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SURVEY STUDY OF DEICING SALT IMPACTS ON ROADSIDE LAKES AND PONDS

77-37

TRANSPORTATION LABORATORY

APRIL, 1977

Caltrans

CALIFORNIA DEPARTMENT OF TRANSPORTATION

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Caltrans
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State of California

Business and Transportation Agency

Memorandum

To : Mr. E. B. Thomas
Chief, Maintenance

Date: April 19, 1977

File : 657243

From : DEPARTMENT OF TRANSPORTATION
Transportation Laboratory

Subject: Report on Impacts of Deicing Salts on Roadside Lakes and Ponds

Attached is the completed Translab report on the special study conducted for Maintenance concerning potential impacts of highway runoff waters containing deicing salts on adjacent roadside lakes and ponds.

This study stemmed from a research recommendation in the 1975 Goldman report as follows:

> "Recommendation : A statewide survey of lakes and ponds near heavily salted highways should be conducted to check for possible adverse impact areas, and to collect base-line chloride and phytoplankton data to aid assessment of any long term changes not detected in this study."

The statewide survey was begun in April 1976 and included all lakes and ponds adjacent to state highways. We are pleased to report that no adverse effects due to the Caltrans deicing practices were identified. It is recommended, however, that drainage modification be completed for Putt's Lake on Interstate 80. Mr. Gary Winters (444-4872) of my staff is available to assist on planning for the redirection of flows to accomplish this task.

If we can be of further assistance, please let me know.

George A Hill

GEORGE A. HILL, P.E.
Chief, Transportation Laboratory

GW:bd

Attachment

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SURVEY STUDY OF DEICING SALT IMPACTS ON ROADSIDE LAKES AND PONDS

by

Gary R. Winters
Associate Water Quality Biologist

April 1977

Water Quality Section
Transportation Laboratory
California Department of Transportation
Sacramento, California

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ACKNOWLEDGEMENTS

This study was conducted by the Transportation Laboratory of the California Department of Transportation. Recognition is given to the numerous district maintenance personnel for their cooperation in providing information on the lakes and ponds found in their areas of maintenance responsibility.

The contents of this report reflect the views of the Transportation Laboratory which is responsible for the facts and accuracy of the data presented within. The contents do not necessarily reflect the official views or policies of the State of California. This report does not constitute a standard, specification, or regulation.

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Introduction

Complete utilization and vehicle safety of highways during winter months requires control of snow and ice in areas of sub-freezing weather. The use of deicing salts for this function is widespread on highways in the United States. In practice, salts are spread on the highways prior to the beginning of a snow storm to prevent bondage of snow to the pavement. Normally, the applied salts leave the highway as saline runoff or are distributed on the accompanying environment during snow removal operations.

During the last fifteen years it has become evident there may be undesirable effects of deicing salts on the environment. As a result of these concerns, the Department of Transportation contracted with Dr. Charles Goldman of Ecological Research Associates to conduct an investigation of the effects of deicing salts on aquatic ecosystems.

Goldman's report, "A Study of the Influence of Highway Deicing Agents on the Aquatic Environment in the Lake Tahoe Basin and Drainages along Interstate 80", noted no significant effects on the aquatic environment but did recommend a statewide survey of lakes and ponds near salted roadways to ascertain if any of them have developed a monimolimnion (unmixed salt water layer) or show delayed mixing due to accumulations of salt-laden runoff. Water bodies with low volume to depth ratios are known to have the essential physical characteristics for the formation of detrimental salt accumulations if conditions are correct.

Normally, water bodies with sufficient depth will stratify during warmer summer months and are characterized during those months by warmer upper waters and cold deeper waters separated by a temperature dependent density gradient called a thermocline. Normal seasonal temperature changes are conducive to the breakup of the thermocline. The temperature changes affect water density which causes the water to overturn, supplying needed nutrients and oxygen to the lower depths. Density gradients are especially prevalent where lakes have small surface areas, deep waters, and are sheltered from substantial winds by surrounding topography. Winds tend to keep shallower, large surfaced areas well mixed and density gradients do not develop.

While temperature is the most common agent responsible for stratification, saline water is known to cause density gradients which, unlike thermal gradients, are not temperature dependent and will not breakup to allow normal circulation patterns and oxygen replenishment. When a lake receiving a substantial saline input is deep, has a small surface area, and is sheltered from mixing winds, conditions are ripe for the development of a permanent saline density gradient. As a result, normal lake mixing is curtailed resulting in oxygen stagnation, fish die off, and destruction of the lake bottom ecosystem follows.

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Conclusions and Recommendations

This survey indicates some ponds may have some chloride enrichment from deicing operations, but there are no lakes and/or ponds which would be suspected of forming a permanent density gradient due to highway salt runoff.

A vast majority of the lakes and/or ponds did not have a basin morphology which allows a low surface to depth ratio. Most lakes were relatively shallow with large surface areas and were exposed to winds. This results in mixing of the entire water column and precludes density gradient formation. In the few water bodies which did have reasonably deep basins, the water body's distance from salted roads and relatively low salt usage levels resulted in the conclusion that monimolimnion formation was impossible.

Putt's Lake (03-Pla 80 P.M. 54[81]) was found by Goldman to have a temperature inversion stabilized by saline runoff but no permanent monimolimnion was found. Formation of a permanent monimolimnion in Putt's Lake was considered impossible by Goldman because of the Lake's basin shape and exposure to wind.

Putt's Lake lies directly adjacent to U.S. 80 with three culverts draining this portion of the highway. Saline runoff from one of the culverts enters Putt's Lake directly. This area has a fairly high salt usage (10-12 tons/lane mile in 1974-75) and a considerable amount of the salt enters directly into Putt's Lake.

The problem is compounded because Putt's Lake freezes over during the winter and negates the mixing effects of wind. Inflowing saline water tends to sink into the lower lake levels resulting in differential salt concentrations and, hence, densities. The water could not stratify if the lake did not freeze over and protect the lake's waters from mixing due to wind action.

It is recommended that the drainage system for I-80 entering directly into Putt's Lake be altered such that the runoff is given a chance to infiltrate and enter the lake in a more diffuse manner.

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Discussion-

This lake and pond survey included all roads salted with State maintenance forces (Appendix A). To insure that all lakes and ponds associated with salting activities were inventoried, district maintenance personnel were contacted. These individuals have in depth knowledge of all lakes and ponds located in their particular area of maintenance responsibility.

Survey questionnaires (Appendix B) were distributed to each District Director of Transportation and directed to the attention of the particular District Maintenance Engineer. The questionnaires were completed by local maintenance personnel working on deicing operations.

The survey questionnaires were used to locate all lakes and ponds associated with state roadways in snow removal and deicing areas and to provide information about each water body. This information was utilized in an evaluation of the lake or pond's potential for adverse salt impacts. Survey results were evaluated with particular emphasis on basin morphology and surrounding topography, wind characteristics, proximity to salted roadways, ice and snow coverage, culvert distribution, and amounts of salt used annually. This evaluation indicated whether a lake or pond had the potential for salt problems. Where a potential existed, the candidate water bodies were reviewed in the field by Translab.

Lakes and ponds near highways in portions of District 02,major lakes in District 03,all lakes and ponds in Districts 08 and 09, and portions of District 10 were reviewed in the field. No lakes or ponds were found which could be considered to have salt problems at the current salt usage levels.

In this report, the lakes and ponds surveyed and/or reviewed in the field are listed by District. Pertinent information such as location, salt usage in the nearby vicinity, lake or pond uses and comments are noted. The comments list the considerations used in determining possible degree of impact.

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District 02	Location	Salt Usage	Uses	Comments
Shasta Lake	Dist. 02 Co 06 Rte 005 P.M. 40.1-67.02	Moderate	Recreation, Irrigation Power production	Very large, somewhat deep, little salt usage not large enough to be a problem. Lake 1/ to 1/2 mile from roadways.
Poison Lake	Dist. 02 Co 07 Rte 44 P.M. 6.31	500 lb/yr	Grazing, migratory Bird Rest Area	700-900 acres. Usually dry in Fall. Ave. depth 3 ft. Lake is shallow with substantial wind.
Summit Lake	Dist. 02 Co 06 Rte 44 P.M. 68.53	150 lb/yr	Grazing,watering cattle, some migratory water fowl resting	85-9- acres. Ave. depth 1'. Usually dry mid-summer to Fall.
Almanor Lake	Dist. 02 Ca Plu Rte 36 " P.M. 90-1100 Rte 147 " P.M. 0.23 " " " Rte 89 P.M. 29.97	 4 tons/yr 3 tons/yr 10 tons/yr	Recreation, irrigation, Power production	2.6 mi x 3.3 mi. Yearly salt usage low. Substantial winds in area.
Dry Pond	Dist. 02 Co Plu Rte 89	500 lb/yr	Migratory rest area	600'x100' max. depth 2 ft. Fill with tules and vegetation
Eagle Lake	Dist. 02 Co. Las Rte139 P.M. 24-30	5 tons/yr	Recreation (summer & winter	14 mi x 3 mi. 50-90 ft. ave. depth, substantial winds; minimum salt usage.
Honeylake	Dist. 02 Co Las Rte395 P.M. 59-77	5 tons/yr	Recreation(summer & winter)	Closest salting to lake approx. 1 mile
Feather Lake	Dist. 02 Las Rte 44 P.M. 20.00	1 ton/yr	Grazing	Dry during summer.
McCoy Res.	Dist. 02 Las Rte 44 24.73-27.20	5 tons/yr	Cattle grazing, water reservoir, bird nesting.	1 mi x 2.5 mi. Ave. depth 5-10' shallow lake with wind swept surface
Hog Flat Res.	Dist. 02 Co las Rte 44 P.M. 29.05-29.83	5 tons/yr	Cattle grazing. Water reservoir, minor migratory bird rest.	Ave. depth 3-5 ft; dries up most years. Substantial winds.
Goose Lake	Dist. 02 Co Mod Rte395 P.M. 49-61. 5±	Minimal	Wildlife, agricultural recreation	7.4 mi by 1.6 mi. Ave. depth unknown. Very small amount of salt used.
Lower Klamath Lake	Dist. 02 Co Sis Rte161 P.M. 10.0±	Minimal	Agricultural, wildlife, recreation	4 mi x 6 mi. Minimal salt usag

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District 02 (continued)	Location	Salt Usage	Uses	Comments
Middle Alkali Lake	Dist. 02 Co Mod Rte 299 P.M. 60.0±	Minimal	Wildlife	18 mi x 2 mi- Shallow lake with substantial winds. Alkali lands supply salt
White Lake	Dist. 02 Sis. Rte 161	"	"	1.5 mi x 1 mi. Shallow lake with substantial winds. Minimal salt usage.
Said Valley Res.	Dist. 02 Co Las. Rte 139 P.M. 43.7	"	Recreation-Agriculture	.6 mi x .5 mi. Shallow Lake with winds. Minimal salt usage
Henske Res. (Spaulding Res.)	Dist. 02 Co Mod Rte. 139 P.M. 16.0	"	Wildlife	1 mi x .5 mi. Shallow Lake with winds. Minimal salt usage.
Lake Britton	Dist. 02 Co Sha Rte 89 P.M. 29.2	"	Wildlife	6 mi x 1/4 mi; very shallow
Rock Reservoir	Dist. 02 Co Plu Rte 70 P.M. 12.1-14.6	4 tons/yr	Hydroelectric	2.52 mi x 570' (38 acres) Ave. depth 25 ft. Winds present.
Poe Reservoir	Dist. 02 Co But Rte 70	1/2 ton/yr	Hydroelectric	1.56 mi x 430' (52 acres) 10' to 50' depth. Ave. 25 ft. Part of Feather River with accompanying currents.
Eresta Reservoir	Dist. 02 Co Plu Rte 70	1/2 ton/yr	Hydroelectric	245 mi x 394 ft (95 acres) Constant current- part of Feather River.
Brazle Lake	Dist. 02 Co Sis Rte 5 P.M. 43.10	100 lbs/yr	Fishing & Irrigation	1500 ft x 500 ft (17 acres) Ave. depth 3 ft. Salt use insignificant
Foulk Lake	Dist. 02 Sis. Rte 5	1000 lbs/yr	Storage	Alkali Lake. No salt problem.
Locust Lake	Dist. 02 Sis Rte 5 P.M. 23.00	700 lbs/yr	None	Alkali Lake, Lake 300' from road.
Grass Lake	Dist. 02 Co Sis Rte 097	900 Tons	Cattle graze, some hunting	3 mi x 3 mi. Lake almost always dries up each year.
Klamath Wildlife Refuse	Dist. 02 Co Sis Rte 161	0-1 Ton	Wildlife Refuse	1-3 mi x 9 mi. Max. depth 5'. Very shallow with winds.
Trinity or Cleir Engle Lake	Dist. 02 Ca.05 Rte 003	0-3 yrs	Recreation, Flood Control, Irrigation	A salt free area.
Whiskeytown Lake	Dist. 02 Co Sha Rte 299	None	Recreation	A salt free area.
Slattery Pond	Dist. 02 Co 05 Rte 299	500 lbs/yr	Recreation	500' x 2000' (11 acres) A depth 15' on uphill side of road

District 01

No Lakes or Ponds associated with salted roadways

District 04

No Lakes or Ponds associated with salted roadways

District 05

No salt used in this district

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District 03	Location	Salt Usage	Uses	Comments
West Lake (West bound)	Dist. 03 Co Nev Rte 80 P.M. 5.65	15.6 tons/lane mi	Reststop	Studied by Goldman-Small Lake (Pond) No salt problem
West Lake (East bound)	Dist. 03 Co Nev Rte 80 P.M. 6.02	15.6 tons/lane mile	"	" " " " No salt problem
Donner Lake	Dist. 03 Co Nev Rte Old 40	100 tons	Recreation	" " " " Large Lake. No salt problems found
Lake Tahoe	Dist. 03 Co Eld. Co Pla Variable P.M.	Total 1155 tons (1974-75)	Recreation, Water Supply	" " " " Large Lake No salt problems found
Putts Lake	Dist. 03 Co Pla Rte 80 P.M. 54.5±	10-12 ton/mi/yr	Water supply for Blue Canyon	32.86± acres. Goldman studied. Temporary monomolimnion when covered with ice
Grass Lake	Dist. 03 Co Ed Rte 89 P.M. 1.47	?	Recreation	1 mi x 1/4 mi. Max. depth 20 ft.
Frog Pond	Dist 03 Co Ed Rte 50 P.M. 68.35	39.1 tons/ln	Water rights for domestic water	1/4 mi. diameter. Studied by Goldman. No salt problems.
Dist. 06				
Lake Isabella	Dist. 06 Co 50 Rte 178 Rte 155 P.M. 45-50 P.M. 53-71	.65 tons/ln mi	Recreation, Irrigation, power, flood control	1/4-1/2 mi from roads. 5 mi x 5 mi. Natural alkali inputs
Shaver Lake	Dist 06 Co Fre Rte 168 P.M. 47.7-49.85	2 tons/ln mi	Power, flood control, Recreation	35 mi x 3 mi.
Huntington Lake	Dist. 06 Co Fre Rte 168 P.M. 65.60-65-95	2 tons/yr	" " "	4.5 mi x 1.5 mi. Highway 168 crosses lake at extreme upper end when the lake is full
Kellers Pond	Dist. 06 Co Mpa Rte .41 P.M. 3.40	200 lbs/yr	Recreation	250 ft.x 250 ft. Depth 10' ave. 5'

District 09

	Location	Salt Usage	Uses	Comments
Topaz Lake	Dist. 09 Co Mno Rte 395	1 1/2 tons/ln mi/yr	Recreation/irrigation	2.5 mi x 1.1 mi. Wind exposed
Casa Diablo Lake	Dist. 09 Co Mno Rte 395	3± tons/ln mi/yr	Wildlife use	Very small pond (40' x 40') with average depth of 18".
Mono Lake	Dist. 09 Co Mno Rte 395 P.M. ± 51-58	Minimal	Some recreation, some brine fish, shrimp harvest	Salt Lake .
Crowley Lake	Dist. 09 Co Mno Rte 395 P.M. 12.0-18.0±	.5 tons/ln mi/yr	Water supply, recreation	3 1/2 mi x 1/2 mi and 3 mi x 2.7 mi. State Highway 300' or more from lake
June Lake	Dist. 09 Co Mno Rte 158 P.M. 1.5-2.7	2.9 tons/ln mi/yr	Recreation	1.15 mi x 0.5 mi. 45-500 ft from roadwa
Gull Lake	Dist. 09 Co Mno Rte 158 P.M. 3.2-3.6	3 1/2 tons/ln mi/yr	Recreation	Good distance from roadway; substantial winds; Lake .5 mi x .4 mi
Intake #2	Dist. 09 Co Inyo Rte 168 P.M.± 6.0-6.2	1000 lb/ln mi/yr	Power production	Highway adjacent to inlet creek for about 6 miles above the pond
Warren Lake	Dist. 09 Co Inyo Rte 395 P.M. 102.9-103.9	250 lbs/ln mi/yr	Occasional duck hunting	Salt usage 2400' to 4200' from lake
Klondike Lake	" " " " " " "		" " "	Salt usage 2000' to 1 mi from lake
Tinemaha Res.	Dist. 09 Co. Inyo Rte 395 P.M. 91.6-94.1±	250 lbs/ln mi/yr	Domestic water, recreation (restricted)	" " 1900' to 1 1/2 mi from Res.

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District 10	Location	Salt Usage	Uses	Comments
Red Lake	Dist. 10 Co Alp Rte 98 P.M. 5.5-6.5	3 tons/ln mi/yr	Recreation: irrigation	300' to 900' from salted road. Considerable wind exposure. Ave. depth 12'
Caples Lake	Dist. 10 Co Alp Rte 88 P.M. 0.5-3.0	3.0 tons/ln mi/yr	Recreation: Power production	275 acres. Ave. depth 20'. Substantial winds
Silver Lake	Dist. 10 Co Ama Rte 88 P.M. 66.4	<4 tons/yr	Recreation: Power production	400 acres. Ave. depth 15/ 1/2 mi to salted pavement
Pond (no name)	Dist. 10 Co Ama Rte 88	<1 ton/yr	None	No culverts
Dist. 11				
Pond "A"	Dist. 11 Co Sd Rte 8 P.M. 41.1	10 tons/yr	Wildlife cattle water	Ave. depth 3 feet. No snow cover. Open to winds. 190' x 200'
Pond "B"	Dist. 11 Co Sd Rte 8 P.M. 41.6	10 tons/yr	Wildlife; cattle	365' x 365'. Ave. depth 12'. No freeze over. Substantial winds

APPENDIX A

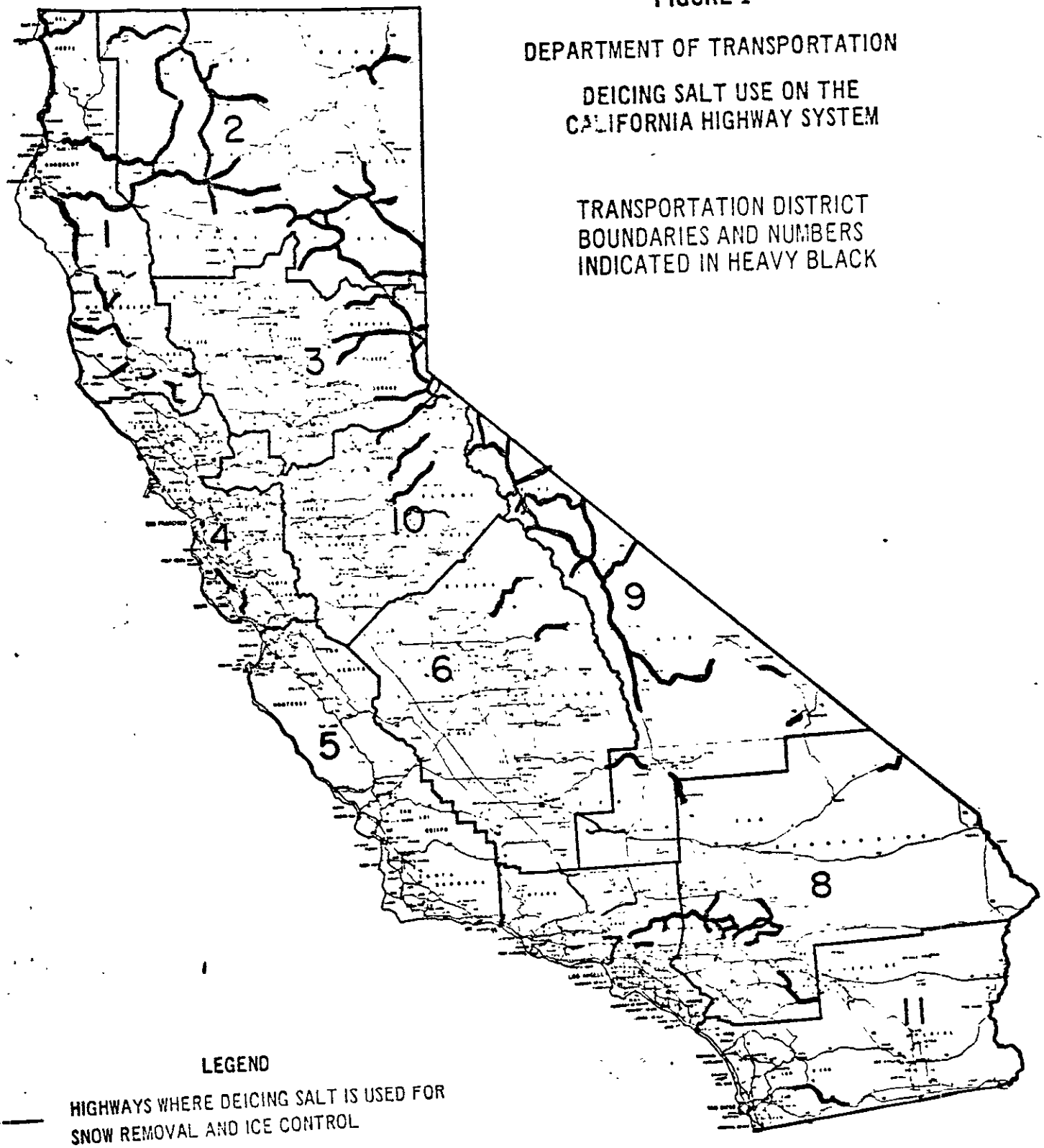

FIGURE 1

DEPARTMENT OF TRANSPORTATION

DEICING SALT USE ON THE CALIFORNIA HIGHWAY SYSTEM

TRANSPORTATION DISTRICT BOUNDARIES AND NUMBERS INDICATED IN HEAVY BLACK

LEGEND

HIGHWAYS WHERE DEICING SALT IS USED FOR SNOW REMOVAL AND ICE CONTROL

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LAKE AND POND SURVEY

Translab Enviro-Chemical Branch

Sacramento, California 95819

Date_____

APPENDIX "B"

1) Lake/Pond Name_____Dist___Co____Rte____PM _____

USGS Quadrangle(if known) _____Range_____

Township_____Section _____(if known) Elevation_____

What uses are made of the lake/pond? _____

_____

2) Dimensions(Length/width) _____

Approximate surface area _____

Depth(maximum) _____Ave. _____

Lake's general shape _____

3) Does the lake/pond freeze over during the winter? _____

If so, does snow collect on the surface? _____

General topography of the area around the lake/pond_____

_____

Type of vegetation around lake/pond _____

_____

Are their substantial winds in the immediate area? _____

_____

Is the lake/pond exposed to winds? _____

Is the lake/pond sheltered from winds? _____

If winds are present does the lake/pond get murky? _____

4) Distance from salted roadway _____

Approximate salt usage in immediate area _____

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Extent of road runoff into lake/pond _____

Do culverts exit directly into or very near the lake/pond? _____

_____

If so, number and size of culverts _____

If no culverts exist does road runoff enter the water by another means? _____

Are there other sources of salt? _____

5) Sketch of lake/pond and road (use reverse side of page). IF POSSIBLE, ATTACH A PHOTOGRAPH OF THE LAKE/POND AND ROAD.

6) Comments:

Signed _____

Title _____

Phone _____

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