.	60
AC Source	Ashland	394	Shiely-Larson	30
AC Grade	120-150			
AC Sp.G.	c 1.017			

Tests | B.I. | Mr | Ts | Extraction | Gradation | Other

			MIX A date: 8/11 (48 wt. AC % AC b; # Blows 50)					MIX B date: (55 wt AC % AC b; # Blows 50)			
Marshall I.D.			1	2	3			1	2	3	
Height		a	2 1/2	2 1/2	2 1/2		a	2 31/64	2 31/64	2 31/64	
Dry Wght.		A	1203.4	1205.5	1203.2		A	1204.2	1203.7	1205.3	
SSD Wght.		B	1206.0	1207.0	1204.9		B	1204.9	1204.5	1206.9	
Imm. Wght.		C	697.2	699.6	697.2		C	701.0	699.7	701.6	
Volume	B − C	D	508.8	507.4	507.7		D	503.9	504.8	505.3	
Bulk Sp.G.	A/D	E	2365	2376	2373	2371	E	2390	2385	2385	2387
Density	E × 62.3	F				147.7	F				148.7
Flow			10	12	14	12		13	15	13	14
Stability Dial			1660	1560	1560			1500	1180	1720	
Stability	chart × ht. cor.		1660	1560	1560	1593		1515	1192	1737	1481
Container I.D.			A					B			
Cont. + Sa Dry		K					K				
Cont. Dry		L	943.1				L	912.5			
Sa. Dry	K − L	M	2017.8				M	2011.0			
Cont. + Sa Imm.		N	1559.7				N	1519.5			
Cont. Imm.		P	353.2				P	327.4			
Sa Imm.	N − P	Q	1206.5				Q	1192.1			
Sa Volume	M − Q	R	811.3				R	818.9			
Max. Sp.G.	M/R	S	2.487			2.487	S	2.456			2.456
Rice Voids	100×((S−E)/S)	T				4.7	T				2.8

			Abrasions		2.682			Abrasions		2.676	
Pan, Agg. Dry	target 1.5339%E	d		AC ratio	b/c	226.6	p				
Pan Dry	(set 6)	e		Agg ratio	(100−b)/n		q				
Agg Dry	Actual Dry	f			p + q	1142.6	r				
Foil, AC Dry	SSD	g		TM Sp.G.	100/r	1146.0	s				
Foil, AC Imm.	Imm	h		V.F. MIX	(E/s)×100	631.9	t				
Foil, AC Volume	Orig h	i		Vol. AC	E×p	1181.5	u				
Foil, AC, Agg. Dry	Final	j		V.M.A.	u + y	1100.0	v				
Foil, AC, Agg. Imm.	Loss	k		V.F. Agg.	(u/v)×100	81.5	w				
Foil, AC, Agg. Vol.	j − k	l		BI Voids	100 − t	6.9	y				
Agg. Volume	% Loss	m									
Agg. Sp.G.	f/m	r.									

signed R.J. Walker date: 8/23

Mn/DOT TP-24450-03 (1-90)

BITUMINOUS PAVING RECOMMENDATION # 0-

Minnesota Department of Transportation
Materials and Research Laboratory
1400 Gervais Avenue
Maplewood, MN 55109

Date: 8/23/90
Phone: 612-779-5614
FAX: 612-779-5580

To: ______________________, Engineer, ______________________

The mix design for Spec. 2340-Special, Mixture Type 41 S is hereby approved for this project as follows:

S.P. / S.A.P. | 9 | | | | | | | | - | | | | (1 2 … 11) | | | J | O | B | - | M | I | X | (12 … 20) FORMULA

Begin with test number:

	(Card)	Code (21–27)
For Base	Card 1	4 1 B B 1 0 0
For Binder	Card 2	4 1 B I 1 0 0
For Leveling	Card 3	4 1 L V 1 0 0
For Wearing	Card 4	4 1 W E 1 0 0
For Shoulders	Card 5	S H

Formula (Percent pass)	Sieve Size		Working Range Min.	Working Range Max.	
100	1 1/2"	33	100	100	38
100	3/4"	39	100	100	44
100	5/8"	45	100	100	50
96	1/2"	51	90	100	56
81	3/8"	57	75	87	62
51	#4	63	45	57	68
42	#10	69	38	46	74
23	#40	75	19	27	80
4.2	#200	81	2.	6.	86
6.8 Target (New)	% A. C.		6.5	7.1	

Use 120/150 penetration grade asphalt.

Trial Mix No. 0- 90191 indicates a Marshall Density of 137.3 PCF at 50 blows per side.

Proportions	Source of Material	BA or BR#
9 %	Solberg - Nininger (3/4 Rock)	0- 90392
59 %	Bituminous Roadways (3/4" Minus)	0- 90393
29 %	Shiely - Larson (1/2" Rock)	0- 90394
3 %	Trash Depot (Rubber)	0- 90397
%		0-

Remarks: Obtain 60# Sample & send to Maplewood Lab c/o R. Walkosz / C. Turgeon. for further testing. Mix will be tender until cooled below 140°F.

Approved by:

Assistant Bituminous Engineer

cc:
Dist. Mat'ls Engr. (Dist.) (2)
Bituminous Office (3)
Ft. Snelling (3)
Contractor

MnDOT TP 24303A (1-88)

Sheet __ of __

T.M. No.	0-90191
Specification No.	415
Previous Mix No.	

		AB No.	Source	Proportion
Project No.	9PR 1008-0303			
Location	Ramsey T.H. No.	90 392	Solberg	9
Additive	%	393	Bit Rdways	59
AC Source	Ashland	394	Shiely/Larson	29
AC Grade	120/150	397	Trash Rubber	3
AC Sp.G. [c]	1.017			

Tests | B.I. | Mr | Ts | Extraction | Gradation | Other |

			MIX A (wt. AC 620.9) 5.8 % AC [b] 5.84	date: 8-11	# Blows 50			MIX B wt AC 6.5 % AC [b] 6.58		# Blows 50 (date:)	
Marshall I.D.			1	2	3			1	2	3	
Height		a	2 35/64	2 35/64	2 18/32		a	2 33/64	2 33/64	2 1/2	
Dry Wght.		A	1098.4	1132.3	1129.3		A	1123.8	1125.2	1119.9	
SSD Wght.		B	1107.2	1137.9	1137.1		B	1127.8	1128.3	1123.4	
Imm. Wght.		C	598.6	622.9	619.2		C	617.5	619.2	614.6	
Volume	B − C	D	5086	5150	5179		D	5103	5091	5088	
Bulk Sp.G.	A/D	E	2.160	2199	2181	2180	E	2202	2210	2201	2204
Density	E × 62.3	F				135.8	F				137.3
Flow			20	25	20	22		15	16	16	16
Stability Dial			1100	2100	1600			2100	2100	1600	
Stability	chart × ht. cor.		1067	2037	1536	1547		2079	2079	1600	1919
Container I.D.			C					D			
Cont. + Sa Dry		K					K				
Cont. Dry		L	742.1				L	767.2			
Sa. Dry	K − L	M	2016.1				M	2014.9			
Cont. + Sa Imm.		N	1328.9				N	1338.0			
Cont. Imm.		P	162.1				P	185.4			
Sa Imm.	N − P	Q	1166.8				Q	1152.6			
Sa Volume	M − Q	R	849.3				R	862.3			
Max. Sp.G.	M/R	S	2.374			2374	S	2.337			2337
Rice Voids	100×((S−E)/S)	T				8.2	T				5.7

Abrasions				2.586		Abras.		2.573	Abrasions
Pan, Agg. Dry	Target	d		AC ratio	b/c		p		210.6
Pan Dry	(set 6)	e		Agg ratio	(100−b)/n		q		
Agg Dry	Dry Actual	f			p + q		r		1062.1
Pail, AC Dry	SSD	g		TM Sp.G.	100/r		s		1074.1
Pail, AC Imm.	Imm	h		V.F. MIX	(E/s)×100		t		511.5
Pail, AC Volume	Orig h	i		Vol. AC	E × p		u		1140.1
Pail, AC, Agg. Dry	Final	j		V.M.A.	u + y		v		843.1
Pail, AC, Agg. Imm.	Loss	k		V.F. Agg.	(u/v)×100		w		247.0
Pail, AC, Agg. Vol.	j − k	l		BI Voids	100 − t		y		21.6
Agg. Volume	% Loss	m							
Agg. Sp.G.	f/m	r.							

signed R. J. Walker date: 8/23

Mn/DOT TP-24450-03 (1-90)

BITUMINOUS PAVING RECOMMENDATION #0-

Minnesota Department of Transportation
Materials and Research Laboratory
1400 Gervais Avenue
Maplewood, MN 55109

Date: 8/23/90
Phone: 612-779-5614
FAX: 612-779-5580

To: ______________________, Engineer, ______________________

The mix design for Spec. 2340 - Special, Mixture Type 41S is hereby approved for this project as follows:

S.P. / S.A.P. (1–11): 9 | | | | | | | | – | | | (12–20): | | J | O | B | - | M | I | X FORMULA

Begin with test number: (columns 21–27)

Course	Card	Test number
For Base	(Card 1)	4 1 B B 2 0 0
For Binder	(Card 2)	4 1 B I 2 0 0
For Leveling	(Card 3)	4 1 L V 2 0 0
For Wearing	(Card 4)	4 1 W E 2 0 0
For Shoulders	(Card 5)	S H

Formula (Percent pass)	Sieve Size	Columns	Working Range Min.	Working Range Max.	Columns
100	1 1/2"	33	100	100	38
100	3/4"	39	100	100	44
100	5/8"	45	100	100	50
96	1/2"	51	90	100	56
82	3/8"	57	76	88	62
53	#4	63	47	59	68
43	#10	69	39	47	74
23	#40	75	19	27	80
4.1	#200	81	2.	6.	86
7.7 Target (New)	% A. C.		7.4	8.0	

Use 120 / 150 penetration grade asphalt.

Trial Mix No. 0- 90192 indicates a Marshall Density of 127.0 PCF at 50 blows per side.

Proportions	Source of Material	BA or BR#
8 %	Solberg - Nininger (3/4" Rock)	0- 90392
58 %	Bituminous Roadways (3/4" Minus)	0- 90393
28 %	Shiely - Larson (1/2" Rock)	0- 90394
6 %	Trash Depot (Rubber)	0- 90397
%		0-

Remarks: Obtain 60# Sample, send to Maplewood Lab c/o C. Turgeon / R. Walkosz. Mix will be tender until cooled below 140° F.

Approved by:

Assistant Bituminous Engineer

cc:
Dist. Mat'ls Engr. (Dist.) (2)
Bituminous Office (3)
Ft. Snelling (3)
Contractor

MnDOT TP 24303A (1-88)

Sheet __ of __

T.M. No. 0-90192

Specification No. 415 | Previous Mix No.

Project No. 9 PR 1008 -0303	AB No.	Source	Proportion
Location Ramsey T.H. No.	90392	Solberg	8
Additive %	393	Bit Rdways	58
AC Source Ashland	394	Shiely-Larson	28
AC Grade 120/150	397	Trash Rubber	6
AC Sp.G. c 1.017			

Tests | B.I. | Mr | Ts | Extraction | Gradation | Other

			MIX A 695.2 wt. AC % AC b 6.5		date: 8/12 # Blows 50			MIX B 842.5 wt AC % AC b 7.77		date: # Blows 50	
Marshall I.D.			1	2	3			1	2	3	
Height		a	2 39/64	2 39/64	2 20/32		a	2 18/32	2 17/32	2 17/32	
Dry Wght.		A	1090.5	1094.0	1090.9		A	1074.5	1070.1	1075.4	
SSD Wght.		B	1098.5	1001.7	1100.0		B	1081.2	1075.3	1082.5	
Imm. Wght.		C	564.6	567.6	557.1		C	553.5	550.2	555.9	
Volume	B - C	D	533.9	534.1	542.9		D	527.7	525.1	526.6	
Bulk Sp.G.	A/D	E	2043	2048	2009	2046	E	2036	2038	2042	2039
Density	E × 62.3	F				127.5	F				127.0
Flow			15	10	10			11	11	11	
Stability Dial			100	50	50			50	50	50	
Stability	chart × ht. cor.					67					50
Container I.D.			E					F			
Cont. + Sa Dry		K					K				
Cont. Dry		L	780.1				L	776.5			
Sa. Dry	K - L	M	2020.8				M	2020.6			
Cont. + Sa Imm.		N	1330.4				N	1314.0			
Cont. Imm.		P	196.4				P	193.9			
Sa Imm.	N - P	Q	1134.0				Q	1120.1			
Sa Volume	M - Q	R	886.8				R	900.5			
Max. Sp.G.	M/R	S	2.279			2279	S	2.244			2.244
Rice Voids	100×((S-E)/S)	T				10.2	T				9.1

				2.494		Abreas		2.498			Abreas
Pan, Agg. Dry	target	d		AC ratio	b/c	195.6	p			194.8	195.8
Pan Dry	set 6	e		Agg ratio	(100-b)/n	1173.6	q				1168.8
Agg Dry	Dry Actual	f			p + q	1192.4	r				1189.2
Pail, AC Dry	SSD	g		TM Sp.G.	100/r	1203.0	s				1205.9
Pail, AC Imm.	Imm	h		V.F. MIX	(E/s)×100	496.5	t				531.4
Pail, AC Volume	Orig h	i		Vol. AC	E × p	1336.3	u				1293.0
Pail, AC, Agg. Dry	Final	j		V.M.A.	u + y	950.0	v				1090.0
Pail, AC, Agg. Imm.	Loss	k		V.F. Agg.	(u/v)×100	386.3	w				203.0
Pail, AC, Agg. Vol.	j - k	l		BI Voids	100 - t	28.9	y				15.7
Agg. Volume	% Loss	m									
Agg. Sp.G.	f/m	r.		signed	R. J. Walker					date: 8/23	

Mn/DOT TP-24450-03 (1-90)

BITUMINOUS PAVING RECOMMENDATION # 0-

Minnesota Department of Transportation
Materials and Research Laboratory
1400 Gervais Avenue
Maplewood, MN 55109

Date: 8/23/90
Phone: 612-779-5614
FAX: 612-779-5580

To: ______________________, Engineer, ______________________

The mix design for Spec. 2340 Special, Mixture Type 415 is hereby approved for this project as follows:

S.P. / S.A.P. | 9 | | | | | | | – | | | | JOB-MIX FORMULA (columns 1, 2 … 11, 12 … 20)

Begin with test number:		Formula (Percent pass)	Sieve Size	Working Range		
For Base (Card 1)	41BB300 (21–27)	100	1 1/2"	33	100 / 100	38
		100	3/4"	39	100 / 100	44
For Binder (Card 2)	41BI300 (21–27)	100	5/8"	45	100 / 100	50
		96	1/2"	51	90 / 100	56
For Leveling (Card 3)	41LV300 (21–27)	82	3/8"	57	76 / 88	62
		53	#4	63	47 / 59	68
For Wearing (Card 4)	41WE300 (21–27)	41	#10	69	37 / 45	74
		22	#40	75	18 / 26	80
For Shoulders (Card 5)	· SH (21–27)	3.9	#200	81	2. / 6.	86
		5.9 Target (New)	% A. C.		5.6 Min. / 6.2 Max.	

Use 120 / 150 penetration grade asphalt.

Trial Mix No. 0- 90193 indicates a Marshall Density of 133.9 PCF at 50 blows per side.

Proportions	Source of Material	BA or BR#
7 %	Solberg-Nininger (3/4" Rock)	0- 90392
57 %	Bituminous Roadways (3/4" Minus)	0- 90393
27 %	Shiely-Larson (½" Rock)	0- 90394
3 %	Trash Depot (Rubber)	0- 90397
6 %	Oman (Shingles)	0- 90415

Remarks: Obtain 60# Sample for Maplewood Lab c/o C. Turgeon/R. Walters
Mix will be tender until cool.

Approved by:

Assistant Bituminous Engineer

cc:
Dist. Mat'ls Engr. (Dist.) (2)
Bituminous Office (3)
Ft. Snelling (3)
Contractor

MnDOT TP 24303A(1-88)

Sheet __ of __ T.M. No. 0-90193

Specification No. 415 Previous Mix No.

Project No. 9PR 1008 0303		AB No.	Source	Proportion
Location Ramsey	T.H. No.	90392	Solberg	7
Additive	%	393	Bit Rdways	57
AC Source Ashland		394	Shiely-Larson	27
AC Grade 120/150		397	Trash Rubber	3
AC Sp.G. c 1.017		415	Oman Shingles	6

Tests | B.I. | Mr | Ts | Extraction | Gradation | Other

MIX A — date: 8/13 — 522.6 wt. AC; 5.5 % AC b 5.5; # Blows 50

MIX B — date: 8/21 — 675.2 wt AC; 6.5 % AC b 6.5; # Blows 50

			Mix A 1	2	3	Avg		Mix B 1	2	3	Avg
Marshall I.D.			1	2	3			1	2	3	
Height		a	2 19/32	2 18/32	2 18/32		a	2 10/32	2 10/32	2 10/32	
Dry Wght.		A	1108.9	1109.8	1114.7		A	1031.6	1031.6	1027.2	
SSD Wght.		B	1110.1	1110.8	1117.4		B	1032.0	1032.6	1027.9	
Imm. Wght.		C	593.9	594.2	597.7		C	568.8	566.3	564.7	
Volume	B − C	D	515.1	516.6	519.7		D	463.2	466.3	463.2	
Bulk Sp.G.	A/D	E	2153	2148	2145	2149	E	2.227	2.212	2.217	2.219
Density	E × 62.3	F				133.9	F				138.2
Flow			12	12	11			20	17	17	
Stability Dial			320	320	380			540	430	430	
Stability	chart × ht. cor.		304	307.2	365	325		615	490	490	532
Container I.D.			A					A			
Cont. + Sa Dry		K					K				
Cont. Dry		L	943.1				L	943.1			
Sa. Dry	K − L	M	2028.0				M	2023.9			
Cont. + Sa Imm.		N	1508.3				N	1485.0			
Cont. Imm.		P	353.2				P	353.2			
Sa Imm.	N − P	Q	1155.1				Q	1131.8			
Sa Volume	M − Q	R	872.9				R	892.1			
Max. Sp.G.	M/R	S	2.323	2.311		2.323	S	2.269			2.269
Rice Voids	$100 \times (\frac{S-E}{S})$	T		7.0		7.4	T		2.7		2.2

EFF SpG 2511 | Abras | 2481 | Avg = 2.0 [illegible] | Abras

Pan, Agg. Dry	Target	d		AC ratio	b/c	205.4	p	212.0
Pan Dry	(set 6)	e		Agg ratio	(100−b)/n		q	1272.0
Agg Dry	Dry Act.	f			p + q		r	
Foil, AC Dry	SSD	g		TM Sp.G.	100/r		s	
Foil, AC Imm.	Imm	h		V.F. MIX	(E/s) × 100		t	
Foil, AC Volume	Orig	i		Vol. AC	E × p		u	
Foil, AC, Agg. Dry	Final	j		V.M.A.	u + y		v	
Foil, AC, Agg. Imm	Loss	k		V.F. Agg.	(u/v) × 100		w	
Foil, AC, Agg. Vol.	j − k	l		BI Voids	100 − t		y	
Agg. Volume	% Loss	m						
Agg. Sp.G.	f/m	r						

signed [signature] date: 8/23

Mn/DOT TP-24450-03 (1-90)

BITUMINOUS PAVING RECOMMENDATION #0-

Minnesota Department of Transportation
Materials and Research Laboratory
1400 Gervais Avenue
Maplewood, MN 55109

Date: 8/23/90
Phone: 612-779-5614
FAX: 612-779-5580

To: ______________________, Engineer, ______________________

The mix design for Spec. 2340-Special, Mixture Type 41S is hereby approved for this project as follows:

S.P. / S.A.P. (1–11): 9 | | | | | | | – | | |

(12–20): | | J | O | B | - | M | I | X FORMULA

Begin with test number:

	(Card)	Columns 21–27
For Base	(Card 1)	41 BB 400
For Binder	(Card 2)	41 BI 400
For Leveling	(Card 3)	41 LV 400
For Wearing	(Card 4)	41 WE 400
For Shoulders	(Card 5)	SH

Formula (Percent pass)	Sieve Size	Columns	Working Range		Columns
100	1 1/2"	33	100	100	38
100	3/4"	39	100	100	44
100	5/8"	45	100	100	50
96	1/2"	51	90	100	56
84	3/8"	57	78	90	62
58	#4	63	52	64	68
44	#10	69	40	48	74
21	#40	75	17	25	80
3.6	#200	81	2.	6.	86
6.8 Target (New)	% A. C.		6.5 Min.	7.1 Max.	

Use 120/150 penetration grade asphalt.

Trial Mix No. 0- 90194 indicates a Marshall Density of 126.2 PCF at 50 blows per side.

Proportions	Source of Material		BA or BR#
4 %	Solberg - Nininger	(3/4" Rock)	0-90392
54 %	Bituminous Roadways	(3/4" Minus)	0-90393
24 %	Shiely-Larson	(1/2" Rock)	0-90394
6 %	Trash Depot	(Rubber)	0-90397
12 %	Oman	(Shingles)	0-90415

Remarks: Obtain 60# Sample for Maplewood Lab c/o C. Turgeon/R. Walkosz.
Mix will be Tender until cool

Approved by:

Assistant Bituminous Engineer

cc:
Dist. Mat'ls Engr. (Dist.) (2)
Bituminous Office (3)
Ft. Snelling (3)
Contractor

MnDOT TP 24303A(1-88)

Sheet __ of __ **T.M. No.** 90194

Specification No. 415 Previous Mix No.

Project No. 9PR 1008 0303		AB No.	Source	Proportion
Location RAMSEY	T.H. No.	90392	SOLBERG-NININGER 3/4 ROCK	4 %
Additive	%	90393	BIT. ROADWAYS 3/4 minus	54 %
AC Source ASHLAND		90394	SHIELY LARSON	24 %
AC Grade		90397	TRASH DEPOT RUBBER	6 %
AC Sp.G. c		90415	OMAN SHINGLES	12 %

Tests | B.I. | Mr | Ts | Extraction | Gradation | Other

			MIX A 6008 date: 8/21 582.0 wt. AC 5.5 % AC b 5.66		# Blows 50			MIX B date: 695.2 wt AC 6.5 % AC b 6.5		# Blows 50	
Marshall I.D.			1	2	3			1	2	3	
Height		a	2 15/32	2 15/32	2 1/2		a	2 15/32	2 31/64	2 33/64	
Dry Wght.		A	1000.7	1004.8	1007.9		A	1015.1	1010.4	1009.5	
SSD Wght.		B	1003.4	1009.4	1014.1		B	1019.6	1012.3	1013.1	
Imm. Wght.		C	497.5	506.2	511.1		C	523.0	514.1	510.1	
Volume	B − C	D	505.9	503.2	503.0		D	496.6	498.2	503.0	
Bulk Sp.G.	A/D	E	1.978	1.997	2.004	1.993	E	2.044	2.028	2.006	2.026
Density	E × 62.3	F				124.1	F				126.2
Flow			25	29	26			26	29	22	
Stability Dial			270	350	380			320	270	270	
Stability	chart × ht. cor.		275	357	380	337		326	271	271	289
Container I.D.			B					C			
Cont. + Sa Dry		K					K				
Cont. Dry		L	912.5				L	742.1			
Sa. Dry	K − L	M	2020.3				M	2024.7			
Cont. + Sa Imm.		N	1426.2				N	1252.5			
Cont. Imm.		P	327.4				P	162.1			
Sa Imm.	N − P	Q	1098.8				Q	1090.4			
Sa Volume	M − Q	R	921.5				R	934.3			
Max. Sp.G.	M/R	S	2.192			2.192	S	2.167			2.167
Rice Voids	100×((S−E)/S)	T				9.0	T				6.5

			2355					2352			
Pan, Agg. Dry		d	Target	AC ratio	b/c		p				1935
Pan Dry		e	set 6	Agg ratio	(100−b)/n		q				1161.6
Agg Dry	d − e	f	Dry Act		p + q		r				
Pail, AC Dry		g	SSD	TM Sp.G.	100/r		s				
Pail, AC Imm.		h	Imm	V.F. MIX	(E/s)×100		t				
Pail, AC Volume	g − h	i	Orig	Vol. AC	E × p		u				
Pail, AC, Agg. Dry		j	Final	V.M.A.	u + y		v				
Pail, AC, Agg. Imm		k	Loss	V.F. Agg.	(u/v)×100		w				
Pail, AC, Agg. Vol.	j − k	l		BI	100 − t		y				
Agg. Volume	l − i	m	% Loss	Voids							
Agg. Sp. G.	f/m	n		signed							date: 8/23

Mn/DOT TP-24450-03 (1-90)

BITUMINOUS PAVING RECOMMENDATION # 0-

Minnesota Department of Transportation
Materials and Research Laboratory
1400 Gervais Avenue
Maplewood, MN 55109

Date: 8/23/90
Phone: 612-779-5614
FAX: 612-779-5580

To: ______________________, Engineer, ______________________

The mix design for Spec. 2340 (Special) Mixture Type 41S is hereby approved for this project as follows:

S.P. / S.A.P. | 9 | | | | | | | – | | | (1 2 … 11) | | | J | O | B | - | M | I | X | (12 … 20) **FORMULA**

Begin with test number:

	Card	Test number (21–27)
For Base	(Card 1)	4 1 B B 5 0 0
For Binder	(Card 2)	4 1 B I 5 0 0
For Leveling	(Card 3)	4 1 L V 5 0 0
For Wearing	(Card 4)	4 1 W E 5 0 0
For Shoulders	(Card 5)	S H

Formula (Percent passing)	Sieve Size		Working Range		
100	1 1/2"	33	100	100	38
100	3/4"	39	100	100	44
100	5/8"	45	100	100	50
96	1/2"	51	90	100	56
82	3/8"	57	76	88	62
53	#4	63	47	59	68
41	#10	69	37	45	74
22	#40	75	18	26	80
3.9	#200	81	2.	4.	86
3.0 Target (New)	% A. C.		2.7 Min.	3.3 Max.	

Use 120 / 150 penetration grade asphalt.

Trial Mix No. 0-90195 indicates a Marshall Density of 146.0 PCF at 50 blows per side.

Proportions	Source of Material		BA or BR#
7 %	Solberg-Nininger	(3/4" Rock)	0-90392/464
57 %	Bituminous Roadways	(3/4" Minus)	0-90393/465
27 %	Shiely – Larson	(1/2" Rock)	0-90394/463
9 %	Oman	(Shingles)	0-90415
%			0-

Remarks: Obtain 60# Sample for Maplewood Lab % C. Turgeon/R. Walkosz

Approved by:

Assistant Bituminous Engineer

cc:
Dist. Mat'ls Engr. (Dist.) (2)
Bituminous Office (3)
Ft. Snelling (3)
Contractor

MnDOT TP 24303A(1-88)

Sheet __ of __ T.M. No. 0-90195

Specification No. 415 Previous Mix No.

Project No. 9PR 1008 0303	AB No.	Source	Proportion
Location Ramsey (Bike Path) T.H. No.	90464	Solberg-Nininger 3/4 Rock	7
Additive %	465	Bit Rdways 3/4 Minus	57
AC Source Ashland	463	Shiely Larson 1/2 Rock	27
AC Grade 120/150	397	Trash Depot Rubber	
AC Sp.G. c 1.017	415	Oman Shingles	9

Tests | B.I. | Mr | Ts | Extraction | Gradation | Other

MIX C date: 309.3 / 3.0 wt. AC 366.0 % AC b 3.53 # Blows 50

MIX date: wt AC % AC b # Blows

			1	2	3						
Marshall I.D.			1	2	3						
Height		a	2 29/64	2 29/64	2 15/32		a				
Dry Wght.		A	1176.1	1175.4	1174.4		A				
SSD Wght.		B	1177.2	1176.3	1176.3		B				
Imm. Wght.		C	675.3	675.7	674.2		C				
Volume	B − C	D	501.9	500.6	502.1		D				
Bulk Sp.G.	A/D	E	2.343	2.348	2.339	2.343	E				
Density	E × 62.3	F				146.0	F				
Flow			15	12.5	17						
Stability Dial			2510	2370	2320						
Stability	chart × ht. cor.		2585	2441	2366	2464					
Container I.D.			A								
Cont. + Sa Dry		K					K				
Cont. Dry		L	943.1				L				
Sa. Dry	K − L	M	2015.2				M				
Cont. + Sa Imm.		N	1537.0				N				
Cont. Imm.		P	353.2				P				
Sa Imm.	N − P	Q	1183.8				Q				
Sa Volume	M − Q	R	831.4				R				
Max. Sp.G.	M/R	S	2.424			2.424	S				
Rice Voids	100×((S−E)/S)	T				3.3	T				

2.553

Pan, Agg. Dry	Target	d		AC ratio	b/c	223.9	p
Pan Dry	set 6	e		Agg ratio	(100−b)/n	1343.4	q
Agg Dry	Dry Act.	f			p + q		r
Pail, AC Dry	SSD	g		TM Sp.G.	100/r		s
Pail, AC Imm.	Imm	h		V.F. MIX	(E/s)×100		t
Pail, AC Volume	Orig	i		Vol. AC	E × p		u
Pail, AC, Agg, Dry	Final	j		V.M.A.	u + y		v
Pail, AC, Agg, Imm	Loss	k		V.F. Agg.	(u/v)×100		w
Pail, AC, Agg, Vol.	j − k	l		BI Voids	100 − t		y
Agg. Volume	% Loss	m					
Agg. Sp.G.	f/m	n					

signed R J Walkosz date: 8/23

MnDOT TP 24303A (1-88)

Sheet __ of __

T.M. No. 90195

Specification No. 415 | Previous Mix No.

		AB No.	Source	Proportion
Project No.	9PR 1008 03 03	90392	SOLBERG NININGER 3/4 rock	7%
Location	RAMSEY (BIKE PATH) T.H. No.	90393	BIT ROADWAYS 3/4 minus	57%
Additive	%	90394	SHIELY LARSON 1/2 rock	27%
AC Source	ASHLAND	90397	TRASH DEPOT RUBBER	
AC Grade	120/150	415	OMAN SHINGLES	9%
AC Sp.G.	c			

Tests | B.I. | Mr | Ts | Extraction | Gradation | Other

MIX A — date: 8/21 — wt. AC 443.4 (416.7) — % AC b 4.25 (4.0) — # Blows 50

MIX B — date: 8/21 — wt AC 620.0 (543) — % AC b 5.84 (5.0) — # Blows 50

			Mix A 1	Mix A 2	Mix A 3	Mix A avg		Mix B 1	Mix B 2	Mix B 3	Mix B avg
Marshall I.D.			1	2	3			1	2	3	
Height		a	2 9/32	2 19/64	2 9/32		a	2 10/32	2 10/32	2 10/32	
Dry Wght.		A	1096.8	1095.1	1092.3		A	1081.5	1083.7	1086.6	
SSD Wght.		B	1097.8	1096.4	1092.7		B	1082.2	1084.1	1086.9	
Imm. Wght.		C	633.7	630.0	626.9		C	614.2	617.6	621.1	
Volume	B − C	D	464.1	466.4	466.8		D	468.0	466.5	465.8	
Bulk Sp.G.	A/D	E	2.363	2.438	2.340	2.380	E	2.311	2.323	2.333	2.322
Density	E × 62.3	F				148.2	F				144.6
Flow			13	15	15			17	19	17	
Stability Dial			1880	1610	1350			800	1020	960	
Stability	chart × ht. cor.					1775					1020

			Mix A			Mix A result		Mix B			Mix B result
Container I.D.			D					E			
Cont. + Sa. Dry		K					K				
Cont. Dry		L	767.2				L	780.1			
Sa. Dry	K − L	M	2041.9				M	2034.2			
Cont. + Sa. Imm.		N	1386.7				N	1364.1			
Cont. Imm.		P	185.4				P	196.4			
Sa. Imm.	N − P	Q	1201.3				Q	1168.7			
Sa. Volume	M − Q	R	840.6				R	865.5			
Max. Sp.G.	M/R	S	2.429	2.417		2.429	S	2.350	2.343		2.350
Rice Voids	100×((S−E)/S)	T		1.5		2.0	T		1.7		1.1
			2.559	4% 5.4				2.558			

Pan, Agg. Dry		d	AC ratio	b/c		p
Pan Dry		e	Agg ratio	(100−b)/n		q
Agg Dry	d − e	f		p + q		r
Pail, AC Dry		g	TM Sp.G.	100/r		s
Pail, AC Imm.		h	V.F MIX	(E/s)×100		t
Pail, AC Volume	g − h	i	Vol. AC	E × p		u
Pail, AC, Agg. Dry		j	V.M.A.	u + y		v
Pail, AC, Agg. Imm.		k	V.F. Agg.	(u/v)×100		w
Pail, AC, Agg. Vol.	j − k	l	BI Voids	100 − t		y
Agg. Volume	l − i	m				
Agg. Sp.G.	f/m	r				

signed RJ Walker date: 8/23

BC 910001

STATE OF MINNESOTA
DEPARTMENT OF TRANSPORTATION

TEST REPORT ON SAMPLE OF BITUMINOUS CORE

LABORATORY----	ST. PAUL	REPORT DATE----	FEB 01, 1991
TESTS COMPLETED	01/26/91	PROJECT NUMBER-	9PR6002
SUBMITTED BY--	C TURGEON	TYPE OF CONST.-	2341
INSPECTOR-----		COURSE---------	
DATE SAMPLED--		STATION NO.----	
DATE RECEIVED-	01/07/91	FIELD ID-------	2,3,4

TESTS REQUIRED: EXTRACTION GRADATION SPECIAL TESTS
COMMENTS: BIKEPATH 2,3,4

TEST RESULTS

SIEVE ANALYSIS(SQUARE OPENINGS)

	% PASSING
PASS 1 IN. SIEVE--	
PASS 3/4 IN. SIEVE	
PASS 5/8 IN. SIEVE	100.0
PASS 1/2 IN. SIEVE	97.0
PASS 3/8 IN. SIEVE	81.0
PASS #4 SIEVE-----	50.0
PASS #10 SIEVE----	40.0
PASS #20 SIEVE----	32.0
PASS #40 SIEVE----	24.0
PASS #80 SIEVE----	9.0
PASS #100 SIEVE---	8.0
PASS #200 SIEVE---	5.8

BITUMEN(%)-----------	6.2
MOISTURE(%)----------	
VOLATILE(%)----------	
TESTS ON RECOVERED ASPHALT	
PENETRATION 77 F.--	76
DUCTILITY 77 F.(CM)	
SOFTENING POINT, F.	
KVISC 275 F. CS----	
AVISC 140 F. POISES	1153
RICE VOIDS-----------	
DENSITY LBS PER CU FT	
FLOW-----------------	
STABILITY------------	

REMARKS: 3% CRUMB RUBBER

COPIES TO:	CHARGE NO.:
BIT. OFFICE	1125
	1020
	1111

THIS REPORT INTENDED ONLY FOR INFORMATION AS TO UNIFORMITY OF PRODUCTION MAKE NO CHANGES IN RECOMMENDED ASPHALT PERCENTAGE WITHOUT CONTACTING BITUMINOUS ENGINEER.

SIGNED-----------------------------------
ASST. CHIEF CHEMIST

BC 910002

STATE OF MINNESOTA
DEPARTMENT OF TRANSPORTATION

TEST REPORT ON SAMPLE OF BITUMINOUS CORE

LABORATORY----	ST. PAUL	REPORT DATE----	FEB 01, 1991
TESTS COMPLETED	01/26/91	PROJECT NUMBER-	9PR6002
SUBMITTED BY--	C TURGEON	TYPE OF CONST.-	2341
INSPECTOR-----		COURSE---------	
DATE SAMPLED--		STATION NO.----	
DATE RECEIVED-	01/07/91	FIELD ID-------	6,7,8

TESTS REQUIRED: EXTRACTION GRADATION SPECIAL TESTS
COMMENTS: BIKEPATH 6,7,8

TEST RESULTS

SIEVE ANALYSIS(SQUARE OPENINGS)

	% PASSING		
PASS 1 IN. SIEVE--		BITUMEN(%)-----------	5.3
PASS 3/4 IN. SIEVE		MOISTURE(%)----------	
PASS 5/8 IN. SIEVE	100.0	VOLATILE(%)----------	
PASS 1/2 IN. SIEVE	96.0	TESTS ON RECOVERED ASPHALT	
PASS 3/8 IN. SIEVE	83.0	PENETRATION 77 F.--	52
PASS #4 SIEVE-----	58.0	DUCTILITY 77 F.(CM)	
PASS #10 SIEVE----	47.0	SOFTENING POINT, F.	
PASS #20 SIEVE----	39.0	KVISC 275 F. CS----	
PASS #40 SIEVE----	28.0	AVISC 140 F. POISES	2125
PASS #80 SIEVE----	11.0	RICE VOIDS-----------	
PASS #100 SIEVE---	9.0	DENSITY LBS PER CU FT	
PASS #200 SIEVE---	10.5	FLOW-----------------	
		STABILITY------------	

REMARKS:

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	1111	

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ASST. CHIEF CHEMIST

STATE OF MINNESOTA
DEPARTMENT OF TRANSPORTATION

TEST REPORT ON SAMPLE OF BITUMINOUS CORE

LABORATORY----	ST. PAUL	REPORT DATE----	FEB 01, 1991
TESTS COMPLETED	01/29/91	PROJECT NUMBER-	9PR6002
SUBMITTED BY--	C TURGEON	TYPE OF CONST.-	2341
INSPECTOR-----		COURSE---------	
DATE SAMPLED--		STATION NO.----	
DATE RECEIVED-	01/07/91	FIELD ID-------	10,11,12

TESTS REQUIRED: EXTRACTION GRADATION SPECIAL TESTS
COMMENTS: BIKEPATH 10,11,12

TEST RESULTS

SIEVE ANALYSIS(SQUARE OPENINGS)

	% PASSING		
PASS 1 IN. SIEVE--		BITUMEN(%)-----------	7.8
PASS 3/4 IN. SIEVE		MOISTURE(%)----------	
PASS 5/8 IN. SIEVE	100.0	VOLATILE(%)----------	
PASS 1/2 IN. SIEVE	94.0	TESTS ON RECOVERED ASPHALT	
PASS 3/8 IN. SIEVE	81.0	PENETRATION 77 F.--	111
PASS #4 SIEVE-----	57.0	DUCTILITY 77 F.(CM)	
PASS #10 SIEVE----	44.0	SOFTENING POINT, F.	
PASS #20 SIEVE----	34.0	KVISC 275 F. CS----	
PASS #40 SIEVE----	24.0	AVISC 140 F. POISES	268
PASS #80 SIEVE----	9.0	RICE VOIDS-----------	
PASS #100 SIEVE---	8.0	DENSITY LBS PER CU FT	
PASS #200 SIEVE---	5.7	FLOW-----------------	
		STABILITY------------	

REMARKS: 6% CRUMB RUBBER

COPIES TO:	CHARGE NO.:
BIT. OFFICE	1125
	1020
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ASST. CHIEF CHEMIST

STATE OF MINNESOTA
DEPARTMENT OF TRANSPORTATION

TEST REPORT ON SAMPLE OF BITUMINOUS CORE

LABORATORY----	ST. PAUL	REPORT DATE----	FEB 01, 1991
TESTS COMPLETED	01/26/91	PROJECT NUMBER-	9PR6002
SUBMITTED BY--		TYPE OF CONST.-	2341
INSPECTOR-----		COURSE---------	
DATE SAMPLED--		STATION NO.----	
DATE RECEIVED-	01/07/91	FIELD ID-------	C TURGEON

TESTS REQUIRED: EXTRACTION GRADATION SPECIAL TESTS
COMMENTS: BIKEPATH 14,15,16

TEST RESULTS

SIEVE ANALYSIS(SQUARE OPENINGS)

	% PASSING		
PASS 1 IN. SIEVE--		BITUMEN(%)-----------	5.4
PASS 3/4 IN. SIEVE		MOISTURE(%)----------	
PASS 5/8 IN. SIEVE	100.0	VOLATILE(%)----------	
PASS 1/2 IN. SIEVE	96.0	TESTS ON RECOVERED ASPHALT	
PASS 3/8 IN. SIEVE	84.0	PENETRATION 77 F.--	34
PASS #4 SIEVE-----	56.0	DUCTILITY 77 F.(CM)	
PASS #10 SIEVE----	46.0	SOFTENING POINT, F.	
PASS #20 SIEVE----	38.0	KVISC 275 F. CS----	
PASS #40 SIEVE----	27.0	AVISC 140 F. POISES	
PASS #80 SIEVE----	13.0	RICE VOIDS-----------	
PASS #100 SIEVE---	11.0	DENSITY LBS PER CU FT	
PASS #200 SIEVE---	7.8	FLOW-----------------	
		STABILITY------------	

REMARKS: 9% SHINGLES

COPIES TO:	CHARGE NO.:
BIT. OFFICE	1125
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ASST. CHIEF CHEMIST

BC 910005

STATE OF MINNESOTA
DEPARTMENT OF TRANSPORTATION

TEST REPORT ON SAMPLE OF BITUMINOUS CORE

LABORATORY----	ST. PAUL	REPORT DATE----	FEB 01, 1991
TESTS COMPLETED	01/26/91	PROJECT NUMBER-	9PR6002
SUBMITTED BY--	C TURGEON	TYPE OF CONST.-	2341
INSPECTOR-----		COURSE---------	
DATE SAMPLED--		STATION NO.----	
DATE RECEIVED-	01/07/91	FIELD ID-------	18,19,20

TESTS REQUIRED: EXTRACTION GRADATION SPECIAL TESTS
COMMENTS: BIKEPATH 18,19,20

TEST RESULTS

SIEVE ANALYSIS(SQUARE OPENINGS)

% PASSING

PASS 1 IN. SIEVE--		BITUMEN(%)-----------	7.3
PASS 3/4 IN. SIEVE	100.0	MOISTURE(%)----------	
PASS 5/8 IN. SIEVE	99.0	VOLATILE(%)----------	
PASS 1/2 IN. SIEVE	96.0	TESTS ON RECOVERED ASPHALT	
PASS 3/8 IN. SIEVE	81.0	PENETRATION 77 F.--	55
PASS #4 SIEVE-----	52.0	DUCTILITY 77 F.(CM)	
PASS #10 SIEVE----	41.0	SOFTENING POINT, F.	
PASS #20 SIEVE----	33.0	KVISC 275 F. CS----	
PASS #40 SIEVE----	23.0	AVISC 140 F. POISES	2548
PASS #80 SIEVE----	9.0	RICE VOIDS-----------	
PASS #100 SIEVE---	8.0	DENSITY LBS PER CU FT	
PASS #200 SIEVE---	5.5	FLOW-----------------	
		STABILITY------------	

REMARKS: 3% C RUBBER 6% SHING

COPIES TO:	CHARGE NO.:
BIT. OFFICE	1125
	1020
	111

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ASST. CHIEF CHEMIST