



**Cavanaugh Macdonald**  
CONSULTING, LLC  
*The experience and dedication you deserve*



**Retirement System for Employees of the  
City of Cincinnati**

**Experience Investigation for the  
Five-Year Period  
Ending December 31, 2016**

**Approved by the Board of Trustees  
on March 1, 2018**





# Cavanaugh Macdonald

CONSULTING, LLC

*The experience and dedication you deserve*

February 27, 2018

Board of Trustees  
Cincinnati Retirement System  
801 Plum Street, Suite 328  
Cincinnati, OH 45202

Members of the Board:

We are pleased to submit the results of an investigation of the economic and demographic experience for the Cincinnati Retirement System (CRS) for the five-year period from January 1, 2012 to December 31, 2016. The study was based on the data submitted by CRS 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 CRS 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, mortality and salary increase at each age are shown in the attached tables in Appendix D 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.

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).



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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,

A handwritten signature in blue ink that reads 'Edward J. Koebel' in a cursive style.

Edward J. Koebel, EA, FCA, MAAA  
Principal and Consulting Actuary

A handwritten signature in blue ink that reads 'Jeffrey Gann' in a cursive style.

Jeffrey Gann, FSA, MAAA, EA  
Senior Actuary

A handwritten signature in blue ink that reads 'Ben Mobley' in a cursive style.

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EJK/JG/BM-kc



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## ***Section I - Executive Summary***

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

The basic purpose of an experience study is to determine whether the actuarial assumptions currently in use have adequately anticipated the actual emerging experience. This information, along with the professional judgment of system CRS 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 CRS for the five-year period ending December 31, 2016. This report presents the results, analysis, and resulting recommendations of our study. It is anticipated that the changes, if approved, will first be reflected in the December 31, 2017 actuarial valuation.

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

### ***Our Philosophy***

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



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- **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 the same result, we will probably recognize the trend at that point in time or at least move further in the direction of the observed experience. On the other hand, if experience returns closer to its prior level, we will not have overreacted, possibly causing volatility in the actuarial contribution rates.
- **Anticipate Trends:** If there is an identified trend that is expected to continue, we believe that this should be recognized. 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 the ones that do not materially improve the accuracy of the liability projections.

The following summarizes the findings and recommendations with regard to the assumptions utilized for CRS. 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 lowering of the price inflation assumption from 3.00% to 2.75%**. While some might argue that inflation may be even lower in the future, we believe these



## ***Section I - Executive Summary***

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experts are reacting to short-term experience and this lowering of the assumption by 0.25% is consistent with our desire to avoid overreacting.

**In addition, we are also recommending that the long-term expected return on assets assumption be lowered from 7.50% to 7.25%**, reflecting the 2.75% inflation assumption. This will be discussed in detail later in this report, but the real rate of return of 4.50% (difference between 7.25% and 2.75%) is supported by the forecasting models developed using the Board’s investment consultant and the 35 sets of capital market assumptions included in the Horizon Actuarial Services, LLC. Survey conducted in 2017 and the Board’s target asset allocation.

The following table summarizes the current and proposed economic assumptions:

<b>Item</b>	<b>Current</b>	<b>Proposed</b>
Price Inflation	3.00%	2.75%
Investment Return*	7.50%	7.25%

\* 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 CRS. 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 CRS perspective, as long, as the assumptions are reasonable and consistent.

Section II of this report will provide more detail to these recommended 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 III of this report, we recommend no changes in these actuarial methods.**



## ***Section I - Executive Summary***

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### ***Recommended Demographic Assumption Changes***

In the experience study, actual experience for the study period is compared to that expected based on the current actuarial assumption. The analysis is most commonly performed based on counts, i.e. each member is one exposure as to the probability of the event occurring and one occurrence if the event actually occurs. Comparing the 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 some 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 through 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 for 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 retirement ages. 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 and when 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





## ***Section I - Executive Summary***

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observed experience are set near 100% as future mortality improvements will be taken into account directly in the actuarial valuation process.

The current post-retirement healthy mortality assumption for CRS is the RP-2000 Combined Mortality Table, projected with Scale AA to 2020, with a two year age set-forward for males and a one year age set-forward for females. This is a static mortality table with margin. The results of the experience analysis indicate that this table has provided a reasonable approximation to the actual number of deaths during the period and will provide for a reasonable margin for future mortality improvements. However, we note that the State of Ohio Public Employees Retirement System (OPERS) has recently changed their mortality table to a generational approach. Since CRS has a small number of deaths when compared to the State in whole and the State's data provides for more credible statistics, **we are recommending that CRS adopt a generational mortality approach similar to the State's mortality table.** More information will be discussed later in the report.

The following is a list of other recommended changes to the demographic assumptions for CRS.

- **Retirement:** We recommend slightly decreasing the rates of retirement for members who retire with less than 30 years of service and increasing the rates of retirement for members who retire with 30 or more years of service.
- **Disability:** We recommend decreasing the rates of disability further to better match the experience of CRS.
- **Withdrawal:** We recommend decreasing the rates of withdrawal in the first year of service and changing the rates of withdrawal for years of service in excess of four years to better match the experience of CRS.
- **Merit Salary Scale:** We recommend decreasing the rates of salary increases generally at higher levels of service.
- **Other Pension-Related Assumptions:**
  - We recommend increasing the assumed administrative expense component that is added to the total normal cost from 0.75% to 0.80% of payroll.
  - We recommend changing the assumed proportion of deferred vested members who will elect to receive a deferred benefit and who will elect to withdraw their contributions.



## ***Section I - Executive Summary***

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- **We recommend changing the assumed percentage of members who are married for the purposes of valuing pre-retirement survivor benefits.**

Section IV of this report will provide more detail to these recommended changes.

### **Retiree Health Benefits Assumptions**

We have decided to focus our attention in this report to the Health Benefit Plan Participation rates that are a major component of our liabilities. The current and proposed rates of participation for Group 1 and Group 2 service retirement members are as follows:

<b>Service Retirement Group</b>	<b>Current Rate of Participation (%)</b>	<b>Proposed Rate of Participation (%) (Pre-65 Retirement)</b>	<b>Proposed Rate of Participation (%) (Post-64 Retirement)</b>
Group 1	90	95	95
Group 2 with 90+ Points	90	90 grading to 45 over 20 years	45 for all years
Group 2 with 80 – 89 Points	80	90 grading to 45 over 20 years	45 for all years
Group 2 with 70 – 79 Points	60	40 grading to 0 over 20 years	0
Group 2 with 60 – 69 Points	40	40 grading to 0 over 20 years	0

Section V of this report will provide more detail to these recommended changes.



## Section I - Executive Summary

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### Financial Impact

The following tables highlight the impact of the recommended changes for the pension and retiree health benefits as of December 31, 2016 valuation on the unfunded accrued liabilities (UAL), actuarial determined contribution (ADC), and the funding ratio based on actuarial value of assets.

#### **Pension Results** (\$ in Thousands)

	<b>Before All Changes</b>	<b>After Demographic Changes Only</b>	<b>After All Changes</b>
UAL	\$520,822	\$570,454	\$627,068
ADC	27.95%	30.66%	33.34%
Funding Ratio*	76.9%	75.2%	73.4%

\* The actuarial value of plan assets as a percentage of actuarial accrued liability.

#### **Retiree Health Benefits** (\$ in Thousands)

	<b>Before All Changes</b>	<b>After Demographic Changes Only</b>	<b>After All Changes</b>
UAL	(\$35,819)	(\$19,457)	(\$7,621)
ADC	0.71%	1.59%	2.31%
Funding Ratio*	108.0%	104.2%	101.6%

\* The actuarial value of plan assets as a percentage of actuarial accrued liability.



## *Section II – Economic Assumptions*

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There are two economic assumptions used in the actuarial valuations performed for CRS. They are:

- Price Inflation
- Investment Return

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 and the rates of salary increases. However, it is not directly used in the valuation process.

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.

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.



## *Section II – Economic Assumptions*

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<b>Item</b>	<b>Current</b>	<b>Proposed</b>
Price Inflation	3.00%	2.75%
Real Rate of Return*	<u>4.50</u>	<u>4.50</u>
Investment Return	7.50%	7.25%

\* net of investment expenses.



## ***Section II – Economic Assumptions***

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### **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 and the wage inflation assumption. These latter two assumptions will be discussed in detail in the following sections.

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

The current price inflation assumption is 3.00% 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 December 31st.

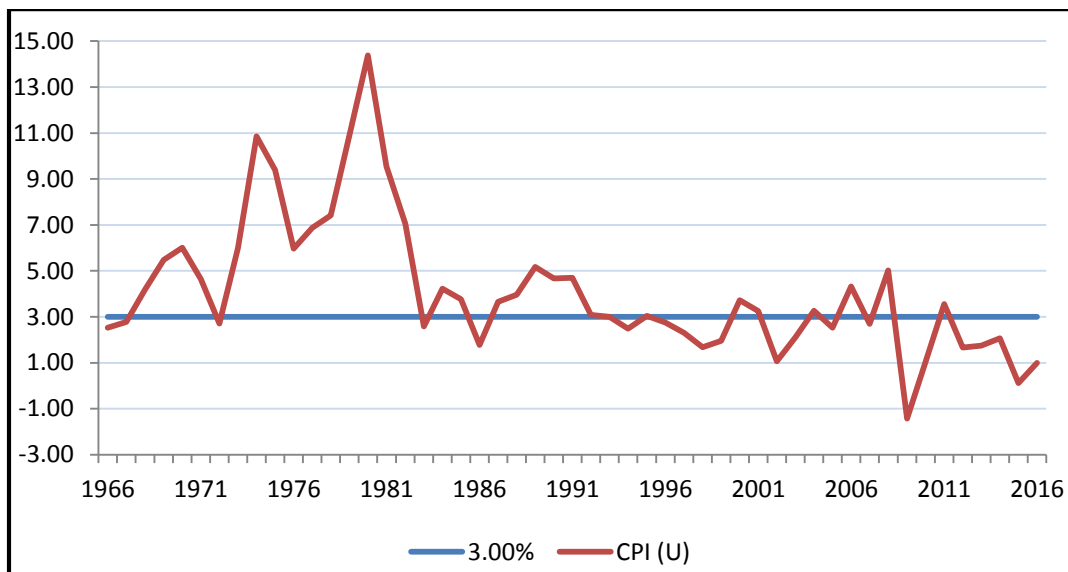
<b>Period</b>	<b>Number of Years</b>	<b>Annualized Rate of Inflation</b>	<b>Annual Standard Deviation</b>
1926 – 2016	90	2.9%	4.1%
1956 – 2016	60	3.7%	2.9%
1966 – 2016	50	4.1%	3.0%
1976 – 2016	40	3.6%	2.9%
1986 – 2016	30	2.6%	1.3%
1996 – 2016	20	2.1%	1.0%
2006 - 2016	10	1.8%	1.2%



## Section II – Economic Assumptions

The following graph illustrates the historical levels of price inflation measured as of December 31st of each of the last 50 years and compared to the current 3.00% annual rate currently assumed.

Annual Rate of CPI (U) Increases



Over the last 30 years, the average annual rate of increase in the CPI-U has been below 3.00%. 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 first quarter of 2017 as published by the Philadelphia Federal Reserve Bank, the median expected annual rate of inflation for the next ten years is 2.3%. 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 lower rates of inflation for the near term future.



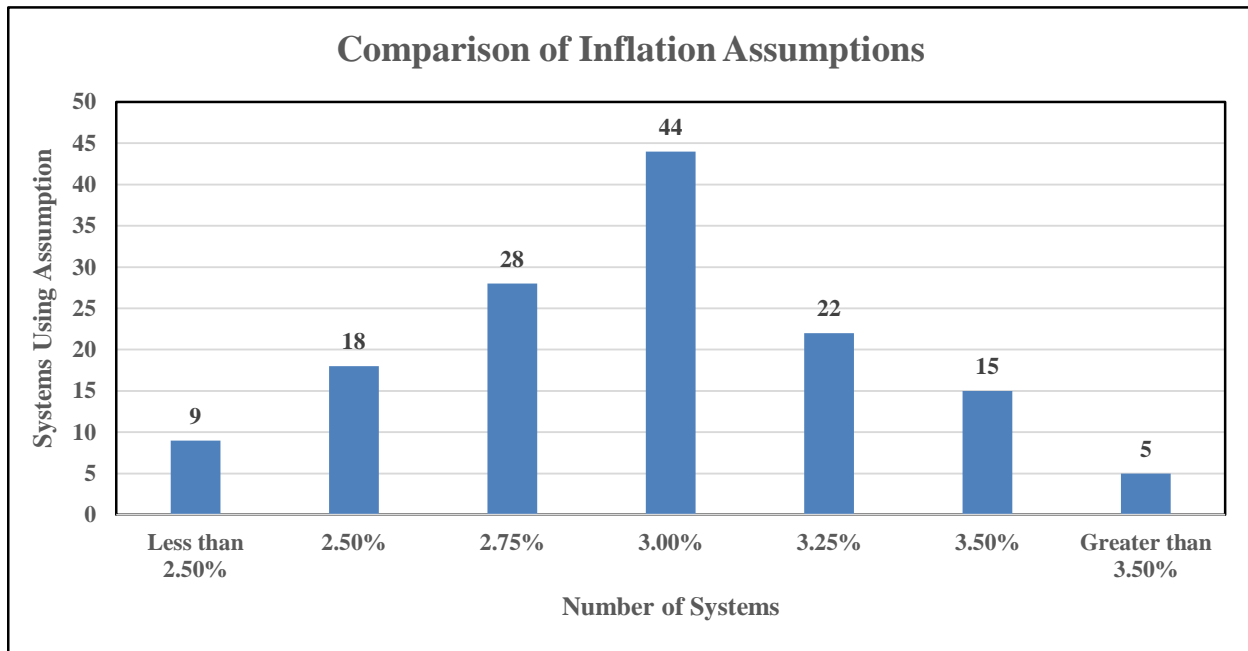
## Section II – Economic Assumptions

### 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 most recent report (June, 2017), the projected ultimate average annual increase in the CPI over the next 75 years was estimated to be 2.60%, 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 2.00% to 3.20%.

### 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 141 plans in the Public Plan Database of the Center for Retirement Research. The assumptions are from the last actuarial valuation reported to the center (ranging from 2015 to 2016).







## *Section II – Economic Assumptions*

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### *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 1.8% is lower than the System's assumed rate of 3.00%, the longer 50-year averages of 4.1% is somewhat higher than CRS' current rate. The reasonableness of CRS' 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 2.00% to 3.20% to be reasonable and, therefore, **we recommend the inflation assumption for CRS be lowered from 3.00% to 2.75% at this time.**

<b>Price Inflation Assumption</b>	
Current	3.00%
Recommended	2.75%



## ***Section II – Economic Assumptions***

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### **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 3.00% and a real rate of return assumption of 4.50%.

#### ***Long Term CRS 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 CRS, 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.



## ***Section II – Economic Assumptions***

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The assets for CRS 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.

<b>Year Ending 12/31</b>	<b>Actuarial Value</b>	<b>Actual Market Value Returns</b>
2012	0.25%	12.06%
2013	12.11%	16.99%
2014	10.27%	6.86%
2015	7.47%	(0.11)%
2016	8.53%	9.24%
Average	7.73%	9.01%

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***

ASOP 27 provides that the actuary may rely on outside experts in setting economic assumptions. CRS utilizes the services of Marquette to assist them in developing investment strategies and providing capital market assumptions for the CRS portfolio. As part of their duties, Marquette periodically performs asset-liability studies, along with comprehensive reviews of the expected return of the various asset classes in which the CRS portfolio is invested. We believe it is appropriate to consider the results of Marquette’s 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 2017 study with a 10-year horizon) and provide ranges of results as well as averages. This information provides an additional CRS 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 Marquette’s capital market assumptions from the fourth quarter of 2017 and CRS’ 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



## Section II – Economic Assumptions

time horizon. Looking at one year’s results produces a mean real return of 6.17%, 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				
			5 <sup>th</sup>	25 <sup>th</sup>	50 <sup>th</sup>	75 <sup>th</sup>	95 <sup>th</sup>
1	6.17%	11.78%	(12.04)%	(2.07)%	5.52%	13.69%	26.58%
5	5.65%	5.23%	(2.73)%	2.05%	5.52%	9.10%	14.47%
10	5.58%	3.70%	(0.39)%	3.06%	5.52%	8.04%	11.77%
20	5.55%	2.61%	1.31%	3.77%	5.52%	7.29%	9.90%
30	5.54%	2.13%	2.07%	4.09%	5.52%	6.96%	9.08%
40	5.53%	1.85%	2.52%	4.28%	5.52%	6.77%	8.60%
50	5.53%	1.65%	2.84%	4.41%	5.52%	6.64%	8.27%

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 (0.39)% 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 4.41% and a 25% chance they will be above 6.64%. In other words, there is a 50% chance the real returns will be between 4.41% and 6.64%.

For a broader view of expected returns, we also reviewed the 2017 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. Using the current CRS target asset allocation, we applied the same statistical analysis to these survey results as we did the capital market assumption of CRS investment advisor with the following real return results for the 10-year horizon:



**Section II – Economic Assumptions**

**Mean Real Return Projection based on the CRS Asset Allocation and the Capital Market Assumptions from the 10-year Horizon Actuarial Services Survey**

Time Span In Years	Mean Real Return	Standard Deviation	Real Returns by Percentile				
			5 <sup>th</sup>	25 <sup>th</sup>	50 <sup>th</sup>	75 <sup>th</sup>	95 <sup>th</sup>
1	5.54%	11.14%	(11.72)%	(2.23)%	4.96%	12.68%	24.80%
5	5.08%	4.95%	(2.86)%	1.68%	4.96%	8.34%	13.41%
10	5.02%	3.50%	(0.63)%	2.63%	4.96%	7.34%	10.87%
20	4.99%	2.47%	0.97%	3.31%	4.96%	6.64%	9.10%
30	4.98%	2.02%	1.69%	3.61%	4.96%	6.33%	8.33%
40	4.97%	1.75%	2.13%	3.79%	4.96%	6.14%	7.87%
50	4.97%	1.56%	2.42%	3.91%	4.96%	6.02%	7.56%

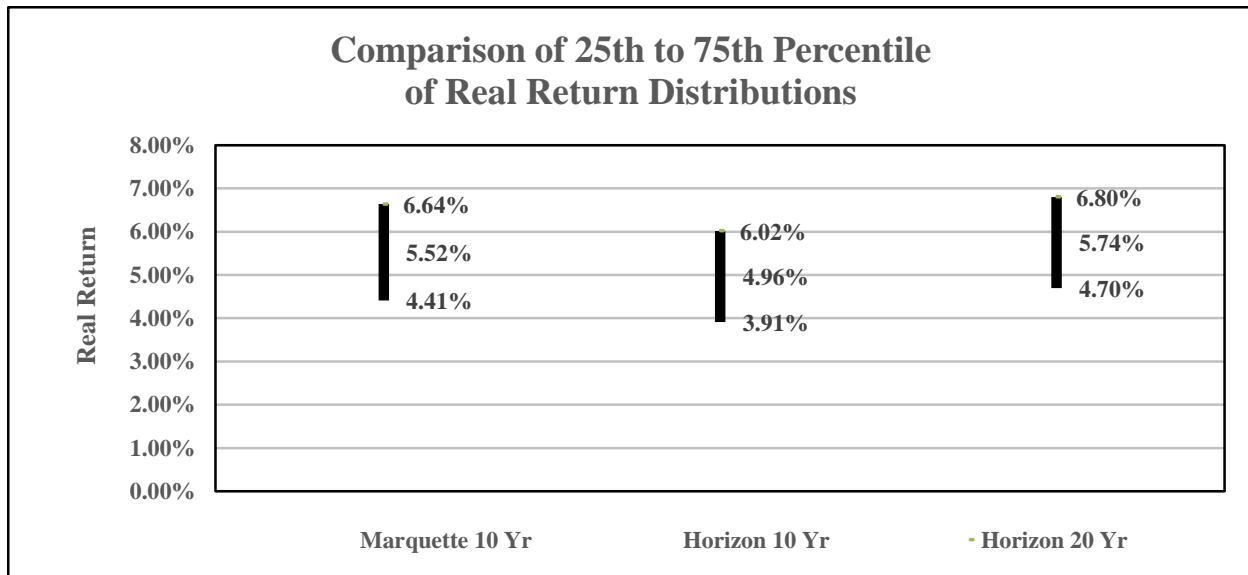
The results for the 20-year horizon are contained in the following table:

**Mean Real Return Projection based on the CRS Asset Allocation and the Capital Market Assumptions from the 20-year Horizon Actuarial Services Survey**

Time Span In Years	Mean Real Return	Standard Deviation	Real Returns by Percentile				
			5 <sup>th</sup>	25 <sup>th</sup>	50 <sup>th</sup>	75 <sup>th</sup>	95 <sup>th</sup>
1	6.32%	11.14%	(10.95)%	(1.45)%	5.74%	13.46%	25.57%
5	5.86%	4.95%	(2.08)%	2.46%	5.74%	9.13%	14.19%
10	5.80%	3.50%	0.15%	3.41%	5.74%	8.13%	11.65%
20	5.77%	2.47%	1.76%	4.09%	5.74%	7.42%	9.89%
30	5.76%	2.02%	2.48%	4.39%	5.74%	7.11%	9.11%
40	5.76%	1.75%	2.91%	4.57%	5.74%	6.93%	8.66%
50	5.76%	1.56%	3.20%	4.70%	5.74%	6.80%	8.34%

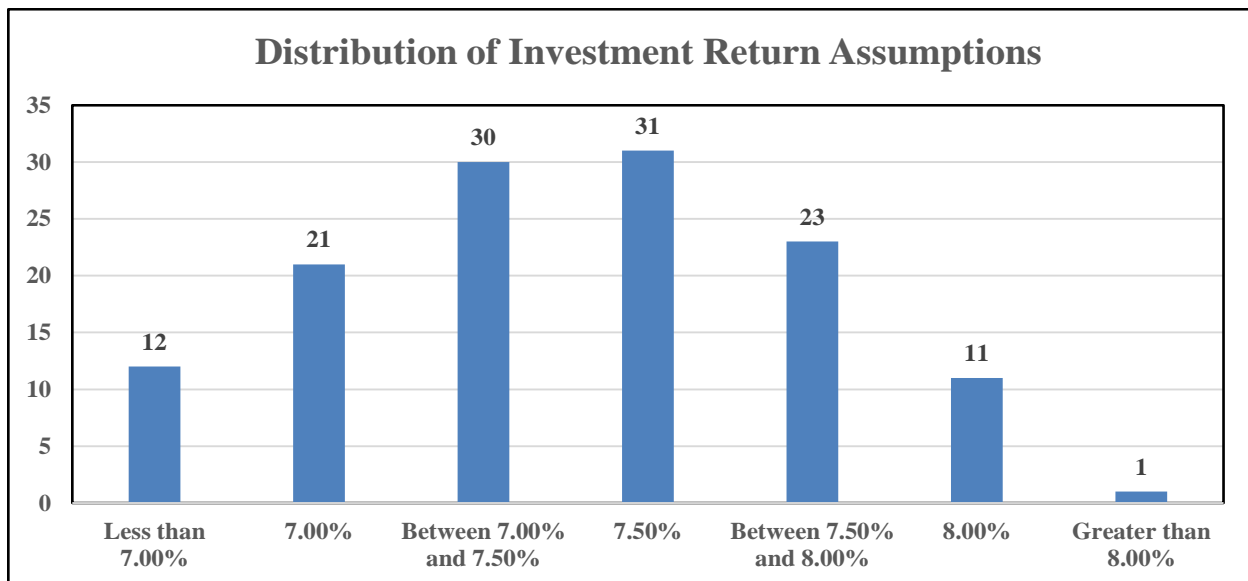


## Section II – Economic Assumptions



### Peer Comparison

The following chart shows the nominal investment return assumptions of the 127 plans from the National Association of State Retirement Administrators (NASRA) Issue Brief entitled, “Public Pension Plan Investment Return Assumptions”, updated February, 2018. The median nominal investment return from this survey is 7.50%.





## Section II – Economic Assumptions

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### *Recommendation*

By actuarial standards, we are required to maintain a long-term CRS 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.

This is a particularly challenging time to develop a recommendation for the investment return assumption. We need to recognize that there is no right answer to the question as no one knows what the future holds. Lately, there has been a significant trend in lowering the investment return assumption for pension plans across the country. According to the 2018 NASRA Issue Brief, the average return assumption has decreased from 7.91% in 2010 to 7.36% in 2018.

Although Marquette’s 10-year horizon analysis generates a real return of 5.52% at the 50<sup>th</sup> percentile, the Horizon Actuarial Services Survey using 10-year horizon analysis is 0.56% lower, or 4.96%, at the 50<sup>th</sup> percentile. Plus, ideally, we would recommend the Board consider a real return analysis slightly less than the 50<sup>th</sup> percentile to be somewhat conservative in the assumption.

**Taking all of this information into consideration, we are recommending the Board lower the investment return assumption from 7.50% to 7.25%, in conjunction with the recommendation of lowering the price inflation assumption by 0.25%.**

Investment Return Assumption		
	Current	Recommended
Real Rate of Return*	4.50%	4.50%
Inflation	<u>3.00</u>	<u>2.75</u>
Net Investment Return	7.50%	7.25%

\* net of investment expenses.



## *Section III – Actuarial Methods*

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### *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 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 CRS.

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

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

Considering that the Entry Age Normal cost method is the most commonly used cost method by public plans, 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 CRS.**





## ***Section III – Actuarial Methods***

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### **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.

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.**



## ***Section III – Actuarial Methods***

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### **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, though remaining level in dollar terms, in all probability decrease as a percentage of payroll. (Even if a plan sponsor’s population is not growing, inflationary salary increases will usually be sufficient to increase the aggregate covered payroll).

The rationale behind the level percentage of payroll amortization method is that since normal costs are calculated to be a constant percentage of pay, the unfunded actuarial accrued liability should be paid off in the same manner. When this method of amortizing the unfunded actuarial accrued liability is adopted, the initial amortization payments are lower than they would be under a level dollar amortization payment method, but the payments increase at a fixed rate each year so that



### ***Section III – Actuarial Methods***

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ultimately the annual payment far exceeds the level dollar payment. The expectation is that total payroll will increase at the same rate so that the amortization payments will remain constant, as a percentage of payroll. In the initial years, the level percentage of payroll amortization payment is often less than the interest accruing on the unfunded actuarial accrued liability meaning that even if there are no experience losses, the dollar amount of the unfunded actuarial accrued liability will grow (called negative amortization). This is particularly true if the plan sponsor is paying off the unfunded actuarial accrued liability over a long period, such as 20 or more years.

**Amortization Bases:** The UAAL can 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 of the outstanding amortization bases on the valuation date and the UAAL payment is the sum of all of the amortization payments on the existing amortization bases. This approach provides transparency in that the current UAAL is paid off over a fixed period of time and the remaining components of the UAAL are clearly identified. Adjustments to the UAAL in future years are also separately identified in each future year. One downside of this approach is that it can create some discontinuities in contribution rates when UAAL layers/components are fully paid off. If this occurs, it likely would be far in the future, with adequate time to address any adjustments needed.

Currently, the amortization methodology is based on the level dollar amortization method with an open, rolling 30-year period over one single UAAL amount. This is the methodology as outlined in the Collective Settlement Agreement.

**We recommend no change in this methodology.**



## *Section IV – Demographic Assumptions*

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

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

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 (January 1, 2012 through December 31, 2016) 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. Salary adjustments, other than the economic assumption for wage inflation discussed in the previous section, are treated as demographic assumptions.



**Section IV – Demographic Assumptions**

**RATES OF WITHDRAWAL**

**COMPARISON OF ACTUAL AND EXPECTED WITHDRAWALS  
FROM ACTIVE SERVICE**

CENTRAL AGE OF GROUP	NUMBER OF WITHDRAWALS					
	First Year of Service			Second or Third Year of Service		
	Actual	Expected	Ratio of Actual to Expected	Actual	Expected	Ratio of Actual to Expected
20	23	8	2.875	3	2	1.500
25	22	23	0.957	24	23	1.043
30	22	25	0.880	37	34	1.088
35	11	20	0.550	27	25	1.080
40	12	16	0.750	20	20	1.000
45	12	11	1.091	14	13	1.077
50	9	13	0.692	12	13	0.923
55	4	6	0.667	9	7	1.286
60	3	3	1.000	9	7	1.286
<b>TOTAL</b>	<b>118</b>	<b>125</b>	<b>0.944</b>	<b>155</b>	<b>144</b>	<b>1.076</b>

CENTRAL AGE OF GROUP	NUMBER OF WITHDRAWALS					
	Fourth or Fifth Year of Service			More than 5 years of service		
	Actual	Expected	Ratio of Actual to Expected	Actual	Expected	Ratio of Actual to Expected
25	12	9	1.333	3	3	1.000
30	26	23	1.130	20	18	1.111
35	8	11	0.727	40	23	1.739
40	5	7	0.714	40	27	1.481
45	3	6	0.500	32	33	0.970
50	6	5	1.200	32	39	0.821
55	7	3	2.333	26	27	0.963
60	1	2	0.500	9	6	1.500
<b>TOTAL</b>	<b>68</b>	<b>66</b>	<b>1.030</b>	<b>202</b>	<b>176</b>	<b>1.148</b>



## ***Section IV – Demographic Assumptions***

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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 current withdrawal assumptions are broken down into four bands: rates in a member's first year of service, rates in the second or third year of service, rates in the fourth or fifth year of service, and rates for more than five years of service. Overall, there were slightly more withdrawals than expected over the study period. **In 2014, the number of withdrawals was noticeably higher than in the other study years and, consequently, slightly less weight was given to observed withdrawals in this year.**

For withdrawals in the first year of service, the number of actual withdrawals was slightly lower than expected and showed no obvious pattern according to age. **We recommend slightly decreasing the rates of withdrawal at all ages from 25% to 22%.**

For withdrawals in the second or third year of service, the number of actual withdrawals was slightly higher than expected but this was driven largely by the experience in 2014 as opposed to the experience observed in the other study years. **We recommend keeping the rates of withdrawal at 10%.**

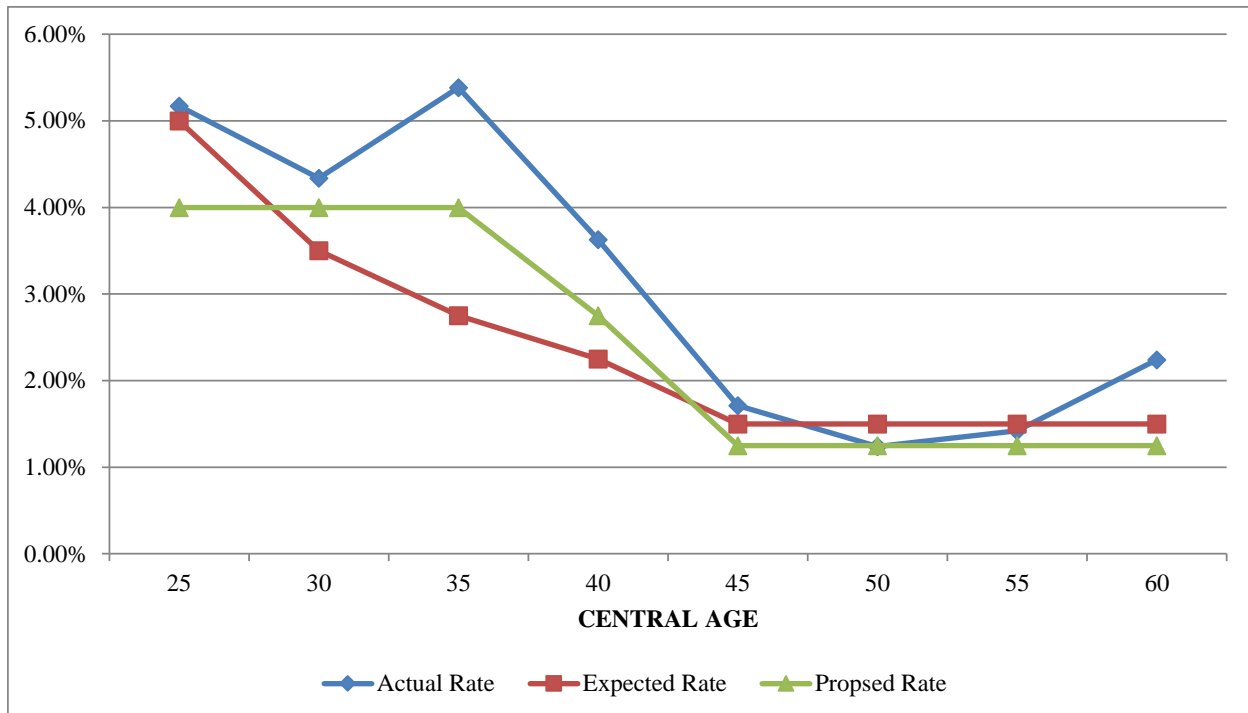
For withdrawals in the fourth or fifth year of service, the number of actual withdrawals was very close to what was expected over the study period with a distinct pattern of higher rates for ages below age 35 then for ages above 35. **We recommend slightly increasing the rates of withdrawal for ages below age 35 from 7.5% to 8.0% and maintaining the rates above age 35 at 4%.**



## Section IV – Demographic Assumptions

The following graphs show a comparison of the present, actual and proposed rates of withdrawal for withdrawals with more than five years of service.

**RATES OF WITHDRAWAL FOR ACTIVE MEMBERS  
WITH MORE THAN FIVE YEARS OF SERVICE**



For withdrawals with more than five years of service, there were more withdrawals than expected overall. In particular, there seemed to be more withdrawals at ages 40 and below than expected. **We recommend increasing rates generally at lower ages and slightly decreasing rates at higher ages.**



## Section IV – Demographic Assumptions

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The following table shows a comparison between the present withdrawal rates and the proposed withdrawal rates.

### COMPARATIVE RATES OF WITHDRAWAL

AGE	RATES OF WITHDRAWAL		RATES OF WITHDRAWAL	
	Present	Proposed	Present	Proposed
	First Year of Service		Second or Third Year of Service	
25	25.00%	22.00%	10.00%	10.00%
30	25.00%	22.00%	10.00%	10.00%
35	25.00%	22.00%	10.00%	10.00%
40	25.00%	22.00%	10.00%	10.00%
45	25.00%	22.00%	10.00%	10.00%
50	25.00%	22.00%	10.00%	10.00%
55	25.00%	22.00%	10.00%	10.00%
60	25.00%	22.00%	10.00%	10.00%

AGE	RATES OF WITHDRAWAL		RATES OF WITHDRAWAL	
	Present	Proposed	Present	Proposed
	Fourth or Fifth Year of Service		More than 5 Years of Service	
25	7.50%	8.00%	5.00%	4.00%
30	7.50%	8.00%	3.50%	4.00%
35	4.00%	4.00%	2.75%	4.00%
40	4.00%	4.00%	2.25%	2.75%
45	4.00%	4.00%	1.50%	1.25%
50	4.00%	4.00%	1.50%	1.25%
55	4.00%	4.00%	1.50%	1.25%
60	4.00%	4.00%	1.50%	1.25%





**Section IV – Demographic Assumptions**

**COMPARISON OF ACTUAL AND EXPECTED WITHDRAWALS  
FROM ACTIVE SERVICE BASED ON PROPOSED RATES**

CENTRAL AGE OF GROUP	NUMBER OF WITHDRAWALS					
	First Year of Service			Second or Third Year of Service		
	Actual	Expected	Ratio of Actual to Expected	Actual	Expected	Ratio of Actual to Expected
20	23	7	3.286	3	2	1.500
25	22	20	1.100	24	23	1.043
30	22	22	1.000	37	34	1.088
35	11	18	0.611	27	25	1.080
40	12	14	0.857	20	20	1.000
45	12	10	1.200	14	13	1.077
50	9	12	0.750	12	13	0.923
55	4	5	0.800	9	7	1.286
60	3	3	1.000	9	7	1.286
<b>TOTAL</b>	<b>118</b>	<b>111</b>	<b>1.063</b>	<b>155</b>	<b>144</b>	<b>1.076</b>

CENTRAL AGE OF GROUP	NUMBER OF WITHDRAWALS					
	Fourth or Fifth Year of Service			More than 5 years of service		
	Actual	Expected	Ratio of Actual to Expected	Actual	Expected	Ratio of Actual to Expected
25	12	10	1.200	3	2	1.500
30	26	23	1.130	20	18	1.111
35	8	9	0.889	40	29	1.379
40	5	7	0.714	40	29	1.379
45	3	6	0.500	32	26	1.231
50	6	5	1.200	32	32	1.000
55	7	3	2.333	26	23	1.130
60	1	2	0.500	9	5	1.800
<b>TOTAL</b>	<b>68</b>	<b>65</b>	<b>1.046</b>	<b>202</b>	<b>164</b>	<b>1.232</b>



*Section IV – Demographic Assumptions*

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**RATES OF DISABILITY RETIREMENT**

**COMPARISON OF ACTUAL AND EXPECTED DISABILITY RETIREMENTS**

<b>CENTRAL AGE OF GROUP</b>	<b>NUMBER OF DISABILITY RETIREMENTS</b>		
	<b>Actual</b>	<b>Expected</b>	<b>Ratio of Actual to Expected</b>
40	2	1	2.000
45	0	4	0.000
50	2	8	0.250
55	2	11	0.182
60	0	7	0.000
<b>TOTAL</b>	<b>6</b>	<b>31</b>	<b>0.194</b>

During the period under investigation, the actual rates of disability retirement were significantly less than expected which continues a trend observed in the previous experience study. After discussing with Retirement System staff, we believe that we will continue to see lower numbers of disability retirement in the future. Therefore, **we recommend reducing the current rates by 50%.**



## Section IV – Demographic Assumptions

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The following table shows a comparison between the present disability retirement rates and the proposed rates.

### COMPARATIVE RATES OF DISABILITY RETIREMENT

AGE	RATES OF DISABILITY RETIREMENT	
	Present	Proposed
25	0.020%	0.010%
30	0.030%	0.015%
35	0.050%	0.025%
40	0.090%	0.045%
45	0.150%	0.075%
50	0.270%	0.135%
55	0.420%	0.210%
60	0.500%	0.250%

### 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
40	2	1	2.000
45	0	2	0.000
50	2	4	0.500
55	2	6	0.333
60	0	4	0.000
<b>TOTAL</b>	<b>6</b>	<b>17</b>	<b>0.353</b>



*Section IV – Demographic Assumptions*

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**RATES OF SERVICE RETIREMENT**

**COMPARISON OF ACTUAL AND EXPECTED RETIREMENTS**

**Normal Retirements with less than 30 years of service**

AGE	NUMBER OF SERVICE RETIREMENTS		
	Less than 30 Years of Service		
	Actual	Expected	Ratio of Actual to Expected
60	69	65	1.062
61	28	38	0.737
62	14	31	0.452
63	12	26	0.462
64	20	24	0.833
65	25	20	1.250
66	12	13	0.923
67	7	10	0.700
68	7	8	0.875
69	4	6	0.667
<b>SUB-TOTAL</b>	<b>198</b>	<b>241</b>	<b>0.822</b>
70+	14	73	0.192
<b>TOTAL</b>	<b>212</b>	<b>314</b>	<b>0.675</b>



*Section IV – Demographic Assumptions*

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**COMPARISON OF ACTUAL AND EXPECTED RETIREMENTS**

**Normal Retirements with 30 or more years of service**

AGE	NUMBER OF SERVICE RETIREMENTS		
	30 or more Years of Service		
	Actual	Expected	Ratio of Actual to Expected
< 50	7	5	1.400
50-54	66	55	1.200
55-59	99	80	1.238
60-64	26	16	1.625
65-69	7	5	1.400
<b>SUB-TOTAL</b>	<b>205</b>	<b>161</b>	<b>1.273</b>
70+	6	31	0.194
<b>TOTAL</b>	<b>211</b>	<b>192</b>	<b>1.099</b>

**Early Retirements**

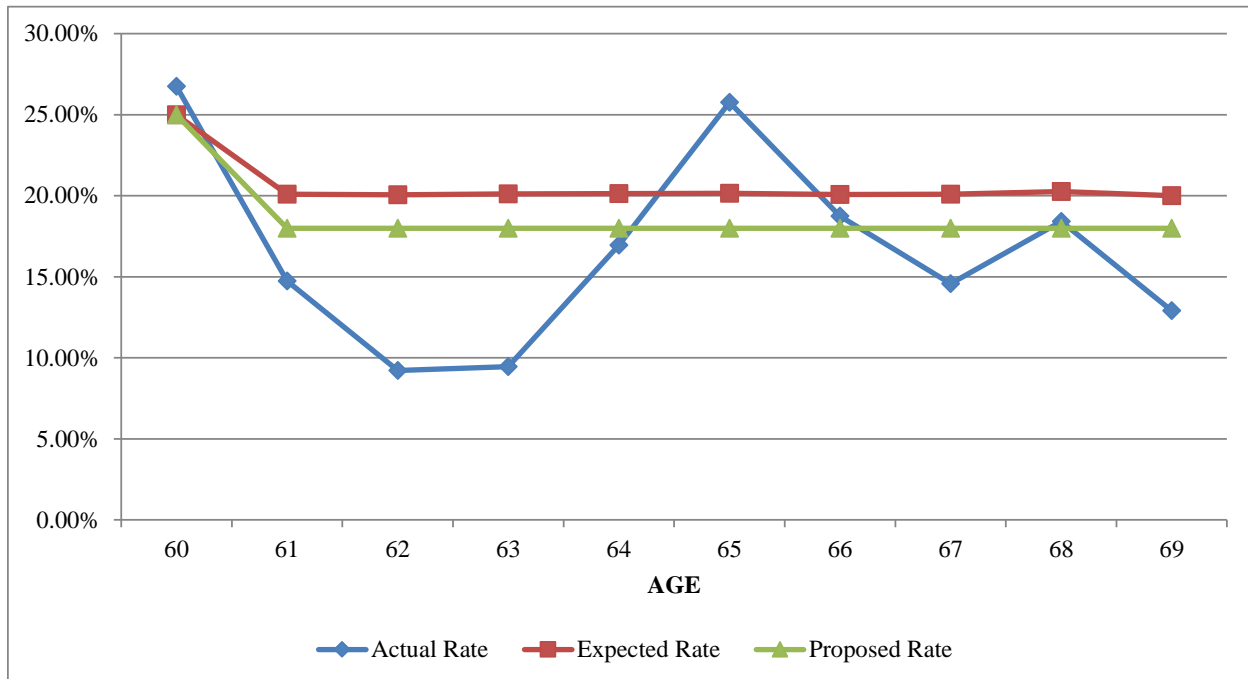
AGE	NUMBER OF SERVICE RETIREMENTS		
	Early Retirement		
	Actual	Expected	Ratio of Actual to Expected
55	4	16	0.250
56	8	15	0.533
57	13	15	0.867
58	11	12	0.917
59	7	8	0.875
<b>TOTAL</b>	<b>43</b>	<b>66</b>	<b>0.652</b>



## Section IV – Demographic Assumptions

The following graphs show a comparison of the present, actual, and proposed rates of service retirements.

### RATES OF NORMAL RETIREMENT FOR ACTIVE MEMBERS WITH LESS THAN 30 YEARS OF SERVICE



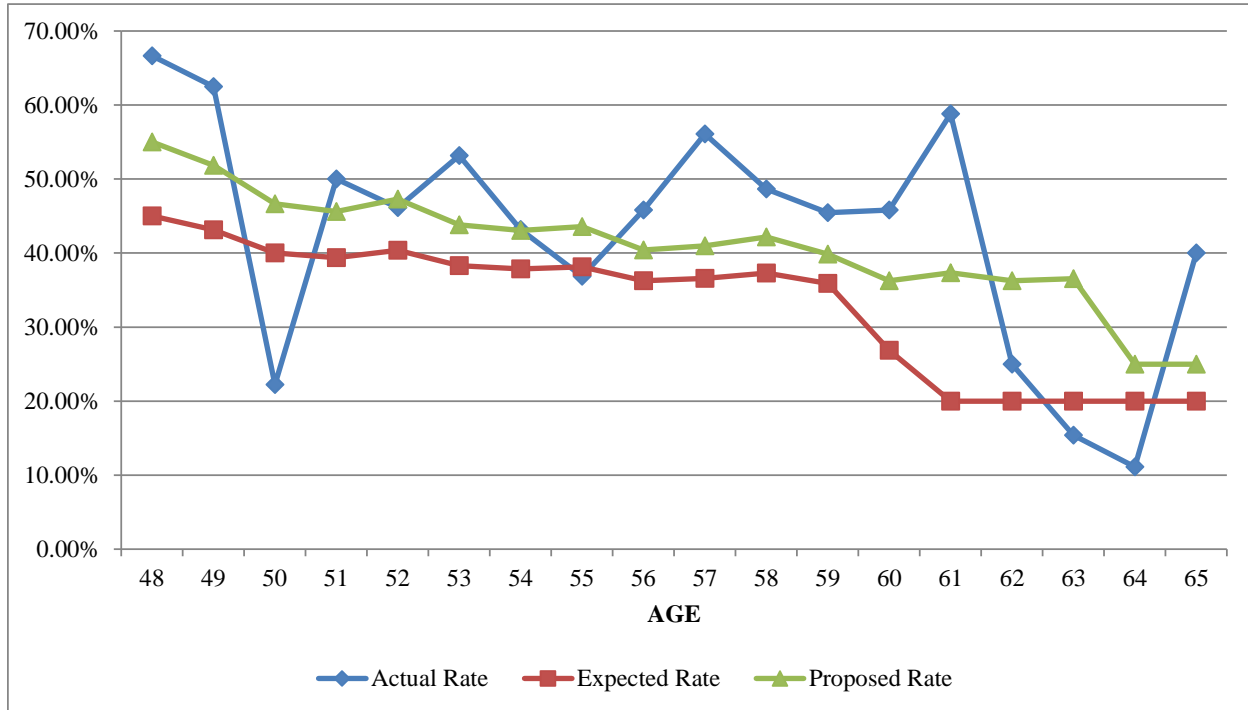
For members with less than 30 years of service, there were significantly fewer retirements than expected over the study period. Under the current assumptions, rates of retirement for ages 70 and above are assumed to be 100%. Even though we observe that some members continue working beyond age 70, we do not recommend changing this assumption at this time. We further note that during the study period, several changes to plan affecting retirement eligibilities were negotiated and implemented which may have had an impact on member behaviors. This has led us to be cautious about putting too much weight on the observed data.

It does appear though that there were somewhat fewer retirements than expected which was also observed in the last experience study. **We recommend another slight decrease in the retirement rates at these age and service combinations.**



## Section IV – Demographic Assumptions

### RATES OF NORMAL RETIREMENT FOR ACTIVE MEMBERS WITH 30 OR MORE YEARS OF SERVICE

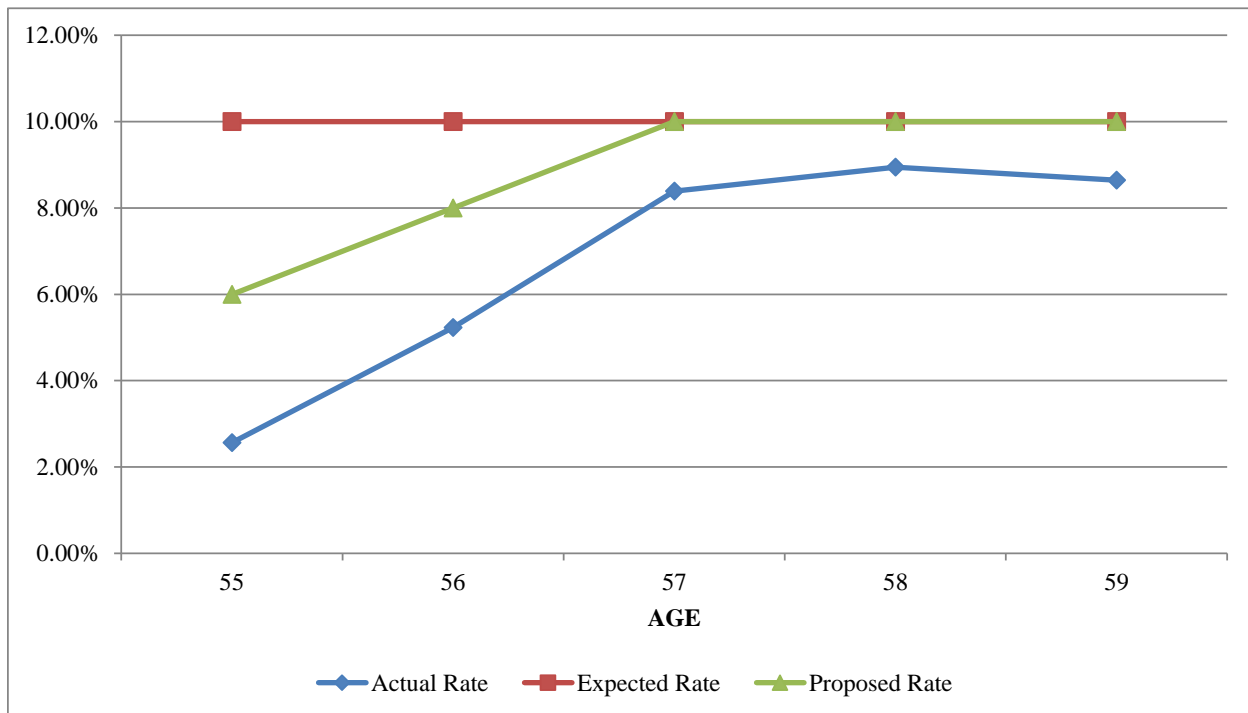


For members with 30 or more years of service, there were significantly more retirements than expected. The current assumptions have one set of retirement rates for members with 30 years of service and another set of retirement rates for 31 or more years of service. Most of the excess in actual retirement rates over what was expected came from members retiring with 30 years of service. In the previous experience study, we observed a similar pattern of more retirements than expected at these age and service combinations. **We recommend continuing to move in the direction of expecting greater number of retirements particularly for members with 30 years of service.**



## Section IV – Demographic Assumptions

### RATES OF EARLY RETIREMENT FOR ACTIVE MEMBERS



For early retirements, the data shows generally fewer actual retirements than what was expected. Again, this pattern was also seen in the previous experience study. Further, the data seems to show a trend of fewer members taking early retirement the further away they are from normal retirement, perhaps due to the greater reduction in benefit. **We recommend slightly decreasing rates of retirement at ages 55 and 56 and maintaining the current rates at all other ages.**





## Section IV – Demographic Assumptions

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

### COMPARATIVE RATES OF RETIREMENT

RATES OF RETIREMENT											
Present						Proposed*					
Age	Years of Service					Age	Years of Service				
	5	6-24	25 - 29	30	31+		5	6-24	25 - 29	30	31+
<b>55</b>	0%	0%	10%	45%	30%	<b>55</b>	0%	0%	6%	55%	30%
<b>56</b>	0%	0%	10%	45%	30%	<b>56</b>	0%	0%	8%	55%	30%
<b>57</b>	0%	0%	10%	45%	30%	<b>57</b>	0%	0%	10%	55%	30%
<b>58</b>	0%	0%	10%	45%	30%	<b>58</b>	0%	0%	10%	55%	30%
<b>59</b>	0%	0%	10%	45%	30%	<b>59</b>	0%	0%	10%	55%	30%
<b>60</b>	25%	25%	25%	30%	25%	<b>60</b>	25%	25%	25%	55%	25%
<b>61</b>	25%	20%	20%	20%	20%	<b>61</b>	25%	18%	18%	55%	25%
<b>62</b>	25%	20%	20%	20%	20%	<b>62</b>	25%	18%	18%	55%	25%
<b>63</b>	25%	20%	20%	20%	20%	<b>63</b>	25%	18%	18%	55%	25%
<b>64</b>	25%	20%	20%	20%	20%	<b>64</b>	25%	18%	18%	55%	25%
<b>65</b>	25%	20%	20%	20%	20%	<b>65</b>	25%	18%	18%	55%	25%
<b>66</b>	25%	20%	20%	20%	20%	<b>66</b>	25%	18%	18%	55%	25%
<b>67</b>	25%	20%	20%	20%	20%	<b>67</b>	25%	18%	18%	55%	25%
<b>68</b>	25%	20%	20%	20%	20%	<b>68</b>	25%	18%	18%	55%	25%
<b>69</b>	25%	20%	20%	20%	20%	<b>69</b>	25%	18%	18%	55%	25%
<b>70 +</b>	100%	100%	100%	100%	100%	<b>70 +</b>	100%	100%	100%	100%	100%

\* Rates shown are for Groups C, E, and F. Rates for Group G are adjusted to account for different eligibilities.



*Section IV – Demographic Assumptions*

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

**Retirements with less than 30 years of service**

AGE	NUMBER OF SERVICE RETIREMENTS		
	Less than 30 Years of Service		
	Actual	Expected	Ratio of Actual to Expected
60	69	65	1.062
61	28	34	0.824
62	14	28	0.500
63	12	23	0.522
64	20	21	0.952
65	25	18	1.389
66	12	12	1.000
67	7	9	0.778
68	7	7	1.000
69	4	6	0.667
<b>SUB-TOTAL</b>	<b>198</b>	<b>223</b>	<b>0.888</b>
70+	14	73	0.192
<b>TOTAL</b>	<b>212</b>	<b>296</b>	<b>0.716</b>

**Retirements with 30 or more years of service**

AGE	NUMBER OF SERVICE RETIREMENTS		
	30 or more Years of Service		
	Actual	Expected	Ratio of Actual to Expected
< 50	7	6	1.167
50-54	66	63	1.048
55-59	99	90	1.100
60-64	26	25	1.040
65-69	7	8	0.875
<b>SUB-TOTAL</b>	<b>205</b>	<b>192</b>	<b>1.068</b>
70+	6	31	0.194
<b>TOTAL</b>	<b>211</b>	<b>223</b>	<b>0.946</b>



*Section IV – Demographic Assumptions*

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

**Early Retirements**

AGE	NUMBER OF SERVICE RETIREMENTS		
	Early Retirement		
	Actual	Expected	Ratio of Actual to Expected
50	4	9	0.444
51	8	12	0.667
52	13	15	0.867
53	11	12	0.917
59	7	8	0.875
<b>TOTAL</b>	<b>43</b>	<b>56</b>	<b>0.768</b>



*Section IV – Demographic Assumptions*

**RATES OF MORTALITY**

**COMPARISON OF ACTUAL AND EXPECTED  
POST-RETIREMENT DEATHS**

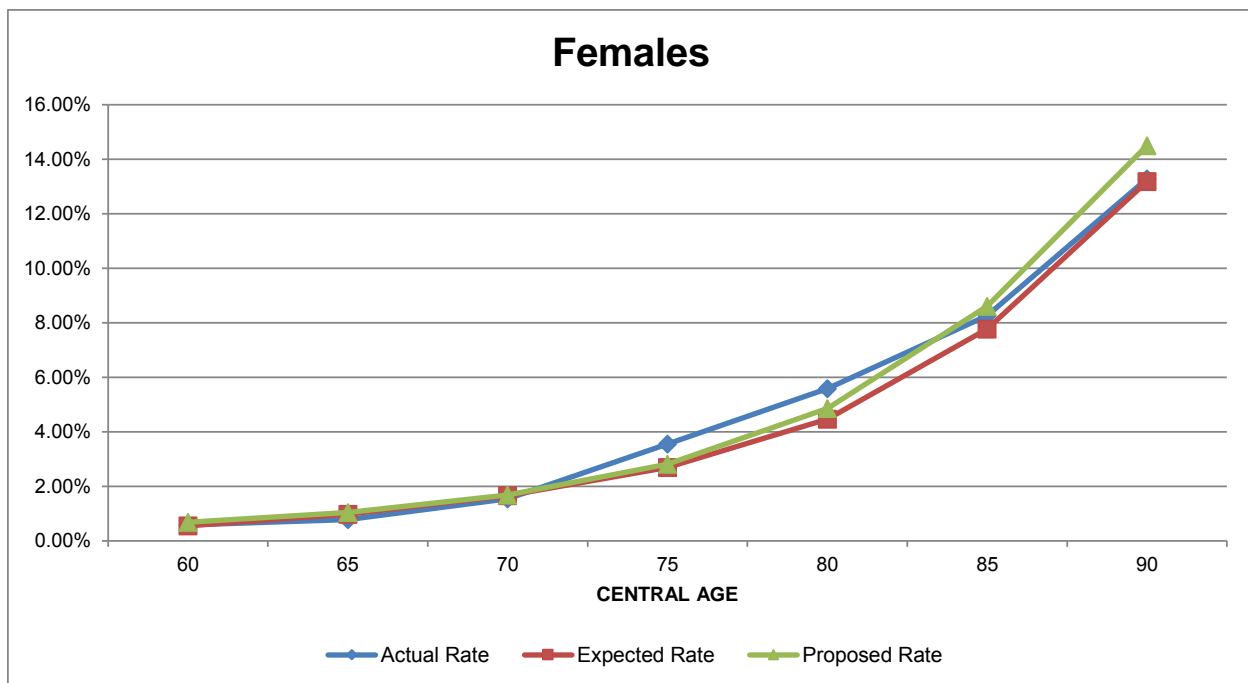
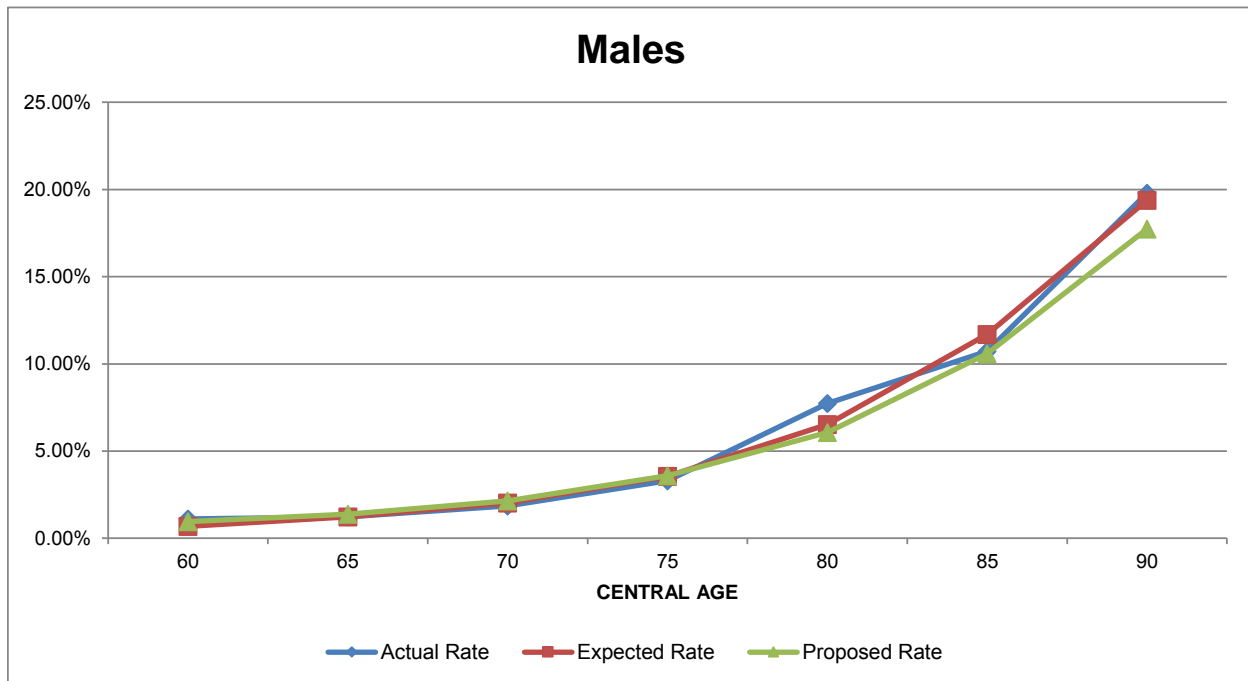
CENTRAL AGE OF GROUP	NUMBER OF POST-RETIREMENT DEATHS					
	MALES			FEMALES		
	Actual	Expected	Ratio of Actual to Expected	Actual	Expected	Ratio of Actual to Expected
	SERVICE RETIREMENTS AND OPTIONEES					
52 and Under	0	0	0.000	1	0	0.000
55	6	2	3.000	2	2	1.000
60	18	11	1.636	9	8	1.125
65	30	30	1.000	14	18	0.778
70	33	36	0.917	21	23	0.913
75	45	48	0.938	45	34	1.324
80	86	73	1.178	74	59	1.254
85	70	76	0.921	106	100	1.060
90	74	73	1.014	125	124	1.008
95	14	24	0.583	59	62	0.952
98 & over	4	3	1.333	31	24	1.292
<b>TOTAL</b>	<b>380</b>	<b>376</b>	<b>1.011</b>	<b>487</b>	<b>454</b>	<b>1.073</b>
	DISABILITY RETIREMENTS					
52 and Under	0	1	0.000	1	0	0.000
55	0	1	0.000	3	1	3.000
60	2	4	0.500	4	2	2.000
65	6	7	0.857	6	3	2.000
70	3	4	0.750	9	3	3.000
75	11	6	1.833	7	3	2.333
80	3	6	0.500	5	3	1.667
85	3	4	0.750	6	2	3.000
90	1	2	0.500	0	3	0.000
95	0	0	0.000	3	1	3.000
98 & over	0	0	0.000	0	0	0.000
<b>TOTAL</b>	<b>29</b>	<b>35</b>	<b>0.829</b>	<b>44</b>	<b>21</b>	<b>2.095</b>



## Section IV – Demographic Assumptions

The following graphs show a comparison of the present, actual and proposed rates of post-retirement deaths.

### POST-RETIREMENT DEATHS SERVICE RETIREMENTS AND BENEFICIARIES





## ***Section IV – Demographic Assumptions***

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The current basis for rates of post-retirement mortality for service retirees and beneficiaries is the static mortality table, RP-2000 Combined Mortality Table set forward two years for males and set forward one year for females and using a Scale AA projection to 2020. The current basis for post-retirement mortality for disability retirements is the RP-2000 Disabled Mortality Table set back five years for females.

For service retirees and beneficiaries over the study period, the current table actually performed quite well in anticipating the number of deaths with Actual/Expected (A/E) ratios very close to 1, particularly for males. However, CRS is not sufficiently large enough for this experience to be relied upon as fully credible. We also considered the findings of an experience study for the five-year period ending December 31, 2015 for the Ohio Public Employees Retirement System (OPERS) in our analysis. This is a much larger retirement system with significantly more mortality experience and it is reasonable to think that CRS would have similar patterns of mortality. The mortality table selected as a result of that study was the RP-2014 Mortality Table with a generational approach to reflect future mortality improvements.

The RP-2014 Mortality Table, a relatively new mortality table, was published by the Society of Actuaries (SOA) in October of 2014. It was created to replace the RP-2000 Table as the mortality table standard for use in the valuation of corporate pension plans. A mortality improvement projection scale, MP-2014, was also published with the RP-2014 Mortality Table for use in projecting future mortality improvements. The SOA found that actual mortality improvements since the RP-2000 Table was published were greater than had been anticipated by Scale AA, the mortality improvement projection scale recommended for use with the RP-2000 Table. We would point out that the public plan data submitted to the SOA for purposes of this mortality study was excluded because it was materially different than the rest of the data submitted (corporate plans). This does not necessarily mean the Table is inappropriate for use by public sector plans, but it does suggest that blind adoption of the table may not be wise, either. Nonetheless, **we recommend that CRS adopt the RP-2014 Mortality Table.**

ASOP 35 requires the actuary to make a specific recommendation with respect to future improvements in mortality. There have been significant improvements in longevity in the past, although there are different opinions about future expectations. We believe it is prudent to anticipate that the trend will continue in some fashion in the future. Therefore, we believe it is appropriate to reflect future mortality improvements in the mortality assumption. The current approach is through the use of a static mortality table where the A/E ratio is intentionally targeted to be over 100% so that mortality can improve without creating actuarial losses, at least in the short term. Depending on the magnitude and duration of actual mortality improvements in the future, the margin may decrease and eventually become insufficient. If and when that occurs, the assumption would need to be updated.



## ***Section IV – Demographic Assumptions***

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The RP-2014 family of tables is designed to be used with generational projection of future mortality improvements. This means that the mortality rates at each age are in general reduced slightly each year in the valuation projections to model the assumed improvements in mortality. For example, someone who is 65 in 2014, the base year of the table, will be assumed to die with the probability shown in the table. Should they not die, the probability of death the following year (2015) at age 66 will be slightly less than the age 66 value in the base year of the table. The probability of death at age 67 will reflect two years of improvement, and so on. The MP-2014 projection scale was published with the RP-2014 tables for this purpose. This scale varies not only by age, but also by year of birth, increasing the sophistication of the projections to more accurately model the broad mortality improvements observed in the United States. Subsequently, the SOA has annually released updated projection scales with the MP-2017 projection scale being the most recently available. **We recommend that CRS adopt a generational approach using the MP-2017 projection scale 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.**

With a generational approach, the A/E ratios should be near 100% as future mortality improvements will be taken into account directly in the actuarial valuation process. To achieve this, actuaries use various adjustments to standard mortality tables in order to match the observed mortality rates of a specific retirement system. One of these is an age adjustment that can be either a “setback” or a “set forward”. The current assumption for CRS incorporates the use of an age set-forward for both males and females. A two year age set-forward treats all members as if they were 2 years older than they truly are when applying the rates in the mortality table. So, a two year set-forward would treat a 62 year old retiree as if she will exhibit the mortality of a 64 year old in the standard mortality table. **We recommend that in the proposed mortality table that rates be set-forward 2 years for both males and females.**

The number of deaths for disability retirements was not enough to be credible. **We recommend adopting the RP-2014 Disabled Retiree Mortality Table with a generational approach using the MP-2017 projection scale.**

Likewise, the number of pre-retirement deaths for active members was not enough to be credible. **We recommend adopting the RP-2014 Employees Mortality Table with a generational approach using the MP-2017 projection scale.**



**Section IV – Demographic Assumptions**

The following tables shows a comparison between the present and proposed rates of mortality.

**COMPARATIVE RATES OF POST-RETIREMENT MORTALITY**

AGE	RATES OF POST-RETIREMENT DEATH			
	MALES		FEMALES	
	Present	Proposed*	Present	Proposed*
	SERVICE RETIREMENTS AND OPTIONEES			
35	0.0818%	0.0614%	0.0412%	0.0362%
40	0.1035%	0.0771%	0.0572%	0.0518%
45	0.1335%	0.1242%	0.0886%	0.0824%
50	0.1855%	0.4860%	0.1314%	0.3116%
55	0.3198%	0.6706%	0.2631%	0.4499%
60	0.6342%	0.9394%	0.5259%	0.6695%
65	1.2125%	1.3616%	0.9909%	1.0132%
70	2.0164%	2.1055%	1.6807%	1.6265%
75	3.5381%	3.4628%	2.6371%	2.7070%
80	6.5830%	5.9410%	4.4124%	4.7022%
85	11.8212%	10.4567%	7.6581%	8.4311%
90	19.9920%	17.8661%	13.6171%	14.6880%

\* Applies to calendar year 2017. Rates in future years will be adjusted by the MP-2017 projection scale.

AGE	RATES OF POST-RETIREMENT DEATH			
	MALES		FEMALES	
	Present	Proposed*	Present	Proposed*
	DISABILITY RETIREMENTS			
35	2.2571%	1.0324%	0.7450%	0.4419%
40	2.2571%	1.1994%	0.7450%	0.6139%
45	2.2571%	1.7591%	0.7450%	0.9325%
50	2.8975%	2.0860%	0.7450%	1.1938%
55	3.5442%	2.4086%	1.1535%	1.5402%
60	4.2042%	2.7984%	1.6544%	1.8695%
65	5.0174%	3.3610%	2.1839%	2.2120%
70	6.2583%	4.2167%	2.8026%	2.9329%
75	8.2067%	5.7105%	3.7635%	4.3123%
80	10.9372%	8.1672%	5.2230%	6.5657%
85	14.1603%	12.1856%	7.2312%	9.9702%
90	18.3408%	18.6045%	10.0203%	14.6980%

\* Applies to calendar year 2017. Rates in future years will be adjusted by the MP-2017 projection scale.





*Section IV – Demographic Assumptions*

**COMPARISON OF ACTUAL AND EXPECTED  
POST-RETIREMENT DEATHS BASED ON PROPOSED RATES**

CENTRAL AGE OF GROUP	NUMBER OF POST-RETIREMENT DEATHS					
	MALES			FEMALES		
	Actual	Expected	Ratio of Actual to Expected	Actual	Expected	Ratio of Actual to Expected
	SERVICE RETIREMENTS AND OPTIONEES					
52 and Under	0	0	0.000	1	0	0.000
55	6	4	1.500	2	2	1.000
60	18	16	1.125	9	10	0.900
65	30	34	0.882	14	19	0.737
70	33	38	0.868	21	23	0.913
75	45	49	0.918	45	36	1.250
80	86	67	1.284	74	64	1.156
85	70	69	1.014	106	111	0.955
90	74	66	1.121	125	136	0.919
95	14	23	0.609	59	73	0.808
98 & over	4	3	1.333	31	33	0.939
<b>TOTAL</b>	<b>380</b>	<b>369</b>	<b>1.030</b>	<b>487</b>	<b>507</b>	<b>0.961</b>
DISABILITY RETIREMENTS						
52 and Under	0	1	0.000	1	0	0.000
55	0	1	0.000	3	1	3.000
60	2	3	0.667	4	2	2.000
65	6	4	1.500	6	3	2.000
70	3	3	1.000	9	4	2.250
75	11	4	2.750	7	3	2.333
80	3	4	0.750	5	4	1.250
85	3	3	1.000	6	3	2.000
90	1	2	0.500	0	5	0.000
95	0	0	0.000	3	1	3.000
98 & over	0	0	0.000	0	0	0.000
<b>TOTAL</b>	<b>29</b>	<b>25</b>	<b>1.160</b>	<b>44</b>	<b>26</b>	<b>1.692</b>



*Section IV – Demographic Assumptions*

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**RATES OF SALARY INCREASE**

**COMPARISON OF ACTUAL AND EXPECTED SALARIES  
OF ACTIVE MEMBERS**

SERVICE OF GROUP	SALARIES AT END OF YEAR (\$1,000's)		
	Actual	Expected	Ratio of Actual to Expected
1	33,477	32,828	1.020
2	28,460	28,902	0.985
3	29,460	29,772	0.990
4	30,243	30,662	0.986
5 - 9	120,737	122,456	0.986
10 - 14	115,217	117,924	0.977
15 - 19	90,432	92,593	0.977
20 - 24	141,589	145,264	0.975
25 - 29	128,195	130,844	0.980
30 & Over	20,384	20,883	0.976
<b>TOTAL</b>	<b>738,194</b>	<b>752,128</b>	<b>0.981</b>

As a result of the previous experience study, no changes were adopted to the long-term salary increase assumption in place at that time but lower rates of salary increases were assumed for a select 5-year period. For this study, actual salary increases were compared to the long-term salary increase assumption. The first two years of the period (2012 and 2013) in fact showed much lower increases than expected and were responsible for very large gains in each of those valuation years. The last three years of the study (2014, 2015, 2016) showed increases much closer to, but still somewhat below, what was expected. **We recommend that a single set of rates be adopted with slightly lower rates of salary increase generally at higher levels of service.**



## ***Section IV – Demographic Assumptions***

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The following table shows a comparison between the present and proposed rates of salary increases.

### **COMPARATIVE RATES OF POST-RETIREMENT MORTALITY**

<b>SERVICE OF GROUP</b>	<b>SALARY INCREASE RATES</b>	
	<b>Present</b>	<b>Proposed</b>
0	7.50%	7.50%
1	7.00%	7.00%
2	6.50%	6.50%
3	6.00%	6.00%
4	5.50%	5.50%
5	5.00%	5.00%
6	5.00%	4.85%
7	5.00%	4.70%
8	4.75%	4.50%
9	4.75%	4.50%
10	4.50%	4.50%
15	4.50%	4.00%
20	4.50%	4.00%
25	4.00%	3.75%
30	4.00%	3.75%



*Section IV – Demographic Assumptions*

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**COMPARISON OF ACTUAL AND EXPECTED SALARIES  
OF ACTIVE MEMBERS BASED ON PROPOSED RATES**

<b>SERVICE OF GROUP</b>	<b>SALARIES AT END OF YEAR (\$1,000's)</b>		
	<b>Actual</b>	<b>Expected</b>	<b>Ratio of Actual to Expected</b>
1	33,477	32,828	1.020
2	28,460	28,902	0.985
3	29,460	29,772	0.990
4	30,243	30,662	0.986
5 - 9	120,737	122,245	0.988
10 - 14	115,217	117,468	0.981
15 - 19	90,432	92,150	0.981
20 - 24	141,589	144,742	0.978
25 - 29	128,195	130,530	0.982
30 & Over	20,384	20,832	0.978
<b>TOTAL</b>	<b>738,194</b>	<b>750,131</b>	<b>0.984</b>



## Section IV – Demographic Assumptions

### OTHER PENSION-RELATED ASSUMPTIONS

**OPTION FACTORS:** The option factors currently used by CRS 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 be based on the proposed mortality table and investment rate of return assumption recommended for the valuation.**

**ADMINISTRATIVE EXPENSE LOAD:** Currently, estimated budgeted administrative expenses of 0.75% of payroll are added to the normal cost rate. Even after taking into account that administrative expenses in 2015 (and possibly 2016) were unusually high due to the negotiation and implementation of the Collaborative Settlement Agreement (CSA), actual administrative expenses were observed to be slightly more than 0.75% of payroll. **We recommend increasing the load added to the normal cost rate from 0.75% to 0.80% of payroll.**

**WITHDRAWAL ASSUMPTION:** Currently, it is assumed that 50% of vested members with over 15 years of service who terminate elect to leave their contributions in the plan in order to be eligible for a benefit at their retirement date while the remaining 50% elect to withdraw their contributions. Additionally, it is assumed that 100% of vested members with less than 15 years of service who terminate elect to withdraw their contributions. **We have reviewed this assumption and recommend changing the assumption to 60% of vested members who terminate elect to leave their contributions in the plan in order to be eligible for a benefit at their retirement date while the remaining 40% elect to withdraw their contributions.** Here is the breakdown by year of members and their election:

	11-12	12-13	13-14	14-15	15-16	Total	Percentage
Benefit	18	5	51	20	24	118	60.2%
Refund	18	23	15	9	13	78	39.8%
Total	36	28	66	29	37	196	100.0%

**PERCENT MARRIED:** Currently, for the purposes of valuing pre-retirement survivor benefits, 100% of members are assumed to be married. **We recommend lowering this assumption to 80% of members are assumed to be married.**

**SPOUSE AGE DIFFERENCE:** Currently, for the purposes of filling in missing dates of birth for beneficiaries of retired members who have elected a joint and survivor benefit, it is assumed a male is three years older than his spouse. We have reviewed this assumption and **recommend no change at this time.**

**PART-TIME MEMBERS:** Currently, we assume that all part time employees will receive a refund of their employee contributions with interest. Over the five year period of this study, only 17 part-time employees appear to have retired directly into pay status and no more than 5 in any given year. Since this is a very minimal number, **we recommend no change in the assumption at this time.**



## ***Section V – Retiree Health Benefits Assumptions***

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The majority of Retiree Health Benefits assumptions are reviewed annually during the actuarial valuation process. Examples of these assumptions are:

- Health Care Trend Rates
- Age Related Morbidity
- Spouse Coverage
- Medicare Coverage and Eligibility

We have decided to focus our attention in this report to the Health Benefit Plan Participation rates that are a major component of our liabilities.

In addition to covering eligible retirees, many plans cover the spouse and dependents of retirees. Also, plans may offer some or all participants a choice of coverage such as HMOs, PPOs, and POS plans. The magnitude of the retiree group benefit obligation can vary significantly as a result of the coverage assumption. The actuary should therefore consider historical participation rates and trends in coverage rates when selecting the coverage assumptions.

***Background:*** For plans that require some form of contribution to maintain coverage, some eligible individuals may not elect to be covered, particularly if they have other coverage available. Empirical data on plan participation, where available and credible, should be considered when selecting the participation assumption for future retirees. When developing the participation rates, how plan eligibility rules, plan choices, or retiree contribution rates have changed over time should be considered.

Furthermore, plan participation may be different in the future due to participants' response to changes in retiree contribution levels and plan choices. For plans that anticipate changes in retiree contributions, the appropriateness of participation rates that vary over the projection period for both current and future retirees should be considered. Also, plan eligibility rules governing dropping coverage and subsequent re-enrollment when selecting participation rates should be considered.

***Recommendation:*** Group 1 members who retired prior to September 1, 2007 and currently qualify for the Secure Plan, are assumed to re-qualify in all future years. All current participants not qualifying for the Secure Plan are covered either by the Select Plan or the Model Plan. Current participants are assumed to maintain their current retiree health benefits coverage until they are no longer eligible.



## ***Section V – Retiree Health Benefits Assumptions***

The active members of Group C with at least 15 years of creditable service shall be entitled to retiree health benefits under the Select Plan as Group 1 members. All other eligible future retirees electing retiree health benefits are assumed to be covered by the Model Plan. Currently, 90% of eligible future retirees in Group 1 are assumed to elect retiree health benefits. Eligible future retirees in Group 2 are required to pay the portion of their cost as determined by the point system, so retiree health benefit election rates are assumed to reduce as the level of cost sharing increases. The point system is based upon the sum of the member’s full years of service and the member’s age at separation from service.

Our review of recent historical participation levels suggest that rates of participation among Group 1 members are stable; whereas, initial observations for Group 2 members suggest that participation rates will likely be lower than the current assumptions for this group. This is most likely due to the relationship between age and service requirements, along with movement from coverage provided by a subsequent employer or a spouse’s plan as the retiree ages. Based upon recent experience, the persistency of plan election rates for Group 2 members (post-retirement) also appears to decline over time, all other things being equal. As a result, the use of historical averages is proposed, with an annual review and adjustment, if indicated. The current and proposed rates of participation for Group 1 and Group 2 service retirement members are as follows:

<b>Service Retirement Group</b>	<b>Current Rate of Participation (%)</b>	<b>Proposed Rate of Participation (%) (Pre-65 Retirement)</b>	<b>Proposed Rate of Participation (%) (Post-64 Retirement)</b>
Group 1	90	95	95
Group 2 with 90+ Points	90	90 grading to 45 over 20 years	45 for all years
Group 2 with 80 – 89 Points	80	90 grading to 45 over 20 years	45 for all years
Group 2 with 70 – 79 Points	60	40 grading to 0 over 20 years	0
Group 2 with 60 – 69 Points	40	40 grading to 0 over 20 years	0

For members with disability retirement benefits, recent initial participation rates are near 100% for both Group 1 and Group 2 members, and re-enrollment rates remain high in subsequent years.

As credible experience for Group 2 participation is still evolving, we will continue to monitor these assumptions annually during the valuation process.



***Appendix A – Historical June CPI (U) Index***

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<b>Year</b>	<b>CPI (U)</b>	<b>Year</b>	<b>CPI (U)</b>
1962	30.2	1990	129.9
1963	30.6	1991	136.0
1964	31.0	1992	140.2
1965	31.6	1993	144.4
1966	32.4	1994	148.0
1967	33.3	1995	152.5
1968	35.7	1996	156.7
1969	34.7	1997	160.3
1970	38.8	1998	163.0
1971	40.6	1999	166.2
1972	41.7	2000	172.4
1973	44.2	2001	178.0
1974	49.0	2002	179.9
1975	53.6	2003	183.7
1976	56.8	2004	189.7
1977	60.7	2005	194.5
1978	65.2	2006	202.9
1979	72.3	2007	208.352
1980	82.7	2008	218.815
1981	90.6	2009	215.693
1982	97.0	2010	217.965
1983	99.5	2011	225.722
1984	103.7	2012	229.478
1985	107.6	2013	233.504
1986	109.5	2014	238.343
1987	113.5	2015	238.638
1988	118.0	2016	241.038
1989	124.1	2017	244.955





**Appendix B – Capital Market Assumptions and Asset Allocation**

**Marquette’s Capital Market Assumptions and  
CRS’ Board of Trustees Asset Allocation**

**Geometric Real Rates of Return and Standard Deviations by Asset Class**

<b>Asset Class</b>	<b>Expected Real Rate of Return</b>	<b>Standard Deviation</b>
Core Bonds	0.7%	4.5%
High Yield Bonds	2.4%	6.2%
Large-Cap Value Equity	4.7%	21.9%
Large-Cap Growth Equity	4.6%	21.2%
Mid-Cap Value Equity	5.0%	22.0%
Mid-Cap Core Equity	5.0%	18.5%
Small-Cap Value Equity	5.5%	22.6%
Non-US Developed Large Cap	4.9%	22.6%
Non-US Small Cap	5.6%	29.2%
Emerging Markets All-Cap	6.0%	31.4%
Emerging Markets Small-Cap	6.0%	35.4%
Real Estate Core Equity	4.9%	5.3%
Infrastructure	5.3%	8.7%
Risk Parity	1.6%	7.3%
Private Equity	8.6%	11.4%

**Asset Allocation Targets**

<b>Asset Class</b>	<b>Asset Allocation</b>
Core Bonds	14.0%
High Yield Bonds	3.0%
Large-Cap Value Equity	7.0%
Large-Cap Growth Equity	5.0%
Mid-Cap Value Equity	4.0%
Mid-Cap Core Equity	4.0%
Small-Cap Value Equity	7.5%
Non-US Developed Large Cap	10.0%
Non-US Small Cap	5.0%
Emerging Markets All-Cap	5.0%
Emerging Markets Small-Cap	3.0%
Real Estate Core Equity	10.0%
Infrastructure	7.5%
Risk Parity	5.0%
Private Equity	10.0%



## *Appendix C – Social Security Administration Wage Index*

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<b>Year</b>	<b>Wage Index</b>	<b>Annual Increase</b>	<b>Year</b>	<b>Wage Index</b>	<b>Annual Increase</b>
1961	4,086.76	1.99	1989	20,099.55	3.96
1962	4,291.40	5.01	1990	21,027.98	4.62
1963	4,396.64	2.45	1991	21,811.60	3.73
1964	4,576.32	4.09	1992	22,935.42	5.15
1965	4,658.72	1.80	1993	23,132.67	0.86
1966	4,938.36	6.00	1994	23,753.53	2.68
1967	5,213.44	5.57	1995	24,705.66	4.01
1968	5,571.76	6.87	1996	25,913.90	4.89
1969	5,893.76	5.78	1997	27,426.00	5.84
1970	6,186.24	4.96	1998	28,861.44	5.23
1971	6,497.08	5.02	1999	30,469.84	5.57
1972	7,133.80	9.80	2000	32,154.82	5.53
1973	7,580.16	6.26	2001	32,921.92	2.39
1974	8,030.76	5.94	2002	33,252.09	1.00
1975	8,630.92	7.47	2003	34,064.95	2.44
1976	9,226.48	6.90	2004	35,648.55	4.65
1977	9,779.44	5.99	2005	36,952.94	3.66
1978	10,556.03	7.94	2006	38,651.41	4.60
1979	11,479.46	8.75	2007	40,405.48	4.54
1980	12,513.46	9.01	2008	41,334.97	2.30
1981	13,773.10	10.07	2009	40,711.61	-1.51
1982	14,531.34	5.51	2010	41,673.83	2.36
1983	15,239.24	4.87	2011	42,979.61	3.13
1984	16,135.07	5.88	2012	44,321.67	3.12
1985	16,822.51	4.26	2013	44,888.16	1.28
1986	17,321.82	2.97	2014	46,481.52	3.55
1987	18,426.51	6.38	2015	48,098.63	3.48
1988	19,334.04	4.93	2016	48,642.15	1.13



TABLE 1

RATES OF WITHDRAWAL FROM ACTIVE SERVICE

AGE	LESS THAN ONE YEAR OF SERVICE	BETWEEN ONE AND THREE YEARS OF SERVICE	BETWEEN THREE AND FIVE YEARS OF SERVICE	FIVE OR MORE YEARS OF SERVICE
20	0.22	0.10	0.080	0.0400
21	0.22	0.10	0.080	0.0400
22	0.22	0.10	0.080	0.0400
23	0.22	0.10	0.080	0.0400
24	0.22	0.10	0.080	0.0400
25	0.22	0.10	0.080	0.0400
26	0.22	0.10	0.080	0.0400
27	0.22	0.10	0.080	0.0400
28	0.22	0.10	0.080	0.0400
29	0.22	0.10	0.080	0.0400
30	0.22	0.10	0.080	0.0400
31	0.22	0.10	0.072	0.0400
32	0.22	0.10	0.064	0.0400
33	0.22	0.10	0.056	0.0400
34	0.22	0.10	0.048	0.0400
35	0.22	0.10	0.040	0.0400
36	0.22	0.10	0.040	0.0375
37	0.22	0.10	0.040	0.0350
38	0.22	0.10	0.040	0.0325
39	0.22	0.10	0.040	0.0300
40	0.22	0.10	0.040	0.0275
41	0.22	0.10	0.040	0.0245
42	0.22	0.10	0.040	0.0215
43	0.22	0.10	0.040	0.0185
44	0.22	0.10	0.040	0.0155
45+	0.22	0.10	0.040	0.0125



TABLE 2  
RATES OF DISABILITY RETIREMENT FROM ACTIVE SERVICE

AGE	RATES OF DISABILITY RETIREMENT*
20	0.00005
21	0.00006
22	0.00007
23	0.00008
24	0.00009
25	0.00010
26	0.00011
27	0.00012
28	0.00013
29	0.00014
30	0.00015
31	0.00017
32	0.00019
33	0.00021
34	0.00023
35	0.00025
36	0.00029
37	0.00033
38	0.00037
39	0.00041
40	0.00045
41	0.00051
42	0.00057
43	0.00063
44	0.00069
45	0.00075
46	0.00087
47	0.00099
48	0.00111
49	0.00123
50	0.00135
51	0.00150
52	0.00165
53	0.00180
54	0.00195
55	0.00210
56	0.00218
57	0.00226
58	0.00234
59	0.00242
60	0.00250

\* Rates are 0% when member is eligible for normal retirement



TABLE 3

RATES OF SERVICE RETIREMENT FROM ACTIVE SERVICE

AGE	RATES OF SERVICE RETIREMENT				
	GROUPS C, E, AND F				
	5 YEARS OF SERVICE	6-24 YEARS OF SERVICE	25-29 YEARS OF SERVICE	30 YEARS OF SERVICE	31+ YEARS OF SERVICE
40					
41					
42					
43					
44					
45				0.55	0.30
46				0.55	0.30
47				0.55	0.30
48				0.55	0.30
49				0.55	0.30
50				0.55	0.30
51				0.55	0.30
52				0.55	0.30
53				0.55	0.30
54				0.55	0.30
55			0.06	0.55	0.30
56			0.08	0.55	0.30
57			0.10	0.55	0.30
58			0.10	0.55	0.30
59			0.10	0.55	0.30
60	0.25	0.25	0.25	0.55	0.25
61	0.25	0.18	0.18	0.55	0.25
62	0.25	0.18	0.18	0.55	0.25
63	0.25	0.18	0.18	0.55	0.25
64	0.25	0.18	0.18	0.55	0.25
65	0.25	0.18	0.18	0.55	0.25
66	0.25	0.18	0.18	0.55	0.25
67	0.25	0.18	0.18	0.55	0.25
68	0.25	0.18	0.18	0.55	0.25
69	0.25	0.18	0.18	0.55	0.25
70	1.00	1.00	1.00	1.00	1.00



**TABLE 4**

**RATES OF SERVICE RETIREMENT FROM ACTIVE SERVICE**

AGE	RATES OF SERVICE RETIREMENT				
	GROUP G				
	5 YEARS OF SERVICE	6-14 YEARS OF SERVICE	15-29 YEARS OF SERVICE	30 YEARS OF SERVICE	31+ YEARS OF SERVICE
40					
41					
42					
43					
44					
45					
46					
47					
48					
49					
50					
51					
52					
53					
54					
55					
56					
57			0.06	0.06	0.06
58			0.06	0.06	0.06
59			0.08	0.08	0.08
60			0.08	0.08	0.08
61			0.10	0.10	0.10
62			0.10	0.25	0.25
63			0.10	0.25	0.18
64			0.10	0.25	0.18
65			0.10	0.25	0.18
66			0.10	0.25	0.18
67	0.25	0.25	0.25	0.25	0.18
68	0.25	0.18	0.18	0.18	0.18
69	0.25	0.18	0.18	0.18	0.18
70	1.00	1.00	1.00	1.00	1.00



**TABLE 5**  
**RATES OF ANTICIPATED SALARY INCREASES**

SERVICE	RATES OF INCREASE
0	7.50%
1	7.00%
2	6.50%
3	6.00%
4	5.50%
5	5.00%
6	4.85%
7	4.70%
8	4.50%
9	4.50%
10	4.50%
11	4.00%
12	4.00%
13	4.00%
14	4.00%
15	4.00%
16	4.00%
17	4.00%
18	4.00%
19	4.00%
20	4.00%
21+	3.75%