Teachers' Retirement System of Oklahoma

Actuarial Experience Study
Through June 30, 2019

Presented to the Board of Trustees on July 22, 2020

July 15, 2020

Board of Trustees
Teachers' Retirement System of Oklahoma
Oliver Hodge Education Building
2500 N. Lincoln Boulevard, 5th Floor
Oklahoma City, Oklahoma 73105

Subject: **Results of 2020 Actuarial Experience Study**

Members of the Board:

We are pleased to present our report on the results of the 2020 Actuarial Experience Study for the Teachers' Retirement System of Oklahoma (OTRS).   It includes our recommendations for new actuarial assumptions and methods to be effective for the June 30, 2020 actuarial valuation, and it describes the actuarial impact produced by these recommendations as though they had been effective for the June 30, 2019 actuarial valuation.

With the Board's approval of the recommendations in this report, we believe the actuarial condition of OTRS will be more accurately portrayed. The Board's decisions should be based on the appropriateness of each recommendation individually, not on their collective effect on the funding period or the unfunded liability.

This study was conducted in accordance with generally accepted actuarial principles and practices, and with the Actuarial Standards of Practice issued by the Actuarial Standards Board. The signing actuaries are independent of the plan sponsor. Mr. Falls and Mr. Randall are Enrolled Actuaries, Members of the American Academy of Actuaries, and meet the Qualification Standards of the American Academy of Actuaries. Finally, they are experienced in performing valuations for large public retirement systems.

We wish to thank the Executive Director and staff for their assistance in this project.

Respectfully submitted,
Gabriel, Roeder, Smith & Company

R. Ryan Falls, FSA, EA, MAAA   Mark R. Randall, FCA, MAAA, EA
Senior Consultant & Actuary   Chief Executive Officer

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SECTION A

EXECUTIVE SUMMARY

Summary of Recommendations

Our recommended changes to the current actuarial assumptions may be summarized as follows:

Economic Assumptions

1. We recommend decreasing the inflation assumption from 2.50% to 2.25%.

2. We recommend reducing the nominal investment return assumption from 7.50% to 7.00%. The recommended assumption of 7.00% is comprised of an inflation assumption of 2.25% and a real return assumption of 4.75%.

3. We recommend continued use of an explicit administrative expense assumption of 0.10% of pay per year into the anticipated payments from the plan, such that the investment return used will be net of investment expenses only.

4. We recommend a general wage inflation assumption of 0.75% above inflation, or 3.00%. This compares to the current assumption of 3.25%. This assumption is used to project future increases in salary for all members (regardless of service) and to index each cohort of new entrants used in the projections to determine the funding period.

5. We recommend no changes to the service-based merit component of the salary increase assumption, consistent with observed experience.

Mortality Assumptions

6. We recommend updating the base healthy post-retirement mortality assumption to the 2020 GRS Southwest Teacher Mortality Table. We also recommend continuing to assume mortality rates will improve in the future using a fully generational approach, but recommend updating the projection scale to the ultimate rates of the Scale MP which we refer to as U–MP.

7. We recommend updating the post-retirement mortality tables for disabled retirees to the proposed tables for healthy retirees, but with a three-year set forward for males and females to reflect the potential impact of their impairment. Additionally, minimum mortality rates of 4.00% and 2.50% will be applied for males and females, respectively. We also recommend assuming mortality rates will improve in the future using a fully generational approach with projection scale U–MP.

8. We recommend updating pre-retirement mortality tables for active employees to the most recently published national tables for teachers, the Pub-2010 Teacher Employee tables. We also recommend continuing to assume mortality rates will improve in the future using a fully generational approach with projection scale U–MP.

Other Demographic Assumptions

9. We recommend adjustments to the termination rates to reflect observed plan experience and to better accommodate the timing of terminations reported in the annual census data.

10. We recommend modest adjustments to retirement rates for males and females to reflect observed plan experience.

11. We recommend modest adjustments to assumed rates of disability incidence for males and females to reflect observed plan experience.

Actuarial Methods and Policies

12. We recommend no change to the current process of estimating the valuation payroll for the upcoming fiscal year.

13. We recommend no change to the actuarial cost method nor the asset smoothing method.

The impact to key actuarial results as of June 30, 2019 are shown below based on current and proposed assumptions:

	June 30, 2019 Valuation	Recommended Assumptions
Unfunded AAL	$6,530 million	$7,798 million
Funded ratio	72.4%	68.7%
Funding Period	14 years	19 years

SECTION B

INTRODUCTION

Introduction

A periodic review and selection of the actuarial assumptions is one of many important components of understanding and managing the financial aspects of the Teachers' Retirement System of Oklahoma (OTRS). Use of outdated or inappropriate assumptions can result in understated costs which will lead to higher future contribution requirements or perhaps an inability to pay benefits when due; or, on the other hand, produce overstated costs which place an unnecessarily large burden on the current generation of members, employers, and taxpayers.

A single set of assumptions is typically not expected to be suitable forever. As the actual experience unfolds or the future expectations change, the assumptions should be reviewed and adjusted accordingly.

It is important to recognize that the impact from various outcomes and the ability to adjust from experience deviating from the assumption are not symmetric. Due to compounding economic forces, legal limitations, and moral obligations, outcomes from underestimating future liabilities are much more difficult to manage than outcomes of overestimates. That asymmetric risk should be considered when the assumption set, investment policy and funding policy are created. As such, the assumption set used in the valuation process needs to represent the best estimate of the future experience of the retirement system and be at least as likely, if not more than likely, to overestimate the future liabilities versus underestimate them.

Using this strategic mindset, each assumption was analyzed compared to the actual experience of OTRS and general experience of other large public employee retirement systems. Changes in certain assumptions and methods are suggested upon this comparison to remove any bias that may exist and to perhaps add in a slight margin for future adverse experience where appropriate. Next, the assumption set as a whole was analyzed for consistency and to ensure that the projection of liabilities was reasonable and consistent with historical trends.

The following report provides our recommended changes to the current actuarial assumptions.

Summary of Process

In determining liabilities and contribution rates for retirement plans, actuaries must make assumptions about the future. Among the assumptions that must be made include:

- Retirement rates
- Mortality rates
- Turnover rates
- Disability rates
- Investment return rate
- Salary increase rates
- Inflation rate

For some of these assumptions, such as the mortality rates, past experience provides important evidence about the future. For others, such as the investment return assumption, the link between past and future results is much weaker. In either case, actuaries should review the plan's assumptions periodically and

determine whether these assumptions are consistent with actual past experience and with anticipated future experience.

The last such actuarial experience investigation was performed following the June 30, 2014 actuarial valuation and the recommendations were adopted on May 13, 2015. For this experience study, we have reviewed OTRS's experience for the five-year period from June 30, 2014 through June 30, 2019. However, for some analysis, such as salary and mortality, we utilized data from the previous experience study dating back to June 30, 2009.

In conducting experience studies, actuaries generally use data over a period of several years. This is necessary in order to gather enough data so that the results are statistically significant. In addition, if the study period is too short, the impact of the current economic conditions may lead to misleading results. It is known, for example, that the health of the general economy can impact salary increase rates and withdrawal rates. Using results gathered during a short-term boom or bust will not be representative of the long-term trends in these assumptions. Also, the adoption of legislation, such as plan improvements or changes in salary schedules, will sometimes cause a short-term distortion in the experience. For example, if an early retirement window was opened during the study period, we would usually see a short-term spike in the number of retirements followed by a dearth of retirements for the following two-to-four years. Using a longer period prevents giving too much weight to such short-term effects. On the other hand, using a much longer period could water down real changes that may be occurring, such as mortality improvement or a change in the ages at which members retire.

In an experience study, we first determine the number of deaths, retirements, etc. that occurred during the period. Then we determine the number expected to occur, based on the current actuarial assumptions. The number of "expected" decrements is determined by multiplying the probability of the occurrence at the given age, by the "exposures" at that same age. For example, let's look at a rate of retirement of 15% at age 55. The number of exposures can only be those members who are age 55 and eligible for retirement at that time. Thus they are considered "exposed" to that assumption. Finally, we calculate the A/E ratio, where "A" is the actual number (of retirements, for example) and "E" is the expected number. If the current assumptions were "perfect", the A/E ratio would be 100%. When it varies much from this figure, it is a sign that new assumptions may be needed. (However, in some cases we prefer to set our assumptions to produce an A/E ratio a little above or below 100%, in order to introduce some conservatism.) Of course we not only look at the assumptions as a whole, but we also review how well they fit the actual results by gender, by age, and by service.

In many circumstances, we enhance this process by using an amount-weighted analysis. An amount-weighted analysis will generally use amounts such as benefits, pay, or liabilities to complete the analysis. From the perspective of the mortality assumption, there are two reasons for using an amount-weighted approach. First, mortality experience across the U.S. has been shown to vary depending on income level. Amount-weighting takes into account differing benefit levels. Second, selecting an assumption based on headcount-weighting is consistent with estimating expected deaths, but selecting an assumption based on amount-weighting is consistent with minimizing gains and losses in an actuarial valuation associated with expected deaths. By weighting the data by annuity amounts, we are giving more weight to members who have larger annuities (and thus have larger liabilities). The same concepts apply when the amount-weighted approach is applied to other demographic assumptions such as termination and retirement. Our prior experience studies were constructed based on a headcount-weighting analysis so our analysis this year, based on amount-weighting, represents an enhancement to our experience study process.

If the data leads the actuary to conclude that new tables are needed, the actuary may "graduate" or smooth the results, since the raw results can be quite uneven from age to age or from service to service.

Please bear in mind that, while the recommended assumption set represents our best estimate, there are other reasonable assumptions sets that could be supported. Some reasonable assumption sets would show higher or lower liabilities or costs.

Section E Exhibits

The exhibits in Section E should generally be self-explanatory. For example, on page E-3, we show an exhibit analyzing the termination rates for male members by years of service. The second column shows the total number of male members with 25 or fewer years of service who terminated during the study period, weighted by pay. This excludes members who died, became disabled or retired. Column (3), labeled "Total Count" shows the total exposures of this group, again weighted by pay. This is the number of members who meet the criteria who could have terminated during any of the years. On this exhibit, the exposures exclude anyone eligible for retirement. A member is counted in each year they could have terminated, so the total shown is the total exposures for the five-year period. Column (4) shows the probability of termination based on the raw data.

That is, it is the result of dividing the actual number of terminations (col. 2) by the number exposed (col. 3). Column (6) shows the new recommended termination rate. Column (8) shows the expected number of terminations based on the proposed termination assumptions (weighted by pay). Column (10) shows the Actual-to-Expected ratios under the proposed termination assumptions.

SECTION C

ANALYSIS OF EXPERIENCE AND RECOMMENDATIONS

Analysis of Experience and Recommendations

We will begin by discussing the economic assumptions: inflation, the investment return rate, the general wage increase assumption, the salary increase assumption for individuals, and cost-of-living increases, if applicable. Then we will discuss the demographic assumptions: mortality, disability, termination and retirement. Finally we will discuss the actuarial methods used.

Inflation and Investment Return Assumptions

Actuarial Standards of Practice (ASOP) No. 27, Selection of Economic Assumptions for Measuring Pension Obligations, provides guidance to actuaries on giving advice on selecting economic assumptions for measuring obligations for defined benefit plans. ASOP No. 27 was revised and adopted by the Actuarial Standards Board (ASB) in September 2013.

As no one knows what the future holds, it is necessary for an actuary to estimate possible future economic outcomes. Recognizing that there is not one right answer, the current standard calls for an actuary to develop a reasonable economic assumption. A reasonable assumption is one that is:

1. appropriate for the purpose of the measurement,
2. reflects the actuary's professional judgment,
3. takes into account historical and current economic data that is relevant as of the measurement date,
4. is an estimate of future experience; an observation of market data; or a combination thereof,
5. and has no significant bias except when provisions for adverse deviation or plan provisions that are difficult to measure are included.

However, the standard explicitly advises an actuary not to give undue weight to recent experience.

Each economic assumption should individually satisfy this standard. Furthermore, with respect to any particular valuation, each economic assumption should be consistent with every other economic assumption over the measurement period. Generally, the economic assumptions are much more subjective in nature than the demographic assumptions.

Inflation Assumption

By "inflation," we mean price inflation, as measured by annual increases in the Consumer Price Index (CPI). This inflation assumption underlies most of the other economic assumptions. It impacts investment return, salary increases, and overall payroll growth. The current annual inflation assumption is 2.50%.

The following chart shows the average annual inflation, as measured by the increase in the Consumer Price Index (CPI-U), in each of the seven consecutive five-year periods over the last 35 years.

Average Annual Inflation
CPI-U, Five-Year Averages

Period	5-year Avg. Increase
1985 - 1989	3.67%
1990 - 1994	3.49%
1995 - 1999	2.37%
2000 - 2004	2.49%
2005 - 2009	2.56%
2010 - 2014	1.69%
2015 - 2019	1.82%
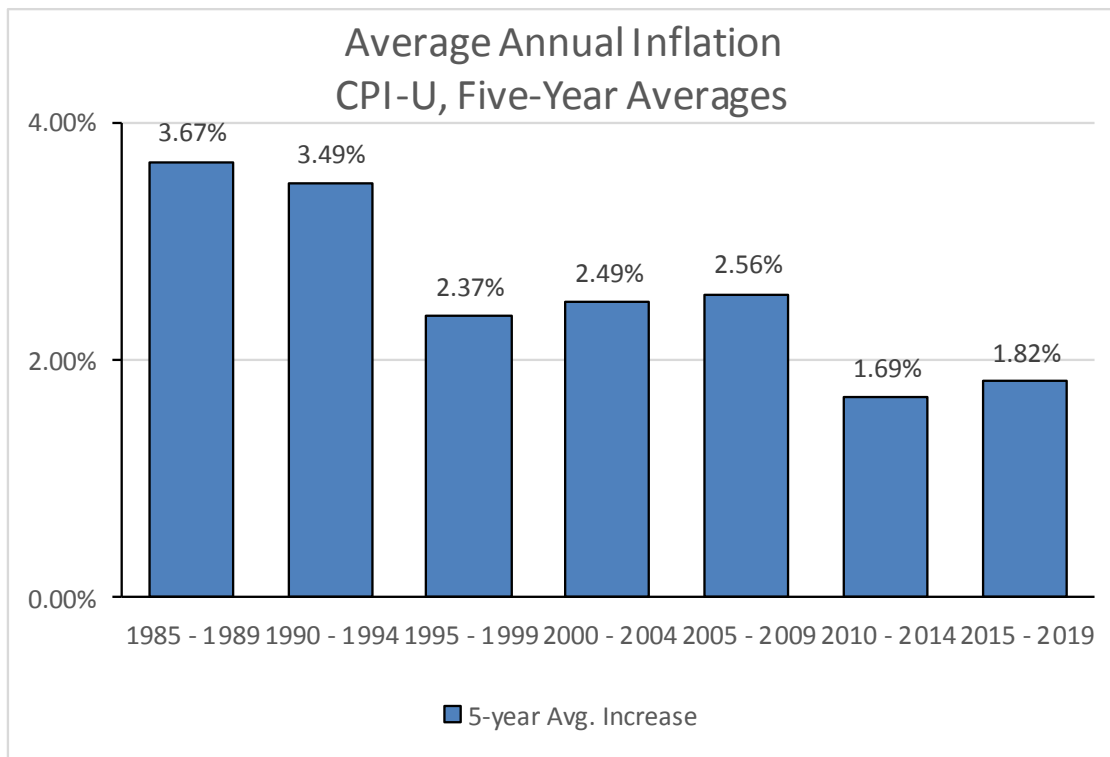
Source: Bureau of Labor Statistics, CPI-U, all items, not seasonally adjusted, Calendar Years

The table below shows the average inflation over various periods, ending December 2019.

Periods Ending Dec. 2019	Average Annual Increase in CPI-U
Last five (5) years	1.82%
Last ten (10) years	1.75%
Last fifteen (15) years	2.02%
Last twenty (20) years	2.14%
Last twenty-five (25) years	2.18%
Last thirty (30) years	2.40%
Since 1913 (first available year)	3.11%

Source: Bureau of Labor Statistics, CPI-U, all items, not seasonally adjusted

As you can see, inflation has been relatively low over the last twenty-five years, and historically so over the past 10 years.

Forecasts from Investment Consulting Firms

We examined the 2019 capital market assumption sets for 14 investment consulting firms and the average assumption for inflation was 2.18%, with a range of 1.70% to 2.50%. All but two of the investment consulting firms in our 2019 survey, in setting their capital market assumptions, assumed that inflation will be less than 2.50%.

Similarly, we examined the 2020 capital market assumption sets for 13 investment consulting firms and the average assumption for inflation was 2.09%, with a range of 1.75% to 2.30%. All of the investment consulting firms in our 2020 survey, in setting their capital market assumptions, currently assume that inflation will be less than 2.50%.

Expectations Implied in the Bond Market

Another source of information about future inflation is the market for US Treasury bonds. Simplistically, the difference in yield between non-indexed and indexed treasury bonds should be a reasonable estimate of what the bond market expects on a forward looking basis for inflation. As of the end of December, the difference for 20-year bonds implies that inflation over the next twenty years would average 1.85%. The difference in yield for 30-year bonds implies 1.80% inflation over the next 30 years.

However, this analysis is known to be imperfect as it ignores the inflation risk premium that buyers of US Treasury bonds often demand as well as possible differences in liquidity between US Treasury bonds and TIPS.

Forecasts from Social Security Administration

In the Social Security Administration's 2019 Trustees Report, the Office of the Chief Actuary is projecting a long-term average annual inflation rate of 2.6% under the intermediate cost assumption. Similarly, the low cost scenario is 2.0% and the high cost scenario is 3.2%.

Survey of Professional Forecasters and Fed Policy

The Philadelphia Federal Reserve conducts a quarterly survey of the Society of Professional Forecasters. Their most recent forecast (fourth quarter of 2019) was for inflation over the next ten years (2019 to 2028) to average 2.20%.

Additionally, the Fed has openly stated that they have a target 2.00% inflation rate.

Recommendation

As a result, we find a reasonable range for this assumption to be 2.00% to 2.50% and are recommending lowering the assumption to 2.25%. This change will bring the assumption closer to recent inflation levels and closer to the levels expected in the financial markets. As you will see, this change also affects all other economic assumptions.

Investment and Administrative Expenses

Since the trust fund pays expenses in addition to member benefits and refunds, we must make some assumption about these. Almost all actuaries treat investment expenses as an offset to the investment return assumption. That is, the investment return assumption represents expected return after payment of investment expenses.

In regards to investment expenses, investment consulting firms periodically issue reports that describe their capital market assumptions. The estimates for core investments (i.e., fixed income, equities, and real estate) are generally based on anticipated returns produced by passive index funds that are net of

investment related fees. The investment return expectations for the alternative asset class such as private equity and hedge funds are also net of investment expenses. Therefore, we did not make any adjustments to account for investment-related expenses. Some of the retirement systems may also employ active management investment strategies that result in higher investment expenses compared to strategies that invest in passive index funds. We have assumed that active management strategies would result in the same returns, net of investment expenses, as passive management strategies.

On the other hand, there is a divergence of practice on the handling of administrative expenses. Some actuaries make an assumption that administrative expenses will be some fixed or increasing dollar amount. Others assume that the administrative expenses will be some percentage of the plan's actuarial liabilities or normal cost. And others treat administrative expenses like investment expenses, as an offset to the investment return assumption.

Since 2015, OTRS has treated administrative expense as an explicit assumption, in the form of a direct increase to the annual normal cost, to incorporate the administrative expenses into the actuarial valuation. We recommend no change to that approach going forward. Using an explicit approach maximizes transparency, aligns better with the standards of the Governmental Accounting Standards Board, and maintains a parallel between the investment returns used by the investment consultant and the actuary.

The following table provides the actual administrative expenses <u>as a percentage of covered payroll</u> for the last four years, along with our recommended assumption which is unchanged.

FY19	FY18	FY17	FY16	FY15	Average	Recommended Assumption
0.12%	0.10%	0.09%	0.10%	0.10%	0.10%	0.10%

Investment Return Rate

The investment return assumption is one of the principal assumptions used in any actuarial valuation of a retirement plan. It is used to discount future expected benefit payments to the valuation date in order to determine the liabilities of the plans. Even a small change to this assumption can produce significant changes to the liabilities and contribution rates. Currently, it is assumed that future investment returns will average 7.50% per year, net of investment expenses.

The chart below shows the historical annualized history of OTRS's market returns through FY 2019.

Annualized Return

Period	Return
25	8.9%
20	7.0%
15	7.6%
10	10.6%
5	5.8%
1	4.9%
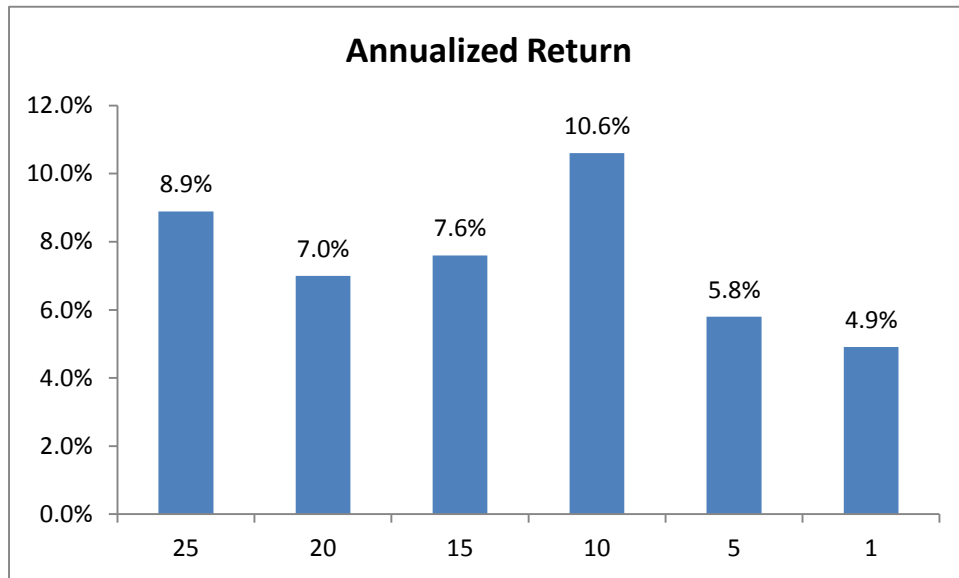
The returns in the chart above are market returns, net of administrative and investment expenses for years prior to 2015 and net of investment expenses only beginning in 2015, as reported in the actuarial valuations. As a point of reference, administrative expenses average approximately 0.05% of assets over the last fifteen years. OTRS did exceed the expected 7.50% return assumption in 16 of the last 25 years, and had an average annualized market return during this period of 8.9%. Over the same period inflation averaged 2.2%, producing an average realized real return of 6.7%.

However, for this assumption, past performance, even averaged over a twenty-five year period, is not a reliable indicator of future performance. The actual asset allocation of the trust fund and forward-looking capital market expectations will significantly impact the overall performance, so returns achieved under a different allocation are not meaningful.

More importantly, the real rates of return for many asset classes, especially equities, vary so dramatically from year to year that even a twenty-five year period is not long enough to provide reasonable guidance. There are strong reasons to believe the next twenty-five years will be different than the last twenty-five, in large part because current bond yields are significantly lower than they were 25 years ago.

Assumption Comparison to Peers

We do not recommend the selection of an investment return assumption based on prevalence information. However, it is still informative to identify where the investment return assumption for OTRS is compared to its peers. The chart below shows the distribution of the investment return assumptions, as reported by NASRA in June, 2020.

Distribution of Nominal Investment Return Assumptions, FY 01 to present

Public Fund Survey, NASRA June-20
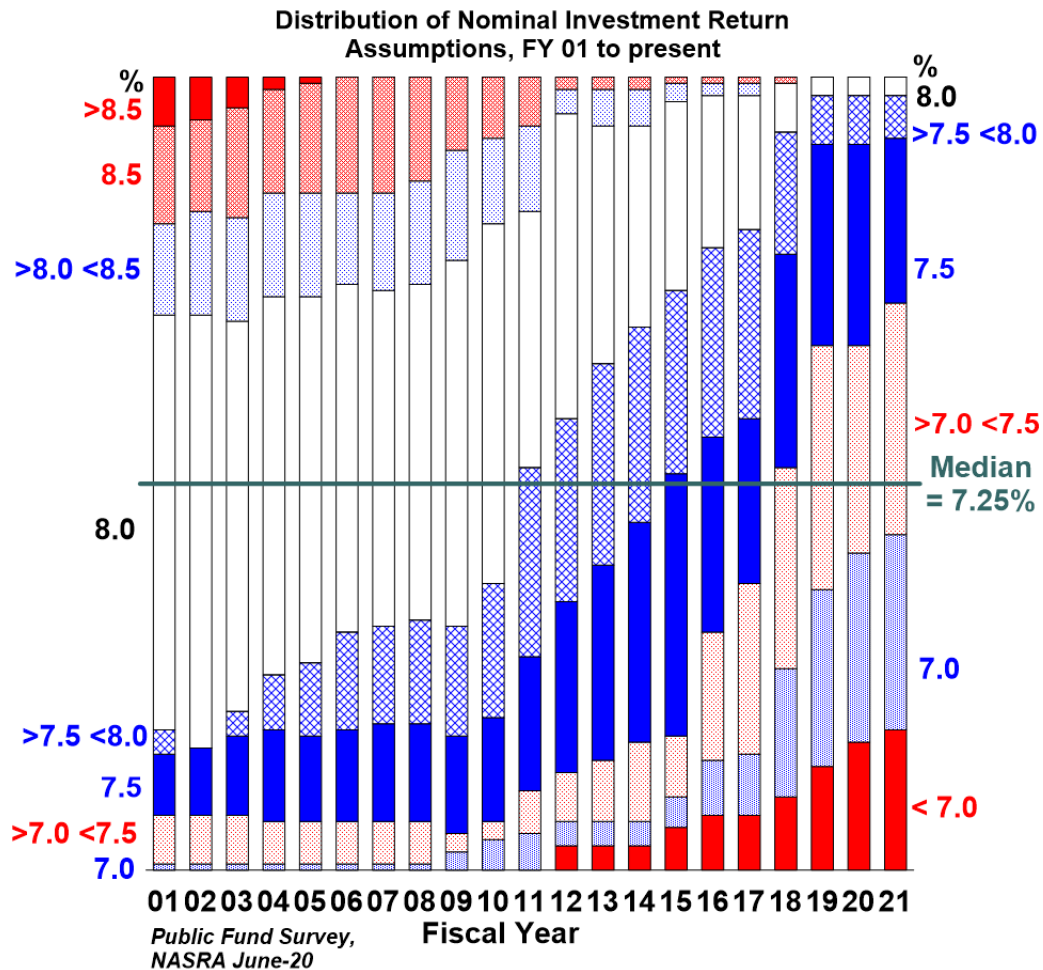
The median rate of return is 7.25%. However, this chart does not tell the entire story. Several of the data points have not been examined in a few years, meaning even the current survey data is a little stale.

Asset Allocation

We believe the most appropriate approach to selecting an investment return assumption is to identify expected returns given the funds' asset allocation mapped to forward-looking capital market assumptions. For this purpose, we have analyzed the OTRS Investment Policy Statement with the following Target Weights:

Asset Class	Target Weight
U.S. Equities	43.5%
International Equities	19.0%
Fixed Income	22.0%
Real Estate	9.0%
Private Equity	6.5%
Total	100%

In order to develop an appropriate estimate for an investment return assumption, we have utilized the forward-looking return expectations developed by several investment consulting firms and industry surveys.

Our 2019 survey includes 14 sets of expectations. Based on the average of these sets of expectations, and the proposed 2.25% inflation assumption, the expected geometric (compound) return is 6.6% with a range of outcomes from 5.1% to 7.8%. The expected one-year arithmetic return is 7.4%.

Our 2020 survey includes 13 sets of expectations. Based on the average of these sets of expectations, and the proposed 2.25% inflation assumption, the expected geometric (compound) return is 6.1% with a range of outcomes from 4.5% to 7.3%. The expected one-year arithmetic return is 6.9%.

We reviewed the survey results for both 2019 and 2020 because they each represented a relative extreme at the point in time which they were published. What we have found is that forward-looking capital market assumptions tend to assume the market will trend back to historical market returns. As a result, the assumptions will tend to be higher following a market downturn and lower following a run up in the market. The beginning of 2019 represented a relatively low point in the market so the forward-looking assumptions were generally high for most asset classes. Similarly, the beginning of 2020 represented a relatively high point in the market so the forward-looking assumptions were generally low. Since the overall investment return assumption is intended to be a "lasting" assumption that is not expected to change on a regular basis, the 2019 and 2020 forward looking expectations may be used together to help develop a range of reasonable expectations going forward.

Recommendation

Based on this analysis, we are recommending the Board reduce the investment return assumption to 7.00%. This would be comprised of a 4.75% net real return and a 2.25% inflation assumption. An achievable investment return assumption is important for any plan, but all the more so for a plan like OTRS with a primarily "fixed" contribution rate.

General Wage Inflation

A General Wage Inflation (GWI) assumption represents the real wage growth over time in the general economy, or, is the assumption on how much the pay scales themselves will change year to year, not necessarily how much the pay increases received by individuals are, or even necessarily how the payroll in total may change, which can be impacted by population changes, etc. This assumption should be applicable to a local economy, not necessarily one group inside a retirement system. This assumption is also used to index the pay of each group of new entrants used in the open group projections. In an open group projection, projected terminations from the current active population are replaced with projected new entrants.

Historically, General Wage Inflation has almost always exceeded price inflation. This is because wage inflation is in theory the result of (a) price inflation, and (b) productivity gains being passed through to wages. Since 1951, for the national economy as a whole, wage inflation has been about 1.00% larger than price inflation each year. For the last 10 years, for the national economy as a whole, wage inflation has been 2.35%, outpacing price inflation by about 0.60%. However, that spread will likely be viewed as overstated due to the historically low inflation during the past decade.

Over both the past 10 and 20 years, the average salary for an OTRS member has increased 1.8% and 2.3% per year, respectively. Over the same periods, the national average wage changed by 3.0% and 2.4%, respectively. This OTRS experience would indicate that pays have actually lagged price inflation, however, when we look at the individual pay increases for long-service members, they have outpaced inflation by

about 0.79%. It may be that the covered membership is more heavily distributed to lower paid roles than it has been historically which accounts for the slow growth in the average pay.

We are recommending a 0.75% real productivity growth assumption, or a nominal 3.00% GWI assumption.

Salary increase rates

Salary increases are composed of both wage inflation and service-based promotional or merit increases. Wage inflation is currently assumed to be 3.25% ("building blocks" of 2.50% price inflation plus 0.75% productivity increases) with additional merit increases during the first 25 years of employment of up to 8.00%. The following will analyze these two components separately in developing our overall salary increase assumption.

Wage Inflation for Long-Service Employees

Salary increases for longer-service employees are almost entirely driven by wage inflation. Many of the factors that result in pay increases are largely inapplicable or have diminished importance for longer-service employees. Step or service-related increases have ceased or are minimal. Promotions occur with less frequency. Additional training or acquisition of advanced degrees usually occurs early in the career. Thus, longer service employees' wages are assumed to grow at the overall rate of wage inflation. Wage inflation is also the increase in the average wage of all members of the workforce of the employer.

Wage inflation is currently assumed to be 3.25%, and this is the assumed salary increase for longer-service members with at least 25 years of service. For members with 25 or more years of service, the observed average salary increase during the last 10 years was 2.53%. Inflation during this 10-year period averaged 1.73%. Therefore, long-service employees received an average salary increase of 0.79% above inflation. We are recommending keeping the productivity assumption at 0.75% which, after reflecting the reduced inflation assumption of 2.25%, produces a base salary increase assumption of 3.00%.

Additional Service-Based Merit Increases

Members who are early in their career typically have salary increases that include both wage inflation as well as a component for promotion. This additional component is part of the service-based component of the salary scale. This component of the salary scale ranges from 8.00% (in addition to wage inflation) in the member's first year of employment to 0.25% in the member's twenty-fourth year of employment. The table on the last page of the report contains additional details on these results.

The table on the last page of the report indicates that the actual service-based increases have been slightly lower than the current merit increases at most years of service. However, we feel that the current service-based increases are a reasonable fit to the actual experience and are recommending no changes at this time.

Demographic Assumptions

Actuaries are guided by the Actuarial Standards of Practice (ASOP) adopted by the Actuarial Standards Board (ASB). One of these standards is ASOP No. 35, *Selection of Demographic and Other Noneconomic Assumptions for Measuring Pension Obligations*. This standard provides guidance to actuaries giving advice

on selecting noneconomic assumptions for measuring obligations under defined benefit plans. We believe the recommended assumptions in this report were developed in compliance with this standard.

Post-Retirement Mortality Rates

OTRS's liability depends in part on how long retirees live. If members live longer, benefits will be paid for a longer period of time, and the liability will be larger. Additionally, teachers generally have longer life expectancies compared to the general population. This experience is also true for the retired teachers and educators in OTRS, and it will be important to reflect this in the mortality assumption used in the valuation.

The mortality table currently being used for non-disabled retirees and for beneficiaries receiving benefits is:

Healthy males – RP-2000 Combined Healthy mortality table for males with White Collar Adjustments, no set back. Generational mortality improvements in accordance with Scale BB from the table's base year of 2000

Healthy females – GRS Southwest Region Teacher Mortality Table, scaled at 105%. Generational mortality improvements in accordance with Scale BB from the table's base year of 2012

These assumptions are considered "generational" mortality projections. A generational mortality projection does not build in a margin up front, but the mortality is assumed to improve every future year in the valuation projection. Since this form of mortality projection assumes continual mortality improvements, there should be less need to periodically reestablish margin for future mortality improvements in the mortality assumption.

In analyzing the mortality experience, we have weighted the analysis by the amount of the member's monthly annuity. By weighting the data by annuity amounts, we are giving more weight to members who have larger annuities (and thus have larger liabilities). Using this method is expected to minimize gains and losses from mortality.

We begin by determining the expected deaths in each year at each age for males and females. Then we compare the actual to the expected. The ratio of the actual deaths to the expected deaths (the A/E ratio), weighted by benefit amounts, tells us whether the assumptions are reasonable. When using a generational approach for mortality improvement, an A/E of 100% is targeted. However, we will also focus on the pattern across all ages and life expectancy created at individual ages when determining whether the assumption is appropriate. We will discuss this in two parts, the recommended base mortality assumption, and the recommended mortality improvement assumption.

Recommended Base Mortality Assumption

Experience used to examine the fit of the current assumption was for non-disabled retirees for the ten-year period ending June 30, 2019. Based on benefit-weighted mortality experience, overall actual-to-expected ratios were 103% and 93% for males and females, respectively. This low female actual-to-expected ratio may suggest that lower-paid participants have notably higher rates of mortality since the current assumption was constructed based on headcount-weighting.

The Society of Actuaries recently conducted a study using specifically public sector data and released new standard tables called Pub-2010. These tables included a variant of the tables specific to retired teacher experience. GRS considered these tables, but did not find them to be a particularly good fit.

GRS works with teacher retirement systems across the country and, in particular, many teacher retirement systems in the Southwest region of the United States. We have generally found that the published mortality tables do not provide a good match to the mortality experience of retired teachers in this region. As a result, GRS has developed specialized mortality tables for retired teachers in the Southwest region. Based on the experience of OTRS over the past ten years, this specialized table provides a superior fit to the mortality experience of OTRS. We recommend updating the base mortality assumption to the 2020 GRS Southwest Teacher Mortality Table with no adjustments.

Recommended Mortality Improvement Assumption

The current mortality assumption includes a fully generational approach to projecting mortality improvement. Because of this strategy of building in continuous mortality improvement, life expectancies for today's younger active members are expected to be materially longer than those of today's retirees, and this has a significant impact on actuarial liabilities contribution requirements. Specifically, mortality is assumed to improve in accordance with Scale BB which was published by the Society of Actuaries.

The Society of Actuaries' Retirement Plans Experience Committee (RPEC) initiated a pension mortality study in 2010. At an early stage of its analysis, RPEC noticed that mortality experience since 2000 has improved at a faster rate than anticipated by Scale AA. As a result, RPEC issued another mortality improvement scale, Scale BB, in the year 2012 as an alternative mortality improvement assumption for pension actuaries to use. In October 2014, RPEC issued final reports of the mortality study that was originally initiated in 2010. These final reports included the release of another mortality improvement assumption, Scale MP-2014. A significant difference between the MP-2014 improvement scales and the prior improvement scales is that the MP tables are a two-dimensional improvement assumption that is a function of the age and calendar year, whereas prior scales were only a function of age.

In 2015 through 2019, the RPEC issued updates to the mortality improvement assumption called Scale MP-xxxx, where xxxx represents the given years. MP-2015 reflected an additional two years of mortality experience, MP-2016 reflected an additional three years of mortality experience, etc. Since the original MP-2014 study, rates of projection have materially decreased, meaning the original MP-2014 table was found to be too conservative. In addition, it has been stated that new projection scales will continue to be published each year.

After approximately 15 years, all MP tables reflect the same improvement rate at each future calendar year (the ultimate mortality improvement rates). In order to balance the two objectives of reflecting the most recent data available, while maintaining stability of results from year to year, GRS recommends the use of the ultimate mortality improvement rates in the MP tables for all years, which we will refer to as U-MP.

Impact of Healthy Mortality Changes

The combined effect of the recommended enhancements to the base mortality table and the mortality improvement scale resulted in a decrease in the male life expectancy and a slight increase in the female life expectancy. Below is an illustration of the change in life expectancy as of selected ages.
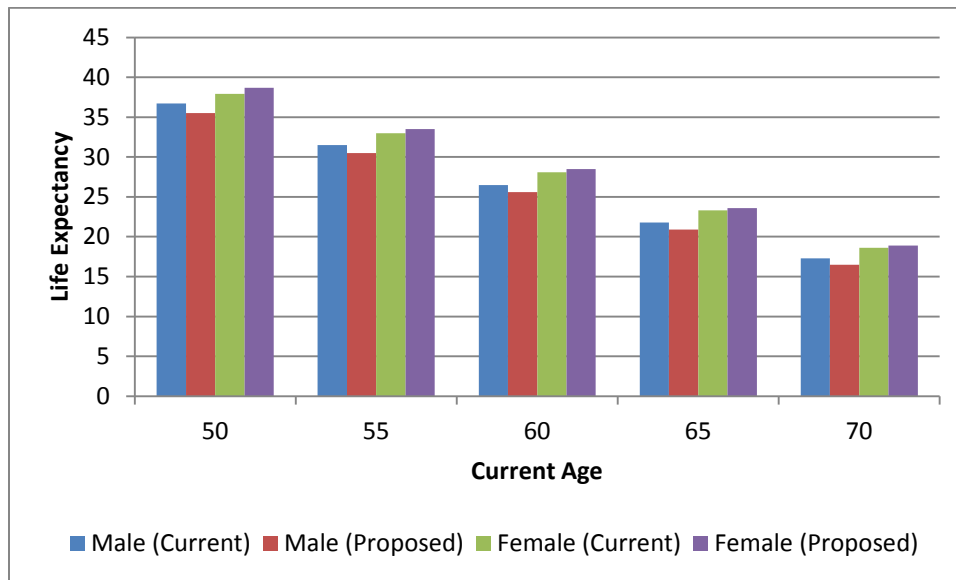
Disabled Mortality Rates

Because the rate of disability incidence is so low for OTRS and the disabled mortality rates apply to a very small subsection of plan participants, this is a minor assumption that has little impact on the liabilities of OTRS. We recommend using the healthy post-retirement tables, set forward three years for males and females, with a minimum mortality rate of 4.0% and 2.5%, for males and females, respectively. Additionally, we recommend continuing to apply future mortality improvements using the ultimate mortality improvement rates in the MP tables. This approach recognizes the underlying mortality patters for OTRS which reflecting an adjustment (i.e., setting the age forward) to reflect the underlying impairment.

	Disabled Retiree Deaths		Actual/Expected	
	Males	Females	Males	Females
Actual Deaths	188	381	N/A	N/A
Actual Deaths (Weighted)	2,455	4,840	N/A	N/A
Current Assumption (Weighted)	1,867	3,214	132%	151%
Recommended Assumption (Weighted)	2,363	4,056	104%	119%

Active Mortality Rates

Active mortality is also a minor assumption. Incidence of active deaths is very low in comparison to terminations and retirements. For active mortality rates, we recommend using the Pub-2010 Teacher Employee mortality tables with future mortality improvements modeled using the ultimate mortality improvement rates in the MP tables.

Disability Rates

Disability is a low-incidence, low impact assumption. Based on recent experience for which the A/E was only 70% for males and 72% for females, we recommend using 90% of the current rates to better reflect recent experience.

	Incidence of Disability		Actual/Expected	
	Males	Females	Males	Females
Actual Disabilities	80	254	N/A	N/A
Current Assumption	115	355	70%	72%
Recommended Assumption	103	324	78%	78%

Retirement Rates

We currently use retirement rates that vary by age and sex. Based on liability-weighted experience, the analysis shows A/E ratios of 92% and 93% for males and females, respectively (rates less than 100% are considered conservative). These overall A/E ratios seem very appropriate; however, upon examining the individual A/E ratios at specific ages, we found some areas where we felt the rates warranted modification.

We observed that increased rates were needed at most ages over 60 for males and 64 for females. After these changes, the A/E ratios decreased to 87% and 88% for males and females respectively.

Members who joined OTRS by October 31, 2011 ("pre-2011" members) are eligible for a Normal Retirement Benefit upon the earliest of age 62 with 5 years of service and the Rule of 90 (Rule of 80 for those hired before July 1, 1992). This group makes up virtually all of the plan experience over the past five years. As a result, we have enough experience to develop reasonable experience-based tables that reflect the retirement patterns for members eligible to retire under these provisions.

Alternatively, members who joined OTRS after October 31, 2011 ("post-2011" members) are eligible for a Normal Retirement Benefit upon the earliest of age 65 with 5 years of service (7 year of service if hired after October 31, 2017) or Rule of 90 (with at least age 60).

Currently the rates for the post-2011 members are based on the pre-2011 member rates, adjusted for post-2011 eligibilities and accounting for pent up demand when they are eligible for retirement at a later date. There is still very little experience on which to analyze the intricacies of this assumption at the various eligibilities and so we recommend continuing to use this approach with the new pre-2011 recommended rates.

Termination Rates

Termination rates reflect members who leave for any reason other than death, disability, or service retirement. They apply whether the termination is voluntary or involuntary, and whether the member takes a refund or keeps their account balance on deposit. The current termination rates reflect the member's gender and service. This assumption is more significant than the disability assumption since the counts are so much higher but less significant than the retirement assumption since these members leave at younger ages with smaller benefits and less liability.

During the experience study process we identified a subset of members whom are classified in the valuation data as actives and, based on the status in the next valuation, were likely already terminated and there is a lag in reporting the change in status. Due to this lag in reporting, the termination results were skewed especially for low service members. This issue arose when there was a transition in OTRS data processing systems in 2012 and can be seen in the last two years of experience in the last experience study and all five years in the current experience study. Specifically, members with a date of last contribution in a given year's

valuation data before the month of April of that year were unlikely to still be classified as an active in the next year's valuation data. We have identified this group as the "pending termination group".

Longer-Term Termination Patterns

To account for this, we made certain adjustments in the development of the termination rates. We looked specifically at the experience of members of the "pending termination group" who were not eligible for an immediate retirement benefit. The overall termination experience was then adjusted by assuming the members of the "pending termination group" in a given year's data who were not still active in the next year's data had actually terminated in the prior year. For example, a member in the "pending termination group" in the 2018 valuation data (i.e. had a date of last contribution prior to April 1, 2018) who was not still active in the 2019 data was treated as a termination during the 2017-2018 experience year. When we made this adjustment, the termination experience was much closer to the historical termination patterns for OTRS. The rates based on this analysis were used in the calculations focused on longer-term decrement patters such as the decrement pattern for new entrants and in the development of the normal cost.

	Males			Females		
Service	Exposed Pay ($,000)	Actual Pay ($,000)	Termination Rate	Exposed Pay ($,000)	Actual Pay ($,000)	Termination Rate
0 - 4	1,601,634	254,833	15.9%	3,478,575	553,188	15.9%
5 - 9	991,450	81,561	8.2%	2,318,692	191,604	8.3%
10 - 14	793,665	42,328	5.3%	1,764,708	94,678	5.4%
15 - 19	702,397	26,711	3.8%	1,315,616	49,150	3.7%
20 - 24	471,763	13,248	2.8%	828,083	19,219	2.3%
Total	4,560,909	418,682	9.2%	9,705,673	907,839	9.4%

Pending Termination Group

With the understanding that members of the "pending termination group" are likely to be reported as a termination in the subsequent valuation, we recommend a separate set of termination rates for calculations focused more on the shorter-term decrement pattern such as the Present Value of Future Benefits (or, PVFB).

When we focus solely on the "pending termination group" (those "actives" with a date of last contribution prior to April of the same year as the valuation), they have approximately an 80% chance of being reported as a termination in the subsequent valuation. Based on the following experience, we are recommending that members of the "pending termination group" have an 80% chance of terminating in the current actuarial valuation.

	Males			Females		
Service	Exposed Pay ($,000)	Actual Pay ($,000)	Termination Rate	Exposed Pay ($,000)	Actual Pay ($,000)	Termination Rate
0 - 4	106,534	93,650	87.9%	199,094	177,572	89.2%
5 - 9	32,758	27,625	84.3%	61,582	49,916	81.1%
10 - 14	15,474	13,034	84.2%	30,001	22,737	75.8%
15 - 19	12,034	6,918	57.5%	14,143	10,530	74.5%
20 - 24	7,099	2,923	41.2%	7,695	3,995	51.9%
25+	587	294	50.1%	835	343	41.1%
Total	174,486	144,443	82.8%	313,349	265,093	84.6%

Active Members not Included in Pending Termination Group

Based on the recommended procedure for the "pending termination group", a large portion of the expected terminations for the year will come from the "pending termination group". With this procedure in place, we analyzed the termination experience for all of the remaining actives in the actuarial valuation that were not included in the "pending termination group". As expected, this sub-group has a much lower probability of terminating after excluding the "pending termination group" with such high termination experience.

	Males			Females		
Service	Exposed Pay ($,000)	Actual Pay ($,000)	Termination Rate	Exposed Pay ($,000)	Actual Pay ($,000)	Termination Rate
0 - 4	1,601,634	157,056	9.8%	3,478,575	369,436	10.6%
5 - 9	991,450	57,911	5.8%	2,318,692	147,309	6.4%
10 - 14	793,665	31,185	3.9%	1,764,708	76,217	4.3%
15 - 19	702,397	20,017	2.8%	1,315,616	40,229	3.1%
20 - 24	471,763	11,377	2.4%	828,083	15,954	1.9%
Total	4,560,909	277,546	6.1%	9,705,673	649,145	6.7%

Summary of Recommended Termination Assumptions

The first set of recommended termination rates represents the anticipated termination rates over the course of an OTRS member's career. As a result, we have used these termination rates to develop the normal cost rate and to model the career of future teachers covered by OTRS. However, the lag in the reporting of terminations in the short term has led to our recommendation that the calculation of the PVFB should utilize two different sets of termination rates. Specifically, members of the "pending termination group" each year will be assumed to have an 80% chance of terminating and the remaining actives will have a lower overall expected rate of termination.

Other Assumptions

There are other assumptions made in the course of a valuation, such as the supplemental medical insurance election rates, the percentage of members who are married, the age difference between husbands and wives (both of which only impact the death benefit liability), the likelihood that a terminating employee will take a refund, etc, all of which have a minor impact on liabilities. We reviewed these, and believe these are generally realistic or conservative, so we decided to recommend no changes to these other assumptions.

Actuarial Methods

Actuarial Cost Method

We recommend continuing to use the Individual Entry Age Normal (IEAN) actuarial cost method. IEAN will generally produce level contribution amounts for each member as a percentage of salary from year to year, and allocates costs among various generations of taxpayers in a reasonable manner. It is by far the most commonly used actuarial cost method for large public retirement systems and the method used for accounting disclosures under GASB Statement No. 67.

For a plan that receives contributions primarily as a fixed percent of payroll, the IEAN method does, however, eliminate the ability to perform a simple and algebraic calculation of the funding period and contribution requirements. Thus, we will continue to include a funding period determined based on an

open group projection. The open group projection incorporates the fact that the normal cost rate will trend down over time. Otherwise, the projection is built to assume no gains or losses on the actuarial accrued liability.

Asset Valuation (Smoothing) Method

The purpose of asset smoothing is to reduce short-term volatility in actuarial valuation results which are intended for long-term decision making and funding. Periods of poor returns are often followed by some amount of recovery or vice versa, and a market value (unsmoothed) approach, may result in overreaction to short-term market volatility.

We believe the method used to determine the actuarial value of assets (AVA) is appropriate, since it does a good job of smoothing asset gains and losses, and reduces fluctuations in the funding period. The current method smooths the differences between the expected returns (based on the annual investment return assumption) and actual returns, net of expenses, over a five-year period. This method of determining the actuarial value of assets is very common and does not have a bias relative to market. In other words, we expect the ratio of the AVA to MVA to average about 100% over the long term. Therefore, we recommend no change to this method.

SECTION D

SUMMARY OF ASSUMPTIONS AND METHODS

Summary of Assumptions and Methods
Incorporating the Recommended Assumptions

The assumptions and methods applied in this actuarial valuation may be adopted by the Board of Trustees on July 22 2020 based on the experience investigation that covered the period ending June 30, 2019.

I. *Valuation Date*

The valuation date is June 30 of each plan year. This is the date as of which the actuarial present value of future benefits and the actuarial value of assets are determined.

II. *Actuarial Cost Method*

Because the employer contribution rate is set by statute, the actuarial valuation is used to determine the number of years required to amortize the Unfunded Actuarial Accrued Liability (UAAL), or the funding period.

The Individual Entry Age Normal actuarial cost method assigns the plan's total unfunded liabilities (the actuarial present value of future benefits less the actuarial value of assets) to various periods. The unfunded actuarial accrued liability is assigned to years prior to the valuation, and the normal cost is assigned to the year following the valuation. The remaining costs are the normal costs that will be recognized in future years. The resulting actuarially determined contribution requirement is composed of (i) the applicable year's normal cost, plus (ii) a payment intended to reduce the unfunded actuarial accrued liability.

The normal contribution is determined using the Individual Entry Age Normal method. Under this method, a calculation is made to determine the rate of contribution which, if applied to the compensation of each individual member during the entire period of anticipated covered service, would be required to meet the cost of all benefits payable on his behalf. The salary-weighted average of these rates is the normal cost rate. This calculation reflects the plan provisions that apply to each individual member. The employer normal cost rate is equal to (i) the normal cost rate, plus (ii) the expected administrative expenses, minus (iii) the member contribution rate.

The actuarial accrued liability is the difference between the total present value of future benefits and the actuarial present value of future normal costs. The unfunded actuarial accrued liability is the excess of the actuarial accrued liability over the actuarial value of assets.

The funding period is calculated as the number of years required to fully amortize the UAAL, assuming that: (a) future market earnings, net of investment-related expenses, will equal 7.00% per year, (b) there will be no liability gains/losses or changes in assumptions, (c) the number of active members will remain unchanged, (d) active members who leave employment will be replaced by new entrants each year except that only 20% of the active members reported with a date of last contribution prior to April of the prior plan year will be replaced, and (e) employer contributions and dedicated State revenue will remain the same percentage of payroll as projected for the current fiscal year.

The Entry Age actuarial cost method is an "immediate gain" method (i.e., experience gains and losses are separately identified as part of the UAAL). However, they are amortized over the same period applied to all other components of the UAAL.

III.   *Actuarial Value of Assets*

The actuarial value of assets is based on the market value of assets with a five-year phase-in of actual investment return in excess of (less than) expected investment income. Expected investment income is determined using the assumed investment return rate and the market value of assets (adjusted for receipts and disbursements during the year). Returns are measured net of all investment expenses.

IV.   *Actuarial Assumptions*

A. Economic Assumptions

1. Investment return: 7.00% per year, net of investment-related expenses (composed of an assumed 2.25% inflation rate and a 4.75% real rate of return)

2. Administrative expenses: 0.10% of valuation payroll per year

3. Salary increase rate: Inflation rate of 2.25% plus productivity increase rate of 0.75% plus step-rate/promotional as shown

Years of Service	Annual Step-Rate/Promotional Component Rates of Increase	Total Annual Rate of Increase
0	8.00%	11.00%
1-2	1.50%	4.50%
3-4	1.25%	4.25%
5-11	1.00%	4.00%
12-17	0.75%	3.75%
18-21	0.50%	3.50%
22-24	0.25%	3.25%
25 or more	0.00%	3.00%

4. New entrant salary growth: 3.00% per year

5. Future ad hoc cost-of-living increases: None

B. Demographic Assumptions

1. Mortality after termination or retirement -

a. Healthy males – 2020 GRS Southwest Region Teacher Mortality Table. Generational mortality improvements in accordance with the Ultimate MP scales are projected from the year 2020.

b. Healthy females – 2020 GRS Southwest Region Teacher Mortality Table. Generational mortality improvements in accordance with the Ultimate MP scales are projected from the year 2020.

Sample healthy retiree mortality rates, including associated annuity value and life expectancy results:

Sample Attained Ages in 2019	Present Value of $1 Monthly for Life *		Future Life Expectancy (years) *		Mortality Rates *	
	Males	Females	Males	Females	Males	Females
40	165.9	168.3	46.0	49.2	0.000621	0.000391
45	161.5	164.8	40.7	43.9	0.000962	0.000650
50	155.6	160.0	35.5	38.7	0.001668	0.001091
55	148.0	153.7	30.5	33.5	0.003116	0.001859
60	138.3	145.3	25.6	28.5	0.004695	0.002693
65	125.9	134.2	20.9	23.6	0.008034	0.004773
70	110.9	120.2	16.5	18.9	0.014492	0.009055
75	93.9	103.7	12.6	14.6	0.026143	0.017173
80	75.5	85.0	9.1	10.7	0.047160	0.032577
85	57.1	65.5	6.3	7.5	0.085072	0.061795

c. Disabled males – 2020 GRS Southwest Region Teacher Mortality Table, set forward three years with minimum rates at all ages of 4.0%. Generational mortality improvements in accordance with the Ultimate MP scales are projected from the year 2020.

d. Disabled females – 2020 GRS Southwest Region Teacher Mortality Table, set forward three years with minimum rates at all ages of 2.5%. Generational mortality improvements in accordance with the Ultimate MP scales are projected from the year 2020.

2. Mortality rates of active members – Pub-2010 Teachers Active Employee Mortality table. Generational mortality improvements in accordance with the Ultimate MP scales are projected from the year 2010.

3. Disability Incidence –As shown below for selected ages (rates are only applied to eligible members, which are members with at least 10 years of service)

	Occurrence of Disability per 100 Members	
Age	Males	Females
25	0.020	0.018
30	0.020	0.018
35	0.028	0.036
40	0.053	0.090
45	0.081	0.144
50	0.243	0.216
55	0.365	0.333
60	0.142	0.234
65	0.000	0.000

4. Retirement rates - Separate male and female rates, based on age, developed from the 2019 Experience Study. Sample rates are shown below:

	Expected Retirements per 100 Lives			
	Unreduced Retirement		Reduced Retirement	
Age	Males	Females	Males	Females
Under 50	0.0	0.0	0.0	0.0
50-54	12.0	12.0	0.0	0.0
55	12.0	12.0	1.0	1.3
56	12.0	14.0	1.0	1.5
57	12.0	14.0	1.3	1.5
58	12.0	14.0	1.5	1.8
59	12.0	14.0	1.8	2.5
60	12.0	16.0	2.0	4.5
61	16.0	20.0	2.8	5.0
62	25.0	25.0	3.5	10.0
63	18.0	20.0	10.0	7.5
64	18.0	20.0	7.5	7.5
65-74	25.0	30.0		
75 and over	100.0	100.0		

The retirement assumption was further modified for members hired after June 30, 1992. The probability of retirement upon first eligibility for Rule of 90 reflects the accumulated probably of retirement between Rule of 80 and Rule of 90, as applicable.

5. Termination Rates – Rates based on the member's service, developed from the 2019 Experience Study, and separate rates are used in the development of the present value of benefits (PVB) and the normal cost (NC) calculation. Rates reflect terminations for causes other than death, disability or retirement. Sample rates are shown below:

Expected Terminations Per 100 Lives				
Credited Service (Years)	Short-Term Expectation (PVFB)		Long Term Expectation (NC, New Entrant)	
	Males	Females	Males	Females
0	11.00	12.00	35.00	35.00
1	10.50	11.50	16.00	16.00
2	10.00	11.00	14.00	14.00
3	8.00	8.50	12.00	12.00
4	7.50	8.00	10.00	10.00
5	7.00	7.50	9.00	9.00
6	6.00	7.00	8.00	8.00
7	5.50	6.00	7.50	7.50
8	5.00	5.50	7.00	7.00
9	4.75	5.00	6.50	6.50
10	4.50	4.75	6.00	6.00
11	4.00	4.50	5.50	5.50
12	3.75	4.00	5.00	5.00
13	3.50	3.75	4.50	4.50
14	3.25	3.50	4.00	4.00
15	3.25	3.25	3.75	3.75
16	3.25	3.00	3.50	3.50
17	3.25	3.00	3.50	3.50
18	2.50	2.75	3.00	3.00
19	2.50	2.50	3.00	3.00
20	2.50	2.25	2.50	2.50
21	2.50	2.00	2.50	2.50
22	2.00	2.00	2.50	2.50
23	2.00	2.00	2.50	2.50
24	2.00	2.00	1.50	1.50
25 or more	2.00	2.00	1.50	1.50

"Pending termination group" defined as members reported as active in the current census data where the date of last contribution is before April of a valuation year. For short term expectations (and PVFB development), this group is assumed to have an 80% termination rate applied in the year after the valuation date.

C. Other Assumptions

1. Percent married: 80% of employees are assumed to be married.

2. Age difference: Males are assumed to be three years older than females.

3. Percent electing annuity on death (when eligible): All of the spouses of married participants who die after becoming eligible for a retirement benefit are assumed to elect an annuity, in lieu of the $18,000 lump sum and refund.

4. Election of deferred termination benefit: vested terminating members are assumed to elect a refund or a deferred benefit, whichever is more valuable at the time of termination.

5. Assumed age for commencement of deferred benefits: Members electing to receive a deferred benefit are assumed to commence receipt at age 62 (age 65 if hired on or after November 1, 2011).

6. Supplemental medical insurance: 50% of eligible members who are active or due a deferred vested benefit are assumed to elect the insurance benefit. For annuitants who began receiving a benefit in the year preceding the valuation date, 50% of those not already receiving the benefit are assumed to elect it. The liability for all other annuitants is based on the actual benefit being paid as shown in the data.

7. Members who retire with at least 24 years of credited service are assumed to have 120 days of unused sick leave for which they will receive one year of service credit. This assumption only applies to reduced and unreduced retirement.

8. No assumption was made that current active members employed by the comprehensive universities will elect to transfer out of OTRS.

9. Reemployment, purchase of service, transfers: No recognition is made of (i) future member reimbursements upon reemployment, (ii) future purchase of additional service, or (iii) special transfer provisions.

10. For EESIP eligible employees, if the refund amount to be paid exceeds the actuarial present value of the additional benefit, then we assume the member does not elect the enhanced benefit.

11. Decrement timing: Decrements of all types are assumed to occur mid-year.

IV. *Valuation Data*

Participant data was supplied on an electronic file for (i) active members, (ii) inactive vested members who are entitled to a future deferred benefit, (iii) inactive nonvested members who are entitled to a refund of their employee contributions, and in some cases a portion of the accumulated interest, and (iv) members and beneficiaries receiving benefits.

The data for active and inactive, non retired members included date of birth, date of hire, gender, years of service, salary, employee contributions and accumulated interest on employee contributions. The data also included a code to indicate whether the employee had elected to make contributions on salary above $25,000, and a code indicating the type of employer (comprehensive university, other college or university, or other employer). For retired members and beneficiaries, the data included date of birth, gender, spouse's date of birth (where applicable), amount of monthly benefit, date of retirement, and a form of payment code.

Individual member contributions for the 12 months prior to the valuation date were used to determine the actual salary for plan members in the prior plan year. The valuation assumptions for salary increases were used to determine the projected salary for the current plan year. Additionally, contributing members were assumed to accrue one additional year of service between the end of the prior employment year and the valuation date.

Additional assumptions were made to correct for missing or inconsistent data. These had no material impact on the results presented.

Some inactive, nonvested employees who are entitled to a refund are not included in the data, but a liability for their refund is included instead in the Suspense Fund, which is included in the liability.

SECTION E

SUMMARY OF DATA AND EXPERIENCE

Non-Disabled Post-Retirement Mortality – Male
Benefit-Weighted
Ten-Year Period Ending June 30, 2019

				Sample Rates		Expected Benefits		Actual/Expected	
				Current	Proposed	Current (3) * (5)	Proposed (3) * (6)	Current (2) / (7)	Proposed (2) / (8)
Age	Actual Deaths	Total Benefits	Actual Rate	Current	Proposed	(3) * (5)	(3) * (6)	(2) / (7)	(2) / (8)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
55-59	$ 1,836	$ 209,028	0.0088	0.0039	0.0040	$ 843	$ 865	218%	212%
60-64	4,958	579,926	0.0085	0.0064	0.0060	3,990	3,698	124%	134%
65-69	10,130	889,979	0.0114	0.0115	0.0108	10,334	9,788	98%	103%
70-74	13,264	760,176	0.0174	0.0193	0.0195	14,675	14,765	90%	90%
75-79	16,169	506,912	0.0319	0.0343	0.0352	17,228	17,683	94%	91%
80-84	18,582	299,862	0.0620	0.0606	0.0634	17,919	18,774	104%	99%
85-89	17,501	155,008	0.1129	0.1069	0.1144	16,145	17,258	108%	101%
90-94	10,239	52,331	0.1957	0.1868	0.2062	9,294	10,229	110%	100%
95-99	2,769	9,437	0.2934	0.2835	0.3714	2,518	3,237	110%	86%
100-104	385	702	0.5481	0.3614	0.5181	242	364	159%	106%
105-109	0	10	0.0000	0.4000	0.5181	4	5	0%	0%
Totals	$ 95,833	$3,463,370	0.0277	0.0269	0.0279	$ 93,192	$ 96,668	103%	99%

Non-Disabled Post-Retirement Mortality – Female
Benefit-Weighted
Ten-Year Period Ending June 30, 2019

Age	Actual Benefits	Total Benefits	Actual Rate	Assumed Rate		Expected Benefits		Actual/Expected	
				Current	Proposed	Current (3) * (5)	Proposed (3) * (6)	Current (2) / (7)	Proposed (2) / (8)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
55-59	$ 1,967	$ 481,652	0.0041	0.0033	0.0023	$ 1,650	$ 1,165	119%	169%
60-64	7,065	1,317,190	0.0054	0.0048	0.0035	6,519	4,850	108%	146%
65-69	12,290	1,761,641	0.0070	0.0073	0.0065	13,051	11,661	94%	105%
70-74	13,801	1,223,786	0.0113	0.0124	0.0124	15,024	15,016	92%	92%
75-79	16,097	716,952	0.0225	0.0239	0.0236	16,956	16,698	95%	96%
80-84	19,143	422,645	0.0453	0.0483	0.0447	20,183	18,691	95%	102%
85-89	19,132	232,127	0.0824	0.0944	0.0848	21,465	19,315	89%	99%
90-94	16,595	108,803	0.1525	0.1744	0.1607	18,426	16,995	90%	98%
95-99	9,720	37,622	0.2584	0.3035	0.3044	10,920	10,915	89%	89%
100-104	2,672	7,002	0.3816	0.4958	0.5176	3,191	3,416	84%	78%
105-109	201	452	0.4447	0.5250	0.5176	237	234	85%	86%
Totals	$ 118,682	$6,309,871	0.0188	0.0202	0.0189	$127,621	$118,955	93%	100%

Termination Experience (Long Term) – Male
Liability-Weighted
Five-Year Period Ending June 30, 2019

Service	Actual Withdrawal	Total Count	Actual Rate	Assumed Rate		Expected Withdrawal		Actual/Expected	
				Current	Proposed	Current	Proposed	Current (2) / (7)	Proposed (2) / (8)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
0	$ 59,275,891	$ 132,240,954	0.4482	0.4475	0.3500	$ 30,415,419	$ 46,284,334	195%	128%
1	76,107,717	496,951,902	0.1531	0.1525	0.1600	89,451,342	79,512,304	85%	96%
2	53,592,287	375,648,822	0.1427	0.1425	0.1400	48,834,347	52,590,835	110%	102%
3	36,606,753	339,801,768	0.1077	0.1075	0.1200	37,378,194	40,776,212	98%	90%
4	29,250,812	256,990,959	0.1138	0.1125	0.1000	23,129,186	25,699,096	126%	114%
5	22,885,075	226,761,671	0.1009	0.1000	0.0900	18,707,838	20,408,550	122%	112%
6	18,375,314	209,348,864	0.0878	0.0875	0.0800	15,701,165	16,747,909	117%	110%
7	16,494,511	191,214,608	0.0863	0.0850	0.0750	12,906,986	14,341,096	128%	115%
8	13,392,561	182,397,937	0.0734	0.0725	0.0700	10,943,876	12,767,856	122%	105%
9	10,413,766	181,726,702	0.0573	0.0550	0.0650	9,540,652	11,812,236	109%	88%
10	12,564,423	176,555,415	0.0712	0.0700	0.0600	7,944,994	10,593,325	158%	119%
11	8,829,213	162,324,916	0.0544	0.0525	0.0550	6,898,809	8,927,870	128%	99%
12	7,677,128	154,253,976	0.0498	0.0475	0.0500	6,170,159	7,712,699	124%	100%
13	6,851,955	150,876,893	0.0454	0.0450	0.0450	5,657,883	6,789,460	121%	101%
14	6,405,627	149,654,100	0.0428	0.0425	0.0400	5,237,894	5,986,164	122%	107%
15	5,784,886	146,860,130	0.0394	0.0375	0.0375	4,772,954	5,507,255	121%	105%
16	6,201,038	148,271,474	0.0418	0.0400	0.0350	4,448,144	5,189,502	139%	119%
17	5,505,839	148,656,036	0.0370	0.0350	0.0350	4,088,041	5,202,961	135%	106%
18	4,649,125	135,326,528	0.0344	0.0325	0.0300	3,383,163	4,059,796	137%	115%
19	4,570,106	123,282,461	0.0371	0.0350	0.0300	2,773,855	3,698,474	165%	124%
20	3,407,752	112,615,009	0.0303	0.0300	0.0250	2,252,300	2,815,375	151%	121%
21	3,694,710	103,686,565	0.0356	0.0350	0.0250	1,814,515	2,592,164	204%	143%
22	2,338,076	93,438,211	0.0250	0.0250	0.0250	1,635,169	2,335,955	143%	100%
23	2,146,073	86,347,297	0.0249	0.0225	0.0250	1,295,209	2,158,682	166%	99%
24	1,661,028	75,675,612	0.0219	0.0200	0.0150	1,135,134	1,135,134	146%	146%
Totals	$418,681,666	$ 4,560,908,810				$356,517,230	$395,645,245	117%	106%

Termination Experience (Long Term) – Female
Liability-Weighted
Five-Year Period Ending June 30, 2019

				Assumed Rate		Expected Withdrawal		Actual/Expected	
Service	Actual Withdrawal	Total Count	Actual Rate	Current	Proposed	Current	Proposed	Current (2) / (7)	Proposed (2) / (8)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
0	$114,587,804	$ 240,030,431	0.4774	0.2300	0.3500	$ 55,206,999	$ 84,010,651	208%	136%
1	170,011,705	1,086,700,014	0.1564	0.1800	0.1600	195,606,003	173,872,002	87%	98%
2	122,297,577	826,360,116	0.1480	0.1300	0.1400	107,426,815	115,690,416	114%	106%
3	84,509,836	742,802,476	0.1138	0.1100	0.1200	81,708,272	89,136,297	103%	95%
4	61,781,213	582,682,398	0.1060	0.0900	0.1000	52,441,416	58,268,240	118%	106%
5	53,003,732	527,036,588	0.1006	0.0825	0.0900	43,480,519	47,433,293	122%	112%
6	45,451,552	489,903,159	0.0928	0.0750	0.0800	36,742,737	39,192,253	124%	116%
7	33,922,154	446,238,952	0.0760	0.0675	0.0750	30,121,129	33,467,921	113%	101%
8	31,447,580	427,579,812	0.0735	0.0600	0.0700	25,654,789	29,930,587	123%	105%
9	27,778,959	427,932,990	0.0649	0.0525	0.0650	22,466,482	27,815,644	124%	100%
10	25,286,746	416,392,175	0.0607	0.0450	0.0600	18,737,648	24,983,531	135%	101%
11	21,392,362	378,486,462	0.0565	0.0425	0.0550	16,085,675	20,816,755	133%	103%
12	18,764,892	344,399,755	0.0545	0.0400	0.0500	13,775,990	17,219,988	136%	109%
13	15,168,941	322,126,197	0.0471	0.0375	0.0450	12,079,732	14,495,679	126%	105%
14	14,065,134	303,303,490	0.0464	0.0350	0.0400	10,615,622	12,132,140	132%	116%
15	11,230,894	288,319,236	0.0390	0.0325	0.0375	9,370,375	10,811,971	120%	104%
16	11,439,334	286,567,583	0.0399	0.0300	0.0350	8,597,027	10,029,865	133%	114%
17	10,698,503	273,850,661	0.0391	0.0275	0.0350	7,530,893	9,584,773	142%	112%
18	8,493,445	246,463,675	0.0345	0.0250	0.0300	6,161,592	7,393,910	138%	115%
19	7,287,894	220,414,661	0.0331	0.0225	0.0300	4,959,330	6,612,440	147%	110%
20	4,701,697	194,095,712	0.0242	0.0200	0.0250	3,881,914	4,852,393	121%	97%
21	3,909,770	175,146,629	0.0223	0.0175	0.0250	3,065,066	4,378,666	128%	89%
22	4,917,291	163,003,532	0.0302	0.0175	0.0250	2,852,562	4,075,088	172%	121%
23	3,850,027	156,773,359	0.0246	0.0150	0.0250	2,351,600	3,919,334	164%	98%
24	1,839,763	139,063,269	0.0132	0.0150	0.0150	2,085,949	2,085,949	88%	88%
Totals	$907,838,805	$ 9,705,673,332				$773,006,137	$852,209,786	117%	107%

Unreduced Retirement Experience – Male
Liability-Weighted
Five-Year Period Ending June 30, 2019

Experience for Members Retiring under the Rule of 80 Eligibility Provisions

Age	Actual Retirements	Total Count	Actual Rate	Assumed Rate Current	Assumed Rate Proposed	Expected Retirements Current	Expected Retirements Proposed	Actual/Expected Current (2)/(7)	Actual/Expected Proposed (2)/(8)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
50	2,724	14,811	0.1839	0.1200	0.1200	1,777	1,777	153%	153%
51	10,606	109,884	0.0965	0.1200	0.1200	13,186	13,186	80%	80%
52	22,107	203,749	0.1085	0.1200	0.1200	24,450	24,450	90%	90%
53	35,230	268,766	0.1311	0.1200	0.1200	32,252	32,252	109%	109%
54	29,570	302,399	0.0978	0.1200	0.1200	36,288	36,288	81%	81%
55	33,097	343,327	0.0964	0.1200	0.1200	41,199	41,199	80%	80%
56	36,083	347,591	0.1038	0.1200	0.1200	41,711	41,711	87%	87%
57	46,297	344,824	0.1343	0.1200	0.1200	41,379	41,379	112%	112%
58	38,794	340,634	0.1139	0.1200	0.1200	40,876	40,876	95%	95%
59	53,701	344,443	0.1559	0.1200	0.1200	41,333	41,333	130%	130%
60	38,833	331,172	0.1173	0.1200	0.1200	39,741	39,741	98%	98%
61	48,418	324,890	0.1490	0.1500	0.1600	48,733	51,982	99%	93%
62	127,404	552,500	0.2306	0.2100	0.2500	116,025	138,125	110%	92%
63	72,806	450,381	0.1617	0.1900	0.1800	85,572	81,069	85%	90%
64	59,629	385,721	0.1546	0.1500	0.1800	57,858	69,430	103%	86%
65	77,505	337,804	0.2294	0.2500	0.2500	84,451	84,451	92%	92%
66	72,201	271,985	0.2655	0.2250	0.2500	61,197	67,996	118%	106%
67	46,178	214,276	0.2155	0.2250	0.2500	48,212	53,569	96%	86%
68	35,690	169,467	0.2106	0.2000	0.2500	33,893	42,367	105%	84%
69	27,107	134,546	0.2015	0.2000	0.2500	26,909	33,637	101%	81%
70	29,651	109,570	0.2706	0.2000	0.2500	21,914	27,393	135%	108%
71	19,577	79,170	0.2473	0.2000	0.2500	15,834	19,792	124%	99%
72	10,733	57,405	0.1870	0.2000	0.2500	11,481	14,351	93%	75%
73	12,146	47,993	0.2531	0.2000	0.2500	9,599	11,998	127%	101%
74	7,416	37,411	0.1982	0.2000	0.2500	7,482	9,353	99%	79%
75 and over	22,611	110,096	0.2054	1.0000	1.0000	110,096	110,096	21%	21%
Subtotal	1,016,114	6,234,814				1,093,448	1,169,801	93%	87%

Unreduced Retirement Experience – Female
Liability-Weighted
Five-Year Period Ending June 30, 2019

Experience for Members Retiring under the Rule of 80 Eligibility Provisions

| Age | Actual Retirements | Total Count | Actual Rate | Assumed Rate | | Expected Retirements | | Actual/Expected | |
| | | | | Current | Proposed | Current | Proposed | Current (2) / (7) | Proposed (2) / (8) |
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
50	5,672	35,751	0.1586	0.1250	0.1200	4,469	4,290	127%	132%
51	24,286	259,318	0.0937	0.1250	0.1200	32,415	31,118	75%	78%
52	47,703	409,098	0.1166	0.1250	0.1200	51,137	49,092	93%	97%
53	48,087	489,657	0.0982	0.1250	0.1200	61,207	58,759	79%	82%
54	58,529	550,722	0.1063	0.1250	0.1200	68,840	66,087	85%	89%
55	65,225	611,520	0.1067	0.1250	0.1200	76,440	73,382	85%	89%
56	75,809	643,666	0.1178	0.1400	0.1400	90,113	90,113	84%	84%
57	75,422	665,310	0.1134	0.1400	0.1400	93,143	93,143	81%	81%
58	85,092	668,202	0.1273	0.1400	0.1400	93,548	93,548	91%	91%
59	100,957	694,746	0.1453	0.1600	0.1400	111,159	97,264	91%	104%
60	101,780	686,090	0.1483	0.1600	0.1600	109,774	109,774	93%	93%
61	118,672	666,994	0.1779	0.2000	0.2000	133,399	133,399	89%	89%
62	255,596	1,060,641	0.2410	0.2500	0.2500	265,160	265,160	96%	96%
63	141,269	811,977	0.1740	0.2000	0.2000	162,395	162,395	87%	87%
64	124,191	692,806	0.1793	0.2000	0.2000	138,561	138,561	90%	90%
65	160,045	586,299	0.2730	0.2500	0.3000	146,575	175,890	109%	91%
66	134,057	422,925	0.3170	0.2500	0.3000	105,731	126,877	127%	106%
67	70,739	280,965	0.2518	0.2500	0.3000	70,241	84,290	101%	84%
68	51,670	215,842	0.2394	0.2250	0.3000	48,564	64,753	106%	80%
69	38,248	147,235	0.2598	0.2250	0.3000	33,128	44,171	115%	87%
70	32,819	103,322	0.3176	0.2250	0.3000	23,247	30,997	141%	106%
71	18,710	70,694	0.2647	0.2250	0.3000	15,906	21,208	118%	88%
72	10,090	52,917	0.1907	0.2250	0.3000	11,906	15,875	85%	64%
73	6,503	39,899	0.1630	0.2250	0.3000	8,977	11,970	72%	54%
74	6,790	30,560	0.2222	0.2250	0.3000	6,876	9,168	99%	74%
75 and over	17,369	75,935	0.2287	1.0000	1.0000	75,935	75,935	23%	23%
Subtotal	1,875,328	10,973,091				2,038,846	2,127,219	92%	88%

Salary Experience
Ten-Year Period Ending June 30, 2019

	Current Salary Scales		Actual Experience (10 Years)			Proposed Salary Scales		Increase/
	Total	Step Rate/ Promotional	Total	Above Inflation (1.73%)	Step Rate/ Promotional	Total	Step Rate/ Promotional	(Decrease) in
Index								Rates
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
0	11.25%	8.00%	6.63%	4.89%	4.10%	11.00%	8.00%	(0.25)%
1	4.75%	1.50%	4.20%	2.47%	1.67%	4.50%	1.50%	(0.25)%
2	4.75%	1.50%	3.26%	1.53%	0.73%	4.50%	1.50%	(0.25)%
3	4.50%	1.25%	3.35%	1.62%	0.82%	4.25%	1.25%	(0.25)%
4	4.50%	1.25%	3.47%	1.74%	0.94%	4.25%	1.25%	(0.25)%
5	4.25%	1.00%	3.71%	1.97%	1.18%	4.00%	1.00%	(0.25)%
6	4.25%	1.00%	3.74%	2.01%	1.22%	4.00%	1.00%	(0.25)%
7	4.25%	1.00%	3.56%	1.83%	1.03%	4.00%	1.00%	(0.25)%
8	4.25%	1.00%	3.25%	1.52%	0.72%	4.00%	1.00%	(0.25)%
9	4.25%	1.00%	3.43%	1.69%	0.90%	4.00%	1.00%	(0.25)%
10	4.25%	1.00%	3.43%	1.69%	0.90%	4.00%	1.00%	(0.25)%
11	4.25%	1.00%	3.35%	1.62%	0.83%	4.00%	1.00%	(0.25)%
12	4.00%	0.75%	3.28%	1.55%	0.76%	3.75%	0.75%	(0.25)%
13	4.00%	0.75%	3.18%	1.45%	0.65%	3.75%	0.75%	(0.25)%
14	4.00%	0.75%	3.28%	1.55%	0.75%	3.75%	0.75%	(0.25)%
15	4.00%	0.75%	3.26%	1.53%	0.73%	3.75%	0.75%	(0.25)%
16	4.00%	0.75%	3.14%	1.40%	0.61%	3.75%	0.75%	(0.25)%
17	4.00%	0.75%	3.08%	1.35%	0.55%	3.75%	0.75%	(0.25)%
18	3.75%	0.50%	3.10%	1.36%	0.57%	3.50%	0.50%	(0.25)%
19	3.75%	0.50%	3.20%	1.46%	0.67%	3.50%	0.50%	(0.25)%
20	3.75%	0.50%	3.04%	1.31%	0.52%	3.50%	0.50%	(0.25)%
21	3.75%	0.50%	2.98%	1.24%	0.45%	3.50%	0.50%	(0.25)%
22	3.50%	0.25%	2.73%	0.99%	0.20%	3.25%	0.25%	(0.25)%
23	3.50%	0.25%	2.79%	1.05%	0.26%	3.25%	0.25%	(0.25)%
24	3.50%	0.25%	2.78%	1.04%	0.25%	3.25%	0.25%	(0.25)%
25+	3.25%	0.00%	2.53%	0.79%	0.00%	3.00%	0.00%	(0.25)%

	2019
a. Current Inflation Assumption	2.50%
b. Current Productivity Component	0.75%
c. Actual CPI-U Inflation for 6/30/2009 - 6/30/2019	1.73%
d. Proposed Inflation Assumption	2.25%
e. Apparent Productivity Component	0.79%
f. Proposed Productivity Component	0.75%