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Teachers Retirement Association of Minnesota

Experience Study
Study Period: July 1, 2014 through June 30, 2018

June 28, 2019

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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, 2014 and ending June 30, 2018. The study was based on the data submitted by TRA for the annual actuarial valuation 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, 2020 actuarial 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, No. 27 (Selection of Economic Assumptions for Measuring Pension Obligations) and No. 35 (Selection of Demographic and Other Non-economic Assumptions for Measuring Pension Obligations).

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 are members of the American Academy of Actuaries and meet the Qualification Standards to render the actuarial opinion contained herein. Also, we meet the requirements of "approved actuary" under Minnesota Statues, Section 356.215, Subdivision 1, Paragraph (c).

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

I, Patrice A. Beckham, F.S.A., am a member of the American Academy of Actuaries and a Fellow of the Society of Actuaries, and meet the Qualification Standards of the American Academy of Actuaries to render the actuarial opinion contained herein.

I, Brent A. Banister, F.S.A., am a member of the American Academy of Actuaries and a Fellow of the Society of Actuaries, and meet the Qualification Standards of the American Academy of Actuaries to render the actuarial opinion contained herein.

Sincerely,

Patrice Beckham

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

Brent A. Banister

Brent A. Banister, PhD, FSA, EA, FCA, MAAA
Chief 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, 2014 through June 30, 2018. 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, 2020 actuarial valuation of the System.

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 of the current actuarial methods be retained. However, we have included some discussion on other options for the amortization of the UAAL in order 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.

Two years ago, in 2017, the full set of economic assumptions were reviewed and significant changes were made, including lowering the investment return assumption to 7.50%. While the data used in our analysis has been updated, where possible, there has been very little change in the general economic outlook.

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.

At the core of the economic assumptions is the inflation assumption. Following a review of the economic assumptions in 2017, the inflation assumption was lowered to 2.5%. While some might argue that inflation will be lower in the future, we believe this approach is consistent with our desire to maintaining a long term perspective.

With the change in the inflation assumption in 2017, other economic assumptions that build upon inflation also changed. The assumption for the expected return on assets was lowered to 7.50%, reflecting the lower inflation assumption as well as a slightly lower anticipated real rate of return. Likewise, the general wage growth and payroll growth assumption were decreased to reflect the lower anticipated price inflation.

We find that the current set of economic assumptions, studied just two years ago in 2017, are still reasonable and appropriate so no changes to the set of economic assumptions are proposed at this time. 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%	7.50%
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, 2018 valuation.

Although we have recommended retaining the current 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. The analysis is performed based on counts, i.e. each member is one exposure as to the probability of the event occurring and one occurrence if the event actually occurs. 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: Changes to the mortality tables used for active members, reflecting higher rates of death for males and lower rates for females, to better match actual experience.

- Termination of employment: Changes to the rates of termination of employment in the first five years of employment to better match the observed 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.

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 mortality tables used for active members, the termination of employment rates, and the probabilities of optional form elections for future retirees, as presented in Appendix B in this report.

Because we are recommending that the current set of economic assumptions be retained, no action is necessary by the Legislature.

Financial Impact

The financial impact of the suggested changes was estimated by performing additional valuations using the July 1, 2018 valuation data. The cost impact, illustrated in the table on the following page, is based on the July 1, 2018 valuation using the recommended set of assumptions outlined in this report.

When this set of assumptions is actually used, likely in the July 1, 2020 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

	7/1/18 Valuation Baseline	Assumption Changes	Percent Change
Actuarial Liability ($M)	$ 28,643	$ 28,637	(0.02%)
Actuarial Assets ($M)	22,023	22,023	0.00%
Unfunded Actuarial Accrued Liability (UAAL) ($M)	$ 6,620	$ 6,614	(0.09%)
Normal Cost Rate	9.16%	9.18%	0.22%
UAAL Amortization Rate	7.70%	7.70%	0.00%
Expense Rate	0.32%	0.32%	0.00%
Total Actuarial Rate	17.18%	17.20%	0.12%
Statutory Contribution Rate	16.10%	16.10%	0.00%
Sufficiency/(Deficiency)	(1.08%)	(1.10%)	1.85%

Numbers may not add due to rounding.

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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 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 (2) and 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 also 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 either 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 the asset smoothing method most 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).

<u>Amortization Period:</u> 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.

<u>Amortization Payment:</u> The <u>level dollar</u> amortization method is similar to the method in which a home owner 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 one amortization base with payments determined as a level percentage of payroll. The amortization period was just reset by statute to a closed 30-year period starting with the July 1, 2018 valuation, subject to adjustment under certain circumstances. Each year, the amortization period is reduced by one year until 2048 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 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 undesired 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 2048. Gains and losses which occur after the change in method 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 2048 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 would 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 somewhere between 15 and 25 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.

While the current method, set by statute, would eventually pay down the UAAL in a fixed period of time if the actuarial contribution were paid, we do 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. The Actuarial Standards Board is also considering some additional required disclosures regarding amortization. Consequently, we believe a greater understanding of the issues involved would be beneficial to the Board.

Because the amortization method does not directly affect the contribution amounts, it does not appear that there is a compelling reason to make a change at this time. To have more stability in the disclosed actuarial rate, adopting a layered approach would certainly be reasonable and acceptable. **We are not recommending a change to the amortization method at this time, but such a change would certainly be reasonable if the Board wished to make a change.**

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
- 2019 Social Security Trustees Report
- Future return expectations of the State Board of Investments (SBI), and their consultants
- 2018 Horizon Actuarial Services Survey of Capital Market Assumptions
- 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, <u>but advises the actuary not to give undue weight to recent experience</u>. 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.

As the following table indicates, we are not recommending any change to the current set of economic assumptions:

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

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.

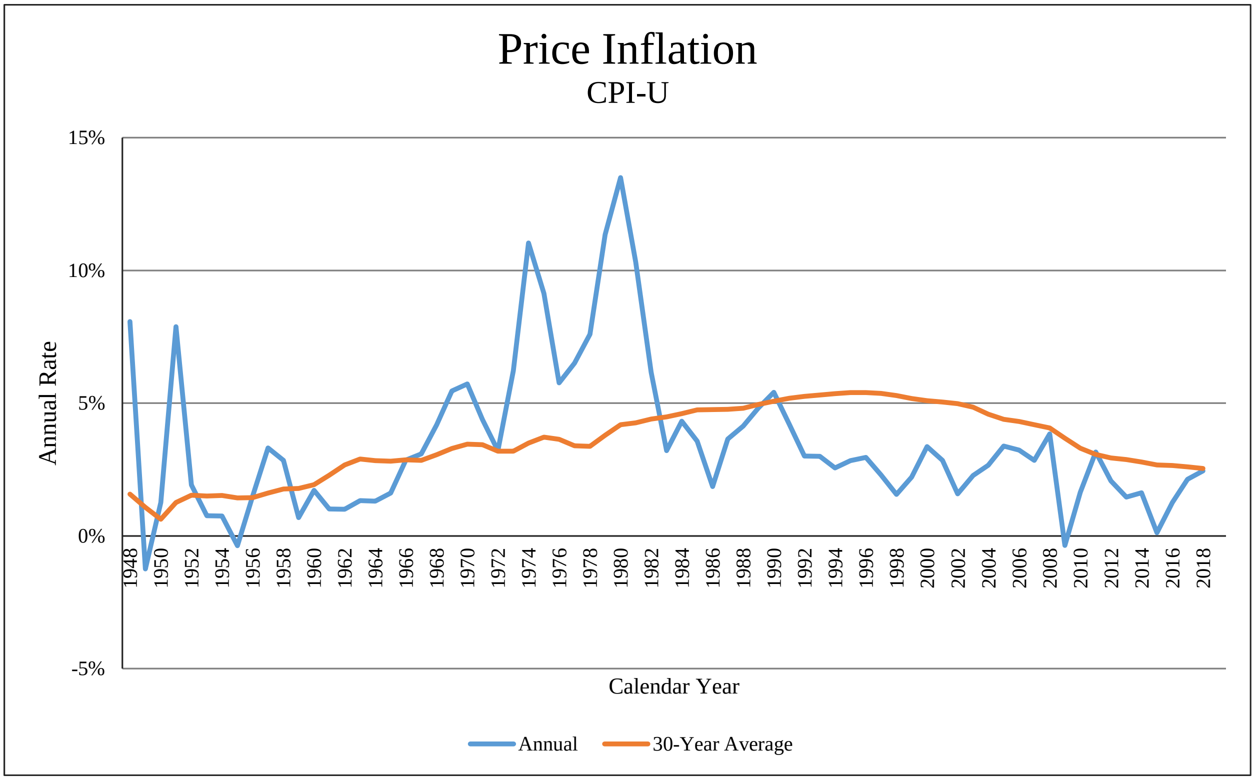
The current assumption for price inflation is 2.50% per year.

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 December 31st.

Period	Number of Years	Annualized Rate of Inflation	Annual Standard Deviation
1926 – 2018	92	2.92%	3.79%
1958 – 2018	60	3.67	2.77
1968 – 2018	50	4.03	2.86
1978 – 2018	40	3.43	2.68
1988 – 2018	30	2.54	1.19
1998 – 2018	20	2.18	1.05
2008 - 2018	10	1.55	0.99

The following graph illustrates the historical annual change in price inflation, measured as of December 31 for each of the last 70 years, as well as the thirty-year rolling average.



Over more recent periods (last thirty years), the average annual rate of increase in the CPI-U has been 2.54% or lower. The period of high inflation from 1973 to 1981 has a significant impact on the averages over longer periods which include these rates, even impacting the average rate of 2.92% over the entire 92-year period. However, the volatility of the annual rates in more recent years has been noticeably lower as evidenced by the significantly lower annual standard deviations. Many experts attribute the lower average annual rates and lower volatility to the increased efforts of the Fed since the early 1980's to stabilize price inflation.

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). 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. The following table provides the calculation of the breakeven rate of inflation as of January 2, 2019.

Years to Maturity	Nominal Bond Yield	TIPS Yield	Breakeven Rate of Inflation
10	2.66%	0.96%	1.70%
20	2.83	1.07	1.76
30	2.97	1.19	1.78

As this data indicates, the bond market is anticipating inflation of approximately 1.75% for both the short and long term. However, that expectation may be heavily influenced by the current low interest rate environment created by the Fed's manipulation of the bond market. We note that recently these measures can move fairly significantly over just a few months. Whether price inflation returns to the higher rates observed historically and if so, when, remains to be seen.

Forecasts from the Social Security Administration

Although many economists forecast lower inflation than the assumption used by retirement plans, they are generally looking at a shorter time horizon 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 (April 2019), the projected average annual increase in the CPI over the next 75 years was estimated to be 2.6%, under the intermediate cost assumption. The range of inflation assumptions used in the Social Security 75-year modeling, which includes a low and high cost scenario, in addition to the intermediate cost projection, was 2.00% to 3.20%.

Forecasts from Investment Consulting Firms and Other Professionals

In setting their capital market assumptions, most investment consulting firms use an inflation assumption. Horizon Actuarial Services, LLC publishes a survey of capital market assumptions obtained from various investment consultants. The 2018 Horizon Survey includes the assumptions, including the expected rate of inflation, for thirteen advisors who develop longer-term assumptions (20 years or more). The Survey showed a range of expected inflation for the next 20 years, for these thirteen consultants, of 2.2% to 2.8%, with a median of 2.5%.

The last asset/liability study for SBI was performed by Callan and Associates in 2016. In that analysis, they used an inflation assumption of 2.25% for a twenty-year period.

Another source to consider in setting this assumption is a quarterly survey of the Society of Professional Forecasters that is conducted by the Philadelphia Federal Reserve of economists. Their most recent forecast (first quarter of 2019) was for inflation over the next ten years (2019 to 2028) to average 2.20%.

Comparison of Inflation Expectations

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

Source	Expected Inflation
SBI's Consultant (Callan)	2.25%
Horizon Survey	2.50%
Bond Market	1.78%
2019 SSA Trustees Report	2.60%
Survey of Professional Forecasters	2.20%

While actuarial standards caution against too much consideration of recent events, the lower inflation over the last 10, 20 and even 30 years, coupled with the low future inflation anticipated by the bond markets, investment consultants, and professional economic forecasters suggests that there may have been a fundamental change away from the longer term historical norms. We believe the change made in the last study appropriately reflects this shift. Based on the information presented above**, we recommend the inflation assumption remain at 2.50%.**

INVESTMENT RETURN

Use in the Valuation

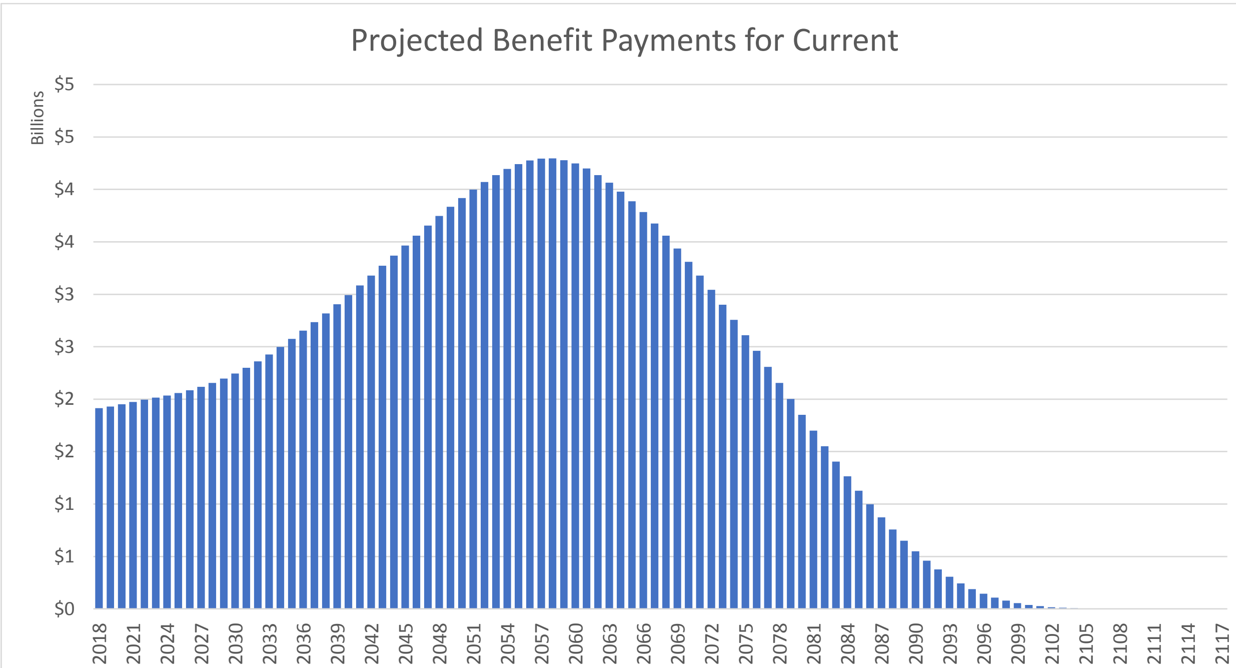
The investment return assumption reflects the anticipated returns on the current and future assets. It is one of the primary determinants in the allocation of the expected cost of the System's benefits, providing a discount of the estimated future benefit payments to reflect the time value of money. 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 is currently 7.50%. 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 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.

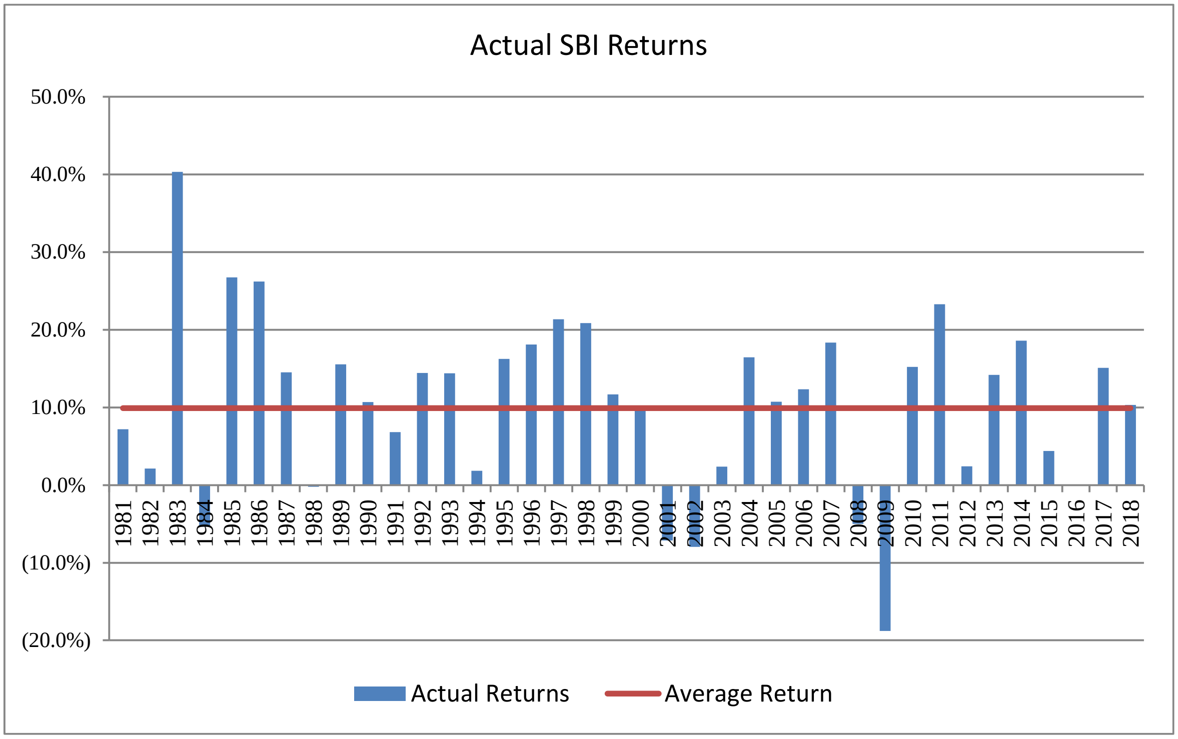
The following graph illustrates the long duration of the expected benefit payments for current members on July 1, 2018.



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 38 years, ending June 30, 2018. The compound return over the entire 38-year period is 9.9%. The returns over various time frames are shown beneath the graph. The graph demonstrates the volatility of the returns – only two of the 38 returns are between 6.5% and 8.5%, while 20 are greater than 11.5% and 11 are less than 3.5%. 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 the historical data.



ANNUALIZED RETURNS through 6/30/18

1-Year Return:	10.3%	10-Year Return:	7.8%
3-Year Return:	8.2%	20-Year Return:	6.8%
5-Year Return:	9.4%	30-Year Return:	9.1%

Forward Looking Analysis

Using SBI Assumptions

TRA's assets are held and invested by the Minnesota State Board of Investment (SBI). This office employs investment professionals who make decisions regarding asset allocation, recognizing the long-term nature of the liabilities of the systems. Since ASOP 27 provides that the actuary may rely on outside experts, we believe it is appropriate to heavily weigh the market outlook and expectations provided by SBI. As part of their duties, SBI performed a comprehensive Asset/Liability Study in 2016 (prepared by Callan and Associates). The portfolio recommended in that study was estimated to have an expected return over the next ten years of 7.30%, assuming a 2.25% inflation assumption, i.e., a real return of 5.05%. The standard deviation of the portfolio was estimated to be 17.44%. SBI has not published updated capital market assumptions since that study was completed, so our analysis is based on the 2016 information which was also used in the study of economic assumptions in 2017.

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, we can produce an expected range of real rates of return over a 50-year time horizon. Looking at one year's results produces a median real return of 5.05% but also has a high standard deviation or measurement of volatility. By expanding the time horizon, the median return does not change much, but the volatility declines significantly. The table below provides a summary of results.

Time Span In Years	Mean Real Return	Standard Deviation	Real Returns by Percentile				
			5th	25th	50th	75th	95th
1	6.45%	17.44%	-19.62%	-5.87%	5.05%	17.24%	37.30%
5	5.33	7.68	-6.80	0.02	5.05	10.34	18.41
10	5.19	5.42	-3.48	1.47	5.05	8.76	14.33
20	5.12	3.83	-1.05	2.50	5.05	7.66	11.53
30	5.10	3.12	0.04	2.97	5.05	7.18	10.31
50	5.08	2.42	1.15	3.43	5.05	6.69	9.10

The percentile results are the percentage of random returns over the time span shown that are expected to be less than the amount indicated. Thus for the 10-year time span, 5% of the real rates of return will be below -3.48% and 95% will be above that. As the time span increases, the results begin to converge. Over a 50-year time span, the results indicate a 25% chance that real returns will be below 3.43% and a 25% chance they will be above 6.69%. There is a 50% chance the real returns will be 5.05% or above and a 50% chance the real return will be below 5.05%.

We note that in the Asset/Liability Study, Callan indicated that they were considering a 10-year horizon, shorter than our long-term perspective. There is general consensus that shorter-term returns will be lower than longer-term returns since the current low interest rate environment is holding bond returns low.

Using Other Consultants' Assumptions (Horizon Survey)

Many investment firms or investment consulting firms produce estimates of future asset returns, similar to the expected return analysis developed by SBI. While it might seem desirable to compare these estimates, there is a challenge to such effort. When SBI indicates what it believes its domestic equities will return, it does so in the context of knowing the construction of its domestic equities portfolio. Another investment consultant will likely have in mind a different blend of large versus small stocks or growth versus value equities. There are also comparison challenges in certain asset classes such as international stock (emerging or developed markets), bonds (duration and credit quality), and alternatives (a very broadly interpreted category). For this reason, we believe there is limited value in trying to compare the expected return developed by SBI with the assumptions of another group of investment professionals. Nonetheless, the alternative analysis using other consultants' assumptions can still provide value as a general confirmation of the analysis performed by SBI and Callan.

Because the goal of this analysis is to corroborate the reasonableness of the SBI results, we consider sets of capital market assumptions resulting from a survey of investment advisors conducted by Horizon Actuarial Services in 2018. The survey looks at the 10-year horizon capital market assumptions for 34 investment advisors (including Callan). The survey also includes results of the 13 advisors who provide assumptions for a twenty-year (or longer) time frame. A summary of these distribution of expected real returns, under both sets of assumptions, are displayed in the following tables:

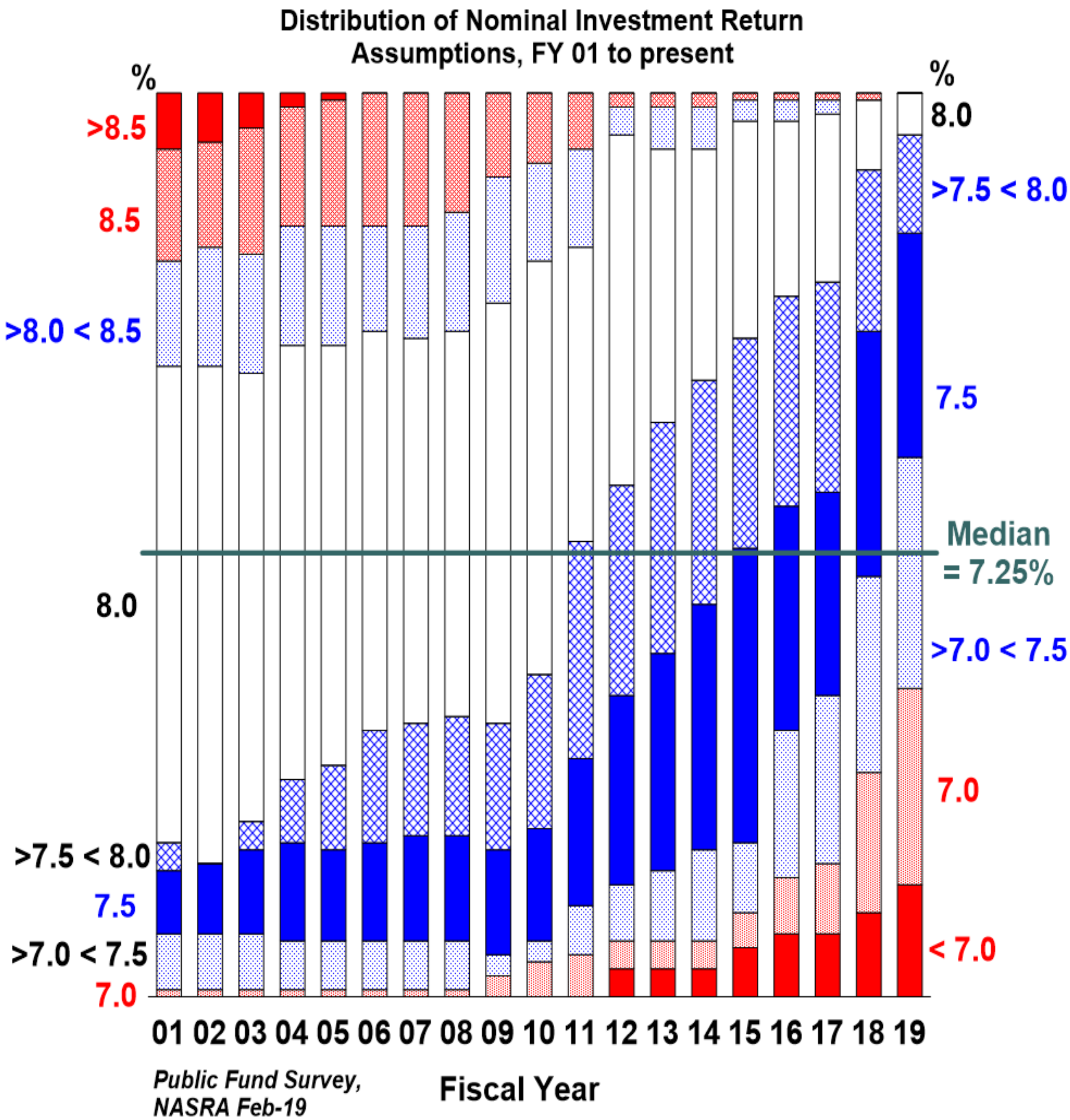
Time Span In Years	Mean Real Return	Standard Deviation	Real Returns by Percentile				
			5th	25th	50th	75th	95th
Ten-Year horizon assumptions							
30	4.46%	2.43%	0.52%	2.81%	**4.43%**	6.08%	8.49%
50	4.45%	1.88%	1.39%	3.17%	**4.43%**	5.70%	7.56%
Twenty-Year horizon assumptions							
30	5.52%	2.43%	1.58%	3.87%	**5.49%**	7.14%	9.56%
50	5.51%	1.88%	2.45%	4.23%	**5.49%**	6.77%	8.63%

One item to note is that the expected real return, using the 20-year horizon assumptions, is about 1% higher than the expected return using the short-term horizon assumption (next 10 years). While actuarial assumptions are set with the long term in mind, the magnitude of benefit payments in the next 10-15 years is large enough that the short term cannot be ignored. A long-term, real return estimate of 5.00% (current assumption) is not inconsistent with this data.

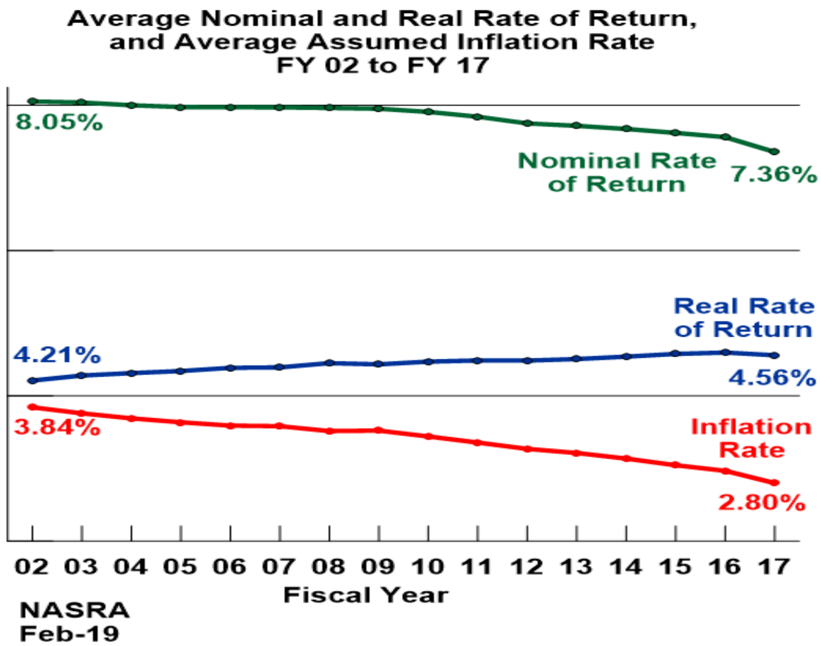
Peer System Comparison

While we do not recommend the selection of an investment return assumption be based on the assumptions used by other systems, it does provide another set of relevant information to consider. It is informative to evaluate where the investment return assumption for TRA is compared to its peer group and the general trend in the assumption over time.

The following graph shows the change in the distribution of the investment return assumption from fiscal year 2001 through 2019 for the 100+ large public retirement systems included in the National Association of State Retirement Administrators (NASRA) Public Fund Survey. It is worth noting that the median investment return assumption dropped from 8.00% to 7.75% in fiscal year 2012, and has continued to decline. When the economic assumptions were reviewed in 2017, the median investment return was 7.50%. It has quickly declined to 7.25% over the last two years. The assumed rate of return is heavily influenced by the asset allocation of the system. The average asset allocation for the systems in the Public Fund Survey is 2.1% cash, 48.8% equities, 22.6% fixed income, 7.2% real estate, and 19.3% alternative investments which has an impact on the expected return of the systems. Note that TRA is invested in a portfolio that differs significantly in that the equity allocation is 58%, the fixed income allocation is 20%, and alternatives is 20%, a somewhat more aggressive portfolio than the average system's asset allocation. As a result, it is reasonable to anticipate that the expected return for TRA could be higher than that of the median of other systems.



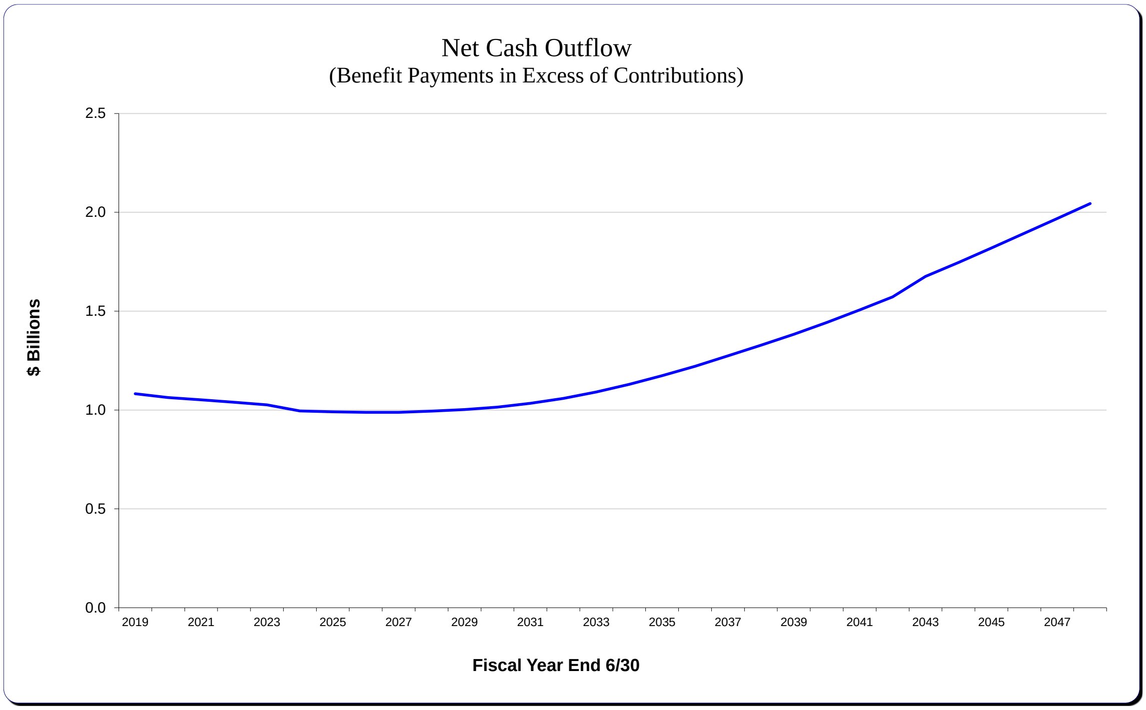
About 90 percent of the systems in the NASRA Public Fund Survey have lowered their assumed rate of return since 2010 and many systems are taking action to make additional reductions. The mean real rate of return (nominal return assumption less the inflation assumption) for these plans is 4.56%, which 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). As the graph below indicates, although the nominal return has decreased, the real rate of return has actually increased.



Plan Dynamics

While TRA is expected to have an indefinite life span, it is a very mature retirement system with a significant portion of its total liability attributable to current retirees and beneficiaries. The July 1, 2018 valuation indicates that 64% of the $28.6 billion actuarial accrued liability was attributable to members who are currently drawing a benefit from the system. Due to the Plan's maturity and the magnitude of benefit payments compared to expected contributions, we believe the investment return assumption should not ignore the short-term forecast.

Because of its maturity, TRA has significant negative cash flow due to benefit payments that far exceed the amount of contributions each year. This is to be expected in a mature plan since the whole reason assets were accumulated in prior years was to pay out benefits to retirees. For the year ended June 30, 2018, the negative cash flow was $1.041 billion, about 4.2% of the market value of assets. The trend of more negative cash flow is expected to continue in the future, as shown in the graph below (based on the projection model created in conjunction with the July 1, 2018 valuation).



This situation has an impact when the return expectations are considerably lower in the short term than the longer term, as is currently the case (see earlier discussion). Essentially, there are fewer assets to be reinvested to earn the higher returns that occur in later years. Thus, the impact on the accumulation of trust fund assets is significant. For instance, the assumptions summarized by Horizon have a short-term real return (excluding inflation) of 4.43% and a long-term real return of 5.49%. The compound real return, *in the absence of external cash flows,* for the next 30 years is 5.13% (which equates to 7.63% on a nominal return basis). However, with the expected TRA cash flows, the asset value in 30 years with the Horizon assumptions is the same as if the portfolio earns 5.0% each year over that same period. Thus, the short-term assumptions need to be given more weight because of the plan dynamics.

Finally, historically the Plan has been funded with fixed contribution rates and this funding approach is expected to continue. Without the ability for contribution rates to increase in future years to compensate for actual investment experience that is lower than expected by the assumption, we believe that it is prudent to include some conservatism in setting the investment return assumption.

Recommendation

Based on all the information outlined in this section, **we recommend the 7.50% investment return assumption be retained (**composed of an inflation assumption of 2.50% and a real rate of return of 5.00%).

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 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 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.

There are numerous ways to review this data. For consistency with our observations of CPI, the table below shows the compound annual rates of wage growth for various 10-year periods, and for longer periods ended in 2017 (most recent available data).

Decade	Wages
2007-2017	2.2%
1997-2007	4.0%
1987-1997	4.1%
1977-1987	6.5%
1967-1977	6.5%
1957-1967	3.7%

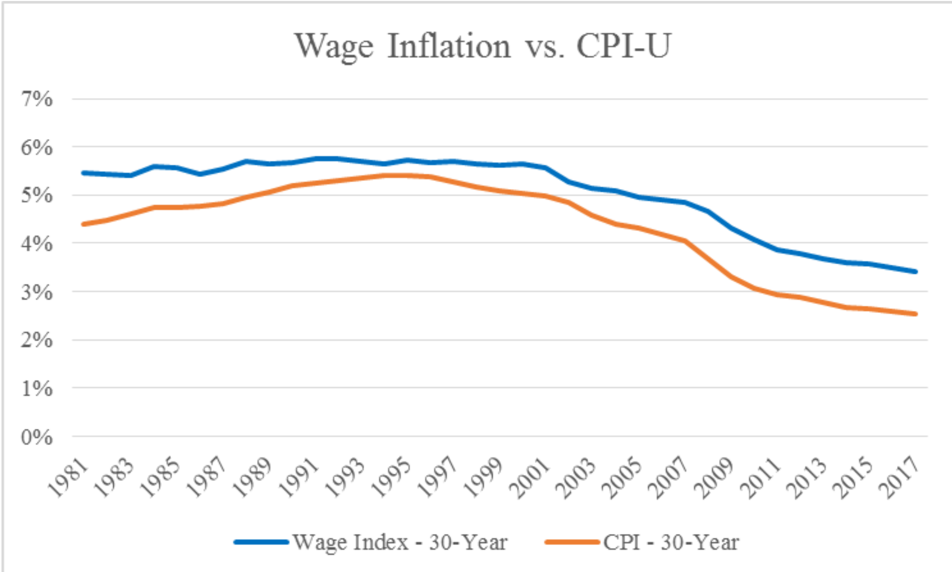
Period	Years	Wages
2007-2017	10	2.2%
1997-2017	20	3.1%
1987-2017	30	3.4%
1977-2017	40	4.2%
1967-2017	50	4.6%
1957-2017	60	4.5%

The excess of wage growth over price inflation represents the real wage inflation rate. Although real wage inflation has been very low in recent years, likely due to the recovery from the 2008 financial crisis, our focus must remain on the long term. 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. The data for each year is documented in Exhibit 3.

Decade	General Wage Growth	CPI Incr.	Real Wage Inflation
2007-2017	2.2%	1.7%	0.5%
1997-2007	4.0%	2.6%	1.4%
1987-1997	4.1%	3.5%	0.6%
1977-1987	6.5%	6.4%	0.1%
1967-1977	6.5%	6.1%	0.4%
1957-1967	3.7%	1.7%	2.0%

Period	General Wage Growth	CPI Incr.	Real Wage Inflation
2007-2017	2.2%	1.7%	0.5%
1997-2017	3.1%	2.1%	1.0%
1987-2017	3.4%	2.6%	0.8%
1977-2017	4.2%	3.6%	0.6%
1967-2017	4.6%	4.1%	0.5%
1957-2017	4.5%	3.7%	0.8%

Similar information over rolling thirty year periods is shown in the following graph:



Actual TRA Historical Data

In the 2017 review of economic assumptions, TRA supplied us with data that provided a measurement of average starting teacher salaries for the past 32 years. While the results may be somewhat influenced by the Minneapolis school district not being included in this data until recently, we nonetheless believe it provides a useful assessment of wage inflation for TRA members, particularly because the salaries of all levels of teachers tend to move together. For the period covered, the effective increase in starting salaries was about 2.95% per year compared with 2.65% annual price inflation. This suggests that real wage inflation for Minnesota teachers has been approximately 0.30% during the same period that national real wage inflation, measured using the change in the National Average Wage Index, was approximately 0.8%. This general trend was also observed when analyzing the average teacher salary over the last 25 years in a study of national wages by the state. In addition, an article a couple years ago in the Minneapolis Star Tribune discussed the same salary trend over the last decade, noting that although teacher pay has not kept pace with inflation, much of that is due to the increasing cost of health and pension benefits provided to Minnesota teachers. In other words, employee benefits have become a greater percentage of total compensation (salary plus benefit). Although this is quite insightful when reviewing the data over the recent past, the real question in setting this assumption is whether or not this trend will continue. In our opinion, it seems unlikely to continue for the next 30 to 50 years so we expect the real wage inflation rate to eventually revert back to more normal historical rates.

Social Security Forecast

The wage index we used for the historical analysis is projected forward by the Office of the Chief Actuary of the Social Security Administration in their projection analysis. In a report in 2019, the annual increase in the National Average Wage Index over the next 30 years under the intermediate cost assumption was 1.2% over price inflation. The range of the assumed real wage inflation in the 2019 Trustees report was 0.58% to 1.82% 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).

Recommendation

There is no additional relevant data, compared to the study of economic assumptions performed in 2017 that leads us to feel an adjustment is necessary. We continue to believe that there is also a difference in the short-term and long-term expectations for real wage inflation. In the short term (next 10 years or so), we expect real wage inflation to be comparable to that observed in the recent past, perhaps around 0.30%, as we expect benefits to continue to comprise a larger portion of total compensation increases for public employees. Eventually, however, the wages and salary for educators will have to keep pace with the wage increases in the general economy and we expect to see the wage inflation revert back to longer term, historical levels, around 0.75%. **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
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%

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

We propose continuing the 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 and plus 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. In addition, the budget challenges for governmental employers during this study period is likely to have impacted the actual salary increases.

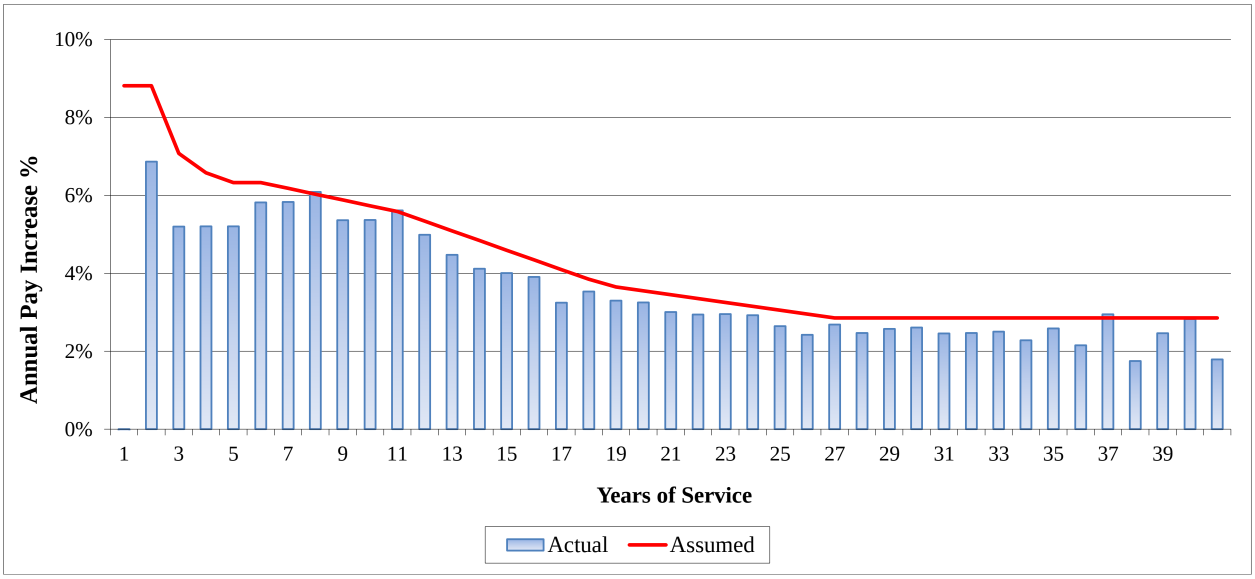
For our first step, we compared individual salary increases using total reported salary for all members active in two consecutive periods (e.g. 2014 and 2015, 2015 and 2016, etc.). The overall results of the current study:

Average Increase in Salaries			
Year	**Actual**	**Expected**	**Difference**
2014-15	5.66%	4.86%	(0.80%)
2015-16	3.67%	4.88%	1.21%
2016-17	3.66%	4.88%	1.22%
2017-18	3.32%	4.88%	1.56%
All years	4.03%	4.88%	0.85%

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 study period, price inflation was around 1.40%, compared to the assumption of 2.50%. This information suggests that we could expect wage increases to be 1.10% lower than the long term expectation, or 0.70% lower than the select period expectation, simply as a function of the overall economy. As noted in the table above, the actual increases were about

0.85% lower. This suggests that the observed experience is in line with what would be expected, given the overall picture of the economy.

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 inflation. 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 lower than assumed, which was expected in light of lower than expected inflation during the period.



We recommend the current merit salary scale assumption be retained.

Exhibit 1

U.S. Consumer Price Index

December of:	Index	Increase	December of:	Index	Increase
1928	17.1				
1929	17.2	0.6 %	**1974**	51.9	12.3
1930	16.1	-6.4	**1975**	55.5	6.9
1931	14.6	-9.3	**1976**	58.2	4.9
1932	13.1	-10.3	**1977**	62.1	6.7
1933	13.2	0.8	**1978**	67.7	9.0
1934	13.4	1.5	**1979**	76.7	13.3
1935	13.8	3.0	**1980**	86.3	12.5
1936	14.0	1.4	**1981**	94.0	8.9
1937	14.4	2.9	**1982**	97.6	3.8
1938	14.0	-2.8	**1983**	101.3	3.8
1939	14.0	0.0	**1984**	105.3	3.9
1940	14.1	0.7	**1985**	109.3	3.8
1941	15.5	9.9	**1986**	110.5	1.1
1942	16.9	9.0	**1987**	115.4	4.4
1943	17.4	3.0	**1988**	120.5	4.4
1944	17.8	2.3	**1989**	126.1	4.6
1945	18.2	2.2	**1990**	133.8	6.1
1946	21.5	18.1	**1991**	137.9	3.1
1947	23.4	8.8	**1992**	141.9	2.9
1948	24.1	3.0	**1993**	145.8	2.7
1949	23.6	-2.1	**1994**	149.7	2.7
1950	25.0	5.9	**1995**	153.5	2.5
1951	26.5	6.0	**1996**	158.6	3.3
1952	26.7	0.8	**1997**	161.3	1.7
1953	26.9	0.7	**1998**	163.9	1.6
1954	26.7	-0.7	**1999**	168.3	2.7
1955	26.8	0.4	**2000**	174.0	3.4
1956	27.6	3.0	**2001**	176.7	1.6
1957	28.4	2.9	**2002**	180.9	2.4
1958	28.9	1.8	**2003**	184.3	1.9
1959	29.4	1.7	**2004**	190.3	3.3
1960	29.8	1.4	**2005**	196.8	3.4
1961	30.0	0.7	**2006**	201.8	2.5
1962	30.4	1.3	**2007**	210.0	4.1
1963	30.9	1.6	**2008**	210.2	0.1
1964	31.2	1.0	**2009**	215.9	2.7
1965	31.8	1.9	**2010**	219.2	1.5
1966	32.9	3.5	**2011**	225.7	3.0
1967	33.9	3.0	**2012**	229.6	1.7
1968	35.5	4.7	**2013**	233.0	1.5
1969	37.7	6.2	**2014**	234.8	0.8
1970	39.8	5.6	**2015**	236.5	0.7
1971	41.1	3.3	**2016**	241.4	2.1
1972	42.5	3.4	**2017**	246.7	2.0
1973	46.2	8.7%	**2018**	252.9	2.5

Exhibit 2

National Average Wage Index

	Index	Increase		Index	Increase
1927	$1,159.14				
1928	1,162.53	0.3%	**1973**	$7,580.16	6.3%
1929	1,196.88	3.0	**1974**	8,030.76	5.9
1930	1,164.95	(2.7)	**1975**	8,630.92	7.5
1931	1,086.09	(6.8)	**1976**	9,226.48	6.9
1932	954.02	(12.2)	**1977**	9,779.44	6.0
1933	892.58	(6.4)	**1978**	10,556.03	7.9
1934	929.34	4.1	**1979**	11,479.46	8.7
1935	968.53	4.2	**1980**	12,513.46	9.0
1936	1,008.20	4.1	**1981**	13,773.10	10.1
1937	1,071.58	6.3	**1982**	14,531.34	5.5
1938	1,047.39	(2.3)	**1983**	15,239.24	4.9
1939	1,076.41	2.8	**1984**	16,135.07	5.9
1940	1,106.41	2.8	**1985**	16,822.51	4.3
1941	1,228.81	11.1	**1986**	17,321.82	3.0
1942	1,455.70	18.5	**1987**	18,426.51	6.4
1943	1,661.79	14.2	**1988**	19,334.04	4.9
1944	1,796.28	8.1	**1989**	20,099.55	4.0
1945	1,865.46	3.9	**1990**	21,027.98	4.6
1946	2,009.14	7.7	**1991**	21,811.60	3.7
1947	2,205.08	9.8	**1992**	22,935.42	5.2
1948	2,370.53	7.5	**1993**	23,132.67	0.9
1949	2,430.52	2.5	**1994**	23,753.53	2.7
1950	2,570.33	5.8	**1995**	24,705.66	4.0
1951	2,799.16	8.9	**1996**	25,913.90	4.9
1952	2,973.32	6.2	**1997**	27,426.00	5.8
1953	3,139.44	5.6	**1998**	28,861.44	5.2
1954	3,155.64	0.5	**1999**	30,469.84	5.6
1955	3,301.44	4.6	**2000**	32,154.82	5.5
1956	3,532.36	7.0	**2001**	32,921.92	2.4
1957	3,641.72	3.1	**2002**	33,252.09	1.0
1958	3,673.80	0.9	**2003**	34,064.95	2.4
1959	3,855.80	5.0	**2004**	35,648.55	4.6
1960	4,007.12	3.9	**2005**	36,952.94	3.7
1961	4,086.76	2.0	**2006**	38,651.41	4.6
1962	4,291.40	5.0	**2007**	40,405.48	4.5
1963	4,396.64	2.5	**2008**	41,334.97	2.3
1964	4,576.32	4.1	**2009**	40,711.61	-1.5
1965	4,658.72	1.8	**2010**	41,673.83	2.4
1966	4,938.36	6.0	**2011**	42,979.61	3.1
1967	5,213.44	5.6	**2012**	44,321.67	3.1
1968	5,571.76	6.9	**2013**	44,888.16	1.3
1969	5,893.76	5.8	**2014**	46,481.52	3.5
1970	6,186.24	5.0	**2015**	48,098.63	3.5
1971	6,497.08	5.0	**2016**	48,642.15	1.1
1972	7,133.80	9.8	**2017**	50,321.89	3.5

Exhibit 3

Annual Rates of Price and Wage Inflation

Calendar Year Ends	National Wage Index	National Price CPI Index	National Implied Productivity Increase
1985	4.3%	3.8%	0.5%
1986	3.0%	1.1%	1.8%
1987	6.4%	4.4%	2.0%
1988	4.9%	4.4%	0.5%
1989	4.0%	4.6%	-0.7%
1990	4.6%	6.1%	-1.5%
1991	3.7%	3.1%	0.7%
1992	5.2%	2.9%	2.3%
1993	0.9%	2.7%	-1.9%
1994	2.7%	2.7%	0.0%
1995	4.0%	2.5%	1.5%
1996	4.0%	3.3%	1.6%
1997	5.8%	1.7%	4.1%
1998	5.2%	1.6%	3.6%
1999	5.6%	2.7%	2.9%
2000	5.5%	3.4%	2.1%
2001	2.4%	1.5%	0.8%
2002	1.0%	2.4%	-1.4%
2003	2.4%	1.9%	0.6%
2004	4.6%	3.3%	1.4%
2005	3.7%	3.4%	0.3%
2006	4.6%	2.5%	2.1%
2007	4.5%	4.1%	0.4%
2008	2.3%	0.1%	2.2%
2009	-1.5%	2.7%	-4.2%
2010	2.4%	1.5%	0.9%
2011	3.1%	3.0%	0.1%
2012	3.1%	1.7%	1.4%
2013	1.3%	1.5%	-0.2%
2014	3.5%	0.8%	2.7%
2015	3.5%	0.7%	2.8%
2016	1.1	2.1%	-1.0%
2017	3.5	2.0%	1.5%

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. Identify the types of assumptions. 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. Consider the relevant assumption universe. 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. Consider the assumption format. 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. Select the specific assumptions. In selecting an assumption the actuary should consider the potential impact of future plan design as well as the factors listed above.

5. Evaluate the reasonableness of the selected assumption. 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 mortality improvements after the measurement date. 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, 2014 through June 30, 2018) 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. We continue to perform our analysis on both a count and liability-weighted basis in order to monitor the situation, but the results in this report are on a count-basis.

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.

Actuaries use various adjustments to standard mortality tables in order to match the observed mortality rates of a specific retirement system. 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 two year age setback treats all members as if they were 2 years younger than they truly are when applying the rates in the mortality table. So, a two year set back would treat a 62 year old retiree as if he will exhibit the mortality of a 60 year old in the standard mortality table.

Another adjustment to a standard mortality table that is used to result in mortality rates that are a better fit to those observed is a collar adjustment. There are both "white collar" and "blue collar" variants of the RP- 2014 Mortality Table. The current assumption uses the "white collar" variant of the RP-2014 Mortality Table, a variant that reflects lower rates of mortality than the basic table. The "blue collar" variant reflects higher mortality rates. These variants provide options which may result in a better fit of the assumed mortality to actual experience. They are not necessarily limited to populations that have only white or blue collar employees.

Further, tables may be "scaled", a process in which the 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 adjustments methods to obtain a table which fits the observed experience reasonably well.

The current post-retirement mortality assumption for TRA is the 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 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 after the last experience study (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 static mortality table for each year of birth, with the tables for later years of birth assuming lower mortality than the tables for earlier years of birth. The table contains "built in" mortality improvements, e.g., that a member that turns age 65 in 2040 has a longer life expectancy than a member that turns age 65 in 2020.

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 ratio under the current assumption for each year in the experience study.

CURRENT STUDY PERIOD (2014 TO 2018) - MALES

	Exposure	Actual	Expected	A/E Ratio
July 1, 2014 to June 30, 2015	21,552	566	573	99%
July 1, 2015 to June 30, 2016	22,137	620	617	100%
July 1, 2016 to June 30, 2017	22,170	623	643	97%
July 1, 2017 to June 30, 2018	22,172	611	668	91%
Total	**88,031**	**2,420**	**2,491**	**97%**

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. The actual experience indicates that the current assumption for male retirees is predicting slightly too many deaths, i.e., the A/E ratio over the four year period is less than 100%. However, if the data for the year ended June 30, 2018 is eliminated, the A/E ratio is 99%. Given the variability in the statistical results, we believe the A/E ratio is sufficiently close enough to 100% that we are comfortable leaving the mortality assumption unchanged.

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.

CURRENT STUDY PERIOD (2014 to 2018) - FEMALES

	Exposure	Actual	Expected	A/E Ratio
July 1, 2014 to June 30, 2015	32,166	613	602	102%
July 1, 2015 to June 30, 2016	34,381	649	634	102%
July 1, 2016 to June 30, 2017	35,615	655	653	100%
July 1, 2017 to June 30, 2018	36,725	679	678	100%
Total	**138,887**	**2,596**	**2,557**	**102%**

As with the male data examined in the prior section, the resulting A/E ratio of approximately 100% is an indication that the current table is appropriately estimating the female retiree deaths.

In the 2008-2014 Experience Study, we discussed the issue of the quality of fit of the mortality tables by considering the experience in different age bands. As a result of that analysis, we modified the RP-2014 white collar table to fit the observed data. A simplified version of that analysis was conducted this year and is reflected in the table below:

	Male A/E Ratio	Female A/E Ratio
Ages 55 to 75	100%	90%
Ages 75 to 100	96%	105%
Total	**97%**	**102%**

In the prior six year study period, the disparity between the age bands was substantially more pronounced. These results indicate that the customization of the mortality table to have comparatively better mortality at younger ages and comparatively higher mortality at older ages is still reasonably predicting the observed mortality experience.

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. This table produced similar A/E results to the current mortality table, on average, but was not as good a fit as the current table at the lower ages (55 to 75). While the simplicity of an "off-the-shelf" mortality table has some appeal, we are not suggesting a change at this time since it would not be an improvement in fit over the current table. In addition, any such change would also require an update to the recently revised optional form factors that would involve extensive work by TRA with an insignificant impact on member benefits.

Therefore, we recommend that the current post-retirement mortality assumptions be retained, i.e., the 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.)

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 standard convention be followed and the same mortality assumption be used for beneficiaries as is used for retired members.**

Post-retirement Mortality for Disabled Members (prior to age 65)

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. Because of this limitation and the generally small number of exposures and deaths, it makes sense to use the standard disabled table that is the companion to the retiree mortality table. With less than 70 deaths during the period from disabled status, it is very difficult to draw any meaningful conclusions. The results in the table below do not indicate a particularly good fit, but because the current assumption is somewhat conservative and the impact of the assumption on the valuation results is negligible, we believe it is reasonable to retain the current assumption. **We recommend the RP-2014 Disabled Lives Table be used without generational improvement.**

Gender	Exposure	Actual	Expected	A/E Ratio
Males	402	12	10.5	109%
Females	1,477	54	22.2	245%
Total	**1,879**	**66**	**32.7**	**202%**

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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 6-year age setback for males and a 5-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 RP-2014 family of tables has both an annuitant table (used for retirees) and an employee table (used for actives).

In reviewing the TRA results, it appeared that the current rates could be improved upon with some age adjustments. Because of the limited number of deaths, we can only give partial credibility to the current results. The following table shows that the proposed assumption provides a somewhat better estimate of the observed experience in the current study period than the current assumption. In any case, the assumption has a very minor impact upon the overall cost of the plan.

			Current Assumption		Proposed Assumption
Gender	**Exposure**	**Actual**	**Expected**	**A/E Ratio**	**A/E Ratio**
Males	81,355	59	50	118%	109%
Females	232,569	84	112	75%	88%

Based on this analysis, we would propose using the RP-2014 Employee White Collar Male Mortality Table with 5-year age setback and the RP-2014 Employee White Collar Female Mortality Table with 7-year age setback for males and females, respectively.

Impact of Changes

The proposed change to the active mortality assumption results in no measurable change to the normal cost rate and a very small increase in the actuarial accrued liability.

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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 longer period of payments. 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 roughly 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 no meaningful 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
Early retirement				
Tier 1	7,488	439	708	62%
Tier 2	33,247	2,563	2,815	91%
Unreduced retirement				
Tier 1	10,647	3,712	3,755	99%
Tier 2	2,053	535	714	75%
Total	**53,435**	**7,249**	**7,992**	**91%**

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**
July 1, 2014 to June 30, 2015	2,978	998	1,048	95%
July 1, 2015 to June 30, 2016	2,785	971	985	99%
July 1, 2016 to June 30, 2017	2,533	887	896	99%
July 1, 2017 to June 30, 2018	2,351	856	826	104%
Total	**10,647**	**3,712**	**3,755**	**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 (A/E ratio of 99%). The pattern was consistent across all years 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. **Based on the observed data, we recommend retaining the current assumption.**

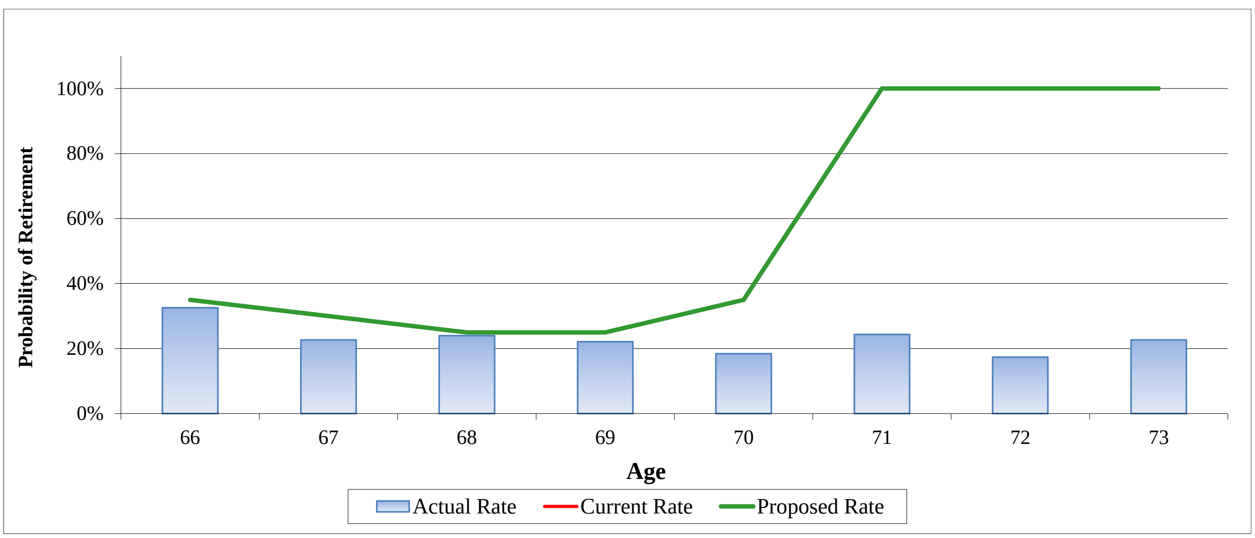
Tier 2 members are those members hired on or after July 1, 1989. The TRA retirement age is contingent on each member's Social Security Retirement Age. For most of the current active group (and likely for future hires), their Social Security Retirement Age is 66 or higher, so unreduced benefits from TRA 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 group 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**
July 1, 2014 to June 30, 2015	463	127	156	81%
July 1, 2015 to June 30, 2016	499	139	172	81%
July 1, 2016 to June 30, 2017	513	116	177	66%
July 1, 2017 to June 30, 2018	578	153	209	73%
Total	**2,053**	**535**	**714**	**75%**

Since we have fewer retirements than we would have expected, we performed two additional analyses. First, if we measure the retirement experience by weighting exposures and retirements by the estimated liability of the members, we have an observed A/E Ratio of 102%. This means that the actual retirements are the longer service members in Tier 2. Since we believe this group will continue to increase, we are inclined to assign more weight to their experience. Secondly, when analyzing the retirement experience by age, as shown in the graph below, we recognize that much of the mismatch is occurring at ages of 71 and above. While the expected probability of retirement at age 71 or older is100%, actual retirement rates have been lower.



Based on the reasonable fit of the current retirement rates at ages 66 to 69, and considering the population is just beginning to mature, we do not believe a reduction to the rates of retirement at ages 70 and later is prudent. We will, however, continue to watch this assumption and consider adjusting the retirement rates if the current pattern persists.

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 finding are summarized in the following table:

Early Retirements – Tier 1				
	Exposures	**Actual**	**Expected**	**A/E Ratio**
July 1, 2014 to June 30, 2015	2,281	150	235	64%
July 1, 2015 to June 30, 2016	2,011	97	194	50%
July 1, 2016 to June 30, 2017	1,748	94	155	61%
July 1, 2017 to June 30, 2018	1,448	98	124	80%
Total	**7,488**	**439**	**708**	**62%**

There were significantly fewer early retirements for Tier 1 members than expected based on the current assumption. The A/E ratio was consistently well below 100% in each of the years. When this assumption was first established in the 2008-2014 Experience Study, the A/E ratio for that study period was 112%, meaning it predicted fewer early retirements than had actually occurred. 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. The number of observed early retirements is only slightly below the expected number in most years, indicating the current assumption is a reasonable fit.

Early Retirements – Tier 2				
	Exposure	**Actual**	**Expected**	**A/E Ratio**
July 1, 2014 to June 30, 2015	7,767	630	664	95%
July 1, 2015 to June 30, 2016	8,128	634	694	91%
July 1, 2016 to June 30, 2017	8,462	608	711	86%
July 1, 2017 to June 30, 2018	8,890	691	746	93%
Total	**33,247**	**2,563**	**2,815**	**91%**

We note that recent legislation changed the calculation of early retirement benefits by removing the augmentation provision. This modification to the benefit structure could result in a change in behavior. If it does, this assumption will be refined, as necessary, over the next few experience studies. For now, we do not believe any adjustment is necessary.

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 (less than 30 years ago), no 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 to help us refine this assumption.

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 of 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.

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 a small impact on the liabilities. In order 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
	35.0% elect 100% J&S option
	45.0% 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	**2014-15**	**2015-16**	**2016-17**	**2017-18**	**Total**	**Percent**
50% J&S	55	62	42	63	222	8.6%
75% J&S	66	60	34	53	213	8.2%
100%J&S	391	406	442	419	1,658	64.0%
Life Annuity	138	134	112	112	496	19.2%
Total	650	662	630	647	2,589	100.0%

Females	**2014-15**	**2015-16**	**2016-17**	**2017-18**	**Total**	**Percent**
50% J&S	280	214	226	237	957	12.8%
75% J&S	111	131	101	122	465	6.2%
100%J&S	793	811	777	806	3,187	42.5%
Life Annuity	800	766	677	645	2,888	38.5%
Total	1,984	1,922	1,781	1,810	7,497	100.0%

Based on this data, the current assumption regarding the election of form of payment for male members remains a reasonable fit. **However, for females we recommend the assumed election of the 100% J&S form of payment be increased from 35% to 38% and the assumed elect of the Life Annuity form of payment be lowered from 45% to 42%.**

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 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.

	2014-15	2015-16	2016-17	2017-18	All Years
Males	2.6	2.6	2.0	2.2	2.4
Females	1.5	1.4	1.7	1.3	1.5

This data in 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 results in no measurable change in the normal cost rate and a very small decrease in 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, 2014 to June 30, 2015	73,944	75	56	134%
July 1, 2015 to June 30, 2016	75,914	51	57	89%
July 1, 2016 to June 30, 2017	76,858	61	57	107%
July 1, 2017 to June 30, 2018	77,967	43	56	77%
Total	**304,683**	**230**	**226**	**102%**

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. In our opinion, the current assumption produced reasonable results, especially when considering the results of the prior study, and we recommend it be retained.

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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 elect 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 0 to 30, and the corresponding A/E Ratios, for the study years:

MALES – Current Assumption

	Exposure	Actual	Expected	A/E Ratio
July 1, 2014 to June 30, 2015	16,407	1,085	1,095	99%
July 1, 2015 to June 30, 2016	16,879	1,013	1,135	89%
July 1, 2016 to June 30, 2017	17,225	1,146	1,192	96%
July 1, 2017 to June 30, 2018	17,488	1,161	1,218	95%
Total	**67,999**	**4,405**	**4,640**	**95%**

FEMALES – Current Assumption

	Exposure	Actual	Expected	A/E Ratio
July 1, 2014 to June 30, 2015	45,653	2,847	3,095	92%
July 1, 2015 to June 30, 2016	47,321	3,104	3,235	96%
July 1, 2016 to June 30, 2017	48,241	3,174	3,305	96%
July 1, 2017 to June 30, 2018	49,250	3,245	3,348	97%
Total	**190,465**	**12,370**	**12,983**	**95%**

The current service-based assumption was first adopted following the last study, i.e., the 2008-2014 Experience Study. An examination of the actual versus expected rates indicates that, for both males and females, most of the disparity between actual and expected results is in the first five years of employment. We propose some slight reductions in termination rates for both males and females to better fit the observed data (see the appendices for specific values). This leads to an A/E ratio of 98% for males and 99% for females.

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.

Although data to analyze actual member behavior regarding the election of a refund was not available in this experience study, such data and the related analysis could be included in the next study if the Board wishes to consider a different approach. 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 slight increase in the normal cost rate and a very small increase 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
2018, the limit is $220,000.

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 2018, the limit is $275,000. Certain members first hired before July 1, 1995 may have a higher limit.

Summary of Actuarial Assumptions

The Allowance for Combined Service Annuity was based on the recommendation of Deloitte Consulting LLP, 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 Deloitte'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***	***Mortality:***
	Post-retirement	
	Post-disability	
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 active members are increased by 1.40% and liabilities for former members are increased by 4.00% 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 35.0% elect 100% J&S option 45.0% 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:	
Date of birth	July 1, 1970
Average salary	$40,000
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	15.00%	13.00%
2	11.00%	11.00%
3	8.50%	9.00%
4	6.25%	7.00%
5	5.25%	5.50%
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%

	Rate (%)			
	Pre-retirement Mortality*		Disability	
Age	Male	Female	Male	Female
20	0.023	0.013	0.00	0.00
25	0.026	0.014	0.00	0.00
30	0.036	0.014	0.00	0.00
35	0.031	0.018	0.01	0.01
40	0.035	0.024	0.03	0.03
45	0.041	0.033	0.05	0.05
50	0.061	0.055	0.10	0.10
55	0.105	0.092	0.16	0.16
60	0.175	0.140	0.25	0.25
65	0.292	0.204	0.00	0.00

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

	Annuitant Mortality Rates (%)			
	Retirement *		Disability	
Age	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%

	Retirement Rate (%)					
					Basic Members	
	Coordinated 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
2018, the limit is $220,000.

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 2018, the limit is $275,000. Certain members first hired before July 1, 1995 may have a higher limit.

Summary of Actuarial Assumptions

The Allowance for Combined Service Annuity was based on the recommendation of Deloitte Consulting LLP, 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 Deloitte'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. Generational projection uses the MP-2015 scale.
	Post-disability	RP 2014 disabled retiree mortality, without adjustment
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 active members are increased by 1.40% and liabilities for former members are increased by 4.00% 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:

Date of birth	July 1, 1970
Average salary	$40,000
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%

	Rate (%)			
	Pre-retirement Mortality*		Disability	
Age	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.*

	Annuitant Mortality Rates (%)			
	Retirement *		Disability	
Age	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%

Retirement Rate (%)

	Coordinated Members				Basic Members	
Age	**Tier 1 Early**	**Tier 1 Unreduced**	**Tier 2 Early**	**Tier 2 Unreduced**	**Eligible for 30 and Out Provision**	**Not Eligible for 30 and Out 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.

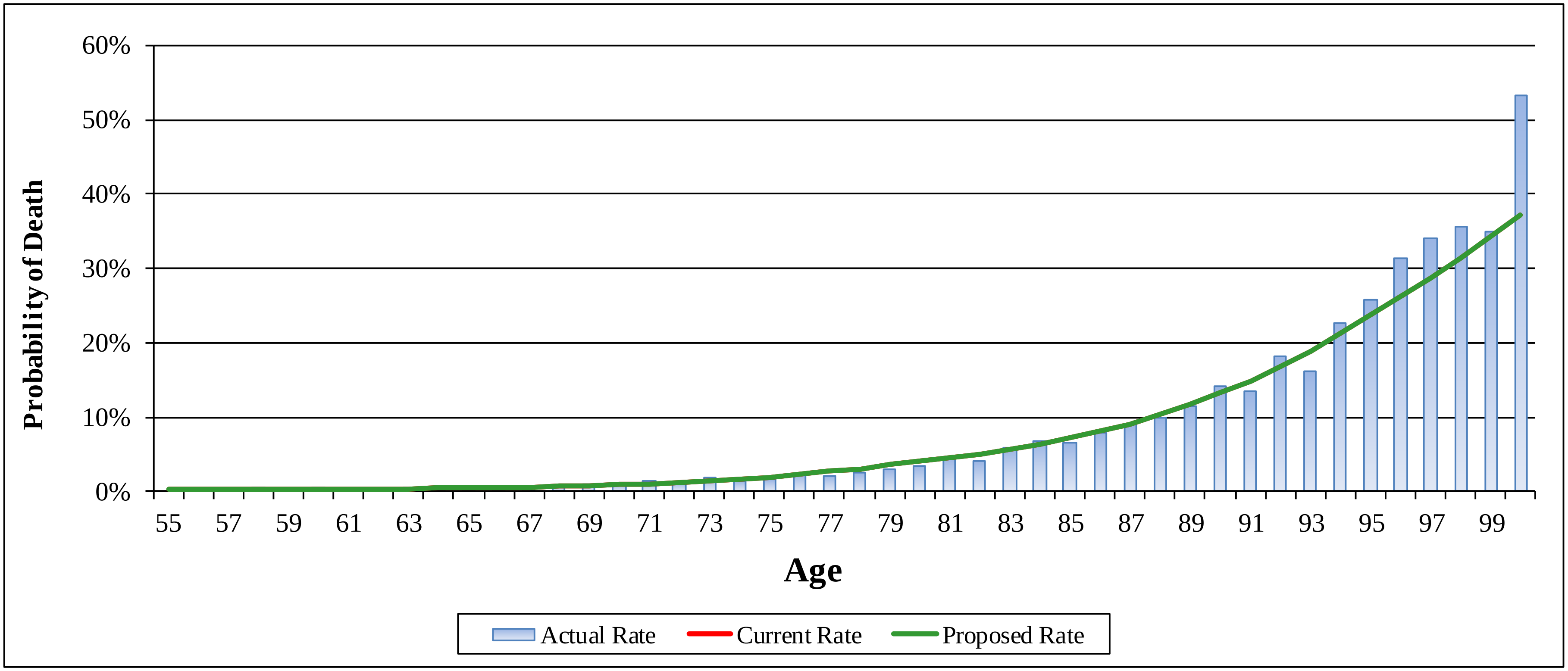
Minnesota Teachers Retirement Association

Experience Study 2014-2018

Exhibit C-1

Probability of Death - Healthy Retirees

Males



	Actual	Expected - Current Assumptions	Expected - Proposed Assumptions
Total Count	2,420	2,491	2,491
Actual/Expected		97%	97%

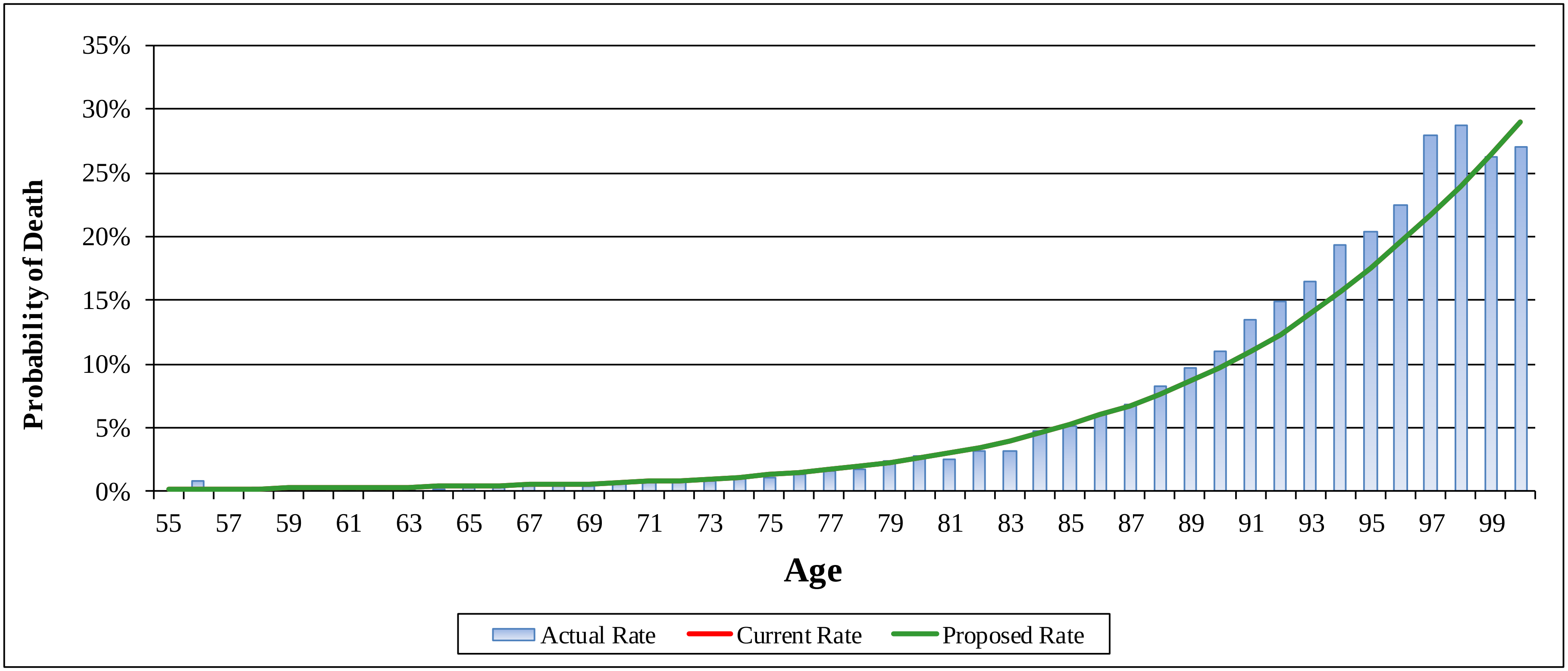
Minnesota Teachers Retirement Association

Experience Study 2014-2018

Exhibit C-2

Probability of Death - Healthy Retirees

Females



	Actual	Expected - Current Assumptions	Expected - Proposed Assumptions
Total Count	2,596	2,557	2,557
Actual/Expected		102%	102%

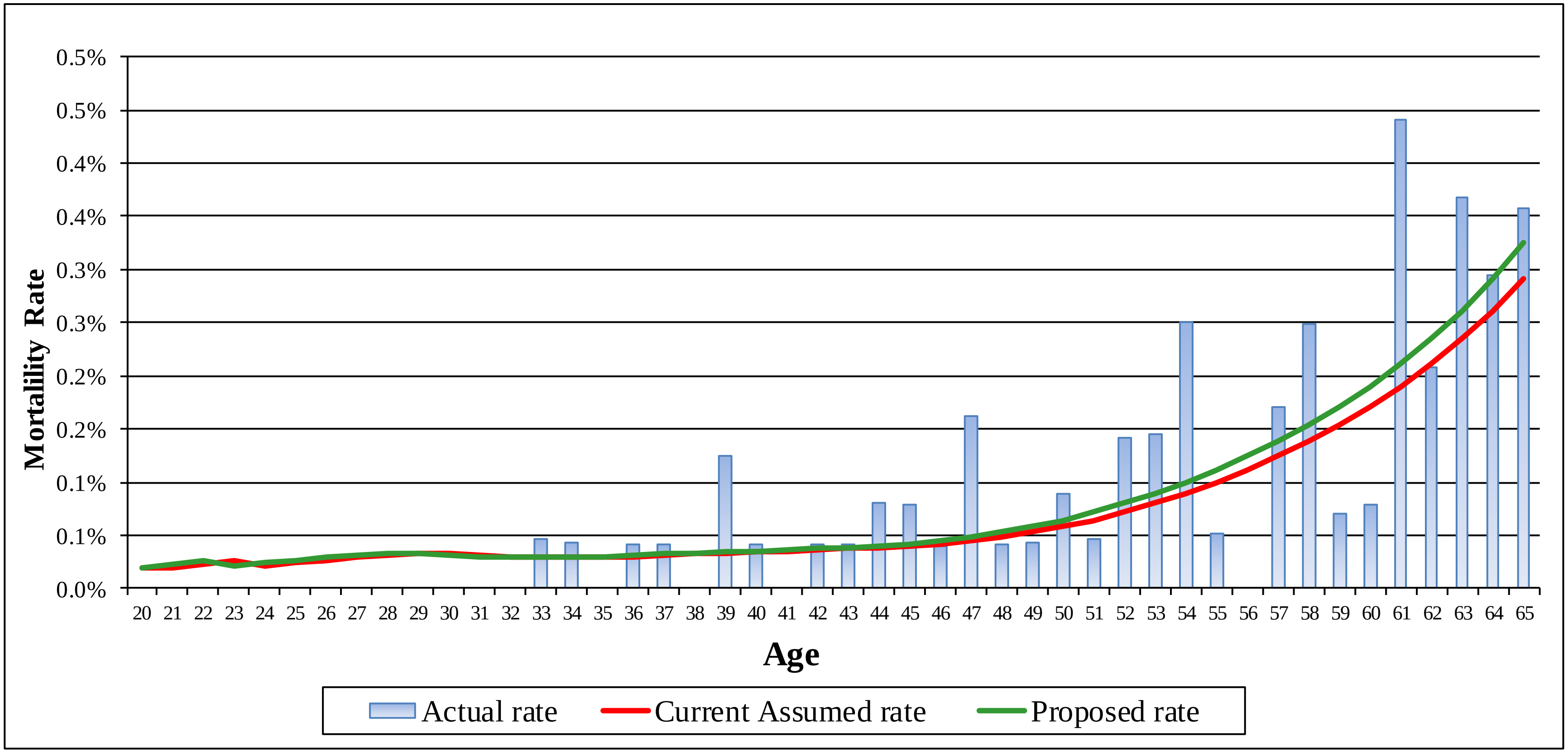
Minnesota Teachers Retirement Association

Experience Study 2014-2018

Exhibit C-3

Probability of Death - Active Lives

Males



	Actual	Expected - Current Assumptions	Expected - Proposed Assumptions
Total Count	59	50	54
Actual/Expected		118%	109%

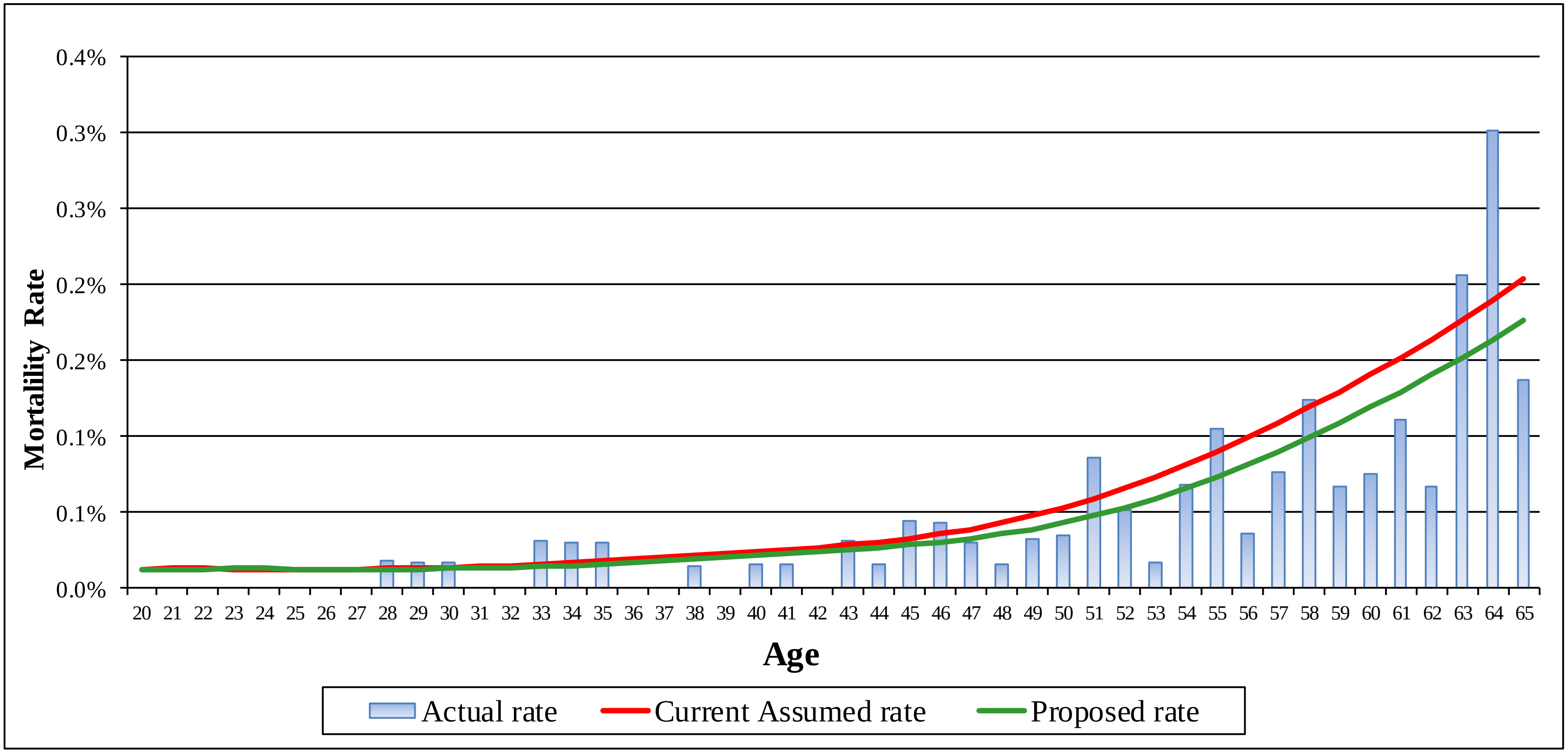
Minnesota Teachers Retirement Association

Experience Study 2014-2018

Exhibit C-4

Probability of Death - Active Lives

Females



	Actual	Expected - Current Assumptions	Expected - Proposed Assumptions
Total Count	84	112	95
Actual/Expected		75%	88%

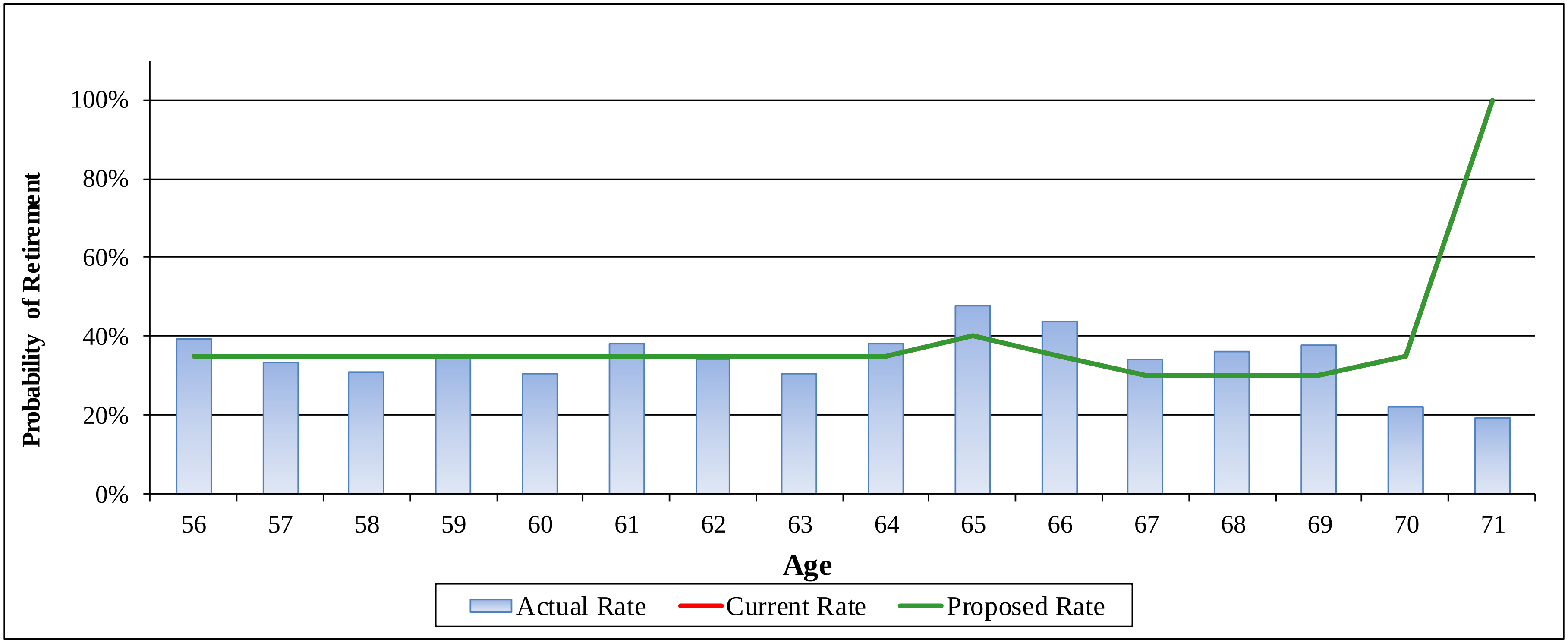
Minnesota Teachers Retirement Association

Experience Study 2014-2018

Exhibit C-5

Retirement Rates

Tier 1 - Unreduced



	Actual	Expected - Current Assumptions	Expected - Proposed Assumptions
Total Count	3,712	3,755	3,755
Actual/Expected		99%	99%

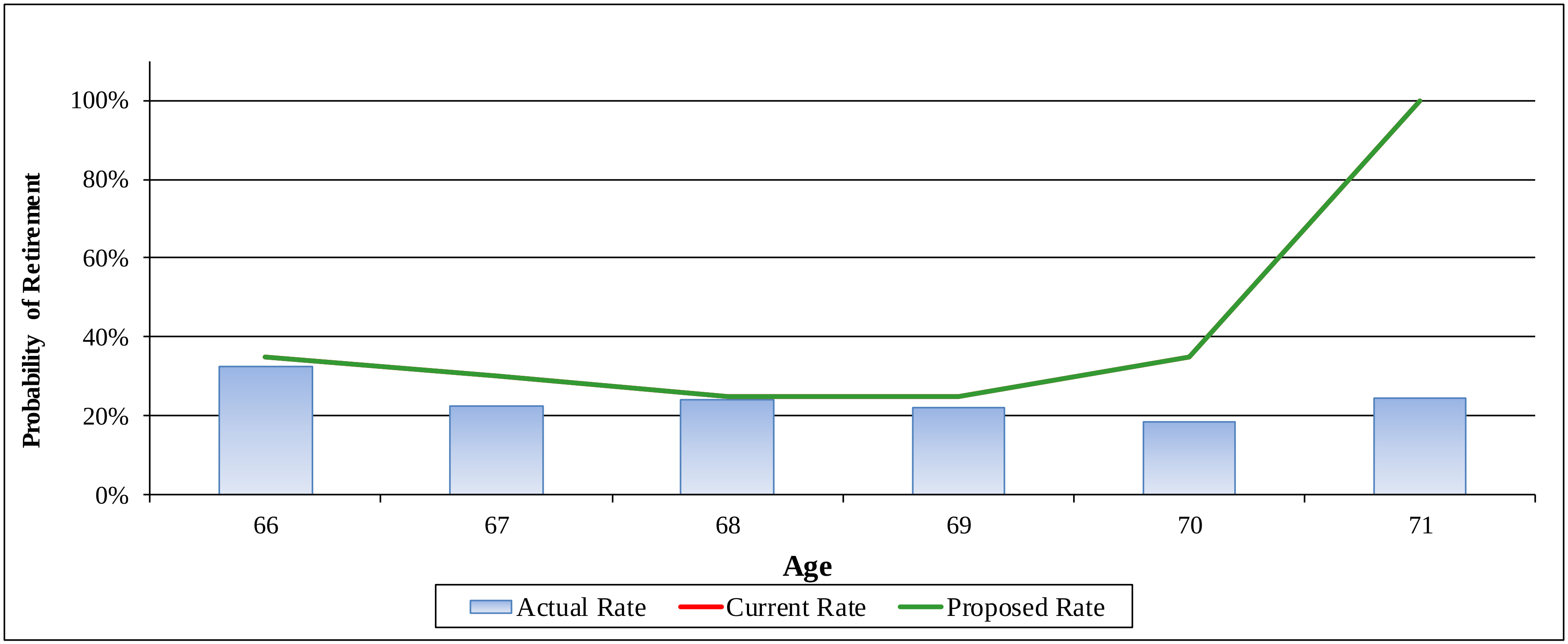
Minnesota Teachers Retirement Association

Experience Study 2014-2018

Exhibit C-6

Retirement Rates

Tier 2 - Unreduced



	Actual	Expected - Current Assumptions	Expected - Proposed Assumptions
Total Count	535	714	714
Actual/Expected		75%	75%

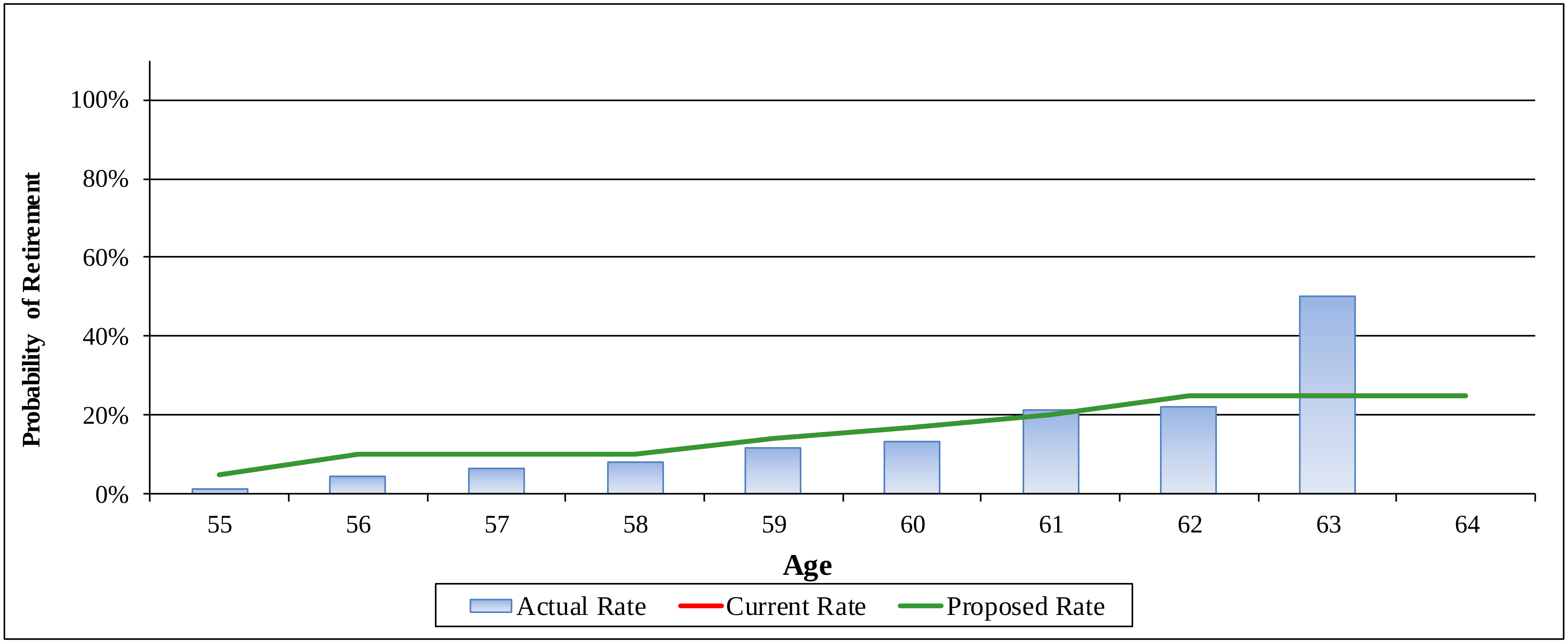
Minnesota Teachers Retirement Association

Experience Study 2014-2018

Exhibit C-7

Retirement Rates

Tier 1 - Early



	Actual	Expected - Current Assumptions	Expected - Proposed Assumptions
Total Count	439	708	708
Actual/Expected		62%	62%

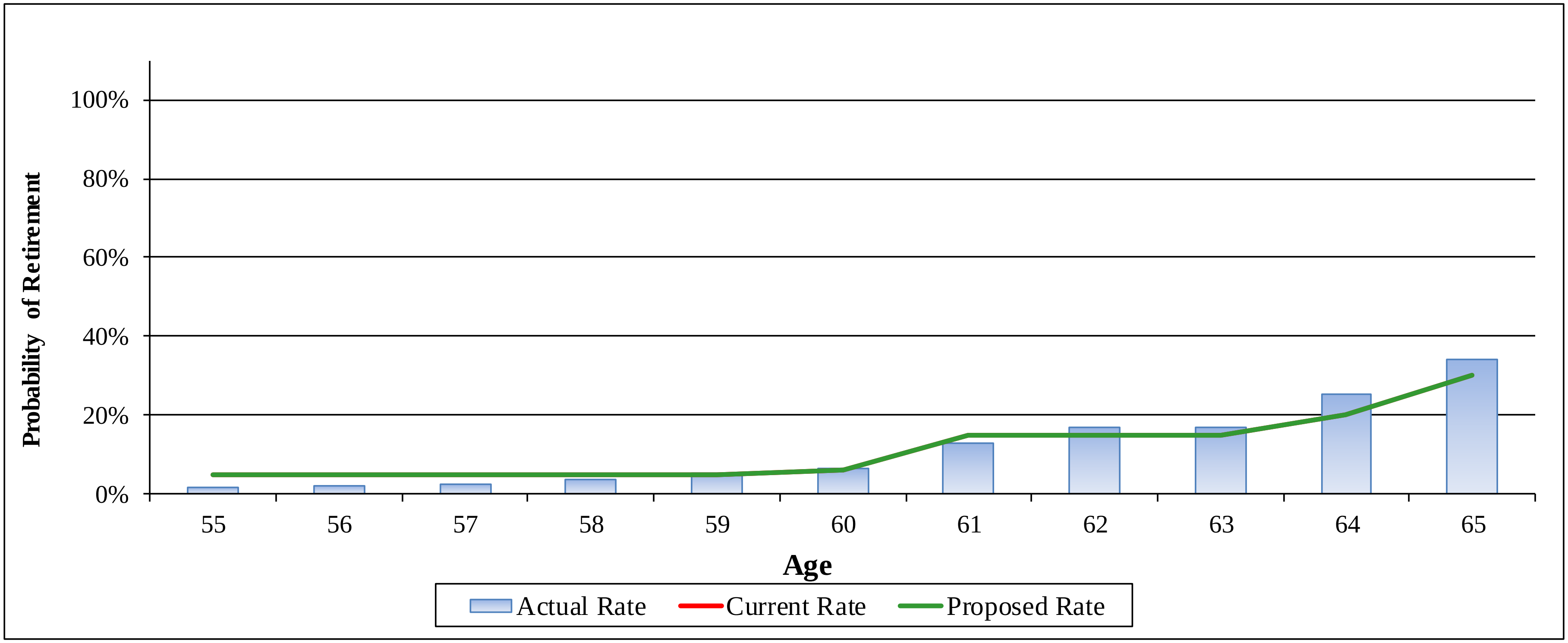
Minnesota Teachers Retirement Association

Experience Study 2014-2018

Exhibit C-8

Retirement Rates

Tier 2 - Early



	Actual	Expected - Current Assumptions	Expected - Proposed Assumptions
Total Count	2,563	2,815	2,815
Actual/Expected		91%	91%

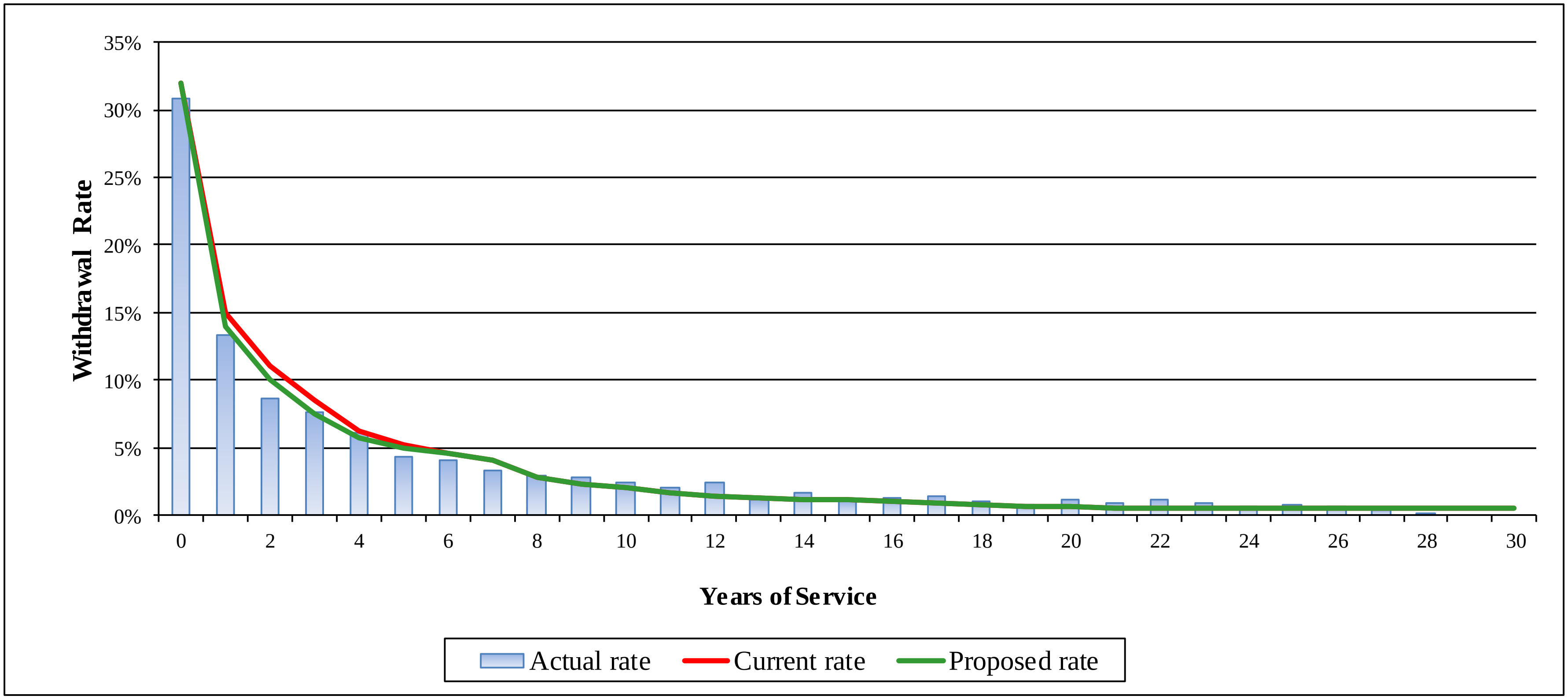
Minnesota Teachers Retirement Association

Experience Study 2014-2018

Exhibit C-9

Rate of Termination of Employment

Males



	Actual	Expected - Current Assumptions	Expected - Proposed Assumptions
Total Count	4,405	4,640	4,486
Actual/Expected		95%	98%

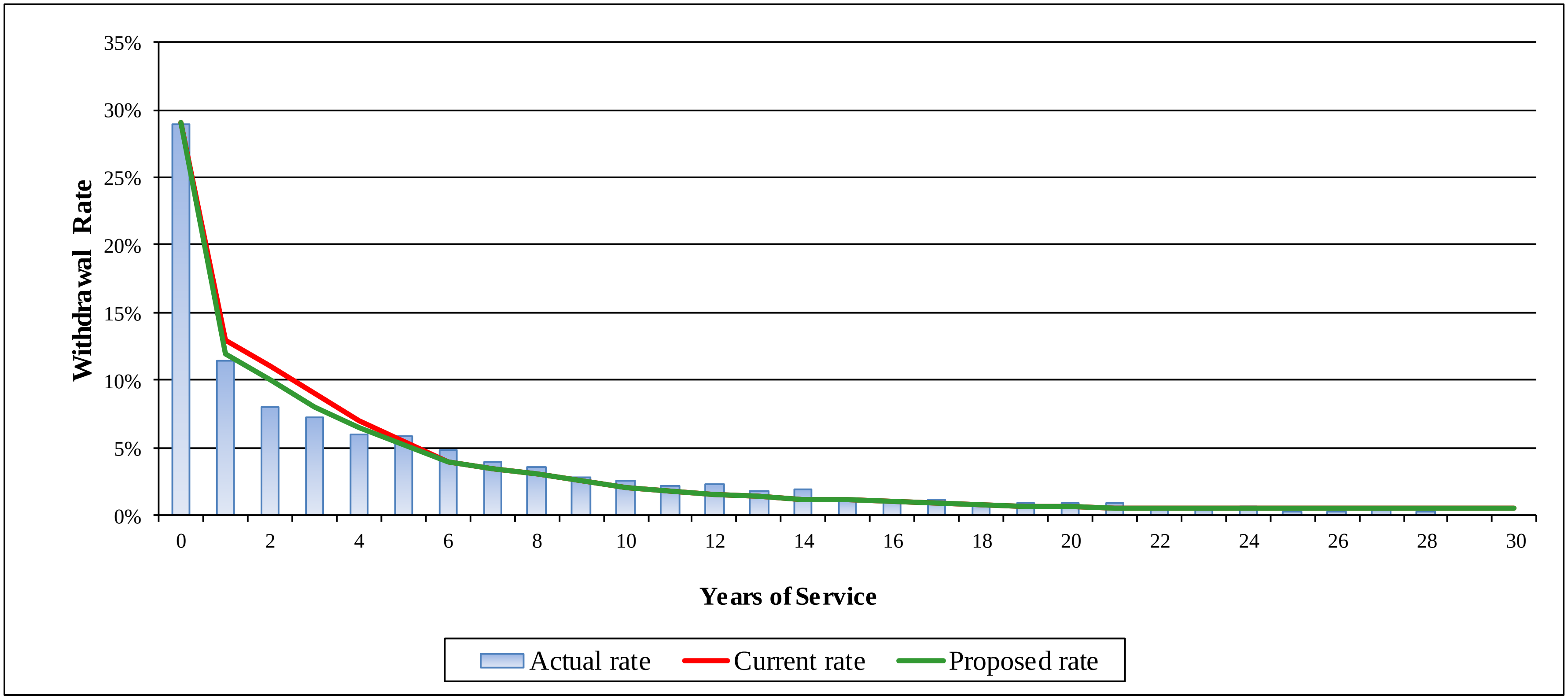
Minnesota Teachers Retirement Association

Experience Study 2014-2018

Exhibit C-10

Rate of Termination of Employment

Females



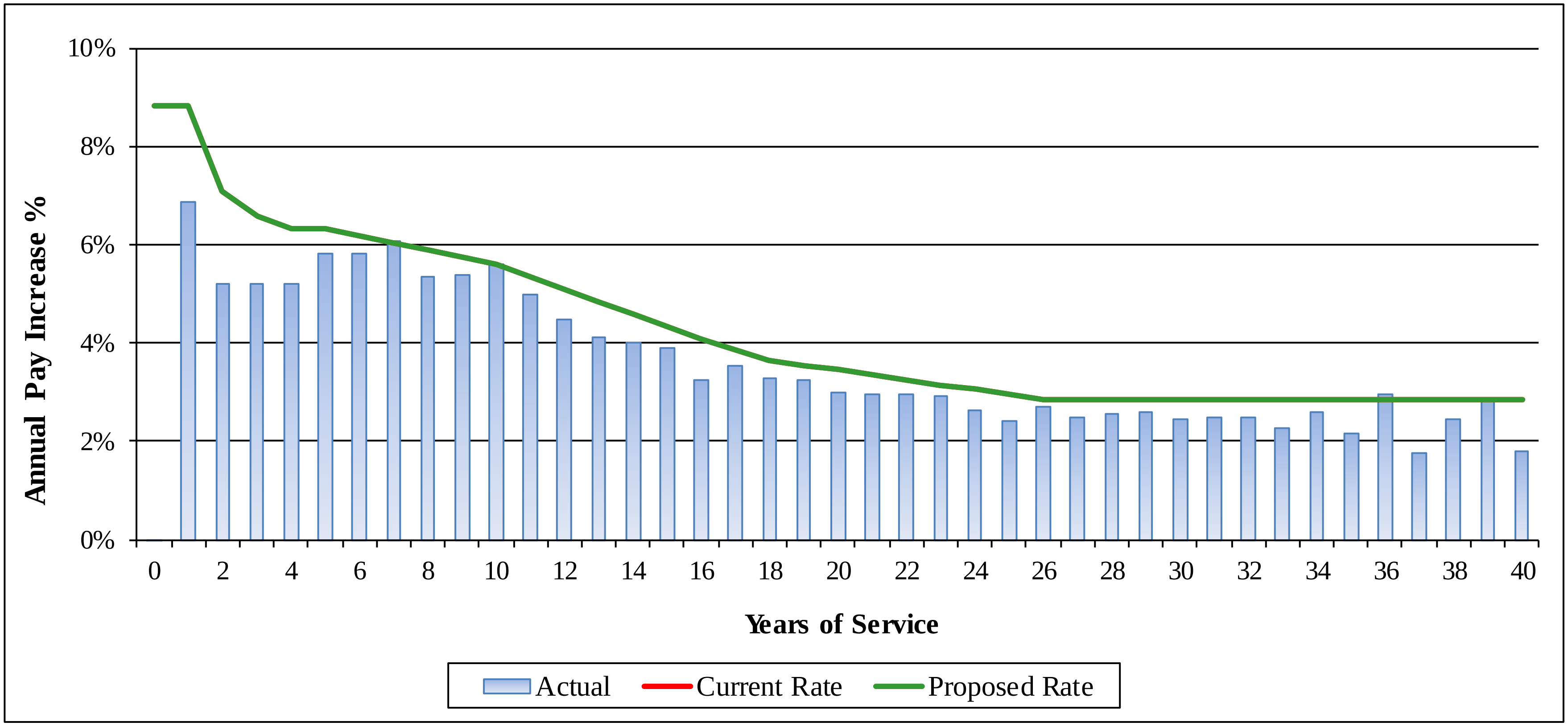
	Actual	Expected - Current Assumptions	Expected - Proposed Assumptions
Total Count	12,370	12,983	12,476
Actual/Expected		95%	99%

Minnesota Teachers Retirement Association

Experience Study 2014 -2018

Exhibit C-11

Total Salary Scale



	Actual	Expected - Current Assumptions	Expected - Proposed Assumptions
Average Increase	4.03%	4.88%	4.88%
Actual/Expected		83%	83%

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Minnesota Teachers Retirement Association

Experience Study 2014-2018

Data Summary D-1

Probability of Death - Healthy Retirees

Males

Age	Exposure	Actual Deaths	Actual Rate	Current Expected	Current Rate	Proposed Expected	Proposed Rate
55	21	-	0.000%	0.1	0.255%	0.1	0.255%
56	72	-	0.000%	0.2	0.273%	0.2	0.273%
57	244	-	0.000%	0.7	0.291%	0.7	0.291%
58	447	2	0.447%	1.4	0.310%	1.4	0.310%
59	729	2	0.274%	2.4	0.327%	2.4	0.327%
60	982	5	0.509%	3.4	0.346%	3.4	0.346%
61	1,211	4	0.330%	4.4	0.367%	4.4	0.367%
62	1,628	3	0.184%	6.4	0.391%	6.4	0.391%
63	2,047	9	0.440%	8.5	0.418%	8.5	0.418%
64	2,470	14	0.567%	11.0	0.447%	11.0	0.447%
65	3,044	9	0.296%	14.6	0.481%	14.6	0.481%
66	3,556	12	0.337%	19.3	0.542%	19.3	0.542%
67	4,062	25	0.615%	25.0	0.614%	25.0	0.614%
68	4,404	35	0.795%	30.8	0.700%	30.8	0.700%
69	4,403	46	1.045%	35.3	0.801%	35.3	0.801%
70	4,360	40	0.917%	40.2	0.922%	40.2	0.922%
71	4,260	64	1.502%	45.4	1.065%	45.4	1.065%
72	4,207	46	1.093%	52.0	1.236%	52.0	1.236%
73	4,218	75	1.778%	60.7	1.438%	60.7	1.438%
74	4,193	57	1.359%	70.2	1.675%	70.2	1.675%
75	3,928	62	1.578%	76.7	1.953%	76.7	1.953%
76	3,656	87	2.380%	83.3	2.278%	83.3	2.278%
77	3,308	67	2.025%	87.9	2.657%	87.9	2.657%
78	3,104	81	2.610%	96.2	3.100%	96.2	3.100%
79	2,861	87	3.041%	102.4	3.579%	102.4	3.579%
80	2,708	95	3.508%	108.3	4.000%	108.3	4.000%
81	2,536	114	4.495%	113.5	4.476%	113.5	4.476%
82	2,292	96	4.188%	115.0	5.017%	115.0	5.017%
83	2,148	126	5.866%	121.0	5.634%	121.0	5.634%
84	1,900	127	6.684%	120.4	6.339%	120.4	6.339%
85	1,658	110	6.634%	118.5	7.145%	118.5	7.145%
86	1,475	117	7.932%	119.0	8.067%	119.0	8.067%
87	1,252	112	8.946%	114.2	9.120%	114.2	9.120%
88	1,061	106	9.991%	109.4	10.313%	109.4	10.313%
89	889	103	11.586%	103.7	11.663%	103.7	11.663%
90	732	103	14.071%	96.5	13.185%	96.5	13.185%
91	577	78	13.518%	85.9	14.894%	85.9	14.894%
92	443	81	18.284%	74.5	16.807%	74.5	16.807%
93	347	56	16.138%	65.8	18.950%	65.8	18.950%
94	239	54	22.594%	50.8	21.250%	50.8	21.250%
95	163	42	25.767%	38.6	23.669%	38.6	23.669%
96	89	28	31.461%	23.3	26.189%	23.3	26.189%
97	44	15	34.091%	12.7	28.784%	12.7	28.784%
98	28	10	35.714%	8.8	31.464%	8.8	31.464%
99	20	7	35.000%	6.9	34.323%	6.9	34.323%
100	15	8	53.333%	5.6	37.299%	5.6	37.299%

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

Minnesota Teachers Retirement Association

Experience Study 2014-2018

Data Summary D-2

Probability of Death - Healthy Retirees

Females

Age	Exposure	Actual Deaths	Actual Rate	Current Expected	Current Rate	Proposed Expected	Proposed Rate
55	67	-	0.000%	0.1	0.193%	0.1	0.193%
56	248	2	0.806%	0.5	0.204%	0.5	0.204%
57	603	-	0.000%	1.3	0.217%	1.3	0.217%
58	1,104	4	0.362%	2.6	0.231%	2.6	0.231%
59	1,593	4	0.251%	3.9	0.247%	3.9	0.247%
60	2,268	5	0.220%	6.0	0.266%	6.0	0.266%
61	2,924	5	0.171%	8.4	0.287%	8.4	0.287%
62	3,991	12	0.301%	12.4	0.310%	12.4	0.310%
63	5,233	12	0.229%	17.6	0.337%	17.6	0.337%
64	6,204	15	0.242%	23.5	0.379%	23.5	0.379%
65	7,325	25	0.341%	30.9	0.422%	30.9	0.422%
66	8,283	30	0.362%	38.7	0.468%	38.7	0.468%
67	8,719	45	0.516%	44.9	0.515%	44.9	0.515%
68	8,612	45	0.523%	48.8	0.566%	48.8	0.566%
69	7,960	39	0.490%	49.5	0.622%	49.5	0.622%
70	7,275	50	0.687%	49.6	0.682%	49.6	0.682%
71	6,495	54	0.831%	50.3	0.774%	50.3	0.774%
72	5,816	55	0.946%	51.2	0.880%	51.2	0.880%
73	5,442	43	0.790%	54.5	1.002%	54.5	1.002%
74	5,027	53	1.054%	57.5	1.143%	57.5	1.143%
75	4,459	48	1.076%	58.2	1.306%	58.2	1.306%
76	4,026	54	1.341%	60.2	1.495%	60.2	1.495%
77	3,662	60	1.638%	62.7	1.713%	62.7	1.713%
78	3,399	59	1.736%	66.8	1.967%	66.8	1.967%
79	3,163	74	2.340%	71.5	2.261%	71.5	2.261%
80	2,859	80	2.798%	74.5	2.604%	74.5	2.604%
81	2,528	65	2.571%	76.0	3.005%	76.0	3.005%
82	2,340	74	3.162%	81.2	3.472%	81.2	3.472%
83	2,198	69	3.139%	88.3	4.019%	88.3	4.019%
84	2,069	97	4.688%	96.4	4.659%	96.4	4.659%
85	1,973	101	5.119%	105.0	5.321%	105.0	5.321%
86	1,774	107	6.032%	106.2	5.989%	106.2	5.989%
87	1,590	108	6.792%	107.3	6.749%	107.3	6.749%
88	1,392	115	8.261%	106.0	7.613%	106.0	7.613%
89	1,179	115	9.754%	101.3	8.593%	101.3	8.593%
90	1,023	113	11.046%	99.3	9.704%	99.3	9.704%
91	863	116	13.441%	94.6	10.957%	94.6	10.957%
92	720	107	14.861%	89.0	12.367%	89.0	12.367%
93	605	100	16.529%	84.4	13.955%	84.4	13.955%
94	466	90	19.313%	73.1	15.693%	73.1	15.693%
95	372	76	20.430%	65.4	17.574%	65.4	17.574%
96	333	75	22.523%	65.2	19.581%	65.2	19.581%
97	258	72	27.907%	56.0	21.721%	56.0	21.721%
98	191	55	28.796%	45.8	23.976%	45.8	23.976%
99	145	38	26.207%	38.3	26.411%	38.3	26.411%
100	111	30	27.027%	32.2	28.975%	32.2	28.975%

Minnesota Teachers Retirement Association

Experience Study 2014-2018

Data Summary D-3
Probability of Death - Active Lives
Males

Age	Exposure	Actual Deaths	Actual Rate	Current Expected	Current Rate	Proposed Expected	Proposed Rate
22	46	-	0.000%	0.0	0.023%	0.0	0.027%
23	410	-	0.000%	0.1	0.027%	0.1	0.021%
24	950	-	0.000%	0.2	0.021%	0.2	0.024%
25	1,355	-	0.000%	0.3	0.024%	0.4	0.026%
26	1,591	-	0.000%	0.4	0.026%	0.5	0.029%
27	1,700	-	0.000%	0.5	0.029%	0.5	0.032%
28	1,784	-	0.000%	0.6	0.032%	0.6	0.033%
29	1,888	-	0.000%	0.6	0.033%	0.6	0.034%
30	1,933	-	0.000%	0.7	0.034%	0.6	0.032%
31	2,016	-	0.000%	0.6	0.032%	0.6	0.030%
32	2,124	-	0.000%	0.6	0.030%	0.6	0.030%
33	2,165	1	0.046%	0.6	0.030%	0.6	0.029%
34	2,336	1	0.043%	0.7	0.029%	0.7	0.030%
35	2,353	-	0.000%	0.7	0.030%	0.7	0.030%
36	2,447	1	0.041%	0.7	0.030%	0.8	0.031%
37	2,432	1	0.041%	0.8	0.031%	0.8	0.032%
38	2,343	-	0.000%	0.8	0.032%	0.8	0.033%
39	2,408	3	0.125%	0.8	0.033%	0.8	0.034%
40	2,400	1	0.042%	0.8	0.034%	0.8	0.035%
41	2,373	-	0.000%	0.8	0.035%	0.9	0.036%
42	2,428	1	0.041%	0.9	0.036%	0.9	0.037%
43	2,437	1	0.041%	0.9	0.037%	0.9	0.039%
44	2,478	2	0.081%	1.0	0.039%	1.0	0.040%
45	2,560	2	0.078%	1.0	0.040%	1.1	0.042%
46	2,559	1	0.039%	1.1	0.042%	1.1	0.045%
47	2,479	4	0.161%	1.1	0.045%	1.2	0.048%
48	2,402	1	0.042%	1.2	0.048%	1.3	0.053%
49	2,303	1	0.043%	1.2	0.053%	1.3	0.058%
50	2,229	2	0.090%	1.3	0.058%	1.4	0.064%
51	2,162	1	0.046%	1.4	0.064%	1.5	0.072%
52	2,130	3	0.141%	1.5	0.072%	1.7	0.080%
53	2,068	3	0.145%	1.7	0.080%	1.9	0.090%
54	1,996	5	0.251%	1.8	0.090%	2.0	0.100%
55	1,960	1	0.051%	2.0	0.100%	2.2	0.112%
56	1,895	-	0.000%	2.1	0.112%	2.4	0.125%
57	1,751	3	0.171%	2.2	0.125%	2.4	0.139%
58	1,608	4	0.249%	2.2	0.139%	2.5	0.154%
59	1,435	1	0.070%	2.2	0.154%	2.5	0.171%
60	1,274	1	0.078%	2.2	0.171%	2.4	0.190%
61	1,134	5	0.441%	2.2	0.190%	2.4	0.211%
62	958	2	0.209%	2.0	0.211%	2.2	0.234%
63	816	3	0.368%	1.9	0.234%	2.1	0.261%
64	680	2	0.294%	1.8	0.261%	2.0	0.291%
65	559	2	0.358%	1.6	0.291%	1.8	0.325%
	81,355	59	0.073%	49.7	0.061%	53.9	0.066%

Minnesota Teachers Retirement Association

Experience Study 2014-2018

Data Summary D-4

Probability of Death - Active Lives

Females

Age	Exposure	Actual Deaths	Actual Rate	Current Expected	Current Rate	Proposed Expected	Proposed Rate
22	293	-	0.000%	0.0	0.014%	0.0	0.012%
23	1,923	-	0.000%	0.2	0.012%	0.3	0.013%
24	3,602	-	0.000%	0.5	0.013%	0.5	0.014%
25	4,598	-	0.000%	0.6	0.013%	0.6	0.012%
26	5,161	-	0.000%	0.7	0.013%	0.7	0.013%
27	5,480	-	0.000%	0.7	0.013%	0.7	0.013%
28	5,583	1	0.018%	0.7	0.013%	0.7	0.013%
29	5,730	1	0.017%	0.8	0.014%	0.7	0.013%
30	5,870	1	0.017%	0.8	0.014%	0.8	0.013%
31	6,054	-	0.000%	0.9	0.014%	0.8	0.014%
32	6,243	-	0.000%	0.9	0.015%	0.9	0.014%
33	6,333	2	0.032%	1.0	0.016%	0.9	0.014%
34	6,536	2	0.031%	1.1	0.017%	1.0	0.015%
35	6,603	2	0.030%	1.2	0.018%	1.1	0.016%
36	6,681	-	0.000%	1.3	0.020%	1.1	0.017%
37	6,765	-	0.000%	1.4	0.021%	1.2	0.018%
38	6,597	1	0.015%	1.4	0.022%	1.3	0.020%
39	6,465	-	0.000%	1.5	0.023%	1.3	0.021%
40	6,490	1	0.015%	1.6	0.024%	1.4	0.022%
41	6,256	1	0.016%	1.6	0.025%	1.4	0.023%
42	6,075	-	0.000%	1.6	0.027%	1.5	0.024%
43	6,326	2	0.032%	1.8	0.028%	1.6	0.025%
44	6,529	1	0.015%	2.0	0.030%	1.7	0.027%
45	6,810	3	0.044%	2.2	0.033%	1.9	0.028%
46	6,993	3	0.043%	2.5	0.036%	2.1	0.030%
47	6,732	2	0.030%	2.6	0.039%	2.2	0.033%
48	6,354	1	0.016%	2.7	0.043%	2.3	0.036%
49	6,039	2	0.033%	2.9	0.048%	2.3	0.039%
50	5,788	2	0.035%	3.1	0.053%	2.5	0.043%
51	5,818	5	0.086%	3.4	0.059%	2.8	0.048%
52	5,859	3	0.051%	3.9	0.066%	3.1	0.053%
53	5,844	1	0.017%	4.3	0.073%	3.5	0.059%
54	5,893	4	0.068%	4.8	0.081%	3.9	0.066%
55	5,732	6	0.105%	5.2	0.090%	4.2	0.073%
56	5,605	2	0.036%	5.6	0.099%	4.6	0.081%
57	5,189	4	0.077%	5.6	0.109%	4.7	0.090%
58	4,837	6	0.124%	5.8	0.119%	4.8	0.099%
59	4,452	3	0.067%	5.8	0.129%	4.8	0.109%
60	3,997	3	0.075%	5.6	0.140%	4.8	0.119%
61	3,584	4	0.112%	5.4	0.152%	4.6	0.129%
62	2,971	2	0.067%	4.9	0.164%	4.2	0.140%
63	2,428	5	0.206%	4.3	0.176%	3.7	0.152%
64	1,993	6	0.301%	3.8	0.189%	3.3	0.164%
65	1,458	2	0.137%	3.0	0.204%	2.6	0.176%
	232,569	84	0.036%	111.6	0.048%	95.0	0.041%

Minnesota Teachers Retirement Association

Experience Study 2014-2018

Data Summary D-5

Retirement Rates

Tier 1 - Unreduced

Age	Exposure	Actual Retirements	Actual Rate	Current Expected	Current Rate	Proposed Expected	Proposed Rate
56	657	258	39.269%	230.0	35.000%	230.0	35.000%
57	1,060	353	33.302%	371.0	35.000%	371.0	35.000%
58	1,303	404	31.005%	456.1	35.000%	456.1	35.000%
59	1,332	460	34.535%	466.2	35.000%	466.2	35.000%
60	1,265	387	30.593%	442.8	35.000%	442.8	35.000%
61	1,242	473	38.084%	434.7	35.000%	434.7	35.000%
62	1,012	344	33.992%	354.2	35.000%	354.2	35.000%
63	846	258	30.496%	296.1	35.000%	296.1	35.000%
64	683	260	38.067%	239.1	35.000%	239.1	35.000%
65	490	235	47.959%	196.0	40.000%	196.0	40.000%
66	284	124	43.662%	99.4	35.000%	99.4	35.000%
67	178	61	34.270%	53.4	30.000%	53.4	30.000%
68	127	46	36.220%	38.1	30.000%	38.1	30.000%
69	82	31	37.805%	24.6	30.000%	24.6	30.000%
70	50	11	22.000%	17.5	35.000%	17.5	35.000%
71	36	7	19.444%	36.0	100.000%	36.0	100.000%
	10,647	3,712	34.864%	3,755.0	35.268%	3,755.0	35.268%

Minnesota Teachers Retirement Association

Experience Study 2014-2018

Data Summary D-6

Retirement Rates

Tier 2 - Unreduced

Age	Exposure	Actual Retirements	Actual Rate	Current Expected	Current Rate	Proposed Expected	Proposed Rate
66	718	234	32.591%	251.3	35.000%	251.3	35.000%
67	472	107	22.669%	141.6	30.000%	141.6	30.000%
68	350	84	24.000%	87.5	25.000%	87.5	25.000%
69	231	51	22.078%	57.8	25.000%	57.8	25.000%
70	163	30	18.405%	57.1	35.000%	57.1	35.000%
71	119	29	24.370%	119.0	100.000%	119.0	100.000%
	2,053	535	26.059%	714.2	34.788%	714.2	34.788%

Minnesota Teachers Retirement Association

Experience Study 2014-2018

Data Summary D-7

Retirement Rates

Tier 1 - Early

Age	Exposure	Actual Retirements	Actual Rate	Current Expected	Current Rate	Proposed Expected	Proposed Rate
55	2,310	28	1.212%	115.5	5.000%	115.5	5.000%
56	1,884	89	4.724%	188.4	10.000%	188.4	10.000%
57	1,306	87	6.662%	130.6	10.000%	130.6	10.000%
58	845	69	8.166%	84.5	10.000%	84.5	10.000%
59	556	65	11.691%	77.8	14.000%	77.8	14.000%
60	343	46	13.411%	58.3	17.000%	58.3	17.000%
61	170	36	21.176%	34.0	20.000%	34.0	20.000%
62	63	14	22.222%	15.8	25.000%	15.8	25.000%
63	10	5	50.000%	2.5	25.000%	2.5	25.000%
64	1	-	0.000%	0.3	25.000%	0.3	25.000%
	7,488	439	5.863%	707.7	9.450%	707.7	9.450%

Minnesota Teachers Retirement Association

Experience Study 2014-2018

Data Summary D-8

Retirement Rates

Tier 2 - Early

Age	Exposure	Actual Retirements	Actual Rate	Current Expected	Current Rate	Proposed Expected	Proposed Rate
55	4,757	83	1.745%	237.9	5.000%	237.9	5.000%
56	4,412	102	2.312%	220.6	5.000%	220.6	5.000%
57	4,074	111	2.725%	203.7	5.000%	203.7	5.000%
58	3,806	137	3.600%	190.3	5.000%	190.3	5.000%
59	3,487	187	5.363%	174.4	5.000%	174.4	5.000%
60	3,205	211	6.583%	192.3	6.000%	192.3	6.000%
61	2,887	372	12.885%	433.1	15.000%	433.1	15.000%
62	2,442	414	16.953%	366.3	15.000%	366.3	15.000%
63	1,982	337	17.003%	297.3	15.000%	297.3	15.000%
64	1,589	403	25.362%	317.8	20.000%	317.8	20.000%
65	606	206	33.993%	181.8	30.000%	181.8	30.000%
	33,247	2,563	7.709%	2,815.4	8.468%	2,815.4	8.468%

Minnesota Teachers Retirement Association

Experience Study 2014-2018

Data Summary D-9

Rate of Termination of Employment

Males

Duration	Exposure	Actual Terminations	Actual Rate	Current Expected	Current Rate	Proposed Expected	Proposed Rate
0	6,542	2,021	30.893%	2,093	32.000%	2,093	32.000%
1	5,489	730	13.299%	823	15.000%	768	14.000%
2	4,269	367	8.597%	470	11.000%	427	10.000%
3	3,508	266	7.583%	298	8.500%	263	7.500%
4	2,990	182	6.087%	187	6.250%	172	5.750%
5	2,547	109	4.280%	134	5.250%	127	5.000%
6	2,236	90	4.025%	103	4.600%	103	4.600%
7	2,222	75	3.375%	91	4.100%	91	4.100%
8	2,225	65	2.921%	62	2.800%	62	2.800%
9	2,264	64	2.827%	52	2.300%	52	2.300%
10	2,226	54	2.426%	45	2.000%	45	2.000%
11	2,096	44	2.099%	36	1.700%	36	1.700%
12	2,084	50	2.399%	29	1.400%	29	1.400%
13	2,048	24	1.172%	27	1.300%	27	1.300%
14	2,124	35	1.648%	25	1.200%	25	1.200%
15	2,331	24	1.030%	26	1.100%	26	1.100%
16	2,445	33	1.350%	24	1.000%	24	1.000%
17	2,478	34	1.372%	22	0.900%	22	0.900%
18	2,358	23	0.975%	19	0.800%	19	0.800%
19	2,139	16	0.748%	15	0.700%	15	0.700%
20	1,966	23	1.170%	12	0.600%	12	0.600%
21	1,845	17	0.921%	9	0.500%	9	0.500%
22	1,719	20	1.163%	9	0.500%	9	0.500%
23	1,483	13	0.877%	7	0.500%	7	0.500%
24	1,262	8	0.634%	6	0.500%	6	0.500%
25	1,014	8	0.789%	5	0.500%	5	0.500%
26	840	6	0.714%	4	0.500%	4	0.500%
27	702	3	0.427%	4	0.500%	4	0.500%
28	545	1	0.183%	3	0.500%	3	0.500%
29	2	-	0.000%	0	0.500%	0	0.500%
30	-	-	0.000%	-	0.500%	-	0.500%
	67,999	4,405	6.478%	4,640	6.824%	4,486	6.597%

Minnesota Teachers Retirement Association

Experience Study 2014-2018

Data Summary D-10
Rate of Termination of Employment
Females

Duration	Exposure	Actual Terminations	Actual Rate	Current Expected	Current Rate	Proposed Expected	Proposed Rate
0	17,280	4,990	28.877%	5,011	29.000%	5,011	29.000%
1	17,307	1,970	11.383%	2,250	13.000%	2,077	12.000%
2	14,134	1,129	7.988%	1,555	11.000%	1,413	10.000%
3	11,860	857	7.226%	1,067	9.000%	949	8.000%
4	10,176	613	6.024%	712	7.000%	661	6.500%
5	8,946	520	5.813%	492	5.500%	470	5.250%
6	8,146	391	4.800%	326	4.000%	326	4.000%
7	7,802	313	4.012%	273	3.500%	273	3.500%
8	7,659	278	3.630%	230	3.000%	230	3.000%
9	7,578	214	2.824%	189	2.500%	189	2.500%
10	7,301	187	2.561%	153	2.100%	153	2.100%
11	6,836	145	2.121%	123	1.800%	123	1.800%
12	6,342	148	2.334%	101	1.600%	101	1.600%
13	5,836	104	1.782%	82	1.400%	82	1.400%
14	5,703	110	1.929%	68	1.200%	68	1.200%
15	5,817	71	1.221%	64	1.100%	64	1.100%
16	5,663	68	1.201%	57	1.000%	57	1.000%
17	5,320	61	1.147%	48	0.900%	48	0.900%
18	4,825	38	0.788%	39	0.800%	39	0.800%
19	4,163	40	0.961%	29	0.700%	29	0.700%
20	3,804	33	0.868%	23	0.600%	23	0.600%
21	3,495	30	0.858%	17	0.500%	17	0.500%
22	3,126	16	0.512%	16	0.500%	16	0.500%
23	2,792	10	0.358%	14	0.500%	14	0.500%
24	2,370	15	0.633%	12	0.500%	12	0.500%
25	1,960	5	0.255%	10	0.500%	10	0.500%
26	1,675	5	0.299%	8	0.500%	8	0.500%
27	1,398	6	0.429%	7	0.500%	7	0.500%
28	1,145	3	0.262%	6	0.500%	6	0.500%
29	6	-	0.000%	0	0.500%	0	0.500%
30	-	-	0.000%	-	0.500%	-	0.500%
	190,465	12,370	6.495%	12,983	6.816%	12,476	6.550%

Minnesota Teachers Retirement Association

Experience Study 2014-2018

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
0	359.4	346.5	-3.59%	391.0	8.81%	391.0	8.81%
1	743.1	794.1	6.86%	808.6	8.81%	808.6	8.81%
2	713.6	750.7	5.20%	764.1	7.07%	764.1	7.07%
3	663.5	698.0	5.20%	707.2	6.58%	707.2	6.58%
4	604.6	636.1	5.21%	642.9	6.33%	642.9	6.33%
5	554.9	587.1	5.82%	590.0	6.33%	590.0	6.33%
6	533.9	565.0	5.83%	566.9	6.18%	566.9	6.18%
7	539.2	572.0	6.09%	571.7	6.03%	571.7	6.03%
8	567.3	597.6	5.36%	600.6	5.88%	600.6	5.88%
9	597.0	629.0	5.36%	631.2	5.73%	631.2	5.73%
10	606.3	640.3	5.61%	640.1	5.58%	640.1	5.58%
11	605.4	635.6	4.99%	637.7	5.33%	637.7	5.33%
12	596.2	622.8	4.47%	626.5	5.09%	626.5	5.09%
13	589.0	613.2	4.12%	617.5	4.84%	617.5	4.84%
14	609.5	633.9	4.00%	637.5	4.59%	637.5	4.59%
15	656.4	682.0	3.90%	684.9	4.34%	684.9	4.34%
16	675.8	697.7	3.25%	703.5	4.09%	703.5	4.09%
17	670.2	693.9	3.53%	696.0	3.84%	696.0	3.84%
18	635.9	656.9	3.29%	659.1	3.64%	659.1	3.64%
19	573.5	592.1	3.25%	593.8	3.55%	593.8	3.55%
20	539.7	555.9	3.01%	558.3	3.45%	558.3	3.45%
21	519.7	535.0	2.94%	537.1	3.35%	537.1	3.35%
22	493.7	508.2	2.95%	509.7	3.25%	509.7	3.25%
23	461.6	475.1	2.92%	476.2	3.15%	476.2	3.15%
24	417.3	428.3	2.64%	430.0	3.05%	430.0	3.05%
25	370.3	379.3	2.42%	381.2	2.95%	381.2	2.95%
26	338.9	348.0	2.68%	348.6	2.85%	348.6	2.85%
27	312.1	319.8	2.47%	321.0	2.85%	321.0	2.85%
28	280.8	288.0	2.57%	288.8	2.85%	288.8	2.85%
29	246.1	252.5	2.61%	253.1	2.85%	253.1	2.85%
30	208.4	213.5	2.45%	214.3	2.85%	214.3	2.85%
31	159.7	163.7	2.47%	164.3	2.85%	164.3	2.85%
32	109.2	111.9	2.50%	112.3	2.85%	112.3	2.85%
33	75.0	76.7	2.28%	77.1	2.85%	77.1	2.85%
34	60.9	62.5	2.58%	62.7	2.85%	62.7	2.85%
35	50.4	51.5	2.15%	51.8	2.85%	51.8	2.85%
36	43.5	44.8	2.94%	44.7	2.85%	44.7	2.85%
37	31.8	32.3	1.75%	32.7	2.85%	32.7	2.85%
38	23.0	23.5	2.46%	23.6	2.85%	23.6	2.85%
39	17.3	17.8	2.82%	17.8	2.85%	17.8	2.85%
40	12.2	12.4	1.79%	12.6	2.85%	12.6	2.85%
	16,866.2	17,545.5	4.03%	17,688.5	4.88%	17,688.5	4.88%