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A Financial Impact Assessment of LD 1725: Stream Crossings

New England Environmental Finance Center

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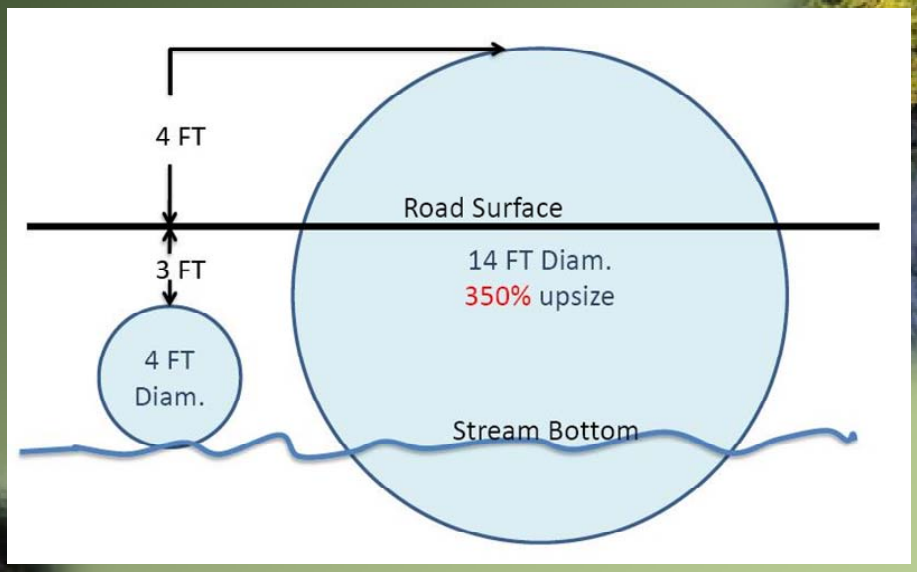

How much to upsize? Should we?

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ABSTRACT

This report looks at the potential financial impact of LD 1725 on the estimated 30,000 stream crossings in the State of Maine that would be affected by the law. Our research for this report included the analysis of nearly 2000 stream crossings and the data collection necessary for the development of extensive stream crossing replacement cost models. We found that the 1.2 bankfull requirements in LD 1725 would result in a 75% - 250% increase in structure widths for stream crossing projects across the state. An upsize of this magnitude would increase the cost of replacing stream crossings statewide by $230 - $474 million over the next twenty years. As written, LD 1725 does not provide the funding mechanisms to finance the substantial additional costs that municipalities and state agencies will face.

BACKGROUND

"LD 1725: Resolve, Regarding Legislative Review of Portions of Section 10: Stream Crossings within Chapter 305 Permit by Rule Standards, a Major Substantive Rule of the Department of Environmental Protection" was considered during the second regular session of the 124th Maine Legislature. The measure presented provisionally adopted rules by the Department of Environmental Protection (DEP). The rule as proposed modified Section 10, Stream Crossings, of Chapter 305, Permit by Rule, to define the "natural stream flow" provision included in two Natural Resources Protection Act (NRPA) exemptions during the prior legislative session. Exemption language required that a standard of "natural stream flow" be met when maintaining, repairing, or replacing an existing stream crossing.

The proposed rule specified that to maintain "natural stream flow" a crossing structure must be at least 1.2 times the natural bankfull width of the stream and include a natural stream bed (i.e., either an embedded or "bottomless" structure). If an existing crossing could not meet the 1.2 bankfull sizing through maintenance, rehabilitation, or replacement, it would not be eligible to be completed under the NRPA exemption and therefore would require permitting. Currently the rule language is in effect only for new structures because the Legislature remanded the discussion on its application to existing structures back to DEP for further stakeholder discussion and potential revision. As drafted, the 1.2 bankfull requirements in LD 1725 would result in a 75% - 250% increase in structure widths for stream crossing projects.

PURPOSE

The purpose of this document is to present a financial impact analysis of LD 1725 for stream crossing replacements in the state of Maine. This analysis was conducted by the New England Environmental Finance Center (EFC), in coordination with the Maine Department of Transportation (MaineDOT), DEP, and state, nongovernmental, and local stakeholders. All documentation supporting this analysis is publicly available and located on the EFC website (http://efc.muskie.usm.maine.edu/pages/tools.html).

METHODOLOGY

Stream Crossing Data

A complete assessment of the financial impact of LD 1725 statewide requires an accurate count of the stream crossings that would be affected by the new rule. Unfortunately, no single municipality or agency in the state of Maine maintains an accurate and complete inventory of stream crossings for their jurisdictions. Although a large amount of information for statewide stream crossings has been collected, the quality and content of the data varies tremendously. Of the data records available, a majority contain only basic information such as location and structure description, and lack any relevant data required to calculate the cost impact of LD 1725 (such as stream bankfull width or structure diameter.) Most of the data collected has been by towns, state agencies, consultants, environmental groups, and volunteers. These organizations often use incompatible measurement techniques that make comparative analysis of the data difficult.

In the absence of an accurate and complete dataset from which the physical characteristics and a total overall tally of roadway stream crossings for the state of Maine could be obtained we were forced to rely on a simple estimate. A widely accepted estimate for the total number of perennial stream crossing in the state of Maine stands at 35,000 with as many as 5,000 of these crossings possibly being exempted from the rule due to a variety of conditions including location on either U.S. Forest Service or private property. The actual number of stream crossings in the State of Maine is likely much higher than this because current estimates generally exclude intermittent and seasonal streams which likely number in the thousands. Lacking a scientifically derived total stream crossing count, we have assumed the total number of stream crossing which will be affected by LD1725 to be a very conservative 30,000.

The majority of these crossings were installed several decades ago using corrugated metal pipe, which has a relatively short service lifespan of 20 to 40 years, and as a result many of them will be requiring replacement in the immediate future. Previously, a failing structure or pipe has been replaced in-kind using an identically sized structure made of the most durable material on hand. However, during the intervening decades storm events that impact stream flow have increased in both frequency and intensity, and the hydrological methodologies for sizing culverts have changed in response. In addition, changes in land use have resulted in more impervious area and groomed landscapes, increasing rates and volumes of runoff previously attenuated by vegetation. Subsequently, many crossings that may have been adequately sized 20 or 30 years ago will likely require a substantial upsize when replaced to handle projected peak storm flows. Further challenges to the in-kind replacement process include environmental and habitat concerns mandating maintenance or restoration of natural stream flow as is prescribed in LD 1725 rule language.

DATA COLLECTION

Scope

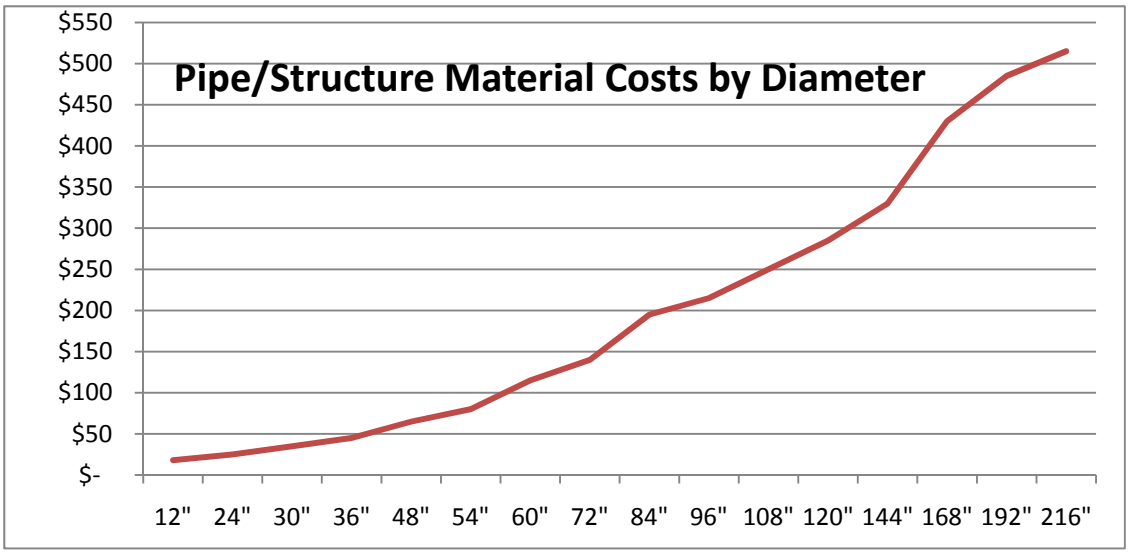
To quantify the statewide cost impact that will be incurred by complying with LD 1725 as currently written, analysis was conducted on the relationship between stream bankfull measurements and the width/diameter of nearly 2000 existing drainage structures found across the state of Maine. Although a sample size of 2000 represents just 5% of the estimated 30,000 crossings that would be affected by the rule statewide, the data was scientifically gathered from multiple watersheds both urban and rural. The collection methodology provides us with the level of accuracy required to make basic assumptions about the remaining 28,000+ crossings. The collected data was sorted and organized by structure width/diameter. The difference of diameter versus bankfull was calculated and expressed as the percentage required to achieve 1.2x bankfull width. To estimate the varying distribution of structure widths seen across the 30,000 stream crossings found in Maine, the distribution ratios observed in our sample population were extrapolated statewide. These relationships were distributed across four common size ranges, and can be found in Table 1.1 below:

Table 1.1

Average Distribution vs. Average Upsize Requirement		
Structure Size Range Distribution	Estimated # of Structures Statewide	AVG Upsize % to Achieve 1.2BF
0" - 47"	11,100	250%
48" - 84"	12,900	200%
85" - 120"	3,900	125%
>120"	2,100	70%

The data contained in Table 1.1 shows that smaller diameter structures (0" – 84") make up nearly 80% of all stream crossings statewide and that these smaller structures will require the greatest upsize (200% -250%) to achieve natural stream flow. In addition, the smaller structures also face the greatest per-foot cost impact due largely to the exponential price structure of pipe material (see Table 1.2 below*).* Market price data for pipe/structure material was obtained from regional material vendors and used to calculate an average price per foot (in 2010 dollars) for the most common pipe/structure diameters.

Table 1.2



For example: a 36"diameter pipe costing $45 per-foot would likely be subject to an average upsize of 233% which would require the use of a 120" diameter pipe at a price of $275 per-foot – a 500% increase in cost In comparison, a 96" diameter pipe costing $225 per-foot would be subject to an average upsize of 125% which requires using a 216" diameter pipe which costs $515 per-foot - just a little over 2x the cost.

COST LIMITATIONS

Variables

A series of cost estimate models similar in format to an engineer's estimate were developed in support of this assessment. In developing the models current material, labor and equipment costs for the region were used and a limited set of site condition variables were included. While the models provided some useful information about what the cost impact of LD 1725 would be to a typical culvert replacement in Maine, they were not able to handle the abundance of variables that could be present in a real world culvert replacement project. For example, construction costs for a rural culvert replacement versus a culvert replacement in an urban environment can vary by as much as 50% due to variables such as lane width, paving depth, traffic count and the presence of potentially conflicting under ground utilities that may be in the construction zone.

Construction cost variables excluded from the models include: site conditions, roadway characteristics (e.g. lane width, traffic level, etc), potential underground utility conflicts, stream or habitat improvements, engineering costs, inspection costs, bidding costs, administrative costs and finance costs. Maine's diverse geography and relatively unbalanced distribution of population and development precluded the use of a model-based construction cost estimate for evaluating the statewide financial impact that LD 1725 would have on the hundreds of towns and cities that replace thousands of culverts each year. Inclusion of all eligible construction cost variables, particularly those carrying a high

number of logistical variables, would significantly skew this study's cost data and result in an unacceptable increase to the margin of error[1]. Therefore, this financial impact assessment is limited to projecting the increase of pipe material purchase price in response to the diameter upsizing that will be required to achieve natural stream flow using the proposed 1.2x bankfull width as a measurement standard.

STATEWIDE COST IMPACT

Projected Total Pipe Material Costs

To obtain a projected total cost of replacing the estimated 30,000 stream crossings statewide, we have arranged the data that characterizes the relationship between existing crossing structure size and 1.2x bankfull width projections into four categories based upon pipe diameter ranges. Diameter size range distribution percentages that were observed in our sample population were extrapolated to calculate the total number of crossings per size range statewide. Total length of pipe per size range category was calculated by multiplying an average structure length of 40 linear feet by the total number of estimated crossings per size range category. Stream crossing replacements will occur incrementally on an annual basis spanning an assumed 20 year replacement window. Projected cost impacts as shown in Table 1.3 below depict the average difference in cost (cost increase) that will result from applying the average percentage upsize requirement to a given pipe/structure size range. The average cost difference (increase) is expressed as a per-foot cost, a per-pipe/structure cost (assuming 40ft. length) and a total statewide cost for each size range distribution. The resulting overall total average material cost difference of $344,760,000** represents costs to the project proponent for the purchase of pipe/structure materials required to upsize an estimated 30,000 crossings statewide to the 1.2x bankfull width. This figure is in addition to funding currently allocated for in-kind culvert replacements.

Table 1.3

Projected Cost Impact for Pipe Material to Achieve 1.2x Bankfull*						
Culvert Size Range Distribution	% of Structures Statewide	# of Structures Statewide	AVG Upsize % to Achieve 1.2BF	AVG Δ Material Cost per foot to Upsize	Total AVG Δ Material Cost to Upsize 40' L Culvert	Total Statewide AVG Δ Material Cost to Upsize 40' L Culvert
0" - 47"	37%	11,100	250%	$155	$6,200	$68,820,000
48" - 84"	43%	12,900	200%	$350	$14,000	$180,600,000
85" - 120"	13%	3,900	125%	$315	$12,600	$49,140,000
>120"	7%	2,100	70%	$550	$22,000	$46,200,000
				TOTAL AVG MATERIAL COST Δ		**$344,760,000****
**** assumes 30,000 culverts statewide with average culvert length of 40 ft.***						
***** costs are expressed in 2010 dollars using current material prices.***						

[1] The construction cost estimates are available on [http://efc.muskie.usm.maine.edu/pages/tools.html] for review and download.

It should also be pointed out again that the 30,000 crossings figure and the 40-foot length figure are only estimates and as such are variable. Note that even a minor addition or subtraction of value for either of these variables will result in a significant increase or decrease to the total average material cost. For example: decreasing the total number variable to 25,000 crossings and increasing the average length variable to 45 feet results in a **TOTAL AVG MATERIAL COST Δ** of $323,212,500 or a potential savings of over twenty one million dollars.

Tables 1.3a and 1.3b below represent the reasonable lower (N=20,000 and L=40 feet) and upper (N=30,000 and L=55 feet) bounds of the total estimated average material cost difference for culvert replacement under LD1725 in 2010 dollars. It is important to note that whatever the actual statewide cost (range according to these estimates is $230 - $474 million), costs will not accrue immediately but over the course of roughly 20 years when existing culverts are replaced. Nevertheless the annual financial requirements of the proposed rule change are substantial; how to fund them becomes the next question.

Table 1.3a

Assumes 20,000 Culverts to Replace Statewide
Assumes Avg Length of 40 FT

TOTAL #	Length
20000	40

Culvert Size Range Distribution	# of Culverts Statewide	AVG Upsize % to Achieve 1.2BF	AVG Δ Material Cost per foot to upsize	Total AVG Δ Material Cost to Upsize per Culvert	Total Statewide AVG Δ Material Cost to Upsize
0" - 47"	7400	250%	$ 155.00	$ 6,200.00	$ 45,880,000.00
48" - 84"	8600	200%	$ 350.00	$ 14,000.00	$ 120,400,000.00
85" - 120"	2600	125%	$ 315.00	$ 12,600.00	$ 32,760,000.00
>120"	1400	70%	$ 550.00	$ 22,000.00	$ 30,800,000.00
				TOTAL AVG MATERIAL COST Δ	**$ 229,840,000.00**

Table 1.3b

Assumes 30,000 Culverts to Replace Statewide
Assumes Avg Length of 55 FT

TOTAL #	Length
30000	55

Culvert Size Range Distribution	# of Culverts Statewide	AVG Upsize % to Achieve 1.2BF	AVG Δ Material Cost per foot to upsize	Total AVG Δ Material Cost to Upsize per Culvert	Total Statewide AVG Δ Material Cost to Upsize
0" - 47"	11100	250%	$ 155.00	$ 8,525.00	$ 94,627,500.00
48" - 84"	12900	200%	$ 350.00	$ 19,250.00	$ 248,325,000.00
85" - 120"	3900	125%	$ 315.00	$ 17,325.00	$ 67,567,500.00
>120"	2100	70%	$ 550.00	$ 30,250.00	$ 63,525,000.00
				TOTAL AVG MATERIAL COST Δ	**$ 474,045,000.00**

Material Pricing Caveats

1. A small but not insignificant number of the existing structures represented within the >120" distribution range are bridges which could be exempt from the upsizing requirements. The lack of reliable data on statewide bridge infrastructure has prevented us from accurately accounting for this possibility; therefore the figures for that size range category may be overstated by as much as 15%
2. An unknown number of existing crossings have been replaced within the last decade using HDPE pipe material. This pipe material has a service lifespan that places it outside of our 20 year replacement study.

Permitting

As previously discussed, the 1.2x bankfull requirement proposed in LD 1725 will result in crossing structure upsizing. This structure upsizing will impact the permitting process. First, as it currently stands the proposed language requires that all new and/or replacement crossing meet the 1.2x bankfull requirement. If a municipality or jurisdiction cannot meet this requirement for any reason, they will be required to apply for a permit. There are two distinct types of permits applicable to these crossings under the NRPA: Permit-By-Rule or individual permit.

The application processes for these two permit types vary significantly in scope and processing time. The majority of local municipalities and jurisdictions in Maine do not currently maintain personnel equipped to process permit applications. Typically when a project requires permitting, an engineering services firm will support the permitting process as part of the overall cost incurred for a given project. For a breakdown of estimated permitting costs by activity see Table 1.4.

Permit Pricing Caveats

1. These estimates represent approximate survey, design, permitting, and construction administration fees. The capacity of an individual municipality to perform one of more of these services may vary, which will have a direct correlation on the estimated consultant's fee.

2. Due to the variation of individual characteristics associated with stream crossings, these estimates may vary significantly on a case-by-case basis. The estimates have been prepared to be generally representative of a minor and a major project.

3. For the purposes of this estimate a minor project consists of a small stream (potentially intermittent), could be spanned without the use of a bottomless s culvert (recessing the invert of a culvert and filling appropriately with gravel), with a relatively small watershed area, and qualifies for an NRPA Permit-By-Rule. This project is anticipated to be small enough to be constructed by the Public Works/Services Department located in the municipality of ownership.

4. For the purposes of these estimates, a major project consists of a large stream channel (steady base flow and likely associated with a 100-year flood hazard area), will require the use of a bottomless arch culvert or small bridge, associated with a large watershed area, and will require a Individual NRPA Permit from the MDEP. (Construction of the crossing will likely be performed by an outside contractor.)

Table 1.4

Minor Stream Crossing (NRPA - Permit By Rule)

Task	# of FTEs Required	Days Required	Cost/Day	TOTAL
Hydraulic Assessment	1	1	$900.00	$900.00
Hydrologic Assessment	1	1	$900.00	$900.00
Surveyor	2	1	$1,000.00	$2,000.00
Design/Detail	1	1	$900.00	$900.00
CAD Drafting	1	2	$600.00	$1,200.00
Project Management	1	1	$900.00	$900.00
Project Administration	1	0.5	$450.00	$225.00
Permit Fee				$65.00
Reimbursable (mileage, postage, photocopies, etc..)				$200.00
TOTALS	**8**	**7.5**		**$7,290.00**

Major Stream Crossing (NRPA - Individual Permit)

Task	# of FTEs Required	Days Required	Cost/Day	TOTAL
Hydraulic Assessment	1	4	$900.00	$3,600.00
Hydrologic Assessment	1	4	$900.00	$3,600.00
Geotechnical Investigation	2	1	$2,000.00	$4,000.00
Geotechnical Assessment	1	3	$900.00	$2,700.00
Structural Assessment	1	2	$900.00	$1,800.00
Surveyor	2	3	$1,000.00	$6,000.00
Design/Detail	1	4	$900.00	$3,600.00
CAD Drafting	1	4	$600.00	$2,400.00
Project Management	1	4	$900.00	$3,600.00
Project Administration	1	8	$450.00	$3,600.00
Construction Document Preparation	1	2	$900.00	$1,800.00
Bidding and Construction Administration	1	5	$900.00	$4,500.00
Periodic Construction Inspection	1	5	$900.00	$4,500.00
Permit Fee				$267.00
Reimbursable (mileage, postage, photocopies, etc..)				$1,500.00
TOTALS	**15**	**49**		**$47,467.00**

Projected Total Permitting Costs to the State

Based on data from previous years and the upsizing required for new stream crossings, it can be estimated that the number of PBR and Individual permit applications will increase if the rule is passed in its current form. As a point of reference in 2009, MDOT processed or reviewed the following activities:

Table 1.5

Permit Type	Projects
NRPA – Exempt	169
NRPA – PBR	62
NRPA – Individual	53

CONCLUSIONS

The information contained in this report provides a limited basis for assessing the financial impact of LD 1725 on stream crossings in the state of Maine. This limited scope is largely due to the vast number of stream crossing within the state for which no quantitative information is currently available. To fully evaluate the scope and scale of the impact that LD 1725 would have on the practice of culvert replacement in the state would require an extensive data collection effort to establish a statewide stream crossing inventory.

The U.S. Fish and Wildlife, MaineDOT, Maine DEP and numerous non-profits are currently in the process of surveying streams and stream crossings across the state and a great deal of information has already been collected to date. Unfortunately, the data collection process varies from organization to organization and many of the surveys are not collecting information that is critical to determining structure width or have collected the data using incompatible or non-standard methods. Maine should develop a uniform, comprehensive methodology to inventory, inspect and evaluate stream crossings. The resulting database would provide useful information for establishing appropriate replacement budgets, prioritizing replacements, analyzing structure lifespan, and modeling climate change impact.

The statewide cost estimate of $230 - $474 million addresses only the additional pipe material costs which will be incurred for the projected culvert upsizing; the total overall statewide cost impact of LD1725 will ultimately include construction, engineering, permitting and other related costs. When combined these costs could be more than 50% higher than the estimated additional cost of pipe material. Although the total overall costs will be spread out over the course of roughly 20 years as existing stream crossings are replaced. Maine municipalities and agencies such as the Maine Department of Transportation will face the substantial annual financial requirements of the proposed rule without an established source of funding.

Although it was beyond the scope of this report to provide a full cost benefit analysis, it is important to point out that there are potential benefits to be gained from upsizing stream crossings to meet the 1.2x bankfull requirements. These benefits include but are not limited to:

- Accommodation of increased flows resulting from climate change.
- Reduced maintenance due to increased width – diminished risk of plugging.
- Reduced scouring and storm related damage.
- Reduced rate of corrosion for metal pipes.
- Reduction in vehicle-wildlife collisions.
- Adds value to Maine's natural resource based economy.
    - Sport fishing
    - Commercial Fishing
    - Eco Tourism
- Habitat Creation/Restoration

At this date the language contained in LD 1725 is being refined. MDOT is conducting further analysis on design year storm and culvert sizing formulas that will likely be included in the rule language and which could significantly reduce upsizing costs.