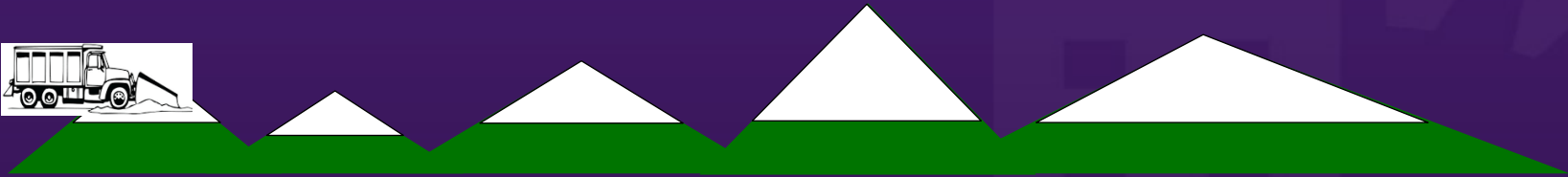
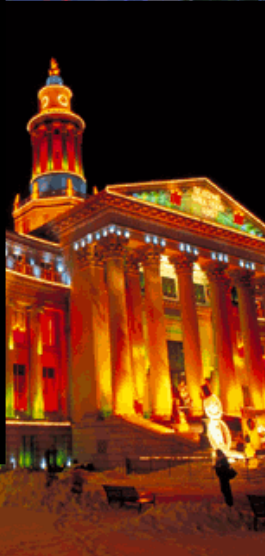


Denver, Colorado

Plowing Snow A Mile High



Pat Kennedy, PE
Denver Street Maintenance
2018 PNS Snow Conference



Denver

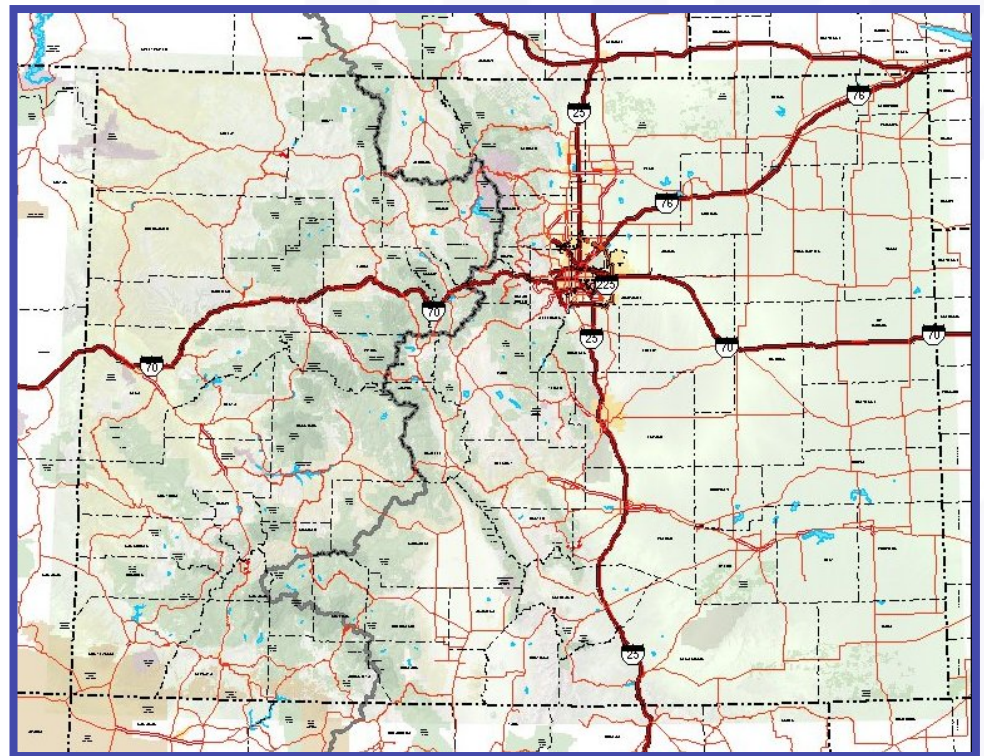
2017 population estimate over 700,000 (19th)

Average annual snowfall 55"-60"

Average 23 winter weather events

- Sept 3, 1961 earliest
- June 12, 1947 latest

- 21.3" least
- 118.7" most



Agenda

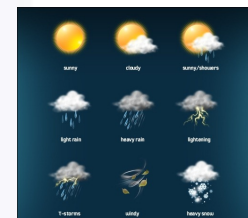
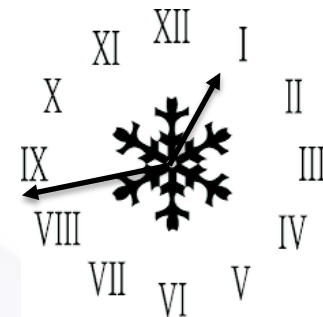
- **Ma** [REDACTED]



**Snow Operations Are
Emergency Operations**

Weather

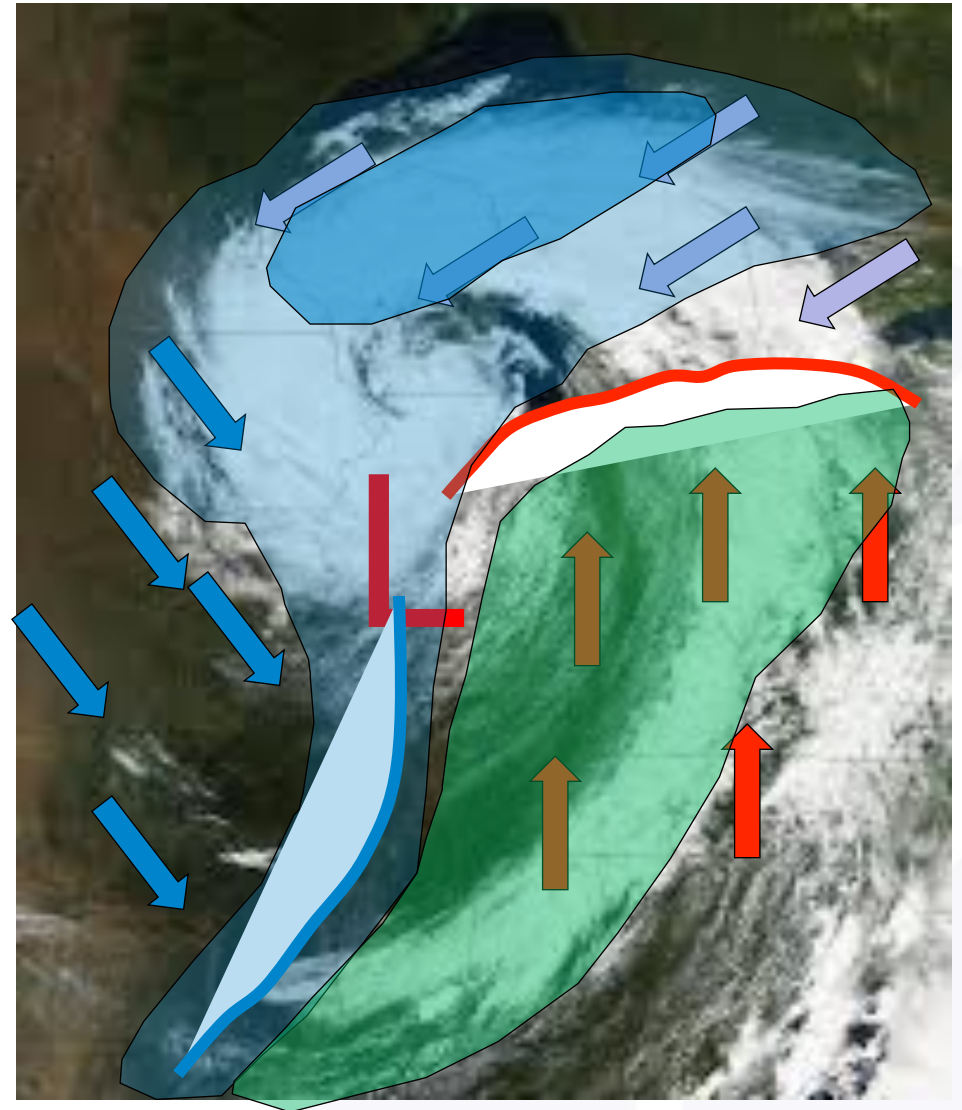
- **What is important?**
 - **Start time**
 - Budgetary and safety implications
 - **Storm track**
 - Small change has big impact
 - **Precipitation type**
 - Deployment and tactical decisions
 - **Pavement effects**
 - Decisions affect public safety



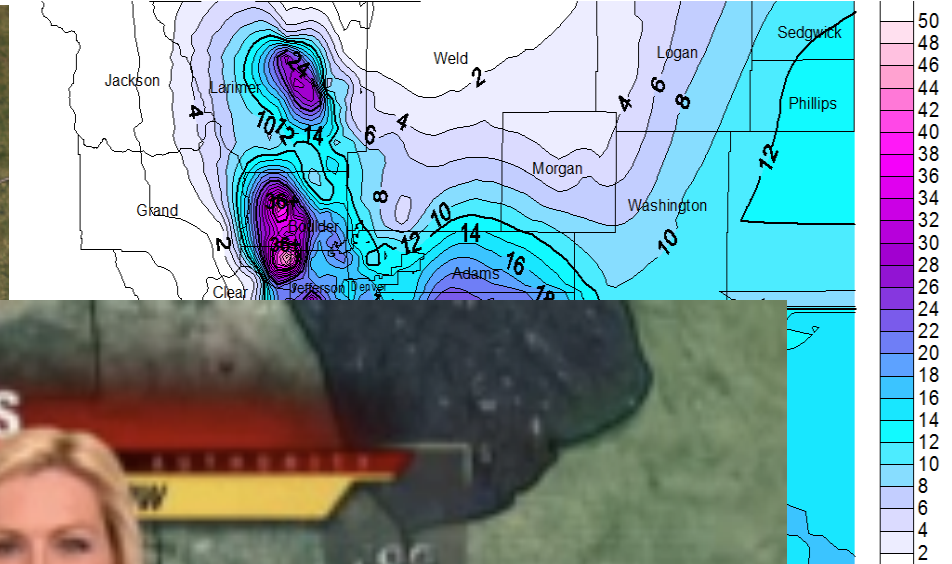
Weather

System anatomy

- Comma Cloud
- Wind direction
 - Southerly, warm
 - Northeasterly, snow
 - Northwesterly, dry
- Proximity
 - 250 miles
- Speed of Low
- Multiple Fronts



Weather



Weather AUTHORITY CONDITIONS

Weather Authority logo

Weather icons for various locations:

- Lansing: Cloudy
- Howell: Sunny
- Jackson: Sunny
- Ann Arbor: Sunny
- Metro: Cloudy
- City: Sunny
- Grosse Ile: Sunny
- Port Huron: Cloudy
- Mt. Clemens: Cloudy

FOX 11

Forecast Updates

Forecast for Sunday thru Wednesday 1-31 to 2-3												
Friday 0800												
Forecaster	Start	End	High	Low	High	Low	High	Low	Prob	Type	Accumulation	Comments
			1-31	1-31/2-1	2-1	2-1/2	2-2	2-2/3				
Skyview	Saturday 2100 light	Tuesday	34	20	25	13			90%	snow	uncertain	
NWS	Saturday after 1900	Tuesday night	36	20	29	12			70%	snow	variable, up to 10"	
Accuweather	Saturday 2000	Tuesday morning	38	24	28	17			80%	snow	12" by Tuesday	
TWC	Sat pm showers	Tuesday morning	42	22	29	15			90%	snow	7"-13" total	
Channel 4	Saturday pm rain	Tuesday morning	36	12	26	3				snow	5"-10"	
Channel 7	Saturday pm mix	Tuesday am	38	25	30	17				snow	6"-12"	
Channel 9	Saturday pm rain	Tuesday	35	15	23	9				snow	8"-16"	
Channel 31	Saturday pm rain		36	16	30	10			60%	snow	uncertain	
Comments	Models predicting track to slide south and may result in lesser snow north of Palmer Divide, some models still at 15" to 20"											
Monday 0800												
Forecaster	Start	End	High	Low	High	Low	High	Low	Prob	Type	Accumulation	Comments
			1-31	1-31/2-1	2-1	2-1/2	2-2	2-2/3				
Skyview		Tuesday midday			27	16	26	8	100%	snow	7"-13"	
NWS		Tuesday 0900			28	16	26	8	100%	snow	7"-13"	
Accuweather		Tuesday noon			29	19	25	8	80%	snow	8"-12"	
TWC		Tuesday noon			31	19	28	6	100%	snow	4"-8"	
Channel 4												
Channel 7												
Channel 9												
Channel 31												
Comments												
Actual												
	Start	End	High	Low	High	Low	High	Low	Prob	Type	Accumulation	Comments
			1-31	1-31/2-1	2-1	2-1/2	2-2	2-2/3				
	Saturday evening	Tuesday 1100	34	24	30	20	22	1		snow	10"-12"	
Comments	Approx 2" of snow Sat night, pvmt Sunday only wet. Light snow Sunday night with 1" additional. Daytime Monday banded snow crossed the City, total accumulation through day 3" +/- . Heavy snow Monday evening into Tuesday morning, total by morning rush 8"-10". Light snow Tuesday morning added maybe 1".											

Level Of Service



Program Expansion

- Do you have the resources to handle the changing transportation needs?
 - Expanding mobility options
 - Bicycles
 - Pedestrians
 - ADA



Denver LOS



- Heavy equipment
- Light Plows

Denver LOS

A, B, S routes, bare pavement within 24 hours, 5 hour cycle time

Residential, 3” accumulation, one pass down the middle each 12 hours

- Historically for 12” and greater storms
- Changing to plow with all storms

Deicers used only on A, B, and S routes

Residential Plowing

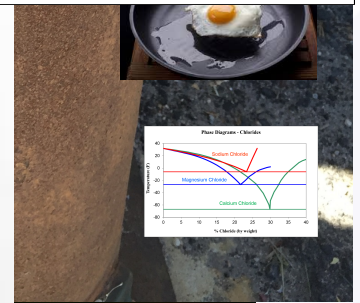
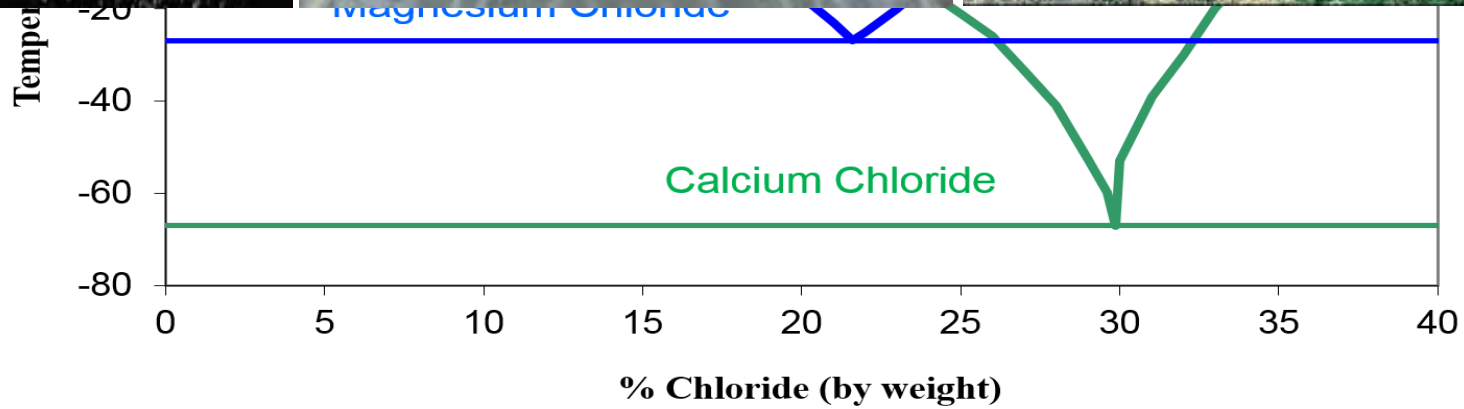
Side benefit of expanding paving program

Local streets, 3” accumulation, one pass down the middle of street during overnight shift

- Historically for 12” and greater storms
- Changing to plow with all storms

No deicers, main purpose is to avoid major rutting and ice accumulation

Environmental Effects



Communication

- **Proactive/Reactive**
- **Internal/External**
- **Pre-season**
 - **Media distribution**
 - **General policy description**
 - **Emphasis on difference between A,B,S plowing and RSP**
- **Pre-event**
 - **Snow meeting**
 - **When and what crews will deploy**
 - **Wide distribution**

Communication

- **During an event**
 - Route tracker
 - Media updates
 - Special requests
- **Post-event**
 - 311 service requests
 - After-action

Budget

- **Treat as expected expenditures**
 - Standard Labor
 - Overtime
 - Deicers

- **Denver**
 - Labor- \$4M
 - Overtime- \$0.5M
 - Deicers- \$1.5M

Season	Events	Snow Total
2008-2009	33	38
2009-2010	17	61
2010-2011	18	23
2011-2012	22	56
2012-2013	24	78
2013-2014	23	38
2014-2015	24	58
2015-2016	22	73
2016-2017	24	22
2017-2018	23	25

Unusual Events

- Occasional Blizzard
 - Modified deployment
 - Share
 - Esser



Unusual Events

Branch Breaker

- Early or late season snow when t
- Severe ice storm
- Heavy snow
- Clogged streets

January							Febru			
S	M	T	W	T	F	S	S	M	T	W
1	2	3	4	5	6	7				1
8	9	10	11	12	13	14	5	6	7	8
15	16	17	18	19	20	21	12	13	14	15



Unusual Events

Ice accumulation

- Freeze/thaw
- Shady
- Mitigation

Temperature
70°
60°
50°
40°
30°
20°
10°
0°
-10°
-20°



Blizzardpalooza



Hail

- Other weather events that may require response
- Clogged inlets
- Property damage
- Impassable



Conclusions

- **Public safety is foremost**
- **Have a plan in place**
 - Helps minimize politics
 - Defensible
 - Public education
- **Be part of development and infrastructure design process**
- **Remember this is an emergency response**

Questions?

Thank you!



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