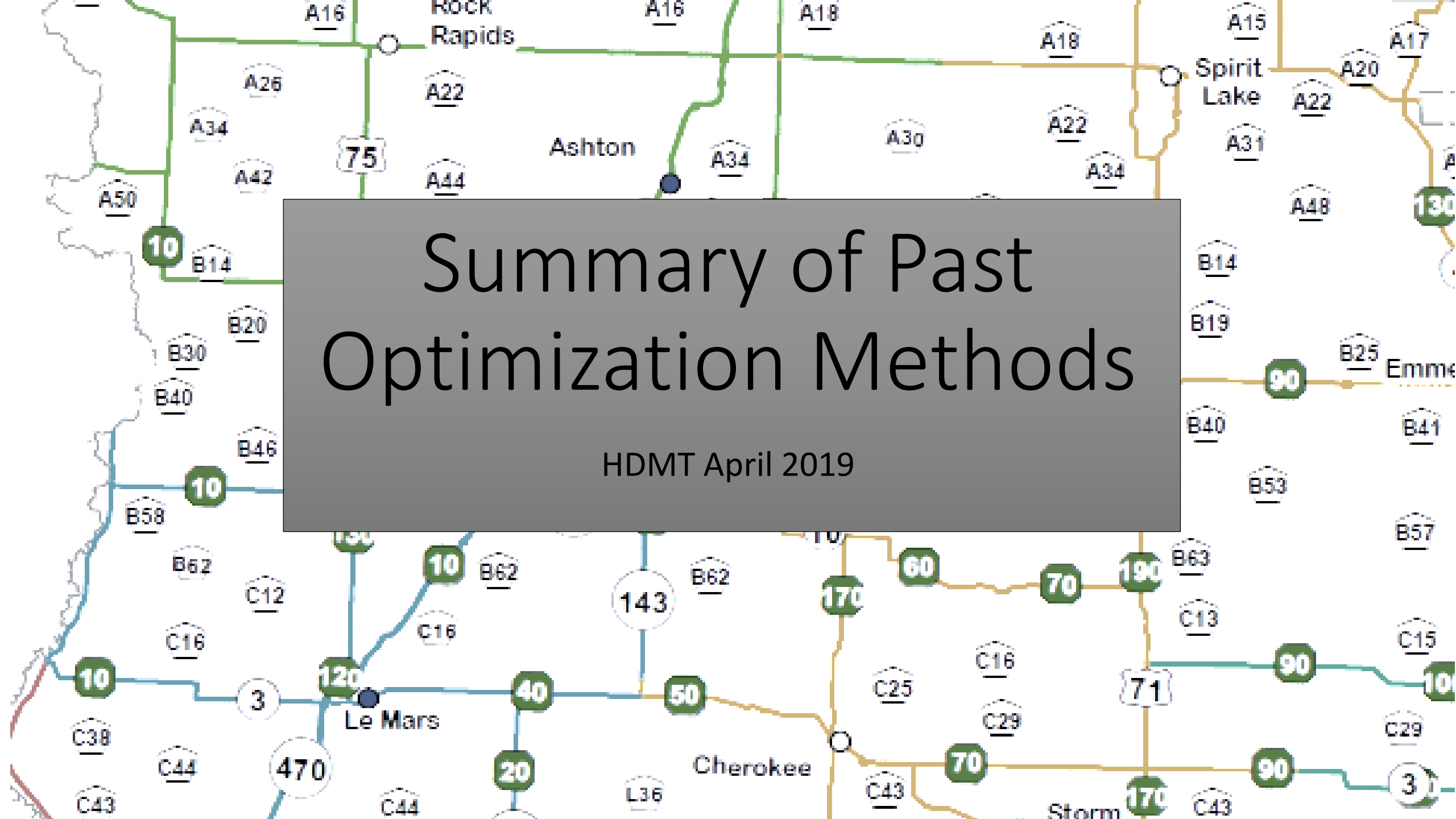
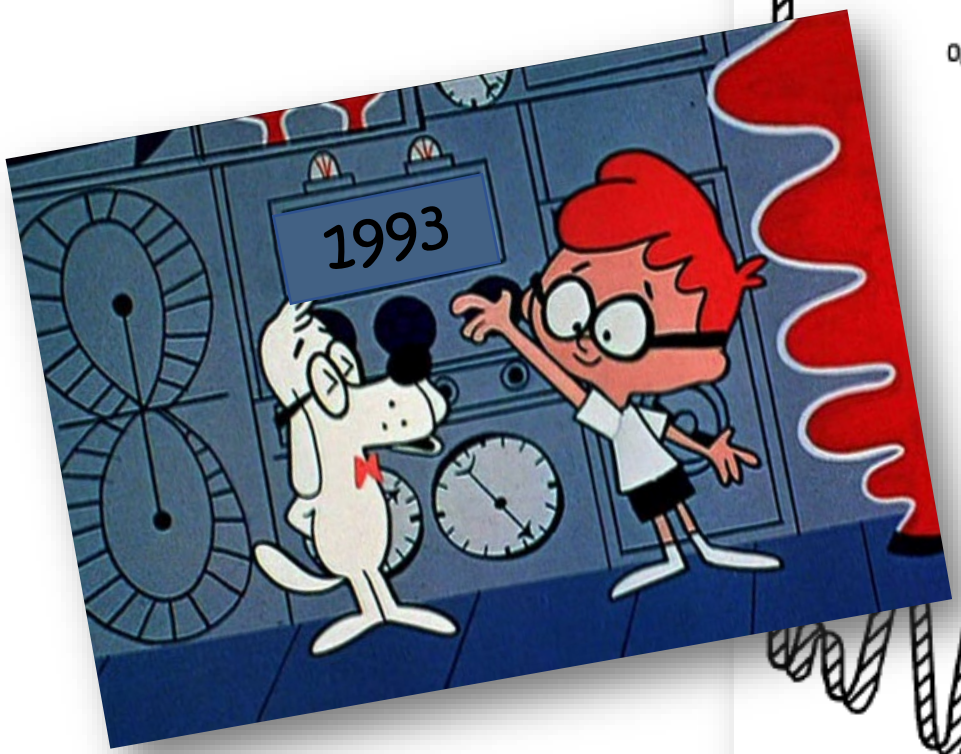


Summary of Past Optimization Methods

HDMT April 2019

1980's & 90's Truck Staffing Analysis



Office of Maintenance

TRUCK & STAFFING ANALYSIS

$$\text{Location Factor} = \frac{LMau}{20} + \frac{LMar}{25} + \frac{LMb}{30} + \frac{LMc}{40} + \frac{LMd}{50} + \frac{LMp\&i}{60} + \frac{Ramps}{12} + \frac{RA}{4} + \frac{WS}{4} - \frac{\text{Contr. P\&I}}{60} - \frac{\text{City Contr.}}{150}$$

Snow Removal Trucks = Location Factor x 1.11 for average dead heading x ( ) for down equipment

Operator/Mechanic = Location Factor x Staffing Factor ( )

LMau = Lane Miles Service Level A, Urban Area Interstate

LMar = Lane Miles Service Level A, Rural Area Interstate

LMb = Lane Miles Service Level B

LMc = Lane Miles Service Level C

LMd = Lane Miles Service Level D

LMp&i = Lane Miles of Park & Institutional Roads

Ramps = Number of Interchange Ramps

RA = Number of Rest Areas

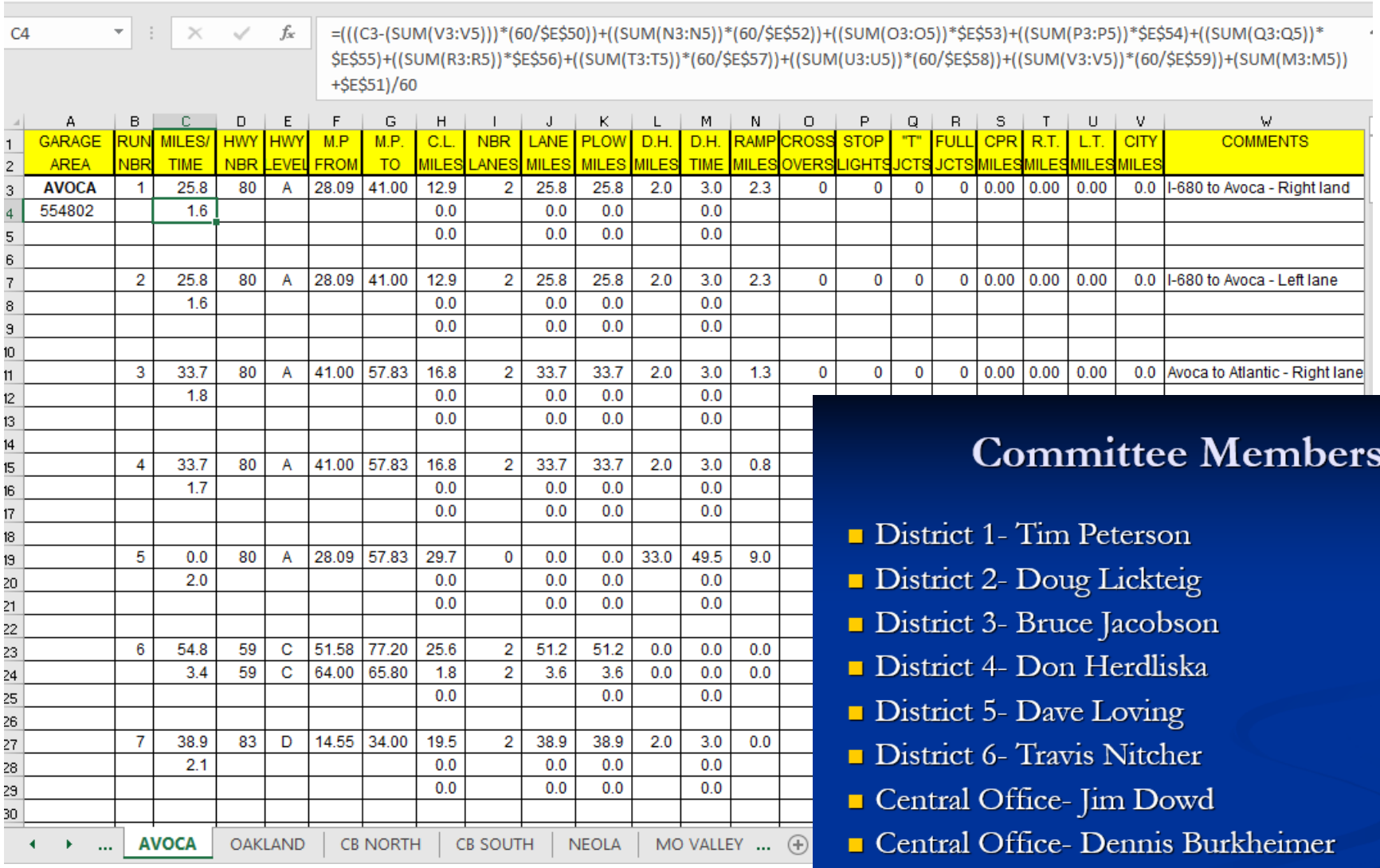
WS = Number of Weigh Stations

Contr. P&I = Lane Miles of Park & Institutional Roads Under Contract Maintenance

City Contr. = Lane Miles of Primary Extension Under Contract Maintenance

2005-2010? District Plow Route Committee

- Group of district reps reviewed and “timed” proposed snow runs
- Times based on mileage, deadhead, ramps, stops, turns, etc.
- Proposed by district and reviewed by committee



C4

=(((C3-(SUM(V3:V5)))*(60/$E$50))+((SUM(N3:N5))*(60/$E$52))+((SUM(O3:O5))*$E$53)+((SUM(P3:P5))*$E$54)+((SUM(Q3:Q5))*$E$55)+((SUM(R3:R5))*$E$56)+((SUM(T3:T5))*(60/$E$57))+((SUM(U3:U5))*(60/$E$58))+((SUM(V3:V5))*(60/$E$59))+(SUM(M3:M5))+$E$51)/60

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W
1	GARAGE	RUN	MILES/	HWY	HWY	M.P	M.P.	C.L.	NBR	LANE	PLOW	D.H.	D.H.	RAMP	CROSS	STOP	"T"	FULL	CPR	R.T.	L.T.	CITY	COMMENTS
2	AREA	NBR	TIME	NBR	LEVEL	FROM	TO	MILES	LANES	MILES	MILES	MILES	TIME	MILES	OVERS	LIGHTS	JCTS	JCTS	MILES	MILES	MILES	MILES	
3	AVOCA	1	25.8	80	A	28.09	41.00	12.9	2	25.8	25.8	2.0	3.0	2.3	0	0	0	0	0.00	0.00	0.00	0.0	I-680 to Avoca - Right land
4	554802		1.6					0.0		0.0	0.0		0.0										
5								0.0		0.0	0.0		0.0										
6																							
7		2	25.8	80	A	28.09	41.00	12.9	2	25.8	25.8	2.0	3.0	2.3	0	0	0	0	0.00	0.00	0.00	0.0	I-680 to Avoca - Left lane
8			1.6					0.0		0.0	0.0		0.0										
9								0.0		0.0	0.0		0.0										
10																							
11		3	33.7	80	A	41.00	57.83	16.8	2	33.7	33.7	2.0	3.0	1.3	0	0	0	0	0.00	0.00	0.00	0.0	Avoca to Atlantic - Right lane
12			1.8					0.0		0.0	0.0		0.0										
13								0.0		0.0	0.0		0.0										
14																							
15		4	33.7	80	A	41.00	57.83	16.8	2	33.7	33.7	2.0	3.0	0.8									
16			1.7					0.0		0.0	0.0		0.0										
17								0.0		0.0	0.0		0.0										
18																							
19		5	0.0	80	A	28.09	57.83	29.7	0	0.0	0.0	33.0	49.5	9.0									
20			2.0					0.0		0.0	0.0		0.0										
21								0.0		0.0	0.0		0.0										
22																							
23		6	54.8	59	C	51.58	77.20	25.6	2	51.2	51.2	0.0	0.0	0.0									
24			3.4	59	C	64.00	65.80	1.8	2	3.6	3.6	0.0	0.0	0.0									
25								0.0			0.0		0.0										
26																							
27		7	38.9	83	D	14.55	34.00	19.5	2	38.9	38.9	2.0	3.0	0.0									
28			2.1					0.0		0.0	0.0		0.0										
29								0.0		0.0	0.0		0.0										
30																							

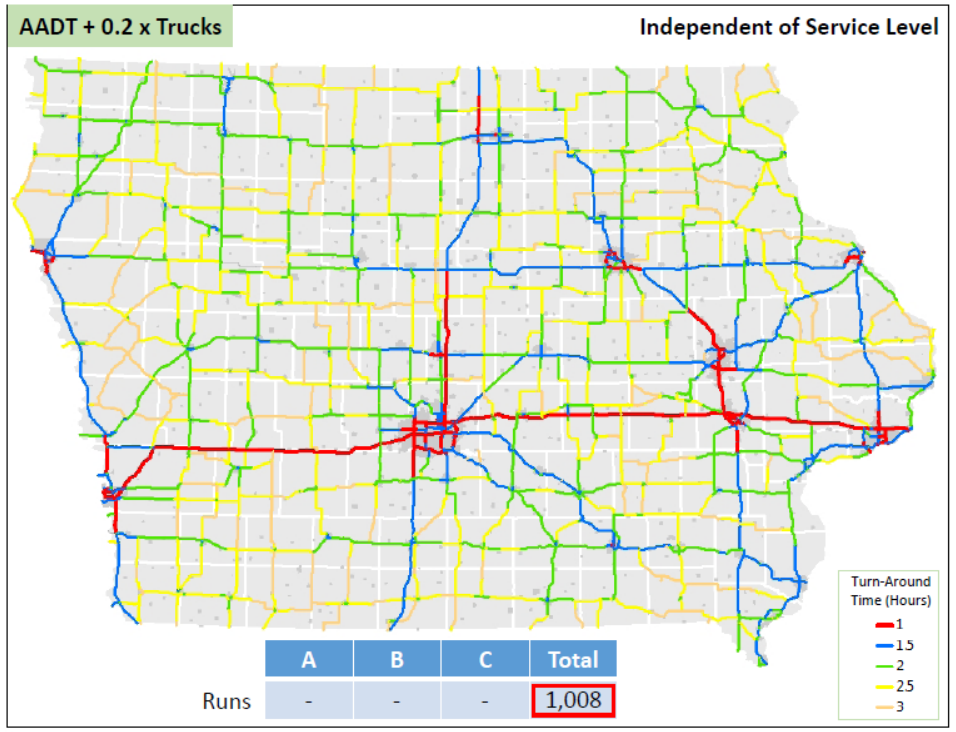
AVOCA | OAKLAND | CB NORTH | CB SOUTH | NEOLA | MO VALLEY

Committee Members

- District 1- Tim Peterson
- District 2- Doug Lickteig
- District 3- Bruce Jacobson
- District 4- Don Herdliska
- District 5- Dave Loving
- District 6- Travis Nitcher
- Central Office- Jim Dowd
- Central Office- Dennis Burkheimer

2012-14 ISU

- Researchers worked with DMMs to develop a turn-around classification combining AADT and service level assignment as a basis for resource optimization



	A	B	C	Total
Runs	-	-	-	1,008

Lane miles including ramps

Service level A

LANE_MILES	LOW_AADT	HIGH_AADT
505.841	0	12500
1678.618	12500	25000
936.7	25000	37500
214.678	37500	50000
98.063	50000	62500
107.953	62500	75000
70.459	75000	87500
41.212	87500	100000
33.446	100000	112500
5.384	112500	125000+

1.5-1.75 hrs

1-1.5 hrs

Service level B

LANE_MILES	LOW_AADT	HIGH_AADT
3963.251	0	4000
3405.507	4000	8000
2131.23	8000	12000
705.65	12000	16000
545.688	16000	20000
283.827	20000	24000
180.97	24000	28000
99.316	28000	32000
33.626	32000	36000
6.826	36000	40000+

2.0-2.5

1.5-2 hrs

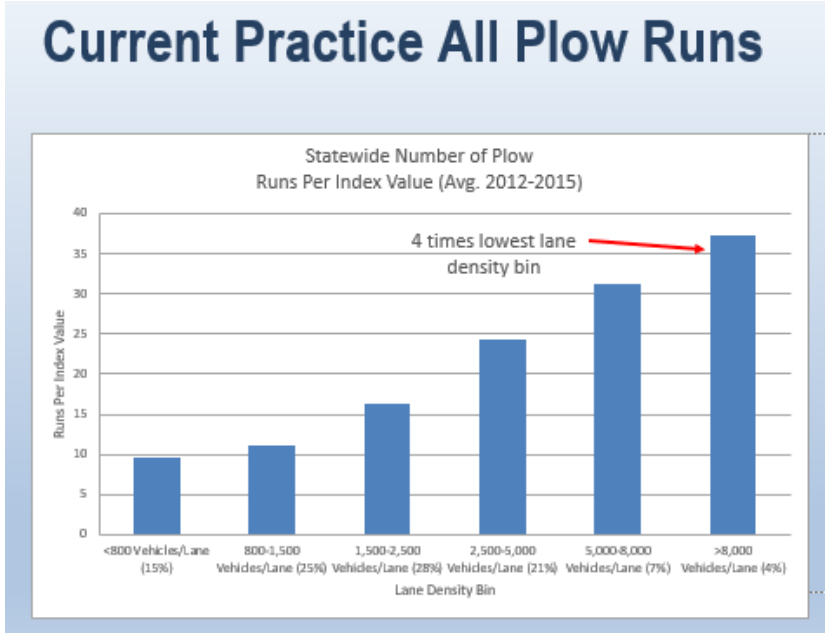
Service level C

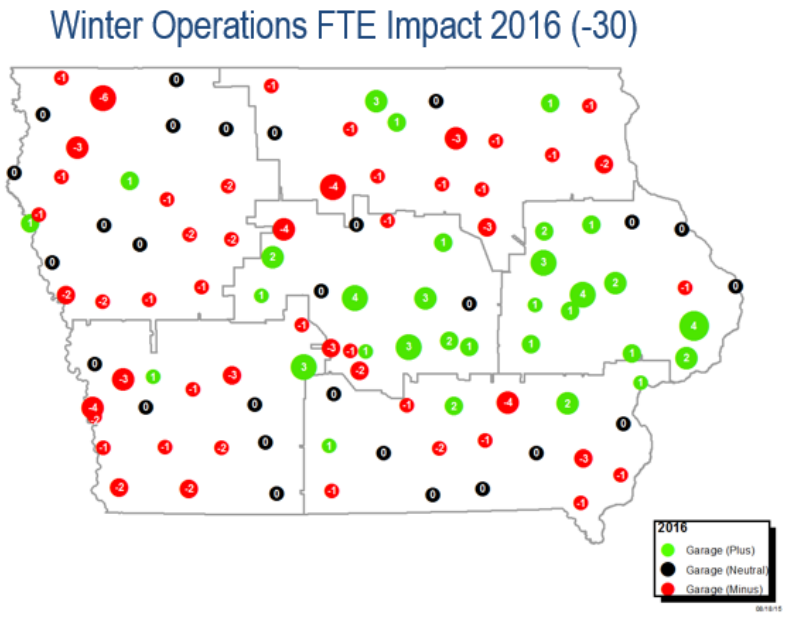
LANE_MILES	LOW_AADT	HIGH_AADT
2979.434	0	1300
4205.972	1300	2600
1251.964	2600	3900
364.995	3900	5200
156.871	5200	6500
77.311	6500	7800
47.235	7800	9100
14.227	9100	10400
5.899	10400	11700
3.312	11700	13000
1.626	13000	14300+

2.5-3 hrs

2015 – AADT and FTE Modeling

- FTE funding gap was driving reduction of field staff vacancies
- Used GPS pings to study current effort levels on different AADT roads and night vs. day patterns
- Used plow speed to estimate how many FTEs needed to traverse garages' miles at a frequency defined by AADT classification
- First appearance of the infamous "bubble maps"





2016 and Ongoing -- ISU Garage Optimizations

- Muscatine consolidation and new Dubuque location
  - Started with new routes at Muscatine (for consolidating Wapello) and expanded to new garage/route possibilities for Dubuque
  - Simulated all possible route and garage locations
  - Select those that used the fewest trucks and deadhead miles while still adhering to turn-around frequency requirements and assumed truck capacities
- D3 is the subject of ongoing work to also simulate routes as well as potential garage boundary revisions and multi-garage routes

2017 – FTE Modeling Take 2

- Like 2016, AADT-based. But with updated:
  - Vacancy reduction targets
  - Included look into temporary driver needs/utilization
- Provided comparisons to area total staff need vs FTEs
  - If every district targeted a 53% FTE-to-Temp ratio, where would positions shuffle?

The Model: Assumptions

Average plow speed = 23.6 MPH
Truck uptime = 90%
Crew availability based on 12 hour shift

Route cycle time expectations:	hours
8000 cars/lane/day	1.1
5000-8000 cars/lane/day	1.2
2500-5000 cars/lane/day	1.5
1500-2500 cars/lane/day	2.0
800-1500 cars/lane/day	2.5
<800 cars/lane/day	3.0

Results – FTE and Temp Staff Needs

If we plow to those turn-around goals for a 24 hour storm:

- We would need 1570 plow drivers statewide
- With 838 FTEs, that means we'd need the temp equivalent of 732 drivers
- That means that our FTEs make up 53% of our total staff need.