Gravel Basics

2022 NDACE County Roads Conference

January 26, 2022 Pre-conference on Gravel Roads

Steve Monlux

LVR Consultants LLC

Missoula MT

406-544-1919

stevemonlux@gmail.com

Topics

- Gravel Performance and Costs
- Performance Problems & Solutions
- Gravel Specifications
- Gravel Pit Investigation & Drawings
- Gravel Placement and Maintenance
- Summary of Primary Points

Gravel Performance on Arterials (100 + vehicles/day)

Performance	Desired	Typical
Road Surface	High speed, good ride	Moderate speed, rough ride (Potholes, Loose Rock)
Safety (Skid Resistance, Dust	Good skid resistance & little dust	Poor skid resistance, very dusty
Blade Jobs per Year	2	10

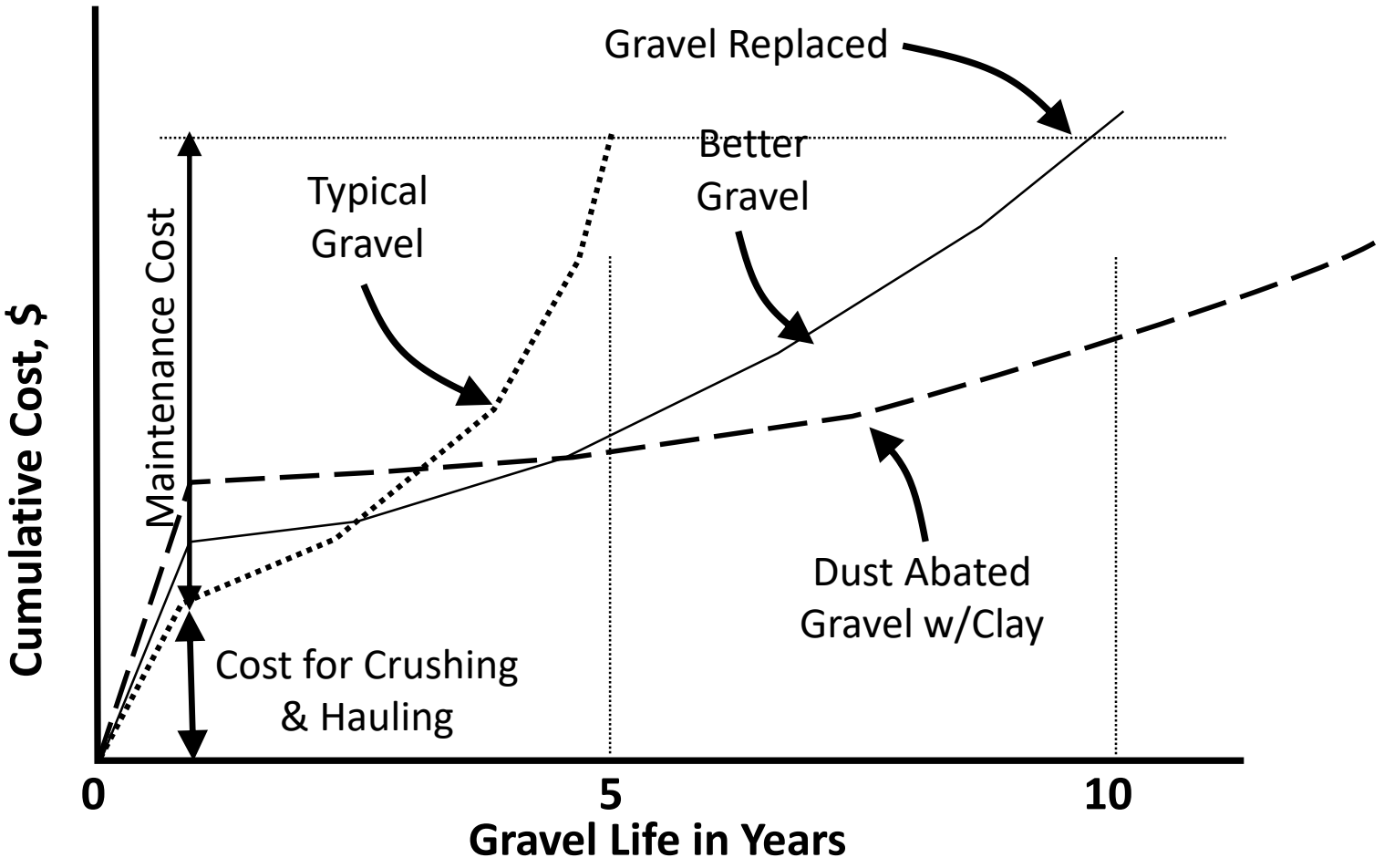
Gravel Costs – Initial, Cumulative & Life Cycle

Cost	Desired	Typical
Initial Cost (Crush,Haul)	Low*	Low*
Annual Mtc Cost (Blading & Dust Abatement)	Low	high
Cumulative (Life Cycle) Cost	Low	Moderate
Life	10	5
Annual Costs	Low	High

* Low Initial Cost normally causes high Life Cycle Costs

Cumulative Cost/Life in Years = Annual Cost

Google: NDSU Local Road Surfacing Selection Tool



Primary Factors Affecting Gravel Life

Factors We Can Control

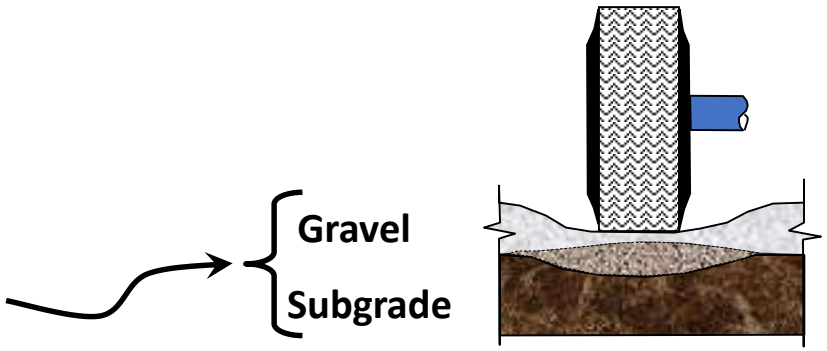
- Gravel: Gradation, % Fracture, Clay Content, Compaction,
- Dust loss: Shortens gravel life
- Maintenance: Blading methods, % crown, dust control, snow removal
- Drainage: Surface & Subsurface

Factors We Can <u>Not</u> Control

- Traffic: Speed, Amount & Type
- Road grades and curvature

Crown

Gravel layers mix with weak subgrade soils

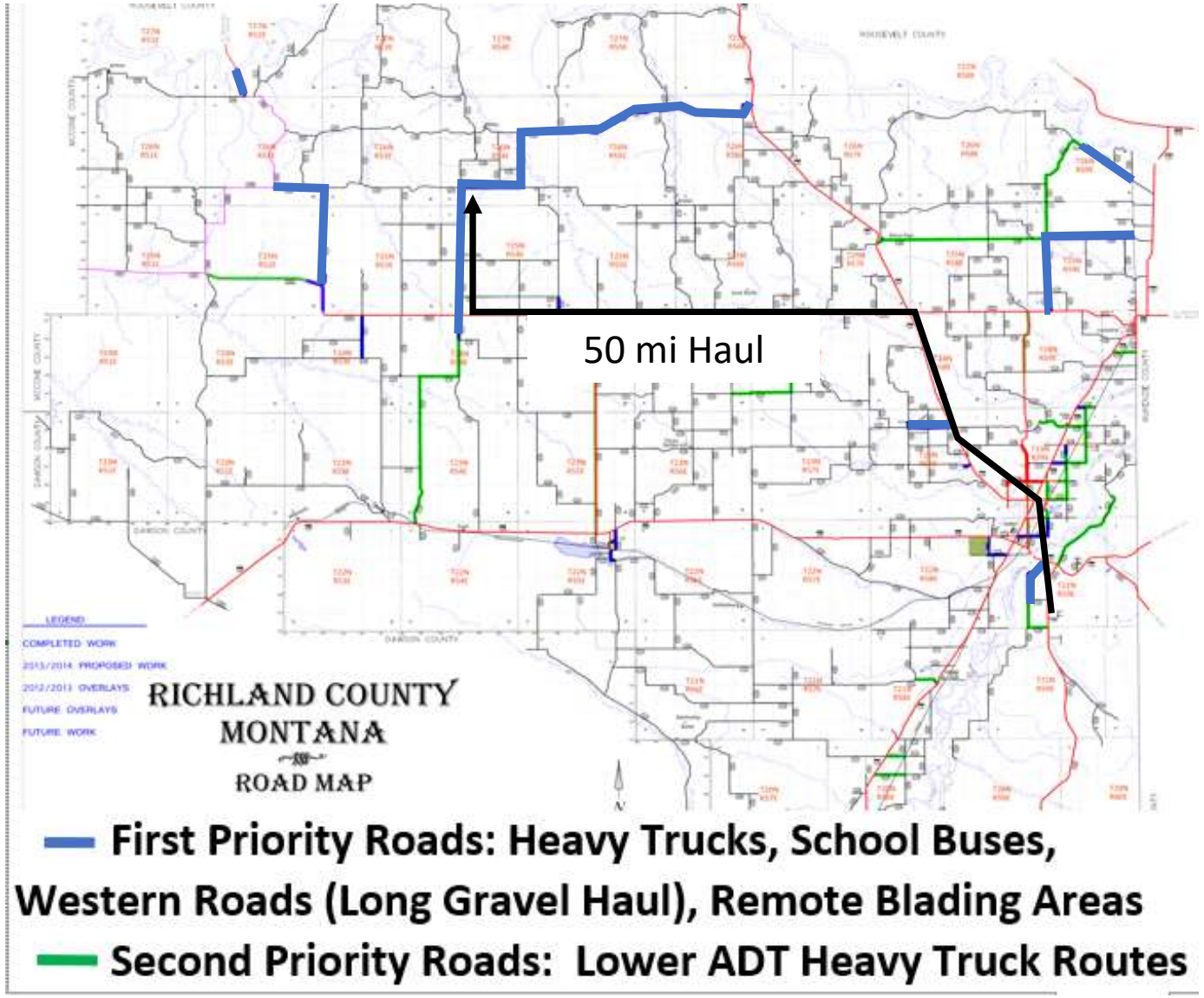


Best Locations for High Quality, Expensive Gravel

Greatest return on investment is on Heavy Truck routes

Why?

Greatest gravel replacement



Performance Problems and Solutions

Problems

- Wash Boarding
- Float (Raveling)
- Dusting
- Gravel Loss

Typical Solutions

Good Gradation

Add Clay – better road crust

Dust Abatement

- Rutting →
- Potholing →

Washboarding

Float (Raveling)

Large **vs** Small top size
Strength **vs** Resistance to Raveling (Float)

Solutions
Better gradation – smaller top size, higher fracture
Add clay – better road crust

Note: Rebuild crown and check gravel thickness before adding clay – some gravel is too worn out for this option to work well.

Dusting

Solutions
Chloride treatment
Better gradation
Add clay – better road crust

Note: Rebuild crown and check gravel thickness before adding clay – some gravel is too worn out for this option to work well

Rutting

1.7% Crown

Solutions

Less clay

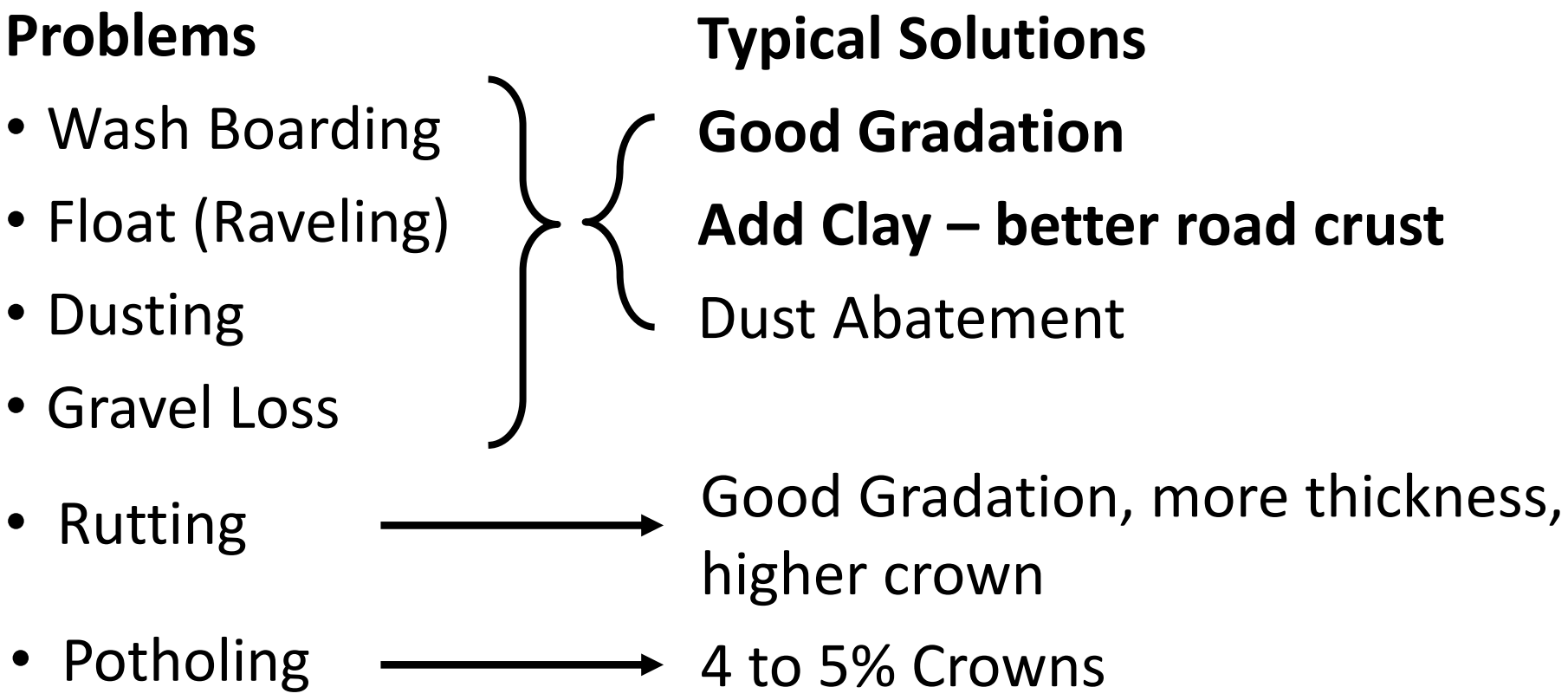
Higher crown

Increase gravel thickness

Potholing

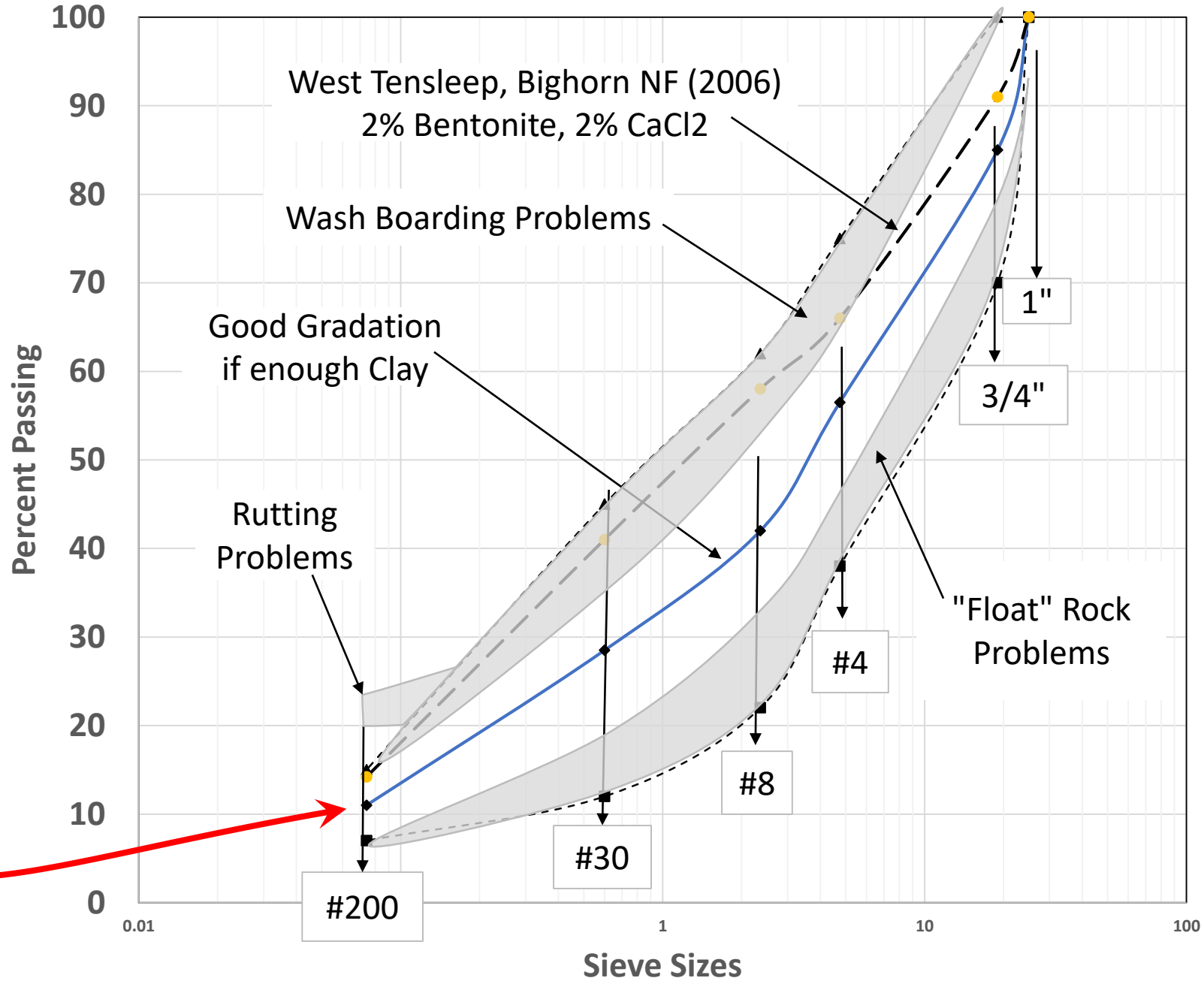
Solution
4 to 5% crown

Problem and Solution Summary



714 & SSP 6 Gravel Gradation Limits

Std Sieve	Limits		Spec Center
	Low	High	
1	100	100	100.0
3/4"	70	100	85.0
#4	38	75	56.5
#8	22	62	42.0
#30	12	45	28.5
#200	7	15	11.0



Gradation Rating Exercise

Too Much Rock. Problems?

Raveling or Float

Good Gravel Surfacing Gradation. Problems?

Best Performance if enough clay

Wash Boarding

Too Much Sand. Problems?

Specification & Contract Options to Consider

- Tighten gradation limits where realistic for specific pits
- Index Minus #200 to PI

% Passing #200	8 to 14	12 to 18
Plasticity Index	6 to 10	3 to 7

- If designated pit does not have clay for plasticity, use optional bid items for both of the following
  - Meet PI specs using clay from private sources
  - Add 2% bentonite to the crushed gravel by bin feeder and conveyor belt

- Include statement on Pit Plan Drawings: "Other private sources of gravel or clay additive may be used provided the gravel is stockpiled in the provided pit".

Additional Spec Options For Stockpile Contracts

- **Sampling & Testing:** Daily Acceptance Sample tested by Certified Lab (See Next Slide)
- **Payment:** Use Average Test Results and Simple Pay Adjustment System with 5% Bonus
- **Measurement:** Pay by Drone measure of Cubic Yards in Stockpile – 90 to 110% of specified

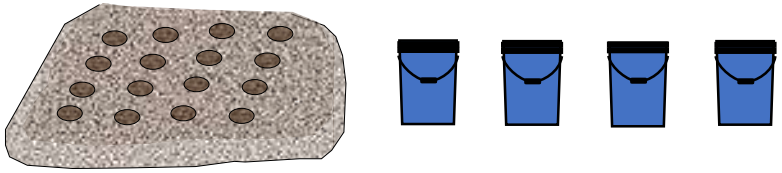
Best Practices for Sampling & Testing
(AASHTO T2 or ASTM D75)

- Take full loader bucket samples every two hours

- Form a sampling stockpile throughout day

- Back drag stockpile to flatten

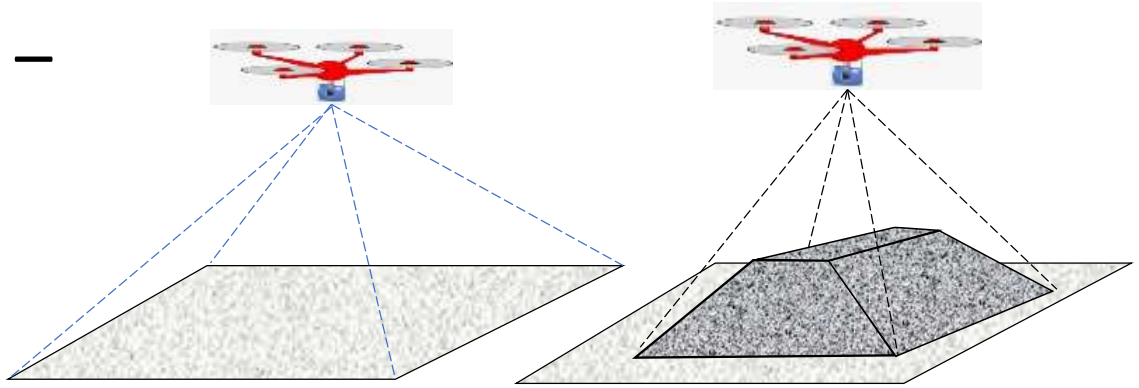
- Take two composite samples at the end of each day - minimum of 140 lbs. for 1” minus



- Fill at least two 5 gallon buckets from the same locations – Contractor tests half the sample, Engineer tests the other half for acceptance testing
- Follow AASHTO T2 or ASTM D75 Procedure

Quantity Assurance

- Cubic Yards for Stockpile Contracts – measured by drone
- Agency pays for two surveys:
  - Stockpile floor
  - Stockpile

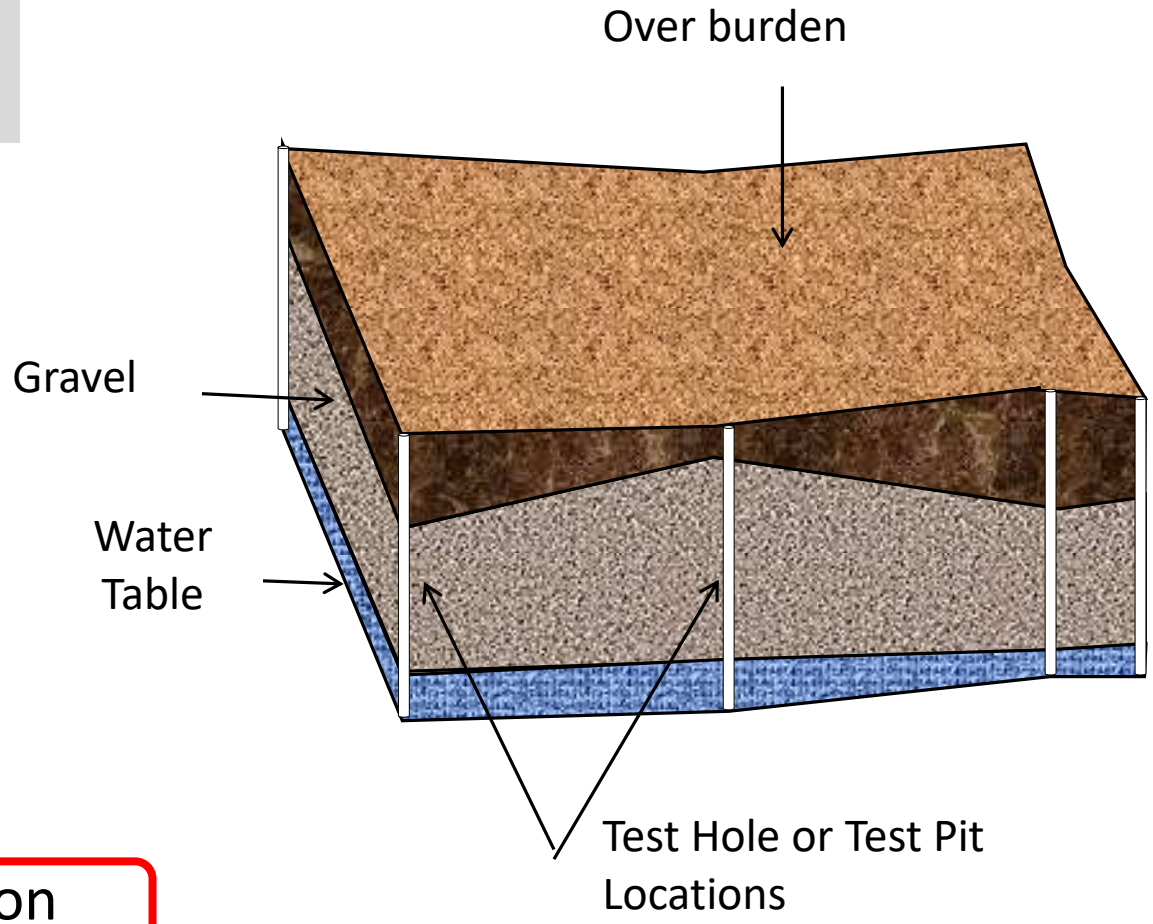


- If quantity less than 95% of specified, Contractor crushes more gravel and pays for final survey
- Pay on actual cubic yards in stockpile between 95% and 105% of specified quantity

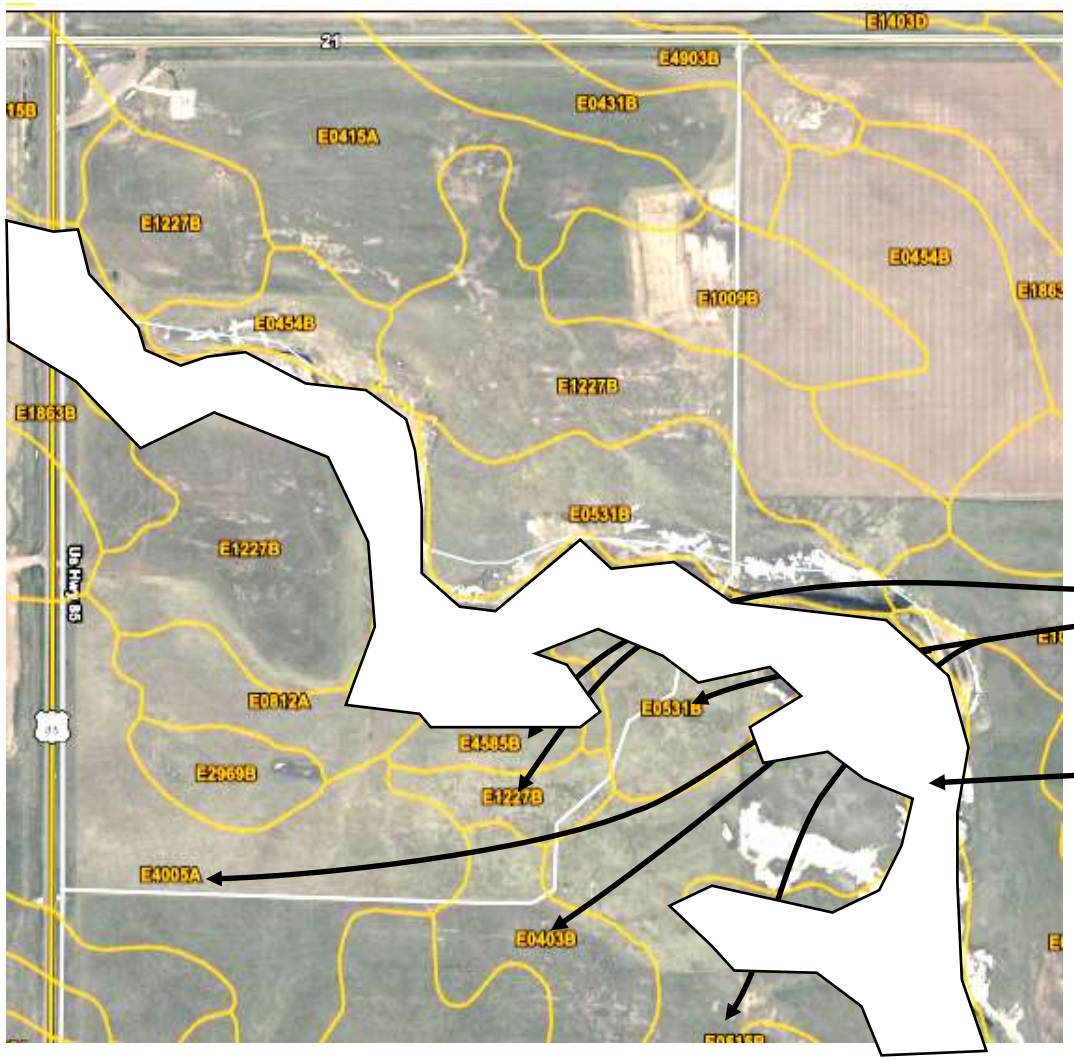
Gravel Pit Investigation

- Purpose –> Reduce Costs
- Objectives for Both Existing & New Pits
  - Determine Layer Depths
  - Determine/Confirm Quantity & Quality
- Location of New Pits
  - NRCS WSS and Vegetation on Google Earth Image
  - Road cut slopes

Quality
- Gradation
- Clay Content
- Hardness
- Durability



NRCS Web Soil Survey (Slope Co & Knife River)

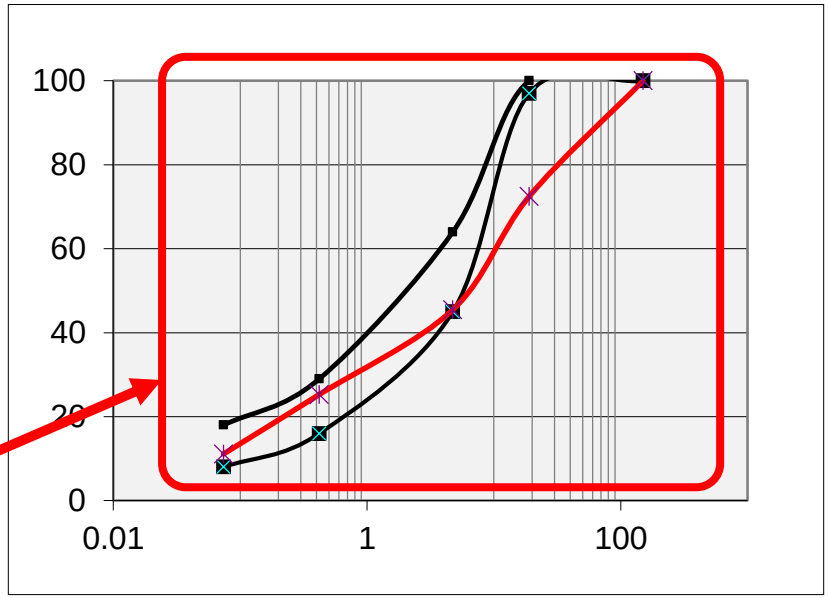


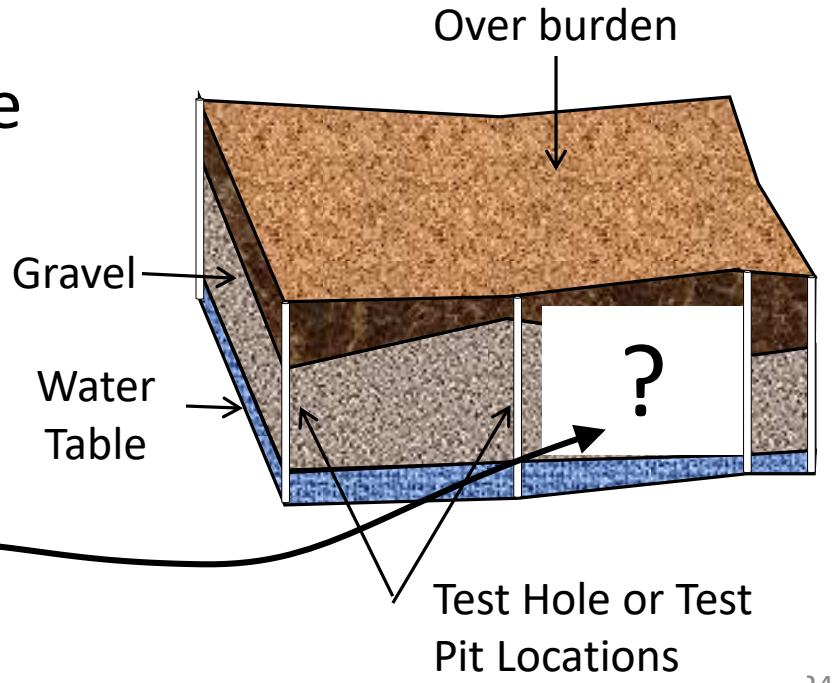
Sieve Sizes	
Spec	WSS
1"	1"
3/4"	3/4"
#4	#4
#8	#10
#30	#40
#200	#200
PI	
Depth, Inches	

If you have to reject sand to get in spec, add overburden with high minus #200 and PI to reduce costs

Gravel Pit Drawings

- Mine boundaries, backslope ratios etc.
- Overburden and gravel layer depths, etc
- Test pit locations and depths, pit run gradations, plasticity index test data, old crusher contract test results, etc
- Precautions: meeting specs may require more crushing/screening equipment, selective mining, importing gravel or clay from private sources, etc
- Disclaimer – Quality and amount of gravel between test pits is not known

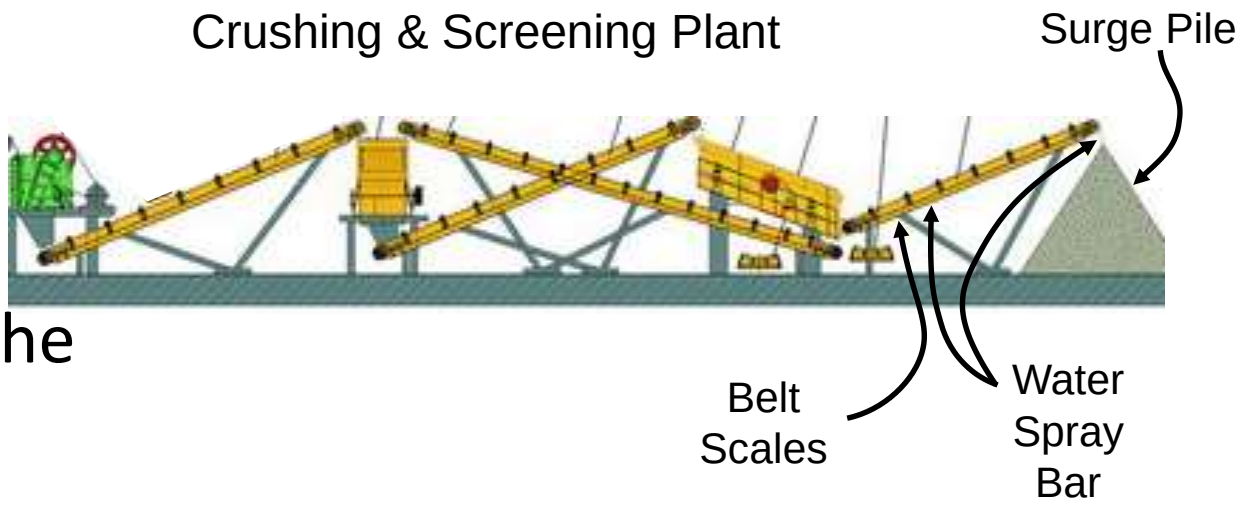




Gravel Placement and Maintenance

- Water is Critical
- Spreading and Processing
- Crown Building
- Compaction
- Making Road Surface Crust

Water is Critical



- Best Location to Add Water – On the Crusher Pay Belt
- Less segregation in stockpile
- Less evaporation and water haul than when applied to road
- Less segregation during blade processing, less blade processing →
  - Better compaction, less rolling
  - Longer lasting crown

Higher Crown Benefits

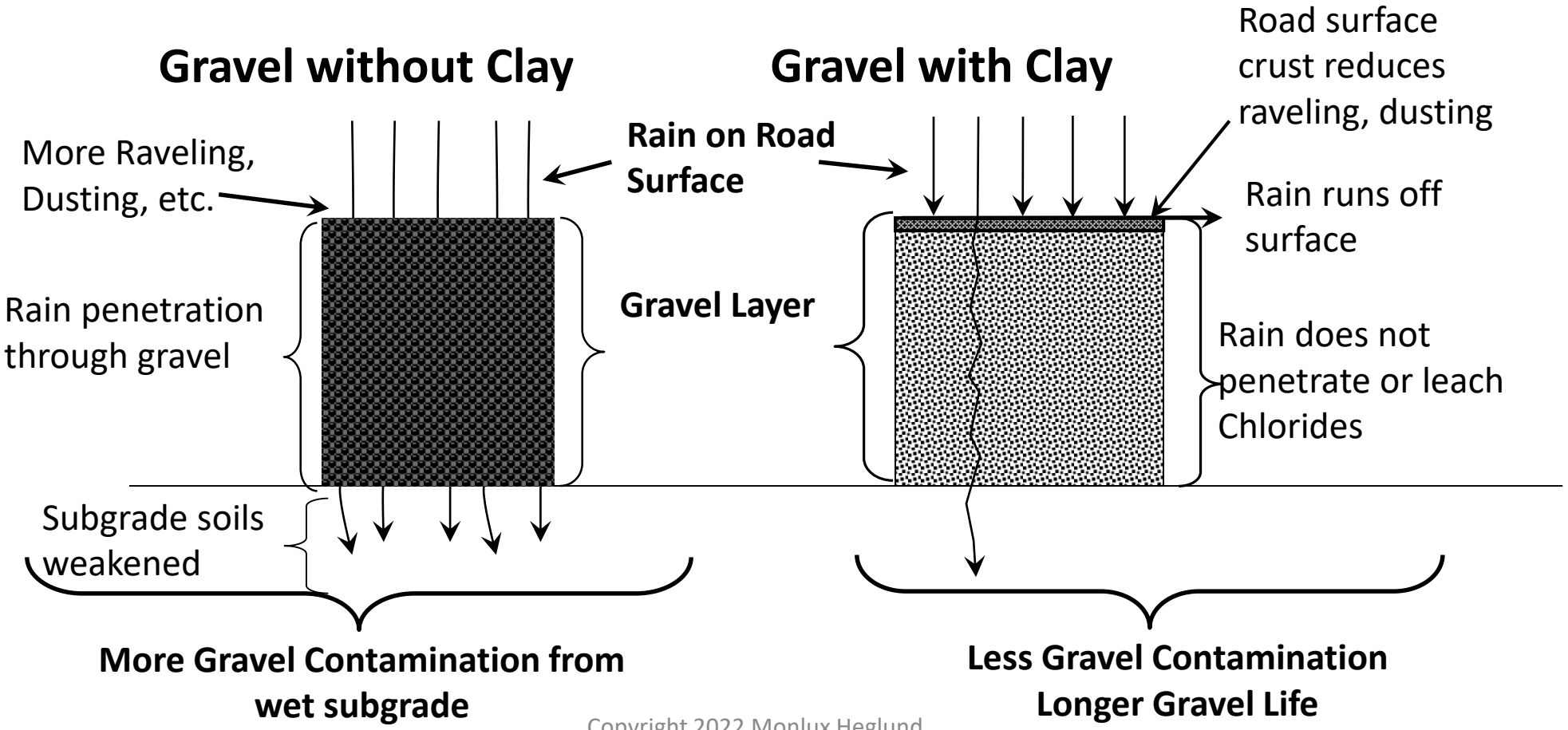
- Reduces pothole formation
- Reduces blading
- Lowers traffic speed which reduces accidents, lowers gravel loss rate
- Lowers complaints (potholes, washboards, loose rock)

Road Surface Maintenance

- 4% to 5% Crown to Reduce Blading
- Use Water while Blading to help the following:
  - Control segregation
  - Increase density
  - Develop hard road crust
- Extend Gravel Life by the following:
  - Add clay to gravel → One time initial cost – good buy!
  - Chloride dust abatement → If Clay in Gravel, annual chloride cost can be offset by reduced gravel loss on high traffic roads

Clay Road Crust

- Clay fills voids in gravel, forms road crust, sheds rain, retains chloride, etc.
- Chloride increases clay life by reducing dust



Road Crust Rebuilding Process

- Blade after rains if possible
- Cut out defects, mix gravel, rebuild 4% crown
- Add water if not wet enough to compact
- Compact gravel layer
- After compaction is complete,
  - Lightly water surface,
  - Increase roller speed to pump fines to the surface.
- Use 10 mph sign to reduce pickup on vehicles

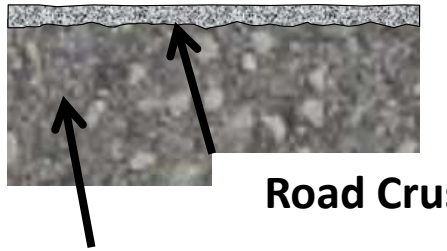
Building a Good Road Crust after Compaction

Wet road surface full width – try to limit runoff on shoulders

Stark Co ND

Lethbridge Co AB

Rolling “pumps” fines to surface & forms hard road crust when dry



Road Crust

Compacted Gravel

Good Road Crust

West Tensleep Road
Bighorn NF, Wyoming - 2006

Summary of Primary Points

- Better quality gravel can lower long term costs
- Clay binder improves gravel performance.
- Testing for Clay is critical
- Sampling and Testing is cheap insurance
- Consider spec options that have worked well for others
- Good blading practices increase gravel life
- There are many ways to add clay while crushing, to existing stockpiles and to gravel already on the road

Summary Continued

Lower Cost/CY by:

- Investigate gravel and overburden sources, pick realistic spec limits
- Get contractor feedback on spec before advertisement
- Allow two-year crushing option

Lower Annual Costs (Life Cycle Costs) by:

- Tighter gradation & PI specs
- Require PI and Tie PI to minus #200 in specs
- Test good and bad performing gravel to improve spec limits

Try something new on small scale and share results with others

Thank You!

- Questions
- Comments

Dawson County Montana