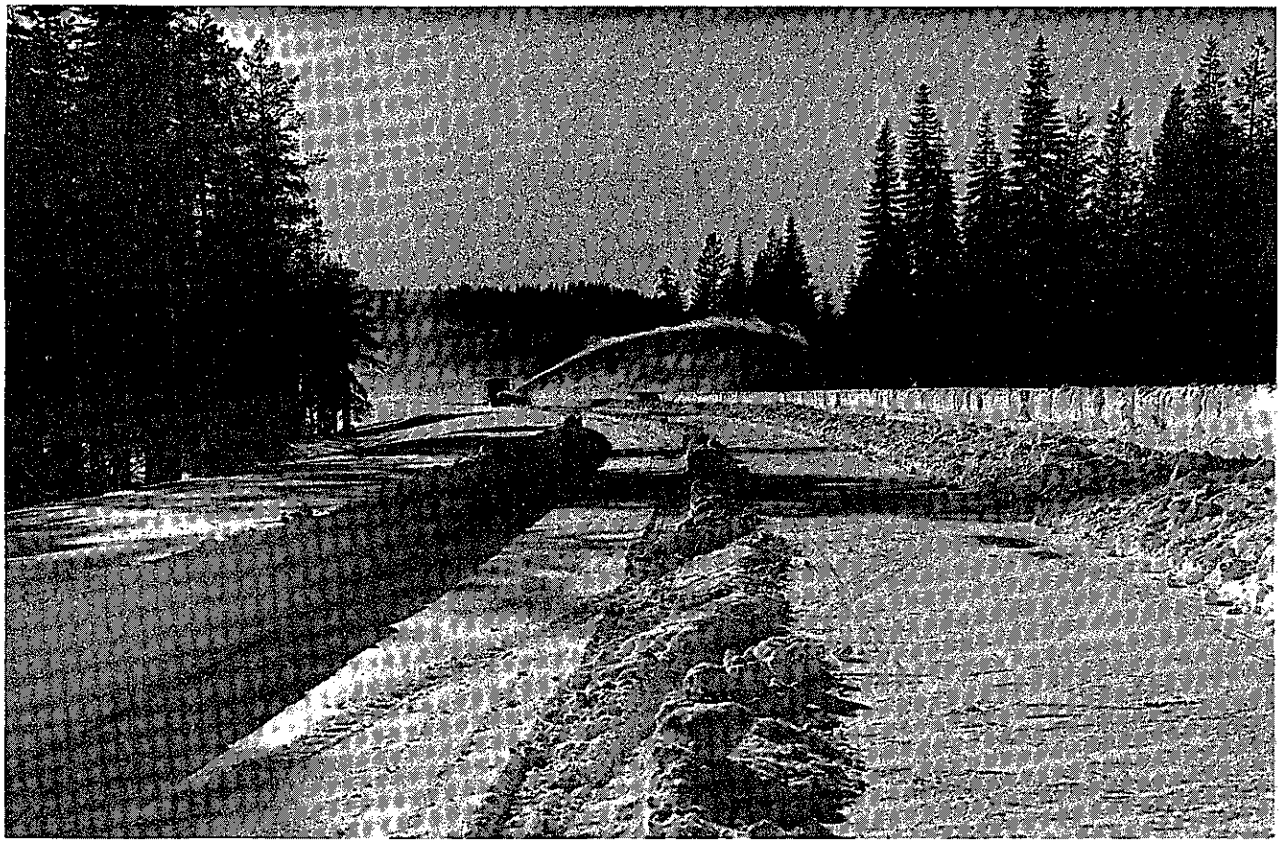
REPORT NO. FHWA-CA-TL-79-02

DEICING SALT APPLICATION RATES AT TERRESTRIAL VEGETATION STUDY SITES IN THE LAKE TAHOE VICINITY (1974-78)



INTERIM REPORT

JAN. 1979

Caltrans
CALIFORNIA DEPARTMENT OF TRANSPORTATION

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This study was conducted in cooperation with the U.S. Department of Transportation, Federal Highway Administration, under the research project F-5-14 entitled "Highway Operation and Plant Damage".

16. ABSTRACT

The Transportation Laboratory in cooperation with the University of California, Davis, is engaged in a study of the effects of deicing salts on roadside vegetation in and around the Lake Tahoe Basin. The portion of the study dealing with soil chemistry, deicing salt application rates, ozone concentrations, and precipitation, was reported in a TransLab Interim Report dated January 1976. A Data Appendix Report containing the backup data for that Interim Report was published in September 1976. The University is preparing a report on the effects on vegetation.

This Interim Report contains deicing salt application rates for the winters of 1974-75, 1975-76, 1976-77 and 1977-78. Salt application rates for the winters of 1974-75 and 1975-76, contained in previous reports, are revised in this report. Deicing salt application data contained in this report supersede the previously reported data.

The portion of the study that addresses vegetation is being conducted by the University of California at Davis and will be the subject of the Final Report.

17. KEY WORDS Deicing salts, salt application	18. DISTRIBUTION STATEMENT No restrictions. This document is available to the public through the National Technical Information Service, Springfield, VA 22161

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STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION
DIVISION OF CONSTRUCTION
OFFICE OF TRANSPORTATION LABORATORY

January 1979

FHWA No. F-5-14
TL No. 657134

Mr. C. E. Forbes
Chief Engineer

Dear Sir:

I have approved and now submit for your information this interim research project report titled:

DEICING SALT APPLICATION RATES AT TERRESTRIAL VEGETATION STUDY SITES IN THE LAKE TAHOE VICINITY (1974-1978)

Study made by . . . . . Enviro-Chemical Branch

Under the Supervision of . . . Earl Shirley, P.E.

Principal Investigator . . . . Richard B. Howell, P.E.

Report Prepared by . . . . . Don I. Nakao

Very truly yours,

Neal Andersen

NEAL ANDERSEN
Chief, Office of Transportation Laboratory

Attachment
DIN:caj

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ACKNOWLEDGEMENTS

The authors wish to express their appreciation to Robert Mulcahy, District 03 Assistant District Maintenance Engineer and Donald Bergevin, District 10 Assistant District Maintenance Engineer, for coordinating the collection of the salt information.

Special acknowledgement is given to TransLab personnel Kwan Lam, Patrick Monahan and Martin Nolan, under the direction of Don Nakao, for compiling and summarizing the deicing salt information.

The technical review and comments of Karl Baumeister, Richard Howell and Earl Shirley of TransLab are appreciated.

The review and comments of this report by Al Dildine and Dave Currier, Office of Maintenance, Howard Miller and Robert Mulcahy, District 03 Maintenance, are appreciated. Review and comments of the first years salt data by the District 03 Environmental Branch, under the direction of Bob Skidmore, are appreciated.

Drafting of the figures was completed by Elmer Wiggington and typing of the report was by Carol Johnson.

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CONVERSION FACTORS

English to Metric System of Measurement

Quantity	English unit	Multiply by	To get metric equivalent
Length	inches (in)	25.4	millimetres (mm)
		.0254	metres (m)
	feet (ft)	.3048	metres (m)
	miles (mi)	1.6093	kilometres (km)
Area	square inches (in^2)	6.4516×10^{-4}	square metres (m^2)
	square feet (ft^2)	.092903	square metres (m^2)
	acres	4046.9	square metres (m^2)
		.40469	hectares (ha)
		.40469	square hectometres (hm^2)
		.0040469	square kilometres (km^2)
	square miles (mi^2)	2.590	square kilometres (km^2)
Volume	gallons (gal)	3.7854	litres (l)
		.0037854	cubic metres (m^3)
	million gallons (10^6 gal)	3785.4	cubic metres (m^3)
	cubic feet (ft^3)	.028317	cubic metres (m^3)
	cubic yards (yd^3)	.76455	cubic metres (m^3)
	acre-feet (ac-ft)	1233.5	cubic metres (m^3)
		.0012335	cubic hectometres (hm^3)
		1.233×10^{-6}	cubic kilometres (km^3)
Volume/Time (Flow)	cubic feet per second (ft^3/s)	28.317	litres per second (l/s)
		.028317	cubic metres per second (m^3/s)
	gallons per minute (gal/min)	.06309	litres per second (l/s)
		6.309×10^{-5}	cubic metres per second (m^3/s)
	million gallons per day (mgd)	.043813	cubic metres per second (m^3/s)
Mass	pounds (lb)	.45359	kilograms (kg)
	tons (short, 2,000 lb)	.90718	tonne (t)
		907.18	kilograms (kg)
Power	horsepower (hp)	0.7460	kilowatts (kW)
Pressure	pounds per square inch (psi)	6894.8	pascal (Pa)
Temperature	Degrees Fahrenheit (°F)	$\frac{tF - 32}{1.8} = tC$	Degrees Celsius (°C)

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INTRODUCTION

In April 1973, the Transportation Laboratory (TransLab) was requested by District 03 and Office of Maintenance to study the effects of deicing salt on roadside vegetation in the Lake Tahoe Basin and adjoining Trans-Sierra highways. As part of the 5-year research study, TransLab contracted with the Department of Environmental Horticulture at the University of California, Davis, to conduct the study of effects of deicing salts on roadside vegetation. Fifteen study sites were selected for field investigation by the University as shown in Figure 1. TransLab examined the soil chemistry, prepared topographic site maps, delineated drainage patterns, and compiled deicing salt application records at the 15 vegetation study sites. This information was published in the TransLab Interim Reports "Highway Operation and Plant Damage" dated January 1976(1) and "Data Appendix" dated September 1976(2). The Data Appendix included all the information from the TransLab field investigation and laboratory tests.

The deicing salt application rates for the 1974-75, 1975-76, 1976-77 and 1977-78 winters were calculated from Maintenance salt application logs which were started in the 1974-75 winter. These rates, for the 1974-75 and 1975-76 winters, were published in the previously cited reports. The calculations to determine these rates considered only the area of the traveled way and did not take into account additional areas that were salted such as road approaches, bridges, passing lanes and frontage roads. The inclusion of these areas are presented in this report as shown in Table 1 to more accurately reflect the actual application rates. These rates supersede the previously published rates presented in the two interim reports of 1976(1,2).

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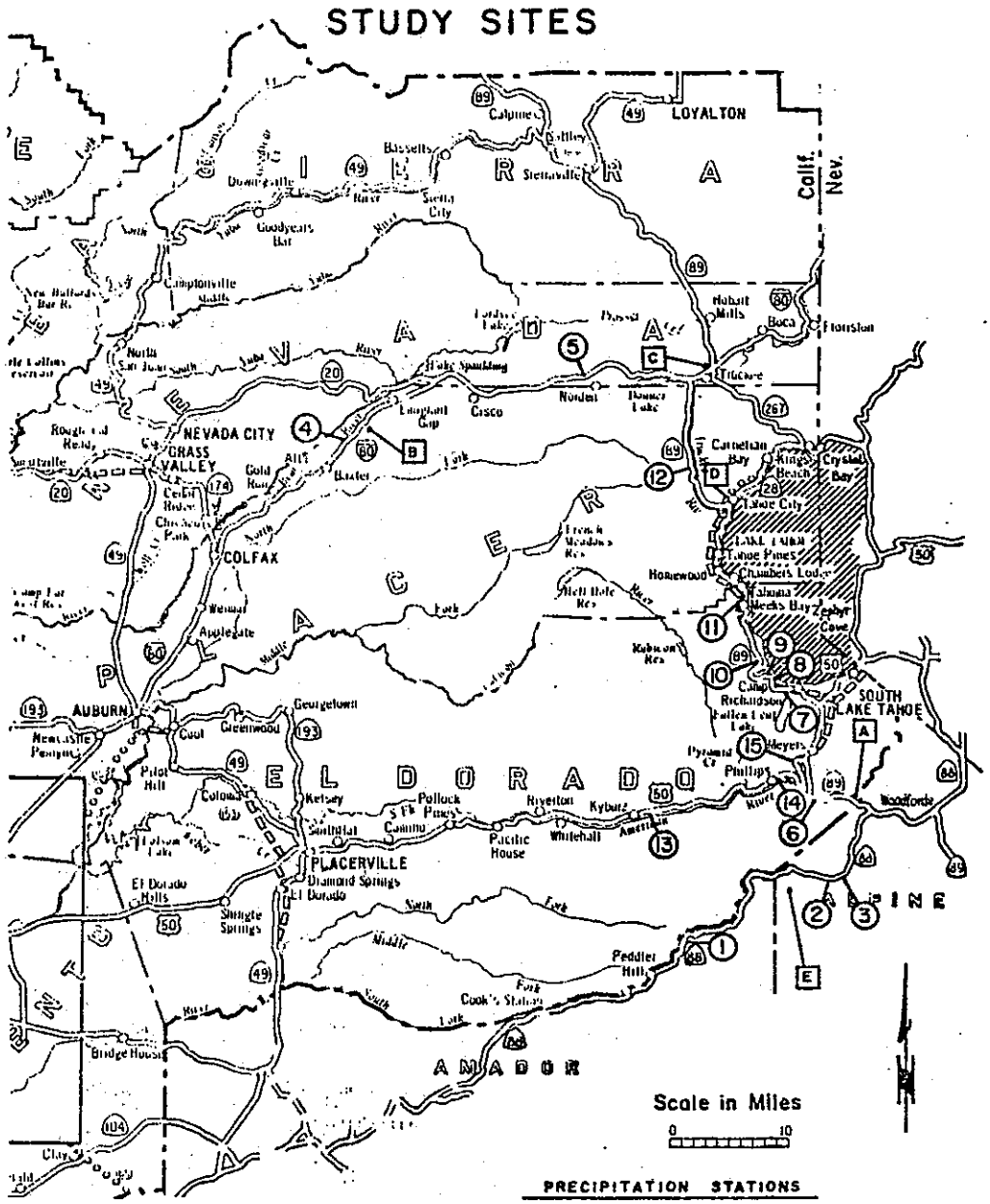
FIGURE 1

TERRESTRIAL VEGETATION STUDY SITES



SITE	LOCATION*		SITE	LOCATION	
1	10-Ama-88	PM 60.5	9	03-ED-89	PM 15.47
2	10-Alp-88	PM 4.53	10	03-ED-89	PM 18.10
3	10-Alp-88	PM 5.05	11	03-ED-89	PM 26.4
4	03-Pla-80	PM 50.26	12	03-Pla-89	PM 13.49
5	03-Nev-80	PM 3.53	13	03-ED-50	PM 51.43
6	03-ED-89	PM 3.98	14	03-ED-50	PM 62.63
7	03-ED-89	PM 10.43	15	03-ED-50	PM 69.44
8	03-ED-89	PM 14.32			

*Dist-County-Hwy-Post Mile

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TABLE 1

DEICING SALT APPLICATION RATES

Site	Salt Application Rate (Tons/Lane Mile) 1974-75 Original	1974-75 Revised	1975-76 Original	1975-76 Revised	1976-77 Original	1976-77 Revised	1977-78 Original	1977-78 Revised
1	0.5	0.5	0.6	0.6	0.1	0.1	0.1	0.1
2 & 3	1.9	1.9	0.2	0.2	1.3	1.3	0.8	0.8
4	12.5	9.3	6.5	4.9	17.8	13.1	11.0	8.2
5	15.6	13.0	9.7	8.0	7.4	6.1	8.4	7.5
6	5.0	4.7	3.4	3.2	2.3	2.2	8.5	8.7
7	1.4	1.1	1.7	1.4	0	0	0	0
8	1.4	1.1	0	0	0	0	0	0
9	1.4	1.1	0	0	0	0	0	0
10	4.4	4.4	0	0	0	0	0	0
11	4.4	4.4	2.6	2.6	0.6	0.6	2.2	2.2
12	11.9	10.8	6.6	6.0	2.2	2.0	5.9	5.4
13	18.9	15.2	10.4	7.9	5.3	4.1	12.9	10.9
14	32.1	24.1	12.7	9.5	13.0	9.7	20.8	15.5
15	39.1	23.7	18.7	11.1	20.4	13.0	27.2	19.5

Note: There were no revisions for Sites 1, 2, 3, 10 and 11 since the additional lane miles from road approaches, bridges, passing lanes and frontage roads were insignificant at these locations.

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DEICING SALT APPLICATION

Maintenance and Operation

Application of deicing salts during the winter months to all state highways and other facilities subjected to infrequent periods of snow and ice is a major responsibility of Caltrans. Salt (sodium chloride), or salt mixed with abrasives (sand or cinders), is generally applied at the early stages of a snow storm. The deicing salts dissolve to form solutions with lower freezing points. This brine solution melts ice and prevents ice formation at low temperatures, thus preventing the bonding of ice and snow to the pavement and facilitates removal by maintenance equipment. The abrasives increase the friction factor of the pavement surface or the surface covered with snow or ice.

Salt or salt mixed with abrasives is also spread during clear weather, when low temperatures are anticipated, to keep ice from forming on the pavement. These usually consist of spot applications on bridges, shady areas, grades, and dangerous curves.

Salt is always stored in overhead bins or inside sheds (Photo 1). The storage areas are carefully controlled to prevent runoff from these sites. Salt is loaded into the spreader trucks from the overhead bins or by front end loaders (Photo 2). As a check on application rates, maintenance periodically weighs salt in the equipment.

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TABLE 1

DEICING SALT APPLICATION RATES

	Salt Application Rate (Tons/Lane Mile)							
	1974-75		1975-76		1976-77		1977-78	
Site	Original	Revised	Original	Revised	Original	Revised	Original	Revised
1	0.5	0.5	0.6	0.6	0.1	0.1	0.1	0.1
2 & 3	1.9	1.9	0.2	0.2	1.3	1.3	0.8	0.8
4	12.5	9.3	6.5	4.9	17.8	13.1	11.0	8.2
5	15.6	13.0	9.7	8.0	7.4	6.1	8.4	7.5
6	5.0	4.7	3.4	3.2	2.3	2.2	8.5	8.7
7	1.4	1.1	1.7	1.4	0	0	0	0
8	1.4	1.1	0	0	0	0	0	0
9	1.4	1.1	0	0	0	0	0	0
10	4.4	4.4	0	0	0	0	0	0
11	4.4	4.4	2.6	2.6	0.6	0.6	2.2	2.2
12	11.9	10.8	6.6	6.0	2.2	2.0	5.9	5.4
13	18.9	15.2	10.4	7.9	5.3	4.1	12.9	10.9
14	32.1	24.1	12.7	9.5	13.0	9.7	20.8	15.5
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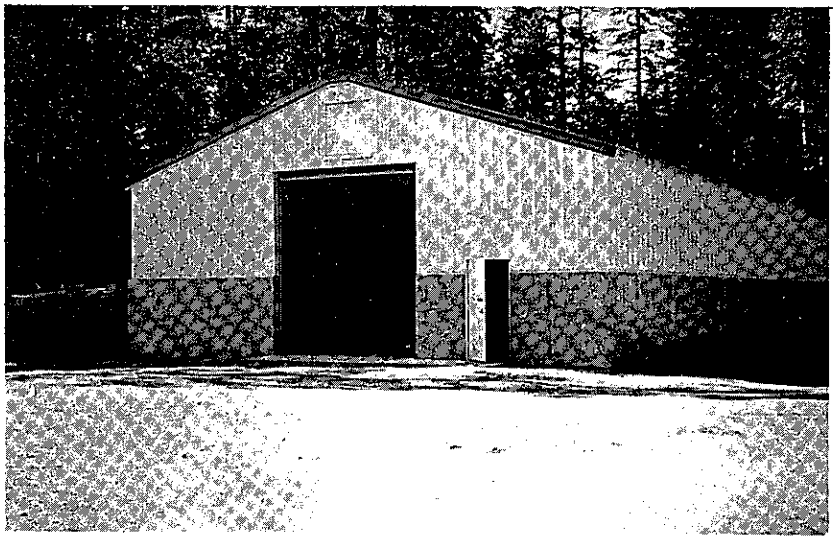

Photo 1
Salt Storage Shed

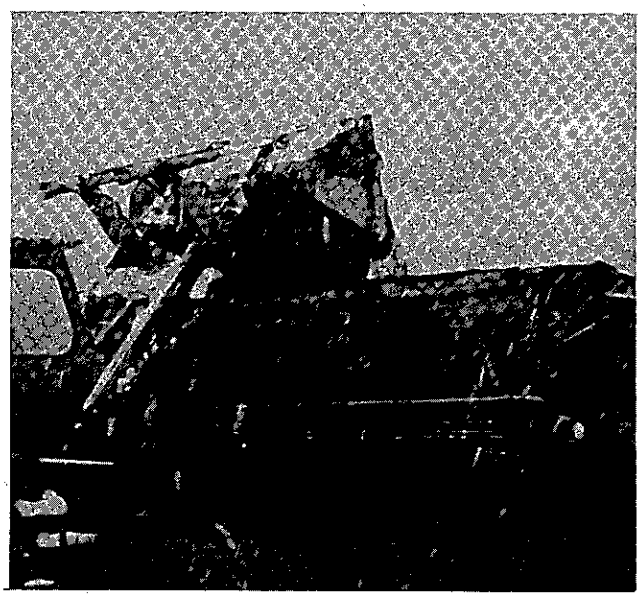

Photo 2
Front End Loader Loading Salt into a Spreader Truck

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Salt is spread with the use of a control mechanism on the spreader trucks that releases the salt, or salt mixed with abrasives, at a predetermined rate. This also allows the operator to apply salt at selected locations such as bridges, shady areas, grades and dangerous curves.

Application Rates

Yearly salt application rates for 1974-75, 1975-76, 1976-77 and 1977-78 were determined for the 15 vegetation study sites (Figures 2 through 5). This information was developed from deicing salt application logs maintained by maintenance crews during the time of salt spreading in the vicinity of the study sites. A copy of the field log is shown in Appendix A. The data from the logs was transferred to laboratory sheets to determine the application rates. The data is shown in Appendix B.

Given the amount of salt spread (tons) and the lane miles within the limits of the application, the rate for each application was calculated (tons per lane mile). The yearly application rates are the sum of the individual application rates for a winter.

The original deicing salt application rates were calculated by the following method:

$$\frac{\text{Tons of Salt Applied for a Run}}{(\text{Number of Lanes})\times(\text{Length of the Run})} = \text{Application Rate (tons/lane mile)}$$

The revised rates were calculated using lane miles from the "Maintenance Branch Highway Inventory", which includes road approaches, bridges, passing lanes and frontage roads in the determination of lane miles within a length of roadway.

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Table 1 shows the original and revised application rates. There were no revisions for Sites 1, 2, 3, 10 and 11, since the additional lane miles from road approaches, bridges, passing lanes and frontage roads were insignificant.

Sites 7, 8, 9 and 10 are within the District 03 ten mile "no salt" test section.

During the Fall 1974, the Transportation Laboratory requested the Districts 03 and 10 Maintenance Departments to maintain salt records during salt spreading in the vicinity of the 15 vegetation study sites. Maintenance responded to the request and began maintaining salt logs immediately. Implementation of such a task is impossible to accomplish overnight. The maintenance personnel had to be trained and equipment calibrated. For these reasons, the salt used as determined from the logs for the 1974-75 winter, did not compare with records (Maintenance Salt Usage Records) that show the amount of salt used in a maintenance area. Table 2 shows an example of this discrepancy.

TABLE 2

SALT USE DATA

Maintenance Territory	Year	Tons of Salt Used	Tons of Salt Applied as Shown on Logs
Tahoe City	1974-75	629	356
Echo Summit	1974-75	1109	679

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Therefore, for study Sites 6 through 9 and 14 and 15 which are in the Echo Summit Maintenance Territory, an adjustment factor of 1109/679 = 1.63 was applied to the data to arrive at the appropriate application rates. For Sites 10 through 12, which are in the Tahoe City Maintenance Territory, the adjustment factor was 629/356 = 1.77. Data from other sites were not adjusted because of lack of information.

The accuracy of the deicing salt logs improved after the first year (1974-75) they were kept and adjustments to the 1975-76, 1976-77 and 1977-78 salt application data were unnecessary. The improvement was due to a continuous training and equipment calibration program. Information on the Program is given in Appendix C. Improvements in the calibration program will continue to be made as information on other states' activities and studies become available(4). Maintenance now records locations of deicing salt applications throughout the state as part of statewide deicing salt control program.

The salt application rates shown on Figures 2 through 5 indicate average rates in a section of roadway that encompasses a site. The lengths of these sections vary, even for individual sites, and are dependent on salt spreader truck turnaround points, climate, etc. The salt application rate at the exact location of a study site may be different from the "average rate" because salting is not uniform. Areas such as bridges, shady areas, grades and dangerous curves receive more salt than a straight stretch of roadway.

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Salt is applied during winter "Bluebird Weather", that is, periods of low temperature and sunshine when there is a tendency for melted snow to form ice on the pavement. During these periods, critical locations such as bridges, shady areas, grades and dangerous curves are salted. These critical locations may or may not be near one of the vegetation study sites.

It should be emphasized that the quantity of salt applied and locations of the applications vary with climatological conditions. Road approaches, passing lanes and frontage roads may not be salted during each application to the travelled way. Also, as stated previously, there are circumstances when only critical areas are salted. In the calculation of the deicing salt application rates, an assumption was made that all the areas were salted with each application.

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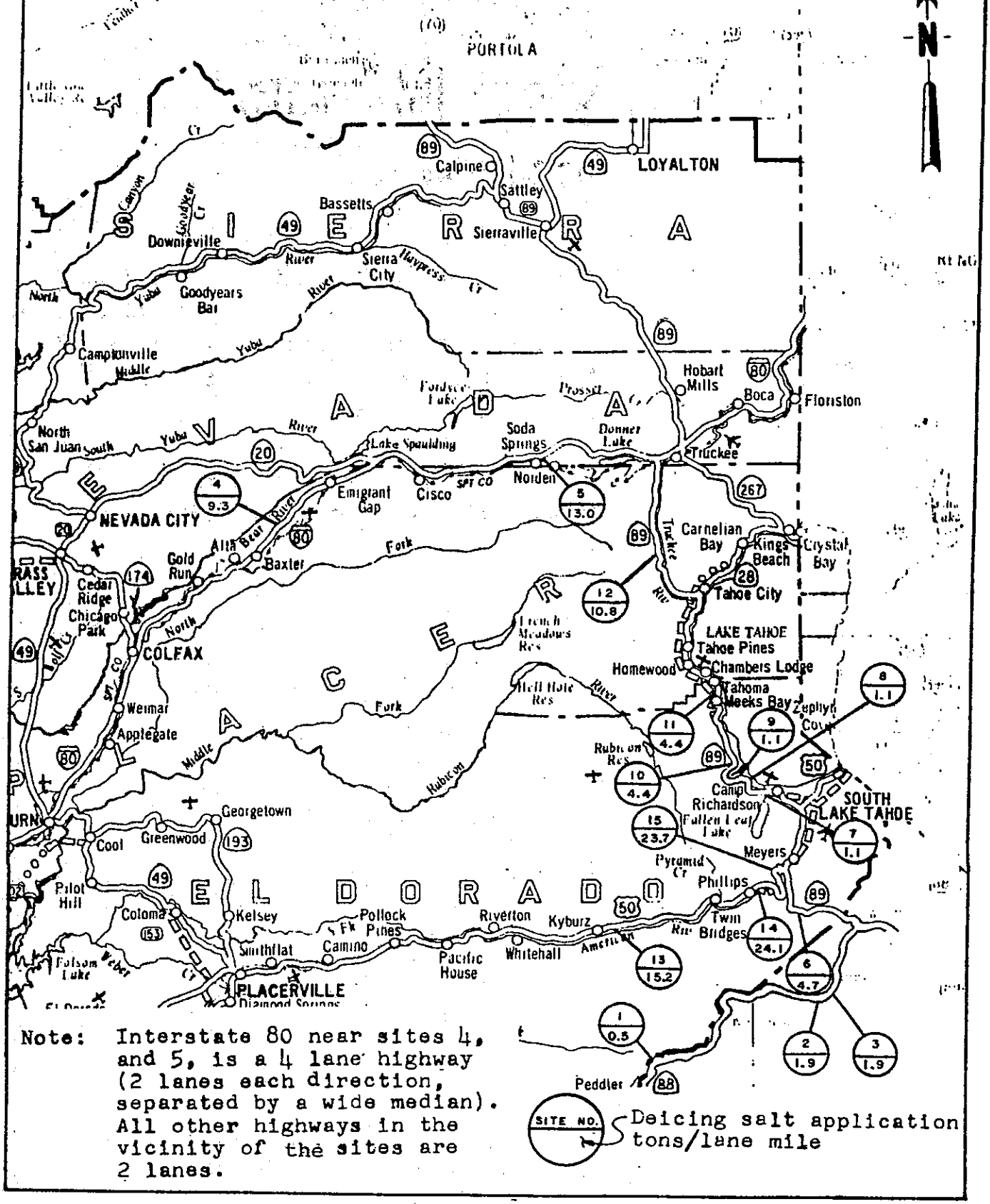
Figure 2

DEICING SALT APPLICATION RATES AT THE TERRESTRIAL VEGETATION STUDY SITES WINTER 1974-75



Note: Interstate 80 near sites 4, and 5, is a 4 lane highway (2 lanes each direction, separated by a wide median). All other highways in the vicinity of the sites are 2 lanes.

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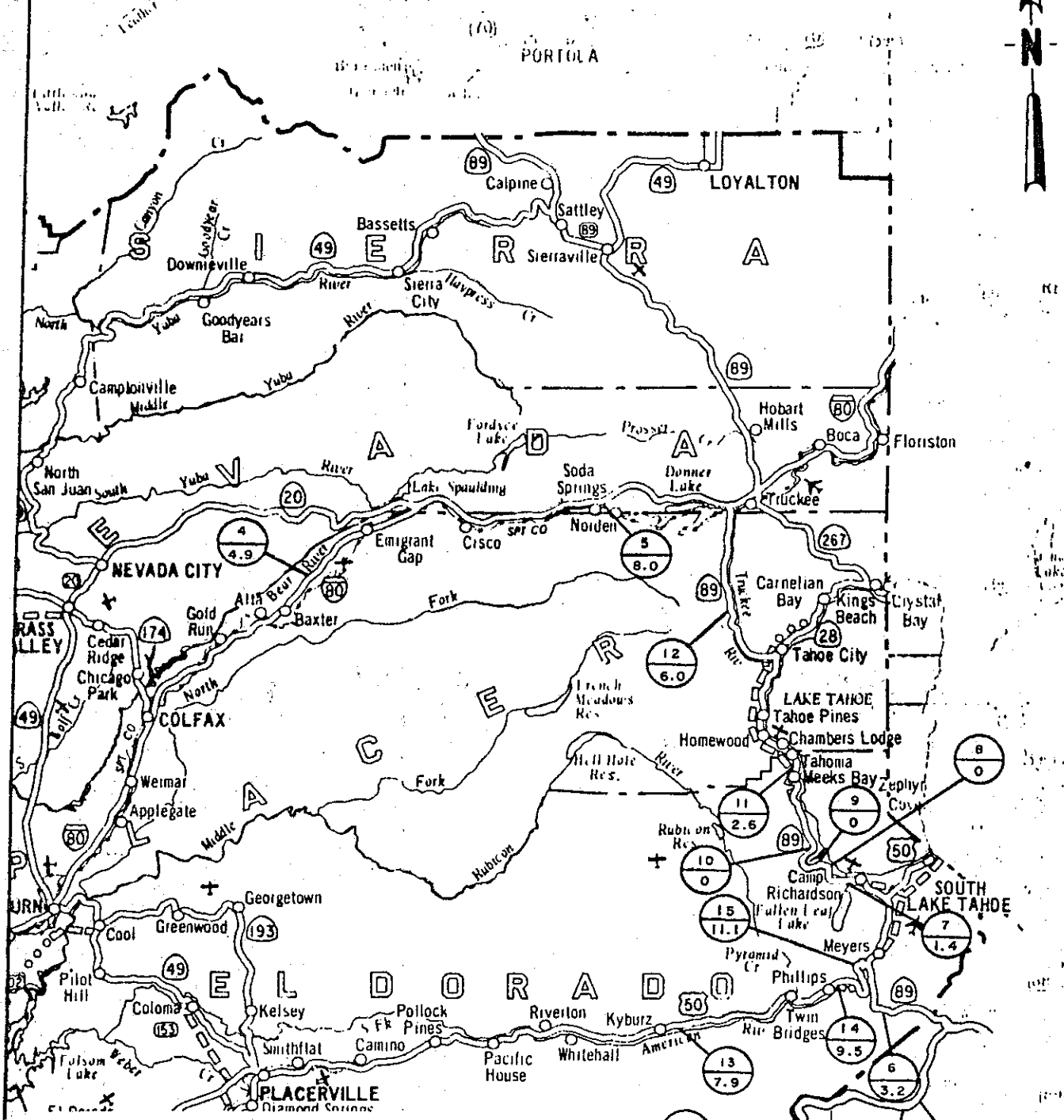
Figure 3

DEICING SALT APPLICATION RATES AT THE TERRESTRIAL VEGETATION STUDY SITES WINTER 1975-76



Note: Interstate 80 near sites 4, and 5, is a 4 lane highway (2 lanes each direction, separated by a wide median). All other highways in the vicinity of the sites are 2 lanes.

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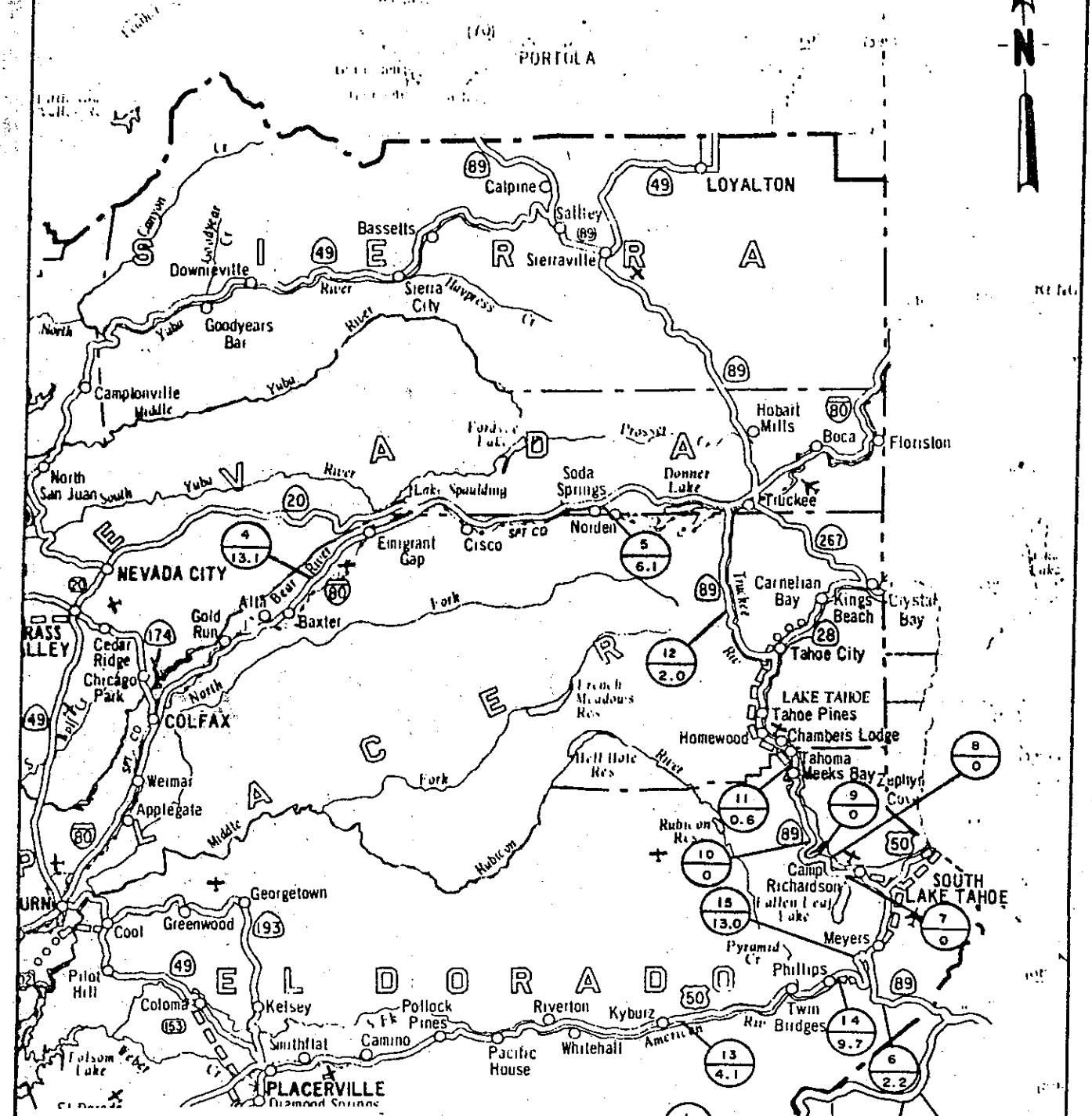
Figure 4

DEICING SALT APPLICATION RATES AT THE TERRESTRIAL VEGETATION STUDY SITES WINTER 1976-77



Note: Interstate 80 near sites 4, and 5, is a 4 lane highway (2 lanes each direction, separated by a wide median). All other highways in the vicinity of the sites are 2 lanes.

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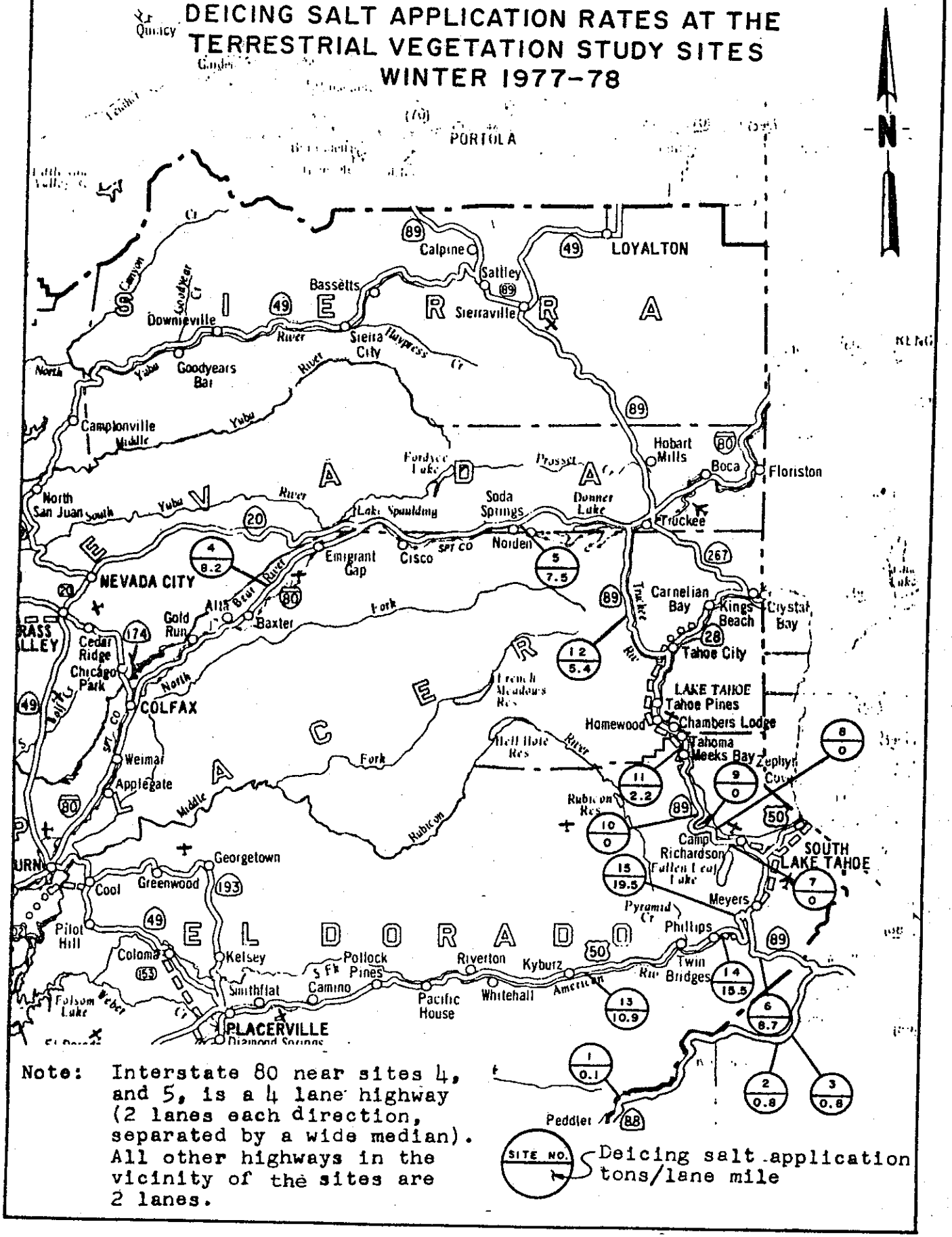
Figure 5

DEICING SALT APPLICATION RATES AT THE TERRESTRIAL VEGETATION STUDY SITES WINTER 1977-78



Note: Interstate 80 near sites 4, and 5, is a 4 lane highway (2 lanes each direction, separated by a wide median). All other highways in the vicinity of the sites are 2 lanes.

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PRECIPITATION

Precipitation data for the period July 1, 1974, through June 30, 1978, for areas near the vegetation study sites were obtained from "Climatological Data", U.S. Department of Commerce and are shown in Table 3(5). Refer to Figure 1 for the location of the precipitation gages.

Precipitation in and around the Lake Tahoe Basin for the year 1974-75 (July 1, 1974 to June 30, 1975) was about normal. Precipitation during the year 1975-76 was far below normal. This was the first year of a two-year drought. The year 1976-77 was the driest year of 130 years of record in California. It also was the second consecutive year of the worst two year drought in California's history. Precipitation in California during the year 1977-78 was above normal in most locations. Precipitation at Blue Canyon located between Sites 4 and 5 was about 20 inches above normal.

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TABLE 3

ANNUAL PRECIPITATION

(Inches, July through June)

Year	Blue Canyon		Truckee Ranger Station		Tahoe City		Twin Lakes	
	Normal	Actual	Normal	Actual	Normal	Actual	Normal	Actual
1974-75	67.58	68.92	32.82	31.56	33.13	27.33	51.13	49.96
1975-76	"	34.75	"	17.42	"	14.32	"	29.14
1976-77	"	26.98	"	17.91	"	12.16	"	26.68
1977-78	"	87.87	"	33.47	"	28.71	"	55.00

Note: TransLab monitored precipitation at Luther Pass at the southern end of the Lake Tahoe Basin (03-ED-89-P.M. 2.4). This data, for January 1972 through July 1975, can be found in the Data Appendix(2).

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2. "Highway Operation and Plant Damage - Data Appendix", D. I. Nakao, R. B. Howell, E. C. Shirley, CA-DOT-TL-7134-2-76-56, September 1976.

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DEICING SALT LOG

TERRITORY _____

TRUCK NO. _____

DATE	TIME	WEATHER	TEMP.	OPERATOR	LOCATION CO - RTE - PM		SAND (TONS)	SALT (TONS)	LOAD USED (TONS)
					FROM	TO			

DH-TL-712 (Orig. 11/73)

SITE 1.

SALT APPLICATION-WINTER 1974-75

APPLICATION LIMITS (POST MILES)	LANE MILES	SALT APPLICATION	
		Tons	Tons/Lane Mi.
24.1 – 65.9	83.6	0.75	0.01
38.0 – 66.0	56.0	0.25	~0
38.3 – 65.8	55.0	0.25	~0
38.3 – 71.2	65.8	0.75	0.01
39.0 – 66.4	54.8	0.75	0.01
41.8 – 65.9	48.2	1.63	0.03
41.8 – 65.8	48.0	0.25	0.01
41.8 – 68.8	54.0	0.25	~0
45.0 – 63.0	36.0	1.00	0.03
45.5 – 65.9	40.8	3.63	0.09
52.6 – 65.8	26.4	0.75	0.03
52.7 – 65.8	26.2	0.25	0.01
52.7 – 65.9	26.4	3.50	0.13
52.9 – 71.2	36.6	0.25	0.01
54.0 – 65.9	23.8	0.50	0.02
54.0 – 66.0	24.0	3.00	0.13
59.8 – 65.9	12.2	0.25	0.02

TOTAL 0.5 TONS/LANE MI.

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SITE 1.

SALT APPLICATION-WINTER 1975-76

APPLICATION LIMITS (POST MILES)	LANE MILES	SALT APPLICATION	
		Tons	Tons/Lane Mi.
24.1 – 65.9	83.60	0.5	0.01
35.0 – 65.9	61.80	0.75	0.01
38.3 – 65.9	55.20	1.00	0.02
41.8 – 65.9	48.2	0.25	0.01
41.8 – 64.4	49.2	0.5	0.01
42.0 – 65.9	47.8	1.00	0.02
42.0 – 66.0	48.0	1.00	0.02
45.4 – 66.0	53.2	0.25	~0
45.5 – 61.0	31.0	0.5	0.02
48.0 – 65.0	34.0	0.5	0.02
52.7 – 65.9	27.4	1.5	0.05
54.0 – 62	16.0	0.25	0.01
54.0 – 64.4	10.8	0.75	0.07
54.0 – 65.8	23.6	0.5	0.02
54.0 – 65.9	23.6	0.25	0.01
54.0 – 66.0	24.0	0.5	0.02
59.3 – 65.9	13.2	0.5	0.04
59.8 – 65.9	12.2	0.5	0.04
65.9 – 46.0	39.8	3	0.08
65.9 – 59.0	13.8	1.5	0.11

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SITE 1.

SALT APPLICATION-WINTER 1975-76

APPLICATION LIMITS (POST MILES)	LANE MILES	SALT APPLICATION	
		Tons	Tons/Lane Mi.
71.2 – 39	64.4	0.75	0.02
72.0 – 45	57.0	1.00	0.02
72.0 – 45.5	53.0	1.00	0.02

TOTAL 0.6 TONS/LANE MI.

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SITE 1.

SALT APPLICATION-WINTER 1976-77

APPLICATION LIMITS (POST MILES)	LANE MILES	SALT APPLICATION	
		Tons	Tons/Lane Mi.
33.0 – 66.0	66.0	1.0	0.02
41.8 – 65.9	48.2	2.5	0.05
42.0 – 66.0	48.0	2.0	0.04
42.0 – 66.4	48.8	1.0	0.02

TOTAL 0.1 TONS/LANE MI.

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SITE 1.

SALT APPLICATION-WINTER 1977-78

APPLICATION LIMITS (POST MILES)	LANE MILES	SALT APPLICATION	
		Tons	Tons/Lane Mi.
31.8 - 65.9	68.20	1	0.01
41.8 - 65.9	48.20	1	0.02
52.6 - 65.9	26.60	1	0.04
54.0 - 65.9	23.80	0.5	0.02
54.0 - 71.6	35.20	0.5	0.01

TOTAL 0.1 TONS/LANE MI.

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SITE 2 & 3.

SALT APPLICATION-WINTER 1974-75

APPLICATION LIMITS (POST MILES)	LANE MILES	SALT APPLICATION	
		Tons	Tons/Lane Mi.
0.0 - 6.0	12.0	0.62	0.05
0.0 - 6.5	13.0	0.50	0.04
0.0 - 8.1	16.2	23.25	1.44
0.0 - 10.0	20.0	0.50	0.03
0.0 - 13.4	26.8	0.12	~0
0.0 - 19.4	38.8	0.25	0.01
0.0 - 29.8	59.6	3.87	0.06
4.5 - 8.5	8.2	0.50	0.06
AMA 65.0 - ALP 6.0	25.3	1.00	0.04
AMA 65.0 - ALP 8.0	29.3	1.50	0.05
AMA 69.2 - ALP 8.1	19.1	2.00	0.10

TOTAL 1.9 TONS/LANE MI.

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SITE 2 & 3

SALT APPLICATION-WINTER 1975-76

APPLICATION LIMITS (POST MILES)	LANE MILES	SALT APPLICATION	
		Tons	Tons/Lane Mi.
65.0 - 8.10	29.5	0.33	0.01
65.0 - 8.10	29.5	0.25	0.01
65.0 - 5.10	23.5	0.50	0.02
65.0 - 5.10	23.5	2.40	0.10
65.0 - 8.10	29.5	2.32	0.08

TOTAL 0.2 TONS/LANE MI.

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SITE 2 & 3

SALT APPLICATION-WINTER 1976-77

APPLICATION LIMITS (POST MILES)	LANE MILES	SALT APPLICATION	
		Tons	Tons/Lane Mi.
0.00 - 8.2	16.4	12.25	0.75
65.0 - 8.2	29.7	6.00	0.20
65.3 - 8.2	29.1	0.25	0.01
65.4 - 8.1	28.7	1.88	0.07
65.8 - 8.1	27.9	1.00	0.04
65.8 - 8.3	28.3	3.00	0.11
71.6 - 6.5	13.1	1.50	0.11
71.6 - 8.1	16.3	0.75	0.05

TOTAL 1.3 TONS/LANE MI.

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SITE 2 & 3

SALT APPLICATION-WINTER 1977-78

APPLICATION LIMITS (POST MILES)	LANE MILES	SALT APPLICATION	
		Tons	Tons/Lane Mi.
ALP 0.46 – ALP 6.87	12.8	3.5	0.27
AMA 66.35 – ALP 6.87	25.0	5.0	0.20
AMA 66.35 – ALP 8.0	24.5	2.25	0.09
AMA 71.3 – ALP 6.87	14.4	3.0	0.21

TOTAL 0.8 TONS/LANE MI.

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SITE 4.

SALT APPLICATION-WINTER 1974-75

APPLICATION LIMITS (POST MILES)	LANE MILES	SALT APPLICATION	
		Tons	Tons/Lane Mi.
49.0 - 50.7	9.1	85.0	9.34

TOTAL 9.3 TONS/LANE MI.

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SITE 4.

SALT APPLICATION-WINTER 1975-76

APPLICATION LIMITS (POST MILES)	LANE MILES	SALT APPLICATION	
		Tons	Tons/Lane Mi.
41.37 - 50.7	44.2	7.5	0.17
43.17 - 50.7	36.1	1.0	0.03
43.17 - 56.08	64.6	1.5	0.02
43.37 - 63.7	94.8	1.5	0.02
44.75 - 50.7	28.6	0.25	0.01
46.31 - 50.7	21.6	4.2	0.19
46.31 - 54.81	43.7	2.0	0.05
46.31 - 56.08	49.6	0.75	0.02
46.94 - 50.7	18.2	0.5	0.03
46.94 - 54.81	40.3	3.0	0.07
49.0 - 50.7	9.1	29.5	3.24
49.0 - 54.81	31.2	21.8	0.70
49.0 - 56.08	37.6	7.75	0.21
50.2 - 56.08	32.6	4.50	0.14

TOTAL 4.9 TONS/LANE MI.

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SITE 4.

SALT APPLICATION-WINTER 1976-77

APPLICATION LIMITS (POST MILES)	LANE MILES	SALT APPLICATION	
		Tons	Tons/Lane Mi.
33.13 - 50.7	73.4	0.50	0.01
33.13 - 63.7	132.8	0.20	~0
38.23 - 50.7	53.0	1.00	0.02
41.3 - 50.7	44.2	6.32	0.14
41.3 - 53.58	59.0	1.59	0.03
41.3 - 54.81	66.6	1.48	0.02
41.3 - 56.08	72.7	3.53	0.05
41.3 - 60.0	89.1	0.38	~0
41.3 - 63.7	104.2	3.56	0.03
43.3 - 50.7	36.1	3.61	0.10
43.3 - 53.57	50.6	0.50	0.01
43.3 - 56.08	64.6	0.23	~0
43.3 - 63.7	94.8	0.89	0.01
44.75 - 50.7	28.6	9.95	0.35
44.75 - 54.81	50.7	0.68	0.01
44.75 - 60.0	73.5	0.58	0.01
46.31 - 50.7	21.6	10.39	0.48
46.31 - 53.58	35.9	0.36	0.01
46.31 - 54.81	43.7	1.39	0.03
46.31 - 56.08	49.6	3.88	0.08

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SITE 4.

SALT APPLICATION-WINTER 1976-77

APPLICATION LIMITS (POST MILES)	LANE MILES	SALT APPLICATION	
		Tons	Tons/Lane Mi.
46.31 - 60.0	66.5	1.23	0.02
46.31 - 63.7	95.2	0.67	0.01
46.94 - 50.7	18.2	4.97	0.27
46.94 - 53.58	35.9	13.97	0.39
46.94 - 54.81	40.3	1.00	0.02
46.94 - 56.08	47.9	0.30	0.01
46.94 - 63.7	79.1	1.84	0.02
49.0 - 50.7	9.1	89.09	9.79
49.0 - 53.58	23.9	0.94	0.04
49.0 - 54.81	31.2	18.29	0.59
49.0 - 55.48	34.6	1.80	0.05
49.0 - 56.08	37.6	0.30	0.01
49.0 - 56.08	37.6	13.78	0.37
49.0 - 57.10	42.4	0.75	0.02
49.0 - 60.0	54.0	0.32	0.01
49.0 - 63.7	68.8	3.35	0.05

TOTAL 13.1 TONS/LANE MI.

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SITE 4.

SALT APPLICATION-WINTER 1977-78

APPLICATION LIMITS (POST MILES)	LANE MILES	SALT APPLICATION	
		Tons	Tons/Lane Mi.
33.1 - 50.7	73.4	0.31	~0
33.1 - 54.81	95.4	0.36	~0
40.0 - 50.7	52.3	2.06	0.04
41.3 - 50.7	44.2	22.75	0.51
41.3 - 54.81	66.6	10.58	0.16
41.3 - 56.08	72.7	6.92	0.10
41.3 - 56.6	77.1	5.21	0.07
41.3 - 63.7	104.2	0.73	0.01
41.3 - 63.7	104.2	0.38	~0
41.7 - 50.7	42.0	0.81	0.02
43.17 - 50.7	36.5	3.99	0.11
43.17 - 54.81	57.0	2.03	0.04
43.7 - 50.7	34.0	0.31	0.01
44.75 - 50.7	28.6	8.39	0.29
44.75 - 54.81	50.7	1.39	0.03
44.75 - 56.08	57.0	3.76	0.07
44.75 - 56.6	66.5	0.60	0.01
44.75 - 60.0	73.5	0.23	~0
44.75 - 60.0	73.5	0.26	~0
44.75 - 63.7	89.1	0.38	~0

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SITE 4.

SALT APPLICATION-WINTER 1977-78

APPLICATION LIMITS (POST MILES)	LANE MILES	SALT APPLICATION	
		Tons	Tons/Lane Mi.
44.75 - 63.7	89.1	4.01	~ 0
46.31 - 50.7	21.6	0.72	0.03
46.31 - 54.81	43.3	0.72	0.02
46.31 - 56.6	51.8	0.67	0.01
46.31 - 63.7	80.2	0.76	0.01
46.94 - 50.7	18.2	17.11	0.94
46.94 - 51.04	20.2	0.36	0.02
46.94 - 54.81	40.3	1.22	0.23
46.94 - 56.08	52.6	7.04	0.13
46.94 - 56.6	55.59	4.01	0.07
46.94 - 60.0	61.1	6.00	0.10
46.94 - 63.7	57.8	6.63	0.11
49.0 - 50.7	9.1	22.25	2.45
49.0 - 51.04	11.3	0.36	0.03
49.0 - 54.81	31.2	45.92	1.47
49.0 - 56.08	37.6	34.25	0.91
49.0 - 56.6	38.6	5.15	0.13
49.0 - 60.0	54.0	1.54	0.02
49.0 - 63.7	71.8	2.26	0.03

TOTAL 8.2 TONS/LANE MI.

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SITE 5.

SALT APPLICATION-WINTER 1974-75

APPLICATION LIMITS (POST MILES)	LANE MILES	SALT APPLICATION	
		Tons	Tons/Lane Mi.
2·5 — 5·1	12·5	162·2	12·98

TOTAL 13·0 TONS/LANE MI.

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SITE 5.

SALT APPLICATION-WINTER 1975-76

APPLICATION LIMITS (POST MILES)	LANE MILES	SALT APPLICATION	
		Tons	Tons/Lane Mi.
2.5 — 5.1	12.5	76.35	6.11
2.5 — 9.0	34.2	28.5	0.83
PLA 60.01 — NEV. 9.0	83.9	4.4	0.05
PLA 63.7 — NEV. 9.0	68	23.0	0.34
PLA 69.2 — NEV 5.1	28.3	4.2	0.15
PLA 69.2 — NEV 9.0	47.1	25.2	0.54

TOTAL 8.0 TONS/LANE MI.

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SITE 5.

SALT APPLICATION-WINTER 1976-77

APPLICATION LIMITS (POST MILES)	LANE MILES	SALT APPLICATION	
		Tons	Tons/Lane Mi.
2.5 - 9.0	34.2	6	0.18
69.2 - 5.1	28.3	3.7	0.13
PLA 69.2 - NEV 9.0	47.1	274.0	5.82

TOTAL 6.1 TONS/LANE MI.

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SITE 5.

SALT APPLICATION-WINTER 1977-78

APPLICATION LIMITS (POST MILES)	LANE MILES	SALT APPLICATION	
		Tons	Tons/Lane Mi.
0.0 – 9.0	43.2	21.2	0.49
2.5 – 5.1	12.5	3.0	0.24
2.5 – 9.0	34.2	33.0	0.96
PLA 59.5 – NEV 9.0	86.4	20.0	0.23
PLA 63.7 – NEV 5.1	48.3	2.5	0.05
PLA 63.7 – NEV 9.0	68	87.2	1.28
PLA 69.2 – NEV 5.1	28.3	10.5	0.37
PLA 69.2 – NEV 9.0	47.1	181.0	3.84

TOTAL 7.5 TONS/LANE MI.

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SITE 6.

SALT APPLICATION-WINTER 1974-75

APPLICATION LIMITS (POST MILES)	LANE MILES	SALT APPLICATION	
		Tons	Tons/Lane Mi.
0·0 – 8·19	17·5	50·0	2·86

TOTAL 2·86 TONS/LANE MI.

ADJUSTMENT 1·63 x 2·86 TONS/LANE MILE = 4·7 TONS/LANE MI.

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SITE 6.

SALT APPLICATION-WINTER 1975-76

APPLICATION LIMITS (POST MILES)	LANE MILES	SALT APPLICATION	
		Tons	Tons/Lane Mi.
0.0 – 8.19	17.5	56.0	3.2

TOTAL 3.2 TONS/LANE MI.

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SITE 6.

SALT APPLICATION-WINTER 1976-77

APPLICATION LIMITS (POST MILES)	LANE MILES	SALT APPLICATION	
		Tons	Tons/Lane Mi.
0.0 — 8.19	17.5	38.50	2.2

TOTAL 2.2 TONS/LANE MI.

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SITE 6.

SALT APPLICATION-WINTER 1977-78

APPLICATION LIMITS (POST MILES)	LANE MILES	SALT APPLICATION	
		Tons	Tons/Lane Mi.
0.0 – 8.19	17.5	152.0	8.7

TOTAL 8.7 TONS/LANE MI.

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SITE 7, 8, & 9

SALT APPLICATION-WINTER 1974-75

APPLICATION LIMITS (POST MILES)	LANE MILES	SALT APPLICATION	
		Tons	Tons/Lane Mi.
8.56 – 17.08	21.2	14.5	0.68

TOTAL 0.68 TONS/LANE MI.

ADJUSTMENT 1.63 × 0.68 TONS/LANE MILE = 1.1 TONS/LANE MI.

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SITE 7.

SALT APPLICATION-WINTER 1975-76

APPLICATION LIMITS (POST MILES)	LANE MILES	SALT APPLICATION	
		Tons	Tons/Lane Mi.
8.56 - 13.82	13.2	18.48	1.4

TOTAL 1.4 TONS/LANE MI.

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SITE 10.

SALT APPLICATION-WINTER 1974-75

APPLICATION LIMITS (POST MILES)	LANE MILES	SALT APPLICATION	
		Tons	Tons/Lane Mi.
PLA 8.6 - ED 17.1	37.8	13	0.34
PLA 1.7 - ED 17.0	24.2	1	0.04
ED 16.0 - ED 27.0	22.0	6	0.27
ED 17.0 - ED 21.9	9.8	5	0.51
ED 17.0 - ED 24.6	15.2	2.5	0.16
ED 17.0 - ED 26.4	18.8	2	0.11
ED 17.0 - ED 27.0	20.0	1	0.05
ED 17.0 - ED 27.4	20.8	1	0.05
ED 17.1 - ED 27.4	20.6	16.5	0.80
ED 17.9 - ED 27.4	19.0	3	0.16

TOTAL 2.49 TONS/LANE MI.

ADJUSTMENT 1.77 x 2.49 TONS/LANE MILE = 4.4 TONS/LANE MI.

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SITE 11.

SALT APPLICATION-WINTER 1974-75

APPLICATION LIMITS (POST MILES)	LANE MILES	SALT APPLICATION	
		Tons	Tons/Lane Mi.
PLA 8.6 - ED 17.1	37.8	13	0.32
PLA 1.7 - ED 17.0	24.2	1	0.04
ED 16.0 - ED 27.0	22.0	6	0.27
ED 17.0 - ED 26.4	18.8	2	0.11
ED 17.0 - ED 27.0	20.0	1	0.05
ED 17.0 - ED 27.4	20.8	1	0.05
ED 17.1 - ED 27.4	20.6	16.5	0.80
ED 17.9 - ED 27.4	19.0	3	0.16
ED 24.6 - ED 27.4	5.6	4	0.71

TOTAL 2.51 TONS/LANE MI.

ADJUSTMENT 1.77 x 2.51 TONS/LANE MILE = 4.4 TONS/LANE MI.

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SITE 11.

SALT APPLICATION-WINTER 1975-76

APPLICATION LIMITS (POST MILES)	LANE MILES	SALT APPLICATION	
		Tons	Tons/Lane Mi.
PLA 2.2 - ED 18.0	23.2	1	0.04
PLA 2.2 - ED 19.1	21.0	2	0.10
PLA 8.6 - ED 17.1	37.8	2	0.05
PLA 8.6 - ED 17.9	36.2	3.8	0.10
PLA 8.6 - ED 19.3	33.4	7.5	0.22
PLA 8.6 - ED 24.6	22.8	7.9	0.35
ED 17.1 - ED 27.4	20.6	2	0.10
ED 17.9 - ED 27.4	19.0	6	0.32
ED 18.7 - ED 27.4	17.4	2	0.11
ED 19.3 - ED 27.4	16.2	17	1.05
ED 22.8 - ED 27.4	9.2	1	0.11

TOTAL 2.6 TONS/LANE MI.

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SITE 11.

SALT APPLICATION-WINTER 1976-77

APPLICATION LIMITS (POST MILES)	LANE MILES	SALT APPLICATION	
		Tons	Tons/Lane Mi.
PLA 8.50 - ED 19.03	33.74	8.60	0.25
ED 27.4 - ED 19.3	16.20	2.36	0.15
ED 27.4 - ED 19.03	16.74	4.00	0.24

TOTAL 0.6 TONS/LANE MI.

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SITE 11.

SALT APPLICATION-WINTER 1977-78

APPLICATION LIMITS (POST MILES)	LANE MILES	SALT APPLICATION	
		Tons	Tons/Lane Mi.
PLA 8.50 - ED 26.00	19.80	2	0.10
PLA 8.50 - ED 25.00	21.80	2	0.09
PLA 8.50 - ED 23.60	24.60	2	0.08
PLA 8.50 - ED 22.50	26.82	4	0.15
PLA 8.50 - ED 19.0	33.80	10	0.30
PLA 8.50 - ED 19.30	33.20	32	0.96
ED 27.0 - ED 19.0	16.00	4	0.25
ED 27.4 - ED 19.3	16.20	5	0.31

TOTAL 2.2 TONS/LANE MI.

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SITE 12.

SALT APPLICATION-WINTER 1974-75

APPLICATION LIMITS (POST MILES)	LANE MILES	SALT APPLICATION	
		Tons	Tons/Lane Mi.
8.5 – 13.5	11.0	67	6.09

TOTAL 6.09 TONS/LANE MI.

ADJUSTMENT 1.77 x 6.09 TONS/LANE MILE = 10.8 TONS/LANE MI.

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SITE 12.

SALT APPLICATION-WINTER 1975-76

APPLICATION LIMITS (POST MILES)	LANE MILES	SALT APPLICATION	
		Tons	Tons/Lane Mi.
8.5 — 13.5	11.0	66.0	6.0

TOTAL 6.0 TONS/LANE MI.

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SITE 12.

SALT APPLICATION-WINTER 1976-77

APPLICATION LIMITS (POST MILES)	LANE MILES	SALT APPLICATION	
		Tons	Tons/Lane Mi.
8.5 — 13.5	11.0	22	2.0

TOTAL 2.0 TONS/LANE MI.

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SITE 12.

SALT APPLICATION-WINTER 1977-78

APPLICATION LIMITS (POST MILES)	LANE MILES	SALT APPLICATION	
		Tons	Tons/Lane Mi.
8.5 — 13.5	11.0	59.4	5.4

TOTAL 5.4 TONS/LANE MI.

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SITE 13.

SALT APPLICATION-WINTER 1974-75

APPLICATION LIMITS (POST MILES)	LANE MILES	SALT APPLICATION	
		Tons	Tons/Lane Mi.
49.6 - 59.7	25.2	383	15.2

TOTAL 15.2 TONS/LANE MI.

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SITE 13.

SALT APPLICATION–WINTER 1975-76

APPLICATION LIMITS (POST MILES)	LANE MILES	SALT APPLICATION	
		Tons	Tons/Lane Mi.
41.50 – 52.00	26.6	1.0	0.04
46.0 – 53.00	19.6	2.0	0.10
46.96 – 51.47	12.4	3.0	0.24
47.50 – 58.00	25.7	1.5	0.06
48.68 – 52.0	9.1	4.5	0.50
48.68 – 54.0	14.4	10.5	0.73
48.68 – 58.32	25.7	1.5	0.06
48.68 – 59.68	27.6	7.5	0.27
49.0 – 54.0	13.4	5.0	0.37
49.0 – 55.0	17.3	3.0	0.17
49.0 – 57.9	23.6	1.5	0.06
49.0 – 59.77	30.2	6.5	0.22
49.07 – 52.00	8.1	2.0	0.25
49.7 – 59.7	25.0	98.0	3.92
49.72 – 52.50	8.0	2.0	0.25
49.97 – 52.00	6.0	1.0	0.17
49.97 – 58.00	22.0	2.0	0.09
51.00 – 59.77	25.6	2.5	0.10
51.43 – 57.88	20.7	4.0	0.19
51.43 – 59.00	20.0	1.5	0.08
51.41 – 59.77	19.9	1.5	0.08

TOTAL 7.9 TONS/LANE MI.

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SITE 13.

SALT APPLICATION-WINTER 1976-77

APPLICATION LIMITS (POST MILES)	LANE MILES	SALT APPLICATION	
		Tons	Tons/Lane Mi.
38.00 - 55.00	43.1	1.0	0.02
39.60 - 54.00	35.8	2.0	0.06
39.69 - 59.67	52.6	1.0	0.02
47.41 - 52.03	12.3	2.0	0.16
48.00 - 60.00	27.3	1.0	0.04
48.65 - 51.47	7.3	2.0	0.27
48.65 - 55.00	18.3	3.0	0.16
48.65 - 59.66	27.6	14.0	0.51
48.68 - 52.50	10.4	1.0	0.10
48.68 - 54.00	14.4	4.0	0.28
48.68 - 57.88	24.3	1.0	0.04
48.68 - 59.77	27.6	14.0	0.51
48.68 - 61.00	33.6	4.5	0.13
49.00 - 52.03	8.1	2.0	0.25
49.00 - 54.00	13.4	8.0	0.60
49.00 - 54.80	16.5	3.0	0.18
49.00 - 59.00	26.1	6.5	0.25
49.00 - 60.00	30.2	3.0	0.10
49.00 - 61.90	34.8	4.0	0.11
49.07 - 53.50	12.1	1.0	0.08

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SITE 13.

SALT APPLICATION-WINTER 1976-77

APPLICATION LIMITS (POST MILES)	LANE MILES	SALT APPLICATION	
		Tons	Tons/Lane Mi.
49.7 - 59.7	28.2	4.0	0.14
51.00 - 59.00	21.5	1.0	0.05

TOTAL 4.1 TONS/LANE MI.

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SITE 13.

SALT APPLICATION-WINTER 1977-78

APPLICATION LIMITS (POST MILES)	LANE MILES	SALT APPLICATION	
		Tons	Tons/Lane Mi.
39.9 - 52.0	30.5	1.8	0.1
48.7 - 55.0	19.1	22.8	1.2
48.7 - 59.8	31.7	186.6	5.9
51.5 - 54.0	7.4	27.6	3.7

TOTAL 10.9 TONS/LANE MI.

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SITE 14.

SALT APPLICATION-WINTER 1974-75

APPLICATION LIMITS (POST MILES)	LANE MILES	SALT APPLICATION	
		Tons	Tons/Lane Mi.
59.68 - 66.88	19.2	283.9	14.79

TOTAL 14.79 TONS/LANE MI.

ADJUSTMENT 1.63 × 14.79 TONS/LANE MILE = 24.1 TONS/LANE MI.

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SITE 14

SALT APPLICATION-WINTER 1975-76

APPLICATION LIMITS (POST MILES)	LANE MILES	SALT APPLICATION	
		Tons	Tons/Lane Mi.
59.68 – 66.88	19.2	182.4	9.5

TOTAL 9.5 TONS/LANE MI.

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SITE 14

SALT APPLICATION-WINTER 1976-77

APPLICATION LIMITS (POST MILES)	LANE MILES	SALT APPLICATION	
		Tons	Tons/Lane Mi.
59.7 - 66.7	19.2	175.9	9.2
59.7 - 70.4	31.8	15.8	0.5

TOTAL 9.7 TONS/LANE MI.

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SITE 14.

SALT APPLICATION-WINTER 1977-78

APPLICATION LIMITS (POST MILES)	LANE MILES	SALT APPLICATION	
		Tons	Tons/Lane Mi.
58.4 - 70.4	37.9	0.5	0.01
59.7 - 66.7	19.2	96.5	5.1
59.7 - 75.4	47.8	61.5	1.29
59.7 - 80.4	72.7	365.3	5.02
59.8 - 70.4	31.80	129.2	4.06

TOTAL 15.5 TONS/LANE MI.

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SITE 15.

SALT APPLICATION-WINTER 1974-75

APPLICATION LIMITS (POST MILES)	LANE MILES	SALT APPLICATION	
		Tons	Tons/Lane Mi.
66.9 - 70.6	12.2	177.4	14.54

TOTAL 14.54 TONS/LANE MI.

ADJUSTMENT 1.63 x 14.54 TONS/LANE MILE = 23.7 TONS/LANE MI.

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SITE 15.

SALT APPLICATION-WINTER 1975-76

APPLICATION LIMITS (POST MILES)	LANE MILES	SALT APPLICATION	
		Tons	Tons/Lane Mi.
66.9 - 70.4	11.8	131.0	11.1

TOTAL 11.1 TONS/LANE MI.

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SITE 15.

SALT APPLICATION-WINTER 1976-77

APPLICATION LIMITS (POST MILES)	LANE MILES	SALT APPLICATION	
		Tons	Tons/Lane Mi.
57.8 - 70.4	31.8	13.8	0.4
66.9 - 70.4	11.8	149.0	12.6

TOTAL 13.0 TONS/LANE MI.

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SITE 15.

SALT APPLICATION-WINTER 1977-78

APPLICATION LIMITS (POST MILES)	LANE MILES	SALT APPLICATION	
		Tons	Tons/Lane Mi.
66.9 - 70.4	11.8	107.2	9.1
59.7 - 75.4	47.8	61.5	1.29
59.7 - 80.4	72.7	365.3	5.02
59.8 - 70.4	31.80	129.2	4.06

TOTAL 19.5 TONS/LANE MI.

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APPENDIX C

Training and Equipment Calibration Program*
October 1978

A continuing calibration effort is necessary because of the characteristic of salt bulking. As necessary throughout the winter season, the equipment commonly used for handling, such as front end loaders and spreading equipment, is calibrated by comparing measured volumes vs. actual weights.

Training of Application Personnel

Each district, at the beginning of the winter season, is required to train all new employees and to give refresher training to all experienced employees in the following related salt work items: The techniques for spreading salt; newer equipment used for spreading salt; and the techniques for treating curves, shady areas, grades, or other critical areas. In addition, training and refresher training is emphasized relative to environmental concerns.

The training, depending upon how critical the area is from both the traffic and environmental aspects, may be for as long as three days and is conducted at the various mountain stations. It is important to conduct the training in the area where the trainee will work to obtain a better appreciation of the environmental problems and of the special critical locations such as shady areas, curves, grades, etc. where the use of salt is particularly important for the safe travel of motor vehicles.

*California Department of Transportation
Office of Highway Maintenance
Use of Deicing Salt Report - 1977/78 Season

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Salt Application Equipment

Two principle types of salt and abrasive spreaders are used in ice control operations. These are the tailgate spreader and the hopper body type. Statewide, Caltrans has 338 tailgate spreaders and 139 hopper body units. The majority of these units are located in the higher mountain elevations, however, there are some units in valley areas where severe winter ice conditions sometimes occur.

The tailgate and hopper body type spreaders are hydraulically driven and controlled from the trick cab. Both types have independently adjustable discharge ports which control the amount of material spread. The spread width and rate of application are independently selected by controls for determining spinner, auger, and conveyer speeds.

In the more critical areas, Caltrans has 43 spreaders with electronic, ground oriented, controls. Thirty-seven additional units are being equipped with the electronic controls to make a total of 80 such units available for the 1978-79 winter. THese controls are designed to automatically give equal spread no matter what speed the truck may travel. They are particularly useful on heavily traveled routes such as I-5 in the Tehachapis or Siskiyous, and Routes 50 and I-80 in the Sierras, where traffic flow speeds vary tremendously and consequently spreader speeds must also vary because of the necessity of following the traffic flow.

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Caltrans is continuing to experiment with a hopper body type spreader that has been modified to include a separate 1 ton hopper for salt. With this unit a calibrated amount of salt can be disbursed into the abrasive conveyer which in turn carries the mixture of salt and abrasives to the spreader.

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