Missouri Department of Transportation and Highway Patrol Employees' Retirement System (MPERS) Actuarial Valuation Report

June 30, 2019





Table of Contents

	Pages
Introduction	
Summary of Results and Comments	1-13
Section A: Valuation Results	
Development of Contribution Rate and Liabilities System Resources and Obligations Amortization of Unfunded Actuarial Accrued Liabilities Historical Funding Progress and Employer Contributions Gain/Loss Analysis Risk Measures	A1-A3 A4 A5 A6-A10 A11-A12 A13-A14
Section B: Summary of Benefits	B1-B12
Section C: Financial Information	
Summary of Fund Operations Development of Actuarial Value of Assets Allocation of Assets	C1 C2 C3
Section D: Summary of Member Data	
Active Members Retirees and Survivors Disabled Retirees Data Reconciliation	D1-D10 D11-D20 D21-D22 D23
Section E: Assumptions Used in the Valuation and Glossary	E1-E18
Section F: Financial Principles and Operational Techniques	F1-F4
Section G: Supplemental Information for Comprehensive Annual Financial Reporting	G1-G12





September 25, 2019

Retirement Board Missouri Department of Transportation and Highway Patrol Employees' Retirement System 1913 William Street Jefferson City, Missouri 65102-1930

Ladies and Gentlemen:

The results of the regular annual actuarial valuation as of June 30, 2019 of the Missouri Department of Transportation and Highway Patrol Employees' Retirement System, as established by Chapter 104 of the Missouri Revised Statutes, are presented in this report. Reports providing accounting and financial reporting information that are intended to comply with the Governmental Accounting Standards Board Statements No. 67 and No. 68 will be provided separately. The purposes of this valuation were:

- to measure the System's funding progress;
- to determine the employer contribution rate for Fiscal Year 2021; and
- to provide certain supplemental schedules for use in the System's CAFR.

Your attention is directed particularly to the summary of the results on pages 1-13.

This report was prepared at the request of the Board and is intended for use by the Retirement System and those designated or approved by the Board. This report may be provided to parties other than the System only in its entirety and only with the permission of the Board. This report should not be relied on for any purpose other than the purpose described. GRS is not responsible for unauthorized use of this report.

The member statistical data required for the valuation together with pertinent data on financial operations was furnished by your Executive Director and his staff. Member data was reviewed for reasonableness, but was not audited by the actuary. Financial data was received in aggregate and reviewed for reasonableness. Individual investments were not reviewed. Assets are not audited by the actuary. We are not responsible for the accuracy or completeness of the data provided by MPERS.

The cooperation of the Executive Director and the staff in furnishing materials requested for this valuation, and the complete and excellent condition of the records, is acknowledged with appreciation.

The valuation results summarized in this report involve actuarial calculations that require assumptions about future events. The assumptions are established by the Board after consulting with the actuary. We believe that the assumptions and methods used in this report are reasonable and appropriate for the purpose for which they have been used. However, other assumptions and methods could also be reasonable and could result in materially different results. In addition, because it is not possible or practical to consider every possible contingency, we may use summary information, estimates or simplifications of calculations to facilitate the modeling of future events. We may also exclude factors or data that are deemed to be immaterial.

Retirement Board September 25, 2019 Page 2

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. This report does not contain an analysis of the potential range of such future measurements.

To the best of our knowledge, this report is complete and accurate and was made in accordance with standards of practice promulgated by the Actuarial Standards Board. The actuarial assumptions used for the valuation produce results which, individually and in the aggregate, are reasonable. The actuarial assumptions used in making the valuation are shown in Section E of this report.

The employer contributions determined in this report are based on Board funding policy. This policy is discussed on page 3 of this report. We commend the Board for its aggressive monitoring and updating of the funding policy over the recent past. However, continued employer contributions at the current level do not guarantee benefit security. We therefore encourage the Board to continue to routinely monitor and update its funding policy and to continue to consider benefit security when doing so.

This report has been prepared by individuals who have substantial experience valuing public employee retirement systems. Heidi G. Barry and Jamal Adora are Members of the American Academy of Actuaries (MAAA) and meet the Qualification Standards of the American Academy of Actuaries to render the actuarial opinions contained herein.

The signing individuals are independent of the plan sponsor.

This report replaces our report dated September 23, 2019. While the valuation results are unchanged, Section D has been updated to correct some of the census schedules.

Respectfully submitted,

Heidi & Barry

Heidi G. Barry, ASA, FCA, MAAA

Jamal Adora, ASA, MAAA

Kenneth G. Alberts

HGB/JA/KGA:dj

2248



Summary

This report contains the results of the June 30, 2019 valuation. The table below shows a summary of the data used in the valuation as well as the unfunded actuarial accrued liability for the two experience rated groups. This data was the basis for determining valuation results and recommended employer contribution rates.

		Non-Uniforme	d		
	Patrol	MoDOT	Non-Uniformed	Uniformed	
	Employees	Employees	Total	Patrol	Total
Participants					
Active Members					
Closed Plan	265	1,460	1,725	493	2,218
Year 2000 Plan (also closed)	402	1,577	1,979	368	2,347
Year 2011 Tier (open)	446	2,060	2,506	350	2,856
Total Active Members	1,113	5,097	6,210	1,211	7,421
Total Active Members Prior Year	1,114	5,046	6,160	1,231	7,391
Retiree Regular Pensioners					
Closed Plan	488	3,374	3,862	971	4,833
Year 2000 Plan (also closed)	583	3,465	4,048	8	4,056
Year 2011 Tier (open)	3	2	5	0	5
Total Regular Pensioners	1,074	6,841	7,915	979	8,894
Self Insured Disability Pensioners	3	41	44	3	47
Fully Insured Disability Pensioners	11	76	87	7	94
Terminated Vested Members	240	1,626	1,866	176	2,042
Total	2,441	13,681	16,122	2,376	18,498
Active Member Valuation Payroll	\$49,980,131	\$224,584,899	\$ 274,565,030	\$ 84,731,026	\$ 359,296,056
Active Mem. Val. Payroll Prior Year	\$47,859,971	\$219,664,025	\$ 267,523,996	\$ 83,972,559	\$ 351,496,555
Unfunded Actuarial Accrued Liability	N/A	N/A	\$1,176,812,729	\$445,213,548	\$1,622,026,277

The June 30, 2019 valuation results are used to determine the contribution rate for the plan year beginning July 1, 2020. A summary of valuation results and recommended contribution rates follows.



Summary (Continued)

	FY 2021 Employer Contribution Rates Expressed as % of Active Payroll									
	for Total Benefits									
		Non-Uniformed								
	Civilian Patrol	MoDOT		Uniformed Patrol	Combined Rate					
	Employees	Employees	Total	Total	(System Total)					
Benefit Normal Cost	8.36%	8.36%	8.36%	15.71%	10.13%					
Expenses	1.15%	1.15%	1.15%	1.15%	1.15%					
Disability Insurance	0.53%	0.53%	0.53%	0.53%	0.53%					
Total Normal Cost	10.04%	10.04%	10.04%	17.39%	11.81%					
Unfunded Liability	47.96%	47.96%	47.96%	40.61%	46.19%					
Total	58.00%	58.00%	58.00%	58.00%	58.00%					
Projected \$	\$30,753,874	\$138,192,029	\$168,945,903	\$52,136,864	\$221,082,767					
Prior Year Projected \$	\$29,449,293	\$135,164,107	\$164,613,400	\$51,670,163	\$216,283,563					

The **total contribution rate** for the plan year beginning July 1, 2020 is shown below:

The projected dollar amounts are the total employer rate multiplied by the valuation payroll projected to the fiscal year the rate is effective. The projection factor is 1.0609 for Non-Uniformed and 1.0609 for Uniformed. Actual contributions will be based on the actual payroll during the 2021 Fiscal Year. The total contribution is based on a 5-year amortization period for unfunded retiree liabilities and a 20-year amortization period for other unfunded liabilities from July 1, 2020 in accordance with Board policy adopted September 17, 2009. In accordance with Board Policy adopted September 26, 2014, a minimum Employer contribution of 58% of payroll was included to establish a Contribution Stabilization Reserve Fund.

The contributions above are Employer contributions only. In addition, Employee contributions are estimated to be (on average) 1.39% for Non-Uniformed members and 0.92% for Uniformed members.

The combined contribution rate (58.00% of active payroll) is less than the actual benefit payout rate (72.31% of active payroll). The difference is intended to be made up by investment return. The ability to contribute less than the benefit payout is one of the advantages of a funded retirement plan.

Prior year projected dollars (FY 2021) are based on rates of 58.00% for Non-Uniform and 58.00% for Uniform.



Summary (Continued)

Benefits, Assumptions and Methods for the June 30, 2019 valuation: There were no changes in benefits for the June 30, 2019 valuation. The assumptions and methods used were those adopted by the Board from the July 1, 2012 through June 30, 2017 Experience Study and titled Alternate 3 in that report. The Board formally adopted these new assumptions at the February 14, 2018 Board meeting. The next Experience Study is scheduled to follow the June 30, 2022 valuation.

Experience: System assets earned a 6.7% return on a market basis, although the fund recognized an 8.3% rate of return on an actuarial basis after accounting for the smoothing of the 2017 and 2018 gains (please see page C-2). In aggregate, there was an experience gain of \$29 million (approximately 0.7% of beginning of year liabilities). This gain was primarily investment related and contributed to an increase in funding status from 57.1% to 59.8%. Pages A-10 and A-11 show the derivation of the gain/(loss) in aggregate and by division.

The table below shows a comparison of actual demographic activity versus expected activity (based on the prior year's valuation assumptions).

Demographic Experience

		Non-Unife	ormed		Uniformed					
	Numb	er Count		General		er Count		General		
_	Actual	Expected	A/E%	Direction	Actual	Expected	A/E%	Direction		
Retirement	192	256.6	75%	Gain	40	32.8	122%	Loss		
Death	4	5.1	78%	Gain	0	0.7	0%	Gain		
Disability	17	15.9	107%	Gain	3	1.1	273%	Loss		
Vested Terminations	121	120.4	100%	Loss	25	8.8	284%	Gain		
Other Terminations	347	211.4	164%	Gain	11	5.9	186%	Gain		
Post-Retirement Death	291	248.1	117%	Gain	30	27.2	110%	Gain		

Liability losses were more than offset by recognized investment gains resulting in an experience gain of \$18 million (Non-Uniformed) and \$11 million (Uniformed) in aggregate.

Funding Policy:

Permanent Policy: The total contribution will be based on normal cost plus a 16-year amortization of unfunded actuarial accrued liabilities. The amortization period is a closed 16-year period starting July 1, 2020.

Temporary Accelerated Policy: The total contribution is based on normal cost plus a 5-year amortization period for unfunded retiree liabilities and a 20-year amortization period for other unfunded liabilities. Both amortization periods are closed periods starting July 1, 2020.

In accordance with RSMo 105.684, an accelerated amortization schedule was prepared and presented to the Board. This temporary accelerated policy was adopted by the Retirement Board on September 17, 2009 and will remain in effect until such time as the retiree liability becomes 100% funded or the permanent policy produces a higher contribution rate.

In September 2014, the Board adopted a contribution stabilization reserve fund from experience gains in an effort to keep the employer contribution rate at or near 58%, in the near term. In February 2015, the Board established a maximum of \$250 million in the contribution stabilization reserve fund. The contribution stabilization reserve fund is expected to result in the fund becoming more than 100% funded by the end of the amortization period, if experience is exactly as assumed.



Summary (Continued)

Rate Reconciliation: The table below shows the computed rate last year and the approximate effect of the changes that occurred during the year.

	Non-Uniform	Uniform
Computed employer contribution rate, prior valuation	58.00%	58.00%
Effects of:		
Change in disability premiums	0.00%	0.00%
Change in plan provisions	0.00%	0.00%
Change in assumptions and methods	0.00%	0.00%
Phase-in of 2011 Tier members	(0.33)%	(0.61)%
18/19 recognized investment loss/(gain)	(1.58)%	(2.10)%
18/19 liability experience loss/(gain)	0.20%	(0.64)%
Change in administrative expenses	(0.11)%	(0.11)%
Change due to payroll increase other than expected	0.25%	1.58%
Misc (demographic, payroll weighting, component interaction, etc.)	(1.59)%	(0.37)%
Change in Contribution Stabilization Reserve Fund	3.16%	2.25%
Computed employer contribution rate, current valuation	58.00%	58.00%

Funded Status of Retiree Liability: The chart below indicates the funding status of retiree liabilities on a funding value asset basis and a market value asset basis:

	Jun	June 30, 2018			
Asset Basis	Non-Uniformed	Uniformed	<u>Total</u>	<u>Total</u>	
Funding Value	87.0%	99.9%	90.4%	87.1%	
Market Value	87.3%	100.0%	90.7%	88.7%	

Total Plan Funded Status: The plan is currently 59.82% funded on an actuarial value of assets basis or 60.02% funded on a market value of assets basis.

If not for the minimum contribution rate and the contribution stabilization reserve, the permanent funding policy would have resulted in a higher employer contribution for the Uniformed division and the temporary policy would have resulted in a higher employer contribution for the Non-Uniformed division, using current valuation assumptions.

Plan Provisions: There were no plan provisions intentionally excluded from the valuation that were in effect on the valuation date. However, certain disability benefits are funded through third party insurance. The premiums for this insurance are included in the normal cost. The liabilities for these disability benefits are not included in the accrued liabilities of the plan, since they are liabilities of the insurance carrier.



Summary (Concluded)

Look Forward: Before recognizing any fiscal year 2020 activity, the fund is positioned to recognize an investment gain of approximately \$9 million next year (see page C-2). Since this gain (by itself) will not increase the contribution stabilization reserve fund above \$250 million (currently the contribution stabilization reserve is \$205 million), the employer contribution rate is not expected to decrease under the current funding policy. However, this gain, if not offset by other experience losses, will put upward pressure on the funded status of the plan. Should experience gains, in total, exceed \$31 million in fiscal year 2020, there will be downward pressure on employer contribution rates.

Recommendations:

- 1) In accordance with changes in actuarial standards along with more recent changes in forecasts of future economic conditions, we recommend that economic assumptions continue to be reviewed annually each spring before the next valuation cycle begins.
- 2) Unless there are actuarial experience losses in FY 2020 or FY 2021, we expect the contribution stabilization reserve fund to reach the Board approved maximum within the next couple of years. While no change in the funding policy is needed at this time, we recommend the Board consider reviewing the funding policy to determine if small changes (effective for the June 30, 2020 valuation) might reduce future contribution volatility. We further recommend that once June 30, 2020 asset values can reasonably be estimated, we use the projection tool interactively with the Board to model potential changes in the funding policy. Mid-July 2020 would be an ideal time if reasonable asset estimates are available at that time.

Conclusion: Based upon the results of the June 30, 2019 regular annual actuarial valuation, it is our opinion that the Missouri Department of Transportation and Highway Patrol Employees' Retirement System continues to be financed in accordance with actuarial principles of level percent-of-payroll financing. This statement is based upon the fact that the employer is contributing to the System based upon actuarially determined rates and presumes a continuation of payment of actuarially determined contributions. In addition, we commend the 2009 Board in its decision to more aggressively address the unfunded retiree liability issue, the 2011 Board in its decision to reflect the near term downsizing of MoDOT, and the 2014 Board for establishing the contribution stabilization reserve fund, which effectively accelerated the funding of the UAAL.



Other Observations

General Implications of Contribution Allocation Procedure or Funding Policy on Future Expected Plan Contributions and Funded Status

Given the plan's contribution allocation procedure, if all actuarial assumptions are met (including the assumption of the plan earning 7.00% on the actuarial value of assets), it is expected that:

- 1) The unfunded actuarial accrued liabilities will be fully amortized after 16 years, based on the permanent funding policy;
- 2) The funded status of the plan will increase gradually towards a 100% funded ratio and then slightly exceed 100%; and
- 3) The unfunded accrued liability will follow the pattern shown on page A-5.

Limitations of Funded Status Measurements

Unless otherwise indicated, a funded status measurement presented in this report is based upon the actuarial accrued liability and the actuarial value of assets. Unless otherwise indicated, with regard to any funded status measurements presented in this report:

- 1) The measurement is inappropriate for assessing the sufficiency of plan assets to cover the estimated cost of settling the plan's benefit obligations, in other words, of transferring the obligations to an unrelated third party in an arm's length market value type transaction.
- 2) The measurement is dependent upon the actuarial cost method which, in combination with the plan's amortization policy, affects the timing and amounts of future contributions. A funded status measurement in this report of 100% is not synonymous with no required future contributions. If the funded status were 100%, the plan would still require future normal cost contributions (i.e., contributions to cover the cost of the active membership accruing an additional year of service credit).
- 3) The measurement would produce a different result if the market value of assets were used instead of the actuarial value of assets, unless the market value of assets is used in the measurement.

Limitations of Project Scope

Actuarial standards do not require the actuary to evaluate the ability of the plan sponsor or other contributing entity to make required contributions to the plan when due. Such an evaluation was not within the scope of this project and is not within the actuary's domain of expertise. Consequently, the actuary performed no such evaluation.

Risks to Future Employer Contribution Requirements

There are ongoing risks to future employer contribution requirements to which the Retirement System is exposed, such as:

- Actual and Assumed Investment Rate of Return
- Actual and Assumed Mortality Rates
- Amortization Policy



Summary of Key Valuation Results

				June 30, 2018		
				(2)	(3)	
		(1)		Portion	Actuarial	
		Actuarial		Covered By	Accrued	Actuarial
		Present	Future Normal		Liabilities	Accrued
Actuarial Present Value		Value	Cos	st Contributions	(1) - (2)	Liabilities
Active Members						
Service retirement benefits based on service rendered before and likely	ć	4 407 552 002	ć	254 522 002	¢ 4 222 040 004	¢ 4 000 040 700
to be rendered after valuation date	Ş	1,487,552,983	Ş	254,533,992	\$ 1,233,018,991	\$ 1,233,848,702
Disability benefits likely to be paid to present active members who become totally and permanently disabled*		29,618,797		17,802,274	11,816,523	11,909,894
					,,	
Survivor benefits likely to be paid to widows and children of present active members who die before retiring		16,095,943		5,482,423	10,613,520	10,600,860
present active members	_	55,967,578	-	31,282,013	24,685,565	27,164,423
Active Member Totals	\$	1,589,235,301	\$	309,100,702	\$ 1,280,134,599	\$ 1,283,523,879
Terminated Vested Members		100.826.491			100.826.491	99.889.190
Retired Lives		2.656.408.618			2.656.408.618	2.598.425.872
Total Actuarial Accrued Liability	\$	4,346,470,410	\$	309,100,702	\$ 4,037,369,708	\$ 3,981,838,941
Actuarial Value of Assets					2,415,343,431	2,274,248,122
Unfunded Actuarial Accrued Liability					\$ 1,622,026,277	\$ 1,707,590,819
Contribution Stabilization Reserve Fund					\$ 204,781,636	\$ 157,556,374
Total Amount Financed					\$ 1,826,807,913	\$ 1,865,147,193

* The amounts presented for this category represent liabilities for retirement benefits for active members that may become participants of the long-term disability plan until they reach normal retirement eligibility. These are not liabilities for active members currently on long-term disability.



7

Summary of Key Valuations Results – (Concluded)



The first chart, above, shows the Present Value of Future Benefits (PVFB) and the Actuarial Accrued Liability (AAL) at four different interest rates. Using an interest rate of 3.00%, we obtain a value of \$7.8 billion PVFB and \$6.6 billion AAL. This is akin to the cost (in uninflated or 2019 dollars) of all future expected benefit payments to current members of the System (PVFB) and the portion that is allocated to the post AAL.

Using an interest rate of 3.13%, the PVFB is \$7.7 billion and the AAL is \$6.5 billion. The 3.13% interest rate is shown as an estimate of the return that might be achieved with "risk free" investments (U.S. Treasuries and their "safe" fixed income securities) in a 2.25% inflationary environment. The difference between these first two measurements is an estimate of the value of pre-funding the System with little to no investment risk. (Note: this is intended to show the risk defeasement calculation that is expected to be required by actuarial standards, in the future). Also for comparison, using an interest rate of 4.00% we obtain a value of \$6.6 billion PVFB and \$5.7 billion AAL.

Using an investment return of 7.00% (the current valuation assumed investment return based on the current investment portfolio), the PVFB is \$4.4 billion and the AAL is \$4.0 billion. The difference between the 2nd and 3rd measures (3.13% interest and 7.00% interest) is the estimate of the reward the System expects to receive as a result of investing in a balanced portfolio instead of "risk free" securities.

The second chart shows the funded status (AAL/Actuarial Value of Assets) at each interest rate. This illustration was not intended to satisfy the recommended actuarial standards regarding solvency measures.



Expected Development of Present Populations as of June 30, 2019





The charts above show the expected future development of the present population in simplified terms. The Retirement System presently covers 7,421 active members. Eventually, 6% of the population is expected to terminate covered employment prior to retirement and forfeit eligibility for an employer provided benefit. Of the present population, 90% is expected to receive monthly retirement benefits either by retiring directly from active service, or by separating from service with a vested benefit, and 4% of the present population is expected to become eligible for death-in-service or disability benefits. Within 10 years, over half of the covered membership is expected to consist of new hires.



9

Historical Contribution Rates and Benefit Payouts



Computed Contribution Rates

Contribution Rates vs. Benefit Payout





Historical Contribution Rates and Benefit Payouts (Concluded)

Contribution Dollars vs. Benefit Payout Dollars (in Millions)





Historical Funded Ratios





The funded status shown herein is not appropriate to assess the sufficiency of plan assets to cover the estimated cost of settling the Plan's benefit obligations. A funded status below 100% is an indication that additional contributions will be needed in the future, if experience is exactly as assumed. However, a funded status at or above 100% (by itself) cannot be used to determine the need for future contributions.



SECTION A

VALUATION RESULTS

Computed Contributions to Support Benefits for Fiscal Year 2021 Contributions Computed as of June 30, 2019

	Non-Uniformed Employees		Ur				
	Closed			Closed			MPERS
Contributions for	& Year 2000	2011 Tier	Total	& Year 2000	2011 Tier	Total	Total
Normal Cost							
Age & service benefits	8.09%	6.29%	7.46%	16.37%	12.11%	15.39%	9.37%
Disability benefits #	0.64%	0.93%	0.74%	0.38%	0.29%	0.36%	0.65%
Survivor benefits	0.16%	0.22%	0.18%	0.25%	0.20%	0.24%	0.19%
Separation benefits	1.45%	1.23%	1.37%	0.74%	0.29%	0.64%	1.20%
Total Normal Cost	10.34%	8.67%	9.75%	17.74%	12.89%	16.63%	11.41%
Member Contributions	0.00%	4.00%	1.39%	0.00%	4.00%	0.92%	1.28%
Employer Normal Cost	10.34%	4.67%	8.36%	17.74%	8.89%	15.71%	10.13%
Unfunded Actuarial Accrued Liabilities*			47.96%			40.61%	46.19%
Expense Provision			1.15%			1.15%	1.15%
Subtotal			57.47%			57.47%	57.47%
Disability Insurance			0.53%			0.53%	0.53%
Total Contribution Rate			58.00%			58.00%	58.00%
Projected Dollar Contribution			\$ 168,945,903			\$ 52,136,864	\$ 221,082,767
Prior Year							
Total Contribution Rate			58.00%			58.00%	58.00%
Projected Dollar Contribution			\$ 164,613,400			\$ 51,670,163	\$ 216,283,563

Includes costs for benefits payable after conversion to normal retirement and/or benefits payable to survivors. Costs for disability benefits payable prior to conversion are shown under Disability Insurance which is outsourced.

* Amortized as a level-percentage of payroll over a 5-year amortization period for unfunded retiree liabilities and a 20-year amortization period for other unfunded liabilities from July 1, 2020 and then increased to achieve a 58% total employer contribution rate.



Development of Contribution Stabilization Reserve Fund as of June 30, 2019

	No	n-Uniformed			
	Employees		Uniformed Patrol		Total
Beginning of Year Contribution Stabilization Reserve Fund	\$	124,035,739	\$	33,520,635	\$ 157,556,374
Growth (to maintain contribution rate)		38,624,527		8,600,735	47,225,262
Reduction (to match contribution rate)		-		-	-
End of Year Contribution Stabilization Reserve Fund	\$	162,660,266	\$	42,121,370	\$ 204,781,636

At the September 25, 2014 Board meeting, the Board adopted the use of a contribution stabilization reserve fund that would result in an MPERS employer contribution of 58.00% of pay.

At the February 19, 2015 Board meeting, the Board adopted to cap the contribution stabilization reserve fund at \$250 million. Furthermore, the Board adopted a motion that if MPERS experienced a loss, MPERS would deplete the entire reserve fund if a loss of that magnitude were to be realized.

In order to determine the current amount of the contribution stabilization reserve fund for the separate groups, we determined the amount of growth needed to achieve a 58.00% contribution rate for each group.



Development of Liabilities as of June 30, 2019

Non-Uniformed	Uniformed	
Employees	Patrol	Total
\$1,931,987,733	\$ 701,824,017	\$2,633,811,750
19,311,650	3,285,218	22,596,868
85,751,230	15,075,261	100,826,491
2,037,050,613	720,184,496	2,757,235,109
944,870,451	542,682,532	1,487,552,983
26,237,206	3,381,591	29,618,797
11,268,523	4,827,420	16,095,943
51,225,926	4,741,652	55,967,578
1,033,602,106	555,633,195	1,589,235,301
3,070,652,719	1,275,817,691	4,346,470,410
185,875,328	123,225,374	309,100,702
2 004 777 201	1 152 502 217	4 027 260 709
2,004,777,331	1,132,392,317	4,037,309,708
1,707,964,662	707,378,769	2,415,343,431
1,176,812,729	445,213,548	1,622,026,277
162,660,266	42,121,370	204,781,636
1,339,472,995	487,334,918	1,826,807,913
\$ 139,700,785	\$ 36,504,794	\$ 176,205,579
47.96%	40.61%	46.19%
	Non-Uniformed Employees \$1,931,987,733 19,311,650 85,751,230 2,037,050,613 944,870,451 26,237,206 11,268,523 51,225,926 1,033,602,106 3,070,652,719 185,875,328 2,884,777,391 1,707,964,662 1,176,812,729 162,660,266 1,339,472,995 \$ 139,700,785 47.96%	Non-Uniformed EmployeesUniformed Patrol\$1,931,987,733\$ 701,824,01719,311,6503,285,21885,751,23015,075,2612,037,050,613720,184,496944,870,451542,682,53226,237,2063,381,59111,268,5234,827,42051,225,9264,741,6521,033,602,106555,633,1953,070,652,7191,275,817,691185,875,328123,225,3742,884,777,3911,152,592,3171,707,964,662707,378,7691,176,812,729445,213,548162,660,26642,121,3701,339,472,995487,334,918\$ 139,700,785\$ 36,504,79447.96%40.61%

* Amortized as a level-percentage of payroll over a 5-year amortization period for unfunded retiree liabilities and a 20-year amortization period for other unfunded liabilities from July 1, 2020 and then increased to achieve a 58% total employer contribution rate.



System Resources and Obligations Sources and Uses of \$4,346.5 Million as of June 30, 2019









Financing Unfunded Actuarial Accrued Liabilities (UAAL) Which Were Calculated Using a Wage Inflation Assumption of 3.00%* and an Investment Return Assumption of 7.00% Compounded Annually 5/20 Year Amortization*

Fiscal Year Ending June 30	Active Employee Payroll	Unfunded Actuarial Accrued Liability at End of Year	Annual UAAL Contributions During Fiscal Year Dollars % of Payroll		UAAL at Year End as % of Payroll
	i uyion		Donais	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	- ayron
2019	\$ 359,296,056	\$ 1,622,026,277			
2020	370,074,938	1,560,744,417	\$ 168,976,217	45.66%	421.7%
2021	381,177,186	1,487,837,967	176,065,742	46.19%	390.3%
2022	392,612,502	1,404,363,308	181,347,715	46.19%	357.7%
2023	404,390,877	1,309,416,724	186,788,146	46.19%	323.8%
2024	416,522,603	1,202,026,319	192,391,790	46.19%	288.6%
2025	429,018,281	1,081,147,098	198,163,544	46.19%	252.0%
2026	441,888,829	1,029,246,194	123,313,880	27.91%	232.9%
2027	455,145,494	969,884,790	127,013,297	27.91%	213.1%
2028	468,799,859	902,425,830	130,823,695	27.91%	192.5%
2029	482,863,855	826,184,216	134,748,406	27.91%	171.1%
2030	497,349,771	740,423,345	138,790,859	27.91%	148.9%
2031	512,270,264	644,351,401	142,954,584	27.91%	125.8%
2032	527,638,372	537,117,373	147,243,222	27.91%	101.8%
2033	543,467,523	417,806,804	151,660,519	27.91%	76.9%
2034	559,771,549	285,437,232	156,210,334	27.91%	51.0%
2035	576,564,695	138,953,309	160,896,644	27.91%	24.1%
2036	593,861,636	-22,778,425	165,723,544	27.91%	-3.8%
2037	611,677,485	-200,975,134	170,695,250	27.91%	-32.9%
2038	630,027,810	-250,000,000	33,787,382	5.36%	-39.7%
2039	648,928,644	-250,000,000	-16,914,662	-2.61%	-38.5%
2040	668,396,503	-250,000,000	-16,914,662	-2.53%	-37.4%

* Amortized as a level-percentage of payroll over a 5-year amortization period for unfunded retiree liabilities and a 20year amortization period for other unfunded liabilities from July 1, 2020 and then increased to achieve a 58% total employer contribution rate. Growth of the stabilization fund was capped at \$250 million. Payroll was assumed to increase 3.00%.



Projected Employer Contributions, 30 Years

Fiscal Year	Active	Annual Employe	r Contributions	
Ending	Employee	During Fiscal Year		
June 30	Payroll	Dollars	% of Payroll	
2019	\$ 359,296,056			
2020	370,074,938	\$ 212,682,067	57.47%	
2021	381,177,186	221,082,768	58.00%	
2022	392,612,502	227,715,251	58.00%	
2023	404,390,877	234,546,709	58.00%	
2024	416,522,603	241,583,110	58.00%	
2025	429,018,281	248,830,603	58.00%	
2026	441,888,829	175,500,951	39.72%	
2027	455,145,494	180,765,979	39.72%	
2028	468,799,859	186,188,959	39.72%	
2029	482,863,855	191,774,628	39.72%	
2030	497,349,771	197,527,867	39.72%	
2031	512,270,264	203,453,703	39.72%	
2032	527,638,372	209,557,314	39.72%	
2033	543,467,523	215,844,033	39.72%	
2034	559,771,549	222,319,354	39.72%	
2035	576,564,695	228,988,935	39.72%	
2036	593,861,636	235,858,603	39.72%	
2037	611,677,485	242,934,361	39.72%	
2038	630,027,810	108,193,666	17.17%	
2039	648,928,644	59,723,810	9.20%	
2040	668,396,503	62,022,965	9.28%	
2041	688,448,398	64,391,093	9.35%	
2042	709,101,850	66,830,266	9.42%	
2043	730,374,906	69,342,614	9.49%	
2044	752,286,153	71,930,332	9.56%	
2045	774,854,738	74,595,682	9.63%	
2046	798,100,380	77,340,992	9.69%	
2047	822,043,391	80,168,662	9.75%	
2048	846,704,693	83,081,162	9.81%	
2049	872,105,834	86,081,037	9.87%	



Projected Employer Contributions and Benefit Payment, 5 Years

Fiscal Year Ending	Projected Annual Employer Contributions During Fiscal Year	Projected Annual Benefit Payments During Fiscal Year *
June 30	Dollars	Dollars
2019		
2020	\$ 212,682,067	\$ 256,749,758
2021	221,082,768	263,477,132
2022	227,715,251	270,128,118
2023	234,546,709	277,596,631
2024	241,583,110	284,681,075

* Projected benefit payments include assumed backdrop elections, but does not include any other optional forms of payment elections (other than straight life)



Historical Funding Progress June 30, 2019

Year	Actuarial	Entry Age	Unfunded		Estimated	UAAL as a
Ending	Asset	Accrued	Accrued	Funded	Covered	Percentage of
June 30	Value	Liability	Liability (UAAL)	Ratio	Payroll**	Covered Payroll
2010#	\$ 1,375,844,573	\$ 3,258,866,925	\$ 1,883,022,352	42.22%	\$ 378,063,006	498.07%
2011	1,427,290,718	3,297,589,869	1,870,299,151	43.28%	362,654,376	515.72%
2012#	1,531,033,613	3,306,278,671	1,775,245,058	46.31%	341,637,559	519.63%
2013#	1,657,402,393	3,583,975,559	1,926,573,166	46.24%	329,481,506	584.73%
2014	1,795,264,291	3,650,241,741	1,854,977,450	49.18%	336,590,797	551.11%
2015	1,967,001,509	3,715,845,651	1,748,844,142	52.94%	342,264,593	510.96%
2016	2,086,654,348	3,761,733,004	1,675,078,656	55.47%	344,275,147	486.55%
2017	2,172,787,144	3,802,443,730	1,629,656,586	57.14%	356,142,973	457.58%
2018#	2,274,248,122	3,981,838,941	1,707,590,819	57.12%	353,371,000	483.23%
2019	2,415,343,431	4,037,369,708	1,622,026,277	59.82%	362,356,771	447.63%

** Values are estimated from contribution rate and amount.

New assumptions and/or methods adopted.



Historical Employer Contributions Non-Uniformed Group ^{##}

June 30, 2019

	Fiscal Year	Estimated	Actual	Actual	Annually Determined	Annually Determined	Percentage
Valuation	Ending	Covered	Employer	Employer	Employer Contribution	Employer Contribution	of ADEC
Date	June 30,	Payroll**	Contributions	Contribution %	(ADEC) %	(ADEC) \$	Contributed
June 30, 2007	2009	\$ 311,718,239	\$ 95,759,843	30.72%	30.72%	\$ 95,759,843	100.00%
June 30, 2008	2010#	310,637,016	97,540,023	31.40%	31.40%	97,540,023	100.00%
June 30, 2009	2011	294,637,164	116,263,825	39.46%	39.46%	116,263,825	100.00%
June 30, 2010	2012#	268,722,565	122,134,406	45.45%	45.45%	122,134,406	100.00%
June 30, 2011	2013	254,928,368	129,809,525	50.92%	50.92%	129,809,525	100.00%
June 30, 2012	2014#	259,720,022	140,898,112	54.25%	54.25%	140,898,112	100.00%
June 30, 2013	2015	258,737,537	152,034,177	58.76%	58.76%	152,034,177	100.00%
June 30, 2014	2016	260,714,141	151,344,559	58.05%	58.05%	151,344,559	100.00%
June 30, 2015	2017	269,522,202	156,322,877	58.00%	58.00%	156,322,877	100.00%
June 30, 2016	2018#	269,229,112	156,152,885	58.00%	58.00%	156,152,885	100.00%
June 30, 2017	2019	276,575,119	160,413,569	58.00%	58.00%	160,413,569	100.00%

** Values are estimated from contribution rate and amount.

New assumptions and/or methods adopted.

Includes non-uniformed employees of MoDOT, Patrol, and MPERS.

This information is presented in draft form for review by the System's auditor. Please let us know if there are any items that the auditor changes so that we may maintain consistency with the System's financial statements.



Historical Employer Contributions Uniformed Patrol Group June 30, 2019

	Fiscal Year	Estimated	Actual	Actual	Annually Determined	Annually Determined	Percentage
Valuation	Ending	Covered	Employer	Employer	Employer Contribution	Employer Contribution	of ADEC
Date	June 30,	Payroll**	Contributions	Contribution %	(ADEC) %	(ADEC) \$	Contributed
June 30, 2007	2009	\$ 67,872,034	\$ 27,298,132	40.22%	40.22%	\$ 27,298,132	100.00%
June 30, 2008	2010#	67,425,990	26,936,683	39.95%	39.95%	26,936,683	100.00%
June 30, 2009	2011	68,017,212	33,688,925	49.53%	49.53%	33,688,925	100.00%
June 30, 2010	2012#	72,914,994	42,750,061	58.63%	58.63%	42,750,061	100.00%
June 30, 2011	2013	74,553,138	41,026,592	55.03%	55.03%	41,026,592	100.00%
June 30, 2012	2014#	76,870,775	42,455,729	55.23%	55.23%	42,455,729	100.00%
June 30, 2013	2015	83,527,056	48,604,394	58.19%	58.19%	48,604,394	100.00%
June 30, 2014	2016	83,561,006	48,264,837	57.76%	57.76%	48,264,837	100.00%
June 30, 2015	2017	86,620,771	50,240,047	58.00%	58.00%	50,240,047	100.00%
June 30, 2016	2018#	84,141,888	48,802,295	58.00%	58.00%	48,802,295	100.00%
June 30, 2017	2019	85,781,652	49,753,358	58.00%	58.00%	49,753,358	100.00%

** Values are estimated from contribution rate and amount.

New assumptions and/or methods adopted.

This information is presented in draft form for review by the System's auditor. Please let us know if there are any items that the auditor changes so that we may maintain consistency with the System's financial statements.



Development of Gain/(Loss) July 1, 2018 to June 30, 2019

	UAAL =	AAL -	Assets
Beginning of Year Values (at July 1)	\$ 1,707,590,819	\$ 3,981,838,941	\$ 2,274,248,122
Normal Cost	48,532,753	48,532,753	0
Contributions	(218,595,641)	0	218,595,641
Disbursements	0	(264,190,777)	(264,190,777)
Interest	113,579,156	271,180,695	157,601,539
Expected Value Before Any Changes	1,651,107,087	4,037,361,612	2,386,254,525
Effect of Benefit Changes	0	0	0
Effect of Changes in Assumptions & Methods	0	0	0
Effect of Adjustment	0	0	0
Expected Value After Changes	1,651,107,087	4,037,361,612	2,386,254,525
End of Year Values (at June 30)	1,622,026,277	4,037,369,708	2,415,343,431
Γ			
Gain/(Loss) for Year	\$ 29,080,810	\$ (8,096)	\$ 29,088,906



Development of Gain/(Loss) July 1, 2018 to June 30, 2019

	Total		Non-Uniformed	Uniformed
Beginning of Year UAAL (at July 1)	\$ 1,707,590,819	\$	1,247,028,653	\$ 460,562,166
Normal Cost	48,532,753		32,211,762	16,320,991
Contributions	(218,595,641)		(166,970,140)	(51,625,501)
Interest	113,579,156		82,575,462	31,003,694
Net Change in LTD Assets	0		0	0
Expected Value Before Any Changes	1,651,107,087		1,194,845,737	456,261,350
Effect of Benefit Changes	0		0	0
Effect of Changes in Assumptions & Methods	0		0	0
Effect of Adjustment	0		0	0
Expected Value After Changes	1,651,107,087		1,194,845,737	456,261,350
End of Year UAAL (at June 30)	1,622,026,277		1,176,812,729	445,213,548
		<u> </u>		
Aggregate Gain/(Loss) for Year	\$ 29,080,810	\$	18,033,008	\$ 11,047,802
Gain/(Loss) as a % of Beginning of Year Liabilities	0.73%		0.63%	0.98%
Г				
Asset Gain/(Loss) for Year	\$ 29,088,906	\$	20,610,298	\$ 8,478,608
Liability Gain/(Loss) for Year	(8,096)		(2,577,290)	2,569,194
Aggregate Gain/(Loss) for Year	\$ 29,080,810	\$	18,033,008	\$ 11,047,802



Risk Measures

Plan Maturity Measures: Risks facing a pension plan evolve over time. A young plan with virtually no investments and paying few benefits may experience little investment risk. An older plan with a large number of members in pay status and a significant trust may be much more exposed to investment risk. Generally accepted plan maturity measures include the following:

	<u>2019</u>	<u>2018</u>
Ratio of the market value of assets to total payroll	6.74	6.58
Ratio of actives to retirees and beneficiaries	1.22	1.21
Duration of the actuarial liability	11.52	11.70

Ratio of Market Value of Assets to Payroll: The relationship between assets and payroll is a useful indicator of the potential volatility of contributions. For example, if the market value of assets is 2.0 times the payroll, a return on assets 5% different than assumed would equal 10% of payroll. A higher (lower) or increasing (decreasing) level of this maturity measure generally indicates a higher (lower) or increasing (decreasing) level of payroll.

Ratio of Actives to Retirees and Beneficiaries: A young plan with many active members and few retirees will have a high ratio of active to retirees. A mature open plan may have close to the same number of actives to retirees resulting in a ratio near 1.0. A super-mature or closed plan may have significantly more retirees than actives resulting in a ratio below 1.0.

Duration of Actuarial Liability: The duration of the actuarial liability may be used to approximate the sensitivity to a 1% change in the assumed rate of return. For example, a duration of 10 indicates that the liability would increase approximately 10% if the assumed rate of return were lowered 1%.

Additional Risk Assessment: Additional risk assessment is outside the scope of the annual actuarial valuation. Additional assessment may include scenario tests, sensitivity tests, stochastic modeling, stress tests, and a comparison of the present value of accrued benefits at low-risk discount rates with the actuarial accrued liability.

A table of additional historical risk measures is shown on the next page



Risk Measures

(\$ Thousands)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Valuation Date	Accrued Liabilities	Market Value of	Unfunded AAL	Valuation	Funded Ratio	Liability/ Payroll	Assets/ Payroll	Unfunded/ Payroll	Portfolio Rate of	10-Year Trailing	Non-Investment	Non-Investment Net Cash Flow Percent of Beginning of Year Assets
June 30	(AAL)	Assets	(1)-(2)	Payroll	(2)/(1)	(1)/(4)	(2)/(4)	(3)/(4)	Return	Average	Net Cash Flow	(11)/(2[Prior Year])
2016	\$ 3,761,733	\$ 1,992,074	\$ 1,769,659	\$ 339,799	53.0%	1,107.0%	586.2%	520.8%	1.1%	N/A	\$ (38,725)	(1.9)%
2017	3,802,444	2,169,775	1,632,669	348,979	57.1%	1,089.6%	621.8%	467.8%	11.2%	N/A	(42,601)	(2.1)%
2018	3,981,839	2,314,530	1,667,309	351,497	58.1%	1,132.8%	658.5%	474.3%	9.2%	N/A	(51,928)	(2.4)%
2019	4,037,370	2,423,262	1,614,108	359,296	60.0%	1,123.7%	674.5%	449.2%	6.7%	N/A	(45,595)	(2.0)%

(5) The funded ratio is the most widely known measure of a plan's financial strength, but the trend in the funded ratio is much more important than the absolute ratio. The funded ratio should trend to 100%. As it approaches 100%, it is important to re-evaluate the level of investment risk in the portfolio and potentially to re-evaluate the assumed rate of return.

(6) and (7) the ratio of liabilities and assets to payroll gives an indication of both maturity and volatility. Many systems have values between 500% and 700%. Values significantly above that range may indicate difficulty in supporting the benefit level as a level % of payroll.

(8) The ratio of unfunded liability to payroll gives an indication of the plan's sensitivity to differences between assumed and actual experience related to the employer contributions. A value above approximately 300% or 400% may indicate high volatility relative to small gains and losses.

(9) and (10) Investment return is probably the largest single risk that most systems face. The year-by-year return and the 10-year geometric average give an indicator of the realism of the System's assumed return.

(11 and 12) Non-Divestment Net Cash Flow is a measure of both risk and maturity. For a mature plan the absolute value of (12) should be in the order of the assumed real rate of return over wage inflation (currently assumed to be 4.00%). A more negative number indicates a plan that is more at risk of fund depletion and more sensitive to annual gains and losses.



SECTION B

SUMMARY OF BENEFITS

Missouri Department of Transportation and Highway Patrol Employees' Retirement System Summary of Benefit Provisions Evaluated as of June 30, 2019

Closed Plan	Year 2000 Plan	2011 Tier			
Participation	Participation	Participation			
Participants include: All MPERS active members, vested terminated members, disability recipients, retirees and survivors who first became members prior to July 1, 2000 and who do not elect to transfer to the Year 2000 Plan at retirement.	 Participants include: All active employees who first became members on or after July 1, 2000 but prior to January 1, 2011. Closed Plan active members and vested former members who elect to transfer to the Year 2000 Plan at retirement. Closed Plan retirees who elected to transfer to the Year 2000 Plan during the election window from July 1, 2000 through July 1, 2001 and the in survivors 	 Participants include: 1. All employees who first become members on or after January 1, 2011. 			
	 Closed Plan members who left state employment prior to becoming vested (not eligible for a future retirement benefit) and return to work in a benefit eligible position on or after July 1, 2000. 				



Closed Plan	Year 2000 Plan	2011 Tier		
Normal Retirement Eligibility (unreduced benefit)	Normal Retirement Eligibility (unreduced benefit)	Normal Retirement Eligibility (unreduced benefit)		
 Non-Uniformed Employees: The earlier of attaining: Age 65 with at least 4 years of creditable service. Age 60 with at least 15 years of creditable service. Age 48 with age plus creditable service equal to 80 or more. Age 65 with at least 5 years of service (deferred).* 	 Non-Uniformed Employees: The earlier of attaining: 1. Age 62 with at least 5 years of creditable service. 2. Age 48 with age plus creditable service equal to 80 or more. 	 Non-Uniformed Employees: The earlier of attaining: 1. Age 67 with at least 5 years of creditable service. 2. Age 55 with age plus creditable service equal to 90 or more. 		
 Uniformed Patrol Employees Only: The earlier of attaining: 1. Age 55 with at least 4 years of creditable service. 2. Mandatory retirement at age 60. 3. Age 48 with age plus creditable service equal to 80 or more. 	 Uniformed Patrol Employees Only: The earlier of attaining: 1. Mandatory retirement at age 60. 2. Age 48 with age plus creditable service equal to 80 or more. 	 Uniformed Patrol Employees Only: The earlier of attaining: 1. Age 55 with at least 5 years of creditable service. 2. Mandatory retirement at age 60. 		
Final Average Pay Used for Benefit Determination Final Average Pay is the average annual pay of a member for the three consecutive years of service during which pay was highest (overtime pay is included for purposes of determining average pay). Employees terminating after reaching retirement eligibility will receive 1/12 of a year of creditable service for every 168 hours of unused sick leave (usable only for benefit computation, not eligibility).	Final Average Pay Used for Benefit Determination Final Average Pay is the average annual pay of a member for the three consecutive years of service during which pay was highest (overtime pay is included for purposes of determining average pay). All vested members will receive 1/12 of a year of creditable service for every 168 hours of unused sick leave (usable only for benefit computation, not eligibility).	Final Average Pay Used for Benefit Determination Final Average Pay is the average annual pay of a member for the three consecutive years of service during which pay was highest (overtime pay is included for purposes of determining average pay). Employees terminating after reaching retirement eligibility will receive 1/12 of a year of creditable service for every 168 hours of unused sick leave (usable only for benefit computation, not eligibility).		
*See Chapter 104.010.1(32) RSMo				



Closed Plan		Year 2000 Plan	2011 Tier	
Normal Retire Non-Uniforme Life Benefit: Uniformed Pa Life Benefit: Special Benefi	ement Benefit Amount ed Employees: 1.6% of final average pay times years of creditable service. trol Employees: 2.1333% of final average pay times years of creditable service. t: \$90 per month payable until age 65. Offset by any amount earned from gainful employment. This benefit does not apply to uniformed members hired on or after January 1 1995	Normal Retirement Benefit Amount All Employees: Life Benefit: 1.7% of final average pay times years of creditable service. Temporary Benefit: If member retires between ages 48 and 62 with age plus creditable service equal to 80 or more, a temporary benefit is payable in the amount of 0.8% of final average pay times years of creditable service until attainment of age 62 or death, whichever occurs first. All Uniformed Patrol members are eligible for the temporary benefit until age 62.	Normal Retirement Benefit Amount All Employees: Life Benefit: 1.7% of final average pay times years of creditable service. Temporary Benefit: If member retires between ages 55 and 62 with age plus creditable service equal to 90 or more, a temporary benefit is payable in the amount of 0.8% of final average pay times years of creditable service until attainment of age 62 or death, whichever occurs first. All Uniformed Patrol members are eligible for the temporary benefit until age 62.	
Early Retirement (reduced benefit)		Early Retirement (reduced benefit)	Early Retirement (reduced benefit)	
<i>Eligibility: Not</i> Age 55 with at <i>Amount:</i> Normal retires each month th for normal ret <i>Uniformed Pa</i> early retireme	n-Uniformed Employees t least 10 years of creditable service. ment amount reduced by 0.6% for nat retirement precedes eligibility cirement. Htrol members are not eligible for ent.	<i>Eligibility: All Employees</i> Age 57 with at least 5 years of creditable service. <i>Amount:</i> Normal retirement amount reduced by 0.5% for each month that retirement precedes eligibility for normal retirement.	<i>Eligibility: All Active Non-Uniformed Employees</i> Age 62 with at least 5 years of creditable service. <i>Amount:</i> Normal retirement amount reduced by 0.5% for each month that retirement precedes eligibility for normal retirement. <i>Uniformed Patrol</i> members are not eligible for early retirement.	



Closed Plan	Year 2000 Plan	2011 Tier
Vested Deferred Benefits	Vested Deferred Benefits	Vested Deferred Benefits
<i>Eligibility: All Employees</i> Fully vested in accrued pension with 5 years of creditable service. The benefit will commence at the age the individual is eligible for early or normal retirement, considering years of creditable service. Minimum Base Benefit	<i>Eligibility: All Employees</i> Fully vested in accrued pension with 5 years of creditable service. The benefit will commence at the age the individual is eligible for early or normal retirement considering years of creditable service. Normal retirement eligibility begins at age 62. Minimum Base Benefit	<i>Eligibility: All Employees</i> Fully vested in accrued pension with 5 years of creditable service. The benefit will commence at the age the individual is eligible for normal retirement considering years of creditable service. Normal retirement eligibility begins at age 67. Minimum Base Benefit
Receive a monthly base benefit of no less than \$15 for each full year of creditable service. Must be eligible to receive a normal or early retirement benefit the first of the month immediately following the date you leave state employment. Not required to immediately start drawing a benefit.	Same.	Same.
Death Prior to Retirement	Death Prior to Retirement	Death Prior to Retirement

The spouse of the member who dies after accruing 5 years of creditable service may elect to receive an annuity as if the employee had retired on the date of death and elected a joint and 100% survivor annuity.

If no eligible spouse survives or upon the death of the spouse, 80% of the member's accrued annuity will be paid to eligible children until age 21.

If the member has 3 or more, but less than 5 years of creditable service, the surviving spouse may elect to receive an annuity equal to 25% of the accrued benefit.

If the death is duty-related, there is no service requirement and the minimum annuity is 50% of the final average pay (FAP) to the surviving spouse or eligible children.

The spouse of the member who dies after accruing 5 years of creditable service may elect to receive an annuity as if the employee had retired on the date of death and elected a joint and 100% survivor annuity.

If no eligible spouse survives or upon the death of the spouse, 80% of the member's accrued annuity will be paid to eligible children until age 21.

If the death is duty related, there is no service requirement and the minimum annuity is 50% of the final average pay (FAP) to the surviving spouse or eligible children.

Actives: The spouse of the member who dies after accruing 5 years of creditable service may elect to receive an annuity as if the employee had retired on the date of death and elected a joint and 100% survivor annuity. Deferred: The spouse of a vested former member who dies after accruing 5 years of creditable service may elect to receive an annuity on the date the member would have attained normal retirement eligibility based on a joint and 100% survivor annuity election.

If no eligible spouse survives or upon the death of the spouse, 80% of the member's accrued annuity will be paid to eligible children until age 21.

If the death is duty related, there is no service requirement and the minimum annuity is 50% of the final average pay (FAP) to the surviving spouse or eligible children.


Closed Plan	Year 2000 Plan	2011 Tier
Death After Retirement	Death After Retirement	Death After Retirement
The benefit payable is 50% of the benefit the retired member was receiving on the date of death (the normal form of payment), or the benefit payable under the joint and survivor or period certain form of payment, if the member elected an optional form of payment at time of retirement.	The benefit payable under the joint and survivor or period certain form of payment, if the member elected an optional form of payment at time of retirement.	The benefit payable under the joint and survivor or period certain form of payment, if the member elected an optional form of payment at time of retirement.
A member who is not married at retirement but marries thereafter may designate a spouse as beneficiary. Additionally, a member may designate a new spouse as beneficiary in the event of the death of the spouse the member was married to at the date of retirement. The election must be completed within one year of the date of marriage.	 A member who is not married at retirement but marries thereafter may designate a spouse as beneficiary. Additionally, a member may designate a new spouse as beneficiary in the event of the death of the spouse the member was married to at the date of retirement. The election must be completed within one year of the date of marriage. For period certain annuities, beneficiaries may be changed at any time. 	A member who is not married at retirement but marries thereafter may designate a spouse as beneficiary. Additionally, a member may designate a new spouse as beneficiary in the event of the death of the spouse the member was married to at the date of retirement. The election must be completed within one year of the date of marriage. For period certain annuities, beneficiaries may be
For period certain annuities, beneficiaries may be changed at any time.		changed at any time.
Pop-Up Provision	Pop-Up Provision	Pop-Up Provision
Benefits to members who choose a reduced survivor form of payment and whose spouse precedes the member in death, will "pop-up" or revert to the amount the member would have	Same.	Same.



survivor option.

received had he/she not elected a reduced

Closed Plan	Year 2000 Plan	2011 Tier	
\$5,000 Death Benefit	\$5,000 Death Benefit	\$5,000 Death Benefit	
MPERS provides a \$5,000 death benefit for a designated beneficiary(ies) of members who retire from service or were approved for normal or work-related disability benefits after September 28, 1985. Members who die while on terminated vested status or long-term disability status do not qualify for this benefit. Long-term disability recipients who retire on or after September 28, 1985 are eligible to receive this benefit.	MPERS provides a \$5,000 death benefit for a designated beneficiary(ies) of members who retire from service or were approved for work-related disability benefits. Members who die while on terminated vested status or long-term disability status do not qualify for this benefit. Long-term disability recipients who retire are eligible to receive this benefit.	MPERS provides a \$5,000 death benefit for a designated beneficiary(ies) of members who retire from service or were approved for work-related disability benefits. Members who die while on terminated vested status or long-term disability status do not qualify for this benefit. Long-term disability recipients who retire are eligible to receive this benefit.	
Purchase of Service Military: Prior to retirement, qualifying members may purchase up to a maximum of 4 years military service that includes active service, and/or active and inactive duty training from which they were honorably discharged. All months the member is eligible for must be purchased. This service credit <u>can</u> be used to satisfy the vesting requirement. Periods of military service cannot coincide with employment in a state agency.	Purchase of Service Military: Prior to retirement, qualifying members may purchase up to a maximum of 4 years military service that includes active service from which they were honorably discharged. All months the member is eligible for must be purchased. This service credit <u>cannot</u> be used to satisfy the vesting requirement. Periods of military service cannot coincide with employment in a state agency.	Purchase of Service Military: Not available.	
Police Service: Prior to retirement, uniformed patrol members only, may purchase up to a maximum of 4 years police service. Members must purchase all months of service they are eligible for.	Police Service: Not available.	Police Service: Not available.	



Year 2000 Plan	2011 Tier
Portability: Same as Closed Plan Section 105.691.	Portability: Same as Closed Plan Section 105.691.
Public Employment Prior Service (Subsidized Purchase)	Public Employment Prior Service (Subsidized Purchase)
Not available.	Not available.
Disability	Disability
Benefits that may be payable during the period of disability (whether Normal, Work-related, or LTD) are administered through a separate program and were not considered for purposes of the valuation.	Benefits that may be payable during the period of disability (whether Normal, Work-related, or LTD) are administered through a separate program and were not considered for purposes of the valuation.
Normal retirement benefits become payable at the time a disabled member becomes eligible for normal retirement, and are computed based on: i) the service that would have accrued to the member if active employment had continued; and ii) the member's rate of pay at the time of disability increased by 80% of CPI to the retirement	Normal retirement benefits become payable at the time a disabled member becomes eligible for normal retirement, and are computed based on: i) the service that would have accrued to the member if active employment had continued; and ii) the member's rate of pay at the time of disability increased by 80% of CPI to the retirement date.
	Year 2000 Plan Portability: Same as Closed Plan Section 105.691. Public Employment Prior Service (Subsidized Purchase) Not available. Disability Benefits that may be payable during the period of disability (whether Normal, Work-related, or LTD) are administered through a separate program and were not considered for purposes of the valuation. Normal retirement benefits become payable at the time a disabled member becomes eligible for normal retirement, and are computed based on: i) the service that would have accrued to the member if active employment had continued; and ii) the member's rate of pay at the time of disability is proceed by 0% of CPU to the retirement

Closed Plan	Year 2000 Plan	2011 Tier
Post-Retirement Benefit Adjustments	Post-Retirement Benefit Adjustments	Post-Retirement Benefit Adjustments
For active and inactive employees hired prior to August 28, 1997 and current retirees, the benefits of pensioners and their beneficiaries are increased annually by 80% of the increase in the Consumer	Benefits are increased to retired members (including survivors) annually in accordance with the following:	Benefits are increased to retired members (including survivors) annually* in accordance with the following:
Price Index (subject to a maximum increase of 5% and a minimum of 4%). These increases are made until the total of the increases reaches 65% of initial benefit at which time the increases will have the minimum removed.	 Annual benefit percentage increase equal to the lesser of: i) 80% of the CPI-U increase, or ii) 5%. 	 Annual benefit percentage increase equal to the lesser of: i) 80% of the CPI-U increase, or ii) 5%.
 For employees hired on or after August 28, 1997 the annual percentage increase is equal to the lesser of: i) 80% of the CPI-U increase, or ii) 5%. 		increased beginning on the second anniversary of retirement.

Member Contributions Member Contributions		Member Contributions	
None.	None.	4% contributions with interest credited annually at	
		a rate equal to the investment rate published by the US Department of Treasury for 52-week treasury bill, nearest the preceding July 1st. The state of Missouri employer shall pick up and pay the contributions. A deduction shall be made from each member's compensation equal to the amount of the member's contributions picked up by the	
		each member's compensation eq of the member's contributions pio employer.	



The Closed Plan and Year 2000 Plan BackDROP Option

Legislation effective January 1, 2002 provides a Deferred Retirement Option Provision (BackDROP) to members of MPERS. It is available in both the Closed Plan and the Year 2000 Plan.

To be eligible to participate in the BackDROP, a member must have been eligible to retire under normal age and/or service conditions for at least two years. A retroactive starting date is established for BackDROP purposes which is the later of: 1) the member's normal retirement date; or 2) five years prior to the annuity starting date under the retirement plan selected by the member.

The BackDROP period for the accumulation of the BackDROP amount is from the retroactive starting date to the annuity starting date. This results in a BackDROP period of one to five years depending upon the individual situation.

A theoretical BackDROP account is accumulated that includes 90% of the value of the benefit payments that would have been paid during the BackDROP period had the member retired at the retroactive starting date. These payments include applicable post-retirement benefit increases. These payments do not include any reduction for spouse options during the BackDROP period. The member may choose the BackDROP period in twelve-month increments or their maximum period, not to exceed 60 months.

The member is paid the resulting lump sum value of the BackDROP account as of the annuity starting date or as three equal annual installments beginning at the annuity starting date.

The annuity benefit payable from the actual retirement date is computed with years of service and final average pay as of the retroactive starting date for the BackDROP. Post-retirement benefit increases that occurred during the BackDROP period are applied in the calculation of the monthly annuity.



Sample Benefit Computation for Closed Plan Members Retiring July 1, 2019 Non-Uniformed Employee

	Data	Description
A.	\$40,000	Final Average Pay
В.	20	Years of Creditable Service
C.	60	Age of Retiree
D.	50%	Automatic percentage to continue to spouse after retirant's death
Sa	mple Computation Steps	
E. Re	etirement Benefit Formula:	0.016 x 20 x \$40,000 = \$12,800
Ве	enefit payable to:	
F. Re	etiree while spouse is alive (E)	\$ 12,800

F. Retiree while spouse is alive (E)G. Spouse after retiree's death (D x E)

H. Retiree after spouse's death

Year Ended June 30	Annual Amount Payable if Price Inflation is 2.25% and Post-Retirement Increases are 1.8%
2019	\$12,800
2020	13,030
2021	13,265
2022	13,504
2023	13,747
2024	13,994
2025	14,246
2026	14,503
2027	14,764
2028	15,029

\$ 6,400 \$ 12,800



Sample Benefit Computation for Closed Plan Members Retiring July 1, 2019 Uniformed Patrol

	Data	Description
A.	\$40,000	Final Average Pay
В.	20	Years of Creditable Service
C.	60	Age of Retiree
D.	50%	Automatic percentage to continue to spouse after retirant's death
	Sample Computation Steps	
E.	Retirement Benefit Formula:	0.021333 x 20 x \$40,000 = \$17,066
	Benefit payable to:	
F. G. H.	Retiree while spouse is alive (E) Spouse after retiree's death (D x E) Retiree after spouse's death	\$ 17,066 \$ 8,533 \$ 17,066

Amounts shown below do not include the \$1,080 annual supplementary benefit payable to age 65.

Year Ended June 30	Annual Amount Payable if Price Inflation is 2.25% and Post-Retirement Increases are 1.8%
2019	\$17,066
2020	17,373
2021	17,686
2022	18,004
2023	18,328
2024	18,658
2025	18,994
2026	19,336
2027	19,684
2028	20,038



Sample Benefit Computation for Year 2000 Plan Members Retiring July 1, 2019

	Data	Description
A.	\$40,000	Final Average Pay
В.	20	Years of Creditable Service
C.	60 (67 for 2011 Tier)	Age of Retiree
D.	0%	Automatic percentage to continue to spouse after retirant's death
E1.	Retirement Benefit Formula:	0.017 x 20 x \$40,000 = \$13,600
E2. Supplemental Benefit Formula:		.008 x 20 x \$40,000 = \$6,400
	Benefit payable to:	
F1.	Retiree prior to age 62 (E1+E2)	\$ 20,000
F2.	Retiree after age 62 (E1)	\$ 13,600
G.	Spouse after retiree's death (D x E)	\$ 0

Year Ended June 30	Annual Amount Payable if Price Inflation is 2.25% and Post-Retirement Increases are 1.8%
2019	\$20,000
2020	20,360
2021	14,094
2022	14,348
2023	14,606
2024	14,869
2025	15,137
2026	15,409
2027	15,686
2028	15,969



SECTION C

FINANCIAL INFORMATION

Summary of Fund Operations

_	2019	2018
Market Value of Fund Beginning of Fiscal Year	\$2,314,530,148	\$2,169,775,040
Post Valuation Audit Adjustment	0	(936,419)
Contributions		
Employer	210,166,927	204,955,180
Employee	4,449,428	3,721,984
Transfer from MOSERS	2,460,905	1,922,187
Service Purchase (Employee)	1,518,381	1,224,692
Total Contributions	\$ 218,595,641	\$ 211,824,043
Investment Return		
Interest	\$ 31,016,755	\$ 25,440,798
Dividends	10,150,262	8,046,447
Real Estate	33,464,850	37,238,083
Realized Capital Gains	355,939,616	320,023,862
Realized Capital Losses	(260,796,855)	(207,190,689)
Miscellaneous Income	0	11,007
Securities Lending Income	166,774	192,433
Other	0	1,424
Total Investment Return	\$ 169,941,402	\$ 183,763,365
Other Income (Rental Income and Misc)	307	472
Increase (Decrease) in Unrealized Appreciation	19,036,291	44,342,908
Benefit Payments		
Retirement Payments	\$ 239,029,540	\$ 238,675,488
Retirement Payments - BackDROP	15,424,880	14,546,108
Death Benefits	820,000	860,000
Long-Term Disability Payments	35,987	49,613
Insured Disability Program	1,615,860	1,601,605
Employee Contribution Refunds	780,538	503,007
Service Transfer Payments - Employer	2,111,007	2,823,042
Total Benefit Payments	\$ 259,817,811	\$ 259,058,863
Expenses		
Investment	\$ 34,651,182	\$ 30,486,906
Other	4,372,966	4,693,492
Total Expenses	\$ 39,024,148	\$ 35,180,398
Market Value of Fund End of Fiscal Year	\$2,423,261,830	\$2,314,530,148



Missouri MPERS Development of Actuarial Value of Assets

	Valuation Date of June 30	2015	2016	2017	2018	2019	2020	2021
А.	Actuarial value at beginning of year	\$1,795,264,291	\$1,967,001,509	\$2,086,654,348	\$2,172,787,144	\$2,274,248,122		
в.	Market value at end of year	2,009,367,134	1,992,073,946	2,169,775,040	2,314,530,148	2,423,261,830		
c.	Market value at beginning of year	1,937,268,639	2,009,367,134	1,992,073,946	2,169,775,040	2,314,530,148		
D.	Cash flow							
	D1. Contributions	205,047,170	205,821,588	213,198,963	211,824,043	218,595,641		
	D2. Benefit Payments	(241,714,875)	(240,176,011)	(251,284,152)	(259,058,863)	(259,817,811)		
	D3. Administrative Expenses	(4,066,944)	(4,370,860)	(4,515,458)	(4,693,492)	(4,372,966)		
	D4. Non-Investment Net Cash Flow	(40,734,649)	(38,725,283)	(42,600,647)	(51,928,312)	(45,595,136)		
Ε.	Investment income							
	E1. Market total (B - C - D4)	112,833,144	21,432,095	220,301,741	196,683,420	154,326,818		
	E2. Assumed Rate of Return	7.75%	7.75%	7.75%	7.75%	7.00%		
	E3. Amount for Immediate Recognition (A+.5xD4)xE2	137,554,515	150,942,012	160,064,937	166,378,782	157,601,539		
	E4. Amount for Phased-In Recognition	(24,721,371)	(129,509,917)	60,236,804	30,304,638	(3,274,721)		
F.	Phased in recognition of investment income							
	F1. Current Year (33 1/3% of E4)	(8,240,457)	(43,169,972)	20,078,935	10,101,546	(1,091,574)		
	F2. First Prior Year	58,846,539	(8,240,457)	(43,169,972)	20,078,935	10,101,546	\$ (1,091,574)	
	F3. Second Prior Year	24,311,270	58,846,539	(8,240,457)	(43,169,973)	20,078,934	10,101,546	\$(1,091,573)
	F4. Total Recognized Investment Gain (F1 + F2 + F3)	74,917,352	7,436,110	(31,331,494)	(12,989,492)	29,088,906	9,009,972	(1,091,573)
G.	Actuarial value at end of year (A + D4 + E3 + F4)	1,967,001,509	2,086,654,348	2,172,787,144	2,274,248,122	2,415,343,431		
	Less LTD Assets	0	0	0	0	0		
н.	Preliminary Plan AVA	1,967,001,509	2,086,654,348	2,172,787,144	2,274,248,122	2,415,343,431		
١.	Corridor (Maximum of 120% of Market Value)	2,411,240,561	2,390,488,735	2,603,730,048	2,777,436,178	2,907,914,196		
J.	Corridor Minimum of 80% of Market Value)	1,607,493,707	1,593,659,157	1,735,820,032	1,851,624,118	1,938,609,464		
к.	Additional Investment Gain/(Loss) recognized							
	due to corridor	0	0	0	0	0		
L.	Final Plan AVA after corridor adjustment, if any	1,967,001,509	2,086,654,348	2,172,787,144	2,274,248,122	2,415,343,431		
	Difference between market and actuarial values	42,365,625	(94,580,402)	(3,012,104)	40,282,026	7,918,399		
	Market Rate of Return	5.89%	1.08%	11.18%	9.17%	6.73%		
	Ratio of Funding Value to Market Value	97.89%	104.75%	100.14%	98.26%	99.67%		
	Recognized actuarial rate of return	11.97%	8.13%	6.23%	7.14%	8.29%		



Allocation of Assets Between Groups

The allocation of the funding value of assets between the Uniformed Patrol and Non-Uniformed Employee groups is in proportion to their market value of assets, as shown below:

	June 30	
Allocation of Funding Value of Assets	2019	2018
1. Funding Value of Assets	\$2,415,343,431	\$2,274,248,122
2. Reported Market Value of Assets		
a) Uniformed Patrol	709,697,821	675,510,288
b) Non-Uniformed Employees	1,713,564,009	1,639,019,860
c) Total	2,423,261,830	2,314,530,148
3. Funding Value of Assets Split		
a) Uniformed Patrol		
(2a) / (2c) x (1)	707,378,769	663,753,723
b) Non-Uniformed Employees		
(2b) / (2c) x (1)	1,707,964,662	1,610,494,399
4. Total Assets Allocated	2,415,343,431	2,274,248,122



SECTION D

SUMMARY OF MEMBER DATA

Civilian Patrol Closed Active Members as of June 30, 2019 by Attained Age and Years of Service

		Count by	Complete Y	ears of Serv	ice to Valua	tion Date			Totals
Attained Age	0-4	5-9	10-14	15-19	20-24	25-29	30+	No.	Valuation Payroll
Under 20									
20-24									
25-29									
30-34									
35-39				1				1	\$ 33,182
40-44				5	16	1		22	1,114,785
45-49		1		7	35	11		54	2,759,881
50-54		2	1	8	35	28	13	87	4,658,512
55-59	1	1	1	4	24	15	19	65	3,371,554
60			1		4	2	3	10	499,615
61				1	5	1		7	263,221
62					2	1	1	4	165,774
63				1		2		3	145,665
64					2	1	1	4	255,688
65					3			3	172,013
66				1			2	3	127,289
67									
68									
69									
70					1		1	2	67,065
Over 70									
Totals	1	4	3	28	127	62	40	265	\$13,634,244

Average Age: 52.7 years Average Service: 24.7 years Average Pay: \$51,450



Civilian Patrol Year 2000 Active Members as of June 30, 2019 by Attained Age and Years of Service

		Count by	Complete Y	ears of Serv	vice to Valua	tion Date			Totals
Attained Age	0-4	5-9	10-14	15-19	20-24	25-29	30+	No.	Valuation Payroll
Under 20									
20-24									
25-29	1		1					2	\$ 96,878
30-34	1	15	23	1				40	1,977,243
35-39	1	15	44	23				83	4,013,615
40-44	3	12	29	27				71	3,597,651
45-49		9	22	23	1			55	2,556,761
50-54	2	8	30	19	1			60	2,733,590
55-59	1	9	16	23	2			51	2,320,363
60		3	1	2	2			8	347,949
61			4	4				8	356,684
62			2					2	72,510
63		1	1	1				3	110,122
64		2	2	2				6	217,304
65	1			1	1			3	113,353
66		3		1				4	131,289
67		1		1				2	77,217
68		1						1	36,145
69									
70									
Over 70			2	1				3	82,168
Totals	10	79	177	129	7			402	\$18,840,842

Average Age: 46.2 years Average Service: 13.1 years Average Pay: \$46,868



Civilian Patrol 2011 Tier Active Members as of June 30, 2019 by Attained Age and Years of Service

		Count by	Complete Y	ears of Serv	ice to Valua	tion Date			Totals Valuation No. Payroll	
Attained Age	0-4	5-9	10-14	15-19	20-24	25-29	30+	No.	Valuation Payroll	
									-	
Under 20										
20-24	38							38	\$ 1,290,870	
25-29	81	15						96	3,934,115	
30-34	44	38						82	3,545,588	
35-39	31	16						47	2,043,674	
40-44	19	15						34	1,320,858	
45-49	25	19						44	1,721,453	
50-54	25	14						39	1,407,647	
55-59	28	10						38	1,316,737	
60	1	2						3	98,944	
61	5	2						7	205,710	
62	5	2						7	251,773	
63	1	2						3	97,411	
64	1	1						2	72,545	
65	1	1						2	57,909	
66	2	1						3	96,381	
67										
68		1						1	43,430	
69										
70										
Over 70										
Totals	307	139						446	\$17,505,045	

Average Age: 38.7 years Average Service: 3.7 years Average Pay: \$39,249



MoDOT Closed Active Members as of June 30, 2019 by Attained Age and Years of Service

		Count by	Complete Y	ears of Serv	ice to Valua	tion Date			Totals
Attained Age	0-4	5-9	10-14	15-19	20-24	25-29	30+	No.	Valuation Payroll
Under 20									
20-24									
25-29									
30-34									
35-39				7	8			15	\$ 669,645
40-44		1	2	59	94	1		157	7,906,408
45-49		2		42	200	108	3	355	19,357,633
50-54		2	2	47	140	200	55	446	24,283,753
55-59		2	2	28	122	77	86	317	16,549,817
60				3	17	11	10	41	2,106,020
61				3	8	12	10	33	1,681,175
62				1	12	8	5	26	1,248,317
63				1	9	12	1	23	1,149,640
64				2	9	6	6	23	1,178,967
65				3	3	5	2	13	644,031
66				1	1	1		3	171,102
67						2	1	3	168,366
68					1		1	2	90,298
69									
70									
Over 70							3	3	303,163
Totals		7	6	197	624	443	183	1,460	\$77,508,335

Average Age: 51.9 years Average Service: 24.6 years Average Pay: \$53,088



MoDOT Year 2000 Active Members as of June 30, 2019 by Attained Age and Years of Service

		Count by	Complete Y	ears of Serv	ice to Valua	tion Date			Totals
Attained Age	0-4	5-9	10-14	15-19	20-24	25-29	30+	No.	Valuation Payroll
Under 20									
20-24									
25-29		1						1	\$ 40,232
30-34	7	18	81	1				107	4,701,946
35-39	4	20	180	80				284	13,075,670
40-44	8	21	127	149	1			306	14,222,226
45-49	10	29	101	111	1			252	11,380,935
50-54	5	11	97	106	3			222	9,504,141
55-59	3	21	93	119	2	3		241	10,234,234
60	1	1	17	21	1			41	1,715,141
61	1	4	18	7				30	1,222,003
62		3	15	13	1			32	1,292,681
63		1	10	5				16	674,704
64		3	7	8				18	812,817
65		1	5	3				9	405,615
66			5	3			1	9	410,308
67			2	3				5	214,399
68	1							1	30,558
69									
70			1	1				2	95,027
Over 70			1					1	37,160
Totals	40	134	760	630	9	3	1	1,577	\$70,069,797

Average Age: 47.1 years Average Service: 13.8 years Average Pay: \$44,432



MoDOT 2011 Tier Active Members as of June 30, 2019 by Attained Age and Years of Service

		Count by	Complete Y			Totals			
Attained Age	0-4	5-9	10-14	15-19	20-24	25-29	30+	No.	Valuation Payroll
Under 20	12							12	\$ 225 660
20-24	211							211	5 323,000 7 158 771
25-29	396	49						445	17 352 884
20-20	299	77						376	14 376 505
35-39	233	63						276	10 191 296
40-44	153	42						195	7 118 170
45-49	138	41						179	6 898 848
50-54	112	43						155	5 608 847
55-59	82	45						127	4.847.024
55 55	02	15						127	1,017,021
60	19	10						29	1,069,353
61	9	4						13	446,795
62	6	3						9	346,922
63	2	7						9	371,402
64	9	1						10	322,108
65		4						4	192,306
66	1							1	30,795
67	2	1						3	106,244
68	2	1						3	141,635
69	1							1	32,382
70	1							1	32,689
Over 70	1							1	36,131
Totals	1,669	391						2,060	\$77,006,767

Average Age: 37.1 years Average Service: 2.9 years Average Pay: \$37,382



Uniformed Patrol Closed Active Members as of June 30, 2019 by Attained Age and Years of Service

		Count by	Complete Y	ears of Serv	ice to Valua	tion Date			Totals
Attained Age	0-4	5-9	10-14	15-19	20-24	25-29	30+	No.	Valuation Payroll
Age Under 20 20-24 25-29 30-34 35-39 40-44 45-49 50-54 55-59 60 61 62 63 64 65 66 67 68	0-4	5-9	10-14	15-19 15 8 4 1	20-24 33 135 73 11	25-29 46 100 16 1	30+ 21 26	No. 1 48 190 199 54 1	Payroll \$ 51,510 3,866,151 15,471,071 16,517,323 4,542,200 73,678
69 70									
Over 70									
Totals	1	1	1	28	252	163	47	493	\$40,521,933

Average Age: 49.7 years Average Service: 24.9 years Average Pay: \$82,195



Uniformed Patrol Year 2000 Active Members as of June 30, 2019 by Attained Age and Years of Service

		Count by	Complete Y	ears of Serv	vice to Valua	tion Date			Totals
Attained Age	0-4	5-9	10-14	15-19	20-24	25-29	30+	No.	Valuation Payroll
Under 20									
20-24									
25-29		1						1	\$ 59,142
30-34		31	50	1				82	5,014,959
35-39		10	82	28				120	8,224,928
40-44		3	33	64	1			101	7,525,575
45-49		4	15	32				51	3,502,056
50-54			3	7				10	688,554
55-59			2	1				3	206,157
60									
61									
62									
63									
64									
65									
66									
67									
68									
69									
70									
Over 70									
Totals		49	185	133	1			368	\$25,221,371

Average Age: 39.2 years Average Service: 13.7 years Average Pay: \$68,536



Uniformed Patrol 2011 Tier Active Members as of June 30, 2019 by Attained Age and Years of Service

		Count by	Complete Y			Totals			
Attained									Valuation
Age	0-4	5-9	10-14	15-19	20-24	25-29	30+	No.	Payroll
Under 20									
20-24	48							48	\$ 2.517.867
25-29	100	44						144	7.680.879
30-34	29	88						117	6.518.140
35-39	11	12						23	1,265,815
40-44	5	8						13	722,169
45-49		2						2	115,409
50-54	1	2						3	167,443
55-59									
60									
61									
62									
63									
64									
65									
66									
67									
68									
69									
70									
Over 70									
Totals	194	156						350	\$18,987,722

Average Age: 29.6 years Average Service: 4.3 years Average Pay: \$54,251



Growth of Active Member Payroll

Actuarial				% Change
Valuation for		Covered	Average	in Average Pay
June 30,	Number	Payroll	Рау	from Prior Year
1989	8,181	\$194,452,400	\$23,769	(0.5)%
1990	8,256	211,414,753	25,607	7.7 %
1991	8,308	220,856,988	26,584	3.8 %
1992	8,591	228,503,592	26,598	0.1 %
1993	8,658	236,236,082	27,285	2.6 %
1994	8,849	242,864,780	27,445	0.6 %
1995	8,904	250,529,253	28,137	2.5 %
1996	9,023	264,196,115	29,280	4.1 %
1997	8,997	280,209,116	31,145	6.4 %
1998	8,871	284,889,796	32,115	3.1 %
1999	9,140	298,673,247	32,678	1.8 %
2000	9,171	312,532,009	34,078	4.3 %
2001	9,087	327,049,257	35,991	5.6 %
2002	8,695	312,747,492	35,969	(0.1)%
2003	8,892	318,744,192	35,846	(0.3)%
2004	9,002	328,210,887	36,460	1.7 %
2005	9,193	345,695,867	37,604	3.1 %
2006	9,033	348,614,699	38,593	2.6 %
2007	8,640	360,842,421	41,764	8.2 %
2008	8,599	369,424,653	42,961	2.9 %
2009	8,784	377,652,245	42,993	0.1 %
2010	8,457	369,911,252	43,740	1.7 %
2011	8,231	361,639,001	43,936	0.4 %
2012	7,458	329,293,168	44,153	0.5 %
2013	7,319	323,205,767	44,160	0.0 %
2014	7,390	332,085,689	44,937	1.8 %
2015	7,358	334,400,980	45,447	1.1 %
2016	7,441	339,799,379	45,666	0.5 %
2017	7,456	348,979,212	46,805	2.5 %
2018	7,391	351,496,555	47,557	1.6 %
2019	7,421	359,296,056	48,416	1.8 %
	1.2 %			

Ten-Year Average:



Count and Total Monthly Benefits Civilian Patrol Closed Retired (Non-Disabled) Members and Survivors as of June 30, 2019 by Attained Age

Age	Number	Monthly Benefit Amount
Less than 20		
20-24		
25-29		
30-34		
35-39		
40-44		
45-49		
50-54	4	\$ 9,307
55-59	30	52,292
60-64	57	102,830
65-69	79	128,718
70-74	74	107,773
75-79	66	121,699
80-84	80	153,709
85-89	73	135,348
90-94	23	30,409
95-99	2	1,406
100-104		
105 & Over		
TOTAL	488	\$ 843,491



Count and Total Monthly Benefits of Civilian Patrol Year 2000 Retired (Non-Disabled) Members and Survivors as of June 30, 2019 by Attained Age

Age	Number	Monthly Benefit Amount
Less than 20		
20-24		
25-29		
30-34		
35-39		
40-44		
45-49		
50-54	6	\$ 16,766
55-59	62	143,057
60-64	134	229,913
65-69	173	244,263
70-74	136	189,553
75-79	64	93,924
80-84	6	3,136
85-89	1	2,265
90-94		
95-99	1	1,035
100-104		
105 & Over		
TOTAL	583	\$ 923,912



Count and Total Monthly Benefits of Civilian Patrol 2011 Tier Retired (Non-Disabled) Members and Survivors as of June 30, 2019 by Attained Age

Age	Number	Monthly B Amou	enefit nt
Less than 20			
20-24			
25-29			
30-34			
35-39			
40-44			
45-49			
50-54			
55-59			
60-64			
65-69	3	\$	705
70-74			
75-79			
80-84			
85-89			
90-94			
95-99			
100-104			
105 & Over			
TOTAL	3	\$	705



Count and Total Monthly Benefits of MoDOT Closed Retired (Non-Disabled) Members and Survivors as of June 30, 2019 by Attained Age

Age	Number	Monthly Benefi Amount		
Less than 20	1	\$ 456		
20-24	2	2,427		
25-29				
30-34				
35-39	1	610		
40-44	3	1,326		
45-49	10	8,265		
50-54	39	63,154		
55-59	162	255,459		
60-64	345	535,761		
65-69	369	581,985		
70-74	383	623,115		
75-79	542	1,201,046		
80-84	786	1,971,514		
85-89	465	1,088,805		
90-94	216	438,254		
95-99	45	62,111		
100-104	4	3,122		
105 & Over	1	149		
TOTAL	3,374	\$ 6,837,559		



Count and Total Monthly Benefits of MoDOT Year 2000 Retired (Non-Disabled) Members and Survivors as of June 30, 2019 by Attained Age

		Monthly Benefit
Age	Number	Amount
Less than 20	9	\$ 1,779
20-24	3	1,382
25-29	1	235
30-34	3	1,634
35-39	1	121
40-44	4	3,930
45-49	9	8,038
50-54	96	294,227
55-59	519	1,462,869
60-64	835	1,568,336
65-69	846	1,290,715
70-74	736	1,290,104
75-79	336	625,385
80-84	37	49,228
85-89	12	19,159
90-94	13	24,088
95-99	5	6,121
100-104		
105 & Over		
TOTAL	3,465	\$ 6,647,351



Count and Total Monthly Benefits of MoDOT Year 2011 Tier Retired (Non-Disabled) Members and Survivors as of June 30, 2019 by Attained Age

Age	Number	Monthly Ame	/ Benefit ount
Less than 20			
20-24			
25-29			
30-34			
35-39			
40-44			
45-49			
50-54			
55-59			
60-64			
65-69			
70-74	2	\$	591
75-79			
80-84			
85-89			
90-94			
95-99			
100-104			
105 & Over			
TOTAL	2	\$	591



Count and Total Monthly Benefits of Uniformed Patrol Closed Retired (Non-Disabled) Members and Survivors as of June 30, 2019 by Attained Age

Age	Number	Monthly Benefit Amount
Less than 20	3	\$ 4,171
20-24		
25-29		
30-34		
35-39	1	1,406
40-44	5	12,262
45-49	6	15,005
50-54	25	102,640
55-59	131	578,508
60-64	158	804,592
65-69	159	810,393
70-74	170	828,061
75-79	134	675,765
80-84	102	500,125
85-89	44	193,749
90-94	28	121,400
95-99	5	14,316
100-104		
105 & Over		
TOTAL	971	\$ 4,662,393



Count and Total Monthly Benefits of Uniformed Patrol Year 2000 Retired (Non-Disabled) Members and Survivors as of June 30, 2019 by Attained Age

Age	Number	Monthly Benefit Amount
Less than 20	2	\$ 409
20-24	1	1,111
25-29		
30-34		
35-39		
40-44	2	2,619
45-49		
50-54		
55-59	1	4,553
60-64	2	4,225
65-69		
70-74		
75-79		
80-84		
85-89		
90-94		
95-99		
100-104		
105 & Over		
TOTAL		é 12.047



Growth of Pension Population by Year

	Retired				Annual	Active	Benefits as a
Year	Employees	Survivors	Total	% Increase	Benefits	Payroll	% of Payroll
1989	2,610	441	3,051	8.2%			
1990	2,669	543	3,212	5.3%			
1991	2,814	632	3,446	7.3%			
1992	2,908	699	3,607	4.7%			
1993	3,047	1,269	4,316	19.7%			
1994	3,156	1,307	4,463	3.4%			
1995	3,419	1,365	4,784	7.2%			
1996	3,536	1,405	4,941	3.3%			
1997	3,646	1,486	5,132	3.9%			
1998	3,781	1,549	5,330	3.9%	\$ 80,686,152	\$284,889,796	28.3%
1999	3,924	1,600	5,524	3.6%	91,512,311	298,673,247	30.6%
2000	4,236	1,621	5,857	6.0%	100,794,676	312,532,009	32.3%
2001	4,482	1,663	6,145	4.9%	115,998,915	327,049,257	35.5%
2002	4,623	1,716	6,339	3.2%	125,623,460	312,747,492	40.2%
2003	4,845	1,751	6,596	4.1%	136,320,125	318,744,192	42.8%
2004	4,996	1,735	6,731	2.0%	142,359,307	328,210,887	43.4%
2005	5,068	1,761	6,829	1.5%	148,340,170	345,695,867	42.9%
2006	5,164	1,790	6,954	1.8%	155,230,301	348,614,699	44.5%
2007	5,336	1,805	7,141	2.7%	164,048,455	360,842,421	45.5%
2008	5,496	1,829	7,325	2.6%	172,112,941	369,424,653	46.6%
2009	5,604	1,866	7,470	2.0%	179,850,466	377,652,245	47.6%
2010	5,739	1,867	7,606	1.8%	187,267,535	369,911,252	50.6%
2011	5,926	1,849	7,775	2.2%	191,892,660	361,639,001	53.1%
2012	6,172	1,883	8,055	3.6%	201,906,768	329,293,168	61.3%
2013	6,382	1,908	8,290	2.9%	210,904,464	323,205,767	65.3%
2014	6,507	1,894	8,401	1.3%	217,149,528	332,085,689	65.4%
2015	6,720	1,868	8,588	2.2%	223,021,512	334,400,980	66.7%
2016	6,814	1,870	8,684	1.1%	227,218,908	339,799,379	66.9%
2017	6,969	1,862	8,831	1.7%	231,168,516	348,979,212	66.2%
2018	7,064	1,852	8,916	1.0%	235,395,456	351,496,555	67.0%
2019	7,180	1,855	9,035	1.3%	241,935,168	359,296,056	67.3%



Growth of Pension Population by Year

Number of Pensioners by Year





Self-Insured Disabled Retired Members as of June 30, 2019

Age	Number	Monthly Benefit Amount
Less than 20		
20-24		
25-29		
30-34		
35-39		
40-44		
45-49	3	\$ 7,078
50-54	5	5,803
55-59	9	10,941
60-64	7	12,321
65-69	11	16,715
70-74	7	10,446
75-79	4	5,979
80-84		
85-89	1	113
90-94		
95-99		
100-104		
105 & Over		
TOTAL	47	\$ 69,396

These members became disabled prior to outsourcing disability claims. Liabilities for these members include benefits payable during and after the period of disability.



Fully Insured Disabled Retired Members as of June 30, 2019

Δαρ	Number	Mont A	hly Benefit mount
	Humber		
Less than 20			
20-24			
20-24	1	ć	2 201
25-29	1 2	Ş	2,201
30-34	3		7,240
35-39	1		2,024
40-44	9		23,739
45-49	16		32,447
50-54	26		45,981
55-59	30		41,122
60-64	7		7,400
65-69	1		715
70-74			
75-79			
80-84			
85-89			
90-94			
95-99			
100-104			
105 & Over			
TOTAL	94	Ş	162,949

These members became disabled after disability claims became outsourced. Liabilities for these members during the period of disability are an obligation of the insurance company and not included in this valuation. Liabilities for these members after the period of disability are included in the valuation.



Data Reconciliation as of June 30, 2019

		Vested	
	Active	Terminated	
Non-Uniformed	Members	Members	Retired *
Number at Start of Year	6,160	1,822	7,960
Increase (Decrease) From			
New Entrants/Rehires	731	(8)	
Service Retirement	(192)	(59)	251
Vested Terminations	(121)	134	(8)
Deaths/Removals	(4)	(21)	(178)
Disability Retirement	(17)	(2)	21
Non-Vested Terminations	(347)		
Number at End of Year	6,210	1,866	8,046

	Activo	Vested	
Uniformed	Members	Members	Retired *
Number at Start of Year	1,231	158	956
Increase (Decrease) From			
New Entrants/Rehires	59	0	
Service Retirement	(40)	(7)	47
Vested Terminations	(25)	25	(1)
Deaths/Removals	0	0	(16)
Disability Retirement	(3)		3
Non-Vested Terminations	(11)		
Number at End of Year	1,211	176	989

* Including disability participants.


SECTION E

Assumptions Used in the Valuation and Glossary

Summary of Valuation Method and Assumptions June 30, 2019

The actuarial assumptions used in the valuation are shown in this Section of the report unless stated otherwise. The assumptions were established for the June 30, 2018 actuarial valuation, following a five-year actuarial investigation covering the period July 1, 2012 through June 30, 2017. They were adopted by the Board.

An actuarial valuation is based upon an actuarial cost method, an asset valuation method, and actuarial assumptions. These methods and assumptions are chosen by the Board of Trustees after consultation with the Actuary and other advisors.

The actuarial cost method is called the Entry Age Actuarial Cost Method. This method is consistent with the Board's level percent-of-payroll funding objective. With this method, the level percent-of-payroll is determined that will fund a member's retirement benefit over the member's entire working lifetime, from date of hire (Entry Age) to date of exit from the active member population. Differences in the past between assumed and actual experience become part of unfunded actuarial accrued liabilities and are amortized with level percent-of-payroll contributions. This cost method was first used in the *June 30*, *1999* valuation.

The asset valuation method is a three-year smoothed market value method in which assumed investment return is recognized immediately each year and differences between actual and assumed investment return are phased-in over a closed three-year period. This asset valuation method is intended to give recognition to the long term accuracy of market values while filtering out and dampening short term market swings. This method was first used in the *June 30, 1999* valuation.

Economic Assumptions

The assumed investment return rate used in making the valuations was 7.00% per year, compounded annually (net after investment expenses). The **wage inflation rate** was assumed to be 3.00%. The real rate of return over wage growth is defined to be the portion of total investment return, which is more than the rate of wage inflation. The 7.00% investment return rate and 3.00% wage inflation rate translates to an assumed real rate of return over wage growth net of expenses of 4.00%. Based upon other assumptions, the net real rate of return over price inflation is 4.75%.

Pay increase assumptions for merit and seniority for individual active members are shown on page E-6. Part of the total assumed pay increase at each age is for merit and/or seniority, and the other 3.00% recognizes wage inflation. **The active member payroll** for all members is assumed to increase 3.00% annually for all years.

The price inflation rate is assumed to be 2.25% annually. This is the inflation rate upon which the postretirement increases are based. The difference between wage and price inflation of 0.75% is attributable to overall productivity increases and macroeconomic factors.

The total number of active members is assumed to continue at the present total number.



Summary of Valuation Method and Assumptions June 30, 2019 (Continued)

Reviewing the Investment Return Assumption

The review of the investment return assumptions in this report are forward-looking measures of likely investment return outcomes for the asset classes in the current investment policy. For purposes of this analysis, we have analyzed the System's investment policy with the capital market assumptions from fourteen nationally recognized investment consultants.

The investment consultants who have shared their capital market assumptions with us are (in alphabetical order Aon, BlackRock, BNY Mellon, Callan, Cambridge, JPM, Marquette, Meketa, Mercer, NEPC, RVK, Verus, VOYA, Wilshire. It is important to understand that, in general, no two investment consultants will consider the same asset classes. Moreover, there are differences in investment horizons, price inflation, the treatment of investment expenses, excess manager performance (i.e., alpha), geometric vs. arithmetic averages, and other technical differences.

We have incorporated the assumptions of these 14 consultants into our Capital Market Assumption Modeler (CMAM). To the best of our ability, we have adapted the System's investment policy to fit with the 14 consultants' assumptions adjusting for these known differences in assumptions and methodology. In the following charts, all returns are net of investment expenses only and have no assumption for excess manager performance (alpha).



Summary of Valuation Method and Assumptions June 30, 2019 (Continued)

Investment Consultant	Investment Consultant Expected Nominal Return	Investment Consultant Inflation Assumption	Expected Real Return (2)–(3)	Actuary Inflation Assumption	Expected Nominal Return (4)+(5)	Investment Expenses	Expected Nominal Return Net of Expenses (6)-(7)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1	5.52%	2.20%	3.32%	2.25%	5.57%	0.00%	5.57%
2	6.35%	2.50%	3.85%	2.25%	6.10%	0.00%	6.10%
3	6.19%	2.20%	3.99%	2.25%	6.24%	0.00%	6.24%
4	6.77%	2.50%	4.27%	2.25%	6.52%	0.00%	6.52%
5	6.64%	2.00%	4.64%	2.25%	6.89%	0.00%	6.89%
6	7.14%	2.31%	4.84%	2.25%	7.09%	0.00%	7.09%
7	7.22%	2.25%	4.97%	2.25%	7.22%	0.00%	7.22%
8	7.51%	2.26%	5.25%	2.25%	7.50%	0.00%	7.50%
9	7.05%	2.00%	5.05%	2.25%	7.30%	0.00%	7.30%
10	7.44%	2.21%	5.22%	2.25%	7.47%	0.00%	7.47%
11	7.67%	2.15%	5.52%	2.25%	7.77%	0.00%	7.77%
12	8.16%	2.30%	5.86%	2.25%	8.11%	0.00%	8.11%
13	7.75%	2.00%	5.75%	2.25%	8.00%	0.00%	8.00%
14	7.83%	1.70%	6.13%	2.25%	8.38%	0.00%	8.38%
Average	7.09%	2.18%	4.90%	2.25%	7.15%	0.00%	7.15%



	Distribut Geomet	Distribution of 20-Year Average Geometric Net Nominal Return			Probability of Exceeding	Probability of Exceeding
Consultant	40th	50th	60th	7.00%	6.75%	6.50%
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1	4.32%	4.96%	5.60%	21.22%	24.14%	27.28%
2	4.77%	5.44%	6.11%	27.85%	31.08%	34.46%
3	5.43%	5.90%	6.38%	28.04%	32.65%	37.55%
4	5.28%	5.92%	6.56%	33.49%	37.12%	40.89%
5	5.85%	6.42%	6.98%	39.74%	44.10%	48.54%
6	5.95%	6.55%	7.16%	42.54%	46.67%	50.83%
7	5.93%	6.59%	7.24%	43.67%	47.49%	51.35%
8	5.92%	6.67%	7.43%	45.60%	48.93%	52.29%
9	6.12%	6.74%	7.36%	45.80%	49.87%	53.94%
10	6.25%	6.88%	7.52%	48.16%	52.14%	56.11%
11	6.55%	7.18%	7.82%	52.85%	56.81%	60.72%
12	6.85%	7.50%	8.15%	57.78%	61.58%	65.27%
13	7.25%	7.70%	8.16%	65.37%	70.41%	75.10%
14	7.03%	7.71%	8.39%	60.50%	64.07%	67.54%
Average	5.97%	6.58%	7.20%	43.76%	47.65%	51.56%

Based on the current asset allocation policy as well as the current price inflation assumption, the investment return assumption is reasonable. Both the price inflation assumption and the investment return assumption were reviewed in the Plan's most recent experience study. While we have stated that the assumptions are reasonable for this valuation, that may not continue in the future if recent trends in forward looking expectations continue.

Investment Return					
With Policy Allocation					
CMAM Year	Mean	Median			
2015	6.84%	6.28%			
2016	7.28%	6.70%			
2017	6.82%	6.26%			
2018	7.15%	6.58%			

Generally, we recommend an investment return assumption between the arithmetic mean and the geometric median of our most recent capital market assumption modeler. Because the results of the most recent CMAMs are not trending in a single direction, we would broaden our range slightly for a recommendation



Summary of Valuation Method and Assumptions June 30, 2019 (Concluded)

Non-Economic Assumptions

Post-Retirement Healthy Mortality Rates are used to measure the probabilities of members dying after retirement. The rates currently in use are from the RP-2014 Healthy Annuitant Mortality Tables projected to 2022 using projection scale MP-2017, shown on page E-7.

Post-Retirement Disabled Mortality Rates. The rates currently in use for disabled lives are from the RP-2014 Disabled Retiree Annuitant Mortality Tables projected to 2022 using projection scale MP-2017, shown on page E-8.

Pre-Retirement Mortality Rates. The rates currently in use for active lives are the RP-2014 Employee Mortality Table projected to 2022 using projection scale MP-2017 and multiplied by a factor of 65%, shown on page E-9.

The probabilities of age and service retirement are shown on page E-11. Upon retirement, members are assumed to pick the BackDROP period that when combined with the remaining annuity produces the highest liability.

The probabilities of disability are shown on page E-12.

The probabilities of withdrawal from service are shown on page E-13.

Employer contributions were assumed to be *paid in equal installments* throughout the employer fiscal year.

Present assets (cash & investments) were used with a market value adjustment. Assets may be used in the valuation prior to the final audit. The exact method is shown on page C-2.

The data about persons now covered and about present assets were furnished by the System's administrative staff. Although examined for general reasonableness, the data was not audited by the Actuary. Data was furnished as of May 31 and assumed to be statistically equivalent to June 30.

The actuarial valuation computations were made by or under the supervision of a Member of the American Academy of Actuaries (MAAA) who has experience performing public plan valuations.



Service Based Salary Scale

% Merit Increases in						
Salaries Next Year						
Service Index	Uniformed Members	Non-Uniformed Members				
1	9.45%	6.80%				
2	5.00%	4.50%				
3	2.75%	2.80%				
4	2.50%	1.50%				
5	2.00%	1.00%				
6	1.50%	0.80%				
7	1.25%	0.00%				
8	1.25%	0.00%				
9	1.00%	0.00%				
10	0.75%	0.00%				
11	0.75%	0.00%				
12	0.75%	0.00%				
13	0.50%	0.00%				
14	0.50%	0.00%				
15	0.25%	0.00%				
16	0.25%	0.00%				
17	0.25%	0.00%				
18	0.25%	0.00%				
19	0.25%	0.00%				
20	0.25%	0.00%				
21	0.00%	0.00%				
22	0.00%	0.00%				
23	0.00%	0.00%				
24	0.00%	0.00%				
25	0.00%	0.00%				



Post-Retirement Mortality

Retired Lives Mortality Rates

	% Dying I	Next Year		% Dying	% Dying Next Year			% Dying I	Next Year
Age	Male	Female	Age	Male	Female		Age	Male	Female
] [
20	0.0369%	0.0174%	60	0.7938%	0.5667%		100	31.3381%	28.0166%
21	0.0408%	0.0195%	61	0.8547%	0.6147%		101	33.3774%	30.0266%
22	0.0449%	0.0223%	62	0.9205%	0.6657%		102	35.3995%	32.0621%
23	0.0492%	0.0256%	63	0.9918%	0.7196%		103	37.3951%	34.0941%
24	0.0538%	0.0295%	64	1.0684%	0.7773%		104	39.3487%	36.0900%
25	0.0588%	0.0340%	65	1.1511%	0.8398%		105	41.2343%	38.0614%
26	0.0641%	0.0388%	66	1.2408%	0.9085%		106	43.0470%	39.9941%
27	0.0700%	0.0441%	67	1.3387%	0.9850%		107	44.7813%	41.8213%
28	0.0764%	0.0499%	68	1.4472%	1.0710%		108	46.4200%	43.5827%
29	0.0836%	0.0567%	69	1.5680%	1.1678%		109	47.9720%	45.2475%
30	0.0916%	0.0644%	70	1.7034%	1.2770%		110	49.4044%	46.8213%
31	0.1004%	0.0731%	71	1.8549%	1.4005%		111	49.9809%	48.2854%
32	0.1098%	0.0828%	72	2.0259%	1.5392%		112	49.9755%	49.6513%
33	0.1201%	0.0933%	73	2.2187%	1.6965%		113	49.9953%	50.2110%
34	0.1300%	0.1047%	74	2.4366%	1.8727%		114	49.9851%	50.0952%
35	0.1405%	0.1166%	75	2.6823%	2.0723%		115	50.0000%	50.0000%
36	0.1519%	0.1291%	76	2.9606%	2.2975%		116	50.0000%	50.0000%
37	0.1638%	0.1413%	77	3.2770%	2.5540%		117	50.0000%	50.0000%
38	0.1766%	0.1532%	78	3.6348%	2.8455%		118	50.0000%	50.0000%
39	0.1899%	0.1644%	79	4.0410%	3.1769%		119	50.0000%	50.0000%
40	0.2035%	0.1750%	80	4.5024%	3.5553%		120	100.0000%	100.0000%
41	0.2169%	0.1838%	81	5.0252%	3.9869%	'			
42	0.2307%	0.1918%	82	5.6159%	4.4782%				
43	0.2453%	0.1994%	83	6.2866%	5.0381%				
44	0.2609%	0.2070%	84	7.0474%	5.6722%				
45	0.2779%	0.2146%	85	7.9002%	6.3897%				
46	0.2964%	0.2231%	86	8.8634%	7.1988%				
47	0.3167%	0.2325%	87	9.9417%	8.1051%				
48	0.3394%	0.2424%	88	11.1427%	9.1109%				
49	0.3644%	0.2533%	89	12.4767%	10.2194%				
50	0.3922%	0.2660%	90	13.9500%	11.4522%				
51	0.4231%	0.2806%	91	15.4968%	12.7799%				
52	0.4563%	0.2986%	92	17.0856%	14.1857%				
53	0.4885%	0.3200%	93	18.6789%	15.6544%				
54	0.5223%	0.3449%	94	20.2575%	17.1685%	1			
55	0.5582%	0.3734%	95	21.8007%	18.7264%	1			
56	0.5971%	0.4054%	96	23.6045%	20,4458%	1			
57	0.6398%	0.4409%	97	25.4442%	22.2335%	1			
58	0.6865%	0.4797%	98	27.3578%	24.1013%	1			
59	0.7377%	0.5218%	99	29.3232%	26.0345%	1			



Post-Retirement Mortality (Disability)

Disabled Retired Lives Mortality Rates

	% Dying I	Next Year		% Dying Next Year		Iſ		% Dying I	Next Year
Age	Male	Female	Age	Male	Female		Age	Male	Female
20	0.0428%	0.02029/	60	2 7176%	1 9560%		100	22 6005%	20 77/00/
20	0.0438%	0.020376	61	2.7170%	1.0300%		100	32.0063%	20.7749%
21	0.0012%	0.0204%	62	2.0205/0	1.9100%		101	34.2709%	30.3090%
22	0.0630%	0.0397%	62	2.94557/0	1.97.59%		102	27 60/5%	52.4095/0 21 779/0/
23	0.1108%	0.034776	64	2 18/0%	2.030778		103	20 / 520%	34.2704/0
24	0.1555%	0.072878	65	2 2118%	2.1023/0		104	11 72/20/0	30.1343/0
25	0.2003/8	0.0340%	66	2 1117%	2.1708/6		105	41.234370	20 00/14/0
20	0.2555%	0.1174/0	67	2 5 8 5 5 %	2.2033/0		100	43.047076	33.334170 /1 8212%
27	0.3130%	0.1430%	68	2 7200%	2.3002/0		107	44.781378	41.021370
20	0.380176	0.172576	60	3.7399%	2.4002/0		100	40.4200%	45.382776
20	0.434376	0.2031/6	70	1 009/1%	2.0317/0		110	47.3720%	45.2475%
21	0.3336%	0.2419/0	70	4.0964/0	2.7900/0		110	49.404470	40.0213/0
22	0.0253%	0.2020/0	71	4.5061/0	2.3323/0		112	49.900976	40.2004/0
22	0.7138/0	0.3281/0	72	4.3430%	3.2120/0		112	49.9755%	49.0313/0
24	0.0114%	0.3770%	73	5 1008%	3.404878		113	49.995576	50.0052%
25	0.9020%	0.4300%	74	5 / 281%	3.740376 4.0624%		114	50 0000%	50.095278
36	1 0858%	0.480478	75	5 7020%	4.002476		115	50.0000%	50.0000%
30	1.0050%	0.5450%	70	6 2011%	4.41557%		117	50.0000%	50.0000%
30	1.175176	0.6557%	78	6 6520%	5 2368%		118	50.0000%	50.0000%
20	1 3//3%	0.000778%	70	7 1550%	5 7097%		110	50.0000%	50.0000%
40	1 /20/1%	0.7560%	80	7 7133%	6 2278%		120	100 0000%	100 0000%
40 //1	1 / 852%	0.7965%	81	8 3320%	6 7925%		120	100.000070	100.000070
41	1.4002/0	0.8333%	82	9.0153%	7 4046%				
/2	1.5445%	0.85557%	83	9 7759%	8 0682%				
45 44	1 6518%	0.9006%	84	10 6221%	8 7816%				
45	1 7022%	0.9338%	85	11 5504%	9 5490%				
46	1 7528%	0.9691%	86	12 5809%	10 3728%				
47	1.8036%	1.0081%	87	13,7130%	11.2504%				
48	1.8561%	1.0486%	88	14.9503%	12.1767%				
49	1.9108%	1.0931%	89	16.2983%	13.1470%				
50	1.9679%	1.1445%	90	17.7578%	14.1809%				
51	2.0285%	1.2025%	91	19.1980%	15.3068%				
52	2.0949%	1.2677%	92	20.6246%	16.5148%				
53	2.1519%	1.3387%	93	22.0177%	17.7919%				
54	2.2110%	1.4144%	94	23.3675%	19.1177%				
55	2.2745%	1.4929%	95	24.6544%	20.4885%				
56	2.3451%	1.5721%	96	26.2066%	22.0265%				
57	2.4253%	1.6494%	97	27.7603%	23.6241%				
58	2.5146%	1.7227%	98	29.3541%	25.2910%				
59	2.6124%	1.7921%	99	30.9669%	27.0120%				



Pre-Retirement Mortality

Death-in-Service Mortality Rates

	% Dying I	Next Year		% Dying Next Year			% Dying	Next Year
Age	Male	Female	Age	Male	Female	Age	Male	Female
20	0.0239%	0.0106%	60	0.3113%	0.1733%	100	20.3698%	18.2108%
21	0.0268%	0.0108%	61	0.3515%	0.1870%	101	21.6953%	19.5173%
22	0.0295%	0.0109%	62	0.3965%	0.2013%	102	23.0097%	20.8404%
23	0.0313%	0.0112%	63	0.4467%	0.2166%	103	24.3068%	22.1612%
24	0.0324%	0.0116%	64	0.5019%	0.2329%	104	25.5767%	23.4585%
25	0.0309%	0.0119%	65	0.5624%	0.2506%	105	26.8023%	24.7399%
26	0.0302%	0.0122%	66	0.6210%	0.2753%	106	27.9806%	25.9962%
27	0.0300%	0.0127%	67	0.6844%	0.3028%	107	29.1078%	27.1838%
28	0.0303%	0.0133%	68	0.7539%	0.3335%	108	30.1730%	28.3288%
29	0.0311%	0.0140%	69	0.8303%	0.3680%	109	31.1818%	29.4109%
30	0.0322%	0.0150%	70	0.9147%	0.4070%	110	32.1129%	30.4338%
31	0.0337%	0.0161%	71	1.0083%	0.4510%	111	32.4876%	31.3855%
32	0.0352%	0.0174%	72	1.1130%	0.5006%	112	32.4841%	32.2733%
33	0.0368%	0.0187%	73	1.2299%	0.5572%	113	32.4969%	32.6372%
34	0.0382%	0.0200%	74	1.3608%	0.6207%	114	32.4903%	32.5619%
35	0.0393%	0.0214%	75	1.5071%	0.6928%	115	32.5000%	32.5000%
36	0.0402%	0.0227%	76	1.6706%	0.7741%	116	32.5000%	32.5000%
37	0.0412%	0.0242%	77	1.8540%	0.8664%	117	32.5000%	32.5000%
38	0.0423%	0.0258%	78	2.0582%	0.9704%	118	32.5000%	32.5000%
39	0.0437%	0.0276%	79	2.2859%	1.0874%	119	32.5000%	32.5000%
40	0.0456%	0.0296%	80	2.5398%	1.2190%	120	100.0000%	100.0000%
41	0.0478%	0.0317%	81	2.8770%	1.4450%		•	
42	0.0506%	0.0340%	82	3.2941%	1.7633%			
43	0.0543%	0.0367%	83	3.7903%	2.1715%			
44	0.0588%	0.0398%	84	4.3640%	2.6658%			
45	0.0640%	0.0434%	85	5.0073%	3.2435%			
46	0.0705%	0.0474%	86	5.7229%	3.9007%			
47	0.0777%	0.0521%	87	6.5034%	4.6310%			
48	0.0860%	0.0571%	88	7.3429%	5.4253%			
49	0.0954%	0.0626%	89	8.2360%	6.2734%			
50	0.1058%	0.0688%	90	9.1736%	7.1761%			
51	0.1174%	0.0757%	91	10.1429%	8.1223%			
52	0.1305%	0.0835%	92	11.1417%	9.1047%			
53	0.1442%	0.0922%	93	12.1542%	10.1144%			
54	0.1594%	0.1017%	94	13.1696%	11.1381%			
55	0.1764%	0.1121%	95	14.1705%	12.1722%			
56	0.1960%	0.1233%	96	15.3429%	13.2898%			
57	0.2187%	0.1351%	97	16.5387%	14.4518%			
58	0.2452%	0.1474%	98	17.7826%	15.6658%			
59	0.2759%	0.1602%	99	19.0601%	16.9224%			



Joint Life Retirement Values (7.00% Interest)

Comple	Single Life Retirement Values								
Sample	Present Va	alue of \$1	Percen	it Dying	Futur	e Life			
Attained	Monthly	for Life	Next	Year	Expectan	Expectancy (years)			
Ages	Men	Women	Men	Women	Men	Women			
50	\$149.37	\$153.84	0.3922%	0.2660%	32.36	34.85			
55	142.00	147.02	0.5582%	0.3734%	28.05	30.34			
60	132.97	138.52	0.7938%	0.5667%	23.89	25.97			
65	122.06	128.13	1.1511%	0.8398%	19.90	21.76			
70	109.01	115.45	1.7034%	1.2770%	16.11	17.74			
75	93.80	100.44	2.6823%	2.0723%	12.58	13.97			
80	76.99	83.55	4.5024%	3.5553%	9.41	10.56			

The present values shown above are for illustrative purposes only and include a 50% survivor benefit but do not include the value of future post-retirement increases. Males are assumed to be 3 years older than their spouses.



Rates of Retirement

		% of Active Participants Retiring							
		Closed	and Year 2	000 Plans			2011 Tier		
	No	n-Uniforn	ned Memb	ers		Non-Uniformed			
	Ma	ale	Fen	nale	Uniformed	Noi	mal		Uniformed
						Age &	Rule of		
Age	Normal	Early	Normal	Early	Normal	Service	90	Early	Normal
50	40%		25%		45%				
51	30%		20%		15%				
52	26%		20%		15%				
53	26%		20%		16%				
54	24%		24%		16%				
55	27%	3%	32%	3%	25%		30%		30%
56	25%	3%	35%	3%	30%		30%		30%
57	26%	4%	29%	4%	20%		30%		30%
58	22%	2%	25%	4%	30%		30%		30%
59	25%	4%	30%	5%	40%		30%		30%
60	19%	5%	22%	5%	100%		30%		100%
61	18%	5%	22%	5%	100%		30%		100%
62	40%	40%	36%	30%	100%		30%	10%	100%
63	35%	35%	22%	30%	100%		30%	10%	100%
64	25%	30%	20%	25%	100%		30%	10%	100%
65	35%		35%		100%		30%	10%	100%
66	40%		45%		100%		30%	10%	100%
67	45%		40%		100%	50%	30%		100%
68	30%		40%		100%	50%	30%		100%
69	30%		40%		100%	50%	30%		100%
70	40%		50%		100%	100%	100%		100%
71	50%		50%		100%	100%	100%		100%
72	50%		100%		100%	100%	100%		100%
73	50%		100%		100%	100%	100%		100%
74	100%		100%		100%	100%	100%		100%



Rates of Disability

All Plan Participants

	% of Act	tive Participar	ts Becoming D	Disabled
	Uniformed	Members	Non-Uniform	ned Members
Age	Male	Female	Male	Female
	0.400/	0.400/	0.000/	0.000/
20	0.10%	0.10%	0.06%	0.06%
21	0.10%	0.10%	0.06%	0.06%
22	0.10%	0.10%	0.07%	0.07%
23	0.10%	0.10%	0.07%	0.07%
24	0.10%	0.10%	0.07%	0.07%
25	0.10%	0.10%	0.08%	0.08%
26	0.10%	0.10%	0.08%	0.08%
27	0.10%	0.10%	0.09%	0.09%
28	0.10%	0.10%	0.09%	0.09%
29	0.10%	0.10%	0.09%	0.09%
30	0.10%	0.10%	0.10%	0.10%
31	0.10%	0.10%	0.10%	0.10%
32	0.10%	0.10%	0.11%	0.11%
33	0.10%	0.10%	0.11%	0.11%
34	0.10%	0.10%	0.12%	0.12%
35	0.10%	0.10%	0.13%	0.13%
36	0.10%	0.10%	0.13%	0.13%
37	0.10%	0.10%	0.14%	0.14%
38	0.10%	0.10%	0.14%	0.14%
39	0.10%	0.10%	0.15%	0.15%
40	0.10%	0.10%	0.17%	0.17%
41	0.10%	0.10%	0.19%	0.19%
42	0.10%	0.10%	0.21%	0.21%
43	0.10%	0.10%	0.23%	0.23%
44	0.10%	0.10%	0.24%	0.24%
45	0.10%	0.10%	0.27%	0.27%
46	0.10%	0.10%	0.30%	0.30%
47	0.10%	0.10%	0.32%	0.32%
48	0.10%	0.10%	0.36%	0.36%
49	0.10%	0.10%	0.41%	0.41%
50	0.10%	0.10%	0.46%	0.46%
51	0.10%	0.10%	0.52%	0.52%
52	0.10%	0.10%	0.59%	0.59%
53	0.10%	0.10%	0.68%	0.68%
54	0.10%	0.10%	0.77%	0.77%
55	0.10%	0.10%	0.86%	0.86%
50	0.10%	0.10%	0.97%	0.97%
57	0.10%	0.10%	1.09%	1.09%
58	0.10%	0.10%	1.22%	1.22%
59	0.10%	0.10%	1.35%	1.35%
60 C1	0.10%	0.10%	1.49%	1.49%
61	0.10%	0.10%	1.04%	1.04%
62	0.10%	0.10%	1.00%	1.00%
64	0.10%	0.10%	1.97%	1.97%
65	0.10%	0.10%	2.13%	2.13%
65	0.10%	0.10%	0.00%	0.00%
67	0.10%	0.10%	0.00%	0.00%
60	0.10%	0.10%	0.00%	0.00%
60	0.10%	0.10%	0.00%	0.00%
70	0.10%	0.10%	0.00%	0.00%
70	0.10%	0.10%	0.00%	0.00%
72	0.10%	0.10%	0.00%	0.00%



Rates of Separation from Active Employment

		% of Active Participants Withdrawing				
		Uniformed	Members	Non-Uniform	ed Members	
Age	Service	Male	Female	Male	Female	
	0-1	12.00%	12.00%	30.00%	20.00%	
	1-2	6.00%	6.00%	16.00%	14.00%	
	2-3	2.50%	2.50%	9.00%	11.00%	
	3-4	2.50%	2.50%	7.00%	9.00%	
	4-5	2.50%	2.50%	5.50%	6.00%	
25	5 & Up	1.89%	1.89%	5.60%	6.00%	
26		1.89%	1.89%	5.60%	6.00%	
27		1.89%	1.89%	5.60%	6.00%	
28		1.89%	1.89%	5.60%	6.00%	
29		1.89%	1.89%	5.60%	6.00%	
30		1.89%	1.89%	5.60%	6.00%	
31		1.89%	1.89%	5.53%	6.00%	
32		1.83%	1.83%	5.46%	6.00%	
33		1.65%	1.65%	5.39%	6.00%	
34		1.49%	1.49%	5.32%	6.00%	
35		1.34%	1.34%	5.25%	6.00%	
36		1.19%	1.19%	5.18%	6.00%	
37		1.06%	1.06%	5.11%	6.00%	
38		0.95%	0.95%	5.04%	6.00%	
39		0.86%	0.86%	4.97%	5.78%	
40		0.79%	0.79%	4.90%	5.54%	
41		0.74%	0.74%	4.48%	5.29%	
42		0.69%	0.69%	4.06%	5.05%	
43		0.64%	0.64%	3.64%	4.81%	
44		0.60%	0.60%	3.22%	4.56%	
45		0.55%	0.55%	2.80%	4.32%	
46		0.50%	0.50%	2.66%	4.12%	
47		0.46%	0.46%	2.52%	3.92%	
48		0.41%	0.41%	2.38%	3.72%	
49		0.36%	0.36%	2.24%	3.36%	
50		0.32%	0.32%	2.10%	3.00%	
51		0.27%	0.27%	1.96%	3.00%	
52		0.23%	0.23%	1.82%	3.00%	
53		0.21%	0.21%	1.68%	3.00%	
54		0.19%	0.19%	1.54%	3.00%	
55		0.16%	0.16%	1.40%	3.00%	
56		0.17%	0.17%	1.40%	3.00%	
57		0.13%	0.13%	1.40%	3.00%	
58		0.13%	0.13%	1.40%	3.00%	
59		0.13%	0.13%	1.40%	3.00%	
60		0.12%	0.12%	1.40%	3.00%	

All Plan Participants



Miscellaneous and Technical Assumptions

Administrative Expenses:	1.15% of payroll, based upon actual results from previous year.
Disability Expenses:	0.53% of payroll included in contribution. Retirement system pays premium directly to an outside insurance company or TPA.
Marriage Assumption:	90% of participants are assumed to be married for purposes of death-in- service benefits. Applies to disabled members entitled to future retirement benefits also. Male spouses are assumed to be 3 years older than females if beneficiary information is not available. For purposes of valuing the 50% death after retirement benefit, 100% of closed active members are assumed to be married.
Pay Increase Timing:	Beginning of (Fiscal) year. This is equivalent to assuming that reported pays represent amounts paid to members during the year ended on the valuation date.
Decrement Timing:	Decrements of all types are assumed to occur mid-year.
Eligibility Testing:	Eligibility for benefits is determined based upon the age nearest birthday and service nearest whole year on the date the decrement is assumed to occur.
Benefit Service:	Exact fractional service is used to determine the amount of benefit payable.
Decrement Relativity:	Decrement rates are used directly from the experience study, without adjustment for multiple decrement table effects.
Normal Form of Benefit:	The assumed normal form of benefit is a 50% joint & survivor benefit for married members in the Closed Plan and a straight life benefit for all other members.
Optional Benefit Factors:	Optional Benefit Factors are in accordance with tables adopted by the Board. We believe these factors are reasonably close to actuarial equivalence based on valuation assumptions. The reduction for the Y2K and 2011 Tier benefits was calculated in accordance with 104.1027 RSMo.
Deferred Joint and Survivor:	It was assumed that all deferred members eligible for the Closed plan would choose Closed plan benefits at retirement.
Other:	Turnover decrements do not operate during retirement eligibility.
Miscellaneous Adjustments:	The calculated normal and early retirement benefits for the Closed and Year 2000 plans were increased by 3.75% for Uniformed and 2.6% for Non-Uniformed to account for the inclusion of unused sick leave in the calculation of Average Pay. The calculated normal and early retirement benefits for the 2011 Tier plan were increased by 1.5% for Uniformed and 1.0% for Non-Uniformed to account for the inclusion of unused sick leave in the calculation of Average Pay. Post disability benefit liabilities were increased by 50% for all future disabilities to account for potential survivor benefits payable by the retirement system during the period of disability. Current self-insured disability retirant liabilities are increased by 12% to account for future survivor benefits.



Miscellaneous and Technical Assumptions

Contribution Stabilization

Reserve Fund:	The contribution stabilization reserve fund affects the total amount of UAAL financed and is assumed to grow at the investment return rate.
Death Prior to Retirement:	100% of deaths in service are assumed to be non-duty.
Gainful Employment Offset:	30% of the \$90 per month special benefit is assumed to be offset by gainful employment.
Minimum Benefit Eligibility:	Deferred benefits and death prior to retirement benefits are assumed to be eligible for the minimum base benefit along with normal and early retirement benefits.
Active Plan Choice:	It was assumed that active members eligible for the Closed plan would choose the Closed plan benefits at retirement.
Member Contribution Interest:	Member contributions are assumed to be credited with 3.0% interest.

Data

Active and retired member data was reported as of May 31. It was brought forward to June 30 by adding one month of service for all active members and otherwise making no other adjustments. It was assumed that the population as of May 31 was statistically equivalent to the population as of June 30. Financial information is reported as of June 30.

Salary Adjustments: Salary from data as provided in prior valuations was used for two active members on leave. Salary for new hires was annualized.

Disabled Member Data: Y2K and 2011 Tier data as provided are increased by 80% of CPI from date of disability to the valuation date and projected increases from the valuation date to the retirement date at 2.0% annually. For purposes of valuing these benefits, the 2.0% projected annual increases are backed out and replaced with 1.8% (80% of the current 2.25% CPI assumption) projected annual increases.

Reconciliation and Review: Reported data was reconciled to data reported for the prior year and reviewed for completeness and reasonableness. Any questions arising from this review were discussed with System staff. Upon completion of the review control totals (see page 1), were shared with the Executive Director and discussed to ensure MPERS also agreed that the data was reasonable.



Method of Financing Future Benefits for Present Active Members

The valuation was prepared in accordance with Section 104.1066 of the Missouri Revised Statutes, which requires the use of the entry-age normal actuarial cost method for determining normal cost and level percent-of-payroll financing of unfunded actuarial accrued liabilities. Details of the application of these methods are described below.

Normal cost and the allocation of present values between service rendered before and after the valuation date were determined using an individual entry-age actuarial cost method having the following characteristics:

- (i) the annual normal cost for each individual active member, payable from the date of employment to the date of retirement, is sufficient to accumulate the value of the member's benefit at the time of retirement; and
- (ii) each annual normal cost is a constant percentage of the member's year by year projected covered pay.

The *Value of Future Benefits* was calculated using the benefits assumed to be payable in the future to current active, terminated vested and retired members. It was assumed that current active and retired Uniformed Patrol members hired prior to July 1, 2000 would elect to retain the benefits under the current plan. Computed costs were increased in accordance with the adjustments described on page E-14.

The *Present Value of Future Normal Costs* was defined as the average normal cost rate multiplied by the present value of future payroll for the group.

The *Actuarial Accrued Liabilities* were defined as the difference between the present value of future benefits and the present value of future normal costs.

The **Contribution Stabilization Reserve Fund (CSR)** is set by the Board based on deferred recognition of gains in an effort to stabilize employer contributions from year to year. The fund is capped at \$250,000,000.

Actuarial Accrued Liabilities, less pension assets as of June 30, 2019, resulted in **Unfunded Actuarial Accrued Liabilities (UAAL).** The UAAL plus the CSR was amortized using the following funding policy.

Permanent Policy: The total contribution will be based on normal cost plus a 16-year amortization of unfunded actuarial accrued liabilities. The amortization period is a closed 16-year period starting July 1, 2020.

Temporary Accelerated Policy: The total contribution is based on normal cost plus a 5-year amortization period for unfunded retiree liabilities and a 20-year amortization period for other unfunded liabilities. Both amortization periods are closed periods starting July 1, 2020.

This temporary accelerated policy was adopted by the Retirement Board on September 17, 2009 and will remain in effect until such time as the retiree liability becomes 100% funded or the permanent policy produces a higher contribution rate.

Post-Valuation Date Activity: No other adjustments were made to the valuation results to reflect other post-valuation date activity.



June 30, 2019 Actuarial Valuation Glossary

Actuarial Accrued Liability. The difference between (i) the actuarial present value of future plan benefits, and (ii) the actuarial present value of future normal cost. Sometimes referred to as "accrued liability" or "past service liability."

Accrued Service. The service credited under the plan which was rendered before the date of the actuarial valuation.

Actuarial Assumptions. Estimates of future plan experience with respect to rates of mortality, disability, turnover, retirement, rate or rates of investment income and salary increases. Decrement assumptions (rates of mortality, disability, turnover and retirement) are generally based on past experience, often modified for projected changes in conditions. Economic assumptions (salary increases and investment income) consist of an underlying rate in an inflation-free environment plus a provision for a long-term average rate of inflation.

Actuarial Cost Method. A mathematical budgeting procedure for allocating the dollar amount of the "actuarial present value of future plan benefits" between the actuarial present value of future normal cost and the actuarial accrued liability. Sometimes referred to as the "actuarial funding method."

Actuarial Equivalent. A series of payments is called an actuarial equivalent of another series of payments if the two series have the same actuarial present value.

Actuarial Present Value. The amount of funds presently required to provide a payment or series of payments in the future. It is determined by discounting the future payments at a predetermined rate of interest, taking into account the probability of payment.

Actuarial value of Assets. Also referred to as funding value of assets, smoothed market value of assets, or valuation assets.

Valuation assets recognize assumed investment return fully each year. Differences between actual and assumed investment return are phased-in over a closed 3-year period. This treatment helps remove the timing of investment activities from the valuation process. During periods when investment performance exceeds the assumed rate, valuation assets will tend to be less than market value. During periods when investment performance is less than the assumed rate, valuation assets will tend to be greater than market value. If assumed rates are exactly realized for 3 consecutive years, valuation assets will become equal to market value.

Actuary. A person who is trained in the applications of probability and compound interest to problems in business and finance that involve payment of money in the future, contingent upon the occurrence of future events. Most actuaries in the United States are Members of the American Academy of Actuaries. The Society of Actuaries is an international research, education and membership organization for actuaries in the life and health insurance, employee benefits, and pension fields. It administers a series of examinations leading initially to Associateship and the designation ASA and ultimately to Fellowship with the designation FSA.



June 30, 2019 Actuarial Valuation Glossary (Concluded)

Amortization. Paying off an interest-bearing liability by means of periodic payments of interest and principal, as opposed to paying it off with a lump sum payment.

Experience Gain (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, in accordance with the actuarial cost method being used.

Normal Cost. The annual cost assigned, under the actuarial funding method, to current and subsequent plan years. Sometimes referred to as "current service cost." Any payment toward the unfunded actuarial accrued liability is not part of the normal cost.

Plan Termination Liability. The actuarial present value of future plan benefits based on the assumption that there will be no further accruals for future service and salary. The termination liability will generally be less than the liabilities computed on a "going concern" basis and is not normally determined in a routine actuarial valuation.

Reserve Account. An account used to indicate that funds have been set aside for a specific purpose and are not generally available for other uses.

Unfunded Actuarial Accrued Liability. The difference between the actuarial accrued liability and actuarial value of assets. Sometimes referred to as "unfunded accrued liability."

The existence of unfunded actuarial accrued liabilities is not in itself bad, any more than a mortgage on a house is bad. Unfunded actuarial accrued liabilities do not represent a debt that is payable today. What is important is the ability to amortize the unfunded actuarial accrued liabilities and the trend in their amount (after due allowance for devaluation of the dollar).

Valuation Payroll. Active member payroll that is intended to reflect the annual salary considered as covered compensation for Retirement System benefits.



SECTION F

FINANCIAL PRINCIPLES AND OPERATIONAL TECHNIQUES

Financial Principles and Operational Techniques of the Retirement System

Promises Made, and To Be Paid For. As each year is completed, the Retirement System in effect hands an "IOU" to each member then acquiring a year of service credit -- the "IOU" says: "The Missouri Department of Transportation and Highway Patrol Employees' Retirement System owes you one year's worth of retirement benefits, payments in cash commencing when you qualify for retirement."

The principal related financial question is: When shall the money required to cover the "IOU" be contributed? This year, when the benefit of the member's service is received? Or, some future year when the "IOU" becomes a cash demand?

The objective of level percent-of-payroll financing is that this year's taxpayers contribute the money to cover the IOUs being handed out this year. By following this objective, the employer contribution rate will remain approximately level from year to year --- and will not have to be increased for future generations of taxpayers. However, "Level percent-of-payroll" does NOT mean "Fixed percent-of-payroll." The level percent-of-payroll is an estimate that may change from one year to the next.

(There are systems which have a design for deferring contributions to future taxpayers, lured by a lower contribution rate now and putting aside the consequence that the contribution rate must then relentlessly grow much greater over decades of time.)

An inevitable by-product of the level-cost design is the accumulation of reserve assets, for decades, and the income produced when the assets are invested. *Invested assets are a by-product and not the objective.* Investment income becomes the 3rd contributor for benefits to employees, and is interlocked with the contribution amounts required from employees and employer.



Financial Principles and Operational Techniques of the Retirement System (Concluded)

Translated to actuarial terminology, this level-cost objective means that the contribution rates must total at least the following:

Normal Cost (the value assigned to service being rendered this year)

. . . plus . . .

Interest on Unfunded Actuarial Accrued Liabilities (the difference between liabilities for service already rendered and the accrued assets of the Retirement System).

Computing Contributions to Support System Benefits. From a given schedule of benefits and from the employee data and asset data furnished by the system, the actuary determines the contribution rates to support the benefits, by means of **an actuarial valuation.**

An actuarial valuation has a number of ingredients such as: the rate of investment return which plan assets will earn; the rates of withdrawal of active members who leave covered employment; the rates of mortality; the rates of disability; the rates of pay increases and the assumed age or ages at actual retirement.

In an actuarial valuation the actuary must assume what the above rates will be, for the next year and for decades in the future. Only the subsequent actual experience of the plan can indicate the degree of accuracy of the assumptions.

Reconciling Differences Between Assumed Experience and Actual Experience. Once actual experience has occurred and has been observed, it will not coincide exactly with assumed experience, regardless of the skill of the actuary and the many calculations made. Most retirement systems cope with such differences by having annual actuarial valuations. Each actuarial valuation is a complete recalculation of assumed future experience, taking into account all past differences between assumed and actual experience. The result is **continuing adjustments to the financial position.**



Actuarial Valuation Process

The *actuarial valuation* is the mathematical process by which the contribution rate is determined, and the flow of activity constituting the valuation may be summarized as follows:

A. *Covered people data* furnished by plan administrator, including:

Retired lives now receiving benefits

Former employees with vested benefits not yet payable

Active employees

- B. + Asset data (cash & investments), furnished by the plan administrator
- C. + Benefit provisions which specify eligibility and amounts of pensions
- D. + **Assumptions concerning future experience in various risk areas,** which are established by the Retirement Board after consulting with the actuary
- E. + **The funding method** for employer contributions (the long-term, planned pattern for employer contributions)
- F. + Mathematically combining the assumptions, the funding method, and the data
- G. = Determination of:

Plan Financial Position and/or

New Employer Contribution Rate



Meaning of "Unfunded Actuarial Accrued Liabilities"

"Actuarial accrued liabilities" are the portion of the present value of plan promises to pay benefits in the future that are not covered by future normal cost contributions. A liability has been established ("accrued") because the service has been rendered but the resulting monthly cash benefit may not be payable until years in the future. Actuarial accrued liabilities are the result of complex mathematical calculations, which are made by the plan's actuary.

If "actuarial accrued liabilities" exceed the plan's accrued assets (cash & investments), the difference is *"unfunded actuarial accrued liabilities."* This is the usual condition. If the plan's assets equaled the plan's "actuarial accrued liabilities," then the plan would be termed "fully funded." This is an unusual condition.

Each time a plan adds a new benefit, which applies to service already rendered, an "actuarial accrued liability" is created, which is also an "unfunded actuarial accrued liability" because the plan can't print instant cash to cover the value of the new benefit promises. Payment for such unfunded actuarial accrued liabilities is spread over a period of years, commonly in the 20-30 year range.

Unfunded actuarial accrued liabilities can occur in another way: if actual plan experience is less favorable than assumed plan experience, the difference is added to unfunded actuarial accrued liabilities. In plans where benefits are directly related to an employee's pay near time of retirement, unfunded actuarial accrued liabilities rose dramatically during the 1970's. Unexpected rates of pay increase created additional actuarial accrued liabilities, which could not be matched by reasonable investment results. More recent experience has generally been more favorable with some reductions in unfunded actuarial accrued liabilities.

The existence of unfunded actuarial accrued liabilities is not bad, but the changes from year to year in the amount of unfunded actuarial accrued liabilities are important, --- "bad" or "good" or somewhere in between.

Even though unfunded actuarial accrued liabilities don't constitute a bill payable immediately, it is important that policy-makers prevent the amount from becoming unreasonably high and *it is vital for plans to have a sound method for making payments toward them* so that they are controlled.



SECTION G

SUPPLEMENTAL INFORMATION FOR COMPREHENSIVE ANNUAL FINANCIAL REPORTING



Retirement Board Missouri Department of Transportation and Highway Patrol Employees' Retirement System 1913 William Street Jefferson City, Missouri 65102-1930

Ladies and Gentlemen:

This report was prepared at the request of the Board and is intended for use by the Retirement System and those designated or approved by the Board. This report may be provided to parties other than the System only in its entirety and only with the permission of the Board. GRS is not responsible for unauthorized use of this report. This report should not be relied on for any purpose other than the purpose described.

The basic financial objective of the Missouri Department of Transportation and Highway Patrol Employees' Retirement System (MPERS) is to establish and receive contributions which:

- (1) when expressed in terms of percents of active member payroll, will remain approximately level from generation to generation of Missouri citizens; and
- (2) when combined with present assets and future investment returns, will be sufficient to meet the present and future financial obligations of MPERS.

In order to measure progress toward this fundamental objective, MPERS has annual actuarial valuations performed. The valuations (i) measure the present financial position, and (ii) establish contribution rates that provide for the current cost and level percent-of-payroll amortization of unfunded actuarial liabilities over a reasonable period. An actuarial valuation was performed based upon benefit conditions, data and assumptions as of June 30, 2019. This valuation indicates that contribution rates for the period beginning July 1, 2020 that are at least equal to the calculated contribution rates will meet the Board's financial objective. The calculated contribution rates are 58.00% of payroll for the 6,210 Non-Uniformed employees and 58.00% of payroll for the 1,211 Uniformed patrol employees.

The plan administrative staff provides the actuary with data for the actuarial valuation. The actuary relies on the data after reviewing it for internal and year to year consistency. Member data was not audited by the actuary. The actuary summarizes and tabulates population data in order to analyze longer term trends. We are not responsible for the accuracy or completeness of the data provided by MPERS.

Retirement Board September 25, 2019 Page 2

Gabriel, Roeder, Smith & Company was responsible for the following schedules found in the Actuarial Section:

Summary of Actuarial Assumptions and Methods
Probabilities of Separation from Active Employment
Individual Salary Increases
Joint Life Retirement Values
Probabilities of Retirement for Members
Probabilities of Disability for Members
Summary of Member Data Included in Valuations
Active Members by Attained Age and Years of Service
Schedule of Active Member Valuation Data
Solvency Test
Derivation of Financial Experience
Schedule of Retirees and Beneficiaries Added and Removed
Summary of Plan Provisions
Legislative Changes

Gabriel, Roeder, Smith & Company was responsible for the following schedules found in the Financial Section:

Schedule of Changes in the Employer's Net Pension Liability Schedule of Employer's Net Pension Liability Schedule of Employer Contributions Schedule of the Actuarially Determined Contributions

Actuarial valuations are based upon assumptions regarding future activity in specific risk areas including the rates of investment return and payroll growth, eligibility for the various classes of benefits, and longevity among retired lives. These assumptions are adopted by the Board. The assumptions and the methods comply with the requirements of the Governmental Accounting Standards Board. Each actuarial valuation takes into account all prior differences between actual and assumed experience in each risk area and adjusts the contribution rates as needed. Actuarial methods and assumptions were adopted by the Board pursuant to the June 30, 2017 Experience Study. Gabriel, Roeder, Smith & Company has produced the following reports as of June 30, 2019:

Annual Actuarial Valuation Report GASB Nos. 67 and 68 Valuation Report

In order to gain a full understanding of the condition of this plan, these reports should be read in their entirety.



Retirement Board September 25, 2019 Page 3

To the best of our knowledge, the report is complete and accurate and was made in accordance with standards of practice promulgated by the Actuarial Standards Board. The assumptions and methods used for funding purposes meet the parameters set by Actuarial Standards of Practice. The actuarial assumptions used for the valuation produce results which, individually and in the aggregate, are reasonable.

The employer contributions determined in this report are based on Board funding policy. This policy is discussed on page 3 of the annual actuarial valuation report. We commend the Board for its aggressive monitoring and updating of the funding policy over the recent past. However, continued employer contributions at the current level do not guarantee benefit security. We therefore encourage the Board to continue to routinely monitor and update its funding policy and to continue to consider benefit security when doing so.

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 (such as the end of an amortization period or additional cost or contribution requirements based on the plan's funded status); and changes in plan provisions or applicable law.

This report has been prepared by individuals who have substantial experience valuing public employee retirement systems. Heidi G. Barry is a Member of the American Academy of Actuaries (MAAA) and meets the Qualification Standards of the American Academy of Actuaries to render the actuarial opinions contained herein.

The signing individuals are independent of the plan sponsor.

Based upon the valuation results, it is our opinion that the Missouri Department of Transportation and Highway Patrol Employees' Retirement System continues to operate in accordance with actuarial principles of level percent-of-payroll financing. It is important to the well-being of the System that it continues to receive contributions at the actuarially determined levels. It is also important to continue to monitor both the total funded status and the funded status of the retiree liabilities to ensure that the funding policy is consistent with the expected life span of the respective unfunded obligation.

Respectfully submitted,

Heidi H Barry, ASA, FCA, MAAA

Kenned & allet

Kenneth G. Alberts



Solvency Test

The MPERS funding objective is to meet long term benefit promises through contributions that remain approximately level from year-to-year as a percent of member payroll. If the contributions to the System are level in concept and soundly executed, the System will *pay all promised benefits when due – the ultimate test of financial soundness.*

A solvency test is one means of checking a system's progress under its funding program. In a solvency test for a non-contributory plan, the plan's present assets (cash and investments) are compared with: 1) The liabilities for future benefits to present retired lives, and 2) The liabilities for service already rendered by members. In a system that has been following the discipline of level percent-of-payroll financing, the liabilities for future benefits to present retired lives (liability 1) will be fully covered by present assets (except in rare circumstances). In addition, the liabilities for service already rendered by members (liability 2) will be partially covered by the remainder of present assets. The larger the funded portion of liability 2, the stronger the condition of the system.

Val. Date	(1) Member	(2) Retirees and	(3) Active and Inactive	Present Valuation	Portion of Present Values Covered by Present Assets				
June 30	Contributions	Benef.	Members	Assets	(1) (2) (3) T				
		\$ Mil	lions						
2010#	0	2,034	1,225	1,376	100%	68%	0%	42%	
2011	0	2,045	1,253	1,427	100%	70%	0%	43%	
2012#	0	2,133	1,173	1,531	100%	72%	0%	46%	
2013#	1	2,333	1,250	1,657	100%	71%	0%	46%	
2014	2	2,384	1,264	1,795	100%	75%	0%	49%	
2015	3	2,444	1,269	1,967	100%	80%	0%	53%	
2016	5	2,470	1,287	2,087	100%	84%	0%	55%	
2017	8	2,488	1,306	2,173	100%	87%	0%	57%	
2018#	11	2,598	1,373	2,274	100%	87%	0%	57%	
2019	14	2,656	1,367	2,415	100%	90%	0%	60%	

The schedule below illustrates the history of liability 2 of the System.

New assumptions and/or methods adopted.



Derivation of Experience Gain/(Loss)

Actual experience will never coincide exactly with assumed experience (except by coincidence). Gains and losses may offset each other over a period of years, but sizeable year-to-year variations from assumed experience are common. Detail on the derivation of the experience gain/(loss) is shown below:

	\$ Millions
UAAL Beginning of Year (at July 1) Normal Cost Contributions Interest Net Change in LTD Assets	\$ 1,707,590,819 48,532,753 (218,595,641) 113,579,156 -
Expected UAAL Before Any Changes Effect of Benefit Changes Effect of Changes in Assumptions & Methods Effect of Adjustment Expected UAAL After Changes	1,651,107,087 - - 1,651,107,087
End of Year UAAL (at June 30)	\$ 1,622,026,277
Gain/(Loss) for Year	\$ 29,080,810
Gain/(Loss) as a percent of actuarial accrued liabilities at start of year (\$3,981.8 million)	0.7%

	Experience Gain/(Loss)
Valuation Date	as % of Beginning
June 30	Accrued Liability
2010	(3.8)%
2011	2.2 %
2012	3.2 %
2013	2.1 %
2014	2.1 %
2015	2.4 %
2016	1.1 %
2017	0.1 %
2018	0.6 %
2019	0.7 %



Summary of Actuarial Assumptions and Methods

Valuation Date:
Actuarial Cost Method:
Amortized Method:
Remaining Amortization Period:
Asset Valuation Method:
Actuarial Assumptions:
Investment Rate of Return:
Projected Salary Increase:
Cost-of-Living Adjustments:
Includes Wage Inflation at:

June 30, 2019 Entry Age Closed, level percent-of-payroll 13 years# 3-year smoothing

7.00% 3.00% to 12.45% 1.80% Compound 3.00%

Single equivalent period.

An actuarial valuation is based upon an actuarial cost method, an asset valuation method, and actuarial assumptions. These methods and assumptions are chosen by the Board of Trustees after consultation with the Actuary and other advisors.

The actuarial cost method is called the Entry Age Actuarial Cost Method. This method is consistent with the Board's level percent-of-payroll funding objective. With this method, the level percent-of-payroll is determined that will fund a member's retirement benefit over the member's entire working lifetime, from date of hire (Entry Age) to date of exit from the active member population. Differences in the past between assumed and actual experience become part of unfunded actuarial accrued liabilities and are amortized with level percent-of-payroll contributions. This cost method was first used in the *June 30*, *1999* valuation.

The asset valuation method is a three-year smoothed market value method in which assumed investment return is recognized immediately each year and differences between actual and assumed investment return are phased-in over a closed three-year period. This asset valuation method is intended to give recognition to the long term accuracy of market values while filtering out and dampening short term market swings. This method was first used in the *June 30, 1999* valuation.

The actuarial assumptions used in producing the valuation fall into two broad classes: economic assumptions, and demographic assumptions. Economic assumptions refer to long term rates of investment return, wage growth, covered population growth, and inflation. Demographic assumptions refer to retirement rates, turnover rates, disability rates, merit and seniority pay increases, and mortality rates. The current assumptions are based upon a 2012-2017 study of experience of the MPERS. The assumptions are reviewed from time to time to keep them reasonably current with expected experience. The next experience study is scheduled to follow the June 30, 2022 valuation.

Economic Assumptions

The investment return rate used in making the valuation was 7.00% per year, compounded annually (net after administrative expenses). This rate of return is not the assumed real rate of return. The real rate of return over wage inflation is defined to be the portion of investment return which is more than the wage inflation rate. Considering wage inflation recognition of 3.00%, the 7.00% rate translates to an assumed real rate of return over wage inflation of 4.00%. This rate was first used for the *June 30, 2018* valuation.



Summary of Actuarial Assumptions and Methods (Concluded)

Pay increase assumptions for individual active members are shown on Table I. Part of the assumption for each year of service is for a merit and/or seniority increase, and the other 3.00% recognizes wage inflation. These rates were first used for the **June 30, 2018** valuation.

Price Inflation is assumed to be 2.25%. This results in a 1.8% annual COLA assumption. It is assumed that the 1.8% COLA will always be paid.

The Active Member Group size is assumed to remain constant at its present level.

The active member payroll for all members is assumed to increase 3.00% annually.

Non-Economic Assumptions

The mortality table used to measure Post-Retirement Healthy Mortality Rates are from the RP-2014 Healthy Annuitant Mortality Tables projected to 2022 using projection scale MP-2017, shown in Table II. Post-Retirement Disabled Mortality Rates use the RP-2014 Disabled Retiree Annuitant Mortality Tables projected to 2022 using projection scale MP-2017, shown in Table III. Pre-Retirement Mortality Rates use the RP-2014 Employee Mortality Tables projected to 2022 using projection scale MP-2017 and multiplied by a factor of 65%, shown in Table IV. These tables were first used for the **June 30, 2018** valuation.

The probabilities of retirement for members eligible to retire are shown on Table VI. The rates for full retirement were first used in the **June 30, 2018** valuation. The rates for reduced retirement were first used in the **June 30, 2018** valuation. Upon retirement, members are assumed to pick the BackDROP period that when combined with the remaining annuity produces the highest liability.

The probabilities of disability for members eligible to retire are shown on Table VII. The rates for disability were first used in the **June 30, 2018** valuation.

The probabilities of withdrawal from service, death-in-service and disability are shown for sample ages on Table VIII. The death-in-service and disability rates were first used in the **June 30, 2018** valuation. The withdrawal rates were first used in the **June 30, 2018** valuation.

The data about persons now covered and about present assets was furnished by the System's administrative staff. Although examined for general reasonableness, the data was not audited by the Actuary. Data was furnished as of May 31 and assumed to be statistically equivalent to June 30.

The actuarial valuation computations were made by or under the supervision of a Member of the American Academy of Actuaries (MAAA).



Table IService Based Salary Scale

Г

% Merit Increases in Salaries Next Year							
Service Uniformed Non-Uniforme Index Members Members							
1	9.45%	6.80%					
2	5.00%	4.50%					
3	2.75%	2.80%					
4	2.50%	1.50%					
5	2.00%	1.00%					
6	1.50%	0.80%					
7	1.25%	0.00%					
8	1.25%	0.00%					
9	1.00%	0.00%					
10	0.75%	0.00%					
11	0.75%	0.00%					
12	0.75%	0.00%					
13	0.50%	0.00%					
14	0.50%	0.00%					
15	0.25%	0.00%					
16	0.25%	0.00%					
17	0.25%	0.00%					
18	0.25%	0.00%					
19	0.25%	0.00%					
20	0.25%	0.00%					
21	0.00%	0.00%					
22	0.00%	0.00%					
23	0.00%	0.00%					
24	0.00%	0.00%					
25	0.00%	0.00%					



Table IIPost-Retirement Mortality

Retired Lives Mortality Rates

	% Dying I	Next Year		% Dying Next Year				% Dying I	Next Year
Age	Male	Female	Age	Male	Female		Age	Male	Female
	0.00.000/	0.04740/		0.70000/	0.50070/		400	24.20240	
20	0.0369%	0.0174%	60	0.7938%	0.5667%		100	31.3381%	28.0166%
21	0.0408%	0.0195%	61	0.8547%	0.6147%		101	33.3774%	30.0266%
22	0.0449%	0.0223%	62	0.9205%	0.6657%		102	35.3995%	32.0621%
23	0.0492%	0.0256%	63	0.9918%	0.7196%		103	37.3951%	34.0941%
24	0.0538%	0.0295%	64	1.0684%	0.7773%		104	39.3487%	36.0900%
25	0.0588%	0.0340%	65	1.1511%	0.8398%		105	41.2343%	38.0614%
26	0.0641%	0.0388%	66	1.2408%	0.9085%		106	43.0470%	39.9941%
27	0.0700%	0.0441%	67	1.3387%	0.9850%		107	44.7813%	41.8213%
28	0.0764%	0.0499%	68	1.4472%	1.0710%		108	46.4200%	43.5827%
29	0.0836%	0.0567%	69	1.5680%	1.1678%		109	47.9720%	45.2475%
30	0.0916%	0.0644%	70	1.7034%	1.2770%		110	49.4044%	46.8213%
31	0.1004%	0.0731%	71	1.8549%	1.4005%		111	49.9809%	48.2854%
32	0.1098%	0.0828%	72	2.0259%	1.5392%		112	49.9755%	49.6513%
33	0.1201%	0.0933%	73	2.2187%	1.6965%		113	49.9953%	50.2110%
34	0.1300%	0.1047%	74	2.4366%	1.8727%		114	49.9851%	50.0952%
35	0.1405%	0.1166%	75	2.6823%	2.0723%		115	50.0000%	50.0000%
36	0.1519%	0.1291%	76	2.9606%	2.2975%		116	50.0000%	50.0000%
37	0.1638%	0.1413%	77	3.2770%	2.5540%		117	50.0000%	50.0000%
38	0.1766%	0.1532%	78	3.6348%	2.8455%		118	50.0000%	50.0000%
39	0.1899%	0.1644%	79	4.0410%	3.1769%		119	50.0000%	50.0000%
40	0.2035%	0.1750%	80	4.5024%	3.5553%		120	100.0000%	100.0000%
41	0.2169%	0.1838%	81	5.0252%	3.9869%	'			
42	0.2307%	0.1918%	82	5.6159%	4.4782%				
43	0.2453%	0.1994%	83	6.2866%	5.0381%				
44	0.2609%	0.2070%	84	7.0474%	5.6722%				
45	0.2779%	0.2146%	85	7.9002%	6.3897%				
46	0.2964%	0.2231%	86	8.8634%	7.1988%				
47	0.3167%	0.2325%	87	9.9417%	8.1051%				
48	0.3394%	0.2424%	88	11.1427%	9.1109%				
49	0.3644%	0.2533%	89	12.4767%	10.2194%				
50	0.3922%	0.2660%	90	13.9500%	11.4522%				
51	0.4231%	0.2806%	91	15.4968%	12.7799%				
52	0.4563%	0.2986%	92	17.0856%	14.1857%				
53	0.4885%	0.3200%	93	18.6789%	15.6544%				
54	0.5223%	0.3449%	94	20.2575%	17.1685%				
55	0.5582%	0.3734%	95	21.8007%	18.7264%				
56	0.5971%	0.4054%	96	23.6045%	20.4458%				
57	0.6398%	0.4409%	97	25.4442%	22.2335%				
58	0.6865%	0.4797%	98	27.3578%	24.1013%				
59	0.7377%	0.5218%	99	29.3232%	26.0345%				



Table III Post-Retirement Mortality

Disabled Retired Lives Mortality Rates

	% Dying I	Next Year		% Dying Next Year			% Dying	Next Year
Age	Male	Female	Age	Male	Female	Age	Male	Female
20	0.0438%	0.0203%	60	2.7176%	1.8560%	100	32.6085%	28.7749%
21	0.0612%	0.0284%	61	2.8283%	1.9166%	101	34.2769%	30.5690%
22	0.0856%	0.0397%	62	2.9435%	1.9759%	102	35.9695%	32.4095%
23	0.1168%	0.0547%	63	3.0631%	2.0367%	103	37.6945%	34.2784%
24	0.1553%	0.0728%	64	3.1849%	2.1023%	104	39.4530%	36.1549%
25	0.2005%	0.0940%	65	3.3118%	2.1768%	105	41.2343%	38.0614%
26	0.2533%	0.1174%	66	3.4447%	2.2633%	106	43.0470%	39.9941%
27	0.3130%	0.1436%	67	3.5855%	2.3662%	107	44.7813%	41.8213%
28	0.3801%	0.1725%	68	3.7399%	2.4882%	108	46.4200%	43.5827%
29	0.4543%	0.2051%	69	3.9098%	2.6317%	109	47.9720%	45.2475%
30	0.5358%	0.2419%	70	4.0984%	2.7988%	110	49.4044%	46.8213%
31	0.6235%	0.2828%	71	4.3081%	2.9925%	111	49.9809%	48.2854%
32	0.7158%	0.3281%	72	4.5436%	3.2128%	112	49.9755%	49.6513%
33	0.8114%	0.3776%	73	4.8065%	3.4648%	113	49.9953%	50.2110%
34	0.9026%	0.4306%	74	5.1008%	3.7463%	114	49.9851%	50.0952%
35	0.9943%	0.4864%	75	5.4281%	4.0624%	115	50.0000%	50.0000%
36	1.0858%	0.5436%	76	5.7929%	4.4139%	116	50.0000%	50.0000%
37	1.1751%	0.6006%	77	6.2011%	4.8052%	117	50.0000%	50.0000%
38	1.2617%	0.6557%	78	6.6529%	5.2368%	118	50.0000%	50.0000%
39	1.3443%	0.7078%	79	7.1550%	5.7097%	119	50.0000%	50.0000%
40	1.4204%	0.7560%	80	7.7133%	6.2278%	120	100.0000%	100.0000%
41	1.4852%	0.7965%	81	8.3320%	6.7925%	-		
42	1.5449%	0.8333%	82	9.0153%	7.4046%			
43	1.6000%	0.8677%	83	9.7759%	8.0682%			
44	1.6518%	0.9006%	84	10.6221%	8.7816%			
45	1.7022%	0.9338%	85	11.5504%	9.5490%			
46	1.7528%	0.9691%	86	12.5809%	10.3728%			
47	1.8036%	1.0081%	87	13.7130%	11.2504%			
48	1.8561%	1.0486%	88	14.9503%	12.1767%			
49	1.9108%	1.0931%	89	16.2983%	13.1470%			
50	1.9679%	1.1445%	90	17.7578%	14.1809%			
51	2.0285%	1.2025%	91	19.1980%	15.3068%			
52	2.0949%	1.2677%	92	20.6246%	16.5148%			
53	2.1519%	1.3387%	93	22.0177%	17.7919%			
54	2.2110%	1.4144%	94	23.3675%	19.1177%			
55	2.2745%	1.4929%	95	24.6544%	20.4885%			
56	2.3451%	1.5721%	96	26.2066%	22.0265%			
57	2.4253%	1.6494%	97	27.7603%	23.6241%			
58	2.5146%	1.7227%	98	29.3541%	25.2910%			
59	2.6124%	1.7921%	99	30.9669%	27.0120%			



Table IV Pre-Retirement Mortality

Death-in-Service Mortality Rates

	% Dying I	Next Year		% Dying Next Year				% Dying I	Next Year
Age	Male	Female	Age	Male	Female		Age	Male	Female
•	0.02000/	0.01050/		0.044004	0.47000/		400		10.00000
20	0.0239%	0.0106%	60	0.3113%	0.1733%		100	20.3698%	18.2108%
21	0.0268%	0.0108%	61	0.3515%	0.18/0%		101	21.6953%	19.51/3%
22	0.0295%	0.0109%	62	0.3965%	0.2013%		102	23.0097%	20.8404%
23	0.0313%	0.0112%	63	0.4467%	0.2166%		103	24.3068%	22.1612%
24	0.0324%	0.0116%	64	0.5019%	0.2329%		104	25.5767%	23.4585%
25	0.0309%	0.0119%	65	0.5624%	0.2506%		105	26.8023%	24.7399%
26	0.0302%	0.0122%	66	0.6210%	0.2753%		106	27.9806%	25.9962%
27	0.0300%	0.0127%	67	0.6844%	0.3028%		107	29.1078%	27.1838%
28	0.0303%	0.0133%	68	0.7539%	0.3335%		108	30.1730%	28.3288%
29	0.0311%	0.0140%	69	0.8303%	0.3680%		109	31.1818%	29.4109%
30	0.0322%	0.0150%	70	0.9147%	0.4070%		110	32.1129%	30.4338%
31	0.0337%	0.0161%	71	1.0083%	0.4510%		111	32.4876%	31.3855%
32	0.0352%	0.0174%	72	1.1130%	0.5006%		112	32.4841%	32.2733%
33	0.0368%	0.0187%	73	1.2299%	0.5572%		113	32.4969%	32.6372%
34	0.0382%	0.0200%	74	1.3608%	0.6207%		114	32.4903%	32.5619%
35	0.0393%	0.0214%	75	1.5071%	0.6928%		115	32.5000%	32.5000%
36	0.0402%	0.0227%	76	1.6706%	0.7741%		116	32.5000%	32.5000%
37	0.0412%	0.0242%	77	1.8540%	0.8664%		117	32.5000%	32.5000%
38	0.0423%	0.0258%	78	2.0582%	0.9704%		118	32.5000%	32.5000%
39	0.0437%	0.0276%	79	2.2859%	1.0874%		119	32.5000%	32.5000%
40	0.0456%	0.0296%	80	2.5398%	1.2190%		120	100.0000%	100.0000%
41	0.0478%	0.0317%	81	2.8770%	1.4450%				
42	0.0506%	0.0340%	82	3.2941%	1.7633%				
43	0.0543%	0.0367%	83	3.7903%	2.1715%				
44	0.0588%	0.0398%	84	4.3640%	2.6658%				
45	0.0640%	0.0434%	85	5.0073%	3.2435%				
46	0.0705%	0.0474%	86	5.7229%	3.9007%				
47	0.0777%	0.0521%	87	6.5034%	4.6310%				
48	0.0860%	0.0571%	88	7.3429%	5.4253%				
49	0.0954%	0.0626%	89	8.2360%	6.2734%				
50	0.1058%	0.0688%	90	9.1736%	7.1761%				
51	0.1174%	0.0757%	91	10.1429%	8.1223%				
52	0.1305%	0.0835%	92	11.1417%	9.1047%				
53	0.1442%	0.0922%	93	12.1542%	10.1144%				
54	0.1594%	0.1017%	94	13.1696%	11.1381%				
55	0.1764%	0.1121%	95	14.1705%	12.1722%				
56	0.1960%	0.1233%	96	15.3429%	13.2898%				
57	0.2187%	0.1351%	97	16.5387%	14.4518%				
58	0.2452%	0.1474%	98	17.7826%	15.6658%				
59	0.2759%	0.1602%	99	19.0601%	16.9224%				


Table V Joint Life Retirement Values (7.00% Interest)

Comula	Single Life Retirement Values						
Attained	Present Value of \$1 Monthly for Life		Percent Dying Next Year		Future Life		
Ages					Expectancy (years)		
	Men	Women	Men	Women	Men	Women	
50	\$149.37	\$153.84	0.3922%	0.2660%	32.36	34.85	
55	142.00	147.02	0.5582%	0.3734%	28.05	30.34	
60	132.97	138.52	0.7938%	0.5667%	23.89	25.97	
65	122.06	128.13	1.1511%	0.8398%	19.90	21.76	
70	109.01	115.45	1.7034%	1.2770%	16.11	17.74	
75	93.80	100.44	2.6823%	2.0723%	12.58	13.97	
80	76.99	83.55	4.5024%	3.5553%	9.41	10.56	

The present values shown above are for illustrative purposes only and include a 50% survivor benefit but do not include the value of future post-retirement increases. Males are assumed to be 3 years older than their spouses.



Table VI Rates of Retirement

	% of Active Participants Retiring								
	Closed and Year 2000 Plans					2011 Tier			
	Non-Uniformed Members				Non-Uniformed				
	Male		Female		Uniformed	Noi	Normal		Uniformed
						Age &	Rule of		
Age	Normal	Early	Normal	Early	Normal	Service	90	Early	Normal
50	40%		25%		45%				
51	30%		20%		15%				
52	26%		20%		15%				
53	26%		20%		16%				
54	24%		24%		16%				
55	27%	3%	32%	3%	25%		30%		30%
56	25%	3%	35%	3%	30%		30%		30%
57	26%	4%	29%	4%	20%		30%		30%
58	22%	2%	25%	4%	30%		30%		30%
59	25%	4%	30%	5%	40%		30%		30%
60	19%	5%	22%	5%	100%		30%		100%
61	18%	5%	22%	5%	100%		30%		100%
62	40%	40%	36%	30%	100%		30%	10%	100%
63	35%	35%	22%	30%	100%		30%	10%	100%
64	25%	30%	20%	25%	100%		30%	10%	100%
65	35%		35%		100%		30%	10%	100%
66	40%		45%		100%		30%	10%	100%
67	45%		40%		100%	50%	30%		100%
68	30%		40%		100%	50%	30%		100%
69	30%		40%		100%	50%	30%		100%
70	40%		50%		100%	100%	100%		100%
71	50%		50%		100%	100%	100%		100%
72	50%		100%		100%	100%	100%		100%
73	50%		100%		100%	100%	100%		100%
74	100%		100%		100%	100%	100%		100%



Table VII Rates of Disability

All Plan Participants

	% of Active Participants Becoming Disabled							
	Uniformed	l Members	Non-Uniformed Members					
Age	Male	Female	Male	Female				
20	0 10%	0.10%	0.06%	0.06%				
21	0.10%	0.10%	0.06%	0.06%				
22	0.10%	0.10%	0.07%	0.07%				
23	0.10%	0.10%	0.07%	0.07%				
24	0.10%	0.10%	0.07%	0.07%				
25	0.10%	0.10%	0.08%	0.08%				
26	0.10%	0.10%	0.08%	0.08%				
27	0.10%	0.10%	0.09%	0.09%				
28	0.10%	0.10%	0.09%	0.09%				
29	0.10%	0.10%	0.09%	0.09%				
30	0.10%	0.10%	0.10%	0.10%				
31	0.10%	0.10%	0.10%	0.10%				
32	0.10%	0.10%	0.11%	0.11%				
33	0.10%	0.10%	0.11%	0.11%				
34	0.10%	0.10%	0.12%	0.12%				
35	0.10%	0.10%	0.13%	0.13%				
36	0.10%	0.10%	0.13%	0.13%				
37	0.10%	0.10%	0.14%	0.14%				
38	0.10%	0.10%	0.14%	0.14%				
39	0.10%	0.10%	0.15%	0.15%				
40	0.10%	0.10%	0.17%	0.17%				
41	0.10%	0.10%	0.19%	0.19%				
42	0.10%	0.10%	0.21%	0.21%				
43	0.10%	0.10%	0.23%	0.23%				
44	0.10%	0.10%	0.24%	0.24%				
45	0.10%	0.10%	0.27%	0.27%				
46	0.10%	0.10%	0.30%	0.30%				
47	0.10%	0.10%	0.32%	0.32%				
48	0.10%	0.10%	0.36%	0.36%				
49	0.10%	0.10%	0.41%	0.41%				
50	0.10%	0.10%	0.46%	0.46%				
51	0.10%	0.10%	0.52%	0.52%				
52	0.10%	0.10%	0.59%	0.59%				
53	0.10%	0.10%	0.68%	0.68%				
54	0.10%	0.10%	0.77%	0.77%				
55	0.10%	0.10%	0.86%	0.86%				
50	0.10%	0.10%	0.97%	0.97%				
57	0.10%	0.10%	1.09%	1.09%				
50	0.10%	0.10%	1.22%	1.22%				
60	0.10%	0.10%	1 /19%	1 /19%				
61	0.10%	0.10%	1.45%	1.45%				
62	0.10%	0.10%	1.80%	1.80%				
63	0.10%	0.10%	1.97%	1.97%				
64	0.10%	0.10%	2.15%	2.15%				
65	0.10%	0.10%	0.00%	0.00%				
66	0.10%	0.10%	0.00%	0.00%				
67	0.10%	0.10%	0.00%	0.00%				
68	0.10%	0.10%	0.00%	0.00%				
69	0.10%	0.10%	0.00%	0.00%				
70	0.10%	0.10%	0.00%	0.00%				
71	0.10%	0.10%	0.00%	0.00%				
72	0.10%	0.10%	0.00%	0.00%				



Table VIIITable Rates of Separation from Active Employment

All	Plan	Partici	pants

		% of Active Participants Withdrawing			
		Uniformed Members		Non-Uniform	ed Members
Age	Service	Male	Female	Male	Female
	0-1	12.00%	12.00%	30.00%	20.00%
	1-2	6.00%	6.00%	16.00%	14 00%
	2-3	2.50%	2.50%	9.00%	11.00%
	3-4	2.50%	2.50%	7.00%	9.00%
	4-5	2.50%	2.50%	5.50%	6.00%
25	5 & Up	1.89%	1.89%	5.60%	6.00%
26		1.89%	1.89%	5.60%	6.00%
27		1.89%	1.89%	5.60%	6.00%
28		1.89%	1.89%	5.60%	6.00%
29		1.89%	1.89%	5.60%	6.00%
30		1.89%	1.89%	5.60%	6.00%
31		1.89%	1.89%	5.53%	6.00%
32		1.83%	1.83%	5.46%	6.00%
33		1.65%	1.65%	5.39%	6.00%
34		1.49%	1.49%	5.32%	6.00%
35		1.34%	1.34%	5.25%	6.00%
36		1.19%	1.19%	5.18%	6.00%
37		1.06%	1.06%	5.11%	6.00%
38		0.95%	0.95%	5.04%	6.00%
39		0.86%	0.86%	4.97%	5.78%
40		0.79%	0.79%	4.90%	5.54%
41		0.74%	0.74%	4.48%	5.29%
42		0.69%	0.69%	4.06%	5.05%
43		0.64%	0.64%	3.64%	4.81%
44		0.60%	0.60%	3.22%	4.56%
45		0.55%	0.55%	2.80%	4.32%
46		0.50%	0.50%	2.66%	4.12%
47		0.46%	0.46%	2.52%	3.92%
48		0.41%	0.41%	2.38%	3.72%
49		0.36%	0.36%	2.24%	3.36%
50		0.32%	0.32%	2.10%	3.00%
51		0.27%	0.27%	1.96%	3.00%
52		0.23%	0.23%	1.82%	3.00%
53		0.21%	0.21%	1.68%	3.00%
54		0.19%	0.19%	1.54%	3.00%
55		0.16%	0.16%	1.40%	3.00%
56		0.17%	0.17%	1.40%	3.00%
57		0.13%	0.13%	1.40%	3.00%
58		0.13%	0.13%	1.40%	3.00%
59		0.13%	0.13%	1.40%	3.00%
60		0.12%	0.12%	1.40%	3.00%

