



Nicollet County Gravel Road Basics

Local Road Conference NDLTAP

Roughly 50% of Public Roads in MN are Gravel (70,000 miles)



Updated 10-19-26

Mission Statement

Providing efficient services with innovation and accountability.

Vision Statement

Setting the standard for providing superior and efficient county government services through leadership, accountability and innovation to a growing and diverse society.

Leadership. Efficiency.
Accountability.
Innovation. Integrity.

Key Gravel Manual



Gravel Road Maintenance Meeting the Challenge

<https://www.youtube.com/watch?v=htZU2ligpH8>

Surface Gravel

No bigger than $\frac{3}{4}$ "

GRAVEL MATERIAL

Retained on 3/8" Sieve



Retained on No 4 Sieve



Retained on No 10 Sieve



Retained on No 40 Sieve



Retained on 200 Sieve



-200



"Max -200 is 50% of +200"

Mother Nature determines the amount of moisture gravel roads receive throughout the year. **WATER** bonds the mix together so it can be molded and shaped to create a hardpan surface on the road. The amount of water can greatly affect the final product. 0.3" of rain seems to be the perfect amount before blading.



NC Converts Passing to Retained



Retained Gravel Calculator

Material Test Report

Report No: MAT:20-27846-S3
Issue No: 1

Client: TIMMS TRUCKING
Project: PRODUCTION CHECK

CC: MIKE SUSKA
RANDY TIMM
ZAC TIMM

COURTLAND MN
Job No: 08-20870

Date of Issue: 11/16/2020
Reviewed By: Lee McLaughlin
Project Manager

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Lee McLaughlin

Sample Details

Sample ID: 20-27846-S3
Field Sample ID: Class 5 #43
Date Sampled: 11/6/2020
Source: Nicollet County Pit
Material: Natural Gravel
Specification: MNDOT 3138-3 CL 5 Agg Surface Nic Cty
Sampling Method: Sampled by Contractor
Location: 44,000 Tons
Date Submitted: 11/12/2020

Particle Size Distribution

Method: MndOT 1202, MndOT 1203
Drying by: Natural
Date Tested: 11/12/2020
Tested By: Bryce Boyer

Sieve Size	% Passing	Limits
1/2 in (19.0mm)	100	100
5/8 in (16.0mm)	100	
3/4 in (12.5mm)	94	
3/8 in (9.5mm)	87	50 - 90
No. 4 (4.75mm)	71	35 - 80
No. 10 (2.0mm)	54	20 - 65
No. 30 (600µm)	25	
No. 40 (425µm)	18	10 - 35
No. 100 (150µm)	10	
No. 200 (75µm)	8.6	6 - 13.5

Other Test Results

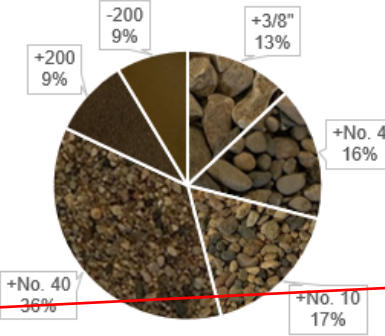
Description	Method	Result	Limits
Approximate maximum grain size	ASTM D 4318		
Material retained on 425µm (No. 40) (%)		82.2	
Method of Removal			
Grooving Tool Type			
Specimen preparation method		Wet	
Drying Method		Air	
Special selection process			
Rolling Method for PL		Hand	
As Received Water Content (%)			
Liquid Limit Device Type	Manual		
Liquid Limit		25	
Plastic Limit		18	
Plasticity Index		7	6 - 12
Liquid Limit Procedure	One-point (B)		
Date Tested		11/13/2020	
Granular Ratio		MNDOT 1202, MNDOT 1203	

Chart

Comments

The sample meets MNDOT Class 5 specifications.

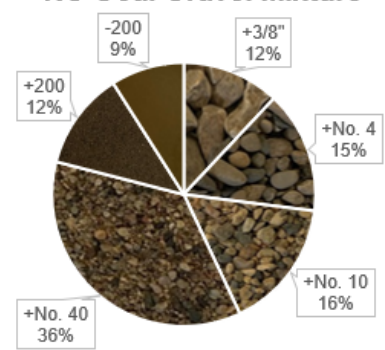
Current Gravel Mixture



Enter Data in Yellow Sections

	Current Gravel	
	Passing Test	Retained Test
+ 3/4"	100	0.00%
+ 3/8"	87	13.00%
+ No. 4	71	16.00%
+ No. 10	54	17.00%
+ No. 40	18	36.00%
+ 200	8.6	9.40%
- 200		8.60%
		100.00%

NC Goal Gravel Mixture



	Goal Gravel	
	Passing Test	Retained Test
+ 3/4"	100	0.00%
+ 3/8"	88	12.00%
+ No. 4	73	15.00%
+ No. 10	57	16.00%
+ No. 40	21	36.00%
+ 200	9	12.00%
- 200		9.00%
		100.00%

Have a separate Plasticity Index test done too (6-12)

It was common to only focus on what passed the 200 sieve.

Now we focus on the whole mix.

Also have Spreadsheet Calculators for mixing materials

Retained Calculators



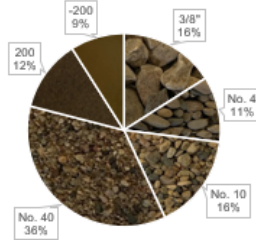
Retained Gravel Calculator for Custom Mixes

Custom Mix Ratio 2 to Current 1

Enter Data in Yellow Sections

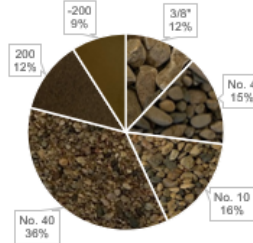
Notes: Must quantify dry blade window to know how much to spread tons per mile

Goal Gravel Mixture



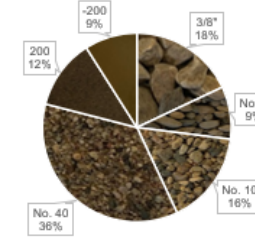
Goal Gravel			
Retained		Passing	
3/8"	16.00%	3/4"	100
No. 4	11.00%	3/8"	84
No. 10	16.00%	No. 4	73
No. 40	36.00%	No. 10	57
200	12.00%	No. 40	21
-200	9.00%	200	9
100.00%			

Current Gravel Mixture



Current Gravel			
Retained		Passing	
3/8"	12.00%	3/4"	100
No. 4	15.00%	3/8"	88
No. 10	16.00%	No. 4	73
No. 40	36.00%	No. 10	57
200	12.00%	No. 40	21
-200	9.00%	200	9
100.00%			

Custom Mix for Goal Gravel



Custom Mix			
Retained		Passing	
3/8"	18.00%	3/4"	100.00
No. 4	9.00%	3/8"	82.00
No. 10	16.00%	No. 4	73.00
No. 40	36.00%	No. 10	57.00
200	12.00%	No. 40	21.00
-200	9.00%	200	9.00
100.00%			

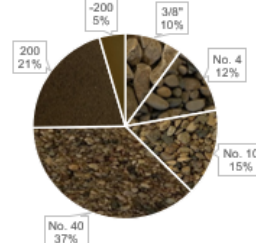
Retained Gravel Calculator for Blend Mixes

Gravel Mix Ratio 1 to Gravel 0.5

Enter Data in Yellow Sections

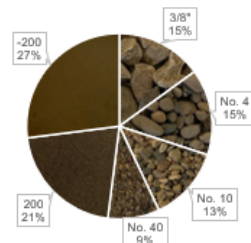
Notes: Must quantify dry blade window to know how much to spread tons per mile

Gravel #1 Mixture



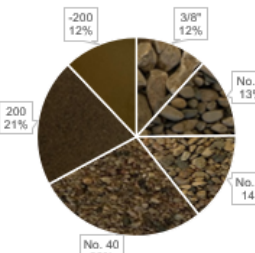
Gravel #1			
Retained		Passing	
3/8"	10.00%	3/4"	99
No. 4	12.00%	3/8"	89
No. 10	15.00%	No. 4	77
No. 40	37.00%	No. 10	62
200	20.50%	No. 40	25
-200	4.50%	200	4.5
99.00%			

Gravel #2 Mixture



Gravel #2			
Retained		Passing	
3/8"	15.00%	3/4"	99
No. 4	15.00%	3/8"	84
No. 10	13.00%	No. 4	69
No. 40	9.00%	No. 10	56
200	21.00%	No. 40	47
-200	27.00%	200	26.5
100.00%			

Results from Gravel #1 & #2



Blend Calculation			
Retained		Passing	
3/8"	11.67%	3/4"	100.00
No. 4	13.00%	3/8"	88.33
No. 10	14.33%	No. 4	75.33
No. 40	27.67%	No. 10	61.00
200	20.67%	No. 40	33.33
-200	12.00%	200	12.67
99.00%			

Material



3138 AGGREGATE FOR SURFACE AND BASE COURSES

- D Surfacing Aggregates

2025 MNDOT Gravel Spec

Table 3138.2-3
Base and Surfacing Aggregate
(Containing less than 25 percent recycled Aggregates)
Total Percent Passing *

Sieve Size	Class 1 (Surfacing)	Class 2 (Surfacing †)	Class 3 (Subbase)	Class 4 (Subbase)	Class 5 (Base)	Class 6 (Base)
2 inch	—	—	100	100	—	—
1 1/2 inch	—	—	—	—	100	100
1 inch	—	—	—	—	—	—
3/4 inch	100	100	—	—	70 - 100	70 - 100
3/8 inch	65 - 95	65 - 90	—	—	45 - 90	45 - 85
No. 4	40 - 85	35 - 70	35 - 100	35 - 100	35 - 80	35 - 70
No. 10	25 - 70	25 - 45	20 - 100	20 - 100	20 - 65	20 - 55
No. 40	10 - 45	12 - 35	5 - 50	5 - 35	10 - 35	10 - 30
No. 200	8.0 - 15.0	5.0 - 16.0	5.0 - 10.0	4.0 - 10.0	3.0 - 10.0	3.0 - 7.0

* If product contains recycled Aggregate, add letters in parentheses for each Aggregate blend designating the type of recycled products included in the mixture: (B) = Bituminous, (C) = Concrete, (G) = Glass, (BC) = Bituminous and Concrete, (BG) = Bituminous and Glass, (CG) = Concrete and Glass, (BCG) = Bituminous, Concrete, and Glass.
 || Recycled concrete when used for surfacing is only allowed for Shoulders.
 † Class 2 must be composed of 100 percent crushed quarry rock per 3138.2B, "Virgin Materials," Note (2).
 For 100 percent crushed quarried class 5 aggregate, the required passing the number 4 sieve is 30 - 80, the required passing the number 10 sieve is 15 - 65, the required passing the number 40 sieve is 7 - 35, and the required passing the Number 200 sieve is 3.0 - 12.0. The 1-1/2 inch, 3/4 inch, and 3/8 inch requirements for crushed quarried class 5 aggregate are the same as in Table 3138.2-3.

Class 1 Surface: Largest rock size is 3/4"

Max -200 fines is 15% (binder)

Class 5 Base: Largest rock size is 1.5"

Max -200 fines is 10%

(Specs do change from time to time)

2025 MnDOT Gravel Spec

3138

D Surfacing Aggregates

Provide surfacing Aggregates in accordance with 3138.2A, "General," 3138.2B, "Virgin Materials," and 3138.2C, "Recycled Materials," and meeting the following requirements:

- (1) 100 percent of the Material passes the 3/4 inch Sieve, regardless of the class specified; this modifies the requirements of Table 3138.2-3, Table 3138.2-4, and Table 3138.2-5 for surfacing Aggregates
- (2) Does not contain glass
- (3) Recycled concrete Materials may only be used for the Roadway Shoulders
- (4) There is no restriction on the bitumen content, if used for shouldering
- (5) Provide Aggregate with a minimum clay content of 3 percent and a Plasticity Index (PI) of 5 - 12. In lieu of meeting the minimum clay content and PI, the requirements are fulfilled if one of the following are met:
 - (a) The Aggregate is composed of at least 25 percent recycled Materials.
 - (b) The Aggregate is composed of at least 25 percent crushed quarry Aggregate.
 - (c) If using glacial or fluvial Aggregate, a minimum of 5 percent 3/8 minus crushed limestone is added.

Added in 2018

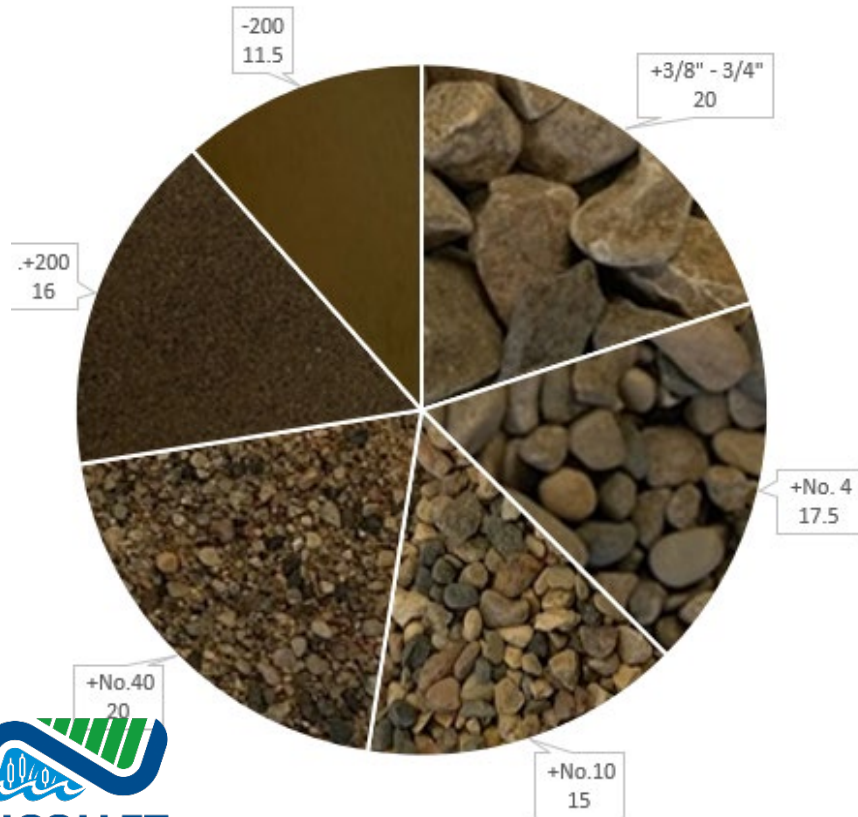
Note: Class 2 must be composed of 100 percent crushed quarry rock per 3138.2B, "Virgin Materials," Note (2).

Average MnDOT 2025 Spec

Class 1

2025 MNDOT Class 1 Surface Gravel (3/4" Max)

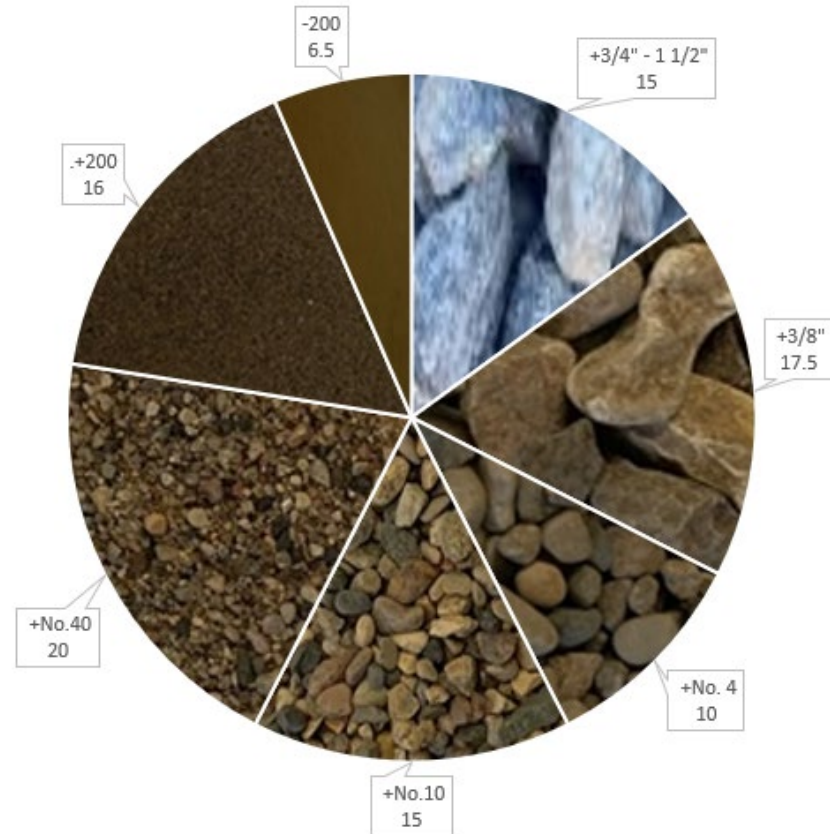
Average Retained Test Results



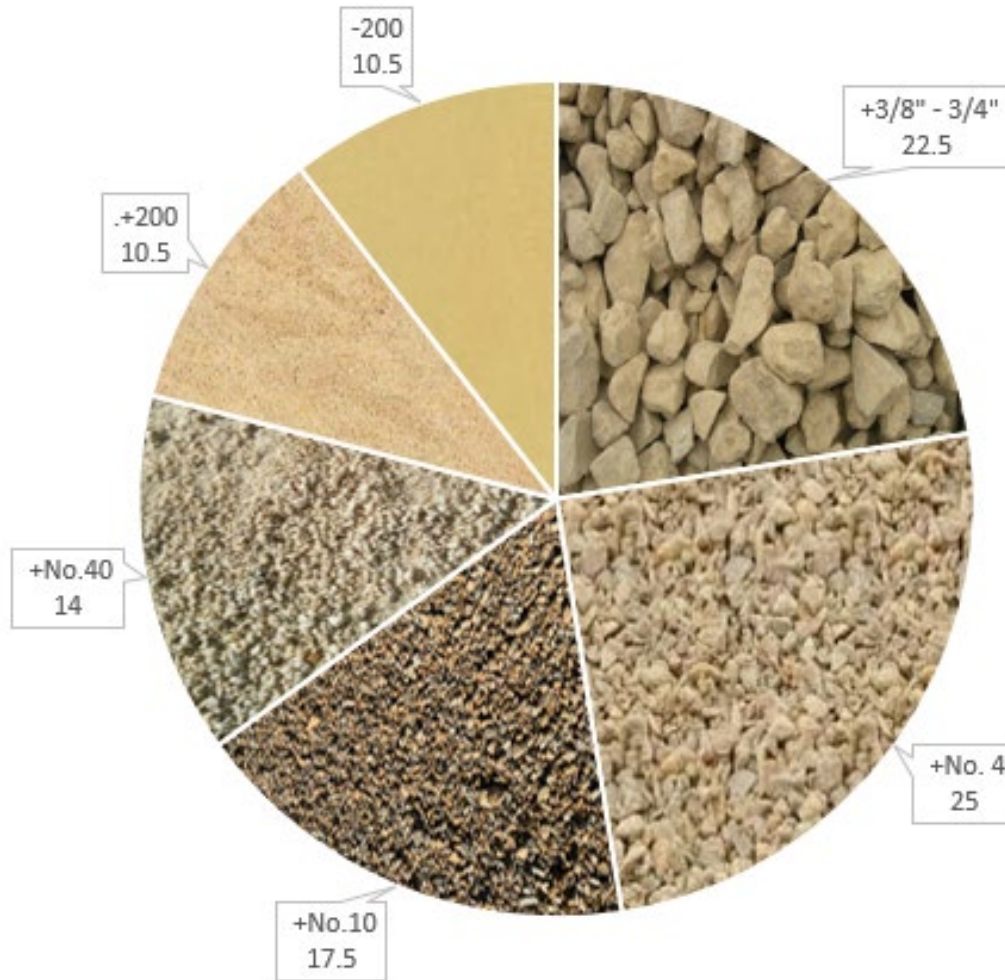
Class 5

2025 MNDOT Class 5 Base (1 1/2" Max)

Average Retained Test Results



Average MnDOT 2025 Spec Class 2



↓
Limestone
Granite
Quartz

Must be 100% quarry rock

Material

STANDARD SPECIFICATIONS FOR ROADS AND BRIDGES



Version:

10-7-2026

**SOUTH DAKOTA
DEPARTMENT OF TRANSPORTATION**

883 Clay Spec

- The plasticity index of the clay will be from 10 to 32 and the liquid limit will not exceed 50, when tested in accordance with SD 207.
- During production the clay will be screened over a 1 inch sieve to remove oversize clumps and vegetation, SD 883 CLAY



Clay Samples with Plasticity Results

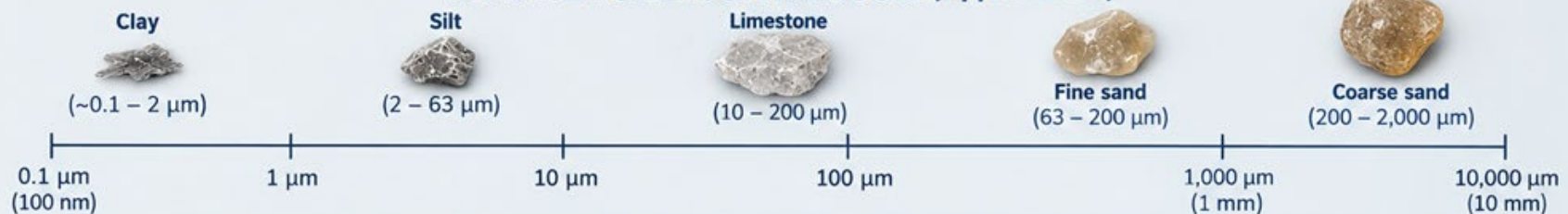
SD Clay Plasticity



SD 883 CLAY

	South Dakota Goals	Sandy Loam from NC Courtland Pit	Tan Clay from NC Courtland Pit	Tan Clay from Ulland Pit	Red Clay from NC Courtland Pit	Tan Clay from West Newton	Black Dirt from field off of CSAH 52 2022
3/4 Rock							
3/8 Rock							
No. 4 Rock							
No. 10 C Sand		0.4	5.1				
No. 40 F Sand		5.2	22.9				
-200		94.4	72				
% of Silt in -200		83	41.1				
% of Clay in -200		11.4	30.9				
Plasticity Limit		27.5	18	18	18	17	34
▶ Plasticity Index	10-32	1.1	★ 20	15	13	9	14
Liquid Limit	0-50	28.6	37	33	31	26	48

PARTICLE SIZE COMPARISON (Approximate)



NC 2016 - Current Gravel Spec.



(2111) AGGREGATE BASE

The provision of MnDOT 2111 are supplemented as follows:

Production requirements for **Stockpile Aggregate Surfacing Class 5MOD** are as follows:

Stockpile Aggregate Surfacing Class 5MOD will conform to the requirements of 3138 for Virgin Class 5 Surfacing Aggregate (100% passing the ¾" sieve).

Table 3138-3 is modified to require that 6-12% passes the No. 200 sieve for Class 5.

Stockpile Aggregate Surfacing Class 5MOD requires a minimum clay content of 3% and a Plasticity Index of 6-12.

Contractor's sampling and testing will be in accordance with Specification 3138.3 along with the following:

- G Particle Size Analysis Laboratory Manual Method
- H Liquid Limit Determination Laboratory Manual Method
- I Plastic Limit Determination Laboratory Manual Method

→ Contractor is required to provide Quality Control (QC) testing for gradation at a rate of 1/1000 tons produced into the stockpile. Percent crushing test is required 1/day. Tests results shall be provided to the County.

Contractor is required to verify that the minimum clay content and Plasticity Index are being met. Contractor shall have the aggregate material tested at the start of production to verify the minimum clay content and Plasticity Index meet the requirements of S-17.3. These parameters shall be verified after the initial passing test at a rate of 1/5,000 tons produced into stockpile. Test results shall be provided to the County. Failing Plasticity Index tests will require the Contractor to immediately make adjustments to production and to take another Plasticity Index test. While the Plasticity Index test is being completed production must cease. Once a passing Plasticity Index test is achieved the testing rate will resume at 1/5,000 tons.

testing →

Gradation, clay content, and Plasticity Index tests shall be performed by personnel that have MnDOT certifications to do so. Contractor shall provide to the County copies of the tester's MnDOT certification card.

The County may take companion aggregate samples to complete verification testing for gradation, percent crushing, minimum clay percent, and Plasticity Index.

Material represented by failing tests may be subject to reduced payment per Table 2211-4. Material with failing plasticity test may be subject to reduced payment.

NOTE: Contractor may need to supplement, from an outside source, the County's virgin pit material with oversize rock to meet the coarse sieve and crushing requirements. All costs to provide this material shall be included in the bid price for Aggregate Surfacing Class 5MOD.

Binder material shall meet the requirements of 3146 and special provision S-17.3.

NOTE: The County Gravel Pit does not contain binder material that meets the requirements of 3146 and special provision S-17.3. Contractor will be required to provide binder material from an outside source that meets the requirements of 3146 and special provision S-17.3. Cost to provide this material shall be included in the bid price for Stockpile Aggregate Surfacing Class 5MOD.

The contractor is required to provide and utilize a cone crusher to produce the Stockpile Aggregate Surfacing Class 5MOD.

No adjustment will be made in the contract unit price regardless of the amount of material crushed.

Mining locations shall be directed by the Engineer.

Stripping required to access suitable crushing material shall be incidental to 2111.509 Stockpile Aggregate Surfacing Class 5MOD.

testing →

testing →

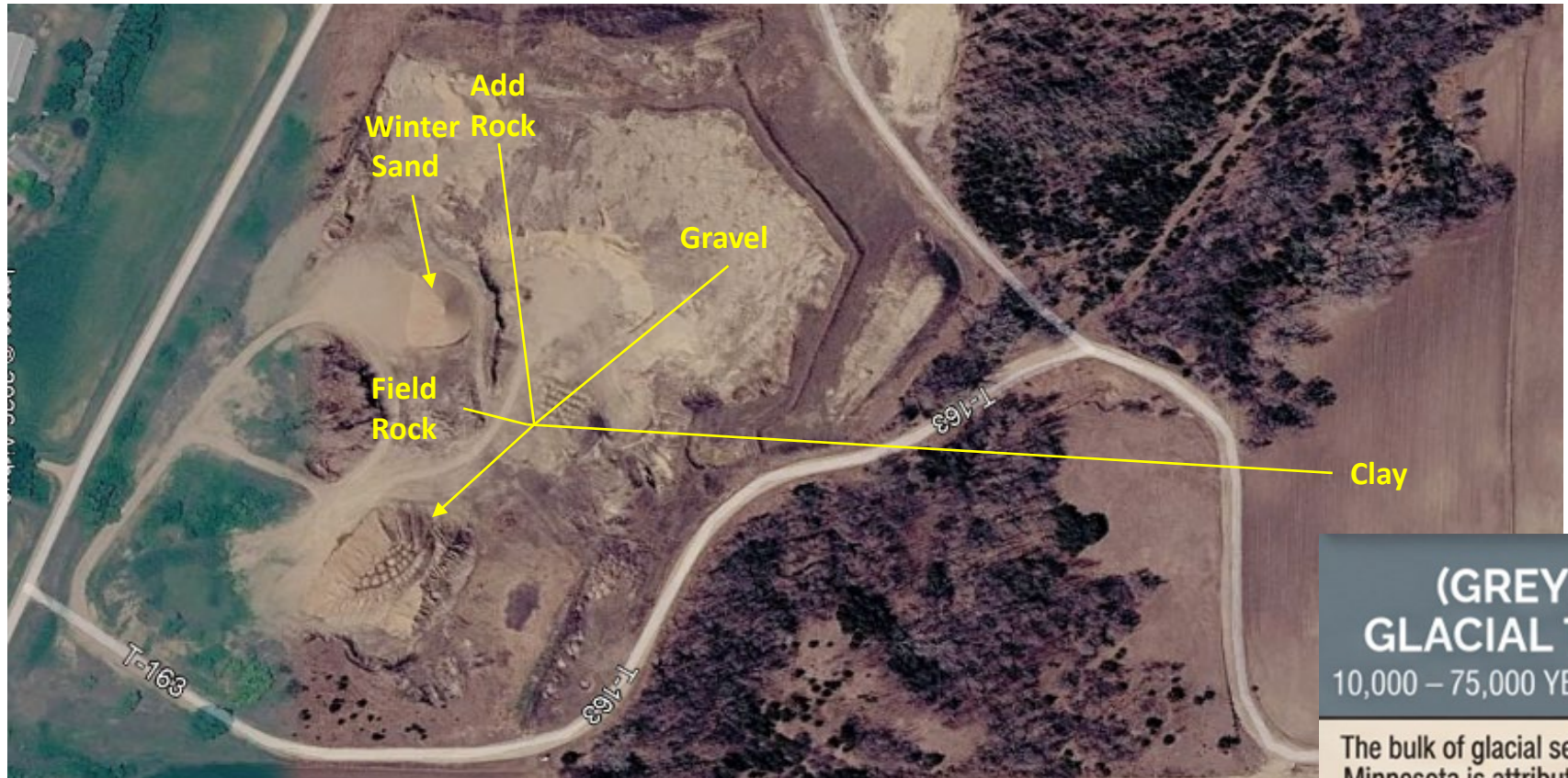
testing →



Seth Greenwood P.E. / Nicollet County CL5Mod

4 Tests Gradation, Plasticity, Clay Content, % Crushing

2015 Balanced County Sand & Gravel Pit



Nicollet County Courtland Pit

(GREY)
GLACIAL TILL
10,000 – 75,000 YEARS OLD

The bulk of glacial sediment in Minnesota is attributed to one time interval, the Wisconsin Episode, which began about 75,000 years ago. It is a chaotic mix of clay, silt, sand, gravel, and angular rocks that were eroded, transported, and deposited by ice.



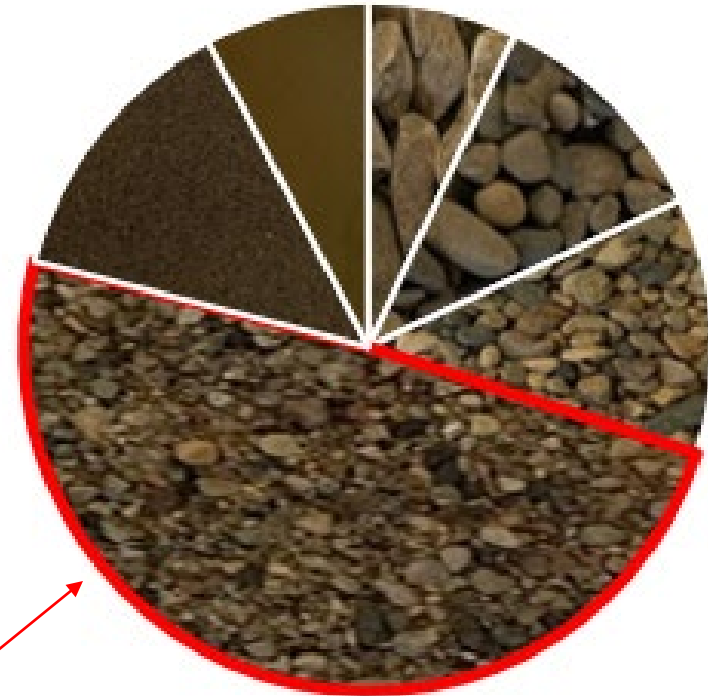
NC 1988 vs 2013

1988 Nicollet Class 1 Gravel

2013 Nicollet Class 7B 30% RecBit 70% Gravel



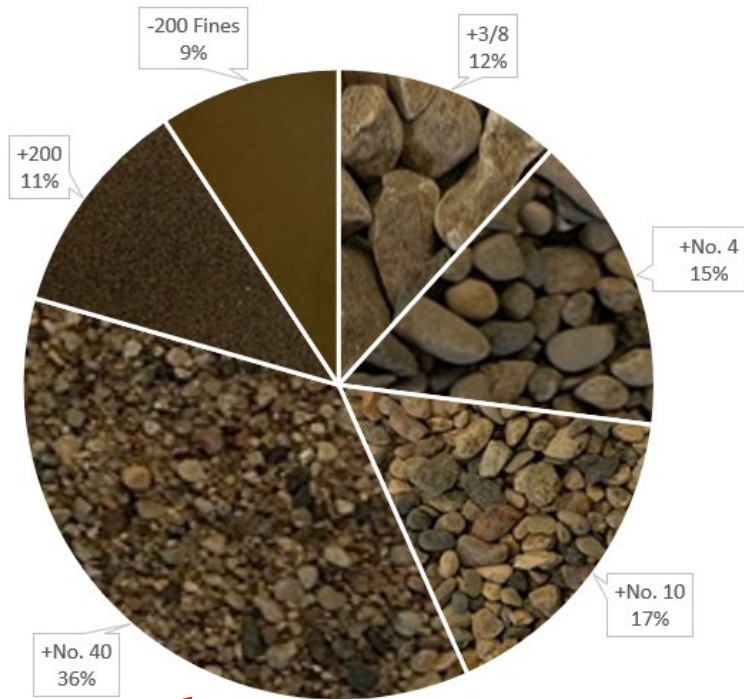
Rocks	48%
Sand	52%



Rocks	30%
Sand	70%

NC 2020

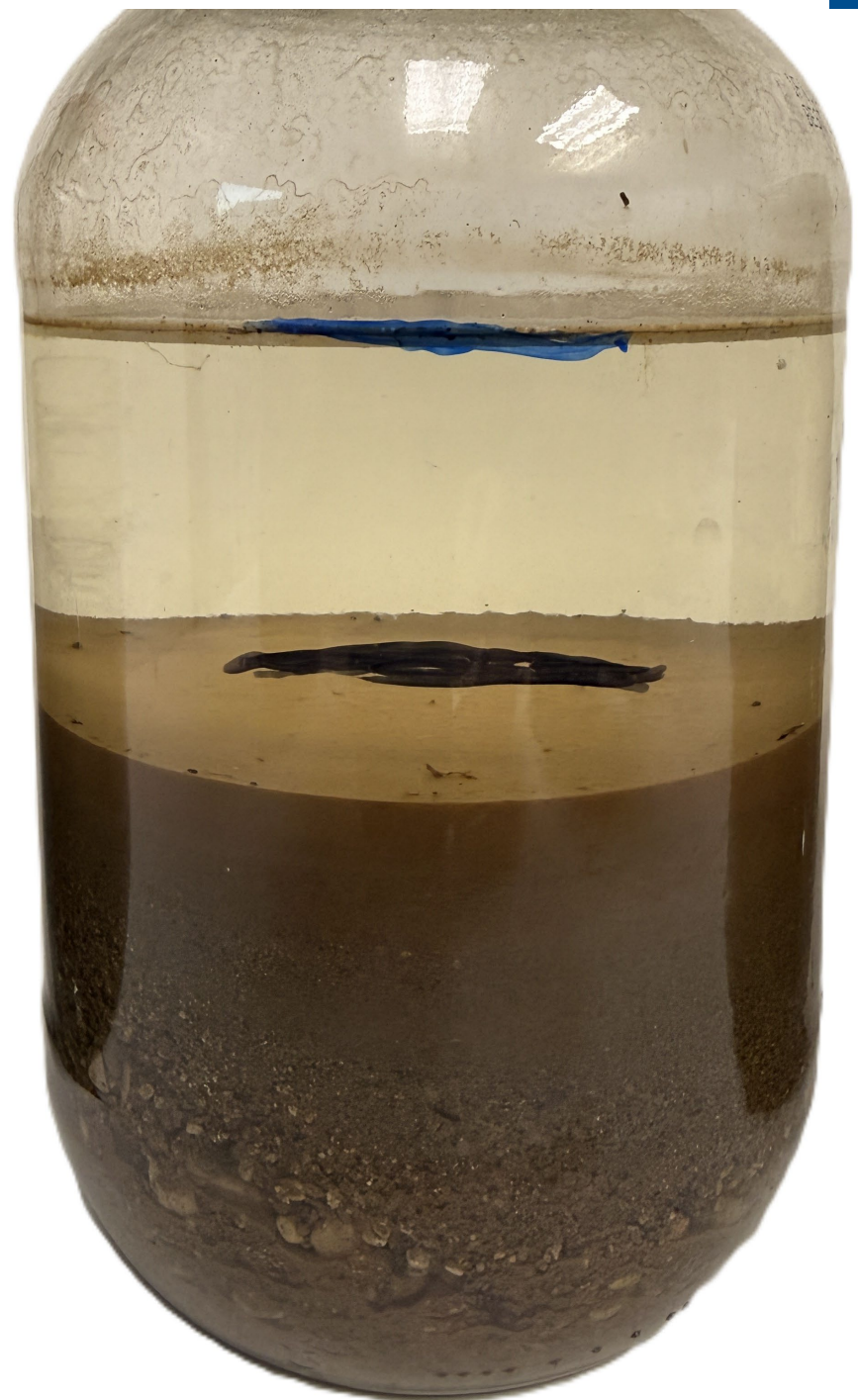
2020 Nicollet MNDOT Class 5 Mod Max 3/4"



2016 Class 5Mod

200: 6 -12% (13.5 MAX)

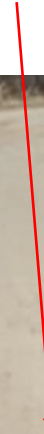
(P.I.) Plasticity Index: 6-12



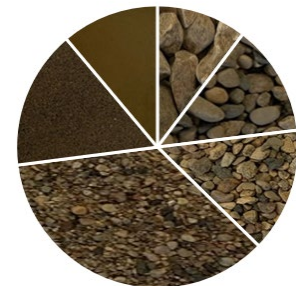


2016 Class 5Mod

Burnouts on hardpan!



1st time we saw hardpan!



Contractor vs Nicollet County Gravel



Did Not Meet P.I.



Met P.I.

Spring Shoulder Reclaim

2021 Reclaim



April 1st – June 15th

Disk 1 side of the shoulders or in-slope if needed

WAIT UNTIL APRIL 1st TO DISK, WINTER NEEDS TO BE OVER WITH!

Common Reclaim Issue



Excessive Binder / Slimy Roads

Fix is to Mix

2021 Reclaim



Mix loose surface rocks with
reclaimed material

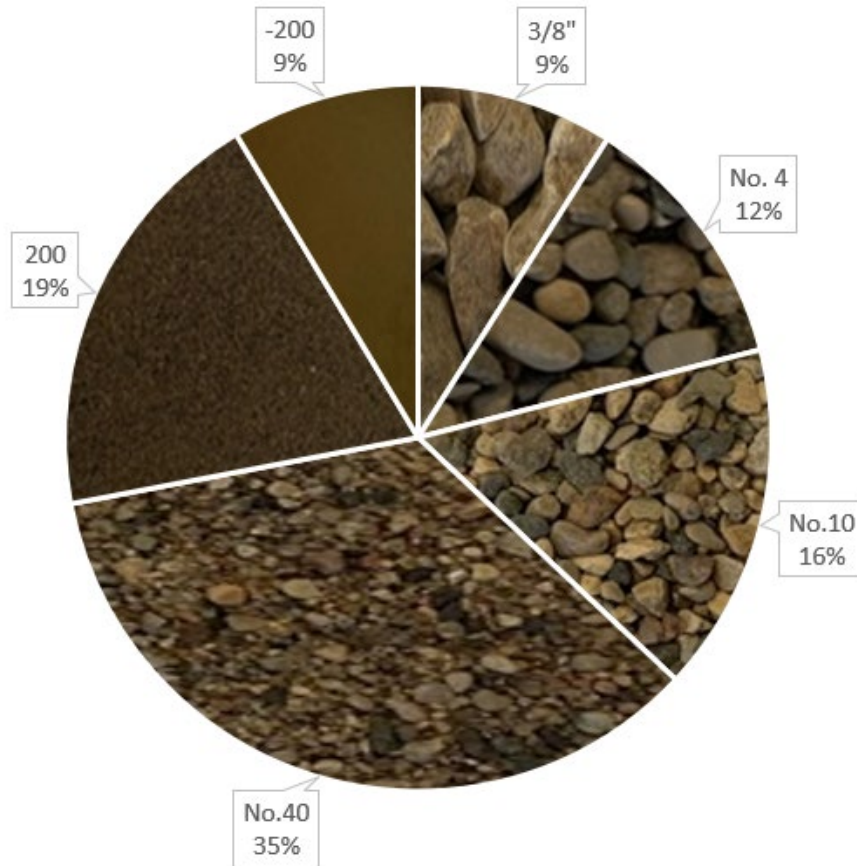


LTAP OPERA GRANT
Rotating Tine Sod Mulcher/Reclaimer

Spring Shoulder Reclaim Mix

2021 Reclaim

Reclaim Mix 2021 CNTY 82

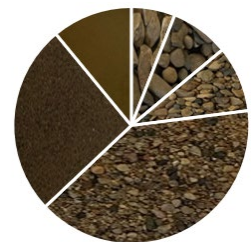


- “Blade shoulders as needed to recover loose aggregate and valuable fines and to destroy vegetation.” pg 18 Nace
- “By remixing loose aggregate with fines from the road edge it may be possible to produce a well graded mix” pg 12 Paser Manual

Fix!



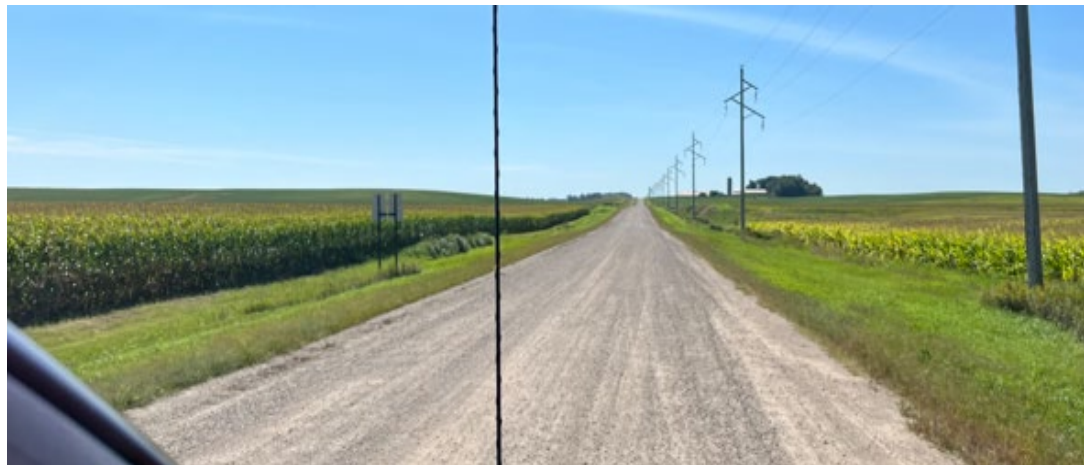
Finished Reclaim Mix
(June 15th is the completion goal)



Spring Roads VS Fall Roads



4-2-24 (Mixing loose surface rocks and fines back)



9-3-24 (Loose surface rocks = washboards)

5% fines



3:1 Calculation

27% fines



Results from Gravel #1 & #2



Blend Calculation			
Retained		Passing	
3/8"	11.25%	3/4"	100.00
No. 4	12.75%	3/8"	88.75
No. 10	14.50%	No. 4	76.00
No. 40	30.00%	No. 10	61.50
200	20.63%	No. 40	31.50
-200	10.13%	200	10.88
	99.00%		



Limestone



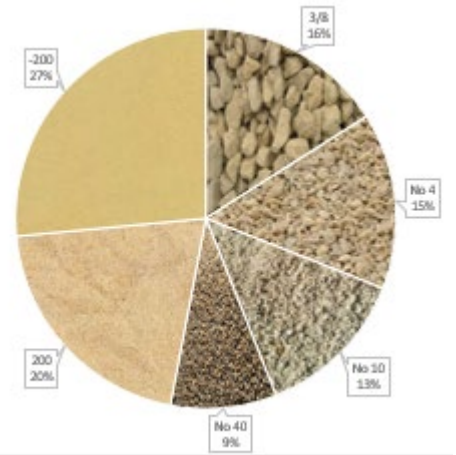
LIMESTONE:

- 1 1/2" Clean: Base for large hole repairs and frost boils.
- 1" Clean: Muddy areas from frost boils, reclaiming or graveling, winter hills that face south.
- 1" With fines: Use on Gravel Road Curves, Intersections, Hills, and off of blacktop. Reduces washboards by adding high fines back to roads.
- Ballfield: Tested on CNTY 62. Added 5 ton in 2,000 feet. Good results.

LIMESTONE
450 MILLION YEARS

Originated in an ancient marine environment; formed from the accumulation of shells, coral, and debris.

1" Dirty Limestone



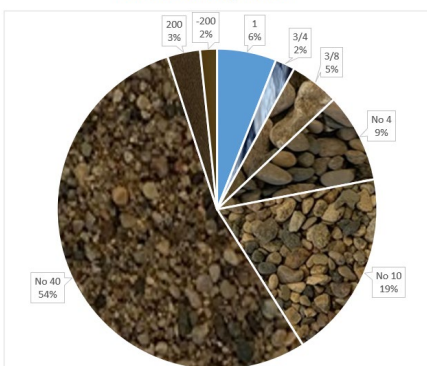
Nicollet started doing this in 2014. Limestone does very well on low speed areas: hills, curves, and intersections.



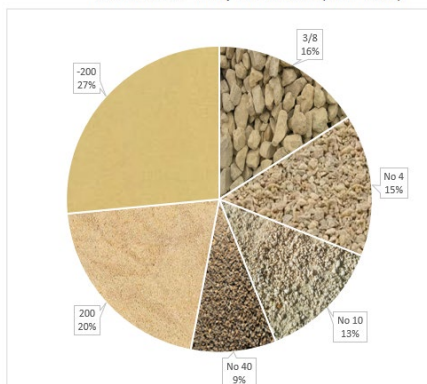
Park



Nicollet County Pit Run

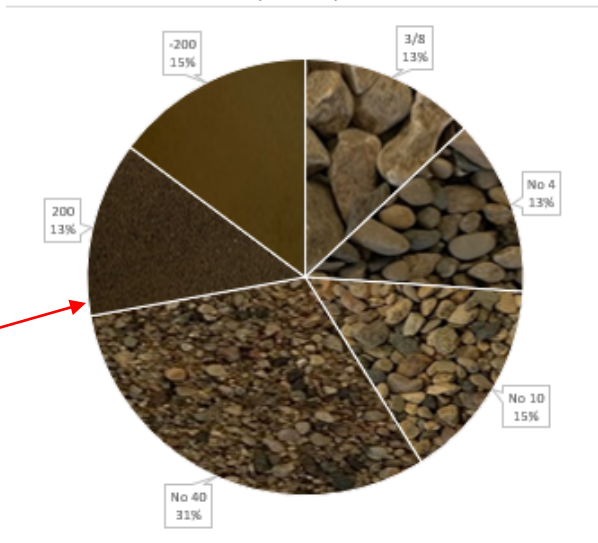


Holtmeier 1" Dirty Limestone (3/4" Max)



Retained Test Results

2021 Holtmeier 1" Fines Limestone w/ Nicollet County Pit Run 1:1 Ratio (3/4" Max)



Material vs NC 2020 MnDOT Class 5

	Mix	2020 NC	Difference
Rock	41%	44%	-3%
Sand	44%	47%	-3%
Fines	15%	9%	6%

RETAINED RESULT	%
3/8"	13
No 4	13
No 10	15
No 40	31
200	13
-200	15

PASSING RESULT	%
3/4" Rock	97
3/8" Rock	87
No. 4 Rock	74
No. 10 Sand	59
No. 40 Fine Sand	28
Minus 200 Fines	14.8

American Engineering Testin
10/26/2021 Park Trails



Notes

- 1 Good mix
- 2 1:1 Mix with Nicollet County pit run works the best
- 3 Doesn't get sloppy like 100% limestone
- 4 Plasticity is 2

7-Mile Park



1/2" Granite and Quartz



1
100%



MORTON GRANITE

3.6 BILLION YEARS

Morton Gneiss

Molten magma; cooled slowly deep underground to form one of the oldest rocks.

SIoux QUARTZITE

1.7 BILLION YEARS

Metamorphosed, super-hard rock where quartz grains, silica, have fused together.

Misc. Nicollet County Materials

GRAVEL:

Class5MOD: Nicollet County crushes their own gravel. -200 6-13.5% and Plasticity 6-12. Works great with a roller and binds together to create a lot of hardpan.

LIMESTONE:

1 1/2" Clean: Base for large hole repairs and frost boils

1" Clean: Muddy areas from frost boils, reclaiming, or graveling. South facing winter hills too

1" With Fines: SUMMER: Use on Gravel Road Curves, Intersections, Hills, and off of blacktop. Reduces washboards by adding high fines back to road.

3/4" MOD: Harder rock that doesn't break down as fast.

QUARTZ & GRANITE

1 1/2" 23 Construction/Inspection hill 5Q Granite, not used as a daily road.

1" minus base/fill material. Doesn't have plasticity.

3/4"

1/2" Use on gravel road hills

3/8" FA-3 Sealcoat: Use on all roads Rate 18lbs / SQYD

5/16" FA2.5 Sealcoat

1/4" FA2 Sealcoat: Use on Parking lots due to the turning of slow vehicles.

RIP RAP MNDOT 3138 Quartz or Granite

Rip Rap Class I* (6")

Rip Rap Class II* (12") outlets only small culvert repairs

Rip Rap Class III* (18") Inlet and outlet small culvert repairs

Rip Rap Class IV* (24") Inlet and outlet for large culvert repairs (Use this all the time since 2020)

SAND Screened from Courtland Pit with 3/8 minus

Mixed at sand/salt for winter at 3:1 or 2:1. Clean sand needs to have less than 3% of -200 or it bridges auger

PARK TRAILS

Mix Pitrun from Courtland Pit and 1" Limestone with fines at a 1:1 ratio.

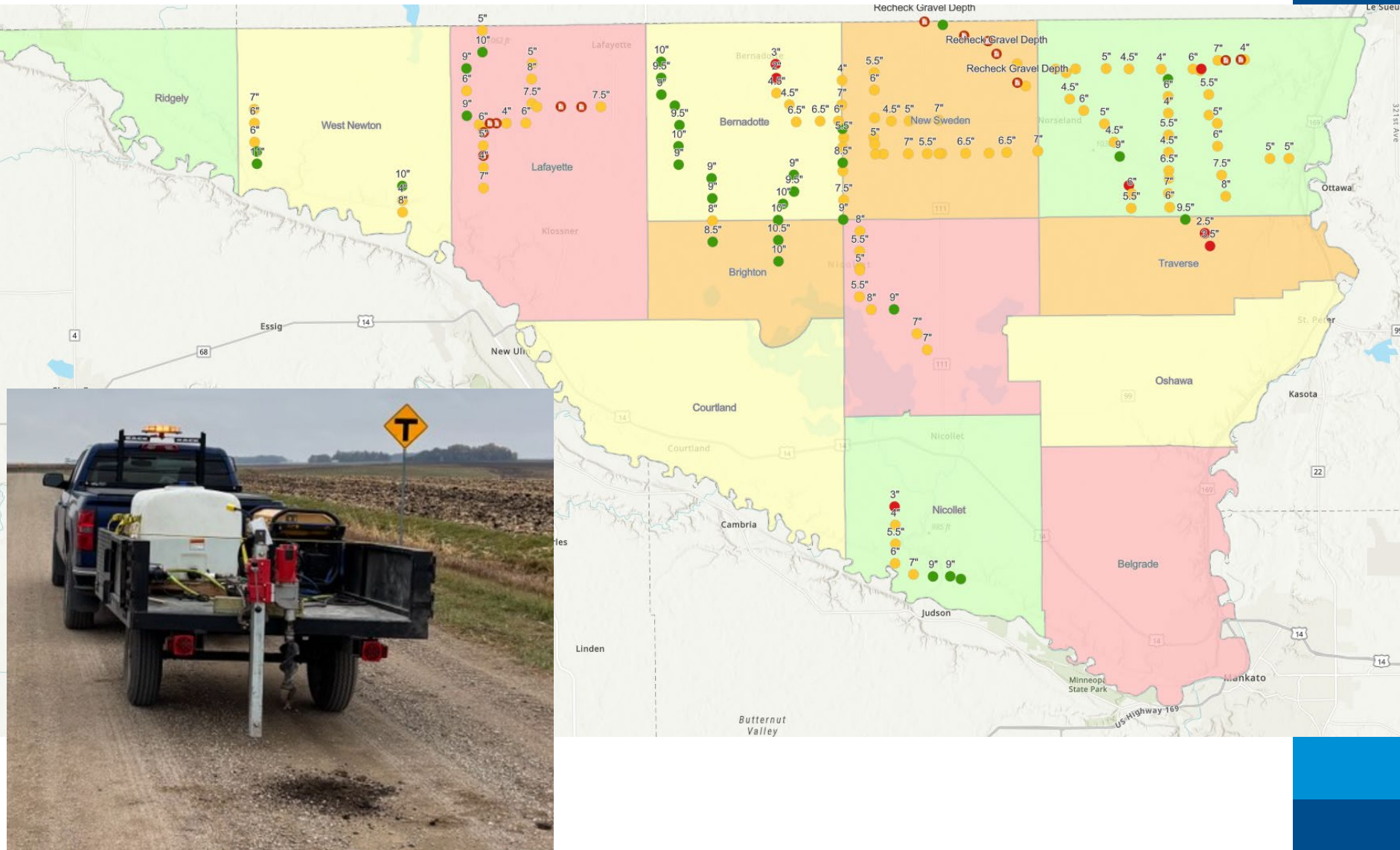
Use recycled blacktop for base

CULVERTS

Pitrun under and on the sides of the culverts

Use salvaged material on top of the culvert so it's the same as the rest of the road

2025/2026 Gravel Depth 4"-8"





Projects:

1. 2025 Roadside Mowing and Vegetation Management (SRF Consulting, Sue Miller)
2. 2025 Fleet Life Cycle (Iowa State University, Jennifer Shane)
3. 2025 Cutting Edges Study (SRF)
4. 2025 Gravel Road and Shoulder Maintenance (Stonebrooke Engineering, John Brunkorst)
5. 2026 Effect of using RAP on Gravel Roads (Iowa State University)
6. 2026 Law Resources for County Engineers (SRF)
7. 2026 Sign Management (SRF)
8. 2027 Comprehending Surface Gravel Testing (Pie Chart/Calculator) Pending



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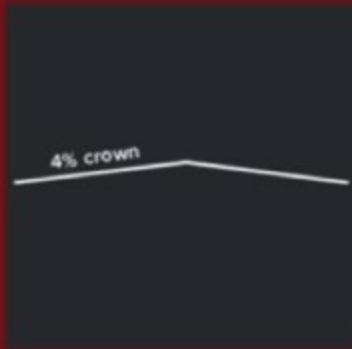
1. Gravel Roads Shop Talk
2. On-Line Training Module
3. Mouse Trap (Smart Transformation Award)
4. OPERA (Local Operational Research Assistance Program) Grant



AI On-Line Training Modules

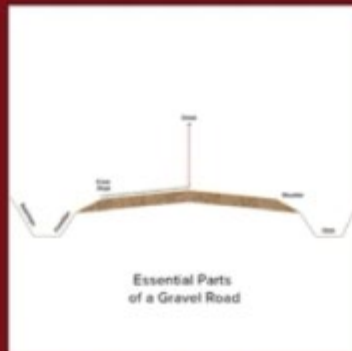
Objectives

The Properly Shaped Gravel Road



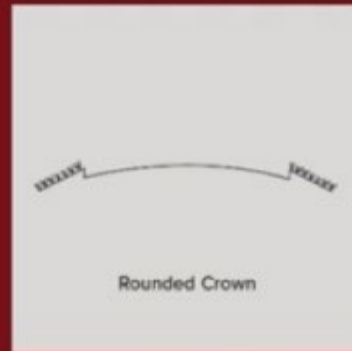
Cross-Slope

Identify the proper cross-slope and shape of a road crown.



Drainage Anatomy

Identify the parts of the roadway that handle drainage.



Common Issues

Recognize common problems such as a flat road, a high shoulder, or a rounded crown.



Different Shapes

Name four areas that need a different shape other than the normal crown.


MINNESOTA LTAP
UNIVERSITY OF MINNESOTA

Minnesota Local Technical Assistance Program (LTAP)



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Thank you!

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Michael Suska

Assistant Public Works Director – M&O
Nicollet County Public Works

Minnesota State
University MANKATO

Nicollet County Gravel Team:

Nicollet County Public Works Director: Seth Greenwood P.E.

Public Works Accountant: Thomas Goblirsch

Supervisor: Devron Havemeier

Blade Operators: Kyle Peterson, Matt Bode, Matt Mickelson

Other Team Members: Todd Meyer, Dean Enter,

Don Wolfe, John Bethke, Mat Hackett

Seth Greenwood, P.E.

Public Works Director/County Engineer

Nicollet County Public Works



Mission Statement

Providing efficient services with innovation and accountability.

Vision Statement

Setting the standard for providing superior and efficient county government services through leadership, accountability and innovation to a growing and diverse society.



Devron Havemeier

Highway Maintenance Supervisor

Nicollet County Public Works