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EMPLOYEES' RETIREMENT SYSTEM OF GEORGIA

GEORGIA PUBLIC SCHOOL EMPLOYEES' RETIREMENT SYSTEM

EXPERIENCE INVESTIGATION FOR THE FIVE-YEAR PERIOD ENDING JUNE 30, 2019

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December 17, 2020

Board of Trustees
Georgia Public School Employees' Retirement System
Two Northside 75, Suite 300
Atlanta, GA 30318

Members of the Board:

We are pleased to submit the results of an investigation of the economic and demographic experience for the Georgia Public School Employees' Retirement System (PSERS) for the five-year period from July 1, 2014 to June 30, 2019. The study was based on the data submitted by PSERS for the annual valuation. In preparing this report, we relied, without audit, on the data provided.

The purpose of the investigation was to assess the reasonability of the current economic assumptions and demographic actuarial assumptions for the Retirement System. As a result of the investigation, it is recommended that revised economic assumptions and demographic tables be adopted by the Board for future use.

All recommended rates of separation and mortality at each age are shown in the attached tables in Appendix C of this report. In the actuary's judgment, the rates recommended are suitable for use until further experience indicates that modifications are desirable.

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) and the Code of Professional Conduct and Qualification Standards for Public Statements of Actuarial Opinion of the American Academy of Actuaries.

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We further certify that, in our opinion, the assumptions developed in this report satisfy Actuarial 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).

The experience investigation was performed by, and under the supervision of, independent actuaries who are members of the American Academy of Actuaries with experience in performing valuations for public retirement systems. The undersigned meet the Qualification Standards of the American Academy of Actuaries to render the actuarial opinion contained herein.

Respectfully submitted,

Edward J. Koebel, EA, FCA, MAAA
Chief Executive Officer

Cathy Turcot
Principal and Managing Director

Ben Mobley, ASA, EA, MAAA
Senior Actuary

Table of Contents

Section I – Executive Summary

The purpose of an actuarial valuation is to provide a timely best estimate of the ultimate costs of a retirement system. An actuarial valuation of the Public Schools Employees' Retirement System of Georgia (PSERS) is prepared annually to determine the actuarial contribution rates required to fund it on an actuarial reserve basis, (i.e. the current assets plus future contributions, along with investment earnings are expected to 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 death, termination of employment, retirement, and salary changes (if applicable) 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 anticipated 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. Therefore, actual experience is expected to vary from study period to study period, without necessarily indicating a change in assumptions is needed.

Cavanaugh Macdonald Consulting, LLC (CMC) has performed a study of the experience of each of the Plans under the ERS Board of Trustees purview for the five-year period ending June 30, 2019. This report presents the results, analysis, and resulting recommendations of our study for PSERS only. Each plan will have its own report. It is anticipated that the changes, if approved, will first be reflected in the June 30, 2020 actuarial valuations.

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 in this area are generally minor. However, the setting of assumptions is more likely to result in differences between actuaries, 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:

- **Do Not Overreact**: When we see significant changes in experience, 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 similar results, 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. 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 the expected increase in life expectancy.

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

The following summarizes the findings and recommendations regarding the assumptions utilized for PSERS. Detailed explanations for the recommendations are found in the sections that follow.

Recommended Economic Assumption Changes

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 the rebound in many financial markets in the years following. Our goal is to try to find the emerging long-term trends in the midst of this volatility so that we can then apply reasonable assumptions.

Most of the economic assumptions used by actuaries are developed through a building-block approach. For example, the expected return on assets 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. As we discuss later in the report, based on recent trends of inflation, the market pricing of inflation, and the Chief Actuary of the Social Security Administration's view of inflation, **we are recommending a decrease in the price inflation assumption from 2.75% to 2.50%**.

We are also recommending a corresponding decrease in the long-term expected return on assets assumption from 7.50% to 7.00%, reflecting the 0.25% decrease in the inflation assumption and a 0.25% decrease in the real rate of return assumption. This will be discussed in detail later in this report, but a real rate of return of 4.50% is supported by the forecasting models developed using the capital market assumptions from Division of Investment Services that oversees PSERS' investments and the Board's target asset allocation. Further analysis of the 35 sets of capital market assumptions included in the Horizon Actuarial Services, LLC. survey conducted in 2020 also supports this recommendation.

The current PSERS funding policy states that the long-term expected return on assets assumption, which was set at 7.50% in the previous experience study, shall be reduced by 0.10% per year from the immediate prior valuation when the actual rate of return for the fiscal year exceeds the assumed rate. The minimum return assumption stated in the funding policy is 7.00%. The asset return assumption used in the most recent actuarial valuation is 7.30%. We concur with the Board policy that will continue to reduce the rate of return used in future valuations until a 7.00% return in achieved so, therefore, the recommended rate change does not have any impact on the valuation results expected in the next few years.

The following table summarizes the current and proposed economic assumptions:

Item	Current	Proposed
Price Inflation	2.75%	2.50%
Investment Return*	7.50%	7.00%

* Net of investment expenses only.

Although we have recommended a change in the set of economic assumptions, we recognize there may be other sets of economic assumptions that are also reasonable for purposes of funding PSERS. For example, we have typically reflected conservatism to the degree we would classify as moderate. Actuarial Standards of Practice allow for this difference in approaches and perspective, as long, as the assumptions are reasonable and consistent.

Recommended Demographic Assumption Changes

In the experience study, actual experience for the study period is compared to that expected based on the current actuarial assumptions. The analysis is most commonly performed based on counts, i.e. each member is one exposure to the probability of the event occurring and one count if the event actually occurs. Comparing the actual 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 issue of future mortality improvement is one that the actuarial profession has become increasingly focused on studying in recent years. This has resulted in changes to the relevant Actuarial Standard of Practice, ASOP 35, *Selection of Demographic and Other Noneconomic Assumptions for Measuring Pension Obligations*. This ASOP requires the pension actuary to make and disclose a specific recommendation with respect to future improvements in mortality after the valuation date. 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 to some degree in the future. Therefore, we believe it is appropriate to reflect future mortality improvement as part of the mortality assumption.

There are two widely used approaches for reflecting future improvements in mortality:

(1) Static table with "margin"
(2) Generational mortality

The first approach to reflecting mortality improvements is with the use of a static mortality table with "margin." Under this approach, the A/E ratio is intentionally targeted to be over 100% so that mortality can improve without creating actuarial losses. While there is no formal guidance as to the amount of margin required (how far above 100% is appropriate for the A/E ratio), we typically prefer to have a margin of around 10 to 14% at the core ages of the retired member. The goal is still for the general shape of the curve to be a reasonable fit to the observed experience. Depending on the magnitude and duration of actual mortality improvements in the future, the margin may decrease and eventually become insufficient. If that occurs, the assumption would need to be updated.

Another approach, referred to as generational mortality, directly anticipates future improvements in mortality by using a different set of mortality rates for each year of birth, with the rates for later years of birth assuming lower mortality than the rates for earlier years of birth. The varying mortality rates by year of birth create a series of tables that contain "built-in" mortality improvements, e.g., a member who turns age 65 in 2035 has a longer life expectancy than a member who turns age 65 in 2020. When using generational mortality, the A/E ratios for the observed experience are set near 100% since future mortality improvements will be taken into account directly in the actuarial valuation process.

For the mortality decrements, we also analyzed the experience using a liability-weighted approach. This is approximated by using the member's retirement benefit from the data collected. The exposure and actual occurrences are then multiplied by the benefit level to provide the liability-weighted experience. This approach is particularly insightful when analyzing experience from a non-homogenous group. While we reviewed the mortality experience on both a count and liability-weighted basis, we ultimately decided on the liability-weighted results to evaluate experience and develop a new mortality table.

The current post-retirement mortality assumption for healthy lives is a static table, the RP-2000 Blue Collar Mortality Table projected to 2025 with projection scale BB and set forward 3 years for males and set forward 2 years for females. This table is currently used by PSERS only. The results of the experience analysis indicate that this table provided a very reasonable expectation of mortality for the past 5 years. However, we have decided to adopt a generational mortality approach and have selected the mortality assumptions from the recently published Pub-2010 Public Mortality Plans Mortality Tables. These tables, released in 2019, were developed using public pension plan mortality experience only. This recommended table will be used for PSERS only. More information will be discussed in the demographic section of this report.

The following is a general list of the other recommended changes to the demographic assumptions specific to the PSERS plan.

- **Retirement: Decreased rates of retirement at all ages and extended fixed retirement from age 75 to age 80.**

- **Disability: Modified the rates of disability retirement to better match the experience.**

- **Withdrawal: Increased rates of withdrawal at most ages for each service band.**

Section V will provide more detail to these recommended demographic changes.

Actuarial Methods

The basic actuarial methodologies used in the valuation process include the:

- Actuarial Cost Method
- Asset Valuation Method
- Amortization Method

Based on our review, discussed in full detail in Section IV of this report, we recommend no changes in these actuarial methods at this time.

Other Assumptions

Another assumption that is included in the valuation is the determination of administrative expense component that is added to the total normal cost each year. The current method used to determine the load for administrative expenses is to use the budgeted expenses provided to us by the System for the applicable fiscal year (currently $2,061,000 for PSERS). **After reviewing the total administrative expenses for the past five years as a dollar amount, we are recommending a decrease in this assumption to $1,400,000 for the next 5-year period.** The following table shows actual expenses over the past five years:

($ in Thousands)

Year Ending June 30	Administrative Expenses
2015	$1,545
2016	1,321
2017	1,308
2018	1,331
2019	1,377

Section II – Financial Impact

Although the assumption changes, if approved, will first be reflected in the 2020 valuations, we have provided the following table which highlights the impact of the recommended changes on the Unfunded Actuarial Accrued Liability (UAAL), Funding Ratio, Amortization Period and Actuarially Determined Employer Contribution on the 2019 valuation results.

Impact on Principal Valuation Results		
	Valuation Results 2019	**Recommended Assumptions**
Unfunded Accrued Liability	$177,626,248	$211,379,598
Funding Ratio	84.0%	81.5%
Actuarially Determined Employer Contribution		
Normal Cost*	$13,558,000	$12,930,000
Accrued Liability	17,333,000	20,308,000
Total	$30,891,000	$33,238,000
Amortization Period (in years)	19.6	20.2

*Normal Cost includes estimated administrative expenses

Section III – Economic Assumptions

There are three economic assumptions used in the actuarial valuations performed for the System. They are:

- Price Inflation
- Investment Return

Actuarial Standard of Practice (ASOP) No. 27, *"Selection of Economic Assumptions for Measuring Pension Obligations"* provides guidance to actuaries in selecting economic assumptions for measuring obligations under defined benefit plans. ASOP No. 27 was revised in September 2013, and no longer includes the concept of a "best estimate range". Instead, the revised standard now requires that each economic assumption selected by the actuary should be reasonable which means it has the following characteristics:

- It is appropriate for the purpose of the measurement;
- It reflects the actuary's professional judgment;
- It takes into account historical and current economic data that is relevant as of the measurement date;
- 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
- It has no significant bias (i.e., it is not significantly optimistic or pessimistic), except when provisions for adverse deviation or plan provisions that are difficult to measure are included and disclosed, or when alternative assumptions are used for the assessment of risk.

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.

Section III – Economic Assumptions

In our opinion, the economic assumptions recommended in this report have been developed in accordance with ASOP No. 27. The following table shows our recommendations followed by detailed discussions of each assumption.

Item	Current	Proposed
Price Inflation	2.75%	2.50%
Real Rate of Return*	4.75	4.50
Investment Return	7.50%	7.00%

* Net of investment expenses

Note that future price inflation has an indirect impact on the results of the actuarial valuation through the development of the assumptions for investment return. However, it is not directly used in the valuation process.

Price Inflation

Background

As can be seen from the table on the previous page, assumed price inflation is used as the basis for both the investment return assumption. The latter assumption will be discussed in detail in the following section.

It is important that the price inflation assumption be consistently applied throughout the economic assumptions utilized in an actuarial valuation. This is called for in ASOP No. 27 and is also required to meet the parameters for determining pension liabilities and expense under Governmental Accounting Standards Board (GASB) Statements No. 67 and 68.

The relationship between price inflation and investment return has long been recognized by economists. The basic principle is that the investor demands a relatively level "real return" – the excess of actual investment return over price inflation. Over the long-term, 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.

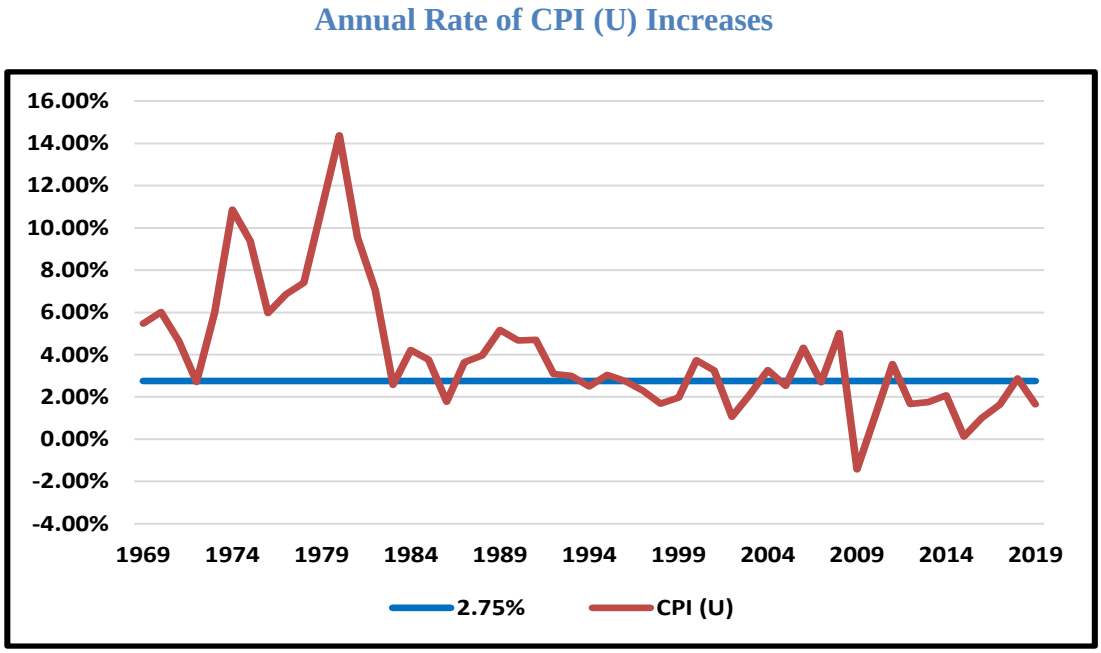
The current price inflation assumption is 2.75% per year.

Past Experience

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 table below provides historical annualized rates and annual standard deviation of the CPI-U over periods ending June 30th.

Period	Number of Years	Annualized Rate of Inflation	Annual Standard Deviation
1926 – 2019	93	2.90%	4.06%
1959 – 2019	60	3.69	2.87
1969 – 2019	50	3.97	3.00
1979 – 2019	40	3.21	2.59
1989 – 2019	30	2.44	1.38
1999 – 2019	20	2.19	1.49
2009 - 2019	10	1.73	0.96

The following graph illustrates the historical levels of price inflation measured as of June 30th of each of the last 50 years and compared to the current 2.75% annual rate currently assumed.



Over the last 50 years, the average annual rate of increase in the CPI-U has been just below 4.00%. The period of high inflation from 1973 to 1982 has a significant impact on the averages over periods which include these rates. The volatility of the annual rates in the more recent years has been markedly lower as indicated by the significantly lower annual standard deviations. Many experts attribute the lower average annual rates and lower volatility to the increased efforts of the Federal Reserve since the early 1980's to stabilize price inflation.

Forecasts

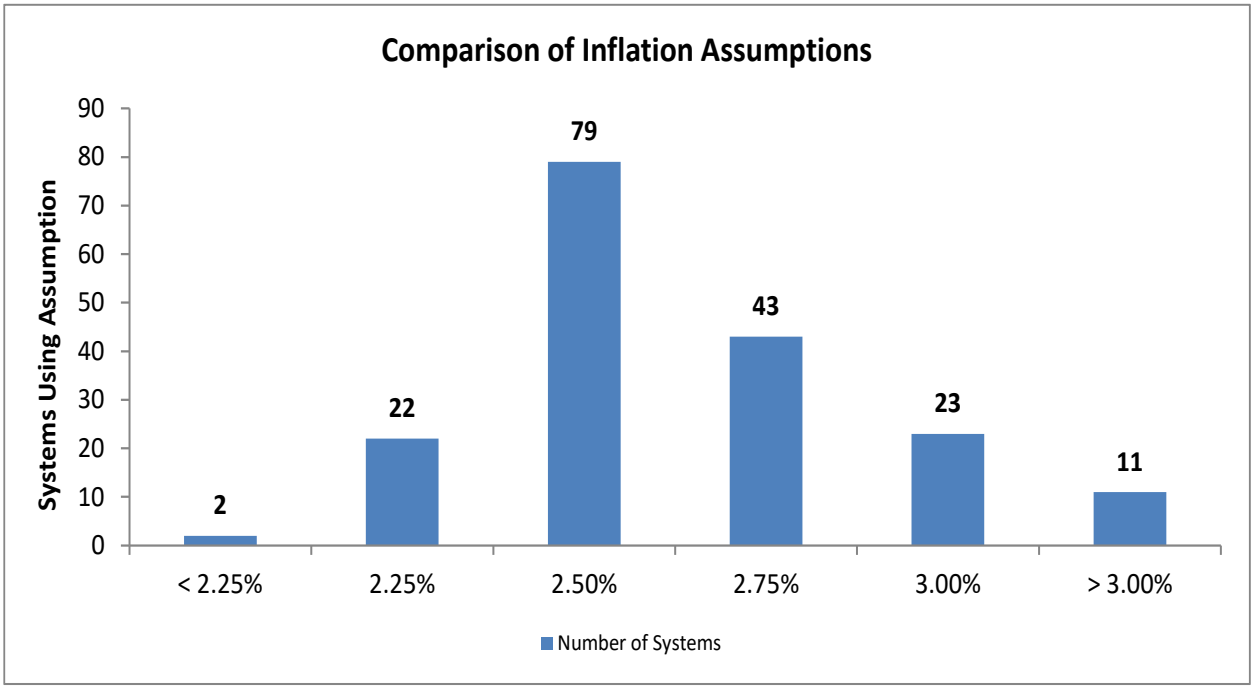
Based upon information contained in the "Survey of Professional Forecasters" for the fourth quarter of 2020 as published by the Philadelphia Federal Reserve Bank, the median expected annual rate of inflation for the next ten years is 2.12%. Although 10 years of future expectation is too short of a period for the basis of our inflation assumption, the information does provide some evidence that the consensus expectations of these experts are for rates of inflation lower than our current assumption of 2.75% for the near term future.

Social Security Administration

Although many economists forecast lower inflation than the assumption used by most 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 2020 annual report, the projected ultimate average annual increase in the CPI over the next 75 years was estimated to be 2.40%, under the intermediate (best estimate) 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 1.80% to 3.00%. This is a decline of 0.20% in the CPI forecasts from the Social Security Administration from their 2019 annual report.

Peer Comparison

While we do not recommend the selection of any assumption based on what other systems use, it does provide another set of relevant information to consider. The following chart shows the inflation rate assumptions of 180 plans in the Public Plan Database of the Center for Retirement Research. The assumptions are from actuarial valuation reported in FYE 2019.



Recommendation

It is difficult to predict inflation accurately. Inflation's short-term volatility is illustrated by comparing its average rate over the last 10 and 50 years. Although the 10-year average of 1.73% is lower than the System's assumed rate of 2.75%, the longer 50-year averages of 3.97% is somewhat higher than PSERS' current rate. The reasonableness of PSERS' assumption is, therefore, dependent upon the emphasis one assigns to the short and long-terms.

Current economic forecasts suggest lower inflation but are generally looking at a shorter time period than appropriate for our purposes. We consider the range included in the Social Security Administration of 1.80% to 3.00% to be reasonable and recommend lowering the inflation assumption for PSERS from 2.75% to 2.50%.

Price Inflation Assumption	
Current	2.75%
Recommended	2.50%

Investment Return

Background

The assumed investment return is one of the most significant assumptions in the annual actuarial valuation process as it is used to discount the expected benefit payments for all active, inactive and retired members. Minor changes in this assumption can have a major impact on valuation results. The investment return assumption should reflect the asset allocation target for the funds set by the Board of Trustees.

The current assumption is 7.50%, consisting of a price inflation assumption of 2.75% and a real rate of return assumption of 4.75%. The current PSERS funding policy states that the long-term expected return on assets assumption, which was set at 7.50% in the previous experience study, shall be reduced by 0.10% per year from the immediate prior valuation when the actual rate of return for the fiscal year exceeds the assumed rate. The minimum return assumption stated in the funding policy is 7.00%. The asset return assumption used in the most recent actuarial valuation is 7.30%.

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. For example, a newly, hired employee who is 25 years old may work for 35 years, to age 60, and live another 30 years, to age 90 (or longer). The retirement system would receive contributions for the first 35 years and then pay out benefits for the next 30 years. During the entire 65-year period, the system is investing assets related to 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 system like PSERS, 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.

Past Experience

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 assets for PSERS are valued using a widely accepted asset-smoothing methodology that fully recognizes the expected investment income and also recognizes 20% of each year's investment gain or loss (the difference between actual and expected investment income). The recent experience over the last five years is shown in the table below.

Year Ending 6/30	Actuarial Value	Market Value
2015	9.13%	3.73
2016	7.39	1.21
2017	7.90	12.41
2018	8.44	9.20
2019	6.65	6.75
Average	7.90%	6.66%

While important to review and analyze, historical returns over such a short time period are not credible for the purpose of setting the long-term assumed future rate of return.

Future Expectation Analysis

The Division of Investment Services (DIS) assists the PSERS Board with developing investment strategies and providing capital market assumptions for the PSERS portfolio. As part of their duties, DIS periodically performs asset-liability studies, along with comprehensive reviews of the expected return of the various asset classes in which the PSERS portfolio is invested. We believe it is appropriate to consider the results of DIS' work as one factor in assessing expected future returns.

We also recognize that there can be differences of opinion among investment professionals regarding future return expectations. Horizon Actuarial Services prepares an annual study in which they survey various investment advisors (35 were included in the 2020 study with a 10-year horizon) and provide ranges of results as well as averages. This information provides an additional perspective on what a broad group of investment experts anticipate for future investment returns.

Our forward-looking analysis used the real rates of return in the DIS capital market assumptions and the PSERS target asset allocation. Using statistical projections that assume investment returns approximately follow a lognormal distribution with no correlation between years, produces an expected range of real rates of return over a 50-year time horizon. Looking at one year's results produces a mean real return of 6.18%, but also has a high standard deviation or measurement of volatility. By expanding the time horizon, the real return does not change, 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	6.18%	13.90%	-15.04%	-3.58%	5.28%	14.95%	30.46%
5	5.46	6.15	-4.35	1.22	5.28	9.50	15.87
10	5.37	4.35	-1.62	2.39	5.28	8.25	12.66
20	5.32	3.07	0.35	3.23	5.28	7.37	10.45
30	5.31	2.51	1.24	3.60	5.28	6.98	9.48
40	5.30	2.17	1.77	3.82	5.28	6.75	8.91
50	5.30	1.94	2.13	3.98	5.28	6.59	8.52

The percentile results are the percentages of random returns over the time span shown that are expected to be less than the amount indicated. For example, for the 10-year time span, 5% of the resulting real rates of return will be below -1.62% 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 there will be a 25% chance that real returns will be below 3.98% and a 25% chance they will be above 6.59%. In other words, there is a 50% chance the real returns will be between 3.98% and 6.59%.

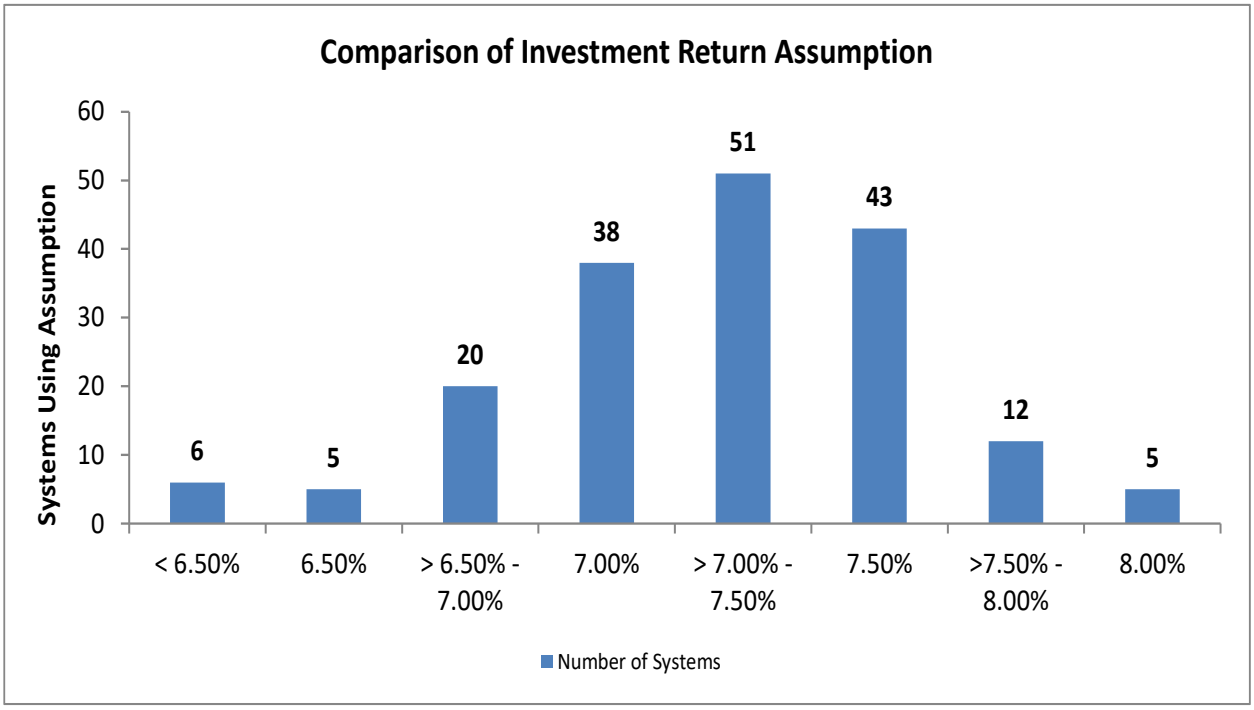
For a broader view of expected returns, we also reviewed the 2020 Survey of Capital Market Assumptions produced by Horizon Actuarial Services, LLC to see what other investment professionals are currently using for capital market assumptions. The Horizon survey includes both 10-year horizon and 20-year horizon capital market assumptions. We applied the same statistical analysis to these survey results as we did the capital market assumptions of DIS with the following real return results for the 20-year horizon:

Time Span In Years	Mean Real Return	Standard Deviation	Real Returns by Percentile				
			5th	25th	50th	75th	95th
1	4.85%	11.49%	-12.92%	-3.18%	4.22%	12.19%	24.74%
5	4.35	5.10	-3.82	0.84	4.22	7.71	12.94
10	4.28	3.60	-1.54	1.82	4.22	6.68	10.32
20	4.25	2.55	0.12	2.52	4.22	5.95	8.50
30	4.24	2.08	0.86	2.83	4.22	5.63	7.70
40	4.24	1.80	1.30	3.01	4.22	5.44	7.23
50	4.23	1.61	1.61	3.14	4.22	5.31	6.90

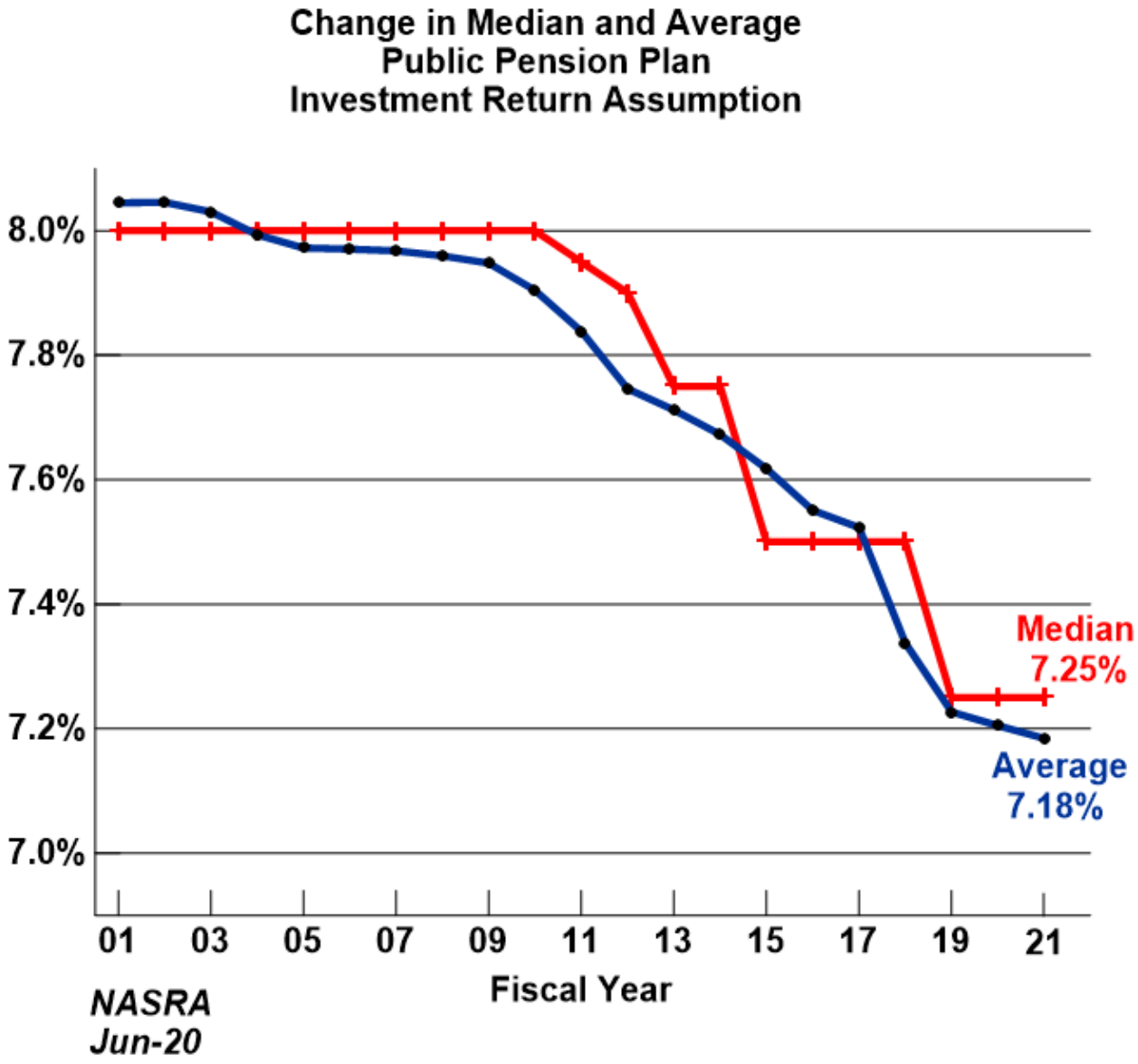
As can be seen from the Horizon survey analysis, the forecast shows that over a 50-year time span, there is a 50% chance that real returns will be between 3.14% and 5.31%. This is slightly lower than the results from DIS' analysis.

Peer Comparison

The following chart shows the nominal investment return assumptions of 180 plans in the Public Plan Database of the Center for Retirement Research. The assumptions are from FYE 2019 reporting.



The following chart shows the changes in expected investment return assumption from the NASRA public plan survey over the last 20 years from 2001.



Recommendation

By actuarial standards, we are required to maintain a long-term perspective in setting all assumptions, including the investment return assumption. Therefore, we believe we must be careful not to let recent experience or the short-term expectations impact our judgment regarding the appropriateness of the current assumption over the long term.

Based on our analysis of the DIS' capital market assumptions and the Horizon Survey capital market assumptions, we are recommending a reduction in the real return assumption from 4.75% to 4.50%. Based on our recommended inflation assumption of 2.50%, we are recommending a 7.00% expected long term nominal rate of return assumption.

Investment Return Assumption		
	Current*	**Recommended**
Real Rate of Return**	4.75%	4.50%
Inflation	2.75	2.50
Net Investment Return	7.50%	7.00%

* actual assumption for the 2019 valuation is 7.30% based on the Board funding policy
** net of investment expenses.

Actuarial Cost Method

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 (EAN) 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 PSERS.

The rationale of the (EAN funding method is that the cost of each member's benefit is determined to be a level dollar amount from date of hire to the end of employment. This level amount is referred to as the normal cost and is that portion of the total cost of the employee's benefit that is allocated to the current year. The portion of the present value of future benefits allocated to the future is determined by multiplying this amount times the present value of the member's probability of remaining an active member for all future years including the current year. The EAN 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 EAN actuarial accrued liability. The current year's cost to amortize the unfunded actuarial accrued liability is developed by applying an amortization factor based on the funding policy.

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 EAN cost method is the most commonly used cost method by public plans, that it 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 for PSERS.**

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 manipulate 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. The 5-year phase-in methodology that PSERS currently uses meets these rules and is, in fact, the most commonly used methodology for plans similar to PSERS.

Currently, the actuarial value of assets recognizes a portion of the difference between the market value of assets and the expected market value of assets, based on the assumed valuation rate of return. The amount recognized each year is 20% of the difference between market value and expected market value. **We recommend no change in this methodology.**

Amortization of the Unfunded Actuarial Accrued Liability

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

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

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

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

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

Amortization Payment: The level dollar amortization method is similar to the method in which a homeowner pays off a mortgage. The liability, once calculated, is financed by a constant fixed dollar amount, based on the amortization period until the liability is extinguished. This results in the liability steadily decreasing while the payments remain level in dollar terms.

Amortization Bases: The UAAL can be amortized either 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 the outstanding amortization bases on the valuation date and the UAAL payment is the sum of all the amortization payments on the existing amortization bases. This approach provides transparency in that the current UAAL is paid off over a fixed period 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.

Recommendation

In the current PSERS Board funding policy, an actuarially determined employer contribution (ADEC) is calculated during each annual valuation. The methodology in calculating the ADEC is as follows:

- Amortization Period – Closed period with maximum period of 25 years for new bases
- Amortization Payment – Level dollar
- Amortization Bases – Separate bases for all experience gains and losses, assumption changes or benefit changes

We recommend no changes in these methods.

Section V – Demographic Assumptions

There are several demographic assumptions used in the actuarial valuations performed for Georgia PSERS. They are:

- Rates of Withdrawal
- Rates of Disability Retirement
- Rates of Service Retirement
- Rates of Mortality

Actuarial Standard of Practice (ASOP) No. 35, *"Selection of Demographic and Other Noneconomic Assumptions for Measuring Pension Obligations"*, provides guidance to actuaries in selecting demographic assumptions for measuring obligations under defined benefit plans. In our opinion, the demographic assumptions recommended in this report have been developed in accordance with ASOP No. 35.

The purpose of a study of demographic experience is to compare what actually happened to the membership during the study period (July 1, 2014 through June 30, 2019) with what was expected to happen based on the assumptions used in the most recent Actuarial Valuations.

Detailed tabulations by age, service and/or gender are performed over the entire study period. These tabulations look at all active and retired members during the period as well as separately annotating those who experience a demographic event, also referred to as a decrement. In addition, the tabulation of all members together with the current assumptions permits the calculation of the number of expected decrements during the study period.

If the actual experience differs significantly from the overall expected results, or if the pattern of actual decrements, or rates of decrement, by age, gender, or service does not follow the expected pattern, new assumptions are recommended. Recommended changes usually do not follow the exact actual experience during the observation period. Judgment is required to extrapolate future experience from past trends and current member behavior. In addition, non-recurring events, such as early retirement windows, need to be taken into account in determining the weight to give to recent experience.

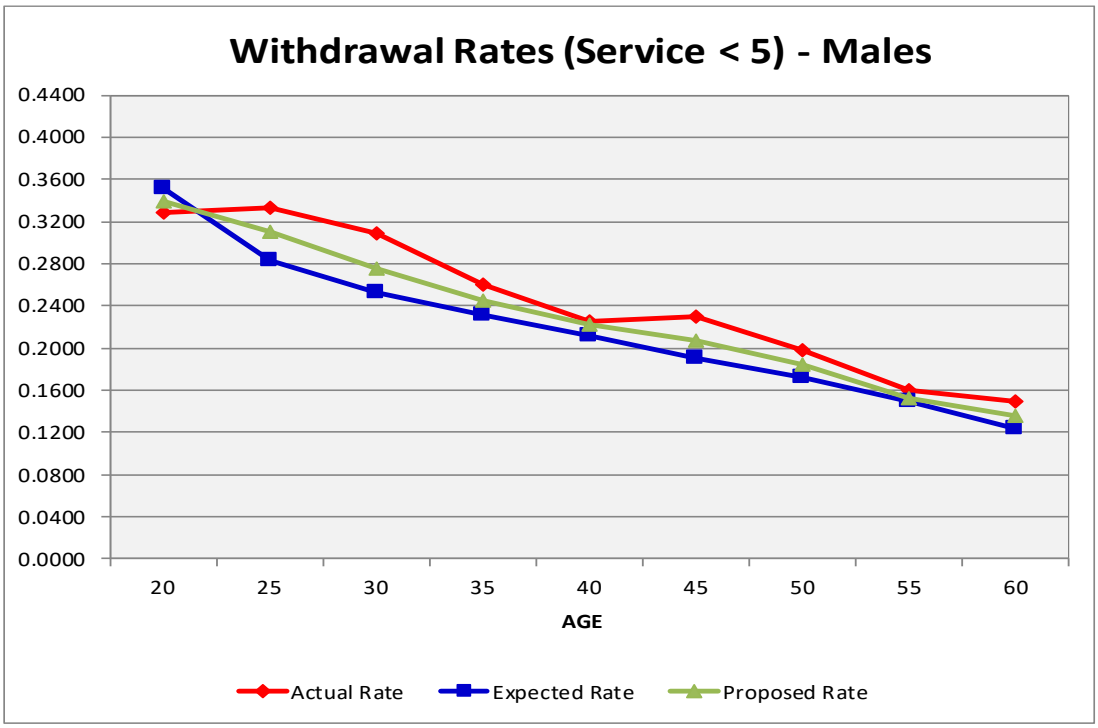
The remainder of this section presents the results of the demographic study. We have prepared tables that show a comparison of the actual and expected decrements and the overall ratio of actual to expected results (A/E Ratios) under the current assumptions. If a change is being proposed, the revised A/E Ratios are shown as well.

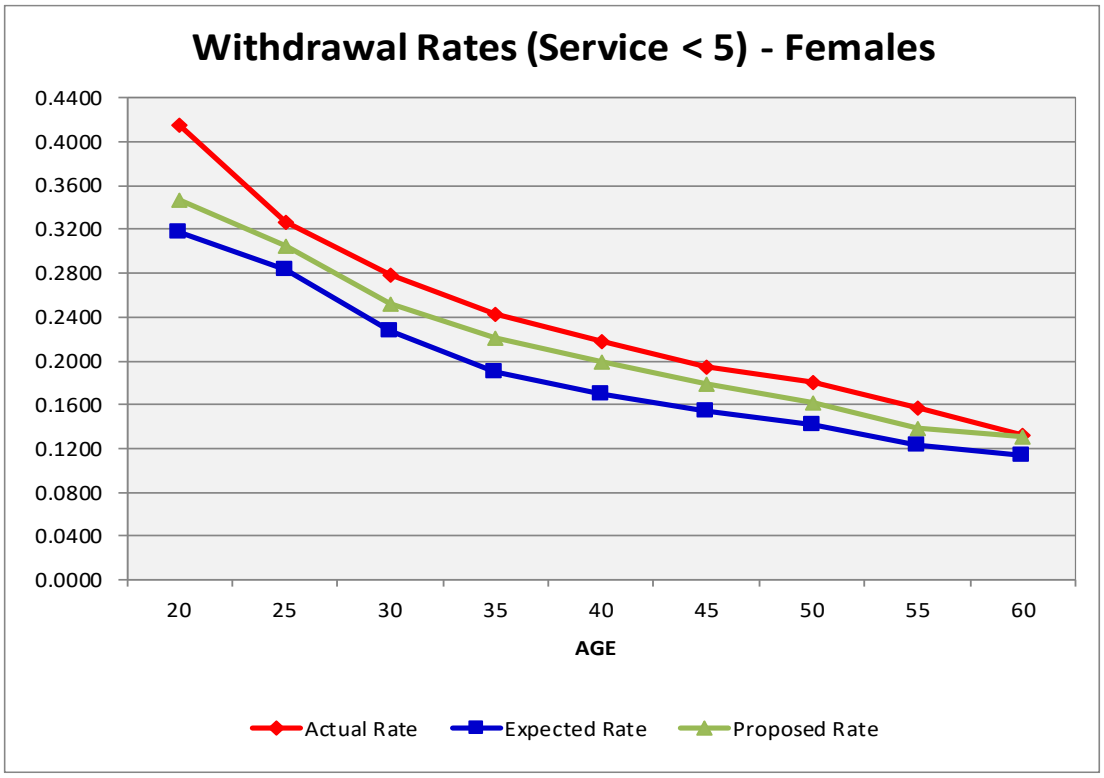
RATES OF WITHDRAWAL

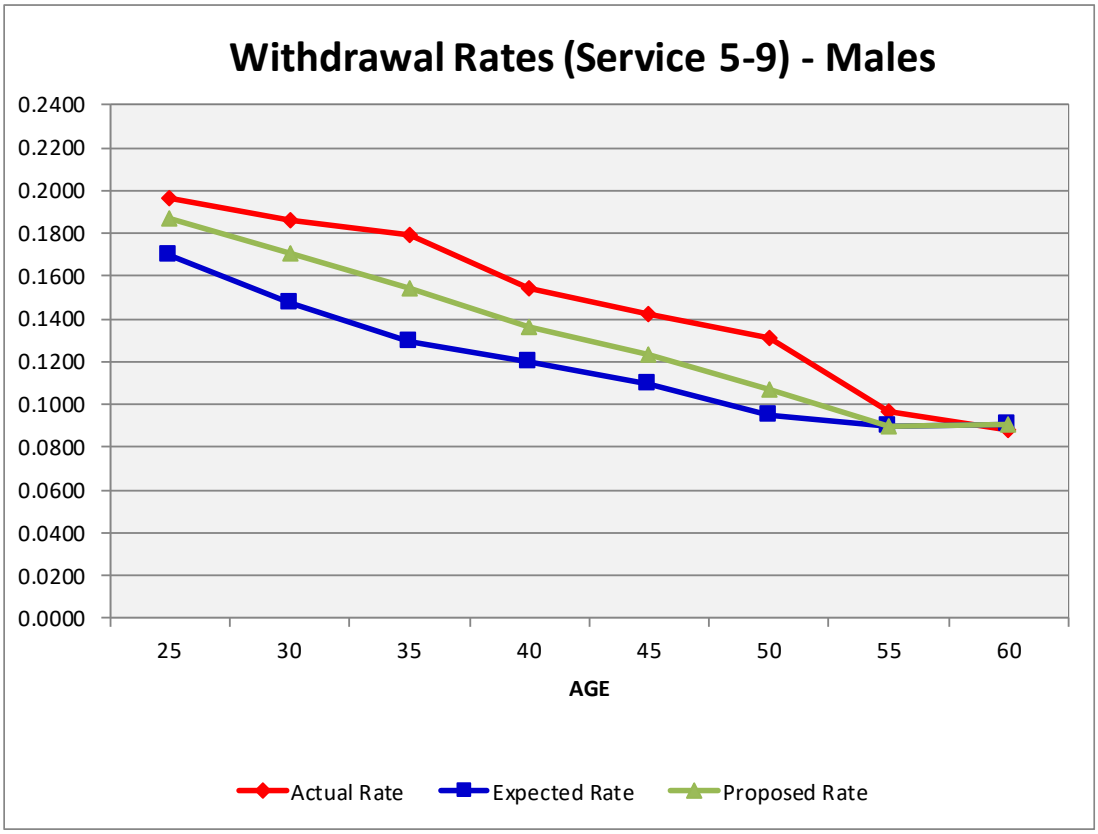
COMPARISON OF ACTUAL AND EXPECTED WITHDRAWALS FROM ACTIVE SERVICE

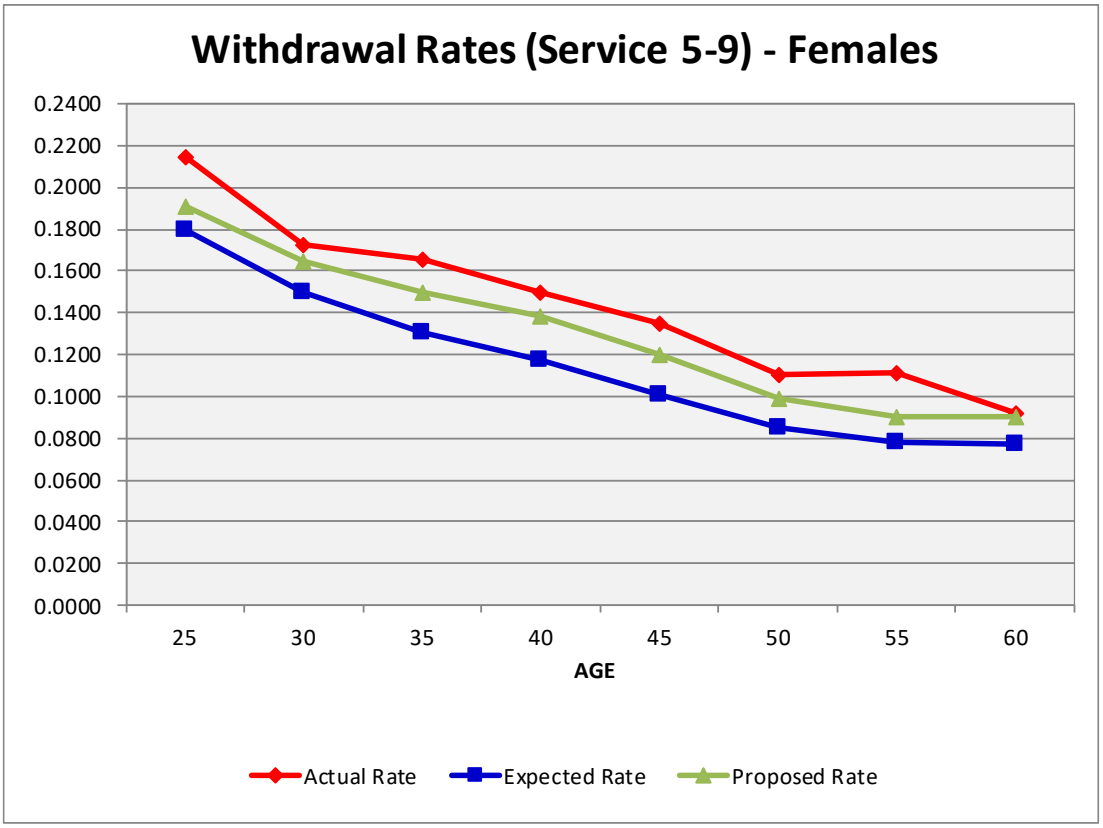
CENTRAL AGE OF GROUP	NUMBER OF WITHDRAWALS					
	MALE			FEMALE		
	Actual	Expected	Ratio of Actual to Expected	Actual	Expected	Ratio of Actual to Expected
	Withdrawals with less than 5 years of service					
20	119	127.6	0.933	117	89.6	1.306
25	488	415.0	1.176	586	508.0	1.154
30	457	373.5	1.224	981	797.2	1.231
35	400	355.4	1.125	1,160	907.8	1.278
40	388	364.0	1.066	1,171	915.1	1.280
45	485	401.1	1.209	1,199	954.4	1.256
50	516	445.8	1.157	1,076	844.3	1.274
55	502	470.8	1.066	965	756.8	1.275
60	504	414.8	1.215	622	531.8	1.170
63 & Over	729	632.8	1.152	554	408.8	1.355
TOTAL	**4,588**	**4,000.8**	**1.147**	**8,431**	**6,713.8**	**1.256**
	Withdrawals with at least 5 but less than 10 years of service					
25	24	20.7	1.159	21	17.6	1.193
30	97	76.9	1.261	108	93.9	1.150
35	104	75.1	1.385	258	203.3	1.269
40	116	90.0	1.289	400	313.8	1.275
45	145	112.1	1.293	540	403.8	1.337
50	213	154.6	1.378	529	406.3	1.302
55	208	193.1	1.077	552	387.6	1.424
60	214	222.2	0.963	413	343.6	1.202
63 & Over	601	516.2	1.164	616	396.5	1.554
TOTAL	**1,722**	**1,460.9**	**1.179**	**3,437**	**2,566.4**	**1.339**
	Withdrawals with 10 or greater years of service					
30	15	13.9	1.079	6	5.5	1.091
35	37	36.5	1.014	49	50.0	0.980
40	56	47.7	1.174	172	143.0	1.203
45	84	75.7	1.110	413	329.9	1.252
50	163	138.2	1.179	682	521.5	1.308
55	205	186.8	1.097	779	632.0	1.233
58 & Over	80	64.8	1.235	287	215.3	1.333
TOTAL	**640**	**563.6**	**1.136**	**2,388**	**1,897.2**	**1.259**

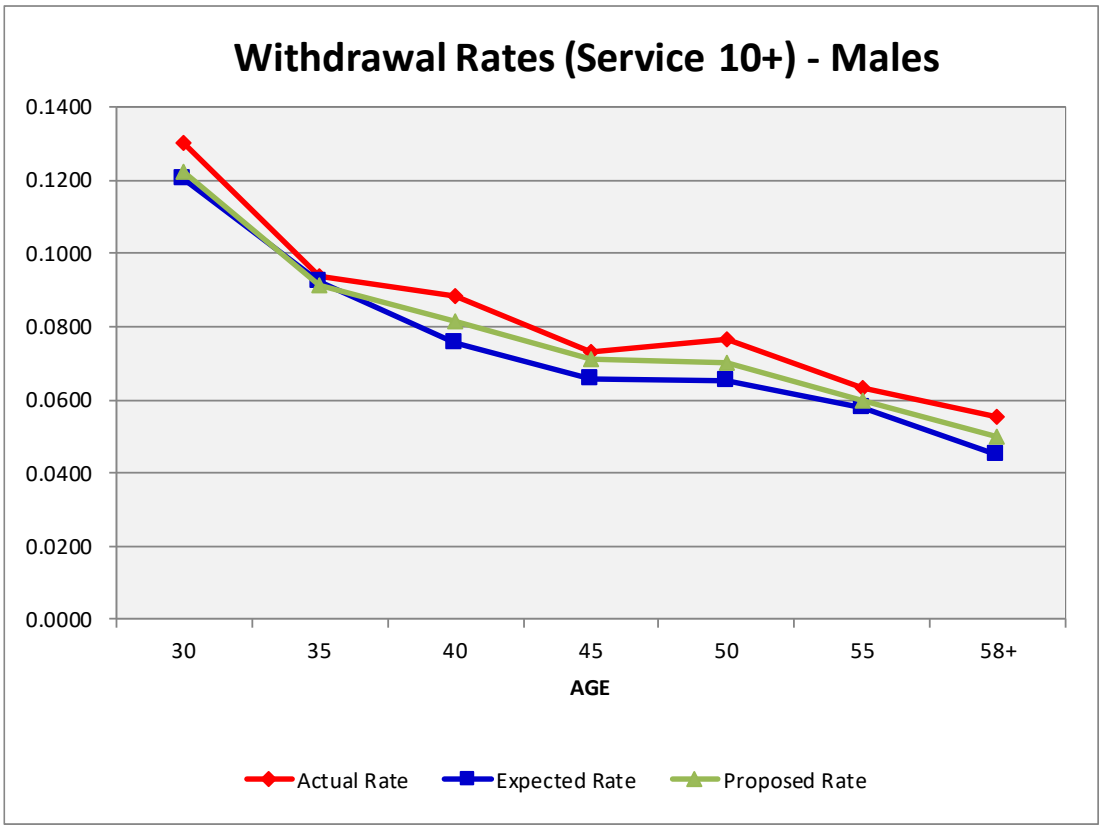
The following graphs show a comparison of the current expected, actual, and proposed rates of withdrawal for actives.

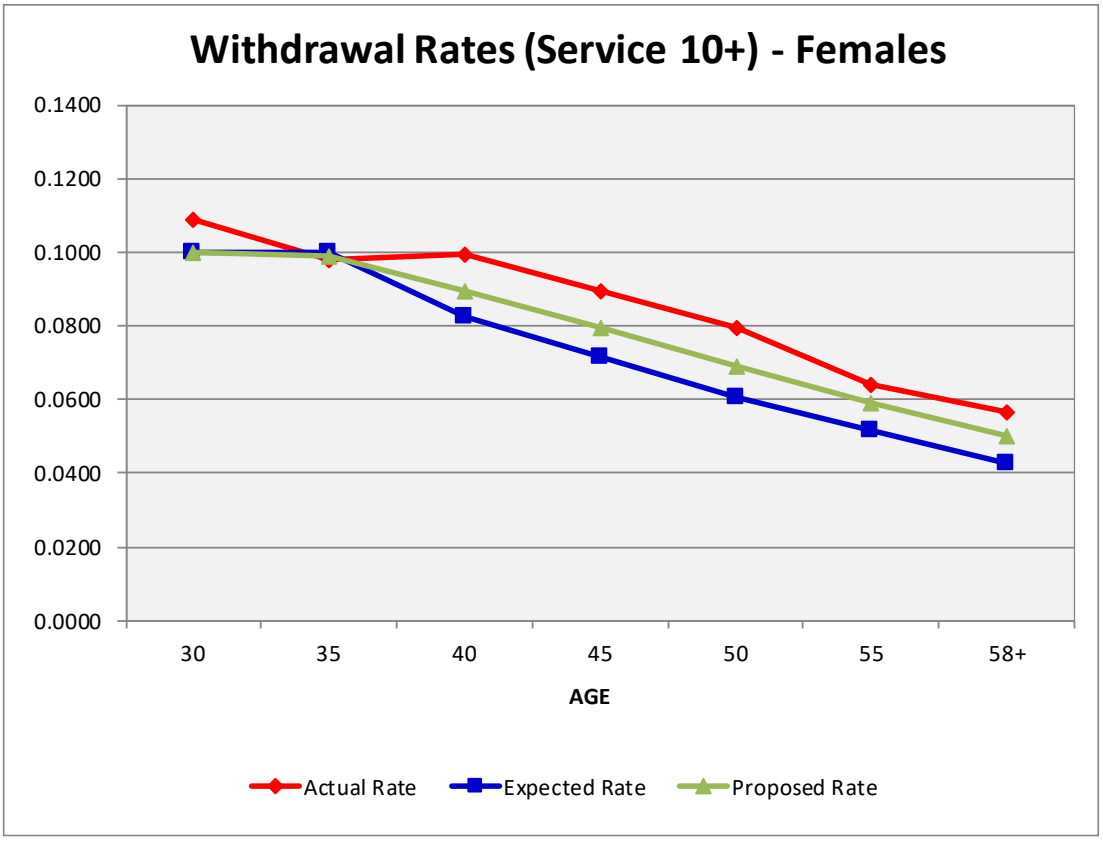





Withdrawal Rates (Service 5-9) - Males
0.2400
0.2200
0.2000
0.1800
0.1600
0.1400
0.1200
0.1000
0.0800
0.0600
0.0400
0.0200
0.0000
25
30
35
40
45
50
55
60
AGE
Actual Rate
Expected Rate
Proposed Rate


Withdrawal Rates (Service 5-9) - Females
0.2400
0.2200
0.2000
0.1800
0.1600
0.1400
0.1200
0.1000
0.0800
0.0600
0.0400
0.0200
0.0000
25
30
35
40
45
50
55
60
AGE
Actual Rate
Expected Rate
Proposed Rate


Withdrawal Rates (Service 10+) - Males
0.1400
0.1200
0.1000
0.0800
0.0600
0.0400
0.0200
0.0000
30
35
40
45
50
55
58+
AGE
Actual Rate
Expected Rate
Proposed Rate


Withdrawal Rates (Service 10+) - Females
0.1400
0.1200
0.1000
0.0800
0.0600
0.0400
0.0200
0.0000
30
35
40
45
50
55
58+
AGE
Actual Rate
Expected Rate
Proposed Rate

The rates of withdrawal adopted by the Board are used to determine the expected number of separations from active service which will occur as a result of resignation or dismissal. The preceding results indicate that during the study period the number of withdrawals varied from the expected in many age categories. We recommend that the rates of withdrawal be revised at this time to more closely reflect the experience of the System and maintain a degree of conservatism.

COMPARATIVE RATES OF WITHDRAWAL
FROM ACTIVE SERVICE

AGE	RATES OF WITHDRAWAL					
	Present			Proposed		
	Years Of Service			Years Of Service		
	0 - 4	5 - 9	10 +	0 - 4	5 - 9	10 +
	Male					
20	37.00%			34.00%		
25	28.00%	17.00%		31.00%	19.00%	
30	25.00%	15.00%	12.00%	27.50%	17.00%	12.50%
35	23.00%	13.00%	9.00%	24.50%	15.50%	9.00%
40	21.00%	12.00%	7.50%	22.00%	13.50%	8.25%
45	19.00%	11.00%	6.50%	21.00%	12.50%	7.00%
50	17.00%	9.00%	6.50%	18.50%	11.00%	7.00%
55	15.00%	9.00%	6.00%	15.25%	9.00%	6.00%
60	12.00%	7.50%	0.00%	13.50%	9.00%	0.00%
64	13.50%	11.50%	0.00%	13.50%	9.50%	0.00%
	Female					
20	32.00%			35.00%		
25	28.00%	18.00%		31.00%	20.00%	
30	23.00%	15.00%	10.00%	25.00%	16.50%	10.00%
35	19.00%	13.00%	10.00%	22.00%	15.00%	10.00%
40	17.00%	12.00%	8.00%	20.00%	14.00%	9.00%
45	15.50%	10.00%	7.00%	18.00%	12.00%	8.00%
50	14.00%	8.50%	6.00%	16.25%	10.00%	7.00%
55	12.00%	8.00%	5.50%	13.50%	9.00%	6.00%
60	11.00%	7.50%	0.00%	13.00%	9.00%	0.00%
64	12.00%	9.00%	0.00%	13.00%	9.00%	0.00%

COMPARISON OF ACTUAL AND EXPECTED WITHDRAWALS BASED ON PROPOSED RATES

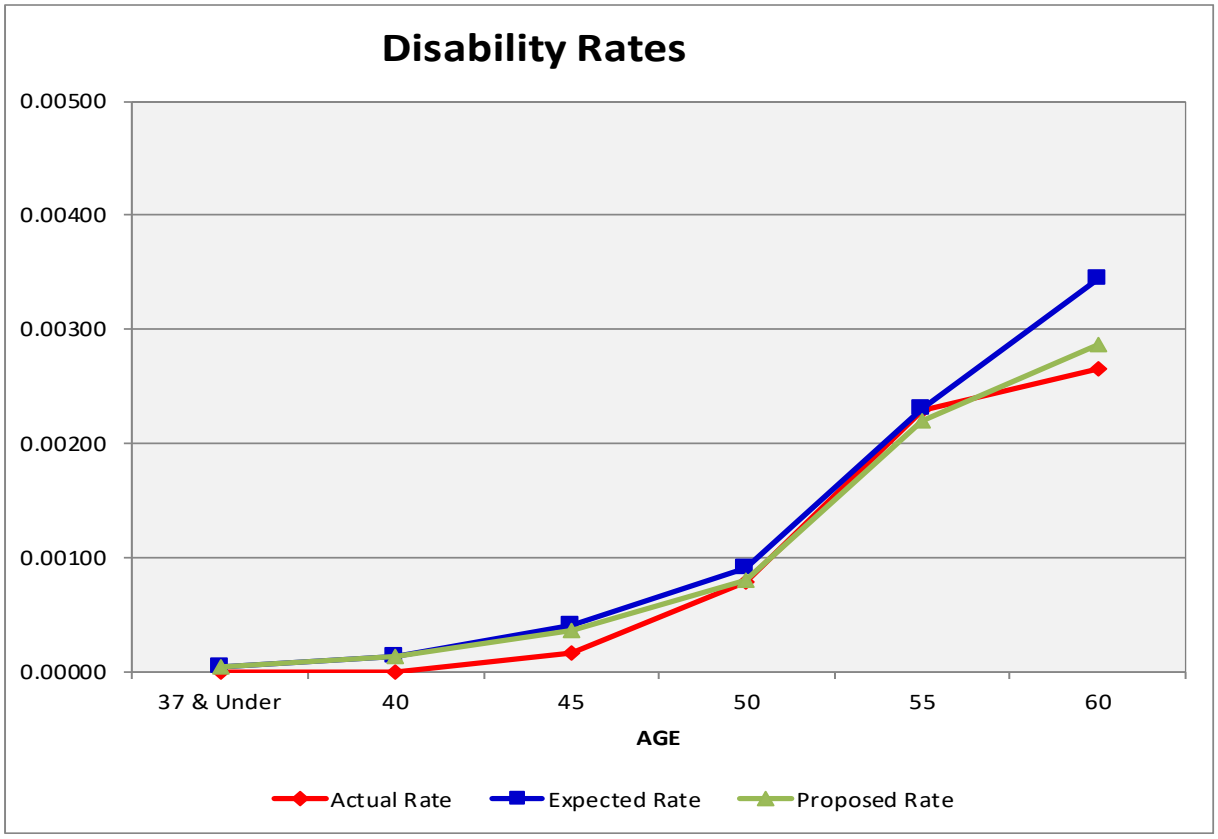
CENTRAL AGE OF GROUP	NUMBER OF WITHDRAWALS					
	MALE			FEMALE		
	Actual	Expected	Ratio of Actual to Expected	Actual	Expected	Ratio of Actual to Expected
	Withdrawals with less than 5 years of service					
20	119	123.1	0.967	117	98.0	1.194
25	488	454.6	1.073	586	548.4	1.069
30	457	408.1	1.120	981	887.3	1.106
35	400	376.2	1.063	1,160	1,056.7	1.098
40	388	381.1	1.018	1,171	1,077.3	1.087
45	485	436.5	1.111	1,199	1,104.4	1.086
50	516	480.6	1.074	1,076	964.2	1.116
55	502	479.9	1.046	965	846.9	1.139
60	504	455.3	1.107	622	609.8	1.020
63 & Over	729	632.8	1.152	554	442.9	1.251
TOTAL	**4,588**	**4,228.2**	**1.085**	**8,431**	**7,635.9**	**1.104**
	Withdrawals with at least 5 but less than 10 years of service					
25	24	22.8	1.053	21	18.7	1.123
30	97	88.7	1.094	108	103.4	1.044
35	104	89.3	1.165	258	234.0	1.103
40	116	102.1	1.136	400	368.8	1.085
45	145	125.5	1.155	540	480.3	1.124
50	213	173.4	1.228	529	474.6	1.115
55	208	193.1	1.077	552	447.3	1.234
60	214	222.1	0.964	413	402.8	1.025
63 & Over	601	426.4	1.409	616	396.5	1.554
TOTAL	**1,722**	**1,443.4**	**1.193**	**3,437**	**2,926.4**	**1.174**
	Withdrawals with 10 or greater years of service					
30	15	14.1	1.064	6	5.5	1.091
35	37	36.0	1.028	49	49.5	0.990
40	56	51.5	1.087	172	154.4	1.114
45	84	81.9	1.026	413	366.7	1.126
50	163	148.8	1.095	682	593.7	1.149
55	205	193.6	1.059	779	717.3	1.086
58 & Over	80	72.0	1.111	287	253.3	1.133
TOTAL	**640**	**597.9**	**1.070**	**2,388**	**2,140.4**	**1.116**

RATES OF DISABILITY RETIREMENT

COMPARISON OF ACTUAL AND EXPECTED DISABILITY RETIREMENTS

CENTRAL AGE OF GROUP	NUMBER OF DISABILITY RETIREMENTS		
	Actual	Expected	Ratio of Actual to Expected
37 & Under	0	0.4	0.000
40	0	1.8	0.000
45	3	7.8	0.385
50	20	23.4	0.855
55	73	73.5	0.993
60	82	106.4	0.771
TOTAL	**178**	**213.3**	**0.835**

The following graph shows a comparison of the current expected, actual, and proposed rates of disability retirement.



During the period under investigation, the actual rates of disability retirement were somewhat less than expected over all age groups. We recommend that the rates of disability be revised at this time to more closely reflect the experience of the System and maintain a degree of conservatism.

COMPARATIVE RATES OF DISABILITY RETIREMENT

AGE	RATES OF DISABILITY RETIREMENT	
	Present	Proposed
35	0.0025%	0.0018%
40	0.0110%	0.0110%
45	0.0370%	0.0330%
50	0.0865%	0.0770%
53	0.1750%	0.1490%
54	0.2000%	0.1700%
55	0.2250%	0.2250%
56	0.2500%	0.2500%
57	0.3000%	0.3000%
58	0.3250%	0.3250%
59	0.3500%	0.3500%
60	0.3500%	0.2500%
61	0.3500%	0.2500%
62	0.3500%	0.2500%
63	0.3500%	0.2500%
64	0.3500%	0.2500%

COMPARISON OF ACTUAL AND EXPECTED DISABILITY RETIREMENTS BASED ON PROPOSED RATES

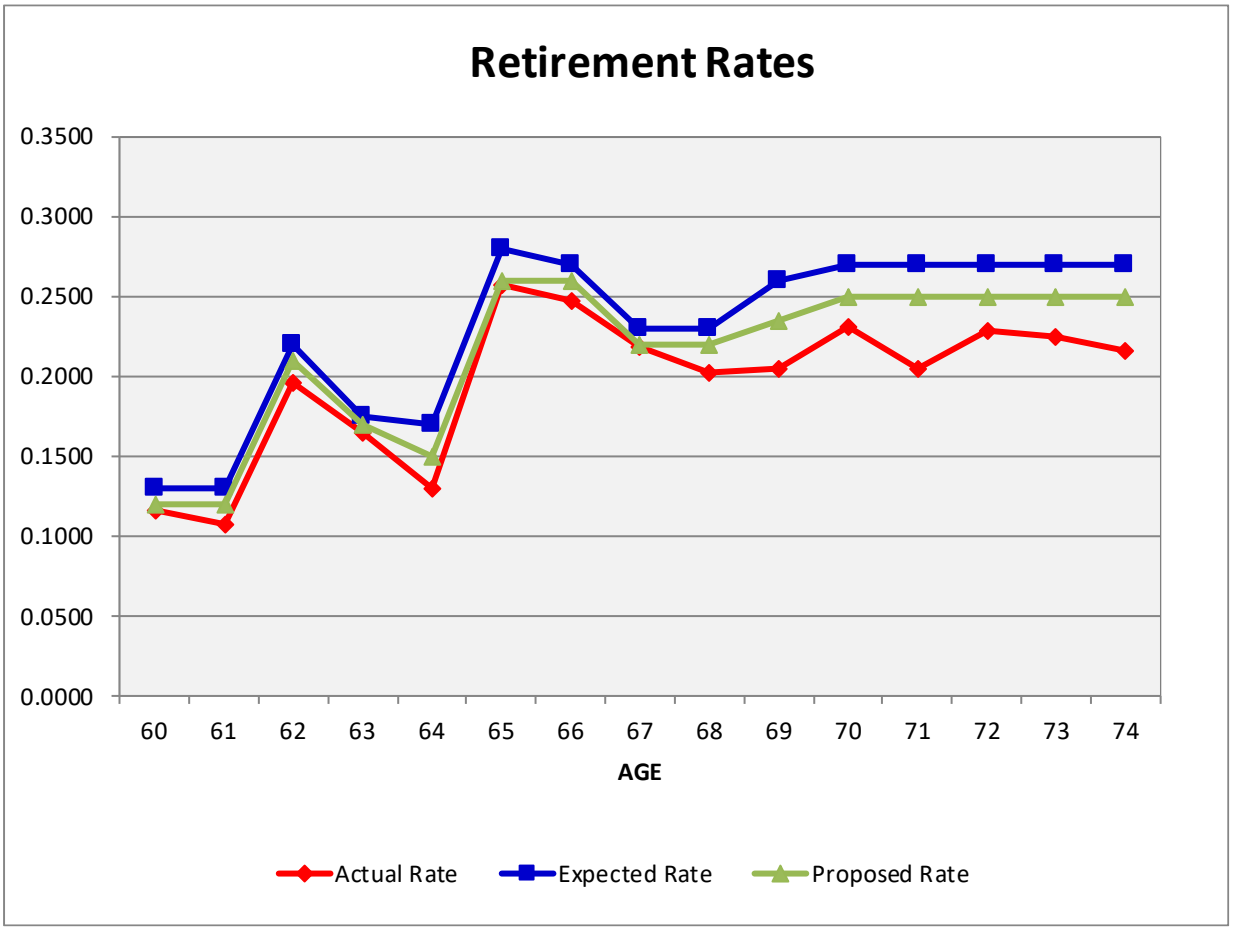
CENTRAL AGE OF GROUP	NUMBER OF DISABILITY RETIREMENTS		
	Actual	Expected	Ratio of Actual to Expected
37 & Under	0	0.4	0.000
40	0	1.7	0.000
45	3	7.0	0.429
50	20	20.4	0.980
55	73	70.0	1.043
60	82	88.4	0.928
TOTAL	**178**	**187.9**	**0.947**

RATES OF RETIREMENT

COMPARISON OF ACTUAL AND EXPECTED RETIREMENTS

AGE	NUMBER OF SERVICE RETIREMENTS		
	Actual	Expected	Ratio of Actual to Expected
60 & Under	384	428.0	0.897
61	334	406.8	0.821
62	577	648.1	0.890
63	402	427.2	0.941
64	287	376.9	0.761
65	535	584.1	0.916
66	424	462.5	0.917
67	312	328.2	0.951
68	262	298.8	0.877
69	237	301.9	0.785
70	242	283.8	0.853
71	185	244.1	0.758
72	173	204.4	0.846
73	144	172.8	0.833
74	118	147.7	0.799
SUBTOTAL	4,616	5,315.3	0.868
75 & Over	587	2,221.0	0.264
TOTAL	**5,203**	**7,536.3**	**0.690**

The following graph shows a comparison of the present, actual, and proposed rates of service retirements.



The analysis of the experience reflects that the current assumed rates of retirement were lower than expected at all ages. We recommend decreasing the rates to reflect the experience as well as extending the fixed retirement age from age 75 to age 80. These changes will continue to maintain a reasonable degree of margin.

The following table shows a comparison of the present and proposed rates of service retirement.

COMPARATIVE RATES OF RETIREMENT

AGE	RATES OF SERVICE RETIREMENT	
	Present	Proposed
60	13.0%	12.0%
61	13.0%	12.0%
62	22.0%	21.0%
63	17.5%	17.0%
64	17.0%	15.0%
65	28.0%	26.0%
66	27.0%	26.0%
67	23.0%	22.0%
68	23.0%	22.0%
69	26.0%	23.5%
70	27.0%	25.0%
71	27.0%	25.0%
72	27.0%	25.0%
73	27.0%	25.0%
74	27.0%	25.0%
75	100.0%	25.0%
76	100.0%	25.0%
77	100.0%	25.0%
78	100.0%	25.0%
79	100.0%	25.0%
80	100.0%	100.0%

COMPARISON OF ACTUAL AND EXPECTED RETIREMENTS BASED ON PROPOSED RATES OF RETIREMENT

AGE	NUMBER OF SERVICE RETIREMENTS		
	Actual	Expected	Ratio of Actual to Expected
60 & Under	384	395.0	0.972
61	334	375.5	0.889
62	577	618.7	0.933
63	402	415.0	0.969
64	287	332.6	0.863
65	535	542.4	0.986
66	424	445.4	0.952
67	312	313.9	0.994
68	262	285.8	0.917
69	237	272.9	0.868
70	242	262.8	0.921
71	185	226.0	0.819
72	173	189.3	0.914
73	144	160.0	0.900
74	118	136.8	0.863
75	117	120.3	0.973
76	97	100.5	0.965
77	68	82.8	0.821
78	62	70.0	0.886
79	68	58.5	1.162
SUBTOTAL	5,028	5,404.2	0.930
80 & Over	175	493.0	0.355
TOTAL	**5,203**	**5,897.2**	**0.882**

RATES OF MORTALITY

One of the most important demographic assumptions in the valuation is mortality because it projects how long benefit payments will be made. The longer members live, the greater the true cost of future benefit obligations will be.

For many years, rates of mortality have been declining, meaning people, in general, are living longer. Consequently, we anticipate that mortality tables will need to be updated periodically. Because of potential differences in mortality, we break down our study by gender (males and females) and by status (healthy retirees, beneficiaries, disabled retirees, and active members).

Because of the substantial amount of data required to construct a mortality table, actuaries usually rely on standard tables published by the Society of Actuaries. Actuaries then use various adjustments such as age or scaling adjustments to the standard, published mortality tables in order to better match the observed mortality rates of a specific group.

The first of these adjustments is an age adjustment that can be either a "setback" or a "set forward". A one-year age setback treats all members as if they were one year younger than they truly are when applying the rates in the mortality table. For example, a one year set back would treat a 61-year old retiree as if he will exhibit the mortality of a 60-year old in the standard mortality table.

The second adjustment that can be used to adjust the mortality rates in a standard table to better fit actual experience is to "scale" a mortality table by multiplying the probabilities of death by factors less than one (to reflect better mortality) or factors greater than one (to reflect poorer mortality). Scaling factors can be applied to an entire table or a portion of the table. Of course, if needed, actuaries may use both of these methods to develop an appropriate table to model the mortality of the specific plan population.

In 2019, the Society of Actuaries released a family of mortality tables named the Pub-2010 tables. While prior pension mortality tables have been based solely on private corporate and union retirement plans, these new tables are based entirely on public sector plan data. These tables are split by three membership types: Safety, Teachers, and General to reflect the observed differences in mortality patterns related to the three groups. Tables are further split for healthy retirees, disabled retirees, contingent beneficiaries, and employees. There are still other breakdowns in these tables for at, above or below median annuity values. We anticipate that this family of tables will be a good starting point in developing a recommended mortality assumption.

The issue of future mortality improvement is one that the actuarial profession has become increasingly focused on studying and monitoring. This has resulted in changes to the relevant Actuarial Standard of Practice, ASOP 35, *Selection of Demographic and Other Noneconomic*

Assumptions for Measuring Pension Obligations. This ASOP requires the pension actuary to make and disclose a specific recommendation with respect to future improvements in mortality after the valuation date, although it does not require that an actuary assume there will be future improvements. There have been significant improvements in longevity in the past, although there are different opinions about future expectations, and thus there is a subjective component in the estimation of future mortality improvement. We believe it is prudent to anticipate that the trend will continue to some degree in the future and that it is appropriate to reflect some future mortality improvement as part of the mortality assumption.

There are two, widely-used ways to reflect future improvements in mortality:

(1) Static table with "margin"
(2) Generational mortality

The first approach to reflecting mortality improvements is through the use of a static mortality table with "margin." Under this approach, the Actual to Expected Ratio is intentionally targeted to be over 100% so that mortality can improve without creating actuarial losses. This has been the approach used historically by many other systems because of its computational simplicity.

Another approach, referred to as generational mortality, directly anticipates future improvements in mortality by using a different set of mortality rates based on each year of birth, with the rates for later years of birth assuming lower mortality than the rates for earlier years of birth. The varying mortality rates by year of birth create a series of tables that contain "built-in" mortality improvements, e.g., a member who turns age 65 in 2035 has a longer life expectancy than a member who turns age 65 in 2020. When using generational mortality, the Actual to Expected Ratios for the observed experience are set near 100% as future mortality improvements will be taken into account directly in the actuarial valuation process. 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. Over the last 10-15 years, this method has become quite common as computing power has increased.

MORTALITY – Healthy Retirees

The valuation currently uses the same mortality assumption for all healthy members, including service retirees and beneficiaries. This table is divided for male and female members. The current underlying mortality table is from the Society of Actuaries RP-2000 table projected statically to 2025. For this study, we have reviewed service retirees separately from beneficiaries.

We also analyzed recent experience on a benefit-weighted basis where the exposures and deaths are multiplied by the monthly retirement benefit amount. This helps to reflect any differences that arise from better mortality experience among those with larger benefits. Because a valuation is designed to measure the amount and timing of future benefit payments (liability) rather than simply the number of retirees leaving pay status, this benefit-weighted approach is an important factor in valuing plan obligations. The Actual to Expected Ratios on the benefit-weighted basis were different from the Actual to Expected Ratios on a count basis, confirming that members with higher benefits also tend to have better mortality. Please note that we are not saying that larger benefits definitely lead to better mortality, but simply that there is a correlation between the two.

The Actual to Expected Ratios on a benefit-weighted basis are summarized and compared to those on a count basis in the following table. The fact that the ratios are lower on a weighted basis than on a count basis is an indication that individuals with larger benefits do indeed have slightly better mortality on average, as was anticipated. (Note that most mortality tables used by actuaries are developed on a weighted basis.)

The results of the experience study for healthy retirees ages 60 to 90, on a count and liability-weighted basis, are summarized in the following chart.

Healthy Retiree Deaths
A/E Ratio

	Count Basis	Liability-Weighted Basis
Male	103%	105%
Female	102%	104%

In order to more closely anticipate future liability experience, we believe that assigning more credibility to the benefit-weighted analysis is the better approach. Based on the observations summarized in the table above, we believe that mortality assumption changes are appropriate for PSERS. We believe the new Pub-2010 tables would be a good choice and we recommend changing the mortality basis for all the Systems so that all ERS can share a common family of tables. We also recommend the mortality improvement scale, MP-2019, be used to anticipate future mortality improvements in the valuation process through at least the next experience study.

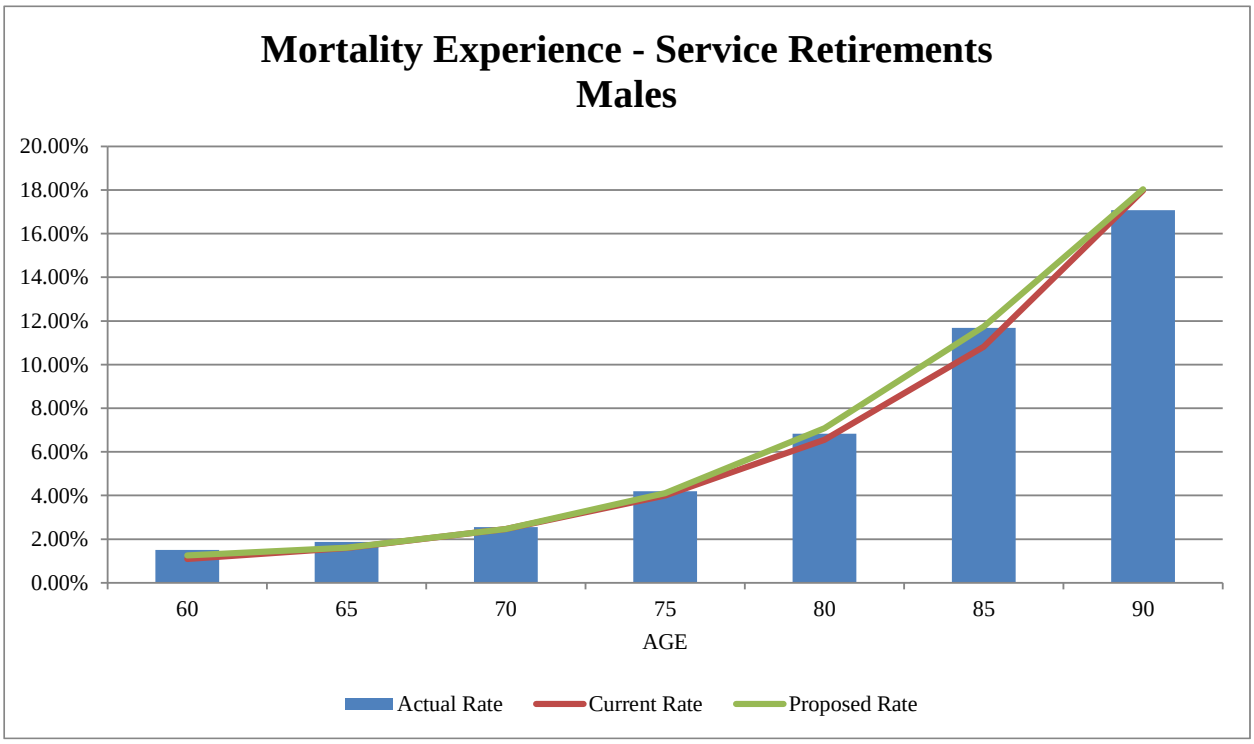
Therefore, our recommended mortality assumption for service retirees is based on the Pub-2010 Healthy Below-Median Annuitant Tables, with adjustments as outlined below to better fit actual experience, projected generationally with the MP-2019 scale.

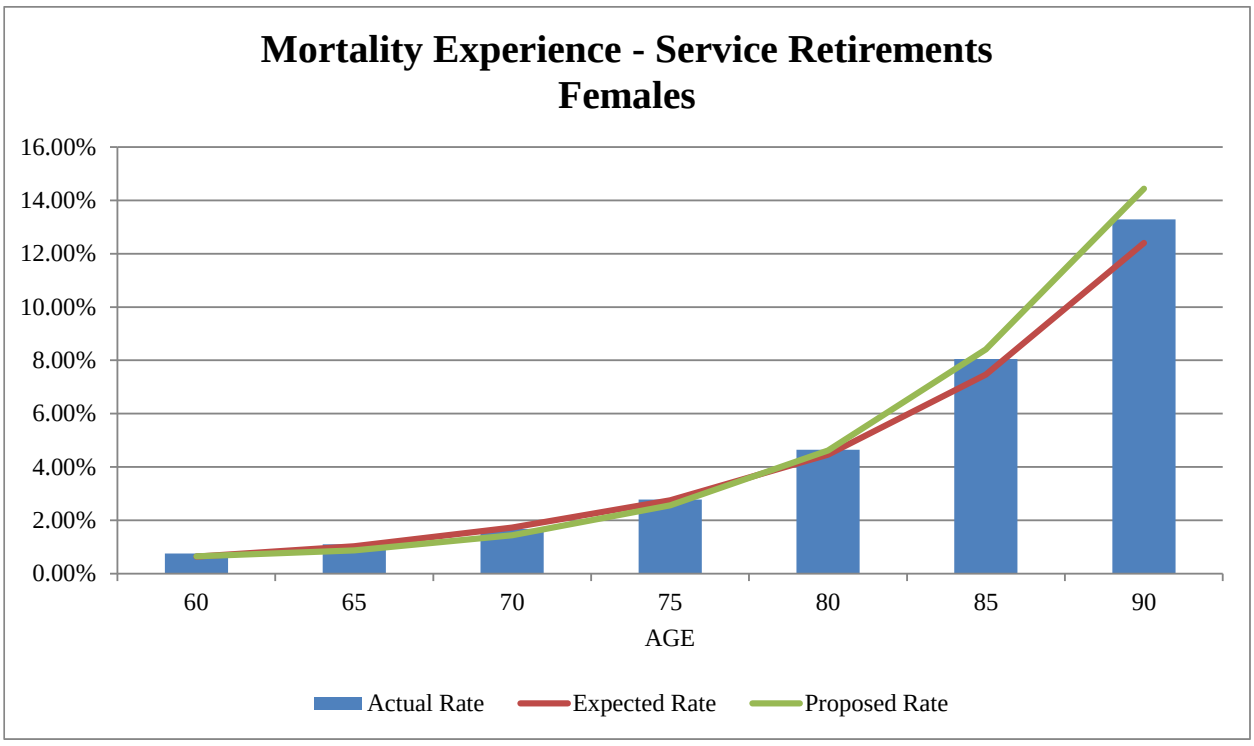
Group	Membership Table	Set Forward (+)/ Setback (-)	Adjustment to Rates
Service Retirees	General	Male: +2, Female: +2	Male: 101%, Female: 103%

The resulting Actual to Expected Ratios, based on the proposed assumption for ages 60 to 90, are shown in the following table.

Healthy Mortality A/E Ratios (Liability Weighted)		
	Current	Proposed
Male	105%	100%
Female	104	100

The resulting comparisons of rates of mortality are shown in the following graphs





MORTALITY – Beneficiaries

The mortality of beneficiaries applies to the survivors of members who retired with a joint and survivor option. There are fewer members receiving survivor benefits under the joint and survivor options, but we do believe that the data is still somewhat credible. The results are summarized in the following table:

Beneficiary Mortality A/E Ratios (Weighted)		
	Current	**Proposed**
Male	108%	101%
Female	109	100

We recommend the Pub-2010 Healthy Below-Median Contingent Survivors Tables be used with adjustments as outlined below to better fit actual experience, projected generationally with the MP-2019 scale.

Group	**Membership Table**	**Set Forward (+)/ Setback (-)**	**Adjustment to Rates**
Beneficiaries	General	Male: +2, Female: +2	Male: 104%, Female: 99%

MORTALITY – Disabled Retirees

The valuation assumes that disabled members, in general, will not live as long as retired members who met the regular service retirement eligibility. There tends to be more fluctuation in disabled mortality than healthy mortality because of differences in the types of disabilities. In addition, the smaller number of exposures makes the results more volatile. Unfortunately, the mortality for disabled members was not credible enough to warrant setting a mortality table to fit the PSERS experience. Therefore, we recommend using the same disabled mortality table for PSERS as recommended for ERS.

We recommend the Pub-2010 General Disabled Table be used with adjustments as outlined below to better fit actual experience, projected generationally with the MP-2019 scale.

Group	Membership Table	Set Forward (+)/ Setback (-)	Adjustment to Rates
Disabled Retirees	General	Male: -3, Female: 0	Male: 103%, Female: 106%

MORTALITY – Actives

The active member mortality assumption models eligibility for death benefits prior to retirement. Therefore, it has a much smaller impact on the valuation results than the post-retirement mortality assumption.

It is difficult to isolate the mortality for active members as it may be impacted by active members first terminating or moving to disabled status before death. The data collection methods used in this study do not fully capture known deaths, and so can be misleading. Finally, the probability of active death is very small so volatility is not uncommon. Consequently, we prefer to set this assumption by utilizing the more reliable analysis performed on the retiree data.

Our recommended mortality assumption is based on the Pub-2010 Below-Median General Employee table, with no adjustments, projected generationally with the MP-2019 scale.

ADMINISTRATIVE EXPENSES: Currently, the method used for administrative expenses is to add the budgeted expenses for the fiscal year to the normal cost. **We recommend an expense assumption of $1,400,000 each year.**

COST OF LIVING: Currently, we assume cost of living increases of 1.5% semi-annually. **We recommend maintaining this assumption.**

OPTION FACTORS: The option factors currently used by the Retirement System are based on the mortality tables and investment rate of return (discount rate) used in the valuation. **We recommend that the factors be revised to the mortality table recommended in this experience study.**

ASSUMPTION FOR ACTIVE VESTED MEMBERS TERMINATION BENEFITS: Currently, we assume that 50% of active members who terminate with ten or more years of service before retirement will receive a benefit beginning at age 65 and 50% will receive a refund of member contributions. **We recommend changing this to assume that 75% will receive a benefit beginning at age 65 and 25% will receive a refund of member contributions**

Appendix A – Historical June CPI(U) Index

Year	CPI (U)	Year	CPI (U)
1961	29.8	1991	136.0
1962	30.2	1992	140.2
1963	30.6	1993	144.4
1964	31.0	1994	148.0
1965	31.6	1995	152.5
1966	32.4	1996	156.7
1967	33.3	1997	160.3
1968	35.7	1998	163.0
1969	34.7	1999	166.2
1970	38.8	2000	172.4
1971	40.6	2001	178.0
1972	41.7	2002	179.9
1973	44.2	2003	183.7
1974	49.0	2004	189.7
1975	53.6	2005	194.5
1976	56.8	2006	202.9
1977	60.7	2007	208.352
1978	65.2	2008	218.815
1979	72.3	2009	215.693
1980	82.7	2010	217.965
1981	90.6	2011	225.722
1982	97.0	2012	229.478
1983	99.5	2013	233.504
1984	103.7	2014	238.343
1985	107.6	2015	238.638
1986	109.5	2016	241.018
1987	113.5	2017	244.955
1988	118.0	2018	251.989
1989	124.1	2019	256.143
1990	129.9	2020	257.797

As Provided by the System

Arithmetic Rates of Return and Standard Deviations by Asset Class

Asset Class	Expected Rate of Return*	Standard Deviation
Fixed Income	1.4%	2.3%
US Large Stocks	12.1%	19.8%
US Small Stocks	16.3%	31.5%
Int'l Developed Mkt Stocks	12.1%	21.8%
Int'l Emerging Mkt Stocks	13.3%	31.7%
Alternatives	13.5%	27.9%

*Includes 2.90% assumed inflation

Asset Class Correlation Coefficients

Asset Class	Fixed Income	US Large Stocks	US Small Stocks	Int'l Dev Mkt Stocks	Int'l EM Mkt Stocks	Alts
Fixed Income	1.00					
US Large Stocks	0.01	1.00				
US Small Stocks	(0.09)	0.79	1.00			
Int'l Developed Mkt Stocks	(0.11)	0.67	0.51	1.00		
Int'l Emerging Mkt Stocks	(0.11)	0.67	0.51	0.72	1.00	
Alternatives	0.31	0.74	0.74	0.64	0.62	1.00

Asset Allocation Targets

Asset Class	Asset Allocation
Fixed Income	30.0%
US Large Stocks	46.4%
US Small Stocks	1.1%
Int'l Developed Mkt Stocks	11.7%
Int'l Emerging Mkt Stocks	5.8%
Alternatives	5.0%

As Determined by the 2020 Horizon Actuarial Services, LLC. Survey of Capital Market Assumptions (20-year Horizon)

Arithmetic Rates of Return and Standard Deviations by Asset Class

Asset Class	Expected Rate of Return*	Standard Deviation
Fixed Income	2.28%	1.78%
US Large Stocks	8.36%	16.22%
US Small Stocks	9.54%	20.22%
Int'l Developed Mkt Stocks	9.09%	18.05%
Int'l Emerging Mkt Stocks	11.33%	24.23%
Alternatives (Private Equity)	12.54%	21.99%

*Includes 2.17% assumed inflation

Asset Class Correlation Coefficients

Asset Class	Fixed Income	US Large Stocks	US Small Stocks	Int'l Dev Mkt Stocks	Int'l EM Mkt Stocks	Alts
Fixed Income	1.00					
US Large Stocks	(0.08)	1.00				
US Small Stocks	(0.08)	0.89	1.00			
Int'l Developed Mkt Stocks	(0.07)	0.84	0.76	1.00		
Int'l Emerging Mkt Stocks	(0.06)	0.73	0.69	0.80	1.00	
Alternatives (Private Equity)	(0.06)	0.73	0.71	0.67	0.59	1.00

TABLE 1
RATES OF SEPARATION FROM ACTIVE SERVICE – MALES

AGE	Rates of Withdrawal Service 0 - 4	Rates of Withdrawal Service 5 - 9	Rates of Withdrawal Service 10+	Death	Disability	Retirement
19	0.34000			0.000400		
20	0.34000			0.000410		
21	0.34000			0.000420		
22	0.34000			0.000410		
23	0.33000	0.19000		0.000410		
24	0.32000	0.19000		0.000400		
25	0.31000	0.19000		0.000410		
26	0.30300	0.18700		0.000430		
27	0.29600	0.18500		0.000450		
28	0.28900	0.17900	0.14000	0.000470		
29	0.28200	0.17300	0.13500	0.000500		
30	0.27500	0.17000	0.12500	0.000520		
31	0.26900	0.16700	0.12200	0.000550	0.000005	
32	0.26300	0.16400	0.11900	0.000580	0.000005	
33	0.25700	0.16100	0.10000	0.000610	0.000009	
34	0.25100	0.15800	0.09500	0.000650	0.000014	
35	0.24500	0.15500	0.09000	0.000680	0.000018	
36	0.24000	0.15100	0.08850	0.000730	0.000036	
37	0.23500	0.14700	0.08700	0.000770	0.000054	
38	0.23000	0.14300	0.08550	0.000830	0.000072	
39	0.22500	0.13900	0.08400	0.000890	0.000090	
40	0.22000	0.13500	0.08250	0.000960	0.000110	
41	0.21800	0.13300	0.08000	0.001030	0.000154	
42	0.21600	0.13100	0.07750	0.001120	0.000198	
43	0.21400	0.12900	0.07500	0.001210	0.000242	
44	0.21200	0.12700	0.07250	0.001320	0.000286	
45	0.21000	0.12500	0.07000	0.001430	0.000330	
46	0.20200	0.12100	0.07000	0.001560	0.000420	
47	0.19900	0.11700	0.07000	0.001700	0.000510	
48	0.19400	0.11500	0.07000	0.001850	0.000600	
49	0.18900	0.11200	0.07000	0.002010	0.000690	
50	0.18500	0.11000	0.07000	0.002180	0.000770	
51	0.18100	0.10300	0.07000	0.002360	0.000870	
52	0.17700	0.09700	0.07000	0.002550	0.000990	
53	0.15250	0.09000	0.06500	0.002750	0.001490	
54	0.15250	0.09000	0.06000	0.002970	0.001700	
55	0.15250	0.09000	0.06000	0.003200	0.002250	
56	0.15250	0.09000	0.06000	0.003450	0.002500	
57	0.15250	0.09000	0.05500	0.003710	0.003000	
58	0.13500	0.09000	0.05000	0.004000	0.003250	
59	0.13500	0.09000	0.05000	0.004320	0.003500	
60	0.13500	0.09000		0.004660	0.002500	0.12000
61	0.13500	0.09000		0.005020	0.002500	0.12000
62	0.13500	0.09500		0.005420	0.002500	0.21000
63	0.13500	0.09500		0.005850	0.002500	0.17000
64	0.13500	0.09500		0.006310	0.002500	0.15000
65	0.13500	0.09500		0.006820		0.26000
66	0.13500	0.09500		0.007370		0.26000
67	0.13500	0.09500		0.007990		0.22000
68	0.13500	0.09500		0.008660		0.22000
69	0.13500	0.09500		0.009420		0.23500
70	0.13500	0.09500		0.010250		0.25000
71	0.13500	0.09500		0.011180		0.25000
72	0.13500	0.09500		0.012210		0.25000
73	0.13500	0.09500		0.013350		0.25000
74	0.13500	0.09500		0.014610		0.25000
75	0.13500	0.09500		0.015990		0.25000
76	0.13500	0.09500		0.017510		0.25000
77	0.13500	0.09500		0.019180		0.25000
78	0.13500	0.09500		0.021010		0.25000
79	0.13500	0.09500		0.023020		0.25000
80	0.00000	0.00000		0.025230		1.00000

***Base mortality rates as of 2010 before application of the improvement scale**

TABLE 2
RATES OF SEPARATION FROM ACTIVE SERVICE – FEMALES

AGE	Rates of Withdrawal Service 0 - 4	5 - 9	10+	Death	Disability	Retirement
19	0.35000			0.000140		
20	0.35000			0.000130		
21	0.35000			0.000130		
22	0.35000			0.000120		
23	0.33500	0.20000		0.000120		
24	0.32000	0.20000		0.000110		
25	0.31000	0.20000		0.000120		
26	0.29800	0.19300		0.000130		
27	0.28600	0.18600		0.000140		
28	0.27400	0.17900	0.10000	0.000160		
29	0.26200	0.17200	0.10000	0.000170		
30	0.25000	0.16500	0.10000	0.000190		
31	0.24400	0.16200	0.10000	0.000210	0.000005	
32	0.23800	0.15900	0.10000	0.000220	0.000005	
33	0.23200	0.15600	0.10000	0.000250	0.000009	
34	0.22600	0.15300	0.10000	0.000270	0.000014	
35	0.22000	0.15000	0.10000	0.000300	0.000018	
36	0.21600	0.14800	0.10000	0.000320	0.000036	
37	0.21200	0.14600	0.09700	0.000360	0.000054	
38	0.20800	0.14400	0.09500	0.000390	0.000072	
39	0.20400	0.14200	0.09300	0.000430	0.000090	
40	0.20000	0.14000	0.09000	0.000470	0.000110	
41	0.19600	0.13600	0.08800	0.000510	0.000154	
42	0.19200	0.13200	0.08600	0.000550	0.000198	
43	0.18800	0.12800	0.08400	0.000600	0.000242	
44	0.18400	0.12400	0.08200	0.000660	0.000286	
45	0.18000	0.12000	0.08000	0.000720	0.000330	
46	0.17500	0.11600	0.07800	0.000780	0.000420	
47	0.17000	0.11200	0.07600	0.000840	0.000510	
48	0.16750	0.10800	0.07400	0.000910	0.000600	
49	0.16500	0.10400	0.07200	0.000990	0.000690	
50	0.16250	0.10000	0.07000	0.001070	0.000770	
51	0.15500	0.09500	0.06750	0.001150	0.000870	
52	0.15500	0.09000	0.06500	0.001240	0.000990	
53	0.14900	0.09000	0.06250	0.001340	0.001490	
54	0.13500	0.09000	0.06000	0.001450	0.001700	
55	0.13500	0.09000	0.06000	0.001570	0.002250	
56	0.13500	0.09000	0.05750	0.001700	0.002500	
57	0.13500	0.09000	0.05500	0.001850	0.003000	
58	0.13000	0.09000	0.05000	0.002000	0.003250	
59	0.13000	0.09000	0.05000	0.002180	0.003500	
60	0.13000	0.09000		0.002380	0.002500	0.12000
61	0.13000	0.09000		0.002600	0.002500	0.12000
62	0.13000	0.09000		0.002850	0.002500	0.21000
63	0.13000	0.09000		0.003130	0.002500	0.17000
64	0.13000	0.09000		0.003440	0.002500	0.15000
65	0.13000	0.09000		0.003800		0.26000
66	0.13000	0.09000		0.004190		0.26000
67	0.13000	0.09000		0.004630		0.22000
68	0.13000	0.09000		0.005120		0.22000
69	0.13000	0.09000		0.005670		0.23500
70	0.13000	0.09000		0.006270		0.25000
71	0.13000	0.09000		0.006930		0.25000
72	0.13000	0.09000		0.007670		0.25000
73	0.13000	0.09000		0.008480		0.25000
74	0.13000	0.09000		0.009370		0.25000
75	0.13000	0.09000		0.010360		0.25000
76	0.13000	0.09000		0.011450		0.25000
77	0.13000	0.09000		0.012650		0.25000
78	0.13000	0.09000		0.013970		0.25000
79	0.13000	0.09000		0.015430		0.25000
80	0.00000	0.00000		0.017050		1.00000

***Base mortality rates as of 2010 before application of the improvement scale**

TABLE 3
RATES OF MORTALITY FOR MEMBERS RETIRED ON ACCOUNT OF SERVICE*

AGE	MALES	FEMALES	AGE	MALES	FEMALES
19	0.000424	0.000134	71	0.028563	0.017108
20	0.000414	0.000124	72	0.031664	0.019137
21	0.000414	0.000124	73	0.035128	0.021403
22	0.000404	0.000113	74	0.039006	0.023937
23	0.000414	0.000124	75	0.043329	0.026770
24	0.000434	0.000134	76	0.048167	0.029973
25	0.000455	0.000144	77	0.053591	0.033578
26	0.000475	0.000165	78	0.059661	0.037677
27	0.000505	0.000175	79	0.066468	0.042354
28	0.000525	0.000196	80	0.074043	0.047679
29	0.000556	0.000216	81	0.082446	0.053766
30	0.000586	0.000227	82	0.091678	0.060708
31	0.000616	0.000258	83	0.101737	0.068629
32	0.000657	0.000278	84	0.112615	0.077662
33	0.000687	0.000309	85	0.124301	0.087849
34	0.000737	0.000330	86	0.136794	0.099220
35	0.000778	0.000371	87	0.150096	0.111734
36	0.000838	0.000402	88	0.164155	0.125289
37	0.000899	0.000443	89	0.178578	0.139328
38	0.000970	0.000484	90	0.193173	0.153594
39	0.001040	0.000525	91	0.207939	0.168034
40	0.001131	0.000567	92	0.222988	0.182763
41	0.001222	0.000618	93	0.238532	0.198018
42	0.001333	0.000680	94	0.254783	0.214065
43	0.001444	0.000742	95	0.271932	0.231173
44	0.001576	0.000803	96	0.290102	0.249528
45	0.001717	0.000865	97	0.309302	0.269191
46	0.001869	0.000937	98	0.329351	0.290048
47	0.002030	0.001020	99	0.349824	0.311730
48	0.007282	0.004326	100	0.370064	0.333535
49	0.007626	0.004429	101	0.389900	0.355288
50	0.007989	0.004532	102	0.409171	0.376784
51	0.008363	0.004635	103	0.427755	0.397838
52	0.008726	0.004738	104	0.445541	0.418273
53	0.009100	0.004841	105	0.462439	0.437946
54	0.009474	0.004934	106	0.478376	0.456712
55	0.009837	0.005037	107	0.493314	0.474490
56	0.010201	0.005150	108	0.505000	0.491207
57	0.010565	0.005305	109	0.505000	0.506811
58	0.010938	0.005490	110	0.505000	0.515000
59	0.011322	0.005727	111	0.505000	0.515000
60	0.011726	0.006015	112	0.505000	0.515000
61	0.012171	0.006355	113	0.505000	0.515000
62	0.012655	0.006736	114	0.505000	0.515000
63	0.013211	0.007159	115	0.505000	0.515000
64	0.014372	0.007941	116	0.505000	0.515000
65	0.015736	0.008827	117	0.505000	0.515000
66	0.017291	0.009837	118	1.000000	1.000000
67	0.019069	0.010970	119	1.000000	1.000000
68	0.021069	0.012247	120	1.000000	1.000000
69	0.023301	0.013689			
70	0.025785	0.015296			

***Base mortality rates as of 2010 before application of the improvement scale**

TABLE 4
RATES OF MORTALITY FOR BENEFICIARIES OF DECEASED MEMBERS*

AGE	MALES	FEMALES	AGE	MALES	FEMALES
19	0.000437	0.000129	71	0.033498	0.022523
20	0.000426	0.000119	72	0.036566	0.024512
21	0.000426	0.000119	73	0.039894	0.026720
22	0.000416	0.000109	74	0.043503	0.029165
23	0.000426	0.000119	75	0.047414	0.031878
24	0.000447	0.000129	76	0.051698	0.034917
25	0.000468	0.000139	77	0.056410	0.038313
26	0.000489	0.000158	78	0.061630	0.042154
27	0.000520	0.000168	79	0.067454	0.046510
28	0.000541	0.000188	80	0.073944	0.051450
29	0.000572	0.000208	81	0.081141	0.057044
30	0.000603	0.000218	82	0.089118	0.063380
31	0.000634	0.000248	83	0.097906	0.070557
32	0.000676	0.000267	84	0.107578	0.078656
33	0.000707	0.000297	85	0.118154	0.087684
34	0.000759	0.000317	86	0.129667	0.097584
35	0.000801	0.000356	87	0.142230	0.108237
36	0.000863	0.000386	88	0.157154	0.119434
37	0.000926	0.000426	89	0.173399	0.131254
38	0.000998	0.000465	90	0.190320	0.143778
39	0.001071	0.000505	91	0.207542	0.157113
40	0.001165	0.000545	92	0.224942	0.171369
41	0.001258	0.000594	93	0.242559	0.186635
42	0.001373	0.000653	94	0.260551	0.202980
43	0.007623	0.004594	95	0.279105	0.220433
44	0.007904	0.004742	96	0.298366	0.238966
45	0.008195	0.004881	97	0.318406	0.258479
46	0.008486	0.005029	98	0.339134	0.278784
47	0.008788	0.005178	99	0.360214	0.299624
48	0.009474	0.005316	100	0.381056	0.320582
49	0.009724	0.005613	101	0.401482	0.341491
50	0.009984	0.005930	102	0.421325	0.362152
51	0.010244	0.006257	103	0.440461	0.382388
52	0.010525	0.006603	104	0.458775	0.402029
53	0.010837	0.006970	105	0.476174	0.420938
54	0.011159	0.007346	106	0.492586	0.438976
55	0.011523	0.007742	107	0.507967	0.456063
56	0.011929	0.008168	108	0.520000	0.472131
57	0.012397	0.008623	109	0.520000	0.487130
58	0.012927	0.009118	110	0.520000	0.495000
59	0.013541	0.009653	111	0.520000	0.495000
60	0.014258	0.010237	112	0.520000	0.495000
61	0.015080	0.010870	113	0.520000	0.495000
62	0.016047	0.011563	114	0.520000	0.495000
63	0.017160	0.012306	115	0.520000	0.495000
64	0.018470	0.013187	116	0.520000	0.495000
65	0.019978	0.014147	117	0.520000	0.495000
66	0.021694	0.015197	118	1.000000	1.000000
67	0.023618	0.016365	119	1.000000	1.000000
68	0.025750	0.017662	120	1.000000	1.000000
69	0.028111	0.019117			
70	0.030680	0.020731			

***Base mortality rates as of 2010 before application of the improvement scale**

TABLE 5
RATES OF MORTALITY FOR MEMBERS RETIRED ON ACCOUNT OF DISABILITY*

AGE	MALES	FEMALES	AGE	MALES	FEMALES
19	0.000237	0.002597	71	0.036297	0.032213
20	0.000319	0.002470	72	0.038172	0.034333
21	0.004151	0.002279	73	0.040180	0.036718
22	0.004336	0.002056	74	0.042364	0.039411
23	0.004244	0.001866	75	0.044743	0.042432
24	0.003976	0.001738	76	0.047370	0.045813
25	0.003626	0.001738	77	0.050264	0.049587
26	0.003255	0.001897	78	0.053478	0.053795
27	0.002977	0.002078	79	0.057031	0.058480
28	0.002863	0.002279	80	0.060986	0.063674
29	0.003008	0.002491	81	0.065374	0.069430
30	0.003152	0.002724	82	0.070267	0.075790
31	0.003306	0.002979	83	0.075684	0.082797
32	0.003471	0.003254	84	0.081669	0.090482
33	0.003646	0.003562	85	0.088220	0.098909
34	0.003832	0.003890	86	0.095368	0.107728
35	0.004027	0.004251	87	0.103103	0.116748
36	0.004233	0.004643	88	0.111395	0.125907
37	0.004470	0.005077	89	0.120283	0.135224
38	0.004717	0.005554	90	0.129831	0.144849
39	0.005006	0.006084	91	0.140111	0.154940
40	0.005335	0.006667	92	0.153068	0.165731
41	0.005717	0.007303	93	0.167406	0.177444
42	0.006149	0.007992	94	0.182114	0.190323
43	0.006644	0.008745	95	0.196998	0.204559
44	0.007210	0.009561	96	0.212056	0.220310
45	0.007859	0.010441	97	0.227403	0.237906
46	0.008590	0.011374	98	0.243255	0.256796
47	0.009435	0.012370	99	0.259828	0.277031
48	0.010372	0.013430	100	0.277317	0.298496
49	0.011423	0.014554	101	0.295847	0.320809
50	0.012576	0.015720	102	0.315427	0.343249
51	0.013823	0.016271	103	0.335873	0.365636
52	0.015141	0.016822	104	0.356751	0.387759
53	0.016531	0.017384	105	0.377392	0.409425
54	0.017634	0.017935	106	0.397621	0.430455
55	0.018725	0.018465	107	0.417274	0.450701
56	0.019786	0.018963	108	0.436226	0.470015
57	0.020806	0.019430	109	0.454364	0.488310
58	0.021774	0.019864	110	0.471596	0.505514
59	0.022670	0.020288	111	0.487849	0.521573
60	0.023484	0.020734	112	0.503083	0.530000
61	0.024257	0.021200	113	0.515000	0.530000
62	0.025008	0.021741	114	0.515000	0.530000
63	0.025781	0.022366	115	0.515000	0.530000
64	0.026615	0.023087	116	0.515000	0.530000
65	0.027573	0.023914	117	0.515000	0.530000
66	0.028686	0.024868	118	0.515000	0.530000
67	0.029952	0.025970	119	0.515000	0.530000
68	0.031353	0.027231	120	1.000000	1.000000
69	0.032888	0.028684			
70	0.034536	0.030337			

***Base mortality rates as of 2010 before application of the improvement scale**