Our Legacy of Neglect

The Longfellow Bridge and the Cost of Deferred Maintenance

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A Pioneer Institute White Paper

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Executive Summary

The Longfellow Bridge, connecting Boston and Cambridge, is in bad shape, due not only to its age and the ravages of our weather, but also to a troubling and persistent lack of maintenance. Fixing the bridge, in effect paying the bill for our unwillingness to maintain it, is estimated to cost at least $180 million, with the potential for cost overruns reaching into the hundreds of millions.

Once the bridge is rebuilt, will we again let it deteriorate without proper maintenance, running up another massive repair bill for future generations? The neglect of the Longfellow Bridge is symptomatic of a problem that encompasses almost all the assets owned by the Commonwealth.

The MBTA, UMass, MassHighway, Department of Conservation and Recreation, and the County Sheriffs each have maintenance backlogs in excess of $1 billion apiece. Overall, the Commonwealth's physical assets suffer from a maintenance backlog in the tens of billions of dollars. However, the calculation of an overall state figure is a difficult exercise, as there is no centralized system for comprehensively managing the state's assets. The responsibility for asset maintenance is scattered across state government, idiosyncratic in form and execution, and riddled with redundancies and ambiguities, particularly regarding the practical responsibilities of the Division of Capital Asset Management and the various executive branch agencies.

No matter which entity is responsible, every state asset suffers from the same treatment. We fail to adequately budget for maintenance; even worse, we actively create perverse incentives that discourage state managers from maintaining state assets.

Any maintenance spending from an agency's operating budget reduces funds available for programs. The postponement of routine maintenance maximizes operating funds available in the current year, but also hastens the failure of capital assets. The eventual failure of the assets will result in an emergency disbursement of capital funds, which are under DCAM's control and will not impact the agency's operating budget. Thus managers who spend money on maintenance are in effect penalized for trying to maintain their assets.

There is no comprehensive plan in place to stop the problem from growing worse. Budgeting for maintenance simply lacks the inherent political appeal of new spending on new assets. Every new structure that is built, every road that is paved, every new asset the Commonwealth builds is doomed to decay prematurely through a lack of maintenance.

This problem will not be solved in a single step. It will require a sustained, multi-generational effort. The first step is to stop exacerbating the problem. We must reexamine our current practices, including our financial reporting requirements and our asset management structure, and determine their impact.

We should also consider the innovations of other states. Utah and Missouri have established mandatory set-asides of state funds for maintenance. Washington and Virginia have increased accountability and transparency through comprehensive assessments of maintenance needs and regular reporting on performance.

In addition, alternative contracting mechanisms have the potential to extend the life-cycle of assets by contractually obligating proper maintenance budgeting and execution.

To address its systemic asset maintenance problem, as symbolized by the Longfellow Bridge, the Commonwealth should:

- **Stop** building new assets without first examining and budgeting for their life-cycle costs, including regular maintenance.

- **Measure** the condition of the Commonwealth's assets, and present easy-to-understand metrics of expenditures and progress in a comprehensive, standardized public report. Proper measurement of maintenance needs will also require changes to the state's accounting system to allow easier tracking of maintenance, as well as the adoption of financial reporting standards that emphasize asset management.

- **Budget** for maintenance by requiring agencies to expend operating funds equal to 2 percent of asset replacement value on maintenance, establishing a Facilities Maintenance Reserve Fund, and utilize budgetary surpluses to perform pay-as-you-go maintenance.

- **Execute** on improved maintenance practices by empowering those agencies with maintenance oversight, providing leadership from the Governor's Office, and mandating the usage of asset management systems.

- **Reward** managers and department heads with additional funding if they take a responsible approach to asset maintenance.

Photo by Christopher Penler

1. Introduction

Bridges are the physical manifestation of vital connections between communities. The Longfellow Bridge connects two economic and cultural powerhouses - Boston and Cambridge - yet suffers from such neglect and disrepair that reconstruction may cost several times more than the price of simply building a new bridge. The bridge's problems, clearly visible to the naked eye but even more dramatic below the surface, are symptomatic of a statewide failure to maintain our public assets. This deferral of maintenance is caused by a number of factors:

- Unwillingness to prioritize maintenance over new projects.
- Diffusion of responsibility for assets across disparate public entities.
- Political incentives that discourage spending on maintenance.

The result is a wasteful shortening of service life, a dysfunctional asset construction scheme, and ultimately, diminished quality of life for the Commonwealth's citizens.

To define the problem and propose a better way, this paper will present:

- The Longfellow Bridge's design, construction, history, current condition and urgent maintenance needs.
- Hypothetical models of how sustained investment would have reduced the overall cost of owning the Longfellow Bridge for the past hundred years.
- A broader portrait of how the Commonwealth maintains – or fails to maintain – all of our vital physical infrastructure, and an exploration of political and bureaucratic obstacles to proper maintenance.
- An overview of how other states have confronted their maintenance needs, and policy recommendations for the Commonwealth.

2. The Life of the Longfellow Bridge: 1907-2007

2.1 History

Transportation between Boston and Cambridge has been important since the earliest days of English settlement in Massachusetts. Three structures have been built over the Charles River where the Longfellow Bridge currently stands. A wooden bridge built in 1792 was replaced in 1854 by a second wooden bridge. The bridge that stands today was constructed out of granite and steel in 1907. The first bridge was immortalized in Henry Wadsworth Longfellow's poem "The Bridge," which begins:

> "I stood on the bridge at midnight,
> As the clocks were striking the hour,
> And the moon rose o'er the city,
> Behind the dark church tower,
>
> I saw her bright reflections
> In the waters under me,
> Like a golden goblet falling,
> And sinking into the sea…"

Massachusetts Governor John Hancock ratified incorporation of the West Boston Bridge Corporation in 1792. [1] Construction began on a causeway on July 15, 1792 and work on a wooden bridge began on April 6, 1793. [2] The causeway and bridge replaced a ferry service paid for in part by Harvard College. The bridge was 40 feet wide and included a 30-foot drawbridge that allowed ships to pass by.

The proprietors of the West Boston Bridge opened it to the public on November 23, 1793. Tolls were collected for 40 years, after which the bridge was turned over to the Commonwealth. Initially, the proprietors were required to pay 300 pounds per annum to Harvard College to support indigent scholars.

Under an act passed by the Legislature on March 26, 1846, the bridge and causeway were sold to the Hancock Free Bridge Corporation in July of that year. The wooden bridge was completely rebuilt in 1854 and transferred to the City of Cambridge by an act passed in 1857. Tolls were no longer charged and horse-drawn rail cars began using the bridge on March 26, 1856. This bridge lasted until 1899, when a temporary bridge was built and work began on the granite and steel bridge that stands today.

Plans to replace the old bridge began to take shape in 1890. Since the Charles River was considered a navigable stream, the federal War Department had to approve construction plans for a drawless bridge. President William McKinley authorized the bridge on March 29, 1890. [3]

The new bridge was designed by Edmund M. Wheelwright, twice director of the American Institute of Architects and a fellow to the Boston Society of Architects. Wheelwright also designed the Boston Public Library, Horticultural Hall, and Jordan Hall, and was consulting architect for the Bulkeley Bridge in Hartford, Connecticut.

The new bridge's style was inspired by the 1893 Columbian Exposition. The Exposition, held in Chicago, was a celebration of the 400th anniversary of Columbus' founding of the new world and included buildings from the world's great architects.

With its characteristic towers and stonework, including ornate sculptures of Viking ships, the West Boston Bridge was to rival the great bridges of Europe. The shape of its four ornamental granite towers gave the bridge its nickname: the salt and pepper bridge.

William Jackson, Boston's City Engineer, was the structural designer. Mortared granite piers are connected by eleven steel arches, which support a concrete deck. Two mass-transit rail lines were later added to the center of the bridge.

Construction began in 1900 with the placing of 20,168 wooden piles in the riverbed for the 10 stone and concrete piers, and the abutments on each bank. The construction process is well documented in the Bulletins of the Boston Society of Civil Engineers. [4] Almost 17,000 cubic yards of stone granite and 77,421 cubic yards of concrete were placed prior to steel erection. Erection of the steel superstructure was completed by the Phoenix Bridge Company in November 1904, and surfacing of the roadway finished approximately a year later. Total cost for the bridge was $2,654,896, which equates to $137,809,259 in 2007 dollars. [5]

Over 100,000 people attended the grand opening of the new West Boston Bridge on July 31, 1907. Festivities included a parade, an invitation-only lunch, a grandstand with 2,000 ticketed guests, a program of speeches and evening fireworks.

In 1927, upon petition from the Cambridge Historical Society to the Massachusetts Legislature's Committee on Metropolitan Affairs, it was proposed to rename the bridge after Henry Wadsworth Longfellow. A group of Cambridge citizens representing the Historical Society, lead by Judge Robert Walcott and Professor Ephraim Emerton of Harvard University, spoke in favor of the change. Judge Wolcott read a letter from a daughter of Longfellow, which said that the poet pictured a former bridge at the same location when he wrote "The Bridge".

Mr. Van Ness Bates of Brookline took exception to the change at the hearing. He said, "The present day bridge with the high mass of stone and roaring trains" would not be in keeping with the solitude and meditation which characterized the poet. The Historical Society prevailed, however, and the name change was made official. "His" bridge became another historical point of interest to the many Longfellow admirers of the day. [6]

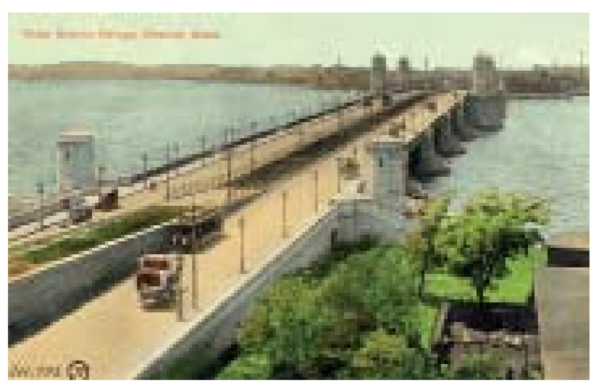


Figure 1: Postcard of the West Boston Bridge (Source: Applewood Books)

2.2 The Bridge Today

A century later, the Longfellow Bridge carries over 49,500 vehicles per day, [7] plus an estimated 97,000 daily MBTA Red Line transit passengers. This traffic volume means that the Longfellow is subject to a bridge inspection program. Though the bridge falls under the jurisdiction of the Commonwealth's Department of Conservation and Recreation, the Massachusetts Highway Department (MHD) assists DCR with inspection of bridges under its jurisdiction.

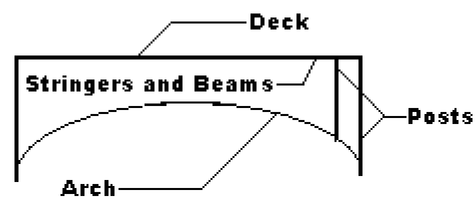
The Longfellow has undergone two repair projects; first in 1959, then again in 2002. The 1959 project included some structural repairs and replacements while the 2002 project spent approximately $1.1 million of the $3.2 million total on steel repairs and completed sidewalk and street light safety repairs. About $160,000 was spent on graffiti removal.

The most recent inspection of the bridge was done on September 21, 2006.[8, 9] The inspection report includes remarks about the major components of the bridge including: the bridge deck and approaches, the steel superstructure that supports the deck, and the substructure that includes the river piers, granite towers and abutments. The report also provides remarks on traffic safety and includes 21 photographs taken during the inspection.

Bridge Deck

The original bridge deck that supports the roadways consists of a 3/8" thick steel buckle plate supporting a 7" thick unreinforced concrete deck. The deck is supported by a set of stringers and beams located below the deck. The checkerboard of structural steel is supported by posts that carry the load to the arch members below. The curved arches are the main structural members of the bridge. Pleasing in appearance with their graceful curves, they support the bridge and transfer the loads to the stone piers in the river. There are ten granite piers across the river and the bridge ends on each side with a stone abutment located on either bank.

Figure 2: Generic Bridge Structure Diagram



(Source: Authors)

During the 1959 reconstruction, areas of the deck were replaced with reinforced concrete. The 2006 inspection report described some of the original deck sections as being in "[s]erious condition with large rust holes (100% section loss) in the buckle plates with voids due to deterioration of the concrete deck." [8] The term "100% section loss" means that portions of the arch ribs have corroded to the extent that 100% of the cross section of the rib is rusted away and holes appear in the rib. A 50% section loss would mean that half of the rib section was still available for carrying load and holes would not be visible.

These conditions are comparable to those of many Interstate bridges whose decks are deteriorating. In those cases, nettings or false work is put in place below the deck to prevent concrete deck debris from falling onto traffic below. Under the Longfellow, any deteriorating deck debris falls into the Charles River.

Figure 3: Longfellow Bridge Deck (Photo by Peter Begley)

Superstructure

The steel superstructure includes stringers and floor beams that transfer the load of the deck and traffic through posts to the arched beams of the bridge. The 2006 inspection report states that "[t]he stringers are in poor condition with heavy rusting and section loss."

Some of the stringers were repaired during the 2002 rehabilitation, but most suffer from severe section loss. The girders over the approach span over Memorial Drive outbound also display collision damage from accidents on the street below.

Figure 4: Beams (perpendicular to bridge) and Stringers (sections with "x" bracing) (Source: DCR 2006 Inspection Report)

Floor Beams

The floor beams in all spans show severe corrosion and some have 100 percent section loss in the center section under the MBTA Red Line tracks, which the inspection report attributes to "[w]ater leaking through the two longitudinal joints in the median." Some of these beams have repair plates from the 1959 rehabilitation. The application of salt and de-icing materials to the road surface has intensified this deterioration. The freezing, thawing and refreezing cycles of a New England winter also accelerate the process.

Figure 5: 100% section loss to stringer (Source: DCR 2006 Inspection Report)

Arch Ribs

The curved arch ribs are the main pieces of the superstructure. They consist of 12 curved riveted girders in each of the 11 spans. Riveted girders are no longer commonly used for this purpose; modern bridges use welded structural steel girders or precast concrete girders. The 2006 Inspection Report notes that "[t]he arch ribs have heavy rusting throughout with heavy section loss [in] the top flange outer edges." Repair plates have been added to the ribs, particularly at the ends near the piers where some of the outer ribs have 100% section loss.

Substructure: Bridge Piers

The substructure consists of the 10 granite piers in the river and 2 abutments, one on the Boston side near Leverett Circle and the other on the Cambridge side along Memorial Drive. The substructure supports the steel and concrete superstructure and includes the visible stone piers above the river waterline and the stonework and wooden piles below the waterline. The pier walls display a variety of cracked and deteriorated mortar joints. Four of the piers have vertical cracks extending down through four courses of granite block and some have vertical cracks extending all the way down to the water line.

The bridge's four distinctive ornamental towers are located on piers numbered 5 and 6. Within these piers is a large bed of sand upon which the towers rest. Based on a 2003 consultant's report, the towers have settled since construction. The tower on Pier 5 has settled about 1 to 2 inches and the tower on Pier 6 has settled about 5 to 6 inches. The towers are leaning due to this settlement and there are vertical cracks in the granite.

While there appears to be no settlement in the piers themselves, the settlement of the towers will require complete disassembly and reconstruction.

Figure 6: Bridge Pier (below bridge deck) and Tower (above bridge deck) (Source: Authors)

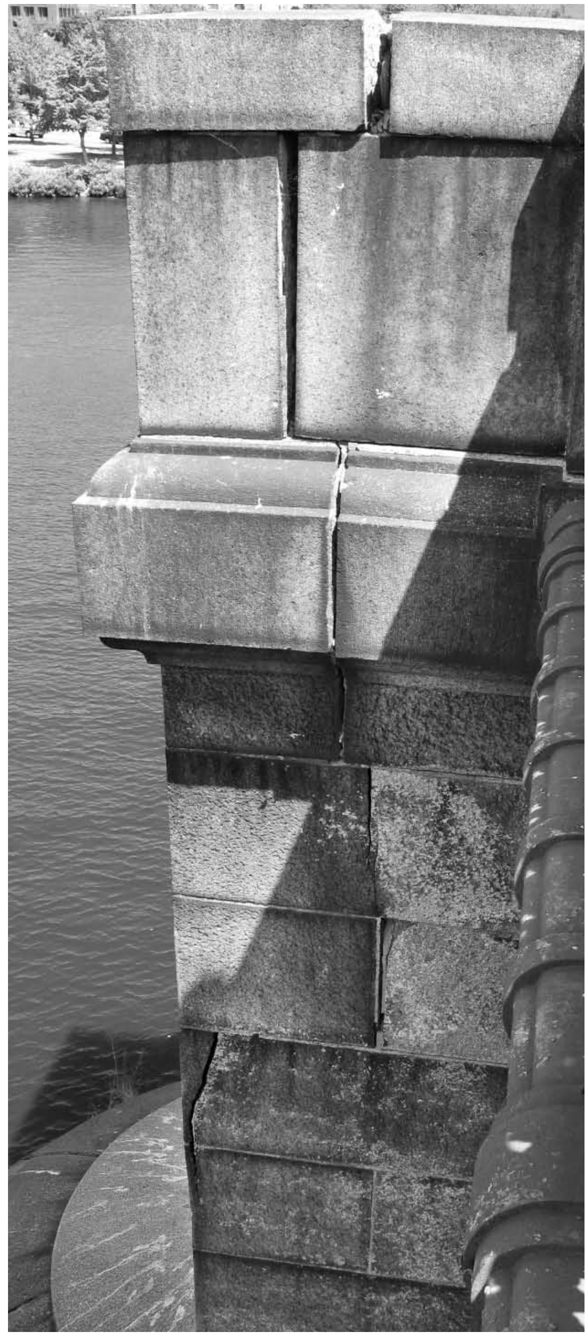


Figure 7: Cracking in Pier (Photo by Peter Begley)

Overall design and construction

The Longfellow's problems are rooted in its design, and the construction methods used to build it. There is a reason that bridges today are built differently than they were a hundred years ago.

The most significant drawbacks of the Longfellow's design involve its foundation and substructure. The Longfellow is built on 20,000 wooden pilings driven into the bed of the Charles River. Under current engineering practice, steel or concrete piles would be driven down to bedrock, or structural shafts and caissons would be built. This virtually eliminates settlement in new bridges.

Water has also affected the granite piers, as the cycle of freezing and thawing has shifted and deteriorated the granite blocks. Most bridges built since 1930 are made of reinforced concrete substructures with steel or concrete superstructures. Granite blocks are no longer used in modern bridges. Block construction requires frequent repointing of the mortar joints to keep the effects of moisture from eventually shifting the blocks.

Removal of the bridge deck and coring and reinforcing the piers with a new foundation may be the only economical alternative to avoid further settling and deterioration. Newer projects are designed to minimize the need for such maintenance. For instance, piers for the Leonard Zakim/Bunker Hill Bridge are constructed of solid reinforced concrete.

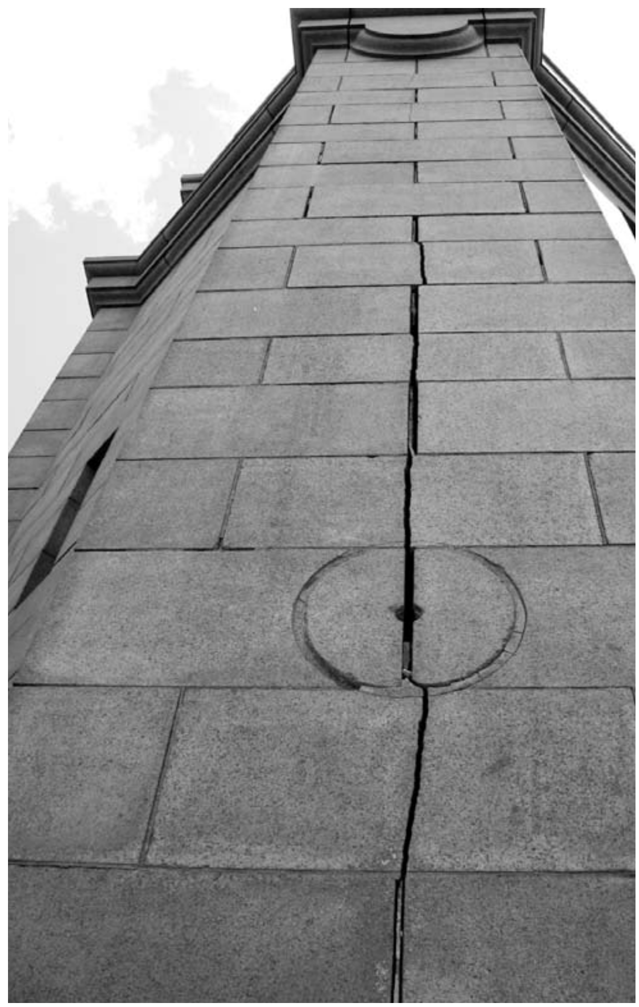


Figure 8: Cracking in Pier
(Photo by Peter Begley)

3. Neglect vs. Maintenance: Which is Cheaper?

The 2006 inspection of the Longfellow provides insight into how the bridge has deteriorated since its construction, despite the two rehabilitations in 1959 and 2002. It also enables us to compare the cost of alternate approaches to stewardship of a capital asset. The first, involving minimal upkeep and the renovation or replacement of the bridge after 100 years, is a fact. The second is hypothetical: How much could the Commonwealth have saved by taking proper care of the Longfellow for the past hundred years? This comparison highlights the urgency of changing the way we maintain our infrastructure.

3.1 Estimated Costs of Rebuilding or Replacement

The 2006 inspection report – or even a cursory visual inspection of the Bridge – confirms the need for major renovation. The first public meeting on the proposed project was held in May 2006 by MassHighway, and included a presentation on the extent of renovations needed and potential construction scenarios. [10] It was hoped that a final plan could be put in place by 2007 or 2008, in order to allow for construction between 2009 and 2013.

The bridge is considered safe and not in danger of imminent failure, but its deterioration means that action must be taken within the next few years, before safety concerns may force its closure. Most urgent are the structural deficiencies of the stringers, floor beams and posts, which are rated as "4-Poor," on a scale of "1-Imminent failure to "9-Excellent."

In addition to these flaws in the superstructure, the reconstruction process will include a thorough investigation of the substructure, including the piers and the wooden pile foundation below them. Evaluation must account for the dead weight of the bridge, traffic and MBTA train loads, wind and snow loads and a consideration of seismic impacts. A best-case scenario would find that the piers and foundations are still capable of withstanding all loading conditions. The worst-case scenario would be that the piers and foundations would require structural enhancements before the superstructure and deck can be rehabilitated.

The bridge structure and deck will be renovated while maintaining most MBTA Red Line rail service and three of the four lanes of traffic. The entire bridge deck will be removed and replaced in several stages, limiting vehicular and Red Line traffic to alternate lanes while one or more lanes are under construction. Limited construction access will increase the time needed for renovation and may cause some temporary suspension (on weekends) of Red Line service.

Structural members, including the arches, ribs and posts supporting the deck would then be repaired in place or removed and replaced. The bridge seats, where the arches sit on the piers, and the substructure itself may also need to be replaced in certain locations, which could further extend projected construction schedules.

The recommended tower repairs are to be completed by dismantling and rebuilding them. Once down to the sand base, an inspection can be made of the granite blocks below river level. At that point a decision can be made on whether the base is suitable for rebuilding. The four towers are located on two of the ten piers, but the other eight piers may have to be similarly dismantled and rebuilt.

The initial cost estimates are preliminary, since much of the work cannot be precisely estimated until the foundations are exposed. On January 22, 2006, Jon Carlisle, then of the Executive Office of Transportation, stated that “[t]he current $70 million price tag could rise to $100 million.” [11] Currently, the official Massachusetts Highway Department estimate is $180 million. The report of the Commonwealth’s Transportation Finance Commission, issued on March 28, 2007, estimated repair costs at $200 million.[12]

Given the preliminary nature of these estimates and the potential for substantial additional construction depending on the condition of the piers, it is conceivable that the actual cost of reconstructing the Longfellow could be several times the current estimates.

With an approximate total historical cost of $270 million (see table on page 13) plus the current estimated cost of repairs of $200 million for a total of $470 million, a new replacement bridge begins to appear economically reasonable. However, given the historical and cultural significance of the Longfellow, the construction of a new bridge is an unlikely alternative.

3.2 The Road Not Taken: Two Alternative Life-Cycle Scenarios

The following scenarios demonstrate that the massive reconstruction cost of the Longfellow could have been reduced through a cost-effective plan of proper maintenance. We will compare the Commonwealth’s actual investment in the bridge with the hypothetical impact that proper maintenance could have had.

As mentioned previously, the total cost for the bridge in 1907 was $2,654,896, which, based on the ENR Construction Cost index, equates to $249 million in 2007 dollars. The 1959 rehabilitation cost an estimated $2 million and the 2002 rehabilitation cost $3.2 million. [8] Although there are normal annual operational expenditures for routine activities like line painting and snow removal, these two rehabilitation projects are the only known major work performed on the bridge since its construction in 1907. Some small contracts have recently been let to improve the lighting systems on the bridge. Based on the ENR Construction Cost Index, the $2 million 1959 rehabilitation would be equivalent to $19.7 million and the $3.2 million 2002 rehabilitation equivalent to $3.8 million in 2007 dollars. Thus the historical cost to date is $272.5 million.

Figure 9: Longfellow Construction Costs

	Date	Cost	Cost (2007 $)
Initial Construction	1907	$2.6M	$249.0M
First Rehab	1959	$2.0M	$19.7M
Second Rehab	2002	$3.2M	$3.8M
Total Historical Cost (2007 $)			**$272.5M**

This historical cost of $272.5M is an estimate of the "sunk cost" into the bridge as it stands today. In other words, this is what has been spent on the bridge, in 2007 dollars, over its 100-year lifespan.

The concept of Life-Cycle Costs (LCC) is an important component of an investment decision for initial construction of any facility. [11B] LCC encompasses all relevant costs over a designated study period, including the costs of designing, purchasing/leasing, constructing/installing, operating, maintaining, repairing, replacing and disposing of a particular building or system.

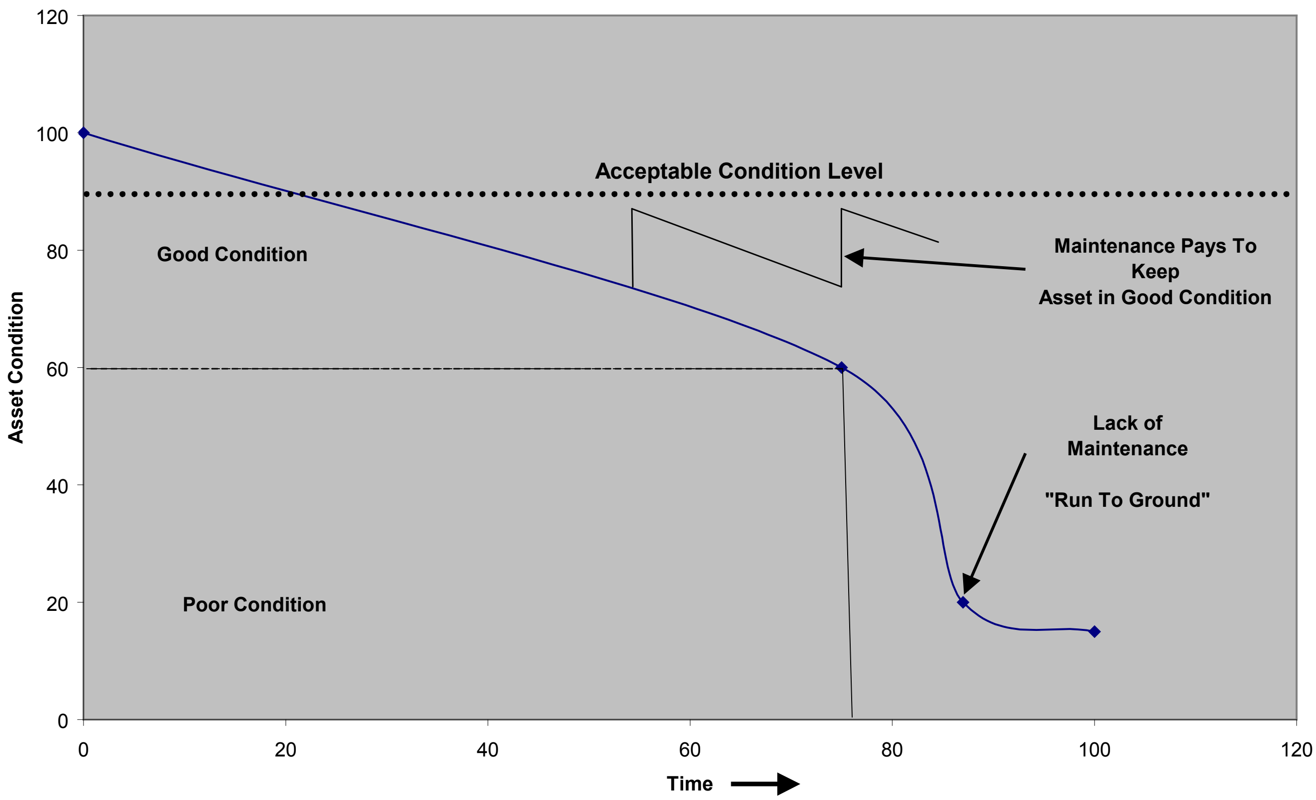
The effect of maintenance spending on the reduction of the cost of deferred maintenance with time is widely accepted. [13] In general, maintenance investments are more cost effective early in the life of the asset. For any asset, it is expected that there is a 40 percent drop in quality over 75 percent of its lifetime, followed by a more precipitous drop in the final quarter of the asset's life. Since deferred maintenance is the compounded effect of deferring maintenance from one year to the next, the cost of deferred maintenance in year one will increase significantly in every subsequent year. De Sitter's "Law of Fives" [14] estimates that if maintenance is not performed, then repairs equaling five times the maintenance costs are required; if the repairs are not made, the rehabilitation costs will be five times the repair costs. Thus the compounding effects of deferring maintenance are dramatic, especially for an asset as old and neglected as the Longfellow Bridge.

As figure 11 shows, maintenance can restore the condition of an asset before its condition reaches the inflection point and begins to decline rapidly. At the other extreme, the effect of not maintaining an asset is sometimes called "running to ground." Once an asset exceeds its useful life, investment in maintenance is often fruitless unless major renovation is undertaken. The Longfellow Bridge suffers from a lack of annual maintenance compounded over many years. Major repairs were undertaken in 1959 and a facelift done in 2002, but years of neglect have caught up with the structure. To determine what could have occurred had a planned and funded maintenance program been in effect, we will describe three scenarios that evaluate different levels of investment in maintenance.

Maintenance practices in the private sector have evolved considerably over the years. Most companies now implement some form of Reliability-Centered Maintenance (RCM), which predicts and prepares for future maintenance requirements. [15]

Scheduled restoration is an essential component of RCM. Rather than waiting for a facility to begin to fail, renovation/restoration projects

Figure 10: Condition vs Age Curve for General Assets showing the Effects of Maintenance Activities on the Condition of the Asset (Source: Based on Roberta Reese's GASB Reporting Model from July 13, 2006 ASCE/USACE Workshop on Condition Assessment)



are scheduled during a slack or non-emergency period.

Researchers are now considering the application of RCM principles to public-sector asset maintenance. Risk analysis, reliability assessment, and computer modeling have enabled better predictions of the actual costs of various maintenance scenarios. For example, it has been estimated that if all public assets in Canada were renewed at the end of their service life, then approximately $196.5 billion would be required each year to maintain and replace Canada's estimated $5.5 trillion current built assets. [16]

Recent advances in facility management have lead to the development of a standard set of definitions for asset lifecycle models. In order to prioritize maintenance activities, "condition indexing" describes the current condition of the asset and enables more accurate budgeting. [17]

In particular, the facility condition index (FCI) has become a useful tool for capital asset planning. The FCI is equal to the amount of deferred maintenance plus any capital improvements required, divided by the current replacement value of the facility. If no capital improvements are required, such as building code upgrades or program changes, then the FCI is simply the amount of deferred maintenance divided by the replacement value. An FCI of 0 to 5% is considered good condition. [18] An FCI of 6% to 15% is fair condition, and above 15% is poor condition.

This calculation also provides a corresponding rule of thumb for the annual reinvestment rate (funding percentage) required to prevent expansion of the deferred maintenance backlog. [19] In Minnesota, for instance, the Statewide Facility Management Group recommended a annual reinvestment rate of 2.82% of the replacement cost. Current actual spending is at a rate of 1% due to budgetary constraints.

To apply the concept of annual reinvestment to the Longfellow Bridge, scenarios were developed for an annual reinvestment rate of 1% per year, another at 2.5% per year, and as the actual scenario of 0% reinvestment over 100 years, with two renovation projects.

The percentages in the first two scenarios were selected based on their relevance to existing best practices. At higher maintenance investment levels, (e.g. five percent per year), the facility is maintained in pristine condition and savings from maintenance are negative. This would be similar to taking your car to the shop when no repairs were needed.

In order to estimate the savings from past maintenance, the results of a Lifetime Extending Maintenance Model were used. [20] The model is based on the study of sixteen concrete deck bridges with applied road salt and freeze-thaw conditions. The condition model used in the validation model was:

$$y = c - at^{b}$$

Where: y = condition
c = start condition (100%)
a = constant
b = power constant

The Lifetime Extending Maintenance Model attempts to estimate the impact of maintenance spending on the decline of an asset's condition. The estimated condition resulting from a 1% investment in maintenance was approximated at 60% of start condition *c*, thus the penalty for deferred maintenance is the cost of a renovation that would restore the bridge's 40% decline from start condition *c*. The estimated condition resulting from a 2.5% investment in maintenance was approximated at 80% of *c*, thus any catch-up restoration efforts would only need to counteract the loss of 20% of start condition.

Scenario 1

Annually invest 1 percent of the bridge's capital cost in a maintenance program. If an investment in maintenance of 1 percent occurred each year, that would have resulted in total lifetime maintenance spending of $62.7 million in 2007 dollars. With the addition of a projected $80 million in current rehabilitation costs (equal to 40% of the estimate), the total savings (relative to the actual scenario) would be approximately $80.8 million.

Scenario 2

Annually invest 2.5 percent of the bridge's capital cost in a maintenance program. Maintenance spending at a rate of investment of 2.5 percent each year would have resulted in total lifetime maintenance spending of $156.8 million. With the addition of projected rehabilitation costs, equal to 20% of the estimate, the total savings would be $26.7 million.

Scenario 3

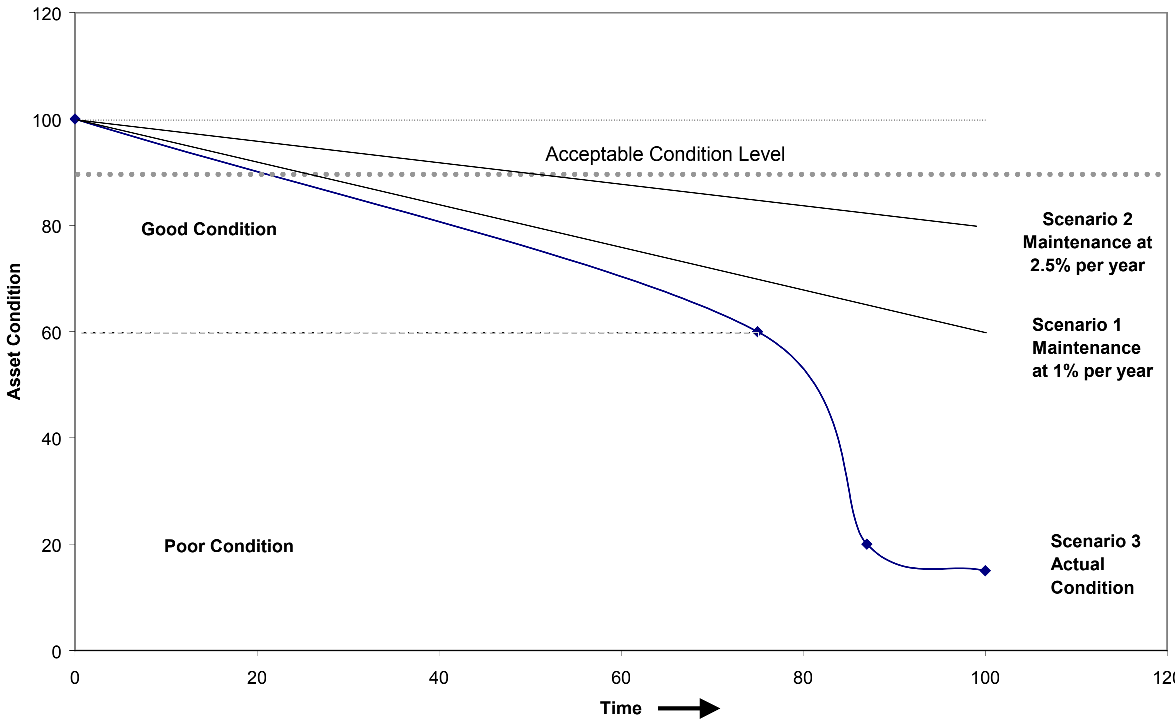
The actual scenario: no annual maintenance program but a major rehabilitation in 1959 followed by another facelift in 2002. Capital depreciation is assumed to be 100 percent of the rehabilitation cost, currently set at $200,000,000. The total cost to keep the bridge in good repair is $223.5 million in 2007 dollars.

Clearly, regular maintenance will keep an asset in better condition than occasional maintenance or no maintenance at all. Also, maintenance dollars spent early in the life of an asset have greater leverage than those spent towards the end of an asset's life. Other lessons from the scenarios are described on page 17.

Figure 11: Summary of Maintenance Scenarios (% asset value spent annually on maintenance)

	Scenario 1 (1%)	**Scenario 2 (2.5%)**	**Scenario 3 (0)**
Maintenance Cost	$62.7M	$156.8M	$23.5M
Current Cost to Rehab	$80.0M	$40.0M	$200.0M
Total Cost to Return Bridge to Good Repair	$142.7M	$196.8M	$223.5M
Estimated Savings from Maintenance	**$80.8M**	**$26.7M**	**N/A**

Figure 12. Degradation Curve (Source: Based on Roberta Reese's GASB Reporting Model from July 13, 2006 ASCE/ USACE Workshop on Condition Assessment and Author's Calculations)



Lessons from the three scenarios

- **Early maintenance is more cost-effective than later maintenance.** By spending regularly early in the life of the asset, high replacement costs in the future can be avoided.

- **Maintenance is cost effective, and more so as the reconstruction price increases.** The current scenarios are all based on the base case reconstruction cost of $200 million. If that figure increases, so will the savings from maintenance.

- **Regular maintenance improves the service level of the asset.** While the Longfellow is not in danger of collapse, it is a minimally functional bridge, an eyesore with visible holes in its deck, periodically dropping debris into the river below. If we want our assets to contribute more to the Commonwealth's quality of life, then regular maintenance is essential.

- **Regular maintenance is more palatable from a budget perspective than major repairs.** The Commonwealth has grappled for several years with the need to fund massive repairs on the Longfellow. It would have been easier (and more cost effective) to find room in the budget for regular maintenance payments rather than a large lump sum to repair the structure.

4. The Real Cost of Neglect: A Statewide Crisis

The Longfellow Bridge is a dramatic example of the cost of deferred maintenance. While we have focused on a highway bridge as an example, neglect threatens all types of public assets throughout the Commonwealth.

4.1 The Extent of our Maintenance Backlog

The many agencies and authorities of the Commonwealth own a huge spectrum of assets, from hospitals to parks to dormitories to beaches. According to the Massachusetts Division of Capital Asset Management's [21] Report on Real Property, dated September 2006, the Commonwealth owns 78,838,841 square feet of buildings and 611,594 acres of land. In the June 2006 Comprehensive Annual Finance Report, the Comptroller's Office estimates the total depreciated value of state assets at $24.9 billion. Almost all of these assets suffer from deferred maintenance or lack proper planning and funding to keep them properly maintained. The Office of Facilities Maintenance at DCAM maintains that the state's overall backlog of deferred maintenance is $2.2 billion. [22]

The problems caused by inadequate maintenance of public infrastructure plague all levels of government. Since asset deterioration occurs gradually, there is a tendency to defer preventative maintenance. Treating maintenance as a discretionary expense, combined with a diffusion of responsibility and outright inability to monitor asset condition, results in a massive and growing maintenance backlog.

Figure 13 lists deferred backlog estimates for Massachusetts public entities, using publicly available studies and statements from each agency. It should be noted that there are variations in methodology across each estimate, so the aggregate number should not be regarded as precise; rather it is a rough estimate of the Commonwealth's deferred maintenance problem.

Note that this table is only a snapshot of our current maintenance backlog. Other recent studies have found comparable problems throughout state government. For instance, the Judiciary has just completed a condition assessment on its 113 facilities. Sixty-eight have deferred maintenance issues that need to be addressed. [23] This work is estimated to cost $500 million.

As for highway assets, MassHighway lists, under its structurally deficient (SD) bridge program, 501 structurally deficient bridges as of November 2006. [18b] 232 of these bridges are being evaluated for repair, and of these 129 are undergoing repair construction. An investment of $200 million per year is planned to reduce the number of structurally deficient bridges to 443 by 2010.

The Transportation Finance Commission report has also estimated a "funding gap" based on an analysis of needs and resources over an extended period of time. [24] The TFC's "gap" is a projection of future needs; the table below lists estimates of what state entities need today, to clear the maintenance backlog they already have.

Figure 13: Estimates of Maintenance Backlogs for State Entities.

Entity	**Source**	**Backlog Estimate ($B)**
MassHighway - Pavement	MHD 5 Year Pavement Condition Tables	$6.2
MBTA	April 2007 PMT Advisory Board Meeting	$2.7
UMass (Amherst Campus)	UMass 2007 Financial Indicators Report	$1.6
DCR	11/12/06 Boston Globe Article	$1.3
State and Community Colleges	11/06 Roadmap	$1.2
Other UMass Campuses	UMass 2007 Financial Indicators Report	$1.1
MassHighway - Bridges	10/06 Performance Report	$1.1
County Sheriffs	Authors' Estimates	>$1.0*
Trial Court	Gienapp Design Associates 6/26/07 Report	$.5
Mass Pike - Bridges	5/15/07 Press Report	$.4
Other – MWRA, Massport, RTAs, Steamship Authority		Unknown
Total Maintenance Backlog		**At least $17 billion**

* County Sheriffs have a massive backlog of maintenance that is difficult to measure. Most jail facilities operate in excess of stated capacity and many are not in compliance with all relevant Department of Public Safety and Department of Public Health regulations. An effort to comply with all applicable regulations would be a multi-billion dollar effort.

While there are pockets of excellence on maintenance issues, notably the efforts of DCAM's Office of Facilities Maintenance and MassHighway's PONTIS system, there appears to be no high-level awareness of the magnitude of the problem of deferred maintenance, or any comprehensive statewide effort to address it in either the legislative or the executive branch of state government. The table above includes data from at least nine separate reports and reporting systems, indicating the bureaucratic obstacles to any comprehensive statewide maintenance program.

4.2 Political and Bureaucratic Barriers to Reform

Just as the Longfellow Bridge symbolizes the cost of deferred maintenance, the question of who's responsible for the bridge also highlights a statewide problem. The bridge was initially constructed by the cities of Boston and Cambridge, and then operated by the Metropolitan Park System. In 1923, the Metropolitan Park System became the Metropolitan District Commission (MDC), which took on the original work of the Boston water and sewer boards.

In 2003, MDC was merged with the Department of Environmental Management to become the Department of Conservation and Recreation (DCR). This new entity took on responsibilities for state forests and parks, while also overseeing a large portfolio of transportation-related assets, including 164 pedestrian and vehicular bridges.

Under an agreement with MassHighway, eight of DCR's facilities are to be rehabilitated at an estimated cost of $397M. They are the Longfellow Bridge, Storrow Drive Tunnel, Woods Memorial Bridge, Craigie Drawbridge, Craigie Dam, Craddock Bridge, Gilman Street Bridge and the Lech Walesa Bridge. Ownership would remain with DCR, but responsibility for design and construction would be in the hands of MassHighway.

As for other state assets, DCAM has some statutory oversight of maintenance activities for state agencies and building authorities. However, the relevant statutes, (Massachusetts General Law, Chapter 7, sections 39A - 43I) make a critical distinction between state agencies and public agencies. Public agencies are defined to include authorities and other non-executive branch entities. DCAM has only limited ability to compel record-keeping and reporting from public agencies.

The statutory responsibility for maintenance sits with each agency, which is typically charged with the ”care,” ”control,” or ”“supervision” of its facilities. For instance, the commissioner of the Department of Public Health is charged with “general supervision and control” of its hospitals. [25] At the University of Massachusetts, the trustees are to:

> …manage and administer the university and all property, real and personal, belonging to the commonwealth and occupied or used by the university, and shall keep in repair houses, buildings and equipment so used or occupied. [26]

This placement of responsibility creates a conflict, as agency managers and overseers face incentives to spend scarce budget dollars on operations, not maintenance. Meanwhile, facility managers, who are most attuned to maintenance needs, report to agency managers who may not share their priorities.

For state agencies, DCAM's primary statutory role is in enforcing standards (contained in MGL Chapter 7, Section 43C). This section provides for yearly reporting of compliance with maintenance standards and empowers DCAM to perform regulatory inspections. An escalating series of sanctions are provided for, including a take-over of an agency's maintenance operations by DCAM until standards are met.

As a practical and political matter, DCAM has not utilized these powers. It lacks the funding, staff, and political power to effectively collect money from another agency and manage their maintenance operations for any length of time.

4.3 Attempts to Reduce the Backlog

Given the diffusion of responsibility for assets, it is no surprise that the Commonwealth does not have one system to adequately inventory assets, assess their condition, or estimate the cost of deferred maintenance.

In the case of the Longfellow Bridge, the MDC (now DCR) had no formal inventory systems until two years ago. Now they are utilizing FAMIS, the Facility Administration and Maintenance Information System, for their own assets, with the exception of major bridges including the Longfellow. With MHD's assumption of responsibility for the Longfellow, the bridge (and several other DCR bridges) will now become part of the PONTIS bridge maintenance system.

PONTIS was developed by the Federal Highway Administration. The software was made available to states in 1991 and incorporated into the American Association of State Highway and Transportation Officials (AASHTO) software product line in 1995. PONTIS includes data and analytical models for an inventory of the state's bridges including condition data, engineering and economic models to include deterioration prediction models, an array of improvement options and updating procedures, according to the USDOT Asset Management Primer. Thirty-seven states, including Massachusetts, have procured a license to implement PONTIS.

PONTIS and FAMIS each serve as asset management systems for relatively limited classes of assets. The asset management system with the broadest reach is CAMIS, operated by DCAM. CAMIS is a comprehensive Capital Asset Management Information System that uses the same base software as FAMIS. In a 1999 Supplemental Budget, the Massachusetts Legislature appropriated $18 million for a statewide asset survey, which was conducted by Parsons Brinckerhoff in 2000-2001. CAMIS survey data of over 5000 buildings, comprising more than 73 million square feet of space, is used to inform and support capital planning and decision-making.

In addition to CAMIS, DCAM has built up its maintenance-related programming. It has established an Office of Facilities Management (OFM) and it has begun a facility self-assessment program for state buildings. OFM has organized the Massachusetts Facilities Managers Association (MAFMA) to promote the wise use of assets and their maintenance and to promote the use of CAMIS as an operating tool. However, as noted above, DCAM has limited statutory and practical powers to improve maintenance practices across all of state government.

CAMIS was made available to all executive branch agencies, higher education schools, and the judicial branch. Buildings owned by our public authorities, including MBTA, MTA, MWRA, MassPort, etc. have been excluded from the use of CAMIS as a management tool. Also excluded are all college and university buildings owned by the Massachusetts State College Building Authority or the University of Massachusetts Building Authority, which include certain dormitories, athletic centers, and dining halls. [27]

CAMIS provides an array of asset management services, including the cataloging of deferred maintenance, the production of preventive maintenance orders, and the transmittal of service requests. While all major facility-owning agencies in the Executive Branch use CAMIS to some extent, its features have not been fully utilized across state government.

5. Strategies for Effective Asset Maintenance

5.1 Remove Disincentives for Maintenance Budgeting

Maintenance spending is currently bifurcated between the operating budget (where many departments spend their own funds on maintenance) and the capital budget. For many of the buildings and other non-highway structures in state government, DCAM spends its own capital funds for maintenance projects.

This bifurcation creates a disincentive for agency heads and program managers to spend on routine maintenance. Any maintenance spending from an agency's operating budget reduces funds available for programs. The postponement of routine maintenance maximizes operating funds available in the current year, but also hastens the failure of capital assets. The eventual failure of the assets will result in an emergency disbursement of capital funds, which are under DCAM's control and will not impact the agency's operating budget. Thus managers who spend money on maintenance are in effect penalized for trying to maintain their assets.

These disincentives for maintenance should be removed by rewarding agency leaders who keep their assets in good condition. An accurate database and reporting system, such as CAMIS, should serve as the basis for any system of rewards. Such a system would evaluate each agency's ability to properly maintain assets, and direct incentive funding to those entities that have demonstrated a track record of responsible stewardship.

5.2 Explore Innovative Contracting

There is a robust public debate about the utility of different contractual forms to shift risk, cost, and control from the public sector onto the private sector. The traditional process for construction is a three-step process of design-bid-build, with a separate procurement process for each step. Several innovative methods combine multiple steps in the process. The text box below describes several of these methods.

Each method provides a potential advantage for the state, including access to financing, faster execution of projects, outsourcing of maintenance responsibility or greater accountability for construction quality. The inclusion of life-cycle costs and a plan for extended maintenance at the outset of a project, during the financing, design and construction stage, will insure that an adequate maintenance plan is in place and can be funded.

Along with these positive attributes, potential shortcomings should also be considered, such as a perceived or actual loss of control of assets. This section does not address that broader debate. It is intended to examine how innovative contracting has the potential to embed life-cycle costs into every project, ensuring that adequate maintenance is planned and funded.

It should also be noted that current state law prevents the regular utilization of most of these techniques without special legislation. Most of these contracting methods would require the suspension or amendment of several state laws, including sections of the public construction laws (Chapter 149 of the Massachusetts General Laws), procurement laws (Chap. 7 and Chap. 30B) and public works construction law (Chapter 30, Section 9M).

Several innovative methods of construction contracting, financing and operation are currently being used throughout the United States and elsewhere. These include:

Build-Lease-Transfer - Similar to design-build, the facility is leased by the contractor to the government after construction. The lease pays the contractor for construction costs of the facility. During the lease, the government operates the facility. After the lease period, the government may or may not assume operation and maintenance to the facility. This method would provide an incentive for higher quality construction (with expected result of lower maintenance costs) as the contractor would pay for maintenance previous to the transfer.

Design-Build-Operate - a firm would design and build the facility and then operate it for a period of years. The quality of construction would be expected to be high since the contractor would pay for the cost of maintenance of the structure. The government owns the facility and may or may not assume maintenance at the end of the period.

Build-Operate-Own - This arrangement is similar to the previous example except that here the private sector contractor retains ownership of the facility. This practice would place responsibility for maintenance on the owner, and funding for life-cycle costs would be embedded in the initial price of the project or on-going lease payments.

Lease - For existing facilities, the government can provide the contractor with a leasehold interest in the asset. The contractor makes improvements and operates and maintains the asset in agreement with terms of the lease.

Concession -The government grants the contractor exclusive rights to provide, operate, and maintain an asset over a long period of time. The government maintains ownership of the asset, but maintenance standards are embedded in the contract and are the responsibility of the contractor.

Divestiture - The government transfers (sells) all or part of an asset to the private sector. Conditions of sale provide for continued services, maintenance and operation.

5.3 Dedicate Statewide Oversight and Funding to Maintenance

In some states, the maintenance of facilities has become an integral and automatic part of state budgeting. This section provides an overview of how Missouri, Utah, Washington, and Virginia have addressed their facilities maintenance problems. The State Infrastructure Bank program, created through federal legislation, has also shown promise. Massachusetts has explored similar approaches, as explained below, with uneven success.

Missouri

Missouri established a separate fund for maintenance in 1998. [28] In the program's first fiscal year, one tenth of one percent (0.1%) of the general fund was deposited in the Facilities Maintenance Reserve Fund (FMRF). This percentage has increased by one tenth of one percent each year until the FMRF reaches 1% of the general fund in 2007. Thereafter, it will continue to receive 1% of the general fund every fiscal year.

By comparison, Massachusetts expects $17.85 billion to flow into its General Fund in fiscal year 2008, therefore a fully funded contribution of 1% to a Facilities Maintenance Reserve Fund would be $178.5 million, and the initial payment (at 0.1%) to phase in a fund would be $17.85 million.

Missouri withdraws money from the fund on an as-needed basis. This requires each department to review the condition of facilities under their control and estimate the costs for repairs to maintain existing conditions or make needed upgrades.

Utah

The state of Utah has been working on the problem of deferred maintenance for almost 15 years. The first step was the creation of the Facilities Condition Analysis Program. The state contracted with ISES Corp of Atlanta, GA to do an initial condition assessment of all state facilities. Legislation was passed that established standards for evaluating condition and funding for capital improvements. [29]

The statute defines "capital improvements" as any remodeling, alteration, replacement or repair project with a cost of less than $1.5 million; a site or utility improvement with a total cost of less than $1.5 million; or a new facility with a total construction cost of less than $250,000. "Capital developments" are defined as any remodeling, site or utility projects with a total cost of $1.5 million or more, new facility with a construction cost of $250,000 or more; or purchase of real property where an appropriation is requested to fund the purchase.

The law prohibits the Legislature from funding design or construction of any new capital development projects until they have appropriated 1.1% of the replacement cost of existing state facilities to capital improvements. While such a binding restriction would most likely not pass the Massachusetts Legislature, it would serve as a useful tool to prioritize maintenance.

New construction accounts for about 8.5 percent of Utah's $1.6B FY 2008 capital and debt service budget. Under the law $10,138,600 is set aside for capital improvements.

The capital improvement funds are administered by Division of Facilities and Construction Management. Agency projects are funded based on priorities from a Facility Condition Analysis database, maintained and upgraded each year by ISES Corp. There are four categories of projects: Plant Adaptation, Capital Renewal, Deferred Maintenance, and O&M. These projects are prioritized based on the urgency of the asset's needs:

1. Immediate
2. Within one year
3. Two-to-five years
4. Six-to-ten years.

Kent Beers, Utah Director of Capital Planning, notes that for new capital development projects, funding is a "free for all," but for capital improvement projects the state now has a "condition planning tool." In discussions with legislators, he often equates this to the need to change the oil in your car. Better to do that, he says, than have to buy a new engine.

As a state that uses the GASB 34's modified approach to address infrastructure assets, Utah has shown leadership in addressing deferred maintenance. (See text box on page 30 for a summary of GASB 34.)

This affects not only their budget documents but also their financial reporting documents. The State's Comprehensive Annual Financial Report (CAFR) includes Required Supplementary Information on the infrastructure assets (roads and bridges) of the Utah Department of Transportation (UDOT). A description of the pavement management system for roads and the structures inventory system for bridges is provided along with condition levels for the last three years. Tables showing actual costs over the last five years and an estimate of the costs to maintain and preserve roads and bridges at or above the established condition levels are also included.

For instance, in FY2005 Utah spent $308 million to maintain state roads and $54 million to maintain bridges. Presenting these figures in the CAFR is a critical component of the maintenance program, since it provides information on cost of maintenance to legislators, other elected officials, agency heads, non-profit organizations, business leaders and the general public.

Washington

The state of Washington has embarked on a rigorous look at state maintenance practices. The Washington State Department of Transportation conducted customer (driver) surveys in 2000 and again in 2005. The results of the surveys have helped WSDOT focus on those infrastructure components most in need of repair. [29]

Both the 2000 survey and 2005 survey indicated that roadway surfaces had the most pressing need to be improved. Most of the respondents rated highway maintenance as average to above average. The surveys are part of a Maintenance Accountability Process (MAP) where in-house

GASB 34: An Accounting Standard that Improves Asset Management?

New governmental accounting standards provide another potential avenue for addressing asset management. In June 1999, the Government Accounting and Standards Board published Statement 34 (GASB 34), which set reporting standards for public entities and required them to depreciate their assets using one of two methods – a "straight-line method" or a "modified method"

The straight-line method is based on historical costs and straight-line depreciation of assets. The Commonwealth has selected this method for its financial reporting and is recommending that local governments use it as well. (MASS 2001, p.6-9)

The modified method is a more labor-intensive system of reporting that requires entities to have an asset management system and regular reporting on the effect of maintenance efforts. The asset management system must be comprehensive, up-to-date, and provide guidance on required maintenance expenditures. Although this system is clearly more complex and difficult to administer, it provides a more accurate picture of the true state of an entity's assets.

Using the Commonwealth's straight-line method, no condition evaluations are required and, after its 40-year life (as determined for the purposes of accounting standards), an asset, such as the Tobin Bridge, falls off the financial report. Thus the current CAFR contains no information on any asset older than 40 years.

Using Capital Asset Inventory Control (the "modified method") in the future could result in better financial reporting and a better accounting for maintenance and preservation of capital assets.

condition surveys assess the maintenance levels that exist at any given point in time. These surveys assess a broad range of metrics - pavement condition, function of drainage structures, condition of bridges, vegetation levels, etc. These assessments are collected quarterly in a report, known as "The Gray Notebook," which presents the metrics in a simple format, and also includes additional detail for expert study.

In addition, recently enacted legislation requires the Washington State Department of Transportation to utilize a life-cycle cost model for all of its capital assets. All assets must be inspected and updated for asset condition at least every three years. [31]

Virginia

The Commonwealth of Virginia has studied the issue of deferred maintenance for several years. [32] In response to legislation passed by the

General Assembly (Chap 4, Section C. 194.1 of the Special Session) the Virginia Auditor of Public Accounts (APA) issued an interim report in December 2004. That report contained a summary of state-owned buildings and compared Virginia's Building Life Cycle with an Ideal Building Life Cycle. A final report was issued in December of 2005 indicating that 5,269 of Virginia's 10,449 buildings had a deferred maintenance backlog of $1.626 billion.

State Infrastructure Banks

With the passage of ISTEA, the 1995 transportation funding authorization, the Federal Highway Administration encouraged formation of State Infrastructure Banks to fund transportation projects. Originally limited to 10 pilot states, the program has proven highly successful. The states involved in the pilot program capitalized their banks with a combination of federal funds, state appropriations and bond proceeds.

In concept, a SIB is similar to a revolving fund. Capitalized funds are placed in the bank and then loaned out to qualified borrowers. Payments made back to the bank in the form of capital and interest are then loaned out to new borrowers. In the latest 2005 federal transportation reauthorization act, called SAFETEA-LU, all states are eligible to establish an SIB and Massachusetts has legislation pending.

The SIB can also issue letters of security or loan guarantees to borrowers who wish to finance through private sources such as a bank or private trust. Borrowers can be public entities such as cities, towns or regional agencies, or private entities like railroads or private toll road builders. By providing such funds, significant leveraging of private investments can occur. The pending legislation in Massachusetts proposes a Board of Trustees including the Secretary of Administration and Finance, the Secretary of Transportation, the State Treasurer and a fourth member appointed by the Governor, possibly with the consent of the Senate.

Proposed projects must be approved by an advisory board, which may consist of the appointees of the Co-Chairmen of the Legislature's Joint Committee on Transportation, and the Directors of the Metropolitan Planning Organizations.

States that have created an SIB have moved ahead of Massachusetts in providing for transportation infrastructure. In Arizona, the SIB was first capitalized in 1996 with $6.7 million in federal funds. By 1998, the SIB was capitalized with $25.1 million in federal funds and $2.4 million in matching state monies. [33] With interest earnings of $2.2 million, the SIB account as of October 1998 was $39.7 million. By 2006 the state had approved 53 loans for transportation/economic development projects at a value of $582 million. [34]

In Texas, the state legislature authorized the SIB in 1997. As of August 2000, the Texas SIB had disbursed $39 million and made commitments of nearly $26 million more. As of August 2000, the SIB had a cash balance of roughly $197 million, of which $171.5 million was not yet committed to projects. Today the Texas SIB has approved 67 loans, totaling $294.9 million which have leveraged more than $2.03 million. [35]

With a focus on economic development and transportation needs, the proposed

Massachusetts State Infrastructure Bank could provide significant leveraging power in helping cities and towns to solve the maintenance and replacement needs of aging transportation facilities.

Massachusetts

This study chronicles many of the problems faced by Massachusetts in the area of asset maintenance. There has been some attempt to address these problems. In the mid-'90s, the Massachusetts House Ways & Means Committee began to explore options for increasing budgeting for maintenance. The initiative that resulted in the CAMIS database grew out of this period. A Capital Maintenance Reserve was created and funded with $12 million for a single fiscal year, but was eliminated in the following fiscal year.

6. Conclusion

The Longfellow Bridge is in sad shape, in part because of age and weather conditions, but mostly due to our neglect of maintenance. It serves as a crucial artery for the city, carrying almost 50,000 vehicles per day plus 100,000 Red Line riders. Yet, it has only received two significant rehabilitation efforts in a hundred years, totaling $23.5 million in 2007 dollars.

The results of this neglect are troubling: massive deterioration of key structural components of the bridge, significant cracking in the stone piers, and potential settling of the foundation. Fixing these problems is currently estimated to cost $180 million to $200 million, with the potential for huge cost escalation if additional problems are found.

Applying industry standard life-cycle cost scenarios to the bridge demonstrates that a regular program of maintenance would have extended its useful service life and lowered the Commonwealth's overall costs.

The decay of the Longfellow is symptomatic of a problem that threatens most of the Commonwealth's assets. These assets suffer from a maintenance backlog in the tens of billions of dollars. We lack a centralized system to comprehensively manage our assets. Our financial reporting system lacks procedures for condition assessment of these assets. The responsibility for their maintenance is highly compartmentalized and responsibility for maintenance can be unclear. Most importantly, we either fail to budget for maintenance, or discourage upkeep by forcing state managers to fund maintenance out of annual operating budgets.

Furthermore, there is no statewide plan in place to stop the problem from growing worse. Every new structure that is built, every road that is paved, every new asset of the Commonwealth is currently doomed to decay for lack of maintenance.

7. Recommendations

7.1 A Recommendation for Immediate Reform

Until the Commonwealth has a system in place to measure, fund, and address the maintenance needs of its assets, it should only begin a building project when it has a comprehensive life-cycle maintenance and capital replacement plan in hand. This plan must detail the annual operating and maintenance investments that are required to keep the facility in good condition. Our failure to maintain our assets has actually driven up infrastructure costs, as the risk of catastrophic failure forces us to fund emergency repairs. Building new assets without a comprehensive maintenance plan merely exacerbates the problem.

7.1 Recommendations for Systemic Reform: Measure, Budget, Execute

Measure

The Executive Office of Administration and Finance should, in cooperation with the Executive Office of Transportation and Public Works, and the Division of Capital Asset Management, prepare a report on asset conditions, condition trends, maintenance efforts and maintenance plans for each department and authority by asset class. The report should be presented to the Governor and general public.

This report should be updated on a yearly basis, and present in a digestible format: the status of assets by department, including maintenance efforts performed over the previous year, funds expended, and the progress (or lack thereof) in maintenance levels from previous years. A model program would be the Washington State Department of Transportation's Gray Notebook accountability program. (see http://www.wsdot.wa.gov/accountability/).

As part of this report, the amounts expended by each department on maintenance should be included and tracked on a yearly basis (and matched to specific assets where possible). Changes to the state accounting system already allow some automatic tabulation of maintenance-related spending. To the extent feasible, further changes to the system should be made to allow for transparent budgeting, expenditure, and tracking of maintenance spending.

Another option to be considered is the implementation of the modified method of GASB 34 reporting, which would require comprehensive usage of asset management systems. This would insure that condition assessments would be conducted and the value of public assets would be measured.

Budget

The Executive Office for Administration and Finance should work to reverse the existing disincentives that discourage the use of operating funds for maintenance and actively reward those agencies that are working diligently on maintenance. Each state agency having use of and responsibility for maintenance of any capital asset should include in its annual operating budget an amount equal to 2 percent of the replacement value for its capital assets. (Note that this is not 2% of total program budgets.) On or before the beginning of each fiscal year, each agency should submit to the division a plan for addressing deferred maintenance for each such capital asset.

A Commonwealth Facilities Maintenance Reserve Fund should be established, beginning with only 0.1 percent of the general fund in the first year and rising 0.1 percent per year to 1 percent of the general fund in the 10th year.

The Legislature and Governor should continue to utilize budgetary surpluses to perform pay-as-you-go capital maintenance projects. This is sound budgeting practice as it utilizes one-time sources of funds to address existing maintenance needs, rather than creating a liability in future years that must be included in future budgets.

Execute

Maintenance accountability issues in Massachusetts stem from several systemic problems, including a lack of centralized, accessible data and the diffusion of responsibility for asset maintenance. The lack of data is a larger problem where ownership is distributed among multiple agencies and authorities. With diffusion of ownership comes diffusion of maintenance responsibility, some of which lies with DCAM and some of which lies with the individual agencies and authorities.

The Governor should establish general principles for infrastructure maintenance to be followed by all state infrastructure agencies, and should charge the Executive Office of Transportation and Public Works and the Division of Capital Asset Management with responsibility for establishing a process to more fully develop and oversee guidelines that require each state agency to plan for maintenance, and make regular public reports on the magnitude of unfunded maintenance needs.

The Governor's Office should empower DCAM to fulfill its statutory ability to monitor the state's asset maintenance. DCAM's operating funds were effectively pulled during the budget process several years ago, a clear signal of the agency's relative political weakness. For DCAM to properly manage state assets would require not only increased funding for operations, but also a public expenditure of political capital to empower the agency.

The existing CAMIS database represents an underutilized resource. Funds for maintenance should only be made available for projects included in the CAMIS database. The Governor should issue an Executive Order compelling all state agencies and authorities (with the exception of those using another asset management system, such as PONTIS and FAMIS) to take advantage of CAMIS.

Lastly, the Governor's Office and the Executive Office for Administration and Finance should make a sustained effort to make maintenance a priority for program managers, and rewarding them and their programs for sustained improvements in maintenance practices and asset condition.

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