Cavanaugh Macdonald
CONSULTING, LLC
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Montana Teachers' Retirement System

Risk Analysis Report

Section	**Page**

Cavanaugh Macdonald
CONSULTING, LLC
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April 6, 2020

Teachers' Retirement Board
State of Montana
1500 Sixth Avenue
Helena, MT 59620-0139

Re: Risk Analysis Report

Dear Members of the Board:

At your request, we have performed a study of the actuarial-related risks faced by the Teachers' Retirement System (TRS). This report is designed to support and expand on the actuarial valuation report that we prepare annually for basic benefits valuation for TRS. While the exhibits and graphs shown in this report are based on the July 1, 2019 TRS actuarial valuation, the analysis of the results and the discussion of the implications for TRS and its stakeholders are expected to remain substantially unchanged for the next few years.

The primary objective of this report is to provide the analysis of risk, as required under Actuarial Standard of Practice Number 51, *Assessment and Disclosure of Risk Associated with Measuring Pension Obligations and Determining Pension Plan Contributions.* There are other risks that TRS faces, including issues such as cyber security, a catastrophe to the physical location, and many others. These are outside the scope of our analysis, which focuses only on those risks relating to the variance in the measurement of the benefit obligations as well as the contribution rates. There is no specific action by the TRS Board either required or expected in response to this report, although it is possible that a deeper understanding of the risks faced by TRS may prompt some additional discussion or study.

In preparing our report, we utilized the data, methods, assumptions, and benefit provisions described in the July 1, 2019 actuarial valuation of TRS. That report should be consulted for a complete description of how our work was performed. Some of the results in this report are based upon modifying one or more of the valuation assumptions as noted in the discussion of the analysis being performed.

The consultants who worked on this assignment are pension actuaries with significant public plan experience. In addition, the signing actuaries are independent of the System and the plan sponsor. We are not aware of any relationship that would impair the objectivity of our work.

On the basis of the foregoing, we hereby certify that, to the best of our knowledge and belief, this report is complete and accurate. The valuation, on which this analysis was based, was prepared in accordance with principles of practice prescribed by the Actuarial Standards Board. Furthermore, the actuarial calculations were performed by qualified actuaries in accordance with accepted actuarial procedures, based on the current provisions of the retirement system and on actuarial assumptions that are internally consistent and reasonable based on the actual experience of the System. I am a member of the American Academy of Actuaries and meet the Qualification Standards to render the actuarial opinion contained herein.

We respectfully submit the following report and look forward to discussing it with you.

Todd B. G

Todd B. Green, ASA, FCA, MAAA
President

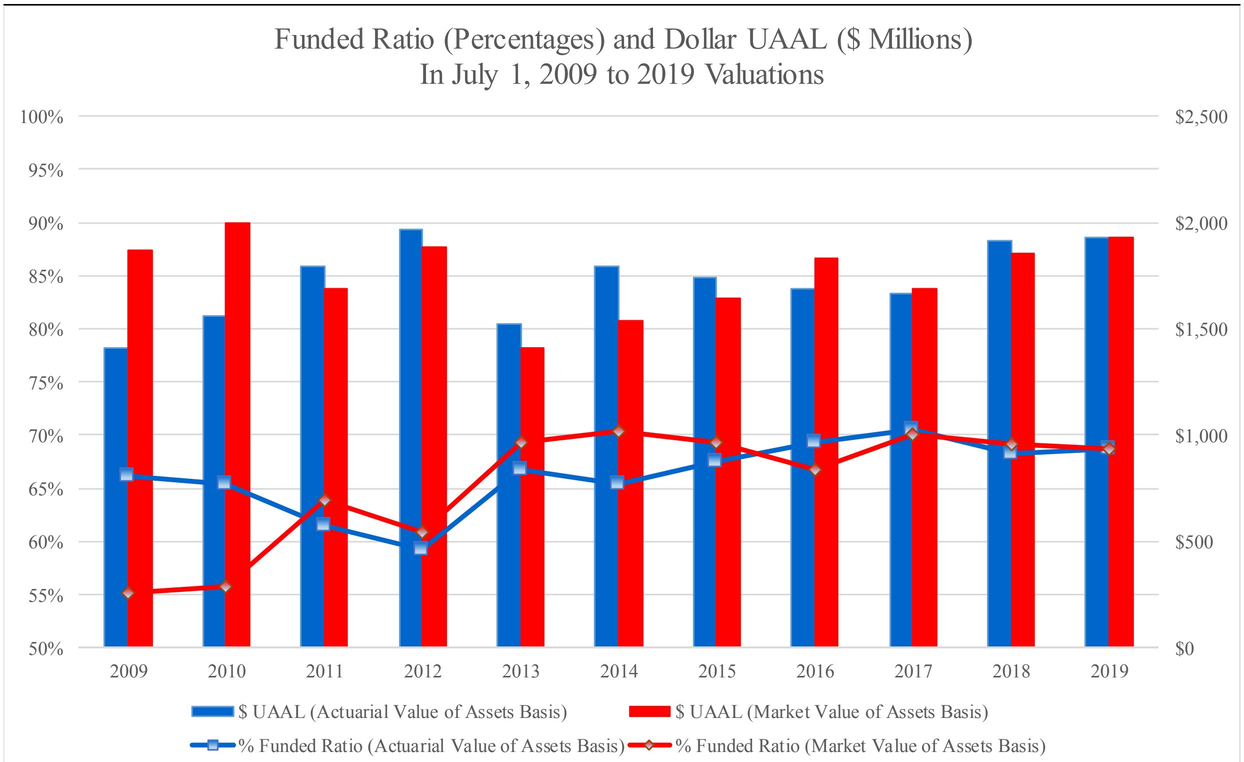
Actuarial Standard of Practice Number 51 (ASOP 51)

Actuarial Standards of Practice (ASOPs) are issued by the Actuarial Standards Board and are binding for credentialed actuaries practicing in the United States. These standards generally identify what the actuary should consider, document and disclose when performing an actuarial assignment. In September, 2017, ASOP 51, *Assessment and Disclosure of Risk Associated with Measuring Pension Obligations and Determining Pension Plan Contributions*, was issued as final with application to measurement dates on or after November 1, 2018. This ASOP applies to funding valuations, actuarial projections, and actuarial cost studies of proposed plan changes.

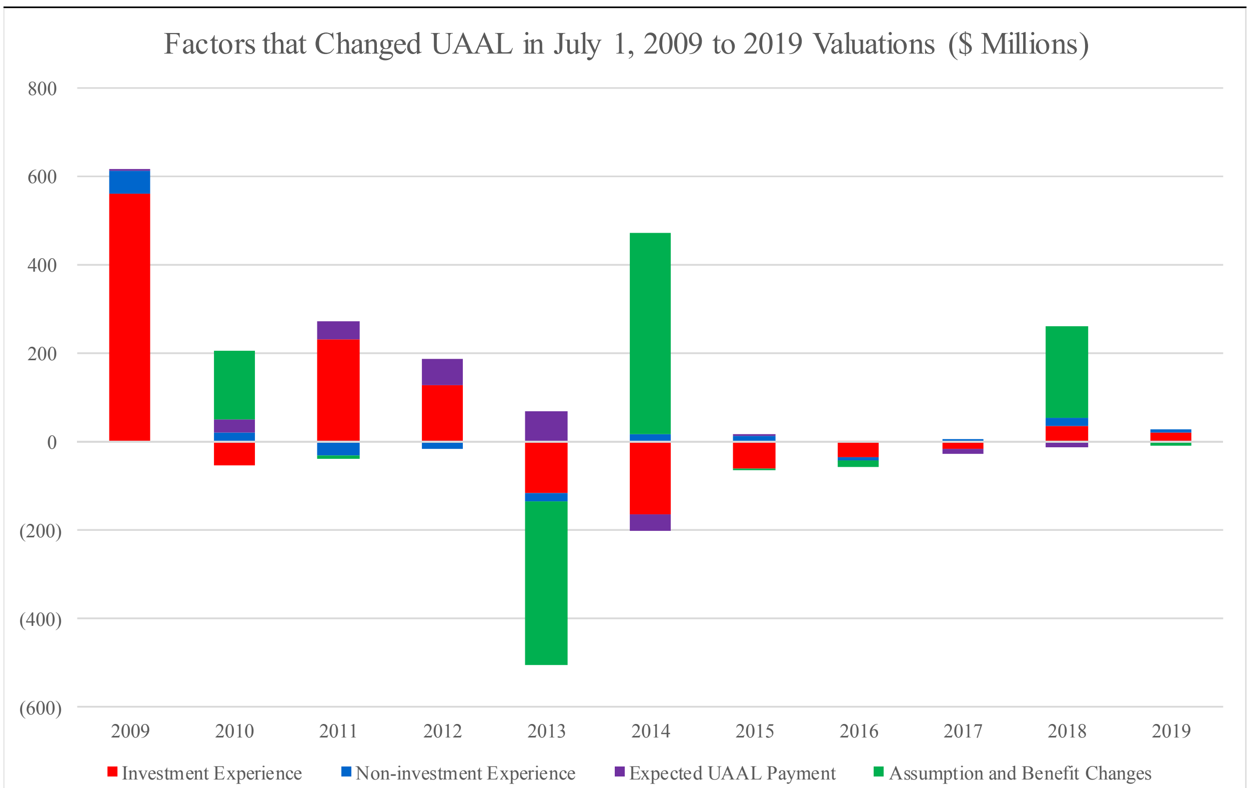
A typical retirement system faces many different risks. The greatest risk for a retirement system is the inability to make benefit payments when due. If system assets are depleted, benefits may not be paid which could create legal and litigation risk. The term “risk” is most commonly associated with an outcome with undesirable results. However, in the actuarial world risk is defined as uncertainty. The actuarial valuation process uses many actuarial assumptions to project how future contributions and investment returns will meet the cash flow needs for future benefit payments. Of course, we know that actual experience will not unfold exactly as anticipated by the assumptions and that uncertainty, whether favorable or unfavorable, creates risk. ASOP 51 defines risk as the potential of actual future measurements deviating from expected future measurements due to actual experience that is different than the actuarial assumptions.

Factors that have Historically Impacted Funded Status and Employer Contribution Rates

The funding ratios and unfunded actuarial accrued liabilities (UAAL) calculated on both an actuarial value of assets and market value of assets basis for the past 11 valuations from July 1, 2009 to 2019 are shown on the first graph on the next page. The factors that caused changes in the UAAL for the past 11 valuations from July 1, 2009 to 2019 are shown in the second graph on the next page. The funded ratio on an actuarial value of assets basis steadily declined from 2009 to 2012 due to the recognition of the investment losses due to the great recessions. On July 1, 2013 the funded ratio increased due to the passage of HB 377 which reduced the Guaranteed Annual Benefit Adjustment provision of the System. On July 1, 2014, a court ordered injunction was issued to suspend the Guaranteed Annual Benefit Adjustment as noted in HB 377 which caused a decrease to the funded ratio. Since July 1, 2014 the funded ratio has steadily improved until July 1, 2018 in which the actuarial assumptions were updated to reflect recent experience which included the reduction of the discount rate and the assumed mortality was updated to reflect recent observed improvements in mortality experience. The July 1, 2019 valuation reflected a slight improvement in the funded ratio when compared to the July 1, 2018 valuation.



Funded Ratio (Percentages) and Dollar UAAL ($ Millions)
In July 1, 2009 to 2019 Valuations
100%
95%
90%
85%
80%
75%
70%
65%
60%
55%
50%
$2,500
$2,000
$1,500
$1,000
$500
$0
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
$ UAAL (Actuarial Value of Assets Basis)
$ UAAL (Market Value of Assets Basis)
% Funded Ratio (Actuarial Value of Assets Basis)
% Funded Ratio (Market Value of Assets Basis)



Factors that Changed UAAL in July 1, 2009 to 2019 Valuations ($ Millions)
800
600
400
200
0
(200)
(400)
(600)
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
Investment Experience
Non-investment Experience
Expected UAAL Payment
Assumption and Benefit Changes

Identifying Risks

The first step in a project such as this is to identify the significant risks that affect how TRS liabilities are measured and contributions determined. Some risks, such as investment return for a funded retirement plan, are obvious, but there are others that are not as clear. There is no definition of "significant" to clearly define which risks should be considered, nor is it possible to tell in advance whether certain risks are significant or not.

The identification of risks is also specific to the retirement plan being studied. Different plans expect different risks. Thus, this analysis for TRS is uniquely prepared for TRS and the risks it faces.

Assessing Risks

In this report, we consider a variety of risks faced by TRS. A common theme for most retirement plans is that risks change as a plan matures. Because this is a fundamental issue, ASOP 51 gives special attention to requiring the disclosure of appropriate measures of how a plan is maturing. In the section of this report that considers maturity measures, we provide a number of illustrations to help demonstrate this trend.

There are some risks that are inherently difficult to quantify, as well as some risks that are addressed by the way in which a system is designed to react. In our section on qualitative measures, we discuss some of these risks. We also discuss how the TRS funding and benefit policy is designed to help address the way in which TRS faces risks.

Finally, we conclude this report with numerical assessment of some of the significant demographic and economic risks. The point of this analysis is to provide some perspective on the magnitude of the risks faced by TRS.

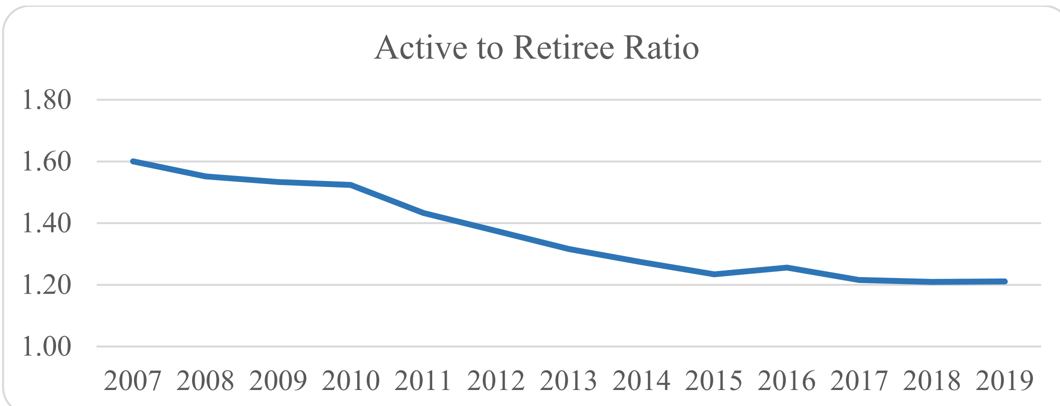
Conclusions

Risk is not necessarily a negative concept. As humans, we regularly take risks such as driving in an automobile because we believe that the gain to be received outweighs the possible negative consequences. We do, however, take steps to mitigate the risk by looking both ways at an intersection before proceeding, wearing seatbelts, etc. We do these things, because we have some understanding of the sources of risk. The goal of this report is to help the TRS understand the major risks facing TRS funding, thereby allowing a reasoned approach to determining how to move into the future if negative experience emerges. Based on the current assets levels and projected cash flow characteristics, the largest risk factor facing TRS is short term investment volatility. Since both the benefits and the funding source of System are set in statute, there are no tools available to mitigate this risk. In this report, we have demonstrated alternative funding methods in which we demonstrate changing the employer contribution from a fixed statutory contribution to a layered amortization methodology. The layered amortization approach is discussed in more detail in this report, but the main benefit is that it allows the funding source of the System to fluctuate based on recent experience. Although it may have a higher cost in the short term, it eliminates the possibility that the System will have an undesirable outcome in the future.

In general, the aging of the population, including the retirement of the baby boomers, has created a shift in the demographics of most retirement systems. The demographic shift and maturing of the plans have increased the risk associated with funding the systems. There are different ways to measure and assess the maturity level of a retirement system and we will discuss several in this section of the report.

Historical Active to Retiree Ratio

One way to assess the maturity of the system is to consider the ratio of active members to retirees. In the early years after a retirement system is established, the ratio of active to retired members will be very high as the system is largely composed of active members. As the system matures over time, the ratio starts to decline. A very mature system often has a ratio near or below one. In addition, if the size of the active membership declines over time, it can accelerate the decline in the ratio.



Asset Volatility Ratio

As a retirement system matures, the size of the market value of assets increases relative to the covered payroll of active members, on which the System is funded. The size of the plan assets relative to covered payroll, sometimes referred to as the asset volatility ratio, is an important indicator of the contribution risk for the System. The higher this ratio, the more sensitive a plan's contribution rate is to investment return volatility.

Even though the System is funded with statutory contribution rates, these measures are still meaningful as an indication of the expected pressure on the portion of the statutory employer funding required for pension benefits.

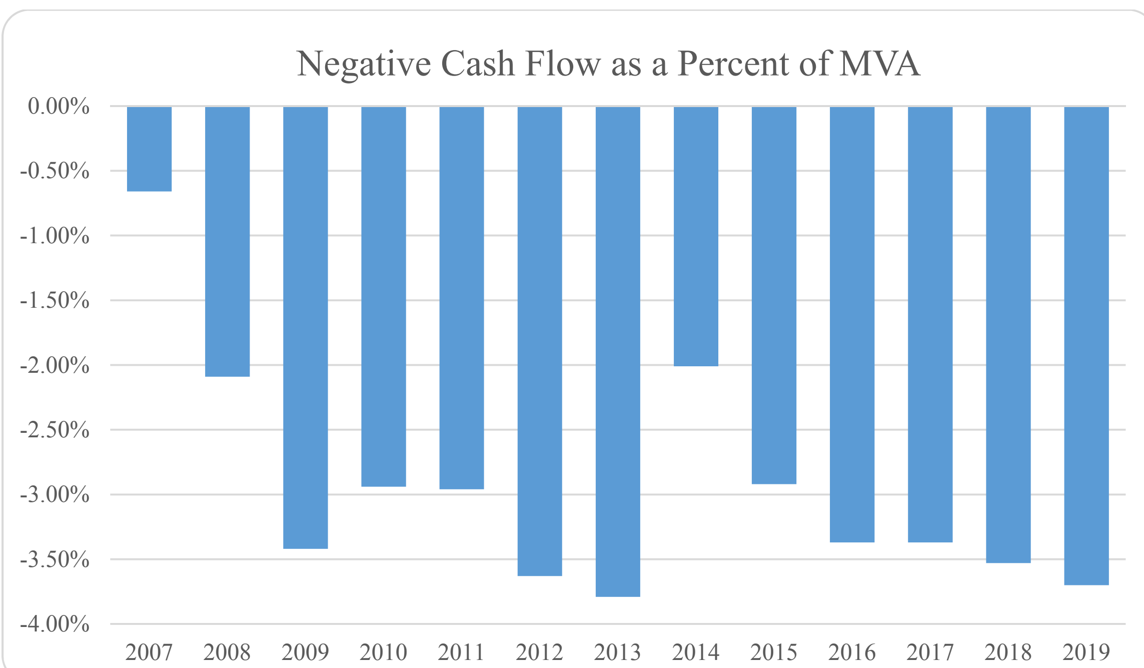
The asset volatility measure reflects the change to contributions which would be necessary to offset the impact of a change in the market value of assets. The following tables show the historical trend for the asset volatility ratio for TRS. For example, a 1% decrease in the market value of assets as of June 30, 2019 would require a contribution equal to 4.92% of payroll to immediately offset the 1% decrease in the market value of assets.

Fiscal Year End	Market Value of Assets ($ Millions)	Covered Payroll ($ Millions)	Asset Volatility Ratio
6/30/07	$3,209.3	$664.1	4.83
6/30/08	2,993.4	657.4	4.55
6/30/09	2,301.8	683.2	3.37
6/30/10	2,521.4	747.0	3.38
6/30/11	2,972.4	746.7	3.98
6/30/12	2,932.2	735.6	3.99
6/30/13	3,185.1	742.6	4.29
6/30/14	3,652.1	750.6	4.87
6/30/15	3,708.4	768.7	4.82
6/30/16	3,656.8	795.9	4.59
6/30/17	3,950.7	818.1	4.83
6/30/18	4,148.3	829.7	5.00
6/30/19	4,220.3	857.5	4.92

Historical Cash Flows

The table below illustrates the System's net cash flow as a percentage of the market value of assets. As you can see, the benefit payments and expenses have exceeded contributions for the past 13 years. This is not inherently a bad thing and it is a common feature among mature pension plans.

Fiscal Year End	Market Value of Assets (MVA)	Contributions	Benefit Payments and Expenses	Net Cash Flow	Net Cash Flow as a Percent of MVA
7/1/07	3,209,259,107	$169,200,000	$190,400,000	($21,200,000)	(0.66%)
7/1/08	2,993,392,632	140,983,159	203,553,060	(62,569,901)	(2.09%)
7/1/09	2,301,828,565	138,254,333	217,016,060	(78,761,727)	(3.42%)
7/1/10	2,521,445,720	152,265,267	226,311,497	(74,046,230)	(2.94%)
7/1/11	2,972,419,220	153,310,508	241,381,903	(88,071,395)	(2.96%)
7/1/12	2,932,202,476	152,011,611	258,581,166	(106,569,555)	(3.63%)
7/1/13	3,185,064,406	154,484,223	275,351,783	(120,867,560)	(3.79%)
7/1/14	3,652,100,237	218,831,287	292,078,818	(73,247,531)	(2.01%)
7/1/15	3,708,385,838	202,896,194	311,219,370	(108,323,176)	(2.92%)
7/1/16	3,656,830,798	205,286,917	328,358,741	(123,071,824)	(3.37%)
7/1/17	3,950,704,563	210,520,833	343,660,051	(133,139,218)	(3.37%)
7/1/18	4,148,324,206	214,833,474	361,183,971	(146,350,497)	(3.53%)
7/1/19	4,220,285,752	220,949,305	376,909,937	(155,960,632)	(3.70%)



Plans with negative cash flows will experience increased sensitivity to investment return volatility. If the System has negative cash flows and experiences returns below the assumed rate, there are fewer assets to be reinvested to earn the higher returns that typically follow. Typically, a pension plan can sustain negative cash flow that is equal to the long term return on the system's assets minus the growth in the projected benefit payments. The expected long term growth in the assets of TRS is 7.50%. The table shows the annual benefit growth rate and the amount of sustainable negative cash flow over the next 30 years. In the short term, the System is subject to negative cash flow risk that gradually mitigates over next 17 years.

Year End	Projected Benefit Payments	Benefit Growth Rate	Sustainable Negative Cash Flow	Projected Negative Cash Flow
2020	396,993,270	6.21%	**1.29%**	**4.17%**
2021	420,198,187	6.03%	**1.47%**	**4.62%**
2022	436,160,595	5.28%	**2.22%**	**4.75%**
2023	451,310,430	4.82%	**2.68%**	**4.86%**
2024	466,226,134	4.52%	**2.98%**	**4.96%**
2025	480,832,871	4.29%	**3.21%**	**5.06%**
2026	494,403,461	4.08%	**3.42%**	**5.13%**
2027	507,176,567	3.89%	**3.61%**	**5.19%**
2028	519,107,231	3.72%	**3.78%**	**5.21%**
2029	530,292,066	3.56%	**3.94%**	**5.22%**
2030	540,935,000	3.42%	**4.08%**	**5.21%**
2031	551,207,982	3.29%	**4.21%**	**5.19%**
2032	560,914,556	3.17%	**4.33%**	**5.15%**
2033	569,854,611	3.06%	**4.44%**	**5.09%**
2034	578,487,210	2.95%	**4.55%**	**5.01%**
2035	586,355,658	2.85%	**4.65%**	**4.92%**
2036	593,646,181	2.76%	**4.74%**	**4.81%**
2037	600,395,989	2.67%	4.83%	4.68%
2038	606,841,401	2.58%	4.92%	4.53%
2039	612,396,440	2.50%	5.00%	4.37%
2040	617,027,825	2.42%	5.08%	4.19%
2041	620,727,179	2.33%	5.17%	3.98%
2042	623,728,885	2.25%	5.25%	3.76%
2043	625,869,550	2.17%	5.33%	3.52%
2044	627,088,371	2.09%	5.41%	3.27%
2045	628,408,877	2.02%	5.48%	3.03%
2046	630,372,700	1.95%	5.55%	2.80%
2047	633,612,352	1.90%	5.60%	2.58%
2048	638,042,556	1.86%	5.64%	2.39%
2049	642,544,773	1.82%	5.68%	2.20%

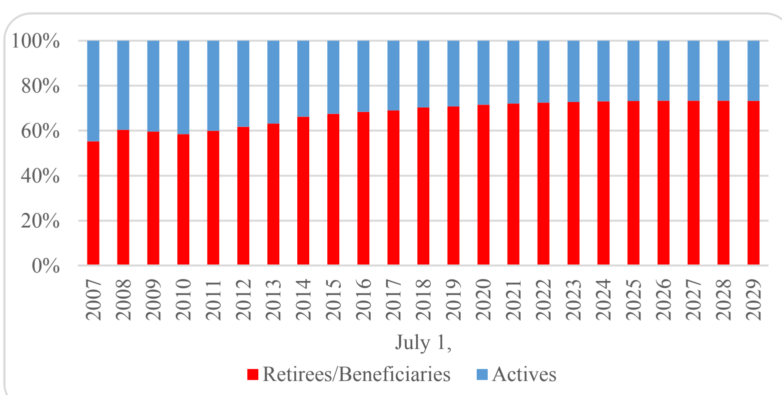
Liability Maturity Measurements

As discussed earlier, TRS is a mature pension system. As a result, it has an aging population indicated by a decreasing ratio of active members to retirees and a growing percentage of retiree liability when compared to the total. The retirement of the remaining baby boomers over the next 10-15 years is expected to further exacerbate the aging of the retirement system population. With more of the total liability residing with retirees, investment volatility has a greater impact on the funding of the system since it is more difficult to restore the system financially after losses occur when there is comparatively less payroll over which to spread costs.

The retirement system is also growing larger as can be seen by the ratio of actuarial liability to payroll.

Fiscal Year End	Retiree Liability (a)	Total Actuarial Liability (b)	Retiree Percentage (a) / (b)	Covered Payroll (c)	Ratio (b) / (c)
7/1/07	2,171,100,000	3,928,500,000	55.27%	629,451,000	6.24
7/1/08	2,386,727,517	3,953,751,643	60.37%	657,435,444	6.01
7/1/09	2,488,431,011	4,173,776,822	59.62%	683,235,462	6.11
7/1/10	2,642,221,337	4,518,167,977	58.48%	747,037,330	6.05
7/1/11	2,792,930,106	4,658,593,652	59.95%	746,694,434	6.24
7/1/12	2,971,657,139	4,814,725,919	61.72%	735,586,961	6.55
7/1/13	2,899,761,360	4,592,658,392	63.14%	742,608,987	6.18
7/1/14	3,438,010,657	5,191,069,342	66.23%	750,604,063	6.92
7/1/15	3,609,722,311	5,351,391,599	67.45%	768,718,699	6.96
7/1/16	3,748,186,878	5,483,673,777	68.35%	795,920,906	6.89
7/1/17	3,888,518,484	5,636,841,900	68.98%	818,122,561	6.89
7/1/18	4,223,371,459	6,004,434,112	70.34%	829,708,595	7.24
7/1/19	4,350,787,062	6,148,556,456	70.76%	857,467,932	7.17

The chart below shows both the historical and a ten year projection of the ratio of retiree liability compared to the total liability of the System.



ASOP 51 provides that the assessment of risk does not necessarily have to be quantitative, but may be qualitative. This report will provide quantitative analysis for TRS in a later section, but first we will discuss the overall assessment of risk for TRS from a qualitative perspective.

(1) Contribution Rate Funding Policy

The table below shows a history of the legislated contribution rates as a percent of pay. In addition to these contributions the State will contribute $25 million annually to the System payable July 1st of each year.

MCA 19-20-605 requires each employer to contribute 9.85% of total compensation paid to all re-employed TRS retirees employed in a TRS reportable position. Pursuant to MCA 19-20-609, this amount shall increase by 1.00% for fiscal year 2014 and increase by 0.10% each fiscal year through 2024 until the total employer contribution is equal to 11.85% of re-employed retiree compensation.

The Montana University Supplemental Retirement Program (MUS-RP) supplemental contribution ensures the university member benefits are funded by university employers. The Supplemental contribution is currently 4.72% of MUS-RP payroll.

History of Legislated Contributions
(as a Percent of Pay)

School District and Other Employers

	Members	Employers	General fund	Total employee & employer
Prior to July 1, 2007	7.15%	7.47%	0.11%	14.73%
July 1, 2007 to June 30, 2009	7.15%	7.47%	2.11%	16.73%
July 1, 2009 to June 30, 2013	7.15%	7.47%	2.49%	17.11%
July 1, 2013 to June 30, 2014	8.15%	8.47%	2.49%	19.11%
July 1, 2014 to June 30, 2015	8.15%	8.57%	2.49%	19.21%
July 1, 2015 to June 30, 2016	8.15%	8.67%	2.49%	19.31%
July 1, 2016 to June 30, 2017	8.15%	8.77%	2.49%	19.41%
July 1, 2017 to June 30, 2018	8.15%	8.87%	2.49%	19.51%
July 1, 2018 to June 30, 2019	8.15%	8.97%	2.49%	19.61%
July 1, 2019 to June 30, 2020	8.15%	9.07%	2.49%	19.71%
July 1, 2020 to June 30, 2021	8.15%	9.17%	2.49%	19.81%
July 1, 2021 to June 30, 2022	8.15%	9.27%	2.49%	19.91%
July 1, 2022 to June 30, 2023	8.15%	9.37%	2.49%	20.01%
July 1, 2023 to June 30, 2024	8.15%	9.47%	2.49%	20.11%

State and University Employers

	Members	Employers	General fund	Total employee & employer
Prior to July 1, 2007	7.15%	7.47%	0.11%	14.73%
July 1, 2007 to June 30, 2009	7.15%	9.47%	0.11%	16.73%
July 1, 2009 to June 30, 2013	7.15%	9.85%	0.11%	17.11%
July 1, 2013 to June 30, 2014	8.15%	10.85%	0.11%	19.11%
July 1, 2014 to June 30, 2015	8.15%	10.95%	0.11%	19.21%
July 1, 2015 to June 30, 2016	8.15%	11.05%	0.11%	19.31%
July 1, 2016 to June 30, 2017	8.15%	11.15%	0.11%	19.41%
July 1, 2017 to June 30, 2018	8.15%	11.25%	0.11%	19.51%
July 1, 2018 to June 30, 2019	8.15%	11.35%	0.11%	19.61%
July 1, 2019 to June 30, 2020	8.15%	11.45%	0.11%	19.71%
July 1, 2020 to June 30, 2021	8.15%	11.55%	0.11%	19.81%
July 1, 2021 to June 30, 2022	8.15%	11.65%	0.11%	19.91%
July 1, 2022 to June 30, 2023	8.15%	11.75%	0.11%	20.01%
July 1, 2023 to June 30, 2024	8.15%	11.85%	0.11%	20.11%

TRS has adopted a Funding and Benefits Policy to provide general guidelines to help ensure decisions are made based on sound, consistent, and thoroughly examined criteria. The Funding and Benefits Policy includes guidance on the following topics:

1) Additional Funding
   a) The Funding and Benefits Policy states:
      1. If the amortization period is greater than 30 years, the actuary will recommend the single contribution rate increase that can reasonably expect to fully amortize the UAAL over a closed 30-year period effective July 1, following the next regular legislative session.
      2. If the amortization period is less than 30 years, but greater than 0, and it is projected to continue to decline over the remainder of the closed period, the actuary will not recommend a change in the statutory contribution rates.
      3. If the amortization period is less than 30 years, but has increased over prior valuations and is projected to continue to grow, the actuary will recommend a contribution rate increase that is reasonably expected to reverse the recent trend and reestablish a closed amortization period equal to that of the last valuation."
2) Ultimate Goal
   a) The Funding and Benefits Policy states: "It is the desire of the Board to fully fund the System. However, until the System becomes fully funded, any unfunded liabilities will be amortized over a closed period of no more than 30 years and funded as a level percent of pay. At such time as the System becomes fully funded and has as stabilization reserve of at least 10% of the actuarial accrued liability, the allowed amortization period for any subsequent unfunded liabilities will be reduced to a closed period of not greater than 20 years."

(2) Amortization Policy

Actuarial assumptions are intended to be long-term estimates so even if experience follows the assumption over the long-term, short-term fluctuations are to be expected. When this occurs, and when changes to the actuarial assumptions, methods, or benefit structure occur, any deviation in the unfunded actuarial liability is financed based on the provisions of the amortization policy.

Amortization Policy

As noted previously. The TRS Board shall establish a period of not more than thirty years to amortize the TRS unfunded actuarial accrued pension liability. If the amortization period exceeds 30 years, the actuary will recommend the single contribution rate increase that can reasonably expect to fully amortize the UAAL over a closed 30-year period effective July 1, following the next regular legislative session.

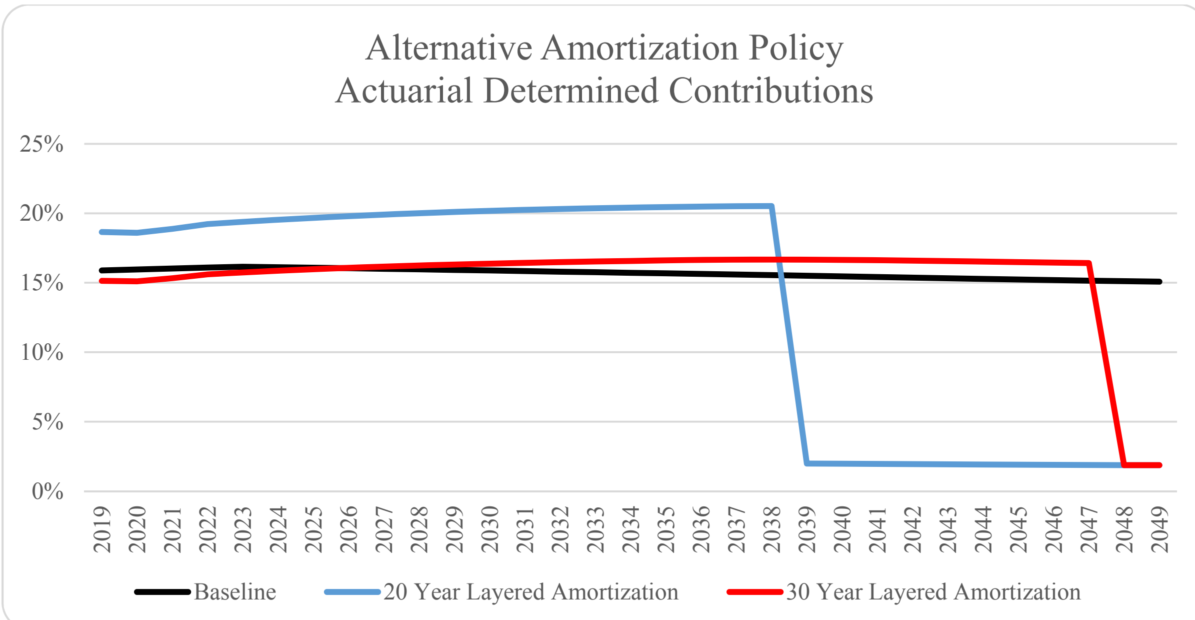
The remaining amortization period as of June 30, 2019 is 29 years. The amortization payments are calculated as a level percentage of payroll assuming payroll will grow at 3.25%.

TRS amortization policy should be considered as a positive factor in risk assessment because it requires the Board to take action if the amortization period exceeds 30 years.

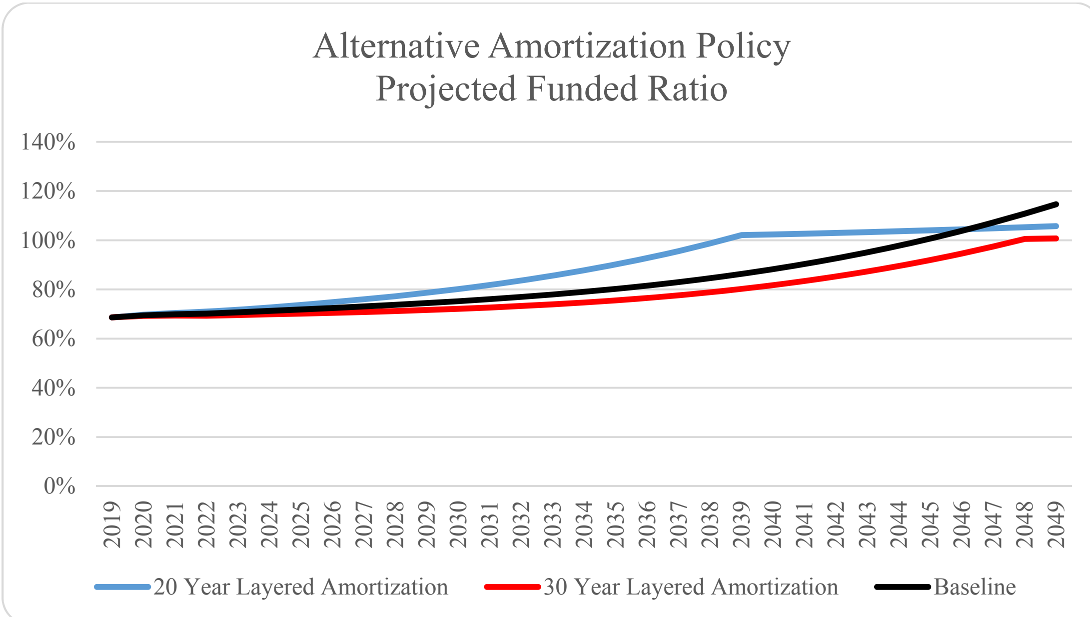
The current amortization policy is based on the fixed statutory contributions which are intended to amortize the unfunded liability as a single amortization base over a closed 30 year period. From year to year, the future funding status of the TRS will be determined by the System's experience. The amortization period of the Unfunded Actuarial Accrued Liability is not likely to decrease by the expected 1.0 year with each passing actuarial valuation. Instead, the amortization period is expected to decrease more or less than 1.0 years each year, reflecting gains and losses due to experience different than the actuarial assumptions.

We demonstrate two alternative approaches to amortize the unfunded accrued liability which require the calculation of an actuarial determined contribution which fluctuates from year to year. Instead of a single amortization base the alternative approach establishes a series of layered amortization bases. We demonstrate the layered amortization method using amortization periods of 20 and 30 years. The first layer established is the Systems initial unfunded actuarial accrued liability established on July 1, 2019. With each additional valuation, the incremental change in the unfunded actuarial accrued liability is amortized over a new closed period, and the resulting payment is added to the existing amortization payments. The charts on the following page compare the annual cost and projected funded ratio utilizing the 20 and 30 year layered amortization approach to the current amortization method.

The chart below compares the annual cost to fund the System using the two amortization methodologies noted above as a percentage of payroll. The baseline cost represents all employer funding sources of TRS. The 20 year amortization period produce higher annual costs in the short term, but reduces the amount of interest paid on the unfunded actuarial accrued liabiltiy. The total amount of employer contributions paid over the 30 year period is $4.6 billion, $5.8 billion and $6.2 billion for the 20 year layer amortization, 30 year layered amortization and the current statutory funding rates respectively.



The chart below shows the projected funded ratio of TRS under the Systems current funding policy compared to the projected funded ratio under the 20 and 30 year layered amortization methodologies.



(3) Payroll Growth Assumption and Active Membership

When the actuarial valuation is performed each year, it determines if the statutory contributions are sufficient to fund the TRS within the parameters of the Funding Policy established by the TRS Board. Because the amortization period of the unfunded actuarial accrued liability is determined using the level percent of payroll methodology, an assumption must be used to develop the payment stream for the amortization of the unfunded accrued liability. The current payroll growth assumption for TRS is 3.25% per year which implicitly assumes that the number of active members remains stable over time.

The funding of the System could be impacted if there was a material shift in the TRS active membership. When the payroll of TRS does not grow at the assumed rate, it requires an increase in the amortization rate to maintain the amortization schedule. While the dollar amount of the unfunded accrued liability amortization payment might be the same, the amortization payment as a percent of payroll has to increase maintain the same amortization payment. Given the statutory limit on the employers and member contributions rates, sustained declines in payroll over a long time could prevent the amortizing of the system according to the amortization schedule. In addition, experience losses due to other sources, such as investment returns, would exacerbate the System decline in funding progress.

There are a number of risks inherent in the funding of a defined benefit plan. These include:

- demographic risks such as mortality, payroll growth, aging population including impact of baby boomers, and retirement ages;
- economic risks, such as investment return and inflation;
- contribution risk, i.e., the potential for contribution rates to be too high for the plan sponsor/employer to pay; and
- external risks such as the regulatory and political environment.

The various risk factors for a given system can have a significant impact – favorable or unfavorable – on the actuarial projection of liabilities and contribution rates. Under ASOP 51, the actuary is required to include plan-specific commentary regarding the risks that are identified. However, such comments can be qualitative rather than quantitative. In this section of the report, we include quantitative analysis to assist with a better understanding of some of the key risks for TRS.

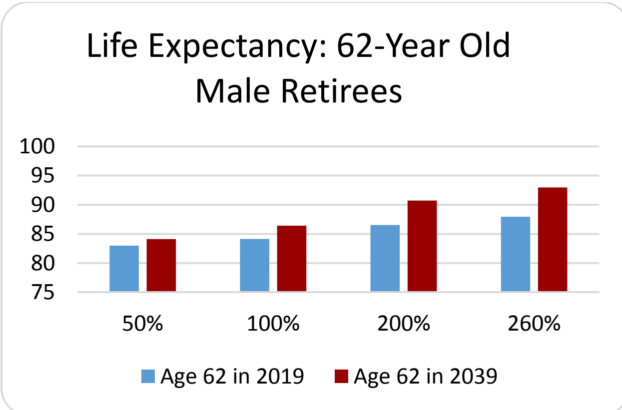
Demographic Risks

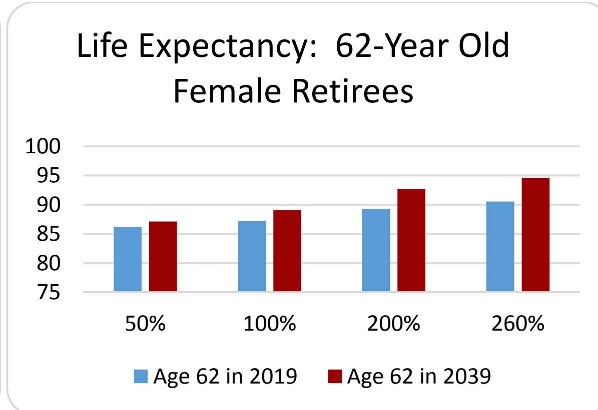
Demographic risks are those arising from the actual behavior of members differing from that expected based on the actuarial assumptions. These changes may arise when a significant portion of members is influenced to take some particular action due to employer or governmental actions, when there are improvements in medicine that affect broad groups of retirees, when societal trends encourage new behavior, or they may simply be random. Examples include early retirement windows, new drugs to treat common diseases, or trends across society to work longer before retiring. Many of these risks are minor in nature since they unfold gradually and generally have a small impact on a retirement system. Some, however, are comparatively more significant and warrant additional discussion.

Mortality Risk

A key demographic risk for all retirement systems, including TRS, is improvement in mortality (longevity) greater or less than anticipated. While the actuarial assumptions used in the valuation reflect, reflect a margin for mortality improvement, and these assumptions are evaluated and refined in every experience study, the risk arises because there is a possibility of some sudden shift, perhaps from a significant medical breakthrough that could quickly impact life expectancy and increase liabilities. Likewise, there is some possibility of a significant public health crisis that could result in a significant number of additional deaths in a short time period, which would also be significant, although more easily absorbed.

To consider longevity risk, we considered the impact of faster improvements in life expectancies of 2.0 and 2.6 times as much improvement, along with only half as much improvement. As the following charts illustrate, a greater improvement factor greatly increases the life expectancy over time.



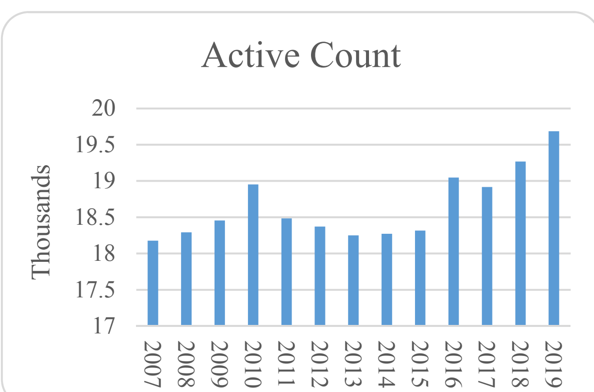


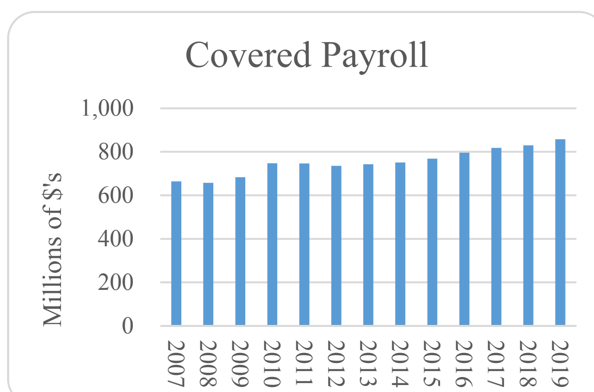
In performing valuations, we do not directly use life expectancy values, but rather apply the mortality rates at each age directly. For 2019, if the mortality improvement scale were cut in half (to a 0.5% per year improvement), the liabilities would decrease by about 1% at age 62, while if the mortality improvement scale were doubled (resulting in a 2% per year improvement), liabilities at age 62 would increase approximately 2%. Over the next 20 years, the impact of either change would roughly double. Note that these changes in mortality improvement are noticeable departures from historical norms, but they are plausible.

Active Population Growth or Decline Risks

Valuations consider the data on a single date and do not make a direct assumption regarding future members, with the exception of the amortization method's assumption of payroll increases that inherently assumes a constant population size. However, the reality is that if the active membership increases or decreases, it will lead to decreases or increases in the funding of the system.

The following graphs show the historical count and covered payroll for active members:





A decline in TRS active membership could occur for a number of reasons. If the local school systems experiences severe and prolonged fiscal challenges, the number of teachers might be reduced. Alternatively, if there is a decline in the student population, it could reduce the need to maintain the current level of teachers. Another possibility that could impact the number of active members is a shift in the way education is delivered, with higher utilization of online teaching.

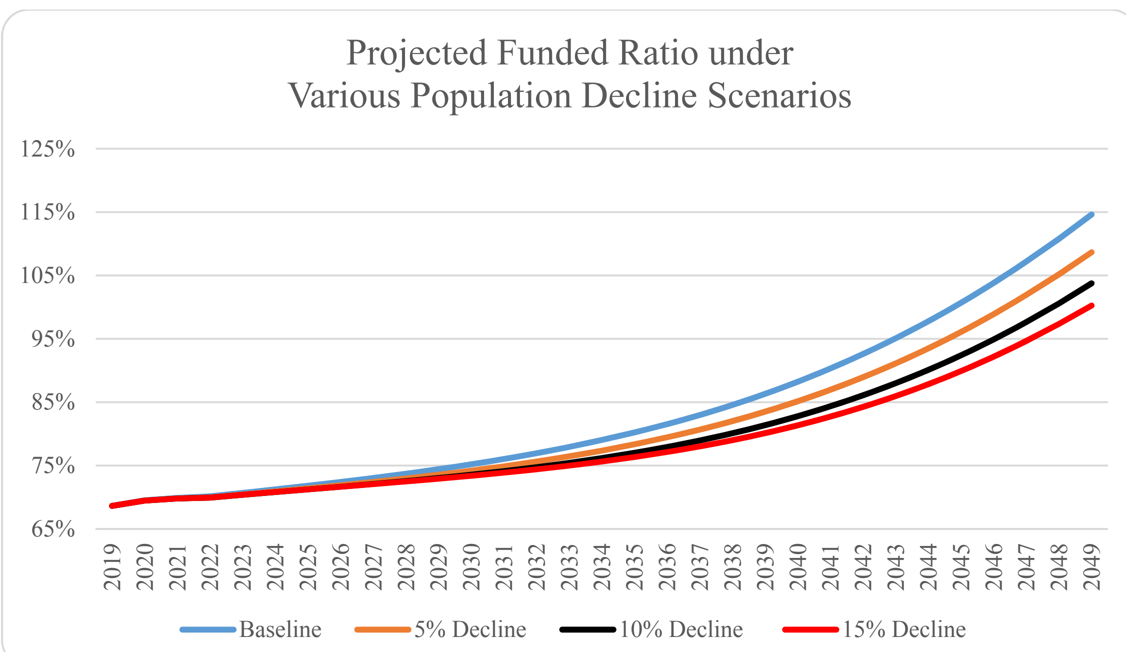
In the event of a significant decrease in population, the payroll used to amortize the UAAL is unlikely to grow at the assumed rate. This will, in turn, increase the actuarial contribution rate, although not the contribution amount, needed to pay off the UAAL.

Referring to the maturity measures shown earlier in the report, lower payroll will increase the Asset Volatility Ratio. Of course, an increase in active membership would decrease the contribution rate and Asset Volatility Ratio.

The chart below illustrates the projected funded ratio based on three population reduction scenarios:

- The first assumes an immediate 5% reduction in the population followed by no further reduction in active membership.
- The second assumes an immediate 5% reduction in the population followed by additional 1% reductions in the active population until the total reduction in the active workforce is 10%.
- The final scenario assumes an immediate 5% reduction in the population followed by additional 1% reductions in the active population until the total reduction in the active workforce is 15%.

Since employer and member contributions to the system are set in statute, any reduction in the workforce reduces the income stream to TRS, thereby prolonging the amount of time TRS will need to achieve 100% funded status. If these population scenarios were combined with investment returns that are less than the assumed rate of return of 7.50% the effects would be magnified.



Other Demographic Risks

Changes to retirement and termination rates are likely to occur through time as the nature of the workforce and societal expectations shift. For instance, over the past decade or so, we have observed a general shift in retirement patterns in which retirements are occurring later. This may be a function of economic considerations, expectations of longer life in retirement, a proportionate decrease in physically-demanding jobs, or changes in family composition. Such changes do affect the funding of the plan, but generally these changes are minor and gradual and are reflected in modified assumptions resulting from regular experience studies.

More significant changes in demographic assumptions are likely to be influenced by something significant such as a legislative change. Obviously, some changes in TRS provisions or state employment rules could quickly change behavior patterns, but these would probably be anticipated as part of the legislation. Externally, a significant change in Social Security or Medicare provisions could change retirement patterns if the changes were implemented rapidly. These changes are not ones that can be easily quantified because the timing of such events, the impact of the event on behavior, and the magnitude of the behavior change cannot be anticipated.

Investment Return Risk

Investment risk volatility is the greatest risk facing TRS and most public retirement systems today. In recent years, interest rates have been in decline. In response, retirement systems had to choose between reducing expected returns which would increase required contributions or increase investment risk and maintain expected returns and contribution levels. Most systems chose to increase investment risk. In 2019 the average yield on the 10-year treasury was 2.14%. Compared to the current assumed rate of return of 7.50%, the risk premium is 5.36%. As the System continues to mature, investment returns will have an increasingly greater impact on the funding of the system. When investment returns are below the expected return (investment return assumption), the unfunded actuarial liability increases which prolongs the time period necessary for TRS to achieve full funding. Likewise, returns above the expected return, which are easier to absorb, decrease the unfunded actuarial liability and reduce the period necessary for TRS to achieve full funding. Because of the inherent volatility of most retirement system investment portfolios, there is, therefore, volatility in the plans' funded status and contribution requirements.

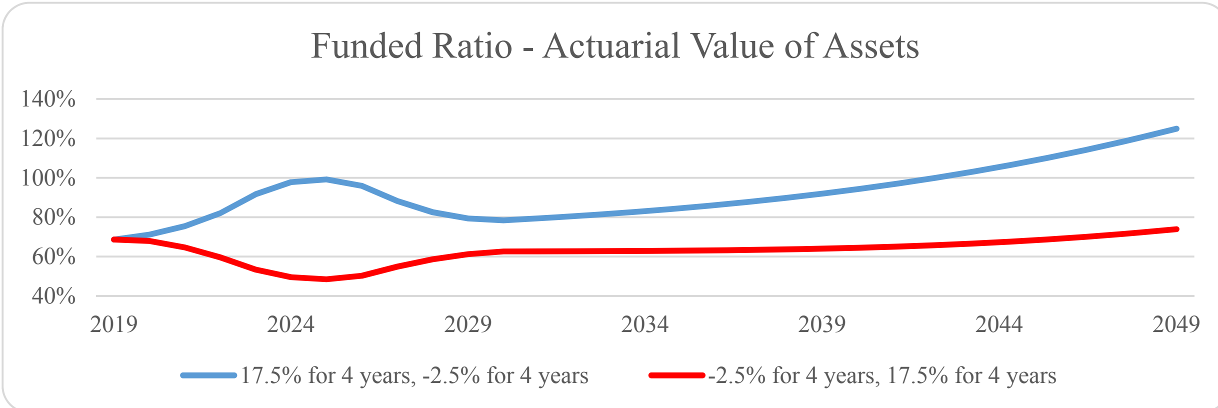
In order to understand the impact of investment volatility, we present a sequence of projections. These "deterministic" projections use one or more selected scenarios to help illustrate certain key concepts. Following these projections, we show a summary of the results of a "stochastic" projection in which 1,000 equally plausible random scenarios are run and summarized.

Risk Due to Return Order

The funding outcome is dependent not only on the returns but also the order in which they occur. In other words, a "good" return followed by a "bad" return can lead to a different final result than the same "bad" return followed by the same "good" return. While this may not be intuitive at first, the concept makes sense once it is realized that there are net cash flows out of the system.

To illustrate this concept, consider the funded ratio for TRS under two different scenarios. In each case, there are four years of returns that are 17.5% (10% above the assumed 7.5% return). There are also four years of -2.5% returns (10% below the assumed return). In one case, we assume the four good years come before the four bad years, while in the other case, we assume that the four bad years are followed by the four good years.

The following graph shows the results:



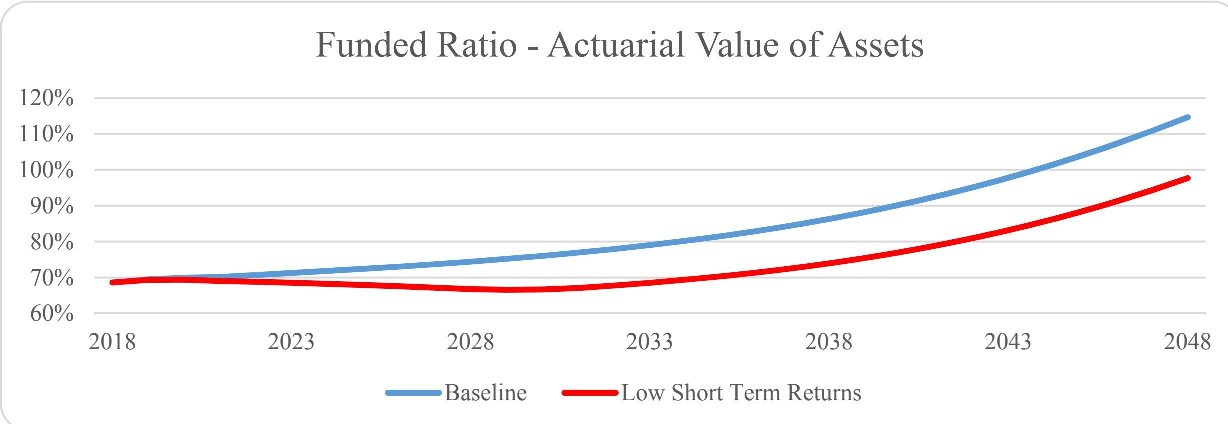
At the end of the projection, the high return followed by low return scenario has a funded ratio of 125%, while the low return followed by a high return is 74% funded. The order of the returns leads to a $4.0 billion dollar difference in market value ($10.9 billion vs. $6.4 billion). While the scenarios displayed here are artificial, they do illustrate that the return order matters.

Risk of Low Returns for Sustained Period

The current view from most investment consultants is that a low return environment may persist for a number of years into the future. Some consultants anticipate that after this extended period, returns will return to historic norms, while others do not extend their assumptions that far into the future. There is no way to know whether this view of low returns for five to ten years is correct or not, but it is important to determine the potential impact of low returns over a sustained period on TRS funding.

In particular, we want to examine the scenario, that returns will be 6.5% for the next 10 years, and 8.0% thereafter. It should be noted that such an assumption is not inconsistent with the 7.5% long-term rate of return currently used for the TRS valuation. The difference is really a variant of the prior discussion on order of returns: How does a scenario that has lower returns followed by higher returns compare with a scenario that has the (approximately) average returns for all years?

The following graphs shows the impact of low returns on the funded ratio of TRS. In each case, the scenario (6.5% for 10 years, 8.0% thereafter) is compared with the baseline scenario of 7.5% for all years.



In this scenario, the low returns for the next 10 years reduce the funded ratio until 2030. The gap is greatest, reaching a 17.0% difference (97.6% funded vs. 114.6% funded, reflecting a UAAL difference of $206 million).

While this scenario will not happen exactly as modeled, if the average returns over the next 10 years are around 6.5% and then the average returns increase to 8.0%, similar patterns as these will emerge. It should be stressed, however, that this is only one plausible scenario and there is not universal consensus on return expectations.

Risk of Shock in a Single Year

From late 2007 through early 2009, the financial markets crashed both in the U.S. and abroad resulting in the most impactful loss due to investment return ever experienced by TRS. The return on the market value of assets for FY 2009 was -20.8% and this single year dropped the funded status on a market value basis by more than 20%. Like many other systems around the country, TRS and the State of Montana responded with changes in the benefit structure. Coupled with the financial market recovery, significant progress has been made in improving the situation.

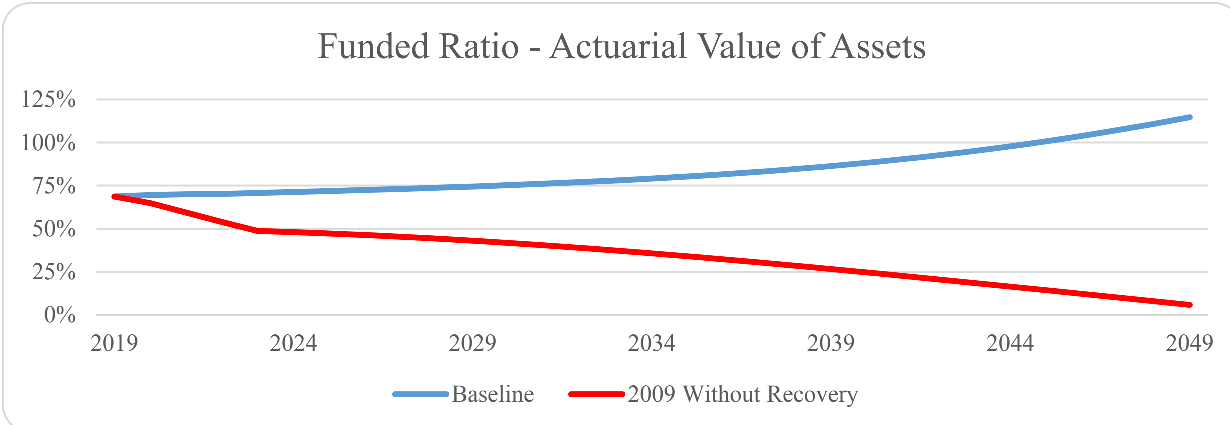
Even with TRS' current Contribution Rate Funding Policy and the progress made toward improving the funding, there is still risk from another shock of this magnitude in a single year. The impact of such an event would be different depending on when it occurs. As the System matures and assets grow in comparison to payroll (increasing the asset volatility ratio), severe investment declines will have a greater impact on the actuarial contribution rate.

To study the impact of a similar shock, we modeled a repeat of 2009 with its -20.8% return in FY 2019, but 7.5% returns in every other year. In particular, this analysis assumes that the market bounce-back that followed Fiscal Year 2009 is not repeated.

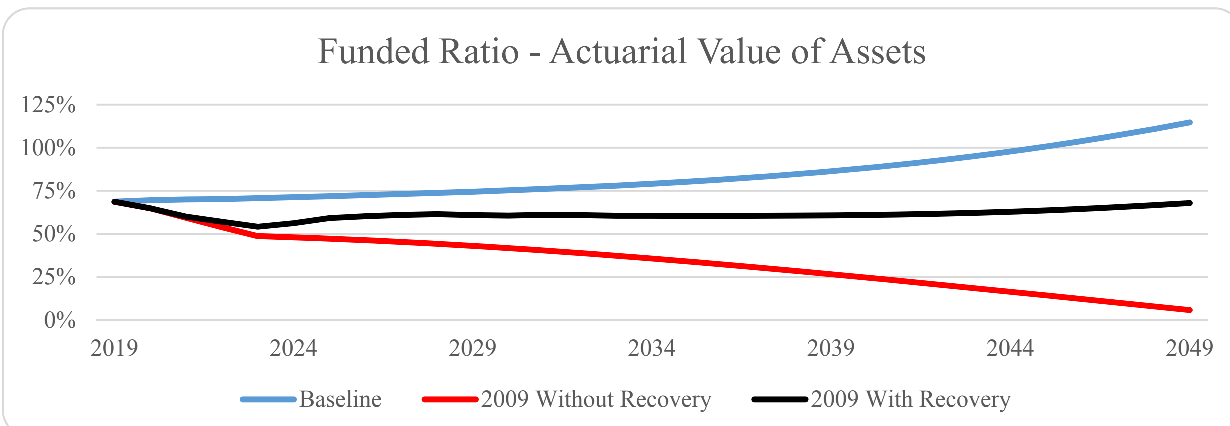
This scenario, as presented, reflects a compound return over the thirty year period of about 6.4%. Market crashes have been historically followed by significant rebounds in the following few years that have recovered significant portions of the losses. TRS and its stakeholders have a history of addressing significant problems by making changes in the benefit provisions and/or funding mechanism. This is not to minimize the risk of a shock. Rather, it is a reminder that the risk can be addressed in multiple ways.

Because there has been a tendency for severe drops in the financial markets to be followed by a market rebound, another graph is shown that includes a third scenario which repeats the shock experienced in 2009, but then reflects the actual returns recognized by TRS for fiscal years 2010 through 2019. In other words, the returns modeled for 2021 up to 2030 are the actual returns observed from 2010 through 2019. For 2030 and beyond, a 7.5% return was assumed to occur.

These graphs illustrate that some, but not all, of the damage following a very significant market downturn can be mitigated by the tendency of financial markets to recover.



In this scenario, the funded ratio drops significantly in the initial years. Note that this graph is based on the actuarial value of assets, so the smoothing mechanism delays the recognition of the return over several years. The funded ratio gradually declines over the projection period.

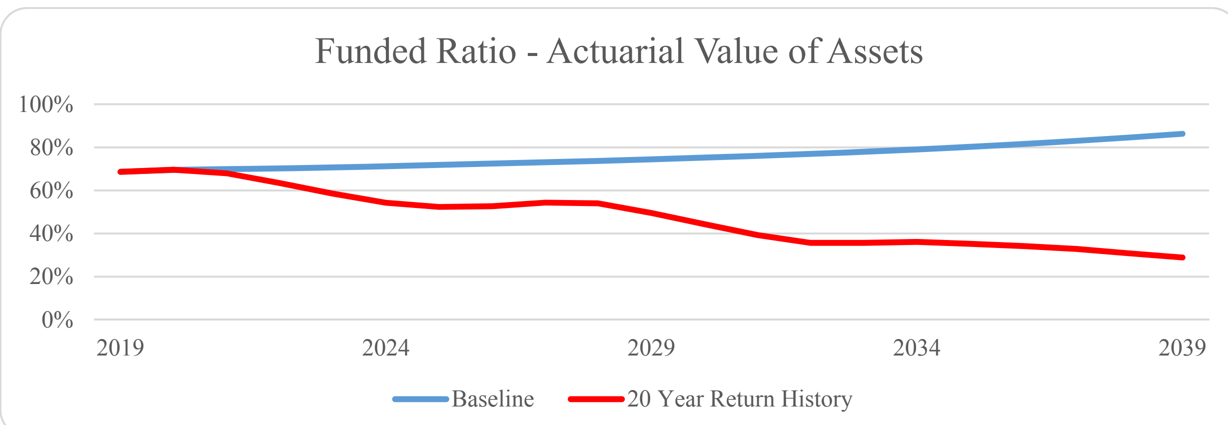


The black line shows that the recovery in the financial markets helps to reverse the declining funded ratio but still does not produce an ideal result in which the funded ratio improves significantly.

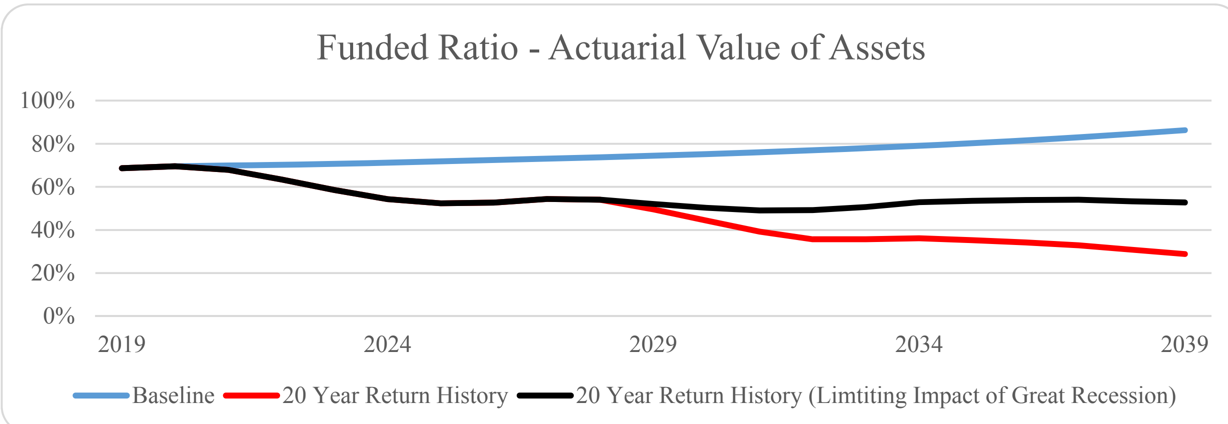
The table below illustrates the market value investment returns that occurred over the most recent 20 year period ended June 30, 2019.

Year	Market Return	Year	Market Return
7/1/1999 to 6/30/2000	7.80%	7/1/2009 to 6/30/2010	12.87%
7/1/2000 to 6/30/2001	-5.09%	7/1/2010 to 6/30/2011	21.67%
7/1/2001 to 6/30/2002	-7.26%	7/1/2011 to 6/30/2012	2.21%
7/1/2002 to 6/30/2003	6.16%	7/1/2012 to 6/30/2013	12.94%
7/1/2003 to 6/30/2004	13.31%	7/1/2013 to 6/30/2014	17.09%
7/1/2004 to 6/30/2005	8.04%	7/1/2014 to 6/30/2015	4.57%
7/1/2005 to 6/30/2006	8.91%	7/1/2015 to 6/30/2016	2.08%
7/1/2006 to 6/30/2007	17.64%	7/1/2016 to 6/30/2017	11.92%
7/1/2007 to 6/30/2008	-4.88%	7/1/2017 to 6/30/2018	8.82%
7/1/2008 to 6/30/2009	-20.80%	7/1/2018 to 6/30/2019	5.69%

The graph below illustrates the impact on the TRS funded ratio if the returns noted above beginning with the plan year ended June 30, 2000 were repeated over the next 20 years. As you can see the result is not ideal as the funded ratio declines with some improvement up to July 1, 2028, beyond which the funded ratio declines without improvement.

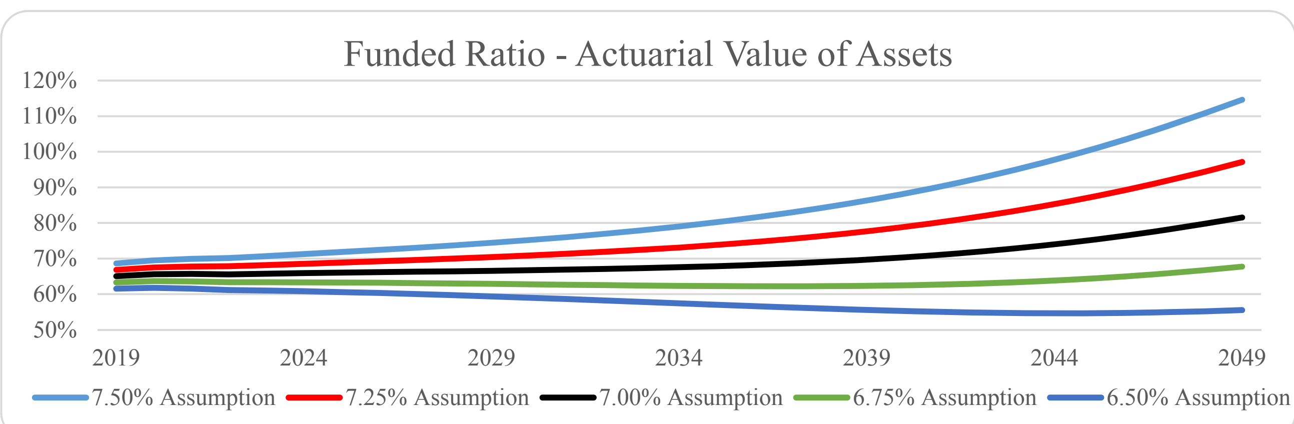


The graph below illustrates the impact on the TRS funded ratio if the returns noted on the previous page beginning with the plan year ended June 30, 2000 were repeated over the next 20 years, with one change, The impact of the great recession for the year ended 2009 is limited to 0% investment return instead of the actual return on the market value of -20.80%. As you can see the funded ratio declines and stabilizes at 50%.



Sensitivity Analysis

The valuation results are sensitive to the set of economic assumptions used to estimate the System's liabilities. In all scenarios considered thus far, the baseline results are those based on the assumption that all of the current actuarial assumptions (those used in the June 30, 2019 actuarial valuation) will be met in the future. To illustrate the sensitivity of the valuation results to different investment return assumptions, we have modeled the results if the investment return assumption is changed incrementally from 7.50% to 6.50%, with no other change in the set of economic assumptions. These illustrations further reflect that the assumed rate of return is earned in all years.



As would be expected, the 7.5% assumption has the highest funded ratio, largely because the liabilities are the lowest and the assets grow at the highest rate. Conversely, the 6.5% assumption is the lowest.

Another way to perform sensitivity analysis is to look at how results would unfold if the assumptions remain unchanged, but actual experience varies. Of course, in reality, the assumptions would eventually be updated to reflect actual experience, so this type of analysis is useful only when shorter periods of time are considered. In the following charts, rates of return from 5.0% to 8.0% are considered. The impact is shown using a "heat map" in which the results are color coded from green (most favorable) to red (least favorable) to help visually show trends.

In this analysis, the current investment return assumption is not changed, but the impact of differing actual returns over the next ten years is studied.

Funded Ratio at July 1 Valuation

	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
5.00%	69%	69%	69%	67%	66%	65%	63%	62%	60%	58%	56%
5.25%	69%	69%	69%	68%	66%	65%	64%	63%	61%	60%	58%
5.50%	69%	69%	69%	68%	67%	66%	65%	64%	62%	61%	60%
5.75%	69%	69%	69%	68%	67%	67%	66%	65%	64%	63%	61%
6.00%	69%	69%	69%	68%	68%	67%	66%	66%	65%	64%	63%
6.25%	69%	69%	69%	69%	68%	68%	67%	67%	66%	66%	65%
6.50%	69%	69%	69%	69%	69%	69%	68%	68%	68%	67%	67%
6.75%	69%	69%	69%	69%	69%	69%	69%	69%	69%	69%	69%
7.00%	69%	69%	70%	70%	70%	70%	70%	70%	70%	70%	71%
7.25%	69%	69%	70%	70%	70%	71%	71%	71%	72%	72%	72%
7.50%	69%	70%	70%	70%	71%	71%	72%	72%	73%	74%	74%
7.75%	69%	70%	70%	70%	71%	72%	73%	74%	74%	75%	76%
8.00%	69%	70%	70%	71%	72%	73%	74%	75%	76%	77%	78%

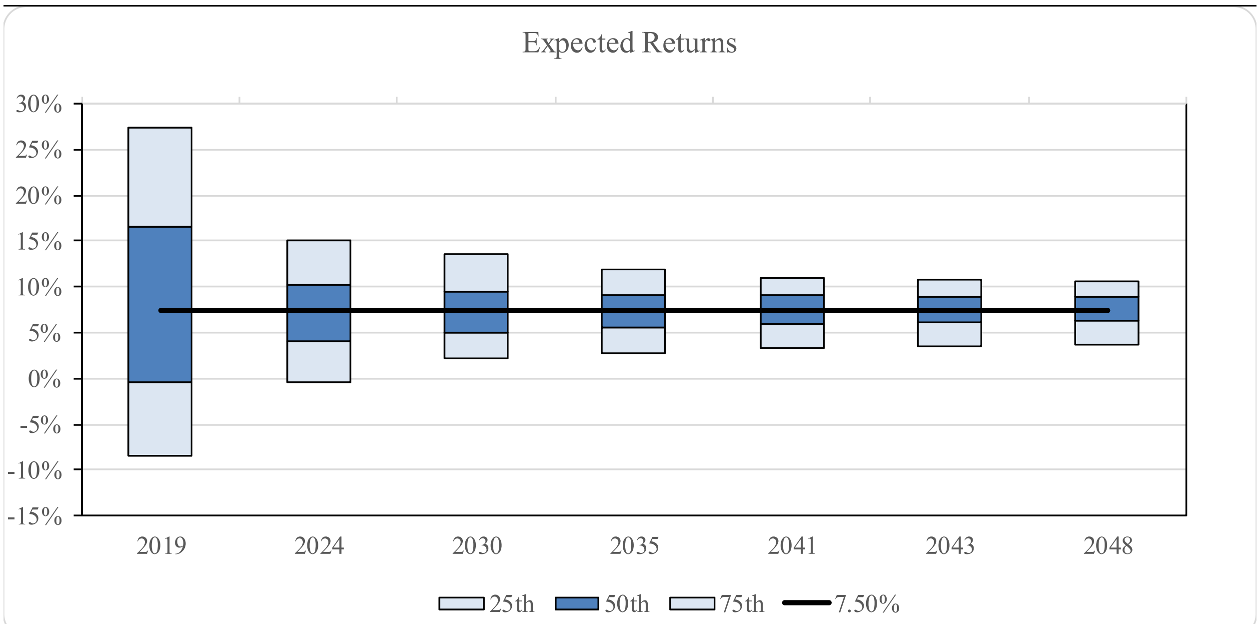
The yellow that predominates the left side of the charts indicates that the system is starting from a position that is comparatively in the middle of the outcomes. Higher returns lead to higher funded ratios, indicated by the green color in the lower right, while lower returns lead to lower funded ratios, as indicated in the red in the upper right.

Variability of Returns – Stochastic Modeling

Deterministic modeling is helpful to compare different scenarios, which can lead to a better understanding of the funding dynamics of the system. Missing in this analysis is an understanding of the likelihood of various scenarios and the plausible range of outcomes from the anticipated volatility associated with the asset allocation. These issues are handled with the more robust approach of stochastic modeling, in which investment performance is varied, based on the expected distribution of portfolio returns. Rather than obtaining a single result, this approach develops the results for many plausible scenarios, so that the distribution of outcomes can be considered.

For this modeling, we generated 1,000 30-year scenarios based on the expected return and standard deviation of the TRS's portfolio. For each simulation, the asset, liabilities, and actuarial contribution rate were modeled for the next 30 years.

The chart below is based on a survey of capital market assumptions. We utilize those assumptions to produce the percentile ranks of expected returns over 30 years. Focusing on the longer time spans, the analysis indicates that over the next 30 years there is a 25% chance that the cumulated rate of return will be below 6.29% and a 25% chance it will be above 8.86%. In other words there is a 50% chance the cumulative market returns over the next 30 years will be between 6.29% and 8.86%.



Probability of Low Funding Ratios

Because of issues such as asset liquidity and the ability to withstand severe market volatility, low funded ratios are a concern. Consequently, understanding the likelihood of the occurrence of a low funded ratio can be helpful to those responsible for the plan. The following tables show the probability of being below a given level during the specified period.

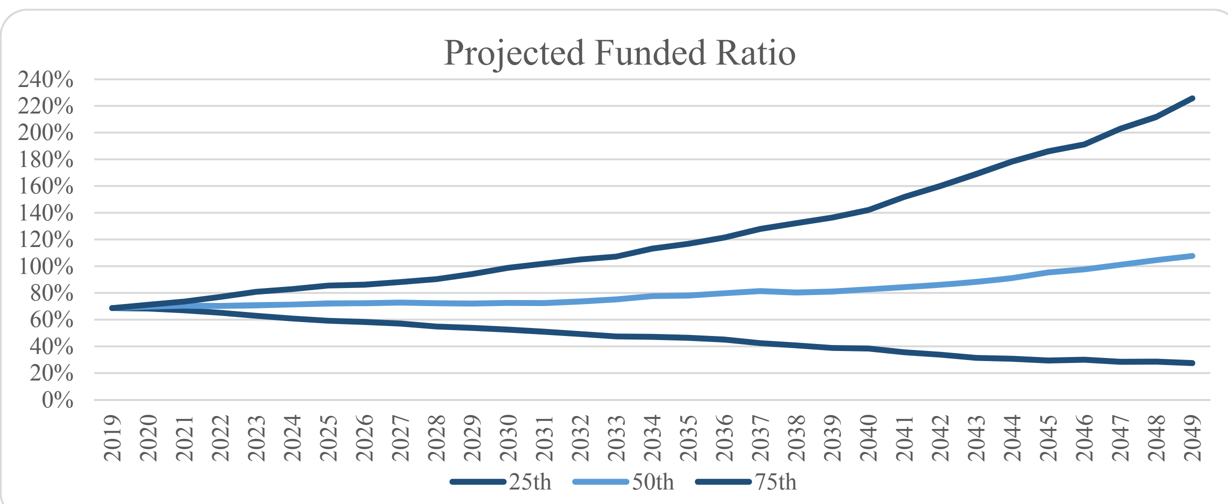
	Ratio <40%	Ratio <50%	Ratio <60%	Ratio <70%	Ratio <80%
2019 – 2029	3%	9%	18%	52%	76%
2019 – 2039	11%	18%	27%	49%	65%
2019 – 2049	17%	23%	30%	46%	59%

It is important to note that these are probabilities of the event occurring at any point during the period. There are scenarios in which the first few years may have low investment returns, leading to a low funded ratio, but due to strong investment returns in later years, the funding ratio after 10 or 15 years may be over 100%. Nonetheless, such scenarios would count in this table as an occurrence of a low funded ratio.

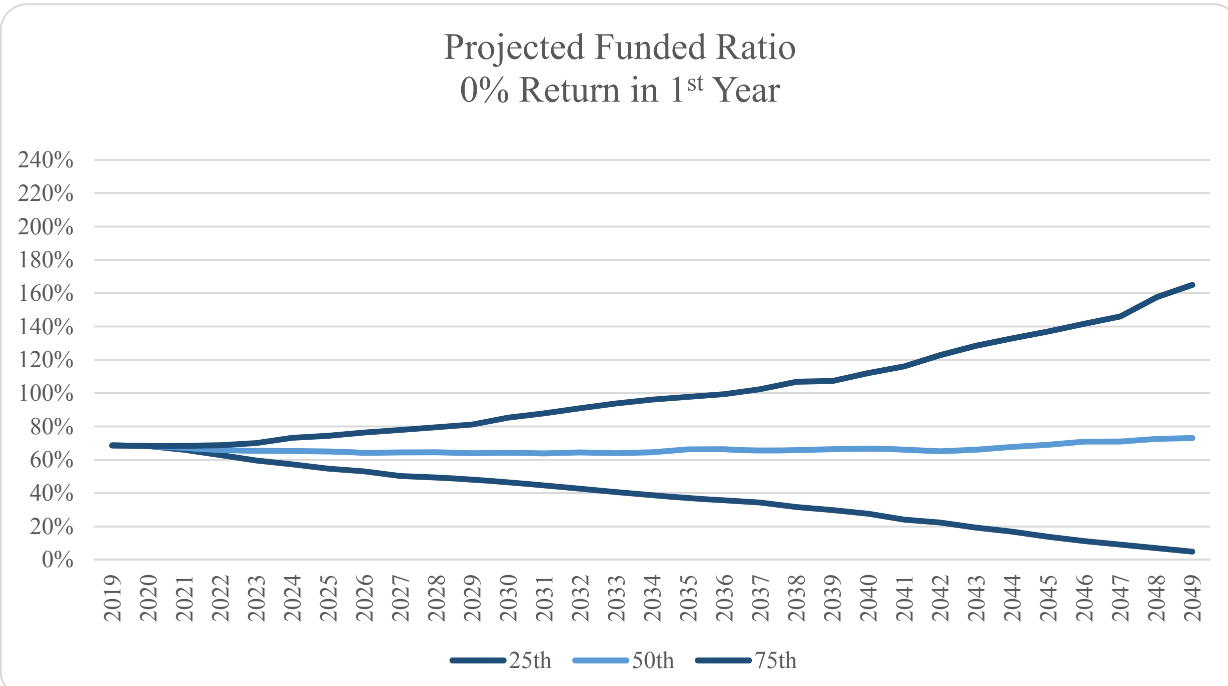
In general, there is a 30% chance that the funded ratio will decline below 60% over the next 30 years, and about a 46% chance that it will drop below 70%. However, there is a 59% chance the funded ratio remains below 80% in the next 30 years.

Distributions of Outcomes

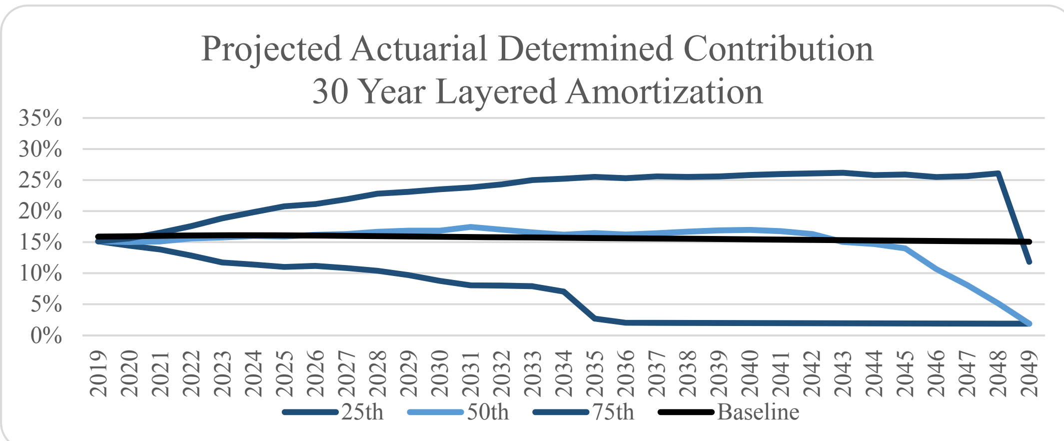
To this point, the discussion of stochastic modeling has focused on the probability of selected outcomes. It can also be useful to examine the distribution of outcomes for insight into the risk associated with investment returns. The following charts show the distribution for the next 30 years of the funded ratio. The darker blue lines represent the range between the 25th and 75th percentiles, or the middle 50% of results. A lighter blue line in the middle of the blue portion indicates the median (50th percentile) result. The results indicate that in ten years, the probability of outcomes is 50% that the funded ratio will range from 54% to 94% with a median result of 72%.



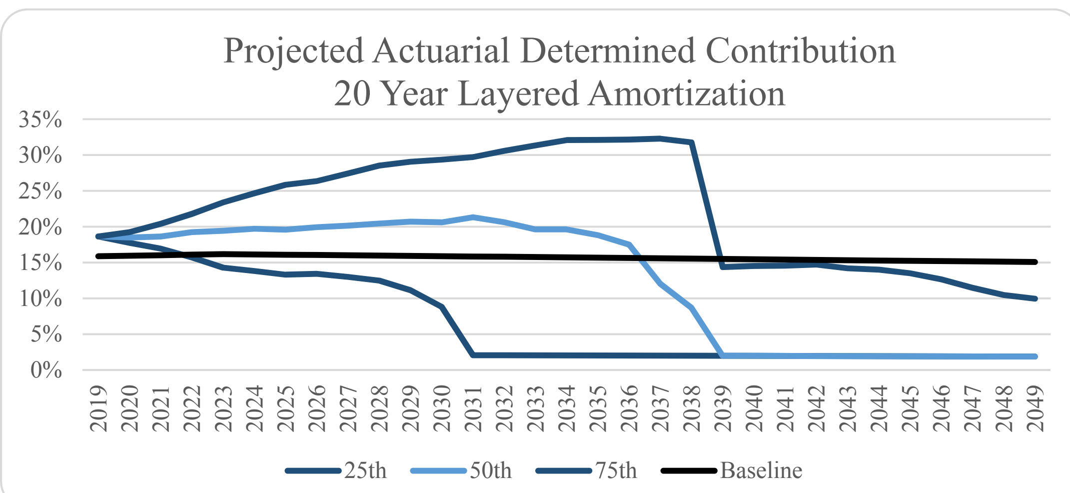
In light of recent events, we have also modeled a stochastic scenario in which the first years return on the market value of assets is 0%. As with the previous example, the following charts show the distribution for the next 30 years of the funded ratio. The darker blue lines represent the range between the 25th and 75th percentiles, or the middle 50% of results. The lighter blue line in the middle of the blue lines indicates the median (50th percentile) result. In the previous result, in ten years, the probability is 50% that the funded ratio will range between 94% and 54%, with a median result of 72%. By setting the first year return with a value of 0% followed by the stochastic process, in ten years, the probability is 50% that the funded ratio is between 81% and 48%, with a median result of 64%. A lighter blue line in the middle of the blue portion indicates the median (50th percentile) result.



In order to highlight the differences between the layered amortization approach we have stochastically modeled the actuarial determined contributions and the funded ratio of the System under the 20 and 30 year amortization methods. As with the previous examples, the darker blue lines represent the range between the 25th and 75th percentiles, or the middle 50% of results. The lighter blue line in the middle indicates the median (50th percentile). The black line shows the current projected employer contributions from all sources. The first thing you will notice is under the layered amortization method, the actuarial determined contribution fluctuates based on the most recent actuarial experience. If the experience is positive, the actuarial determined contributions will decrease. On the contrary, if the actuarial experience is negative, the actuarial determined contribution will increase. This adjustment happens faster under the shorter amortization period, resulting in a much greater range of results. The advantage of this approach is that the contribution can adjust quickly to reflect recent experience.

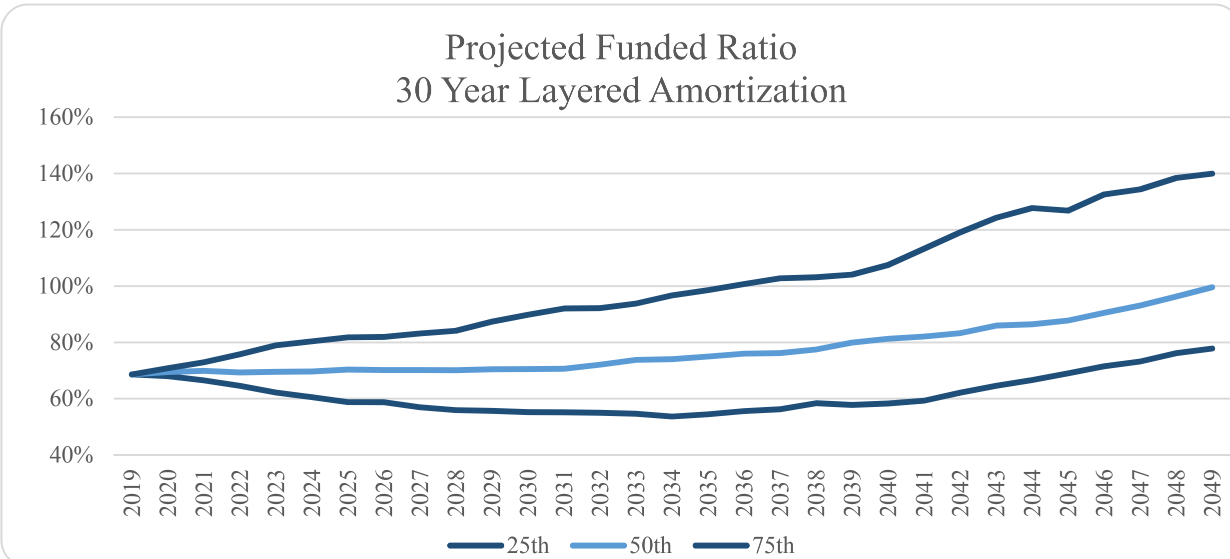


Under the 30 Year Layered Amortization method, in ten years, the probability is 50% that the actuarial determined employer contribution will range from 10% of payroll to 23% of payroll. The median (50th Percentile) actuarial determined contribution is 17% of payroll.

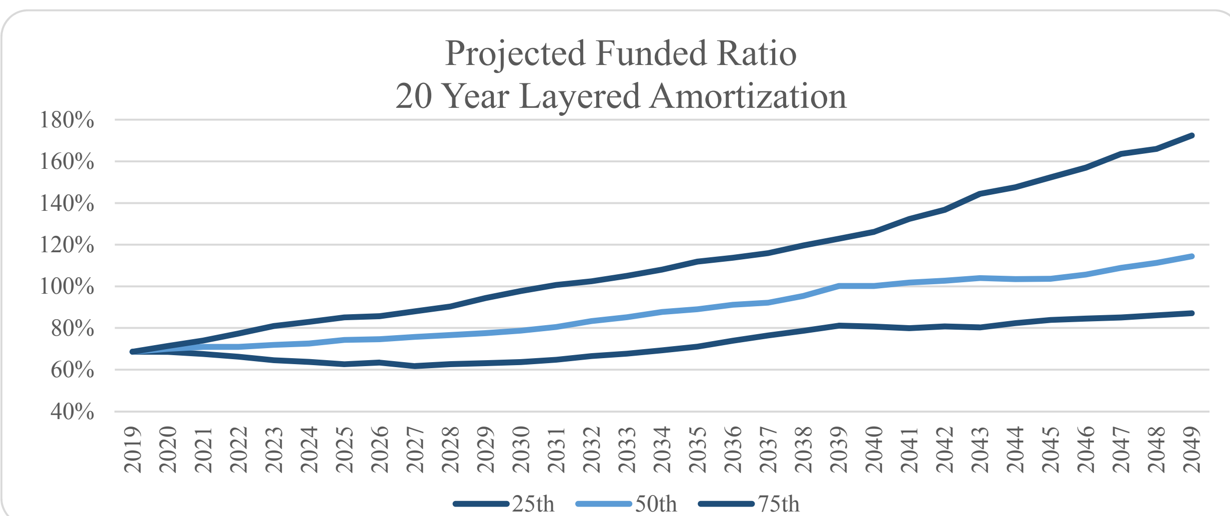


Under the 20 Year Layered Amortization method, in ten years, the probability is 50% that the actuarial determined employer contribution will range from 11% of payroll to 29% of payroll. The median (50th Percentile) actuarial determined contribution is 21% of payroll. In general the 20 year layered amortization method is more costly in the short term because the amortization period is shorter.

The chart below illustrates the projected funded ratio of the System using the 30 year and 20 year amortization methods. The first thing to notice is that the range of funded ratios increase over the 30 year projection period regardless of the actuarial experience of the System. This is a direct result of the annual adjustments made to the actuarial determined contribution. As with the previous examples, the darker blue lines represent the range between the 25th and 75th percentiles, or the middle 50% of results. The lighter blue line in the middle indicates the median (50th percentile).

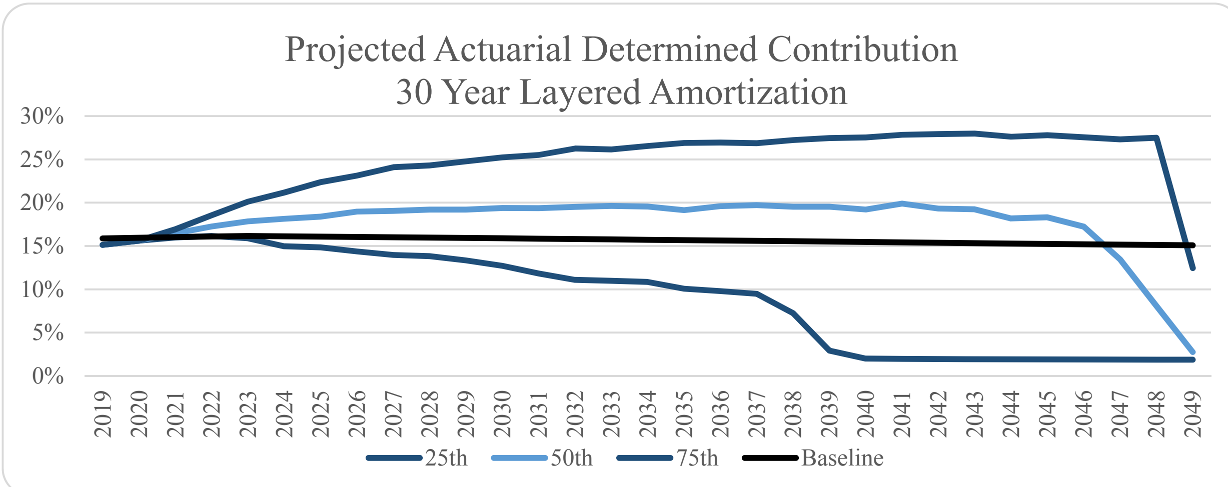


Based on the 30 year layered amortization method, in ten years, the probability is 50% that the funded ratio will range between 56% and 87%. The median (50th Percentile) funded ratio is 70%.

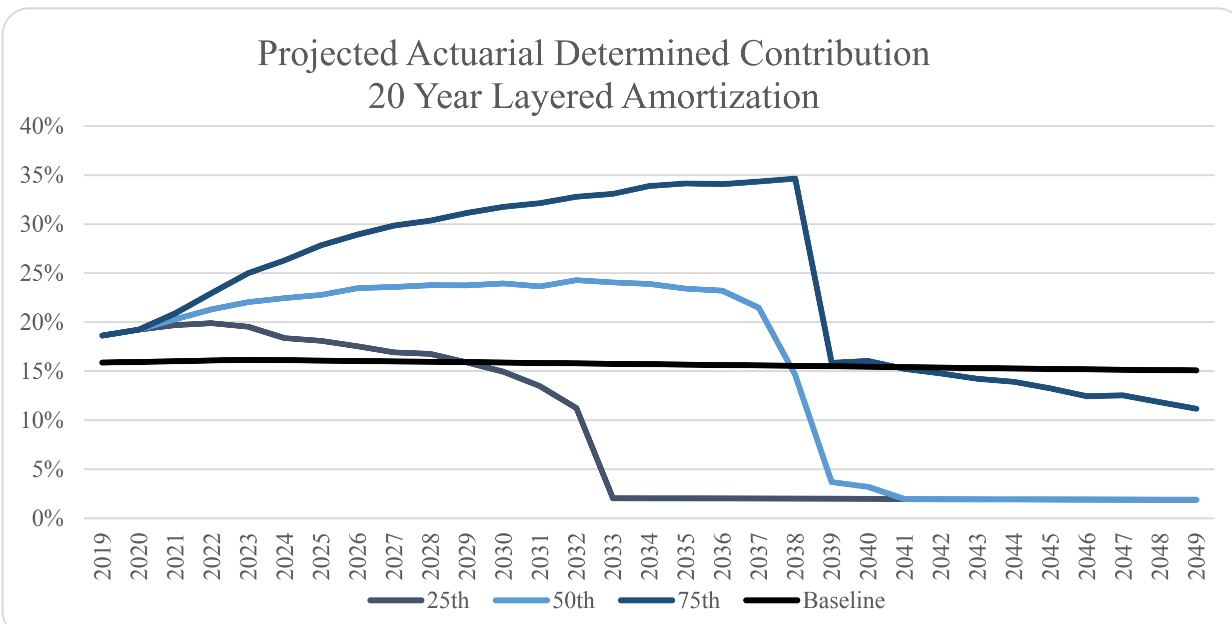


Based on the 20 year layered amortization method, in ten years, the probability is 50% that the funded ratio will range between 63% and 94%. The median (50th Percentile) funded ratio is 77%. The better result under the 20 year layered approach is driven by the shorter amortization period compared to the 30 year amortization method.

In conjunction with the layered amortization methods, we have also modeled a stochastic scenario in which the first years return on the market value of assets is 0%. As with the previous example, the following charts show the distribution for the next 30 years of the required employer contributions. The darker blue lines represent the range between the 25th and 75th percentiles, or the middle 50% of results. The lighter blue line in the middle of the blue lines indicates the median (50th percentile) result. The black line indicates the current employer contributions from all sources as a percentage of payroll.

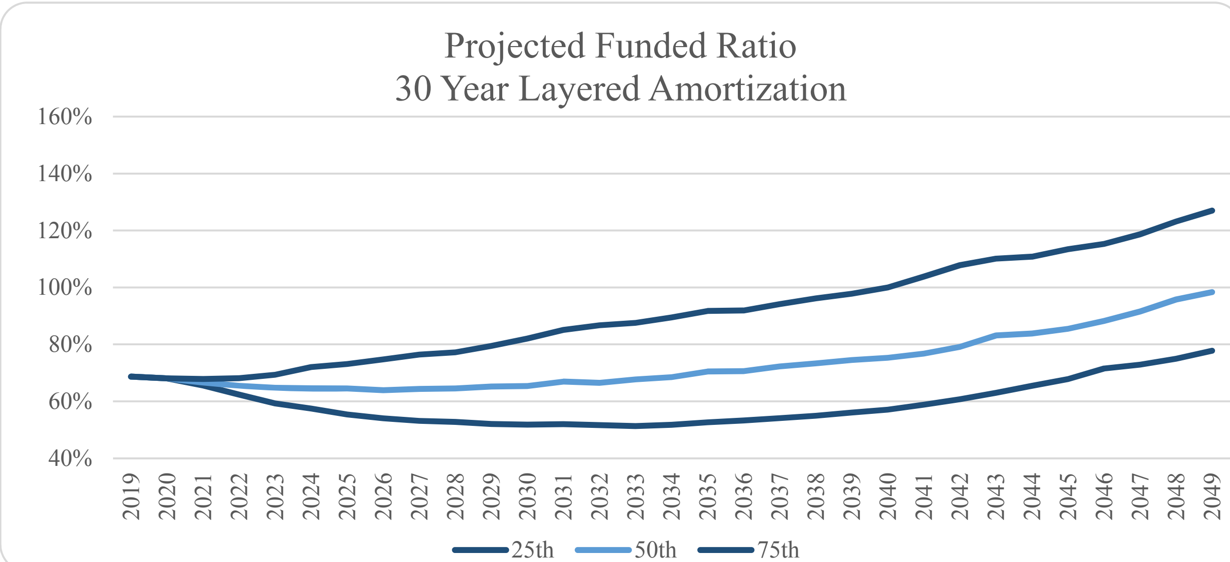


Under the 30 Year Layered Amortization method, in ten years, the probability is 50% that the actuarial determined employer contribution will range from 13% of payroll to 25% of payroll. The median (50th percentile) actuarial determined contribution is 19% of payroll.

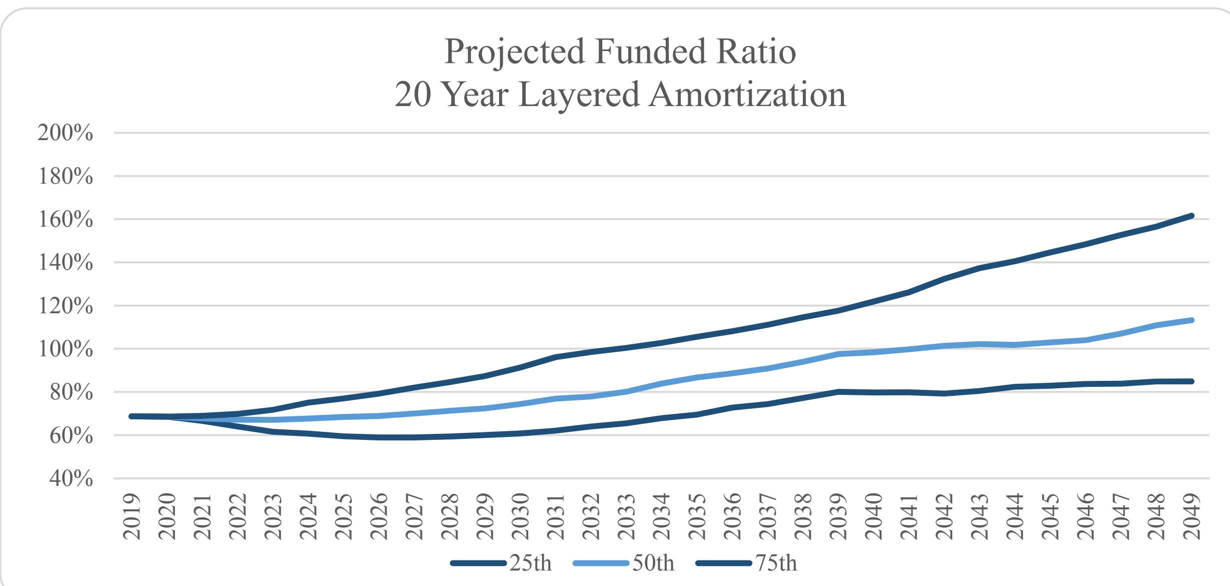


Under the 20 Year Layered Amortization method, in ten years, the probability is 50% that the actuarial determined employer contribution will range from 16% of payroll to 31% of payroll. The median (50th percentile) actuarial determined contribution is 24% of payroll.

In light of recent events, in conjunction with the layered amortization methods we have shown above, we have also modeled a stochastic scenario in which the first years return on the market value of assets is 0%. As with the previous example, the following charts show the distribution for the next 30 years of the funded ratio. The darker blue lines represent the range between the 25th and 75th percentiles, or the middle 50% of results. The lighter blue line in the middle of the blue lines indicates the median (50th percentile) result.



Based on the 30 year layered amortization method, in ten years, the probability is 50% that the funded ratio will range between 52% and 79%. The median (50th Percentile) funded ratio is 65%.



Based on the 20 year layered amortization method, in ten years, the probability is 50% that the funded ratio will range between 60% and 87%. The median (50th Percentile) funded ratio is 72%. The better result under the 20 year layered approach is driven by the shorter amortization period compared to the 30 year amortization method.