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Teachers Retirement Association of Minnesota

Experience Study
Study Period: July 1, 2018 through June 30, 2022

August 2, 2023

APPENDICES

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August 2, 2023

Board of Trustees
Teachers Retirement Association of Minnesota
60 Empire Drive, Suite 400
St. Paul, MN 55103

Dear Members of the Board:

It is a pleasure to submit this report of our investigation of the experience of the Teachers Retirement Association of Minnesota (TRA) for the period beginning July 1, 2018 and ending June 30, 2022. The study was based on the data submitted by TRA for the annual actuarial valuations of the system. In preparing our report we relied, without audit, on the data provided.

The purpose of this report is to present the results of our review of the actuarial methods and assumptions used in the actuarial valuation. With the approval of the recommendations in this report from the Board and the Legislative Commission on Pensions and Retirement (LCPR), these assumptions and methods would be used in the July 1, 2024 actuarial valuation, except for the investment return assumption which is set by statute and will be used in the July 1, 2023 valuation.

We hereby certify that, to the best of our knowledge and belief, this report is complete and accurate and has been prepared in accordance with generally recognized and accepted actuarial principles and practices which are consistent with the principles prescribed by the Actuarial Standards Board (ASB), the Code of Professional Conduct, and Qualification Standards for Public Statements of Actuarial Opinion of the American Academy of Actuaries. We further certify that the assumptions developed in this report satisfy ASB Standards of Practice, in particular, Numbers 4, 27, 35, and 44.

In addition, to the best of our knowledge and belief this study was performed in accordance with the requirements of Minnesota Statues, Section 356.215, and the requirements of the Standards for Actuarial Work established by the State of Minnesota Legislative Commission on Pensions and Retirement (LCPR). We are available to answer any questions on the material contained in the report, or to provide explanations or further details as may be appropriate.

We would like to acknowledge the help in the preparation of the data for this investigation given by the TRA staff.

Board of Trustees
August 2, 2023
Page 2

We, Patrice A. Beckham, F.S.A., Brent A. Banister, F.S.A., and Ben Mobley, A.S.A., are members of the American Academy of Actuaries and Fellows or Associates of the Society of Actuaries and meet the Qualification Standards of the American Academy of Actuaries to render the actuarial opinion contained herein. Further, Patrice Beckham and Brent Banister meet the requirements of "approved actuary" under Minnesota Statues, Section 356.215, Subdivision 1, Paragraph (c).

Sincerely,

Patrice A. Beckham, FSA, EA, FCA, MAAA
Principal and Consulting Actuary

Brent A. Banister, PhD, FSA, EA, FCA, MAAA
Chief Actuary

Ben Mobley, ASA, EA, FCA, MAAA
Consulting Actuary

Introduction

The purpose of an actuarial valuation is to provide a timely best estimate of the ultimate costs of a retirement system which are the future benefits paid to members. Actuarial valuations of the Teachers Retirement Association of Minnesota (TRA) are prepared annually to determine the actuarial contribution rate required to fund the System on an actuarial reserve basis, i.e., the current assets plus future contributions, along with investment earnings will be sufficient to provide the benefits promised by the system. The valuation requires the use of certain assumptions with respect to the occurrence of future events, such as rates of death, termination of employment, retirement age, and salary changes to estimate the obligations of the system.

The basic purpose of an experience study is to determine whether the actuarial assumptions currently in use have adequately projected the actual emerging experience. This information, along with the professional judgment of system personnel and advisors, is used to evaluate the appropriateness of continued use of the current actuarial assumptions. When analyzing experience and assumptions, it is important to recognize that actual experience is reported in the short term while assumptions are intended to be long-term estimates of experience. Consequently, we must attempt to determine what part of recent experience is simply due to variability and what part is related to a permanent shift in patterns.

At the request of the Board of Trustees, Cavanaugh Macdonald Consulting, LLC (CMC), performed a study of the experience of TRA, for the period July 1, 2018 through June 30, 2022. This report presents the results and recommendations of our study. None of the recommendations will require legislation to adopt the changes. The Board has the statutory authority to adopt the recommended changes to the assumptions, subject to approval by the Legislative Commission on Pensions and Retirement (LCPR). It is anticipated that the changes, if approved, will first be reflected in the July 1, 2024 actuarial valuation of the System. Note the investment return assumption is set by statute and will be effective with the July 1, 2023 valuation.

These assumptions have been developed in accordance with generally recognized and accepted actuarial principles and practices that are consistent with the applicable Actuarial Standards of Practice adopted by the Actuarial Standards Board (ASB). While the recommended assumptions represent our best estimate of future experience, there are other reasonable assumption sets that could be supported by the results of this experience study. Those other sets of reasonable assumptions could produce liabilities and costs that are either higher or lower.

Our Philosophy

Similar to an actuarial valuation, the calculation of actual and expected experience is a fairly mechanical process, and differences between actuaries are generally minor. However, analyzing the experience and setting the assumptions differs, as it is more art than science. In this report, we have recommended changes to certain assumptions. To explain our thought process, we offer a brief summary of our philosophy:

- **Don't Overreact**: When we see significant changes in experience, we first evaluate the credibility of the experience. Even if we believe it is credible, we generally do not adjust our rates to reflect the entire difference. We will typically recommend rates somewhere between the old rates and the new experience. If the experience during the next study period shows the same result, we will probably recognize the trend at that point in time or at least move further in the direction of the observed experience. On the other hand, if experience returns closer to its prior level, we will not have overreacted, possibly causing volatility in the actuarial contribution rates.

- **Anticipate Trends**: If there is an identified trend that is expected to continue, we believe that this should be recognized in order to better estimate the system's liability. An example is the retiree mortality assumption. It is an established trend that people are living longer. Therefore, we believe the best estimate of liabilities in the valuation should reflect some expected increase in life expectancy.

- **Simplify**: In general, we attempt to identify which factors are significant and eliminate or ignore the ones that do not materially improve the accuracy of the liability projections.

Actuarial Methods

The basic actuarial methodologies used in the valuation process include the actuarial cost method, the asset valuation method and the unfunded actuarial accrued liability (UAAL) amortization methodology. These are set in statute and in the LCPR Standards for Actuarial Work. We recommend that all the current actuarial methods be retained. However, we have included some discussion on other options for the amortization of the UAAL to promote discussion at a future date if the Board is so inclined.

Summary of Recommendations – Economic Assumptions

Economic assumptions are some of the most visible and significant assumptions used in the valuation process. The items in the broad economy modeled by these assumptions can be very volatile over short periods of time, as clearly seen in the economic downturn in 2008 followed by a rebound in many financial markets in the years following. Our goal is to try to find the emerging long-term trends in the midst of this volatility so that we can then apply reasonable assumptions.

Most of the economic assumptions used in the valuation are developed through the "building-block" approach. For example, the long-term investment return is based on the expectation for inflation plus the expected real return on assets.

While most of the economic assumptions remain reasonable, we are recommending that the investment return assumption be reduced from 7.50% to 7.00%. Note that the investment return assumption is set in statute and has been changed to 7.00% effective with the July 1, 2023 valuation. The following table summarizes the current and proposed economic assumptions:

	Current Assumptions*	Proposed Assumptions
Price Inflation	2.50%	2.50%
Long-term Investment Return	7.50%	7.00%
Wage inflation (above price inflation)	0.35% through 2028, 0.75% thereafter	0.35% through 2028, 0.75% thereafter
Payroll Growth	3.00%	3.00%
Total Salary Increase	Wage inflation plus merit	Wage inflation plus merit

*Current assumptions are those used in the July 1, 2022 valuation.

Although we have recommended this set of economic assumptions, we recognize that there may be other sets of economic assumptions which are also reasonable for purposes of funding TRA. The valuation results would be different under different sets of economic assumptions.

Summary of Recommendations – Demographic Assumptions

In the experience study, actual demographic experience for the study period is compared to that expected based on the current actuarial assumptions. Comparing the incidence of the event to what was expected (called the Actual-to-Expected ratio, or A/E ratio) then provides the basis for our analysis.

The following are the recommended changes to the demographic assumptions:
- Mortality: Update the mortality tables for active employees, retirees, disabled retirees, and contingent beneficiaries to recently published tables derived from public plan data known as the Pub2010 family of tables.

- Retirement: Increase some of the tier 2 early retirement rates and change some of the unreduced retirement rates for both tiers to better align with actual experience.

- Optional form election: Changes to the probability that new female retirees elect either the Straight Life Annuity or 100% Joint & Survivor Annuity were refined to reflect the actual experience.

- Termination of employment: Reductions in the rates of termination of employment in the first ten years of employment and some very slight increases for 16 to 25 to better match the observed experience.

- Disability: Decreased disability rates over age 45 by 15% to reflect the continued lower than expected observations.

Miscellaneous Assumptions

There are other assumptions used in the data and valuation processes for TRA that are less critical in terms of their impact on the System's liabilities. We confirm that all of these other assumptions used in the valuation are reasonable and should be maintained.

Summary of Recommendations

We recommend that the Board adopt changes to the demographic assumptions, generally described above, and presented more fully in Appendix B in this report.

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Financial Impact

The financial impact of the recommended changes was estimated by performing additional valuations using the July 1, 2022 valuation with the recommended set of assumptions outlined in this report.

When this set of assumptions is actually used, likely in the July 1, 2024 valuation, we expect the relative impact to be similar to the results shown here (as a percentage of the actuarial accrued liability and normal cost). However, the actual impact may vary due to underlying changes between valuation dates.

Comparison of Valuation Results and Costs			
($ in millions)	July 1, 2022 Valuation (Baseline)	With 7.0% Investment Return Assumption Change	With All Assumption Changes
Actuarial Accrued Liability (AAL)	$31,616	$33,600	$32,681
Actuarial Assets	25,926	25,926	25,926
Unfunded AAL (UAAL)	$5,690	$7,674	$6,755
Funded Ratio	82.00%	77.16%	79.33%
Normal Cost Rate	9.23%	10.50%	10.33%
UAAL Amortization Rate	6.21%	7.96%	7.01%
Expense Rate	0.28%	0.28%	0.28%
Total Actuarial Rate	15.72%	18.74%	17.62%
Statutory Contribution Rate	16.82%	16.82%	16.82%
Sufficiency/(Deficiency)	1.10%	(1.92%)	(0.80%)

Numbers may not add due to rounding.

ACTUARIAL COST METHOD

The systematic financing of a pension plan requires that contributions be made in an orderly fashion while a member is actively employed, so that the accumulation of these contributions, together with investment earnings should be sufficient to provide promised benefits and cover administration expenses. The actuarial valuation is the process used to determine when money should be contributed, i.e., as part of the budgeting process.

The actuarial valuation will not impact the amount of benefits paid or the actual cost of those benefits. In the long run, actuaries cannot change the costs of the pension plan, regardless of the funding method used or the assumptions selected. However, the choice of actuarial methods and assumptions **will** influence the incidence of costs.

The actuary does not have complete freedom in assigning this value. The Actuarial Standards Board also has basic principles regarding the calculation of a smoothed asset value, Actuarial Standard of Practice No. 4 (ASOP 4), *Measuring Pension Obligations and Determining Pension Plan Costs or Contribution* provides guidance on the Actuarial Cost Method, Amortization Method and other consideration for the development of contributions.

The valuation or determination of the present value of all future benefits to be paid by the System reflects the assumptions that best seem to describe anticipated future experience. The choice of a funding method does not impact the determination of the present value of future benefits. The funding method determines only the incidence or allocation of cost. In other words, the purpose of the funding method is to allocate the present value of future benefits determination into annual costs. In order to do this allocation, it is necessary for the funding method to "break down" the present value of future benefits into two components: (1) that which is attributable to the past, and (2) that which is attributable to the future. The excess of that portion attributable to the past over the plan assets is then amortized over a period of years. Actuarial terminology calls the part attributable to the past the "past service liability" or the "actuarial accrued liability". The portion of the present value of future benefits allocated to the future is commonly known as the "present value of future normal costs", with the specific piece of it allocated to the current year being called the "normal cost". The difference between the plan assets and actuarial accrued liability is called the "unfunded actuarial accrued liability".

Two key points should be noted. First, there is no single "correct" funding method. Second, the allocation of the present value of future benefits, and hence cost, to the past for amortization and to the future for annual normal cost payments is not necessarily in a one-to-one relationship with service credits earned in the past and future service credits to be earned.

There are various actuarial cost methods, each of which has different characteristics, advantages, and disadvantages. However, Governmental Accounting Standard Board (GASB) Statement Numbers 67 and 68 require that the Entry Age Normal cost method be used for financial reporting. Most systems do not want to use a different actuarial cost method for funding and financial

reporting. In addition, the Entry Age Normal method has been the most common funding method for public systems for many years. This is the cost method currently used by TRA.

The rationale of the Entry Age Normal (EAN) cost method is that the cost of each member's benefit is determined to be a level percentage of his salary from date of hire to the end of his employment with the employer. This level percentage multiplied by the member's annual salary is referred to as the normal cost and is that portion of the total cost of the employee's benefit which is allocated to the current year. The portion of the present value of future benefits allocated to the future is determined by multiplying this percentage times the present value of the member's assumed earnings for all future years including the current year. The entry age normal actuarial accrued liability is then developed by subtracting from the present value of future benefits that portion of costs allocated to the future. To determine the unfunded actuarial accrued liability, the value of plan assets is subtracted from the Entry Age Normal actuarial accrued liability. The current year's cost to amortize the unfunded actuarial accrued liability is developed by applying an amortization factor.

It is to be expected that future events will not occur exactly as anticipated by the actuarial assumptions in each year. Actuarial gains/losses from experience under this actuarial cost method can be directly calculated and are reflected as a decrease/increase in the unfunded actuarial accrued liability. Consequently, the gain/loss results in a decrease/increase in the amortization payment, and therefore the contribution rate.

Considering that the Entry Age Normal cost method is the most commonly used cost method by public plans, develops a normal cost rate that tends to be stable and less volatile, and is the required cost method under calculations required by GASB Numbers 67 and 68, **we recommend the Entry Age Normal actuarial cost method be retained.**

ACTUARIAL VALUE OF ASSETS

In preparing an actuarial valuation, the actuary must assign a value to the assets of the fund. An adjusted market value is often used to smooth out the volatility that is reflected in the market value of assets. This is because most employers would rather have annual costs remain relatively smooth, as a percentage of payroll or in actual dollars, as opposed to a cost pattern that is extremely volatile.

The actuary does not have complete freedom in assigning this value. The Actuarial Standards Board has basic principles regarding the calculation of a smoothed asset value, Actuarial Standard of Practice No. 44 (ASOP 44), *Selection and Use of Asset Valuation Methods for Pension Valuations.*

ASOP 44 provides that the asset valuation method should bear a reasonable relationship to the market value. Furthermore, the asset valuation method should be likely to satisfy both of the following:

- Produce values within a reasonable range around market value, AND
- Recognize differences from market value in a reasonable amount of time.

In lieu of both of the above, the standard will be met if <u>either</u> of the following requirements is satisfied:

- There is a sufficiently narrow range around the market value, OR
- The method recognizes differences from market value in a sufficiently short period.

These rules or principles prevent the asset valuation methodology from being used to distort annual funding patterns. No matter what asset valuation method is used, it is important to note that, like a cost method or actuarial assumptions, the asset valuation method does not affect the true cost of the plan; it only impacts the incidence of cost.

TRA values assets, for actuarial valuation purposes, based on the principle that the difference between actual and expected investment returns should be subject to partial recognition to smooth out fluctuations in the total return achieved by the fund from year to year. This philosophy is consistent with the long-term nature of a retirement system. Under the current method in statute, the difference between the actual investment return on the market value of assets and the assumed investment return on the market value of assets is recognized equally over a five-year period. This methodology is an asset smoothing method commonly used by public plans and we believe that it meets actuarial standards under ASOP 44. **We recommend the current asset valuation method be retained**.

AMORTIZATION OF UAAL

As described earlier, actuarial accrued liability is the portion of the actuarial present value of future benefits that are not included in future normal costs. Thus, it represents the liability that, in theory, should have been funded through normal costs for past service. Unfunded actuarial accrued liability (UAAL) exists when the actuarial accrued liability exceeds the actuarial value of plan assets. These deficiencies can result from:

(i)   plan improvements that have not been completely paid for,
(ii)   experience that is less favorable than expected,
(iii) assumption changes that increase liabilities, or
(iv)   contributions that are less than the actuarial contribution rate.

There are a variety of different methods that can be used to amortize the UAAL. Each method results in a different payment stream and, therefore, has cost implications. For each methodology, there are three characteristics:

- The period over which the UAAL is amortized,
- The rate at which the amortization payment increases, and
- The number of components of UAAL (separate amortization bases).

Amortization Period: The amortization period can be either closed or open. If it is a closed amortization period, the number of years remaining in the amortization period declines by one in each future valuation. Alternatively, if the amortization period is an open or rolling period, the amortization period does not decline but is reset to the same number each year. This approach essentially "refinances" the System's debt (UAAL) every year.

Amortization Payment: The <u>level dollar</u> amortization method is similar to the method in which a homeowner pays off a mortgage. The liability, once calculated, is financed by a constant fixed dollar amount, based on the amortization period until the liability is extinguished. This results in the liability steadily decreasing while the payments, though remaining level in dollar terms, in all probability decrease as a percentage of payroll. (Even if a plan sponsor's population is not growing, inflationary salary increases will usually be sufficient to increase the aggregate covered payroll).

The rationale behind the <u>level percentage of payroll</u> amortization method is that since normal costs are calculated to be a constant percentage of pay, the unfunded actuarial accrued liability should be paid off in the same manner. When this method of amortizing the unfunded actuarial accrued liability is adopted, the initial amortization payments are lower than they would be under a level dollar amortization payment method, but the payments increase at a fixed rate each year so that ultimately the annual payment far exceeds the level dollar payment. The expectation is that total payroll will increase at the same rate so that the amortization payments will remain constant, as a percentage of payroll. In the initial years, the level percentage of payroll amortization payment is often less than the interest accruing on the unfunded actuarial accrued liability meaning that even if there are no experience losses, the dollar amount of the unfunded actuarial accrued liability will grow (called negative amortization). This is particularly true if the plan sponsor is paying off the unfunded actuarial accrued liability over a long period, such as 20 or more years.

Amortization Bases: The UAAL can either be amortized as one single amount or as components or "layers", each with a separate amortization base, payment and period. If the UAAL is amortized as one amount, the UAAL is recalculated each year in the valuation and experience gains/losses or other changes in the UAAL are folded into the single UAAL amortization base. The amortization payment is then the total UAAL divided by an amortization factor for the applicable amortization period.

If separate amortization bases are maintained, the UAAL is composed of multiple amortization bases, each with its own payment schedule and remaining amortization period. In each valuation, the unexpected change in the UAAL is established as a new amortization base over the appropriate amortization period beginning on that valuation date. The UAAL is then the sum of all of the outstanding amortization bases on the valuation date and the UAAL payment is the sum of all of the amortization payments on the existing amortization bases. This approach provides

transparency in that the current UAAL is paid off over a fixed period of time and the remaining components of the UAAL are clearly identified. Adjustments to the UAAL in future years are also separately identified in each future year. One downside of this approach is that it can create some discontinuities in contribution rates when UAAL layers/components are fully paid off. If this occurs, it likely would be far in the future, with adequate time to address any adjustments needed.

Current TRA Actuarial Amortization Method: TRA is funded with fixed contribution rates (employee and employer) so the amortization policy does not impact the actual funding of the System. The UAAL amortization rate is utilized, however, in the calculation of the actuarial contribution rate which then determines the contribution sufficiency or deficiency (difference between the actuarial and statutory contribution rates). However, perhaps the more relevant question, given TRA's funding policy, is the remaining years to amortize the UAAL, given the current contribution rates.

The current amortization method used by TRA includes a single amortization base with payments determined as a level percentage of payroll. The amortization period is scheduled by statute to reset to a closed 30-year period starting with the July 1, 2025 valuation. This period is subject to adjustment under certain circumstances. Each year, the amortization period will be reduced by one year until 2055 when the amortization of the base will be considered completed.

One weakness of a single closed amortization base is that as the remaining amortization period declines, there can be increasing volatility in the actuarial contribution rate. When the amortization period gets to 10-12 years or less, the volatility exhibited may make it desirable to change to a layered base approach or retain a single base with a "floor" (minimum number of years applicable to amortizing the UAAL) to address the contribution volatility created by the end of the current amortization period. The amortization period could also be reset to a longer period, although this is our less preferred method to address the concern.

With the layered base approach, the current UAAL would be fully paid off in 2055. Gains and losses would be paid off over a specified period of time. This approach allows for a definite payoff date, something not possible with a floor. Because the current UAAL is much larger than a typical year's gain or loss, we would anticipate that the majority of the UAAL payment through 2055 would be for the current UAAL base. New layers would likely be composed of both experience gains and losses (both asset and liability), so the total impact of all these bases is expected be fairly small as the gains and losses partially offset each other. Note that a gain being "paid off" means recognizing the favorable experience by lowering the amortization payment.

If a layered approach were adopted, we suggest that new experience (gains and losses) bases be paid off over a selected period of 15 to 20 years. This bears some resemblance to the time period from entry to retirement of a typical active member and should span most economic cycles. Using a shorter period, such as 10 years, would pay down the amortization base faster, but create more volatility. Likewise, longer periods reduce contribution rate volatility, but delay recognition of the experience. Changes in the UAAL resulting from other items such as plan amendments or changes in assumptions/methods will be amortized over an appropriate period. For example, assumption

changes might be amortized over a longer period of time recognizing that such a change reflects the difference in expected experience many years in the future.

We note that the Government Finance Officers Association (GFOA) and the Conference of Consulting Actuaries (CCA) have published guidance on public pension plan funding, including the amortization period. Although these recommendations are not binding, they do point to an increased focus on developing amortization policies that are designed to pay down the UAAL in a meaningful way over a reasonable period of time. The Actuarial Standards Board recently updated Actuarial Standard of Practice (ASOP) No. 4 to include some additional disclosures related to amortization of the UAAL. As a result, we anticipate we will disclose two different actuarial contribution rates – one for compliance with state statute, and the other for compliance with actuarial standards. Consequently, we believe a greater understanding of the issues involved would be beneficial to the Board.

Because of the requirement in ASOP 4 related to disclosing a "Reasonable Actuarially Determined Contribution," **we recommend the Board adopt an amortization method that amortizes the July 1, 2023 UAAL over a closed 25-year period and creates new 20-year amortization layers for unexpected changes in the UAAL in each subsequent valuation.** We will still prepare the annual valuation report with the statutory single amortization base, amortized through 2055, for compliance with the statutory requirements.

Economic assumptions include the long-term investment return (net of investment expenses), price inflation, and wage inflation (the across-the-board portion of individual salary increases). The merit salary scale is actually a demographic assumption, but it is being discussed with the economic assumptions because the total salary increase assumption applied to individual members includes the wage inflation assumption. Unlike demographic assumptions, economic assumptions do not lend themselves to analysis based heavily upon internal historical patterns, because both salary increases and investment return are influenced more by external forces which are difficult to accurately predict over the long term. The investment return and salary increase assumptions are generally selected on the basis of expectations in an inflation-free environment and then increased by the long-term expectation for price inflation (called the building block approach).

Sources of data considered in the analysis and selection of the economic assumptions included:

- Historical observations of price and wage inflation statistics and investment returns
- 2023 Social Security Trustees Report
- Future return expectations of the State Board of Investments (SBI), and their consultants
- U. S. Department of the Treasury bond rates
- Assumptions used by other large public retirement systems, based on the Public Fund Survey, published by the National Association of State Retirement Administrators.

Guidance regarding the selection of economic assumptions for measuring pension obligations is provided by Actuarial Standard of Practice (ASOP) No. 27, *Selection of Economic Assumptions for Measuring Pension Obligations*. Because no one knows what the future holds, the best an actuary can do is to use professional judgment to estimate possible future economic outcomes. These estimates are based on a mixture of past experience, future expectations, and professional judgment.

ACTUARIAL STANDARD OF PRACTICE NUMBER 27

Actuarial Standards of Practice are issued by the Actuarial Standards Board to provide guidance to actuaries with respect to certain aspects of performing actuarial work. As mentioned earlier, Actuarial Standard of Practice Number 27 (ASOP 27) is the standard that addresses the selection of economic assumptions for measuring pension obligations. Therefore, our analysis of the expected rate of return, as well as other economic assumptions, was performed following the guidance in ASOP 27.

Due to the application of ASOP 27, it may be informative for others to be aware of the basic content of ASOP 27. The standard applies to the selection of economic assumptions to measure obligations under any defined benefit pension plan that is not a social insurance program (e.g., Social Security).

With respect to relevant data, the standard recommends the actuary review appropriate recent and long-term historical economic data but advises the actuary not to give undue weight to recent experience. Furthermore, it advises the actuary to consider that some historical economic data may not be appropriate for use in developing assumptions for future periods due to changes in the

underlying environment. In addition, with respect to any particular valuation, the standard requires that each economic assumption be consistent with all other economic assumptions over the measurement period.

ASOP 27 recognizes that economic data and analyses are available from a variety of sources, including representatives of the plan sponsor, investment advisors, economists, and other professionals. The actuary is permitted to incorporate the views of experts, but the selection or advice must reflect the actuary's professional judgment. The standard calls for the actuary to select a "reasonable" assumption. For this purpose, an assumption is considered reasonable if it has the following characteristics:

a. it is appropriate for the purpose of the measurement;

b. it reflects the actuary's professional judgment;

c. it takes into account historical and current economic data that is relevant as of the measurement date;

d. it reflects the actuary's estimate of future experience, the actuary's observation of the estimates inherent in market data, or a combination thereof; and

e. it has no significant bias (i.e., it is neither significantly optimistic nor pessimistic), except when provisions for adverse deviation or plan provisions that are difficult to measure are included.

The standard goes on to discuss a "range of reasonable assumptions" which in part states "the actuary should also recognize that different actuaries will apply different professional judgment and may choose different reasonable assumptions. As a result, a range of reasonable assumptions may develop both for an individual actuary and across actuarial practice."

The remaining section of this report will address the relevant types of economic assumptions used in the actuarial valuation to determine the obligations of the System. In our opinion, the economic assumptions proposed in this report have been developed in accordance with ASOP No. 27.

The following table summarizes the current and recommended economic assumptions:

	Current Assumptions	Proposed Assumptions
Price Inflation	2.50%	2.50%
Investment Return	7.50%	7.00%
Wage Inflation	2.85% through 2028, then 3.25%	2.85% through 2028, then 3.25%
Payroll Growth	3.00%	3.00%

INFLATION

Use in the Valuation

Future price inflation has an indirect impact on the results of the actuarial valuation through the development of the assumptions for investment return, wage growth, payroll growth and individual salary increases.

The long-term relationship between price inflation and investment return has long been recognized by economists. The basic principle is that the investor demands a more or less level "real return" – the excess of actual investment return over price inflation. If inflation rates are expected to be high, investment return rates are also expected to be high, while low inflation rates are expected to result in lower expected investment returns, at least in the long run.

The current assumption for price inflation is 2.50% per year.

Past Experience

Although economic activities, in general, and inflation in particular, do not lend themselves to prediction solely on the basis of historical analysis, historical patterns and long-term trends are factors to be considered in developing the inflation assumption. The Consumer Price Index, US City Average, All Urban Consumers, CPI (U), has been used as the basis for reviewing historical levels of price inflation. The following table provides historical annualized rates and annual standard deviations of the CPI-U over periods ending June 30th.

Period	Number of Years	Annualized Rate of Inflation	Annual Standard Deviation
1926 – 2022	96	2.98%	4.08%
1962 – 2022	60	3.88	2.92
1972 – 2022	50	4.00	3.11
1982 – 2022	40	2.83	1.76
1992 – 2022	30	2.53	1.83
2002 – 2022	20	2.53	2.23
2012 - 2022	10	2.59	2.69

The following graph illustrates the historical annual change in price inflation, measured as of June 30 for each of the last 70 years, as well as the thirty-year rolling average.

Historical Inflation
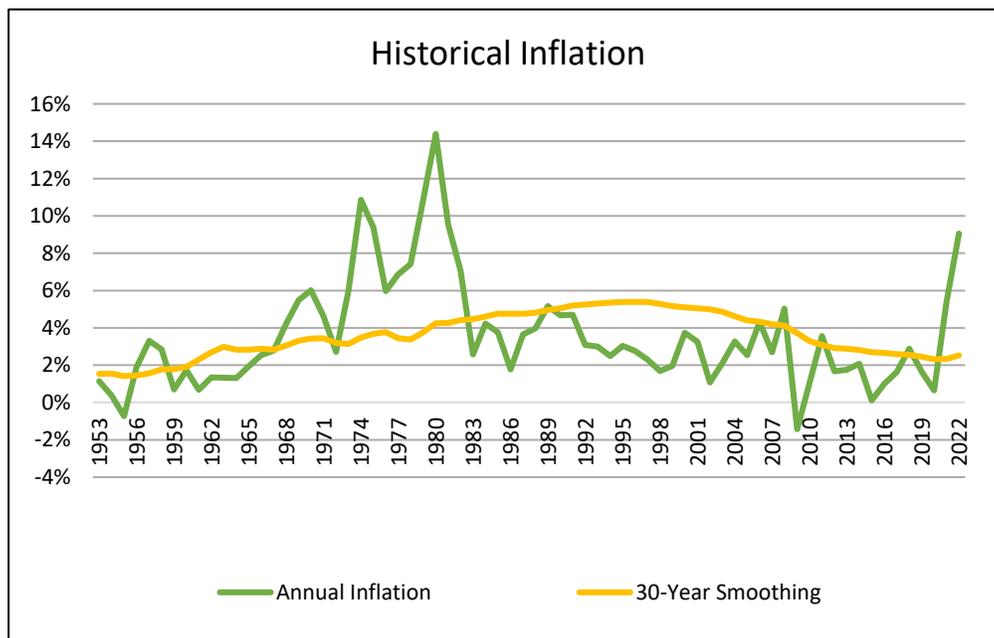
From 2008 through 2020, the annual rate of increase in the CPI-U was below the current assumption of 2.50% almost every year. The period of high inflation from 1973 to 1982 has a significant impact on the averages over periods which include these rates, as does the spike in 2021 and 2022.

Implied Forecasts from the Bond Market

Additional information to consider in formulating this assumption is obtained from measuring the spread on Treasury Inflation Protected Securities (TIPS) and from the prevailing economic forecasts. The spread between the nominal yield on treasury securities (bonds) and the inflation indexed yield on TIPS of the same maturity is referred to as the "breakeven rate of inflation" and represents the bond market's expectation of inflation over the period to maturity. Current market prices as this report was being completed suggest that investors expect inflation to be around 2.2% over the next 5 to 30 years. The bond market expectations may be heavily influenced by the interest rate environment created by the Federal Reserve Bank's manipulation of the bond market.

Forecasts from the Social Security Administration

Although many economists forecast lower inflation than the assumptions used by retirement systems, they are generally looking at a shorter time horizon (10 years) than is appropriate for a pension valuation. To consider a longer, similar time frame, we looked at the expected increase in the CPI by the Office of the Chief Actuary for the Social Security Administration. In the most recent report (March 2023), the projected average annual increase in the CPI over the next 75 years

was estimated to be 2.4%, under the intermediate (best estimate) cost assumption. The range of price inflation used in the Social Security 75-year modeling, which includes low and high-cost scenarios, in addition to the intermediate cost projection, was 1.8% to 3.0%.

Forecasts from Investment Consulting Firms and Other Professionals

In setting their capital market assumptions, most investment consulting firms use an inflation assumption. We surveyed the capital market assumptions of 11 different investment consulting firms and found that the average inflation assumption in the first quarter of 2023 to be 2.50%

Another source to consider in setting this assumption is a quarterly survey conducted by the Philadelphia Federal Reserve of economists called the Society of Professional Forecasters. Their most recent forecast (second quarter of 2023) was for inflation over the next ten years to average 2.36%.

Peer System Comparison

While we do not recommend the selection of any assumption based on what other systems use, it does provide another set of relevant information to consider. Based on the Public Plan Database (a survey of over 125+ state and local retirement systems maintained by a collaboration between the Center for Retirement Research at Boston College, the Center for State and Local Government Excellence, and the National Association of State Retirement Administrators), the average inflation assumption for governmental plans has been steadily declining. Based on the current data, the average inflation assumption is 2.52%. This data is largely based on actuarial valuations prepared with measurement dates in 2021. Although inflation has spiked recently, we have not seen a reversal of this trend and expect most systems to take a wait-and-see approach.

Comparison of Inflation Expectations

The following table provides a comparison of the current levels of expected inflation.

Source	Expected Inflation
Investment Consultants Survey	2.46%
Bond Market	2.20%
2023 Social Security Trustees Report	2.40%
2023 Survey of Professional Forecasters	2.36%
Peer Comparison	2.52%

Recommendation

The current inflation assumption is 2.50%. While there has been a spike in inflation the last two years, recent monthly CPI measurements suggest that this may be changing. Most forecasts, including the financial market pricing are also indicating that inflation is expected to return to where it was prior to this spike. Based on all of this information, **we recommend retaining the price inflation assumption of 2.50%.**

Price Inflation	
Current Assumption	2.50%
Recommended Assumption	2.50%

INVESTMENT RETURN

Use in the Valuation

The investment return assumption reflects the anticipated returns on the current and future assets. It is one of the primary determinants in the allocation of the expected cost of the System's benefits, providing a discount of the estimated future benefit payments to reflect the time value of money. It is also the most powerful assumption used in the valuation process with small changes producing significant changes to the liabilities and contribution rates. Generally, the investment return assumption is set with consideration of the asset allocation policy, expected long-term real rates of return on the specific asset classes, the underlying price inflation rate, and investment expenses.

The investment return assumption is set in state statute and was changed in the 2023 legislative session from 7.50% to 7.00%, effective with the July 1, 2023 valuation. This investment return assumption is the nominal rate of return and is composed of two components. The first component is price inflation (previously discussed). Any excess return over price inflation is referred to as the real rate of return. The real rate of return, based on the current set of assumptions is 5.00% (the current 7.50% nominal return less 2.50% inflation).

Long Term Perspective

Because the economy is constantly changing, assumptions about what may occur in the near term are volatile. Asset managers and investment consultants usually focus on this near-term horizon in order to make prudent choices regarding how to invest the trust funds. For actuarial calculations, we typically consider very long periods of time as some current employees will still be receiving benefit payments more than 80 years from now. For example, a newly hired teacher who is 25 years old may work for 35 years, to age 60, and live another 25 years, to age 85. The retirement system would receive contributions for the first 35 years and then pay out benefits for the next 25 years. During the entire 60-year period, the system is investing assets on behalf of the member. For such a typical career employee, more than one-half of the investment income earned on assets accumulated to pay benefits is received after the employee retires. In addition, in an open ongoing plan like TRA, the stream of benefit payments is continually increasing as new hires replace current members who leave covered employment due to death, termination of employment, and retirement. This difference in the time horizon used by actuaries and investment consultants is frequently a source of debate and confusion when setting economic assumptions.

The following graph illustrates the long duration of the expected benefit payments for current members on July 1, 2022.

Projected Benefit Payments for Current Members
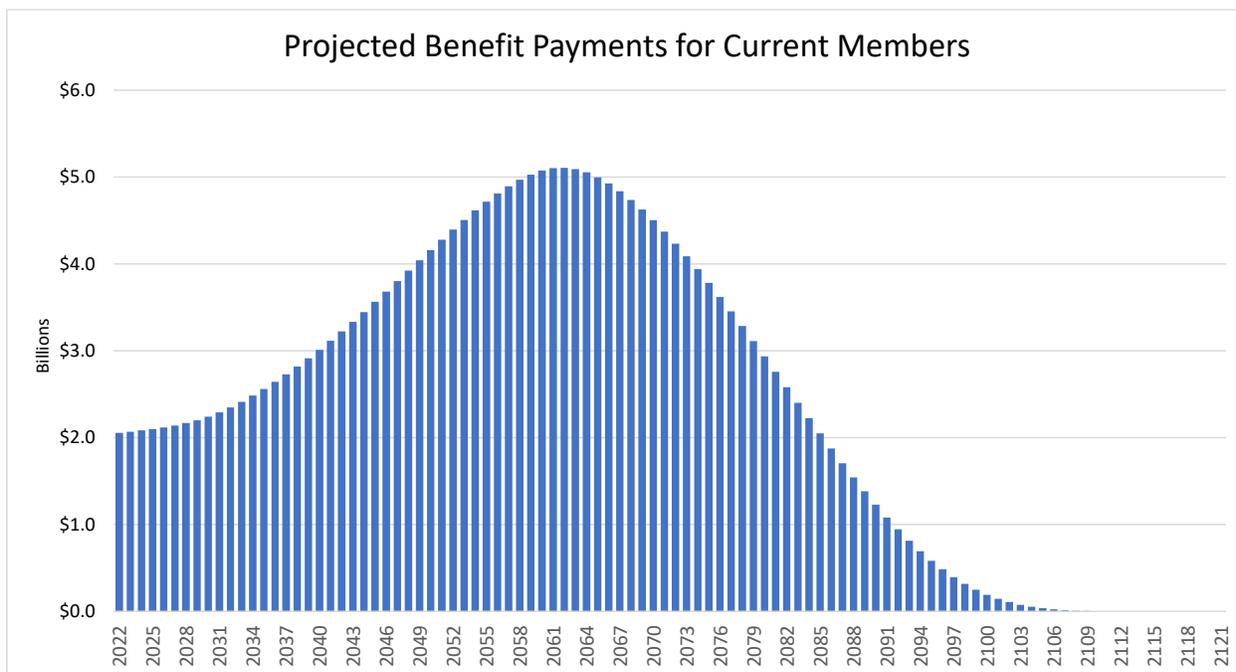
TRA Actual Investment Performance

One of the inherent problems with analyzing historical data is that the results can look significantly different depending on the timeframe used, especially if the year-to-year results vary widely. In addition, the asset allocation can also impact the investment returns so comparing results over long periods when different asset allocations were in place may not be meaningful.

The following graph shows the actual fiscal year (June 30) net returns for the TRA portfolio for the last 42 years, ending June 30, 2022. The compound return over the entire 42-year period is 9.7%. The returns over various time frames are shown beneath the graph. The graph demonstrates the volatility of the returns – only three of the 42 returns are between 6.0% and 8.0%, while 21 are greater than 11.0% and 12 are less than 3.0%. This volatility makes direct analysis of the historical data challenging, since the same analysis performed in two consecutive years can be significantly affected – up or down - by a single year's return. Consequently, we are cautious in our consideration and use of historical data.
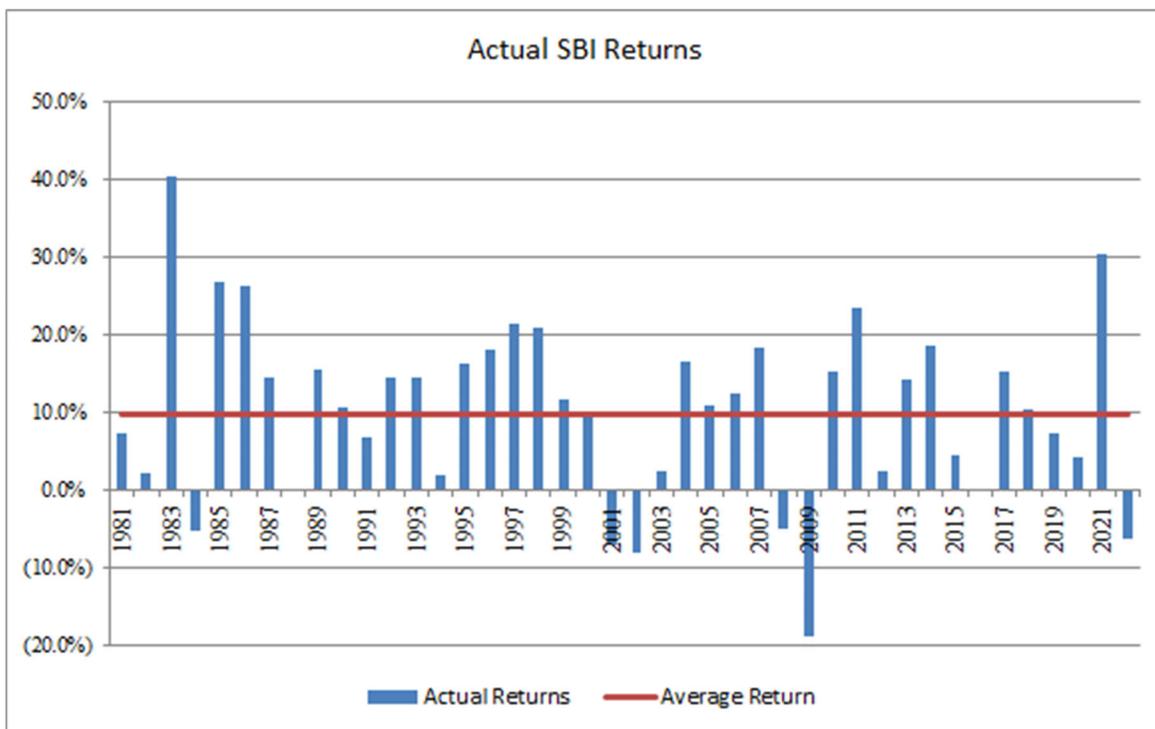
ANNUALIZED RETURNS through 6/30/22			
1-Year Return:	-6.4%	10-Year Return:	9.4%
3-Year Return:	8.3%	20-Year Return:	8.2%
5-Year Return:	8.5%	30-Year Return:	8.6%

Forward Looking Analysis

TRA's assets are held and invested by the Minnesota State Board of Investment (SBI). We considered the asset allocation below and analyzed the expected return from our survey of capital market assumptions of 11 investment consulting firms.

SBI's current target asset allocation, shown in the following table, was used in our analysis:

Asset Class	Target Allocation
Domestic Equities	39%
International Equities	19%
US Fixed Income	20%
Alternative Investments	20%
Cash	2%

Utilizing the statistical properties of the assumption, an expected range of returns over a 20-year time horizon was produced. A ranked summary of these results is shown in the following table:

Investment Consultant	Distribution of Geometric Return		
	25th	50th	75th
1	6.74%	8.90%	11.10%
2	6.02%	7.96%	9.94%
3	6.25%	7.94%	9.65%
4	5.61%	7.61%	9.64%
5	5.55%	7.62%	9.74%
6	5.91%	7.72%	9.56%
7	5.29%	7.45%	9.64%
8	5.50%	7.38%	9.30%
9	4.80%	6.69%	8.62%
10	4.56%	6.62%	8.72%
11	4.75%	6.72%	8.71%
Average	**5.54%**	**7.51%**	**9.51%**
Median	**5.55%**	**7.61%**	**9.64%**

While there is a fair amount of variation amongst the consultants, we estimate that there is a 55% to 60% probability of exceeding 7% over the next 20 years.

Peer System Comparison

Public retirement systems have historically compared their investment performance to their peer group. While we believe there is some merit in assessing the movement in the assumed rate of return for other systems, this is not an appropriate basis for setting this assumption in our opinion. For example, different plans have different asset allocations and different plan dynamics which may impact their choice of the assumed investment return. This peer group information merely provides another set of relevant data to consider as long as we recognize that asset allocation varies from system to system.

The following graph shows the change in the distribution of the investment return assumption from fiscal year 2001 through 2022 for the 120+ large public retirement systems included in the NASRA Public Fund Survey. As it indicates, the investment return assumptions used by public plans have decreased over the last two decades, likely heavily impacted by a corresponding decrease in the underlying inflation assumption over the same period. It is worth noting that the median investment return assumption in fiscal year 2011 dropped from 8.00% to 7.75% and has declined further to 7.00% in 2023.

Distribution of Investment Return Assumptions, FY 01 to present
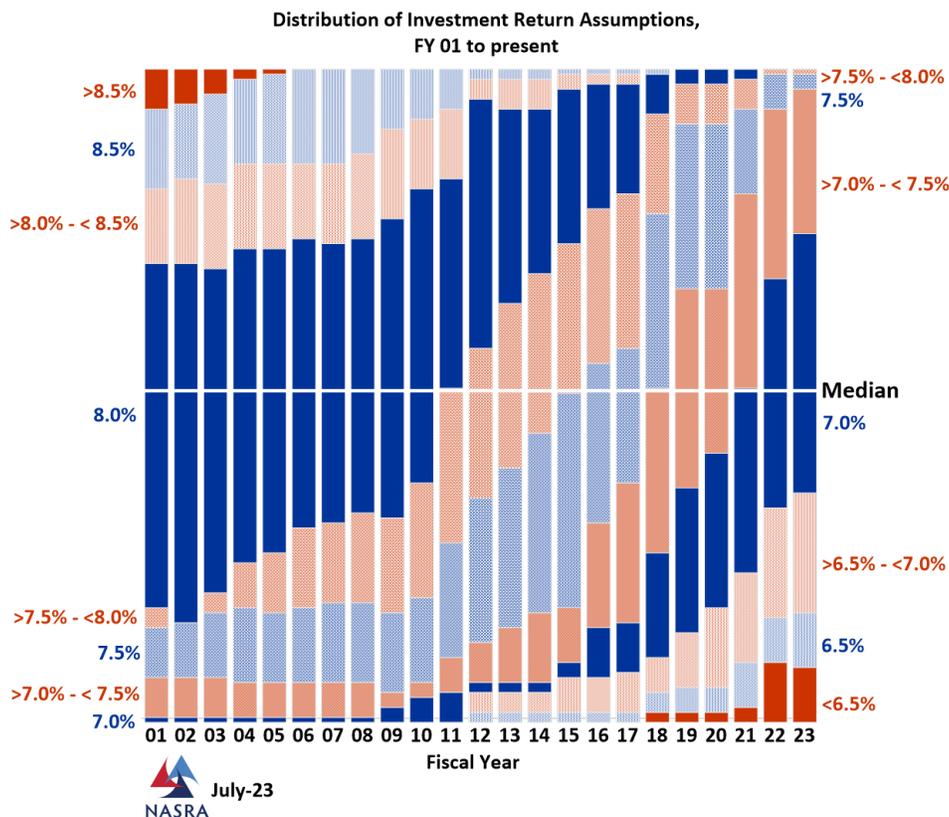
About 90 percent of the systems in the NASRA Public Fund Survey have lowered their assumed rate of return since 2010 and many systems have taken action to make additional reductions. The mean real rate of return (nominal return assumption less the inflation assumption) for these plans is 4.56%, which is significantly less than TRA's current real return of 5.00% (as noted above SBI's asset allocation also differs from the average system in the Survey).

Administrative and Investment Expenses

Budgeted administrative expenses are directly reflected as a separate component in the calculation of the actuarial contribution rate so no adjustment to the investment return assumption is needed. Generally, capital market assumptions are reflective of passive investment strategies where there are minimal investment expenses. Where active management is utilized, it is assumed that the additional return from active management is at least as great as the additional expense. As a result, no adjustment to the investment return assumption for investment expenses is required.

Recommendation

Based on all the information outlined in this section, **we recommend the current assumption of 7.50% investment return assumption be lowered to 7.00% (**composed of an inflation assumption of 2.50% and a real rate of return of 4.50%).

WAGE INFLATION

Background

Wage inflation, thought of as the "across the board" rate of salary increases, is composed of the price inflation assumption combined with an assumption for the real rate of wage increases. In constructing the salary increase assumption, the wage inflation assumption is further combined with an assumption for service-based salary increases (called a merit scale). The service-based salary increase assumption is discussed later in this section of the report. The current assumption for the real rate of wage increase is 0.35% through June 30, 2028, and 0.75% thereafter.

The excess of wage growth over price inflation represents the real wage inflation rate, or increase in the standard of living, also called productivity growth. There has been debate on the issue of whether public sector employees will receive, over the long term, the same rewards for productivity as employees in the private sector, where productivity is more readily measurable. To our knowledge, no definitive research has been completed on this topic. Nevertheless, it is our opinion that public sector employees will eventually be rewarded, even if there is a time lag, with the same or nearly the same productivity increases as those participating in the remainder of the economy.

Historical Perspective

We have used statistics from the Social Security System on the National Average Wage from the most recently available (the 2021 value) back to 1951. Because the National Average Wage is based on all wage earners in the country, it can be influenced by the mix of jobs (full-time vs. part-time, manufacturing vs. service, etc.) as well as by changes in some segments of the workforce that are not seen in all segments (e.g., regional changes or growth in computer technology). Further, if compensation is shifted between wages and benefits, the wage index would not accurately reflect increases in total compensation. TRA's membership is composed exclusively of teachers and administrators, living in Minnesota, whose wages and benefits are somewhat linked as a result of state funding of education. Because the competition for workers can, in the long term, extend across industries and geography, the broad national earnings growth will have some impact on TRA members. In the shorter term, however, the wage growth of TRA and the nation may be less correlated.

The following table shows the compounded wage growth over various periods, along with the comparable price inflation rate for the same period. The differences represent the real wage inflation rate.

Decade	General Wage Inflation	CPI Incr.	Real Wage Inflation
2011-2021	3.49%	2.14%	1.35%
2001-2011	2.70%	2.48%	0.22%
1991-2001	4.20%	2.51%	1.69%
1981-1991	4.70%	3.91%	0.79%
1971-1981	7.80%	8.62%	(0.82%)
1961-1971	4.75%	3.20%	1.55%

Period	General Wage Inflation	CPI Incr.	Real Wage Inflation
2011-2021	3.49%	2.14%	1.35%
2001-2021	3.10%	2.31%	0.79%
1991-2021	3.46%	2.37%	1.09%
1981-2021	3.77%	2.76%	1.01%
1971-2021	4.57%	3.90%	0.67%
1961-2021	4.60%	3.77%	0.83%

Similar information over rolling 30-year periods is shown in the following graph:
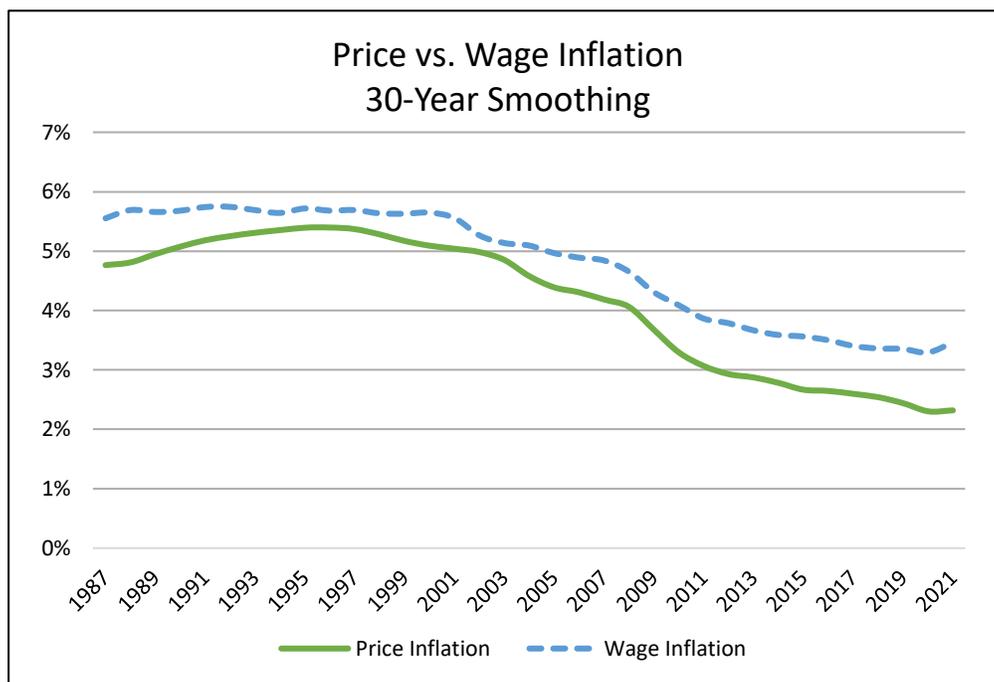
The relationship between the two lines shows that price and wage inflation track together reasonably well over long (30 years in the graph) periods of time.

Forecasts of Future Wages

The wage index used for the historical analysis is projected forward by the Office of the Chief Actuary of the Social Security Administration in their 75-year projections. In the March 2023 Trustees Report, the annual increase in the National Average Wage Index under the intermediate cost assumption (best estimate) was 3.56%, 1.14% higher than the Social Security intermediate inflation assumption of 2.40% per year. The range of the assumed real wage inflation in the 2023 Trustees Report was 0.54% to 1.74% per year. While we give this some consideration, we also recognize that the Index reflects not only wage growth, but also such things as increased hours worked (which would not be applicable to salaried teachers) and changes in the types of jobs worked in the United States (again, not applicable to teachers).

Public Sector Compensation and Wages

The Bureau of Labor Statistics publishes the Employment Cost Index, including detail for real (net of inflation) total compensation and wages and salaries. Further, this index is also broken down for state and local government workers. From 2004 through 2022, total compensation grew at an annualized rate of 2.78%, while wages and salaries grew at a rate of 2.12%. (Inflation was 2.51% over the same period.) This difference is a reflection that state and local government workers have had much of their compensation increase delivered through benefits rather than wages and salaries. While it is certainly reasonable to anticipate that total compensation will continue to increase faster than wages and salaries, it is also reasonable to anticipate that the difference between the two will moderate over time.

An additional consideration for the near term is that many school districts across the country have been facing challenges with fully staffing teacher positions. This situation is probably affected by several factors including the number of Baby Boomers retiring, reactions to experiences during the Covid pandemic, and the general labor shortage that may incent teachers to consider other employment opportunities. It is difficult to assess what, if any, impact may result from all of this, either in the short term or long term. We will continue to monitor this issue and make recommendations when we believe it is appropriate.

Recommendation

In our prior experience study, we selected an assumption for wage inflation that was 0.35% through 2028 (called the "select" period) and then 0.75% thereafter (the "ultimate" period). While this assumption of lower wage increases in the early years has not exactly played out to this point, we do not yet have sufficient data to determine if whether the past few years during Covid were an anomaly or reflect a change. Consequently, we are cautious about changing this assumption. **Our recommendation is to retain the current assumption, which is a select and ultimate approach, reflecting real wage inflation of 0.35% through June 30, 2028 and 0.75% thereafter.**

PAYROLL GROWTH ASSUMPTION

The unfunded actuarial accrued liability for TRA is amortized using the level percent of payroll methodology. Under this approach, the dollar amounts of amortization payments increase in each future year with the expected increase in the plan's covered payroll. Therefore, a specific payroll growth assumption is needed in order to determine the payment schedule for amortizing the unfunded actuarial accrued liability.

Total covered payroll may increase at a rate different from the average pay increase for individual members. When older, long-service members terminate, retire, become disabled or die, they are usually replaced with a new employee with a lower salary. This tends to result in lower growth in total payroll than the average pay increase for individual employees. In addition, the size of the group impacts the total payroll, i.e., an increase or decrease in the number of actives can impact total payroll growth.

The following table shows the average annual payroll growth for TRA, the average annual change in active membership, and the net payroll growth not due to membership growth.

Valuation Date	Count	Covered Payroll (Thousand$)	Total Growth	Average Salary	Average Growth in Period
2003	71,916	$2,952,887		41,060	
2008	76,515*	3,645,230	4.3%	47,641	3.0%
2013	76,765	3,917,310	1.5%	51,030	1.4%
2018	82,495**	4,832,917	4.3%	58,584	2.8%
2022	84,308	$5,944,310	5.3%	70,507	4.9%

  * Minneapolis merger was between 2003 and 2008
  ** Duluth merger was between 2013 and 2018

Recommendation

We propose continuing the current assumption that no future growth or decline in the active membership will occur. With no assumed growth in membership, future salary growth due only to general wage increases is being anticipated. If increases should occur not only because of wage increases but also because of additional active members, there will be a larger pool of salaries over which to spread the unfunded actuarial accrued liability, which would result in lower UAAL payments as a percent of payroll.

We recommend the current payroll growth assumption of 3.0%, used to amortize the UAAL, be retained.

TOTAL SALARY INCREASE

Estimates of future salaries are based on assumptions for two types of increases:

- Increases in each individual's salary due to promotion or longevity (often called a merit scale), and
- Increases in the general wage level of the membership, which are directly related to price and wage inflation.

Earlier in this report, we recommended a general wage growth assumption of 2.50% inflation along with a real growth rate of 0.35% through June 30, 2028 and 0.75% thereafter. Therefore, the merit scale will be added to the appropriate 2.85% or 3.25% wage inflation assumption to develop the total salary increase assumption.

Analysis of the merit salary scale is complicated by the fact that only total salary is reported to TRA, which reflects both the underlying wage inflation component of salary increases and the merit salary scale. Furthermore, there is often a delay in the actual price inflation and wage inflation compared to when it has an impact on salary increases. As a result, it is difficult to isolate the merit scale for purposes of measuring the actual salary experience.

For our first step, we compared individual salary increases using total reported salary for all members active in two consecutive periods (e.g., 2017 and 2018, 2018 and 2019, etc.). The overall results of the current study:

Average Increase in Salaries			
Year	**Actual**	**Expected**	**Difference**
2018-19	3.56%	4.76%	1.20%
2019-20	3.65%	4.76%	1.11%
2020-21	3.40%	4.75%	1.35%
2021-22	4.30%	4.73%	0.43%
All years	3.73%	4.75%	1.02%

Since inflation is a component of the salary increase assumption, we would expect actual salary increases to be lower than the current assumption when actual price and wage inflation is lower than the assumption. During the last 18 months of the study period, there was a significant spike in inflation that did not result in immediate increases in salaries. Much of this period was also during the Covid pandemic which may affect comparison as well. We anticipate that at least a portion of this inflation spike will show up in future salary increases, but we cannot reasonably estimate how much or when.

We also examined how well the total salary increases compared with the combined wage growth and merit scale assumption. For this analysis, we compared the actual salary increases with the expected increases, as well as the expected increases adjusted for the observed general wage inflation as measured by the increases at the longer service durations. This latter analysis allows us to better isolate the merit component of the increases. As the following graph indicates, the current merit scale provides a reasonable approximation of the shape of the observed total increases. The actual increases were generally in line with the expected increases over the first 25 years of service where the merit scale reflects expected increases in excess of wage inflation.
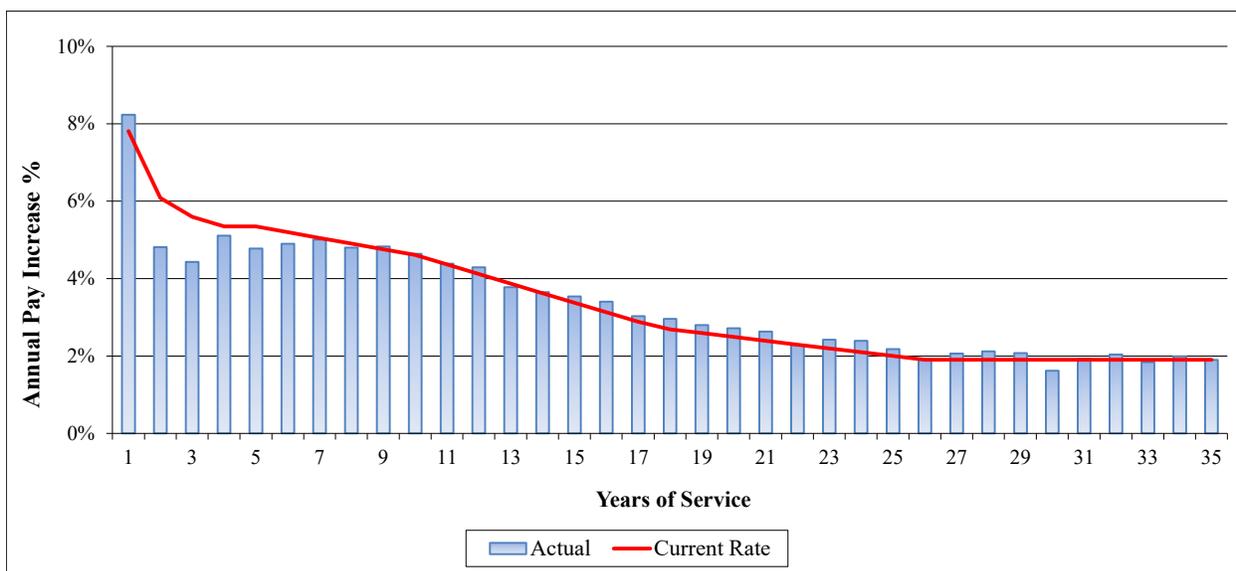
Recommendation

The merit component of the salary scale is often significantly affected by school district policies for experience-based increases. These tend to persist across contracts and so we would expect the merit scale to also change only gradually. Based on what we are observing, we do not yet see any indication for needing to change. **We recommend the current merit salary scale assumption be retained.**

Actuarial Standard of Practice No. 35 (ASOP 35) provides guidance to actuaries regarding the selection of demographic and other non-economic assumptions for measuring pension obligations. ASOP 35 states that the actuary should use professional judgment to estimate possible future outcomes based on past experience and future expectations, and select assumptions based upon application of that professional judgment. The actuary should select reasonable demographic assumptions in light of the particular characteristics of the defined benefit plan that is the subject of the measurement. A reasonable assumption is one that is expected to appropriately model the contingency being measured and is not anticipated to produce significant cumulative actuarial gains or losses over the measurement period.

The actuary should follow the following steps in selecting the demographic assumptions:

1. <u>Identify the types of assumptions</u>. Types of demographic assumptions include but are not limited to retirement, mortality, termination of employment, disability, election of optional forms of payment, administrative expenses, family composition, and treatment of missing or incomplete data. The actuary should consider the purpose and nature of the measurement, the materiality of each assumption, and the characteristics of the covered group in determining which types of assumptions should be incorporated into the actuarial model.

2. <u>Consider the relevant assumption universe.</u> The relevant assumption universe includes experience studies or published tables based on the experience of other representative populations, the experience of the plan sponsor, the effects of plan design, and general trends.

3. <u>Consider the assumption format</u>. The assumption format includes whether assumptions are based on parameters such as gender, age or service. The actuary should consider the impact the format may have on the results, the availability of relevant information, the potential to model anticipated plan experience, and the size of the covered population.

4. <u>Select the specific assumptions</u>. In selecting an assumption, the actuary should consider the potential impact of future plan design as well as the factors listed above.

5. <u>Evaluate the reasonableness of the selected assumption</u>. The assumption should be expected to appropriately model the contingency being measured. The assumption should not be anticipated to produce significant actuarial gains or losses.

ASOP 35 General Considerations and Application

Each individual demographic assumption should satisfy the criteria of ASOP 35. In selecting demographic assumptions, the actuary should also consider: the internal consistency between the assumptions, materiality, cost effectiveness, and the combined effect of all assumptions. At each measurement date the actuary should consider whether the selected assumptions continue to be

reasonable, but the actuary is not required to do a complete assumption study at each measurement date. In addition, ASOP 35 requires the actuary to include a specific assumption with respect to expected future mortality improvements. In our opinion, the demographic assumptions recommended in this report have been developed in accordance with ASOP 35.

Overview of Analysis

The purpose of a study of demographic experience is to compare what actually happened to the individual members of the System during the study period (July 1, 2018 through June 30, 2022) with what was expected to happen based on the actuarial assumptions. Four years is a relatively short observation period for experience given the assumptions are being set with a long-term (30+ years) time horizon in mind. Therefore, we have also considered the results of the prior Experience Study when practical to do so.

Studies of demographic experience generally involve three steps:

- First, the number of members changing membership status, called *decrements*, during the study is tabulated by age, duration, gender, group, and membership class as appropriate (active, retired, etc.).

- Next, the number of members expected to change status is calculated by multiplying certain membership statistics, called *exposure*, by the expected rates of decrement.

- Finally, the number of actual decrements is compared with the number of expected decrements. The comparison is called the actual to expected ratio (*A/E Ratio*), and is expressed as a percentage.

In general, if the actual experience differs significantly from the overall expected results, or if the pattern of actual decrements, or rates of decrement, by age, sex, or duration deviates significantly from the expected pattern, new assumptions are considered. Recommended revisions are normally not an exact representation of the experience during the observation period. Judgment is required to anticipate future experience from past trends and current evidence, including a determination of the amount of weight to assign to the most recent experience.

Revised rates of decrement are tested by using them to recalculate the expected number of decrements during the study period, and the results are shown as revised A/E Ratios.

It is common in demographic studies to weight the exposures and decrements by an approximation of the associated liability. While we generally use this approach, we have found it to be less relevant for a relatively homogeneous population such as TRA where all of the members are educators. We continue to perform our analysis on both a count and liability-weighted basis in order to monitor the situation, but generally draw our conclusions from the weighted analysis.

Retiree Mortality

One of the most important demographic assumptions in the valuation is mortality because it projects the length of time benefits will be paid to current and future retirees and beneficiaries. If members live longer than expected, the true cost of future benefit obligations will be understated.

Over the last few generations, rates of mortality have been declining, meaning people are generally living longer. Furthermore, the actual experience of large, public retirement systems that include school employees indicate that school groups, and teachers in particular, continue to exhibit better mortality than the average working population.

There are distinct differences in the mortality rates of males and females, healthy retired members, disabled retired members and non-retired members. Because of those differences in mortality, we study these groups separately.

To construct a mortality table from scratch requires a significant amount of data. Historically, the Society of Actuaries has collected the large amounts of needed data from many retirement plans and developed "standard" tables for use by practicing actuaries. Actuaries use various adjustments to standard mortality tables in order to better match the observed mortality rates of a specific population. One of these is an age adjustment that can be either a "setback" or a "set forward". The current assumption for TRA incorporates the use of an age setback for both males and females. A three-year age setback treats all members as if they were three years younger than they truly are when applying the rates in the mortality table. Thus, a three-year set back would treat a 62-year-old retiree as if he or she exhibits the mortality of a 59-year-old in the standard mortality table.

Another adjustment to a standard mortality table to improve the fit of the mortality rates in the standard table may be to reflect populations that are "above median" or "below median" based on the amounts of income. Mortality studies have consistently shown that those living in higher socioeconomic conditions tend to have better mortality (live longer). Other times (especially historically) the adjustment to the mortality rates has been done based on whether the members are predominantly a "white-collar" or "blue-collar" group of employees.

Finally, tables may be "scaled", a process in which the mortality rates are multiplied by a scaling factor to proportionately increase (if the scaling factor in greater than 1.0) or decrease (if the scaling factor is less than 1.0) the original mortality rates in the table. In some cases, it is useful to apply more than one of these adjustment methods to create a mortality table that fits the observed experience reasonably well.

The current post-retirement mortality assumption for TRA is:

> RP-2014 white collar annuitant table projected generationally with the MP-2015 projection scale, male rates set back 3 years and female rates set back 3 years, with further adjustments of the rates to fit the actual TRA experience. (The male rates under 70 are multiplied by 0.8, while the rates over 70 are multiplied by 1.478, with smoothing applied around age 70. The female rates under 75 are multiplied by 0.85, while the rates over 75 are multiplied

by 1.362, with smoothing applied around age 75.) This assumption was adopted as part of the 2008-2014 Experience Study.

ASOP 35 requires the actuary to make a specific recommendation with respect to future improvements in mortality. There have been significant improvements in longevity in the past, although there are different opinions about future expectations. We believe it is prudent to anticipate that the trend will continue in some fashion in the future. Therefore, we believe it is appropriate to reflect future mortality improvements in the mortality assumption. The current approach, referred to as generational mortality, anticipates future improvements in mortality by using a different set of mortality rates for each year of birth, with the rates for later years of birth assuming lower mortality than the earlier years of birth. The generational mortality assumption contains "built in" mortality improvements in the future, i.e., a member who turns age 65 in 2050 has a longer life expectancy than a member who turns age 65 in 2025.

The generational approach is our preferred method for recognizing future mortality improvements in the valuation process because it is more direct and results in longer life expectancy for members who are younger, consistent with what we believe is more likely to occur. This is the method currently used in the TRA valuation and we recommend it continue to be used.

Because we are using generational mortality, the A/E ratios should be near 100% as future mortality improvements will be taken into account directly in the actuarial valuation process.

Healthy Retiree Mortality - Males

The following chart shows the exposures, actual deaths, and expected deaths for ages 55 to 100, along with the actual to expected (A/E) ratio under the current assumption for each year in the experience study. While our focus is generally on the weighted A/E ratio, the count-based columns are provided for context by the reader.

CURRENT STUDY PERIOD (2018 TO 2022) - MALES

	Exposure	Actual	Expected	A/E Ratio	Weighted A/E Ratio
July 1, 2018 to June 30, 2019	22,214	755	693	109%	103%
July 1, 2019 to June 30, 2020	22,100	787	709	111%	107%
July 1, 2020 to June 30, 2021	21,919	823	728	113%	107%
July 1, 2021 to June 30, 2022	21,675	858	743	115%	107%
Total	**87,908**	**3,223**	**2,873**	**113%**	**107%**

The retiree membership of TRA is not large enough to expect total consistency in the actual to expected ratio from year to year. Some variation is to be expected simply as a result of statistical randomness and variable events such as the severity of a flu season. Additionally, there is likely

a small impact from Covid affecting the last part of the study period. The actual experience indicates that the current assumption for male retirees is predicting fewer deaths than have been occurring. We believe that one factor contributing to this is that we have been using the MP-2015 projection scale to reflect mortality improvements and that this scale has generally been observed to be too optimistic over the past several years.

Healthy Retiree Mortality- Females

The following chart summarizes the exposures, actual deaths, and expected deaths for ages 55 to 100, along with the actual to expected ratio under the current assumption for each year in the experience study. While our focus is on the weighted A/E ratio, the count-based columns are provided for context by the reader.

CURRENT STUDY PERIOD (2018 to 2022) - FEMALES

	Exposure	Actual	Expected	A/E Ratio	Weighted A/E Ratio
July 1, 2018 to June 30, 2019	37,849	731	699	105%	111%
July 1, 2019 to June 30, 2020	38,902	793	727	109%	110%
July 1, 2020 to June 30, 2021	39,771	847	754	112%	111%
July 1, 2021 to June 30, 2022	40,644	794	778	102%	101%
Total	**157,166**	**3,165**	**2,958**	**107%**	**109%**

As with the male data examined in the prior section, there is an indication that the current assumption is predicting fewer deaths than are being observed.

As mentioned earlier, there is likely some impact of Covid on the number of deaths during this study period. We do note that the examination of the A/E ratio by year does not suggest a significant increase in the time periods when Covid was most significant. Because Covid deaths were lower among higher socio-economic groups and in the Midwest, we would expect less impact on a teacher population, so the observations are consistent with this expectation. To be cautious, we do believe we should have a small amount of margin (meaning an A/E ratio over 100%) so that if death rates reduce in the coming years and return to pre-Covid experience, the estimates of the selected mortality table will not overestimate the death rate.

In early 2019, the Society of Actuaries published a family of tables based solely on public plan data, called the Pub-2010 Tables. (The RP-2014 table intentionally excluded public data). We examined the PubT-2010 mortality table, the table produced for Teacher retirement systems (designated by the "T"). In particular, we considered the above median version of this table as well as the regular version. When we examined this table four years ago, we noted that it was similar to the current assumption in explaining mortality experience. Since the results were similar, we did not recommend a change, partly to avoid changing all of the administrative factors

for optional forms. At this point, however, we believe that the new table provides a better fit with less adjustment, especially with the use of a newer mortality projection scale (MP-2021).

We recommend that the post-retirement mortality assumptions be changed to the PubT-2010(A) Retiree Mortality Table, males set forward one year and females unadjusted, projected generationally with the MP-2021 projection scale.

Beneficiaries

The mortality of beneficiaries applies to the survivors of members who have elected a joint and survivor option. There are fewer members receiving benefits under the joint and survivor options which can produce more volatility in the observed mortality rates. Based on the limited data, **we recommend using the Pub-2010(A) Contingent Survivors Mortality Table, males set forward one year and females unadjusted, projected generationally with the MP-2021 projection scale.**

Post-retirement Mortality for Disabled Members

The valuation assumes that disabled members, in general, will not live as long as retired members who met the regular service retirement eligibility. In addition, future life expectancies for disabled members are not expected to increase as significantly as the future life expectancies for healthy retirees.

Once disabled members in TRA reach normal retirement age (65 for most who have reached it), they are no longer identified in the valuation data as disabled. Therefore, we are unable to distinguish them separately in our mortality analysis. Any analysis on disabled mortality can only be performed on experience before age 65, limiting the available analysis. Published tables are available for Safety and Non-Safety (designated "NS"), in recognition that public safety groups typically have different disability requirements which in turn affects mortality patterns. Because of the limited data, **we recommend using the PubNS-2010 Disabled Retiree Mortality Table, males set forward one year and females unadjusted, projected generationally with the MP-2021 projection scale.**

Impact of Changes

The proposed changes to the retiree, beneficiary, and disabled mortality assumptions result in a decrease in the normal cost rate and the actuarial accrued liability.

Active Mortality

The active member mortality assumption models eligibility for death benefits prior to retirement. Currently, the assumption is the RP-2014 Employee White Collar Mortality Table, with a 5-year age setback for males and a 7-year age setback for females.

Because the probability of death prior to retirement is very low, this assumption has a much smaller impact on the valuation results than the post-retirement mortality assumption. Further, because it is a comparatively rare event, it is difficult to get meaningful analysis from a study of this size. Consequently, it is common practice to use the same table as is used for retiree mortality, possibly with an adjustment like an age setback to better fit the actual experience. The Pub-2010 family of tables has both annuitant tables (used for retirees) and employee tables (used for active members).

There is a very limited number of deaths among active members. Not only are the death rates at these ages in the standard tables quite low, we expect that we undercount deaths because the benefit provided in many cases is a refund of member contributions which cannot be easily distinguished from a termination. Thus, we can only give limited credibility to the current results and prefer to use the same table family as is used for the retirees. In any case, the assumption has a very minor impact upon the overall cost of the plan.

Recommendation

In keeping with the retiree mortality experience and the desire for consistency among tables, **we propose using the PubT-2010(A) Employee Mortality Table, males set forward one year and females unadjusted, projected generationally with the MP-2021 projection scale.**

Impact of Changes

The proposed changes to the active mortality assumptions result in a small decrease in the normal cost rate and the actuarial accrued liability.

The valuation uses several different assumptions to anticipate when retirement benefits will commence for members. They include:

- Retirement from active status under the Rule of 90,
- Normal (unreduced) retirement from active status,
- Early retirement from active status, and
- Retirement from inactive vested status.

Retirement from Active Status

The eligibility requirement for early, normal or unreduced retirement is dependent on the member's date of hire. Tier 1 members were hired before July 1, 1989 and Tier 2 members were hired on or after July 1, 1989. The specific retirement eligibility provisions for both Tier 1 and 2 are summarized below:

Hire Date	Normal Retirement Age	Early Retirement Age	Unreduced Retirement
Before July 1, 1989	Age 65 and 3 years	Age 55 and 3 years of service, or 30 years of service	Rule of 90 or Age 62 with 30 years of service
July 1, 1989 or later	Social Security Retirement Age, but not later than age 66 with 1 year of service	Age 55 and 3 years of service	N/A

For this discussion, it is most useful to focus on the type of retirement a member is eligible to receive. Early retirement is the term used when the accrued benefit is reduced by an early retirement factor to reflect a longer period of payment. Unreduced retirement occurs when such a factor is not applied. Note that Tier 1 members receive the greater of a reduced Tier 2 benefit or the unreduced Tier 1 benefit. Still, for purposes of setting the retirement assumptions, we consider Tier 1 members to be eligible for unreduced retirement if they meet any of the criteria for unreduced retirement, even if the Tier 2 early retirement benefit is more valuable.

In the 2008-2014 Experience Study, separate assumptions for Tier 1 and Tier 2 members were introduced to better match observed experience. There are separate retirement rates for Tier 1 members who meet the Rule of 90 (before age 65) and those who do not. There are also special rates for Tier 2 members who are age 62 or older with at least 30 years of service and entitled to an enhanced early retirement benefit. For analysis purposes, it is generally easier to summarize the results based on early or unreduced retirement (including Rule of 90).

Due to the effective date of Tier 2 (July 1, 1989) and the retirement eligibility requirements, nearly all active Tier 1 members are eligible for retirement, with about half eligible for early retirement and half eligible for unreduced retirement. Further, over the next few years, there will be an increasing proportion of Tier 1 members who will be eligible for unreduced retirement. The Tier 2 effective date also means there is very limited experience available to analyze retirement rates for those who are eligible for the special early benefits under Tier 2 (age 62 with at least 30 years of service).

A summary of the observed and expected experience during the study period for retirement is shown in the table below:

	Exposures	Actual	Expected	A/E Ratio	A/E Ratio (Weighted)
Early retirement					
Tier 1	12,767	1,536	1,661	92%	87%
Tier 2	28,602	2,861	2,290	125%	106%
Unreduced retirement					
Tier 1	9,574	3,498	3,471	101%	99%
Tier 2	1,782	604	629	96%	104%
Total	**52,725**	**8,499**	**8,051**	**106%**	**99%**

A discussion of our findings is included below.

Unreduced Retirement Benefits Including Rule of 90

The following table shows the exposures, actual and expected retirements, and the A/E ratio for Tier 1 members (hired before July 1, 1989) who were eligible to retire with unreduced benefits.

Unreduced Retirements – Tier 1					
	Exposures	Actual	Expected	A/E Ratio	A/E Ratio (Weighted)
July 1, 2018 to June 30, 2019	2,510	874	892	98%	98%
July 1, 2019 to June 30, 2020	2,324	767	829	93%	92%
July 1, 2020 to June 30, 2021	2,598	970	923	105%	101%
July 1, 2021 to June 30, 2022	2,322	887	827	107%	105%
Total	**9,574**	**3,498**	**3,471**	**101%**	**99%**

Overall, there were about as many retirements by Tier 1 members who were eligible to receive unreduced retirement benefits as were expected during the study period (weighted A/E ratio of 99%). The pattern was consistent across all years as well as with the prior study and, as a result, we assign more credibility to the observed experience. An analysis of the rates by age did not indicate any particular issues regarding the quality of the fit, other than at ages 66 and 70. **Based on the observed data, we recommend changing the rate at age 66 from 35% to 40% and the rate at age 70 from 35% to 30%.**

Tier 2 members are those members hired on or after July 1, 1989. The TRA retirement age is contingent on each member's Social Security Retirement Age. For most of the current active

group (and likely for future hires), their Social Security Retirement Age is 66 or higher, so unreduced benefits from TRA are available at age 66. In addition, due to the effective date of Tier 2, the number of long service members (25 years or more) eligible for retirement is a small, but steadily increasing group. Ultimately, the retirement rates for Tier 2 members will be dominated - at least when considered from the impact on liabilities - by these long-service members. Therefore, we are most interested in their retirement experience. However, since the number of members eligible to retire remains small, we need to be cautious about assigning too much credibility to this experience until more data is available.

The following table shows the exposures, actual retirements and expected retirements for Tier 2 members at unreduced retirement.

Unreduced Retirements – Tier 2					
	Exposures	Actual	Expected	A/E Ratio	A/E Ratio (Weighted)
July 1, 2018 to June 30, 2019	444	147	163	90%	98%
July 1, 2019 to June 30, 2020	421	123	145	85%	88%
July 1, 2020 to June 30, 2021	479	183	165	111%	119%
July 1, 2021 to June 30, 2022	438	151	156	97%	108%
Total	**1,782**	**604**	**629**	**96%**	**104%**

The graph in Appendix C shows a reasonably consistent pattern of retirement rates in both the prior study and this study. We believe that increasing the expected retirement rates at ages 68 and 69 will improve the quality of fit. We expect that over the next one or two experience studies that we will have even more data available and can better refine our expectations.

Early Retirement

We examined the data for early retirement separately for the members of each Tier, reflecting that the differences in plan provisions are likely to motivate different behavior. Our findings are summarized in the following table:

Early Retirements – Tier 1					
	Exposures	Actual	Expected	A/E Ratio	A/E Ratio (Weighted)
July 1, 2018 to June 30, 2019	3,727	399	474	84%	75%
July 1, 2019 to June 30, 2020	3,723	502	496	101%	99%
July 1, 2020 to June 30, 2021	3,017	352	377	93%	84%
July 1, 2021 to June 30, 2022	2,300	283	314	90%	88%
Total	**12,767**	**1,536**	**1,661**	**92%**	**87%**

There were fewer early retirements for Tier 1 members than expected based on the current assumption. We also note that the number of exposures is declining significantly each year as Tier 1 is closing in on a point in time where almost all members will be eligible for unreduced retirement. As fewer people are eligible for early retirement, the utilization rates are expected to become more volatile, but the importance of the assumption will diminish as variations will have a smaller impact on the liabilities. In summary, we are not confident that recent experience is a trend that will be observed in the coming years, so we prefer to leave the current assumption unchanged as it becomes less relevant over time.

Examining Tier 2 shows a different pattern than Tier 1, as might be expected. The exposure increases each year as the proportion of active members who are in their late 50's continues to shift from Tier 1 to Tier 2.

Early Retirements – Tier 2					
	Exposures	Actual	Expected	A/E Ratio	A/E Ratio (Weighted)
July 1, 2018 to June 30, 2019	6,631	694	542	128%	117%
July 1, 2019 to June 30, 2020	6,704	620	544	114%	97%
July 1, 2020 to June 30, 2021	7,234	796	577	138%	104%
July 1, 2021 to June 30, 2022	8,033	751	627	120%	106%
Total	**28,602**	**2,861**	**2,290**	**125%**	**106%**

In our analysis of retirement patterns by age, especially on a weighted basis, we note that actual experience over the last two studies indicates higher actual rates of retirement at most ages at or above 60. We recommend some increase in those rates as shown in the appendix.

Early Retirement at Age 62 with 30 Years of Service

The law provides that Tier 2 members who have reached age 62 and have 30 or more years of credited service may retire prior to age 66 with a smaller early retirement reduction than would otherwise apply. However, because the effective date of Tier 2 was in 1989, very few Tier 2 members met these conditions during the study period. Therefore, we cannot evaluate the impact this provision may have on the utilization of early retirement rates. We suggest maintaining the current assumption, which is an increase of 5% in early retirement rates for those who meet these conditions. In the next few experience studies, data will begin to emerge that will help us refine this assumption.

2023 Legislative Changes

In the 2023 legislative session, the legislature passed a bill that was signed by the governor which resulted in the normal retirement age for Tier 2 being moved from 66 to 65. We believe that these changes should be reflected in the assumed retirement rates and must base this on professional judgment since no observations are available. We recommend setting the retirement rate for age 65 to 45%. Further we anticipate that some who are currently retiring at age 64 (two years from normal retirement) will work one more year to avoid an early retirement adjustment. We suggest reducing the age 64 early retirement rate to align with the 20% rate at ages 62 and 63.

Inactive Vested Members

Members who terminate employment after becoming vested (three years of service) are entitled to either a refund of their employee contributions with interest, or a deferred monthly retirement benefit. The valuation currently assumes that members will elect a refund if it is more valuable than the deferred annuity. For those inactive members for whom the deferred retirement benefit is more valuable than the refund, the valuation assumes the benefit will commence at the member's normal retirement age. The LCPR's Standards for Actuarial Work require the actuary to value the termination benefit in this manner. If the actual commencement of the monthly deferred benefit is earlier than assumed, benefits are reduced actuarially so any cost impact is minor. Consequently, we do not see any reason to recommend a change to this assumption.

Combined Service Annuity Assumption

Currently a 7% load for inactive vested liability and a 9% load for inactive non-vested liability are applied to account for members' prior service with other Minnesota retirement systems that may increase the amount of benefits or result in earlier commencement of TRA benefits. The combined service annuity assumptions were studied by the LCPR's actuary who could access data from all the relevant Minnesota retirement systems. Because we do not have the data to review this assumption, we propose retaining the current assumption which was recommended by the LCPR's actuary.

Impact of Changes

The proposed changes to the retirement rates results in a small decrease in the normal cost rate and the actuarial accrued liability.

Miscellaneous Retirement Assumptions

Form of Payment: In the actuarial valuation process, the liabilities for members are calculated using gender specific mortality rates. Because mortality is significantly different for males and females, this approach provides the best estimate of the present value of benefits to be paid to the member over his/her lifetime. However, when a member elects an optional form of payment at retirement, the benefit payable for the member's lifetime is revised to a different amount based on the form factors defined by statute. The form factors applied must be "unisex"; i.e., the same factors apply regardless of the gender of the member. As a result, the election of an optional form of payment by an individual member has an impact on the liabilities. To anticipate the impact in advance, an assumption is made regarding the election of optional forms.

At retirement, a member can elect any of the following forms of benefit payment:
- Straight life annuity: benefit is paid for the lifetime of the member. No benefit is payable to a beneficiary upon the member's death.
- 15-Year Certain and Life: a reduced benefit is paid for the lifetime of the member. If the member dies before 180 payments have been made, the benefit continues to be paid to a beneficiary until 180 payments have been made.
- 50% Joint & Survivor: a reduced benefit is paid while both the member and the joint annuitant are alive. If the member dies first, the joint annuitant receives 50% of this benefit for his or her lifetime. If the joint annuitant dies first, the member receives the unreduced (i.e., before reduction for form of payment) benefit for the remainder of his or her lifetime.
- 75% Joint & Survivor: a reduced benefit is paid while both the member and the joint annuitant are alive. If the member dies first, the joint annuitant receives 75% of this benefit for his or her lifetime. If the joint annuitant dies first, the member receives the unreduced (i.e., before reduction for form of payment) benefit for the remainder of his or her lifetime.
- 100% Joint & Survivor: a reduced benefit is paid while both the member and the joint annuitant are alive. If the member dies first, the joint annuitant receives 100% of this benefit for his or her lifetime. If the joint annuitant dies first, the member receives the unreduced (i.e., before reduction for form of payment) benefit for the remainder of his or her lifetime.

The current set of actuarial assumptions used in the valuation assumes that members elect a straight life annuity or subsidized Joint & Survivor annuity according to the following probabilities:

Males:
    10.0% elect 50% J&S option
    10.0% elect 75% J&S option
    60.0% elect 100% J&S option
    20.0% elect Straight Life option

Females:
    13.5% elect 50% J&S option
    6.5% elect 75% J&S option
    38.0% elect 100% J&S option
    42.0% elect Straight Life option

Members eligible for deferred annuities (including current terminated deferred members) and future disability benefits are assumed to elect a life annuity.

We examined the new retirements for each of the four years in the study period and observed the following:

Males	2018-19	2019-20	2020-21	2021-22	Total	Percent
50% J&S	62	36	48	54	200	8.5%
75% J&S	27	37	33	34	131	5.6%
100%J&S	423	416	382	388	1,609	68.6%
Life Annuity	106	92	90	116	404	17.3%
Total	618	581	553	592	2,344	100.0%

Females	2018-19	2019-20	2020-21	2021-22	Total	Percent
50% J&S	223	227	204	212	866	12.6%
75% J&S	100	73	90	79	342	5.0%
100%J&S	802	793	868	803	3,266	47.5%
Life Annuity	685	579	568	573	2,405	34.9%
Total	1,810	1,672	1,730	1,667	6,879	100.0%

Based on this data, **we recommend revising the assumed elections as follows.**

Males:	10.0% elect 50% J&S option
	5.0% elect 75% J&S option
	70.0% elect 100% J&S option
	15.0% elect Straight Life option
Females:	10% elect 50% J&S option
	5.0% elect 75% J&S option
	45.0% elect 100% J&S option
	40.0% elect Straight Life option

Marriage Assumption

The current assumption is that 85% of male members and 65% of female members are married at retirement.

The data provided to us does not include marital status. Beneficiary information is only reported for those retirees that elect a joint and survivor form of payment. In practice, this assumption is only relevant for valuing pre-retirement death benefits where it affects the reduction for commencement prior to Normal Retirement Age. Without sufficient data to analyze the marital status of plan members and given the assumption does not have a material effect on the actuarial measurements, we believe the current assumption is reasonable and we recommend it be retained.

Age of Beneficiary

Joint and survivor annuity benefit amounts are dependent on the ages of the member and beneficiary. The current assumption is that males are two years older than females. The following table shows the actual age difference for members who elected to receive benefits under a joint and survivor annuity option during the study period. For the purposes of this analysis, records with an age difference of 20 or more were excluded under the assumption that most of those reflected a child, not a spouse, beneficiary.

	Difference
Males	2.1
Females	1.5

This data is consistent with that observed in the prior study. Based on this analysis, we believe retaining the current assumption that males are two years older than females is reasonable.

Impact of Changes

The proposed changes to the form of payment assumption result in no significant change in the normal cost rate or the actuarial accrued liability.

One of the types of benefits provided to members is a disability benefit. Members are eligible for disability benefits if they become totally and permanently disabled after they have completed five years of service, but prior to normal retirement eligibility. The table below indicates the actual and expected disability experience during the study period and the resulting A/E Ratios.

MALE AND FEMALE COMBINED

	Exposure	Actual	Expected	A/E Ratio
July 1, 2018 to June 30, 2019	78,640	45	57	79%
July 1, 2019 to June 30, 2020	79,071	40	57	70%
July 1, 2020 to June 30, 2021	79,334	42	58	72%
July 1, 2021 to June 30, 2022	78,301	33	57	58%
Total	**315,346**	**160**	**229**	**70%**

For disability, we prefer to analyze counts rather than weighted results. This is because salaries leading up to a disability award are often low because a member may have been limited in his or her ability to work. We examined the results separately for males and females but there was no apparent reason to separate the assumption by gender. Given the low probability of disability for this group, it is common to observe volatility in the results from year to year or even from one study period to another. We believe it is appropriate to reduce the disability rates at ages 45 and older by 15% to better fit the observed experience.

Impact of Changes

The proposed changes to the disability rates result in no change in the normal cost rate and a small decrease in the actuarial accrued liability.

Not all active members on the valuation date are expected to continue working until retirement. Therefore, a termination of employment assumption is used to anticipate the probability that a member will leave covered employment at some time in the future. In analyzing the actual results, the number of terminations includes all members reported to have terminated employment. Some of these members subsequently receive refunds of their contributions, some return to active membership and some leave their contributions with the System until retirement. Explicit assumptions are made regarding the elections made by such vested members. Non-vested members are assumed to receive a refund of their employee contribution account balance.

This section of the report summarizes the results of our study of members terminating employment for reasons other than death, retirement, or disability. The current termination of employment assumption varies by gender and years of service.

The following charts show the exposures, actual terminations and expected terminations under the current assumption, for years of service 1 to 30, and the corresponding A/E Ratios, for the study years:

MALES – Current Assumption

	Exposure	Actual	Expected	A/E Ratio	A/E Ratio (weighted)
July 1, 2018 to June 30, 2019	17,627	1,142	1,029	111%	83%
July 1, 2019 to June 30, 2020	17,739	1,176	1,006	117%	83%
July 1, 2020 to June 30, 2021	17,643	1,274	957	133%	92%
July 1, 2021 to June 30, 2022	17,249	978	857	114%	115%
Total	**70,258**	**4,570**	**3,849**	**119%**	**94%**

FEMALES – Current Assumption

	Exposure	Actual	Expected	A/E Ratio	A/E Ratio (weighted)
July 1, 2018 to June 30, 2019	50,178	3,314	2,894	115%	82%
July 1, 2019 to June 30, 2020	50,876	3,444	2,837	121%	86%
July 1, 2020 to June 30, 2021	51,133	3,802	2,747	138%	83%
July 1, 2021 to June 30, 2022	50,412	2,938	2,508	117%	102%
Total	**202,599**	**13,498**	**10,986**	**123%**	**88%**

The current service-based assumption was first adopted in the 2008-2014 Experience Study. An examination of the actual versus expected rates on the weighted basis indicates that, for both males and females, the fourth year of the study has significantly more withdrawals than the first three. We suspect that these results may be affected by issues surrounding Covid and that this is an anomaly rather than an emerging pattern, especially since the first three years of the study are generally similar to the patterns observed in the prior study. Consequently, we have omitted this year from our analysis. Based on this, we suggest that rates during the first ten years of employment be lowered and some of the rates from years 15 to 20 be increased. This moves the A/E ratio a little closer to 100% for both males and females, but also improves the quality of the fit of the observed data to the assumption.

Some vested members who terminate active employment elect to receive a distribution of their member account balance, forfeiting their right to receive monthly benefits in the future. However, the Actuarial Standards issued by the Legislative Commission on Pensions and Retirement require that the actuarial valuation assume that vested members will elect the greater of the refund of their employee account balance or the present value of the deferred monthly benefit.

The current approach is a conservative estimate since it values the greater of the two benefits available to the member, thus avoiding the chance of an actuarial loss on the member's actual election.

Impact of Changes

The proposed changes to the termination of employment assumption results in a small increase in the normal cost rate and a decrease in the actuarial accrued liability.

Actuarial Cost Method

Liabilities and contributions in this report are computed using the Individual Entry Age Normal Cost Method. This method is prescribed by Minnesota Statutes.

The objective under this method is to fund each member's benefits under the Plan as payments which are level as a percentage of salary, starting at original participation date (or employment date), and continuing until the assumed date of retirement termination, disability or death. For valuation purposes, entry age for each member is determined as the age at valuation minus years of service as of the valuation date.

At any given date, a liability is calculated equal to the contributions which would have been accumulated if this method of funding had always been used, the current plan provisions had always been in place, and all assumptions had been met. The difference between this liability and the assets (if any) which are held in the fund is the unfunded actuarial accrued liability. The unfunded actuarial accrued liability is typically funded over a chosen period in accordance with the amortization schedule.

A detailed description of the calculation follows: The normal cost for each active member under the assumed retirement age is determined by applying to earnings the level percentage of salary which, if contributed each year from date of entry into the Plan until the assumed retirement (termination, disability or death) date, is sufficient to provide the full value of the benefits expected to be payable.

- The present value of future normal costs is the total of the discounted values of all active members' normal cost, assuming these to be paid in each case from the valuation date until retirement (termination, disability or death) date.

- The present value of projected benefits is calculated as the value of all benefit payments expected to be paid to the Plan's current members, including active and retired members, beneficiaries, and terminated members with vested rights.

- The actuarial accrued liability is the excess of the present value of projected benefits over the present value of future normal costs.

- The unfunded actuarial accrued liability is the excess of the actuarial accrued liability over the assets of the fund, and represents that part of the actuarial accrued liability which has not been funded by accumulated past contributions.

Amortization Method

The unfunded actuarial accrued liability is amortized as a level percentage of payroll each year to the statutory amortization date of June 30, 2048, assuming payroll increases of 3.00% per year (effective with the 2018 valuation). If the unfunded actuarial accrued liability is negative, the surplus amount is amortized over 30 years as a level percentage of payroll. If there is an increase in the unfunded actuarial accrued liability due to a change in the actuarial assumptions, plan provisions, or actuarial cost method, a new amortization period is determined. This new amortization period is determined by blending the period needed to amortize the prior unfunded actuarial accrued liability over the prior amortization period and the increase in unfunded actuarial accrued liability amortized over 30 years. If there is a decrease in the unfunded actuarial accrued liability, no change is made to the amortization period.

Asset Valuation Method

As prescribed in the Minnesota Statutes Section 356.215, Subdivision 1, Paragraph (f), the assets are valued based on a five-year moving average of expected and market values (five-year average actuarial value) determined as follows:

- At the end of each plan year, an average asset value is calculated as the average of the market asset value at the beginning and end of the fiscal year net of investment income for the fiscal year;

- The investment gain or (loss) is taken as the excess of actual investment income over the expected investment income based on the average asset value as calculated above;

- The investment gain or (loss) so determined is recognized over five years at 20% per year;

- The asset value is the sum of the market value plus the scheduled recognition of investment gains or (losses) during the current and the preceding four fiscal years.

Entry Age Calculation

As required by the LCPR Standards for Actuarial Work, a member's Entry Age is calculated as the age at the valuation date less years of service. Age on the valuation date is calculated as age nearest birthday. The years of service for each member are provided by TRA.

Decrement Timing

All decrements are assumed to occur in the middle of the plan year. This is the preferred decrement timing in the LCPR Standards for Actuarial Work.

Funding Objective

The fundamental financing objective of the fund is to establish contribution rates which, when expressed as a percentage of active member payroll, will remain approximately level from generation to generation and meet the required deadline for full funding.

Benefits included or excluded

To the best of our knowledge, all material benefits have been included in the liability.

IRC Section 415(b): The limitations of Internal Revenue Code Section 415(b) have been incorporated into our calculations. Annual benefits may not exceed the limits in IRC Section 415. This limit is indexed annually. For 2022, the limit is $245,000.

IRC Section 401(a)(17): The limitations of Internal Revenue Code Section 401(a)(l7) have been incorporated into our calculations. Compensation for any 12-month period used to determine accrued benefits may not exceed the limits in IRC Section 401(a)(17) for the calendar year in which the 12-month period begins. This limit is indexed annually. For 2022, the limit is $305,000. Certain members first hired before July 1, 1995 may have a higher limit.

Summary of Actuarial Assumptions

The following assumptions were used in valuing the liabilities and benefits under the plan for the July 1, 2022 Actuarial Valuation. All assumptions are prescribed by Statutes, the LCPR, or the Board of Trustees. The assumptions prescribed are based on the full experience study dated June 28, 2019 and the study of economic assumptions presented to the Board in November 2017 and approved by the LCPR on February 19, 2018.

The Allowance for Combined Service Annuity was based on the recommendation of the actuary for the Legislative Commission on Pensions and Retirement (LCPR). We are unable to judge the reasonableness of this assumption without performing a substantial amount of additional work beyond the scope of this assignment, so we have relied on the LCPR actuary's findings.

Investment Return	7.50% compounded annually.
Future post-retirement adjustments	1.0% for January, 2019 through January, 2023, then increasing by 0.1% each year up to 1.5% annually.
Salary Increases	Reported salary for prior fiscal year, with new hires annualized, is increased according to the salary increase table shown in the rate table for current fiscal year and annually for each future year. See table of sample rates.
Payroll Growth	3.00% per year
Future Service	Members are assumed to earn future service at a full-time rate.
Mortality: **Pre-retirement**	RP 2014 White Collar Employee Table, male rates set back 5 years and female rates set back 7 years. Generational projection uses the MP-2015 scale.
Post-retirement	RP 2014 White Collar Annuitant Table, male rates set back 3 years and female rates set back 3 years, with further adjustments of the rates to fit actual TRA experience. Generational projection uses the MP-2015 scale.
Post-disability	RP 2014 Disabled Retiree Mortality, without adjustment or generational improvement
Disability	Age-related rates based on experience; see table of sample rates.

Summary of Actuarial Assumptions *(continued)*

Withdrawal	Rates vary by service based on actual plan experience, as shown in the rate table.
Expenses	Prior year administrative expenses expressed as percentage of prior year payroll.
Retirement Age	Graded rates beginning at age 55 as shown in rate table. Members who have attained the highest assumed retirement age will retire in one year.
Percentage Married	85% of male members and 65% of female members are assumed to be married. Members are assumed to have no children.
Age Difference	Females two years younger than males.
Allowance for Combined Service Annuity	Liabilities for vested former members are increased by 7.00% and liabilities for non-vested former members are increased by 9.00% to account for the effect of some Participants being eligible for a Combined Service Annuity.
Refund of Contributions	All employees withdrawing after becoming eligible for a deferred benefit are assumed to take the larger of their contributions accumulated with interest or the value of their deferred benefit.
Interest on member contributions	Members and former members who are eligible for the money purchase annuity are assumed to receive interest credits equal to the Pre-Retirement interest rate. All other members and former members receive the interest crediting rate as specified in statutes.
Commencement of deferred benefits	Members receiving deferred annuities (including current terminated deferred members) are assumed to begin receiving benefits at unreduced retirement age.
Form of payment	Married members are assumed to elect subsidized joint and survivor form of annuity as follows:

Males:
- 10.0% elect 50% J&S option
- 10.0% elect 75% J&S option
- 60.0% elect 100% J&S option
- 20.0% elect Straight Life option

Females:
- 13.5% elect 50% J&S option
- 6.5% elect 75% J&S option
- 38.0% elect 100% J&S option
- 42.0% elect Straight Life option

Members eligible for deferred annuities (including current terminated deferred members) and future disability benefits are assumed to elect a life annuity.

Summary of Actuarial Assumptions *(continued)*

Missing data for members	Membership data was supplied by TRA as of the valuation date. This information has not been audited by CMC. We have reviewed the information for internal consistency and we have no reason to doubt its substantial accuracy. In the small number of cases where submitted data was missing or incomplete and could not be recovered from prior years, the following assumptions were applied, if needed:

Data for active members:

Salary, Service, and Date of Birth	Based on current active demographics.
Gender	Female

Data for terminated members:

Average salary	$43,500
Date of termination	Derived from date of birth, original entry age, and service

Data for in-pay members:

Beneficiary date of birth	Wife two years younger than husband
Gender	Based on first name
Form of payment	Life annuity for retirees and beneficiaries, 100% J&S option for disabled retirees.

Termination Rates

Service	Males	Females
Less than 1	32.00%	29.00%
1	14.00%	12.00%
2	10.00%	10.00%
3	7.50%	8.00%
4	5.75%	6.50%
5	5.00%	5.25%
6	4.60%	4.00%
7	4.10%	3.50%
8	2.80%	3.00%
9	2.30%	2.50%
10	2.00%	2.10%
15	1.10%	1.10%
20	0.60%	0.60%
25	0.50%	0.50%
30	0.50%	0.50%
Over 30	0.00%	0.00%

Summary of Actuarial Assumptions *(continued)*

| Age | Rate (%) | | | |
| | Pre-retirement Mortality* | | Disability | |
	Male	**Female**	**Male**	**Female**
20	0.022	0.013	0.00	0.00
25	0.029	0.013	0.00	0.00
30	0.034	0.014	0.00	0.00
35	0.032	0.017	0.01	0.01
40	0.037	0.022	0.03	0.03
45	0.044	0.029	0.05	0.05
50	0.068	0.045	0.10	0.10
55	0.118	0.076	0.16	0.16
60	0.196	0.121	0.25	0.25
65	0.329	0.177	0.00	0.00

*Rates shown are for 2014, the base year of the tables.

| Age | Annuitant Mortality Rates (%) | | | |
| | Retirement * | | Disability | |
	Male	**Female**	**Male**	**Female**
55	0.267	0.196	2.337	1.448
60	0.353	0.267	2.660	1.700
65	0.486	0.430	3.169	2.086
70	0.945	0.706	4.035	2.820
75	2.015	1.352	5.429	4.105
80	4.126	2.682	7.662	6.104
85	7.358	5.456	11.330	9.042
90	13.560	9.947	17.301	13.265
95	24.351	18.062	24.717	19.588
100	38.292	29.731	32.672	27.819

*   Rates shown are for 2014, the base year of the tables.

Summary of Actuarial Assumptions *(continued)*

	Salary Scale	
Service	**Select Salary Increase Before July 1, 2028**	**Ultimate Salary Increase After June 30, 2028**
1	8.85%	9.25%
2	7.10%	7.50%
3	6.60%	7.00%
4	6.35%	6.75%
5	6.35%	6.75%
6	6.20%	6.60%
7	6.05%	6.45%
8	5.90%	6.30%
9	5.75%	6.15%
10	5.60%	6.00%
11	5.35%	5.75%
12	5.10%	5.50%
13	4.85%	5.25%
14	4.60%	5.00%
15	4.35%	4.75%
16	4.10%	4.50%
17	3.85%	4.25%
18	3.65%	4.05%
19	3.55%	3.95%
20	3.45%	3.85%
21	3.35%	3.75%
22	3.25%	3.65%
23	3.15%	3.55%
24	3.05%	3.45%
25	2.95%	3.35%
26 or more	2.85%	3.25%

Summary of Actuarial Assumptions *(continued)*

	Retirement Rate (%)					
	Coordinated Members				Basic Members	
					Eligible for	Not Eligible for
	Tier 1	Tier 1	Tier 2	Tier 2	30 and Out	30 and Out
Age	Early	Unreduced	Early	Unreduced	Provision	Provision
55	5	35	5		40	5
56	10	35	5		40	5
57	10	35	5		40	5
58	10	35	5		40	5
59	14	35	5		40	5
60	17	35	6		25	25
61	20	35	15		25	25
62	25	35	15		25	25
63	25	35	15		25	25
64	25	35	20		25	25
65		40	30		40	40
66		35		35	40	40
67		30		30	40	40
68		30		25	40	40
69		30		25	40	40
70		35		35	60	60
71-74		100		100	60	60
75-79		100		100	60	100
80 & Over		100		100	100	100

Coordinated Tier 2 Members age 62 or older with 30 or more years of service have 5% added to their early retirement rates.

Actuarial Cost Method

Liabilities and contributions in this report are computed using the Individual Entry Age Normal Cost Method. This method is prescribed by Minnesota Statutes.

The objective under this method is to fund each member's benefits under the Plan as payments which are level as a percentage of salary, starting at original participation date (or employment date), and continuing until the assumed date of retirement termination, disability or death. For valuation purposes, entry age for each member is determined as the age at valuation minus years of service as of the valuation date.

At any given date, a liability is calculated equal to the contributions which would have been accumulated if this method of funding had always been used, the current plan provisions had always been in place, and all assumptions had been met. The difference between this liability and the assets (if any) which are held in the fund is the unfunded actuarial accrued liability. The unfunded actuarial accrued liability is typically funded over a chosen period in accordance with the amortization schedule.

A detailed description of the calculation follows: The normal cost for each active member under the assumed retirement age is determined by applying to earnings the level percentage of salary which, if contributed each year from date of entry into the Plan until the assumed retirement (termination, disability or death) date, is sufficient to provide the full value of the benefits expected to be payable.

- The present value of future normal costs is the total of the discounted values of all active members' normal cost, assuming these to be paid in each case from the valuation date until retirement (termination, disability or death) date.

- The present value of projected benefits is calculated as the value of all benefit payments expected to be paid to the Plan's current members, including active and retired members, beneficiaries, and terminated members with vested rights.

- The actuarial accrued liability is the excess of the present value of projected benefits over the present value of future normal costs.

- The unfunded actuarial accrued liability is the excess of the actuarial accrued liability over the assets of the fund, and represents that part of the actuarial accrued liability which has not been funded by accumulated past contributions.

Amortization Method

The unfunded actuarial accrued liability is amortized as a level percentage of payroll each year to the statutory amortization date of June 30, 2048, assuming payroll increases of 3.00% per year (effective with the 2018 valuation). If the unfunded actuarial accrued liability is negative, the surplus amount is amortized over 30 years as a level percentage of payroll. If there is an increase in the unfunded actuarial accrued liability due to a change in the actuarial assumptions, plan provisions, or actuarial cost method, a new amortization period is determined. This new amortization period is determined by blending the period needed to amortize the prior unfunded actuarial accrued liability over the prior amortization period and the increase in unfunded actuarial accrued liability amortized over 30 years. If there is a decrease in the unfunded actuarial accrued liability, no change is made to the amortization period.

Asset Valuation Method

As prescribed in the Minnesota Statutes Section 356.215, Subdivision 1, Paragraph (f), the assets are valued based on a five-year moving average of expected and market values (five-year average actuarial value) determined as follows:

- At the end of each plan year, an average asset value is calculated as the average of the market asset value at the beginning and end of the fiscal year net of investment income for the fiscal year;

- The investment gain or (loss) is taken as the excess of actual investment income over the expected investment income based on the average asset value as calculated above;

- The investment gain or (loss) so determined is recognized over five years at 20% per year;

- The asset value is the sum of the market value plus the scheduled recognition of investment gains or (losses) during the current and the preceding four fiscal years.

Entry Age Calculation

As required by the LCPR Standards for Actuarial Work, a member's Entry Age is calculated as the age at the valuation date less years of service. Age on the valuation date is calculated as age nearest birthday. The years of service for each member are provided by TRA.

Decrement Timing

All decrements are assumed to occur in the middle of the plan year. This is the preferred decrement timing in the LCPR Standards for Actuarial Work.

Funding Objective

The fundamental financing objective of the fund is to establish contribution rates which, when expressed as a percentage of active member payroll, will remain approximately level from generation to generation and meet the required deadline for full funding.

Benefits included or excluded

To the best of our knowledge, all material benefits have been included in the liability.

IRC Section 415(b): The limitations of Internal Revenue Code Section 415(b) have been incorporated into our calculations. Annual benefits may not exceed the limits in IRC Section 415. This limit is indexed annually. For 2022, the limit is $245,000.

IRC Section 401(a)(17): The limitations of Internal Revenue Code Section 401(a)(17) have been incorporated into our calculations. Compensation for any 12-month period used to determine accrued benefits may not exceed the limits in IRC Section 401(a)(17) for the calendar year in which the 12-month period begins. This limit is indexed annually. For 2022, the limit is $305,000. Certain members first hired before July 1, 1995 may have a higher limit.

Summary of Actuarial Assumptions

The following assumptions are proposed for valuing the liabilities and benefits under the plan once adopted and approved by Statutes, the LCPR, or the Board of Trustees.

The Allowance for Combined Service Annuity was based on the recommendation of the actuary for the Legislative Commission on Pensions and Retirement (LCPR). We are unable to judge the reasonableness of this assumption without performing a substantial amount of additional work beyond the scope of this assignment, so we have relied on the LCPR actuary's findings.

Investment Return	7.00% compounded annually.
Future post-retirement adjustments	1.0% for January, 2019 through January, 2023, then increasing by 0.1% each year up to 1.5% annually.
Salary Increases	Reported salary for prior fiscal year, with new hires annualized, is increased according to the salary increase table shown in the rate table for current fiscal year and annually for each future year. See table of sample rates.
Payroll Growth	3.00% per year
Future Service	Members are assumed to earn future service at a full-time rate.
Mortality: ***Pre-retirement***	PubT-2010(A) Employee Mortality Table, male rates set forward 1 year and female rates unadjusted. Generational projection uses the MP-2021 scale.
Healthy Retirees	PubT-2010(A) Retiree Mortality Table, male rates set forward 1 year and female rates unadjusted. Generational projection uses the MP-2021 scale.
Beneficiaries	Pub-2010(A) Contingent Survivor Mortality Table, male rates set forward 1 year and female rates unadjusted. Generational projection uses the MP-2021 scale.
Disabled Retirees	PubNS-2010 Disabled Retiree Mortality Table, male rates set forward 1 year and female rates unadjusted. Generational projection uses the MP-2021 scale.
Disability	Age-related rates based on experience; see table of sample rates.

Summary of Actuarial Assumptions *(continued)*

Withdrawal	Rates vary by service based on actual plan experience, as shown in the rate table.
Expenses	Prior year administrative expenses expressed as percentage of prior year payroll.
Retirement Age	Graded rates beginning at age 55 as shown in rate table. Members who have attained the highest assumed retirement age will retire in one year.
Percentage Married	85% of male members and 65% of female members are assumed to be married. Members are assumed to have no children.
Age Difference	Females two years younger than males.
Allowance for Combined Service Annuity	Liabilities for vested former members are increased by 7.00% and liabilities for non-vested former members are increased by 9.00% to account for the effect of some Participants being eligible for a Combined Service Annuity.
Refund of Contributions	All employees withdrawing after becoming eligible for a deferred benefit are assumed to take the larger of their contributions accumulated with interest or the value of their deferred benefit.
Interest on member contributions	Members and former members who are eligible for the money purchase annuity are assumed to receive interest credits equal to the Pre-Retirement interest rate. All other members and former members receive the interest crediting rate as specified in statutes.
Commencement of deferred benefits	Members receiving deferred annuities (including current terminated deferred members) are assumed to begin receiving benefits at unreduced retirement age.
Form of payment	Married members are assumed to elect subsidized joint and survivor form of annuity as follows:

Males:	10.0% elect 50% J&S option
	5.0% elect 75% J&S option
	70.0% elect 100% J&S option
	15.0% elect Straight Life option
Females:	10% elect 50% J&S option
	5.0% elect 75% J&S option
	45.0% elect 100% J&S option
	40.0% elect Straight Life option

Members eligible for deferred annuities (including current terminated deferred members) and future disability benefits are assumed to elect a life annuity.

Summary of Actuarial Assumptions *(continued)*

Missing data for members

Membership data was supplied by TRA as of the valuation date. This information has not been audited by CMC. We have reviewed the information for internal consistency and we have no reason to doubt its substantial accuracy. In the small number of cases where submitted data was missing or incomplete and could not be recovered from prior years, the following assumptions were applied, if needed:

Data for active members:

Salary, Service, and Date of Birth	Based on current active demographics.
Gender	Female

Data for terminated members:

Average salary	$43,500
Date of termination	Derived from date of birth, original entry age, and service

Data for in-pay members:

Beneficiary date of birth	Wife two years younger than husband
Gender	Based on first name
Form of payment	Life annuity for retirees and beneficiaries, 100% J&S option for disabled retirees.

Termination Rates

Service	Males	Females
Less than 1	20.00%	20.00%
1	12.00%	10.00%
2	8.50%	8.50%
3	6.00%	7.00%
4	5.00%	5.50%
5	4.25%	4.50%
6	3.75%	3.50%
7	3.25%	3.00%
8	2.75%	2.50%
9	2.25%	2.25%
10	2.00%	2.00%
15	1.10%	1.10%
20	0.80%	0.80%
25	0.55%	0.55%
30	0.50%	0.50%
Over 30	0.00%	0.00%

Summary of Actuarial Assumptions *(continued)*

	Rate (%)			
	Pre-retirement Mortality*		Disability	
Age	Male	Female	Male	Female
20	0.029	0.012	0.000	0.000
25	0.015	0.008	0.000	0.000
30	0.021	0.013	0.000	0.000
35	0.029	0.019	0.010	0.010
40	0.041	0.029	0.030	0.030
45	0.067	0.045	0.043	0.043
50	0.110	0.068	0.085	0.085
55	0.169	0.099	0.136	0.136
60	0.263	0.149	0.213	0.213
65	0.436	0.250	0.000	0.000

Rates shown are for 2010, the base year of the tables.

Annuitant Mortality Rates (%)*						
	Retirement		Contingent Survivor		Disability	
Age	Male	Female	Male	Female	Male	Female
55	0.245	0.189	0.854	0.439	2.201	1.742
60	0.379	0.284	1.067	0.596	2.584	1.956
65	0.618	0.446	1.446	0.839	3.193	2.256
70	1.134	0.766	2.258	1.272	4.113	2.862
75	2.161	1.443	3.586	2.037	5.537	4.003
80	4.082	2.762	5.711	3.410	7.929	6.007
85	7.677	5.241	9.361	6.075	11.678	9.331
90	13.971	9.744	15.547	10.979	17.681	13.665
95	23.960	17.771	24.625	18.386	25.226	19.298
100	34.636	28.160	34.636	28.160	34.636	28.160

Rates shown are for 2010, the base year of the tables.

Summary of Actuarial Assumptions *(continued)*

	Salary Scale	
Service	Select Salary Increase Before July 1, 2028	Ultimate Salary Increase After June 30, 2028
1	8.85%	9.25%
2	7.10%	7.50%
3	6.60%	7.00%
4	6.35%	6.75%
5	6.35%	6.75%
6	6.20%	6.60%
7	6.05%	6.45%
8	5.90%	6.30%
9	5.75%	6.15%
10	5.60%	6.00%
11	5.35%	5.75%
12	5.10%	5.50%
13	4.85%	5.25%
14	4.60%	5.00%
15	4.35%	4.75%
16	4.10%	4.50%
17	3.85%	4.25%
18	3.65%	4.05%
19	3.55%	3.95%
20	3.45%	3.85%
21	3.35%	3.75%
22	3.25%	3.65%
23	3.15%	3.55%
24	3.05%	3.45%
25	2.95%	3.35%
26 or more	2.85%	3.25%

Summary of Actuarial Assumptions *(continued)*

Retirement Rate (%)

| | Coordinated Members | | | | Basic Members | |
| | Tier 1 | Tier 1 | Tier 2 | Tier 2 | Eligible for 30 and Out | Not Eligible for 30 and Out |
Age	Early	Unreduced	Early	Unreduced	Provision	Provision
55	5	35	5		40	5
56	10	35	5		40	5
57	10	35	5		40	5
58	10	35	5		40	5
59	14	35	5		40	5
60	17	35	10		25	25
61	20	35	15		25	25
62	25	35	20		25	25
63	25	35	20		25	25
64	25	35	20		25	25
65		40		45	40	40
66		40		35	40	40
67		30		30	40	40
68		30		30	40	40
69		30		30	40	40
70		30		35	60	60
71-74		100		100	60	60
75-79		100		100	60	100
80 & Over		100		100	100	100

Coordinated Tier 2 Members age 62 or older with 30 or more years of service have 5% added to their early retirement rates.

Minnesota Teachers Retirement Association
Experience Study 2018-2022
Exhibit C-1
Probability of Death - Healthy Retirees
Males (Key Ages)
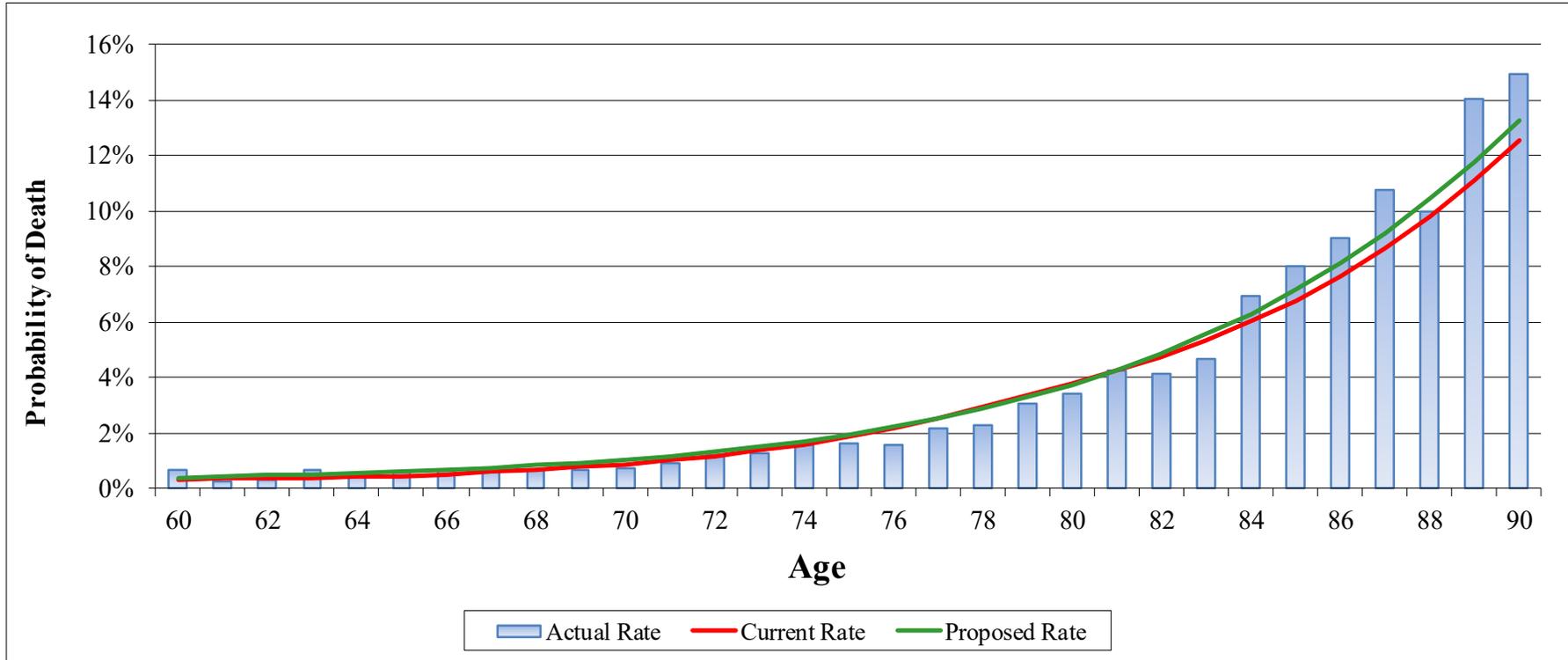
	Actual	Expected - Current Assumptions	Expected - Proposed Assumptions
Total Count	87,425,739	84,193,126	88,564,023
Actual/Expected		104%	99%

Minnesota Teachers Retirement Association
Experience Study 2018-2022
Exhibit C-2
Probability of Death - Healthy Retirees
Females (Key Ages)

	Actual	Expected - Current Assumptions	Expected - Proposed Assumptions
Total Count	60,618,243	57,340,812	58,868,961
Actual/Expected		106%	103%

Minnesota Teachers Retirement Association
Experience Study 2018-2022
Exhibit C-3
Probability of Death - Active Lives
Males
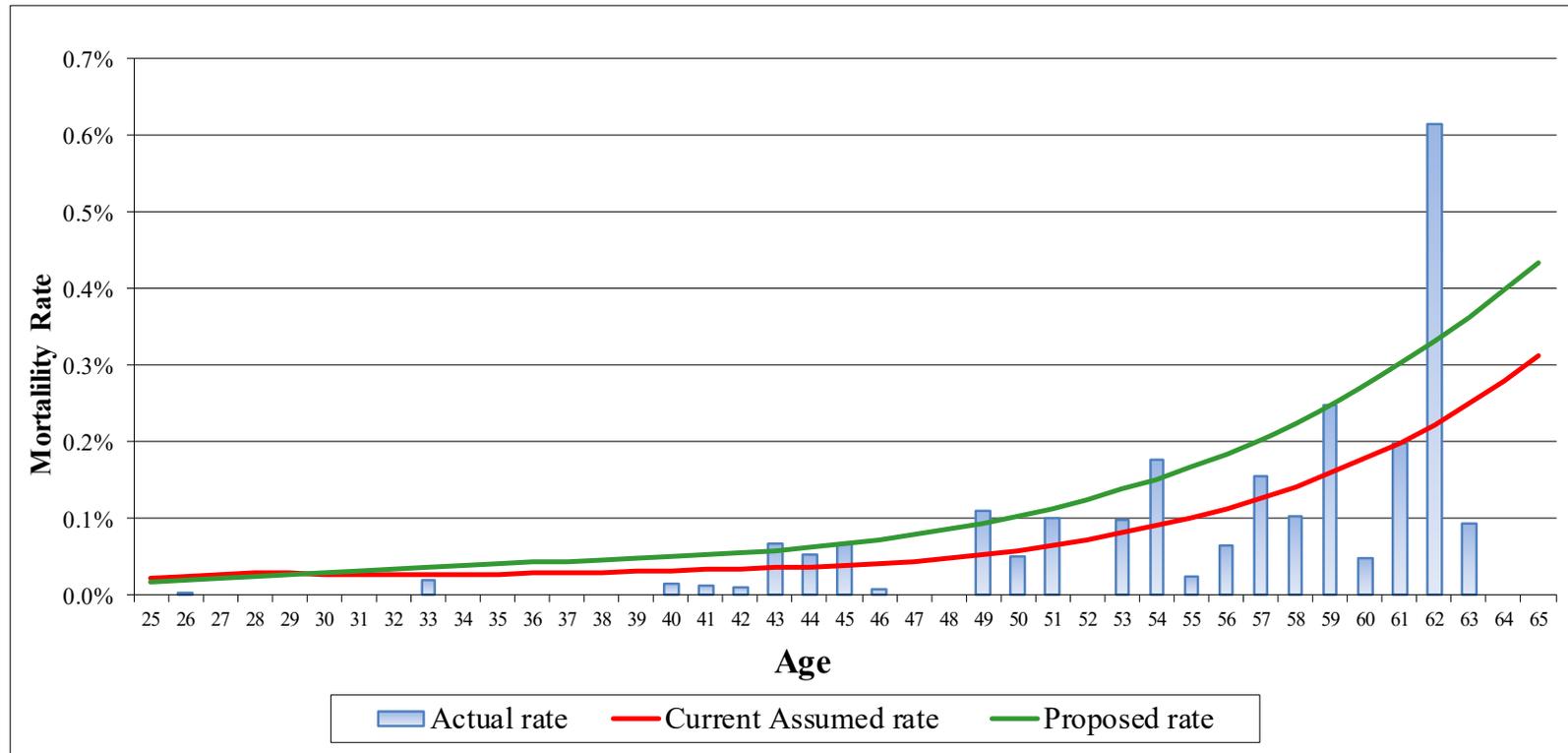
	Actual	Expected - Current Assumptions	Expected - Proposed Assumptions
Weighted Count	62	71	115
Actual/Expected		88%	55%

Minnesota Teachers Retirement Association
Experience Study 2018-2022
Exhibit C-4
Probability of Death - Active Lives
Females
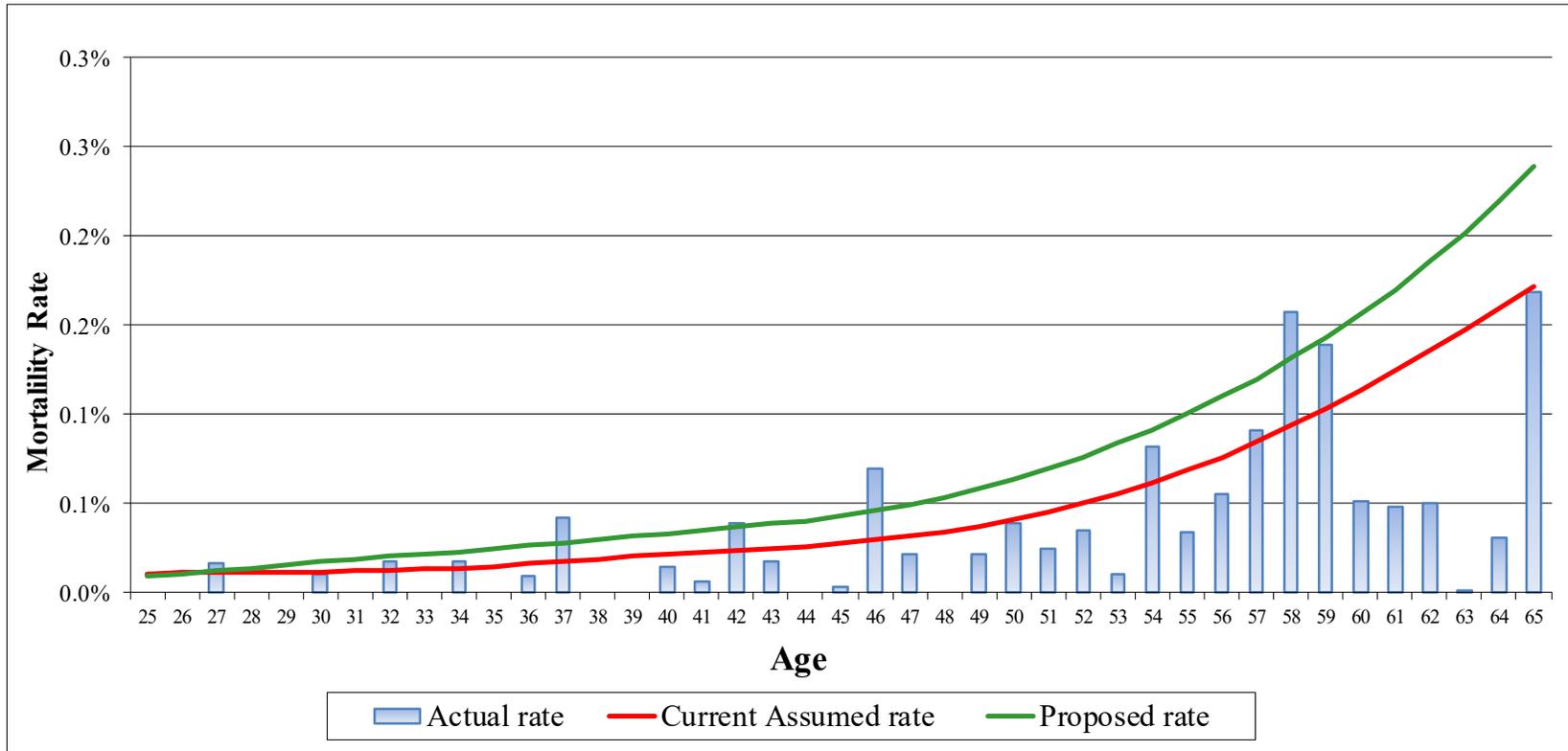
	Actual	Expected - Current Assumptions	Expected - Proposed Assumptions
Weighted Count	80	109	159
Actual/Expected		73%	50%

Minnesota Teachers Retirement Association
Experience Study 2018-2022
Exhibit C-5
Retirement Rates
Tier 1 - Unreduced
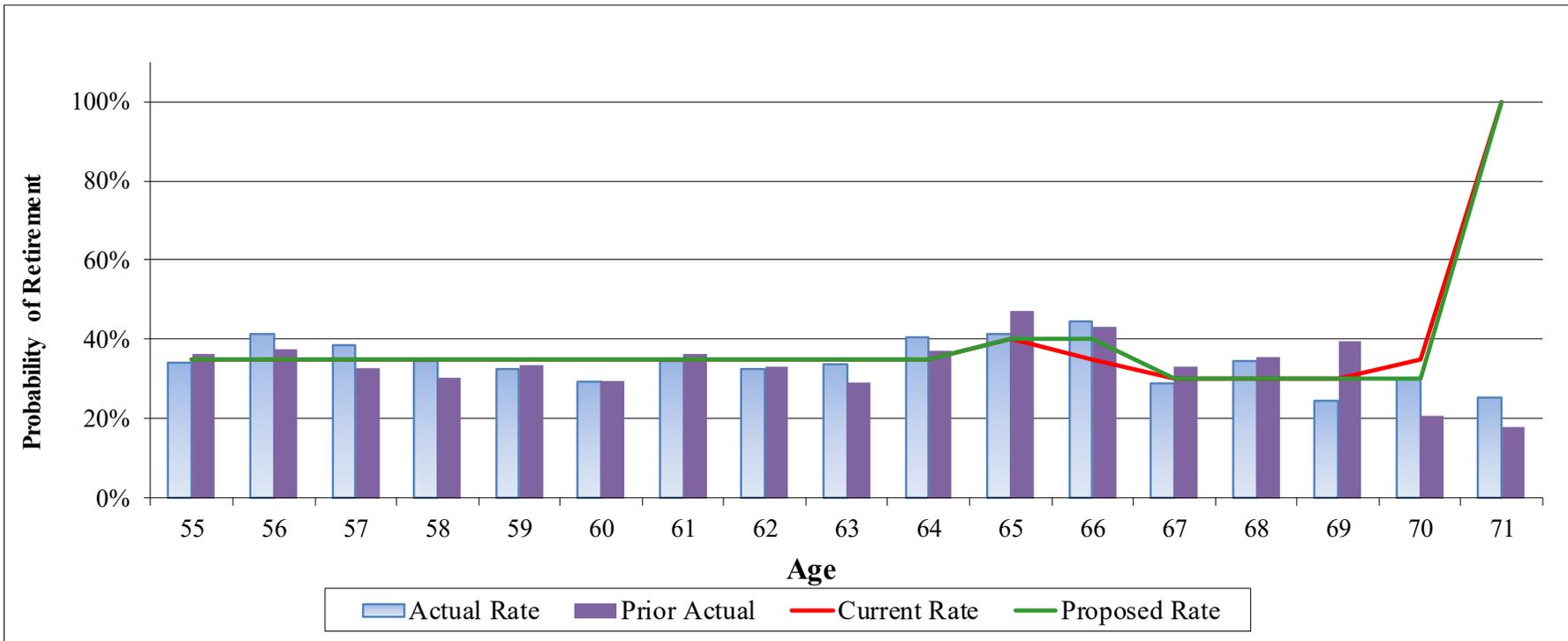
	Actual	Expected - Current Assumptions	Expected - Proposed Assumptions
Weighted Count	9,202	9,280	9,308
Actual/Expected		99%	99%

Minnesota Teachers Retirement Association
Experience Study 2018-2022
Exhibit C-6
Retirement Rates
Tier 2 - Unreduced
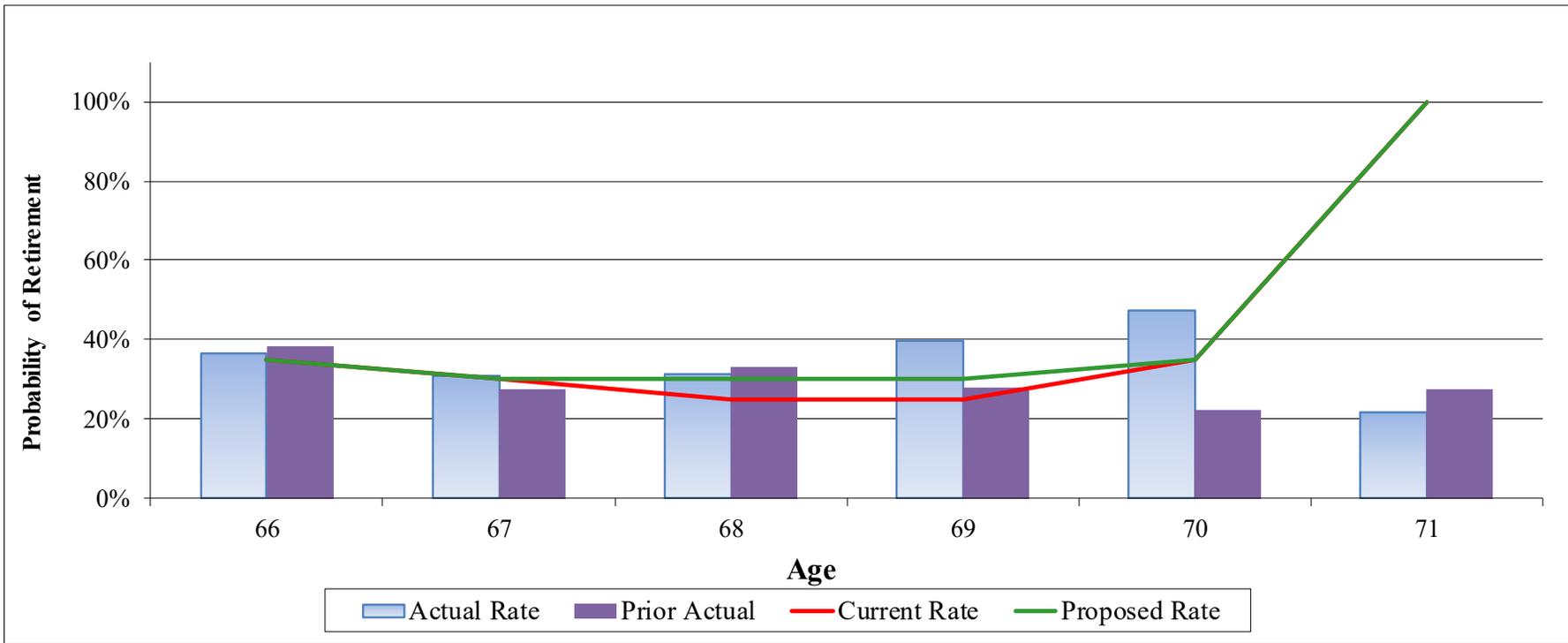
	Actual	Expected - Current Assumptions	Expected - Proposed Assumptions
Weighted Count	491	472	491
Actual/Expected		104%	100%

Minnesota Teachers Retirement Association
Experience Study 2018-2022
Exhibit C-7
Retirement Rates
Tier 1 - Early
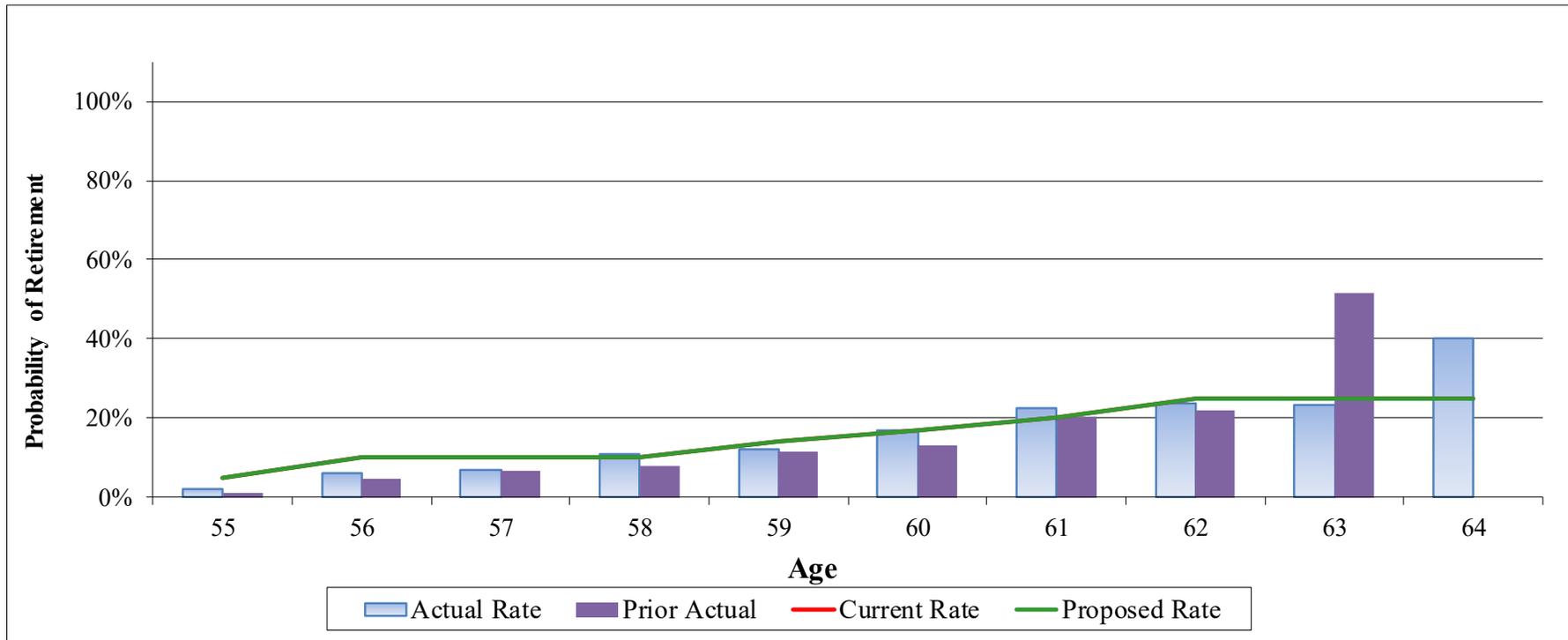
	Actual	Expected - Current Assumptions	Expected - Proposed Assumptions
Weighted Count	2,231	2,597	2,597
Actual/Expected		86%	86%

Minnesota Teachers Retirement Association
Experience Study 2018-2022
Exhibit C-8
Retirement Rates
Tier 2 - Early
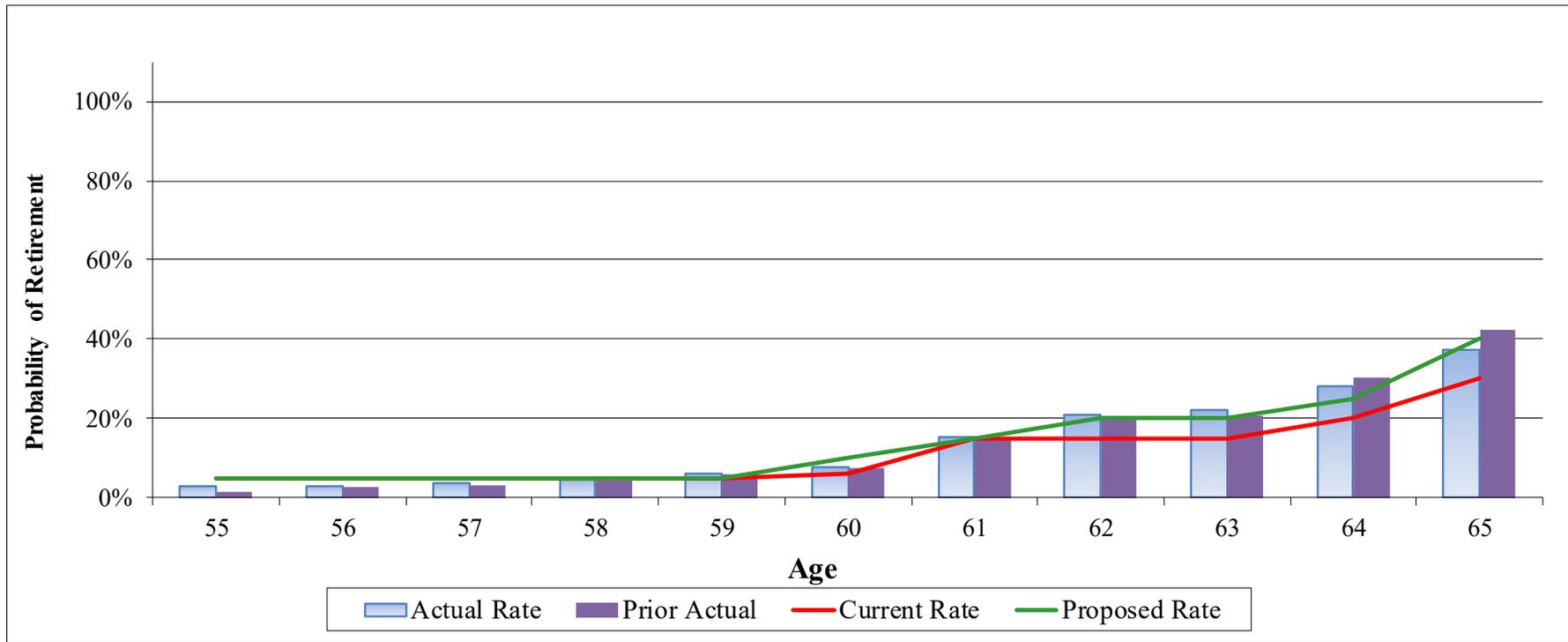
	Actual	Expected - Current Assumptions	Expected - Proposed Assumptions
Weighted Count	3,198	3,027	3,482
Actual/Expected		106%	92%

Minnesota Teachers Retirement Association
Experience Study 2018-2022
Exhibit C-9
Rate of Termination of Employment
Males
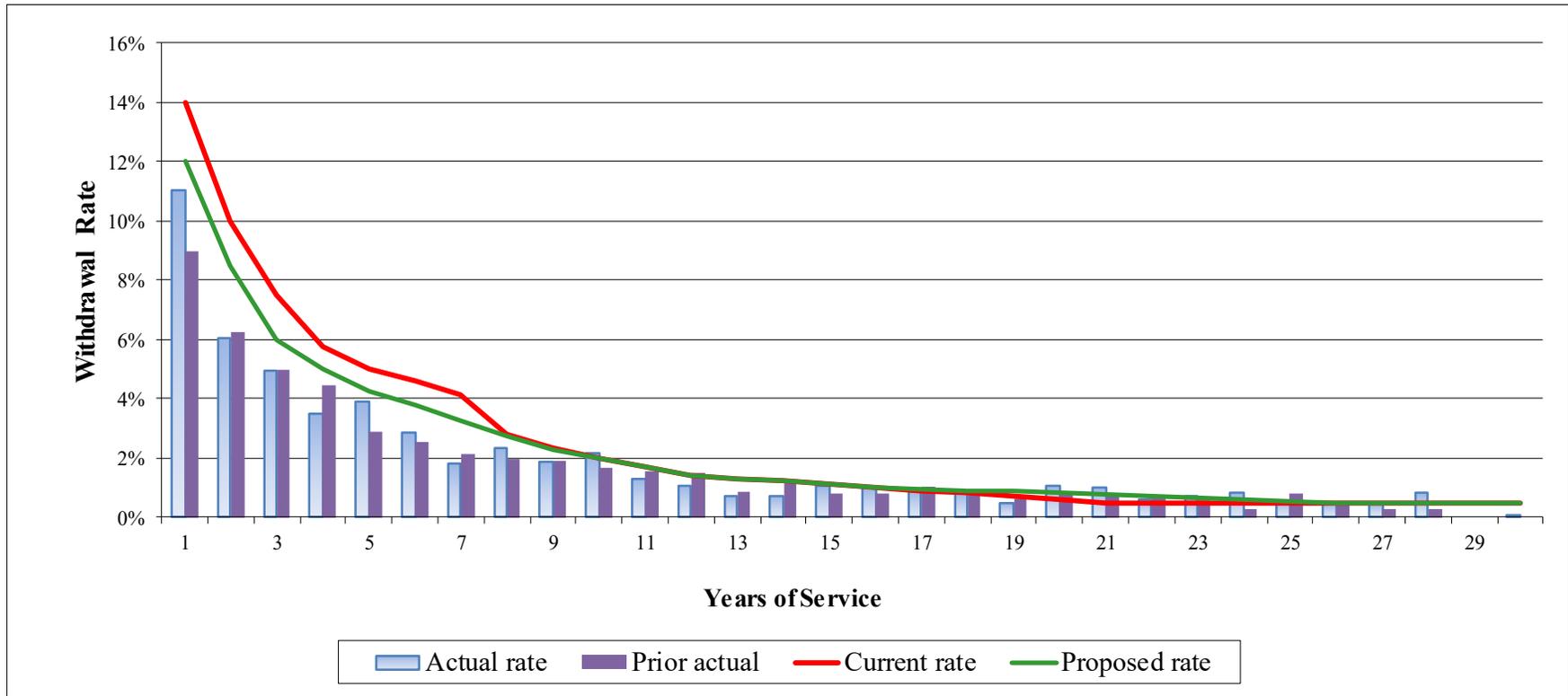
	Actual	Expected - Current Assumptions	Expected - Proposed Assumptions
Weighted Count	501	581	576
Actual/Expected		86%	87%

Minnesota Teachers Retirement Association
Experience Study 2018-2022
Exhibit C-10
Rate of Termination of Employment
Females
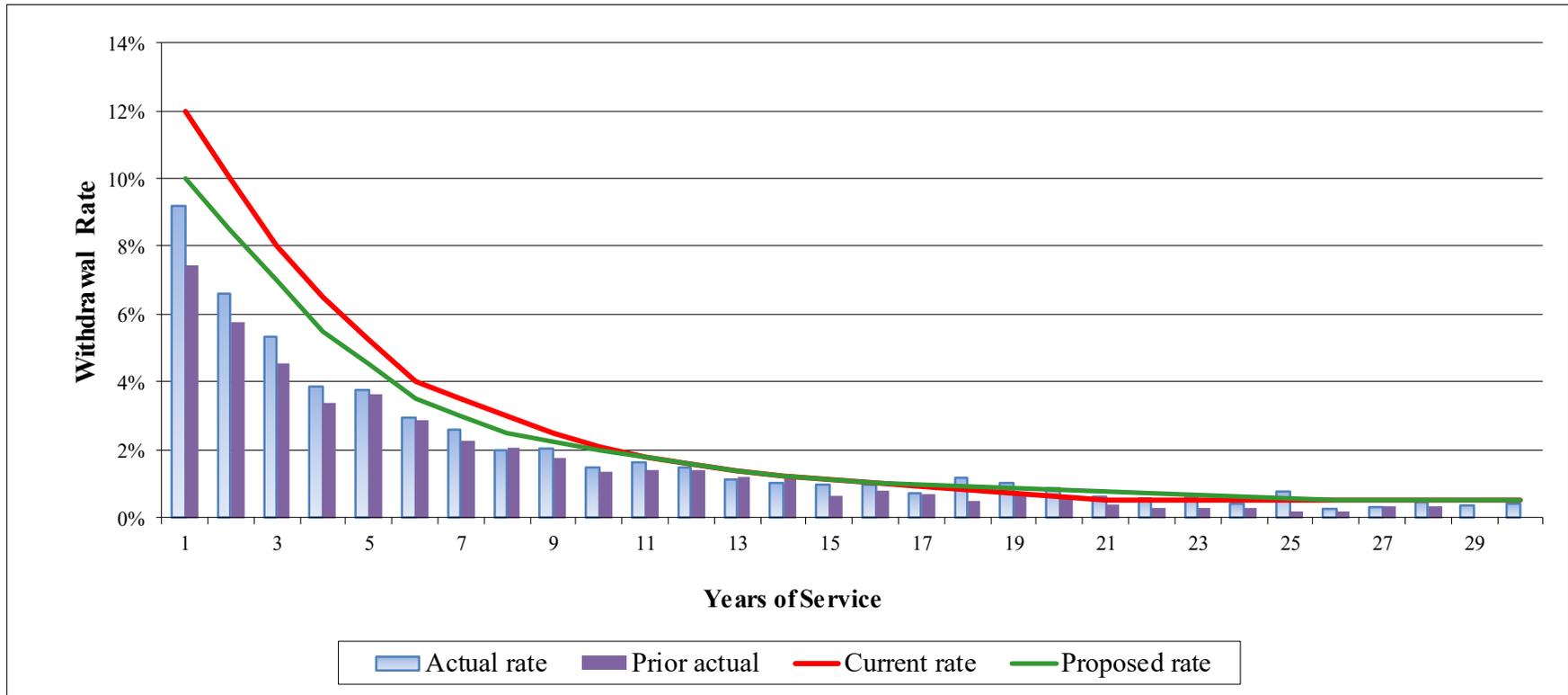
	Actual	Expected - Current Assumptions	Expected - Proposed Assumptions
Weighted Count	1,305	1,561	1,508
Actual/Expected		84%	86%

Minnesota Teachers Retirement Association
Experience Study 2018 -2022
Exhibit C-11
Total Salary Scale
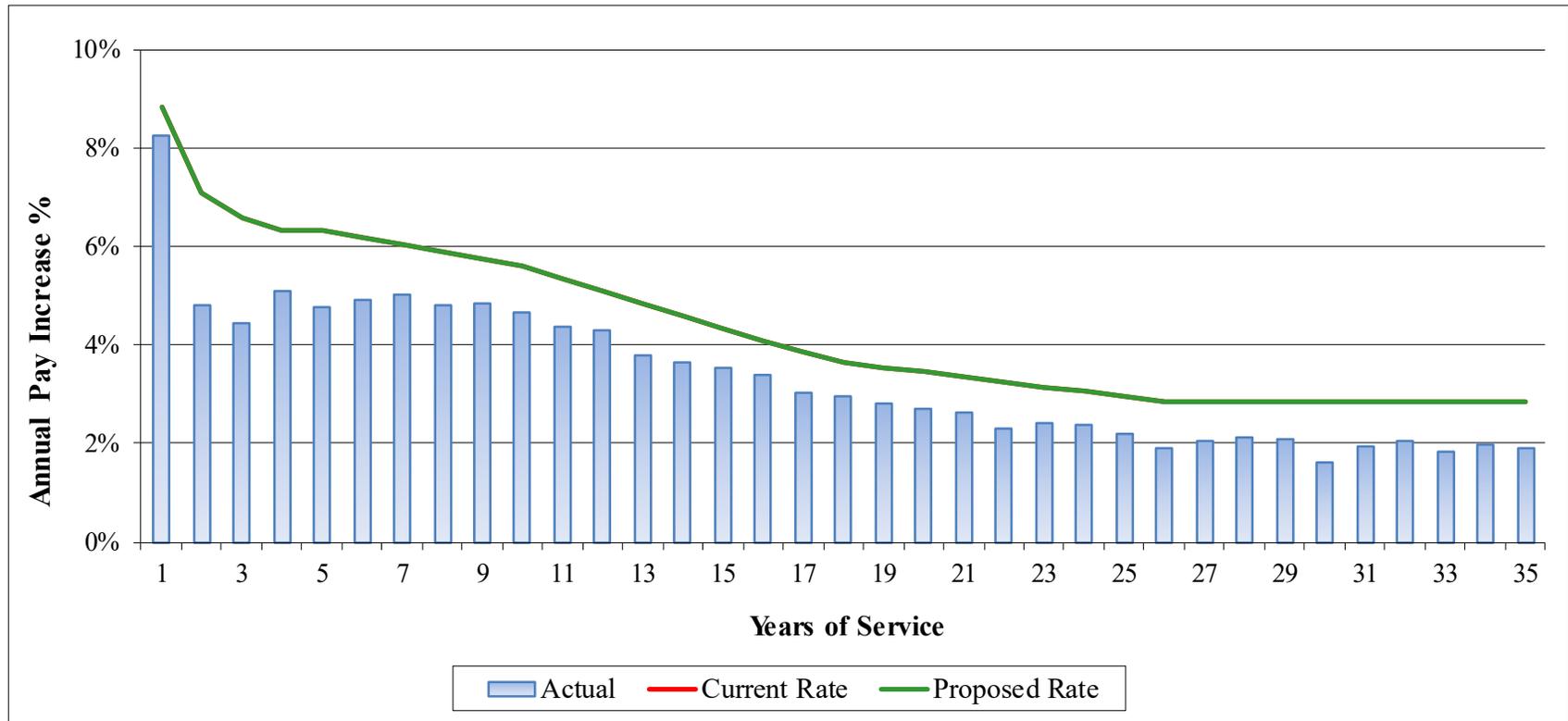
	Actual	Expected - Current Assumptions	Expected - Proposed Assumptions
Average Increase	3.73%	4.75%	4.75%
Actual/Expected		79%	79%

Minnesota Teachers Retirement Association
Experience Study 2018-2022
Data Summary D-1
Probability of Death - Healthy Retirees
Males (Weighted)

Age	Exposure	Actual Deaths	Actual Rate	Current Expected	Current Rate	Proposed Expected	Proposed Rate
55	0.2	-	0.000%	0.0	0.233%	0.0	0.242%
56	1.4	-	0.000%	0.0	0.251%	0.0	0.269%
57	6.5	0.0	0.443%	0.0	0.270%	0.0	0.297%
58	13.4	-	0.000%	0.0	0.291%	0.0	0.328%
59	19.3	-	0.000%	0.1	0.309%	0.1	0.361%
60	23.6	0.2	0.704%	0.1	0.330%	0.1	0.395%
61	28.1	0.1	0.284%	0.1	0.352%	0.1	0.432%
62	35.5	0.1	0.337%	0.1	0.376%	0.2	0.471%
63	43.2	0.3	0.689%	0.2	0.403%	0.2	0.512%
64	49.4	0.3	0.536%	0.2	0.432%	0.3	0.559%
65	57.4	0.4	0.619%	0.3	0.465%	0.4	0.614%
66	68.9	0.5	0.691%	0.4	0.525%	0.5	0.678%
67	79.1	0.6	0.745%	0.5	0.594%	0.6	0.750%
68	86.9	0.6	0.668%	0.6	0.676%	0.7	0.835%
69	98.8	0.7	0.661%	0.8	0.772%	0.9	0.931%
70	106.0	0.8	0.750%	0.9	0.886%	1.1	1.045%
71	115.9	1.1	0.945%	1.2	1.021%	1.4	1.177%
72	123.1	1.5	1.213%	1.5	1.181%	1.6	1.331%
73	121.6	1.5	1.258%	1.7	1.370%	1.8	1.509%
74	117.3	1.8	1.572%	1.9	1.592%	2.0	1.716%
75	113.4	1.9	1.649%	2.1	1.853%	2.2	1.953%
76	112.8	1.8	1.599%	2.4	2.159%	2.5	2.225%
77	115.1	2.5	2.177%	2.9	2.515%	2.9	2.533%
78	118.0	2.7	2.261%	3.5	2.933%	3.4	2.885%
79	114.8	3.5	3.071%	3.9	3.386%	3.8	3.285%
80	108.8	3.7	3.426%	4.1	3.785%	4.1	3.741%
81	102.9	4.4	4.269%	4.4	4.238%	4.4	4.264%
82	99.7	4.1	4.125%	4.7	4.753%	4.8	4.860%
83	95.1	4.5	4.694%	5.1	5.342%	5.3	5.539%
84	93.4	6.5	6.965%	5.6	6.015%	5.9	6.310%
85	88.0	7.0	7.991%	6.0	6.784%	6.3	7.178%
86	78.0	7.0	9.031%	6.0	7.665%	6.4	8.148%
87	70.8	7.6	10.753%	6.1	8.669%	6.5	9.230%
88	60.8	6.1	9.961%	6.0	9.808%	6.3	10.433%
89	52.2	7.3	14.046%	5.8	11.096%	6.1	11.756%
90	43.0	6.4	14.943%	5.4	12.550%	5.7	13.241%
91	33.7	5.6	16.740%	4.8	14.177%	5.0	14.886%
92	26.3	5.5	20.956%	4.2	16.003%	4.4	16.682%
93	20.4	4.7	23.110%	3.7	18.044%	3.8	18.599%
94	15.7	3.6	22.918%	3.2	20.230%	3.2	20.587%
95	11.1	2.6	23.456%	2.5	22.535%	2.5	22.720%
96	8.2	2.3	28.628%	2.0	24.929%	2.0	24.874%
97	4.9	1.4	29.533%	1.3	27.388%	1.3	27.024%
98	3.2	0.9	27.070%	0.9	29.933%	0.9	29.157%
99	2.2	0.9	40.822%	0.7	32.735%	0.7	31.240%
100	0.8	0.2	24.568%	0.3	35.659%	0.3	33.275%

Current and proposed rates are projected to the middle of the period.

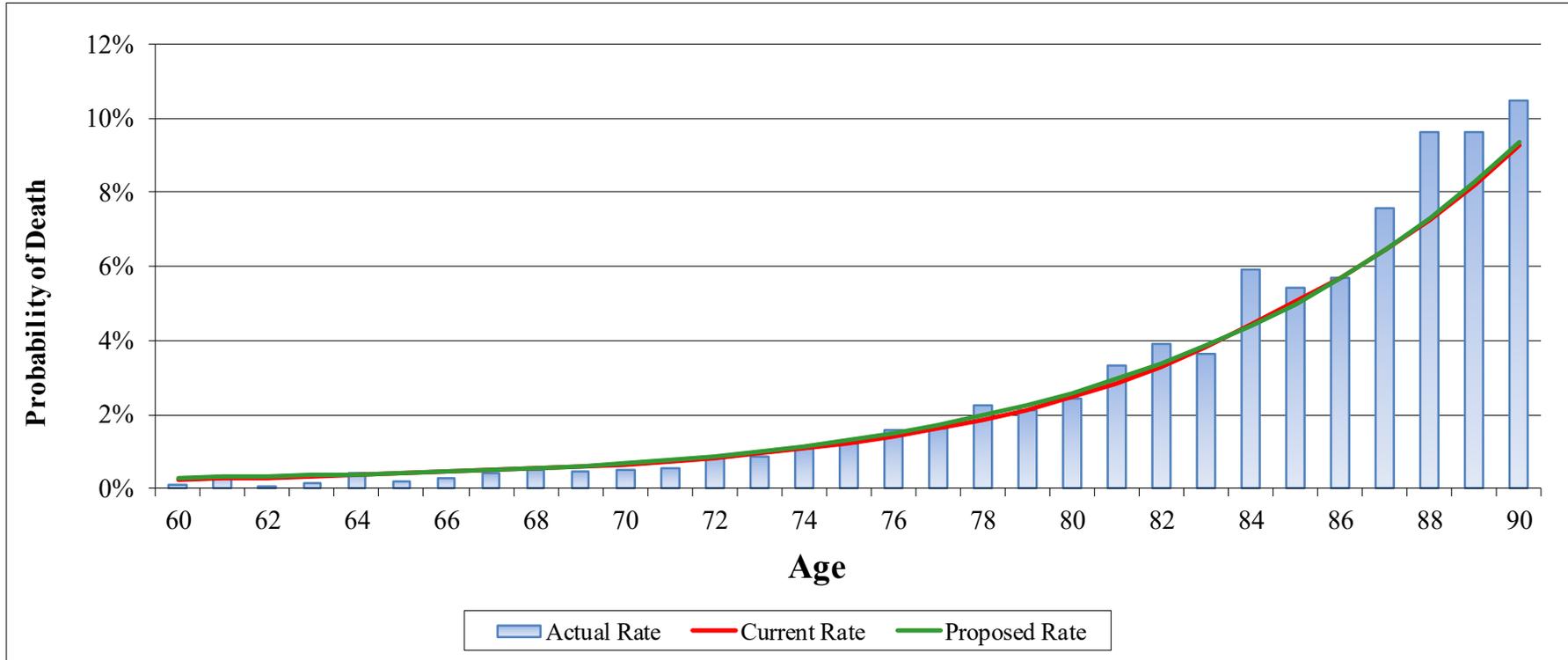# Minnesota Teachers Retirement Association
Experience Study 2018-2022
Data Summary D-2

Probability of Death - Healthy Retirees

Females (Weighted)

Age	Exposure	Actual Deaths	Actual Rate	Current Expected	Current Rate	Proposed Expected	Proposed Rate
55	0.7	0.0	1.032%	0.0	0.183%	0.0	0.192%
56	3.2	-	0.000%	0.0	0.195%	0.0	0.211%
57	13.9	0.0	0.026%	0.0	0.209%	0.0	0.232%
58	27.1	-	0.000%	0.1	0.224%	0.1	0.254%
59	39.3	0.1	0.209%	0.1	0.241%	0.1	0.275%
60	53.5	0.1	0.116%	0.1	0.259%	0.2	0.298%
61	66.1	0.2	0.338%	0.2	0.280%	0.2	0.320%
62	85.7	0.1	0.083%	0.3	0.303%	0.3	0.344%
63	102.3	0.2	0.150%	0.3	0.328%	0.4	0.369%
64	120.0	0.5	0.411%	0.4	0.367%	0.5	0.396%
65	141.9	0.3	0.188%	0.6	0.408%	0.6	0.427%
66	167.1	0.5	0.281%	0.8	0.450%	0.8	0.461%
67	190.3	0.8	0.431%	0.9	0.495%	1.0	0.503%
68	204.7	1.1	0.514%	1.1	0.542%	1.1	0.551%
69	216.7	1.0	0.473%	1.3	0.593%	1.3	0.611%
70	221.6	1.1	0.508%	1.4	0.648%	1.5	0.683%
71	222.8	1.3	0.569%	1.6	0.733%	1.7	0.769%
72	213.8	1.9	0.880%	1.8	0.831%	1.9	0.872%
73	192.7	1.6	0.856%	1.8	0.944%	1.9	0.993%
74	169.2	1.9	1.098%	1.8	1.076%	1.9	1.136%
75	145.3	1.8	1.216%	1.8	1.229%	1.9	1.301%
76	127.8	2.0	1.563%	1.8	1.407%	1.9	1.492%
77	117.7	1.9	1.641%	1.9	1.615%	2.0	1.712%
78	107.4	2.4	2.266%	2.0	1.857%	2.1	1.965%
79	95.4	2.0	2.133%	2.0	2.138%	2.1	2.251%
80	85.9	2.1	2.426%	2.1	2.468%	2.2	2.577%
81	80.5	2.7	3.332%	2.3	2.852%	2.4	2.947%
82	77.5	3.0	3.903%	2.6	3.301%	2.6	3.369%
83	73.0	2.7	3.640%	2.8	3.825%	2.8	3.848%
84	68.4	4.1	5.921%	3.0	4.440%	3.0	4.389%
85	60.9	3.3	5.418%	3.1	5.076%	3.0	5.001%
86	56.0	3.2	5.681%	3.2	5.716%	3.2	5.688%
87	53.1	4.0	7.560%	3.4	6.444%	3.4	6.460%
88	48.0	4.6	9.651%	3.5	7.271%	3.5	7.326%
89	44.6	4.3	9.623%	3.7	8.208%	3.7	8.293%
90	39.3	4.1	10.467%	3.6	9.270%	3.7	9.373%
91	34.9	4.9	14.018%	3.7	10.466%	3.7	10.605%
92	28.2	3.5	12.312%	3.3	11.809%	3.4	11.995%
93	23.5	3.5	14.875%	3.1	13.322%	3.2	13.543%
94	19.2	3.8	19.601%	2.9	14.973%	2.9	15.222%
95	13.6	2.7	19.435%	2.3	16.761%	2.3	17.015%
96	10.1	2.3	22.401%	1.9	18.668%	1.9	18.957%
97	7.5	1.7	22.865%	1.6	20.701%	1.6	20.972%
98	5.4	1.2	22.947%	1.2	22.844%	1.2	23.034%
99	3.4	1.0	29.621%	0.9	25.222%	0.9	25.122%
100	3.0	0.9	29.238%	0.8	27.737%	0.8	27.217%

Current and proposed rates are projected to the middle of the period.

Minnesota Teachers Retirement Association
Experience Study 2018-2022
Data Summary D-3
Probability of Death - Active Lives
Males (Weighted)

Age	Exposure	Actual Deaths	Actual Rate	Current Expected	Current Rate	Proposed Expected	Proposed Rate
25	83.1	-	0.000%	0.0	0.023%	0.0	0.018%
26	137.3	0.0	0.001%	0.0	0.025%	0.0	0.021%
27	192.7	-	0.000%	0.1	0.028%	0.0	0.023%
28	267.3	-	0.000%	0.1	0.029%	0.1	0.025%
29	364.7	-	0.000%	0.1	0.030%	0.1	0.027%
30	450.2	-	0.000%	0.1	0.028%	0.1	0.029%
31	570.4	-	0.000%	0.2	0.027%	0.2	0.032%
32	680.9	-	0.000%	0.2	0.027%	0.2	0.034%
33	802.6	0.2	0.020%	0.2	0.026%	0.3	0.037%
34	933.7	-	0.000%	0.3	0.027%	0.4	0.038%
35	1,069.3	-	0.000%	0.3	0.027%	0.4	0.041%
36	1,248.7	-	0.000%	0.4	0.028%	0.5	0.043%
37	1,436.5	-	0.000%	0.4	0.029%	0.6	0.045%
38	1,735.4	-	0.000%	0.5	0.031%	0.8	0.047%
39	2,003.5	-	0.000%	0.6	0.032%	1.0	0.048%
40	2,284.4	0.3	0.015%	0.8	0.033%	1.1	0.050%
41	2,490.4	0.3	0.012%	0.8	0.034%	1.3	0.052%
42	2,628.6	0.3	0.011%	0.9	0.035%	1.4	0.055%
43	2,839.0	1.9	0.067%	1.0	0.036%	1.7	0.059%
44	2,997.0	1.6	0.053%	1.1	0.037%	1.9	0.062%
45	3,178.4	2.2	0.068%	1.2	0.039%	2.1	0.067%
46	3,425.4	0.2	0.007%	1.4	0.041%	2.5	0.073%
47	3,611.0	-	0.000%	1.6	0.044%	2.8	0.079%
48	3,846.1	-	0.000%	1.8	0.048%	3.3	0.086%
49	4,144.7	4.6	0.111%	2.2	0.053%	3.9	0.094%
50	4,287.2	2.2	0.051%	2.5	0.058%	4.4	0.103%
51	4,360.1	4.4	0.100%	2.8	0.065%	5.0	0.114%
52	4,255.9	-	0.000%	3.1	0.073%	5.3	0.125%
53	4,185.0	4.1	0.099%	3.4	0.081%	5.8	0.138%
54	4,199.8	7.4	0.177%	3.8	0.091%	6.4	0.152%
55	4,098.6	1.0	0.024%	4.2	0.101%	6.8	0.167%
56	4,043.9	2.6	0.064%	4.6	0.113%	7.5	0.185%
57	3,639.4	5.7	0.155%	4.6	0.127%	7.4	0.204%
58	3,003.1	3.1	0.103%	4.3	0.142%	6.7	0.225%
59	2,551.3	6.3	0.247%	4.1	0.159%	6.3	0.248%
60	2,092.9	1.0	0.048%	3.7	0.178%	5.7	0.274%
61	1,809.4	3.6	0.197%	3.6	0.199%	5.5	0.303%
62	1,384.4	8.5	0.616%	3.1	0.223%	4.6	0.332%
63	1,077.6	1.0	0.092%	2.7	0.250%	3.9	0.364%
64	890.2	-	0.000%	2.5	0.280%	3.5	0.398%
65	621.4	-	0.000%	1.9	0.314%	2.7	0.433%
	89,921.2	62.4	0.069%	71.2	0.079%	114.5	0.127%

Current and proposed rates are projected to the middle of the period.

Minnesota Teachers Retirement Association
Experience Study 2018-2022
Data Summary D-4
Probability of Death - Active Lives
Females (Weighted)

Age	Exposure	Actual Deaths	Actual Rate	Current Expected	Current Rate	Proposed Expected	Proposed Rate
25	360.0	-	0.000%	0.0	0.011%	0.0	0.010%
26	554.2	-	0.000%	0.1	0.011%	0.1	0.011%
27	771.1	0.1	0.016%	0.1	0.011%	0.1	0.013%
28	1,005.5	-	0.000%	0.1	0.011%	0.1	0.014%
29	1,262.2	-	0.000%	0.1	0.012%	0.2	0.016%
30	1,512.5	0.2	0.011%	0.2	0.012%	0.3	0.017%
31	1,763.4	-	0.000%	0.2	0.012%	0.3	0.019%
32	2,008.8	0.4	0.018%	0.3	0.013%	0.4	0.020%
33	2,271.9	-	0.000%	0.3	0.013%	0.5	0.022%
34	2,605.4	0.5	0.018%	0.4	0.014%	0.6	0.023%
35	3,004.2	-	0.000%	0.5	0.015%	0.8	0.025%
36	3,512.0	0.3	0.009%	0.6	0.016%	1.0	0.027%
37	4,021.6	1.7	0.043%	0.7	0.018%	1.1	0.028%
38	4,495.5	-	0.000%	0.8	0.019%	1.3	0.030%
39	4,992.5	-	0.000%	1.0	0.020%	1.6	0.032%
40	5,401.2	0.8	0.015%	1.2	0.022%	1.8	0.033%
41	5,868.0	0.4	0.007%	1.3	0.023%	2.1	0.035%
42	6,159.9	2.4	0.039%	1.5	0.024%	2.3	0.037%
43	6,494.5	1.1	0.018%	1.6	0.025%	2.5	0.039%
44	6,837.6	-	0.000%	1.8	0.026%	2.8	0.041%
45	6,858.7	0.2	0.004%	1.9	0.028%	3.0	0.043%
46	6,915.8	4.8	0.070%	2.0	0.030%	3.2	0.046%
47	7,363.9	1.6	0.022%	2.3	0.032%	3.6	0.049%
48	7,905.4	-	0.000%	2.7	0.034%	4.2	0.054%
49	8,553.7	1.9	0.022%	3.2	0.037%	5.0	0.058%
50	9,195.3	3.6	0.039%	3.7	0.041%	5.8	0.063%
51	9,133.1	2.3	0.025%	4.1	0.045%	6.4	0.070%
52	8,820.0	3.1	0.035%	4.4	0.050%	6.7	0.076%
53	8,641.4	0.9	0.010%	4.8	0.055%	7.3	0.084%
54	8,497.6	6.9	0.081%	5.2	0.062%	7.8	0.092%
55	8,760.6	3.0	0.034%	6.0	0.068%	8.8	0.100%
56	8,819.1	4.9	0.055%	6.7	0.076%	9.7	0.110%
57	8,290.4	7.6	0.091%	7.0	0.085%	10.0	0.120%
58	7,509.1	11.8	0.157%	7.0	0.094%	9.9	0.132%
59	6,592.3	9.2	0.139%	6.8	0.104%	9.4	0.143%
60	5,582.6	2.8	0.051%	6.4	0.114%	8.7	0.156%
61	4,686.2	2.3	0.049%	5.8	0.125%	8.0	0.170%
62	3,813.2	1.9	0.050%	5.2	0.136%	7.1	0.186%
63	2,944.2	0.0	0.000%	4.3	0.148%	5.9	0.201%
64	2,317.3	0.7	0.031%	3.7	0.160%	5.1	0.219%
65	1,584.7	2.7	0.168%	2.7	0.172%	3.8	0.239%
	207,686.9	80.0	0.039%	109.0	0.052%	159.1	0.077%

Current and proposed rates are projected to the middle of the period.

Minnesota Teachers Retirement Association
Experience Study 2018-2022
Data Summary D-5
Retirement Rates
Tier 1 - Unreduced

Age	Exposure	Actual Retirements	Actual Rate	Current Expected	Current Rate	Proposed Expected	Proposed Rate
55	179.8	61.5	34.207%	62.9	35.000%	62.9	35.000%
56	1,965.1	810.5	41.244%	687.8	35.000%	687.8	35.000%
57	3,458.0	1,335.0	38.606%	1,210.3	35.000%	1,210.3	35.000%
58	3,575.0	1,232.0	34.463%	1,251.2	35.000%	1,251.2	35.000%
59	3,248.2	1,053.3	32.429%	1,136.9	35.000%	1,136.9	35.000%
60	2,788.2	814.9	29.226%	975.9	35.000%	975.9	35.000%
61	2,404.0	830.1	34.530%	841.4	35.000%	841.4	35.000%
62	1,954.4	633.1	32.395%	684.0	35.000%	684.0	35.000%
63	1,568.1	530.0	33.801%	548.8	35.000%	548.8	35.000%
64	1,394.4	564.4	40.478%	488.0	35.000%	488.0	35.000%
65	1,188.8	490.5	41.262%	475.5	40.000%	475.5	40.000%
66	816.7	364.1	44.581%	285.8	35.000%	326.7	40.000%
67	499.0	144.1	28.877%	149.7	30.000%	149.7	30.000%
68	412.0	142.0	34.461%	123.6	30.000%	123.6	30.000%
69	303.8	75.1	24.734%	91.1	30.000%	91.1	30.000%
70	253.3	76.7	30.295%	88.7	35.000%	76.0	30.000%
71	178.1	44.9	25.187%	178.1	100.000%	178.1	100.000%
	26,186.8	9,202.4	35.141%	9,279.9	35.437%	9,308.0	35.545%

Weighted results are shown

Minnesota Teachers Retirement Association
Experience Study 2018-2022
Data Summary D-6
Retirement Rates
Tier 2 - Unreduced

Age	Exposure	Actual Retirements	Actual Rate	Current Expected	Current Rate	Proposed Expected	Proposed Rate
66	534.2	194.9	36.490%	187.0	35.000%	187.0	35.000%
67	358.7	111.3	31.039%	107.6	30.000%	107.6	30.000%
68	230.0	72.5	31.500%	57.5	25.000%	69.0	30.000%
69	149.3	59.6	39.950%	37.3	25.000%	44.8	30.000%
70	87.0	41.2	47.339%	30.5	35.000%	30.5	35.000%
71	51.9	11.4	21.947%	51.9	100.000%	51.9	100.000%
	1,411.1	490.9	34.791%	471.8	33.433%	490.7	34.777%

Weighted results are shown

Minnesota Teachers Retirement Association
Experience Study 2018-2022
Data Summary D-7
Retirement Rates
Tier 1 - Early

Age	Exposure	Actual Retirements	Actual Rate	Current Expected	Current Rate	Proposed Expected	Proposed Rate
55	4,968.0	107.1	2.155%	248.4	5.000%	248.4	5.000%
56	4,782.5	289.0	6.042%	478.2	10.000%	478.2	10.000%
57	3,355.1	234.6	6.993%	335.5	10.000%	335.5	10.000%
58	2,482.6	273.3	11.008%	248.3	10.000%	248.3	10.000%
59	1,917.7	228.9	11.938%	268.5	14.000%	268.5	14.000%
60	1,454.6	248.5	17.082%	247.3	17.000%	247.3	17.000%
61	1,193.1	268.5	22.507%	238.6	20.000%	238.6	20.000%
62	925.3	220.4	23.815%	231.3	25.000%	231.3	25.000%
63	735.9	170.8	23.209%	184.0	25.000%	184.0	25.000%
64	469.6	189.6	40.370%	117.4	25.000%	117.4	25.000%
	22,284.3	2,230.6	10.010%	2,597.5	11.656%	2,597.5	11.656%

Weighted results are shown

Minnesota Teachers Retirement Association
Experience Study 2018-2022
Data Summary D-8
Retirement Rates
Tier 2 - Early

Age	Exposure	Actual Retirements	Actual Rate	Current Expected	Current Rate	Proposed Expected	Proposed Rate
55	7,701.2	223.0	2.896%	385.1	5.000%	385.1	5.000%
56	6,105.0	181.3	2.970%	305.3	5.000%	305.3	5.000%
57	5,103.4	189.8	3.718%	255.2	5.000%	255.2	5.000%
58	4,443.4	220.6	4.965%	222.2	5.000%	222.2	5.000%
59	3,967.0	247.7	6.245%	198.4	5.000%	198.4	5.000%
60	3,425.1	269.8	7.878%	205.5	6.000%	342.5	10.000%
61	2,892.4	444.4	15.364%	433.9	15.000%	433.9	15.000%
62	2,308.5	479.1	20.752%	346.3	15.000%	461.7	20.000%
63	1,713.2	376.2	21.958%	257.0	15.000%	342.6	20.000%
64	1,336.2	378.5	28.322%	267.2	20.000%	334.1	25.000%
65	502.3	187.3	37.294%	150.7	30.000%	200.9	40.000%
	39,497.8	3,197.7	8.096%	3,026.6	7.663%	3,481.7	8.815%

Weighted results are shown

Minnesota Teachers Retirement Association
Experience Study 2018-2022
Data Summary D-9
Rate of Termination of Employment
Males

Duration	Exposure	Actual Terminations	Actual Rate	Current Expected	Current Rate	Proposed Expected	Proposed Rate
1	157.6	17.4	11.035%	22.1	14.000%	18.9	12.000%
2	303.0	18.3	6.028%	30.3	10.000%	25.8	8.500%
3	436.2	21.5	4.918%	32.7	7.500%	26.2	6.000%
4	572.9	19.9	3.474%	32.9	5.750%	28.6	5.000%
5	690.6	26.8	3.884%	34.5	5.000%	29.3	4.250%
6	802.2	22.9	2.850%	36.9	4.600%	30.1	3.750%
7	882.0	16.0	1.815%	36.2	4.100%	28.7	3.250%
8	928.9	21.6	2.321%	26.0	2.800%	25.5	2.750%
9	946.5	17.8	1.884%	21.8	2.300%	21.3	2.250%
10	1,027.0	21.8	2.126%	20.5	2.000%	20.5	2.000%
11	1,155.9	15.2	1.311%	19.7	1.700%	19.7	1.700%
12	1,365.7	14.3	1.049%	19.1	1.400%	19.1	1.400%
13	1,492.9	10.3	0.692%	19.4	1.300%	19.4	1.300%
14	1,625.3	11.6	0.711%	19.5	1.200%	19.5	1.200%
15	1,693.5	18.0	1.064%	18.6	1.100%	18.6	1.100%
16	1,813.5	17.5	0.966%	18.1	1.000%	18.1	1.000%
17	1,931.9	16.5	0.852%	17.4	0.900%	18.4	0.950%
18	2,178.6	18.0	0.825%	17.4	0.800%	19.6	0.900%
19	2,550.1	12.7	0.497%	17.9	0.700%	21.7	0.850%
20	2,908.4	31.1	1.068%	17.5	0.600%	23.3	0.800%
21	3,033.9	31.0	1.021%	15.2	0.500%	22.8	0.750%
22	2,834.3	17.0	0.599%	14.2	0.500%	19.8	0.700%
23	2,631.1	18.4	0.701%	13.2	0.500%	17.1	0.650%
24	2,495.4	20.6	0.825%	12.5	0.500%	15.0	0.600%
25	2,491.6	13.7	0.550%	12.5	0.500%	13.7	0.550%
26	2,241.4	11.1	0.493%	11.2	0.500%	11.2	0.500%
27	1,865.6	8.5	0.455%	9.3	0.500%	9.3	0.500%
28	1,468.1	11.7	0.800%	7.3	0.500%	7.3	0.500%
29	982.8	-	0.000%	4.9	0.500%	4.9	0.500%
30	449.8	0.0	0.004%	2.2	0.500%	2.2	0.500%
	45,956.8	501.0	1.090%	581.0	1.264%	575.7	1.253%

Weighted results are shown

Minnesota Teachers Retirement Association
Experience Study 2018-2022
Data Summary D-10
Rate of Termination of Employment
Females

Duration	Exposure	Actual Terminations	Actual Rate	Current Expected	Current Rate	Proposed Expected	Proposed Rate
1	484.8	44.7	9.213%	58.2	12.000%	48.5	10.000%
2	928.9	61.5	6.624%	92.9	10.000%	79.0	8.500%
3	1,318.5	70.3	5.332%	105.5	8.000%	92.3	7.000%
4	1,731.8	67.2	3.879%	112.6	6.500%	95.2	5.500%
5	2,105.1	79.2	3.761%	110.5	5.250%	94.7	4.500%
6	2,400.4	70.8	2.950%	96.0	4.000%	84.0	3.500%
7	2,626.5	68.5	2.606%	91.9	3.500%	78.8	3.000%
8	2,718.8	53.5	1.967%	81.6	3.000%	68.0	2.500%
9	2,808.0	57.0	2.029%	70.2	2.500%	63.2	2.250%
10	2,998.5	44.6	1.488%	63.0	2.100%	60.0	2.000%
11	3,407.4	55.0	1.614%	61.3	1.800%	61.3	1.800%
12	3,938.4	57.6	1.464%	63.0	1.600%	63.0	1.600%
13	4,354.1	48.3	1.109%	61.0	1.400%	61.0	1.400%
14	4,651.9	46.5	1.000%	55.8	1.200%	55.8	1.200%
15	4,618.5	44.8	0.970%	50.8	1.100%	50.8	1.100%
16	4,692.9	46.2	0.984%	46.9	1.000%	46.9	1.000%
17	4,670.4	33.9	0.726%	42.0	0.900%	44.4	0.950%
18	5,026.9	58.1	1.156%	40.2	0.800%	45.2	0.900%
19	5,542.2	57.1	1.031%	38.8	0.700%	47.1	0.850%
20	5,897.3	52.7	0.894%	35.4	0.600%	47.2	0.800%
21	5,871.1	36.1	0.615%	29.4	0.500%	44.0	0.750%
22	5,308.5	30.7	0.577%	26.5	0.500%	37.2	0.700%
23	4,707.2	30.1	0.640%	23.5	0.500%	30.6	0.650%
24	4,275.7	16.8	0.394%	21.4	0.500%	25.7	0.600%
25	4,143.4	31.3	0.756%	20.7	0.500%	22.8	0.550%
26	3,854.4	10.2	0.263%	19.3	0.500%	19.3	0.500%
27	3,400.6	10.4	0.306%	17.0	0.500%	17.0	0.500%
28	2,591.1	11.9	0.458%	13.0	0.500%	13.0	0.500%
29	1,729.2	6.7	0.387%	8.6	0.500%	8.6	0.500%
30	719.4	2.8	0.393%	3.6	0.500%	3.6	0.500%
	103,521.9	1,304.5	1.260%	1,560.6	1.508%	1,508.1	1.457%

Weighted results are shown

Minnesota Teachers Retirement Association
Experience Study 2018-2022
Exhibit D-11

Total Salary Scale

Duration	Initial Salary (Millions)	Subsequent Salary (Millions)	Actual Rate	Current Expected (Millions)	Current Rate	Proposed Expected (Millions)	Proposed Rate
1	761.2	823.9	8.23%	828.3	8.81%	828.3	8.81%
2	798.2	836.7	4.81%	854.7	7.07%	854.7	7.07%
3	786.8	821.7	4.43%	838.6	6.58%	838.6	6.58%
4	783.2	823.2	5.11%	832.7	6.33%	832.7	6.33%
5	781.1	818.4	4.78%	830.5	6.33%	830.5	6.33%
6	755.1	792.1	4.90%	801.8	6.18%	801.8	6.18%
7	725.5	761.8	5.01%	769.2	6.03%	769.2	6.03%
8	682.7	715.5	4.80%	722.9	5.88%	722.9	5.88%
9	632.2	662.8	4.83%	668.5	5.73%	668.5	5.73%
10	607.6	635.8	4.64%	641.5	5.58%	641.5	5.58%
11	606.7	633.3	4.38%	639.1	5.33%	639.1	5.33%
12	635.6	662.8	4.29%	667.9	5.09%	667.9	5.09%
13	661.0	685.9	3.77%	693.0	4.84%	693.0	4.84%
14	674.0	698.6	3.65%	705.0	4.59%	705.0	4.59%
15	662.0	685.4	3.53%	690.8	4.34%	690.8	4.34%
16	640.0	661.8	3.40%	666.2	4.09%	666.2	4.09%
17	632.1	651.2	3.03%	656.4	3.84%	656.4	3.84%
18	626.8	645.4	2.96%	649.7	3.64%	649.7	3.64%
19	664.3	682.8	2.80%	687.8	3.55%	687.8	3.55%
20	683.2	701.8	2.72%	706.7	3.45%	706.7	3.45%
21	682.5	700.5	2.63%	705.4	3.35%	705.4	3.35%
22	649.8	664.6	2.29%	670.9	3.25%	670.9	3.25%
23	578.9	592.9	2.42%	597.1	3.15%	597.1	3.15%
24	529.5	542.2	2.39%	545.7	3.05%	545.7	3.05%
25	507.1	518.2	2.18%	522.1	2.95%	522.1	2.95%
26	475.4	484.5	1.91%	488.9	2.85%	488.9	2.85%
27	432.8	441.8	2.06%	445.2	2.85%	445.2	2.85%
28	391.2	399.4	2.12%	402.3	2.85%	402.3	2.85%
29	323.9	330.7	2.07%	333.2	2.85%	333.2	2.85%
30	272.2	276.6	1.62%	280.0	2.85%	280.0	2.85%
31	228.2	232.6	1.92%	234.7	2.85%	234.7	2.85%
32	163.9	167.3	2.04%	168.6	2.85%	168.6	2.85%
33	105.7	107.6	1.84%	108.7	2.85%	108.7	2.85%
34	72.7	74.1	1.99%	74.8	2.85%	74.8	2.85%
35	48.4	49.3	1.90%	49.8	2.85%	49.8	2.85%
36	32.5	33.1	1.94%	33.4	2.85%	33.4	2.85%
37	22.5	22.9	1.79%	23.2	2.85%	23.2	2.85%
38	16.3	16.4	0.45%	16.7	2.85%	16.7	2.85%
39	10.6	10.7	1.03%	10.9	2.85%	10.9	2.85%
40	10.2	10.3	1.08%	10.5	2.85%	10.5	2.85%
	19,353.8	20,076.5	3.73%	20,273.2	4.75%	20,273.2	4.75%