Segal Consulting

Barnstable County Retirement System

Actuarial Valuation and Review as of January 1, 2018

This report has been prepared at the request of the Barnstable County Retirement Board to assist in administering the Barnstable County Retirement System. This valuation report may not otherwise be copied or reproduced in any form without the consent of the Retirement Board and may only be provided to other parties in its entirety. The measurements shown in this actuarial valuation may not be applicable for other purposes.

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July 24, 2018

Retirement Board
Barnstable County Retirement System
750 Attucks Lane
Hyannis, MA 02601

Dear Board Members:

We are pleased to submit this Actuarial Valuation and Review as of January 1, 2018. It summarizes the actuarial data used in the valuation, analyzes the preceding two years' experience, and establishes the funding requirements for fiscal 2019 and later years.

This report was prepared in accordance with generally accepted actuarial principles and practices at the request of the Board to assist in administering the Retirement System. The census information and financial information on which our calculations were based was prepared by the staff of the Barnstable County Retirement System. That assistance is gratefully acknowledged.

The actuarial calculations were directed under my supervision. I am a member of the American Academy of Actuaries and I meet the Qualification Standards of the American Academy of Actuaries to render the actuarial opinion herein. To the best of my knowledge, the information supplied in this actuarial valuation is complete and accurate. Further, in my opinion, the assumptions as approved by the Board are reasonably related to the experience of and the expectations for the Barnstable County Retirement System.

We look forward to reviewing this report at your next meeting and to answering any questions.

Sincerely,

Segal Consulting, a Member of The Segal Group, Inc.

By:
Kathleen A. Riley, FSA, MAAA, EA
Senior Vice President and Consultant

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Barnstable County Retirement System Actuarial Valuation and Review as of January 1, 2018

Section 1: Actuarial Valuation Summary

Purpose and Basis

This report was prepared by Segal Consulting to present a valuation of the Barnstable County Retirement System as of January 1, 2018. The valuation was performed to determine whether the assets and contributions are sufficient to provide the prescribed benefits. The measurements shown in this actuarial valuation may not be applicable for other purposes. In particular, the measures herein are not necessarily appropriate for assessing the sufficiency of Plan assets to cover the estimated cost of settling the Plan's benefit obligations. Future actuarial measurements may differ significantly from the current measurements presented in this report due to such factors as the following: plan experience differing from that anticipated by the economic or demographic assumptions; changes in economic or demographic assumptions; increases or decreases expected as part of the natural operation of the methodology used for these measurements; and changes in plan provisions or applicable law.

Certain disclosure information required by GASB Statements No. 67 and 68 as of December 31, 2017 for the Barnstable County Retirement System is provided in a separate report.

The contribution requirements presented in this report are based on:

- The benefit provisions of Massachusetts General Law Chapter 32;
- The characteristics of covered active participants, inactive participants, and retired participants and beneficiaries as of December 31, 2017, provided by the staff of the Retirement System;
- The assets of the System as of December 31, 2017, provided by the staff of the Retirement System;
- Economic assumptions regarding future salary increases and investment earnings; and
- Other actuarial assumptions regarding employee terminations, retirement, death, etc.

Significant Issues

1. Segal Consulting ("Segal") strongly recommends an actuarial funding method that targets 100% funding of the actuarial accrued liability. Generally, this implies payments that are ultimately at least enough to cover normal cost, interest on the unfunded actuarial accrued liability and the principal balance. The funding policy adopted by the Barnstable County Retirement Board meets this standard and funds the unfunded actuarial accrued liability of the plan by June 30, 2035.

2. The funded ratio (the ratio of the actuarial value of assets to actuarial accrued liability) is 59.50%, compared to the prior valuation's funded ratio of 58.23%. This ratio is one measure of funding status, and its history is a measure of funding progress. Using the market value of assets, the funded ratio is 61.86%, compared to 55.84% as of the prior valuation date. These measurements are not necessarily appropriate for assessing the sufficiency of assets to cover the estimated cost of settling the Barnstable County Retirement System's benefit obligation or the need for or the amount of future contributions.

3. During the plan years ending December 31, 2016 and December 31, 2017, the market value rate of return was 7.39% and 17.06%, respectively. Because the actuarial value of assets gradually recognizes market value fluctuations, the actuarial rate of return for the plan years ended 2016 and 2017 was 6.70% and 8.70%, respectively. The actuarial value of assets as of December 31, 2017 was $1.06 billion, or 96.2% of the market value of assets of $1.10 billion (as reported in the Annual Statement). As of December 31, 2015, the actuarial value of assets was 104.3% of the market value.

4. As indicated in Section 2 of this report, the total unrecognized investment gain as of December 31, 2017 was $42.0 million. This investment gain will be recognized in the determination of the actuarial value of assets for funding purposes in the next few years, to the extent it is not offset by recognition of investment losses derived from future experience. This implies that earning the assumed rate of investment return (net of expenses) on a market value basis will result in investment gains on the actuarial value of assets in the next few years. The funding schedule shown in Section 2 reflects the deferred investment gains in accordance with the asset valuation method adopted by the Board.

5. The following actuarial assumptions were changed with this valuation:
   - The investment return assumption was lowered from 7.625% to 7.375%.
   - The salary increase assumption, which varies by years of service and by Group, was lowered by 0.25% to 4.00% for Group 1 employees with 11 or more years of service, 4.25% for Group 2 employees with 9 or more years of service and 4.50% for Group 4 employees with 8 or more years of service.
   - The mortality assumption for non-disabled participants was updated from the RP-2000 Employee and Healthy Annuitant Mortality Tables projected generationally from 2009 with Scale BB2D to the RP-2014 Blue Collar Employee and Healthy Annuitant Mortality Tables projected generationally with Scale MP-2017.

- The mortality assumption for disabled participants was updated from the RP-2000 Healthy Annuitant Mortality Table projected generationally from 2015 with Scale BB2D to the RP-2014 Blue Collar Healthy Annuitant Mortality Table set forward one year and projected generationally with Scale MP-2017.
- The administrative expense assumption was changed from $1,500,000 for calendar 2016, increasing 3.5% per year, to $1,500,000 for calendar 2018, increasing 3.25% per year

  Changing these assumptions increased the unfunded liability by approximately $61.7 million and increased the employer normal cost by approximately $1,623,000.

6. As permitted by Section 19 of Chapter 188 of the Acts of 2010, the Cost of Living Adjustment base was increased to $17,000 as of July 1, 2016, and to $18,000 as of July 1, 2017. This increase in the COLA base was reflected in the January 1, 2016 valuation.
7. The unfunded liability was expected to increase by $10.3 million from $653.0 million as of January 1, 2016 to $663.3 million as of January 1, 2018. The actual unfunded liability of $722.4 million as of January 1, 2018 is $59.1 million greater than expected, primarily due to the assumption changes noted above. Sources of gains and losses are discussed in Section 2.
8. The funding schedule included in this report fully funds the System by June 30, 2035 with appropriations that increase 5.28% per year. With the prior valuation, the Board approved a funding schedule that fully funded the System by June 30, 2036 with appropriations that increase 5.28% per year. In the funding schedule in this report and in the prior funding schedule, the 2010 ERI is amortized in level payments through fiscal year 2022, and the 2002 and 2003 ERI are amortized in 4.0% increasing payments through June 30, 2036 and 2035, respectively. In the prior funding schedule, the Retiree Sheriff liability was amortized in 4.0% increasing payments through June 30, 2036 and in 6.30% increasing payments per year through June 30, 2035 in the funding schedule in this report. The remaining unfunded liability is amortized such that the total appropriation increases 5.28% per year.
9. This actuarial report as of January 1, 2018 is based on financial and demographic data as of that date. Changes subsequent to that date are not reflected and will affect future actuarial costs of the plan.
10. Since the actuarial valuation results are dependent on a given set of assumptions, there is a risk that emerging results may differ significantly as actual experience proves to be different from the assumptions. We have included a discussion of various risks that may affect the plan in Section 2.

Summary of Key Valuation Results

		2018	2016
Contributions for fiscal year beginning July 1:	• Actuarially Determined Contributions for fiscal year 2019 and 2017	$63,512,249	$57,301,467
	• Actuarially Determined Contributions for fiscal year 2020 and 2018	66,865,696	60,326,984
	• Actuarially Determined Contributions for fiscal year 2021 and 2019	70,396,205	63,512,249
Actuarial accrued liability for plan year beginning January 1:	• Retired participants and beneficiaries	$940,532,571	$785,024,281
	• Inactive vested participants	20,102,987	16,737,713
	• Active participants	818,628,315	758,211,712
	• Inactive participants due a refund of employee contributions	4,673,413	3,468,313
	• Total	1,783,937,286	1,563,442,019
	• Normal cost including administrative expenses for plan year beginning January 1	43,552,752	40,367,439
Assets for plan year beginning January 1:	• Market value of assets (MVA)	$1,103,493,815	$873,002,091
	• Actuarial value of assets (AVA)	1,061,514,465	910,455,464
	• Actuarial value of assets as a percentage of market value of assets	96.20%	104.29%
Funded status for plan year beginning January 1:	• Unfunded actuarial accrued liability on market value of assets	$680,443,471	$690,439,928
	• Funded percentage on MVA basis	61.86%	55.84%
	• Unfunded actuarial accrued liability on actuarial value of assets	$722,422,821	$652,986,555
	• Funded percentage on AVA basis	59.50%	58.23%
Key assumptions:	• Net investment return	7.375%	7.625%
	• Long-term inflation rate	3.25%	3.50%
Demographic data for plan year beginning January 1:	• Number of retired participants and beneficiaries	3,117	2,937
	• Number of inactive vested participants	130	146
	• Number of inactive participants entitled to a refund of employee contributions	564	476
	• Number of active participants	4,633	4,699
	• Total payroll	$271,510,348	$258,172,567
	• Average payroll	58,604	54,942

Important Information About Actuarial Valuations

An actuarial valuation is a budgeting tool with respect to the financing of future projected obligations of a pension plan. It is an estimated forecast – the actual long-term cost of the plan will be determined by the actual benefits and expenses paid and the actual investment experience of the plan.

In order to prepare a valuation, Segal Consulting ("Segal") relies on a number of input items. These include:

Plan of benefits	Plan provisions define the rules that will be used to determine benefit payments, and those rules, or the interpretation of them, may change over time. Even where they appear precise, outside factors may change how they operate. It is important to keep Segal informed with respect to plan provisions and administrative procedures, and to review the plan summary included in our report to confirm that Segal has correctly interpreted the plan of benefits.
Participant data	An actuarial valuation for a plan is based on data provided to the actuary by the Barnstable County Retirement System. Segal does not audit such data for completeness or accuracy, other than reviewing it for obvious inconsistencies compared to prior data and other information that appears unreasonable. It is important for Segal to receive the best possible data and to be informed about any known incomplete or inaccurate data.
Assets	The valuation is based on the market value of assets as of the valuation date, as provided by the Barnstable County Retirement System. The Barnstable County Retirement System uses an "actuarial value of assets" that differs from market value to gradually reflect year-to-year changes in the market value of assets in determining the contribution requirements.
Actuarial assumptions	In preparing an actuarial valuation, Segal projects the benefits to be paid to existing plan participants for the rest of their lives and the lives of their beneficiaries. This projection requires actuarial assumptions as to the probability of death, disability, withdrawal, and retirement of each participant for each year. In addition, the benefits projected to be paid for each of those events in each future year reflect actuarial assumptions as to salary increases and cost-of-living adjustments. The projected benefits are then discounted to a present value, based on the assumed rate of return that is expected to be achieved on the plan's assets. There is a reasonable range for each assumption used in the projection and the results may vary materially based on which assumptions are selected. It is important for any user of an actuarial valuation to understand this concept. Actuarial assumptions are periodically reviewed to ensure that future valuations reflect emerging plan experience. While future changes in actuarial assumptions may have a significant impact on the reported results, that does not mean that the previous assumptions were unreasonable.

The user of Segal's actuarial valuation (or other actuarial calculations) should keep the following in mind:

- The actuarial valuation is prepared at the request of the Barnstable County Retirement System. Segal is not responsible for the use or misuse of its report, particularly by any other party.
- An actuarial valuation is a measurement of the plan's assets and liabilities at a specific date. Accordingly, except where otherwise noted, Segal did not perform an analysis of the potential range of future financial measures. The actual long-term cost of the plan will be determined by the actual benefits and expenses paid and the actual investment experience of the plan.
- Actuarial results in this report are not rounded, but that does not imply precision.
- If the Barnstable County Retirement System is aware of any event or trend that was not considered in this valuation that may materially change the results of the valuation, Segal should be advised, so that we can evaluate it.
- Segal does not provide investment, legal, accounting, or tax advice. Segal's valuation is based on our understanding of applicable guidance in these areas and of the plan's provisions, but they may be subject to alternative interpretations. The Barnstable County Retirement System should look to their other advisors for expertise in these areas.

As Segal Consulting has no discretionary authority with respect to the management or assets of the System, it is not a fiduciary in its capacity as actuaries and consultants with respect to the System.

Section 2: Actuarial Valuation Results

Participant Data

The Actuarial Valuation and Review considers the number and demographic characteristics of covered participants, including active participants, inactive participants, retired participants and beneficiaries.

This section presents a summary of significant statistical data on these participant groups.

More detailed information for this valuation year and the preceding valuation can be found in *Section 3, Exhibits A* and *B*.

PARTICIPANT POPULATION: 2001 – 2017

Year Ended December 31	Active Participants	Inactive Participants	Retired Participants and Beneficiaries	Total Non-Actives	Ratio of Non-Actives to Actives
2001	4,970	899	1,952	2,851	0.57
2003	5,031	834	2,125	2,959	0.59
2005	5,269	765	2,201	2,966	0.56
2006	5,314	787	2,267	3,054	0.57
2008	5,290	748	2,368	3,116	0.59
2009	4,786*	772	2,422	3,194	0.67
2011	4,670	637	2,556	3,193	0.68
2013	4,696	651	2,729	3,380	0.72
2015	4,699	622	2,937	3,559	0.76
2017	4,633	694	3,117	3,811	0.82

* Reflects transfer of County Sheriffs to State Retirement System.

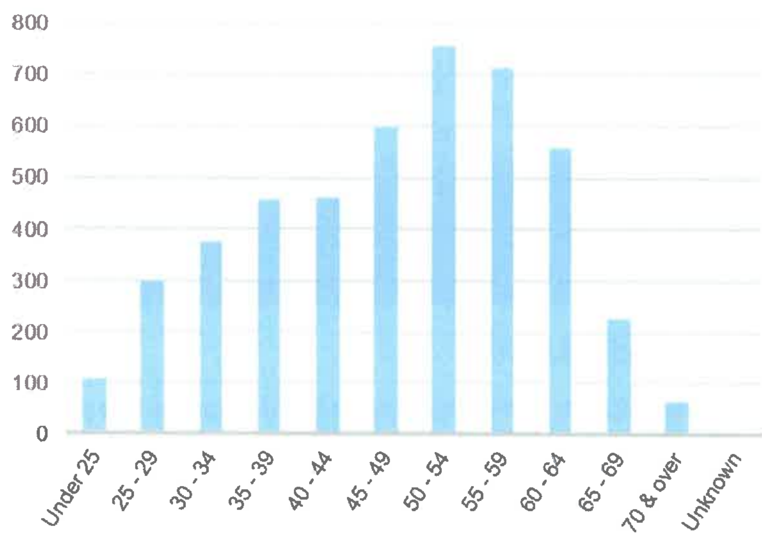
Active Participants

Plan costs are affected by the age, years of service and payroll of active participants. In this year's valuation, there were 4,633 active participants with an average age of 48.4, average service of 12.0 years and average payroll of $58,604. The 4,699 active participants in the prior valuation had an average age of 48.8, average service of 12.2 years and average payroll of $54,942.

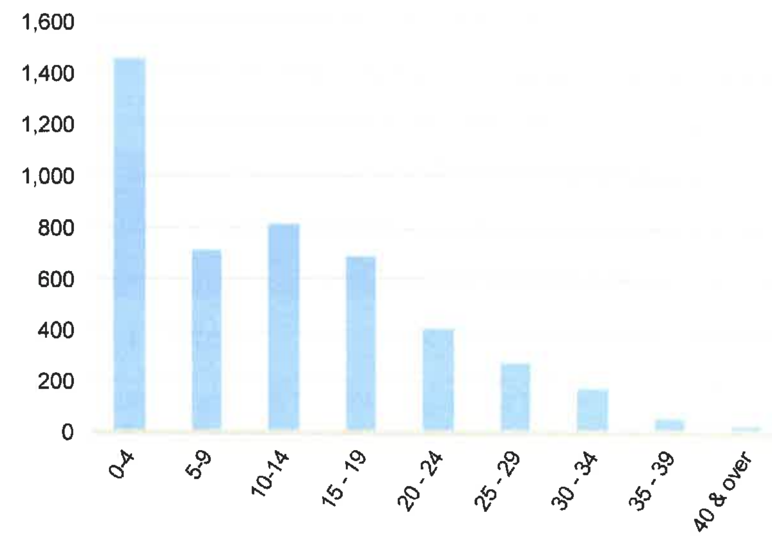
Among the active participants, there was one participant with unknown age information. The actuarial calculations were adjusted for the missing information by assuming that it was the same as information provided for other active participants with similar known characteristics.

Distribution of Active Participants as of December 31, 2017

BY AGE



BY YEARS OF SERVICE



Inactive Participants

In this year's valuation, there were 130 participants with a right to a deferred or immediate benefit and 564 participants entitled to a return of their employee contributions.

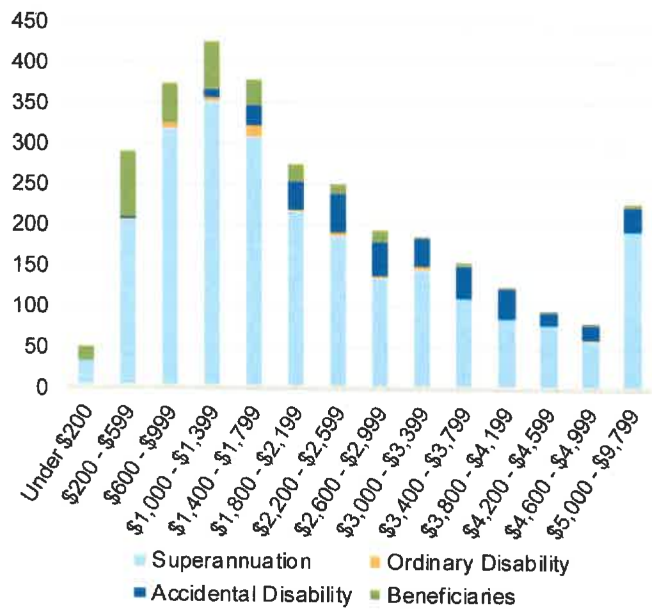
Retired Participants and Beneficiaries

As of December 31, 2017, 2,807 retired participants and 310 beneficiaries were receiving total monthly benefits of $7,152,307, excluding COLAs reimbursed by the Commonwealth. For comparison, in the previous valuation, there were 2,633 retired participants and 299 beneficiaries receiving monthly benefits of $6,130,942, excluding COLAs reimbursed by the Commonwealth. There were no retired participants in suspended status this year compared to five retired participants in suspended status in the prior valuation.

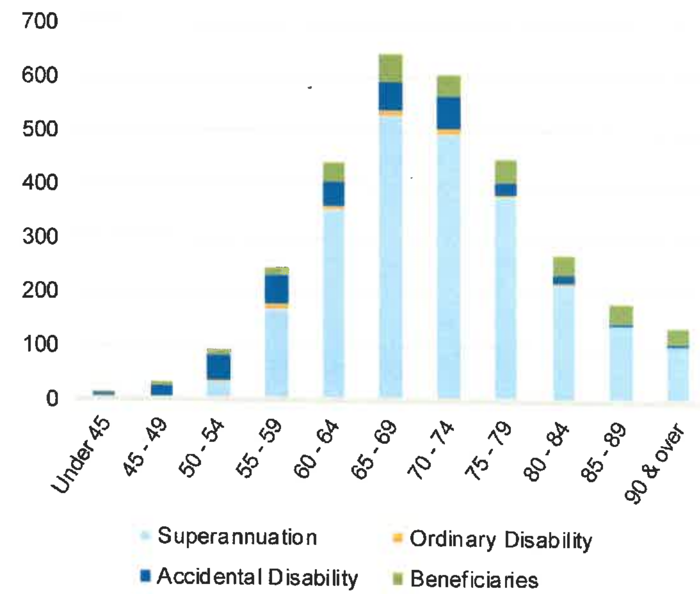
As of December 31, 2017, the average monthly benefit for retired participants and beneficiaries is $2,295, compared to $2,090 in the previous valuation. The average age for retired participants and beneficiaries is 70.7 in the current valuation, compared with 70.5 in the prior valuation.

Distribution of Pensioners and Beneficiaries as of December 31, 2017

BY TYPE AND MONTHLY AMOUNT



BY TYPE AND AGE

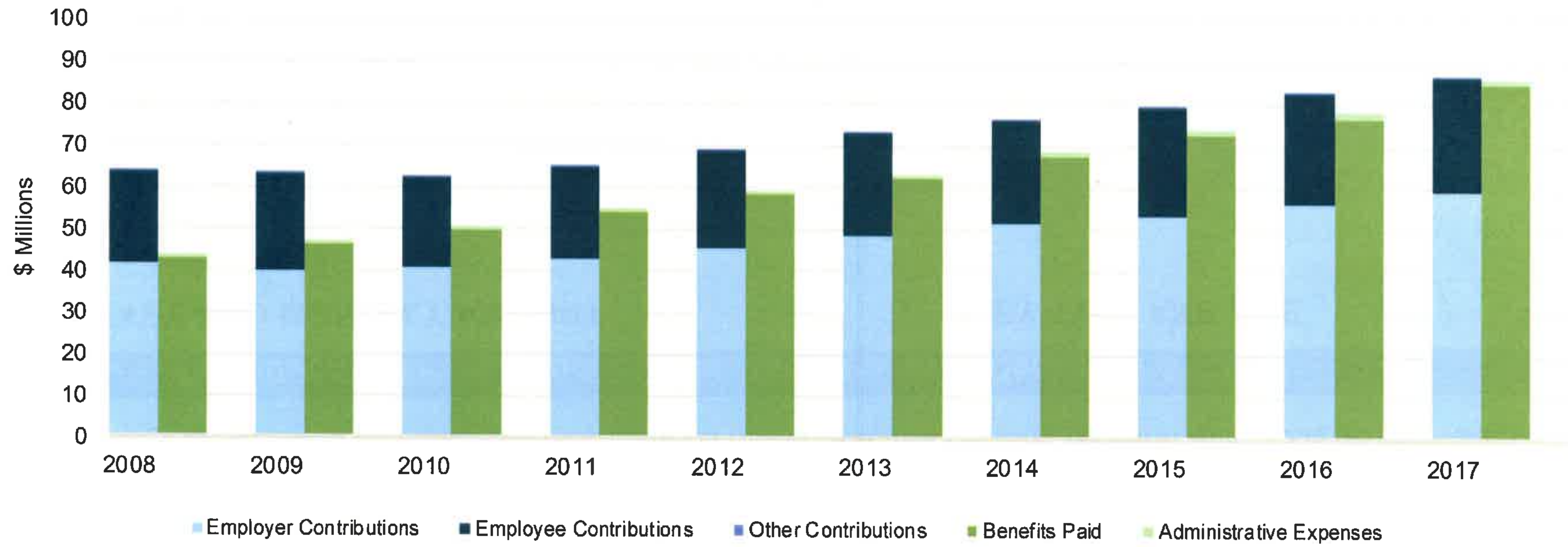


Financial Information

Retirement plan funding anticipates that, over the long term, both contributions (less administrative expenses) and investment earnings (less investment fees) will be needed to cover benefit payments. Retirement plan assets change as a result of the net impact of these income and expense components.

Additional financial information, including a summary of transactions for the valuation year, is presented in *Section 3, Exhibits C and D*.

COMPARISON OF CONTRIBUTIONS WITH BENEFITS AND EXPENSES FOR YEARS ENDED DECEMBER 31, 2008 – 2017



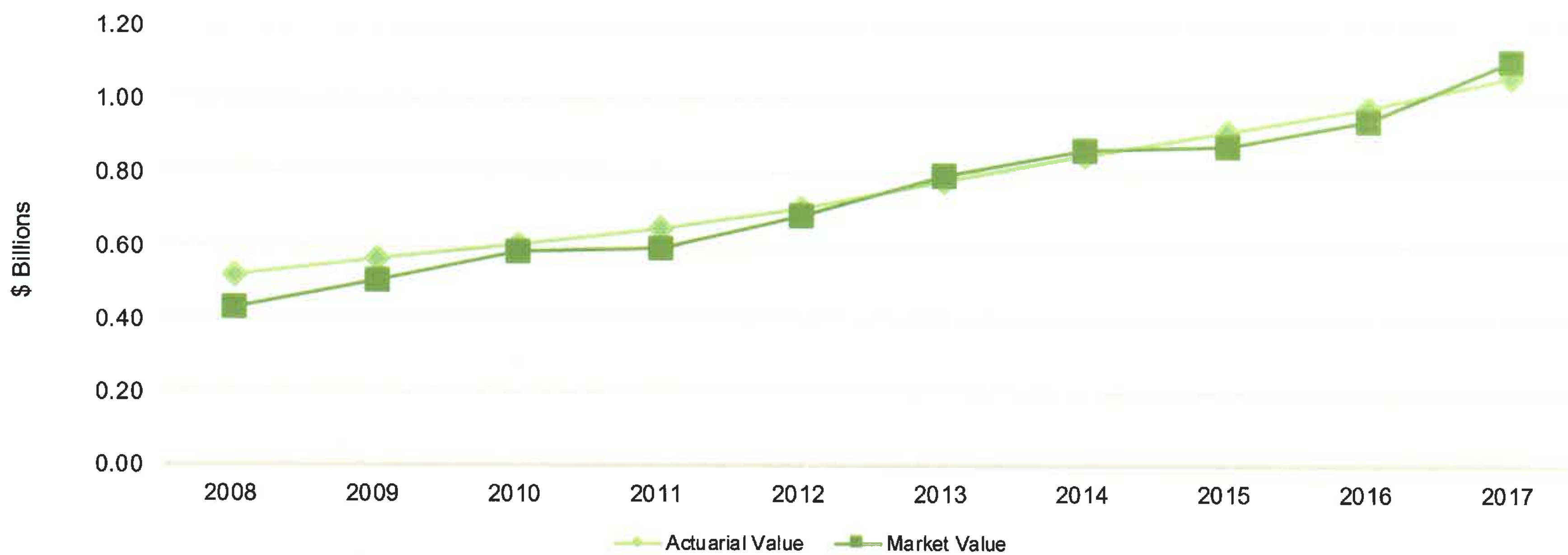
It is desirable to have level and predictable plan costs from one year to the next. For this reason, the Board has approved an asset valuation method that gradually adjusts to market value. Under this valuation method, the full value of market fluctuations is not recognized in a single year and, as a result, the asset value and the plan costs are more stable. The amount of the adjustment to recognize market value is treated as income, which may be positive or negative. Realized and unrealized gains and losses are treated equally and, therefore, the sale of assets has no immediate effect on the actuarial value.

DETERMINATION OF ACTUARIAL VALUE OF ASSETS

		Year Ended	
		December 31, 2017	December 31, 2016
1	Actuarial value of assets at the beginning of the year	$976,057,351	$910,455,464
2	Contributions, less benefit payments and expenses during the year	518,150	4,482,423
3	Average actuarial value: **(1) + [50% of (2)]**	976,316,426	912,696,675
4	Expected investment income: **.07625 x (3)**	74,444,127	69,593,121
5	Preliminary actuarial value of assets at the end of the year: **(1) + (2) + (4)**	1,051,019,628	984,531,008
6	Market value of assets at the end of the year	1,103,493,815	942,162,721
7	Adjustment toward market value: **20% of [(6) - (5)]**	10,494,837	-8,473,657
8	Adjustment to be within 20% corridor	0	0
9	Final actuarial value of assets at the end of the year: **(5) + (7) + (8)**	$1,061,514,465	$976,057,351
10	Actuarial value as a percentage of market value: **(9) ÷ (6)**	96.20%	103.60%

Both the actuarial value and market value of assets are representations of the Barnstable County Retirement System's financial status. As investment gains and losses are gradually taken into account, the actuarial value of assets tracks the market value of assets. The actuarial asset value is significant because the Barnstable County Retirement System's liabilities are compared to these assets to determine what portion, if any, remains unfunded. Amortization of the unfunded actuarial accrued liability is an important element in determining the contribution requirement.

ACTUARIAL VALUE OF ASSETS VS. MARKET VALUE OF ASSETS AS OF DECEMBER 31, 2008 – 2017



Actuarial Experience

To calculate the actuarially determined contribution, assumptions are made about future events that affect the amount and timing of benefits to be paid and assets to be accumulated. Each year actual experience is measured against the assumptions. If overall experience is more favorable than anticipated (an actuarial gain), any contribution requirement will decrease from the previous year. On the other hand, the contribution requirement will increase if overall actuarial experience is less favorable than expected (an actuarial loss).

Taking account of experience gains or losses in one year without making a change in assumptions reflects the belief that the single year's experience was a short-term development and that, over the long term, experience will return to the original assumptions. For contribution requirements to remain stable, assumptions should approximate experience.

If assumptions are changed, the contribution requirement is adjusted to take into account a change in experience anticipated for all future years.

The net experience gain over the two-year period is $2,656,244, which includes a gain of $2,021,180 from investment gains and a net gain of $635,064 from all other sources. The net experience variation from individual sources other than investments was insignficant compared to the actuarial accrued liability. A discussion of the major components of the actuarial experience is on the following pages.

ACTUARIAL EXPERIENCE FOR TWO-YEAR PERIOD ENDED DECEMBER 31, 2017

1	Net gain from investments	$2,021,180
2	Net gain from administrative expenses	466,850
3	Net gain from other experience	168,214
4	Net experience gain: 1 + 2 + 3	$2,656,244

Investment Experience

A major component of projected asset growth is the assumed rate of return. The assumed return should represent the expected long-term rate of return, based on the Barnstable County Retirement System's investment policy. The rate of return on the market value of assets for the 2017 and 2016 plan years was 17.06% and 7.39%, respectively.

For valuation purposes, the assumed rate of return on the actuarial value of assets was 7.625% for the 2017 and 2016 plan years. The actual rates of return on an actuarial basis for the 2017 and 2016 plan years were 8.70% and 6.70%, respectively. The Barnstable County Retirement System experienced an actuarial gain during the two-year period ending December 31, 2017 with regard to its investments.

INVESTMENT EXPERIENCE

		Year Ended December 31, 2017		Year Ended December 31, 2016	
		Market Value	Actuarial Value	Market Value	Actuarial Value
1	Net investment income	$160,812,944	$84,938,964	$64,678,207	$61,119,464
2	Average value of assets	942,421,796	976,316,426	875,243,303	912,696,675
3	Rate of return: 1 ÷ 2	17.06%	8.70%	7.39%	6.70%
4	Assumed rate of return	7.625%	7.625%	7.625%	7.625%
5	Expected investment income: 2 x 4	$71,859,662	$74,444,127	$66,737,302	$69,593,121
6	Actuarial gain/(loss): 1 – 5	$88,953,282	$10,494,837	-$2,059,095	-$8,473,657

Because actuarial planning is long term, it is useful to see how the assumed investment rate of return has followed actual experience over time. The chart below shows the rate of return on an actuarial basis compared to the actual market value investment return for the last 12 years, including averages over select time periods.

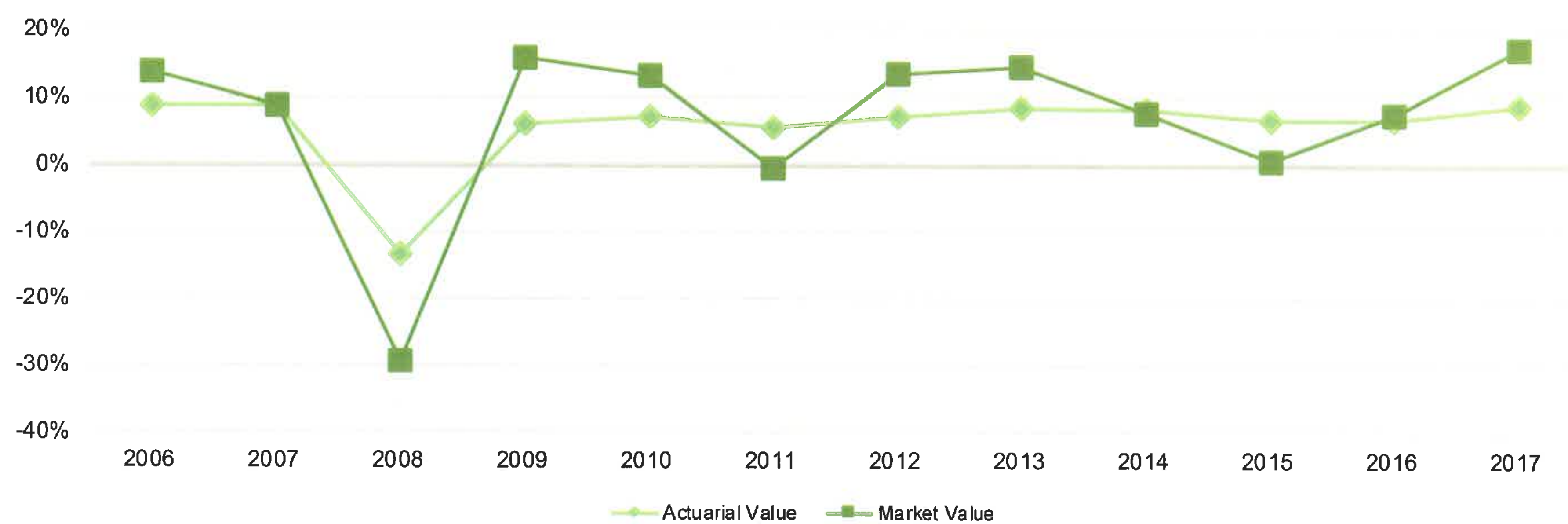
Based on this experience and future expectations, we have lowered the assumed rate of return from 7.625% to 7.375%.

INVESTMENT RETURN – ACTUARIAL VALUE VS. MARKET VALUE: 2006 - 2017

Year Ended December 31	Actuarial Value Investment Return		Market Value Investment Return	
	Amount	Percent	Amount	Percent
2006	$41,126,626	8.73%	$62,425,689	13.61%
2007	45,884,534	8.73%	46,934,182	8.78%
2008	-79,377,767	-13.47%	-176,200,834	-29.39%
2009	31,460,127	5.96%	69,758,113	15.81%
2010	39,828,569	7.10%	68,065,161	13.28%
2011	34,646,341	5.67%	-2,301,715	-0.39%
2012	45,883,414	7.00%	79,901,995	13.34%
2013	60,295,420	8.47%	100,382,552	14.58%
2014	63,924,668	8.19%	60,589,023	7.60%
2015	56,598,881	6.65%	5,470,561	0.63%
2016	61,119,464	6.70%	64,678,207	7.39%
2017	84,938,964	8.70%	160,812,944	17.06%
Total	$486,329,241		$540,515,878	
Most recent five-year average return		7.72%		9.40%
Most recent ten-year average return		5.56%		6.24%
Most recent 12-year average return		5.95%		6.84%

The actuarial asset valuation method gradually recognizes fluctuations in the market value rate of return. The goal of this is to stabilize the actuarial rate of return and to produce more level pension plan costs.

MARKET AND ACTUARIAL RATES OF RETURN FOR YEARS ENDED DECEMBER 31, 2006 - 2017



Administrative Expenses

Administrative expenses for the years ended December 31, 2016 and 2017 were $1,384,804 and $1,282,474, respectively, compared to the assumption of $1,500,000 for calendar 2016 and $1,552,500 for calendar 2017. This resulted in a gain of $466,850 for the two-year period, including an adjustment for interest. Based on information on expenses provided by the Retirement System, we have reset the assumption to $1,500,000 for calendar year 2018.

Other Experience

There are other differences between the expected and the actual experience that appear when the new valuation is compared with the projections from the previous valuation. These include:

- the extent of turnover among participants,
- retirement experience (earlier or later than projected),
- mortality (more or fewer deaths than projected),
- the number of disability retirements (more or fewer than projected), and
- salary increases (greater or smaller than projected).

The net gain from this other experience for the two-year period ending December 31, 2017 amounted to $168,214.

LIABILITY CHANGES DUE TO DEMOGRAPHIC EXPERIENCE FOR TWO-YEAR PERIOD ENDED DECEMBER 31, 2017

Salaries increasing less than expected for continuing actives	$11,727,727
More deaths than expected among retired members and beneficiaries	159,437
Loss from data changes, new active participants with high service and other miscellaneous experience	-11,718,950
Total	**$168,214**

Changes in the Actuarial Accrued Liability

The actuarial accrued liability as of January 1, 2018 is $1,783,937,286, an increase of $220,495,267, or 14.1%, from the actuarial accrued liability as of the prior valuation date. The liability is expected to grow each year with normal cost and interest, and to decline due to benefit payments made. Additional fluctuations can occur due to actual experience that differs from expected (as discussed in the previous subsection) and changes in assumptions (as noted below).

Actuarial Assumptions

The following actuarial assumptions were changed with this valuation:

- The investment return assumption was lowered from 7.625% to 7.375%.
- The salary increase assumption, which varies by years of service and by Group, was lowered by 0.25% to 4.00% for Group 1 employees with 11 or more years of service, 4.25% for Group 2 employees with 9 or more years of service and 4.50% for Group 4 employees with 8 or more years of service.
- The mortality assumption for non-disabled participants was updated from the RP-2000 Employee and Healthy Annuitant Mortality Tables projected generationally from 2009 with Scale BB2D to the RP-2014 Blue Collar Employee and Healthy Annuitant Mortality Tables projected generationally with Scale MP-2017.
- The mortality assumption for disabled participants was updated from the RP-2000 Healthy Annuitant Mortality Table projected generationally from 2015 with Scale BB2D to the RP-2014 Blue Collar Healthy Annuitant Mortality Table set forward one year and projected generationally with Scale MP-2017.
- The administrative expense assumption was changed from $1,500,000 for calendar 2016, increasing 3.5% per year, to $1,500,000 for calendar 2018, increasing 3.25% per year.

Changing these assumptions increased the unfunded liability by approximately $61.7 million and increased the employer normal cost by approximately $1,623,000.

Details on actuarial assumptions and methods are in *Section 4, Exhibit I.*

Plan Provisions

As permitted by Section 19 of Chapter 188 of the Acts of 2010, the Cost of Living Adjustment base was increased to $17,000 as of July 1, 2016 and to $18,000 as of July 1, 2017. This increase in the COLA base was reflected in the January 1, 2016 valuation.

A summary of plan provisions is in *Section 4, Exhibit II.*

Development of Unfunded Actuarial Accrued Liability

		Year Ended			
		December 31, 2017		December 31, 2016	
1	Unfunded actuarial accrued liability at beginning of year		$659,337,973		$652,986,555
2	Normal cost at beginning of year		41,780,299		40,367,439
3	Total contributions		-86,825,193		-82,680,888
4	Interest				
	• For whole year on 1 + 2	$53,460,268		$52,868,242	
	• For half year on 3	-4,418,068		-4,203,375	
	Total interest		49,042,200		48,664,867
5	Expected unfunded actuarial accrued liability		$663,335,279		$659,337,973
6	Changes due to:				
	• Net gain from investments	-$2,021,180		-	
	• Net gain from other experience	-635,064		-	
	• Change in assumptions	61,743,786		-	
	Total changes		59,087,542		-
7	Unfunded actuarial accrued liability at end of year		$722,422,821		-

Actuarially Determined Contribution

The actuarially determined contribution is equal to the employer normal cost payment and a payment on the unfunded actuarial accrued liability. For fiscal 2019, the actuarially determined contribution has been set equal to the previously budgeted amount of $63,512,249.

The funding schedule included in this report fully funds the System by June 30, 2035 with appropriations that increase 5.28% per year. With the prior valuation, the Board approved a funding schedule that fully funded the System by June 30, 2036 with appropriations that increase 5.28% per year. In the funding schedule in this report and in the prior funding schedule, the 2010 ERI is amortized in level payments through fiscal year 2022, and the 2002 and 2003 ERI are amortized in 4.0% increasing payments through June 30, 2036 and 2035, respectively. In the prior funding schedule, the Retiree Sheriff liability was amortized in 4.0% increasing payments through June 30, 2036 and in 6.30% increasing payments per year through June 30, 2035 in the funding schedule in this report. The remaining unfunded liability is amortized such that the total appropriation increases 5.28% per year.

ACTUARIALLY DETERMINED CONTRIBUTION FOR YEAR BEGINNING JANUARY 1

		2018		2016	
		Amount	% of Projected Payroll	Amount	% of Projected Payroll
1	Total normal cost	$42,052,752	14.85%	$38,867,439	14.41%
2	Administrative expenses	1,500,000	0.53%	1,500,000	0.56%
3	Expected employee contributions	-27,757,674	-9.80%	-26,126,579	-9.69%
4	Employer normal cost: **(1) + (2) - (3)**	$15,795,078	5.58%	$14,240,860	5.28%
5	Actuarial accrued liability	1,783,937,286		1,563,442,019	
6	Actuarial value of assets	1,061,514,465		910,455,464	
7	Unfunded actuarial accrued liability: **(5) - (6)**	$722,422,821		$652,986,555	
8	Employer normal cost projected to July 1, 2018 and 2016, adjusted for timing	16,337,763	5.68%	14,756,545	5.38%
9	Projected unfunded actuarial accrued liability	748,588,317		677,424,379	
10	Payment on projected unfunded actuarial accrued liability, adjusted for timing	47,174,486	16.40%	42,544,922	15.51%
11	Actuarially Determined Contribution: **(8) + (10)**	$63,512,249	22.08%	$57,301,467	20.89%
12	Projected payroll as of July 1	$287,710,185		$274,351,495	

Notes: Actuarially Determined Contributions are assumed to be paid on July 1 and December 31.
Actuarially Determined Contributions are set equal to the budgeted amounts determined with the prior valuation.

Funding Schedule

(1) Fiscal Year Ended June 30,	(2) Employer Normal Cost	(3) Amortization of ERI (2002) Liability	(4) Amortization of ERI (2003) Liability	(5) Amortization of ERI (2010) Liability	(6) Amortization of Remaining Liability	(7) Plan Cost Without Retired County Sheriff Liability: (2)+(3)+(4)+(5)+(6)	(8) Amortization of Retired County Sheriff Liability	(9) Total Appropriation: (7)+(8)	(10) Total UAL at Beginning of Fiscal Year	(11) Increase Over Prior Appropriation
2019	$16,337,763	$471,957	$222,050	$261,648	$44,712,255	$62,005,673	$1,506,576	$63,512,249	$748,588,317	- -
2020	16,936,108	490,835	230,932	261,648	47,344,752	65,264,275	1,601,421	66,865,696	745,013,294	5.28%
2021	17,556,192	510,468	240,170	261,648	50,125,417	68,693,895	1,702,310	70,396,205	739,794,723	5.28%
2022	18,198,801	530,887	249,776	261,647	53,062,458	72,303,569	1,809,556	74,113,125	732,441,270	5.28%
2023	18,864,748	552,122	259,767	0	56,426,103	76,102,740	1,923,558	78,026,298	722,445,271	5.28%
2024	19,554,873	574,207	270,158	0	59,702,107	80,101,345	2,044,742	82,146,087	709,277,871	5.28%
2025	20,270,050	597,176	280,965	0	63,161,648	84,309,839	2,173,561	86,483,400	692,382,504	5.28%
2026	21,011,183	621,063	292,203	0	66,814,780	88,739,229	2,310,495	91,049,724	671,169,820	5.28%
2027	21,779,206	645,905	303,891	0	70,672,090	93,401,092	2,456,057	95,857,149	645,012,047	5.28%
2028	22,575,089	671,741	316,047	0	74,744,741	98,307,618	2,610,788	100,918,406	613,236,977	5.28%
2029	23,399,837	698,611	328,689	0	79,044,493	103,471,630	2,775,268	106,246,898	575,122,338	5.28%
2030	24,254,490	726,555	341,836	0	83,583,743	108,906,624	2,950,110	111,856,734	476,698,444	5.28%
2031	25,140,125	755,618	355,510	0	88,375,550	114,626,803	3,135,967	117,762,770	419,450,562	5.28%
2032	26,057,858	785,842	369,730	0	93,433,682	120,647,112	3,333,532	123,980,644	352,685,042	5.28%
2033	27,008,845	817,276	384,519	0	98,772,637	126,983,277	3,543,545	130,526,822	275,404,881	5.28%
2034	27,994,284	849,967	399,900	0	104,407,699	133,651,850	3,766,788	137,418,638	186,523,403	5.28%
2035	29,015,415	883,954	415,895	0	81,075,868	111,391,132	4,004,096	115,395,228	84,856,765	-16.03%
2036	30,073,524	0	0	0	0	30,073,524	0	30,073,524	0	-73.94%
2037	31,169,940	0	0	0	0	31,169,940	0	31,169,940	0	3.65%
2038	32,306,042	0	0	0	0	32,306,042	0	32,306,042	0	3.64%

Notes: Actuarially Determined Contributions are assumed to be paid on July 1 and December 31.
Actuarially Determined Contribution for fiscal year 2019 is set equal to the budgeted amount determined with the prior valuation.
Item (2) reflects 3.25% growth in payroll as well as a 0.15% adjustment to total normal cost to reflect the effects of mortality improvement due to generational mortality assumption.
Projected normal cost does not reflect the future impact of pension reform for future hires.
2002 and 2003 ERI amortization payments calculated to increase 4.0% per year and 2010 ERI amortizations are level.
Payment on Retired County Sheriff Liability (item (8)) increases 6.30% per year and includes the 2002 ERI payment.
Projected unfunded actuarial accrued liability reflects deferred investment gains.

Risk

The actuarial valuation results depend on a single set of assumptions; however, there is a risk that emerging results may differ significantly as actual experience proves to be different from the current assumptions.

We have not been engaged to perform a detailed analysis of the potential range of the impact of risk relative to the System's future financial condition, but have included a brief discussion of some of the risks that may affect the System. This discussion is focused on funding-related risks, but similar concerns may apply to risks regarding the level of expense and liabilities reported for System accounting purposes as well.

We recommend a more detailed assessment of the risks to provide the Board with a better understanding of the risks inherent in the System. This assessment may include scenario testing, sensitivity testing, and/or stochastic modeling.

A detailed risk assessment is important for your System because relatively small changes in investment performance can produce large increases in the contribution requirements since the funding schedule is relatively short.

- Investment Risk (the risk that returns will be different than expected)

  The market value rate of return over the last 12 years has ranged from a low of -29.39% to a high of 17.06%.

- Longevity Risk (the risk that mortality experience will be different than expected)

  The actuarial valuation includes an expectation of future improvement in life expectancy. Emerging plan experience that does not match these expectations will result in either an increase or decrease in the actuarially determined contribution.

- Contribution Risk (the risk that actual contributions will be different from actuarially determined contribution)

  Massachusetts General Law requires payment of the actuarially determined contribution. If future experience matches the current assumptions, we project the unfunded actuarial accrued liability will be paid off in 17 years.

- Demographic Risk (the risk that participant experience will be different than assumed)

  Examples of this risk include:

  - Actual retirements occurring earlier or later than assumed.
  - More or less active participant turnover than assumed.

- Disability experience greater or less than expected
- Salary increases greater or less than projected.

Actual Experience in Recent Years and Implications for the Future

Past experience can help demonstrate the sensitivity of key results to the Plan's actual experience.

- The investment gain(loss) over the past ten years has ranged from a loss of $225,664,868 to a gain of $88,953,282.
- The non-investment gain(loss) over the past six valuations has ranged from a loss of $7,230,822 to a gain of $34,222,321.
- Since 2002, the funded percentage on the actuarial value of assets has ranged from a low of 53.8% as of January 1, 2009 to a high of 65.6% as of January 1, 2002.

Maturity Measures

As pension plans mature, the cashed need to fulfill benefit obligations will increase over time. Therefore, cash flow projections and analysis should be performed to assure that the Plan's asset allocation is aligned to meet emerging pension liabilities.

EXHIBIT A – TABLE OF PLAN COVERAGE

Category	Year Ended December 31		Change From Prior Year
	2017	2015	
Active participants in valuation:			
• Number	4,633	4,699	-1.4%
• Average age	48.4	48.8	-0.4
• Average years of service	12.0	12.2	-0.2
• Total payroll for prior year	$271,510,348	$258,172,567	5.2%
• Average payroll	58,604	54,942	6.7%
• Member contributions	255,150,662	239,399,454	6.6%
• Number with unknown age information	1	0	N/A
Inactive participants due a refund of employee contributions	564	476	18.5%
Inactive participants with a vested right to a deferred or immediate benefit	130	146	-11.0%
Retired participants:			
• Number in pay status	2,428	2,264	7.2%
• Average age	71.5	71.4	0.1
• Average monthly benefit	$2,297	$2,084	10.2%
Disabled participants:			
• Number in pay status	379	369	2.7%
• Average age	63.9	63.4	0.5
• Average monthly benefit	$3,042	$2,798	8.7%
Beneficiaries:			
• Number in pay status	310	299	3.7%
• Average age	73.1	72.3	0.8
• Average monthly benefit	$1,363	$1,271	7.2%

Note: Number of active participants for calendar 2015 includes records for participants who worked in multiple units, which were combined into one record for calendar 2017.

EXHIBIT B – PARTICIPANTS IN ACTIVE SERVICE AS OF DECEMBER 31, 2017 BY AGE, YEARS OF SERVICE, AND AVERAGE PAYROLL

		Years of Service								
Age	Total	0-4	5-9	10-14	15 - 19	20 - 24	25 - 29	30 - 34	35 - 39	40 & over
Under 25	107	105	2	- -	- -	- -	- -	- -	- -	- -
	$39,360	$39,204	$47,563	- -	- -	- -	- -	- -	- -	- -
25 - 29	299	260	35	4	- -	- -	- -	- -	- -	- -
	$48,023	$45,993	$60,488	$70,882	- -	- -	- -	- -	- -	- -
30 - 34	377	190	128	57	2	- -	- -	- -	- -	- -
	$55,916	$48,328	$63,409	$63,822	$71,927	- -	- -	- -	- -	- -
35 - 39	460	177	100	134	48	1	- -	- -	- -	- -
	$60,010	$44,956	$61,016	$70,512	$82,865	$119,882	- -	- -	- -	- -
40 - 44	461	171	80	85	92	30	3	- -	- -	- -
	$60,639	$43,247	$60,023	$67,632	$78,254	$84,079	$95,697	- -	- -	- -
45 - 49	597	166	85	89	122	88	44	3	- -	- -
	$62,447	$40,352	$54,406	$57,830	$75,490	$83,651	$88,949	$108,820	- -	- -
50 - 54	760	158	91	139	115	85	94	73	5	- -
	$65,255	$42,561	$50,948	$56,333	$70,463	$82,987	$84,922	$94,002	$80,027	- -
55 - 59	716	132	90	131	142	83	64	46	22	6
	$58,952	$40,652	$52,508	$58,778	$51,986	$62,765	$79,819	$88,832	$96,862	$83,473
60 - 64	561	72	64	115	106	85	48	36	23	12
	$56,675	$39,968	$52,410	$53,646	$52,514	$56,840	$64,025	$73,383	$91,290	$98,405
65 - 69	228	17	33	46	55	33	22	15	4	3
	$53,850	$48,321	$40,714	$50,583	$54,363	$55,599	$59,505	$68,166	$73,057	$112,503
70 & over	66	10	8	17	13	4	6	4	1	3
	$46,980	$41,324	$30,260	$46,052	$46,185	$47,593	$67,113	$56,967	$48,938	$64,081
Unknown	1	1	- -	- -	- -	- -	- -	- -	- -	- -
	$42,882	$42,882	- -	- -	- -	- -	- -	- -	- -	- -
Total	4,633	1,459	716	817	695	409	281	177	55	24
	$58,604	$43,560	$56,087	$60,067	$64,997	$71,206	$78,566	$85,690	$90,399	$92,144

EXHIBIT C – SUMMARY STATEMENT OF INCOME AND EXPENSES ON A MARKET VALUE BASIS

	Year Ended December 31, 2017		Year Ended December 31, 2016	
Net assets at market value at the beginning of the year		$942,162,721		$873,002,091
Contribution income:				
• Employer contributions	$59,204,601		$56,175,028	
• Employee contributions	27,532,956		26,411,360	
• Federal grant reimbursement contributions	87,636		94,500	
• Less administrative expenses	-1,282,474		-1,384,804	
Net contribution income		85,542,719		81,296,084
Net investment income		160,812,944		64,678,207
Total income available for benefits		$246,355,663		$145,974,291
Less benefit payments:				
• Pensions, annuities, refunds and net transfers	-$85,396,070		-$77,670,811	
• Net 3(8)(c) reimbursements	371,501		857,150	
Net benefit payments		-$85,024,569		-$76,813,661
Change in reserve for future benefits		$161,331,094		$69,160,630
Net assets at market value at the end of the year		$1,103,493,815		$942,162,721

EXHIBIT D – DEVELOPMENT OF THE FUND THROUGH DECEMBER 31, 2017

Year Ended December 31	Employer Contributions	Employee Contributions	Other Contributions	Net Investment Return	Administrative Expenses	Benefit Payments	Market Value of Assets at Year-End	Preliminary Actuarial Value of Assets at Year-End	Transfer to State Retirement System	Actuarial Value of Assets at End of Year	Actuarial Value as a Percent of Market Value
2008	$41,826,233	$22,037,322	$109,158	-$176,200,834	$955,794	$42,926,907	$433,408,212	$520,089,855	$0	$520,089,855	120.0%
2009	39,820,453	23,266,441	116,859	69,758,113	1,105,896	46,373,532	506,492,896	567,274,308	12,397,754	554,876,554	109.6%
2010	40,770,344	21,742,489	166,011	68,065,161	987,783	49,810,805	586,438,315	606,585,379	0	606,585,379	103.4%
2011	43,048,024	21,754,938	118,153	-2,301,715	1,080,590	54,008,264	593,968,860	651,063,981	0	651,063,981	109.6%
2012	45,725,078	23,220,718	107,650	79,901,995	1,065,300	58,305,330	683,553,671	706,630,211	0	706,630,211	103.4%
2013	48,540,969	24,760,772	182,538	100,382,552	1,104,266	62,331,944	793,984,292	776,973,700	0	776,973,700	97.9%
2014	51,438,214	24,847,689	123,957	60,589,023	1,210,998	67,702,886	862,069,291	848,394,344	0	848,394,344	98.4%
2015	53,512,418	25,867,836	113,933	5,470,561	1,288,422	72,743,526	873,002,091	910,455,464	0	910,455,464	104.3%
2016	56,175,028	26,411,360	94,500	64,678,207	1,384,804	76,813,661	942,162,721	976,057,351	0	976,057,351	103.6%
2017	59,204,601	27,532,956	87,636	160,812,944	1,282,474	85,024,569	1,103,493,815	1,061,514,465	0	1,061,514,465	96.2%

Notes: Net Investment Return is on a market basis, net of investment fees.
2010 Employee Contributions exclude Annuity Savings Fund transfer of $12,397,754 to the State Retirement System for the county sheriffs, which was previously reflected in the December 31, 2009 actuarial value of assets.

EXHIBIT E – TABLE OF AMORTIZATION BASES AS OF JULY 1, 2018

Base Name	Annual Payment	Years Remaining	Outstanding Balance
2002 ERI liability	$471,957	17.00	$6,179,717
2003 ERI liability	222,050	17.00	2,907,490
2010 ERI liability	261,648	4.00	926,979
Retired county sheriffs liability	1,506,576	17.00	23,241,534
Remaining unfunded liability	44,712,255	17.00	715,332,597
Total	**$47,174,486**		**$748,588,317**

Notes: Payments assumed to be made on July 1 and December 31.
2002 and 2003 ERI amortization payments are calculated to increase 4.0% per year, except for 2010 ERI amortization payments, which are level.
Payments on retired county sheriffs liability increase 6.30% per year.
Payment on remaining unfunded liability reflects adjustment to set fiscal 2019 appropriation to budgeted amount.

EXHIBIT F – UNIT ALLOCATION OF ERI AMORTIZATIONS FOR FISCAL 2019

Unit	2002 ERI	2003 ERI	2010 ERI	Total
Barnstable County	$98,238	$31,016	$0	$129,254
Barnstable Fire	4,753	0	0	4,753
Barnstable Housing Authority	4,269	0	0	4,269
Bourne Recreation	18,788	0	0	18,788
Bourne Water	5,446	0	0	5,446
C.O.M.M. Fire	0	5,442	0	5,442
Cape Cod Mosquito	2,980	0	0	2,980
County Hospital	8,456	0	0	8,456
Dennis Housing	2,846	0	0	2,846
Hyannis Fire	1,880	0	0	1,880
Mashpee Water	0	4,737	0	4,737
Town of Barnstable	113,627	0	105,544	219,171
Town of Bourne	88,279	0	0	88,279
Town of Brewster	18,652	0	0	18,652
Town of Chatham	0	0	100,633	100,633
Town of Eastham	26,173	0	0	26,173
Town of Mashpee	41,777	0	0	41,777
Town of Nantucket	0	131,550	0	131,550
Town of Truro	15,251	0	0	15,251
Town of Wellfleet	15,974	0	0	15,974
Town of Yarmouth	0	44,723	55,471	100,194
Veterans District	4,568	0	0	4,568
Yarmouth Housing	0	4,582	0	4,582
Total	$471,957	$222,050	$261,648	$955,655

EXHIBIT G – DEFINITIONS OF PENSION TERMS

The following list defines certain technical terms for the convenience of the reader:

Actuarial Accrued Liability for Actives:	The equivalent of the accumulated normal costs allocated to the years before the valuation date.
Actuarial Accrued Liability for Pensioners and Beneficiaries:	The single-sum value of lifetime benefits to existing pensioners and beneficiaries. This sum takes account of life expectancies appropriate to the ages of the annuitants and the interest that the sum is expected to earn before it is entirely paid out in benefits.
Actuarial Cost Method:	A procedure allocating the Actuarial Present Value of Future Benefits to various time periods; a method used to determine the Normal Cost and the Actuarial Accrued Liability that are used to determine the actuarially determined contribution.
Actuarial Gain or Loss:	A measure of the difference between actual experience and that expected based upon a set of Actuarial Assumptions, during the period between two Actuarial Valuation dates. Through the actuarial assumptions, rates of decrements, rates of salary increases, and rates of fund earnings have been forecasted. To the extent that actual experience differs from that assumed, Actuarial Accrued Liabilities emerge which may be the same as forecasted, or may be larger or smaller than projected. Actuarial gains are due to favorable experience, *e.g.*, assets earn more than projected, salary increases are less than assumed, members retire later than assumed, etc. Favorable experience means actual results produce actuarial liabilities not as large as projected by the actuarial assumptions. On the other hand, actuarial losses are the result of unfavorable experience, *i.e.*, actual results yield in actuarial liabilities that are larger than projected. Actuarial gains will shorten the time required for funding of the actuarial balance sheet deficiency while actuarial losses will lengthen the funding period.
Actuarially Equivalent:	Of equal actuarial present value, determined as of a given date and based on a given set of Actuarial Assumptions.
Actuarial Present Value (APV):	The value of an amount or series of amounts payable or receivable at various times, determined as of a given date by the application of a particular set of Actuarial Assumptions. Each such amount or series of amounts is: Adjusted for the probable financial effect of certain intervening events (such as changes in compensation levels, marital status, etc.) Multiplied by the probability of the occurrence of an event (such as survival, death, disability, withdrawal, etc.) on which the payment is conditioned, and Discounted according to an assumed rate (or rates) of return to reflect the time value of money.

Actuarial Present Value of Future Plan Benefits:	The Actuarial Present Value of benefit amounts expected to be paid at various future times under a particular set of Actuarial Assumptions, taking into account such items as the effect of advancement in age, anticipated future compensation, and future service credits. The Actuarial Present Value of Future Plan Benefits includes the liabilities for active members, retired members, beneficiaries receiving benefits, and inactive members entitled to either a refund or a future retirement benefit. Expressed another way, it is the value that would have to be invested on the valuation date so that the amount invested plus investment earnings would provide sufficient assets to pay all projected benefits and expenses when due.
Actuarial Valuation:	The determination, as of a valuation date, of the Normal Cost, Actuarial Accrued Liability, Actuarial Value of Assets, and related Actuarial Present Values for a plan. An Actuarial Valuation for a governmental retirement system typically also includes calculations of items needed for compliance with GASB, such as the Actuarially Determined Contribution (ADC) and the Net Pension Liability (NPL).
Actuarial Value of Assets (AVA):	The value of the Fund's assets as of a given date, used by the actuary for valuation purposes. This may be the market or fair value of plan assets, but commonly plans use a smoothed value in order to reduce the year-to-year volatility of calculated results, such as the funded ratio and the ADC.
Actuarially Determined:	Values that have been determined utilizing the principles of actuarial science. An actuarially determined value is derived by application of the appropriate actuarial assumptions to specified values determined by provisions of the law.
Actuarially Determined Contribution (ADC):	The employer's periodic required contributions, expressed as a dollar amount or a percentage of covered plan compensation, determined under the Plan's funding policy. The ADC consists of the Employer Normal Cost and the Amortization Payment.
Amortization Method:	A method for determining the Amortization Payment. The most common methods used are level dollar and level percentage of payroll. Under the Level Dollar method, the Amortization Payment is one of a stream of payments, all equal, whose Actuarial Present Value is equal to the UAAL. Under the Level Percentage of Pay method, the Amortization Payment is one of a stream of increasing payments, whose Actuarial Present Value is equal to the UAAL. Under the Level Percentage of Pay method, the stream of payments increases at the assumed rate at which total covered payroll of all active members will increase.
Amortization Payment:	The portion of the pension plan contribution, or ADC, that is designed to pay interest on and to amortize the Unfunded Actuarial Accrued Liability.

Assumptions or Actuarial Assumptions:	The estimates upon which the cost of the Fund is calculated, including: Investment return - the rate of investment yield that the Fund will earn over the long-term future; Mortality rates - the death rates of employees and pensioners; life expectancy is based on these rates; Retirement rates - the rate or probability of retirement at a given age or service; Disability rates – the probability of disability retirement at a given age; Withdrawal rates - the rates at which employees of various ages are expected to leave employment for reasons other than death, disability, or retirement; Salary increase rates - the rates of salary increase due to inflation and productivity growth.
Closed Amortization Period:	A specific number of years that is counted down by one each year, and therefore declines to zero with the passage of time. For example, if the amortization period is initially set at 30 years, it is 29 years at the end of one year, 28 years at the end of two years, etc. See Open Amortization Period.
Decrements:	Those causes/events due to which a member's status (active-inactive-retiree-beneficiary) changes, that is: death, retirement, disability, or withdrawal.
Defined Benefit Plan:	A retirement plan in which benefits are defined by a formula applied to the member's compensation and/or years of service.
Defined Contribution Plan:	A retirement plan, such as a 401(k) plan, a 403(b) plan, or a 457 plan, in which the contributions to the plan are assigned to an account for each member, the plan's earnings are allocated to each account, and each member's benefits are a direct function of the account balance.
Employer Normal Cost:	The portion of the Normal Cost to be paid by the employer. This is equal to the Normal Cost less expected member contributions.
Experience Study:	A periodic review and analysis of the actual experience of the Fund that may lead to a revision of one or more actuarial assumptions. Actual rates of decrement and salary increases are compared to the actuarially assumed values and modified as deemed appropriate by the Actuary.
Funded Ratio:	The ratio of the actuarial value of assets (AVA) to the actuarial accrued liability (AAL). Plans sometimes calculate a market funded ratio, using the market value of assets (MVA), rather than the AVA.
GASB 67 and GASB 68:	Governmental Accounting Standards Board (GASB) Statements No. 67 and No. 68. These are the governmental accounting standards that set the accounting rules for public retirement systems and the employers that sponsor or contribute to them. Statement No. 68 sets the accounting rules for the employers that sponsor or contribute to public retirement systems, while Statement No. 67 sets the rules for the systems themselves.

Investment Return:	The rate of earnings of the Fund from its investments, including interest, dividends and capital gain and loss adjustments, computed as a percentage of the average value of the fund. For actuarial purposes, the investment return often reflects a smoothing of the capital gains and losses to avoid significant swings in the value of assets from one year to the next.
Net Pension Liability (NPL):	The Net Pension Liability is equal to the Total Pension Liability minus the Plan Fiduciary Net Position.
Normal Cost:	That portion of the Actuarial Present Value of pension plan benefits and expenses allocated to a valuation year by the Actuarial Cost Method. Any payment in respect of an Unfunded Actuarial Accrued Liability is not part of Normal Cost (see Amortization Payment). For pension plan benefits that are provided in part by employee contributions, Normal Cost refers to the total of employee contributions and employer Normal Cost unless otherwise specifically stated.
Open Amortization Period:	An open amortization period is one which is used to determine the Amortization Payment but which does not change over time. If the initial period is set as 30 years, the same 30-year period is used in determining the Amortization Period each year. In theory, if an Open Amortization Period with level percentage of payroll is used to amortize the Unfunded Actuarial Accrued Liability, the UAAL will never decrease, but will become smaller each year, in relation to covered payroll, if the actuarial assumptions are realized.
Plan Fiduciary Net Position:	Market value of assets.
Total Pension Liability (TPL):	The actuarial accrued liability under the entry age normal cost method and based on the blended discount rate as described in GASB 67 and 68.
Unfunded Actuarial Accrued Liability:	The excess of the Actuarial Accrued Liability over the Actuarial Value of Assets. This value may be negative, in which case it may be expressed as a negative Unfunded Actuarial Accrued Liability, also called the Funding Surplus.
Valuation Date or Actuarial Valuation Date:	The date as of which the value of assets is determined and as of which the Actuarial Present Value of Future Plan Benefits is determined. The expected benefits to be paid in the future are discounted to this date.

EXHIBIT I – ACTUARIAL ASSUMPTIONS AND ACTUARIAL COST METHOD

Net Investment Return:

7.375% (previously, 7.625%)

The net investment return assumption is a long-term estimate derived from historical data, current and recent market expectations, and professional judgment. As part of the analysis, a building block approach was used that reflects inflation expectations and anticipated risk premiums for each of the portfolio's asset classes, as well as the Plan's target asset allocation.

Salary Increases:

Years of Service	Group 1	Group 2	Group 4
0	6.00%	6.00%	7.00%
1	5.50%	5.50%	6.50%
2	5.50%	5.50%	6.00%
3	5.25%	5.25%	5.75%
4	5.25%	5.25%	5.25%
5	4.75%	4.75%	5.25%
6	4.75%	4.75%	4.75%
7	4.50%	4.50%	4.75%
8	4.50%	4.50%	4.50%
9	4.25%	4.25%	4.50%
10	4.25%	4.25%	4.50%
11	4.00%	4.25%	4.50%
12+	4.00%	4.25%	4.50%

Includes an allowance for inflation of 3.25% (previously, 3.5%).

Previously, 4.25% for Group 1 employees with 9 or more years of service, 4.50% for Group 2 employees with 7 or more years of service, and 4.75% for Group 4 employees with more than 6 years of service.

The salary scale assumption is a long-term estimate derived from historical data, current and recent market expectations, and professional judgment.

Interest on Employee Contributions:	3.5%
Administrative Expenses:	$1,500,000 for calendar 2018, increasing 3.25% per year (previously, $1,500,000 for calendar 2016, increasing 3.50% per year). The administrative expense assumption is based on information on expenses provided by the Retirement System.
Mortality Rates:	*Pre-Retirement:* RP-2014 Blue Collar Employee Mortality Table projected generationally with Scale MP-2017 (previously, RP-2000 Employee Mortality Table projected generationally from 2009 with Scale BB2D) *Healthy Retiree:* RP-2014 Blue Collar Healthy Annuitant Mortality Table projected generationally with Scale MP-2017 (previously, RP-2000 Healthy Annuitant Mortality Table projected generationally from 2009 with Scale BB2D) *Disabled Retiree:* RP-2014 Blue Collar Healthy Annuitant Mortality Table set forward one year and projected generationally with Scale MP-2017 (previously, RP-2000 Healthy Annuitant Mortality Table projected generationally from 2015 with Scale BB2D) The mortality tables reasonably reflect the projected mortality experience of the Plan as of the measurement date based on historical and current demographic data. As part of the analysis, a comparison was made between the actual number of retiree deaths and the projected number based on the prior year's assumptions over the most recent eight years. The mortality tables were then adjusted to future years using generational projection under Scale MP-2017 to reflect future mortality improvement.

Termination Rates before Retirement:

	Groups 1 and 2 - Rate (%)				
	Mortality				
	Current		Previous		
Age	Male	Female	Male	Female	Disability
20	0.05	0.02	0.03	0.02	0.01
25	0.06	0.02	0.04	0.02	0.02
30	0.06	0.02	0.04	0.03	0.03
35	0.07	0.03	0.08	0.05	0.06
40	0.08	0.04	0.11	0.07	0.10
45	0.13	0.07	0.15	0.11	0.15
50	0.22	0.12	0.21	0.17	0.19
55	0.36	0.19	0.30	0.25	0.24
60	0.61	0.27	0.49	0.39	0.28

Notes: Mortality rates do not reflect generational projection.
55% of the disability rates shown represent accidental disability.
20% of the accidental disabilities will die from the same cause as the disability.
55% of the death rates shown represent accidental death.

	Group 4 - Rate (%)				
	Mortality				
	Current		Previous		
Age	Male	Female	Male	Female	Disability
20	0.05	0.02	0.03	0.02	0.10
25	0.06	0.02	0.04	0.02	0.20
30	0.06	0.02	0.04	0.03	0.30
35	0.07	0.03	0.08	0.05	0.30
40	0.08	0.04	0.11	0.07	0.30
45	0.13	0.07	0.15	0.11	1.00
50	0.22	0.12	0.21	0.17	1.25
55	0.36	0.19	0.30	0.25	1.20
60	0.61	0.27	0.49	0.39	0.85

Notes: Mortality rates do not reflect generational projection.
90% of the disability rates shown represent accidental disability.
60% of the accidental disabilities will die from the same cause as the disability.
90% of the death rates shown represent accidental death.

Withdrawal Rates:

Rate per year (%)			
Years of Service	Groups 1 and 2	Years of Service	Group 4
0	15.0	0 – 10	1.5
1	12.0	11+	0.0
2	10.0		
3	9.0		
4	8.0		
5	7.6		
6	7.5		
7	6.7		
8	6.3		
9	5.9		
10	5.4		
11	5.0		
12	4.6		
13	4.1		
14	3.7		
15	3.3		
16 – 20	2.0		
21 – 29	1.0		
30+	0.0		

The termination rates and disability rates were based on historical and current demographic data, adjusted to reflect economic conditions of the area and estimated future experience and professional judgment. As part of the analysis, a comparison was made between the actual number of terminations and disability retirements and the projected number based on the prior year's assumptions over the past eight years.

Retirement Rates:

	Rate per year (%)		
	Groups 1 and 2		
Age	Male	Female	Group 4
45 – 49	- -	- -	1.0
50 – 51	1.0	1.5	2.0
52	1.0	2.0	2.0
53	1.0	2.5	5.0
54	2.0	2.5	7.5
55	2.0	5.5	15.0
56 – 57	2.5	6.5	10.0
58	5.0	6.5	10.0
59	6.5	6.5	15.0
60	12.0	5.0	20.0
61	20.0	13.0	20.0
62	30.0	15.0	25.0
63	25.0	12.5	25.0
64	22.0	18.0	30.0
65	40.0	15.0	100.0
66 – 67	25.0	20.0	- -
68	30.0	25.0	- -
69	30.0	20.0	- -
70	100.0	100.0	- -

The retirement rates were based on historical and current demographic data, adjusted to reflect economic conditions of the area and estimated future experience and professional judgment. As part of the analysis, a comparison was made between the actual number of retirements by age and the projected number based on the prior years' assumption over the most recent eight years.

Retirement Rates for Inactive Vested Participants: 55 for participants hired prior to April 2, 2012. For participants hired April 2, 2012 or later, 60 for Group 1, 55 for Group 2, and 50 for Group 4.

The retirement age for inactive vested participants was based on historical and current demographic data, adjusted to reflect economic conditions of the area and estimated future experience and professional judgment.

Unknown Data for Participants: Same as those exhibited by participants with similar known characteristics. If not specified, participants are assumed to be male.

Family Composition: 75% of participants are assumed to be married. None are assumed to have dependent children. Females are assumed to be three years younger than their spouses.

Benefit Election: All participants are assumed to elect Option A. The benefit election reflects the fact that all benefit options are actuarially equivalent.

2017 Salary: 2017 salaries are equal to salaries provided in the data, annualized for new hires.

Total Service: Total creditable service reported in the data. If missing, total creditable service estimated from date of hire.

Net 3(8)(c) Liability: No liability is valued for benefits paid to or received from other municipal retirement systems.

Actuarial Value of Assets: A preliminary actuarial value is first determined by taking the actuarial value of assets at the beginning of the year and adding assumed investment earnings (at the assumed actuarial rate of return) and the net new money during the year (contributions less benefit payments and administrative expenses). Twenty percent of the difference between the market value of assets as reported in the System's Annual Statement and the preliminary actuarial value of assets is added to the preliminary actuarial value. In order that the actuarial value not differ too significantly from the market value of assets, the final actuarial value of assets must be within 20% of the market value of assets.

Actuarial Cost Method: Entry Age Normal Actuarial Cost Method. Entry Age is the attained age of the participant minus total creditable service. Normal Cost and Actuarial Accrued Liability are calculated on an individual basis and are allocated by salary. Normal Cost is determined using the plan of benefits applicable to each participant.

Justification for Change in Actuarial Assumptions:

Based on past experience and future expectations, the following actuarial assumption were changed as of January 1, 2018:

- The investment return assumption was lowered from 7.625% to 7.375%.
- The salary increase assumption, which varies by years of service and by Group, was lowered by 0.25% to 4.00% for Group 1 employees with 11 or more years of service, 4.25% for Group 2 employees with 9 or more years of service and 4.50% for Group 4 employees with 8 or more years of service.
- The mortality assumption for non-disabled participants was updated from the RP-2000 Employee and Healthy Annuitant Mortality Tables projected generationally from 2009 with Scale BB2D to the RP-2014 Blue Collar Employee and Healthy Annuitant Mortality Tables projected generationally with Scale MP-2017.
- The mortality assumption for disabled participants was updated from the RP-2000 Healthy Annuitant Mortality Table projected generationally from 2015 with Scale BB2D to the RP-2014 Blue Collar Healthy Annuitant Mortality Table set forward one year and projected generationally with Scale MP-2017.
- The administrative expense assumption was changed from $1,500,000 for calendar 2016, increasing 3.5% per year, to $1,500,000 for calendar 2018, increasing 3.25% per year.

EXHIBIT II – SUMMARY OF PLAN PROVISIONS

This exhibit summarizes the major provisions of the Plan included in the valuation. It is not intended to be, nor should it be interpreted as, a complete statement of all plan provisions.

Plan Year: January 1 through December 31

Plan Status: Ongoing

Retirement Benefits: Employees covered by the Contributory Retirement Law are classified into one of four groups depending on job classification. Group 1 comprises most positions in state and local government. It is the general category of public employees. Group 4 comprises mainly police and firefighters. Group 2 is for other specified hazardous occupations. (Officers and inspectors of the State Police are classified as Group 3.)

For employees hired prior to April 2, 2012, the annual amount of the retirement allowance is based on the member's final three-year average salary multiplied by the number of years and full months of creditable service at the time of retirement and multiplied by a percentage according to the following table based on the age of the member at retirement:

	Age Last Birthday at Date of Retirement		
Percent	**Group 1**	**Group 2**	**Group 4**
2.5	65 or over	60 or over	55 or over
2.4	64	59	54
2.3	63	58	53
2.2	62	57	52
2.1	61	56	51
2.0	60	55	50
1.9	59	--	49
1.8	58	--	48
1.7	57	--	47
1.6	56	--	46
1.5	55	--	45

A member's final three-year average salary is defined as the greater of the highest consecutive three-year average annual rate of regular compensation and the average annual rate of regular compensation received during the last three years of creditable service prior to retirement.

For employees hired on April 2, 2012 or later, the annual amount of the retirement allowance is based on the member's final five-year average salary multiplied by the number of years and full months of creditable service at the time of retirement and multiplied by a percentage according to the following tables based on the age and years of creditable service of the member at retirement:

For members with less than 30 years of creditable service: Age Last Birthday at Date of Retirement			
Percent	Group 1	Group 2	Group 4
2.50	67 or over	62 or over	57 or over
2.35	66	61	56
2.20	65	60	55
2.05	64	59	54
1.90	63	58	53
1.75	62	57	52
1.60	61	56	51
1.45	60	55	50

For members with 30 years of creditable service or greater: Age Last Birthday at Date of Retirement			
Percent	Group 1	Group 2	Group 4
2.500	67 or over	62 or over	57 or over
2.375	66	61	56
2.250	65	60	55
2.125	64	59	54
2.000	63	58	53
1.875	62	57	52
1.750	61	56	51
1.625	60	55	50

A member's final five-year average salary is defined as the greater of the highest consecutive five-year average annual rate of regular compensation and the average annual rate of regular compensation received during the last five years of creditable service prior to retirement.

For employees who became members after January 1, 2011, regular compensation is limited to 64% of the federal limit found in 26 U.S.C. 401(a)(17). In addition, regular compensation for members who retire after April 2, 2012 will be limited to prohibit "spiking" of a member's salary to increase the retirement benefit.

For all employees, the maximum annual amount of the retirement allowance is 80 percent of the member's final average salary. Any member who is a veteran also receives an additional yearly retirement allowance of $15 per year of creditable service, not exceeding $300. The veteran allowance is paid in addition to the 80 percent maximum.

Employee Contributions:

Date of Hire	Contribution Rate
Prior to January 1, 1975	5%
January 1, 1975 – December 31, 1983	7%
January 1, 1984 – June 30, 1996	8%
July 1, 1996 onward	9%

In addition, employees hired after December 31, 1978 contribute an additional 2 percent of salary in excess of $30,000.

Employees hired after 1983 who voluntarily withdraw their contributions with less than 10 ten years of credited service receive 3% interest on their contributions.

Employees in Group 1 hired on or after April 2, 2012 with 30 years of creditable service or greater will pay a base contribution rate of 6%.

Retirement Benefits (Superannuation):

Members of Group 1, 2 or 4 hired prior to April 2, 2012 may retire upon the attainment of age 55. For retirement at ages below 55, twenty years of creditable service is required.

Members hired prior to April 2, 2012 who terminate before age 55 with ten or more years of creditable service are eligible for a retirement allowance upon the attainment of age 55 (provided they have not withdrawn their accumulated deductions from the Annuity Savings Fund of the System).

Members of Group 1 hired April 2, 2012 or later may retire upon the attainment of age 60. Members of Group 2 or 4 hired April 2, 2012 or later may retire upon the attainment of age 55. Members of Group 4 may retire upon attainment of age 50 with ten years of creditable service.

Members hired April 2, 2012 or later who terminate before age 55 (60 for members of Group 1) with ten or more years of creditable service are eligible for a retirement allowance upon the attainment of age 55 (60 for members of Group 1) provided they have not withdrawn their accumulated deductions from the Annuity Savings Fund of the System.

Ordinary Disability Benefit:

A member who is unable to perform his or her job due to a non-occupational disability will receive a retirement allowance if he or she has ten or more years of creditable service and has not reached age 55. The annual amount of such allowance shall be determined as if the member retired for superannuation at age 55 (age 60 for Group 1 members hired on or after April 2, 2012), based on the amount of creditable service at the date of disability. For veterans, there is a minimum benefit of 50 percent of the member's most recent year's pay plus an annuity based on his or her own contributions.

Accidental Disability Benefit:	For a job-connected disability, the benefit is 72 percent of the member's most recent annual pay plus an annuity based on his or her own contributions, plus additional amounts for surviving children. Benefits are capped at 75 percent of annual rate of regular compensation for employees who become members after January 1, 1988.
Death Benefits:	In general, the beneficiary of an employee who dies in active service will receive a refund of the employee's own contributions. Alternatively, if the employee were eligible to retire on the date of death, a spouse's benefit will be paid equal to the amount the employee would have received under Option C. The surviving spouse of a member who dies with two or more years of credited service has the option of a refund of the employee's contributions or a monthly benefit regardless of eligibility to retire, if they were married for at least one year. There is also a minimum widow's pension of $500 per month, and there are additional amounts for surviving children. If an employee's death is job-connected, the spouse will receive 72 percent of the member's most recent annual pay, in addition to a refund of the member's accumulated deductions, plus additional amounts for surviving children. However, in accordance with Section 100 of Chapter 32, the surviving spouse of a police officer, firefighter or corrections officer is killed in the line of duty will be eligible to receive an annual benefit equal to the maximum salary held by the member at the time of death. Upon the death of a job-connected disability retiree who retired prior to November 7, 1996 and could not elect an Option C benefit, a surviving spouse will receive an allowance of $12,000 per year if the member dies for a reason unrelated to cause of disability.
"Heart And Lung Law" And Cancer Presumption:	Any case of hypertension or heart disease resulting in total or partial disability or death to a uniformed fireman, permanent member of a police department, or certain employees of a county correctional facility is presumed to have been suffered in the line of duty, unless the contrary is shown by competent evidence. Any case of disease of the lungs or respiratory tract resulting in total disability or death to a uniformed fireman is presumed to have been suffered in the line of duty, unless the contrary is shown by competent evidence. There is an additional presumption for uniformed firemen that certain types of cancer are job-related if onset occurs while actively employed or within five years of retirement.
Options:	Members may elect to receive a full retirement allowance payable for life under Option A. Under Option B a member may elect to receive a lower monthly allowance in exchange for a guarantee that at the time of death any contributions not expended for annuity payments will be refunded to the beneficiary. Option C allows the member to take a lesser retirement allowance in exchange for providing a survivor with two-thirds of the lesser amount. Option C pensioners will have benefits converted from a reduced to a full retirement if the beneficiary predeceases the retiree.
Post-Retirement Benefits:	The Board has adopted the provisions of Section 51 of Chapter 127 of the Acts of 1999, which provide that the Retirement Board may approve an annual COLA in excess of the Consumer Price Index but not to exceed a 3% COLA on the first $16,000 of a retirement allowance. The Board has adopted an increase in the COLA base from $16,000 to $17,000 effective July 1, 2016 and to $18,000 effective July 1, 2017. Cost-of-living increases granted prior to July 1, 1998 are reimbursed by the Commonwealth and not reflected in this report.
Changes in Plan Provisions:	None.