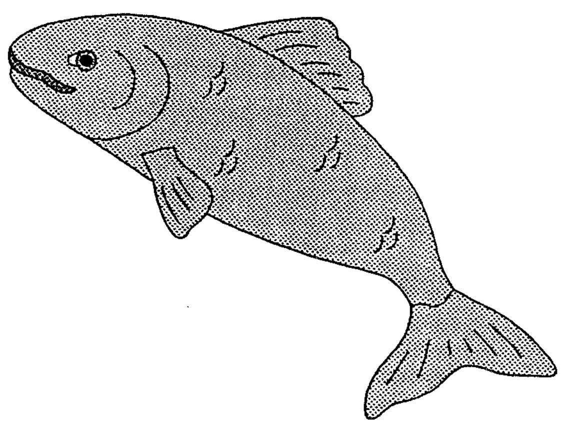
DIOXIN MONITORING PROGRAM

STATE OF MAINE

1992



BY

BARRY MOWER

DEPARTMENT OF ENVIRONMENTAL PROTECTION

AUGUSTA, MAINE

FEBRUARY 1993

TABLE OF CONTENTS

List of Tables

Acknowledgements

The assistance of Acheron Inc. on behalf of the Paper Industry in collection of fish made the program much more efficient and workable in 1992. Also, the assistance of the Department of Marine Resources and Department of Inland Fisheries and Wildlife in collecting samples and providing nets was greatly appreciated. Thanks are also due Dale Libby and the Maine Bass Federation for providing bass from Sebasticook Lake. Assistance of Trout Unlimited was very helpful. Glen Savage, Jim Thibodeau and Dick Poulin supplied brown trout from Shawmut, and Steve Brooke and Charles Winslow provided bass and trout from Augusta.

EXECUTIVE SUMMARY

The goal of Maine's Dioxin Monitoring Program, established in 1988 by the Maine legislature, is "to determine the nature of dioxin contamination in the waters and fisheries of the State". Charged with administration of the program, the Department of Environmental Protection (DEP) is required to sample sludge from no more than 12 bleached pulp mills and municipal wastewater treatment plants once each quarter. DEP is also required to sample fish once a year below the same facilities. The monitoring program is coordinated with other ongoing programs conducted by the Department, the US Environmental Protection Agency and dischargers of wastewater. DEP is to incorporate the results of all studies into a report to the Energy and Natural Resources Committee by December 1 of each year. Costs of sample collection and analysis are to be assessed to the selected facilities. Payment of the fees is a condition of the waste discharge license granted by the state for continued operation of the selected facilities.

Conclusions:

1. Concentrations of dioxin and furan in fish at most sites was as low or lower than in previous years continuing a general decline in concentration first observed in 1991.

2. Concentrations of dioxin and furan in some fish from the Androscoggin, Kennebec, Penobscot, Presumpscot, Salmon Falls, East and West Branch of the Sebasticook Rivers exceeded the Department of Human Services' Bureau of Health's recommended maximum concentration (0.15 ppt) for protection of consumers from an increased cancer risk of one in one million (10^{-6}).

3. Concentrations of dioxin and furan in some fish from the Androscoggin, Kennebec, Penobscot, Salmon Falls, and West Branch of the Sebasticook Rivers exceeded the Department of Human Services' Bureau of Health's recommended maximum concentration (0.37 ppt) for protection of consumers from adverse reproductive effects.

3. Concentrations of dioxin and furan were highest in fish from the Androscoggin River.

4. Concentrations of dioxin and furan were higher in brown trout than in bass.

5. Concentrations of dioxin and furan in rainbow smelt from the Kennebec River in Hallowell were low but exceeded the Department of Human Services' Bureau of Health's recommended maximum concentration (0.37 ppt) for protection of consumers from adverse reproductive effects.

6. Concentrations of dioxin and furan in soft-shelled clams from the lower Kennebec River and Penobscot River exceeded the Department of Human Services' recommended maximum concentration (0.37 ppt) for protection of consumers from adverse reproductive effects.

Recommendations:

1. The statute establishing the Dioxin Monitoring Program, 38 MRSA section 420-A, should be amended as proposed in DEP's report to the Joint Standing Committee of the Legislature on Energy and Natural Resources entitled "Implementation of a Comprehensive Surface Water Ambient Toxic Monitoring Program".

2. Effluent and sludge monitoring for dioxin should be included as a requirement of waste discharge licenses for those facilities that discharge dioxin.

INTRODUCTION

Due to continuing controversy over the effects of dioxin on human and ecological health, the US Environmental Protection Agency (EPA), announced that in 1991 it would begin a thorough scientific reassessment of dioxin. EPA proposed that the process would be open to the public and consequently held several meetings in 1991 and 1992 to share information to and receive comments. Draft reports on a wide range of issues were available in 1992. Initial results indicate that dioxin may exhibit reproductive and developmental effects, immuno-toxic effects, and neuro-toxic effects at concentrations nearly as low or lower than commonly thought to promote cancer (Frakes, 1992; Graham, 1992; Hughes, 1992; Silbergeld, 1992). Currently the reports are undergoing peer review, with final reports due in 1993.

For water quality management planning for the protection of human consumers of contaminated fish against certain involuntary health risks, the Department of Human Services' Bureau of Health (BOH) has recommended maximum allowable concentrations of 2378-TCDD in fish fillets as follows (Frakes, 1990). "For a one in one million (10^{-6}) upper limit cancer risk the concentration of 2378-TCDD in the edible portion (fillets) of fish should not exceed 0.15 ppt (parts per trillion) and for a one in one hundred thousand (10^{-5}) upper limit cancer risk the concentration of 2378-TCDD in the edible portion (fillets) of fish should not exceed 1.5 ppt. For protection against adverse reproductive effects, the concentration of 2378-TCDD in the edible portion (fillets) of fish should not exceed 0.37 ppt (parts per trillion)." Although no risk concentration has been selected, the Board of Environmental Protection has used a risk of 10^{-6} in setting a limit for dioxin in the sludge spreading rules in 1986. For this report concentrations of dioxin in fish exceeding any of these recommendations will be reported as significant.

For managing the risk to consumers of eating fish already contaminated with dioxin, the BOH publishes fish consumption advisories for dioxin for particular waterbodies using risk assessment methods with a threshold of 1.5 ppt. Based on recent research, BOH is also concerned with potential reproductive effects in women from consuming a single fish meal with a dioxin concentration greater than 7 ppt.

METHODS

Program design

Given the decline in concentrations of dioxin found in the fish in the 1991 program, the primary objective of the 1992 program was to collect fish samples from the appropriate sites and species from each river so that accurate, complete, and current data were available to meet the overall goal of the program. The program design included some sites and species that were not sampled in 1991 but from which historical data were used by the BOH in formulating the 1991 fish consumption advisory. The program also included sampling at least one site below each major source to document trends and sampling of historic sites where dioxin concentrations in fish exceeded BOH's recommended maximum concentration (0.15 ppt) for protection of consumers from an increased cancer risk of one in one million (10^{-6}). Another criterion was to sample fish from any new sites or important species suspected of being significantly contaminated with dioxin.

The 1992 program was initially drafted by a team representing DEP, BOH, and the Department of Inland Fisheries and Wildlife (DIFW) according to the objectives listed above. Following meetings held in Augusta, Portland, and Bangor with representatives of DEP, DIFW, DHS, the participating dischargers, and the Natural Resources Council of Maine, and with input from the Department of Marine Resources (DMR), the plan was revised to represent a general consensus among the parties listed.

Since most of the discharging facilities in the program already sample sludge or effluent as part of their Sludge Spreading Permit or NPDES permit, no additional sludge samples were collected as part of this year's program.

In order to sample fish at all necessary sites in 1992, the number of sites was expanded to 20, although no more than 12 facilities were involved as specified by the legislation. Station locations along with target species are shown in Table 1. Sample location maps show exact locations of fish collections (Appendix 6).

To control costs, the number of samples at each site was reduced by use of composite samples. For new sites, two composites of five individuals, or more as necessary to give an adequate amount of tissue, were analyzed. For historic sites ten game fish and ten bottom feeders were collected at each station as in previous years. Game fish were combined into 5 two-fish composites of skinless fillets, while the ten bottom feeders were combined into 2 five-fish composites of whole fish. Each fish was processed and stored

Table 1. Sample stations and species for the 1992 Dioxin Monitoring Program

STATION	FACILITY	SPECIES
Androscoggin R		
Rumford	Boise Cascade	bass, sucker
Jay (Bean Is)	Boise Cascade	bass, sucker
Liv Fls (Otis imp)	International Paper	bass, sucker
Turner (GIP)	International Paper	bass, hornpout
Lisbon Falls	BC & IP	trout/bass, sucker
Kennebec R		
Shawmut Dam	SD Warren	trout, bass, sucker
Sidney	Scott Paper	trout/bass, sucker
Augusta	KSTD	trout, sucker
Gardiner	Statler	smelt
Phippsburg	SD Warren	soft-shelled clam
Penobscot R		
S Lincoln	Lincoln P&P	bass, sucker
Milford	Lincoln P&P	bass, sucker
Veazie	James River Co	bass, sucker
Bucksport	James River Co	soft-shelled clam
Presumpscot R		
Westbrook	SD Warren	bass, sucker
Falmouth	SD Warren	soft-shelled clam
Salmon Falls R		
Berwick	Town of Berwick	bass, sucker
Sebasticook R		
E Br Newport	Town of Corinna	bass, sucker
W Br Palmyra	Town of Hartland	bass, sucker
Reference site(s)	all	bass, sucker soft-shelled clam

separately. Half of the sample of each fish was combined into the composites. If any composite of game fish had a contaminant concentration that exceeded a threshold determined by BOH, 3.5 pg/g, based on the health risk from eating a single highly contaminated fish, then the fish making up that composite were to be analyzed individually.

Results from 1991 (Mower, 1991) showed that only 2378-TCDD and 2378-TCDF are present in significant quantities in most samples, although in a few others congeners were significant. Therefore, only the 2378-TCDD and 2378-TCDF were measured initially in 1992 samples. When adding the values for all the other congeners measured in 1991 to the

1992 data would cause the resultant 1992 estimate for a particular sample to exceed BOH's recommended maximum concentrations for cancer risk, reproductive effects, or historical fish consumption advisory thresholds, that sample was to be reanalyzed for all 2378-substituted and all tetra through octa class congeners.

As much as possible, samples were collected to correspond to the seasons when they were previously collected at the same sites, when high fishing pressure occurs, and when contaminants were expected to be their geatest concentration. Most samples were to be collected in August, but resampling and difficulty in collecting at some sites required sampling in September. Bass from Jay were collected in July. To address the question of difference among seasons, some species were collected twice. Brown trout below the Shawmut dam in Fairfield were collected initially in mid to late May and again on 15 July, while suckers were collected in May and August. Suckers from S. Lincoln and Milford were collected in May and again in August and September respectively.

Sampling procedures

In most locations fish were collected by DEP assisted by Acheron Engineering Inc., a consultant retained by the participating bleached kraft mills in Maine. Selected volunteers assisted collection of brown trout from the Kennebec River. The Department of Marine Resources (DMR) collected the soft-shelled clams and rainbow smelts and assisted in collection of suckers from the Kennebec River at Augusta. Instructions and chain of custody forms were provided to all samplers. Samples remained in the custody of the collector until transferred directly to DEP staff.

Upon capture, fish were immediately killed, weighed and measured, rinsed in river water, wrapped in aluminum foil with the shiny side out, labelled, and placed in a cooler on ice for transport to the lab where they were frozen to await shipment to Midwest Research Institute in Kansas City, Missouri for analysis. All other procedures followed EPA's Sampling Guidance Manual for the National Dioxin Study (July 1984). A laboratory log was kept for an inventory of samples in the lab at any time and final disposition.

RESULTS AND DISCUSSION

Not all target species and numbers were able to be collected. A description of fish collected and results follows for each location. Results show that concentrations of dioxin and furan in fish are generally as low or lower than those from 1991 and previous years (Table 2, Appendix 2). Some sites and/or species cannot be compared since there are no previous data.

No two-fish composite of game fish exceeded 3.5 pg/g, the threshold for protection of women against an unacceptable risk from comsumption of a single fish. Therefore, there was no need to reanalyze any game fish individually.

There was also no need to reanalyze any samples for other congeners since there were no locations where the additional congeners would cause the total TEQs to exceed any of BOH's recommended maximum allowable concentrations in fish. Therefore, total TEQs reported for 1992 are estimated using 1991 congeners added to the 1992 2378-TCDD and 2378-TCDF concentrations.

Androscoggin River

Rumford Ten smallmouth bass and ten white suckers were collected from the river between Rumford and Dixfield. Total dioxin Toxic Equivalents (TEQs) were higher in whole suckers than in skinless bass fillets and were significant even when normalized to skinless fillets (dividing by 3.5 based on historical comparisons between fillets and whole fish). There are no previous data for suckers at this site. TEQs for bass were lower in 1992 than in 1991, although still considered significant. Effluent data show a significant reduction in the amount of TCDD and TCDF in the discharge from the mill since 1989 (Appendix 4) which may be reflected as a latent effect in the decreasing concentrations in fish since 1991.

Jay Ten smallmouth bass and ten white suckers were collected near Bean Island in the Jay Impoundment, which is the impoundment into which International Paper Company's bleached kraft mill discharges about 1 mile downstream. TEQs in bass fillets were an order of magnitude lower than in bass analyzed in 1990 but still significant and slightly higher than in bass fillets from the Rumford site. TCDD concentrations in whole suckers were much higher than in the bass fillets and significant when normalized to skinless fillets, but only about half as high as reported in suckers at the Riley impoundment, immediately upstream, in 1984-86. The reason for such a great reduction of TEQs in fish from 1990 to 1992 is difficult to determine since concentrations

TABLE 2. DIOXIN AND FURAN LEVELS IN MAINE FISH AND SHELLFISH (pg/g)

WATER/STATION	SPECIES	TYPE	EPA NDS/NBS 1984-86 TCDD	DEP DIOXIN MONITORING PROGRAM 1988-90 TEQ	1991 TEQ	1992 TCDD	1992 TCDF	1992 TEQ
ANDROSCOGGIN R								
Gilead	sucker	f/w	1.8/6.5					
Rumford	sucker	w				3.0	30.0	6.9
	bass	f			2.7	0.6	2.6	1.0
Riley	sucker	f/w	<2.1/13.0					
Jay	sucker					/5.4	/49.8	/11.8
	bass	f		20.7		1.2	3.6	1.8
Livermore Falls	sucker	w				3.8	22.0	6.6
	bass	f			3.3	1.1	1.8	1.4
N Turner	sucker	f/w	6.2/30.0					
Turner-GIP	sucker	f/w	8.3/29.0					
	bullhead	f/w	7.8/29.6					
	bass	f/w	3.7/24.0					
Auburn-GIP	sucker	w				5.6	59.4	12.8
	bass sm	f				1.7	7.5	2.6
	bass lm	f				1.1	4.2	1.6
Lisbon Falls	sucker	f/w	5.1/12.0			/3.4	/30.8	/7.2
	trout	f		5.9				
	bass	f		5.0		0.7	1.6	1.0
Brunswick	sucker	w	19.0					
	carp	f	11.0					
BEARCE LAKE								
Baring	pickerel	f	<0.1					
JONES CREEK	clam	m				<0.1	<0.2	<0.3
KENNEBEC R								
Madison	sucker	w				0.1	1.2	0.2
	bass	f				<0.1	0.2	<0.1
Fairfield	sucker	w	6.4	13.6		2.0	5.0	2.5
	trout	f		6.8		1.4	1.7	1.7
	bass	f			1.7	0.6	0.5	0.6
Sidney	sucker	f/w	1.2/11.4			/2.7	/8.4	/4.3
	bass	f/w	/20.3		2.5/	0.4/	0.3/	0.6/
Augusta	sucker	w		6.3		1.5	6.2	2.6
	trout	f		2.4		1.9	2.1	2.5
	bass	f				0.4	0.6	0.6
Hallowell	smelt	c				0.2	1.5	0.5
Phippsburg	clam	m				0.3	1.8	0.8
MESSALONSKEE LAKE								
Belgrade	bass				<0.33			

TABLE 2. (cont.)

WATER/STATION	SPECIES	TYPE	EPA NDS/NBS 1984-86 TCDD	DEP DIOXIN MONITORING PROGRAM 1988-90 TEQ	1991 TEQ	1992 TCDD	1992 TCDF	1992 TEQ
NARRAGUAGUS R								
Cherryfield	fallfish	w	<1.0					
NORTH POND								
Chesterfield	sucker	w	0.37					
	pickerel	f	<0.1					
PENOBSCOT R								
E Branch	sucker	w		<0.4				
	bass	f		<0.4				
E Millinocket	sucker	w		3.1				
	bass	f		<0.6				
N Lincoln	sucker	w		2.3/31.2				
	bass	f		<0.4				
S Lincoln	sucker	w		57.0		3.3	24.9	6.6
	bass	f	5.0	2.0	1.0	0.7	2.0	1.0
Passadumkeag	sucker	w		6.6				
	bass	f		2.4				
Milford	sucker	w		17.1		2.2	17.3	4.5
	bass	f		1.3		0.3	0.9	0.4
Veazie	sucker	f/w	2.6/7.6	/7.4	/5.0	/2.2	/20.2	/4.8
	bass	f/w	/4.6	2.1/	1.6/	0.4/	1.1/	0.6/
Bucksport	clam	m				0.1	1.3	0.9
OWLS HEAD	mussels	m	<0.8					
PISCATAQUIS R								
Sangerville	sucker				0.7			
	bass				<0.2			
	trout				<0.4			
Howland	bass	f		<0.2				
PRESUMPSCOT R								
Westbrook	sucker	w	5.2	6.2	1.7	0.3	2.8	0.9
	bass	f		2.0	0.5	0.1	0.6	0.2
	pickerel	f		<2.6				
	w perch	f		1.6	1.0			
Falmouth	clam	m				<0.07	0.4	<0.42

TABLE 2. (cont.)

WATER/STATION	SPECIES	TYPE	EPA	DEP				
			NDS/NBS	DIOXIN MONITORING PROGRAM				
			1984-86	1988-90	1991	1992		
			TCDD	TEQ	TEQ	TCDD	TCDF	TEQ
ST CROIX R								
Calais	sucker	w	<0.7	0.8				
Woodland	bass	f		0.3	<0.3			
ST JOHN R								
Madawaska	y perch	f		<0.6				
SACO R								
Dayton	sucker	w	<0.3					
SALMON FALLS R								
S Berwick	sucker	w		1.7		2.4	3.6	3.3
	bass	f		0.4				
	pickerel	f		0.3				
SANDY P								
N Anson	bass	f	<1.0					
SEBAGO L								
Naples	bass	w	<0.6					
SEBASTICOOK R								
E Br Newport	bass sm	f				0.1	1.5	0.3
	bass lm	f	<0.2			<0.2	1.4	<0.4
	w perch	f		1.4				
W Br Palmyra	sucker	w	1.57	3.5		1.1	1.1	1.4
	pickerel	f	<0.1			0.2	0.1	0.2
	bass	f		1.2		0.4	0.2	0.5
WEBBER POND								
Vassalboro	bass	f			<0.3			

f = fillet
m = meat
w = whole
TEQ = toxic equivalents using EPA 1989 toxicity equivalency factors (TEF) and nd = detection limit
1988-90 TEQs based on 2378-TCDD AND 2378-TCDF ONLY
1991 TEQs based on full congener analysis
1992 TEQs based on estimates using 1991 full congener analysis

in sludge (Appendix 3) and effluent (Appendix 4) from the mill have remained similar since 1990. Although this site is above the discharge it is in the same impoundment and fish may migrate anywhere throughout. The 1990 fish may have migrated downstream and been exposed to the discharge from the mill while the 1992 fish may have stayed upstream and been exposed only to the discharge from Boise Cascade in Rumford. Alternatively, the lower concentrations in fish in 1992 may reflect a latent effect of the earlier reductions in dioxin discharged.

Livermore Falls Ten smallmouth bass and ten white suckers were captured in the Otis Impoundment approximately 1.5-3 miles below the discharge from International Paper Company's Jay mill. TEQs in bass fillets were significant at about half the concentrations in bass fillets from 1991 and similar to those from the Jay site. Concentrations in whole suckers were higher than in bass fillets and still significant when normalized to skinless fillets, but lower than concentrations in the Jay Impoundment. Lower concentrations in 1992 may reflect the latent effect of a reduced discharge of TCDD and TCDF from the mill in 1989-90.

Auburn-GIP Three smallmouth bass, two largemouth bass, and ten white suckers were collected in Gulf Island Pond (GIP) near Seagull Island near the deep hole. The bass were analyzed as individuals. TEQs in bass fillets were lower than the concentrations in whole suckers. Concentrations in largemouth bass fillets were lower than in smallmouth bass fillets. The concentration of 2378-TCDD in fillets of both species of bass combined was significant, although 2.5 times lower than in bass fillets collected in 1984-6 in GIP a little more upstream in Turner. TEQs in suckers were significant when normalized as fillets, but 2378-TCDD was 5 times lower in whole suckers than in whole suckers collected in 1984-6 in Turner. This site had the highest TEQs of any monitored on the Androscoggin, probably due to the reservoir of dioxin contaminated sediments in GIP as shown by sediment data (Appendix 5). Decreased concentrations since 1984-6 data may reflect decreased discharges by Boise Cascade and International Paper Co. in recent years.

Lisbon Falls Ten smallmouth bass and ten white suckers were captured in the Pejepscot Impoundment. TEQs in whole suckers were higher than in bass fillets. Concentrations in bass were significant but 5 times lower than in samples of bass collected in 1988-90 and lower than in bass fillets from all other Androscoggin River sites except Rumford. The TEQs in suckers were significant when normalized as fillets. However, 2378-TCDD was 3.5 times lower in whole suckers than in whole suckers collected in 1984-6, reflecting the trend toward declining concentrations in fish from all sites along the river in recent years.

Jones Creek

Scarborough Twenty soft-shelled clams were collected about 100 meters upstream of the confluence with the Scarborough River at Pine Point. This site was used as a reference as there are no known sources of dioxin or furan upstream. The site was closed to commercial harvesting of clams due to high bacteria from nearby houses. TEQs in shucked meats were below detectable concentrations and not significant.

Kennebec River

Madison Ten smallmouth bass and nine white suckers were collected from the Anson Impoundment which is upstream from the discharge from Madison Paper Industries' groundwood pulp and paper mill. This site was chosen as a reference site to represent sites with no known point source discharges. Trace amounts of 2378-TCDD were found in whole suckers and trace amounts of 2378-TCDF were found in both species, but none of the amounts were significant. It appears that this site is a good reference to which to compare the other sites.

Fairfield In May three brown trout and ten white suckers were collected within a 2 mile section of the river between the Shawmut dam and the Interstate 95 bridge approximately 7-8 miles below SD Warren's bleached kraft mill in Skowhegan. Three more brown trout were collected in July, while ten smallmouth bass and ten white suckers were collected in August from the same site. Brown trout and suckers were collected at the two different times to determine if time of collection made any difference in body burdens. TEQs in July brown trout fillets averaged slightly higher than in the May brown trout fillets. Concentrations in both were significant but about 4 times lower than in brown trout fillets from this site in 1988-90. TEQs in May whole suckers were higher than in the August whole suckers. Concentrations in both were significant when normalized as fillets but about 4-7 times lower as whole suckers than in whole suckers collected above the dam in 1988-90. TEQs in bass fillets were significant but were lower than in brown trout fillets which were lower than in whole suckers. Concentrations in bass fillets were 2.8 times lower than in fillets of bass sampled in 1991. These declines in body burden are difficult to explain since concentrations of TEQs in sludge from the SD Warren mill are variable but show no significant decline in recent years (Appendix 3) to indicate a lowering in amounts in the discharge. There are no effluent data available from the mill since 1990 (Appendix 4), but the 1990 data showed a reduction in amount discharged compared to 1988 data.

Sidney Ten smallmouth bass and nine white suckers were collected from the river within one mile of the Sidney boat landing, about 25 miles below the SD Warren mill in Skowhegan and about 9-10 miles below the discharges from the Scott Paper mill in Winslow and the Kennebec Sanitary Treatment District's discharge in Waterville. TEQs were lower in bass fillets than in whole suckers. Concentrations in bass fillets were significant but 4 times lower than in bass fillets from 1991. TEQs in whole suckers were significant when normalized as fillets, but 2378-TCDD was about 2.5 times lower than in whole suckers from the site analyzed in 1984-6. TEQs in sludge from each of the three sources have remained essentially unchanged in the last couple of years (Appendix 3). Declines in tissue concentrations of dioxin and furan may reflect a latent effect of any reduced discharges from previous years.

Augusta Two brown trout, one smallmouth bass were collected just below the Edwards Dam in Augusta and ten white suckers were collected about 1 mile downstream. In addition to the upstream sources at the Sidney site, Statler Tissue Company dicharges effluent just above the dam. TEQs in brown trout fillets and whole suckers were similar, and higher than in bass fillets. Concentrations in brown trout fillets were significant and similar to concentrations in trout from 1988-90, and slightly higher than at Fairfield, but only two were collected. The concentration in the one bass collected was also significant and similar to the concentration found in bass fillets from Sidney. Concentrations in whole suckers were also significant when normalized as fillets but were 4 times less than in whole suckers at this site from 1988-90. Since Statler recycles waste paper, dioxin in its sludge reflects the average content in its paper supply and is low but detectable and relatively constant (Appendix 3).

Hallowell Twenty rainbow smelt were collected during the winter hook and line fishery about two miles below the Edwards Dam. The fish were beheaded and cleaned and the remaining skin, muscle and bone ground together. TEQs were significant but slightly lower than in bass fillets at Augusta and Sidney. There are no historical data for this species or this site with which to make comparisons.

Phippsburg Twenty soft-shelled clams were collected from Drummore Bay approximately 40 miles below Augusta. This site is downstream of all the sources on the Androscoggin and Kennebec Rivers. TEQs in the shucked meats were sigificant and 2.7 times higher than in the reference at Jones Creek.

Penobscot River

South Lincoln Ten white suckers were collected in May and August and ten smallmouth bass were collected in August near the boat ramp in South Lincoln, about 3-4 miles below Lincoln Pulp and Paper Company's bleached kraft mill in Lincoln. The suckers were collected at two different times to determine if time of collection was important. TEQs in August whole suckers were slightly higher than the May whole suckers opposite from what was seen at Fairfield. Concentrations were 7-11 times lower than in whole suckers sampled in 1988-90 but were still significant when normalized as fillets. Concentrations in bass fillets were lower than in whole suckers and similar to those in bass fillets from 1991, both of which were significant. There are no new effluent or sludge data available since 1989 to aid interpretation of these results.

Milford Ten white suckers were collected in May, seven white suckers were collected in September, and ten smallmouth bass were collected in August just below Freese Island in Milford about 25 miles below Lincoln Pulp and Paper. TEQs were significantly higher in the September whole suckers than in the May whole suckers, the same trend seen at South Lincoln. Both were higher than in bass fillets. Concentrations in bass were significant but 3 times lower than in bass from 1988-90. Concentrations in whole suckers were 4 times lower than in whole suckers from 1988-90 but significant when normalized as fillets. Concentrations in both species were slightly lower than at South Lincoln.

Veazie Ten smallmouth bass and ten white suckers were collected in September from the Veazie Impoundment about 7-8 miles below James River's bleached kraft mill in Old Town. TEQs were higher in whole suckers than in bass fillets. Concentrations in bass fillets were significant and similar to those in bass fillets from Milford but about 2.7 times lower than in bass fillets from 1991 at this site. Concentrations in whole suckers were similar to those in whole suckers from 1991 and from Milford in 1992 but lower than in whole suckers from South Lincoln. Concentrations were significant when normalized as fillets. Effluent data from James River show concentrations of 2378-TCDD and 2378-TCDF similar to those of 1991, both variable and sometimes higher than concentrations in late 1989 and 1990 (Appendix 4).

Bucksport Twenty soft-shelled clams were collected just upstream of the boat ramp about 30 miles downstream of the James River mill and about 60 miles downstream of the Lincoln Pulp and Paper mill. TEQs in the shucked meats were significant and similar to those at Phippsburg in the Kennebec. Concentrations were 3 times higher than the reference site at Jones Creek.

Presumpscot River

Westbrook Five smallmouth bass were collected in August and ten white suckers were collected in September near the US Route 302 bridge about 1.5 miles downstream of the discharge from SD Warren's bleached kraft pulp and paper mill. TEQs in whole suckers were higher than in bass fillets. Concentrations in bass fillets were marginally significant and were lower than concentrations in bass fillets from 1991. Concentrations in whole suckers were also marginally significant when normalized as fillets and lower than concentrations in whole suckers from 1991. TEQs in sludge from the mill are lower than previous concentrations (Appendix 3).

Falmouth Twelve soft-shelled clams were collected from the estuary behind Maine Audubon Society's Gilsland Farm about 8-9 miles downstream of the SD Warren mill. Most of the congeners were below detection although some furans were detected. TEQs were not much higher than in the clams from the reference at Jones Creek and not considered significant. These results are consistant with the results for fish.

Salmon Falls River

South Berwick Ten white suckers were collected from the Rollinsford Impoundment about 2 miles below the discharge from the Berwick Sewer District in Berwick, which is 85% effluent from Prime Tanning. TEQs in whole suckers were higher than in whole suckers from 1988-90 and significant when normalized as fillets. Concentrations are more than twice as high as in whole suckers from the West Branch of the Sebasticook River below the Hartland Tannery discharge. There are no new effluent or sludge data to aid interpretation of trends.

Sebasticook River

East Branch at Newport Six smallmouth bass and four largemouth bass were collected at a bass tournament on Sebasticook Lake about three miles downstream of the discharge from the Corinna Sewer District, which is 80% effluent from Eastland Woolen Mill. The largemouth bass were analyzed as individual fillets while the six smallmouth bass were combined into 3 two-fish fillet composites. TEQs for both species were marginally significant and similar to each other and to concentrations found in largemouth bass fillets in 1984-86. Trace concentrations of TEQs in sludge from the Corinna Sewer District in 1992 were similar to concentrations measured historically (Appendix 3).

West Branch at Palmyra Three smallmouth bass, two chain pickerel, and ten white suckers were collected near the US Route 2 bridge about 3-4 miles below the discharge from the Town of Hartland, which is about 85% effluent from Irving Tanning Company. TEQs in whole suckers were higher than in bass fillets which were higher than in chain pickerel fillets. Concentrations in bass fillets were significant but about 2.4 times lower than in bass fillets from 1988-90. Concentrations in chain pickerel fillets were marginally significant and similar to concentrations in chain pickerel fillets from 1984-86. Concentrations in whole suckers were significant when normalized as fillets and similar to concentrations in whole suckers from 1984-86. They were, however, 2.5 times lower than concentrations in whole suckers from 1988-90 and concentrations found in the Salmon Falls River below the dicharge from Prime Tanning. There are no new sludge data to aid interpretation of any trend.

REFERENCES

Frakes, R.A., 1990. Health-based water quality criteria for 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD). Maine Department of Human Services, Bureau of Health, Augusta, Maine. 32pp & appendices.

Frakes, R.A., 1992. Testimony before the Board of Environmental Protection at a public hearing 5 November 1992, Augusta, Maine.

Graham, L. 1992. Testimony before the Board of Environmental Protection at a public hearing 5 November 1992, Augusta, Maine.

Hughes, C. 1992. Testimony before the Board of Environmental Protection at a public hearing 6 November 1992, Augusta, Maine.

Silbergeld, E. 1992. Testimony before the Board of Environmental Protection at a public hearing 6 November 1992, Augusta, Maine.

Mower, B., 1991. Dioxin Monitoring Program, State of Maine 1991. Department of Environmental Protection, Augusta, Maine. 54pp.

APPENDIX 1

MAINE BUREAU OF HEALTH

FISH CONSUMPTION ADVISORY

10 FEBRUARY 1992

HUMAN SERVICES News

Office of Public Affairs & Communications
Maine Department of Human Services
State House Station 11
Augusta, Maine 04333
Tel. 289-3707

JOINT STATEMENT, FEBRUARY 10, 1992:
Department of Environmental Protection
Department of Human Services
Department of Inland Fish and Wildlife

SUBJECT: REDUCED DIOXIN LEVELS PROMPT REVISED FISH ADVISORY

CONTACT: Robert Frakes
Department of Human Services
Bureau of Health
Telephone: 289-5378

Dean Marriott, Commissioner
Department of Environmental Protection
Telephone: 289-2812

AUGUSTA - Recent tests by the Department of Environmental Protection (DEP) showed reductions in levels of dioxin in fish taken from Maine's major rivers. The results are similar to those reported by the paper industry in August 1991.

Officials say the changes reflect reduced discharges of the chemical from pulp and paper mills across the state. The improvements have prompted a revision of a fish consumption advisory issued in March 1990.

The new language raises recommended consumption limits for most segments of the population. Previous advisories that pregnant women and nursing mothers not eat fish caught in the Presumpscot River below Westbrook and the West Branch of the Sebasticook below Hartland have also been lifted.

-MORE-

According to State Toxicologist Dr. Robert Frakes, data from Maine's dioxin Monitoring Program supports revising the warnings to be published in the State Open Water Fishing Regulations. However, some cautions remain in place.

"Women of childbearing age still should not eat any fish from the Androscoggin River, the Kennebec River below Skowhegan and the Penobscot River below Lincoln. Furthermore, the general public should not eat more than one fish meal per month from the Androscoggin or more than two fish meals per month from those sections of the Kennebec and Penobscot".

A "fish meal" is considered to be one 8-ounce portion.

Dioxion levels in fish have been monitored under the DEP administered program since 1988. Because even very low levels of TCDD dioxin have been linked to increased cancer rates and reproductive problems in laboratory animals, health advisories were issued in 1985, 1987 and 1990.

Commenting on the latest revision to the advisories, DEP Commissioner Dean Marriott emphasized the progress that has been made in a relatively short period of time.

"Industry has been working to reduce the formation of dioxin by actually changing the manufactoring process. The recent data would seem to indicate that these efforts are showing positive results."

A full report of the 1991 Dioxin Monitoring Program is now being prepared and will be presented to the legislature's Joint Standing Committee on Energy and Natural Resources.

APPENDIX 2

DIOXIN AND FURAN IN MAINE FISH AND SHELLFISH

1992

CODES

STATIONS

ARR	ANDROSCOGGIN RIVER AT RUMFORD
ARJ	ANDROSCOGGIN RIVER AT JAY
ARLVF	ANDROSCOGGIN RIVER AT LIVERMORE FALLS
ARG	ANDROSCOGGIN RIVER AT GULF ISLAND POND, AUBURN
ARLF	ANDROSCOGGIN RIVER AT LISBON FALLS
JC	JONES CREEK AT SCARBOROUGH
KRM	KENNEBEC RIVER AT MADISON
KRS	KENNEBEC RIVER AT SHAWMUT, FAIRFIELD
KRSM	KENNEBEC RIVER AT SHAWMUT, FAIRFIELD
KRSI	KENNEBEC RIVER AT SIDNEY
KRA	KENNEBEC RIVER AT AUGUSTA
KRH	KENNEBEC RIVER AT HALLOWELL
KR	KENNEBEC RIVER AT PHIPPSBURG
PBL	PENOBSCOT RIVER AT SOUTH LINCOLN
PBSL	PENOBSCOT RIVER AT SOUTH LINCOLN
PBM	PENOBSCOT RIVER AT MILFORD
PBV	PENOBSCOT RIVER AT VEAZIE
PBS	PENOBSCOT RIVER AT BUCKSPORT
PRW	PRESUMPSCOT RIVER AT WESTBROOK
PRF	PRESUMPSCOT RIVER AT FALMOUTH
SLF	SALMON FALLS RIVER AT SOUTH BERWICK
SBE	E BR SEBASITCOOK RIVER AT NEWPORT(SEBASTICOOK L)
SBW	W BR SEBASTICOOK RIVER AT PALMYRA

SPECIES

BNT	BROWN TROUT
CHP	CHAIN PICKEREL
LMB	LARGEMOUTH BASS
SSC	SOFT-SHELLED CLAMS
SMB	SMALLMOUTH BASS
WSU	WHITE SUCKER

DIOXIN AND FURAN IN MAINE FISH AND SHELLFISH 1992

Field ID	2378TCDD	2378TCDF (a)	TCDD/F TEQ	TOTAL EST TEQ
ANDROSCOGGIN RIVER				
Rumford				
ARR-SMB-COMP-1	0.359	1.24		
ARR-SMB-COMP-2	0.578	1.93		
ARR-SMB-COMP-3	0.474	2.44		
ARR-SMB-COMP-4	0.615	2.72		
ARR-SMB-COMP-5 (e)	1.07	4.62		
mean	0.62	2.59	0.88	1.02
ARR-WSU-COMP-7	3.11	29.8		
ARR-WSU-COMP-8	2.8	30.2		
mean	2.96	30.00	5.96	6.89
Jay				
ARJ-SMB-COMP-11	1.03	3.1		
ARJ-SMB-COMP-12	0.927	4.39		
ARJ-SMB-COMP-13	1.37	4.4		
ARJ-SMB-COMP-14	2.06	2.36		
ARJ-SMB-COMP-15	0.871	3.99		
mean	1.25	3.65	1.61	1.83
ARJ-WSU-COMP-11	5.34	48.7		
ARJ-WSU-COMP-12	5.53	50.9		
mean	5.44	49.8	10.42	11.84
Livermore Falls				
ARLVF-SMB-COMP-6 (e)	1.25	2.09		
ARLVF-SMB-COMP-7 (e)	1.15	1.61		
ARLVF-SMB-COMP-8	ND(.569 mpc) (d)	0.784		
ARLVF-SMB-COMP-9	0.587	0.861		
ARLVF-SMB-COMP-10	1.9	3.42		
mean	1.09	1.75	1.27	1.4
ARLVF-WSU-COMP-9	4.1	22.2		
ARLVF-WSU-COMP-10	3.48	21.7		
mean	3.79	21.95	5.99	6.6
Auburn				
ARG-SMB-03	2.27	8.75		
ARG-SMB-04	0.868	2.2		
ARG-SMB-06	1.84	11.5		
mean	1.66	7.48	2.41	2.65
ARG-LMB-02	0.756	3.71		
ARG-LMB-05	1.4	4.79		
mean	1.08	4.25	1.5	1.65
ARG-WSU-COMP-19	4.63	46.9		
ARG-WSU-COMP-20	6.63	71.9		
mean	5.63	59.4	11.56	12.75

Field ID	2378TCDD	2378TCDF (a)	TCDD/F TEQ	TOTAL EST TEQ
ANDROSCOGGIN RIVER cont.				
Lisbon Falls				
ARLF-SMB-COMP-16	0.789	2.87		
ARLF-SMB-COMP-17	0.624	0.99		
ARLF-SMB-COMP-18	0.772	0.98		
ARLF-SMB-COMP-19	0.465	0.634		
ARLF-SMB-COMP-20	1.02	2.32		
mean	0.73	1.56	0.89	0.98
ARLF-WSU-COMP-13	3.81	32.8		
ARLF-WSU-COMP-14	3.09	28.8		
mean	3.45	30.8	6.53	7.19
JONES CREEK				
Scarborough				
JC-SSC-01	<0.06	<0.18	<0.07	<0.30
JC-SSC-02	<0.07	0.18	<0.09	<0.30
KENNEBEC RIVER				
Madison				
KRM-SMB-COMP-41	ND(.0649 cdl)	0.163		
KRM-SMB-COMP-42 (e)	ND(.101 cdl)	0.242		
KRM-SMB-COMP-43	ND(.0709 cdl)	0.21		
KRM-SMB-COMP-44	ND(.107 cdl)	0.132		
KRM-SMB-COMP-45	ND(.0773 cdl)	0.173		
mean	<0.08	0.18	<0.10	<0.11
KRM-WSU-COMP-25	0.143	1.05		
KRM-WSU-COMP-26	0.106	1.29		
mean	0.12	1.17	0.24	0.25
Fairfield				
KRS-BNT-03	1.63	1.5		
KRS-BNT-04	0.89	0.712		
KRS-BNT-05	1.59	1.14		
mean	1.24	0.93	1.48	1.51
KRS-BNT-08	1.13	2.15		
KRS-BNT-09	1.87	2.96		
KRS-BNT-10	1.7	2.31		
mean	1.57	2.47	1.82	1.86
KRSM-SMB-COMP-21	0.626	0.636		
KRSM-SMB-COMP-22	ND(.564 mpc)	0.55		
KRSM-SMB-COMP-23	0.475	0.43		
KRSM-SMB-COMP-24	0.529	0.528		
KRSM-SMB-COMP-25	0.594	0.518		
mean	0.56	0.53	0.61	0.62
KRS-WSU-COMP-3 (e)	2.72	5.6		
KRS-WSU-COMP-4	2.15	6.05		
mean	2.44	5.83	3.02	3.08
KRSM-WSU-COMP-15	1.3	3.37		
KRSM-WSU-COMP-16	1.83	4.83		
mean	1.57	4.1	1.97	2.01

DIOXIN AND FURAN IN MAINE FISH AND SHELLFISH 1992

Field ID	2378TCDD	2378TCDF (a)	TCDD/F TEQ	TOTAL EST TEQ
KENNEBEC RIVER				
Sidney				
KRSI-SMB-COMP-26	0.405	0.283		
KRSI-SMB-COMP-27	0.515	ND(.273 mpc)		
KRSI-SMB-COMP-28	ND(.37 mpc)	0.386		
KRSI-SMB-COMP-29	0.521	0.389		
KRSI-SMB-COMP-30	0.371	0.232		
mean	0.45	0.31	0.48	0.58
KRSI-WSU-COMP-21	2.19	6.01		
KRSI-WSU-COMP-22	3.28	10.7		
mean	2.74	8.36	3.58	4.32
Augusta				
KRA-BNT-01	2.58	2.26		
KRA-BNT-02	1.21	1.87		
mean	1.90	2.07	2.11	2.54
KRA-SMB-01	0.451	0.609	0.51	0.62
KRA-WSU-COMP-31	1.39	5.81		
KRA-WSU-COMP-32	1.65	6.6		
mean	1.52	6.205	2.14	2.58
Hallowell				
KRH-RBS-COMP-1	0.238	1.46		
KRH-RBS-COMP-2	0.237	1.48		
mean	0.24	1.47	0.39	0.47
Phippsburg				
KR-SSC-01	0.26	1.77	0.44	0.91
KR-SSC-02	<0.24	1.91	<0.43	0.71
mean	<0.25	1.89	<0.44	0.81
PENOBSCOT RIVER				
South Lincoln				
PBL-SMB-COMP-31	0.226	0.949		
PBL-SMB-COMP-32 (e)	0.178	0.756		
PBL-SMB-COMP-33 (e)	0.233	0.792		
PBL-SMB-COMP-34	1.15	4.55		
PBL-SMB-COMP-35	1.78	2.82		
mean	0.71	1.97	0.91	1.04
PBSL-WSU-COMP-5	1.14	8.89		
PBSL-WSU-COMP-6	4.1	29.7		
mean	2.62	19.30	4.55	5.18
PBL-WSU-COMP-17	4.45	34.2		
PBL-WSU-COMP-18	3.6	26.8		
mean	4.03	30.5	7.08	8.06

DIOXIN AND FURAN IN MAINE FISH AND SHELLFISH 1992

Field ID	2378TCDD	2378TCDF (a)	TCDD/F TEQ	TOTAL EST TEQ
PENOBSCOT RIVER				
Milford				
PBM-SMB-COMP-36	0.258	0.751		
PBM-SMB-COMP-37	0.328	0.879		
PBM-SMB-COMP-38	0.296	1.13		
PBM-SMB-COMP-39	0.244	0.735		
PBM-SMB-COMP-40	0.301	0.788		
mean	0.29	0.86	0.38	0.43
PBM-WSU-COMP-1	0.444	4.42		
PBM-WSU-COMP-2	1.24	10.8		
mean	0.84	7.61	1.6	1.82
PBM-WSU-COMP-33	2.97	24.7		
PBM-WSU-COMP-34	4.1	29.1		
mean	3.54	26.9	6.23	7.1
Veazie				
PBV-SMB-COMP-49	0.248	0.783		
PBV-SMB-COMP-50	0.331	1.24		
PBV-SMB-COMP-51	0.412	1.31		
PBV-SMB-COMP-52	0.551	0.916		
PBV-SMB-COMP-53	0.573	1.16		
mean	0.42	1.08	0.53	0.58
PBV-WSU-COMP-35	2.31	21.1		
PBV-WSU-COMP-36	1.98	19.3		
mean	2.15	20.2	4.15	4.81
Bucksport				
PBS-SSC-01	0.12	1.12	0.23	0.82
PBS-SSC-02	0.14	1.4	0.28	0.91
mean	0.13	1.26	0.26	0.86
PRESUMPSCOT RIVER				
Westbrook				
PRW-SMB-01	0.157	0.858		
PRW-SMB-02	0.0956	0.284		
PRW-SMB-03	0.0992	0.442		
PRW-SMB-05	0.109	0.548		
PRW-SMB-06 (e)	0.188	0.657		
mean	0.13	0.56	0.19	0.23
PRW-WSU-COMP-27	0.295	2.69		
PRW-WSU-COMP-28	0.317	2.97		
mean	0.31	2.83	0.59	0.87
Falmouth				
PRF-SSC-01	<0.07	0.37	<0.10	<0.46
PRF-SSC-02	<0.08	0.36	<0.12	<0.38
mean	<0.08	0.36	<0.11	<0.42
SALMON FALLS RIVER				
S Berwick				
SLF-WSU-COMP-29	2.21	3.98		
SLF-WSU-COMP-30	2.48	3.32		
mean	2.35	3.65	2.71	3.28

Field ID	2378TCDD	2378TCDF (a)	TCDD/F TEQ	TOTAL EST TEQ
SEBASTICOOK RIVER				
Newport E Branch				
SBE-LMB-01	0.303	3.67		
SBE-LMB-02	ND(.17 mpc)	0.638		
SBE-LMB-03	ND(.0623 cdl)	0.304		
SBE-LMB-04	ND(.0746 cdl)	0.86		
mean	<0.15	1.37	<0.29	<0.35
SBE-SMB-COMP-46	0.0955	1.13		
SBE-SMB-COMP-47	0.104	1.3		
SBE-SMB-COMP-48	0.147	1.94		
mean	0.12	1.46	0.27	0.33
Palmyra W Branch				
SBW-SMB-01	0.594	0.251		
SBW-SMB-03	0.363	0.215		
SBW-SMB-02	0.288	0.232		
mean	0.42	0.23	0.44	0.53
SBW-CHP-COMP-01	0.149	0.143		
SBW-CHP-COMP-02	0.154	0.137		
mean	0.15	0.14	0.16	0.19
SBW-WSU-COMP-23	0.979	1.11		
SBW-WSU-COMP-24	1.14	1.17		
mean	1.06	1.14	1.17	1.42
Method Blank 6	ND(.0982 cdl)	ND(.0917 cdl) (b)		
Method Blank 7	ND(.213 cdl)	ND(.176 cdl)		
Method Blank 8	ND(.246 cdl)	ND(.195 cdl)		
Method Blank 9	ND(.0796 cdl)	ND(.0723 cdl)		
Method Blank 10	ND(.0785 cdl)	ND(.0734 cdl)		
Method Blank 11	ND(.0786 cdl)	ND(.0773 cdl)		
Method Blank 12R	ND(.0998 mpc)	0.116		
Method Blank 13	ND(.0862 cdl)	ND(.0855 cdl)		

(a) - Results for 2,3,7,8-TCDF represent a maximum amount since the DB-5 column is not specific for this isomer.
(b) - Not detected with the curve based detection limit (cdl) in parenthesis.
(c) - Below recommended recovery range of 25 to 150%.
(d) - Not detected with a maximum possible concentration (mpc) due to an interference in parenthesis.
(e) - Results for this sample were previously reported by telefax but qualified due to low labeled analog recoveries. Final results reported here after re-extraction and analysis.

APPENDIX 3

2378-TCDD AND 2378-TCDF IN SLUDGE FROM MAINE WASTEWATER TREATMENT PLANTS

APPENDIX 3. DIOXIN AND FURAN IN SLUDGE FROM MIANE WASTEWATER TREATMENT PLANTS (pg/g wet weight)

LOCATION	DATE	%MOIST	TCDD	TCDF	TEQ
AUGUSTA SANITARY DISTRICT	900409		1.2	<1.3	1.3
	900607		<3.9	2.5	<4.2
	900914		<20.0	E20.0	<22.0
	910220		<1.9	0.79	<11.1
ANSON-MADISON SANITARY DISTRICT	910408		<1.3	2.2	<1.5
	911001		1.7	4.6	2.2
BERWICK SEWER DISTRICT	861111		<2.5	<4.0	<2.9
	890301	76.4	3.3	4.7	3.8
	890927	75.3	<3.0	<3.0	<3.3
	891208	87.5	144	109	155
BOISE CASCADE CORP RUMFORD	850621		32.0		
	880602		105.0	674.0	171.4
	890108	77.1	26.2	130.4	39.2
	890407	73.1	12.5	49.6	17.5
	890628	76.8	E2.3	31	E5.4
BREWER	920316		<1.0	6.1	<5.0
	920901		<6.0	110	<43.1
	921116		3.8	19	<10.7
CORINNA SEWER DISTRICT	861106		<0.5	<2.5	<0.7
	871117		<3.6		
	880501		<3.0	E8.5	<3.8
	890222		<13.0	<54.0	<18.4
	890510		<5.0	E41.0	<9.1
	900131		2.3	127	15.0
	900606		<4.0	E130	<17.0
			<4.9	E169	<21.8
	910314		<5	E50	<31.1
	920305		<3.9	<8.4	<26.2
FRASER PAPER LTD MADAWASKA	880903	68.3	4.4	73.9	11.8
	890106	79.1	E4.9	42.6	E9.2
	890406	71.3	E1.1	3.7	1.5
	890930	80.1	1.0	E5.3	1.5
GARDINER WATER DISTRIC	900818		<0.87	0.46	<2.2
	910401		1.4	<0.85	<4.7
	920504		3.5	9.4	6.6
	921116		0.9	6.4	4.8
GEORGIA PACIFIC CO					
MILLINOCKET	850618		<0.4		
	891217		0.94	3.2	2.4
WOODLAND	880602		<1.9	7.3	<2.6
	890113	75.8	<1.5	<0.86	1.6
	890424	74.7	<0.16	1.2	<1.4
	890718	66.0	<0.6	4.4	<1.0

APPENDIX 3. (CONT.)

LOCATION	DATE	%MOIST	TCDD	TCDF	TEQ
HARTLAND WASTEWATER	881007	65.0	<1.0	<0.6	<1.0
TREATMENT PLANT	881221	65.5	<2.5	E2.1	<2.7
	890312	64.3	<0.1	2.0	<0.3
	890627	63.3	<0.5	2.4	<0.7
HAWK RIDGE COMPOST	1989-90	mean n=6	6.6	15.9	8.2
UNITY	1991	(1.6-13)		mean n=4	6.6
(compost)	920101				17.5
	920301				14.9
	920715				19.4
	921007				10.8
INTERNATIONAL PAPER CO	850621		51.3W		
JAY	870115		190	760	266
	880218		24	130	39
	880219		23	121	34.1
	880223		14	75	21.5
	880225		57	250	82
	880226		15	79	22.9
	880227		13	79	20.9
	881231		16.6W	143W	30.9W
	890124		15W	77W	22.7W
	890126		28	112	39.2
	890214	ash		0.1	0.2
	890323		7.7W	42.6W	12.0W
	890417		24	150	39.0
	890714	ash	0.07	0.02	0.1
	891012	ash	0.14	0	2.63
	891231	ash	0.06	0	0.06
	900205		<18.7	150	<33.7
	900402	ash	0.04	0	0.05
	900501	ash	0	0.002	0.002
	900614	ash	0	0	0
	901201	ash	<2.4	<0.08	<4.88
	910117	ash	<3.9	0.11	<0.80
	910701	ash	<0.44	<0.1	<1.07
JAMES RIVER CORP	880801		12.0	34.0	15.4
OLD TOWN	881225	78.6	64.5	206	85.1
	890423	78.7	80.9	255	106.4
	890718	68.8	15.8	149	30.7
BERLIN, NH	88		104	2930	397

APPENDIX 3. (CONT.)

LOCATION	DATE	%MOIST	TCDD	TCDF	TEQ
KENNEBEC SANITARY	870713				38.5
TREATMENT DISTRICT	871105				10.2
WATERVILLE	880118				7.2
	880322				5.4
	880518				18.1
	880921				3.6
	890711				42.2
	891011				106.9
	900410		E7.9	121	20.0
	900824		3.3	54.0	12.7
	900909		3.3	2.4	<26.0
	901101		3.6	1.2	<20.1
	901221		3.5	0.67	<21.3
	910408		<2.3	<3.3	<15.0
	910606		<2.9	<5.0	<19.4
	910808		3.1	4.1	<19.2
	910911		3.1	4.1	<12.2
LEWISTON-AUBURN	871231		<1.0	mean for year (n=	
TREATMENT PLANT	881031		0.04		
	910306		<7.3	<9.4	<19.0
LINCOLN PULP & PAPER C	881119		48	223	70.3
LINCOLN	890123	80.9	228	909	318.9
	890407	85.1	49.5	219	71.4
	890831	83.5	41.3	294	70.7
OAKLAND TREATMENT PLAN	910304		<5	<3.14	<20.9
ORONO TREATMENT PLANT	901004		E3.5	9.2	E4.4
	910328		<2.1	<1.4	<12.6
	910922		<2.9	6.6	<17.7
	920323		<0.6	7.6	10.3
	920915		<0.5	E5.4	<2.1
PORTLAND WATER DISTRIC	861205				3.8
PORTLAND	870402				4.1
	871124				1.0
	891205		E1.2	11.3	3.6
WESTBROOK	861205				0.5
	870402				4.9
	871119				0.2
	891205		E1.6	14.5	4.9
REGIONAL WASTE SYSTEMS	890111	ash	5.5	28	8.3
PORTLAND	890112	ash	6	24	8.4
	890113	ash	10	50	15
	890114	ash	10	20	12
	890121	ash	6	90	15
	900211	ash	E20	210	E41

APPENDIX 3. (CONT.)

LOCATION	DATE	%MOIST	TCDD	TCDF	TEQ
ROBINSON MANUFACTURING	870113		10.1	17.5	18.5
OXFORD	880419		<0.4	<0.2	<0.4
	881004		<7.3	<9.6	<8.2
	890119		<2.1	<1.1	<2.2
	910305		<3	<0.3	<8.0
SCOTT PAPER CO	871008		36		49.8
WINSLOW			31		48.8
	871201		13.5		23.7
	880331		25	219	52.8
	880630		19	177	38.6
	880930		22	189	43.8
	881231		17	181	37.1
	890301	slash	9.7	89	20.3
	890331		18	177	38.5
	890630		14	89	25.1
		slash	7.4	58	14.1
		slash	9.5	63	17.5
	890930		11	67	17.7
	910330		8.3	10	20.5
		slash	6.9	12.3	47.1
	910630		4.6	6.2	13.4
		slash	8.1	16.1	28.9
	910930		6.5	6.9	15
		slash	<1.3	42.4	<10.3
	911230		6.3	6.8	14.3
	920224		5.9	54.2	20.4
		slash	12.3	72.6	36.9
	920225		6.5	72.1	14.7
		slash	9.4	153	36.4
	920630		5.2	5.5	12.5
		slash	3.4	3.3	11.2
	920930		5.1	6	13.2
		slash	2.9	2.9	7.6
	921230		7.2	5.9	18.8
		IWT	5.7	5.3	13.1
		slash	4.7	5.5	17.7
SD WARREN CO	850711		<1.95	pulp mill sludge	
SKOWHEGAN			2.9	paper mill sludge	
	861217		<	47	5
	870519		13	21	15.2
	871201		60		60.1
	880325		27	88	39
	880628		33.0	106	43.6
			6.9	29	9.8
			39.0	149	53.9
		EPA	67.0	330	100.0
	881014		40	98	52.1
	881220		54	177	76.5
	890303		54	91	65.6
	890629		23	53	26

APPENDIX 3. (CONT)

LOCATION	DATE	%MOIST	TCDD	TCDF	TEQ
SD WARREN CO SKOWHEGAN	890926		<	16	<1.6
	891207		18	52	26.4
	900316		<	23	4.9
	900622		35	73	52.1
	900921		45	86	68.8
	901231		39.5	115	57.8
	910331		23.1	50.5	31.8
	910630		39.4	146	66.5
	910917		69.9	260	105.9
	920331		41.2	90.4	<299
	920630		33	56	48.6
	920930		20	39	27.1
SD WARREN CO. WESTBROOK	850620		17.2		
	870929		31		31.1
	871231		21	135	34.7
	880331		5.6	21	7.7
	880401		8.7	3.9	14.9
	880630		13	55	18.5
	881207		19	127	34.2
			19	69	27.5
	890106		<1.8	31	<4.9
	890320		6.2	18	8.6
	890620		5.3	35	10.5
	890731		5	30	16
	890831		8	40	14.9
	890931		9	60	17.8
	891031		5	30	12.9
	891130		3	30	15.5
	891231		7	50	15.2
	900131		6	20	14.0
	900228		2.7	24.6	7.7
	900331		5.1	33.6	17.1
	900430		5.9	34.6	14.9
	900531		5.3	25.8	10.5
	900630		19.0	26.0	29.5
	900730		5.2	20.6	11.6
	900831		2.9	12.1	9.8
	900930		2.5	10	7
	901231		7.7	35.7	24.8
	910331		3.4	21.5	9.1
	910630		2.9	19.6	8.4
	910930		3.8	2.8	11.8
	911231		2.4	25.1	8.2
	920331		1.2	19.4	3.8
	920505		1.6	10.8	5.4
	920821		<	24.5	2.8
S PORTLAND STP	900314		<5.3	3.5	<5.6
	910531		<5	<0.001	<11.2
	920401		<1.0	<0.8	<5.9

APPENDIX 3. (CONT)

LOCATION	DATE	%MOIST	TCDD	TCDF	TEQ
STATLER TISSUE CO	880930	62.6	13.8	155	29.3
AUGUSTA	881223	61.4	14.5	126	27.1
	890403	61.6	13.3	93	22.6
	890628	65.5	6.1	143	20.4

TEQs calculated from TEFs in Water Bureau rule chapter 567 and nd= detection level

APPENDIX 4

2378-TCDD AND 2378-TCDF IN WASTEWATER FROM MAINE PULP AND PAPER MILLS

APPENDIX 4. 2378-TCDD AND 2378-TCDF IN WASTEWATER FROM MAINE PULP AND PAPER MILLS

SOURCE	DATE	TCDD (pg/l)	TCDF (pg/l)
ANSON MADISON	920408	<3	<3
	921001	<3	20
BOISE CASCADE	880518	120	570
	890301	25	80
	890807	<6	20
	890810	<13	20
	890814	<5	13
	890817	<5	18
	890821	<8	21
	890824	<5	10
	890829	<5	18
	890831	<11	20
	890905	<11	20
	890907	<9	18
	891023	<3	7
	891026	<5	6
	891222	<5	20
	900216	<2	6
	900216	<1	7
	900515	<10	<8
	900515	<1	5
	900627	<3	8
	900627	<3	9
	920217	<4.6	14
	920221	<4.6	13
	920311	<4.6	9.9
	920316	3.2	8.7
		3.5	12
		4.6	17
	920326	4.5	8.5
	920430	6.3	24
	920630	<4.6	6.8
	920731	<4.6	<5.8
	920831	<4.6	3.5
GEORGIA PACIFIC	880101	6.8	25
	900316	<5	4
	900423	<3	<6
	900531	<8	<5
	900619	<3	<1

SOURCE	DATE		TCDD (pg/l)	TCDF (pg/l)
GEORGIA PACIFIC	900716		<1	<3
	900807		<2	<5
INTERNATIONAL PAPER	880101		88	420
	880715		30	150
	890307		30	100
			E6	E20
			E20	E20
	890310		16	74
	890616		<8	980
	890621		17	140
	890713		<16	50
	890720	DEP	30	150
	890818		20	110
	900413		<10	90
	910924		<10	60
	910926		<10	60
	911129		50	210
	911219		<20	<80
	920125		20	110
	dup		20	110
	dup		30	100
	dup		30	100
	dup		13.7	68
	dup		12.3	49.9
	920312		19.3	65.6
	920320	?	14.8	73.9
		?	<13.2	59.1
	920610		<5.7	29.5
	920617		<6.3	30.8
	920819		6.6	29.7
	920923		<10	<10
JAMES RIVER	880630		39	130
	890131		27	120
	890222		210	340
	890223		92	290
	890224		77	340
	890320		<	34

SOURCE	DATE	TCDD (pg/l)	TCDF (pg/l)
JAMES RIVER	890324	<	24
	890325	36	73
	890405	30	110
	890410	17	52
	890411	32	89
	890824	32	94
	890831	13	150
	890911	<4.1	14
	890915	<3.3	<8.1
	890921	<5.7	13
	890927	<5.3	9.7
	891011	<3	11
	891019	<5.2	14
	891102	<6	18
	891106	6.7	22
	891114	<9.5	<7.1
	891127	<6.4	20
	891206	<8.4	13
	891213	<8.3	20
	891221	<4.7	23
	900105	<6.8	<8.3
	900111	<9	<8.5
	900118	<5.9	6.1
	900125	<6.7	10
	900207	<4.6	17
	900214	<6.6	23
	900222	<7.3	15
	900301	<6	11
	900308	<3	12
	900315	<4	16
	900329	<7.4	14
	900407	<7.2	24
	900502	<7	19
	900729	<9.9	49
	910330	17	70
	910430	19	65
	910530	9.5	41
	910630	6.8	43
	910830	11	66
	911030	<	7.9
	911130	<7.7	<16

SOURCE	DATE	TCDD (pg/l)	TCDF (pg/l)
JAMES RIVER	920330	<5.7	50
	920730	16	69
	920830	<4.9	23
LINCOLN PULP AND PAPER	881130	32	130
SD WARREN (Skowhegan)	880630	16,19	63100
	900710	<7.1	8.4
	900716	<6.1	5.9
	dup	<5.5	<7.3
	900724	<3.6	<3.9
SD WARREN (Westbrook)	880101	6.3	
	1989	1	

APPENDIX 5

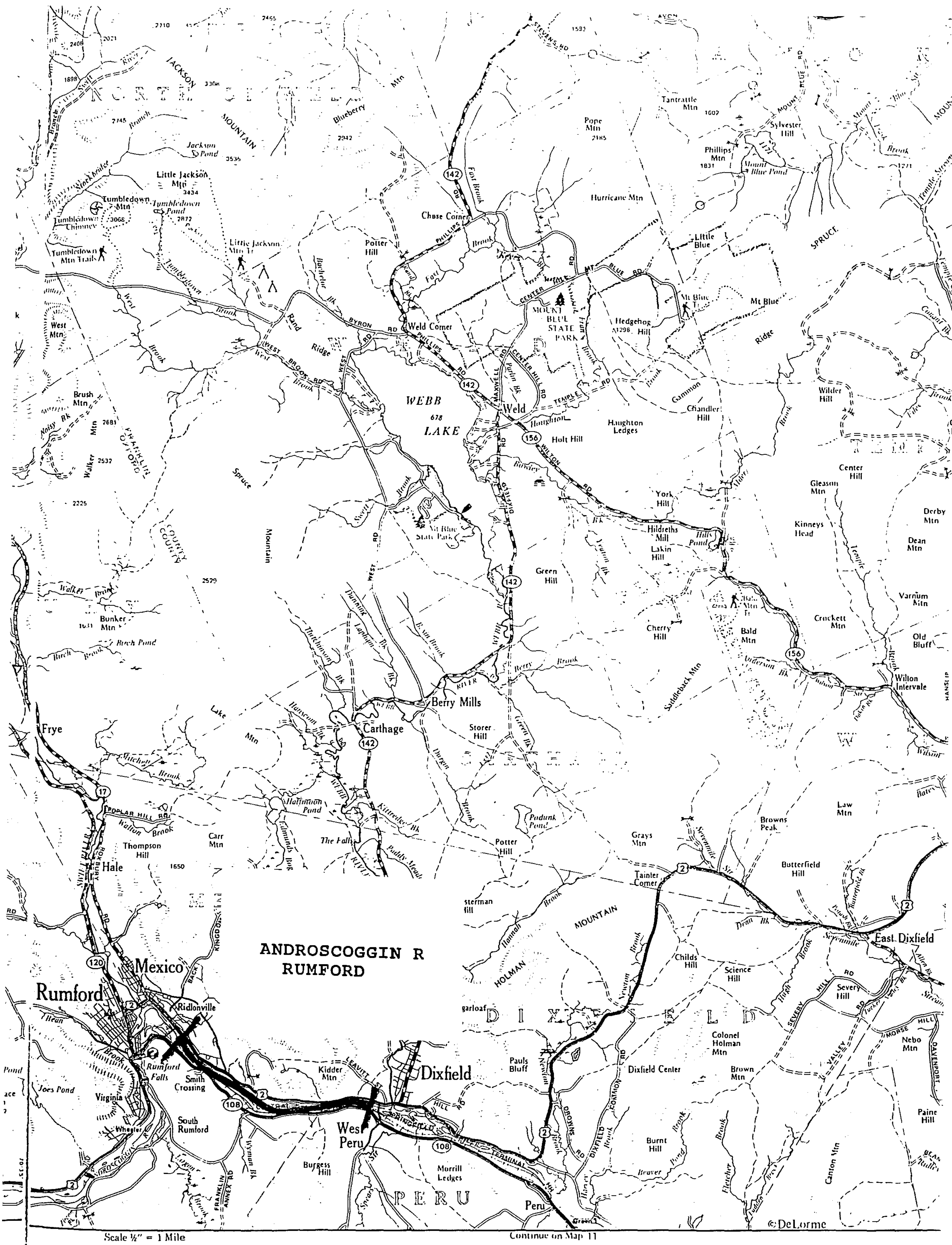
2378-TCDD AND 2378-TCDF IN SEDIMENTS FROM VARIOUS STATIONS ON THE ANDROSCOGGIN RIVER

APPENDIX 5. 2378-TCDD AND 2378-TDCF IN SEDIMENTS FROM VARIOUS STATIONS

LOCATION	2378-TCDD	2378-TCDF	% MOISTURE	% DOC
Virginia Impoundment Rumford N443147 W703217	4.4	185		2.35
Riley Impoundment Jay N443002 W701458	5.3	168		3.31
Otis Impoundment Livermore Falls N442846 W701213	E6.8	162		2.85
Gulf Island Pond Turner N441520 W701050	23.1			
Gulf Island Pond Turner N441420 W701125	30.3			
Gulf Island Pond Turner N441225 W701210	20.4			
Gulf Island Pond Greene N441040 W701240	39.5 42.6dup			
Gulf Island Pond Greene N440932 W701222	27.4	371		6.79
Worumbo Impound. Lisbon Falls N435950 W700405	4.7	64.2		2.31
Brunswick below dam N435445 W695550	2.5			
Brunswick Cow Island N435520 W695745	1.7			

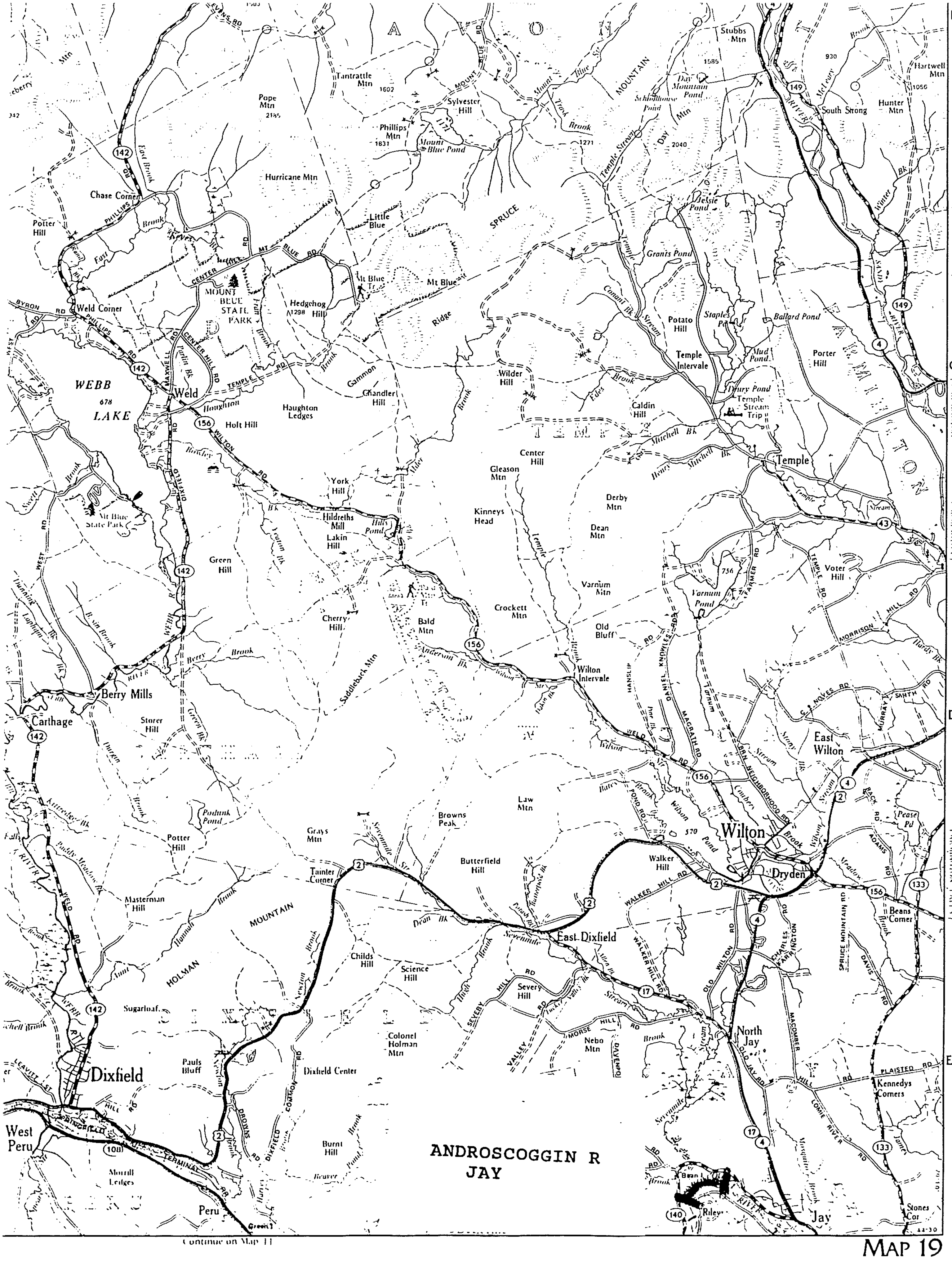
APPENDIX 6

SAMPLE LOCATION MAPS

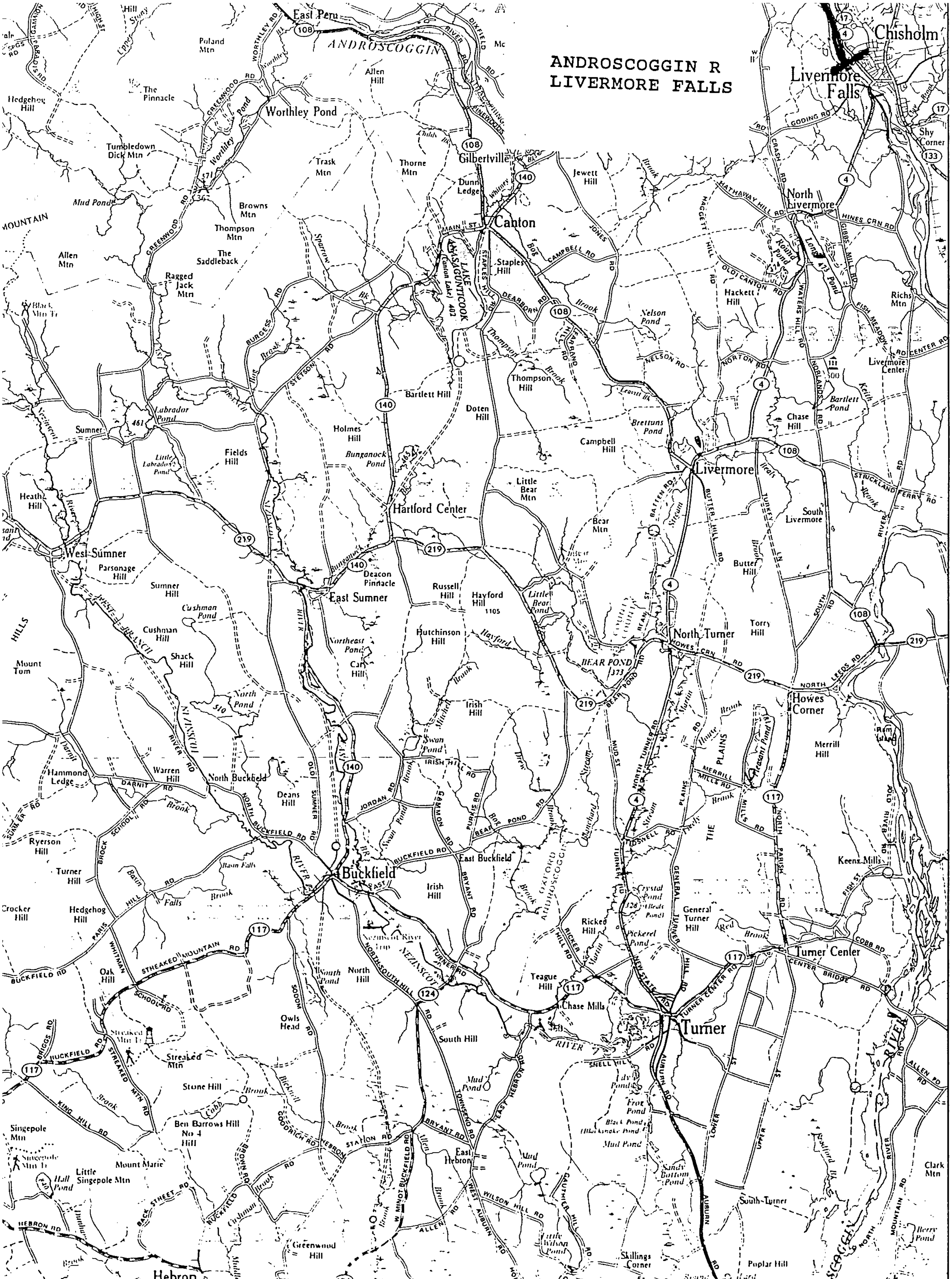


Scale ½" = 1 Mile

Continue on Map 11



Continue on Map 11



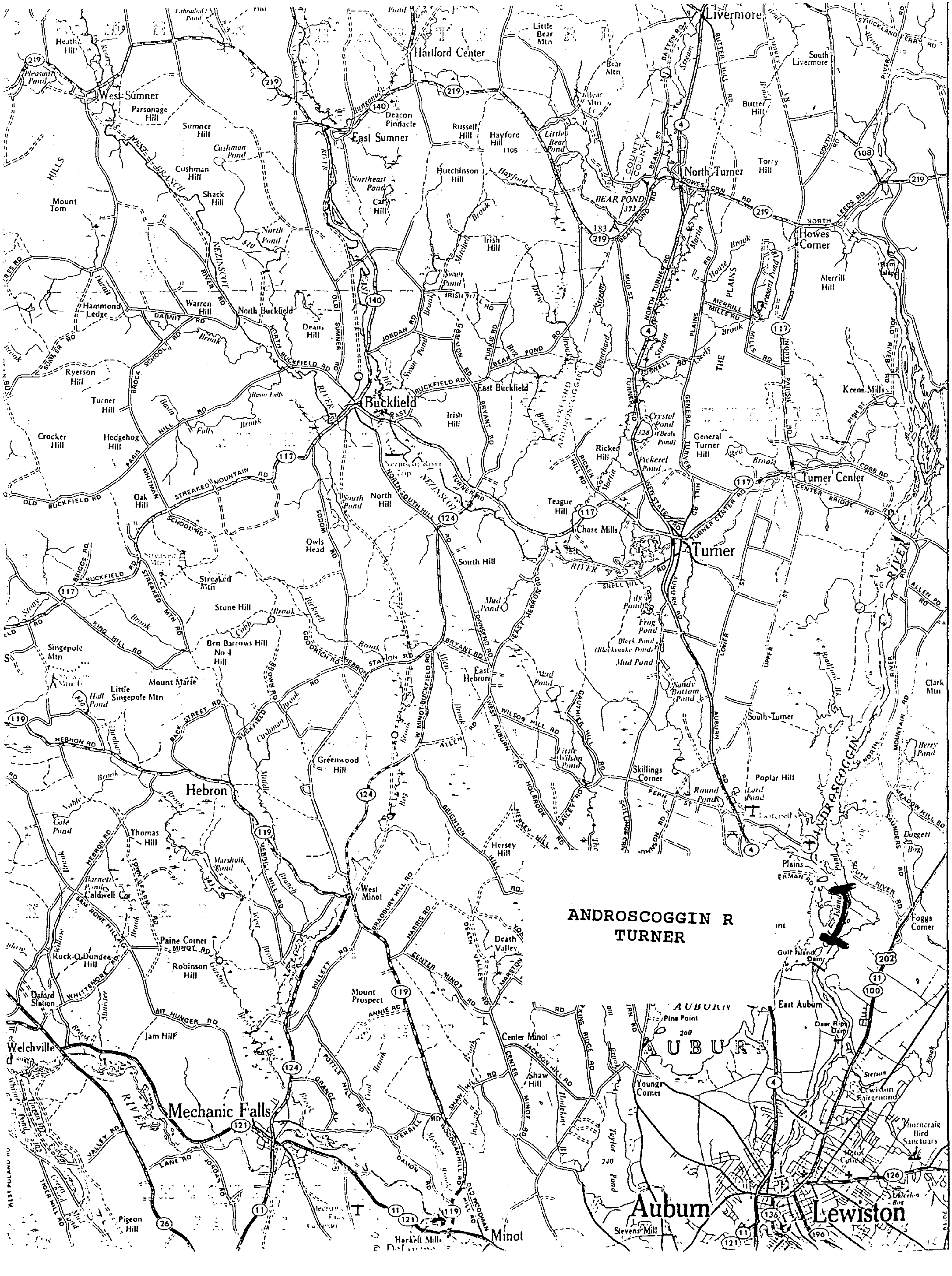
ANDROSCOGGIN R
LIVERMORE FALLS
Chisholm
Livermore Falls
Shy Corner
East Peru
ANDROSCOGGIN
Poland Mtn
Allen Hill
The Pinnacle
Hedgehog Hill
Worthley Pond
Tumbledown Dick Mtn
Trask Mtn
Thorne Mtn
Gilbertville
Dunn Ledge
Jewett Hill
North Livermore
Mud Pond
Browns Mtn
Thompson Mtn
The Saddleback
Allen Mtn
Ragged Jack Mtn
Canton
Staples Hill
LAKE ANASAGUNTICOOK
Round Pond
Long Pond
Hackett Hill
Richs Mtn
Nelson Pond
Livermore Center
Thompson Hill
Bartlett Hill
Doten Hill
Bartlett Pond
Chase Hill
Labrador Pond
Sumner
Holmes Hill
Bunganock Pond
Brettuns Pond
Campbell Hill
Livermore
Fields Hill
Little Labrador Pond
Little Bear Mtn
Heath Hill
Hartford Center
South Livermore
Bear Mtn
West Sumner
Parsonage Hill
Deacon Pinnacle
Russell Hill
Hayford Hill
Butter Hill
East Sumner
Sumner Hill
Cushman Pond
Little Bear Pond
Cushman Hill
Hutchinson Hill
North Turner
Torry Hill
Shack Hill
Northeast Pond
Mount Tom
Cary Hill
BEAR POND
North Pond
Irish Hill
Howes Corner
Swan Pond
Merrill Hill
Hammond Ledge
Warren Hill
North Buckfield
Deans Hill
Ryerson Hill
East Buckfield
Keens Mills
Turner Hill
Buckfield
Irish Hill
Crystal Pond
Crocker Hill
Hedgehog Hill
General Turner Hill
Ricker Hill
Pickerel Pond
Turner Center
Oak Hill
North Hill
South Pond
Teague Hill
Chase Mills
Owls Head
Turner
South Hill
Streaked Mtn
Stone Hill
Mud Pond
Frog Pond
Singepole Mtn
Ben Barrows Hill
Mount Marie
East Hebron
Little Singepole Mtn
Hall Pond
Sandy Bottom Pond
Clark Mtn
South Turner
Greenwood Hill
Little Wilson Pond
Skillings Corner
Poplar Hill
Berry Pond
Hebron

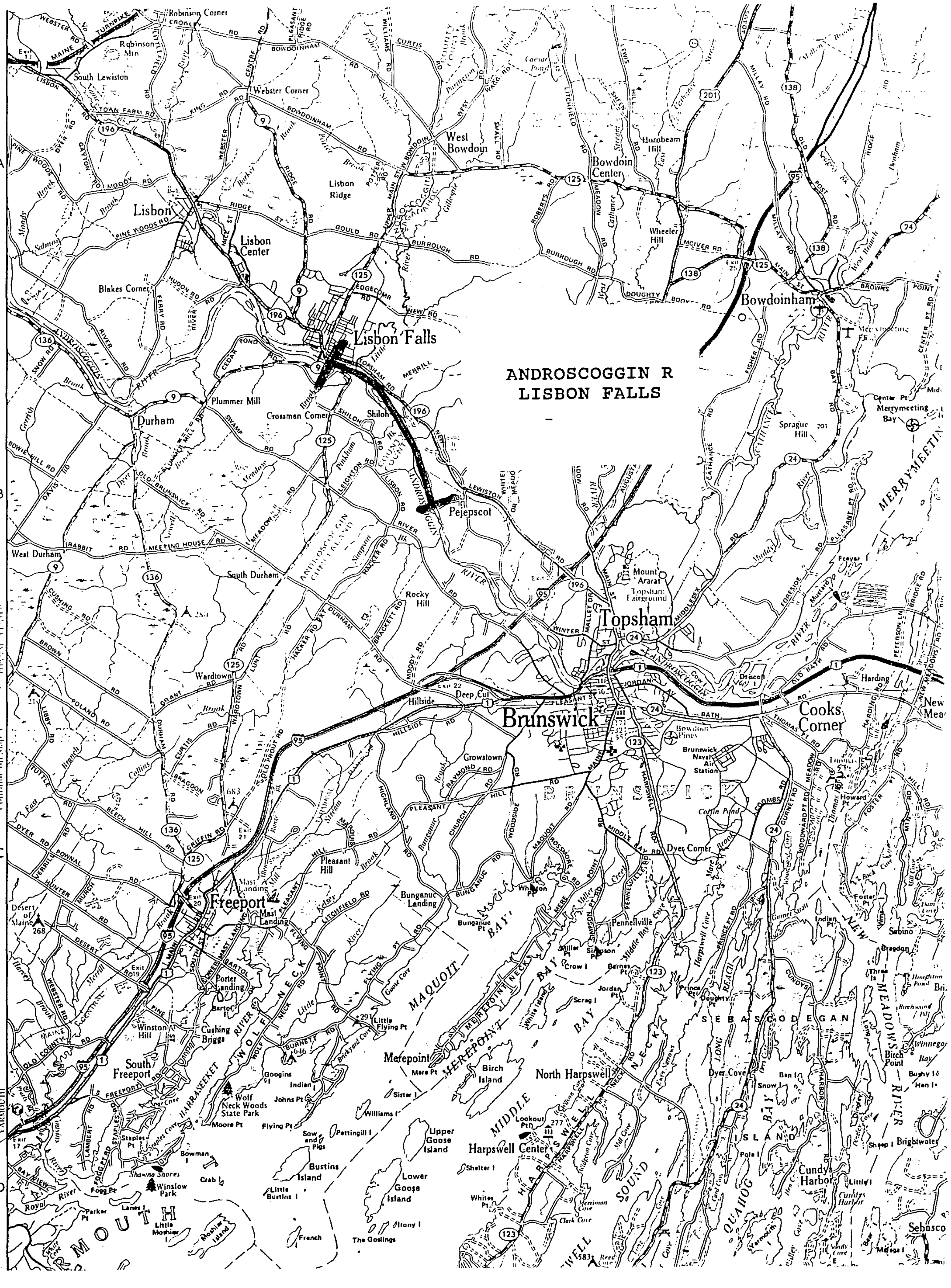
A

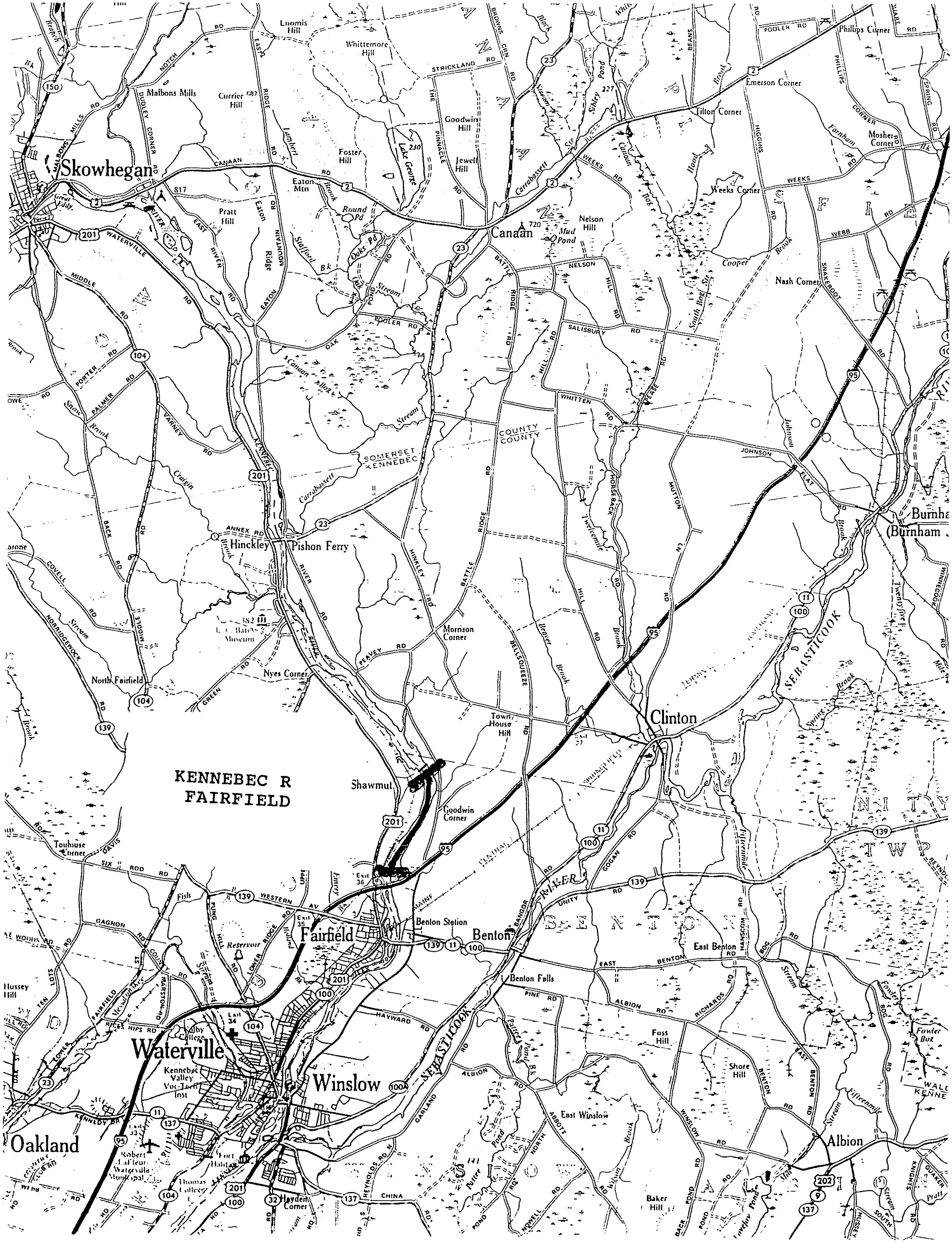
B

C

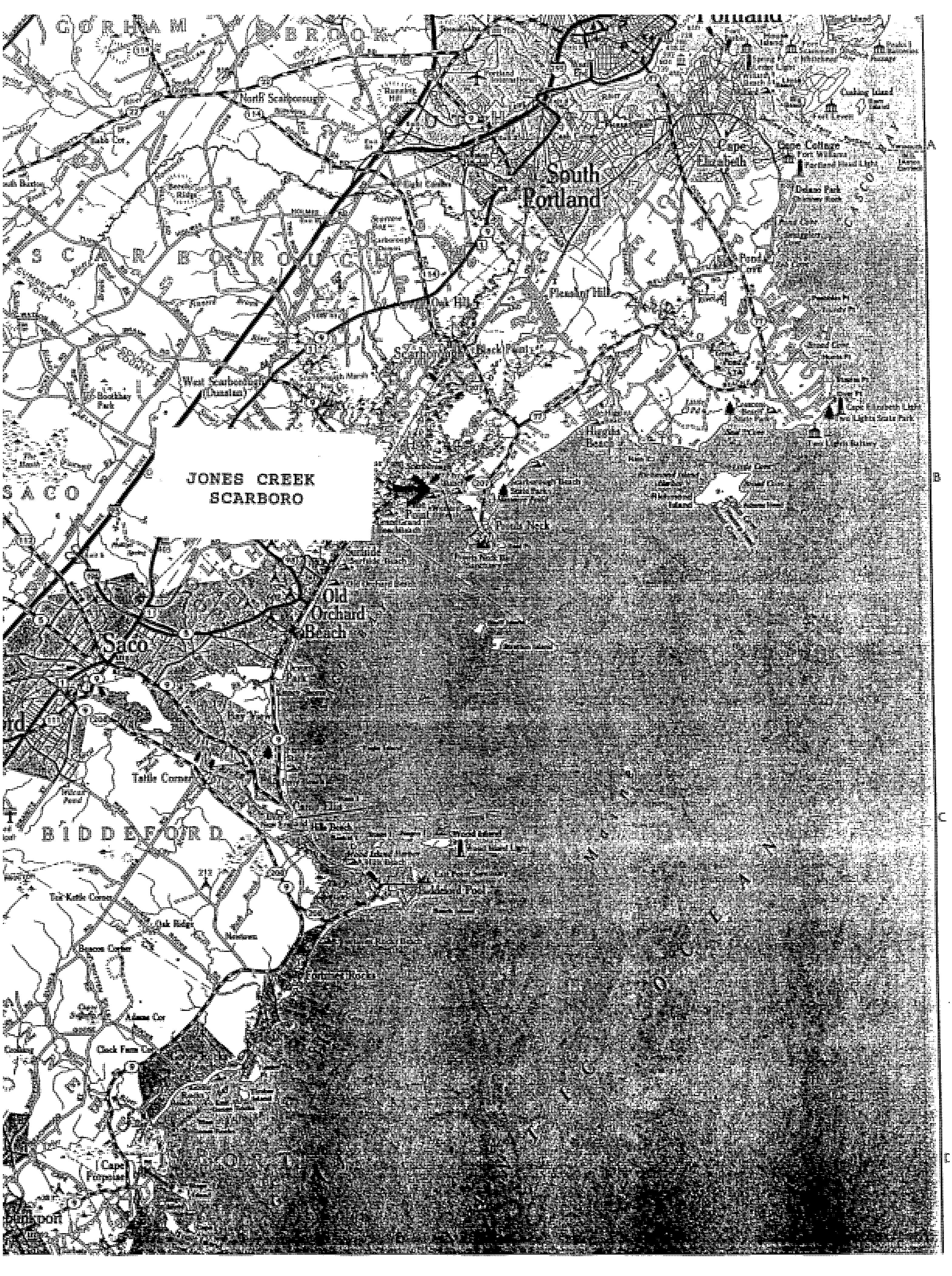
D


ANDROSCOGGIN R
TURNER
Livermore
Hartford Center
West Sumner
East Sumner
Deacon Pinnacle
North Turner
South Livermore
Torry Hill
Howes Corner
Merrill Hill
North Buckfield
Buckfield
East Buckfield
Keens Mills
Turner Center
Turner
Chase Mills
Teague Hill
General Turner Hill
Crystal Pond
Pickerel Pond
South Hill
Owls Head
North Pond
Stone Hill
Streaked Mtn
Singepole Mtn
Little Singepole Mtn
Mount Marie
Ben Barrows Hill
East Hebron
Greenwood Hill
Hebron
Thomas Hill
Caldwell Cor
Paine Corner
Robinson Hill
Ruck-O-Dundee Hill
Oxford Station
Welchville
Mechanic Falls
West Minot
Mount Prospect
Center Minot
Minot
Hackett Mills
Pigeon Hill
Death Valley
Hersey Hill
South Turner
Skillings Corner
Poplar Hill
Clark Mtn
Berry Pond
Foggs Corner
Gulf Island Dam
East Auburn
Pine Point
Young Corner
Shaw Hill
Stevens Mill
Auburn
Lewiston
Thorncrag Bird Sanctuary
Deer Rips Dam
Mount Tom
Hammond Ledge
Ryerson Hill
Turner Hill
Crocker Hill
Hedgehog Hill
Oak Hill
Warren Hill
Deans Hill
Sumner Hill
Cushman Hill
Shack Hill
Parsonage Hill
Heath Hill
Russell Hill
Hayford Hill
Hutchinson Hill
Irish Hill
Cary Hill
Bear Mtn
Little Bear Mtn
Butter Hill
Ricker Hill
North Hill
Jam Hill
BEAR POND
NEZINSCOT RIVER
ANDROSCOGGIN
RIVER


ANDROSCOGGIN R
LISBON FALLS
Robinson Corner
South Lewiston
Robinson Mtn
Webster Corner
West Bowdoin
Bowdoin Center
Hornbeam Hill
Wheeler Hill
Lisbon
Lisbon Center
Lisbon Ridge
Blakes Corner
Lisbon Falls
Bowdoinham
Merrymeeting Bay
Sprague Hill
Plummer Mill
Durham
Crossman Corner
Shiloh
Pejepscot
West Durham
South Durham
Rocky Hill
Mount Ararat
Topsham Fairground
Topsham
Wardtown
Hillside
Deep Cut
Brunswick
Bowdoin Pines
Brunswick Naval Air Station
Cooks Corner
Harding
Growstown
Coffin Pond
Dyer Corner
Pleasant Hill
Mast Landing
Freeport
Desert of Maine
Bunganuc Landing
Bunganuc Pt
Whaleboat Pt
Pennellville
Porter Landing
Winston Hill
Cushing Briggs
South Freeport
Little Flying Pt
Merepoint
Birch Island
North Harpswell
Wolf Neck Woods State Park
Upper Goose Island
Lower Goose Island
Bustins Island
Harpswell Center
Lookout Pt
Dyer Cove
Cundys Harbor
Sebasco
Winslow Park
Maquoit Bay
Middle Bay
Harpswell Sound
Quahog Bay
Sebascodegan Island
New Meadows River
Continue on Map 5
Yarmouth

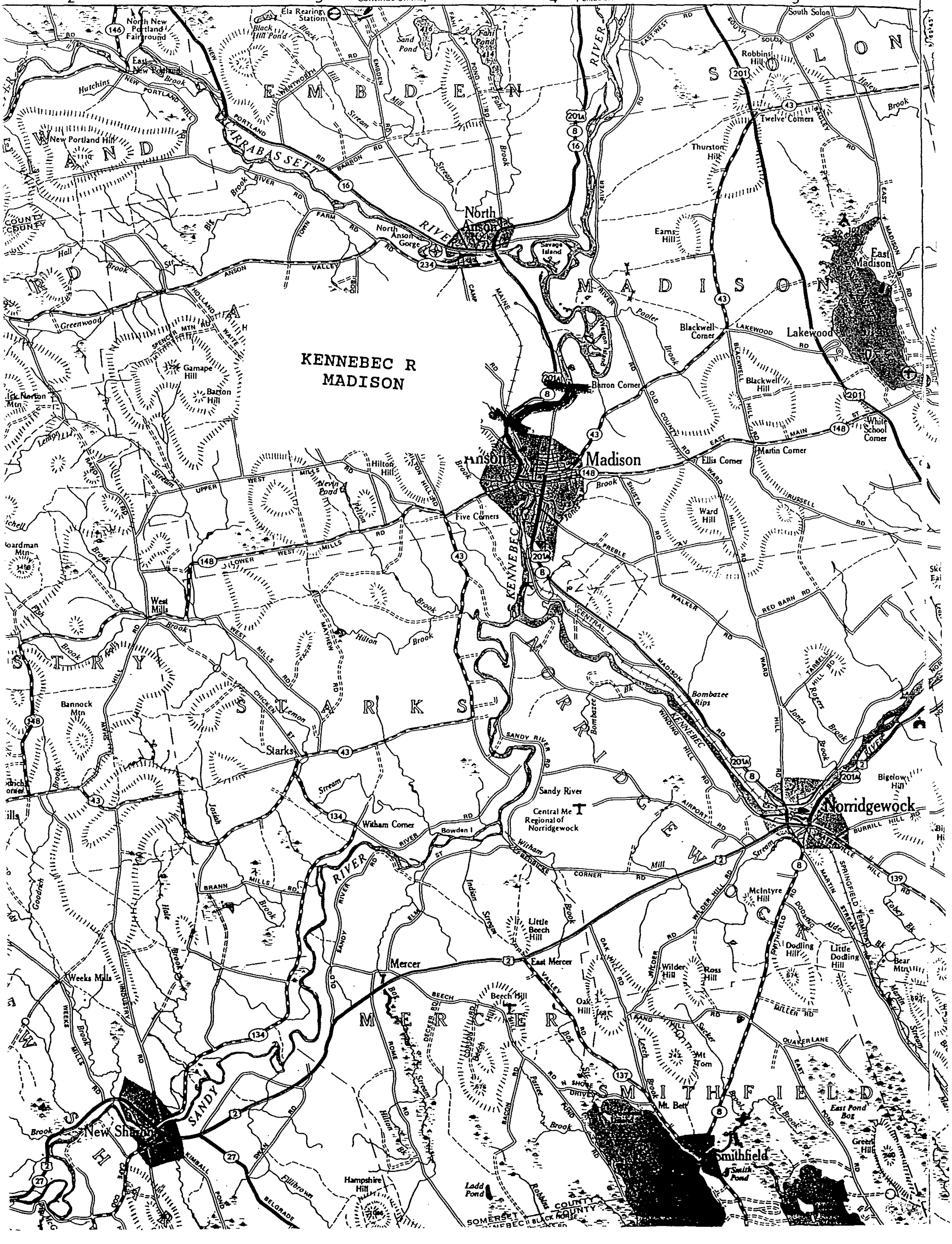


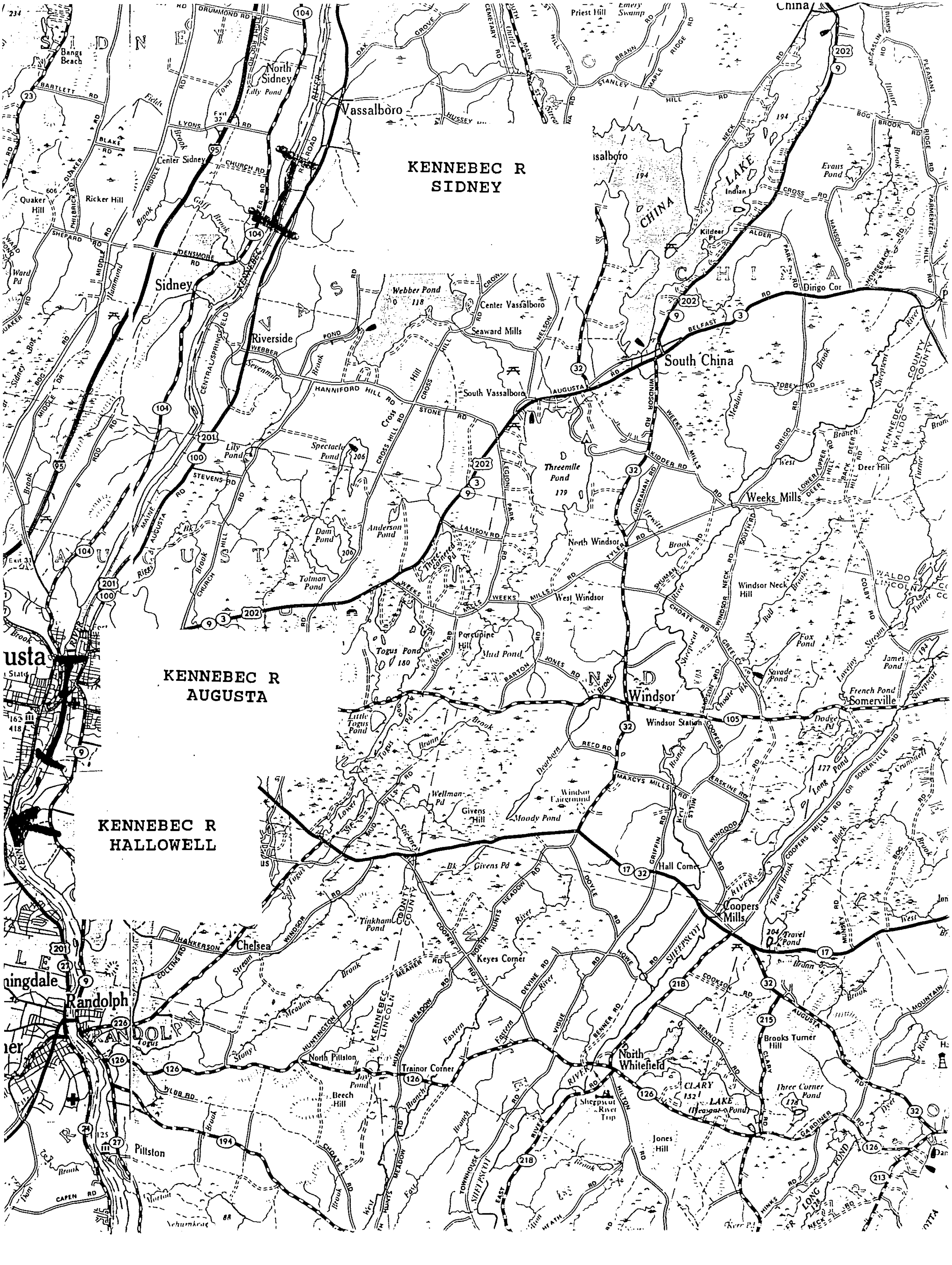
KENNEBEC R
FAIRFIELD
Skowhegan
Canaan
Clinton
Fairfield
Benton
Waterville
Winslow
Oakland
Albion
Shawmut
Hinckley
Pishon Ferry
Nyes Corner
North Fairfield
Morrison Corner
Goodwin Corner
Town House Hill
Benton Station
Benton Falls
East Benton
East Winslow
Foss Hill
Shore Hill
Baker Hill
Hayden Corner
Colby College
Kennebec Valley Voc-Tech Inst
Thomas College
Fort Halifax
Robert LaFleur Waterville Municipal
Tourtouse Corner
Hussey Hill
Malbons Mills
Currier Hill
Loomis Hill
Whittemore Hill
Goodwin Hill
Jewell Hill
Foster Hill
Eaton Mtn
Pratt Hill
Nelson Hill
Mud Pond
Round Pd
Oaks Pd
Lake George
Great Eddy
Tilton Corner
Emerson Corner
Phillips Corner
Mosher Corner
Weeks Corner
Nash Corner
Burnham
SOMERSET
KENNEBEC
COUNTY
SEBASTICOOK
UNITY TWP
WESTERN AV
CANAAN RD
WATERVILLE RD
MIDDLE RD
BATTLE RIDGE RD
HINCKLEY RD
RIVER RD
PEAVEY RD
BELLSQUEEZE RD
MUTTON RD
JOHNSON FLAT
EAST BENTON RD
ALBION RD
PINE RD
HAYWARD RD
CHINA RD
KENNEDY BR
Exit 36
Exit 35
Exit 34
Exit 33
Exit 37



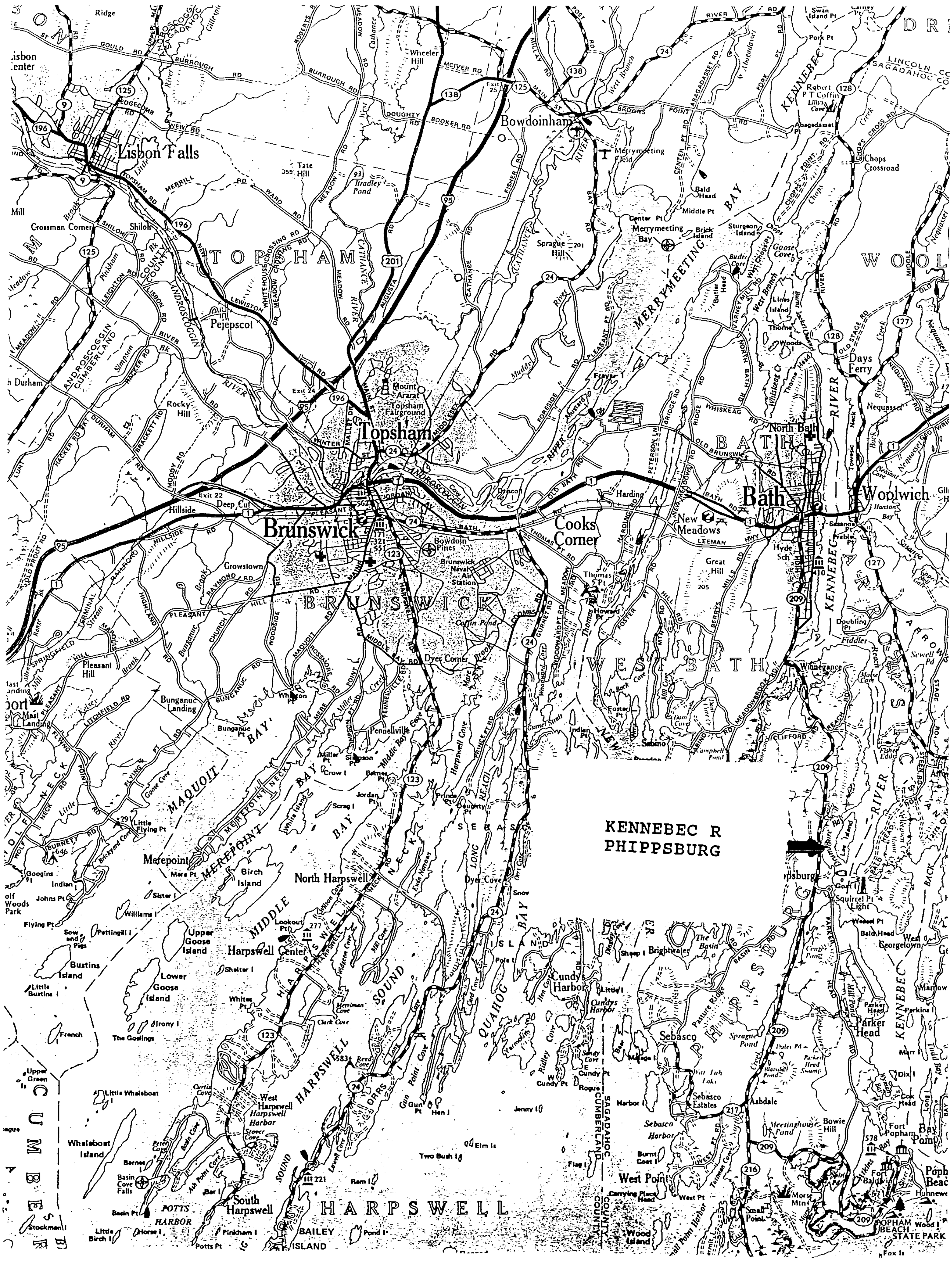
JONES CREEK
SCARBORO
South Portland
Cape Elizabeth
Cape Cottage
Pleasant Hill
West Scarborough
North Scarborough
Old Orchard Beach
Saco
SACO
GORHAM
SCARBOROUGH
BIDDEFORD
Tuttle Corner
Oak Ridge

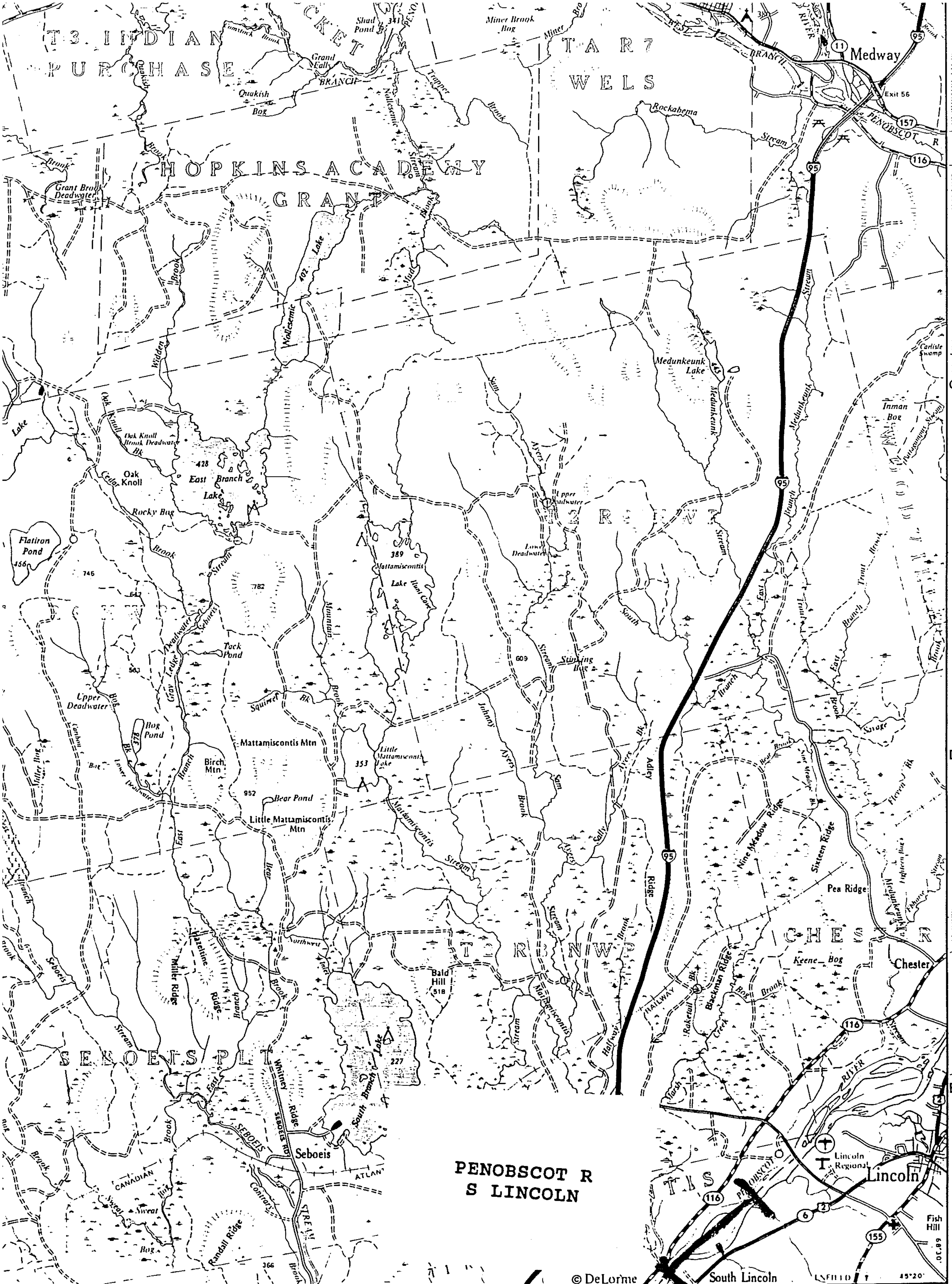
2 3 Continue on Map 30 4 EMBDEN 5



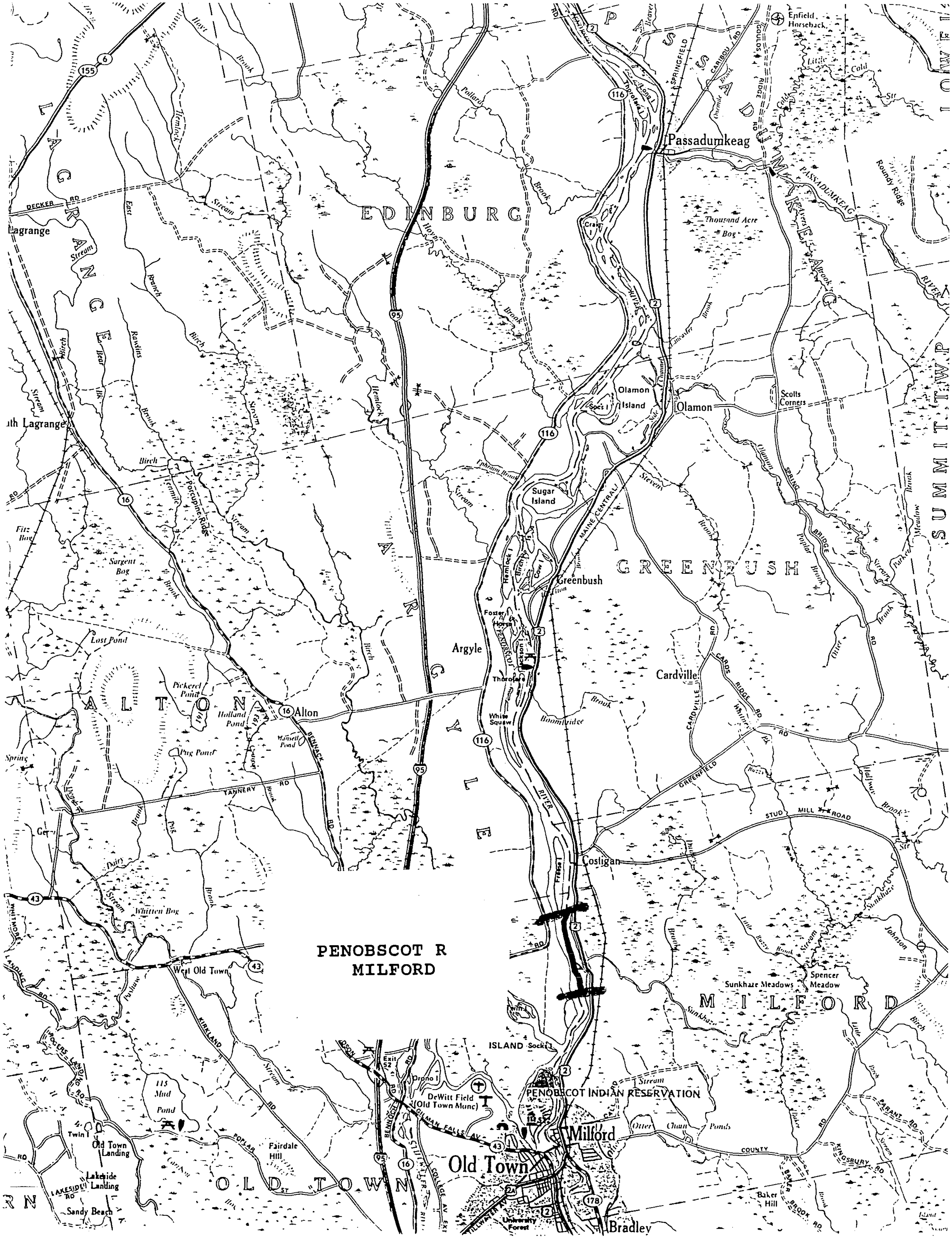


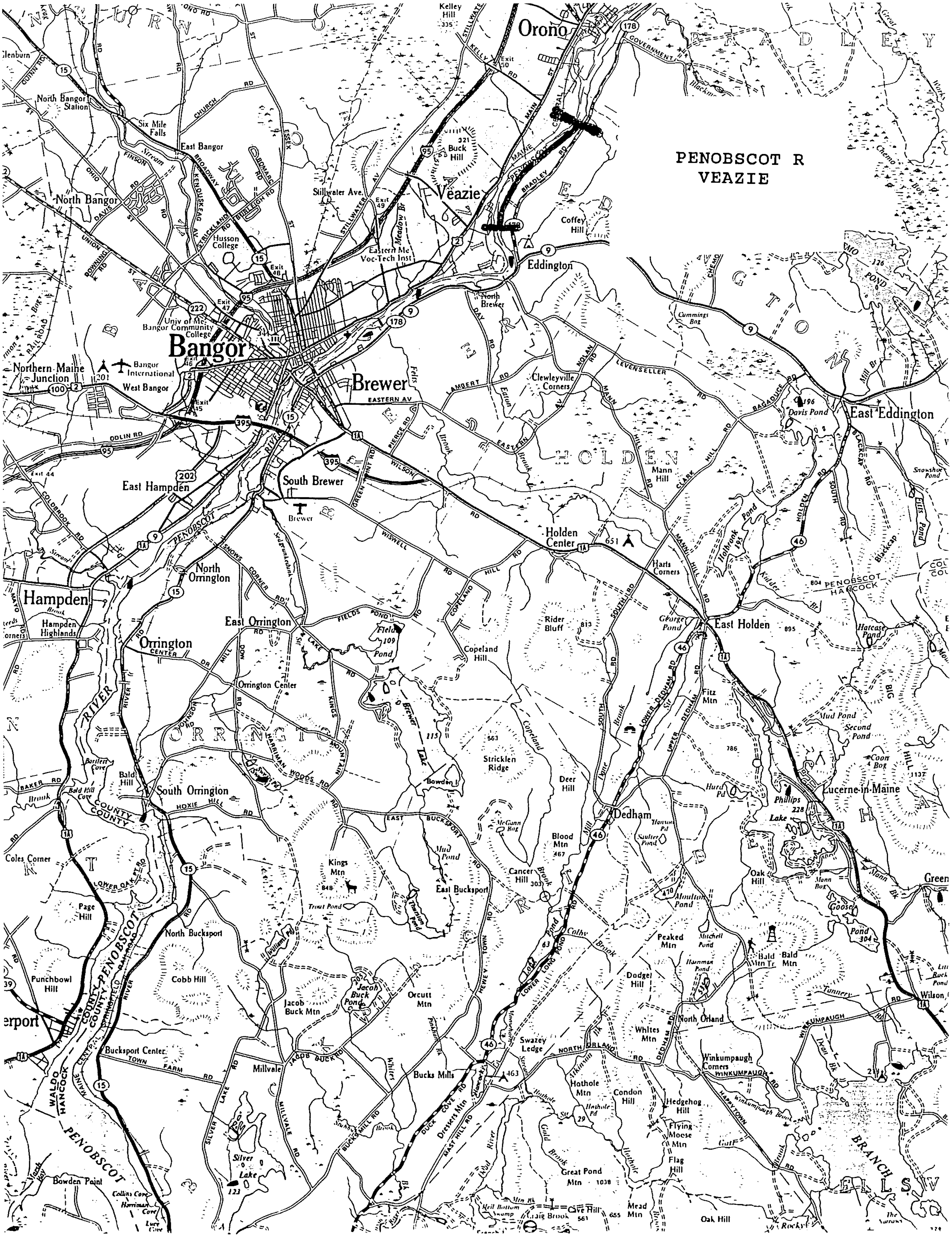
KENNEBEC R
SIDNEY
KENNEBEC R
AUGUSTA
KENNEBEC R
HALLOWELL
SIDNEY
Bangs Beach
North Sidney
Vassalboro
Center Sidney
Quaker Hill
Ricker Hill
Sidney
Riverside
China
CHINA LAKE
South China
Dirigo Cor
Webber Pond
Center Vassalboro
Seaward Mills
South Vassalboro
Spectacle Pond
Threemile Pond
Weeks Mills
Deer Hill
North Windsor
West Windsor
Windsor Neck Hill
Dam Pond
Anderson Pond
Tolman Pond
Three Cornered Pd
Togus Pond
Porcupine Hill
Mud Pond
Windsor
Windsor Station
Savade Pond
Fox Pond
James Pond
French Pond
Somerville
Little Togus Pond
Wellman Pd
Givens Hill
Moody Pond
Windsor Fairground
Givens Pd
Hall Corner
Coopers Mills
Travel Pond
Tinkham Pond
Chelsea
Keyes Corner
Randolph
RANDOLPH
North Pittston
Trainor Corner
Joy Pond
Beech Hill
Pittston
North Whitefield
Sheepscot River Trip
CLARY LAKE
Pleasant Pond
Brooks Turner Hill
Three Corner Pond
Jones Hill
Evans Pond
Priest Hill
Emery Swamp


KENNEBEC R
PHIPPSBURG
Lisbon Falls
Lisbon Center
Topsham
Brunswick
Bowdoinham
Bath
Woolwich
Cooks Corner
TOPSHAM
BRUNSWICK
WEST BATH
HARPSWELL
BATH
MERRYMEETING BAY
Merrymeeting Bay
Merrymeeting Field
Pejepscot
Rocky Hill
Tate Hill
Wheeler Hill
Sprague Hill
Shiloh
Crossman Corner
Pleasant Hill
Growstown
Hillside
Deep Cut
Exit 22
Exit 24
Exit 25
Mount Ararat
Topsham Fairground
Bowdoin Pines
Brunswick Naval Air Station
Coffin Pond
Dyer Corner
Pennellville
Bunganuc Landing
Mast Landing
Mere Point
Merepoint
MAQUOIT
MIDDLE BAY
HARPSWELL SOUND
QUAHOG BAY
North Harpswell
Harpswell Center
West Harpswell
South Harpswell
BAILEY ISLAND
Birch Island
Upper Goose Island
Lower Goose Island
Bustins Island
Whaleboat Island
Little Whaleboat
The Goslings
French
Basin Cove Falls
POTTS HARBOR
Harding
New Meadows
Thomas Pt
Howard Pt
Great Hill
Foster Pt
Sebasco
Sebasco Estates
Cundys Harbor
Brightwater
West Point
Small Point
Ashdale
Bowie Hill
Parker Head
West Georgetown
Fort Popham
Fort Baldwin
POPHAM BEACH STATE PARK
Winnegance
Days Ferry
Nequasset
Chops Crossroad
Bald Head
Middle Pt
Center Pt
Abagadasset Pt
North Bath
Hyde Sch
Doubling Pt
Squirrel Pt Light
Lisbon Falls
Mill
CUMBERLAND
SAGADAHOC COUNTY
CUMBERLAND COUNTY
LINCOLN CO
SAGADAHOC CO

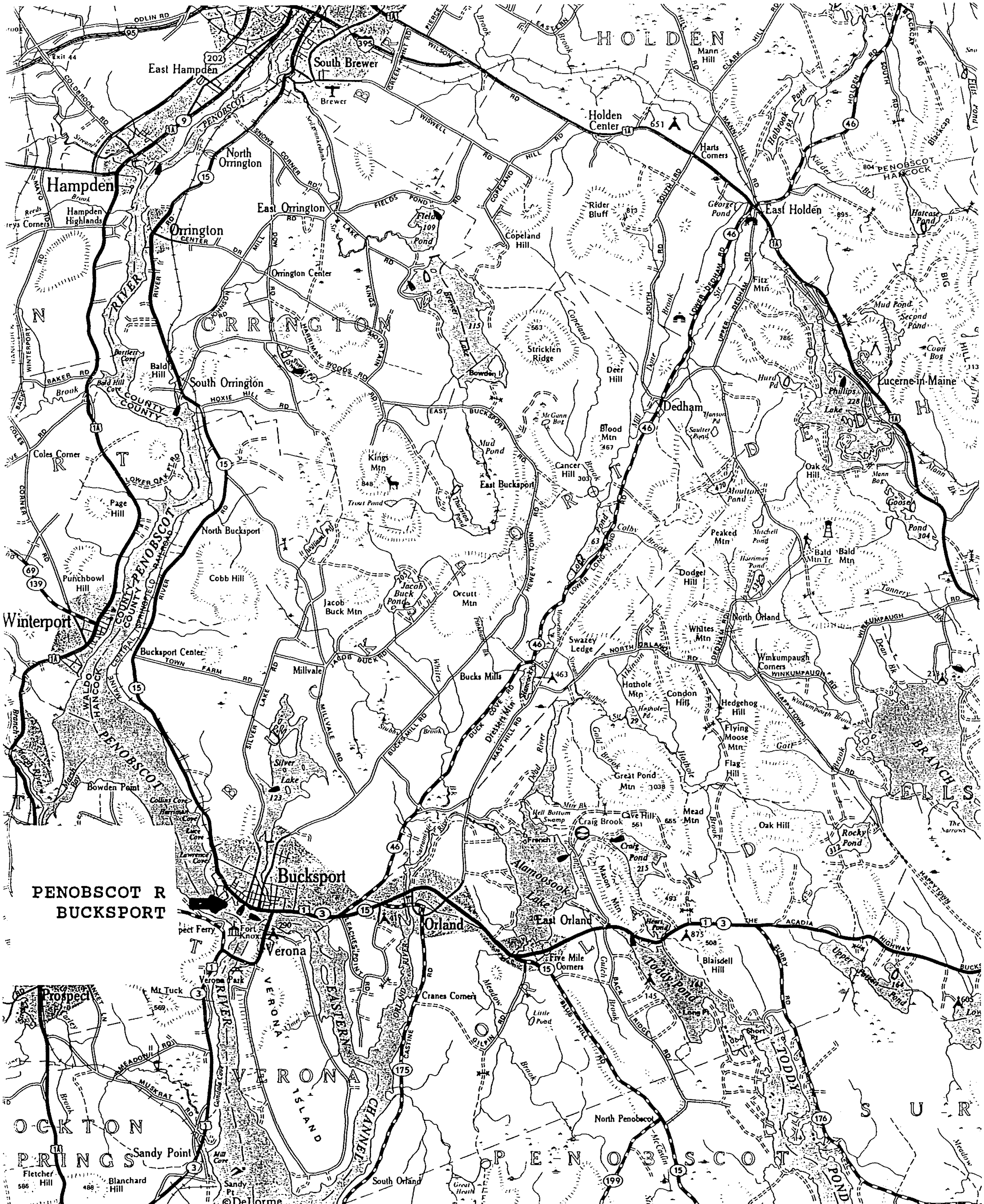


Continue on Map 33

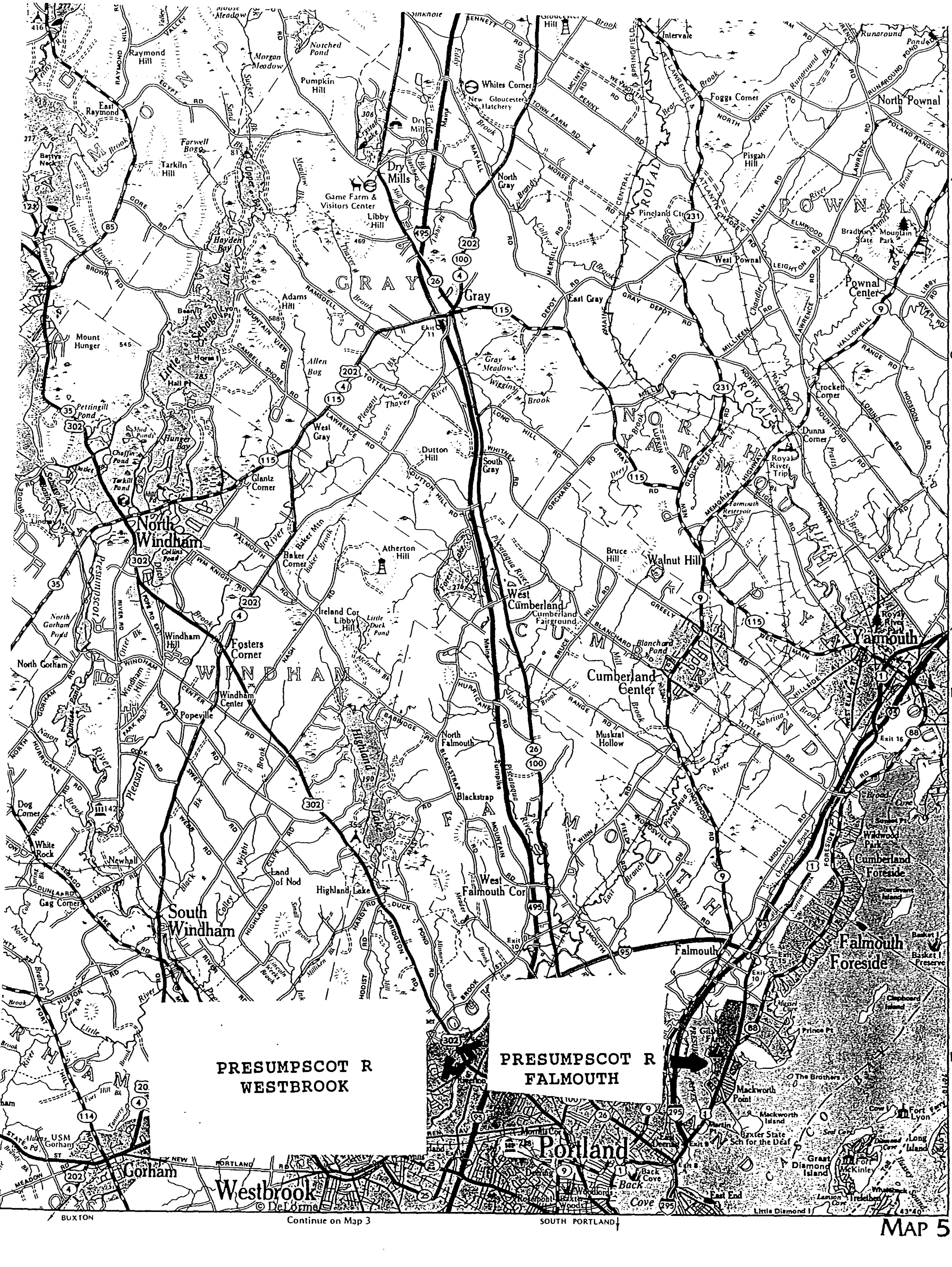

PENOBSCOT R
MILFORD
EDINBURG
GREENBUSH
ALTON
ARGYLE
MILFORD
OLD TOWN
LAGRANGE
PASSADUMKEAG
SUMMIT TWP
Passadumkeag
Enfield Horseback
Lagrange
South Lagrange
Olamon
Olamon Island
Scotts Corners
Sugar Island
Greenbush
Argyle
Cardville
Alton
Costigan
Sunkhaze Meadows
Spencer Meadow
PENOBSCOT INDIAN RESERVATION
DeWitt Field (Old Town Munc)
Milford
Old Town
Bradley
West Old Town
Old Town Landing
Lakeside Landing
Sandy Beach
Fairdale Hill
Baker Hill
Thousand Acre Bog
Sargent Bog
Lost Pond
Pickerel Pond
Holland Pond
Mansell Pond
Pug Pond
Whitten Bog
Mud Pond
Porcupine Ridge
Roundy Ridge
DECKER RD
TANNERY RD
STUD MILL ROAD
GREENFIELD RD
CARDVILLE RD
COUNTY RD
KINGSBURY RD
KIRKLAND RD
POPLAR ST
GILMAN FALLS AV
COLLEGE AV
MAINE CENTRAL
RIVER
Stream
Brook



PENOBSCOT R
VEAZIE



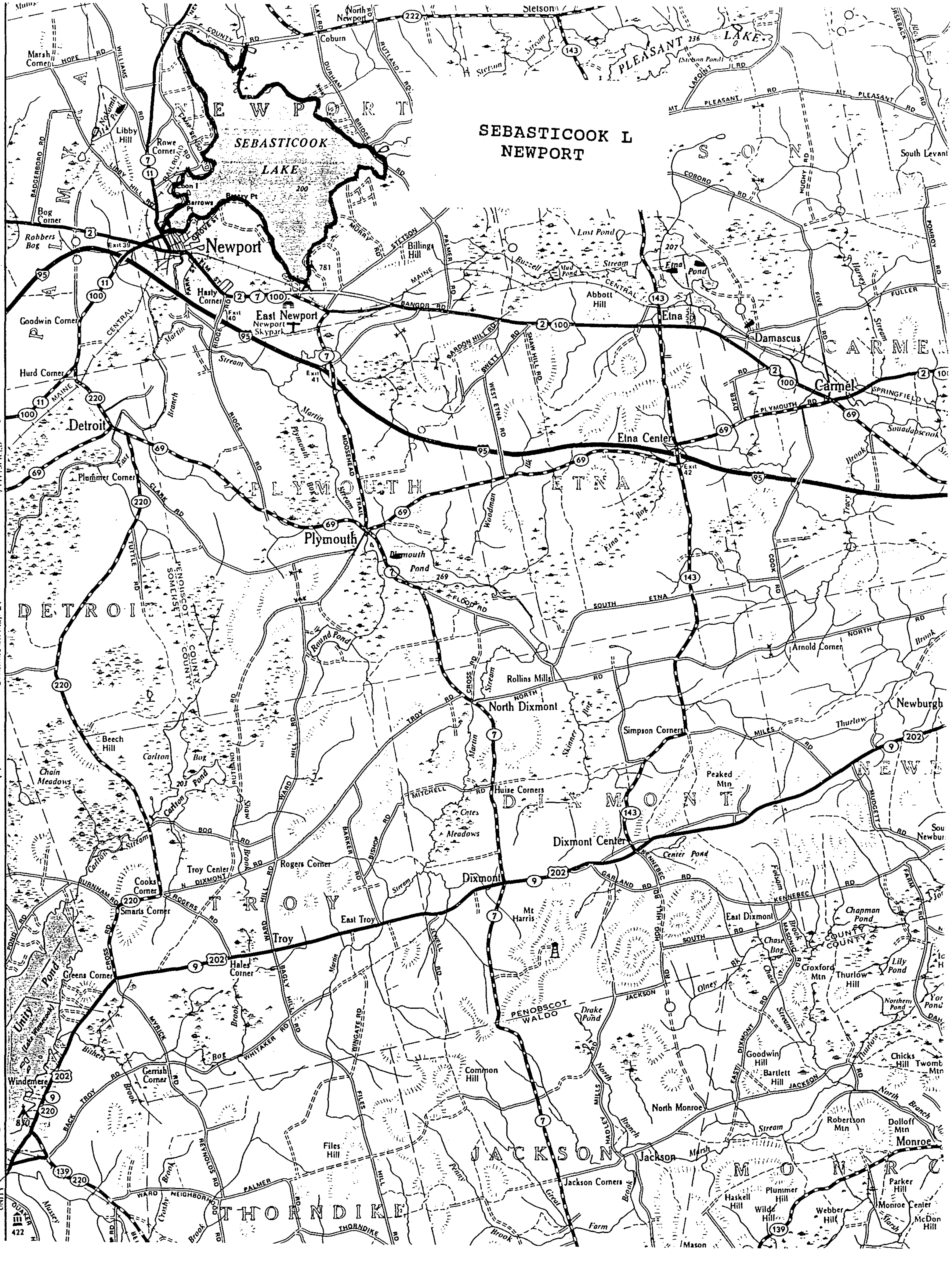
Continue on Map 15


PRESUMPSCOT R
WESTBROOK
PRESUMPSCOT R
FALMOUTH
GRAY
WINDHAM
CUMBERLAND
FALMOUTH
NORTH YARMOUTH
POWNAL
Gray
North Windham
South Windham
Windham Center
Westbrook
Gorham
Portland
Yarmouth
Cumberland Center
West Cumberland
Falmouth Foreside
Falmouth
Dry Mills
North Pownal
Pownal Center
West Pownal
East Gray
North Gray
South Gray
West Gray
Walnut Hill
Fosters Corner
Popeville
Highland Lake
North Falmouth
West Falmouth Cor
Blackstrap
Muskrat Hollow
Cumberland Foreside
Mackworth Island
Back Cove
East End
© DeLorme
Continue on Map 3
Continue on Map 6
SOUTH PORTLAND
BUXTON
DURHAM
FREEPORT

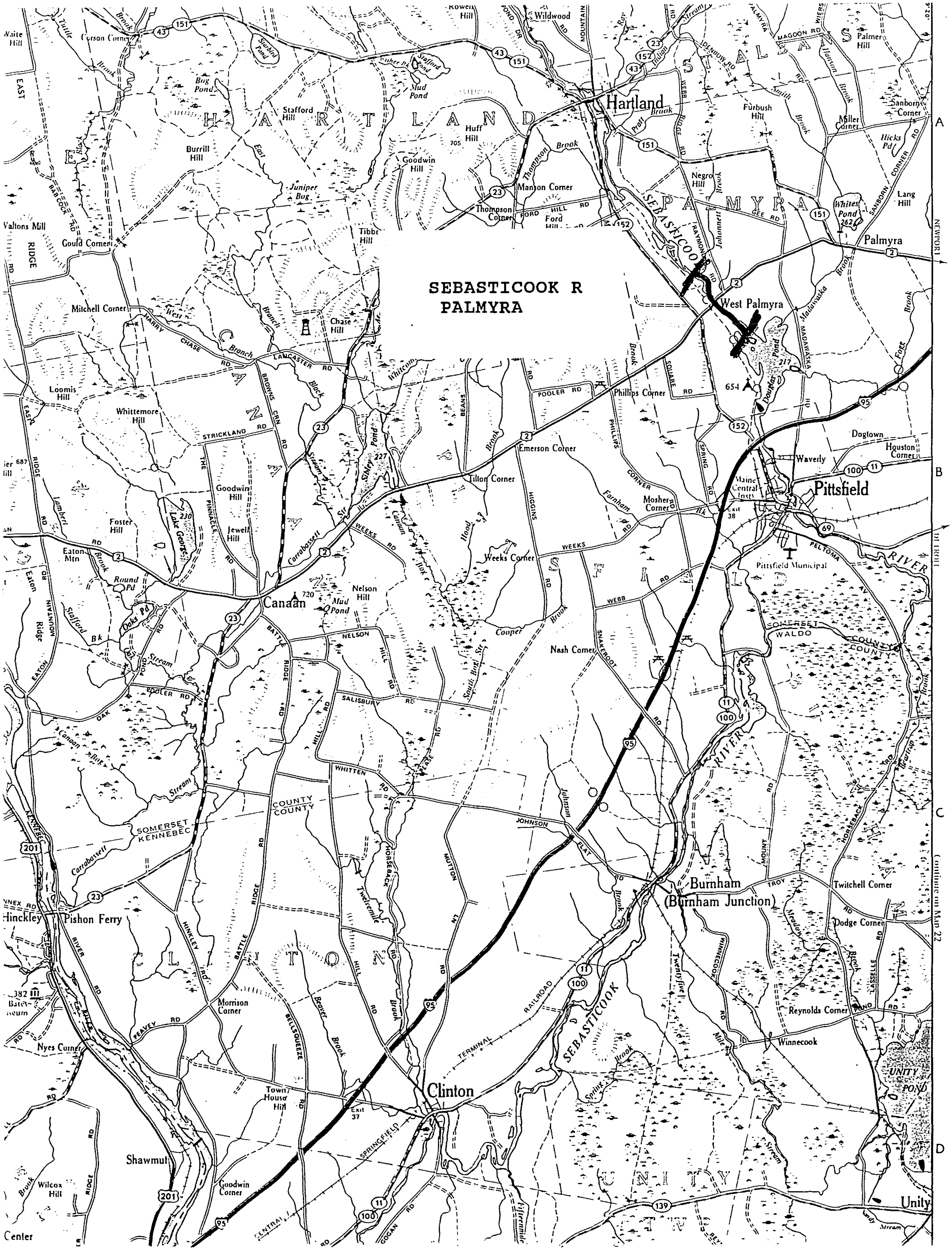
MAP 5


SALMON FALLS R
BERWICK
South Berwick
Salmon Falls
Berwick Academy
Great Works
Vaughan Woods Memorial
Dover
Cocheco River
Durham
Newmarket
Rockingham
Newfields
Exeter
Stratham
Greenland
North Hampton Center
Hampton
Rye
Portsmouth
New Castle
Kittery
Kittery Point
Admiralty Village
Portsmouth Naval Base
Portsmouth Harbor
South Eliot
Eliot
Newington
Pease Air Force Base
Dover Point
Little Bay
Great Bay
Bayside
Piscataqua River
Turnpike
Little Harbor
Odiornes Pt
Rye North Beach
Ragged Neck Pt
Rye Harbor
NEW HAMPSHIRE

SEBASTICOOK L
NEWPORT



Continue on Map 21


SEBASTICOOK R
PALMYRA
Hartland
Palmyra
West Palmyra
Pittsfield
Canaan
Burnham
(Burnham Junction)
Clinton
Unity
Shawmut
Hinckley
Pishon Ferry
Waverly
Dogtown
Houston Corner
Twitchell Corner
Dodge Corner
Reynolds Corner
Winnecook
Nash Corner
Phillips Corner
Emerson Corner
Tilton Corner
Mosher Corner
Weeks Corner
Manson Corner
Thompson Corner
Mitchell Corner
Gould Corner
Carson Corner
Morrison Corner
Goodwin Corner
Nyes Corner
Sanborn Corner
Miller Corner
Stafford Hill
Burrill Hill
Huff Hill
Goodwin Hill
Chase Hill
Loomis Hill
Whittemore Hill
Foster Hill
Jewell Hill
Nelson Hill
Furbush Hill
Negro Hill
Lang Hill
Palmer Hill
Wilcox Hill
Town House Hill
Eaton Mtn
Juniper Bog
Bog Pond
Mud Pond
Stafford Pond
Starbird Pond
Lake George
Sibley Pond
Round Pd
Oaks Pd
Whites Pond
Hicks Pd
Douglas Pond
UNITY POND
HARTLAND
CANAAN
PALMYRA
PITTSFIELD
CLINTON
UNITY
SEBASTICOOK
RIVER
SOMERSET
KENNEBEC
WALDO
COUNTY
Maine Central Inst
Pittsfield Municipal
Exit 38
Exit 37
A
B
C
D
NEWPORT
DETROIT
Continue on Map 22