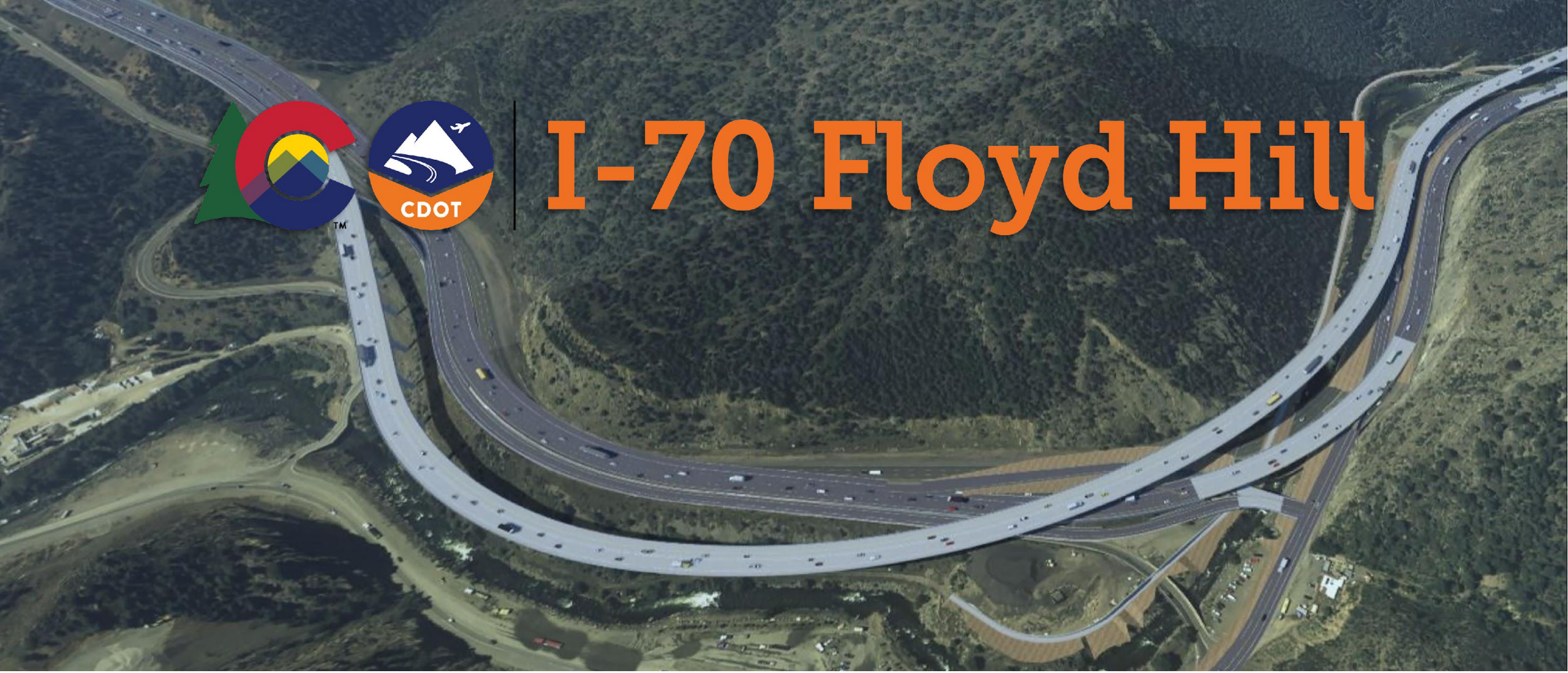


I-70 Floyd Hill

Deicer ITF Meeting

Feb. 15, 2024

AGENDA

- Introductions & Agenda Review
- Issue Recap & Prior Input
- Review of Current Water Quality Monitoring Data (Josh Giovannetti, CDOT)
- Review Maintenance Best Practices in Deicer Application and Tracking (Mike Chapman, CDOT)
- Other Water Quality Updates
- Review Action Items & Wrap Up

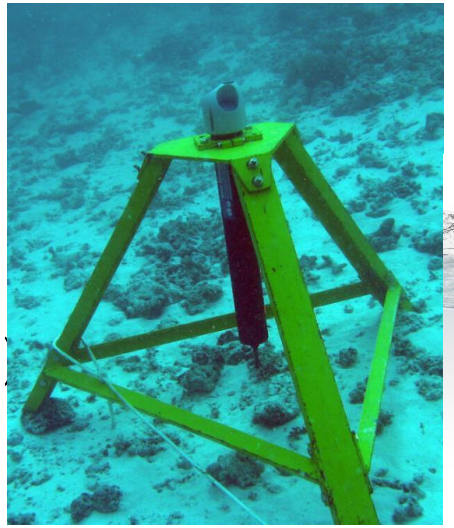
Issue Recap & Prior Input

- **ITF Purpose**
  - Discuss Floyd Hill-specific opportunities and strategies regarding deicing products that balance safety and environmental needs
  - Identify strategies to collect data, share and apply to Floyd Hill maintenance and operations
  - Identify corridor and region-wide ideas and/or process recommendations for addressing issues related to deicing practices and design
- **ITF voiced interests in…**
  - Understanding issue and existing water quality data through data-sharing, expert presentations, other methods
  - Strengthening ITF's collective understanding of the relationship between deicers and the natural environment (including stream health and vegetation)
  - Opportunities to mitigate potential effects of deicers within the Floyd Hill project area
  - Gathering information that may be applied to future I-70 corridor projects

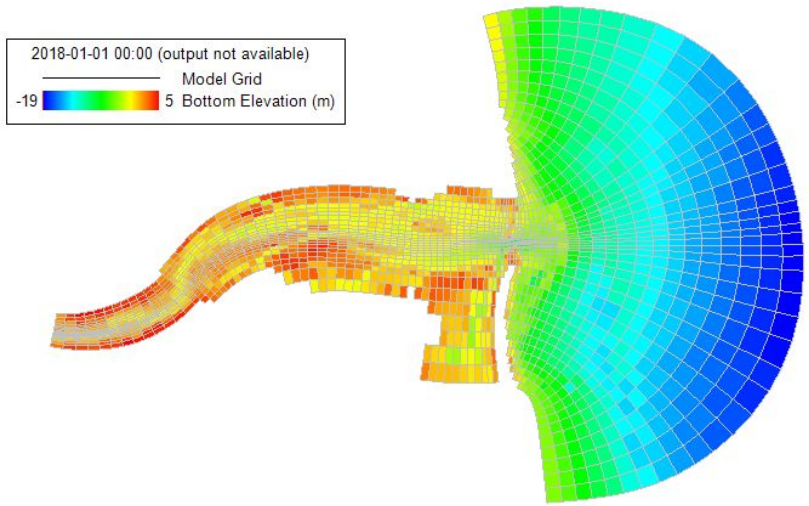
I-70 Floyd Hill

Josh Giovannetti, CDOT WQ Specialist

- Education in Ecology and Env Engineering
- 7 years CDOT, I-70 corridor
- 10 years WQ Engineer in Consulting
  - NPDES permitting compliance
  - TMDL development
  - H&H and WQ modeling (3 major components)
  - Stormwater management

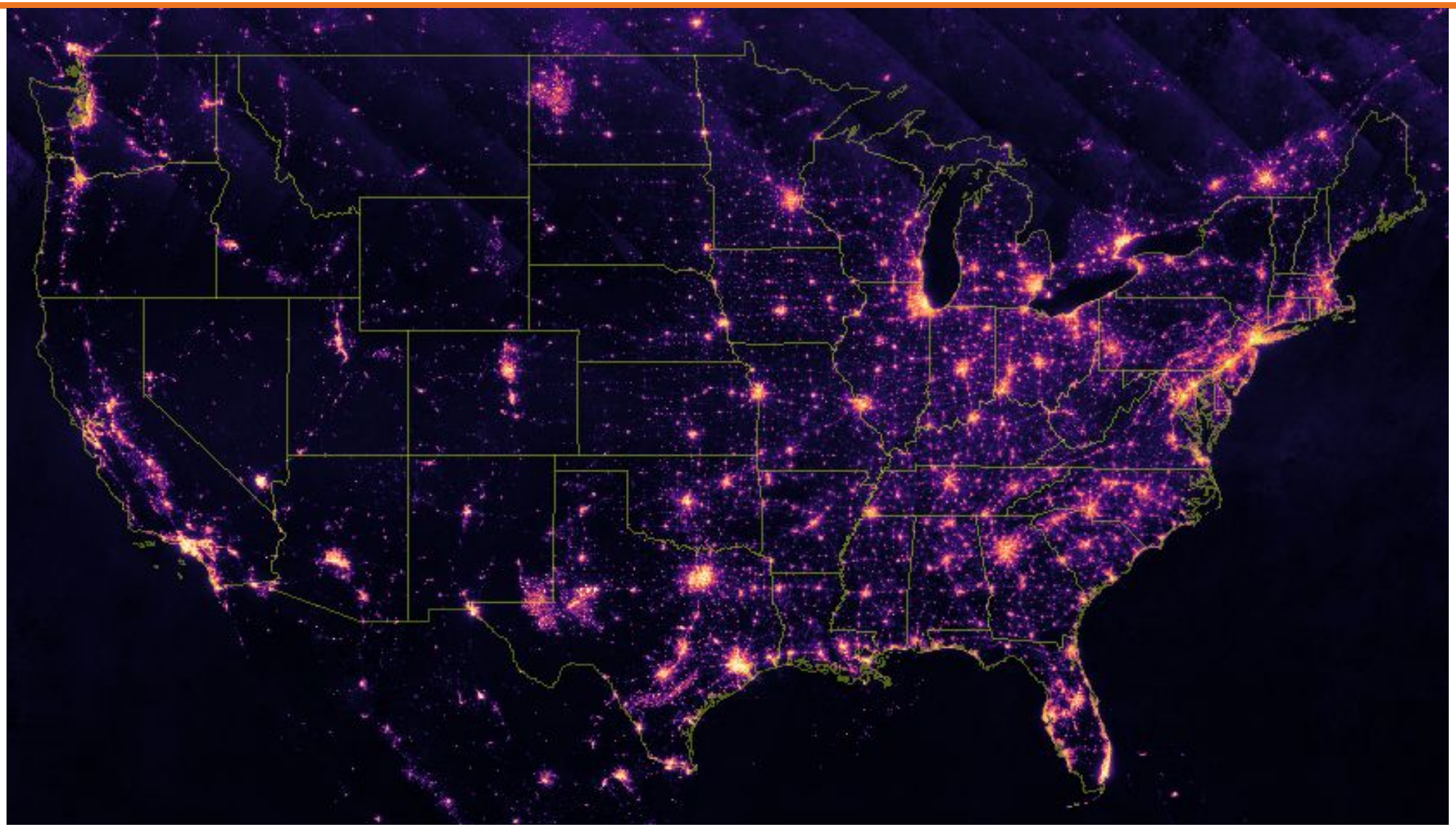


EFDC+ Demonstration



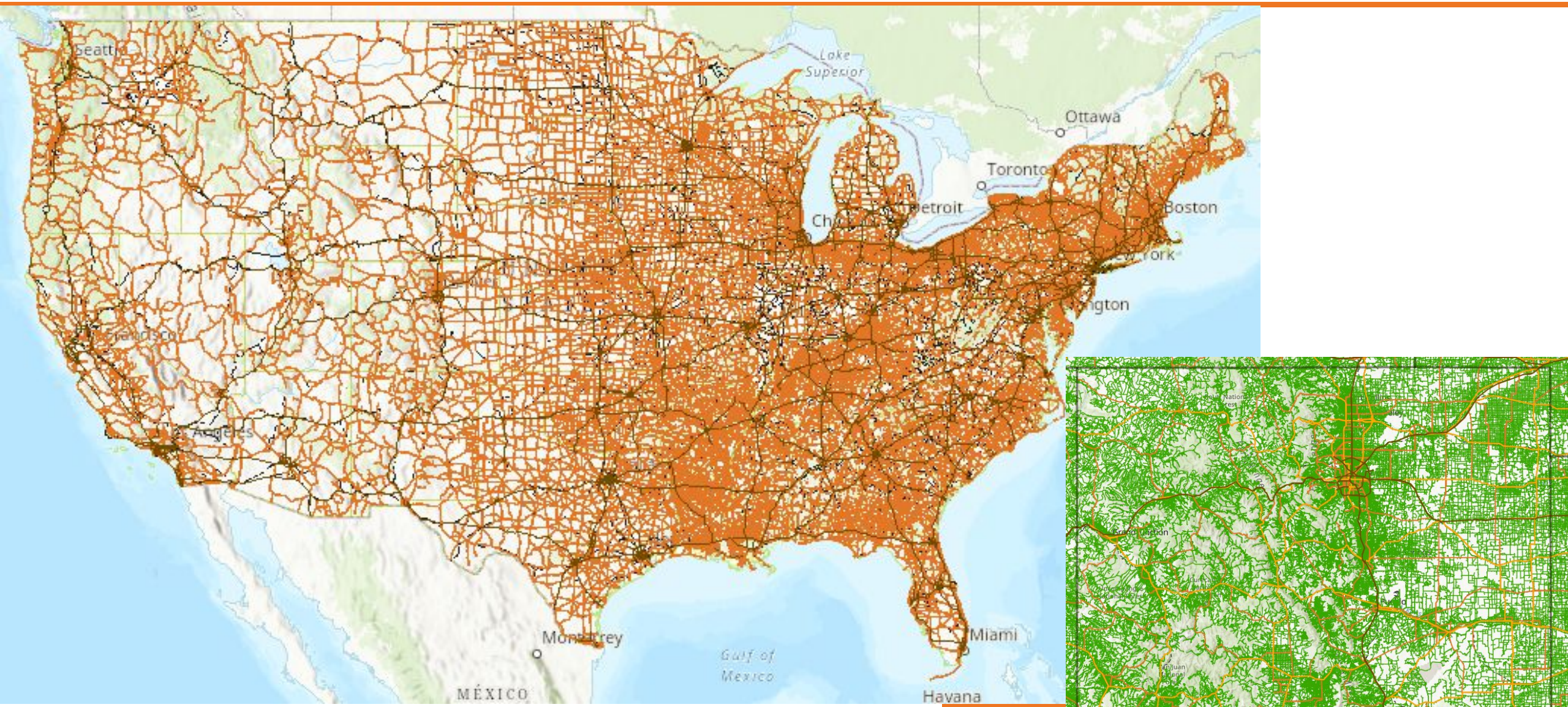
I-70 Floyd Hill

VIIRS Nighttime Lights Cloud-Free Composite



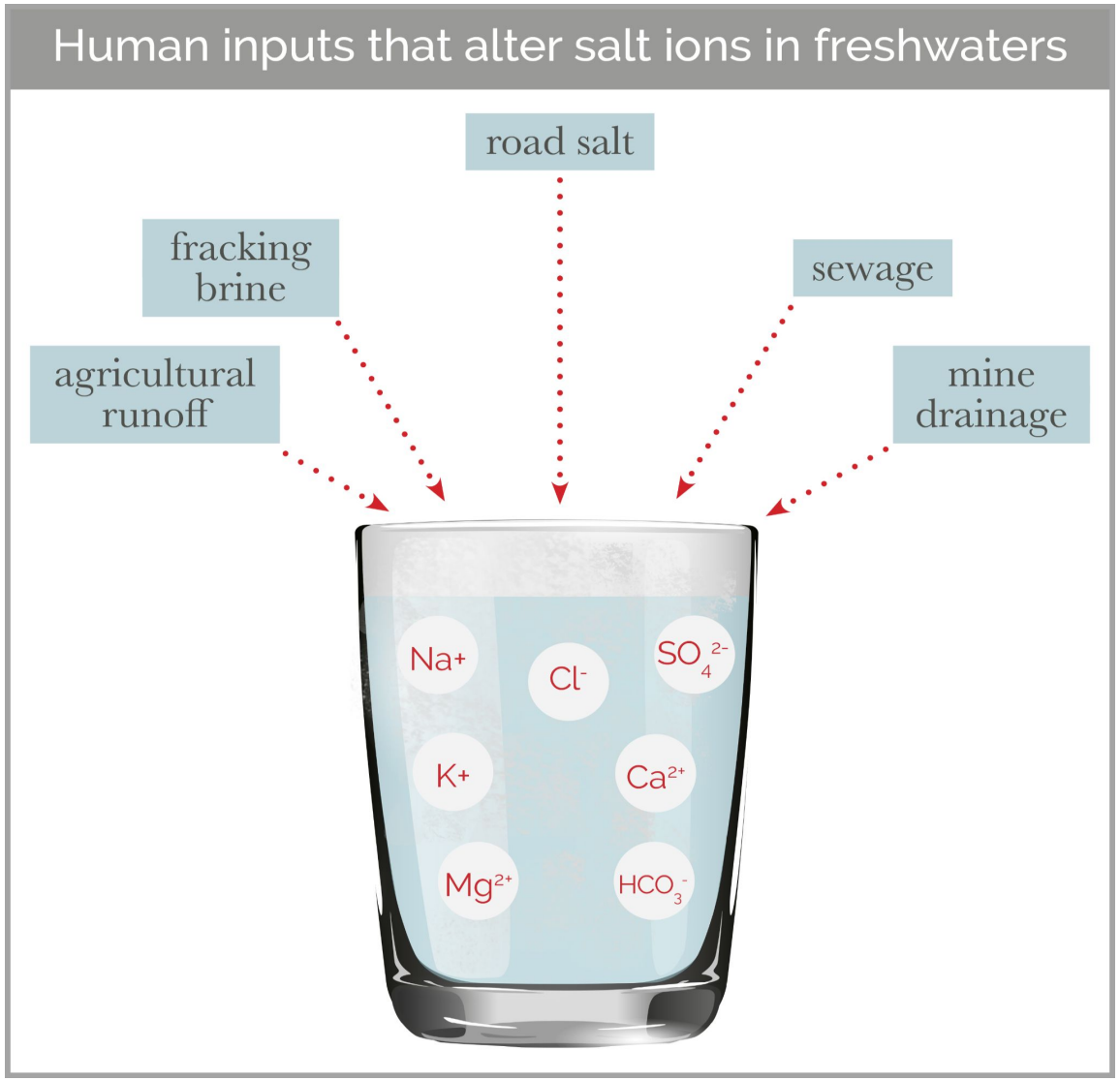
I-70 Floyd Hill

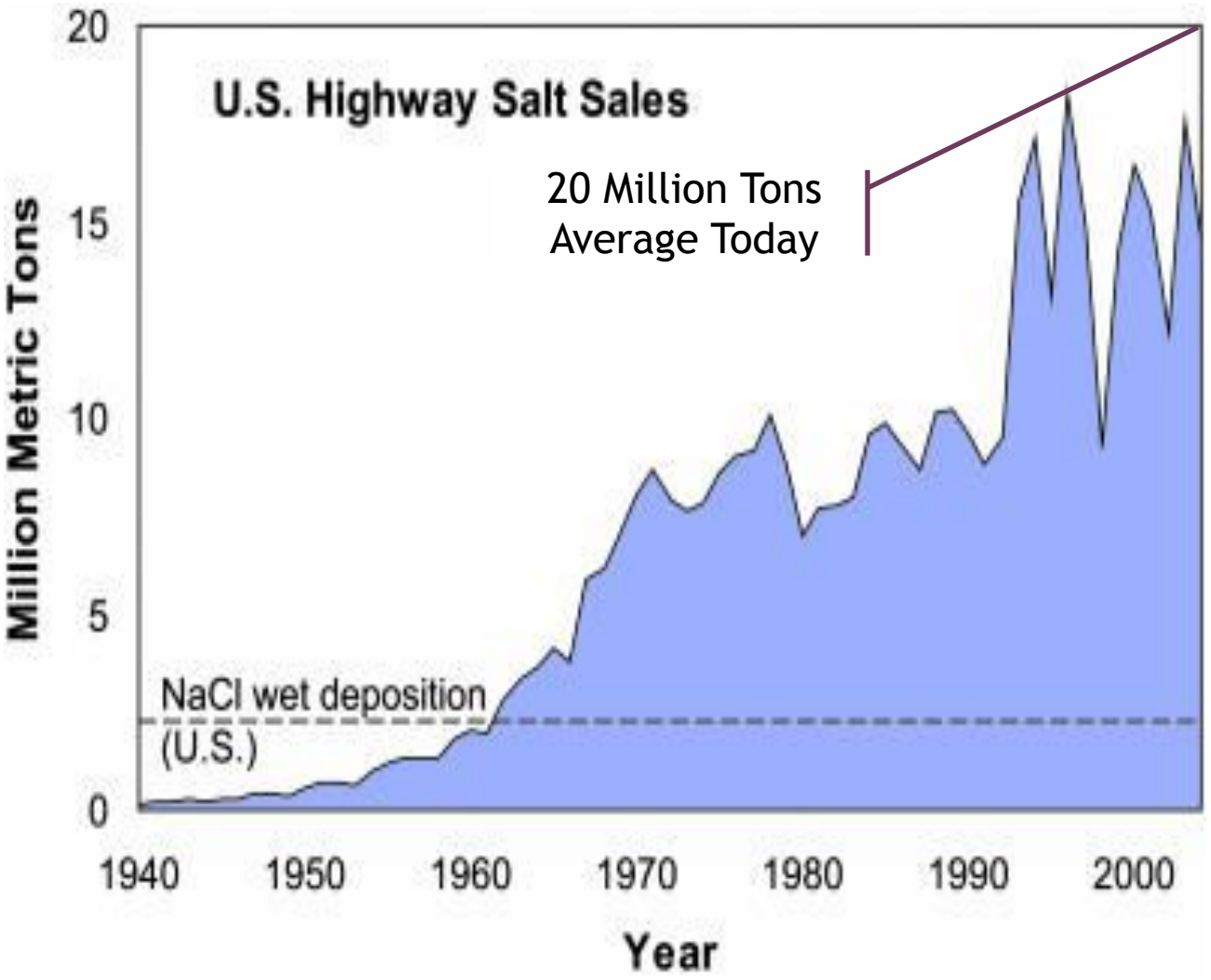
Primary and Secondary Roads



I-70 Floyd Hill

National Salt Perspective



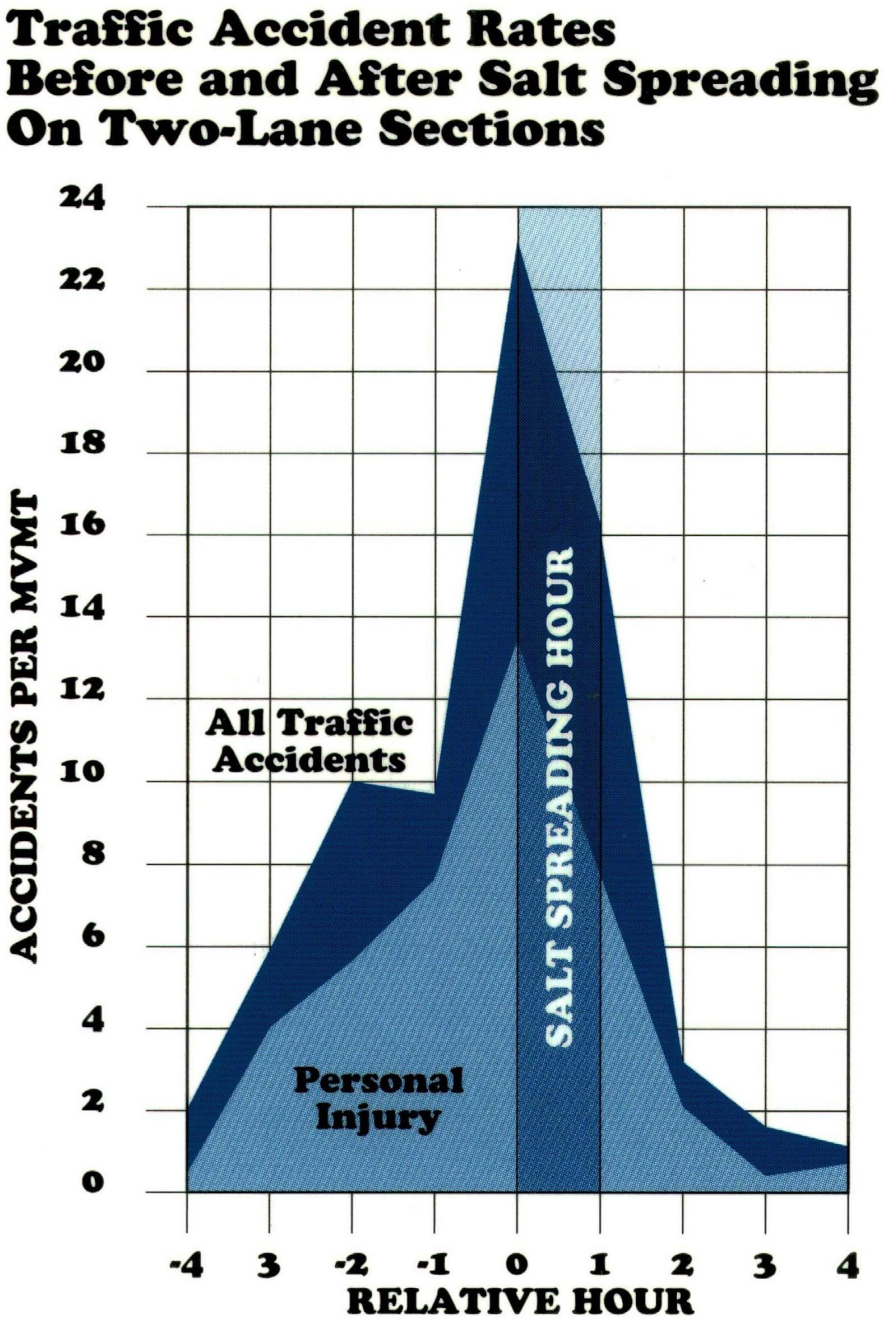


I-70 Floyd Hill

Safety!!

Deicing/Anti-Icing Reduces Accidents By

- 8X on 2-Lane Roads
- 9X on Multi-Lane Roads



Chloride in the Environment Sources

MANY POTENTIAL NATURAL AND ANTHROPOGENIC SOURCES

ABOUT 30 PERCENT OF CL DISPERSED TO THE ENVIRONMENT IS ROAD SALT.

Other sources include:

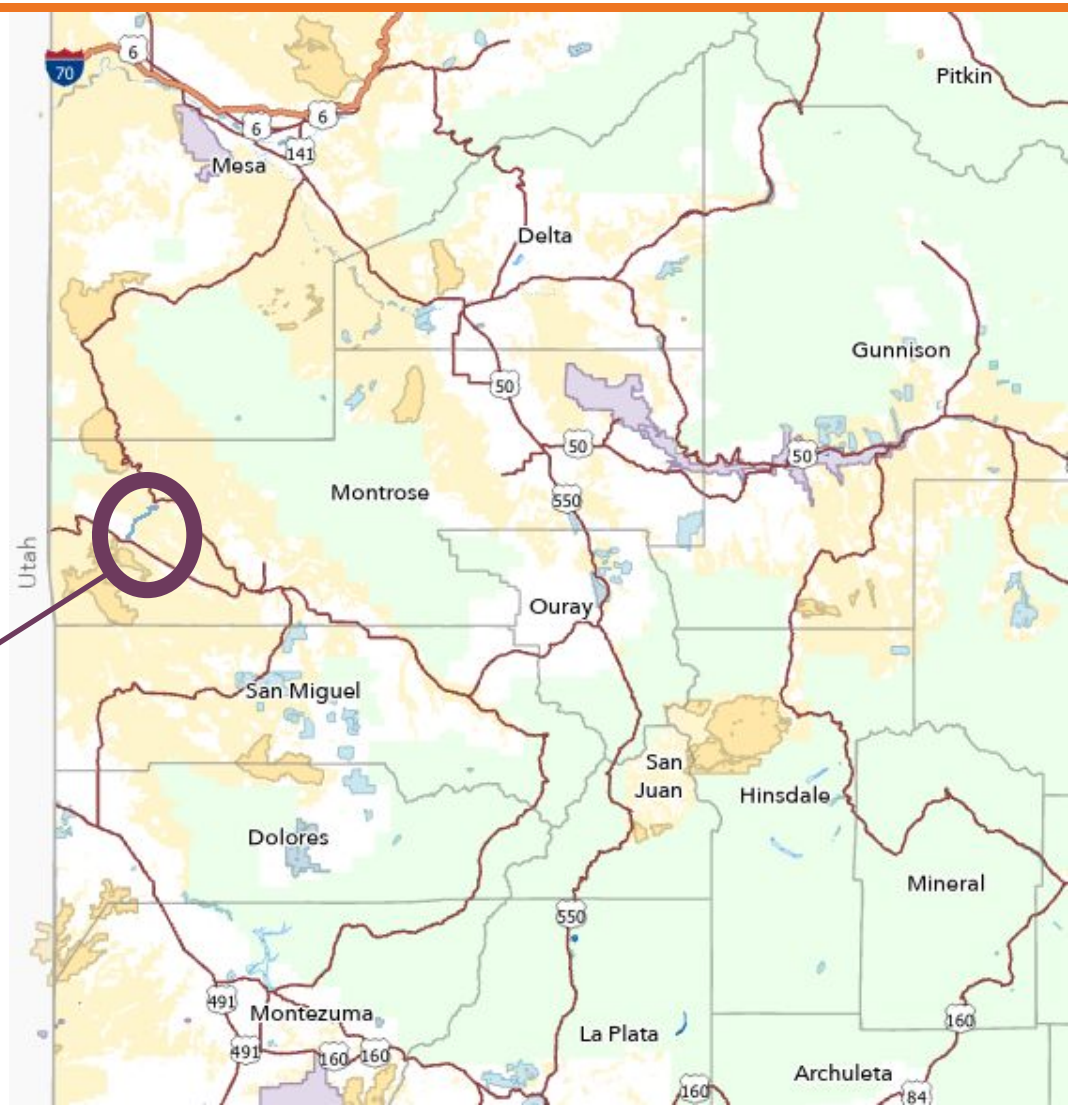
- Chemical Manufacturing/Chlorine
- O&G Extraction Salt Brine
- Fossil Fuel Combustion for Energy Production
- Diversion For Water Supply Reduces Downstream Dilution Capacity
- Increased Use Of Bedrock Wells Increases TDS
- Ground-Water Intrusion Caused By Withdrawals
- Evapotranspiration From Irrigation
- Concentration Of Animal Waste By Agriculture
- Landfills and Trash Incineration

I-70 Floyd Hill

Snapshot of 303(d) Listings

Impaired Waterbodies where Chloride is identified as primary stressor:

- Utah – No chloride pollutant designation
- Wyoming – 5 waterbodies
- Colorado – 1; Mainstem of Dolores River from East Paradox Creek to the San Miguel River, listed 2018
- Minnesota – 50 waterbodies



Minnesota References

Minnesota Stormwater Manual Deicing Agent Properties

https://stormwater.pca.state.mn.us/index.php?title=Table_summarizing_of_properties_of_deicing_agents

COLORADO
Department of Transportation

I-70 Floyd Hill

- Conductivity, Temperature, Turbidity
- Metals discrete and storm event sampling annually
- Four locations on Upper Clear Creek have permanent meters installed for continuous monitoring (15 minute intervals):
  - CC-1 (Near Herman Gulch)
  - CC-2 (Near Outfall of Georgetown Lake)
  - CC-3 (Just Upstream/West of Veterans Memorial Tunnels)
  - CC-4 (Downstream/East of Veterans Memorial Tunnels)
- Conductivity and temperature are used as a surrogate to represent Chloride concentrations, represented as Specific Conductance (uS/cm).
  - Specific Conductance converted to Chloride concentrations using an empirical formula.
  - This surrogate value is confirmed by manual grab samples of Chloride annually.
  - The Specific Conductance to Chloride correlation has not significantly changed over the entire data period, 2001-2023.

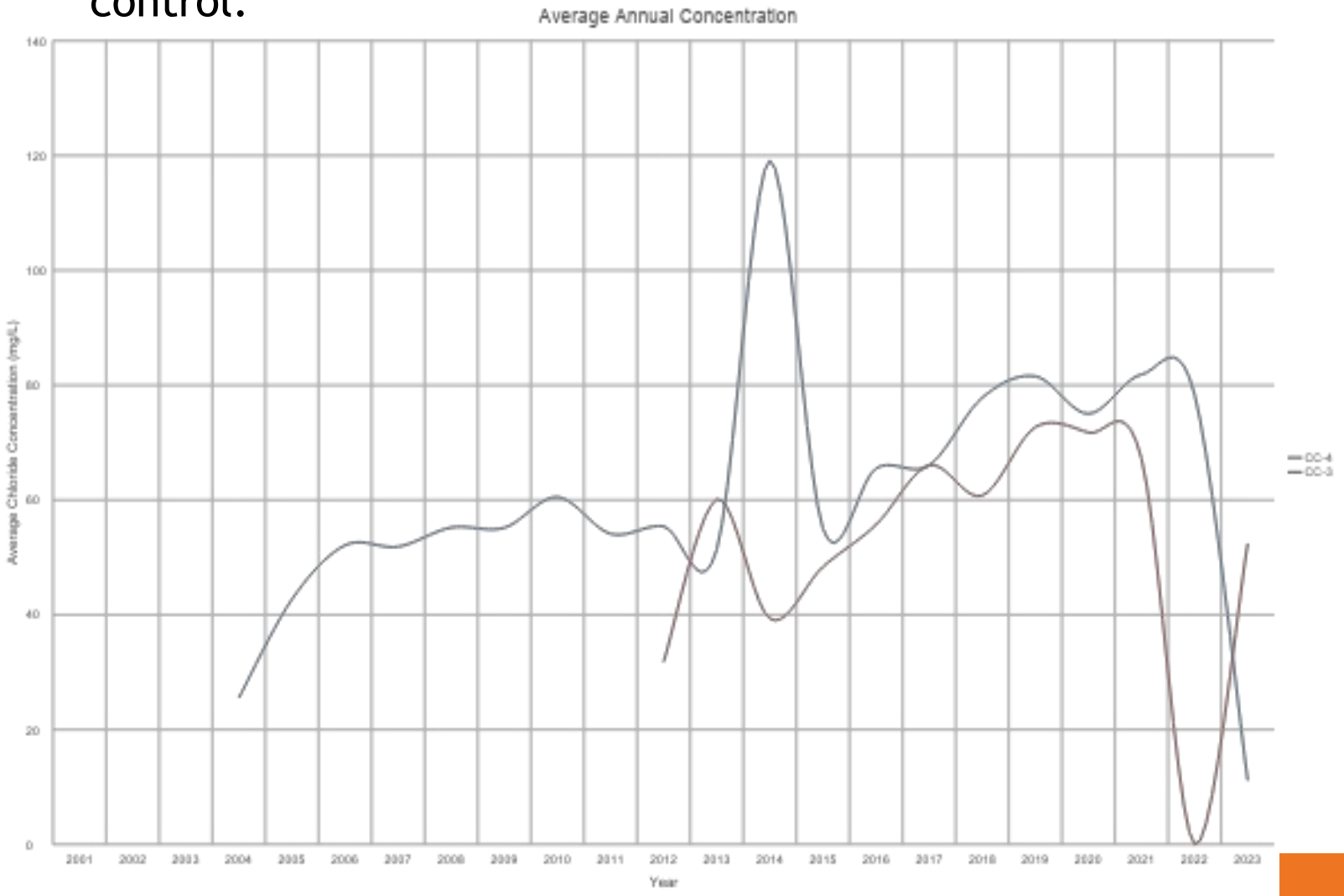
I-70 Floyd Hill

CDOT WQ Monitoring Locations
Floyd Hill Area

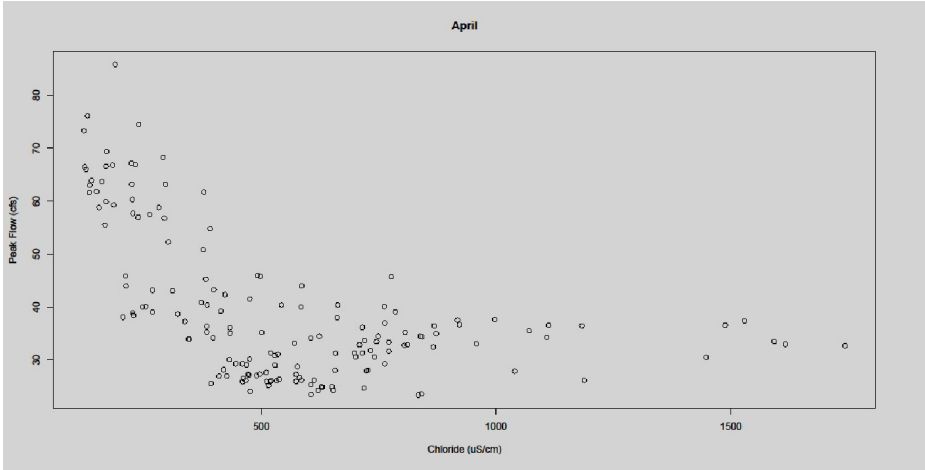
I-70 Floyd Hill

Monitoring Data

Detailed statistical analysis began last year to determine correlations that could lead to source control.



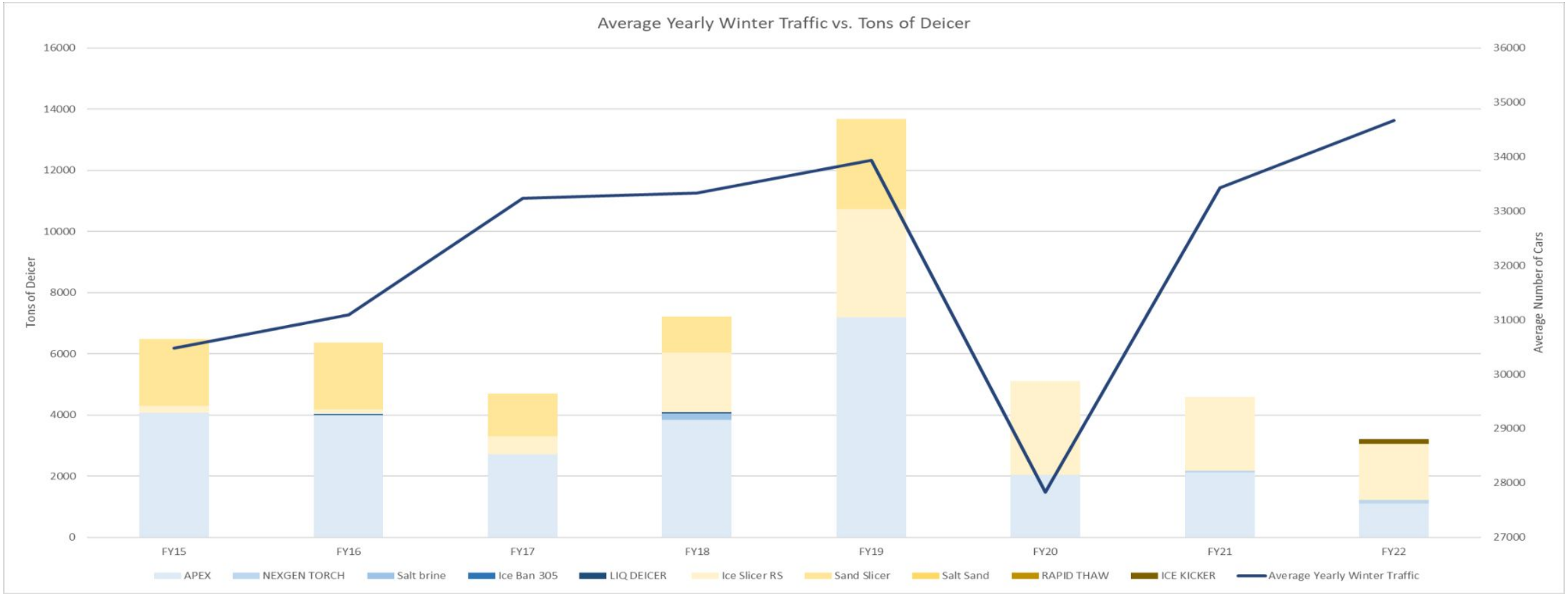
- Increased traffic loading
- Changes in application rates, materials, or practices
- Changes in weather patterns, precipitation, flow regimes
- Political changes



I-70 Floyd Hill

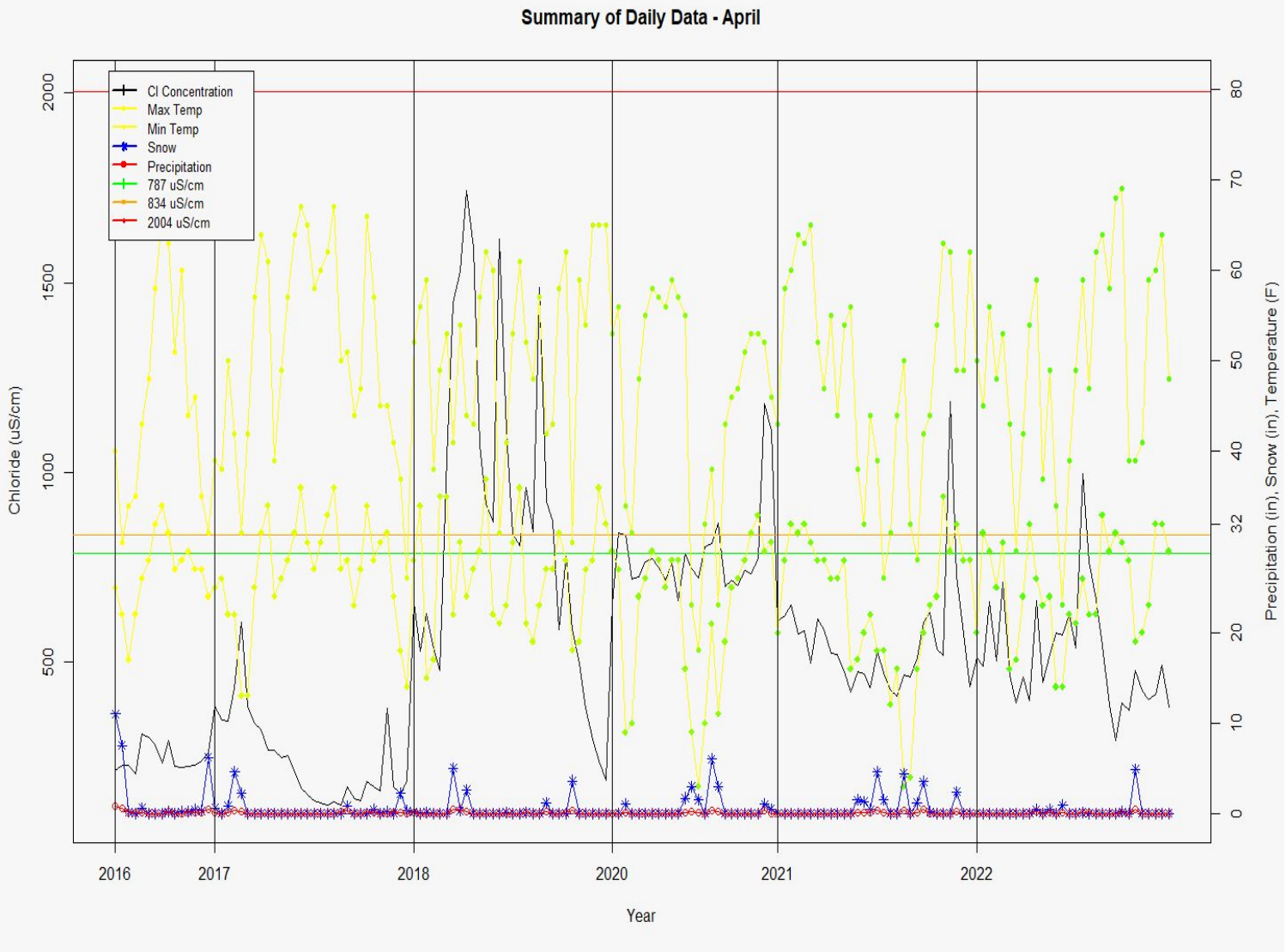
I-70 Clear Creek Corridor Traffic and Deicer

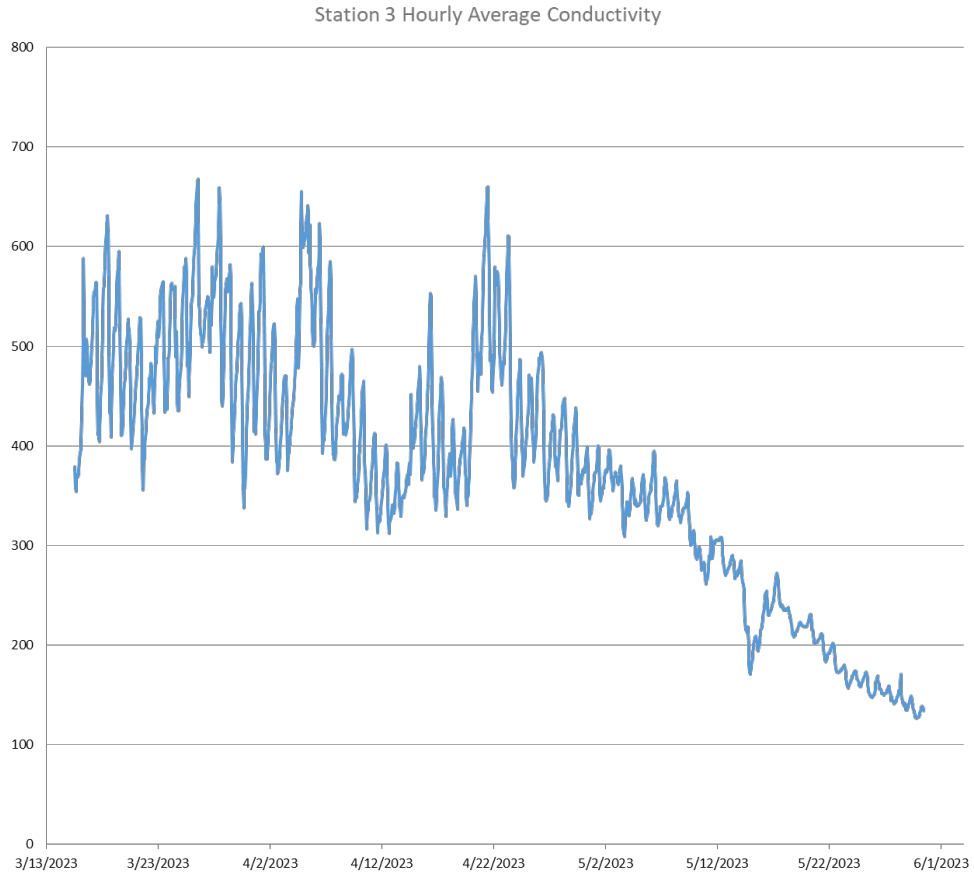
*Liquid deicer converted to tons using APEX lbs/gallon: 10.36lbs/gallon



I-70 Floyd Hill

April greatest concentrations





I-70 Floyd Hill

Recommended Levels

Three recognized levels used to assess water quality

Canadian WQ Guidelines for aquatic life
EPA 1988 Ambient WQ Criteria

- Acute – 860 mg/L one hour average
- Chronic – 4 day averave greater than 230 mg/L
- Secondary drinking water standard is 250 mg/L for aesthetics

Regulation 38

- 250mg/L 30 day average

Daily Max Exceedences		
Value Exceeded	CC-3	CC-4
230+ 4 days	0	0
250+	0	21 individual Not 30 day Avg
860+	0	1

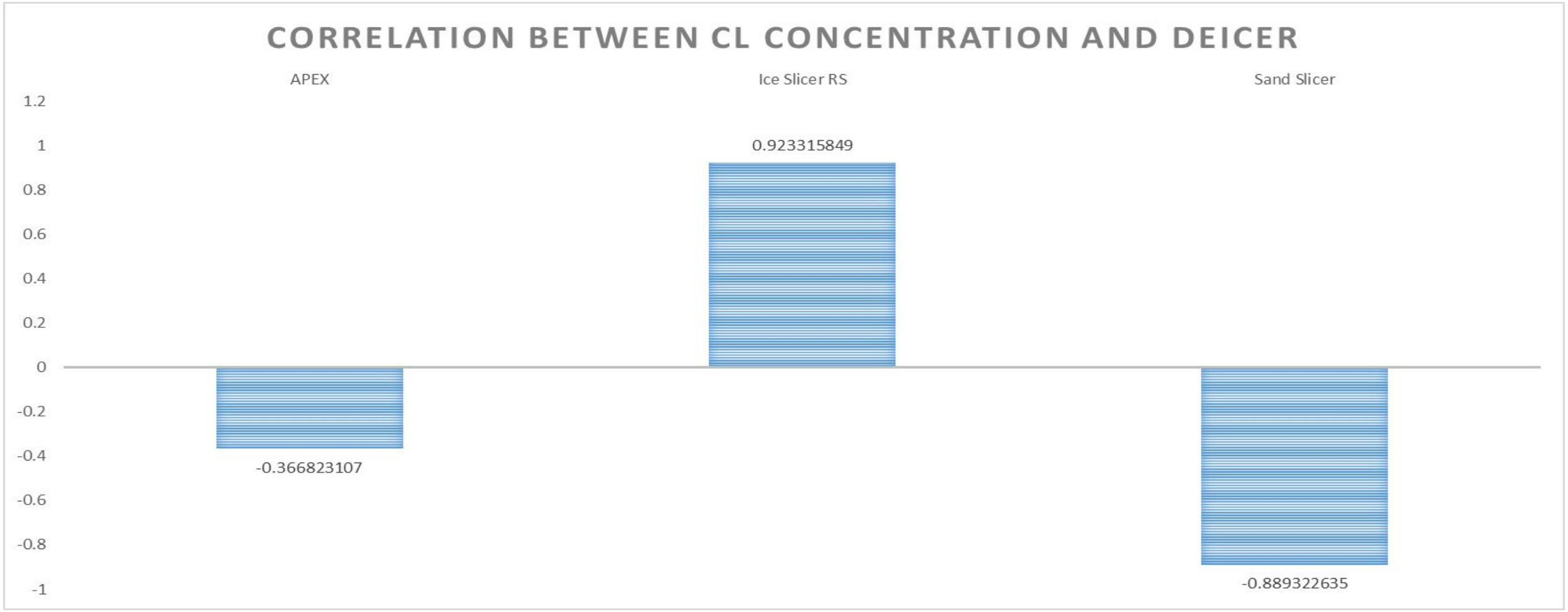
I-70 Floyd Hill

Canadian WQ Guidelines

Average Exceedances				
Value Exceeded	CC-3 2017-present	CC-3 Note	CC-4 2014-present	CC-4 Note
640+ (Short-term)	0		1	Two hours in length
120+ (Long-term >24 Hours)	9	Some occurred within days of eachother and could be considered >7 days. Events are 1.3-6.3 days in length	18	Some occurred within days of eachother and could be considered >7 days. Events are 1-5.6 days in length
120+ (Long-term >7 Days)	2	2023-2024 occurrence is 23.75 days and ongoing as of last data download	3	2019 occurrence lasted >30 days. 2023-2024 event likely, but not captured

I-70 Floyd Hill

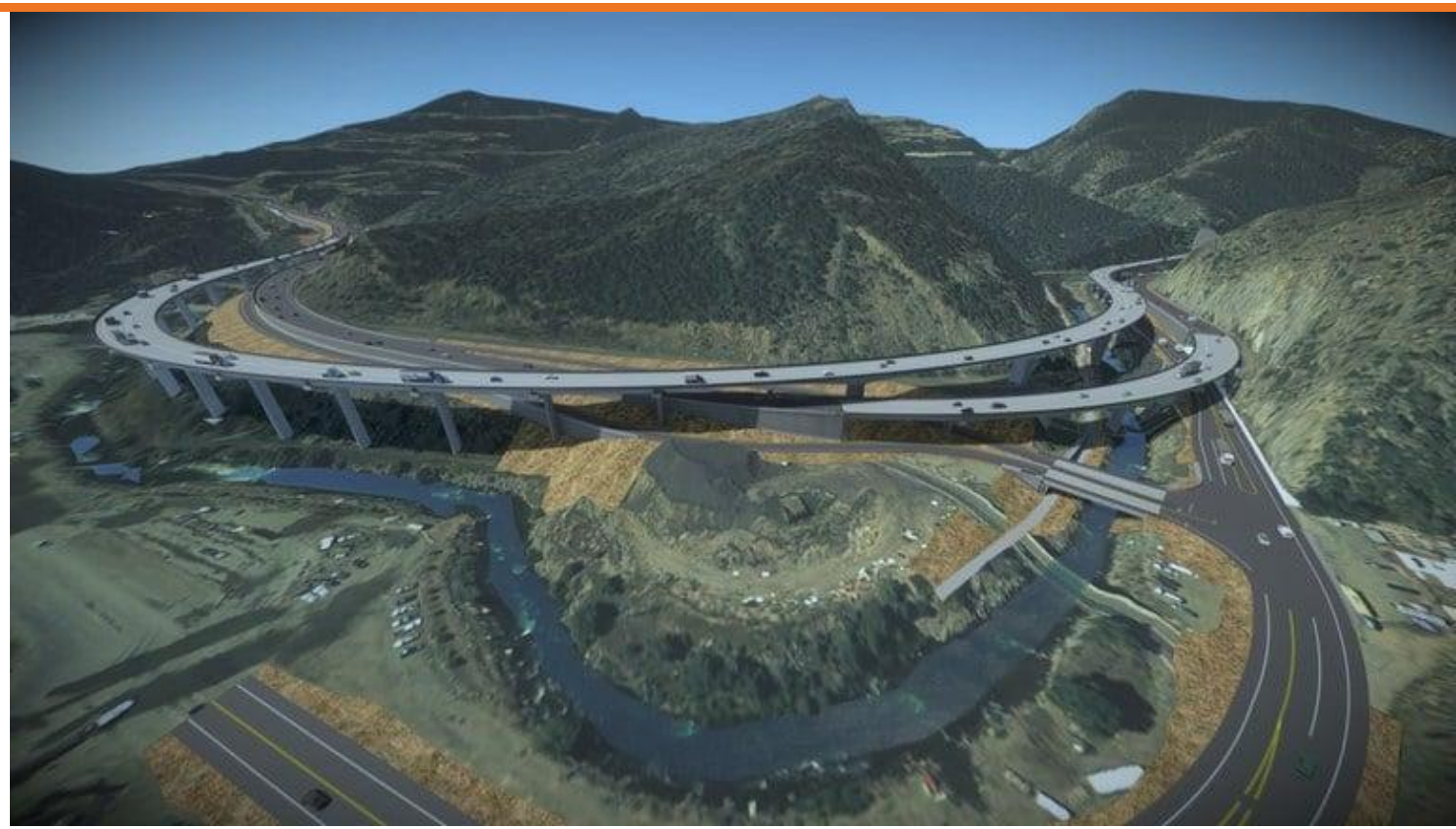
I-70 Clear Creek Corridor: Correlation of Chloride Concentration by Deicer Type



I-70 Floyd Hill

Takeaways

- Chloride trend has changed since 2017.
- Greatest concentrations in 2018.
- Seasonal Chloride concentrations are greatest during low flow winter and snowmelt run-off (March/April) and least during high flow rains (June/July).
- Greatest Chloride concentration and variability occur hightest in the basin and then generally decreases downstream to, likely result of increasing watershed size.
- Veterans Memorial Tunnels station is typically less variable and lower in Cl concentration.
- Guidelines and standards are becoming a consideration, indicating a need to continue source assessment, data collection, and winter maintenance collaboration.



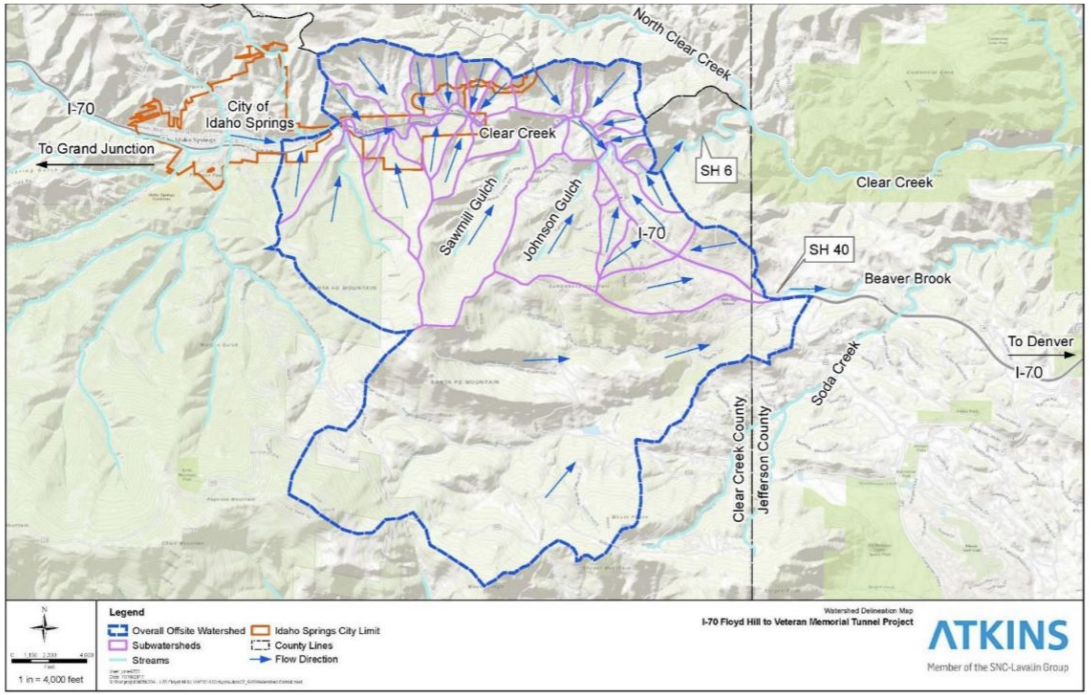
Water Quality

- Water Quality Approach
  - Following treatment for Municipal Separate Storm Sewer System (MS4) permit areas (though project area is outside CDOT's MS4 permit area)
  - Treatment of 90% of added impervious surface across all project sections
  - Management of sediments and other pollutants designed with maintenance accessibility in mind
- Clear Creek is impaired for cadmium, lead, temperature, and zinc.
- Water quality assessment included cadmium, chloride, copper, lead, sediment, and zinc.

I-70 Floyd Hill

Stochastic Empirical Loading and Dilution Model (SELDM)

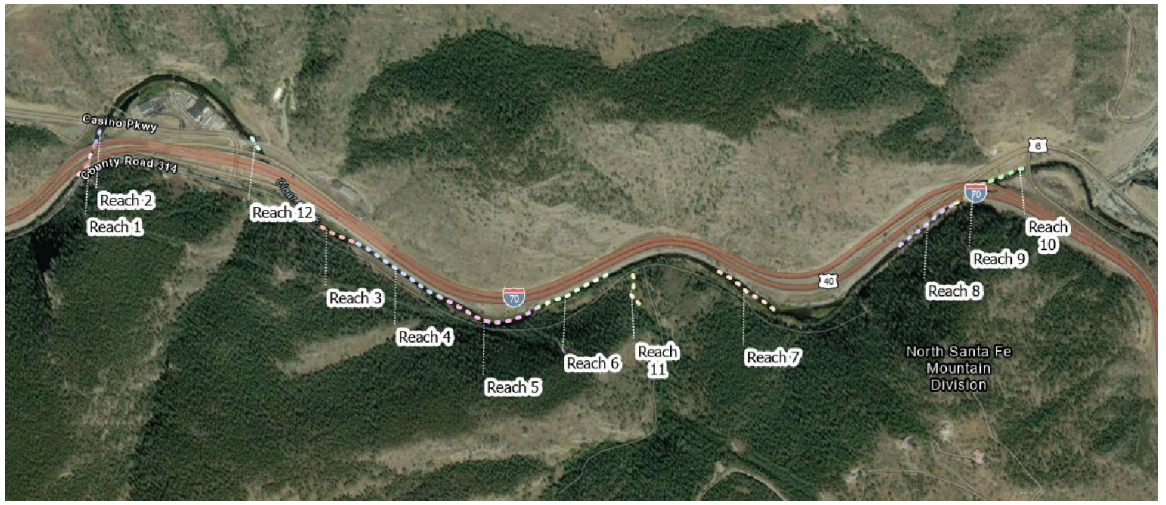
- SELDM FHWA's approved WQ assessment model, developed by USGS for transportation implementation
- SELDM used to evaluate control measures
  - Extended detention basins and vegetated swales recommended as primary control measures. Riprap aprons in constrained areas, such as under bridges
  - Additional conveyance measures to reduce stormwater velocity
- SELDM analysis for chlorides
  - Vegetated swales have some effect on reducing chlorides in runoff
    - Slow down the release of chlorides by using plant uptake
    - Opportunities to dilute with offsite runoff
  - 20 to 33 percent reduction in chlorides compared to no BMPs
  - Control concentration spikes to address temporal component of WQ guidelines



I-70 Floyd Hill

Colorado Stream Quantification Tool (CSQT)

- Regulatory tool to assess baseline stream function and quantify change
- Waters in the project area defined in 12 reaches, 11 along Clear Creek, 1 along Sawmill Gulch
- Existing condition assessment completed
  - Clear Creek falls within the “not functioning” category of the CSQT scoring matrix
  - Sawmill Gulch is “functioning at risk”
- Tool was originally developed to support Section 404 permitting
  - Based on project design changes, permitting does not require CSQT
  - However, informs voluntary enhancements with riparian bench restoration



Winter Operations at CDOT

- **Michael Chapman - Program Manager**
  - Meteorologist
  - 15 years at NCAR (Lead Scientist for Surface Transportation Weather)
  - 7 years in private sector (New Road Weather Technology)
  - 14 years teaching Meteorology and Climate Change (Faculty @ MSU-Denver and Colorado Mountain College)
- Winter Ops is part of CDOT DMO
- Weather Forecasting
- Advanced Technologies and Applications
- Avalanche Mitigation
- Winter Road Maintenance
- Research and Development

I-70 Floyd Hill

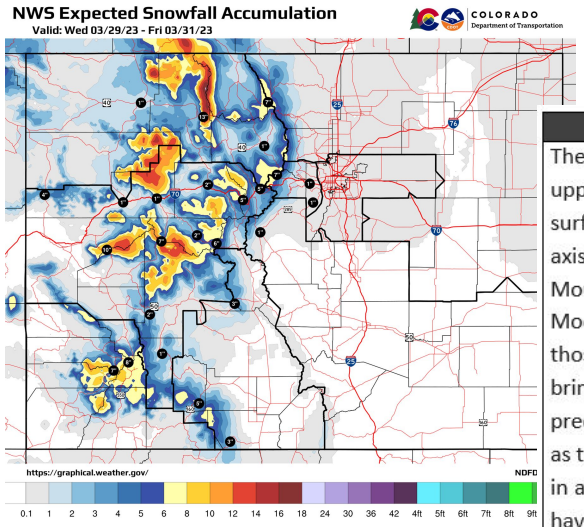
Maintenance Best Practices in Deicer Application and Tracking

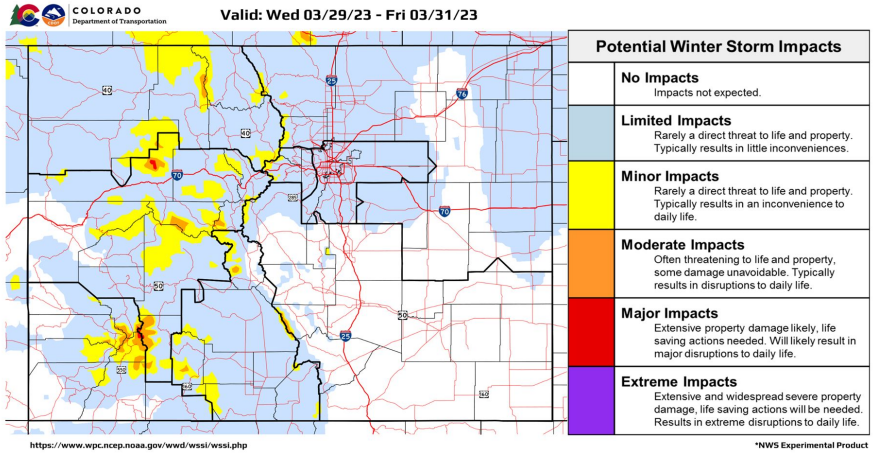
Winter Operations at CDOT

Weather Forecasting

Human Generated

- Storm specific forecasts
- Road-centric
- Geography-centric
- Focus on Impacts
- Maintenance and Traffic





Event Synopsis
The system that hit California this week is going to move over the State Thursday. Out ahead of the trough will be SW Flow in the upper levels and the jet stream. This favors moderate snow over all mountain zones starting Thursday late morning. Strong surface winds will create blowing snow conditions and impacts to the roads later in the day as the snow cranks up. As the trough axis passes over the state early Friday morning, the upper-level winds will shift to the NW favoring heavy snow in the Northern Mountains like the Park Range and high mountain peaks of the Central Mountains including Grand Mesa, Flat Tops and Elk Range. Moderate snow is expected over the I70 Corridor with 4-6 inches possible over Vail Pass and the EJMT and strong winds impacting those areas with blowing snow conditions likely throughout the day on Friday. Over lower elevations, this system is expected to bring windy conditions over most of the urban corridor and Eastern Plains on Thursday and Friday. There is a shot for some precipitation (starting as rain and changing to snow after a few hours) mainly North of the Palmer Divide over the Urban Corridor as the trough moves over the mountains overnight on Thursday but amounts are expected to be light. The jet stream is oriented in a direction that could bring some banded snow over the Northern half of the state overnight on Thursday. These bands will have the potential for moderate/heavy snow over very localized areas. As the trough exits the state on Friday, there is a chance for some accumulating snow over the far NE corner later in the day on Friday. Southern Plains look to remain dry (other than Palmer Divide) and windy with Red Flag conditions continuing through at least Thursday night.
Pavement Impacts
Blowing snow in the higher elevations will impact the roads over the Northern and Central Mountain zones from later in the day on Thursday through Friday night as pavement temps are expected to dip below freezing Thursday afternoon and remain below freezing throughout the day on Friday. Over the lower elevations, snow totals aren't expected to be significant and pavement temps are forecast to stay close to or above freezing. If we do generate some heavier pockets of snow overnight on Thursday, then impacts to the pavement will likely remain minor.
NWS Storm Severity Index

I-70 Floyd Hill

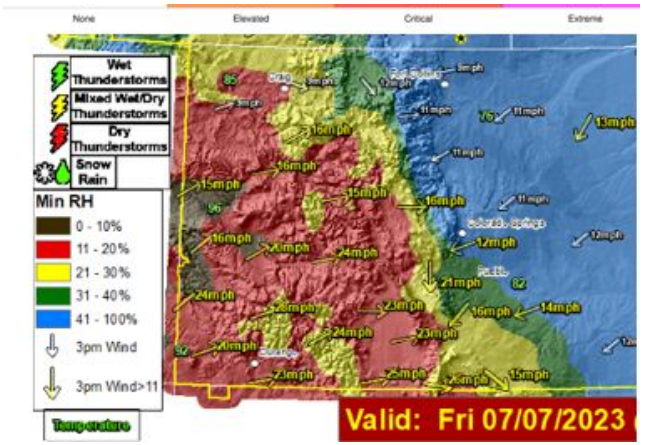
Maintenance Best Practices in Deicer Application and Tracking

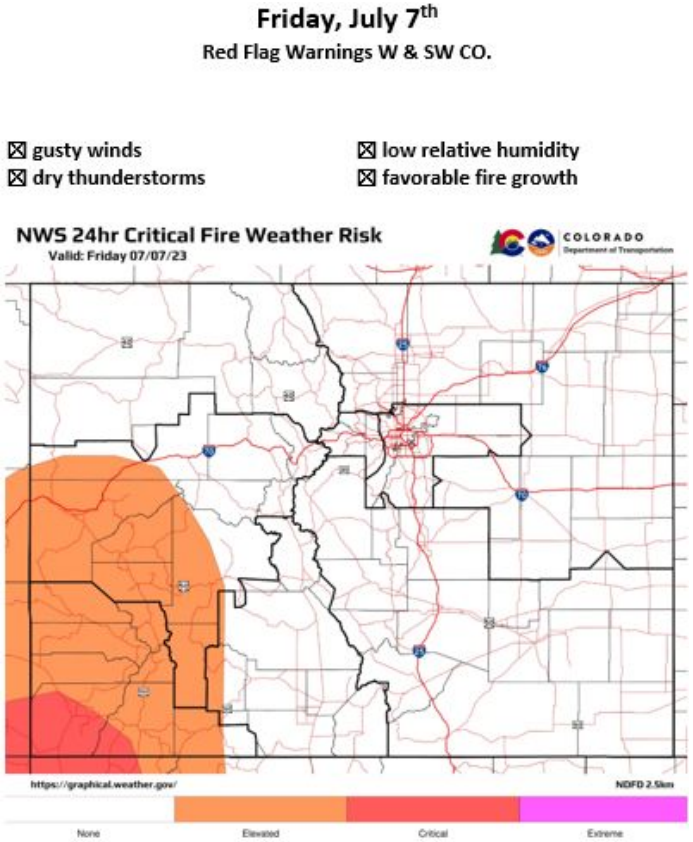
Winter Operations at CDOT

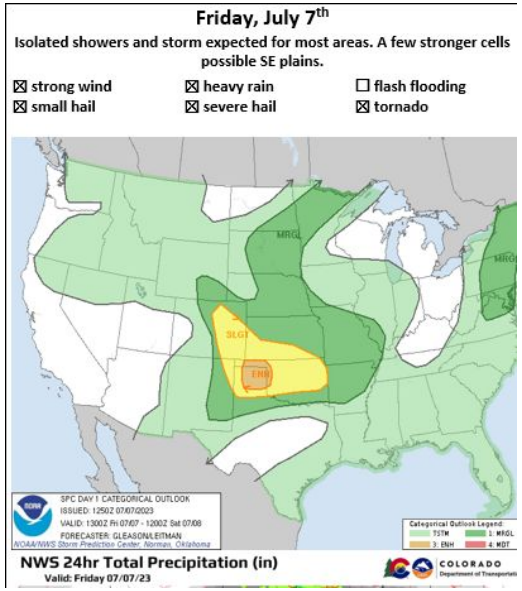
Weather Forecasting

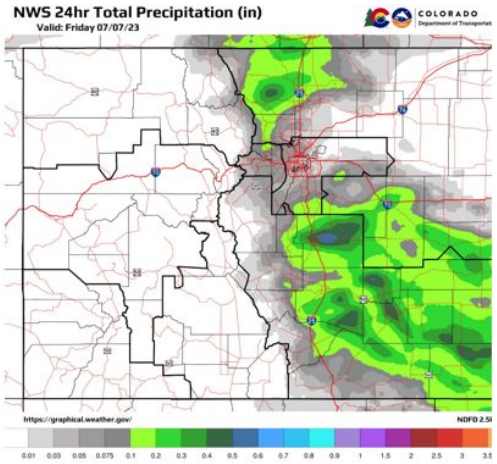
Human Generated

- Non-winter forecasting
- Run-off
- Monsoon
- Fire
- Severe weather
- High wind







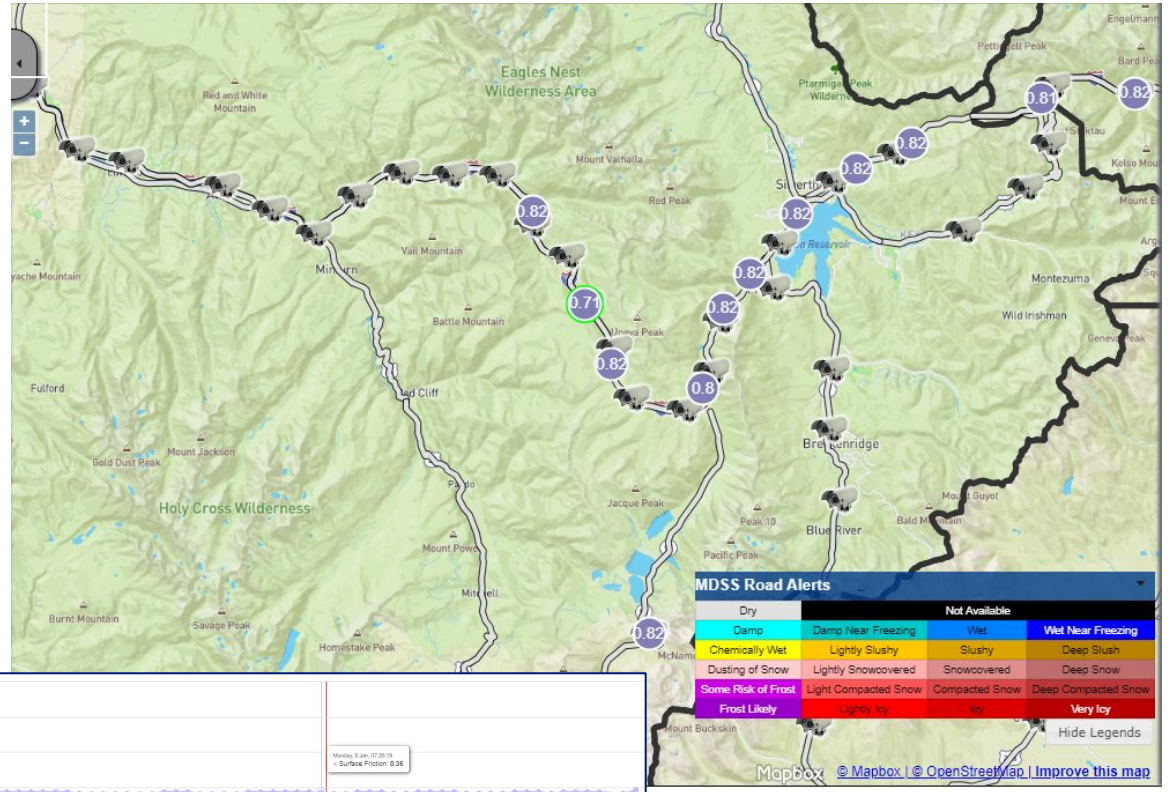


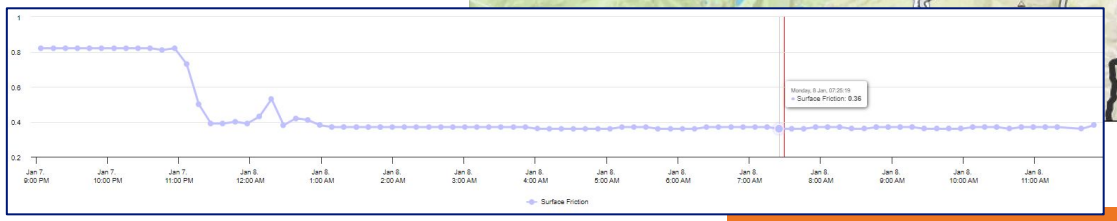
Winter Operations at CDOT

Application Management

Maintenance Decision Support System - MDSS

- Significant Investment over the past 15 years
- Plow Route specific forecasts
  - Pavement Temp and Condition
  - Air Temp and Relative Humidity
  - Wind
  - Precip type and amount
  - Treatment recommendations
- Point Specific at Weather Stations Locations
- End of shift reports - Material Tracking





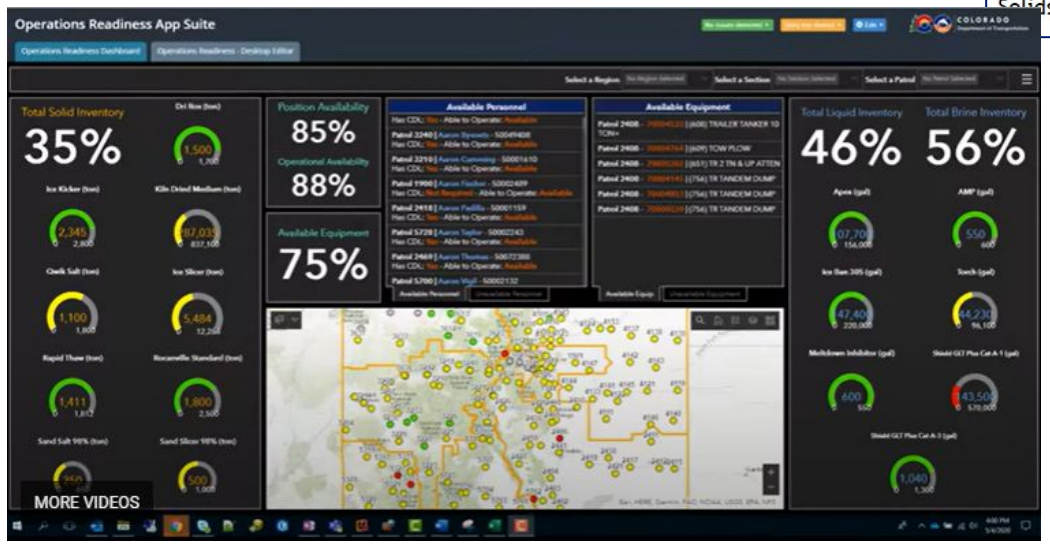
Winter Operations at CDOT

Application Management

Operational Readiness

- Situational Awareness - Section to Section
  - Personel
  - Maintenance Assets
  - Material Availability

Region 1 Section 5 Personnel = 82% Equipement = 84% Liquids = 66% Solids = 68%	Region 1 Section 9 Personnel = 74% Equipement = 84% Liquids = 62% Solids = 53%	Region 2 Section 4 Personnel = 90% Equipement = 85% Liquids = 81% Solids = 55%	Region 3 Section 2 Personnel = 71% Equipement = 79% Liquids = 69% Solids = 43%
Region 3 Section 6 Personnel = 72% Equipement = 75% Liquids = 66% Solids = 76%	Region 4 Section 1 Personnel = 81% Equipement = 86% Liquids = 65% Solids = 72%	Region 5 Section 3 Personnel = 78% Equipement = 80% Liquids = 44% Solids = 48%	Region 5 Section 7 Personnel = 86% Equipement = 77% Liquids = 58% Solids = 43%

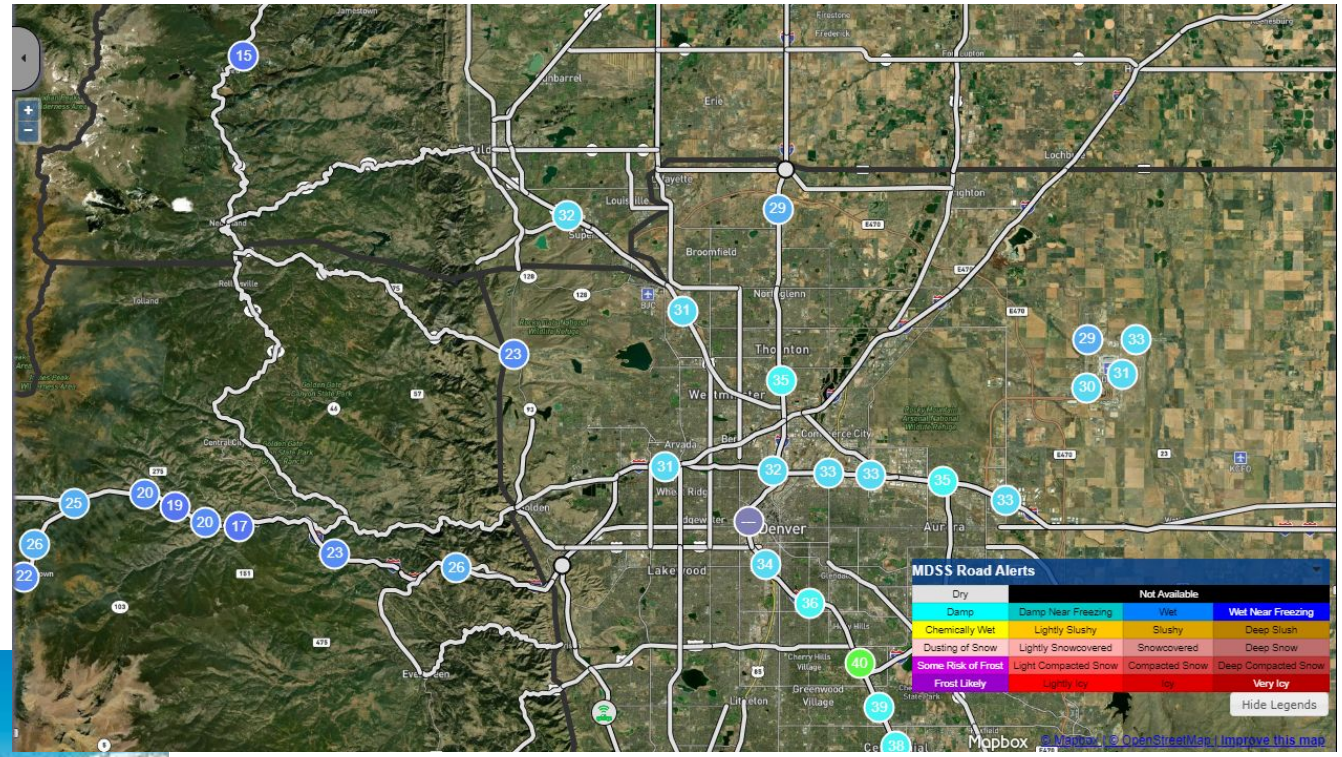


Winter Operations at CDOT

Road Weather Observations

Road Weather Information System (RWIS)

- Over 150 RWIS stations
  - Focused mainly over I70 and I25
  - Material-heavy areas
- Environmental Information
  - Atmospheric Weather
  - Road Weather (Pavement temp and Condition)
  - Camera Imagery

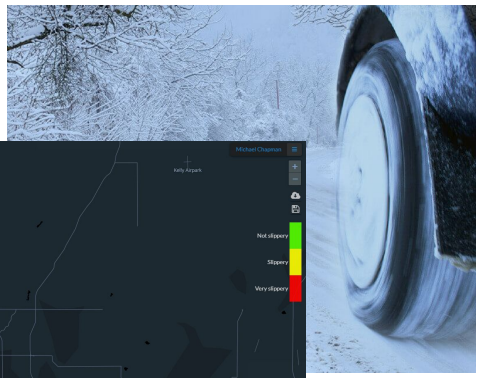


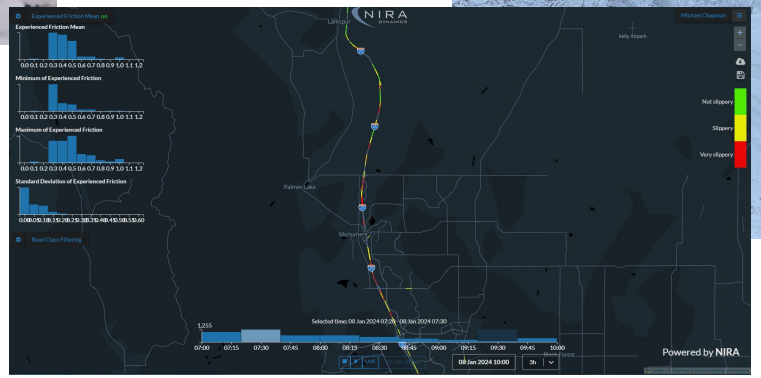
Winter Operations at CDOT

New Technology

- Non-invasive sensors
  - Pavement temperature
  - Pavement condition
  - Friction
- GeoTab - AVL
- Mobile Friction Sensors
  - Material Application
  - Chain Law
  - Performance
- Crowd-sourced Friction
  - Audi/VW/Porsche
- Mini-RWIS
  - Self-contained
  - Cost effective
  - Remote deployment

Road Weather Observations





Winter Operations at CDOT

Road Weather Modeling

Friction and AVL

- MDSS Treatment Module
  - Streamlined recommendations
  - Plow Route specific
  - Material-specific to Section
- GeoTab - AVL
  - Real-time material usage
  - Plow up/down
  - GPS Tracking
- Future modeling
  - Calibrated from AVL usage data
  - Machine Learning modeling
  - CDOT-specific recommendations

Winter Operations at CDOT

Deicer Testing

- CDOT has specifications for deicing products used in winter operations for the management and control of snow and ice on the roadways
- CDOT leverages the research work conducted by a research consortium of thirty-nine (39) State DOTs
- This consortium developed a specifications for deicing materials along with a list of qualified products
- CDOT conducts independent testing of deicer products used on the roadways during winter operations to ensure the products conform to the specifications

Winter Operations at CDOT

Research and Development

National and International Consortiums

- Clear Roads
  - Materials research
  - Best Practices
- Aurora Board
  - Observations Research
  - Best Practices
- Transportation Research Board
- AASHTO
- CDOT Research

CLEAR ROADS
research for winter highway maintenance

TRB
TRANSPORTATION RESEARCH BOARD

Aurora

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS
AASHTO
THE VOICE OF TRANSPORTATION

Winter Operations at CDOT

Research and Development

CLEAR ROADS
research for winter highway maintenance

- CDOT invests yearly in this consortium of DOTs
- Recent applicable studies for deicing/anti-icing on the right
- Similar research has been performed since the early 2000s
- Multiple alternative deicer studies over past few years from CDOT Research

Current	Determining the Migration of Chloride-based Deicers through Different Soil Types
Completed 2023	Efficacy, Cost, and Impacts of Non-Chloride Deicers
Completed 2021	Expanding Application Rate Guidance for Salt Brine Blends for Direct Liquid Application and Anti-icing
Completed 2020	Alternative Methods for Deicing
Completed 2020	Integrating Advanced Technologies into Winter Operations Decisions

Winter Operations at CDOT

Research and Development

- CDOT invests yearly in this consortium of DOTs
- Recent applicable studies for efficiency studies
- Similar research has been performed since the late 1990s

Current	Real User Friction for Winter Maintenance Operation and Evaluation
Completed 2023	Roadway Friction Modeling: Improving the Use of Friction Measurements in State DOTs
Completed 2021	Impacts of Atmospheric Rivers in the Transportation Sector
Completed 2018	Quantifying Salt Concentration on Pavement

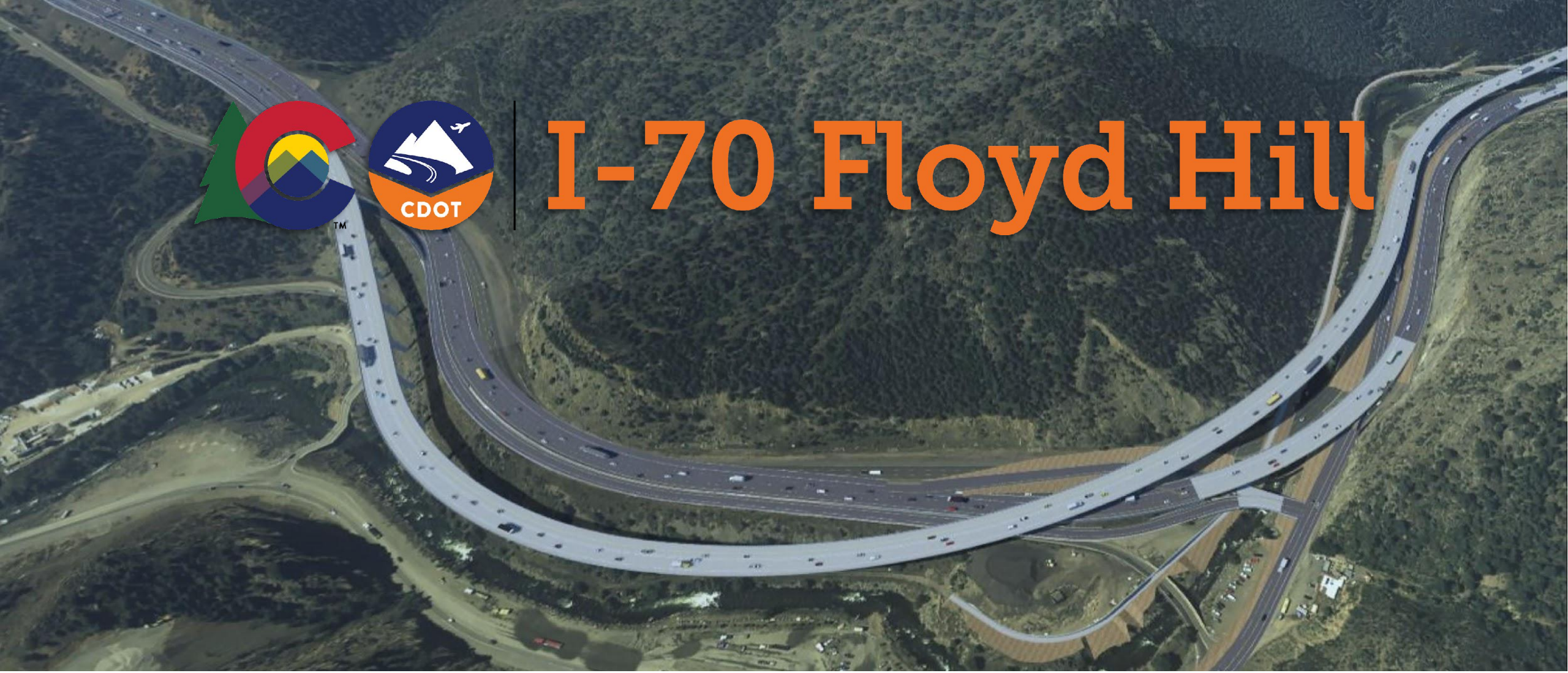
Other Water Quality Updates

- SCAP
  - SCAP purpose and process overview
  - Floyd Hill application and control measures
  - Pollutants of concern
- UCCWA Draft Sampling Plan
- Updates on upcoming research project (CDOT funded with CSU)
- Riparian Bench Restoration
- ITF discusses implications for Floyd Hill project and data sharing opportunities

Wrap Up & Next Steps

- Action Items
- Next Steps
- Final Thoughts

Field trip: to the parking lot…



Thank you!

Feb. 15, 2024