CRITERIA FOR CERTIFICATION

ENVIRONMENTAL INNOVATION, GS-20 Edition 2.0

Sub-Category: Deicers for Doorways and Entryways

APPLICANT INFORMATION:	
Company:	Branch Creek
Product Name:	Entry Liquid Snow and Ice Melt
Website:	www.chloridefree.com

Introduction. Green Seal's Environmental Innovation Standard (GS-20) provides a framework for the certification of environmental innovations. This certification demonstrates that an independent third party has verified the innovative aspect(s) of a product results in a significant reduction of human health and environmental impacts compared to products of the same functional class, achieving innovations not previously demonstrated within a product category. Certification neither constitutes the development of a product category standard or benchmark, nor does it require competitors within a product category to use the same innovation strategies in their approach to claiming innovation.

Beta Program. The Environmental Innovation (GS-20) Beta Program is a high-engagement testing of the business processes, templates, and supplemental program guidance of the Environmental Innovation Standard. Branch Creek is part of the initial cohort of beta participants, who are pursuing certification of their product under the Environmental Innovation Standard (GS-20, Edition 2.0), while providing valuable feedback on the various programmatic aspects under development.

Certification of Environmental Innovation. If the applicant can demonstrate the product conforms to all criteria within this document, Green Seal will provide a Certification of Environmental Innovation.

Disclaimer. This Certification is not intended to identify all possible negative impacts and cannot rule out any unknown negative consequences from the use of this product.

Public Comment. A public comment period for the applicant's Draft Criteria was held from March 4 – 25, 2019.

OVERVIEW

1.0 Eligibility

Entry Liquid Snow and Ice Melt by the company Branch Creek is eligible to be certified under the Environmental Innovation Standard (GS-20, Edition 2.0), because the product:

1. Is commercially available
2. Exists within a market that has comparable options that achieve the same function, and
3. Has lifecycle phases for which there exists published health and environmental impact information from credible sources.

Product Function

Entry Liquid Snow and Ice Melt by the company Branch Creek, when used as intended, provides the following functions:

1) Melts residual ice and snow and prevents melted ice and snow from re-freezing; and

2) Pre-treats surfaces in order to reduce accumulation of snow or ice.

The product is intended for use in the following applications:

- Walkways,
- Building entryways (within the first 15 feet from the entrance), and
- Parking lot drop-off zones.

Comparable Alternatives

Conventional deicing products used on walkways, in building entryways, and in parking lot drop-off zones are typically sodium chloride (NaCl) based. Due to the environmental issues associated with sodium chloride based deicers, a number of alternatives exist, including deicing products formulated with calcium chloride, calcium magnesium acetate, potassium acetate, and urea. The full range of products serves as comparable alternatives to the applicant product, for use on walkways, building entryways, and in parking lot drop off zones.

Legal Compliance

Manufacturer shall not be in violation of any applicable environmental regulations or laws nor any applicable regulations under the authority of the U.S. Federal Trade Commission, U.S. Food and Drug Administration, or the U.S. Environmental Protection Agency (or equivalent if based outside the United States).

2.0 Product Lifecycle Impact Review

This section documents the anticipated human health and environmental lifecycle impacts associated with deicers, noting the most significant (i.e., greatest in negative effect) impact, and includes a detailed technical summary to support the findings in Annex A.

Summary of Lifecycle Impact Review - Deicers

Lifecycle Phase	**Impacts Identified**
Resource Extraction	No significant impacts identified.
Manufacturing	No significant impacts identified.
Use	Soil and groundwater infiltration. Water pollution, and decreased water quality. Eutrophication, especially when nitrogen and phosphorus are present. Negative impacts to aquatic life, soil chemistry, terrestrial plants, and wildlife from chloride contamination.

	Oxygen depletion in waterways from non-chloride deicers. Mild inhalation and skin irritation hazards.
Waste Management and Disposal	No significant impacts identified.

Resources and Manufacture Phases
In general, deicers as a category do not present significant impacts in the resource extraction and manufacturing lifecycle phases. Since the main ingredients of the applicant product are potassium formate and water, it is not classified as hazardous beyond mild skin and inhalation irritation. Workers involved in these phases are not expected to be exposed to significant hazards, and no significant environmental hazards have been identified.

Use Phase
Deicers applied to walkways or entryways will liquify ice and snow, wash into the soil and are likely to infiltrate groundwater and waterways. For conventional deicers, environmental impacts can include water quality degradation, water pollution, eutrophication (especially when nitrogen and phosphorus are present), negative impacts to from chloride to aquatic life, soil chemistry, terrestrial plants, and wildlife.

Many of the environmental impacts caused by deicers made with chlorides, phosphates, nitrogen, acetates, and urea are avoided or reduced[12] by the use of this potassium formate deicer.

The major environmental impact reductions achieved when using a potassium formate based deicer compared to the alternatives are the avoidance of chloride contamination in soil and water, lower biological and chemical oxygen demand (BOD and COD), a measure of water pollution, and avoidance of eutrophication.

Deicer	**How does Entry compare to the alternatives based on impact reduction?**		
	Chloride Contamination	**BOD/COD**	**Eutrophication**
Sodium Chloride (e.g., Rock Salt)	Entry is a better option	N/A	N/A
Magnesium Chloride	Entry is a better option	N/A	N/A
Potassium Chloride	Entry is a better option	N/A	N/A
Calcium Chloride	Entry is a better option	N/A	N/A
Urea	N/A	Entry is a better option	Entry is a better option
Potassium Acetate	N/A	Entry is a better option	N/A
Calcium Magnesium Acetate	N/A	Entry is a better option	N/A

A review of the available literature has documented these benefits and has not identified additional environmental concerns associated with the use of potassium formate.

The product is applied directly to a surface. Minor health hazards include mild inhalation or skin irritation, similar to other deicers.

Waste Management and Disposal Phases
No issues were identified for this life-cycle phase. Any environmental infiltration is from the use phase, not from disposal of leftover products or packaging.

[1] Minnesota Stormwater Manual. *Environmental Impacts of Road Salt and Other Deicing Chemicals.* Minnesota Pollution Control Agency. Last modified May 15, 2017. https://stormwater.pca.state.mn.us/index.php/Environmental_impacts_of_road_salt_and_other_de-icing_chemicals
[2] Transportation Research Synthesis. *Field Usage of Alternative Deicers for Snow and Ice Control.* Minnesota Department of Transportation, September 2017. http://dot.state.mn.us/research/TRS/2017/TRS1706.pdf

CERTIFICATION REQUIREMENTS

3.0 Environmental Innovation Review

This section details the applicant's proposed innovation claims, including

- Innovation Summary: describes how the applicant claims the their product differs from comparable products on the market,
- An Impact Reduction Statement: describes how the applicant claims the their product's innovation results in reductions of significant lifecycle impacts identified in the Product Lifecycle Impact Review (Section 2.0 herein),
- Market Analysis: describes the parameters for the applicant to demonstrate their claim that the product is the first and only product of its type of achieve this innovation during the Certification Phase, and
- Drawbacks Analysis: a summary of any potential drawbacks that Green Seal has identified and mitigations necessary.

The applicant has opted to demonstrate innovation through *Improved Design*, which states: Demonstrate a minimum of 30% reduction of one or 20% in each of two or more significant environmental or human health impacts.

3.1 *Innovation Summary – How does this product differ from others on the market?*

The applicant claims that this product differs from other deicers on the market for use on walkways, building entrances, and parking lot drop off zones because it is based on a formulation using potassium formate; conventional deicers are typically based on sodium chloride; other alternatives to sodium chloride include calcium chloride, calcium magnesium acetate, potassium acetate, and urea.

When formulated using potassium formate, the applicant claims that this deicer achieves the following impact reductions:

- avoids chloride contamination in soil and water, when compared to chloride based deicers
- decreases biological oxygen demand (BOD) and chemical oxygen demand (COD), a measure of water pollution, when compared to non-chloride based deicers, and
- does not contribute toward eutrophication, when compared to non-chloride based deicers, in particular, urea.

During the Certification Phase, Green Seal will verify these claims through a technical review.

3.2 *Impact Reduction Summary – How does the innovation result in impact reduction?*

When formulated using potassium formate, the applicant claims their product achieves the following impact reductions:

- eliminates chloride contamination, when compared to chloride based deicers,
- achieve at least a 20 percent decrease in biological oxygen demand (BOD) and chemical oxygen demand (COD), and
- eliminates the major known contributors to eutrophication (nitrogen and phosphorus);

all of which are significant lifecycle impacts associated with conventional deicers.

Additionally, the applicant claims their product is significantly less harmful to vegetation and soil than the most commonly used alternative, chloride products, and is safer for animals to ingest or

have minor skin contact. Although the product may cause irritation to skin and eyes when inhaled or ingested, it is no worse than any of the alternatives.

During the Certification Phase, Green Seal will verify these claims through a technical review.

3.3 *Drawbacks Analysis – Has burden shifting occurred?*
As a result of a drawbacks analysis, Green Seal has noted the following issues:

The product is sold in diluted, ready-to-use form and is approximately 50 percent water. This is a drawback over dry salt and more concentrated deicers. Green Seal typically requires the use of concentrated products and dilution by the user to avoid environmental impacts incurred from transporting water; however, this product is not appropriate for dilution by end users. In order for the product to work safely, effectively, and result in the anticipated environmental impact reductions, adding water during the product manufacturing process is required. In addition, due to the ability to control the application of the deicing liquid (Entry) versus applying granular ice melts, the applicant claims that one pallet position on a truck of Entry is comparable to eight pallet positions of granular sidewalk salt, requiring less transportation impact than traditional alternatives.

A review of the available literature did not indicate to Green Seal that potassium formate deicers are associated with additional negative impacts when compared to other types of deicers. For example, minor health hazards are present and include mild inhalation or skin irritation; this hazard is similar to or less than other deicers.

Green Seal has determined that no mitigation is necessary. Stakeholder engagement did not produce evidence or information to necessitate further mitigation.

3.4 *Market Analysis – How unique is this innovation?*
During the Certification Phase, applicant shall provide evidence that demonstrates the applicant product is the first and only deicer sold on the North American market for residential and facility application formulated with potassium formate and without sodium chloride, calcium chloride, calcium magnesium acetate, potassium acetate, urea, or glycerol.

Stakeholder engagement did not produce evidence or information to dispute this claim.

4.0 Evaluation of Functional Performance and Fitness for Purpose

This section details the requirements to demonstrate that the applicant product functionally performs at least as well as or better than at least one nationally recognized or market leading product of its type, to be approved by Green Seal, including test methods and test reports to submit during the Certification Phase.

Test Methods
Applicant shall meet the requirements in this section to demonstrate the product functionally performs at least as well as or better than at least one nationally recognized or market leading product of its type, to be approved by Green Seal.

The applicant shall use objective, scientifically validated testing methods conducted under controlled and reproducible laboratory conditions to demonstrate functional performance.

Effective Temperature

The applicant claims[3] that the product's effective temperature is negative thirty degrees Fahrenheit (-30° F), which means it effectively functions (i.e., effectively melts ice, prevents refreeze, and pretreats surfaces) at lower temperatures than other chemical compounds used as deicers in building entryways, on walkways, and parking lot drop off zones. The following table contains information on effective temperature gathered from the public domain, including tests conducted by U.S. State Departments of Transportation.

Deicer Type	Lower Functional Temperature[4]
Sodium Chloride (e.g., Rock Salt)	+15°F (-9.4°C)
Magnesium Chloride	-5°F (-20.5°C)
Potassium Chloride	+25°F (-4°C)
Calcium Chloride	-15°F (-26°C)
Calcium Magnesium Acetate	0°F (-17°C)
Potassium Acetate	-26°F (-32°C)
Urea	+25°F (-4°C)
Potassium Formate (i.e., Entry)	-30°F (-34°C)

5.0 Environmental and Human Health Requirements

This section describes the Environmental and Human Health requirements with which the applicant product must demonstrate compliance. Green Seal uses the following factors to determine requirements for this section:

- **Product Form**: the applicant product is a water-based solution.
- **Potential for Direct Human Exposure**: through regular handling and use of the product, the potential for inhalation, ingestion, or absorption is present. Minor health hazards include mild inhalation or skin irritation, similar to or less than other deicers.
- **Potential for Environmental Releases:** as described in Section 2.2 herein, when the product is used as intended, releases to soil and water occur.

Due to the product form and high exposure potential to both humans and the environment, the strictest application of these requirements applies, as noted below, and a complete formula disclosure of all ingredients is required.

Disclosure

Applicant shall disclose all product components to the certification program, including the chemical name, the Chemical Abstracts Service (CAS) registry number, and the levels (% by weight) present in the product.

Carcinogens, Mutagens, and Reproductive Toxins

The product shall not contain any components that are carcinogens, mutagens, or reproductive toxins.

Prohibited Components

The product shall not contain the following components.

- 1,2-dichlorobenzene
- 2-butoxyethanol
- Alkylphenol ethoxylates

[3] See Entry Resource Guide: Improve Your Track Record. 2017. Page 10 of 24. https://chloridefree.com/wp-content/uploads/2017/11/New_Entry_ResourceGuide_el_2018.pdf

[4] Transportation Research Synthesis. *Field Usage of Alternative Deicers for Snow and Ice Control.* Minnesota Department of Transportation, September 2017. http://dot.state.mn.us/research/TRS/2017/TRS1706.pdf

- Formaldehyde donors
- The heavy metals lead, mercury, cadmium, hexavalent chromium, and antimony in the elemental form or compounds
- o-Phenylphenol
- Neonicotinoid pesticides
- Nitro-musks
- Phthalates
- Polycyclic musks
- Triclosan
- Triphenyl tins and tributyl tins

Volatile Organic Compounds
The VOC content of the product as used shall contain no more than the current regulatory limits of the Air Resources Board for the State of California (CARB) for its product category. If no CARB limit exists for the product category, Green Seal will determine the acceptable VOC content.

Animal Testing
Green Seal will accept previous test results as evidence of meeting a criterion in order to avoid new animal testing.

Acute Toxicity
The product shall not be toxic to humans when inhaled or ingested.

Skin and Eye Damage
The product shall not cause skin corrosion or cause serious eye damage.

Asthmagens
The product shall not contain any components that have been identified as asthmagens.

Respiratory Sensitization
The product shall not contain any *components* that have been identified as respiratory sensitizers.

Skin Sensitization
The product shall not be a skin sensitizer.

Skin Absorption
The undiluted product shall not contain components present at 1% or more in the product that are listed on the American Conference of Governmental Industrial Hygienists (ACGIH) threshold limit value (TLV) list carrying a skin notation or substances that are listed on the German Deutsche Forschungsgemeinschaft (DFG) maximum allowable concentrations (MAK) list with a skin absorption H notation. Further, the product shall not contain components at 0.01% or more in the undiluted product that sum to 1% in the formula that are listed on ACGIH or DFG with the same target organ.

Chronic Inhalation Toxicity
The product as used shall not contain components that are classified as producing significant toxic effects in mammals via inhalation, with a possible inhalation exposure pathway according to Organization for Economic Co-operation and Development (OECD) Harmonized Integrated

Classification System for Human Health and Environmental Hazards of Chemical Substances and Mixtures.

Combustability
The product shall not be combustible.

Fragrances
The product formulation does not contain fragrances; therefore this requirement does not apply.

Colorants
The product formulation does not contain colorants; therefore this requirement does not apply.

Bioaccumulating Compounds
The product shall not contain any components that bioaccumulate or are known to form degradation products that bioaccumulate.

Eutrophication
The product shall not contain phosphorus at more than 0.5% by weight.

Aquatic Biodegradability
Each of the individual organic components shall exhibit ready biodegradability in accordance with the OECD definition, except for polymers.

Toxicity to Aquatic Life
The product as used shall not be toxic to aquatic life.

Recycled Content
The product does not contain fiber-based materials; therefore, this requirement does not apply.

Bleaching
The product does not contain fiber-based materials; therefore, this requirement does not apply.

Additional Product-Specific Requirements
The applicant product shall not be formulated with phosphorous, chlorides, urea, propylene glycol, or glycerol.

Non-Toxic Claim
The applicant product shall be considered non-toxic for both humans and the environment if it meets the requirements for oral toxicity, inhalation toxicity, and aquatic toxicity as described in Environmental Innovation Standard (GS-20, Edition 1.1).

6.0 Packaging Requirements

Applicant shall meet the following packaging requirements as applicable.

Primary and Secondary Packaging
Packaging made from plastic shall be *recyclable*, or source-reduced by 20%, or shall contain 25% recovered material content (pre- or post-consumer material).

If the product's packaging is below these levels, the applicant shall demonstrate that efforts have been made to use the maximum available pre- or post-consumer material in packaging.

Plastic Labeling
Plastic packaging shall be marked with the appropriate Resin Identification Code.

Concentrated Product Packaging
This requirement is not applicable.

Heavy Metal Restrictions
The heavy metals lead, mercury, cadmium, and hexavalent chromium shall not be *intentionally introduced.* Further, the sum of the concentration levels of these metals shall not exceed 100 ppm; an exception is allowed for *refillable packages* or packages that would not exceed this maximum level but for the addition of *post-consumer material*.

Other Restrictions
Phthalates, bisphenol A, and chlorinated packaging material are prohibited from being intentionally introduced to plastic packaging; an exception is allowed for packages that would not have added phthalates, bisphenol A, or chlorinated packaging material but for the addition of post-consumer material.

7.0 Certification Requirements

Applicant shall meet all certification requirements described herein.

Certification Term
The initial Certification Term shall be 4 years. After the Certification Term, the applicant has the option to undergo Recertification.

Site Visit
The applicant shall undergo a site audit of product manufacturing facilities that includes verifying product characteristics and quality manufacturing processes.

Label Language
The product label shall include English and another language or English and a graphical representation or icons.

Label Dilution or Dosage Directions for Concentrates
This requirement is not applicable.

Label Use and Disposal Directions
For products sold as liquids, the product label shall have explicit disposal, recycling, reuse, or refill instructions, proper and clear directions for use, and appropriate precautions and recommendations for the use of personal protective equipment.

Ingredient Line
For products sold as liquids, the product label shall list the product ingredients using the naming convention of the International Nomenclature of Cosmetic Ingredients (INCI) in order of predominance. Where an INCI name does not exist for an ingredient, alternative nomenclature may be used. Ingredients in concentrations of less than 1% may be listed in any order after those in concentrations of more than 1%. A chemical function or chemical class descriptor may be used to protect trade secret information.

Fragrance Labeling
This requirement is not applicable.

Allergen Labeling
This requirement is not applicable.

Certification Mark
The Green Seal® Certification Mark may appear on the product, packaging, secondary documents, and promotional materials, only in conjunction with the certified product. Use of the Mark must be in accordance with Rules Governing the Use of the Green Seal Certification Mark.

The Green Seal Certification Mark shall not be used in conjunction with any modifying terms, phrases, or graphic images that might mislead consumers as to the extent or nature of the certification.

Green Seal must review all uses of the Certification Mark prior to printing or publishing.

Use With Other Claims
The Green Seal Certification Mark shall not appear in conjunction with any human health or environmental claims unless verified and approved in writing by Green Seal.

Statement of Basis for Certification
Wherever the Green Seal Certification Mark appears, it shall be accompanied by a description of the basis for certification. The description shall be in a location, style, and typeface that are easily readable. If online space is limited, a link to the basis of certification may be used. A statement of basis for certification shall be developed for each product. The statement shall be approved in writing by Green Seal, and may be similar to the following example:

"This product is certified by Green Seal™ for Environmental Innovation for reduced harm to aquatic life, soil, and plants; and effective performance. GreenSeal.org"

Annex A: Product Lifecycle Impact Review Technical Discussion

Deicers applied to walkways or entryways will liquify ice and snow, wash into the soil and are likely to infiltrate groundwater and waterways. Many of the environmental impacts caused by deicers made with chlorides, phosphates, nitrogen, acetates, and urea are avoided or reduced[5] by the use of this potassium formate deicer, as listed below.

The major environmental impact reductions achieved when using a potassium formate based deicer compared to the alternatives are the avoidance of chloride contamination in soil and water, lower biological and chemical oxygen demand (BOD and COD), a measure of water pollution), and avoidance of eutrophication.

A review of the available literature has documented these benefits and has not identified additional environmental concerns associated with the use of potassium formate.

The product is applied directly to a surface. Minor health hazards include mild inhalation or skin irritation, similar to or less than other deicers.

Comparison with Chloride Deicers Sodium chloride, calcium chloride, magnesium chloride, and potassium chloride are some common deicers on the market.

Chloride Contamination: When chlorides are released into the environment, they negatively affect aquatic life, soil chemistry, terrestrial plants, and wildlife. The New Hampshire Department of Environmental Services has identified the following negative consequences caused by rock-salt deicers (none of them are associated with potassium formate).

- Water quality impacts: Chloride contamination of surface and groundwater, compounded by stratification
- Human health impacts: Sodium contamination of drinking water supplies
- Pet health impacts: Ingestion of rock salt adhering to paws and paw health.

A number of studies have documented chloride contamination in bodies of water where chloride deicers are used, often at levels that exceed EPA standards for water quality. Corsi, et. al. 2010, for example, reported that in Wisconsin, "chloride concentrations exceeded U.S. Environmental Protection Agency (USEPA) acute (860 mg/L) and chronic (230 mg/L) water-quality criteria at 55 and 100% of monitored sites, respectively."[6]

Chloride contamination has been identified as a major problem in sensitive watersheds. Kaushal (2016, and references therein), for example, calls the salinization of fresh water supplies "a chronic environmental problem," not only in arid zones but in northern regions as well, and calls out the application of chloride-based deicers as a major concern:

> "In northern regions, salinization of fresh water is significantly related to increasing impervious surface cover in watersheds. In addition to geologic sources and other human inputs, salinization increases as deicer is applied to impervious surfaces to promote safe transportation. During winter

[5] Minnesota Stormwater Manual. *Environmental Impacts of Road Salt and Other Deicing Chemicals.* Minnesota Pollution Control Agency. Last modified May 15, 2017. https://stormwater.pca.state.mn.us/index.php/Environmental_impacts_of_road_salt_and_other_de-icing_chemicals

[6] Steven R. Corsi, David J. Graczyk, Steven W. Geis, Nathaniel L. Booth, and Kevin D. Richards. A Fresh Look at Road Salt: Aquatic Toxicity and Water-Quality Impacts on Local, Regional, and National Scales. *Environmental Science and Technology.* 2010, 44 (19), pp 7376–7382. http://pubs.acs.org/doi/abs/10.1021/es101333u

> months, salt concentrations in urban waters can spike up to approximately 25% the salinity of seawater. It can take weeks and months for these salt pulses to diminish, and salt concentrations can remain chronically elevated during summer months. Interestingly, long-term baseline concentrations of salts have increased in fresh water, even during seasons when deicer is not applied. These widespread trends are due to the accumulation of salts stored in soils and groundwater. Thus, even if road salt applications ceased, many freshwater ecosystems would still remain chronically salinized for decades. Increased salinization of fresh water now represents a chronic environmental problem." (Kaushal, 2016 [7])

Water bodies contaminated with chlorides can also become stratified, creating layers of de-oxygenated water, which cannot support life. This type of water quality disruption poses dangers to all biota in that ecosystem including fish, insects, amphibians, and birds. Chlorides cause dehydration and disrupt nutrient uptake in plants, and alter soil chemistry, increasing permeability, decreasing pH, harming bacteria, and increasing erosion and sediment runoff.

There is no effective way to de-contaminate chlorides from the environment other than dilution with water, and as described, chlorides remain in the environment past the deicing season and even over decades. In addition, the equipment needed to remove chloride at wastewater treatment plants is extremely expensive and cost prohibitive in many municipalities. Replacing salt with potassium formate as a deicer avoids the introduction of chlorides into the environment and can significantly reduce groundwater and soil deterioration[8,9].

Damage to Soil, Vegetation and Metals: Chloride salts are well known for reducing soil fertility, damaging vegetation[10], and corrosive effects on metals and other building materials. Potassium formate has been shown to pose much less of a concern, and meets the requirements of AMS 1435[11], the international standard for runway deicing fluids, implemented to prevent the corrosion of airplanes and runways.

Comparison with Non-Chloride Deicers Calcium magnesium acetate, potassium acetate, and urea are other common deicers on the market. These products differ in the hazards that they pose to the environment compared to potassium formate, but in general they cause higher oxygen depletion in waterways and some are less effective as deicers.

Aquatic Oxygen Demand (BOD and COD): Aquatic oxygen demand is a major parameter of concern for water quality. Various substances discharged into waterways can cause chemical or biological processes that deplete dissolved oxygen, which is essential for most aquatic organisms. Substances with high Chemical Oxygen Demand (COD) or Biochemical Oxygen Demand (BOD) can severely impact bodies of water, killing both plants and animals and interfering with aerobic processes that are essential for the health of the ecosystem. The applicant product has lower BOD and COD than non-chloride deicers, causing less degradation of water bodies.

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[7] Sujay S. Kaushal. Increased Salinization Decreases Safe Drinking Water. *Environmental Science & Technology.* 2016, 50, 2765−2766. http://pubs.acs.org/doi/pdfplus/10.1021/acs.est.6b00679

[8] Pasi P. Hellstén, Jani M. Salminen*, Kirsten S. Jørgensen, and Taina H. Nystén. Use of Potassium Formate in Road Winter Deicing Can Reduce Groundwater Deterioration. *Environmental Science & Technology.* 2005, *39* (13), pp 5095–5100. http://pubs.acs.org/doi/abs/10.1021/es0482738

[9] Pasi P. Hellstén, Anna-Liisa Kivimäkia, Ilkka T. Miettinenb, Risto P. Mäkinena, Jani M. Salminena and Taina H. Nystén. Degradation of Potassium Formate in the Unsaturated Zone of a Sandy Aquifer. *Journal of Environmental Quality.* Vol. 34 No. 5, p. 1665-1671. https://dl.sciencesocieties.org/publications/jeq/abstracts/34/5/1665

[10] Gałuszka, A., Migaszewski, Z.M., Podlaski, R. et al. Environ Monit Assess (2011) 176: 451. https://doi.org/10.1007/s10661-010-1596-z

[11] AMS1435 Fluid, Generic, Deicing/Anti-Icing Runways and Taxiway. Last update June 7, 2012. http://standards.sae.org/ams1435c/

Non-chloride deicers, including potassium acetate and calcium magnesium acetate, have significantly higher Biological Oxygen Demands than chloride based deicers and other deicers on the market.[12] High BOD is one of the most significant environmental impacts associated with acetate deicers.[13]

According to the State of Minnesota,

Acetate-based deicers dissociate when in water. The metal ion persists, but the acetate ion will degrade.[14] *Degradation of the acetate ion consumes oxygen, which is one of the biggest environmental concerns associated with the use of acetate-based deicers. At temperatures between 10°C and 20°C, the biological oxygen demand (BOD) was fully applied within 5 to 10 days of the acetate being deposited into the water. At a water temperature of 2°C decomposition took 100 days.*[15]

The applicant claims their potassium formate based product has a BOD of 0.02 kg O_2/kg and a COD of 0.09 kg O_2/kg, and that this results in at least 20 percent decrease in biological oxygen demand than acetate-based deicers.

Eutrophication: Unlike some other deicers like urea, the applicant product does not contain any phosphorous or nitrogen, which can enhance microbial growth in waterways, eutrophying the water and creating dead zones.

Irritation, corrosiveness. At higher concentrations, urea can also burn plant tissue when it comes directly in contact with plants, as it may when applied as a deicer. Potassium formate based deicers avoid these impacts.

Increased alkalinity: Acetate products and calcium, magnesium and acetate ions can increase the alkalinity of a stream, also posing harm to pH-sensitive aquatic life. Potassium formate based deicers avoid these impacts.

[12] Evaluation Of Selected Deicers Based On A Review Of The Literature. Colorado Department of Transportation Research Branch. October 2001. pp 10-11. https://www.codot.gov/programs/research/pdfs/2001/deicers.pdf
[13] Table Summarizing Properties of Deicing Agents. Minnesota Stormwater Manual. *Environmental Impacts of Road Salt and Other Deicing Chemicals.* Minnesota Pollution Control Agency. Last modified May 15, 2017. https://stormwater.pca.state.mn.us/index.php?title=Table_summarizing_of_properties_of_deicing_agents
[14] Fortin, Connie, Tjaden, L. Mulhern, N. 2014. Chloride Free Snow and Ice Control Material. Transportation Research Synthesis, TRS 1411. Minnesota Department of Transportation, St. Paul, MN. http://www.dot.state.mn.us/research/TRS/2014/TRS1411.pdf
[15] Horner, 1992, in Minnesota Stormwater Manual. *Environmental Impacts of Road Salt and Other Deicing Chemicals.* Minnesota Pollution Control Agency. Last modified May 15, 2017. https://stormwater.pca.state.mn.us/index.php/Environmental_impacts_of_road_salt_and_other_de-icing_chemicals