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# CALCIUM CHLORIDE

WHITE PAPER

## This Early Sign of Road Failure is a Threat to Driving Safety, Public Health and the Environment

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Dust produced by traffic on unpaved roads is an unpleasant nuisance, affecting the quality of life for everyone who travels on gravel roads and those who live or work nearby. It is also a warning sign of costly road damage that can increase maintenance requirements and strain road commission budgets. Just as important, road dust can threaten driving safety and public health, damage vehicles and other property, and harm our natural environment.

Considering that there are more than two million miles of unpaved roads in the U.S. and more than 600,000 km in Canada,<sup>1</sup> efforts to control road dust are national and international in scope. But maintenance responsibility for unpaved public roads most often rests with local officials, who must balance resources spent battling dust control with other pressing needs. Fortunately, local road authorities have access to proven dust suppressant products and application methods that have been used successfully for more than 100 years to achieve effective, long-term, and economical dust control when incorporated in normal seasonal road maintenance programs.

### Why Control Dust?

When the importance of dust control is weighed against all other budget priorities, it is important to remember that investments in suppressing road dust are repaid in significant direct and indirect benefits. Dust control can help reduce

the overall cost of road maintenance while providing taxpayers with safer, more drivable roads, as well as a cleaner and healthier environment. Simply put, everyone benefits when communities invest in an effective dust control program for their roads.

Most unpaved roads are located miles from the networks of paved highways serving major metropolitan areas. Yet, these rural roads are an essential link in the transportation infrastructure. They provide millions of people with vital access to work, schools, grocery stores, and health care facilities. They also link farms, forests, mines, and wells—as well as manufacturers and product distributors—with far flung markets, protecting jobs and bolstering the economy.

Unpaved roads are too important to neglect. Dust control is a valuable preventative maintenance measure that protects the durability of those roads for better long-term performance, as well as significant cost-savings. Let's review the important reasons why dust control should be considered by those responsible for maintaining unpaved roads in most regions of North America.

### *Washboard, Potholes, and Ruts*

Road experts will tell you, a dusty road is a deteriorating road. Dust is comprised of fine particles which, when they separate from coarse aggregate, no longer serve as the binding agents necessary to hold road surfaces together. Separation of fine material from coarse load-bearing

aggregate in a road surface leaves the larger material unstable and vulnerable—subject to degradation and loss with every passing vehicle, or washout in a hard rain. When gravel roads deteriorate, ruts, potholes, and washboards form, increasing the need for spot repairs and overall blading with grading equipment. Over time, the deterioration associated with dust can become so severe, the road gravel must be replaced or supplemented with additional material.

### *Higher Maintenance Expense*

Budgets for road maintenance and improvement are under constant pressure, yet motorists, residents, and businesses demand quality roads that are safe and comfortable to drive on. Premature deterioration of unpaved roads increases the need for blading and other maintenance to keep roads in safe and drivable condition. More frequent maintenance places an added burden on work crews and increases equipment and labor expense. That can lead to cutbacks in other areas of the budget.

### *Unsafe Driving Conditions*

According to the Insurance Institute for Highway Safety-Highway Loss Data Institute, 63% of passenger vehicle occupant deaths occur in rural areas. Although there are many reasons for rural traffic fatalities, reduced visibility due to road dust on unpaved roads can be a contributing factor in many accidents. In addition, a loose dusty surface can reduce vehicle traction, increasing

stopping distances. When loose gravel is thrown into the air by spinning tires, coarse components become projectiles that can endanger motorists and pedestrians.

#### *Damage to Vehicles*

U.S. auto glass repair shops generate more than \$1 billion in annual revenue.<sup>2</sup> If just a portion of that amount is for repairing vehicle damage caused by loose aggregate on gravel roads, the economic impact of poor unpaved road conditions is very steep. Loose aggregate not only damages windshields, this airborne filth also takes its toll on paint, chrome, headlights, suspension systems, and other components. Dust clogs filters, erodes seals, and forms an abrasive grit between moving parts. The harsh vibration caused by washboards and the impact of potholes harms steering systems, tires and rims, while loosening other components and contributing to long-term vehicle wear and tear.

#### *Hazard to Health*

Dust is an airborne pollutant that can degrade regional air quality and pose a hazard to public health. According to a 1992 study cited by researchers at Colorado State University, nearly 34% of the particulate matter in the atmosphere above the U.S. originates from unpaved roads.<sup>3</sup> People exposed to airborne dust can experience respiratory symptoms including irritation, coughing, or difficulty breathing. Exposure to dust particles in the air can also decrease lung function and aggravate asthma or hay fever. Dust can convey diseases like tetanus that are harbored by soil. Some health experts even believe that chronic bronchitis and irregular heartbeat can result from exposure to particle pollution, and premature death is possible if individuals already suffer from lung or heart disease.

#### *Compliance with EPA Regulations*

Road dust is considered a coarse particulate, 10 microns or smaller in size, and subject to the 2006 U.S.

Environmental Protection Agency (EPA) PM10 primary (public health) and secondary (public welfare) air quality standards that call for concentrations not to exceed 150 micrograms per cubic meter of air. The 2006 PM10 standards remain in effect after PM2.5 standards for fine particulates were revised in December 2012.<sup>4</sup>

#### *Impact on the Environment*

The effect of road dust on natural scenery and fresh air is unmistakable. But dust is also a harmful pollutant in ways that are less obvious. Dust from roadways and from road maintenance operations can drift or wash into streams and other waterways, increasing sediment and possibly harming aquatic plants and animals. Airborne dust also coats crops and vegetation near unpaved roads, stunting their growth.<sup>5</sup> According to Iowa State University researchers, one car traveling an untreated gravel road once per day throws off one ton of gravel per mile (560 kg/km) per year. In many jurisdictions regulations require that property owners control release of "fugitive" dust generated by mining, transportation, and other industrial and commercial operations to prevent its escape into the surrounding environment.

#### *Lower Quality of Life*

It is difficult to put a price tag on the pleasure of playing in the yard, walking or bicycling along a country road, hunting or fishing, bird watching, or just basking in the sun. But all of those experiences can be diminished by choking clouds of road dust. Dust also reduces leisure time by increasing the need to clean windows and siding, and sweep sidewalks and porches. It can increase energy bills and reduce discretionary income by forcing homeowners to machine dry laundry and use air conditioning to cool their homes.

#### **Tangible Benefits of Dust Control**

Considering the problems road dust creates, identifying and implementing effective solutions should be a high priority for road officials and the taxpayers

they serve. Effective dust control preserves the drivability and durability of unpaved roads, while minimizing impact on the natural environment, and protecting health, safety, property, and quality of life.

**Effective dust control can reduce the overall cost to maintain unpaved roads by 30% or more.**

The benefits of dust control on road maintenance costs are significant and measurable. Effective dust control can reduce the overall cost to maintain unpaved roads by 30% or more. Field trial results have shown that when calcium chloride, a leading dust suppressant, is used to control dust on gravel roads, blading frequency may be decreased by up to 50% and aggregate life can double.<sup>6</sup> Field trials outside of the U.S. revealed that the anticipated interval between re-graveling was extended from 7 to 14 years when roads were treated with calcium chloride.

While not as easily measurable in dollars and cents, the safety, health, environmental, and quality of life benefits of dust control help support other societal goals: Healthcare costs can be reduced, auto insurance rates can come down, and tax increases to fund road repairs can be avoided. Dust control can also help businesses comply with EPA air quality regulations or state fugitive dust requirements. The need for gravel mining and related transportation can be reduced, and related environmental impact can be minimized when dust control makes roads more durable.

#### **Calcium Chloride: A Proven Answer**

For more than a century, calcium chloride has compiled a proven record of effective dust control across North America under a wide range of gravel and climate conditions. Calcium chloride (or  $\text{CaCl}_2$ )

is a hygroscopic salt that draws moisture from the air to form a solution in road gravel that keeps road surfaces constantly damp—and dust at bay—even in hot, dry conditions where other materials fall short.

This moisture helps to bind fine and coarse aggregate particles together to create a longer-lasting, hard, and compact road surface. Because moisture penetrates several inches into the road base, the damp gravel conditions cultivated by calcium chloride also contribute to overall road surface stability. Calcium chloride depresses the freezing point of the moisture in the road surface to help minimize frost heave damage in the winter, further reducing maintenance requirements. While the first application of calcium chloride on a gravel road provides immediate dust suppression, subsequent seasonal applications on the same roadway have a cumulative effect. Each new application builds on residual dust suppressant remaining from previous treatments, which can enable application rates to be reduced and/or road quality to be improved.

**...three times more well head brine would have to be applied to achieve the same hygroscopic performance as LIQUIDOW™.**

Both liquid and solid forms of calcium chloride are hygroscopic and may be used to increase moisture content in road surfaces to effectively control dust. Solid  $\text{CaCl}_2$  may be applied directly to the road surface or dissolved in water for liquid application. OxyChem supplies both types of calcium chloride: LIQUIDOW™ Technical Grade Calcium Chloride Solution is available in concentrations from 28 to 42%. Anhydrous Calcium Chloride 94-97% Mini Pellets and DOWFLAKE™ Xtra 83-87% Calcium Chloride Flakes are the recommended solid products for dust control

applications. DOWFLAKE™ Xtra contains 10% more active ingredient ( $\text{CaCl}_2$ ) than competing calcium chloride flake products. The higher concentration of the product increases the area of dust control coverage, reducing overall application costs.

### Avoid Well Head Brines

Calcium chloride products supplied by OxyChem suppress dust more effectively than the inexpensive well head brines—also known as weak, natural, mineral well, or oil field brines—that are sometimes applied to road surfaces. Most well head brines typically contain very small concentrations of calcium chloride and/or magnesium chloride ( $\text{MgCl}_2$ ), which is another hygroscopic salt. Well head brines also contain significantly higher levels of sodium chloride ( $\text{NaCl}$ ), which does not have the moisture attraction properties of  $\text{CaCl}_2$  or  $\text{MgCl}_2$ . Sodium chloride actually remains solid under most summer climate conditions instead of attracting moisture and forming a solution that dampens road surfaces to control dust.

The lower hygroscopic salt content in well head brines is clearly evident when compared side-by-side in the field with the dust control performance of calcium chloride. In one study on a  $\frac{3}{4}$ -mile section of gravel road, LIQUIDOW™ 38% calcium chloride was compared to a well head brine containing 15%  $\text{NaCl}$  and only a total of 12%  $\text{CaCl}_2$  and  $\text{MgCl}_2$  combined. Controlled sampling over seven weeks found that LIQUIDOW™—with more than three times as much hygroscopic salt—controlled dust three times better than the well head brine.

In this example, three times more well head brine would have to be applied to achieve the same hygroscopic performance as LIQUIDOW™. Application of that much brine could have harmful environmental effects, increasing the potential for run-off or other impact. Relatively high levels of sodium chloride can be detrimental to soil structure and permeability. In light of these

concerns regarding brine content, some jurisdictions have enacted regulations requiring permits for the use of well head brines to treat roadways.<sup>7</sup>

Use of brines to achieve the same level of dust control as calcium chloride would increase the cost of an effective dust control program. In one comparison, 0.46 gal/yd<sup>2</sup> of well head brine was required to achieve the same hygroscopic capacity as 0.28 gal/yd<sup>2</sup> of LIQUIDOW™ 38% calcium chloride. A 3,700 gallon truck making three trips per day could treat 3.4 miles per day with LIQUIDOW™ 38% calcium chloride and only about 2.1 miles per day with well head brine. The resulting higher transportation and application costs can quickly offset any per-gallon cost savings on the material itself.

### Dust Control Best Practices

Dust-free roads are built on a foundation of quality gravel. The proper mixture of fine material and larger aggregate is important to ensure that natural binding action is maximized. For best performance, aggregate should meet these criteria:

#### Recommended Aggregate Characteristics

Characteristic	Preferred	Acceptable
Maximum Size	$\frac{3}{4}$ Inch	1 Inch
Grading Description	Well Graded—Not Uniform or Skip Graded	
Percent Pass #4	55 to 70	50 to 75
Percent Pass #200 (Nonplastic)	14 to 17	12 to 17
Percent Pass #200 (Plastic)	12 to 15	8 to 15
Plasticity Index	2 to 9	Nonplastic
Los Angeles Abrasion	Less than 30	Less than 40
Percent Fracture, One Face	Greater than 85%	Greater than 75%

A season-long dust control program begins in the spring. The road should be bladed while the moisture content and humidity are relatively high.

Unless rain has fallen within the previous two days, the road surface should be watered prior to blading. Blading will remove ruts, washboards, and potholes, and help mix-in loose aggregate. Good drainage is essential. Shaping roads to a 4% or greater crown will help ensure proper drainage. While the road surface is being prepared, ditches, shoulders, and culverts should be reshaped and cleaned as needed.

When blading and shaping are completed, dry or liquid calcium chloride is applied. It is usually preferable to water the surface prior to spreading a solid product. Roads may be slippery while solid product remains on the surface. If roads will remain open to traffic, signs should be posted directing motorists to use appropriate caution.

Calcium chloride application rates required to achieve effective dust control may vary depending on local conditions and past experience. When in doubt, an authorized LIQUIDOW™ distributor can offer a recommendation. OxyChem offers assistance in identifying qualified distributors with the proper expertise at [StableRoads.com/Distributors](http://StableRoads.com/Distributors).

In the weeks and months after initial application, road crews can maintain optimum dust control during unusually long periods of hot, dry weather by watering the road surface to reconstitute the treatment. Re-application of calcium chloride as needed in the late summer or early fall will further prolong dust suppression. Application of calcium chloride is not recommended during heavy rainfall, or if rain is threatening, because rain may leach out or dilute the chloride and may cause it to run off of the road.

## Managing Impact

Anytime a substance is used in proximity to people or natural areas, there is an understandable concern about possible health or environmental effects. In the case of calcium chloride used in dust control applications, the risks are relatively minor and can be minimized

with appropriate handling and application procedures.

Calcium and chloride are considered essential constituents in the bodies of all animals and the human acute oral toxicity of calcium chloride is classified as low. In normal dust control use, calcium chloride does not pose a significant risk to the environment. The likelihood of damage to vegetation can be significantly limited if dust control applications follow current recommended and standard practices.

Ground and surface waters are not likely to be affected by calcium chloride dust suppressant applied in accordance with recommended practices, because the product tends to remain bound in the road surface for extended periods of time, and any material washed into the environment is typically well diluted. For this reason, levels of chlorides released into surface or ground water under properly administered road dust treatment programs should not pose a significant threat to pets and wildlife.

However, proper application of calcium chloride includes measures to avoid contamination of surface or ground water because excessive amounts of chloride salts can be harmful to aquatic life. The calcium component of the material is not a concern because it is a component of nearly all natural waters and is classified as practically non-toxic to aquatic organisms by the U.S. Environmental Protection Agency (EPA).<sup>8</sup>

The United States Department of Agriculture (USDA) Forest Service identified blading as a contributing factor in runoff of harmful sediment from roads into roadside streams and other waterways. Using calcium chloride for dust control makes roads more durable, reducing blading requirements and helping maintain water quality.

## A Valued Investment

Clouds of road dust signal the deterioration of valuable infrastructure that is essential to the prosperity of

residents, visitors, communities, and businesses. Dust control incorporating calcium chloride provides significant benefits to all of society, keeping unpaved roads more drivable and safe, protecting public health and the environment, and removing an unpleasant nuisance from everyday life. Dust control using calcium chloride can also contribute to road maintenance savings, preserving precious budgetary resources and providing welcome relief for taxpayers. With more than 100 years of safe and effective use, calcium chloride is a proven remedy for dust and the problems it causes, outperforming well head brines and sparing communities the potential environmental impact associated with their use.

To learn more about the benefits of dust control and why calcium chloride plays an important role in controlling dust effectively, visit [StableRoads.com](http://StableRoads.com).

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## About the Author

Gerry Matthews (now retired) was a Senior Account Executive with Occidental Chemical Corporation (OxyChem), responsible for North American sales and marketing of LIQUIDOW™ liquid calcium chloride products. He had over 20 years' experience assisting highway and road authorities, as well as supporting engineers and contractors, in the effective use of calcium chloride for applications including dust control, road base stabilization, full-depth reclamation, and highway ice control. Mr. Matthews was a member of the American Public Works Association and a graduate of Central Michigan University.

<sup>1</sup> CIA World Fact Book, 2008 data

<sup>2</sup> U.S. Census Bureau's Statistics of U.S. Businesses.

<sup>3</sup> Road Dust Suppression: Effect on Maintenance Stability, Safety and the Environment, Phases 1-3; Jonathan Q. Addo, Thomas G. Sanders, Melanie Chenard, 2004.

<sup>4</sup> EPA National Ambient Air Quality Standards (40 CFR part 50).

<sup>5</sup> Road Dust Suppression: Effect on Maintenance Stability, Safety and the Environment, Phases 1-3; Jonathan Q. Addo, Thomas G. Sanders, Melanie Chenard, 2004.

<sup>6</sup> The Incorporation of Dust Palliatives as a Maintenance Option in Unsealed Road Management System, D. Jones, E. Sadzik and I. Wolmerans: Paper from 20th ARRB Conference, 19-21 March 2001.

<sup>7</sup> Guidelines for Selecting Dust Suppressants to Control Dust and Prevent Soil Erosion, Michigan Department of Natural Resources and Environment, Office of Pollution Prevention and Compliance Assistance, 2010.

<sup>8</sup> Based on U.S. EPA National Recommended Water Quality Criteria: 2002, EPA-822-R-02-047, November 2002.



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