Brooklyn Bridge Park
Preventative Maintenance Plan

Technical and Program Review Comments

January 19, 2015

Goldenrod Blue Associates
1008 Orchard Lane
Broadview Heights, OH 44147
(216) 456-5285
edwardbartlett@cox.net

Contents

Executive Summary

This document provides technical and program review comments on the preventative maintenance plan dated November 3, 2015 and prepared by CH2M for the Brooklyn Bridge Park Corporation ("BBP"). Unless otherwise cited, all references and footnotes refer to the CH2M plan document. Also, in this Review document any reference to "Report" means the same CH2M plan document.

BBP operates on the east bank of the East River on 6 piers that were built during the late 1950's and early 1960's for industrial use. These piers, supported by 13,000 timber piles and 11,000 concrete pile extensions, provide 830,000 square feet of concrete pier deck. Like any marine structure, these piers and their supporting structures are subject to degradation over time. As such, periodic maintenance is required to maintain the full design load-bearing and operational capabilities of the piers.

The Report has significant deficiencies. The only two maintenance alternatives considered in the Report are the recommended "preventative maintenance" alternative and the other "reactive maintenance" alternative. This is an inappropriate, overly narrow selection of the maintenance alternatives to be studied. A "third option," suggested implicitly by the Report, appears to be technically superior and is likely the lowest cost option for BBP in present value terms.

Even with the inappropriately limited selection of maintenance strategy alternatives examined in the Report, the data, information and analysis provided in the Report fail to support the recommended "preventative maintenance" conclusion. Based upon the information presented in the Report and other supporting information cited in this Review:

- **The proposed option is NOT the best technical choice for BBP to maintain its marine structures**. The Report offers a false dichotomy of choice; the actual best choice, based upon the technical merits, is a third choice. This third choice was actually suggested, but not considered, in the Report. In several places the Report claims that the recommended preventative maintenance system has been used in other installations around the United States. For example, Section 6 of the Report discusses the Lake Pontchartrain Causeway in Louisiana. The data presented in the Report has been formatted into the table below for discussion purposes:[1]

Lake Pontchartrain Causeway				Year Built	1956
				# Piles	9,000
Year Work Done	Bridge Age (Years)	# Piles Done	Total Done to Date	% of Piles Done this Action	Total % of Piles Done
1988	32	21	21	0.2%	0.2%
1996	40	414	435	4.6%	4.8%
2002	46	174	609	1.9%	6.8%
2004	48	174	783	1.9%	8.7%
2010	54	586	1369	6.5%	15.2%

It is unreasonable that the inspection-based phased maintenance approach actually taken to maintain this now-59-year-old causeway was not formally considered in the Report. In fact, according to causeway personnel,[2] the epoxy grout piling encasements done on the causeway, which only represent about 15% of the pilings, were all done in response to evidence of degradation. This was, in fact, a phased, inspection-based, "reactive" maintenance strategy. It is highly likely that a phased installation of the epoxy grout encasements at BBP which takes advantage of the remaining life of the unrepaired existing pilings, would end up being the lowest cost long-term solution. This approach would feature establishing an installation plan that would take advantage of the remaining life of each particular piling prior to it becoming inadequate to bear its design loading. This action, to plan for the phased installation of the epoxy grout encasements prior to functional degradation (based upon both projections and periodic inspections), is a much more reasonable approach than to not perform any maintenance until after "significant deterioration had taken place."[3] Finally, as stated in Section 7 of

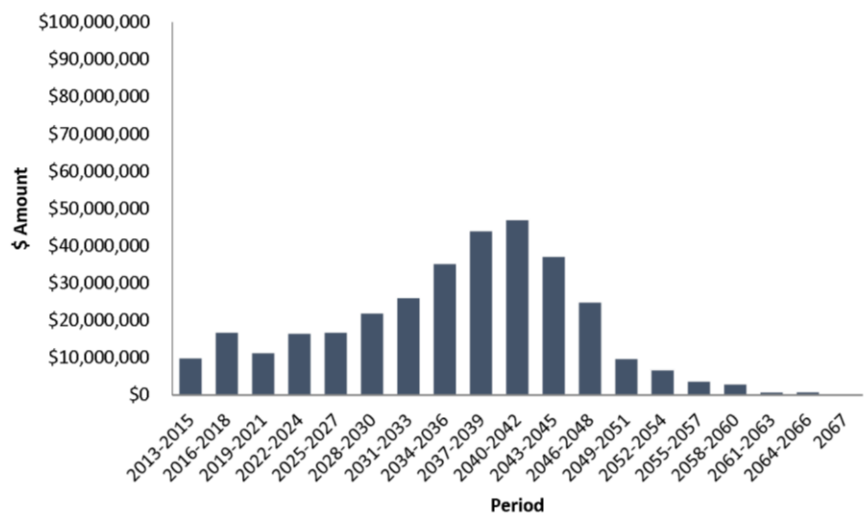
[1] Data taken and/or developed from Report Section 6, page 22

[2] As reported in a detailed telephone conversation between E. Bartlett, Goldenrod Blue Associates and C. Bourgeois, Vice President of Gulf Engineers & Consultants (who acts as the Causeway Chief Engineer) on December 3, 2015

[3] Report, Section 2, page 4

the Report, there are "a total of approximately 8,500 unrepaired piles and associated concrete extensions that are without significant deterioration."[4] ***This reality – that there is no immediate requirement for any extraordinary action to maintain the pilings and concrete extensions – is also represented in Figure 5-3 of the Report***.[5] *As shown in Report Figure 5-3, no significant spending is planned in the "reactive maintenance" plan for another 15 years or so.*

Figure 5-3. Representative Year vs. Cost Curve



Given this relatively long time until significant spending is projected to be required on the "reactive maintenance" approach, it is reasonable to conclude that a fully-effective installation plan for epoxy grout encasements of all unrepaired piers could be developed with a significantly lower cost (considering the economic factors of time value of money and inflation adjustments) by using a 20 or 25 year phased approach to the installation.

- **The Report fails to acknowledge that the "preventative" approach Involves an acceleration of unnecessary repairs that inevitably short-changes future generations.** By rushing to implement the proposed "preventative maintenance" strategy, BBP will require future significant maintenance to be performed (after the useful life of the proposed repairs has expired) considerably sooner than would be required if a phased approach is applied.

[4] Report Section 7, page 26
[5] Report Section 5, page 19

Since these 8,500 unrepaired pilings have no significant deterioration, and since both the "reactive maintenance" approach and the "preventative maintenance" approach have 50 year useful lives according to the Report,[6] failing to take advantage of the remaining unrepaired life of these pilings in the preventative approach instead of installing the epoxy grout encasement in a phased approach will shortchange future generations by 20 to 25 years in the timing of the need for future maintenance.

- **There is no demonstrated cost advantage for the Report's recommended "preventative maintenance" alternative**. The Report claims that the recommended "preventative maintenance" option is $84 million less expensive over 50 years than the "reactive maintenance" option[7] – the other alternative which was examined. But the Report's analysis is overly simplistic because its reliance on "2015 dollars" appears to ignore the fundamental economic factors of (a) the time value of money, and (b) inflation. Consideration of those basic economic factors is an essential element for any reliable comparison of the costs of different plans for any long-term capital project such as this, where one approach calls for payment of the bulk of the expense in the near term and the other defers much of the expense to decades later. In actuality, based upon the data presented in the Report, the current return of long-term bonds issued by New York City, and applying a generally accepted estimate for inflation, the cost of the recommended "preventative" alternative and the "reactive" alternative are essentially the same when the cost is expressed – as it must be -- in present value terms. And, as noted above, the reactive approach provides a significantly longer useful life for the repaired piles. The Report's obvious conceptual analytical error could call into question the validity of the other data and analysis presented in the Report.

Finally, there appears to be a clear conflict of interest between the authors of the Report, CH2M, and the Brooklyn Bridge Park with regard to the proposed preventative maintenance

[6] Report, Section 4, page 8
[7] Report, Section 1, page 3 states "approximately $85 million"; Report Section 8, page 30 states "greater than $84 million"; the mathematical difference between the cost charts shown in Report Figures 5-3 and 6-2 is $84 million.

plan (i.e. the subject of the Report). This is made clear in Section 8 of the Report, where the authors state "We look forward to the opportunity to work with you on this landmark project."[8] This suggests the possibility of impaired objectivity on the part of CH2M. With the apparent expectation on the part of CH2M to gain significant future contracted work "on this landmark project," it is legitimate to question the validity of the selection of data/information included in, the analyses conducted for, and the conclusions and recommendation provided by this Report.

[8] Report, Section 8, page 30

About Goldenrod Blue Associates and the Author

Goldenrod Blue Associates provides technically-oriented subject matter experts (SMEs) and other support services in a broad variety of marine, aerospace, defense, human factors and other industry areas. Goldenrod Blue's SMEs have industry-recognized expertise in areas ranging from submarines to satellites – and many, many areas in-between. Goldenrod Blue's client list includes market-leading technology companies, law firms and others.

The Author of this Review is Capt. Edward L. Bartlett, Jr., US Merchant Marine. Capt. Bartlett's undergraduate education was in marine engineering and naval architecture, leading to a Bachelor of Science degree; his post-graduate education was in business administration (finance), leading to a Master of Business Administration degree. He was also a member of the initial class of the Global Business Leadership Program conducted cooperatively by the Tuck School of Business at Dartmouth and Templeton College at Oxford. He is licensed both as a Master (Captain) and Engineer Officer in the US Merchant Marine. A former submariner and instructor in the US Navy's Nuclear Power Training Program, while employed by General Dynamics Electric Boat he both led a global technology development program and served as Engineering Manager for the design of the VIRGINIA Class nuclear powered attack submarine. As a business executive he turned around a failing ship controls equipment business and then, through a series of divestitures/acquisitions which he led, he built DRS Power Systems (now a unit of Finmeccanica, S.p.A.). DRS Power Systems is America's leading shipboard controls and propulsion systems provider. Capt. Bartlett's core expertise is in all aspects of ship and related marine equipment design, construction, operation and maintenance. His individual innovations include the development of a radically new electrical power distribution system for submarines. This new system simultaneously reduced ship size and cost while improving stealth. He also developed a radically new process for the assembly of shipboard nuclear reactors/powerplants – saving hundreds of millions of dollars in design and construction cost. This process was then adapted and applied to the design and assembly of the whole ship, saving even more cost. He was among the first who realized and demonstrated how power electronics technology could be uniquely applied to solve difficult problems.

Capt. Bartlett is not an expert in wood piling design/maintenance, but has applied his more than 30 years of engineering and business leadership experience to this Pro Bono assignment for Jenner & Block.

Technical Issues

The Report is Deficient in Not Examining All Legitimate Alternatives

The Report examines only two alternative plans for the long-term maintenance of the marine structures at Brooklyn Bridge Park. These options are labeled the "reactive maintenance strategy" and the "preventative maintenance strategy". The suggestion, for a cursory non-technical reviewer, is that the only options are to let the marine structures decay to the point where they lose their functional capability or to act immediately to prevent future decay through the implementation of a comprehensive "preventative" maintenance program. This, in fact, is both a false dichotomy of choice and is misleading.

Please consider that the Report itself offers examples of legitimate alternative maintenance strategies. The Report offers multiple "case studies" discussing other facilities that have employed/are employing the suggested epoxy grout encasement preventative maintenance approach for piling maintenance. In each of these 7 "case studies"[9] the implementation plan used a "phased" approach. In the case of the Lake Pontchartrain Causeway, both the world's longest bridge and one of the first facilities to employ the suggested epoxy grout encasement maintenance approach, this inspection-based phased reactive

implementation approach began in 1988.

Lake Pontchartrain Causeway				Year Built	1956
				# Piles	9,000
Year Work Done	Bridge Age (Years)	# Piles Done	Total Done to Date	% of Piles Done this Action	Total % of Piles Done
1988	32	21	21	0.2%	0.2%
1996	40	414	435	4.6%	4.8%
2002	46	174	609	1.9%	6.8%
2004	48	174	783	1.9%	8.7%
2010	54	586	1369	6.5%	15.2%

[9] Report, Section 6, page 22

Further, in its discussion of the New York Battery Park City Authority installation epoxy grout encasement installation program, the Report discusses the current program there as "Phase IV".[10] The examples cited in the Report therefore suggest that the typical installation process for epoxy grout piling encasements is in a phased manner – whether it is done proactively or reactively. This, then, is both a legitimate alternative maintenance strategy and it should have been considered in the Report as an alternative maintenance approach.

A phased inspection-based installation approach is, in fact, a legitimate maintenance strategy – and, as discussed further below, it appears to be a superior technical solution for Brooklyn Bridge Park. Not only that, the Brooklyn Bridge Park's own 2009 Financial Plan discusses their piling encapsulation plan and states that the plan "must be performed over the next 15 years."[11] This, installing these encapsulation systems over the next 15 years, is the essence of a phased implementation plan. So, until only recently, Brooklyn Bridge Park's own plan was to do exactly as is suggested in this Review (though perhaps with concrete rather than epoxy). This additional alternative, at a minimum, should also have been fully examined in the Report.

The Report is Misleading as to the Lake Pontchartrain Causeway Piling Encapsulation Program

The data presented above is a reproduction of the information provided in the Report.[12] In fact, this data is presented in the Report in a misleading way. In discussions with the Causeway General Manager[13] and the Causeway Chief Engineer[14] the inspection-based phased program to implement epoxy grout encasements on causeway pilings was discussed. Instead of being a "proactive" maintenance program, the Causeway program listed in the Report as a "case study"[15] was clearly a reactive maintenance strategy. The approximately 15% of the pilings that received the epoxy grout

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[10] Report, Section 6, page 22
[11] Brooklyn Bridge Park Financial Plan presentation dated January 29, 2009, Slide 26, as posted at http://brooklynbridgepark.s3.amazonaws.com/s/520/Financial%20Plan%20Presentation.pdf
[12] Report, Section 6, page 22
[13] As reported in a telephone conversation between E. Bartlett, Goldenrod Blue Associates and C. Dufrechou, General Manager of the Greater New Orleans Expressway Commission (colloquially known as "the Causeway Commission") on December 2, 2015
[14] As reported in a telephone conversation between E. Bartlett, Goldenrod Blue Associates and C. Bourgeois, Vice President of Gulf Engineers & Consultants (who acts as the Causeway Chief Engineer) on December 3, 2015
[15] Report, Section 6, page 22

encasement all had demonstrated evidence of deterioration in annual inspections. The damage had been caused by one of three issues (listed in order of prevalence):

1. Allisions by various vessels (vessels striking the pilings)
2. Overdriving when the pilings were originally installed (installation damage)
3. Grout failures between piling sections

Other than to repair any pilings which may be identified in future inspections as starting to degrade, there is no plan to use the epoxy grout encasement on any additional pilings.

The Report is Arguably Misleading as to the True Scope of What is Recommended

The Report, in its Summary presentations, could mislead the casual, or non-technical, reader into thinking that the recommended "preventative approach" is proactive with regard to *all* of the marine structures at Brooklyn Bridge Park – in fact, this is not correct. In the Report's Executive Summary[16] the two reviewed maintenance approaches are described and discussed, and the reader is led to believe that "Proactive, or preventative repairs. . . consist of epoxy (non-structural) encasements of timber piles to arrest deterioration."[17] The Report's Conclusion section also fails to indicate that the recommended maintenance plan does anything other than install these epoxy grout encasements on all pilings that have not already been structurally repaired.[18] At the start of Section 6, where the preventative maintenance strategy (proposed option) is described, the Report is technically accurate but arguably misleading in stating "This repair typically consists of installing. . ."[19]. This paragraph then goes on to describe how pilings are encased in the epoxy grout encasement system. Only at the very end of this Section does the true detail emerge – that there is not enough funding in the "preventative model" to include all of the pilings on Pier 3 in the epoxy grout encasement program.[20] The approximately 1,300 pier 3 pilings that are not included in the epoxy grout encasement program are, in fact, relegated to the "reactive" maintenance program.[21] Finally, the so-called proactive preventative approach does not include any proactive or preventative actions regarding either the concrete piling extensions or the pier

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[16] Report, Section 1, pages 1-3
[17] Report, Section 1, page 1
[18] Report, Section 8, page 30
[19] Report, Section 6, page 20
[20] Report, Section 6, page 23
[21] Report, Section 6, page 23

bulkheads.[22] Given these facts, buried deep within the Report, the non-technical or casual reader may not without careful study obtain a clear understanding of what is actually being proposed.

The Basis of the Timber Piling Deterioration Modeling is Unclear

The Report provides an overview of the modeling process used to prepare the two life cycle maintenance plans. Without providing any context, the Report states that “deterioration rates are dependent on many variables such as temperature, salinity, current, pollution levels, and remaining concentration of preventative treatment.”[23] This, of course, is all true – but is seemingly unquantified in the Report.

For example, water temperature and flow rate does, in fact, have a dramatic impact on the leaching rate of the chemical constituents of the creosote piling treatment used at Brooklyn Bridge Park.

Effects of Water Temperature and Flow Rate on Creosote Leaching

Average Leaching Rate Change/ Degree C	Water Temperature Degrees C	Flow	Acenaphthene Leach Rate (ug-cm^{-1}-day^{-1})	*Leaching Rate Change/ Degree C*	Dibenzofuran Leach Rate (ug-cm^{-1}-day^{-1})	*Leaching Rate Change/ Degree C*	Flouranthene Leach Rate (ug-cm^{-1}-day^{-1})	*Leaching Rate Change/ Degree C*	Flourene Leach Rate (ug-cm^{-1}-day^{-1})	*Leaching Rate Change/ Degree C*	Phenanthrene Leach Rate (ug-cm^{-1}-day^{-1})	*Leaching Rate Change/ Degree C*
Base Rate	5	0	27.3		17.1		26		8		14.7	
0.57%	20	0	39.9	*3.08%*	17.2	*0.04%*	13.6	*-3.18%*	8.3	*0.25%*	20.8	*2.77%*
1.18%	35	0	55.4	*2.59%*	12.7	*-1.74%*	16.2	*1.27%*	7.1	*-0.96%*	34	*4.23%*
Average Leaching Rate Change/ Degree C	Water Temperature Degrees C	Flow	Acenaphthene Leach Rate (ug-cm^{-1}-day^{-1})	*Leaching Rate Change/ Degree C*	Dibenzofuran Leach Rate (ug-cm^{-1}-day^{-1})	*Leaching Rate Change/ Degree C*	Flouranthene Leach Rate (ug-cm^{-1}-day^{-1})	*Leaching Rate Change/ Degree C*	Flourene Leach Rate (ug-cm^{-1}-day^{-1})	*Leaching Rate Change/ Degree C*	Phenanthrene Leach Rate (ug-cm^{-1}-day^{-1})	*Leaching Rate Change/ Degree C*
Base Rate	5	4	149.7		150.3		72.5		59.8		140.6	
0.92%	20	4	145.6	*-0.18%*	178.8	*1.26%*	57.7	*-1.36%*	77.5	*1.97%*	182.7	*2.00%*
6.53%	35	4	236.8	*4.18%*	584.2	*15.12%*	35	*-2.62%*	110.2	*2.81%*	529.8	*12.67%*

USDA Research Note FPL-RN-0286, November 2002; Y. Xiao, J. Simonsen, J.J. Morell

[22] Report, Section 6, page 20
[23] Report, Section 4, page 10

The data above[24] clearly demonstrates that changes in both water temperature and flow rate significantly impact the creosote leaching rate. It is, however, not directly helpful in modeling the deterioration of the pilings at Brooklyn Bridge Park. Even with detailed temperature data (the table to the right compares the annual East River temperature variation with the annual temperature variation at the Lake Pontchartrain Causeway in Louisiana) there is inadequate data to model deterioration rates.

Average Annual Water Temperature Comparison

Lake Pontchartrain Data: USGS NYC Data: NOAA	Lake Pontchartrain (degrees F)	East River *(average of Battery Point and Kings Point Measurements) (degrees F)*	*East River is Cooler by x degrees F*	*East River is Cooler by x degrees C*
January	56.84	37.50	*19.34*	*10.74*
February	57.74	36.00	*21.74*	*12.08*
March	62.24	40.50	*21.74*	*12.08*
April	68.54	47.25	*21.29*	*11.83*
May	76.46	57.00	*19.46*	*10.81*
June	82.22	65.25	*16.97*	*9.43*
July	84.38	70.50	*13.88*	*7.71*
August	84.74	73.50	*11.24*	*6.24*
September	82.22	70.50	*11.72*	*6.51*
October	75.02	61.75	*13.27*	*7.37*
November	67.28	53.50	*13.78*	*7.66*
December	60.80	43.00	*17.80*	*9.89*
Annual Average	**71.54**	**54.69**	***16.85***	***9.36***
Lake Pontchartrain - American Wood Preservers Association Classification				**UC5C/20 PCF**
East River - American Wood Preservers Association Classification				**UC5A/16 PCF**

Given this uncertainty and apparent lack of a quantitative modeling tool, the Report provides, without reference, their modeling assumption for the deterioration of the pilings at Brooklyn Bridge Park. These assumptions offer a constant deterioration rate for the first 6 years, double that rate for the next 6 years and then double that rate again for the following 38 years.[25] Despite an extensive review of the relevant literature, Goldenrod Blue Associates was unable to correlate this projected deterioration rate, or even the shape of such a deterioration rate curve, to any published studies. As a result, Goldenrod Blue Associates would welcome additional information from CH2M in order to duplicate the model used in the development of the Report.

An Alternate Deterioration Model suggests a Different Maintenance Strategy for Brooklyn Bridge Park's Marine Structures

As discussed above, a variety of factors impact the rate at which creosote-protected wood marine pilings deteriorate. The Report does provide adequate data to construct an alternative model as

[24] US Department of Agriculture Forrest Service Research Note FPL-RN-0286, dated November, 2002, Effects of Water Flow and Temperature on Leaching from Creosote-Treated Wood, Y. Xiao, J. Simonsen, J.J. Morrell
[25] Report, Section 4, page 10

to remaining life of the pilings that support the piers at BBP. This data is provided in Table 4-1 of the Report, copied for information below.[26]

Table 4-1. Results of the Creosote Retention Analysis for Piers 2, 3, 5 & 6.

Sample	Species*	Average Creosote Penetration	Composite Creosote Retention
Pier 2	Douglas-fir (6 cores)	1.25 in.	4.60 pcf
	Southern pine (4 cores)	3.25 in.	
Pier 3	Douglas-fir (1 core)	1.25 in	5.03 pcf
	Southern pine (9 cores)	3.44 in	
Pier 5	Douglas-fir (9 cores)	1.31 in	6.40 pcf
	Southern pine (1 core)	4 in	
Pier 6	Douglas-fir (10 cores)	1.19 in	4.49 pcf
	Southern pine (0 cores)	---	

**The number of cores in each sample which were identified as either Douglas-fir or Southern pine are indicated in parentheses.*

The table above establishes the condition of the piers as of 2010, when the analysis was conducted. This data, along with other data which may be inferred from the Report, supports the development of a deterioration model. This derivation of this alternative model, shown immediately below in six versions (low, mid, high creosote initial loading, with each creosote case analyzed for both 1960 and 1940 piling installation), will be discussed in detail further below.

Remaining Pier Life Model Based Upon 2010 Wood Testing Results *(Low Creosote 50 Years)*

BBP Pier	Average Creosote Loading as Measured in 2010 (PCF)	Piling Age (Based on Assumed 1960 Build)	Assumed Initial Creosote Loading Based Upon AWPA Requirements (PCF)	Observed Creosote Initial Half Life in Years	Assumed Minimum Acceptable Creosote Loading Based upon CH2M Report (Pier 3 Degraded in 2034) (PCF)	Model Years from 2010 Until Degraded	Predicted Year When the Pier is Degraded
2	4.6	50	12	31.1	3.93	13.7	2024
3	5.03	50	12	36.1	3.93	24.0	2034
5	6.4	50	12	57.1	3.93	67.2	2077
6	4.49	50	12	29.9	3.93	11.3	2021

Calculated using an Inverse Rectangular Hyperbolic Model: *Loading = Initial Loading x (1-(Elapsed Time/(Elapsed Time + Initial Half Life)))*

[26] Report, Section 4, page 10

Remaining Pier Life Model Based Upon 2010 Wood Testing Results *(Mid Creosote 50 Years)*

BBP Pier	Average Creosote Loading as Measured in 2010 (PCF)	Piling Age (Based on Assumed 1960 Build)	Assumed Initial Creosote Loading Based Upon AWPA Requirements (PCF)	Observed Creosote Initial Half Life in Years	Assumed Minimum Acceptable Creosote Loading Based upon CH2M Report (Pier 3 Degraded in 2034) (PCF)	Model Years from 2010 Until Degraded	Predicted Year When the Pier is Degraded
2	4.6	50	16	20.2	3.78	15.1	2025
3	5.03	50	16	22.9	3.78	24.0	2034
5	6.4	50	16	33.3	3.78	57.6	2068
6	4.49	50	16	19.5	3.78	13.0	2023

Calculated using an Inverse Rectangular Hyperbolic Model: *Loading = Initial Loading x (1-(Elapsed Time/(Elapsed Time + Initial Half Life)))*

Remaining Pier Life Model Based Upon 2010 Wood Testing Results *(High Creosote 50 Years)*

BBP Pier	Average Creosote Loading as Measured in 2010 (PCF)	Piling Age (Based on Assumed 1960 Build)	Assumed Initial Creosote Loading Based Upon AWPA Requirements (PCF)	Observed Creosote Initial Half Life in Years	Assumed Minimum Acceptable Creosote Loading Based upon CH2M Report (Pier 3 Degraded in 2034) (PCF)	Model Years from 2010 Until Degraded	Predicted Year When the Pier is Degraded
2	4.6	50	20	14.9	3.70	15.8	2026
3	5.03	50	20	16.8	3.70	24.0	2034
5	6.4	50	20	23.5	3.70	53.6	2064
6	4.49	50	20	14.5	3.70	13.8	2024

Calculated using an Inverse Rectangular Hyperbolic Model: *Loading = Initial Loading x (1-(Elapsed Time/(Elapsed Time + Initial Half Life)))*

Remaining Pier Life Model Based Upon 2010 Wood Testing Results *(Low Creosote 70 Years)*

BBP Pier	Average Creosote Loading as Measured in 2010 (PCF)	Piling Age (Based on Assumed 1940 Build)	Assumed Initial Creosote Loading Based Upon AWPA Requirements (PCF)	Observed Creosote Initial Half Life in Years	Assumed Minimum Acceptable Creosote Loading Based upon CH2M Report (Pier 3 Degraded in 2034) (PCF)	Model Years from 2010 Until Degraded	Predicted Year When the Pier is Degraded
2	4.6	70	12	43.5	4.19	11.0	2021
3	5.03	70	12	50.5	4.19	24.0	2034
5	6.4	70	12	80.0	4.19	78.9	2089
6	4.49	70	12	41.9	4.19	7.9	2018

Calculated using an Inverse Rectangular Hyperbolic Model: *Loading = Initial Loading x (1-(Elapsed Time/(Elapsed Time + Initial Half Life)))*

Remaining Pier Life Model Based Upon 2010 Wood Testing Results *(Mid Creosote 70 Years)*

BBP Pier	Average Creosote Loading as Measured in 2010 (PCF)	Piling Age (Based on Assumed 1940 Build)	Assumed Initial Creosote Loading Based Upon AWPA Requirements (PCF)	Observed Creosote Initial Half Life in Years	Assumed Minimum Acceptable Creosote Loading Based upon CH2M Report (Pier 3 Degraded in 2034) (PCF)	Model Years from 2010 Until Degraded	Predicted Year When the Pier is Degraded
2	4.6	70	16	28.2	4.07	12.7	2023
3	5.03	70	16	32.1	4.07	24.0	2034
5	6.4	70	16	46.7	4.07	66.7	2077
6	4.49	70	16	27.3	4.07	10.0	2020

Calculated using an Inverse Rectangular Hyperbolic Model: *Loading = Initial Loading x (1-(Elapsed Time/(Elapsed Time + Initial Half Life)))*

Remaining Pier Life Model Based Upon 2010 Wood Testing Results *(High Creosote 70 Years)*							
BBP Pier	Average Creosote Loading as Measured in 2010 (PCF)	Piling Age (Based on Assumed 1940 Build)	Assumed Initial Creosote Loading Based Upon AWPA Requirements (PCF)	Observed Creosote Initial Half Life in Years	Assumed Minimum Acceptable Creosote Loading Based upon CH2M Report (Pier 3 Degraded in 2034) (PCF)	Model Years from 2010 Until Degraded	Predicted Year When the Pier is Degraded
2	4.6	70	20	20.9	4.00	13.6	2024
3	5.03	70	20	23.5	4.00	24.0	2034
5	6.4	70	20	32.9	4.00	61.7	2072
6	4.49	70	20	20.3	4.00	11.0	2021
Calculated using an Inverse Rectangular Hyperbolic Model: *Loading = Initial Loading x (1-(Elapsed Time/(Elapsed Time + Initial Half Life)))*							

Each of the entries in the above models are discussed below:

- **BBP Pier.** This is the individual pier at Brooklyn Bridge Park
- **Average Creosote Loading as Measured in 2010 (PCF).** This data is copied from Table 4-1 in the Report. It represents how much creosote still remained in the pilings, as measured in pounds per cubic foot of wood, as of 2010 testing. This is a model input.
- **Piling Age Based on Assumed 1960 or 1940 Build.** This column provides an estimate, based upon the information provided in the Report, of how old the piers were in 2010, when the testing was completed. This is a model input. This column is used in determining the initial half-life of the creosote in each pier. Two build dates are considered in the sensitivity analyses above. While the Report indicates pier construction/piling installation in 1960, it is Goldenrod Blue's understanding that this site was actually in use as an industrial shipping port for many years prior to 1960. Because of this uncertainty in installation date, a second run of the entire model was conducted to demonstrate the sensitivity of the model results to an installation date prior to World War II (1940).
- **Assumed Initial Creosote Loading Based Upon AWPA Requirements (PCF).** This is the second element of assumed data, and is a model input. The American Wood Protection Association (AWPA) is referenced in the Report, and is the industry standard for wood protection specifications. Since 1999 Marine Pilings have been classified by AWPA as Use Category 5. AWPA further breaks down Use Category 5 by latitude, as the temperature and other factors are different based upon latitude. On the east coast of the United States, Use Category 5A applies to the Northern Waters, defined as any "salt and brackish water which includes Long Island, NY and northward". For UC5A, marine pilings in saltwater installed since 1999 must have a minimum creosote retention of 16 pounds per cubic foot. The requirements were different in

1960, however. The Use Category system was not yet in effect and the applicable standard then was AWPA Standard C3. For Southern Pine pilings used in coastal waters the C3 standard required an average creosote retention of 20 pounds per cubic foot (PCF). For Douglas Fir pilings in the same application the standard allowed the use of pilings with 12, 14 or 16 (for severe conditions) PCF creosote retention.[27] As noted in Report Table 4-1, both species were used at BBP. For the purposes of the analysis models shown above, this is the other input value (along with build date) that was changed between models to develop a sensitivity analysis. As can be seen above, because we have a fixed value in 2010 in the model for each pier, the higher the initial creosote retention, the shorter the creosote initial half-life. This is because the leaching rate had to be faster to get down to the 2010 as-tested creosote retention value for the pilings on each pier when starting from a higher initial value. This creosote initial half-life value impacts the model result, so to provide a broad sensitivity analysis we have run the model for each pier with three different initial creosote loading values. The "high creosote" case is set at 20 PCF, the "mid creosote" case is set at 16 PCF and the "low creosote" case is set at 12 PCF. These values were used as the starting point for the models in both 1960 and 1940.

- **Observed Creosote Initial Half Life in Years.** This is an output of the model. The formula used to calculate this value is based upon applying an inverse rectangular hyperbolic model to the input data, as suggested by Xiao, et. al.[28] This model was used by them to evaluate the flow and temperature sensitivity data shown and discussed above, and correlated well with their observed data regarding creosote leaching rate. Further, as they note, this hyperbolic degradation model compares well with prior quantitative studies. Note, however, that unlike radioactive decay, which follows a natural log (ln, or e^x)-based decay pattern (making "half-lives" repeatable over the complete course of isotope decay) the hyperbolic degradation model slows with elapsed time. As a result, the output value represents only the slope of the degradation curve at T=0. The "half-lives" become longer as the treatment continues to degrade. Finally, note that this is the very best way to establish the degradation rate of the pilings at each individual pier at BBP, since the tested pilings at each pier have been exposed to the exact

[27] Email Series between E. Bartlett, Goldenrod Blue Associates and Colin McCown, Executive Vice President, American Wood Preservers Association, dated December 1 and December 2, 2015

[28] US Department of Agriculture Forrest Service Research Note FPL-RN-0286, dated November, 2002, Effects of Water Flow and Temperature on Leaching from Creosote-Treated Wood, Y. Xiao, J. Simonsen, J.J. Morrell

conditions of that location since installation (either 1960 or 1940). This initial half-life determination can then be used to predict the remaining life of each pier's pilings prior to degradation past the usable point.

- **Assumed Minimum Acceptable Creosote Loading Based upon CH2M Report (Pier 3 Degraded in 2034) (PCF).** Using the model, and the initial half-life established for pier 3 (see above), the model can be advanced until 2034. The Report states that an undetermined number, but assumed as being the majority, of the remaining unrepaired piers on Pier 3 will not be degraded, if not treated with the epoxy grout encasement process, until 2034 or beyond.[29] By advancing the model to 2034, it is then established (derived from data in the Report) that this is the level of creosote retention at which marine borers are able to fully degrade the piers at BBP. This value is then applied to the other piers. This is a model output. Note that this "assumed minimum acceptable creosote loading value" varies from a low of 3.70 PCF to a high of 4.19 PCF. This plus or minus 6% from the mean variation is a weakness in this model. This was unavoidable because of the minimal available data from which to construct a model. This is precisely why 6 variations of the model have been run and included here – to provide a sensitivity analysis that should capture the range of possible outcomes. Further, because the other three piers are tied to the Report's projected condition of pier 3 in 2034, it would be accurate to state that this model's most definitive output is to provide a precise relative comparison of projected condition of the other 3 piers to the projected condition of pier 3 in 2034. As with all math models, the precision of this model can be improved with the provision of additional definitive input data and a definitive "final value" requirement.

- **Model Years from 2010 Until Degraded.** This is a simple application of the model to the 2010 half-life data to establish the years remaining until the pier will be degraded. This is a model output. For the purposes of this model (as discussed immediately above), degraded is defined as the projected 2034 creosote loading value derived from the model for the pilings on pier 3.

- **Predicted Year when the Pier is Degraded.** Using the model years from 2010 model output, this is a simple math exercise to establish what year the pier will be degraded. When considering the results of the various model variations, it is important to understand that – absent the detailed data from prior inspections and individual piling classifications – the six runs of the

[29] Report, Section 6, page 23

model were all constrained (as discussed in more detail above) to reflect pier 3 being deteriorated in 2034, as indicated in the Report. Should this factor change due to additional data being provided, the models would then be recalculated with the updated data. Because of this, the best way to consider the model output is that it produces predicted degradation dates for the other 3 piers based upon pier 3 being degraded in 2034.

The Report recommends that all pilings, except for those on Pier 3, which have not already been structurally repaired, should have the epoxy grout encasement treatment applied starting in 2016. ***When reviewing the results of the alternative degradation model, as discussed above, it becomes clear that there is absolutely no technical reason to rush into this "unprecedented" scale "landmark project"[30] in 2016.***

The results of the six model variations are summarized below:

Remaining Pier Life Comparison - Sensitivity Analysis for Initial Creosote Loading and Piling Installation Date

BBP Pier	Date Range - Predicted Pier Degradtion Year	Predicted Year When the Pier is Degraded - High Creosote - 50 Years (20 PCF Initial Creosote Retention)	Predicted Year When the Pier is Degraded - Mid Creosote - 50 Years (16 PCF Initial Creosote Retention)	Predicted Year When the Pier is Degraded - Low Creosote - 50 Years (12 PCF Initial Creosote Retention)	Predicted Year When the Pier is Degraded - High Creosote - 70 Years (20 PCF Initial Creosote Retention)	Predicted Year When the Pier is Degraded - Mid Creosote - 70 Years (16 PCF Initial Creosote Retention)	Predicted Year When the Pier is Degraded - Low Creosote - 70 Years (12 PCF Initial Creosote Retention)
2	**2021-2026**	2026	2025	2024	2024	2023	2021
3	**2034**	2034	2034	2034	2034	2034	2034
5	**2064-2089**	2064	2068	2077	2072	2077	2089
6	**2018-2024**	2024	2023	2021	2021	2020	2018

There is no Functional Difference in Model Results - The Phased Maintenance Approach is Apprrpiate in Any Case

The Model Results Do Not Support the Proposed Immediate Large Investment in the "Preventative" Maintenance Option

Putting cost questions aside, it would be more technically reasonable to develop a phased epoxy grout installation program – planning to prioritize installation on the pilings that are at earliest risk of degradation, and delaying installation on pilings that have many years left until degradation becomes a significant risk. Reviewing the model output, for instance, shows that the pilings on pier 5 have an average predicted degradation time-frame of 2075. ***There is no technical reason to install the epoxy grout encasement treatment on these pilings in 2016.***

Finally, there is the question of useful life. Many sources have established that marine pilings in seawater environments can have useful lives of over 100 years – sometimes much longer than that.[31]

[30] Report, Section 8, page 30

[31] e.g. The Timber Piling Council (www.timberpilingcouncil.org) and the Wood Products Council (www.woodworks.org/wp-content/uploads/Rollins-Timber-Piling.pdf)

The Report establishes the useful life of the epoxy grout encasement as 50 years.[32] While epoxy grout encasements may well have useful lives of 50 years, the system has only been in service for "approximately 30 years."[33] **So, given the assumptions presented in the Report and the model output above, why would anyone install a 50 year preservation treatment to a piling that has an unprotected calculated remaining useful life of between 48-73 years (pier 5)?** This would, in effect, be spending money now for no useful benefit over the next 50 years – a*nd would cheat future generations of the public from enjoying this pier's facilities without future additional maintenance*. It would be far more reasonable, from a strictly technical perspective, to delay installing the epoxy grout encasement treatment to these pilings until a point in time when they are still structurally sound (not degraded) but are much closer to the time when they will become degraded without additional action. This is the essence of a phased installation plan – an installation plan that all 7 of the cases cited in the Report are utilizing.[34]

Other Technical Observations Regarding the Report

The technical observations discussed above are the major items noted during this Review. Other technical points were noted and are listed below in summary fashion:

- **Pier 3 Planned Disruptions**. In each place that the Report discusses the "advantages" of the recommended plan it cites the advantage of not requiring disruption of public access on the pier during structural piling repairs.[35] What is the plan for public access to pier 3 when every 3 years structural piling repairs are installed as planned in the so-called preventative (proposed) plan?[36]
- **Steel and Concrete Maintenance**. The Report includes significant content on the degradation processes for both steel and concrete in this type of marine structure installation.[37] The recommended plan does not include any preventative maintenance for the steel (primarily the sheet pile bulkheads) or concrete (primarily the concrete piling extensions).[38] If no preventative

[32] Report, Section 4, page 8
[33] Report, Section 6, page 22
[34] Report, Section 6, page 22
[35] e.g. Report, Section 1, page 2
[36] Report, Section 6, page 23
[37] Report, Section 4, pages 11, 12, 13 & 14
[38] Report, Section 6, page 20

treatment is recommended on these areas, why was so much content (> 13%) devoted to these areas in the Report?

- **Concrete vs. Wood Pilings.** The first two "case studies" offered for comparison in the Report involve concrete pilings.[39] These are the longest serving installations of this protection system. In other case studies on the same page the Report discusses New York Harbor. While not noted, it is assumed that these are wood piling structures. Less detail is provided on the New York Harbor installations, including how long this system has been in use on wood pilings. Prior to making an "unprecedented" scale "landmark" investment it would be helpful to have more information on truly comparable installations. What was the condition of the wood pilings prior to installation? What problems, if any, have been encountered? How long have these installations been in service, etc.?

- **Service Life (Durability).** In comparing the two options, the Report notes that the service life and durability of both maintenance options is established at 50 years.[40] The Report, in this discussion, suggests that due to corrosion of the embedded reinforcing steel in the structural repair (reactive) that it "can lead to accelerated deterioration." The Report then goes on to note that the principal (as now known) degradation mechanism for the epoxy grout encasement system is the chemical breakdown (i.e. breakdown of the chemical bonds) of the epoxy due to exposure to the ultraviolet light contained in sunlight. The mitigation treatment to prevent the chemical breakdown of the epoxy is then discussed, closing with "preventative epoxy repairs can have service lives of 50 years. In both cases there are, as there always are, long-term degradation mechanisms for each maintenance system, and both systems are rated, according to the Report, at 50 year lives.[41] With this all in mind, why does the Report then suggest that the structural repair process has risks to reaching its designed 50-year life but that the epoxy grout installation "can" reach its designed 50-year life? This presentation appears to be slanted toward the recommended system, but without supporting technical data.

[39] Report, Section 6, page 22
[40] Report, Section 7, page 27
[41] Report, Section 4, page 8

- **Availability of Warranty.** While this comment is more programmatic than strictly technical, it seems odd that almost a full page of the Report is dedicated to what is, in reality, a straw man.[42] The Contracting Authority for any work establishes the required warranty provisions and requirements (including performance bonding, as appropriate) for all contracted work. Since BBP is the Contracting Authority on this work, whichever method is chosen, it can establish equivalent warranty requirements on whatever work is contracted for. If warranty issues are such a significant problem with the structural repair process, there are two obvious questions. First, what is the specific warranty problem with the 4,907 pilings that have been repaired to date using the structural repair process? Note that this represents 37% of all of the pilings at BBP. Second, if warranty with the structural repair process is such a big issue, why does the Report recommend this process for the unrepaired pilings at pier 3 which require nearest term maintenance?

- **Structural Capacity of Pilings After Treatment.** The Report notes that the added deadweight of the structural repair process is greater than the added deadweight of the epoxy grout encasement process, and that this reduces the useful loading of the affected pilings more for the structural repair process than it does for the epoxy grout encasement process.[43] This, however, has not been quantified in terms of real impact on the load capacity of the pier deck. Note that 37% of all pilings have already had the structural repair process completed on them, and that the pier decks have not been de-rated. It is also noted that many wood pilings have been tested after installation in many locations around the United States to 250% of their design loading without failure.[44] Additionally, the Report characterizes this as potential problem that "may result in a reduction of the load rating of the piers later in time."[45] Given that this is only a potential problem, that the Report provides no useful data concerning current or projected load margins, and that these pilings have substantial (more than a 150% loading safety factor), is this a real concern for piling maintenance process selection?

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[42] Report, Section 7, page 28
[43] Report, Section 7, page 29
[44] Testing conducted in accordance with ASTM Procedure D1143, as Reported in Timber Piling Design, Martin Rollins, P.E., Copyright 2012, (www.woodworks.org/wp-content/uploads/Rollins-Timber-Piling.pdf)
[45] Report, Section 7, page 29

Cost Modeling Issues

The Relevant Economic Factors Associated with the Report's Cost Modeling Appear to Be Ignored in the Report

The very first new concept that is introduced in typical introductory texts in financial management is the concept of time value of money.[46] As outlined by Joy in his referenced text, "Most people would prefer current consumption to future consumption; so investors of all sorts expect to be rewarded for their patience by receiving a rate of return on their investment; for various investments, this return may take the form of interest, dividends, or capital gains. All three represent the return for waiting: the time value of money."

Calculating the time value of money can be done to establish the *'future value'* (FV) of an investment made today, to determine the *'present value'* (PV) of a future stream of capital flows, and to establish the *'net present value'* (NPV) of an irregular stream of future capital flows. What is required for these calculations is to simply know the timing and the value of the capital flows (invested/returned or spent/earned) at each point and to know the *'discount rate'* for this investment. The *'discount rate'* reflects both market conditions for the *'cost of capital'* (including inflation) as well as the *'risk premium'* to be assigned to any particular investment. The capital markets, with their worldwide nexus in New York City, are extraordinarily proficient in establishing this *'discount rate'* – or *'required rate of return'* – for the entire spectrum of possible investments.

In addition to the time value of money, the second relevant economic factor to be considered is the inflation or other non-currency cost impacts on forward prices from data that is measured retrospectively, typically by the consumer price index. The challenge, of course, is to forecast future prices based upon recent backward-looking trends.

In reviewing the Report, the claim is made that the proposed preventative maintenance strategy is $84 million less expensive than the current reactive maintenance strategy.[47]

The apparent 34% cost difference between these options provides an apparently compelling reason for the "unprecedented" scale "landmark" project to be conducted as recommended.[48] Yet the

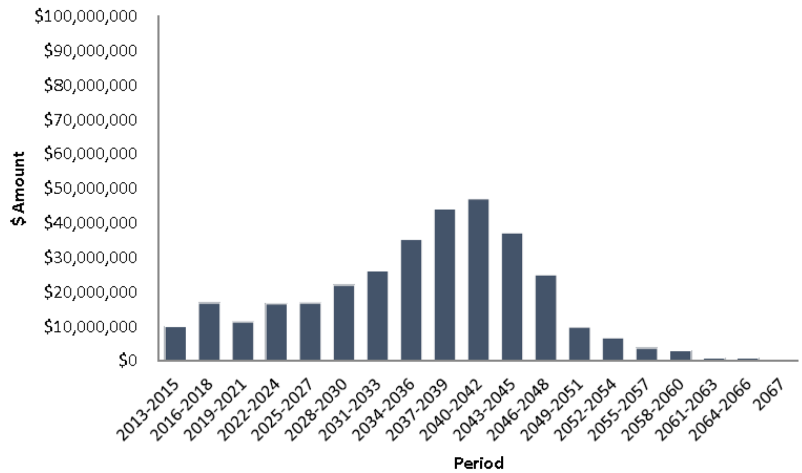
[46] e.g., Introduction to Financial Management, by O. Maurice Joy, published by Richard D Irwin, Inc.
[47] Report, Section 1, page 3 states "approximately $85 million"; Report Section 8, page 30 states "greater than $84 million"; the mathematical difference between the cost charts shown in Report Figures 5-3 and 6-2 is $84 million

Report's data is consistently expressed as "2015 Dollars," which generally is understood to refer to the amounts that would be charged if all payments were made in 2015; in other words, the Report describes costs to be paid in, for example, 2034, as if they were being paid in 2015, without any adjustment for either the time value of money -- the fact that BBP does not have to actually make the payment in 2015 – or for the inflation of the required costs at the time they will actually be incurred.

Report Figures 5-3 and 6-2 are copied below for information.

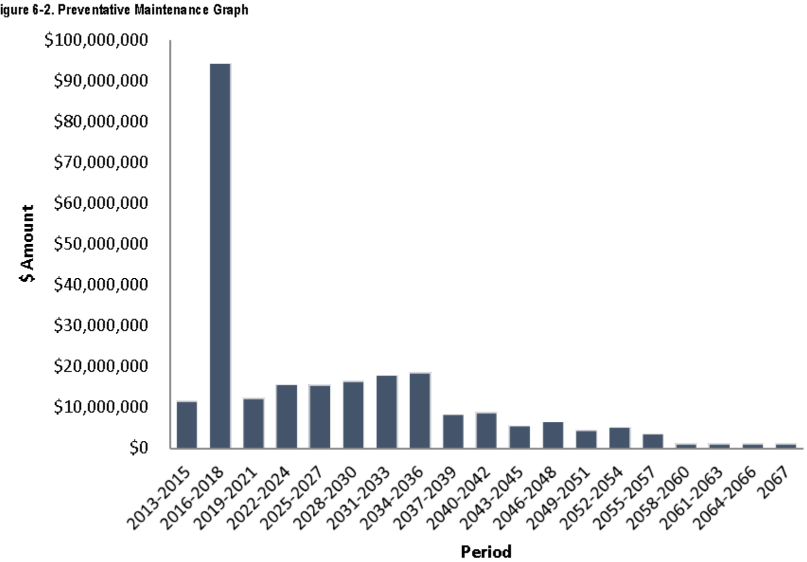
[48] Report, Section 8, page 30

Figure 5-3. Representative Year vs. Cost Curve



The overall total cost of the Reactive program for the timber piles, including both capital and operational costs, is approximately $334M in 2015 dollars.

Figure 6-2. Preventative Maintenance Graph



The overall total cost of the Preventative program for the timber piles, including capital and operational costs, is just under $250M in 2015 dollars.

Reflecting the Economic Factors Necessarily Changes the Financial Analysis Result

In order to consider the true cost of the two plans, it is necessary to prepare an analysis of the net present values of their respective costs. An analysis of the proposed spending in each plan has been conducted using the standard NPV analysis formula, both with and without price adjustments. The analysis that follows is intended to illustrate, with a reasonable example, the importance of applying the required economic factors in any comparative assessment of future costs.

To perform the net present value analysis, the data represented in Report Figures 5-2 and 6-3 have been imputed into annual investments, as shown in the tables below. For the first analysis a basic discount rate of 3.41% has been used. This value was assigned based upon the yield to maturity of a recently traded existing New York City bond with a 2046 maturity.[49] It should be noted that this bond, when issued, had a 4.0% interest rate (coupon). This 4.0% discount rate was also used in one of the analysis variations that includes CPI adjustments. Since Brooklyn Bridge Park derives its income stream, at least in part, from real estate taxes and/or commercial property rents/lease payments and since Brooklyn Bridge Park is a public entity under the cognizance of the Mayor of New York City and the Governor of New York State, it is considered reasonable that the yield to maturity of the noted, recent bond trade is an appropriate proxy for the current discount rate in this analysis. Further, that the original bond coupon (interest) rate is a reasonable proxy for the discount rate over the last 24 months.

The consumer price index – urban (CPI-U), developed and published monthly by the Bureau of Labor Statistics (BLS),[50] has been used to establish a forward pricing adjustment factor. One factor, 0.2%, has been established for the most recent 12-month period (the latest published CPI report is for October, 2015,[51] so the 12 relevant months are November, 2014 through October, 2015). As published by BLS, this trailing 12-month CPI adjustment is 0.2%. Similarly, for the trailing 24-month period the CPI adjustment is 0.95% (the average of 0.2% for 2015 and 1.7% for 2014). Because current bond pricing, and thus the current bond-derived discount rate, reflect the then-current economic conditions, the bond rate for the 24-month analysis was set at 4% (the bond's original issue interest rate). This is consistent with the bond's new, current, yield to maturity since the CPI (i.e. inflation) has significantly dropped in 2015 vs. 2014. This is also consistent with the cost of capital for long-term New York City debt (bonds) at between 300 and 325 basis points (i.e. 3.0% to 3.25%) above CPI. To simplify the math (no change in result) the models were run with a 3.41% discount rate (no CPI adjustment), with a 3.21%

[49] Upon inquiry, PNC Financial Services Reported that an existing New York City bond with a 2046 maturity was traded in the financial markets on November 24, 2015 at a yield to maturity of 3.41%. It was also reported that this bond had an issued "coupon rate" (initial interest rate) of 4.0%

[50] Consumer Price Index information, including the detailed monthly database, are posted the Bureau of Labor Statistics website at: http://www.bls.gov/cpi/

[51] CPI-U for October, 2015 and for the preceding 12 months can be found on page 1 of the October, 2015 CPI report at http://www.bls.gov/cpi/cpid1510.pdf

net discount rate (3.41% bond rate with a 0.2% CPI adjustment) and with a net discount rate of 3.05% (4.0% bond rate with a 0.95% CPI adjustment).

The results of this analysis are presented below. The first two presentations are the model for each maintenance strategy, run without CPI adjustment. The following section provides a comparison of the results of all variations.

Net Present Value - *Reactive Maintenance Strategy (currenly in use)*							
NPV of the	*(all in $M)*	Year	Spending	Year	Spending	Year	Spending
Investment	**$160.92**	2023	$5.67	2038	$15.00	2053	$1.33
Discount		2024	$5.67	2039	$15.00	2054	$1.33
Rate	**3.41%**	2025	$6.00	2040	$16.67	2055	$1.00
Annual Investment		2026	$6.00	2041	$16.67	2056	$1.00
Year	Spending	2027	$6.00	2042	$16.67	2057	$1.00
2013	$3.33	2028	$7.00	2043	$12.33	2058	$0.67
2014	$3.33	2029	$7.00	2044	$12.33	2059	$0.67
2015	$3.33	2030	$7.00	2045	$12.33	2060	$0.67
2016	$6.00	2031	$8.67	2046	$8.67	2061	$0.17
2017	$6.00	2032	$8.67	2047	$8.67	2062	$0.17
2018	$6.00	2033	$8.67	2048	$8.67	2063	$0.17
2019	$3.67	2034	$11.67	2049	$3.33	2064	$0.17
2020	$3.67	2035	$11.67	2050	$3.33	2065	$0.17
2021	$3.67	2036	$11.67	2051	$3.33	2066	$0.17
2022	$5.67	2037	$15.00	2052	$1.33	2067	$0.00

Net Present Value - *Preventative Maintenance Strategy (proposed)*							
NPV of the	*(all in $M)*	Year	Spending	Year	Spending	Year	Spending
Investment	**$163.18**	2023	$5.33	2038	$2.67	2053	$2.00
Discount		2024	$5.33	2039	$2.67	2054	$2.00
Rate	**3.41%**	2025	$5.33	2040	$2.67	2055	$1.17
Annual Investment		2026	$5.33	2041	$2.67	2056	$1.17
Year	Spending	2027	$5.33	2042	$2.67	2057	$1.17
2013	$3.67	2028	$5.67	2043	$2.00	2058	$0.17
2014	$3.67	2029	$5.67	2044	$2.00	2059	$0.17
2015	$3.67	2030	$5.67	2045	$2.00	2060	$0.17
2016	$31.67	2031	$6.33	2046	$2.33	2061	$0.17
2017	$31.67	2032	$6.33	2047	$2.33	2062	$0.17
2018	$31.67	2033	$6.33	2048	$2.33	2063	$0.17
2019	$3.67	2034	$6.50	2049	$1.67	2064	$0.17
2020	$3.67	2035	$6.50	2050	$1.67	2065	$0.17
2021	$3.67	2036	$6.50	2051	$1.67	2066	$0.17
2022	$5.33	2037	$2.67	2052	$2.00	2067	$0.50

Comparing the Financial Projections with and without considering Economic Factors

In the table below the financial projections for the two plan options are compared with and without considering the economic factors.

Understanding the Impact of Economic Factors over this 50 Year Plan				
Analysis Variation Explanation	**Simplistic Model from the Report *Unadjusted for any Economic Factors***	**Adusted to Reflect 3.41% Discount Rate & No Cost Growth**	**Adusted to Reflect 3.41% Discount Rate & 0.2% Twelve Month CPI Growth (per BLS)**	**Adusted to Reflect 4.0% Discount Rate & 0.95% Twenty Four Month CPI Growth (per BLS)**
Plan Option *(all analyses over 50 years)*	**Plan Option Cost *per Report* *($M)***	**Present Value Adjusted Plan Option Cost Reflecting Discount Rate @ 3.41% *($M)***	**Present Value Adjusted Plan Option Cost Reflecting Net Discount Rate @ 3.21% *($M)***	**Present Value Adjusted Plan Option Cost Reflecting Net Discount Rate @ 3.05% *($M)***
Reactive Maintenance Strategy (currently in use)	$334.0	$160.9	167.3	172.6
Preventative Maintenance Strategy (proposed option)	$250.0	$163.2	166.7	169.7
Cost Advantage - "Reactive"		$2.3		
Cost Advantage - "Preventative"	$84.0		$0.6	$2.9
Failing to Consider Economic Factors Inserts Significant (>$81 Million) Analysis Error				

As shown in the table above, based on the illustrative example presented above, there is actually not any real cost advantage, in present value terms, to the proposed preventative program plan in contrast to the reactive plan.[52] In fact, when considering the economic factors (i.e. the time value of money and CPI price adjustments) there is no significant difference in the price between the options – the variation is most likely within the estimating "margin of error" for the underlying cost estimates.

The net present value of a future payment stream is sensitive to the selection of both discount rate and inflation rate. It is believed that the relatively low discount rate applied in the illustrative example in this Review is a conservative assumption (since a higher discount rate would reduce the net present value of the reactive program relative to the preventative program); a higher discount rate could be supported, and that would result in an even lower cost for the reactive program relative to the preventative one. However, one could also support applying a higher inflation factor than the recent value of the CPI applied in the illustrative example, and a higher inflation rate would increase the relative present value of the reactive program. In view of the lack of predictability of marine construction costs decades from now, however, there is little apparent basis to depart from use of the CPI, which is traditionally applied for such purposes. Moreover, the higher the inflation rate one selects

[52] Report, Section 8, page 30

for the net present value analysis the greater the support for applying a higher discount rate also, since discount rates are typically increased as the perception of uncertainty of future conditions increases; a higher discount rate would offset the effect of the higher inflation rate on the relative net present values of the two approaches. It is therefore submitted that the example set out above fairly illustrates the need to apply a present value analysis in the cost comparison, and suggests that the preventative plan does not have a material, if any, cost advantage over the reactive plan.

The Cost of the Third Option is Highly Likely to be the Lowest Cost Plan

Based upon the results of the financial analysis discussed above, it is highly likely that the third option, the phased installation of the epoxy grout encapsulation system, as described in the Technical Section above, will be the lowest cost plan. This is because this plan will avoid the huge near-term spike in spending that is the essential element of the proposed plan. At the same time, it will also avoid the higher unit cost of repairing pilings using the structural repair method. By delaying the spending from 2016 until later (by appropriately using some of the remaining life of the pilings as they are now) the cost, in present value terms is reduced. Determination of the exact savings that are possible under such a phased approach requires access to additional data. Nonetheless, the savings offered by this third option are expected to be significant.

Organizational Conflict of Interest Issues

What is Organizational Conflict of Interest?

Organizational conflict of interest (OCI) refers to a conflict of interest relating to the government. It is similar to private sector conflict of interest in that it requires that parties be impartial and trustworthy. If not, that would constitute conflict of interest. OCI exists when personal or professional interests of a person affect the person's ability to put his interests aside. The types of individuals or entities who are required to comply with OCI laws are government contractors, sub-contractors and affiliates of contractors, any entities owned by the prime contractor and chief executives and directors. Effectively practicing OCI rules helps to ensure that money will not be wasted. OCI laws help to make sure that the best-qualified, rather than the best-connected contractor is used. Eliminating OCI will create more trust in government endeavors. The public expects that preferential treatment not be granted to anyone and that insider deals be stopped. Potential OCI problems are unequal access to information, impaired objectivity and biased ground rules.[53]

Conflict of Interest Regulations Affecting Brooklyn Bridge Park

The Brooklyn Bridge Park, in accordance with applicable New York State Law for non-profit corporations, has an ethics, conflict of interest and contracting policy. These are all published on the park's website.[54] Of particular interest in this Review is the contracting policy. From a non-attorney program manager point of view, this is one of the weakest contracting conflict of interest regulations ever encountered. Essentially, it authorizes the park to do anything that is approved by the Chairman. There is nothing in the Brooklyn Bridge Park contracting policy that attempts to preclude impaired objectivity on the part of park contractors. This is a specific weakness of this policy, and this weakness may have materially affected this program.

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[53] This paragraph was adapted from a discussion available at: www.ehow.com/facts_5964932_organizational-conflict-interest_.html

[54] The Brooklyn Bridge Park website is: www.brooklynbridgepark.org

The Appearance of Impropriety – Impaired Consultant Objectivity

It may be of interest to review the Federal Acquisition Regulations for the Organizational Conflict of Interest regulations that apply to contractors.[55] These regulations, applicable to all contractors doing business with the Federal Government, prohibit a single contractor from defining requirements for a specific program and then gaining a contract to execute such a program. This is a very strong Organizational Conflict of Interest regulation, and is aggressively enforced. In short, the federal OCI requirements are the antithesis of the Brooklyn Bridge Park contracting requirements.

In Section 8 of the Report, where the authors state "We look forward to the opportunity to work with you on this landmark project"[56] it seems that CH2M expects to be a contractor in some unspecified capacity in connection with the execution of the proposed program. It also plausible that CH2M has been aware that the preventative plan is favored by BBP management to justify their plan for immediate revenue-generating development at Pier 6, and the Report has been influenced by that awareness. This may be an area to be examined in determining the validity of the Report.

[55] 48 CFR Part 9, Subpart 9.5 – Organizational and Consultant Conflicts of Interest
[56] Report, Section 8, page 30