



WEATHER-RESPONSIVE MANAGEMENT STRATEGIES

FACTSHEET

Source: Federal Highway Administration.

The City of Fort Collins, Colorado

Background

The Weather-Responsive Management Strategies initiative under the Federal Highway Administration (FHWA) Every Day Counts—Round 5 program promotes the use of road weather data from mobile and connected vehicle technologies to support traffic and maintenance management strategies during inclement weather. The goal is to improve safety and reliability, as well as to reduce impacts on the transportation system resulting from adverse weather.

This factsheet highlights integrating mobile observations technologies that the City of Fort Collins, Colorado, has deployed on snowplow vehicles.

SNOWPLOW TECHNOLOGY DEPLOYMENT

The City of Fort Collins has a long history of making advancements in automating processes and developing data-driven approaches to winter maintenance operations. Fort Collins currently operates 24 snowplow vehicles on 9 routes. Fort Collins was one of the first cities in Colorado to install automatic vehicle location/global positioning system technology on snowplow vehicles, as well as sensors for reporting whether the plow was up or down and the material spread rate. The city identified and selected vendors with which to partner, then started working directly with the manufacturer and vendor to meet needs and collect data to meet identified objectives. One early benefit was being able to automatically adjust the material spread rate based on the travel speed of the snowplow vehicle.

The city strives to reduce the burden on winter maintenance staff, including efforts to standardize equipment across the entire snowplow fleet to reduce training and inventory of parts needed to maintain those vehicles and devices. Additionally, the city has worked to minimize the interactions plow operators need to have with the technology and devices.

The city is currently in the process of implementing a new prototype to further automate processes. Plow operators are sometimes inclined to increase material applications above what is recommended, so the city began equipping snowplows with new technology to automate this process. Specifically, 10 snowplow vehicles were equipped for the 2021–2022 winter season with sensors to gather data on friction, air temperature, relative humidity, surface condition, road temperature, and ice thickness, as well as images captured every second from plow cameras. The city's in-house software system processes these data to help

maintenance crew chiefs understand the real-time road conditions and determine the appropriate treatment, as illustrated in figure 1. Additionally, collected data generate a variety of maps, including a color-coded map based on roadway friction, shown in figure 2.

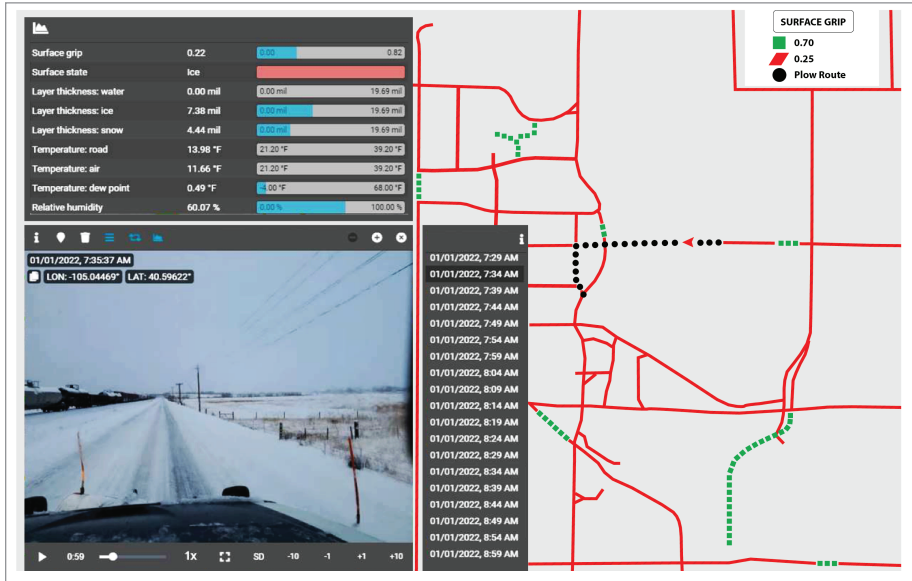


Figure 1. Display of data generated from sensors and plow cameras on equipped snowplow vehicles. These illustrations are intended to be representative of data and information available within the system and do not accurately reflect exact data within the system.

(Source: City of Fort Collins).

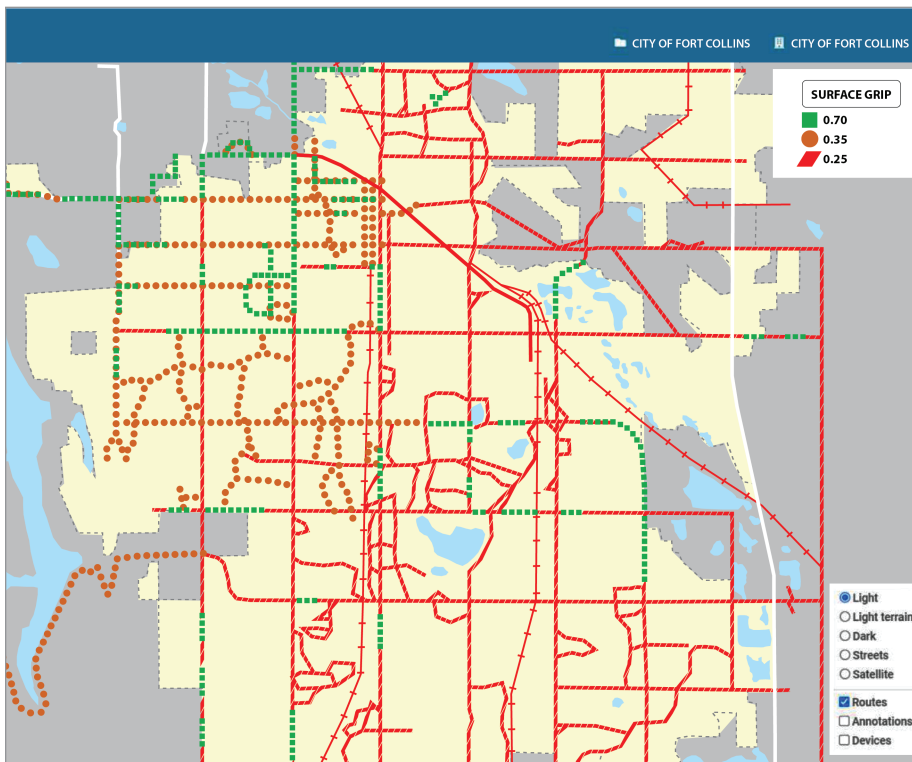


Figure 2. Data from equipped snowplows generate color-coded maps like this one that depicts roadway friction values. These illustrations are intended to be representative of data and information available within the system and do not accurately reflect exact data within the system.

(Source: City of Fort Collins).

Deicing Facility. To support snowplow operations, the city designed a fully automated deicing facility for winter maintenance operations that allows snowplows to be loaded in a timely fashion. The facility has spring-loaded arms that quick-attach to the snowplow to load deicing liquid, which are similar to what the airline industry uses and shown in figure 4. Operators can select different products based on different conditions (e.g., magnesium chloride-based, salt brine). The operator enters the truck number, and the system automatically knows how many gallons to load into the truck. At the same time, data are collected regarding the product and quantity for each truck. A similar system was envisioned for the dry material but not implemented due to costs. However, the city does operate loading equipment with wireless scales (i.e., a loader scale that wirelessly communicates to the plow as material is loaded) for granular material to support data collection efforts.



Figure 4. Spring-loaded arms (left) can quick-attach to snowplows (right) for fast loading of liquid deicing material. (Source: City of Fort Collins).

Performance Targets. The city used a data-driven approach to establish winter maintenance performance goals and to develop appropriate thresholds. Fort Collins categorizes all roads into one of four categories of descending priority:

1. Arterials (i.e., roads that serve emergency services).
2. Collectors (i.e., roads that feed into neighborhoods).
3. School routes.
4. Residential roads.

The city has established the following performance goals for arterials and collectors, as well as sidewalks, given the number of active, year-round bicyclists and pedestrians:

- Achieve bare pavement on major arterials within 4 hours after the storm ends. Although this target is not always achieved due to extreme low temperatures, high snowfall amounts, or plows that need to be repaired, the average time is 3.8 hours.
- Achieve bare pavement on collector roads within 6 hours after the storm ends.
- Open sidewalks within 24 hours after the storm ends.

OTHER ADVANCEMENTS

In addition to facilities, technologies, and performance targets described in previous sections, the City of Fort Collins has made other advancements over the years to create a foundation for success, including:

- *Developing a snow policy* for performing winter maintenance operations. This policy has been updated over the years, as needed.
- *Hiring local meteorologists and private sector weather service providers* for hourly weather forecasting.
- *Conducting prestorm meetings* for all stakeholders to understand what kind of storm is coming and how to best respond to it. The prestorm meeting is also a time to understand what equipment or staff are unavailable in order to make adjustments. These prestorm coordination meetings embody Pathfinder principles.
- *Deploying RWIS ESS* around the city starting in the 1990s, with a total of 12 ESS in use in 2022. These stations help the city support meteorologists when developing forecasts for weather and road conditions, and also to better understand localized problem spots. For example, one ESS was installed at the site of a two-person fatal crash where it was discovered that the roadway is often 10 degrees cooler than other areas due to extensive tree cover.
- *Establishing an interdepartmental agreement* through the city manager for the Streets Department to have access to personnel and equipment from other city departments during major winter weather events, which has strengthened interdepartmental relationships and eased the individual burdens on staff. The city also has an agreement with the county to trade responsibilities between select city and county roads for efficiency purposes, as well as an agreement with the State for the city to plow State roads that pass through Fort Collins.
- *Conducting annual snow training* in October, which is required for staff in all city departments. This 2-day training totals about 14 hours with seven courses that cover all aspects of winter maintenance, including products and materials, environmental impacts, snow policies, technology, and snowplow vehicles and facilities. The training is a combination of hands-on activities and classroom coursework and includes guest speakers, such as those from law enforcement to talk about rules and regulations. The training concludes with a driving course for evaluation, as well as a written test. New drivers also ride along in the snowplows after the course during the first one or two winter storms.
- *Transitioning to healthier and more environmentally friendly liquid materials* from sand in the 1990s, despite higher costs and less common usage (i.e., sand creates poor air quality). Fort Collins adopted practices more common in Europe such as having both liquid and granular materials in a single truck: liquid starts working immediately, and granular material is activated as traffic drives over it, for a longer-term solution. Fort Collins prewets all granular material for better adherence to the roadway surface.

- *Gained an understanding of environmental impacts* of snow maintenance activities by working closely with Colorado State University. The city understands how a given amount of material applied to roadways will affect environmental numbers in adjacent streams. Water samples are collected after every storm from devices placed in the stream. Stream water quality data are compared with the amounts of liquid and granular material applied on roadways in the area and help to ensure that the city remains in compliance and is not overapplying material.
- *Deploying technologies* such as automated spray deicing systems that the city first deployed in the 1990s. These systems use data from an adjacent ESS site to place deicing material at critical locations to reduce the risk of crashes, such as along a steep roadway with a railroad track at the bottom of the hill.

Conclusions

The City of Fort Collins has a long history of making advancements to increasingly automate processes and develop data-driven approaches to winter maintenance operations. These advancements have allowed the city to reduce costs and clear roads faster, resulting in improved safety and mobility for the traveling public. A primary example of cost savings comes from not overapplying material by using friction data and other available information to make better decisions about what material to use, and where and when to use them can make a major impact on costs (e.g., salt brine costs \$0.50 per gallon less than other liquid de-icing materials but can only be used for certain conditions; the city uses between 200,000 and 400,000 gallons of liquid deicing materials per year). Additionally, snowplow camera images have been used to refute false accusations of city snowplow vehicles causing damage or crashes. By automating processes, the city has been able to reduce the burdens on staff and increase efficiencies. The demonstrated success of various efforts has helped to justify the ongoing investments in new technologies and facilities to deploy additional technologies and to expand data-driven efforts.

Available Resources

FHWA Road Weather Management Program website: <https://ops.fhwa.dot.gov/weather>.

<https://highways.dot.gov>

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