Tech Brief:

Using All Terrain Vehicles (ATVs) to Control Dust on Rural and Remote Community Roads

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SI* (MODERN METRIC) CONVERSION FACTORS				
APPROXIMATE CONVERSIONS TO SI UNITS				
Symbol	**When You Know**	**Multiply By**	**To Find**	**Symbol**
		LENGTH		
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
		AREA		
in^2	square inches	645.2	square millimeters	mm^2
ft^2	square feet	0.093	square meters	m^2
yd^2	square yard	0.836	square meters	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	square kilometers	km^2
		VOLUME		
fl oz	fluid ounces	29.57	milliliters	mL L
gal ft^3	gallons	3.785	liters	m^3
yd^3	cubic feet	0.028	cubic meters	m^3
	cubic yards	0.765	cubic meters NOTE:	
	volumes greater than 1000 L shall be shown in m^3			
		MASS		
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
		TEMPERATURE (exact degrees)		
^oF	Fahrenheit	5 (F-32)/9 32)/1.8	Celsius or (F-	^oC
		ILLUMINATION		
fc fl	foot-candles	10.76	lux	lx
	foot-Lamberts	3.426	candela/m^2	cd/m^2
		FORCE and PRESSURE or STRESS		
lbf	poundforce	4.45	newtons	N
lbf/in^2	poundforce per square inch	6.89	kilopascals	kPa
APPROXIMATE CONVERSIONS FROM SI UNITS				
Symbol	**When You Know**	**Multiply By**	**To Find**	**Symbol**
		LENGTH		
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
		AREA		
mm^2	square millimeters	0.0016	square inches	in^2
m^2	square meters	10.764	square feet	ft^2
m^2	square meters	1.195	square yards	yd^2
ha	hectares	2.47	acres	ac
km^2	square kilometers	0.386	square miles	mi^2
		VOLUME		
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	cubic meters	35.314	cubic feet	ft^3
m^3	cubic meters	1.307	cubic yards	yd^3
		MASS		
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg (or "t")	megagrams (or "metric ton")	1.103	short tons (2000 lb)	T
		TEMPERATURE (exact degrees)		
^oC	Celsius	1.8C+32	Fahrenheit	^oF
		ILLUMINATION		
lx	lux	0.0929	foot-candles	fc fl
cd/m^2	candela/m^2	0.2919	foot-Lamberts	
		FORCE and PRESSURE or STRESS		
N	newtons	0.225	poundforce	lbf
kPa	kilopascals	0.145	poundforce per square inch	lbf/in^2

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The Challenge

Many of Alaska's rural and remote communities experience the problem of vehicle-generated road dust on their unpaved dirt and gravel roads. These airborne particles can cause problems including visible irritation, driver safety hazards, contamination of adjacent residences and food (such as drying meat), and respiratory health issues attributed to consistently breathing the unclean air.

The agencies that own Alaska's transportation system have a high percentage of unpaved roadways. Overall, according to its 2019 Certified Public Road Mileage (http://dot.alaska.gov/stwdplng/transdata/pub/2019_CPRM_Final.pdf), Alaska has a road network of 17,735 miles, of which 11,516 miles, or 65 percent, are unpaved. The National Park Service, the U.S. Forest Service, the U.S. Fish and Wildlife Service, the Bureau of Land Management, and the U.S. Army Corps of Engineers collectively own 2,616 miles of these roads, of which 856 miles, or 33 percent, are unpaved. The Alaskan boroughs, municipalities, and other local agencies own 6,967 miles of these roads, of which 5,104 miles, or 73 percent, are unpaved. But, primarily, those most impacted by road dust are the majority of the 138,300 Indigenous people living in tribal communities in Alaska. These communities own 2,314 miles of roads, of which 2,272 miles, or 98 percent, are unpaved.

The Alaskan road network is not a completely interconnected system, and numerous areas are not readily accessible by driving. For instance, in many of the rural and remote 229 Alaskan Native Villages, the roadway lengths are limited to serving only the local community. Vehicles and other supplies must be brought in by boat, barge, snowmobile, air, or ice road. Often the most popular and economical mode of transportation is the all-terrain vehicle (ATV). Unfortunately, the ATV's open operation also exposes drivers to dust generated by other vehicles.

In order to improve quality of life, there is a need to reduce, mitigate, and control the levels of dust produced by these unpaved roads. Traditionally this has been accomplished by the application of a dust-control product, or palliative, to the surface of the road. This traditional method is difficult for Alaska's rural and remote communities to use because of a lack of resources and access.

EXECUTIVE SUMMARY

Innovation

Using an ATV, a flat-bed trailer, and a pressurized spray bar, a simple method to reduce road dust is now available for use by rural and remote communities. With an ATV pulling a trailer-mounted tote filled with a dust palliative, the material is then easily sprayed from the back of the trailer onto a prepared unpaved roadway surface.

Key Results

- Safer, dust-free roads
- Better quality of life

Potential Impact

Communities benefit by managing a cost-effective program to set their own treatment schedules, employ their own people, use their own equipment, and invest locally.

Due to limited accessibility and high transportation costs, paying for dust palliatives already formulated as predominantly liquid or water-based products is cost-prohibitive for many communities. This leaves a reduced number of dust control products to select from that are formulated as solid pellets, flakes, powders, viscous, or liquid concentrates, most of which can be mixed with water readily available at the community. However, when selecting an optimal dust control product, an understanding is needed of its dust mitigation effectiveness on the existing roadway material. For the same economic reasons, traditional dust treatment processes that require the setup and maintenance of work zone traffic control, and the use of a road grader, water truck, dump truck, flatbed truck, dust product distribution truck, vibratory roller compactor, and/or pneumatic roller compactor are even more cost prohibitive.

A more practicable, affordable, timely, and innovative system that uses less and lighter-weight equipment is needed to maintain dust control on rural and remote unsurfaced roads.

The Solution

Lightweight vehicles, equipment, and materials can be easily transported via aircraft to short gravel air strips to deliver a dust control program for rural and remote communities. The final setup comprises an ATV that tows an articulated trailer capable of hauling a full 2,500-pound tote along with a compact, portable sprayer system. One or two people can operate this arrangement to spread a dust-control product and significantly reduce the airborne suspension of dust particles, thereby improving the health and safety of the community. But to get there takes several steps: Planning, Procuring, Placing, and Preservation.

Planning

Community leaders must acknowledge that dust from their unsurfaced roads is a problem, and then commit to funding a solution. With an initial budget in place, the first two tasks are to identify the extent of the dust issue, and to select which roadway segments to treat.

A PROJECT'S 3 MS

Machinery

- ATV: 6x6, or heavier 4x4, with tow hitch
- Trailer: preferably articulated
- Spray bar assembly
- Pump and generator

Materials

- Loader: forklift, backhoe, or skid steer
- Blade: road grader or tractor mounted
- Compactor: smooth drum or rubber tire
- Roadway soil samples to analyze
- Dust palliative: in tubs, totes, bags, or bottles
- Water
- Fuel

Manpower

- Superintendent/Foreman
- Equipment operators
- Laborers
- Dust product supplier's representative

While not critical, current dust levels can be measured prior to applying a dust palliative by using roadside monitoring equipment. The monitoring equipment should be placed near roadways that impact the community the most. The locations should be chosen for monitoring because of a significant existing dust problem or because they are near places where people gather, such as homes, clinics, or schools.

Once dust levels have been measured and documented, the desired family of dust suppressant should be selected using Table 3 of the U.S. Forest Service's Dust Palliative Selection and Application Guide. Information needed for this decision includes the local climate, volume of traffic, and the roadway material's Plasticity Index and minus #200. Note that the budget should provide for the sampling, laboratory testing, and classification of the roadway material planned for treatment.

The main categories of dust suppressants are water, salt-based products, petroleum-based products, organic non-petroleum-based products, electrochemical products, polymer products, synthetic fluids, enzymes, and clay additive products. However, as mentioned above, the cost-effective options will most likely be the solid pellets, flakes, powders, viscous, or liquid concentrates. Table 1 of the U.S. Forest Service's Dust Palliative Selection and Application Guide will show application rates from which the volume of dust-control product needed can be calculated.

Also, planning for the building, buying, or borrowing of the product distribution equipment is key. Needed equipment includes an ATV, an articulated flatbed trailer, a generator, a pump and regulator, a spray bar with nozzles, and various pipes, hoses, and connections.

PULLING A PROJECT OFF

Planning

- Identify the level of the dust problem
- Commit to addressing the dust problem
- Pick a dust product
- Select the equipment

Procuring

- Do your research
- Solicit and select a supplier for material and equipment

Placing

- Assemble and calibrate the equipment
- Prepare, treat, and compact the road

Preservation

- Restore the roadway condition
- Reapply the dust control product

Procuring

At this point, the next steps are to conduct market research to find suppliers for the needed equipment and the selected product: Do an internet search, talk to vendors, and solicit details from other communities who have "gone before." Identify and establish sources of supply, means of transport, costs, and delivery schedules. Then solicit your requirements in an acquisition package that defines material specifications, quantities, and delivery schedule.

Placing

When the ATV, trailer, and equipment components are fully assembled and connected for the first time, calibration runs that spray just water are needed. This establishes the combination of ATV speed and spray bar flow that produces the product's desired application rate. If an empty tote is unavailable, calibrate using one filled with the dust control product. For first-time applications, having someone on site with previous experience, such as the dust product's representative, is recommended.

Place the product on a regraded and smoothed roadway surface with its 4 percent to 6 percent crown reestablished. Then finish the surface with a roller compactor.

Preservation

After a time, the effectiveness of the dust control product diminishes or even goes away because washboards and potholes form as the crown flattens out, and the roads lose their stability. When this happens, it is time to regrade and restore the road, and reapply the dust control product. Based on the manufacturer's recommendations, the dust palliative can be applied either at the original application rate, or at a reduced rate due to a residual amount remaining in the roadway material.

RUBY'S PROJECT COSTS

Machinery: $40,000

- ATV
- Trailer
- Spray bar
- Pump and generator
- Skid steer with forks and smooth drum
- Road grader

Materials: $130,000

- Soil samples
- 12 totes of dust-control product
- Fuel

Manpower: $15,000

- Foreman
- Operators
- Laborers

Shipping and Transport: $15,000

- Equipment
- Dust control product

Total Estimated Cost

- $200,000

The Journey

The Native Village of Ruby, Alaska was selected as the pilot site for this project to solve the inaccessibility problem of transporting conventional construction equipment. Ruby is a typical remote Alaskan village with dust issues due to its gravel and earthen roads. Its roads are not connected to the State highway system and the village is dependent upon river barge and air service for transportation of people, goods, and services. Therefore, Ruby was an ideal site to demonstrate the use of lightweight equipment for dust palliative application, delivered by a DC-6 aircraft landing on a 5,000-foot-long gravel runway. Figure 1 shows the unloading of the equipment and 12 totes of dust control product totaling 29,000 pounds. To be clear, this Technical Brief only demonstrates the use of lightweight equipment to distribute a dust palliative. It is not a documentation of the effectiveness of the dust control product selected by the University of Alaska Fairbanks.

Figure 1. Skid steer unloading equipment and supplies from the aircraft. Source: Native Village of Ruby

Figure 2. ATV hooked up to a trailer loaded with a tote. Source: Native Village of Ruby

The following equipment was identified as shown in Figure 2 to complete the demonstration: Cam Am 1000cc 6x6 ATV as the towing vehicle; articulating trailer as the platform for the sprayer and palliative; electric pump for the sprayer, hoses, and application nozzle bar; electric generator as the power source for sprayer; and 12 one-ton totes of liquid synthetic fluid palliative.

A lightweight portable sprayer was delivered to the village by aircraft. There are many of these sprayers on the market, and they can be assembled easily and relatively quickly with push-connectors. The sprayer was assembled and attached to the back of the trailer at a 90-degree angle behind the tote containing the palliative as Figure 3 shows. Before applying the palliative as shown in Figure 4, workers regraded and compacted the road with a 4 percent crown or cross-slope. This reestablished its proper shape for surface drainage. To ensure the fluid readily penetrated the surface course, the crew used a motor grader to tightly blade the surface by rolling the blade all the way forward and applying light downward pressure to roughen the surface.

Figure 3. Spray bar applying the dust control product. Source: Native Village of Ruby

Figure 4. Application of the dust control product onto a prepared roadway surface. Source: Native Village of Ruby

The Results

Once the blading was complete, workers applied the dust palliative in four passes over a 2-day period. Based on laboratory tests, the target application rate was 40 ft2/gallon. The sprayer used can apply about 8 gallons/minute to the roadway. This means that four passes of the sprayer pulled by the ATV at a slow walking pace of 1.5 miles per hour are required to achieve a total application rate of 1 gallon/40 ft2. At 300 gallons each, the 12 totes treated about 1.4 miles of a 20-foot-wide roadway.

The lighter application over an extended period allowed traffic to pass over the roadway with minimal pickup. This helped with traffic coordination, since alternate routes weren't available. The dust palliative was applied to first one lane and then the other to cover the entire roadway. Two similar yet slightly different dust-control products were provided. The first roadway section and side road approaches were treated with one product, and then the next roadway section was treated using the second product.

After the last pass of the sprayer, and after the palliative had completely penetrated, the crew used a roller attachment on a skid steer tractor to compact the roadways, as shown in Figure 5.

This demonstration showed that rural and remote communities can successfully use lightweight equipment to apply dust-control products by spraying the product onto the roadway surface from a tote on the back of an articulated trailer pulled by an ATV.

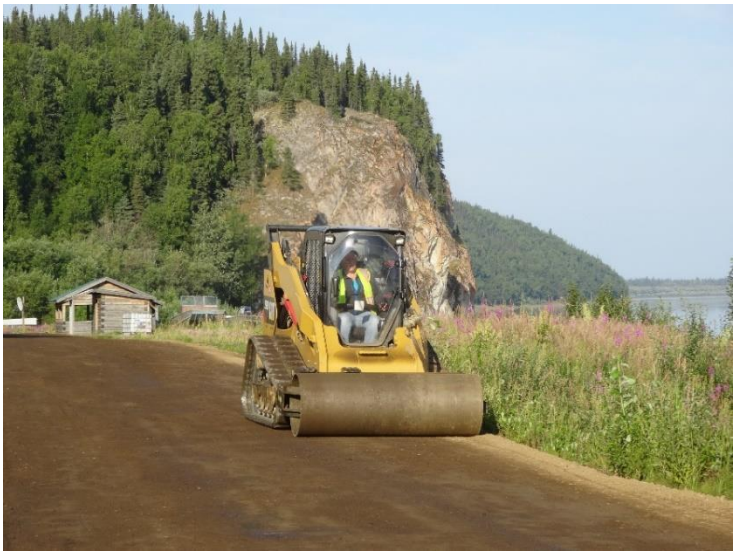

Figure 5. Compacting the finished roadway with a skid steer-mounted roller. Source: Native Village of Ruby

The Q and A

Question: How much funding should I budget for to start my own dust control program?

Answer: Unfortunately, there is no single answer to this question as your costs will vary depending upon your location, equipment needs, selected dust palliative, and roadway treatment length. While your experience may be different, the Native Village of Ruby pilot cost approximately $200,000, excluding the cost of dust monitoring.

Question: How often should I plan on maintaining and re-treating my roadway sections?

Answer: Again, there is no single answer, as this depends upon your selected dust control product, its application rate, traffic volume, weather, and user requests.

Question: Can I borrow rather than buy the recommended equipment?

Answer: Yes, that is an affordable option if you can reach an agreement with another agency who is willing to loan you the equipment.

Question: Our ATV is smaller than the one used in this pilot program. Will it still work?

Answer: It may, depending upon how level your roads are, and your willingness to pull partially full loads on your steep roads. Just be responsible and adhere to the ATV manufacturer's load ratings.

The Wrap-Up

To help other communities anticipate problems and better plan for solutions, here is how the Native Village of Ruby addressed several issues they encountered.

Handling the Problems

***Problem*:** Steep sections in the roadway.

***Solution*:** To avoid excess weight either pushing or dragging the equipment train, workers applied dust palliative on these sections only after the totes were half-full or less.

***Problem*:** Lack of fines in the borrow material.

***Solution*:** This issue of inadequate binder was a primary reason Ruby selected a synthetic fluid dust palliative, which is capable of binding together and controlling dust from open graded roadway materials.

***Problem*:** Rain following completion of the application.

***Solution*:** The crew restricted traffic from traveling on the saturated treated roadway material until it dried out enough so that the roller could compact it.

***Problem*:** "Track on" of dusty material from side streets.

***Solution*:** The project included approach roads, which were treated for a distance of about 50 feet.

***Problem*:** Ripping of the surface at intersections (turning of wheels).

***Solution*:** The crew restricted traffic from traveling on the treated and compacted roadway material until it cured. If a vehicle needed to make a turn through an intersection, workers requested that the driver go slowly and corner as widely as possible.

Lessons Learned

Since shipping of palliative, equipment, and supplies accounts for a high fraction of the overall cost, communities planning synthetic fluid palliative dust management programs should compare shipping costs.

Controlling vehicle speed and aggressive driving results in gains in palliative performance and longevity.

RELATED REPORTS

Dust Palliative Selection and Application Guide

- United States Forest Service
- https://www.fs.fed.us/eng/pubs/html/99771207/99771207.html

Ruby Road Dust PM10 Monitoring, 2015-2016, Ruby, Alaska

- State of Alaska Department of Environmental Conservation
- https://dec.alaska.gov/media/7466/ruby-road-dust-air-quality-monitoring-2015-2016-report-adec.pdf

Guidelines for the Use of Synthetic Fluid Dust Control Palliatives on Unpaved Roads

- University of Alaska Fairbanks
- https://www.researchgate.net/publication/326065375_Guidelines_for_the_use_of_Synthetic_Fluid_Dust_Control_Palliatives_on_Unpaved_Roads

One dust management strategy for rural communities with gravel roads is to only treat the primary roads, which are the roads with the highest traffic volumes. In such cases, vehicles tracking on fine aggregate from untreated connecting gravel roads increases the dustiness of the treated sections. Applying palliative on 25 to 50 feet of connector roads at the intersections will reduce dustiness on the main treated road by reducing tracked-on fine aggregates from the connector roads.

Compacting the treated roadway weekly reconsolidates the aggregate loosened by vehicle abrasion along with the palliative remaining in the road surface, resulting in extended performance.

Best performance of the synthetic fluid palliative requires a fines content in the aggregate between 9 percent and 15 percent.

It may be possible to reconfigure a skid steer to be used to apply palliative. One recommendation is to use the power take-off (PTO) to power the pump used to force the palliative through the spray nozzles, and use the forks of the skid steer to carry the palliative tote. This same skid steer could be used for road preparation as well as compaction. This would save around $15,000 in equipment costs, assuming the community already owns a skid steer.

AGENCY CONTACTS

Road Manager
Native Village of Ruby
210 Bobby Kennedy Sr. Rd.
P.O. Box 210
Ruby, AK 99768
(907) 468-4497

Joe Conway, Director
Center for Local Aid Support

U.S. Department of Transportation
Federal Highway Administration