means that when mixed with water, depending on the concentration, it will lower the temperature at which the solution freezes. Solid sodium chloride loses it effectiveness (has difficulty going into solution) when temperatures fall below 15° F. Applications of dry salt below this temperature, even at high rates, will not result in snow or ice melting; therefore, it is critical that salt is applied at the appropriate pavement temperature. The average cost of NaCl is $58/ton or about $0.07 a gallon for 23.3 percent brine solution.

Dry salt that is applied directly to roads does not all remain in the targeted application area. The salt grains bounce and scatter after being applied and are blown off the pavement surface. With less salt retained on the road additional treatments or higher than needed application rates are required. For best effect with the least environmental impact salt should be pre-wetted with brine rather than applied in dry form. Refer to Appendix F for additional information regarding how salt works and Appendix H on pre-wetting salt.

Other Chlorides

Calcium(CaCl) and magnesium chloride(MgCl) are often used as salt alternatives; however, they have the same impact on water quality since they both contain chlorides. These chemicals work differently than salt in that they do not require heat energy to go into a solution; instead they give off heat when they go from a solid into a solution. Their main benefit is having lower eutectic temperatures, providing more melting power at lower temperatures. They are more effective in dry, cold conditions as compared with salt. It is not recommended that they be applied at high application rates or when pavement temperatures are above 28 degrees Fahrenheit due to an increase in slippery road conditions. They are both corrosive and may contain corrosive inhibitors. The cost associated with making brine using Mg chloride averages between $0.45-$0.75/gal and for Ca chloride the cost of brine is around $0.82/gal and $250/ton for flake.

Alternative De-Icers

Environmental impacts associated with the selection of alternative deicers should be considered. Road salt alternatives are primarily proprietary and are not well documented in scientific literature. Available data is limited, particularly regarding long-term environmental impacts.

Most agricultural by-products are not as good at melting ice; however, they do slow the formation of ice crystals, making them good for anti-icing and pre-treating. Some agricultural byproducts

have freezing points near -30° F. They are less corrosive than many conventional materials. Most products are derived from the processing of grains or other agricultural products. They have a higher cost associated with them and most often are mixed with products such as magnesium chloride.

Table 7. Generalized Environmental Concerns for Chloride Alternatives

Product	Chemical Formula	General Information	Environmental Concern
Calcium Magnesium Acetate (CMA)	CaMgAc	powder, crystal, pellet or liquid, non-corrosive, cost around $1,000/ton or $1.30/gal	Organic content leading to BOD
Potassium Acetate (KA)	KAc	liquid, non-corrosive, 50% concentration cost around $3.00/gal	Organic content leading to BOD
Agricultural By-Products	N/A	mostly proprietary, can be derived from corn, beet, alfalfa, alcohol, grains, or molasses. Less corrosive, lowers freeze point, generally not good at melting alone. Avg cost $1.00/gal	Organic content leading to BOD, Heavy Metals, nutrient enrichment by phosphorus, nitrogen
Urea (Urea, Ammonia)	Urea, Ammonia	fertilizer with high nitrogen content, corrosive, cost around $350.00/ton	Rapid break down and release of Ammonia, Fertilizer leading to nutrient enrichment, algae blooms and BOD

Since Dinsmore Brook flows into Cobbetts Pond and Cobbetts Pond is impaired for dissolved oxygen saturation and total phosphorus, agricultural by-products are not recommended, except in small quantities to pre-wet salt.

Addition of organic compounds (e.g., acetate or mixed organic matter from biomass) may cause deoxygenation in the water, which in turn could cause the release of potentially harmful substances such as heavy metals into the groundwater and could be a cause of taste and odor problems (NCHRP, 2004).

Brine

Using brine is the most cost effective way to anti-ice or pre-wet. Brine is widely used in other states because it is easy to produce, economical and effective for events occurring at moderate or subfreezing temperatures. There are many types of products that are used to make brine such as sodium chloride (NaCl), magnesium chloride (MgCl), potassium acetate(KA), calcium magnesium acetate(CMA) as well as proprietary blends. Each product has its