



New York State and Local  
Employee's Retirement System  
Police and Fire Retirement System  
Public Employee's Group Life Insurance Plan

**Thomas P. DiNapoli, Comptroller**

**Annual Report  
to the  
Comptroller  
on  
Actuarial Assumptions**

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August 2020

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# EXECUTIVE SUMMARY

## Executive Summary

The S&P 500 achieved a record closing high of 3,386 on February 19, 2020. On March 11, 2020, the World Health Organization announced that the COVID-19 outbreak could be characterized as a pandemic. On that same day the Dow Jones Industrial Average entered a bear market for the first time in 11 years, falling from all-time highs approaching 30,000 to under 19,000 in just a few short weeks. The next day the S&P 500 and the Nasdaq followed suit. The bear market that started in March of 2020 began due to a number of factors including shrinking corporate profits and possibly the sheer length of the 11-year bull market that preceded it. The immediate cause of the bear market was a combination of persistent worries about the effect of the COVID-19 pandemic on the world economy and a price war in oil markets between Saudi Arabia and Russia. The economic backdrop for the April 1, 2020 actuarial valuation is one of turmoil and extraordinary uncertainty.

New York State Retirement and Social Security Law (RSSL) Section 11 directs the Actuary for the New York State and Local Retirement Systems (NYSLRS), comprised of the Employees' Retirement System (ERS) and Police and Fire Retirement System (PFRS), to provide a quinquennial report on the Systems' experience and to propose assumptions and methods for the actuarial valuations. If the actuarial assumptions are reasonable, and the actuarially determined contributions are collected in a timely manner, then NYSLRS' pensioners and beneficiaries can have confidence that their benefits are secure.

This marks the second time that there has been a concerted effort to coordinate the Pension Investments and Cash Management (PICM) asset allocation study with the actuarial quinquennial assumption review. On January 6, 2020 I was provided with the capital market assumptions and portfolio expectations of NYSLRS' investment professionals and consultants. These assumptions are regarded to be applicable to a ten-year time frame and are net of investment fees and expenses. Pension funding has a significantly longer time horizon. Nevertheless, I believe the PICM asset allocation study to be the best set of information from which to recommend a rate of return assumption. Unfortunately, the status of the capital markets on the valuation date was significantly different than the status in early January (S&P 500 on January 6 was 3,246.28 while on April 1 was 2,584.59 – a more than 20% drop). Thus the usefulness of the PICM asset allocation study for recommending a rate of return assumption from an April 1, 2020 valuation date is suspect.

A typical quinquennial report recommends changes in most of the significant valuation assumptions. That will not be the case this year as I would prefer to “first do no harm” by exercising restraint and not recommending changes in the economic assumptions with a valuation date in the midst of a bear market. Pension funding is a long term endeavor and there is no need for haste. Further, a change implies some measure of confidence that the future direction of the economy has some level of clarity. The February 2020 economy was very different than the March 2020 economy. Ending the fiscal year in an equity bear market is sufficient to lead to a noteworthy increases in employer contribution rates. Hopefully some of the dust will settle over the next 12 months providing more clarity regarding the future of the economy and asset performance.

# EXECUTIVE SUMMARY

We reduced the assumed rate of return in 2019 and increased the salary scales in 2018, so these assumptions are by no means stale. I recommend that we wait another year before considering changing them again. If this year's increase in employer contribution rates looks insufficient a year from now, we can act accordingly. I think that self-control, calm, and a steady hand are more likely to prove prudent than rashness and actuarial grandstanding.

Changing the demographic assumptions is more defensible and I see no reason to set aside the experience study result for the period April 1, 2015 to March 31, 2020 and the most recent Society of Actuaries mortality improvement scale (MP-2019). These recommendations are made with an eye towards the continually evolving Actuarial Standards of Practice (ASOPs).

By the end of the report the persevering reader will find that the average employer contribution rate that emerges from the new assumptions is about 11% higher in ERS and 16% higher in PFRS than the previous fiscal year's rates (in a relative, not absolute sense). I recommend adopting these new assumptions beginning with the April 1, 2020 valuation, which generates employer contribution rates for fiscal year 2022.

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Retirement Systems Actuary  
August 2020

# ECONOMIC ASSUMPTIONS

## Economic Assumptions

### Inflation (CPI-U) and the Cost of Living Adjustment

Our recent history is predominantly marked by varying levels of inflation, with occasional brief episodes of deflation. Inflation reduces the buying power of consumers with a fixed income, as is often the case with pensioners and beneficiaries.

To mitigate this loss, Chapter 125 of the Laws of 2000 established a permanent COLA program first implemented in September, 2001. The program provides an annual COLA (each September) equal to one-half of the CPI-U increase for the previous fiscal year (April through March). The COLA is rounded to the next highest 0.1%, and then subject to a 1% floor and a 3% ceiling. The COLA applies to the first \$18,000 of benefit for pensioners and accidental death benefit recipients, with most spousal beneficiaries provided 50% of the pensioner's COLA.

The actuarial valuation must estimate future COLAs, which is done by means of a COLA assumption.

Prices for goods and services vary over time. If a "basket" of goods and services is held constant, its change in price over time is attributed to a change in the value of the currency. The Federal Bureau of Labor and Statistics (BLS) measures and tracks this phenomenon. Its Consumer Price Indexes (CPI) program produces monthly data on changes in the prices paid by consumers for a representative basket of goods and services.

The BLS publishes a multitude of CPI indexes each month, including the headline All Items CPI for All Urban Consumers (CPI-U) and the CPI-U for All Items Less Food and Energy. The latter series, widely referred to as the "core" CPI, is closely watched by many economic analysts and policymakers under the belief that food and energy prices are volatile and are subject to price shocks that cannot be damped through monetary policy. However, all consumer goods and services, including food and energy, are represented in the headline CPI-U.

A general and progressive increase in prices is called inflation.  
A general and progressive decrease in prices is called deflation.

The table below provides CPI-U data for the last two decades and COLA data for the last decade. Note that the BLS added digits to the CPI-U beginning January 2007.

# ECONOMIC ASSUMPTIONS

FY Ending 3/31	CPI-U	% Increase	COLA	FY Ending 3/31	CPI-U	% Increase	COLA
1990	128.7			2006	199.8	3.36	1.7
1991	135.0	4.90		2007	205.352	2.78	1.4
1992	139.3	3.19		2008	213.528	3.98	2.0
1993	143.6	3.09		2009	212.709	-0.38	1.0
1994	147.2	2.51		2010	217.631	2.31	1.2
1995	151.4	2.85		2011	223.467	2.68	1.4
1996	155.7	2.84		2012	229.392	2.65	1.4
1997	160.0	2.76		2013	232.773	1.47	1.0
1998	162.2	1.38		2014	236.293	1.51	1.0
1999	165.0	1.73		2015	236.119	-0.07	1.0
2000	171.2	3.76		2016	238.132	0.85	1.0
2001	176.2	2.92	1.5	2017	243.801	2.38	1.2
2002	178.8	1.48	1.0	2018	249.554	2.36	1.2
2003	184.2	3.02	1.6	2019	254.202	1.86	1.0
2004	187.4	1.74	1.0	2020	258.115	1.54	1.0
2005	193.3	3.15	1.6				

The annualized increase in the CPI-U over the thirty year period is given by:

$$(258.115 / 128.7)^{(1 / 30)} - 1 = 2.35\%$$

We now test whether this is a reasonable assumption for projecting future COLAs (which may differ from CPI-U due to the 1% floor and 3% ceiling).

A valuation inflation assumption of 2.5% would project COLAs of 1.3% for all future years (2.5% / 2 = 1.25% rounded up to 1.3%).

This projection would have properly valued the accumulated COLAs over the previous 20 years:

$$1.015 * 1.010 * 1.016 * 1.010 * 1.016 * 1.017 * 1.014 * 1.020 * 1.010 * 1.012 * 1.014 * 1.014 * 1.010 * 1.010 * 1.010 * 1.010 * 1.012 * 1.012 * 1.010 * 1.010 - 1 = 28.45\%$$

The level COLA, rounded to tenths of a percent, that best matches this experience is 1.3%.

$$1.012^{20} - 1 = 26.94\%$$

$$1.013^{20} - 1 = 29.47\%$$

$$1.014^{20} - 1 = 32.06\%$$

**Therefore I recommend no change to the current assumption of 2.5%.**

# ECONOMIC ASSUMPTIONS

## Investment Rate of Return

The actuarial investment rate of return assumption ( $i$ ) is an assumption concerning the long-term (i.e. 30 year) rate of return on pension plan assets. It is used to discount the value of future projected contributions and projected benefits.

The concept of discounting is perhaps best understood by way of illustration. Consider the following question:

Who is older, person A, age 50 today, or person B, age 62 ten years from now?

We trust that you answered person B. You probably arrived at your answer by adding ten years to person A's age and comparing 60 with 62, or by subtracting ten years from person B's age, and comparing 50 with 52. In either case, you brought the data to a common date and then made your comparison. You intuitively understood the "time value of age".

Now a second question:

Assuming that you have an investment fund that has an annual rate of return of 6.8%, which is worth more, \$100 today or \$120 three years from now?

Your intuition may have led you to select \$100 as you reasoned that even at simple interest, \$100 earning 6.8% per year is worth \$120.40 after three years.

At compound interest, \$100 becomes  $\$100 * 1.068 * 1.068 * 1.068 = \$121.82$

In both cases, as with the question about the ages, you brought the data to a common date and made your comparison. Except perhaps in this case you were more likely to bring the \$100 forward in time (accumulating) than you were to bring the \$120 backward in time (discounting).

To solve the problem by discounting, you would divide the \$120 by 1.068 three times.

$$((\$120 / 1.068) / 1.068) / 1.068 = \$98.51$$

These calculations illustrate the concept of the "time value of money". And hopefully the exercise has illustrated the importance of the discount rate. Your answer would have been different if your investment fund had an annual rate of return of 5%.

Actuarial valuations generally rely on discounting projected cash flows to a valuation date.

The valuation projects benefits for over a million people, with the most distant benefit about 110 years down the road (for a baby beneficiary). This projected cash flow is discounted at 6.8% to arrive at the present value of future benefits (PVBs).

# ECONOMIC ASSUMPTIONS

The valuation also projects employee contributions and billing compensation, all of which are discounted back to the valuation date.

And so it is easy to see the importance of the assumed investment return assumption. If the assumption is too optimistic then there will be more investment losses than gains and contributions to the fund will be less timely. If the assumption is too pessimistic then there will be more investment gains than losses and contributions to the fund will be front-loaded.

As for this study's recommendation, we begin with a history of the assumption.

FY	%	FY	%	FY	%	FY	%	FY	%	FY	%	FY	%	FY	%	FY	%	FY	%
70	4.87	75	5.50	82	7.50	86	8.00	89	8.75	97	8.50	01	8.00	11	7.50	16	7.00	19	6.80
71	4.87	76	5.50	83	7.50	87	8.00	90	8.75	98	8.50	02	8.00	12	7.50	17	7.00	20	6.80
72	4.87	77	5.50	84	7.50	88	8.00	91	8.75	99	8.50	03	8.00	13	7.50	18	7.00		
73	4.87	78	5.50	85	7.50			92	8.75	00	8.50	04	8.00	14	7.50				
74	4.87	79	5.50					93	8.75			05	8.00	15	7.50				
		80	5.50					94	8.75			06	8.00						
		81	5.50					95	8.75			07	8.00						
								96	8.75			08	8.00						
												09	8.00						
												10	8.00						

NYSLRS has a track record of not adjusting this assumption very frequently (9 times in 50 years), which is consistent with our long-term (30 year) funding perspective.

The NYSLRS historical returns by fiscal year (since 1981, the first year of serious commitment to equities) are as follows:

Year	Return	Year	Return	Year	Return	Year	Return
81	16.7%	91	11.7%	01	-8.7%	11	14.6%
82	3.3%	92	10.7%	02	2.8%	12	6.0%
83	21.4%	93	12.5%	03	-10.2%	13	10.4%
84	7.9%	94	6.9%	04	28.8%	14	13.0%
85	13.7%	95	8.8%	05	8.5%	15	7.2%
86	24.0%	96	21.8%	06	14.6%	16	0.2%
87	17.8%	97	10.9%	07	12.6%	17	11.5%
88	1.6%	98	30.4%	08	2.6%	18	11.4%
89	13.4%	99	8.8%	09	-26.4%	19	5.2%
90	13.9%	00	17.8%	10	25.9%	20	-2.7%



# ECONOMIC ASSUMPTIONS

This produces the following time-weighted annualized returns (gross of expenses):

Period	Annualized Return
2016-2020: 5 years	5.0%
2011-2020: 10 years	7.5%
2006-2020: 15 years	6.4%
2001-2020: 20 years	5.6%
1996-2020: 25 years	7.9%
1991-2020: 30 years	8.3%
1986-2020: 35 years	9.1%
1981-2020: 40 years	9.5%

While the 6.8% return has been met over the longer time periods, markets have been much more challenging since the year 2000.

What can be said about the view looking forward?

On January 6, 2020, the Division of Pension Investment and Cash Management (PICM) issued their asset allocation study and asset allocation policy. The portion of the report most germane to the actuarial rate of return assumption is repeated below:

Asset Class	(A) Allocation	(B) Arithmetic Return Assumption	Standard Deviation Assumption	(A) * (B)
Broad US Equity	32%	6.80%	17.80%	2.1760%
Broad International Equity	15	8.90	20.95	1.3350
US Agg Fixed Income	23	3.75	6.00	0.8625
CRF Credit	4	6.93	15.04	0.2772
Core Real Estate	9	7.20	17.36	0.6480
CRF Private Equity	10	9.50	23.50	0.9500
CRF Opportunistic	3	7.55	13.89	0.2265
CRF Real Assets	3	8.65	17.62	0.2595
Cash Equivalents	1	3.00	3.00	0.0300
<b>Expected Arithmetic Return</b>				<b>6.7647</b>

The capital market assumptions used in the report are applicable to a ten-year time frame and are net of investment fees and expenses.

# ECONOMIC ASSUMPTIONS

The expected arithmetic return for this portfolio is 6.76%, with a standard deviation of 12.22%, for a geometric return of 6.07%. (The expected arithmetic return is computed in the last column. Correlation coefficients are required to duplicate the portfolio standard deviation, and higher level math to duplicate the geometric return, both of which are beyond the scope of this report.)

The actuarial bureau does not have the expertise to meaningfully comment on the capital market assumptions above, and the correlation coefficients between asset classes given in the PICM report. We do have the expertise to take these capital market assumptions and correlation coefficients and enter them into our in-house stochastic simulation model to confirm the portfolio expectations provided by the investment consultant, and generate additional statistics of interest (namely over time periods longer than ten years) when setting the recommended rate of return assumption.

Though not without some controversy and professional discussion beyond the scope of this paper, the geometric return is generally regarded as the appropriate target for the assumed investment rate of return to be consistent with the application of compound interest.

This is easily understood by example. In FY 2009, NYSLRS investment return was -26.4%. In the year that followed it was 25.9%. The arithmetic average of these two years is approximately 0. This does not mean however, that FY 2010 recouped all of the FY 2009 losses. The geometric return for the two years was  $(1 - 26.4\%) * (1 + 25.9\%) - 1 = -7.3\%$ , or -3.7% annually.

If the capital market conditions on the valuation date were similar to the conditions when the PICM asset allocation study was released then it might be sensible to recommend moving the investment return assumption toward the expected geometric return of 6.07%. However, the approximate value of the Common Retirement Fund on the January 6, 2020 date of PICM's report was \$226.2b while the March 31, 2020 value was \$194.3b (financial statement value - a 14% decline).

If PICM anticipated a 6.07% geometric return from \$226.2b, and assuming the bear market loss is recovered over a 22 year period, one could argue that the anticipated return from \$194.3b is

$$[\$226.2b * 1.0607 ^ 22 / \$194.3b] ^ (1/22) - 1 = 6.8\%$$

While a specific calculation is arbitrary (and I clearly selected 22 to hit 6.8% for illustrative purposes), the idea that the capital market expectations may be meaningfully different from a market value of \$194.3b than they were from a market value of \$226.2b is rational. Therefore, before recommending a change to the assumed rate of return, I would like to emerge from the bear market. Perhaps on the next valuation date the asset level and economic backdrop will be more similar to the one when the PICM expectations were set?

**I recommend maintaining the assumed rate of return at 6.8% and revisiting this assumption next year.**

# ECONOMIC ASSUMPTIONS

Finally, consideration should be given to the position of other public retirement systems. The data below is taken from the National Association of State Retirement Administrators (NASRA) website and represents the investment return assumption (*i*) distribution for public systems in their database.

<i>i</i>	Number of Public Systems		
	July 2020	May 2015	March 2010
< 6.50	2	4	0
6.50	5		0
6.51-6.99	<b>17</b>		0
7.00	32	4	1
7.01-7.49	38	<b>43</b>	21
7.50	26		
7.51-7.99	7	36	16
8.00	3	34	<b>51</b>
8.01-8.49	0	3	16
8.50	0	2	19
Median	7.25	7.75	7.97

# ECONOMIC ASSUMPTIONS

## Salary Scales

The salary scale is the assumed annual rate of salary increase. It is used to project an individual's final average salary and benefit. The current assumptions are indexed by system and age. The ERS regular plan assumptions are based upon ERS regular plan experience. The PFRS assumptions are based upon all PFRS experience. The PFRS assumptions are applied to ERS special plans. ERS special plan experience is ignored as sporadic contract settlements lead to volatility. The current assumptions are in the table below:

Srv	ERS	PFRS	Srv	ERS	PFRS
0	8.80%	29.70%	10	4.18%	4.51%
1	8.80	29.70	11	4.07	4.40
2	7.70	14.85	12	3.96	4.29
3	6.60	12.65	13	3.85	4.18
4	5.50	10.45	14	3.74	4.07
5	4.95	8.25	15	3.63	3.96
6	4.62	5.83	16	3.52	3.85
7	4.51	4.84	17	3.41	3.74
8	4.40	4.73	18+	3.30	3.63
9	4.29	4.62			

The assumptions above were adopted in 2018 using the pattern of increase in the 2011-2015 study while increasing the magnitude by 10% and resulted in a total overall salary scale (for the April 1, 2018 cohort) of 4.3% in ERS and 5.2% in PFRS. The salary scales increased with the ensuing cohorts, particularly in PFRS, due to shifting demographics (i.e. a higher percentage of employees at the lower service levels where the higher salary scale rates are applied).

The table below provides a history of the assumption since fiscal year 1980 (the first year for which a total overall salary scale was computed). Distinctions between systems began in 1997.

FY		FY		FY	ERS	PFRS	FY	ERS	PFRS	FY	ERS	PFRS
80	5.0%	89	7.0%	97	6.0%	6.5%	02	5.9%	6.9%	11	4.9%	6.0%
81	5.0	90	7.0	98	6.0	6.5	03	5.9	6.9	12	4.9	5.7*
82	8.5	91	7.0	99	6.0	6.5	04	5.9	6.9	13	4.8*	5.4*
83	8.5	92	7.0	00	6.0	6.5	05	5.4	6.9	14	4.8	5.4
84	8.5	93	7.0	01	5.5	6.0	06	5.4	6.9	15	4.8	5.4
85	8.5	94	7.0				07	5.4	6.8	16	3.8	4.7
86	8.5	95	7.0				08	5.4	6.8	17	3.9*	4.7
87	7.3	96	7.0				09	5.4	6.8	18	4.3	5.2
88	7.3						10	5.4	6.8	19	4.4*	5.6*
										20	4.5*	5.7*

\*change due to shifts in cohort, not service indexed assumptions

# ECONOMIC ASSUMPTIONS

NYSLRS has a track record of adjusting the salary scale assumption only slightly more frequently than the assumed investment return assumption (11 times in 40 years).

The actual overall salary scale over the period April 1, 2015 to March 31, 2020 was 4.5% in ERS and 7.0% in PFRS.

The current ERS salary scale worked fine. In PFRS, there was an unusual amount of retroactive payments over the last fiscal year with a system average increase in salary for full timers of 12.5%, more than double the amount expected. That's atypical and I am leery of applying the April 1, 2015 to March 31, 2020 PFRS salary scale experience to the next five years.

**Therefore, I recommend maintaining the current salary scale first used in 2018 (with an April 1, 2020 value of 4.5% in ERS and 5.7% in PFRS) and revisiting this assumption next year.**

# ASSET VALUATION METHOD

## Asset Valuation Method

Pension fund managers could direct all assets to be invested in a fixed income portfolio. While this would greatly reduce investment income volatility, it would also increase the expected employer contribution rates.

In general, one expects to profit more as an owner (i.e. an investor in equities) than as a lender (i.e. an investor in bonds), especially if the equity ownership can be diversified and held. Thus pension funds invest in equity index funds. Unfortunately, this introduces volatility in investment income.

The basic equation governing pension funding is:  $C + I = B + E$

where, C = contributions (both employer and employee)

I = investment income

B = benefits

E = expenses [In NYSLRS, administrative expenses are funded independently of the benefits.]

From the basic equation it is clear that volatility in investment income translates into volatility in employer contributions.

Asset valuation methods “smooth” the investment income volatility by phasing in “unexpected” gains and losses, where the “unexpected” and the period of smoothing are defined by the method.

The NYSLRS asset valuation method was revised in 2013 and has the following features:

- 1) expect a gain of the assumed rate of return on the plan net position and fiscal year cash flows,
- 2) recognize (smooth) the unexpected gain (= actual gain – expected gain) over 5 years in equal annual portions, beginning immediately
- 3) do not apply a market value corridor.

**I recommend that we maintain the current asset valuation method.**

The market and actuarial value of assets (MVA & AVA) , along with the entry age normal accrued liability ( $AL_{EAN}$ ), the entry age normal unfunded accrued liability ( $UAL_{EAN}$ ), and the GASB 25 funded ratio ( $AVA/AL_{EAN}$  now obsolete), and the ratio of the plan net position (MVA) to the entry age normal total pension liability ( $TPL_{EAN}$ ) since FY 2000 are given on the following page (in billions).

# ASSET VALUATION METHOD

FY	MVA <sup>a</sup>	AVA	AL <sub>EAN</sub>	UAL <sub>EAN</sub>	GASB 25 Ratio	TPL <sub>EAN</sub>	GASB 67 Ratio
2000	\$128.9	\$110.6	\$90.6	\$-20.0	<b>122.1%</b>	Use AL <sub>EAN</sub> as a proxy	<b>142.3%</b>
2001	114.0	119.4	98.0	-21.4	121.9		116.3
2002	112.7	125.1	103.9	-21.2	120.4		108.5
2003	97.3	106.6	107.3	0.6	99.4		90.7
2004 <sup>b</sup>	120.8	117.4	116.2	-1.2	101.0		104.0
2005	128.0	123.7	120.0	-3.7	103.1		106.7
2006	142.6	132.0	126.6	-5.4	104.3		112.6
2007	156.5	142.5	134.6	-7.9	105.9		116.3
2008	155.8	151.7	141.3	-10.4	107.4		110.3
2009	110.9	148.9	146.7	-2.1	101.5		<b>75.6</b>
2010	134.2	147.7	156.6	8.9	94.3		85.7
2011	149.5	148.6	164.3	15.7	90.5		91.0
2012	153.3	147.8	169.3	21.5	<b>87.3</b>		90.5
2013	164.1	155.3	175.1	19.8	88.7		93.7
2014	181.2	171.6	186.1	14.6	92.2		97.4
2015	189.3	184.2	196.5	12.4	93.7	\$193.1	98.0
2016	183.5	190.6	203.0	12.4	93.9	202.7	90.6
2017	197.5	198.0	210.1	12.1	94.2	209.1	94.5
2018	212.0	206.7	217.6	10.9	95.0	216.3	98.0
2019	215.2	212.8	224.0	11.2	95.0	223.9	96.1
2020	198.1	214.1	231.9	17.8	92.3	229.9	86.2
2021						237.9	
a) Financial Statement Plan Net Position (i.e. Invested Assets + Receivables) [both the MVA & AVA exclude funds for group term life insurance]							
b) The equity smoothing was 'restarted'; MVA > AVA as the market value of the fixed income portfolio exceeded the amortized cost.							

# DEMOGRAPHIC ASSUMPTIONS

## Demographic Assumptions

### Pensioner Mortality Experience

The most significant demographic assumption is pensioner mortality. Our pensioner mortality tables are not developed on a “by number” basis, but on a “by liability” basis.

For example, a pensioner mortality rate of 1% for age 65 pensioners does not mean that we expect 1 in every 100 age 65 pensioners to expire within the year, rather it means that we expect \$1 in every \$100 age 65 pensioner liabilities to expire within a year.

By liability is preferred over by number because the valuation is concerned with the cessation of benefit obligations, not necessarily the cessation of benefit recipients. Generally, mortality by number and mortality by liability should be roughly equivalent. However, experience studies have shown that pensioners with more lucrative benefits enjoy better longevity than those with lesser benefits. Thus a by number mortality table would undervalue the present value of future benefits.

A second feature of the pensioner mortality assumption is the inclusion of a projection regarding mortality improvement. In 2018 we adopted the Society of Actuaries MP-2018 for this purpose.

**I recommend that we use the April 1, 2015 through March 31, 2020 pensioner experience, with mortality improvement using the Society of Actuaries Mortality Projection Scale MP-2019.**

The tables below provide some sample values of the pension liability mortality per \$1,000 in pensioner liability for valuation date April 1, 2020. (Additional pensioner mortality details can be found in Appendix B.)

Ideally, the ratios of “actuals” to “expected” (A/Es) are near 1 (i.e. the “expecteds” were a good estimate of the “actuals”). Thus the 2020 A/E is closer to 1 than the 2015 A/E as the 2020 assumptions are developed from the 2016 to 2020 experience.



# DEMOGRAPHIC ASSUMPTIONS

<b>ERS Service Retirement Pension Mortality per \$1,000</b>									
	<b>Clerk (White Collar)</b>				<b>Laborer (Blue Collar)</b>				
	Male		Female		Male		Female		
<b>Age</b>	'15	'20	'15	'20	'15	'20	'15	'20	'20
55	\$5.0	\$4.22	\$3.7	\$4.12	\$5.5	\$7.34	\$4.0	\$3.53	
62	7.5	7.22	5.3	4.94	10.6	9.64	6.1	7.93	
65	8.7	8.84	6.7	6.26	14.1	12.42	8.1	9.57	
70	13.6	13.22	10.6	10.44	21.7	20.70	13.4	13.72	
80	44.0	41.80	31.3	32.27	57.3	59.19	36.9	39.34	
90	143.7	150.63	113.3	112.90	172.9	174.22	123.7	131.54	
<b>Annuity Values (by liability)</b>									
55	12.158	12.322	12.567	12.677	11.695	11.751	12.378	12.329	
62	11.114	11.192	11.599	11.661	10.433	10.517	11.324	11.211	
65	10.528	10.596	11.057	11.088	9.805	9.848	10.748	10.646	
<b>2016-2020 Experience A/E Ratios</b>									
All	0.943	0.998	0.952	0.985	0.948	0.990	1.024	0.987	

<b>ERS Disability Retirements Pension Mortality per \$1,000</b>				
	Male		Female	
<b>Age</b>	'15	'20	'15	'20
55	\$25.5	\$19.75	\$28.0	\$22.54
62	31.5	24.80	25.2	23.23
65	33.9	27.35	24.9	24.86
70	39.6	34.46	28.6	30.15
80	73.0	78.65	61.0	56.77
90	190.5	191.77	150.9	149.66
<b>Annuity Values (by liability)</b>				
55	9.804	10.271	10.258	10.450
62	9.007	9.285	9.779	9.731
65	8.599	8.767	9.370	9.292
<b>2016-2020 Experience A/E Ratios</b>				
All	0.835	0.994	0.903	1.001

# DEMOGRAPHIC ASSUMPTIONS

<b>PFRS Retirements</b>				
<b>Pension Mortality per \$1,000</b>				
	Service		Disability	
<b>Age</b>	'15	'20	'15	'20
55	\$2.8	\$2.57	\$3.9	\$5.55
62	5.9	4.17	7.2	8.45
65	7.9	5.99	9.5	10.34
70	13.4	12.28	16.6	16.14
80	46.9	46.29	57.6	53.00
90	172.6	151.31	159.7	151.31
<b>Annuity Values (by liability)</b>				
55	12.278	12.537	12.034	12.043
62	11.080	11.296	10.791	10.867
65	10.443	10.613	10.127	10.237
<b>2016-2020 Experience A/E Ratios</b>				
All	0.878	0.985	1.014	1.001

<b>Beneficiaries</b>				
<b>Pension Mortality per \$1,000</b>				
	Male		Female	
<b>Age</b>	'15	'20	'15	'20
55	Same as male clerk service.*	\$5.48	\$4.8	\$4.17
62		9.98	7.5	6.14
65		11.56	9.1	7.75
70		18.12	13.4	12.35
80		52.81	37.7	36.12
90		155.66	113.9	115.74
<b>Annuity Values (by liability)</b>				
55	See males	11.892	12.500	12.506
62		10.726	11.577	11.443
65		10.109	11.079	10.867
<b>2016-2020 Experience A/E Ratios</b>				
All	1.177	1.026	0.939	0.984

- \*Notes: 1. Male beneficiaries use male clerk (white collar) table.  
2. The active valuation assumes all beneficiaries will be female.

# DEMOGRAPHIC ASSUMPTIONS

## Active Member Decrement Experience

The 30 active valuation decrements are as follows:

Decrement	ERS study group (all service is for mid-year)	PFRS study group	also applies to	Name
Withdrawal	0.00 ≤ service ≤ 1.99			WDME01
	2.00 ≤ service ≤ 2.99			WDME2
	3.00 ≤ service ≤ 3.99			WDME3
	4.00 ≤ service ≤ 4.99			WDME4
	5.00 ≤ service ≤ 9.99			WDME59
	10.00 ≤ service			WDMEV
			All P&F	
Accidental Death	All ERS			ADMERS
		All P&F		ADMPPF
Ordinary Death	All ERS		Pens. mortality to age 45 disab age 50 srv/ben	ODMERS
		All P&F	Pens. mortality to age 45 disab & srv/ben	ODMPF
Accidental Disability	Tiers 1 & 2			AIMERST12
	Tiers 3, 4, 5 & 6			AIMERST345
		All P&F	200%: cntypd75 100%: 14-b, shta 50%: State COs, 89w 25%: UCPOs	AIMPF
Ordinary Disability	All ERS			OIMERS
		All P&F		OIMPPF
IPOD Retirement		All P&F	ERS 14-B	IPODPF
Service Retirement	Tier 1, service ≤ 19.99		P&F T-1 regular plans	OR55LT20T1
	T-1, 20.00 ≤ service ≤ 29.99			OR552029T1
	T-1, 30.00 ≤ service			OR55GE30T1
	T-2,3,4, service ≤ 19.99		P&F T-2 reg pl, ERS T-5	OR55LT20T234
	T-2,3,4 20.00 ≤ serv ≤ 29.99			OR552029T234
	T-2,3,4, 30.00 ≤ yr service			OR55GE30T234
	25 yr plan (T-3,5 State COs)		P&F T-2 25 yr	OR25SC
	25 yr + 60ths (T-1,2 state COs)		P&F 25 + 60ths	OR25p60SC
	25 yr w A15 (county COs)		P&F T-1 25 yr, ERS 25yr& 80a	OR2589E
		20 year plan	ERS 20 yr	OR20
		20 yr + 60ths (State Police)		OR20SP
	20 yr + 60ths (not St Pol)	ERS 20 + 60ths	OR20p60	
	20 yr (P&F A14)		ORPFA14	

**I recommend that we update all the active member decrement assumptions based on the experience from April 1, 2015 through March 31, 2020.**

# DEMOGRAPHIC ASSUMPTIONS

The table below provides some values of the expected withdrawal decrements per 1,000 members (in a single decrement context). Withdrawals for ERS with service < 4 years and for PFRS were lower than expected. Withdrawals for ERS with Service  $\geq$  4 years were higher than expected.

Withdrawals															
ERS (WDME)													PFRS (WDMP)		
	0 $\leq$ Srv < 2		2 $\leq$ Srv < 3		3 $\leq$ Srv < 4		4 $\leq$ Srv < 5		5 $\leq$ Srv < 10		10 $\leq$ Service		Any Age		
Age	'15	'20	'15	'20	'15	'20	'15	'20	'15	'20	'15	'20	Srv	'15	'20
20	223	234	122	114	74	83	64	64	43	54	15	21	0	69	71
30	147	138	126	116	98	93	74	79	43	51	16	21	5	12	11
40	131	123	93	79	70	69	55	57	39	46	17	19	10	6	7
50	126	119	78	75	61	57	50	49	32	37	13	14	15	3	3
60	134	136	93	76	73	67	56	66	24	28	0	13	20	0	2
65	148	155	105	89	81	81	59	82	19	39	0	13	25	0	2
2016-2020 Experience A/E Ratios															
All	0.949	0.998	0.892	0.994	0.949	1.005	1.065	1.005	1.168	1.008	1.135	1.006	All	0.902	1.002

Over the experience study period, withdrawal experience for service < 5 was primarily comprised of Tier 5 and 6 members. For service greater than or equal to 5 but less than 10, the experience shifted from predominantly Tier 4 in 2016 to predominantly Tier 6 in 2020. For service greater than 10, the experience was primarily comprised of Tier 4. So withdrawal assumptions are composed of a blending of Tier 4 and Tier 5&6 members. Similarly for PFRS, except Tier 2 (not Tier 4) predated Tiers 5&6.

Tier 5&6 members must accrue 10-years of service credit to become vested, whereas Tier 4 is fully vested after just 5 years. To evaluate the potential impact of this plan change, a separate analysis of the ERS Tier 5&6 experience was conducted. Where credible, Tier 5&6 withdrawal rates are lower than the experience of Tier 4.

Therefore, new this year, multipliers were developed to scale the blended assumptions (above) based on a member's tier.

	0 $\leq$ Srv < 2	2 $\leq$ Srv < 3	3 $\leq$ Srv < 4	4 $\leq$ Srv < 5	5 $\leq$ Srv < 10	10 $\leq$ Srv < 11	11 $\leq$ Srv
Tiers 1,2,3,4	1.3	1.3	1.3	1.3	1.2	1.0	1.0
Tiers 5,6	1.0	0.95	0.95	0.90	0.85	1.7	0.85

Tier-specific withdrawal rates were not developed for PFRS, where withdrawal assumptions are defined without regard to age, as experience is more limited and parsing between tiers was less credible.

# DEMOGRAPHIC ASSUMPTIONS

The table below provides some values of the expected death decrements per 1,000 members (in a single decrement context). Happily our death expectations were too high.

<b>Deaths</b>										
	<b>ERS</b>				<b>PFRS</b>					
	<b>Accidental Death (ADMERS)</b>		<b>Ordinary Death (ODMERS)</b>		<b>Accidental Death (ADMPF)</b>		<b>Ordinary Death (ODMPF)</b>			
<b>Age</b>	'15	'20	'15	'20	'15	'20	'15	'20	'15	'20
20	0.01	0.01	0.32	0.26	0.08	0.01	0.32	0.13		
30	0.01	0.01	0.36	0.45	0.08	0.01	0.32	0.22		
40	0.01	0.01	0.68	0.78	0.08	0.01	0.36	0.39		
50	0.01	0.01	1.44	1.35	0.08	0.04	0.83	0.68		
60	0.01	0.01	2.15	2.36	0.06	0.04	4.54	1.18		
65	0.01	0.01	3.07	3.23	0.06	0.04	6.69	1.62		
<b>2016-2020 Experience A/E Ratios</b>										
<b>All</b>	0.402	0.457	0.967	0.977	0.243	0.910	0.743	1.118		

The table below provides some values of the expected disability decrements per 1,000 members (in a single decrement context).

<b>Disability Retirements</b>										
	<b>ERS</b>				<b>PFRS</b>					
	<b>Accidental Disability (AIMERST3456)</b>		<b>Ordinary Disability (OIMERS)</b>		<b>Accidental Disability (AIMPF)</b>		<b>Ordinary Disability (OIMPF)</b>		<b>IPOD Disability (IPODPF)</b>	
<b>Age</b>	'15	'20	'15	'20	'15	'20	'15	'20	'15	'20
20	0.01	0.01	0.49	0.10	0.42	0.20	0.47	0.02	0.11	0.20
30	0.01	0.01	0.49	0.28	0.42	0.20	0.47	0.06	0.23	0.20
35	0.03	0.01	0.86	0.48	1.29	0.20	0.47	0.10	0.89	0.20
40	0.04	0.01	1.07	0.81	2.26	1.70	0.38	0.16	1.96	1.70
45	0.05	0.04	2.10	1.37	3.37	3.19	0.47	0.27	3.25	3.19
50	0.05	0.04	3.45	2.33	3.75	3.19	0.92	0.47	3.47	3.19
<b>2016-2020 Experience A/E Ratios</b>										
<b>All</b>	0.735	1.033	0.712	1.021	0.758	0.998	0.450	0.976	0.850	0.992

# DEMOGRAPHIC ASSUMPTIONS

The table below provides some values of the expected ERS regular plan service retirement decrements per 1,000 members (in a single decrement context). The display for tier 1 was dropped in 2015 as it made up less than one percent of the system. The Tier 1 assumptions are unchanged since 2010.

Service retirement experience for Tiers 5 and 6 members, where 10 years of service is required for vesting and retirement eligibility, lacks sufficient credibility to be used in defining tier-specific rates. Instead, adjustments are applied to the Tier 4 rates based on actuarial judgement, as detailed in Appendix B, to capture differences in plan provisions.

The average age at retirement for regular plan members increased from 61 years to 62 years.

<b>ERS Age-Based Plans Service Retirements</b>						
Tiers 2, 3, 4 (OR55...T234)						
	'15 Tables			'20 Tables		
<b>Age</b>	<b>Srv &lt; 20</b>	<b>20 ≤ Srv &lt; 30</b>	<b>30 ≤ Srv</b>	<b>Srv &lt; 20</b>	<b>20 ≤ Srv &lt; 30</b>	<b>30 ≤ Srv</b>
55	56	93	398	57	82	381
56	37	57	173	37	48	172
60	53	81	192	47	71	177
62	138	317	297	129	302	258
63	105	218	230	102	199	194
65	153	253	206	154	252	218
<b>2016-2020 Experience A/E Ratios</b>						
All	0.981	0.908	0.929	1.000	1.000	1.000

# DEMOGRAPHIC ASSUMPTIONS

The table below provides some values of the expected ERS and PFRS special plan service retirement decrements per 1,000 members (in a single decrement context). The display for ERS Tier 1 and 2 was dropped in 2015 as it made up less than two percent of the system. The ERS Tier 1 and 2 assumptions are unchanged since 2010.

The average years of service for tier 3 state correction officers increased from 28 to 30 years, and for county correction officers it remained at 29 years

The average years of service for PFRS members in service-based plans was unchanged.

For 20-year plans, average service credit at retirement was 25 years.

For 20 year plans with additional 60ths, average service credit at retirement was 28 years.

For State Police in a 20-year plan with additional 60ths, it was also 28 years.

PF A14 is too new a plan to have any retirees in the study period (and thus no A/E ratios).

<b>Special Plan Service Retirements</b>													
	ERS 25-year Correction Officer				PFRS 20-year (OR20)		PFRS 20-year w add'l 60ths (OR20p60)		State Police (OR20SP)		PF A14 (ORPFA14)		
	County COs (OR2589E)		State COs (OR25SC)										
<b>Srv</b>	'15	'20	'15	'20	'15	'20	'15	'20	'15	'20	'15	'20	
<b>20</b>					229	272	89	101	62	96	20	20	
<b>21</b>					124	139	48	62	95	72	20	20	
<b>25</b>	236	332	252	299	77	96	71	89	81	119	571	571	
<b>26</b>	145	130	184	187	86	74	87	80	104	109	400	400	
<b>30</b>	206	269	146	222	73	73	162	163	200	197	400	400	
<b>35</b>	274	332	189	213	133	143	224	225	220	280	400	400	
<b>2010-2015 Experience A/E Ratios</b>													
<b>Total</b>	1.158	0.998	1.230	1.004	1.197	1.016	1.118	1.001	1.190	1.001	N/A		

# EFFECT ON CONTRIBUTIONS

## Effect on Contributions

The table below summarizes the projected average employer contribution rates for the most recent valuations.

Valuation 4/1	Local Employer Billing Date 2/1	ERS (reg plan GLIP)	PFRS (GLIP)	Total Employer Contributions / FY Benefits (billions)	Contribution Stabilization Program (CSP) Mitigated Rates (does not apply to GLIP, <del>striketrough</del> => no amortizing)				CSP Balance (billions)
					ERS		PFRS		
2005	2007	10.7%	17.0%	\$2.7 / 6.4					
2006	2008	9.6	16.6	2.6 / 6.8					
2007	2009	8.5	15.8	2.5 / 7.2					
2008	2010	7.3	15.1	2.3 / 7.7	Original		Original		
2009	2011	11.9 (0.4)	18.2 (0.1)	3.6 / 8.5	9.5%		17.5%		
2010	2012	16.3 (0.4)	21.6 (0.0)	4.9 / 8.9	10.5		18.5		
2011	2013	18.9 (0.4)	25.8 (0.1)	5.5 / 9.5	11.5	Alternate	19.5	Alternate	\$0.3
2012	2014	20.9 (0.4)	28.9 (0.0)	6.2 / 10.0	12.5	12.0%	20.5	20.0%	1.1
2013	2015	20.1 (0.4)	27.6 (0.1)	6.1 / 10.5	13.5	12.0	21.5	20.0	2.1
2014	2016	18.2 (0.5)	24.7 (0.0)	5.5 / 11.1	14.5	12.5	22.5	20.5	3.3
2015	2017	15.5 (0.4)	24.3 (0.0)	4.8 / 11.5	<del>15.1</del>	13.0	23.5	21.0	4.1
2016	2018	15.3 (0.4)	24.4 (0.1)	4.9 / 12.1	<del>14.9</del>	13.5	<del>24.3</del>	21.5	4.2
2017	2019	14.9 (0.5)	23.5 (0.0)	4.9 / 12.8	<del>14.4</del>	14.0	<del>23.5</del>	22.0	3.8
2018	2020	14.6 (0.4)	23.5 (0.0)	4.9 / 13.4	<del>14.2</del>	<del>14.2</del>	<del>23.5</del>	22.5	3.3
2019	2021	14.6 (0.5)	24.4 (0.0)	5.1 / 14.0	<del>14.1</del>	<del>14.1</del>	<del>24.4</del>	23.0	2.9
2020	<b>2022</b>	<b>16.2 (0.4)</b>	<b>28.3 (0.0)</b>	<b>5.9 / 14.7</b>	<b>15.1</b>	<b>14.6</b>	<b>25.4</b>	<b>23.5</b>	<b>2.3</b>

The 3/31/2020 CSP amortization balance is \$1.41b state + \$0.88b local = \$2.29b total.

In ERS the associated new entrant rate for the valuation cohort is 11.7%, and  $16.2\%/11.7\% = 138\%$ .

In PFRS the associated new entrant rate for the valuation cohort is 20.6%, and  $28.3\%/20.6\% = 137\%$ .

The associated new entrant contribution is \$4.3b. The additional \$1.6b is 9.0% of the  $UAL_{EAN}$  of \$17.8b.

The new entrant rate for the tier 6 valuation cohort is 8.2% in ERS and 14.7% in PFRS.



# GAIN/LOSS ANALYSIS

## Gain/Loss Analysis

	ERS	PFRS
<b>2021 Estimated Contributions (2/1/21 Payment)</b>	14.6%	24.4%
<b>Changes Due to Gains/Losses In:</b>		
FY 2016 Investment Performance (0.2% v 7.0%)	1.0%	1.1%
FY 2017 Investment Performance (11.5% v 7.0%)	-0.6%	-0.6%
FY 2018 Investment Performance (11.4% v 7.0%)	-0.6%	-0.6%
FY 2019 Investment Performance (5.2% v 7.0%)	0.3%	0.3%
FY 2020 Investment Performance (-2.7% v 6.8%)	1.7%	1.9%
FY 2020 Experience	-0.1%	0.2%
Mortality Improvement Scale MP-2018 to MP-2019	-0.2%	-0.2%
Pensioner & Bene Mortality	1.3%	2.4%
other Decrements (withdrawal, retirement, death benefits)	-0.3%	1.0%
Tier 6 New Entrant	-0.8%	-1.2%
GLIP, Administrative Contributions	0.0%	-0.2%
Miscellaneous	-0.1%	-0.2%
<b>Net Change</b>	1.6%	3.9%
<b>2022 Estimated Contributions (2/1/22 Payment)</b>	16.2%	28.3%

The annualized return over the 5 year period is 5.0%, resulting in a rate bump of 1.8% in ERS and 2.1% in PFRS. The large FY2020 new entrant cohort helped to lower rates, but was offset in ERS by the other non-asset categories, and overrun in PFRS.

The good news is that over the quinquennial period NYSLRS payees had lower rates of mortality than expected, especially in PFRS. That of course has funding consequences and adjusting the assumptions resulted in increased contribution rates.

Further, the quinquennial study found that in PFRS there were lower rates of withdrawal, disability, and death than expected, resulting in higher rates of service retirement. This is also good news for participants, but nudges the rates higher.

# SUMMARY OF ASSUMPTIONS AND METHODS

## Summary of Assumptions and Methods

Assumption or Method	Current	Recommendation
<b>Inflation/COLA</b>	2.5 % / 1.3%	<b>2.5 % / 1.3% (no change)</b>
<b>Investment Return</b>	6.8 %	<b>6.8 % (no change)</b>
<b>ERS Salary Scale</b>	4.5 % average (using FY 2020 data) Indexed by Service	<b>4.5 % average (using FY 2020 data) Indexed by Service (no change)</b>
<b>PFRS Salary Scale</b>	5.7 % average (using FY 2020 data) Indexed by Service	<b>5.7 % average (using FY 2020 data) Indexed by Service (no change)</b>
<b>Asset Valuation Method</b>	5 year level smoothing of gains or losses above or below the assumed return applied to all assets and cash flows	5 year level smoothing of gains or losses above or below the assumed return applied to all assets and cash flows <b>(no change)</b>
<b>Pensioner Mortality</b>	Gender/Collar specific tables based upon FY 2011-2015 experience with Society Of Actuaries Scale MP-2018 loading for mortality improvement.	Gender/Collar specific tables based upon <b>FY 2016-2020 experience</b> with Society Of Actuaries Scale <b>MP-2019</b> loading for mortality improvement.
<b>Active Member Decrements</b>	Based upon FY 2011-2015 experience	Based upon <b>FY 2016-2020 experience</b>

These recommendations, after having been reviewed by the Actuarial Advisory Committee in a meeting on August 13, 2020, are heretofore submitted to the State Comptroller, Thomas P. DiNapoli, pursuant to Section 11 of the Retirement and Social Security law. The Actuary for the New York State Retirement System recommends adopting these new assumptions beginning with the April 1, 2020 valuation. I am a Member of the American Academy of Actuaries and meet the Academy's Qualification Standards to issue this Statement of Actuarial Opinion.

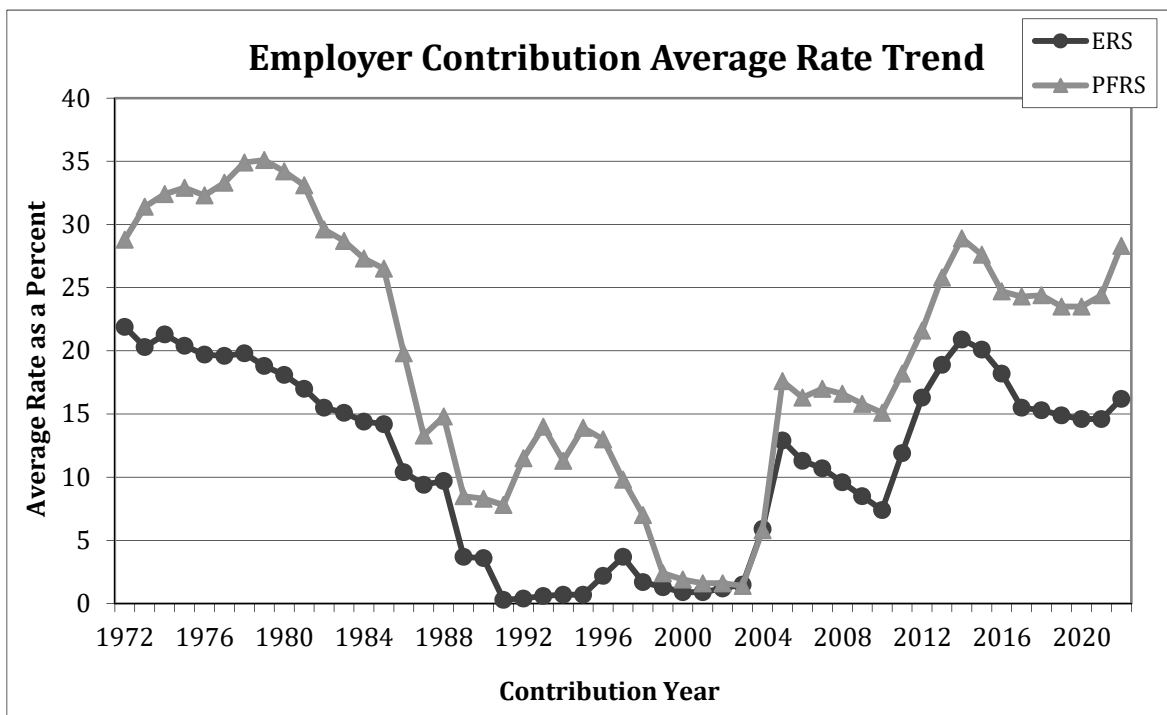
# HISTORIC EMPLOYER CONTRIBUTION AVERAGE RATE

## Historic Employer Contribution Average Rate

Average Rate		
Year	ERS	PFRS
1972	21.9	28.8
1973	20.3	31.4
1974	21.3	32.4
1975	20.4	32.9
1976	19.7	32.3
1977	19.6	33.3
1978	19.8	34.9
1979	18.8	35.1
1980	18.1	34.2
1981	17.0	33.1
1982	15.5	29.6
1983	15.1	28.7
1984	14.4	27.3
1985	14.2	26.5
1986	10.4	19.8
1987	9.4	13.3
1988	9.7	14.8

Average Rate		
Year	ERS	PFRS
1989	3.7	8.5
1990	3.6	8.3
1991	0.3	7.8
1992	0.4	11.5
1993	0.6	14.0
1994	0.7	11.3
1995	0.7	13.9
1996	2.2	13.0
1997	3.7	9.8
1998	1.7	7.0
1999	1.3	2.4
2000	0.9	1.9
2001	0.9	1.6
2002	1.2	1.6
2003	1.5	1.4
2004	5.9	5.8
2005	12.9	17.6

Average Rate		
Year	ERS	PFRS
2006	11.3	16.3
2007	10.7	17.0
2008	9.6	16.6
2009	8.5	15.8
2010	7.4	15.1
2011	11.9	18.2
2012	16.3	21.6
2013	18.9	25.8
2014	20.9	28.9
2015	20.1	27.6
2016	18.2	24.7
2017	15.5	24.3
2018	15.3	24.4
2019	14.9	23.5
2020	14.6	23.5
2021	14.6	24.4
2022	16.2	28.3



## Risk Disclosures

Why should a governmental entity take on defined benefit (DB) pension risk? DB plans are an economically efficient means of attracting and retaining employees. For example, in the matter of public safety, special plans that offer half-pay at 20 or 25 years of service guarantee income in later middle age when physicality may wane while tasks remain grueling. During the career, disability and death benefits provide income protection to those who risk their lives in service to the public.

Optimizing the economic efficiencies of a DB plan requires prefunding the benefit promises, ideally by way of smooth employer contribution rates. Actuarial Standard of Practice No. 51 (ASOP 51 “Assessment and Disclosure of Risk Associated with measuring Pension Obligations and Determining Pension Plan Contributions”) requires assessment and disclosure of risks inherent in the funding of DB plans. The two primary forms of risk are 1) insufficient employer contributions to fund the benefits, and 2) intolerable volatility in the employer contribution rate.

### **Employer Contribution Sufficiency Risk**

#### **Contribution Fulfillment Risk**

Last year, contribution fulfillment risk was presented as a non-threat because in NYS, employers are required to pay the actuarially determined contribution. Employers who are delinquent are pursued and interest is charged on any late payments. Thus there is very little risk that employer contributions will not be paid. This is the most significant component of a well-funded DB plan. Poorly funded DB plans invariably have a stretch of time when employer contributions are neglected.

While this remains true, the economic consequences of the governmental response to COVID-19 is resulting in significant revenue loss for many employers, which increases the risk to timely and complete contribution fulfillment.

#### **Actuarial Assumptions**

Actuarial assumptions and methods determine the allocation of benefit costs over time; they do not, however, determine the ultimate benefit costs. The ultimate cost of benefits is based on the lucrativeness of the promises and the performance of the assets.

# RISK DISCLOSURES

The expected long term employer contribution rate is the rate that would be charged if all assumptions were met annually. As experience deviates from what was assumed, the employer contribution rates deviate from the expected long term rate. When billing rates are greater than the expected long term rates, the current taxpayer is funding benefits earned in prior years. When billing rates are less than the expected long term rates, the current taxpayer is benefiting from contributions collected in prior years. The more conservative a set of assumptions, the more quickly contributions are collected, possibly levying too great a cost to current taxpayers. The less conservative a set of assumptions, the more likely contributions will increase, possibly levying too great a cost to future taxpayers. The best assumptions decrease the likelihood of deviations in one direction persisting over long periods. In so doing, governmental services are compensated by the taxpayers benefitting from those services (i.e. there is intergenerational equity).

New York State Retirement and Social Security Law (NYS RSSL) requires a review of all assumptions at least once every five years. To comply, the New York State and Local Retirement System (NYSLRS) undertakes a quinquennial comprehensive experience study and update of assumptions with a reasonableness review every year. Any emerging trends that are believed to continue in the future may warrant an assumption adjustment between quinquennial studies. Assumptions are reviewed annually by the Comptroller's Actuarial Advisory Committee and quinquennially by a consulting firm. The annual online publishing of the actuarial assumptions provides transparency to interested parties.

## Assumed Investment Return Expectation Risk

Employer contribution rates are most sensitive to the assumed investment return. The following table shows the FY 2022 system average billing rates and tier 6 expected long term billing rate (aka new entrant rate) for various assumed investment returns using the 4-1-2020 valuation cohort. The exceedance column shows the probability of exceeding the assumed return over a 30 year period using the capital market assumptions and policy asset allocation approved by Pension and Investment Cash Management (PICM) in 2020, the year of the most recently provided comprehensive asset/liability analysis.

Assumed Rate	Employees' Retirement System		Police and Fire Retirement System		Probability of Assumed Rate Exceedance
	FY 2022 System Average Billing Rate	Tier 6 New Entrant Rate	FY 2022 System Average Billing Rate	Tier 6 New Entrant Rate	
5.00%	38.5%	14.1%	58.1%	23.8%	69.8%
5.50%	32.0%	12.2%	49.4%	20.7%	61.5%
6.00%	25.7%	10.4%	41.1%	18.0%	52.5%
6.20%	23.3%	9.9%	37.9%	17.0%	48.8%
6.40%	20.9%	9.3%	34.7%	16.1%	45.1%
6.60%	18.5%	8.8%	31.6%	15.2%	43.4%
<b>6.80%</b>	<b>16.2%</b>	<b>8.2%</b>	<b>28.3%</b>	<b>14.7%</b>	<b>37.9%</b>

# RISK DISCLOSURES

## **Inflation and Salary Scale Expectation Risk**

The inflation assumption is used to compute COLA (cost of living adjustment) payments to retirees and beneficiaries. The COLA program provides payments equal to one half of the inflation rate based on the first \$18,000 of the single life allowance. There is a floor of 1% and a cap of 3% so there is little risk of significant gains or losses in this valuation component.

The salary scale assumption is used to project future increases in a member's salary to estimate the final average salary at retirement as well as determine billable salary over a member's career. If members receive greater salary increases than assumed, greater benefits will be paid out in the future than expected, requiring an increase in employer contributions to make up for the shortfall. Salary increases vary within a relatively narrow range, so there is minor risk of significant gains or losses in this valuation component.

## **Demographic Expectation Risks**

Demographic assumptions estimate member behavior with regard to decrements (i.e. change in status) such as retiring, withdrawing or dying. Since NYSLRS is large (over 1.1 million participants), these assumptions are developed with a high degree of credibility using NYSLRS own experience. Actual/Expected (A/E) ratios are displayed on pages 8 and 9 earlier in this report to show how actual pensioner mortality and active member decrements track expectations. Decrement vary within a relatively narrow range, so there is minor risk of significant gains or losses in this valuation component.

NYSLRS is not large enough to develop in-house mortality improvement assumptions and thus relies on mortality improvement scales based on nationwide experience derived from data collected from the Social Security Administration by the Society of Actuaries (SOA). This report recommends using scale MP-2019 for the 4-1-20 valuation. More recent SOA tables vary within a relatively narrow range so there is minor risk of significant gains or losses in this valuation component.

# RISK DISCLOSURES

## Employer Contribution Volatility Risk

### Investment Volatility Risk

Employer contribution rate smoothness is most sensitive to the investment return experience. We can evaluate exposure to investment volatility risk using the following Asset Leverage Ratio:

$$\text{Asset Leverage Ratio} = \frac{\text{Market Value of Assets (MVA)}}{\text{Present Value of Valuation Cohort Billable Salary (PVBS)}}$$

The following table displays the ratio and its components in the middle of the last four decades and for the most recent year (dollar amounts in billions).

	FYE	1985	1995	2005	2015	2020
<b>ERS</b>	MVA	\$22.8	\$53.3	\$108.7	\$161.2	\$168.1
	PVBS	\$102.0	\$158.2	\$176.1	\$203.1	\$249.3
	Ratio	22%	34%	62%	79%	67%
<b>PFRS</b>	MVA	\$4.1	\$9.8	\$19.3	\$28.2	\$30.0
	PVBS	\$11.9	\$16.5	\$27.0	\$30.9	\$39.3
	Ratio	35%	60%	71%	91%	76%

The ratio is zero at plan inception, but increases as assets accumulate. Poor investment performance in a new plan is not problematic as there was not much to lose and plenty of billable salary to collect contributions and accumulate assets before benefits become due. In a more mature fund with a high asset leverage ratio, investment volatility has a greater impact on the employer contribution rate. NYSLRS is now a mature plan with the associated significant exposure to investment volatility risk.

### Mitigating Employer Contribution Volatility Risk

NYSLRS currently employs two methods to reduce employer contribution rate volatility. An industry and GASB standard level five year asset smoothing method is used to dampen annual investment return volatility. Any deviations from the current expected return of 6.8% are recognized in equal increments over a period of five years.

The Contribution Stabilization Program (CSP signed into law in 2010 - the Alternate Program was signed in 2014 and had a one year opt-in window) provides an optional additional layer of employer contribution rate smoothing. Under the CSP, on the billing date, a participating employer is required to remit a graded rate contribution and permitted to amortize over a 10 year period the balance between the actuarial contribution and the graded (12 year period for the Alternate Program). The graded rate increases or decreases up to 1% each year (0.5% for the Alternate Program) in the direction of the system average contribution rate. During "ordinary" investment periods, the actuarial and graded rates converge. Large deviations may occur when there is extraordinary asset performance, such as after the Global Financial Crisis of 2008.

# APPENDICES

## Appendices Appendix A: A History

FY	Contributions [C]		Benefits [B]	Investments [CRF]	(C-B)/CRF	31-Mar S&P 500		Assumed CRF Return	Average Employer Contribution Rate (%)	
	Employer	Employee							ERS	PFRS
<----- (in millions) ----->										
1970	299.2	75.0	158.2	3,532.6	6.1%	89.63	NYSLRS has large positive net cash flow	4.87%	18.9	22.2
1971	346.0	77.4	194.3	3,888.2	5.9%	100.31		4.87%	19.8	23.9
1972	490.8	80.4	243.2	4,389.5	7.5%	107.20		4.87%	21.9	28.8
1973	553.0	73.0	287.9	5,167.8	6.5%	111.52		4.87%	20.3	31.4
1974	664.5	61.6	334.6	5,393.0	7.3%	93.98		4.87%	21.3	32.4
1975	749.3	52.9	373.4	5,915.3	7.2%	83.36		5.50%	20.4	32.9
1976	872.2	48.0	431.0	7,080.7	6.9%	102.77		5.50%	19.7	32.3
1977	981.3	41.7	461.3	7,852.0	7.2%	98.42		5.50%	19.6	33.3
1978	1,001.4	71.7	516.8	8,812.5	6.3%	89.21		5.50%	19.8	34.9
1979	1,020.6	61.2	568.8	10,326.7	5.0%	101.59		5.50%	18.8	35.1
1980	1,296.7	34.5	631.4	11,725.9	6.0%	102.09	Asset allocation shifting to more equities,	5.50%	18.1	34.2
1981	1,296.0	47.8	695.5	14,194.6	4.6%	136.00		5.50%	17.0	33.1
1982	1,363.9	61.5	755.8	15,088.5	4.4%	111.96		7.50%	15.5	29.6
1983	1,481.3	84.0	840.3	18,626.5	3.9%	152.96	Inflation drops significantly	7.50%	15.1	28.7
1984	1,496.1	97.5	940.5	20,618.3	3.2%	159.18		7.50%	14.4	27.3
1985	1,610.5	116.0	1,063.4	24,062.3	2.8%	180.66		7.50%	14.2	26.5
1986	1,277.0	132.3	1,157.0	29,926.1	0.8%	238.90		8.00%	10.4	19.8
1987	1,174.0	151.2	1,275.8	35,621.8	0.1%	291.70		8.00%	9.4	13.3
1988	1,321.3	188.5	1,381.9	35,812.5	0.4%	258.89	8.00%	9.7	14.8	
1989	759.4	194.7	1,624.7	40,280.6	-1.7%	294.87	8.75%	3.7	8.5	
1990	412.2	229.9	1,670.4	45,189.3	-2.3%	339.94	8.75%	3.6	8.3	
1991	-72.4	255.3	1,834.2	48,945.5	-3.4%	375.22	8.75%	0.3	7.8	
1992	356.8	287.0	2,067.7	51,925.8	-2.7%	403.69	Oil is inexpensive,	8.75%	0.4	11.5
1993	369.8	284.1	2,267.9	56,428.9	-2.9%	451.67		8.75%	0.6	14.0
1994	530.1	307.5	2,393.7	58,416.8	-2.7%	445.77	Gov't a lower % of GDP	8.75%	0.7	11.3
1995	315.1	334.0	2,527.9	63,406.6	-3.0%	500.71		8.75%	0.7	13.9
1996	776.9	341.9	2,877.9	74,827.9	-2.4%	645.50		8.75%	2.2	13.0
1997	903.5	348.2	3,122.0	82,333.8	-2.3%	757.12		8.75%	3.7	9.8
1998	462.6	369.4	3,305.0	104,921.8	-2.4%	1,101.75		8.50%	1.7	7.0
1999	291.7	399.8	3,482.0	111,008.7	-2.5%	1,286.37	8.50%	1.3	2.4	
2000	164.5	422.7	3,720.2	127,138.9	-2.5%	1,498.58	8.50%	0.9	1.9	
2001	214.8	319.1	4,181.0	112,432.9	-3.2%	1,160.33	Enron & 9/11	8.00%	0.9	1.6
2002	263.8	210.2	4,488.3	111,168.5	-3.6%	1,147.39		Housing Bubble	8.00%	1.2
2003	651.9	219.2	4,984.6	95,598.3	-4.3%	848.18	Housing decline consequences	8.00%	1.5	1.4
2004	1,286.5	221.9	5,347.5	119,245.0	-3.2%	1,126.21		8.00%	5.9	5.8
2005	2,964.8	227.3	5,674.7	126,083.5	-2.0%	1,180.59		8.00%	12.9	17.6
2006	2,782.2	241.2	6,028.9	140,453.3	-2.1%	1,294.87		8.00%	11.3	16.3
2007	2,718.6	250.2	6,383.4	154,575.5	-2.2%	1,420.86		8.00%	10.7	17.0
2008	2,648.4	265.7	6,835.6	153,877.7	-2.5%	1,322.70		8.00%	9.6	16.6
2009	2,456.2	273.3	7,212.1	108,960.7	-4.1%	797.87		8.00%	8.5	15.8
2010	2,344.2	284.3	7,718.9	132,500.2	-3.8%	1,169.43		8.00%	7.4	15.1
2011	4,164.6	286.2	8,520.2	147,237.0	-2.8%	1,325.83		7.50%	11.9	18.2
2012	4,585.2	273.2	8,937.8	150,658.9	-2.7%	1,408.47		Fed support	7.50%	16.3
2013	5,336.0	269.1	9,521.5	160,660.8	-2.4%	1,569.19	7.50%		18.9	25.8
2014	6,064.1	281.4	9,977.5	176,835.1	-2.1%	1,872.34	7.50%	20.9	28.9	
2015	5,797.4	284.8	10,513.7	184,502.0	-2.4%	2,067.89	7.50%	20.1	27.6	
2016	5,140.2	306.6	11,060.5	178,639.7	-3.1%	2,059.74	7.00%	18.2	24.7	
2017	4,787.0	328.8	11,508.3	192,410.6	-3.3%	2,362.72	Tax Cuts and Deregulation	7.00%	15.5	24.3
2018	4,823.3	349.4	12,128.9	207,416.0	-3.4%	2,640.87		7.00%	15.3	24.4
2019	4,744.3	386.5	12,833.9	210,523.7	-3.7%	2,834.40	Bear Market	6.80%	14.9	23.5
2020	4,782.7	453.7	13,311.1	194,317.2	-4.2%	2,584.59		6.80%	14.6	23.5



## Appendix B: Assumption Details

This section strives to disclose all material assumptions, and details various decrement rates used in the valuation.

Some miscellaneous assumptions in the Employees' Retirement System (ERS) include:

- When a disability benefit is subject to a workers' compensation offset, we assume the offset is 15% of final average salary.
- Some members can convert unused sick leave at retirement into additional service credit. We assume that 3 days are credited for each year of service.
- Members in tiers 5 and 6 are subject to a narrower definition of how much overtime can be included in their final average salary. For Tier 5, the limit increases 3% each year. For Tier 6, the limit is indexed to inflation. Therefore, we assume no valuation impact.
- For Tier 6 members, each year's salary used in computing the final average salary is capped at the Governor's Salary, currently \$225,000. The Governor's Salary is assumed to increase at the rate of inflation each year.
- Tier-specific withdrawal assumptions that reflect differences in vesting schedules for Tier 5 and 6 as compared to prior tiers are obtained by applying the following multipliers to the rates reported in Table 12.

	$0 \leq \text{Srv} < 2$	$2 \leq \text{Srv} < 3$	$3 \leq \text{Srv} < 4$	$4 \leq \text{Srv} < 5$	$5 \leq \text{Srv} < 10$	$10 \leq \text{Srv} < 11$	$11 \leq \text{Srv}$
Tiers 1,2,3,4	1.3	1.3	1.3	1.3	1.2	1.0	1.0
Tiers 5,6	1.0	0.95	0.95	0.90	0.85	1.7	0.85

Additionally, for Tiers 1,2,3,4, when service < 10, the age 58 central rate is used for all ages  $\geq 58$ .

Some miscellaneous assumptions in the Police and Fire Retirement system (PFRS) include:

- When a disability benefit is subject to a workers' compensation offset, we assume the offset is 5% of final average salary. For accidental death benefits, we assume the workers' compensation offset is 18% of final average salary, and we assume the social security offset is 6% of salary.
- Some members can convert unused sick leave at retirement into additional service credit. We assume that 4 days are credited for each year of service, subject to a maximum of 165 days.
- Some members are entitled to a benefit based upon a 1-year final average salary (FAS). In these cases, salary is seen to increase faster than the assumed salary scale in the year prior to retirement. A factor (*OneYearFAS*) is multiplied by the plan's usual FAS calculation to estimate the 1-year FAS. For Tier 1 members with date of membership prior to April 1, 1972, *OneYearFAS* is 1.08. For Tiers 5 and 6, *OneYearFAS* is 1.09. And for all others, *OneYearFAS* is 1.18.
- Members in tiers 5 and 6 are subject to a narrower definition of how much overtime can be included in their final average salary. The active valuation includes an *OTLimit* factor that trims PFRS Tier 5 liabilities by 5% and PFRS Tier 6 liabilities by 10%.
- For Tier 6 members, each year's salary used in computing the final average salary is capped at the Governor's Salary, currently \$225,000. The Governor's Salary is assumed to increase at the rate of inflation each year.
- For Tiers 5 and 6, withdrawal central rates are multiplied by a factor of 0.80 when  $5 \leq \text{service} < 10$ .

# APPENDICES

The remainder of this Appendix provides the assumed decrement rates for pensioner mortality (including beneficiary mortality) and active member decrements (withdrawal, death, disability, service retirement) and salary scale assumptions, for both systems.

Assumption sets are presented in a series of tables organized by system and decrement type.

Table 1	Employees' Retirement System <b>Male Clerk Service</b> Pensioner Mortality <sup>1</sup>
Table 2	Employees' Retirement System <b>Female Clerk Service</b> Pensioner Mortality <sup>1</sup>
Table 3	Employees' Retirement System <b>Male Laborer Service</b> Pensioner Mortality <sup>1</sup>
Table 4	Employees' Retirement System <b>Female Laborer Service</b> Pensioner Mortality <sup>1</sup>
Table 5	Employees' Retirement System <b>Male Disability</b> Pensioner Mortality <sup>1</sup>
Table 6	Employees' Retirement System <b>Female Disability</b> Pensioner Mortality <sup>1</sup>
Table 7	Police & Fire Retirement System <b>Service</b> Pensioner Mortality <sup>1</sup>
Table 8	Police & Fire Retirement System <b>Disability</b> Pensioner Mortality <sup>1</sup>
Table 9	Retirement System <b>Male Beneficiary</b> Mortality <sup>1 2</sup>
Table 10	Retirement System <b>Female Beneficiary</b> Mortality <sup>1 3</sup>
Table 11	Employees' Retirement System <b>Death and Disability</b> Central Rates of Decrement
Table 12	Employees' Retirement System <b>Withdrawal</b> Central Rates of Decrement
Table 13	Employees' Retirement System <b>Age-Based Plans Retirement</b> Central Rates of Decrement
Table 14	Employees' Retirement System <b>Service-Based Plans Retirement</b> Central Rates of Decrement
Table 15	Police & Fire Retirement System <b>Death and Disability</b> Central Rates of Decrement
Table 16	Police & Fire Retirement System <b>Withdrawal</b> Central Rates of Decrement
Table 17	Police & Fire Retirement System <b>Age-Based Plans Retirement</b> Central Rates of Decrement
Table 18	Police & Fire Retirement System <b>Service-Based Plans Retirement</b> Central Rates of Decrement
Table 19	Employees' Retirement System <b>Salary Scale</b>
Table 20	Police & Fire Retirement System <b>Salary Scale</b>

<sup>1</sup> The base mortality ( $q_x$ ) is generally only changed once every five years, with the quinquennial review. Mortality Improvement is applied from the midpoint of the experience study period (10/1/2017) through to the valuation date (4/1/2020). Therefore, the mortality improvement factors will change each year as an additional year of improvement is applied. This causes the valuation mortality rates (Val  $q_x$ ) to change year-over-year.

<sup>2</sup> In the active valuation, it is assumed that all beneficiaries will be female. The liability impact is immaterial.

<sup>3</sup> In the active valuation, it is assumed that beneficiaries are two years younger than the member.

# APPENDICES

TABLE 1 Employees' Retirement System **Male Clerk Service** Pensioner Mortality  
Effective 4/1/2020 (For Valuation Purposes Only)

Age	q <sub>x</sub>	MP-2019 Factor	2020 Val q <sub>x</sub>	Age	q <sub>x</sub>	MP-2019 Factor	2020 Val q <sub>x</sub>
0	0.000190	1.042549	0.000198	55	0.004220	0.990576	0.004180
1	0.000190	1.042549	0.000198	56	0.004579	0.993038	0.004547
2	0.000190	1.042549	0.000198	57	0.004965	0.996027	0.004945
3	0.000190	1.042549	0.000198	58	0.005376	0.999272	0.005372
4	0.000190	1.042549	0.000198	59	0.005809	1.002723	0.005825
5	0.000190	1.042549	0.000198	60	0.006261	1.005680	0.006297
6	0.000190	1.042549	0.000198	61	0.006730	1.008366	0.006786
7	0.000190	1.042549	0.000198	62	0.007216	1.010101	0.007289
8	0.000190	1.042549	0.000198	63	0.007722	1.010932	0.007806
9	0.000190	1.042549	0.000198	64	0.008260	1.010531	0.008347
10	0.000190	1.042549	0.000198	65	0.008842	1.009123	0.008923
11	0.000190	1.042549	0.000198	66	0.009490	1.006638	0.009553
12	0.000190	1.042549	0.000198	67	0.010225	1.003529	0.010261
13	0.000190	1.042549	0.000198	68	0.011075	0.999950	0.011074
14	0.000190	1.042549	0.000198	69	0.012063	0.996354	0.012019
15	0.000190	1.042549	0.000198	70	0.013218	0.992666	0.013121
16	0.000200	1.042549	0.000209	71	0.014565	0.989483	0.014412
17	0.000220	1.042549	0.000229	72	0.016131	0.986802	0.015918
18	0.000230	1.042549	0.000240	73	0.017947	0.984696	0.017672
19	0.000240	1.042549	0.000250	74	0.020047	0.983136	0.019709
20	0.000260	1.042549	0.000271	75	0.022475	0.982245	0.022076
21	0.000270	1.044318	0.000282	76	0.025282	0.981776	0.024821
22	0.000290	1.046757	0.000304	77	0.028533	0.981751	0.028012
23	0.000300	1.049815	0.000315	78	0.032304	0.981998	0.031722
24	0.000320	1.054371	0.000337	79	0.036691	0.982468	0.036048
25	0.000340	1.060415	0.000361	80	0.041796	0.982963	0.041084
26	0.000360	1.067390	0.000384	81	0.047727	0.983680	0.046948
27	0.000380	1.074731	0.000408	82	0.054585	0.984299	0.053728
28	0.000400	1.082130	0.000433	83	0.062463	0.984919	0.061521
29	0.000420	1.089402	0.000458	84	0.071442	0.985513	0.070407
30	0.000450	1.095965	0.000493	85	0.081582	0.986034	0.080443
31	0.000470	1.101971	0.000518	86	0.092925	0.986654	0.091685
32	0.000500	1.106694	0.000553	87	0.105497	0.987125	0.104139
33	0.000530	1.110366	0.000588	88	0.119307	0.987621	0.117830
34	0.000560	1.112500	0.000623	89	0.134353	0.987894	0.132727
35	0.000590	1.113010	0.000657	90	0.150626	0.988117	0.148836
36	0.000620	1.111922	0.000689	91	0.168112	0.988118	0.166114
37	0.000660	1.108972	0.000732	92	0.186795	0.988093	0.184571
38	0.000690	1.104036	0.000762	93	0.206658	0.987745	0.204125
39	0.000730	1.097421	0.000801	94	0.227684	0.987100	0.224747
40	0.000780	1.089013	0.000849	95	0.249859	0.986232	0.246419
41	0.000820	1.079072	0.000885	96	0.273113	0.986877	0.269529
42	0.000870	1.068143	0.000929	97	0.297118	0.987522	0.293411
43	0.000920	1.056453	0.000972	98	0.321122	0.988267	0.317354
44	0.000970	1.044582	0.001013	99	0.345127	0.988987	0.341326
45	0.001020	1.033046	0.001054	100	0.369131	0.989608	0.365295
46	0.001080	1.022322	0.001104	101	0.394636	0.990254	0.390790
47	0.001140	1.012823	0.001155	102	0.422391	0.990999	0.418589
48	0.001210	1.004605	0.001216	103	0.453897	0.991746	0.450150
49	0.001280	0.998050	0.001278	104	0.490654	0.992368	0.486909
50	0.001350	0.993213	0.001341	105	0.534162	0.993015	0.530431
51	0.001924	0.990030	0.001905	106	0.587422	0.993737	0.583743
52	0.002498	0.988391	0.002469	107	0.653435	0.994484	0.649831
53	0.003072	0.988043	0.003035	108	0.738201	0.995232	0.734681
54	0.003646	0.988763	0.003605	109	0.849972	0.995755	0.846364
				110	1.000000	n/a	1.000000

# APPENDICES

TABLE 2 Employees' Retirement System **Female Clerk Service** Pensioner Mortality  
Effective 4/1/2020 (For Valuation Purposes Only)

Age	q <sub>x</sub>	MP-2019 Factor	2020 Val q <sub>x</sub>	Age	q <sub>x</sub>	MP-2019 Factor	2020 Val q <sub>x</sub>
0	0.000190	1.047528	0.000199	55	0.004115	1.002647	0.004126
1	0.000190	1.047528	0.000199	56	0.004118	1.007234	0.004148
2	0.000190	1.047528	0.000199	57	0.004121	1.011557	0.004169
3	0.000190	1.047528	0.000199	58	0.004181	1.015262	0.004245
4	0.000190	1.047528	0.000199	59	0.004287	1.017888	0.004364
5	0.000190	1.047528	0.000199	60	0.004443	1.019078	0.004528
6	0.000190	1.047528	0.000199	61	0.004657	1.018801	0.004745
7	0.000190	1.047528	0.000199	62	0.004938	1.017110	0.005022
8	0.000190	1.047528	0.000199	63	0.005293	1.013831	0.005366
9	0.000190	1.047528	0.000199	64	0.005730	1.009577	0.005785
10	0.000190	1.047528	0.000199	65	0.006257	1.004381	0.006284
11	0.000190	1.047528	0.000199	66	0.006878	0.999175	0.006872
12	0.000190	1.047528	0.000199	67	0.007601	0.993861	0.007554
13	0.000190	1.047528	0.000199	68	0.008431	0.989110	0.008339
14	0.000190	1.047528	0.000199	69	0.009374	0.985092	0.009234
15	0.000190	1.047528	0.000199	70	0.010437	0.982121	0.010250
16	0.000200	1.047528	0.000210	71	0.011627	0.979971	0.011394
17	0.000220	1.047528	0.000230	72	0.012955	0.978861	0.012681
18	0.000230	1.047528	0.000241	73	0.014439	0.978490	0.014128
19	0.000240	1.047528	0.000251	74	0.016104	0.978811	0.015763
20	0.000260	1.047528	0.000272	75	0.017982	0.979552	0.017614
21	0.000270	1.049328	0.000283	76	0.020113	0.980737	0.019726
22	0.000290	1.051232	0.000305	77	0.022548	0.981973	0.022142
23	0.000300	1.053525	0.000316	78	0.025342	0.983334	0.024920
24	0.000320	1.056773	0.000338	79	0.028559	0.984794	0.028125
25	0.000340	1.061091	0.000361	80	0.032265	0.986157	0.031818
26	0.000360	1.065732	0.000384	81	0.036528	0.987596	0.036075
27	0.000380	1.070541	0.000407	82	0.041424	0.988638	0.040953
28	0.000400	1.075181	0.000430	83	0.047032	0.989831	0.046554
29	0.000420	1.079703	0.000453	84	0.053434	0.990576	0.052930
30	0.000450	1.083764	0.000488	85	0.060717	0.991223	0.060184
31	0.000470	1.086993	0.000511	86	0.068961	0.991820	0.068397
32	0.000500	1.089335	0.000545	87	0.078243	0.992093	0.077624
33	0.000530	1.090601	0.000578	88	0.088625	0.992442	0.087955
34	0.000560	1.090420	0.000611	89	0.100162	0.992467	0.099407
35	0.000590	1.088713	0.000642	90	0.112896	0.992467	0.112046
36	0.000620	1.085536	0.000673	91	0.126865	0.992342	0.125894
37	0.000660	1.080819	0.000713	92	0.142099	0.992193	0.140990
38	0.000690	1.074678	0.000742	93	0.158626	0.991845	0.157332
39	0.000730	1.067282	0.000779	94	0.176472	0.991372	0.174949
40	0.000780	1.058778	0.000826	95	0.195656	0.990975	0.193890
41	0.000820	1.049696	0.000861	96	0.220591	0.991273	0.218666
42	0.000870	1.040225	0.000905	97	0.246330	0.991746	0.244297
43	0.000920	1.030703	0.000948	98	0.272069	0.992243	0.269959
44	0.000970	1.021512	0.000991	99	0.297808	0.992741	0.295646
45	0.001020	1.012874	0.001033	100	0.323547	0.993214	0.321351
46	0.001080	1.005282	0.001086	101	0.350894	0.993612	0.348653
47	0.001140	0.998974	0.001139	102	0.380655	0.994110	0.378413
48	0.001210	0.994160	0.001203	103	0.414438	0.994609	0.412204
49	0.001280	0.990999	0.001268	104	0.453850	0.994983	0.451573
50	0.001350	0.989409	0.001336	105	0.500502	0.995381	0.498190
51	0.001903	0.989558	0.001883	106	0.557611	0.995880	0.555314
52	0.002456	0.991272	0.002435	107	0.628393	0.996354	0.626102
53	0.003009	0.994233	0.002992	108	0.719284	0.996853	0.717020
54	0.003562	0.998073	0.003555	109	0.839131	0.997252	0.836825
				110	1.000000	n/a	1.000000

# APPENDICES

TABLE 3 Employees' Retirement System **Male Laborer Service** Pensioner Mortality  
Effective 4/1/2020 (For Valuation Purposes Only)

Age	q <sub>x</sub>	MP-2019 Factor	2020 Val q <sub>x</sub>	Age	q <sub>x</sub>	MP-2019 Factor	2020 Val q <sub>x</sub>
0	0.000190	1.042549	0.000198	55	0.007342	0.990576	0.007273
1	0.000190	1.042549	0.000198	56	0.007403	0.993038	0.007351
2	0.000190	1.042549	0.000198	57	0.007541	0.996027	0.007511
3	0.000190	1.042549	0.000198	58	0.007761	0.999272	0.007755
4	0.000190	1.042549	0.000198	59	0.008072	1.002723	0.008094
5	0.000190	1.042549	0.000198	60	0.008482	1.005680	0.008530
6	0.000190	1.042549	0.000198	61	0.009003	1.008366	0.009078
7	0.000190	1.042549	0.000198	62	0.009644	1.010101	0.009741
8	0.000190	1.042549	0.000198	63	0.010418	1.010932	0.010532
9	0.000190	1.042549	0.000198	64	0.011336	1.010531	0.011455
10	0.000190	1.042549	0.000198	65	0.012415	1.009123	0.012528
11	0.000190	1.042549	0.000198	66	0.013672	1.006638	0.013763
12	0.000190	1.042549	0.000198	67	0.015122	1.003529	0.015175
13	0.000190	1.042549	0.000198	68	0.016774	0.999950	0.016773
14	0.000190	1.042549	0.000198	69	0.018633	0.996354	0.018565
15	0.000190	1.042549	0.000198	70	0.020704	0.992666	0.020552
16	0.000200	1.042549	0.000209	71	0.022999	0.989483	0.022757
17	0.000220	1.042549	0.000229	72	0.025536	0.986802	0.025199
18	0.000230	1.042549	0.000240	73	0.028344	0.984696	0.027910
19	0.000240	1.042549	0.000250	74	0.031455	0.983136	0.030925
20	0.000260	1.042549	0.000271	75	0.034910	0.982245	0.034290
21	0.000270	1.044318	0.000282	76	0.038755	0.981776	0.038049
22	0.000290	1.046757	0.000304	77	0.043042	0.981751	0.042257
23	0.000300	1.049815	0.000315	78	0.047830	0.981998	0.046969
24	0.000320	1.054371	0.000337	79	0.053187	0.982468	0.052255
25	0.000340	1.060415	0.000361	80	0.059189	0.982963	0.058181
26	0.000360	1.067390	0.000384	81	0.065922	0.983680	0.064846
27	0.000380	1.074731	0.000408	82	0.073481	0.984299	0.072327
28	0.000400	1.082130	0.000433	83	0.081960	0.984919	0.080724
29	0.000420	1.089402	0.000458	84	0.091452	0.985513	0.090127
30	0.000450	1.095965	0.000493	85	0.102044	0.986034	0.100619
31	0.000470	1.101971	0.000518	86	0.113820	0.986654	0.112301
32	0.000500	1.106694	0.000553	87	0.126859	0.987125	0.125226
33	0.000530	1.110366	0.000588	88	0.141232	0.987621	0.139484
34	0.000560	1.112500	0.000623	89	0.157002	0.987894	0.155101
35	0.000590	1.113010	0.000657	90	0.174219	0.988117	0.172149
36	0.000620	1.111922	0.000689	91	0.192921	0.988118	0.190629
37	0.000660	1.108972	0.000732	92	0.213135	0.988093	0.210597
38	0.000690	1.104036	0.000762	93	0.234873	0.987745	0.231995
39	0.000730	1.097421	0.000801	94	0.258139	0.987100	0.254809
40	0.000780	1.089013	0.000849	95	0.282929	0.986232	0.279034
41	0.000820	1.079072	0.000885	96	0.309235	0.986877	0.305177
42	0.000870	1.068143	0.000929	97	0.337048	0.987522	0.332842
43	0.000920	1.056453	0.000972	98	0.366363	0.988267	0.362064
44	0.000970	1.044582	0.001013	99	0.397175	0.988987	0.392801
45	0.001020	1.033046	0.001054	100	0.429480	0.989608	0.425017
46	0.001080	1.022322	0.001104	101	0.463277	0.990254	0.458762
47	0.001140	1.012823	0.001155	102	0.498564	0.990999	0.494077
48	0.001210	1.004605	0.001216	103	0.535340	0.991746	0.530921
49	0.001280	0.998050	0.001278	104	0.573605	0.992368	0.569227
50	0.001350	0.993213	0.001341	105	0.613358	0.993015	0.609074
51	0.002548	0.990030	0.002523	106	0.655889	0.993737	0.651781
52	0.003747	0.988391	0.003703	107	0.708086	0.994484	0.704180
53	0.004945	0.988043	0.004886	108	0.775748	0.995232	0.772049
54	0.006144	0.988763	0.006075	109	0.868542	0.995755	0.864855
				110	1.000000	n/a	1.000000

# APPENDICES

TABLE 4 Employees' Retirement System **Female Laborer Service** Pensioner Mortality  
Effective 4/1/2020 (For Valuation Purposes Only)

Age	q <sub>x</sub>	MP-2019 Factor	2020 Val q <sub>x</sub>	Age	q <sub>x</sub>	MP-2019 Factor	2020 Val q <sub>x</sub>
0	0.000190	1.047528	0.000199	55	0.003525	1.002647	0.003534
1	0.000190	1.047528	0.000199	56	0.004275	1.007234	0.004306
2	0.000190	1.047528	0.000199	57	0.004979	1.011557	0.005037
3	0.000190	1.047528	0.000199	58	0.005637	1.015262	0.005723
4	0.000190	1.047528	0.000199	59	0.006254	1.017888	0.006366
5	0.000190	1.047528	0.000199	60	0.006834	1.019078	0.006964
6	0.000190	1.047528	0.000199	61	0.007388	1.018801	0.007527
7	0.000190	1.047528	0.000199	62	0.007925	1.017110	0.008061
8	0.000190	1.047528	0.000199	63	0.008457	1.013831	0.008574
9	0.000190	1.047528	0.000199	64	0.008999	1.009577	0.009085
10	0.000190	1.047528	0.000199	65	0.009570	1.004381	0.009612
11	0.000190	1.047528	0.000199	66	0.010190	0.999175	0.010182
12	0.000190	1.047528	0.000199	67	0.010884	0.993861	0.010817
13	0.000190	1.047528	0.000199	68	0.011682	0.989110	0.011555
14	0.000190	1.047528	0.000199	69	0.012617	0.985092	0.012429
15	0.000190	1.047528	0.000199	70	0.013716	0.982121	0.013471
16	0.000200	1.047528	0.000210	71	0.015003	0.979971	0.014703
17	0.000220	1.047528	0.000230	72	0.016497	0.978861	0.016148
18	0.000230	1.047528	0.000241	73	0.018216	0.978490	0.017824
19	0.000240	1.047528	0.000251	74	0.020179	0.978811	0.019751
20	0.000260	1.047528	0.000272	75	0.022412	0.979552	0.021954
21	0.000270	1.049328	0.000283	76	0.024947	0.980737	0.024466
22	0.000290	1.051232	0.000305	77	0.027835	0.981973	0.027333
23	0.000300	1.053525	0.000316	78	0.031141	0.983334	0.030622
24	0.000320	1.056773	0.000338	79	0.034945	0.984794	0.034414
25	0.000340	1.061091	0.000361	80	0.039337	0.986157	0.038792
26	0.000360	1.065732	0.000384	81	0.044415	0.987596	0.043864
27	0.000380	1.070541	0.000407	82	0.050273	0.988638	0.049702
28	0.000400	1.075181	0.000430	83	0.056995	0.989831	0.056415
29	0.000420	1.079703	0.000453	84	0.064646	0.990576	0.064037
30	0.000450	1.083764	0.000488	85	0.073273	0.991223	0.072630
31	0.000470	1.086993	0.000511	86	0.082903	0.991820	0.082225
32	0.000500	1.089335	0.000545	87	0.093547	0.992093	0.092807
33	0.000530	1.090601	0.000578	88	0.105204	0.992442	0.104409
34	0.000560	1.090420	0.000611	89	0.117868	0.992467	0.116980
35	0.000590	1.088713	0.000642	90	0.131538	0.992467	0.130547
36	0.000620	1.085536	0.000673	91	0.146218	0.992342	0.145098
37	0.000660	1.080819	0.000713	92	0.161917	0.992193	0.160653
38	0.000690	1.074678	0.000742	93	0.178643	0.991845	0.177186
39	0.000730	1.067282	0.000779	94	0.196403	0.991372	0.194709
40	0.000780	1.058778	0.000826	95	0.215200	0.990975	0.213258
41	0.000820	1.049696	0.000861	96	0.239529	0.991273	0.237439
42	0.000870	1.040225	0.000905	97	0.264642	0.991746	0.262458
43	0.000920	1.030703	0.000948	98	0.289756	0.992243	0.287508
44	0.000970	1.021512	0.000991	99	0.314870	0.992741	0.312584
45	0.001020	1.012874	0.001033	100	0.339983	0.993214	0.337676
46	0.001080	1.005282	0.001086	101	0.366666	0.993612	0.364324
47	0.001140	0.998974	0.001139	102	0.395704	0.994110	0.393373
48	0.001210	0.994160	0.001203	103	0.428666	0.994609	0.426355
49	0.001280	0.990999	0.001268	104	0.467121	0.994983	0.464777
50	0.001350	0.989409	0.001336	105	0.512639	0.995381	0.510271
51	0.001785	0.989558	0.001766	106	0.568360	0.995880	0.566018
52	0.002220	0.991272	0.002201	107	0.637422	0.996354	0.635098
53	0.002655	0.994233	0.002640	108	0.726105	0.996853	0.723820
54	0.003090	0.998073	0.003084	109	0.843040	0.997252	0.840724
				110	1.000000	n/a	1.000000

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TABLE 5 Employees' Retirement System **Male Disability Pensioner Mortality**  
Effective 4/1/2020 (For Valuation Purposes Only)

Age	q <sub>x</sub>	MP-2019 Factor	2020 Val q <sub>x</sub>	Age	q <sub>x</sub>	MP-2019 Factor	2020 Val q <sub>x</sub>
0	0.001900	1.042549	0.001981	55	0.019747	0.990576	0.019561
1	0.001900	1.042549	0.001981	56	0.020273	0.993038	0.020132
2	0.001900	1.042549	0.001981	57	0.020958	0.996027	0.020875
3	0.001900	1.042549	0.001981	58	0.021756	0.999272	0.021740
4	0.001900	1.042549	0.001981	59	0.022415	1.002723	0.022476
5	0.001900	1.042549	0.001981	60	0.023078	1.005680	0.023209
6	0.001900	1.042549	0.001981	61	0.023986	1.008366	0.024187
7	0.001900	1.042549	0.001981	62	0.024796	1.010101	0.025046
8	0.001900	1.042549	0.001981	63	0.025585	1.010932	0.025865
9	0.001900	1.042549	0.001981	64	0.026329	1.010531	0.026606
10	0.001900	1.042549	0.001981	65	0.027349	1.009123	0.027599
11	0.001900	1.042549	0.001981	66	0.028422	1.006638	0.028611
12	0.001900	1.042549	0.001981	67	0.029547	1.003529	0.029651
13	0.001900	1.042549	0.001981	68	0.030844	0.999950	0.030842
14	0.001900	1.042549	0.001981	69	0.032439	0.996354	0.032321
15	0.001900	1.042549	0.001981	70	0.034461	0.992666	0.034208
16	0.002000	1.042549	0.002085	71	0.036696	0.989483	0.036310
17	0.002200	1.042549	0.002294	72	0.039382	0.986802	0.038862
18	0.002300	1.042549	0.002398	73	0.042397	0.984696	0.041748
19	0.002400	1.042549	0.002502	74	0.045826	0.983136	0.045053
20	0.002600	1.042549	0.002711	75	0.049728	0.982245	0.048845
21	0.002700	1.044318	0.002820	76	0.054175	0.981776	0.053188
22	0.002900	1.046757	0.003036	77	0.059245	0.981751	0.058164
23	0.003000	1.049815	0.003149	78	0.064984	0.981998	0.063814
24	0.003200	1.054371	0.003374	79	0.071465	0.982468	0.070212
25	0.003400	1.060415	0.003605	80	0.078654	0.982963	0.077314
26	0.003600	1.067390	0.003843	81	0.086410	0.983680	0.085000
27	0.003800	1.074731	0.004084	82	0.095026	0.984299	0.093534
28	0.004000	1.082130	0.004329	83	0.104369	0.984919	0.102795
29	0.004200	1.089402	0.004575	84	0.114448	0.985513	0.112790
30	0.004500	1.095965	0.004932	85	0.125068	0.986034	0.123321
31	0.004700	1.101971	0.005179	86	0.137334	0.986654	0.135501
32	0.005000	1.106694	0.005533	87	0.150178	0.987125	0.148244
33	0.005300	1.110366	0.005885	88	0.162252	0.987621	0.160243
34	0.005600	1.112500	0.006230	89	0.176289	0.987894	0.174155
35	0.005900	1.113010	0.006567	90	0.191767	0.988117	0.189488
36	0.006677	1.111922	0.007424	91	0.207896	0.988118	0.205426
37	0.007454	1.108972	0.008266	92	0.226604	0.988093	0.223906
38	0.008230	1.104036	0.009086	93	0.243525	0.987745	0.240541
39	0.009007	1.097421	0.009884	94	0.264342	0.987100	0.260932
40	0.009784	1.089013	0.010655	95	0.281410	0.986232	0.277536
41	0.010427	1.079072	0.011251	96	0.303686	0.986877	0.299701
42	0.010710	1.068143	0.011440	97	0.326681	0.987522	0.322605
43	0.011405	1.056453	0.012049	98	0.349676	0.988267	0.345573
44	0.012238	1.044582	0.012784	99	0.372671	0.988987	0.368567
45	0.012836	1.033046	0.013260	100	0.395666	0.989608	0.391554
46	0.013298	1.022322	0.013595	101	0.420098	0.990254	0.416004
47	0.013950	1.012823	0.014129	102	0.446686	0.990999	0.442666
48	0.014410	1.004605	0.014476	103	0.476866	0.991746	0.472930
49	0.015279	0.998050	0.015249	104	0.512077	0.992368	0.508169
50	0.016265	0.993213	0.016155	105	0.553756	0.993015	0.549888
51	0.017056	0.990030	0.016886	106	0.604776	0.993737	0.600988
52	0.017894	0.988391	0.017686	107	0.668011	0.994484	0.664326
53	0.018594	0.988043	0.018372	108	0.749212	0.995232	0.745640
54	0.019243	0.988763	0.019027	109	0.856282	0.995755	0.852647
				110	1.000000	n/a	1.000000

# APPENDICES

TABLE 6 Employees' Retirement System **Female Disability** Pensioner Mortality  
Effective 4/1/2020 (For Valuation Purposes Only)

Age	q <sub>x</sub>	MP-2019 Factor	2020 Val q <sub>x</sub>	Age	q <sub>x</sub>	MP-2019 Factor	2020 Val q <sub>x</sub>
0	0.001900	1.047528	0.001990	55	0.022539	1.002647	0.022599
1	0.001900	1.047528	0.001990	56	0.022533	1.007234	0.022696
2	0.001900	1.047528	0.001990	57	0.022537	1.011557	0.022797
3	0.001900	1.047528	0.001990	58	0.022546	1.015262	0.022890
4	0.001900	1.047528	0.001990	59	0.022608	1.017888	0.023012
5	0.001900	1.047528	0.001990	60	0.022726	1.019078	0.023160
6	0.001900	1.047528	0.001990	61	0.022925	1.018801	0.023356
7	0.001900	1.047528	0.001990	62	0.023228	1.017110	0.023625
8	0.001900	1.047528	0.001990	63	0.023641	1.013831	0.023968
9	0.001900	1.047528	0.001990	64	0.024197	1.009577	0.024429
10	0.001900	1.047528	0.001990	65	0.024864	1.004381	0.024973
11	0.001900	1.047528	0.001990	66	0.025679	0.999175	0.025658
12	0.001900	1.047528	0.001990	67	0.026586	0.993861	0.026423
13	0.001900	1.047528	0.001990	68	0.027637	0.989110	0.027336
14	0.001900	1.047528	0.001990	69	0.028838	0.985092	0.028408
15	0.001900	1.047528	0.001990	70	0.030154	0.982121	0.029615
16	0.002000	1.047528	0.002095	71	0.031562	0.979971	0.030930
17	0.002200	1.047528	0.002305	72	0.033176	0.978861	0.032475
18	0.002300	1.047528	0.002409	73	0.034970	0.978490	0.034218
19	0.002400	1.047528	0.002514	74	0.036958	0.978811	0.036175
20	0.002600	1.047528	0.002724	75	0.039229	0.979552	0.038427
21	0.002700	1.049328	0.002833	76	0.041819	0.980737	0.041013
22	0.002900	1.051232	0.003049	77	0.044710	0.981973	0.043904
23	0.003000	1.053525	0.003161	78	0.048307	0.983334	0.047502
24	0.003200	1.056773	0.003382	79	0.052303	0.984794	0.051508
25	0.003400	1.061091	0.003608	80	0.056767	0.986157	0.055981
26	0.003600	1.065732	0.003837	81	0.062062	0.987596	0.061292
27	0.003800	1.070541	0.004068	82	0.068109	0.988638	0.067335
28	0.004000	1.075181	0.004301	83	0.074894	0.989831	0.074132
29	0.004200	1.079703	0.004535	84	0.082566	0.990576	0.081788
30	0.004500	1.083764	0.004877	85	0.091216	0.991223	0.090415
31	0.004700	1.086993	0.005109	86	0.100820	0.991820	0.099995
32	0.005000	1.089335	0.005447	87	0.111356	0.992093	0.110476
33	0.005300	1.090601	0.005780	88	0.123017	0.992442	0.122087
34	0.005600	1.090420	0.006106	89	0.135400	0.992467	0.134380
35	0.005900	1.088713	0.006423	90	0.149661	0.992467	0.148534
36	0.007452	1.085536	0.008089	91	0.164311	0.992342	0.163053
37	0.009004	1.080819	0.009732	92	0.182022	0.992193	0.180601
38	0.010555	1.074678	0.011343	93	0.199471	0.991845	0.197844
39	0.012107	1.067282	0.012922	94	0.218169	0.991372	0.216287
40	0.013659	1.058778	0.014462	95	0.234947	0.990975	0.232826
41	0.015211	1.049696	0.015967	96	0.258664	0.991273	0.256407
42	0.016763	1.040225	0.017437	97	0.283145	0.991746	0.280808
43	0.018315	1.030703	0.018877	98	0.307627	0.992243	0.305241
44	0.019866	1.021512	0.020293	99	0.332109	0.992741	0.329698
45	0.021418	1.012874	0.021694	100	0.356590	0.993214	0.354170
46	0.022970	1.005282	0.023091	101	0.382602	0.993612	0.380158
47	0.022990	0.998974	0.022966	102	0.410909	0.994110	0.408489
48	0.023096	0.994160	0.022961	103	0.443041	0.994609	0.440652
49	0.023024	0.990999	0.022817	104	0.480529	0.994983	0.478118
50	0.022770	0.989409	0.022529	105	0.524902	0.995381	0.522478
51	0.022645	0.989558	0.022409	106	0.579221	0.995880	0.576835
52	0.022625	0.991272	0.022428	107	0.646546	0.996354	0.644189
53	0.022604	0.994233	0.022474	108	0.732997	0.996853	0.730690
54	0.022544	0.998073	0.022501	109	0.846989	0.997252	0.844662
				110	1.000000	n/a	1.000000



# APPENDICES

TABLE 7 Police & Fire Retirement System **Service** Pensioner Mortality  
Effective 4/1/2020 (For Valuation Purposes Only)

Age	q <sub>x</sub>	MP-2019 Factor	2020 Val q <sub>x</sub>	Age	q <sub>x</sub>	MP-2019 Factor	2020 Val q <sub>x</sub>
0	0.000100	1.042549	0.000104	55	0.002572	0.990576	0.002548
1	0.000100	1.042549	0.000104	56	0.002687	0.993038	0.002668
2	0.000100	1.042549	0.000104	57	0.002821	0.996027	0.002810
3	0.000100	1.042549	0.000104	58	0.002982	0.999272	0.002980
4	0.000100	1.042549	0.000104	59	0.003183	1.002723	0.003192
5	0.000100	1.042549	0.000104	60	0.003438	1.005680	0.003458
6	0.000100	1.042549	0.000104	61	0.003762	1.008366	0.003793
7	0.000100	1.042549	0.000104	62	0.004166	1.010101	0.004208
8	0.000100	1.042549	0.000104	63	0.004664	1.010932	0.004715
9	0.000100	1.042549	0.000104	64	0.005267	1.010531	0.005322
10	0.000100	1.042549	0.000104	65	0.005991	1.009123	0.006046
11	0.000100	1.042549	0.000104	66	0.006859	1.006638	0.006905
12	0.000100	1.042549	0.000104	67	0.007899	1.003529	0.007927
13	0.000100	1.042549	0.000104	68	0.009137	0.999950	0.009137
14	0.000100	1.042549	0.000104	69	0.010593	0.996354	0.010554
15	0.000100	1.042549	0.000104	70	0.012283	0.992666	0.012193
16	0.000100	1.042549	0.000104	71	0.014217	0.989483	0.014067
17	0.000110	1.042549	0.000115	72	0.016400	0.986802	0.016184
18	0.000110	1.042549	0.000115	73	0.018842	0.984696	0.018554
19	0.000120	1.042549	0.000125	74	0.021558	0.983136	0.021194
20	0.000130	1.042549	0.000136	75	0.024579	0.982245	0.024143
21	0.000140	1.044318	0.000146	76	0.027951	0.981776	0.027442
22	0.000140	1.046757	0.000147	77	0.031733	0.981751	0.031154
23	0.000150	1.049815	0.000157	78	0.035996	0.981998	0.035348
24	0.000160	1.054371	0.000169	79	0.040820	0.982468	0.040104
25	0.000170	1.060415	0.000180	80	0.046285	0.982963	0.045496
26	0.000180	1.067390	0.000192	81	0.052472	0.983680	0.051616
27	0.000190	1.074731	0.000204	82	0.059458	0.984299	0.058524
28	0.000200	1.082130	0.000216	83	0.067314	0.984919	0.066299
29	0.000210	1.089402	0.000229	84	0.076109	0.985513	0.075006
30	0.000220	1.095965	0.000241	85	0.085898	0.986034	0.084698
31	0.000240	1.101971	0.000264	86	0.096732	0.986654	0.095441
32	0.000250	1.106694	0.000277	87	0.108654	0.987125	0.107255
33	0.000260	1.110366	0.000289	88	0.121701	0.987621	0.120194
34	0.000280	1.112500	0.000311	89	0.135910	0.987894	0.134265
35	0.000290	1.113010	0.000323	90	0.151312	0.988117	0.149514
36	0.000310	1.111922	0.000345	91	0.167932	0.988118	0.165937
37	0.000330	1.108972	0.000366	92	0.185789	0.988093	0.183577
38	0.000350	1.104036	0.000386	93	0.204895	0.987745	0.202384
39	0.000370	1.097421	0.000406	94	0.225256	0.987100	0.222350
40	0.000390	1.089013	0.000425	95	0.246879	0.986232	0.243480
41	0.000536	1.079072	0.000578	96	0.270225	0.986877	0.266679
42	0.000682	1.068143	0.000728	97	0.294325	0.987522	0.290652
43	0.000828	1.056453	0.000875	98	0.318425	0.988267	0.314689
44	0.000974	1.044582	0.001017	99	0.342525	0.988987	0.338753
45	0.001353	1.033046	0.001398	100	0.366625	0.989608	0.362815
46	0.001532	1.022322	0.001566	101	0.392231	0.990254	0.388408
47	0.001695	1.012823	0.001717	102	0.420097	0.990999	0.416316
48	0.001841	1.004605	0.001849	103	0.451728	0.991746	0.447999
49	0.001970	0.998050	0.001966	104	0.488631	0.992368	0.484902
50	0.002084	0.993213	0.002070	105	0.532312	0.993015	0.528594
51	0.002186	0.990030	0.002164	106	0.585783	0.993737	0.582114
52	0.002281	0.988391	0.002255	107	0.652058	0.994484	0.648461
53	0.002374	0.988043	0.002346	108	0.737161	0.995232	0.733646
54	0.002469	0.988763	0.002441	109	0.849376	0.995755	0.845771
				110	1.000000	n/a	1.000000

# APPENDICES

TABLE 8 Police & Fire Retirement System **Disability** Pensioner Mortality  
Effective 4/1/2020 (For Valuation Purposes Only)

Age	q <sub>x</sub>	MP-2019 Factor	2020 Val q <sub>x</sub>	Age	q <sub>x</sub>	MP-2019 Factor	2020 Val q <sub>x</sub>
0	0.000400	1.042549	0.000417	55	0.005554	0.990576	0.005502
1	0.000400	1.042549	0.000417	56	0.005894	0.993038	0.005853
2	0.000400	1.042549	0.000417	57	0.006256	0.996027	0.006231
3	0.000400	1.042549	0.000417	58	0.006641	0.999272	0.006636
4	0.000400	1.042549	0.000417	59	0.007047	1.002723	0.007066
5	0.000400	1.042549	0.000417	60	0.007480	1.005680	0.007522
6	0.000400	1.042549	0.000417	61	0.007944	1.008366	0.008010
7	0.000400	1.042549	0.000417	62	0.008448	1.010101	0.008533
8	0.000400	1.042549	0.000417	63	0.009005	1.010932	0.009103
9	0.000400	1.042549	0.000417	64	0.009630	1.010531	0.009731
10	0.000400	1.042549	0.000417	65	0.010343	1.009123	0.010437
11	0.000400	1.042549	0.000417	66	0.011168	1.006638	0.011242
12	0.000400	1.042549	0.000417	67	0.012130	1.003529	0.012173
13	0.000400	1.042549	0.000417	68	0.013256	0.999950	0.013255
14	0.000400	1.042549	0.000417	69	0.014581	0.996354	0.014528
15	0.000400	1.042549	0.000417	70	0.016140	0.992666	0.016022
16	0.000400	1.042549	0.000417	71	0.017975	0.989483	0.017786
17	0.000440	1.042549	0.000459	72	0.020131	0.986802	0.019865
18	0.000440	1.042549	0.000459	73	0.022648	0.984696	0.022301
19	0.000480	1.042549	0.000500	74	0.025568	0.983136	0.025137
20	0.000520	1.042549	0.000542	75	0.028924	0.982245	0.028410
21	0.000560	1.044318	0.000585	76	0.032745	0.981776	0.032148
22	0.000560	1.046757	0.000586	77	0.037050	0.981751	0.036374
23	0.000600	1.049815	0.000630	78	0.041856	0.981998	0.041103
24	0.000640	1.054371	0.000675	79	0.047172	0.982468	0.046345
25	0.000680	1.060415	0.000721	80	0.053002	0.982963	0.052099
26	0.000720	1.067390	0.000769	81	0.059347	0.983680	0.058378
27	0.000760	1.074731	0.000817	82	0.066204	0.984299	0.065165
28	0.000800	1.082130	0.000866	83	0.073570	0.984919	0.072460
29	0.000840	1.089402	0.000915	84	0.081442	0.985513	0.080262
30	0.000880	1.095965	0.000964	85	0.089816	0.986034	0.088562
31	0.000960	1.101971	0.001058	86	0.098689	0.986654	0.097372
32	0.001000	1.106694	0.001107	87	0.108654	0.987125	0.107255
33	0.001040	1.110366	0.001155	88	0.121701	0.987621	0.120194
34	0.001120	1.112500	0.001246	89	0.135910	0.987894	0.134265
35	0.001160	1.113010	0.001291	90	0.151312	0.988117	0.149514
36	0.001399	1.111922	0.001556	91	0.167932	0.988118	0.165937
37	0.001639	1.108972	0.001818	92	0.185789	0.988093	0.183577
38	0.001878	1.104036	0.002073	93	0.204895	0.987745	0.202384
39	0.002118	1.097421	0.002324	94	0.225256	0.987100	0.222350
40	0.002357	1.089013	0.002567	95	0.246879	0.986232	0.243480
41	0.002597	1.079072	0.002802	96	0.270225	0.986877	0.266679
42	0.002836	1.068143	0.003029	97	0.294325	0.987522	0.290652
43	0.003075	1.056453	0.003249	98	0.318425	0.988267	0.314689
44	0.003315	1.044582	0.003463	99	0.342525	0.988987	0.338753
45	0.003554	1.033046	0.003671	100	0.366625	0.989608	0.362815
46	0.003794	1.022322	0.003879	101	0.392231	0.990254	0.388408
47	0.004033	1.012823	0.004085	102	0.420097	0.990999	0.416316
48	0.004273	1.004605	0.004293	103	0.451728	0.991746	0.447999
49	0.004289	0.998050	0.004281	104	0.488631	0.992368	0.484902
50	0.004371	0.993213	0.004341	105	0.532312	0.993015	0.528594
51	0.004514	0.990030	0.004469	106	0.585783	0.993737	0.582114
52	0.004713	0.988391	0.004658	107	0.652058	0.994484	0.648461
53	0.004957	0.988043	0.004898	108	0.737161	0.995232	0.733646
54	0.005240	0.988763	0.005181	109	0.849376	0.995755	0.845771
				110	1.000000	n/a	1.000000

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TABLE 9 Retirement System **Male Beneficiary** Mortality  
Effective 4/1/2020 (For Valuation Purposes Only)

Age	q <sub>x</sub>	MP-2019 Factor	2020 Val q <sub>x</sub>	Age	q <sub>x</sub>	MP-2019 Factor	2020 Val q <sub>x</sub>
0	0.000190	1.042549	0.000198	55	0.005477	0.990576	0.005425
1	0.000190	1.042549	0.000198	56	0.006302	0.993038	0.006258
2	0.000190	1.042549	0.000198	57	0.007128	0.996027	0.007100
3	0.000190	1.042549	0.000198	58	0.007953	0.999272	0.007947
4	0.000190	1.042549	0.000198	59	0.008779	1.002723	0.008803
5	0.000190	1.042549	0.000198	60	0.009604	1.005680	0.009659
6	0.000190	1.042549	0.000198	61	0.009737	1.008366	0.009818
7	0.000190	1.042549	0.000198	62	0.009976	1.010101	0.010077
8	0.000190	1.042549	0.000198	63	0.010343	1.010932	0.010456
9	0.000190	1.042549	0.000198	64	0.010864	1.010531	0.010978
10	0.000190	1.042549	0.000198	65	0.011561	1.009123	0.011666
11	0.000190	1.042549	0.000198	66	0.012454	1.006638	0.012537
12	0.000190	1.042549	0.000198	67	0.013552	1.003529	0.013600
13	0.000190	1.042549	0.000198	68	0.014860	0.999950	0.014859
14	0.000190	1.042549	0.000198	69	0.016383	0.996354	0.016323
15	0.000190	1.042549	0.000198	70	0.018123	0.992666	0.017990
16	0.000200	1.042549	0.000209	71	0.020087	0.989483	0.019876
17	0.000220	1.042549	0.000229	72	0.022287	0.986802	0.021993
18	0.000230	1.042549	0.000240	73	0.024747	0.984696	0.024368
19	0.000240	1.042549	0.000250	74	0.027496	0.983136	0.027032
20	0.000260	1.042549	0.000271	75	0.030575	0.982245	0.030032
21	0.000270	1.044318	0.000282	76	0.034031	0.981776	0.033411
22	0.000290	1.046757	0.000304	77	0.037919	0.981751	0.037227
23	0.000300	1.049815	0.000315	78	0.042302	0.981998	0.041540
24	0.000320	1.054371	0.000337	79	0.047244	0.982468	0.046416
25	0.000340	1.060415	0.000361	80	0.052814	0.982963	0.051914
26	0.000360	1.067390	0.000384	81	0.059084	0.983680	0.058120
27	0.000380	1.074731	0.000408	82	0.066124	0.984299	0.065086
28	0.000400	1.082130	0.000433	83	0.074005	0.984919	0.072889
29	0.000420	1.089402	0.000458	84	0.082792	0.985513	0.081593
30	0.000450	1.095965	0.000493	85	0.092533	0.986034	0.091241
31	0.000470	1.101971	0.000518	86	0.103254	0.986654	0.101876
32	0.000500	1.106694	0.000553	87	0.114959	0.987125	0.113479
33	0.000530	1.110366	0.000588	88	0.127626	0.987621	0.126046
34	0.000560	1.112500	0.000623	89	0.141213	0.987894	0.139503
35	0.000590	1.113010	0.000657	90	0.155657	0.988117	0.153807
36	0.000620	1.111922	0.000689	91	0.170886	0.988118	0.168855
37	0.000660	1.108972	0.000732	92	0.186820	0.988093	0.184595
38	0.000690	1.104036	0.000762	93	0.203383	0.987745	0.200891
39	0.000730	1.097421	0.000801	94	0.220506	0.987100	0.217662
40	0.000780	1.089013	0.000849	95	0.238128	0.986232	0.234850
41	0.000820	1.079072	0.000885	96	0.261746	0.986877	0.258311
42	0.000870	1.068143	0.000929	97	0.286126	0.987522	0.282556
43	0.000920	1.056453	0.000972	98	0.310506	0.988267	0.306863
44	0.000970	1.044582	0.001013	99	0.334885	0.988987	0.331197
45	0.001020	1.033046	0.001054	100	0.359265	0.989608	0.355531
46	0.001080	1.022322	0.001104	101	0.385169	0.990254	0.381415
47	0.001140	1.012823	0.001155	102	0.413358	0.990999	0.409638
48	0.001210	1.004605	0.001216	103	0.445357	0.991746	0.441681
49	0.001280	0.998050	0.001278	104	0.482689	0.992368	0.479005
50	0.001350	0.993213	0.001341	105	0.526877	0.993015	0.523197
51	0.002175	0.990030	0.002153	106	0.580970	0.993737	0.577331
52	0.003001	0.988391	0.002966	107	0.648015	0.994484	0.644441
53	0.003826	0.988043	0.003780	108	0.734107	0.995232	0.730607
54	0.004652	0.988763	0.004600	109	0.847626	0.995755	0.844028
				110	1.000000	n/a	1.000000

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TABLE 10 Retirement System **Female Beneficiary** Mortality  
Effective 4/1/2020 (For Valuation Purposes Only)

Age	q <sub>x</sub>	MP-2019 Factor	2020 Val q <sub>x</sub>	Age	q <sub>x</sub>	MP-2019 Factor	2020 Val q <sub>x</sub>
0	0.000190	1.047528	0.000199	55	0.004166	1.002647	0.004177
1	0.000190	1.047528	0.000199	56	0.004377	1.007234	0.004409
2	0.000190	1.047528	0.000199	57	0.004599	1.011557	0.004652
3	0.000190	1.047528	0.000199	58	0.004837	1.015262	0.004911
4	0.000190	1.047528	0.000199	59	0.005101	1.017888	0.005192
5	0.000190	1.047528	0.000199	60	0.005400	1.019078	0.005503
6	0.000190	1.047528	0.000199	61	0.005742	1.018801	0.005850
7	0.000190	1.047528	0.000199	62	0.006139	1.017110	0.006244
8	0.000190	1.047528	0.000199	63	0.006601	1.013831	0.006692
9	0.000190	1.047528	0.000199	64	0.007136	1.009577	0.007204
10	0.000190	1.047528	0.000199	65	0.007754	1.004381	0.007788
11	0.000190	1.047528	0.000199	66	0.008462	0.999175	0.008455
12	0.000190	1.047528	0.000199	67	0.009268	0.993861	0.009211
13	0.000190	1.047528	0.000199	68	0.010178	0.989110	0.010067
14	0.000190	1.047528	0.000199	69	0.011203	0.985092	0.011036
15	0.000190	1.047528	0.000199	70	0.012353	0.982121	0.012132
16	0.000200	1.047528	0.000210	71	0.013643	0.979971	0.013370
17	0.000220	1.047528	0.000230	72	0.015090	0.978861	0.014771
18	0.000230	1.047528	0.000241	73	0.016717	0.978490	0.016357
19	0.000240	1.047528	0.000251	74	0.018551	0.978811	0.018158
20	0.000260	1.047528	0.000272	75	0.020625	0.979552	0.020203
21	0.000270	1.049328	0.000283	76	0.022977	0.980737	0.022534
22	0.000290	1.051232	0.000305	77	0.025651	0.981973	0.025189
23	0.000300	1.053525	0.000316	78	0.028695	0.983334	0.028217
24	0.000320	1.056773	0.000338	79	0.032163	0.984794	0.031674
25	0.000340	1.061091	0.000361	80	0.036116	0.986157	0.035616
26	0.000360	1.065732	0.000384	81	0.040616	0.987596	0.040112
27	0.000380	1.070541	0.000407	82	0.045731	0.988638	0.045211
28	0.000400	1.075181	0.000430	83	0.051526	0.989831	0.051002
29	0.000420	1.079703	0.000453	84	0.058068	0.990576	0.057521
30	0.000450	1.083764	0.000488	85	0.065416	0.991223	0.064842
31	0.000470	1.086993	0.000511	86	0.073622	0.991820	0.073020
32	0.000500	1.089335	0.000545	87	0.082729	0.992093	0.082075
33	0.000530	1.090601	0.000578	88	0.092771	0.992442	0.092070
34	0.000560	1.090420	0.000611	89	0.103772	0.992467	0.102990
35	0.000590	1.088713	0.000642	90	0.115743	0.992467	0.114871
36	0.000620	1.085536	0.000673	91	0.128689	0.992342	0.127704
37	0.000660	1.080819	0.000713	92	0.142603	0.992193	0.141490
38	0.000690	1.074678	0.000742	93	0.157474	0.991845	0.156190
39	0.000730	1.067282	0.000779	94	0.173285	0.991372	0.171790
40	0.000780	1.058778	0.000826	95	0.190016	0.990975	0.188301
41	0.000820	1.049696	0.000861	96	0.215125	0.991273	0.213248
42	0.000870	1.040225	0.000905	97	0.241045	0.991746	0.239055
43	0.000920	1.030703	0.000948	98	0.266964	0.992243	0.264893
44	0.000970	1.021512	0.000991	99	0.292884	0.992741	0.290758
45	0.001020	1.012874	0.001033	100	0.318803	0.993214	0.316640
46	0.001080	1.005282	0.001086	101	0.346343	0.993612	0.344131
47	0.001140	0.998974	0.001139	102	0.376312	0.994110	0.374096
48	0.001210	0.994160	0.001203	103	0.410332	0.994609	0.408120
49	0.001280	0.990999	0.001268	104	0.450021	0.994983	0.447763
50	0.001350	0.989409	0.001336	105	0.497000	0.995381	0.494705
51	0.001913	0.989558	0.001893	106	0.554509	0.995880	0.552224
52	0.002477	0.991272	0.002455	107	0.625787	0.996354	0.623505
53	0.003040	0.994233	0.003022	108	0.717316	0.996853	0.715059
54	0.003603	0.998073	0.003596	109	0.838003	0.997252	0.835700
				110	1.000000	n/a	1.000000

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Table 11 Employees' Retirement System **Death and Disability** Central Rates of Decrement  
Effective 4/1/2020

Age	Ordinary Death	Accidental Death	Ordinary Disability	Accidental Disability Tiers 1,2	Accidental Disability Tiers 3,4,5,6
15	0.00019	0.00001	0.00006	0.00020	0.00001
16	0.00020	0.00001	0.00006	0.00020	0.00001
17	0.00022	0.00001	0.00007	0.00020	0.00001
18	0.00023	0.00001	0.00008	0.00020	0.00001
19	0.00024	0.00001	0.00009	0.00020	0.00001
20	0.00026	0.00001	0.00010	0.00020	0.00001
21	0.00027	0.00001	0.00011	0.00020	0.00001
22	0.00029	0.00001	0.00012	0.00020	0.00001
23	0.00030	0.00001	0.00014	0.00020	0.00001
24	0.00032	0.00001	0.00015	0.00020	0.00001
25	0.00034	0.00001	0.00017	0.00020	0.00001
26	0.00036	0.00001	0.00019	0.00020	0.00001
27	0.00038	0.00001	0.00021	0.00020	0.00001
28	0.00040	0.00001	0.00023	0.00020	0.00001
29	0.00042	0.00001	0.00025	0.00020	0.00001
30	0.00045	0.00001	0.00028	0.00020	0.00001
31	0.00047	0.00001	0.00031	0.00020	0.00001
32	0.00050	0.00001	0.00035	0.00020	0.00001
33	0.00053	0.00001	0.00039	0.00020	0.00001
34	0.00056	0.00001	0.00043	0.00020	0.00001
35	0.00059	0.00001	0.00048	0.00020	0.00001
36	0.00062	0.00001	0.00053	0.00020	0.00001
37	0.00066	0.00001	0.00059	0.00020	0.00001
38	0.00069	0.00001	0.00066	0.00020	0.00001
39	0.00073	0.00001	0.00073	0.00020	0.00001
40	0.00078	0.00001	0.00081	0.00020	0.00001
41	0.00082	0.00001	0.00090	0.00020	0.00001
42	0.00087	0.00001	0.00100	0.00020	0.00001
43	0.00092	0.00001	0.00111	0.00020	0.00004
44	0.00097	0.00001	0.00124	0.00020	0.00004
45	0.00102	0.00001	0.00137	0.00020	0.00004
46	0.00108	0.00001	0.00153	0.00020	0.00004
47	0.00114	0.00001	0.00170	0.00020	0.00004
48	0.00121	0.00001	0.00189	0.00020	0.00004
49	0.00128	0.00001	0.00210	0.00020	0.00004
50	0.00135	0.00001	0.00233	0.00020	0.00004
51	0.00143	0.00001	0.00259	0.00020	0.00004
52	0.00151	0.00001	0.00288	0.00020	0.00004
53	0.00160	0.00001	0.00320	0.00020	0.00004
54	0.00169	0.00001	0.00355	0.00020	0.00004
55	0.00178	0.00001	0.00395	0.00015	0.00004
56	0.00189	0.00001	0.00438	0.00015	0.00004
57	0.00199	0.00001	0.00487	0.00015	0.00004
58	0.00211	0.00001	0.00541	0.00015	0.00004
59	0.00223	0.00001	0.00602	0.00015	0.00004
60	0.00236	0.00001	0.00668	0.00015	0.00004
61	0.00249	0.00001	0.00743	0.00015	0.00004
62	0.00263	0.00001	0.00825	0.00015	0.00004
63	0.00278	0.00001	0.00917	0.00015	0.00004
64	0.00294	0.00001	0.01019	0.00015	0.00004
65	0.00324	0.00001	0.01121	0.00015	0.00004
66	0.00356	0.00001	0.01233	0.00015	0.00004
67	0.00392	0.00001	0.01356	0.00015	0.00004
68	0.00431	0.00001	0.01492	0.00015	0.00004
69	0.00474	0.00001	0.01641	0.00015	0.00004
70	0.00000	0.00000	0.00000	0.00000	0.00000

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Table 12 Employees' Retirement System **Withdrawal** Central Rates of Decrement  
blended over all tiers - Effective 4/1/2020

Age	0 ≤ Service < 2	2 ≤ Service < 3	3 ≤ Service < 4	4 ≤ Service < 5	5 ≤ Service < 10	10 ≤ Service
15	0.19800	0.12105	0.08625	0.06565	0.05530	0.02160
16	0.19800	0.12105	0.08625	0.06565	0.05530	0.02160
17	0.19800	0.12105	0.08625	0.06565	0.05530	0.02160
18	0.23699	0.12105	0.08625	0.06565	0.05530	0.02160
19	0.25824	0.12105	0.08625	0.06565	0.05530	0.02160
20	0.26455	0.12105	0.08625	0.06565	0.05530	0.02160
21	0.26061	0.12105	0.08625	0.06565	0.05530	0.02160
22	0.25065	0.12105	0.08625	0.06565	0.05530	0.02160
23	0.23716	0.12105	0.08625	0.06565	0.05530	0.02160
24	0.22128	0.13032	0.09636	0.07120	0.05587	0.02160
25	0.20403	0.13556	0.10074	0.07480	0.05598	0.02160
26	0.18697	0.13799	0.10186	0.07686	0.05561	0.02160
27	0.17211	0.13796	0.10159	0.07820	0.05482	0.02160
28	0.16086	0.13539	0.10077	0.07949	0.05379	0.02160
29	0.15327	0.13034	0.09957	0.08098	0.05274	0.02155
30	0.14830	0.12340	0.09792	0.08243	0.05186	0.02147
31	0.14471	0.11562	0.09574	0.08331	0.05124	0.02133
32	0.14175	0.10824	0.09300	0.08305	0.05087	0.02115
33	0.13924	0.10222	0.08972	0.08131	0.05069	0.02094
34	0.13728	0.09780	0.08598	0.07814	0.05059	0.02072
35	0.13595	0.09459	0.08202	0.07401	0.05047	0.02052
36	0.13506	0.09198	0.07824	0.06962	0.05021	0.02035
37	0.13432	0.08950	0.07511	0.06567	0.04975	0.02020
38	0.13346	0.08700	0.07295	0.06259	0.04901	0.02003
39	0.13237	0.08456	0.07174	0.06044	0.04802	0.01983
40	0.13114	0.08239	0.07112	0.05897	0.04685	0.01961
41	0.12986	0.08066	0.07054	0.05786	0.04562	0.01941
42	0.12861	0.07946	0.06955	0.05687	0.04445	0.01927
43	0.12745	0.07878	0.06796	0.05592	0.04345	0.01921
44	0.12641	0.07850	0.06593	0.05506	0.04261	0.01915
45	0.12556	0.07846	0.06379	0.05430	0.04187	0.01896
46	0.12502	0.07850	0.06189	0.05360	0.04112	0.01845
47	0.12487	0.07846	0.06044	0.05290	0.04027	0.01758
48	0.12516	0.07827	0.05950	0.05214	0.03930	0.01644
49	0.12583	0.07794	0.05897	0.05134	0.03830	0.01527
50	0.12675	0.07746	0.05871	0.05060	0.03737	0.01428
51	0.12775	0.07684	0.05857	0.05007	0.03658	0.01359
52	0.12864	0.07603	0.05844	0.04987	0.03583	0.01316
53	0.12935	0.07502	0.05828	0.05005	0.03490	0.01292
54	0.12990	0.07387	0.05814	0.05063	0.03346	0.01280
55	0.13047	0.07277	0.05818	0.05166	0.03138	0.01274
56	0.13139	0.07204	0.05864	0.05322	0.02888	0.01273
57	0.13308	0.07204	0.05978	0.05550	0.02670	0.01274
58	0.13597	0.07310	0.06183	0.05865	0.02568	0.01279
59	0.14039	0.07542	0.06486	0.06276	0.02633	0.01285
60	0.14640	0.07900	0.06887	0.06781	0.02856	0.01292
61	0.15365	0.08365	0.07372	0.07366	0.03185	0.01300
62	0.16121	0.08885	0.07915	0.07994	0.03563	0.01307
63	0.16746	0.09364	0.08469	0.08600	0.03964	0.01312
64	0.16746	0.09364	0.08469	0.08600	0.03964	0.01312
65	0.16746	0.09364	0.08469	0.08600	0.03964	0.01312
66	0.16746	0.09364	0.08469	0.08600	0.03964	0.01312
67	0.16746	0.09364	0.08469	0.08600	0.03964	0.01312
68	0.16746	0.09364	0.08469	0.08600	0.03964	0.01312
69	0.16746	0.09364	0.08469	0.08600	0.03964	0.01312
70	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

Note: Tier-specific adjustment factors are applied to these blended rates. See the first page of Appendix B for details.

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TABLE 13 Employees' Retirement System **Age-Based Plans Retirement** Central Rates of Decrement  
Effective 4/1/2020

Age	Tier 1			Tiers 2,3,4		
	Service < 20	20 ≤ Srv < 30	30 ≤ Service	Service < 20	20 ≤ Srv < 30	30 ≤ Service
55	0.16985	0.34977	0.77499	0.05895	0.08590	0.47092
56	0.09286	0.13929	0.26808	0.03780	0.04952	0.18857
57	0.07541	0.11619	0.23320	0.03780	0.05216	0.17845
58	0.09055	0.12956	0.21587	0.03960	0.05491	0.17183
59	0.10371	0.15469	0.21164	0.04386	0.06162	0.18384
60	0.10331	0.17394	0.21365	0.04829	0.07343	0.19365
61	0.13785	0.21229	0.24184	0.07578	0.16592	0.23334
62	0.19152	0.34528	0.35390	0.13825	0.35571	0.29639
63	0.15155	0.25017	0.23024	0.10753	0.22081	0.21538
64	0.17236	0.29052	0.23115	0.11760	0.21617	0.20854
65	0.22845	0.29262	0.26254	0.16671	0.28793	0.24495
66	0.23898	0.31788	0.26292	0.19340	0.31970	0.29280
67	0.19844	0.28362	0.22238	0.16763	0.27857	0.24846
68	0.15865	0.31095	0.20547	0.15500	0.25117	0.21412
69	0.19512	0.26244	0.18605	0.16490	0.26427	0.21208
70	2.00000	2.00000	2.00000	2.00000	2.00000	2.00000

Age	Tier 5			Tier 6		
	Service < 20	20 ≤ Srv < 30	30 ≤ Service	Service < 20	20 ≤ Srv < 30	30 ≤ Service
55	0.04716	0.06872	0.08590	0.04716	0.06872	0.08590
56	0.03024	0.03962	0.04952	0.03024	0.03962	0.04952
57	0.03024	0.04173	0.05216	0.03024	0.04173	0.05216
58	0.03168	0.04393	0.05491	0.03168	0.04393	0.05491
59	0.03509	0.04930	0.06162	0.03509	0.04930	0.06162
60	0.03863	0.05874	0.07343	0.03863	0.05874	0.07343
61	0.06062	0.13274	0.16592	0.06062	0.13274	0.16592
62	0.18825	0.45571	1.09639	0.08825	0.15571	0.25571
63	0.10753	0.22081	0.21538	0.20753	0.52081	1.11538
64	0.11760	0.21617	0.20854	0.11760	0.21617	0.20854
65	0.16671	0.28793	0.24495	0.16671	0.28793	0.24495
66	0.19340	0.31970	0.29280	0.19340	0.31970	0.29280
67	0.16763	0.27857	0.24846	0.16763	0.27857	0.24846
68	0.15500	0.25117	0.21412	0.15500	0.25117	0.21412
69	0.16490	0.26427	0.21208	0.16490	0.26427	0.21208
70	2.00000	2.00000	2.00000	2.00000	2.00000	2.00000

The Tier 5 rates and Tier 6 rates listed above are defined using adjustments to the Tiers 2,3,4 rates, as described below.

Age	Tier 5		
	Service < 20	20 ≤ Srv < 30	30 ≤ Service *
<62	Service < 20 rate * 0.80	20 ≤ Srv < 30 rate * 0.80	20 ≤ Srv < 30 rate "as is"
=62	Service < 20 rate + 0.05	20 ≤ Srv < 30 rate + 0.10	30 ≤ Service rate + 0.8
>62	Service < 20 rate "as is"	20 ≤ Srv < 30 rate "as is"	30 ≤ Service rate "as is"

Age	Tier 6		
	Service < 20	20 ≤ Srv < 30	30 ≤ Service
<62	Service < 20 rate * 0.80	20 ≤ Srv < 30 rate * 0.80	20 ≤ Srv < 30 rate "as is"
=62	Service < 20 rate - 0.05	20 ≤ Srv < 30 rate - 0.20	20 ≤ Srv < 30 rate - 0.10
=63	Service < 20 rate + 0.10	20 ≤ Srv < 30 rate + 0.30	30 ≤ Service rate + 0.90
>63	Service < 20 rate "as is"	20 ≤ Srv < 30 rate as is	30 ≤ Service rate "as is"

\* except that Tier 5 Unified Court Peace Officers with 30 ≤ Service use the Tiers 2,3,4 30 ≤ Service rate "as is" at all ages.

# APPENDICES

Table 14 Employees' Retirement System **Service-Based Plans Retirement** Central Rates of Decrement  
Effective 4/1/2020

Service	State Corrections Officers	State Corrections Officers	County Corrections Officers
	25 Year Plan Tiers 1,2	25 Year Plan Tiers 3,5,6	25 Year Plan All Tiers
25	0.20915	0.35143	0.39788
26	0.22135	0.20590	0.13927
27	0.22418	0.17710	0.12715
28	0.21834	0.17526	0.06190
29	0.20314	0.18232	0.12518
30	0.18023	0.25008	0.31048
31	0.15638	0.24101	0.22222
32	0.15787	0.22845	0.22744
33	0.18173	0.19237	0.29032
34	0.20559	0.21389	0.41606
35	0.23067	0.23796	0.39785
36	0.27093	0.29235	0.39785
37	0.33205	0.33040	0.39785
38	0.38247	0.33040	0.39785
39	0.39053	0.33040	0.39785
40	0.39053	0.33040	0.39785
41	0.39053	0.33040	0.39785
42	0.39053	0.33040	0.39785
43	0.39053	0.33040	0.39785
44	0.39053	0.33040	0.39785
45	0.39053	0.33040	0.39785
46	0.39053	0.33040	0.39785
47	0.39053	0.33040	0.39785
48	0.39053	0.33040	0.39785
49	0.39053	0.33040	0.39785
50	0.39053	0.33040	0.39785
51	0.39053	0.33040	0.39785
52	0.39053	0.33040	0.39785
53	0.39053	0.33040	0.39785
54	0.39053	0.33040	0.39785
55	2.00000	2.00000	2.00000



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Table 15 Police & Fire Retirement System **Death and Disability** Central Rates of Decrement  
Effective 4/1/2020

Age	Ordinary Death	Accidental Death	Ordinary Disability	Performance of Duty Disability	Accidental Disability
15	0.00010	0.00001	0.00001	0.00020	0.00020
16	0.00010	0.00001	0.00001	0.00020	0.00020
17	0.00011	0.00001	0.00001	0.00020	0.00020
18	0.00011	0.00001	0.00002	0.00020	0.00020
19	0.00012	0.00001	0.00002	0.00020	0.00020
20	0.00013	0.00001	0.00002	0.00020	0.00020
21	0.00014	0.00001	0.00002	0.00020	0.00020
22	0.00014	0.00001	0.00002	0.00020	0.00020
23	0.00015	0.00001	0.00003	0.00020	0.00020
24	0.00016	0.00001	0.00003	0.00020	0.00020
25	0.00017	0.00001	0.00003	0.00020	0.00020
26	0.00018	0.00001	0.00004	0.00020	0.00020
27	0.00019	0.00001	0.00004	0.00020	0.00020
28	0.00020	0.00001	0.00005	0.00020	0.00020
29	0.00021	0.00001	0.00005	0.00020	0.00020
30	0.00022	0.00001	0.00006	0.00020	0.00020
31	0.00024	0.00001	0.00006	0.00020	0.00020
32	0.00025	0.00001	0.00007	0.00020	0.00020
33	0.00026	0.00001	0.00008	0.00020	0.00020
34	0.00028	0.00001	0.00009	0.00020	0.00020
35	0.00029	0.00001	0.00010	0.00020	0.00020
36	0.00031	0.00001	0.00011	0.00050	0.00050
37	0.00033	0.00001	0.00012	0.00080	0.00080
38	0.00035	0.00001	0.00013	0.00110	0.00110
39	0.00037	0.00001	0.00015	0.00140	0.00140
40	0.00039	0.00001	0.00016	0.00170	0.00170
41	0.00041	0.00001	0.00018	0.00200	0.00200
42	0.00043	0.00001	0.00020	0.00230	0.00230
43	0.00046	0.00004	0.00022	0.00260	0.00260
44	0.00048	0.00004	0.00025	0.00290	0.00290
45	0.00051	0.00004	0.00027	0.00320	0.00320
46	0.00054	0.00004	0.00031	0.00320	0.00320
47	0.00057	0.00004	0.00034	0.00320	0.00320
48	0.00060	0.00004	0.00038	0.00320	0.00320
49	0.00064	0.00004	0.00042	0.00320	0.00320
50	0.00068	0.00004	0.00047	0.00320	0.00320
51	0.00071	0.00004	0.00052	0.00320	0.00320
52	0.00076	0.00004	0.00058	0.00320	0.00320
53	0.00080	0.00004	0.00064	0.00320	0.00320
54	0.00084	0.00004	0.00071	0.00320	0.00320
55	0.00089	0.00004	0.00079	0.00320	0.00320
56	0.00094	0.00004	0.00088	0.00320	0.00320
57	0.00100	0.00004	0.00097	0.00320	0.00320
58	0.00105	0.00004	0.00108	0.00320	0.00320
59	0.00111	0.00004	0.00120	0.00320	0.00320
60	0.00118	0.00004	0.00134	0.00320	0.00320
61	0.00125	0.00004	0.00149	0.00320	0.00320
62	0.00132	0.00004	0.00165	0.00320	0.00320
63	0.00139	0.00004	0.00183	0.00320	0.00320
64	0.00147	0.00004	0.00204	0.00320	0.00320
65	0.00162	0.00004	0.00224	0.00320	0.00320
66	0.00178	0.00004	0.00247	0.00320	0.00320
67	0.00196	0.00004	0.00271	0.00320	0.00320
68	0.00215	0.00004	0.00298	0.00320	0.00320
69	0.00237	0.00004	0.00328	0.00320	0.00320
70	0.00000	0.00000	0.00000	0.00000	0.00000

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Table 16 Police & Fire Retirement System **Withdrawal** Central Rates of Decrement  
Effective 4/1/2020

Service	Withdrawal
0	0.07328
1	0.04003
2	0.02114
3	0.01340
4	0.01142
5	0.01133
6	0.01112
7	0.01043
8	0.00937
9	0.00811
10	0.00673
11	0.00544
12	0.00432
13	0.00351
14	0.00300
15	0.00268
16	0.00230
17	0.00186
18	0.00160
19	0.00160
20	0.00160
21	0.00160
22	0.00160
23	0.00160
24	0.00160
25	0.00160
26	0.00160
27	0.00160
28	0.00160
29	0.00160
30	0.00160
31	0.00160
32	0.00160
33	0.00160
34	0.00160
35	0.00160
36	0.00160
37	0.00160
38	0.00160
39	0.00160
40	0.00160
41	0.00160
42	0.00160
43	0.00160
44	0.00160
45	0.00160
46	0.00160
47	0.00160
48	0.00160
49	0.00160
50	0.00160
51	0.00160
52	0.00160
53	0.00160
54	0.00160
55	0.00000

Note: To get Tier 5 and 6 withdrawal rates for  $5 \leq \text{Service} < 10$ , multiply by 0.8.

# APPENDICES

TABLE 17 Police & Fire Retirement System **Age-Based Plans Retirement** Central Rates of Decrement  
Effective 4/1/2020

Age	Tier 1			Tiers 2,5		
	Service < 20	20 ≤ Srv < 30	30 ≤ Service	Service < 20	20 ≤ Srv < 30	30 ≤ Service
55	0.16985	0.34977	0.77499	0.05895	0.08590	0.08590
56	0.09286	0.13929	0.26808	0.03780	0.04952	0.04952
57	0.07541	0.11619	0.23320	0.03780	0.05216	0.05216
58	0.09055	0.12956	0.21587	0.03960	0.05491	0.05491
59	0.10371	0.15469	0.21164	0.04386	0.06162	0.06162
60	0.10331	0.17394	0.21365	0.04829	0.07343	0.07343
61	0.13785	0.21229	0.24184	0.07578	0.16592	0.16592
62	0.19152	0.34528	0.35390	0.13825	0.35571	0.35571
63	0.15155	0.25017	0.23024	0.10753	0.22081	0.22081
64	0.17236	0.29052	0.23115	0.11760	0.21617	0.21617
65	0.22845	0.29262	0.26254	0.16671	0.28793	0.28793
66	0.23898	0.31788	0.26292	0.19340	0.31970	0.31970
67	0.19844	0.28362	0.22238	0.16763	0.27857	0.27857
68	0.15865	0.31095	0.20547	0.15500	0.25117	0.25117
69	0.19512	0.26244	0.18605	0.16490	0.26427	0.26427
70	2.00000	2.00000	2.00000	2.00000	2.00000	2.00000

Age	Tier 6		
	Service < 20	20 ≤ Srv < 30	30 ≤ Service
55	0.04716	0.06872	0.08590
56	0.03024	0.03962	0.04952
57	0.03024	0.04173	0.05216
58	0.03168	0.04393	0.05491
59	0.03509	0.04930	0.06162
60	0.03863	0.05874	0.07343
61	0.06062	0.13274	0.16592
62	0.08825	0.15571	0.25571
63	0.35753	0.52081	1.11538
64	0.11760	0.21617	0.20854
65	0.16671	0.28793	0.24495
66	0.19340	0.31970	0.29280
67	0.16763	0.27857	0.24846
68	0.15500	0.25117	0.21412
69	0.16490	0.26427	0.21208
70	2.00000	2.00000	2.00000

Age-Based retirement plans make up less than 1% of all PFRS by salary. Therefore, the PFRS service retirement rates are selected to correspond with the ERS assumption reflecting the same early age reduction factors, as described below.

PFRS Tier 1 rates above are identical to ERS Tier 1 across all service groupings.

PFRS Tier 2,5 rates above use the ERS Tier 2,3,4 rates as follows

PFRS Tiers 2,5 Service < 20 uses ERS Tier 2,3,4 Service < 20

PFRS Tiers 2,5 20 ≤ Srv < 30 uses ERS Tier 2,3,4 20 ≤ Srv < 30

PFRS Tiers 2,5 30 ≤ Service uses ERS Tier 2,3,4 20 ≤ Srv < 30

PFRS Tier 6 rates above are identical to ERS Tier 6 across all service groupings.

# APPENDICES

TABLE 18 Police & Fire Retirement System **Service-Based Plans Retirement** Central Rates of Decrement  
Effective 4/1/2020

Service	20 Year Plan (no additional 60ths beyond 20 years)	20 Year Plan (plus additional 60ths beyond 20 years)	State Police 20 Year Plan	Article 14 20 Year Plan
20	0.31492	0.10607	0.10032	0.02000
21	0.14905	0.06366	0.07433	0.02000
22	0.12749	0.05857	0.07743	0.02000
23	0.13002	0.06826	0.06716	0.02000
24	0.10300	0.08483	0.09944	0.02000
25	0.10031	0.09264	0.12625	0.80000
26	0.07680	0.08322	0.11564	0.50000
27	0.11734	0.09188	0.13445	0.50000
28	0.09717	0.12632	0.12134	0.50000
29	0.08140	0.12838	0.14570	0.50000
30	0.07559	0.17748	0.21896	0.50000
31	0.12715	0.27831	0.40367	0.50000
32	0.15484	0.38048	0.53202	0.50000
33	0.12245	0.28649	0.48511	0.50000
34	0.12376	0.27901	0.30769	0.50000
35	0.15385	0.25410	0.32558	0.50000
36	0.14063	0.33438	0.32558	0.50000
37	0.13853	0.29008	0.32558	0.50000
38	0.13853	0.29008	0.32558	0.50000
39	0.13853	0.29008	0.32558	0.50000
40	0.13853	0.29008	0.32558	0.50000
41	0.13853	0.29008	0.32558	0.50000
42	0.13853	0.29008	0.32558	0.50000
43	0.13853	0.29008	0.32558	0.50000
44	0.13853	0.29008	0.32558	0.50000
45	0.13853	0.29008	0.32558	0.50000
46	0.13853	0.29008	0.32558	0.50000
47	0.13853	0.29008	0.32558	0.50000
48	0.13853	0.29008	0.32558	0.50000
49	0.13853	0.29008	0.32558	0.50000
50	0.13853	0.29008	0.32558	0.50000
51	0.13853	0.29008	0.32558	0.50000
52	0.13853	0.29008	0.32558	0.50000
53	0.13853	0.29008	0.32558	0.50000
54	0.13853	0.29008	0.32558	0.50000
55	2.00000	2.00000	2.00000	2.00000

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Table 19 Employees' Retirement System **Salary Scale**  
Effective 4/1/2020

<b>Service</b>	<b>Increase</b>
0	1.0880
1	1.0880
2	1.0770
3	1.0660
4	1.0550
5	1.0495
6	1.0462
7	1.0451
8	1.0440
9	1.0429
10	1.0418
11	1.0407
12	1.0396
13	1.0385
14	1.0374
15	1.0363
16	1.0352
17	1.0341
18	1.0330
19	1.0330
20	1.0330
21	1.0330
22	1.0330
23	1.0330
24	1.0330
25	1.0330
26	1.0330
27	1.0330
28	1.0330
29	1.0330
30	1.0330
31	1.0330
32	1.0330
33	1.0330
34	1.0330
35	1.0330
36	1.0330
37	1.0330
38	1.0330
39	1.0330
40	1.0330
41	1.0330
42	1.0330
43	1.0330
44	1.0330
45	1.0330
46	1.0330
47	1.0330
48	1.0330
49	1.0330
50	1.0330
51	1.0330
52	1.0330
53	1.0330
54	1.0330
55	1.0330

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Table 20 Police & Fire Retirement System **Salary Scale**  
Effective 4/1/2020

<b>Service</b>	<b>Increase</b>
0	1.2970
1	1.2970
2	1.1485
3	1.1265
4	1.1045
5	1.0825
6	1.0583
7	1.0484
8	1.0473
9	1.0462
10	1.0451
11	1.0440
12	1.0429
13	1.0418
14	1.0407
15	1.0396
16	1.0385
17	1.0374
18	1.0363
19	1.0363
20	1.0363
21	1.0363
22	1.0363
23	1.0363
24	1.0363
25	1.0363
26	1.0363
27	1.0363
28	1.0363
29	1.0363
30	1.0363
31	1.0363
32	1.0363
33	1.0363
34	1.0363
35	1.0363
36	1.0363
37	1.0363
38	1.0363
39	1.0363
40	1.0363
41	1.0363
42	1.0363
43	1.0363
44	1.0363
45	1.0363
46	1.0363
47	1.0363
48	1.0363
49	1.0363
50	1.0363
51	1.0363
52	1.0363
53	1.0363
54	1.0363
55	1.0363

## Appendix C: Assumed Rate of Return Development

