The State of New Hampshire

Department of Environmental Services

Michael P. Nolin
Commissioner

May 16, 2006

APPROVED G & C
DATE 21Jun06
ITEM # 9E

The Honorable Frederick W. King, Chairman
Fiscal Committee of the General Court
State House
Concord, NH 03301

His Excellency, Governor John H. Lynch
and The Honorable Council
State House
Concord, NH 03301

APPROVED
FISCAL COMMITTEE
DATE 7Jun06
ITEM # FIS 06-157

REQUESTED ACTION

1. Pursuant to RSA 14:30-a, VI, authorize the Department of Environmental Services (DES) to accept and expend $560,000 in funds from the Department of Transportation (DOT) to carry out water quality studies relative to the I-93 expansion, effective upon Governor and Council approval through June 30, 2007. (100% Other funds.)

Funding is to be budgeted as follows:

I-93 Chloride TMDLs
010-044-1522
FY06

Class	Description	Current Budget	Requested Action	Adjusted Budget
Income				
001	Transfer from DOT	$0.00	($560,000.00)	($560,000.00)
Expenditures				
018	Overtime	$0.00	$10,000.00	$10,000.00
020	Current Expenses	$0.00	$20,183.00	$20,183.00
030	Equipment	$0.00	$133,050.00	$133,050.00
042	Add'l Fringe Benefits	$0.00	$8,306.00	$8,306.00
049	Transfers to State Agencies	$0.00	$17,445.00	$17,445.00
050	Part-time Temp	$0.00	$127,523.00	$127,523.00
060	Benefits	$0.00	$60,510.00	$60,510.00
070	In-State Travel	$0.00	$2,983.00	$2,983.00
090	Water Quality Studies	$0.00	$180,000.00	$180,000.00
Total		$0.00	$560,000.00	$560,000.00

P.O. Box 95, 29 Hazen Drive, Concord, New Hampshire 03302-0095
Telephone: (603) 271-2457 • Fax: (603) 271-7894 • TDD Access: Relay NH 1-800-735-2964
DES Web site: **www.des.nh.gov**

2. Authorize DES and DOT to enter into a Memorandum of Agreement for $560,000 for water quality studies or the protection of water bodies in the vicinity of the I-93 corridor from Massachusetts to Manchester, NH, effective upon Governor and Council approval through June 30, 2016. (80% Federal funds, 20% Highway funds.)

Funding is available in account Consolidated Federal as follows:

		FY2006
015-096-3054-090-0415	Consolidated Federal Aid	$560,000

EXPLANATION

DES and DOT are working cooperatively to assess how deicing of the Interstate 93 between Salem and Manchester and other roads and infrastructure affect the water quality in streams in the area. The occurrence of chloride above acute and chronic water-quality criteria for the protection of aquatic life has been found in some streams in drainage areas through which I-93 passes. DES and DOT are determining the extent of these water quality issues in the region and developing potential actions to reduce chloride levels affecting local stream quality.

DES and DOT have developed a Memorandum of Agreement outlining the roles and responsibilities for completing water quality studies to determine the total maximum daily load (TMDL) of chlorides for the affected water bodies. The TMDL for a water body is the maximum chloride load that the water body can assimilate without violating water quality standards. DES and DOT will work cooperatively to conduct and implement TMDL studies for chlorides on Policy Brook and Unnamed Tributary to Policy Brook (NHRIV700061102-18), Unnamed Brook to Western Embayment of Canobie Lake (NHRIV700061102-23), Dinsmore Brook (NHRIV700061204-01), and Beaver Brook (NHRIV700061203-16). DES will be the lead agency for conducting TMDL studies. DES and DOT will work together on communicating TMDL issues and results to stakeholders. During the conduct of TMDLs and the implementation of chloride load allocations, DES and DOT will hold regular, staff-level coordination meetings on at least a quarterly basis.

The Memorandum of Agreement between DES and DOT has been approved by the Office of the Attorney General as to form, execution, and content.

The total cost associated with the Memorandum of Agreement between DES and DOT is $560,000. The source of funding for the Memorandum of Agreement is the Federal Highway Administration funds from the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU). SAFETEA-LU authorizes the Federal surface transportation programs for highways, highway safety, and transit for the 5-year period 2005-2009. The allocation of SAFETEA-LU funds for this project ($560,000) is part of specifically designated funds for I-93 Water Quality Studies. No funds are being budgeted for class 040, Indirect, or class 41, Audit, because DOT already pays the indirect and audit costs associated with this grant. In the event that Federal funds become no longer available, General Funds will not be requested to support this program.

Specifically, the monies will be used as follows:

1522, Class 050 The additional amount of $127,523 in class 050, Personal Services-Temporary, will not be used for new positions. These funds are available in support of an expanded or new program beyond the original budget scope. Employee support from other Department of Environmental Services organizational units will be utilized to administer this program. These funds will be used to supplant funding of the following positions, which are currently budgeted:

Position #	Title	Budget	Funding Mix	Amount
18556	Administrator IV	100% Federal	010-7602-010	$14,000
16797	Sanitary Engineer III	100% Federal	010-7602-010	26,000
19723	Environmentalist IV	100% Federal	010-2020-010	20,523
42163	Environmentalist IV	100% Federal	010-7602-010	20,800
42164	Environmentalist IV	100% Federal	010-7602-010	12,750
42162	Environmentalist III	100% Federal	010-7602-010	7,050
41638	Outdoor Ed Prog Coord	100% General	010-1000-010	3,000
42155	Environmentalist IV	100% Federal	010-7602-010	5,000
42160	Hydrogeologist III	100% Federal	010-7602-010	5,200
41643	Business Systems Analyst I	100% Federal	010-7602-010	5,200
42174	Planning Analyst	100% Federal	010-7602-010	4,000
42177	Environmentalist III	100% Federal	010-7602-010	4,000

1522, Class 018 To cover the costs of overtime pay for the positions listed above.

1522, Class 020 To cover the costs of current expenses such as supplies, printing and copying.

1522, Class 030 To cover the costs of equipment purchases for the project; specifically two personal computers, four communications cables, 19 data-loggers, four multi-parameter display systems, and three ISCO automated remote samplers.

1522, Class 042 To cover the cost of additional fringe benefits for the positions listed above.

1522, Class 049 To cover the costs of laboratory expenses for water quality sampling.

1522, Class 060 To cover the cost of benefits for the positions listed above.

1522, Class 070 To cover the cost of in-state travel for sampling and field monitoring activities.

1522, Class 090 To cover the cost of contractual expenses for stream flow monitoring, salt application rate research, and other water quality studies.

We respectfully request your approval.

Michael P. Nolin, Commissioner
Department of Environmental Services

Carol A. Murray, Commissioner
Department of Transportation

Memorandum of Agreement
between
New Hampshire Department of Transportation
and
New Hampshire Department of Environmental Services
relative to
The Development and Implementation of Total Maximum Daily Loads for Chloride And Other Activities for Water Quality Protection on Waterbodies in the vicinity of the I-93 Corridor from Massachusetts to Manchester

WHEREAS, The New Hampshire Department of Transportation (DOT) intends to construct and operate an expansion of Interstate 93 from the Massachusetts border to the intersection of I-93 and I-293 in Manchester (the Activity); and

WHEREAS, the Activity requires a federal Dredge and Fill permit under section 404 of the Clean Water Act (the Act), and also a certification by the New Hampshire Department of Environmental Services (DES) under Section 401 of the Act that neither construction nor operation of the activity will cause or contribute to violation of state water quality standards; and

WHEREAS, the Activity will discharge stormwater containing chloride from winter road maintenance to four waterbodies that are presently impaired for chronic chloride toxicity to aquatic life and listed on the list of waters requiring a Total Maximum Daily Load (TMDL) under Section 303(d) of the Act: Policy Brook and Unnamed Tributary to Policy Brook (NHRIV700061102-18); Unnamed Tributary to Western Embayment of Canobie Lake[1] (NHRIV700061102-23); Dinsmore Brook (NHRIV700061204-01); and Beaver Brook (NHRIV700061203-16); and

WHEREAS, DES has issued a water quality certification under Section 401 of the Act that requires DOT to discharge no additional chloride loads to impaired waterbodies from the date of issuance of the 401 certification until the TMDLs are completed and implemented and further requires DOT to implement the chloride load allocations of completed TMDLs for DOT-operated highways; and

WHEREAS, chloride loads to the impaired waterbodies originate from several sources, including winter maintenance of state and municipal highways, private roads and parking lots, as well as atmospheric deposition and domestic water softening brine discharges to groundwater; and

WHEREAS, DES and DOT have agreed in principle to share the effort to conduct and implement the required TMDLs and to expeditiously complete the TMDL studies and associated outreach to stakeholders so that solutions are explored during the design and construction of the Activity;

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[1] Formerly referred to as: "North Tributary to Canobie Lake".

NOW, THEREFORE, DES and DOT agree as follows:

I. MATTERS RELATED TO CONDUCT OF TMDLs

1) DES and DOT will work cooperatively to conduct and implement TMDLs for chlorides on Policy Brook and Unnamed Tributary to Policy Brook (NHRIV700061102-18); Unnamed Brook to Western Embayment of Canobie Lake (NHRIV700061102-23); Dinsmore Brook (NHRIV700061204-01); and Beaver Brook (NHRIV700061203-16).
2) DES will be the lead agency for conducting TMDL studies.
3) DES and DOT will work together on communicating TMDL issues and results to stakeholders.
4) During the conduct of TMDLs and the implementation of chloride load allocations, DES and DOT will hold regular, staff-level coordination meetings, no less often than quarterly.
5) DOT will provide $560,000 of high priority SAFETEA-LU funds to DES for conducting the TMDL studies. These funds have been specifically designated for I-93 Water Quality Studies.
    a. Based on preliminary estimates in **Attachment 1**, the total cost is approximately $560,000. This estimate does not include implementation.
    b. Each agency will maintain a cost accounting system for the TMDLs.
    c. DOT will retain responsibility for ensuring compliance with all applicable federal requirements regarding the use of these earmarked funds.
    d. In-kind services from both agencies will be included in cost accounting.
    e. The agreement will take effect upon approval by the Governor and Council.
    f. DES will submit a quarterly report to DOT at least two weeks in advance of the meetings provided in 4) above. The reports will include an update on the progress of TMDL studies and will identify any project delays or other issues that might affect TMDL completion.
    g. DES will submit to DOT a quarterly voucher of TMDL expenditures at least two weeks in advance of the meetings provided in 4) above. The vouchers will serve as the basis for the transfer of funds designated in d. above from DOT to DES.
6) If federal funds are not available under SAFTEA, DES will stop work on the TMDLs, and DOT will stop work on construction of the I-93 improvements until alternative funding is secured to complete the TMDLs and this agreement is modified accordingly.
7) DES will coordinate with EPA, keep the EPA regional TMDL coordinator apprised of TMDL progress, expeditiously submit the completed TMDLs to EPA for approval and execute other measures required by rule or law to obtain EPA approval of the TMDLs.

8) DES will be the lead agency for data management, and will maintain all environmental data related to the 401 water quality certification, the TMDL studies, and TMDL implementation in the statewide Environmental Monitoring Database administered by DES.

9) DES and DOT will collaborate on communication and outreach for implementation of TMDL load allocations.

10) The Commissioners of DOT and DES are mutually committed to completion and implementation of chloride TMDLs before operation of additional lanes of the Activity. To that end, both DES and DOT shall assign adequate staff to TMDL work to meet the milestones in **Attachment 2** in relation to construction and operation of the I-93 improvements. In the event that a milestone is not met, DES and DOT shall meet within two weeks to negotiate a revised schedule and a level of staffing and effort to meet the revised schedule. The Commissioners shall approve the revised schedule and level of staffing and effort, and shall modify this agreement accordingly.

II. MATTERS RELATED TO INTERIM CONTROL OF CHLORIDE LOADING ON I-93

1) DOT has supplied winter salt application rate data for I-93 in the vicinity of the improvements, and DES has conducted a statistical regression analysis of the data (**Attachment 3**). The analysis shows that there is a relationship between salt usage and the DOT winter severity index (WSI). This relationship can be used to determine the typical salt usage on I-93 during a winter based on records of temperature and snowfall.

2) DOT will apply deicers to State highways at rates that are at or below the application rates specified in the DOT Winter Maintenance Snow Removal and Ice Control Policy. Whenever possible, DOT will use new technologies to reduce the salt application rate while still maintaining public safety.

3) DOT will keep daily records of salt application amounts, salt application rates (in pounds per lane mile), the total number of spreader miles driven by salt spreaders, and the total mass of salt applied per lane mile for different roadway classes in the TMDL watersheds.

4) Cumulative salt application amounts for each winter shall not exceed the expected application amount based on the relationship between salt usage and the WSI. The method for determining compliance with this item is described in **Attachment 3**. DOT will provide to DES records of salt application for I-93 in the vicinity of the improvements by February 15 and April 15 of each year. DES will compare the salt application amounts to the predicted amounts. If application amounts exceed the expected application amounts, DOT shall evaluate the circumstances and confer with DES on salt application reductions for the remainder of the winter, and at the end of the winter DOT shall submit a salt management plan addressing application reduction strategies for future winters.

5) DOT will keep data records of weather conditions in the vicinity of the improvements during the winter road maintenance season, from November 1 to March 31. Weather data will be generated by the Road Weather Information System operated by DOT.

III. MATTERS RELATED TO INCREMENTAL IMPLEMENTATION OF I-93 IMPROVEMENTS IN RELATION TO TMDL STUDY COMPLETION AND IMPLEMENTATION OF CHLORIDE LOAD REDUCTIONS.

1) DOT agrees to incremental implementation of the project, as provided in the last paragraph of Section 1.3 of the Federal Highway Administration Record of Decision, in the event that TMDLs and TMDL implementation plans are not completed, approved by EPA, and established with full implementation of chloride load reductions for the I-93 improvements and other roads operated by the Applicant. Full implementation of chloride load reductions means load reductions have already been achieved. Incremental implementation of the project means paving and operating only three lanes of the improved I-93 roadway in each direction until all chloride load reductions specified in the TMDL implementation plans are achieved for roads operated by DOT in the TMDL watersheds.

IV. MATTERS RELATED TO COMMUNICATION WITH STAKEHOLDERS

1) Within three months of the date of this agreement, DES shall notify the towns of Salem, Windham, Derry, Londonderry, Auburn, and Chester of the requirement for no additional chloride loading in TMDL watersheds until TMDLs are completed and chloride load reductions in accordance with the TMDL implementation plan after TMDL completion.
2) DOT and DES will establish and assign co-chairpersons to an interagency Salt Reduction Work Group. The purpose of the work group will be to advise DES and DOT on the TMDL study and implementation plan until these are complete, and to advise and then to assist with implementation of required salt load reductions. In addition to the chairpersons, the work group may include a representative from:
    a. DOT
    b. EPA
    c. The selectmen's office of each town with area in a TMDL watershed: Salem, Windham, Derry, Londonderry, Auburn, and Chester
    d. The public works department of each town with area in a TMDL watershed: Salem, Windham, Derry, Londonderry, Auburn, and Chester
    e. University of New Hampshire T2 Program
    f. A private winter road and parking lot maintenance company doing business in Derry
    g. A private winter road and parking lot maintenance company doing business in Salem.
    h. Southern New Hampshire Regional Planning Commission
    i. Nashua Regional Planning Commission
    j. Rockingham Planning Commission

3) In calendar year 2007, DOT will work with DES, EPA, and the Salt Reduction Work Group to design and implement a comprehensive outreach, education, and hands-on technical assistance program to all corridor communities.

4) DES and DOT will convene the Winter Road Salt Reduction Work Group at least twice during the conduct of TMDL studies, and three times during preparation of the implementation plan.

5) Earmarked high priority funds remaining following completion of the TMDL studies will be used to facilitate the load allocation and implementation recommendations of the TMDL and to mitigate locally caused sodium chloride impacts.

V. MATTERS RELATED TO IMPLEMENTATION OF TMDL LOAD ALLOCATIONS

1) DES shall be the lead agency for tracking salt loadings and chloride concentrations in TMDL watersheds.

2) DES shall be the lead agency for tracking the success of TMDL implementation and for enforcement of TMDL load allocations.

3) DES and DOT shall cooperate on obtaining long-term funding, first from federal sources, and second from state sources, for staff and monitoring required for effective TMDL implementation.

IN WITNESS WHEREOF, the respective parties have hereunto set their hands on the dates indicated.

Date 4/26/06

Carol A. Murray, Commissioner
Department of Transportation

Date 04 26 06

Michael P. Nolin, Commissioner
Department of Environmental Services

Reviewed and approved as to form, substance and Execution
5/10/06
Assistant Attorney General

SECRETARY OF STATE

I hereby certify that the foregoing contract was approved by the Governor and Executive Council of the State of New Hampshire at their meeting on _____

Signed

Chloride TMDL - Estimated Budget for Empirical Approach
Prepared 10/20/05

		FFY2005	FFY2006				FFY2007				FFY2008				FFY2009				
		Qtr 4	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Qtr 1			Total per Task	Percent of Total
		SFY2006				SFY2007				SFY2008				SFY2009					
Class	Task	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Qtr 1	Qtr 2	Justification			
Personnel	Water Softener Survey	$0														See Note 1		$0	0%
Personnel	Develop MOA between DES and DOT		$0													See Note 2		$0	0%
Personnel	Prepare Scope of Work and manage stakeholder review			$3,270												See Note 3		$3,270	1%
Personnel	Prepare QAPP and manage stakeholder review				$7,083											See Note 4		$7,083	1%
Contractual	Install and operate 5 temporary stream gages					$24,600	$18,600	$18,600	$18,600	$18,600	$18,600					See Note 5		$117,600	23%
Personnel/Lab	Monitor water quality at gages and other stations					$150,350	$20,350	$20,350	$20,350	$20,350	$20,350					See Note 6		$252,100	50%
Personnel/Lab	Stormwater Outfall/Salt Pile Inventory and Runoff Monitoring					$5,310	$5,310	$5,310	$5,310							See Note 7		$21,240	4%
Personnel	Data management					$1,770	$1,770	$1,770	$1,770	$1,770	$1,770					See Note 8		$10,620	2%
Personnel	GIS support					$1,770	$1,770	$1,770	$1,770	$1,770	$1,770					See Note 9		$10,620	2%
Personnel	TMDL Preparation									$10,625	$10,625	$21,250	$21,250			See Note 10		$63,750	13%
Personnel	Public Participation													$10,625	$10,625	See Note 11		$21,250	4%
	Quarterly Totals	**$0**	**$0**	**$3,270**	**$7,083**	**$183,800**	**$47,800**	**$47,800**	**$47,800**	**$53,115**	**$53,115**	**$21,250**	**$21,250**	**$10,625**	**$10,625**			**$507,533**	100%

Project Total	**$507,533**
Extra for Unexpected Contingencies	**$52,467**
Grand Total	**$560,000**

Notes

1 Task will be completed by NEIWPCC intern in 2005
2 Task will be completed by DES before funds transfer.
3 2 weeks of work in one quarter by 1 FTE (17% of time)
4 4 weeks of work in one quarter by 1 FTE (33% of time)
5 USGS quote. For each gage, there will be $1000 in materials costs plus $12,400 in annual O&M expenses. 6 gages are needed.
6 See separate monitoring budget. Equipment cost charged to SFY2006, 4th quarter, and o/m cost amortized across six quarters
7 3 weeks of work per quarter for 1 FTE (25% of time)
8 1 week of work per quarter for 1 FTE (8% of time)
9 1 week of work per quarter for 1 FTE (8% of time)
10 6 weeks of work per quarter by 1 FTE for Qtr 1 and 2 (50% of time); 12 weeks of work per quarter by 1 FTE for Qtr 3 and 4 (100% of time)
11 6 weeks of work per quarter by 1 FTE (50% of time)
* All salaries estimated to be $50,000 per year multiplied by 1.7 to account for benefits.

I-93 CHLORIDE TMDLs FIELD SAMPLING COST ESTIMATE [1,2,3] FOR SPECIFIC CONDUCTIVITY AND CHLORIDE MEASUREMENTS

ITEM	Unit	Qty / Sta	No. Stations	No. Visits[4]	Total	Unit	Units Needed	Cost / Unit	Total Cost
Period: 12/1 - 3/15 in 2006 and 2007 (30 weeks) and 6/1 - 9/30 in 2006 (~ 18 weeks)									
100 µS/cm calibration standard[5]	milliliter	80	22	16	28,160	4,000	7	$55.00	$387
2,000 µS/cm calibration standard6	milliliter	80	22	16	28,160	4,000	7	$55.00	$387
Kimwipes®	sheet	5	22	16	1,760	280	6	$2.69	$17
AA batteries[7]	battery	4	22	16	1,408	4	352	$3.00	$1,056
C batteries[8]	battery	8	22	16	2,816	8	352	$4.00	$1,408
Communication cable	cable						2	$250.00	$500
Datalogger Repair[9]	repair						3	$300.00	$900
Datalogger[10]	datalogger	1	22		20		20	$6,500.00	$130,000
Mileage [11]	mile	300	1	16	4,800	1	4,800	$0.485	$2,328
Labor (field)[12,13]	hour	3	22	16	1,056	1	1,056	$45.00	$47,520
Labor (field prep and data processing)	hour	1.5	22	16	528	1	528	$45.00	$23,760
Laboratory analysis (Cl samples)	sample	1	22	16	352	1	352	$10.00	$3,520
Laboratory analysis (dup and blank samples)[14]	sample				35	1	35	$10.00	$350
SUBTOTAL									**$212,133**
Period: 3/16 - 5/31 in 2006 and 2007 (22 weeks) and 10/1 - 11/30 in 2006 (5 weeks)									
100 µS/cm calibration standard[5]	milliliter	80	6	9	4,320	4,000	1	$55.00	$59
2,000 µS/cm calibration standard6	milliliter	80	6	9	4,320	4,000	1	$55.00	$59
Kimwipes®	sheet	5	6	9	270	280	1	$2.69	$3
AA batteries[7]	battery	4	6	9	216	4	54	$3.00	$162
C batteries[8]	battery	8	6	9	432	8	54	$4.00	$216
Communication cable	cable						0	$250.00	$0
Datalogger Repair[9]	repair						0	$300.00	$0
Datalogger[10]	datalogger	1	6		6		0	$6,500.00	$0
Mileage [11]	mile	150	1	9	1,350	1	1,350	$0.485	$655
Labor (field)[12,13]	hour	2.5	6	9	135	1	135	$45.00	$6,075
Labor (field prep and data processing)	hour	1.5	6	9	81	1	81	$45.00	$3,645
Laboratory analysis (Cl samples)	sample	1	6	9	54	1	54	$10.00	$540
Laboratory analysis (dup and blank samples)[14]	sample	1	6		5	1	5	$10.00	$50
SUBTOTAL									**$11,464**
TOTAL									**$223,597**

ASSUMPTIONS

[1] Five impaired AUs - 6 impaired waterbodies plus 4 additional stations per waterbody = 6+ 4x6 = 30 stations

[2] Three sampling stations/waterbody

[3] Labor estimates are based on DES rates. Staff from NHDOT and EPA will be needed to assist with sampling.

[4] One visit/station/3 weeks

[5] Repeat use at up to four stations, depending on biofouling

[6] Reuse at multiple stations

[7] Two YSI 30 hand held units with one complete battery change per unit during study period

[8] One datalogger/station and complete battery change per visit

[9] Three sonde repairs @$300 each

[10] A total of 20 dataloggers are needed. DES has 4 available dataloggers and the estimate assumes EPA and DOT will contribute an additional 6 dataloggers.

[11] Includes mileage from Concord to first station and from last station to Concord

[12] Hourly rate = $26.00 x 1.7 = $44.20, say $45/hr.

[13] Qty /sta for 30 stations assumes 2 teams x 2 staff / team x 30 stations / 10 stations / day x 7.5 hours/day / 30 stations
Qty /sta for 6 stations assumes 1 team x 2 staff / team x 6 stations / 6 stations / day x 7.5 hours/day / 6 stations

[14] 10% sample frequency

ATTACHMENT 2 to DES & DOT MOA on Chloride TMDLs

PROJECT SCHEDULE TIMELINE

Activity	Dates (MM/DD/YYYY)		Product
	Anticipated Date(s) of Initiation	Anticipated Date(s) of Completion	
Quality Assurance Project Plan (QAPP) Preparation	1/1/06	6/30/06	QAPP Document
Install streamgages for Chloride Impairment Characterization Monitoring	4/1/06	6/30/06	4 stream gages installed
Chloride Source Identification Monitoring	7/1/06	6/30/07	Database of specific conductance at various locations in the TMDL watersheds.
Chloride Impairment Characterization Monitoring	7/1/06	6/30/07	Database of near continuous specific conductance and flow at 4 stations.
Chloride Loading Rate Research	7/1/06	6/30/07	Database of road salt application by state, municipal and private entities.
Draft TMDL Report preparation	7/1/07	9/30/07	Draft report available for public comment. The draft report will not have an implementation plan.
Implementation Plan Development	10/1/07	9/30/08	Implementation plan to achieve the TMDL loadings which is approved by all parties
Final TMDL report preparation	10/1/07	9/30/08	Final TMDL report with implementation plan
TMDL Implementation Monitoring	7/1/07	6/30/16	Trends will be evaluated after 7/1/11
Regional Chloride Surveillance Monitoring	7/1/07	6/30/16	Trends will be evaluated after 7/1/11

(attachment 3 to DES & DOT MOA on Chloride TMDLs)

State of New Hampshire

Inter-Department Communication

Date: January 4, 2006

From: Phil Trowbridge

At (Office): Environmental Services
Watershed Management

Subject: Relationship between salt usage on I-93 and weather severity index (WSI)

To: Gregg Comstock, Supervisor, Water Quality Planning Section
Paul Currier, Administrator, Watershed Management Bureau

Purpose

To identify the best, statistically significant relationship between salt usage for deicing on the I-93 roadway between Manchester and Salem and winter weather.

Data Sources and Methods

Data on salt usage was taken from weekly Salt and Sand Reports from NH Department of Transportation (DOT), District 5, Patrol M528, for fiscal years 1993 through 2005. These reports contain the amount of salt used by the patrol during each week between November through April for each winter. For each winter, I looked at two aggregate measures of salt usage: Salt usage by January 31 and salt usage for the entire winter season. For both measures, I used the values in the "Salt Used to Date" field of the weekly reports. DOT maintenance staff have confirmed that this field contains the most accurate information on salt usage. For the salt usage by January 31, I extracted the "Salt Used to Date" value from weekly report # 12 for each winter because report #12 always occurs at the end of January or beginning of February. For the total salt usage for the whole winter, I used the "Salt Used to Date" value from the last weekly report for the winter.

The lane miles assigned to the M528 patrol only varied between 109 and 113 lane miles during the 1993 to 2005 period. Therefore, salt usage per lane mile was almost perfectly correlated with total salt usage and was not an independent variable. For the purposes of this analysis, total salt usage was used to represent salt loadings to the roadway.

Weather data for Concord NH were provided by Dr. David Brown, NH State Climatologist, and Jim Mansfield from the National Weather Service in Gray, Maine. The Concord NH station is the closest weather station to the study area with high quality daily data on temperature, snowfall, and precipitation (liquid equivalent). The weather data are available at:
http://www.erh.noaa.gov/er/gyx/climate_f6.shtml

The weather data were aggregated for each year using a Winter Severity Index (WSI), which was developed by the State of Washington (SHRP, 1993). Daily minimum and maximum temperatures and snowfall from the Concord weather station were input to the model for

November through March of each winter. The model calculated a WSI value for each month. The average WSI for the winter was calculated as the average of the WSI for the five months.

Linear regression was used to identify significant relationships between annual salt usage and the WSI. Variables were considered significant if their coefficients were statistically significant at the $p<0.05$ level.

Results and Discussion

The salt usage on I-93 for FY1993 through FY2005 is summarized in
The relationship between salt usage and the WSI for each year generally followed a linear model (Figure 1). The only year with data that did not fit the model well was FY1999. In this year, almost 800 tons more salt were applied to the road surface than would have been expected based on the linear model. The anomalous results from FY1999 caused the residuals of the linear regression to be skewed and heteroscedastic. In order to correct this problem, the results from FY1999 were removed from the dataset and the regression was redone (Figure 2). The resulting model was excellent. The linear relationship accounted for 97% of the variance in the salt usage variable. The regression had a standard error of 146 tons.

It is important to note that the model reflects salt usage for DOT's winter road maintenance policies in FY1993 through FY2005. Starting in FY2006, DOT will be using newer methods to reduce salt usage on I-93. Therefore, the model predicts the salt usage that would have occurred had DOT continued its former practices.

Proposed Applications of the Model

Application 1

The model could be used to predict what the salt usage in FY2006 and future years would have been if DOT had continued its former road maintenance policies. These predictions could be compared to the actual salt usage in FY2006 and future years to determine if the new road maintenance policies have caused salt usage to decrease, increase or stay the same compared to the old policies. The specific steps for this comparison would be:

1. For each year, calculate the average WSI for November through March using data from the Concord weather station.

2. Predict the salt usage for the year using the following equation:

Salt Usage = -95.3*WSI + 670.

3. Estimate the 95th percentile confidence interval for the prediction using the equation from Helsel and Hirsh (1992):

$$CI = t \cdot s \sqrt{1 + \frac{1}{n} + \frac{(WSI_o - WSI_{ave})^2}{SS_x}}$$

where
CI is the 95th percentile confidence interval for the prediction
t is the value of the t distribution for 10 degrees of freedom: 2.22
s is the standard error of the regression: 146 tons/year

n is the number of data pairs in the regression: 12
WSI_o is the WSI for the year for which the prediction is being made
WSI_{ave} is the average WSI values in the regression: -21.93
SS_x is the sum of squares of the WSI values in the regression: 679.8

Note: The 95th percentile confidence interval will be between 337 and 370 tons per year depending on the value of WSI_o.

4. Calculate the upper and lower confidence limits of the prediction by adding or subtracting the confidence interval to or from the prediction

5. Compare the upper and lower 95th percentile confidence limits of the prediction to the actual salt usage. Determine if the salt usage has decreased, increased or stayed the same relative to the former road maintenance policies using the following decision rule.

- If the actual salt usage is less than the lower confidence limit of the prediction, then the new road maintenance practices have reduced the salt usage compared to the old practices.
- If the actual salt usage is greater than the lower confidence limit of the prediction but lower than the upper confidence limit of the prediction, then the new road maintenance practices have not resulted in a change in the salt usage compared to the old practices.
- If the actual salt usage is greater than the upper confidence limit of the prediction, then the new road maintenance practices have increased the salt usage compared to the old practices.

Note: This decision rule is a one-sample, two-tailed t-test with $p<0.05$ as the level of significance.

Application 2

Another application of the model would be for a mid-winter check of salt usage. The purpose of this check would be to provide managers with advance warning if the salt usage was on track to exceed the predicted usage based on the WSI as described above. This check would be performed in early February of each year. The specific steps for this analysis would be:

1. For each year, calculate the average WSI for November through January using data from the Concord weather station.

2. Estimate the average WSI for the winter using the WSI values for November, December and January from Step 1 and the average WSI values for February and March from FY1993-FY2005 (-26.66 and -24.89, respectively, from Table 2).

3. Predict the salt usage for the year using the following equation:

Salt Usage = -95.3*WSI + 670.

4. Compare the actual salt usage to date from the weekly Salt and Sand Report #12 to the predicted total salt usage for the winter. Determine if the actual salt usage is on track relative to the former road maintenance policies using the following decision rule.

- If the actual salt usage is less than or equal to 75% of the prediction, then the new road maintenance practices are on track to be equal to or less than the salt usage compared to the old practices.
- If the actual salt usage is greater than 75% of the prediction, then the new road maintenance practices are on track to increase the salt usage compared to the old practices.

*Note: The 75% threshold in this decision rule is based on the salt usage data from FY1993 through FY2005 (**Error! Not a valid bookmark self-reference.**). On average, 60% of the total salt usage for the year has occurred by January 31. The standard deviation of this percentage was 9.5%. Therefore, assuming normality and a sample size of 12, the percentage of total salt usage by January 31 should be less than 73% for 90 percent of the cases. The threshold was rounded to 75%. This decision rule is a one-sample, one-tailed t-test with $p<0.10$ as the level of significance. Uncertainty in the predicted WSI and salt usage is not accounted for in this test.*

References

Helsel DR and Hirsch RM (1992) Statistical Methods in Water Resources. Elsevier, Amsterdam. 522 p.

SHRP (1993) Road Weather Information Systems. Volume 1: Research Report. SHRP-H-350. Strategic Highway Research Program, National Research Council, Washington DC. 219 pp. Available at: http://gulliver.trb.org/publications/shrp/SHRP-H-350.pdf (Accessed January 12, 2006).

Table 1. The WSI values for each month and the annual average are shown on Table 2. Linear regression of the WSI versus salt usage produced statistically significant relationships. Statistics and graphs for different models are presented in Table 3, Figure 1 and Figure 2.

The relationship between salt usage and the WSI for each year generally followed a linear model (Figure 1). The only year with data that did not fit the model well was FY1999. In this year, almost 800 tons more salt were applied to the road surface than would have been expected based on the linear model. The anomalous results from FY1999 caused the residuals of the linear regression to be skewed and heteroscedastic. In order to correct this problem, the results from FY1999 were removed from the dataset and the regression was redone (Figure 2). The resulting model was excellent. The linear relationship accounted for 97% of the variance in the salt usage variable. The regression had a standard error of 146 tons.

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References

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Table 1: Salt Usage on I-93 for FY1993 through FY2005

Fiscal Year	Salt Usage by January 31 (tons)	Salt Usage for Entire Winter (tons)	Salt Usage by January 31 (percent of total)
1993	1445	3285	44%
1994	1685	3155	53%
1995	NA	1800	NA
1996	2300	4065	57%
1997	1815	2860	63%
1998	1990	2510	79%
1999	1830	2795	65%
2000	870	1805	48%
2001	1950	3275	60%
2002	1075	1510	71%
2003	1960	3180	62%
2004	1390	2425	57%
2005	1945	3235	60%
Average	1688	2762	60%
Std. Deviation	416	729	9.5%

Table 2: Monthly and annual average Winter Severity Index values based on the Concord, NH, weather station

FY	WSI_Nov	WSI_Dec	WSI-Jan	WSI_Feb	WSI-Mar	Ave WSI
1993	7.68	-23.91	-37.39	-43.28	-45.44	-28.47
1994	6.89	-20.04	-54.29	-33.73	-35.62	-27.36
1995	2.53	-5.75	-17.06	-36.52	4.57	-10.45
1996	-9.98	-47.78	-44.09	-30.47	-33.10	-33.09
1997	-1.56	-30.31	-31.87	-28.63	-34.63	-25.40
1998	-18.56	-30.71	-31.99	-2.76	-12.12	-19.23
1999	12.88	-9.99	-34.51	-5.45	-21.09	-11.64
2000	15.66	3.08	-32.76	-29.72	-23.41	-13.43
2001	14.12	-31.83	-29.66	-38.71	-50.84	-27.39
2002	15.04	-10.98	-28.42	-0.35	-21.00	-9.14
2003	-10.00	-33.04	-48.41	-38.77	-2.16	-26.48
2004	14.64	-46.49	-22.26	-16.41	-12.53	-16.61
2005	10.23	-15.65	-47.09	-41.81	-36.16	-26.10
Average	4.58	-23.34	-35.37	-26.66	-24.89	-21.14
Std Deviation	11.34	15.30	10.66	15.25	16.41	8.05

Table 3: Linear regression statistics

#	Dependent Variable	Independent Variable	R^2	Standard Error	Adjusted R^2	Comments
1	Salt Usage	WSI (all years)	0.854	292	0.840	See Figure 1
2	Salt Usage	WSI (all years except FY99)	0.967	146	0.963	See Figure 2

Notes:
(1) The relationships between salt usage and WSI are shown below:

Salt Usage = b1*WSI + b0

Model #1	Model #2
b1 = -83.7	b1 = -95.3
b0 = 987	b0 = 670

Figure 1: Relationship between total salt usage and WSI for FY1993 through FY2005

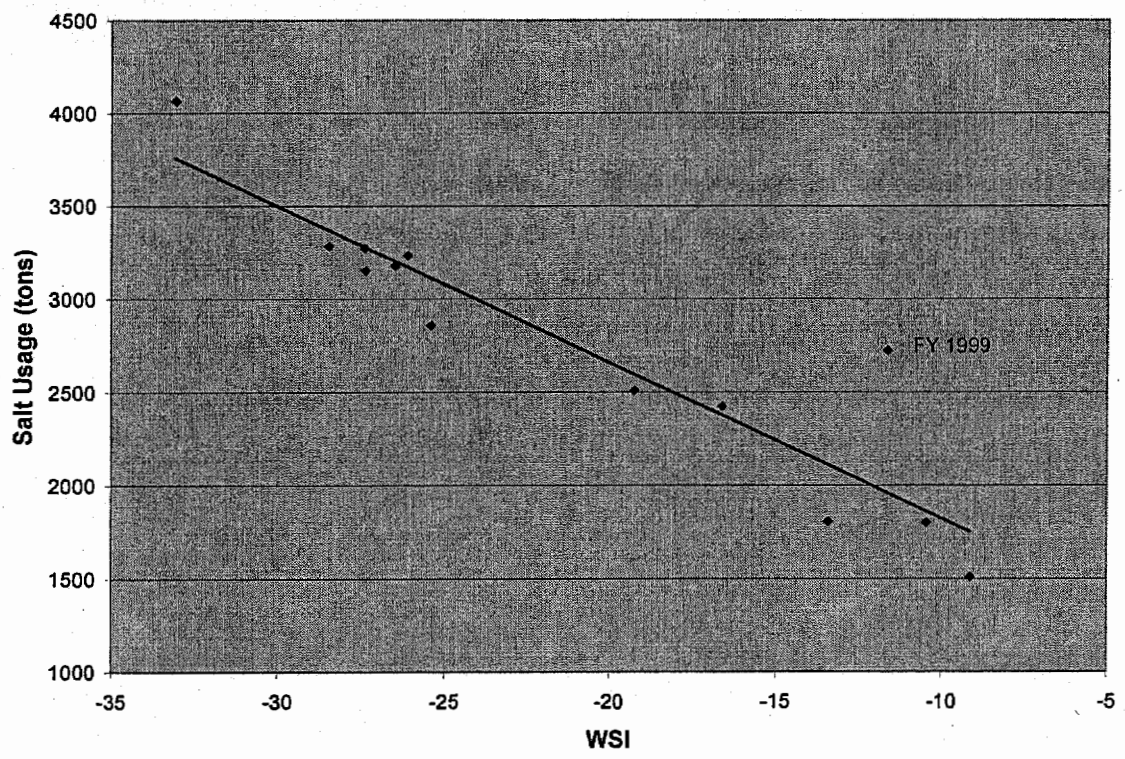

Figure 2: Relationship between total salt usage and WSI for FY1993 through FY2005 excluding FY1999