

Actuarial Valuation Report
June 30, 2021



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September 15, 2021

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, 2021 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 2023; and
- To provide certain supplemental schedules for use in the System's Annual Report.

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.

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 4 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 was prepared using our proprietary valuation model and related software which in our professional judgment has the capability to provide results that are consistent with the purposes of the valuation and has no material limitations or known weaknesses. We performed tests to ensure that the model reasonably represents that which is intended to be modeled.

This report has been prepared by actuaries 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 actuaries are independent of the plan sponsor.

Respectfully submitted,



Heidi G. Barry, ASA, FCA, MAAA



Jamal Adora, ASA, MAAA

HGB/JA:bd



Summary

This report contains the results of the June 30, 2021 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-Uniformed			Uniformed Patrol	Total
	Patrol Employees	MoDOT Employees	Non-Uniformed Total		
Participants					
Active Members					
Closed Plan	214	1,146	1,360	411	1,771
Year 2000 Plan (also closed)	360	1,449	1,809	359	2,168
Year 2011 Tier (open)	502	2,347	2,849	431	3,280
Total Active Members	1,076	4,942	6,018	1,201	7,219
<i>Total Active Members Prior Year</i>	<i>1,090</i>	<i>5,061</i>	<i>6,151</i>	<i>1,204</i>	<i>7,355</i>
Retiree -- Regular Pensioners					
Closed Plan	483	3,238	3,721	1,033	4,754
Year 2000 Plan (also closed)	629	3,702	4,331	9	4,340
Year 2011 Tier (open)	7	11	18	0	18
Total Regular Pensioners	1,119	6,951	8,070	1,042	9,112
Self Insured Disability Pensioners	2	39	41	3	44
Fully Insured Disability Pensioners	10	66	76	3	79
Terminated Vested Members	258	1,699	1,957	176	2,133
Total	2,465	13,697	16,162	2,425	18,587
Active Member Valuation Payroll	\$49,958,709	\$218,770,482	\$ 268,729,191	\$ 86,465,380	\$ 355,194,571
<i>Active Mem. Val. Payroll Prior Year</i>	<i>\$49,999,727</i>	<i>\$226,738,711</i>	<i>\$ 276,738,438</i>	<i>\$ 84,113,107</i>	<i>\$ 360,851,545</i>
Unfunded Actuarial Accrued Liability	N/A	N/A	\$1,142,965,822	\$489,834,587	\$1,632,800,409

The June 30, 2021 valuation results are used to determine the contribution rate for the plan year beginning July 1, 2022. A summary of valuation results and recommended contribution rates follows.

Summary (Continued)

The **total contribution rate** for the plan year beginning July 1, 2022 is shown below:

	FY 2023 Employer Contribution Rates Expressed as % of Active Payroll for Total Benefits				
	Non-Uniformed			Uniformed Patrol Total	Combined Rate (System Total)
	Civilian Patrol Employees	MoDOT Employees	Total		
Benefit Normal Cost	9.250%	9.250%	9.250%	17.230%	11.240%
Expenses	1.220%	1.220%	1.220%	1.220%	1.220%
Disability Insurance	<u>0.475%</u>	<u>0.475%</u>	<u>0.475%</u>	<u>0.475%</u>	<u>0.475%</u>
Total Normal Cost	10.945%	10.945%	10.945%	18.925%	12.935%
Unfunded Liability	47.055%	47.055%	47.055%	39.726%	45.227%
Total	58.000%	58.000%	58.000%	58.651%	58.162%
Projected \$	\$30,740,693	\$134,614,290	\$165,354,983	\$53,801,220	\$219,156,203
<i>Prior Year Projected \$</i>	<i>\$30,765,932</i>	<i>\$139,517,317</i>	<i>\$170,283,249</i>	<i>\$51,756,645</i>	<i>\$222,039,894</i>

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 2023 Fiscal Year. The total contribution is based on a 3-year amortization period for unfunded retiree liabilities and an 18-year amortization period for other unfunded liabilities from July 1, 2022 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) 1.67% for Non-Uniformed members and 1.16% for Uniformed members.

The combined contribution rate (58.16% of active payroll) is less than the actual benefit payout rate (76.05% 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 2022) 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, 2021 valuation: There were no changes in benefits for the June 30, 2021 valuation. The disability insurance premium was reduced from 0.53% of payroll to 0.475% of payroll and is reflected in the calculation of the normal cost. 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. We informally review assumptions with Staff and/or the Board each summer, prior to the beginning of the valuation process with a focus on economic assumptions. After the 2021 review of economic assumptions, the Board elected Alternate B from our Assumed Investment Return Review dated June 8, 2021, lowering the assumed rate of return from 7.00% to 6.50%. Lowering the assumed investment return increased the contribution rate from 58.00% of payroll to 58.162% of payroll and decreased the funded ratio from 65.8% to 62.4%.

Experience: System assets earned a 30.0% return on a market basis, although the fund recognized an 11.7% rate of return on an actuarial basis after accounting for the smoothing of the 2019 and 2020 losses (please see page C-2). In aggregate, there was an experience gain of \$146 million (approximately 3.6% of beginning of year liabilities). This gain was primarily investment related. As a result, the funding status increased from 60.6% to 65.8% before recognition of assumption changes. Pages A-11 and A-12 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-Uniformed				Uniformed			
	Number Count		General		Number Count		General	
	Actual	Expected	A/E%	Direction	Actual	Expected	A/E%	Direction
Retirement	221	264.5	84%	Gain	41	32.9	125%	Loss
Death	1	5.3	19%	Loss	0	0.7	0%	Loss
Disability	8	16.1	50%	Gain	0	1.1	0%	Gain
Vested Terminations	126	119.0	106%	Gain	10	7.7	130%	Gain
Other Terminations	293	222.0	132%	Gain	11	8.0	138%	Gain
Post-Retirement Death	395	261.9	151%	Gain	35	29.9	117%	Gain

Liability gains for Non-Uniformed added to the investment gains while liability losses for Uniformed were overshadowed by investment gains. This resulted in overall experience gains of \$117 million (Non-Uniformed) and \$28 million (Uniformed) in aggregate.

Summary (Continued)

Funding Policy:

Permanent Policy: The total contribution will be based on normal cost plus a 14-year amortization of unfunded actuarial accrued liabilities. The amortization period is a closed 14-year period starting July 1, 2022.

Temporary Accelerated Policy: The total contribution is based on normal cost plus a 3-year amortization period for unfunded retiree liabilities and an 18-year amortization period for other unfunded liabilities. Both amortization periods are closed periods starting July 1, 2022.

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.

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

	<u>Non-Uniform</u>	<u>Uniform</u>
Prior valuation contribution rate		
Without Contribution Stabilization Reserve Fund	46.360%	54.560%
Additional amount for Contribution Stabilization Reserve Fund (CSR)	11.640%	3.440%
Total computed employer contribution rate	58.000%	58.000%
Prior rate without Contribution Stabilization Reserve Fund	46.360%	54.560%
Effects of:		
Accelerated contributions	(4.750)%	0.900%
Change in disability premiums	(0.055)%	(0.055)%
Change in administrative expenses	0.100%	0.100%
Phase-in of 2011 Tier members	(0.190)%	(0.440)%
20/21 liability experience loss/(gain)	(0.670)%	0.530%
20/21 recognized investment loss/(gain)	(6.940)%	(3.170)%
Change due to payroll increase other than expected	0.853%	(1.045)%
Change in assumptions and methods	10.541%	7.271%
Change in plan provisions	0.000%	0.000%
Computed employer contribution rate, current valuation without CSR	45.249%	58.651%
Additional amount for Contribution Stabilization Reserve Fund (CSR)	12.751%	0.000%
Computed employer contribution rate, current valuation	58.000%	58.651%



Summary (Continued)

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

<u>Asset Basis</u>	<u>June 30, 2021</u>			<u>June 30, 2020</u>
	<u>Non-Uniformed</u>	<u>Uniformed</u>	<u>Total</u>	<u>Total</u>
Actuarial Value	91.3%	98.7%	93.3%	90.4%
Market Value	100.0%	100.0%	100.0%	86.0%

Total Plan Funded Status: The plan is currently 62.4% funded on an actuarial value of assets basis or 69.1% 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 both the Uniformed and Non-Uniformed division (when compared to the temporary policy), 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.

Look Forward: Before recognizing any fiscal year 2022 activity, the fund is positioned to recognize an investment gain of approximately \$117 million next year (see page C-2). This gain, if not offset by other experience losses, will increase the funded status of the plan.

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/summer before the next valuation cycle begins.

- 2) The contribution stabilization reserve fund is able to provide a limited buffer against losses in the short term. However, depletion of the contribution stabilization reserve fund would likely result in considerable contribution volatility while the temporary funding policy is in effect. The Uniformed division’s portion of the stabilization reserve fund was depleted for the June 30, 2021 valuation. 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, 2022 valuation) might reduce future contribution volatility.

Summary (Concluded)

Conclusion: Based upon the results of the June 30, 2021 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 6.50% on the actuarial value of assets), it is expected that:

- 1) The unfunded actuarial accrued liabilities will be fully amortized after 14 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% (due to the contribution stabilization reserve fund); 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

Scenario Testing/Sensitivity Testing

MPERS staff is provided a 10-year projection tool that allows for various scenario and sensitivity testing. If the Board would like to see additional projections, we would be happy to perform such projections.



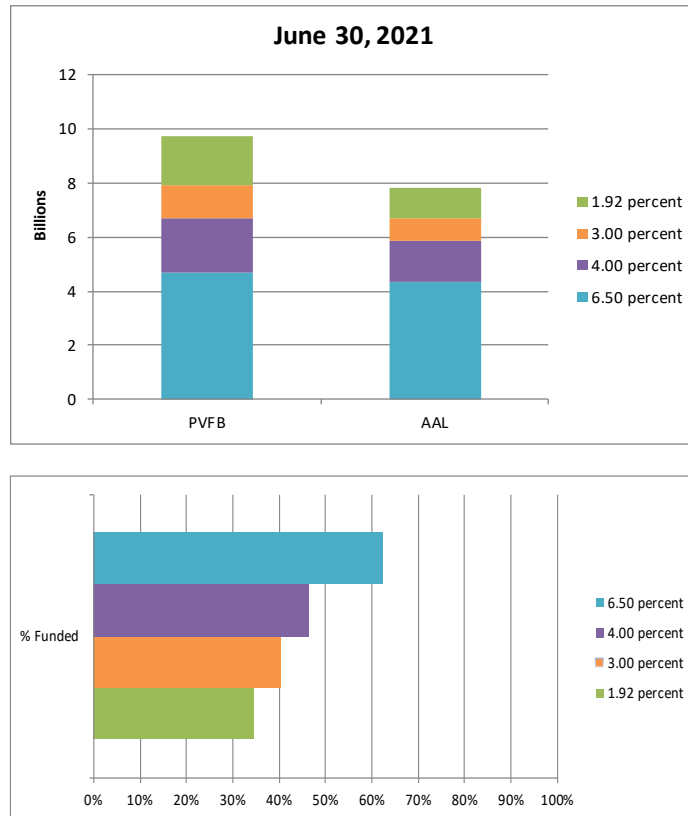
Summary of Key Valuation Results

	June 30, 2021			June 30, 2020
	(1) Actuarial Present Value	(2) Portion Covered By Future Normal Cost Contributions	(3) Actuarial Accrued Liabilities (1) - (2)	Actuarial Accrued Liabilities
Actuarial Present Value				
Active Members				
Service retirement benefits based on service rendered before and likely to be rendered after valuation date	\$ 1,590,172,035	\$ 290,426,481	\$ 1,299,745,554	\$ 1,218,092,259
Disability benefits likely to be paid to present active members who become totally and permanently disabled*	33,217,257	20,957,196	12,260,061	11,792,434
Survivor benefits likely to be paid to widows and children of present active members who die before retiring	17,435,424	6,331,883	11,103,541	10,486,984
Separation benefits likely to be paid to present active members	<u>57,646,355</u>	<u>35,775,678</u>	<u>21,870,677</u>	<u>22,589,624</u>
Active Member Totals	\$ 1,698,471,071	\$ 353,491,238	\$ 1,344,979,833	\$ 1,262,961,301
Terminated Vested Members Retired Lives	117,216,882		117,216,882	102,753,368
	2,881,876,197		2,881,876,197	2,726,383,228
Total Actuarial Accrued Liability	\$ 4,697,564,150	\$ 353,491,238	\$ 4,344,072,912	\$ 4,092,097,897
Actuarial Value of Assets			2,711,272,503	2,481,329,531
Unfunded Actuarial Accrued Liability			\$ 1,632,800,409	\$ 1,610,768,366
Contribution Stabilization Reserve Fund			\$ 96,020,617	\$ 143,863,600
Total Amount Financed			\$ 1,728,821,026	\$ 1,754,631,966

* 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.



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 3.0%, we obtain a value of \$7.9 billion PVFB and \$6.7 billion AAL. This is akin to the cost (in uninflated or 2021 dollars) of all future expected benefit payments to current members of the System (PVFB) and the portion that is allocated to the post AAL.

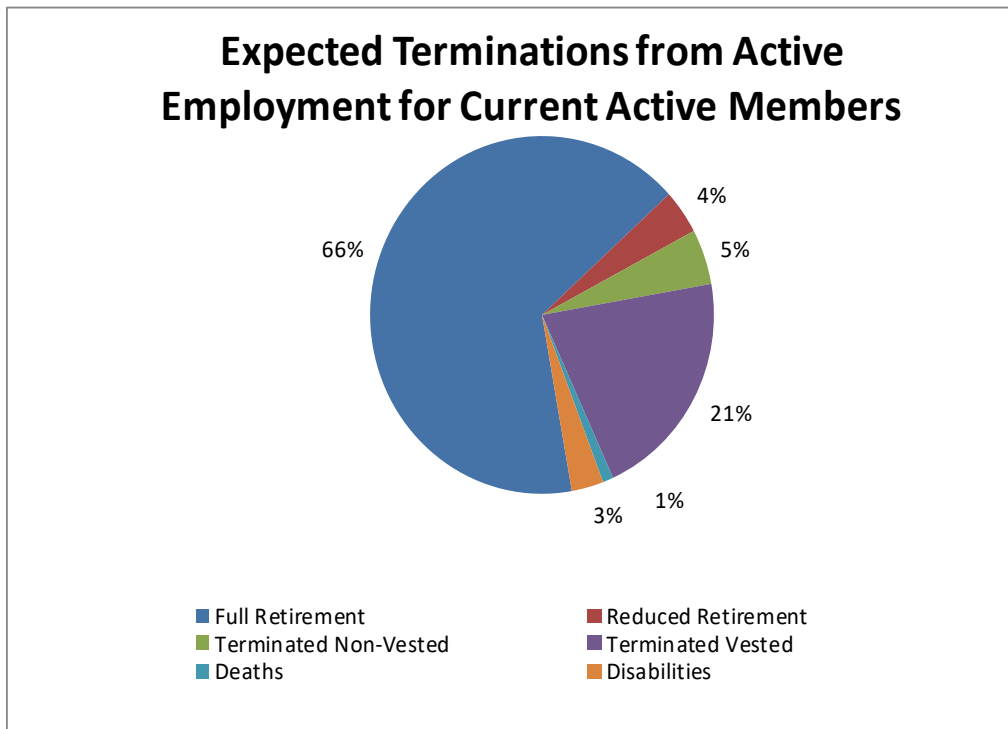
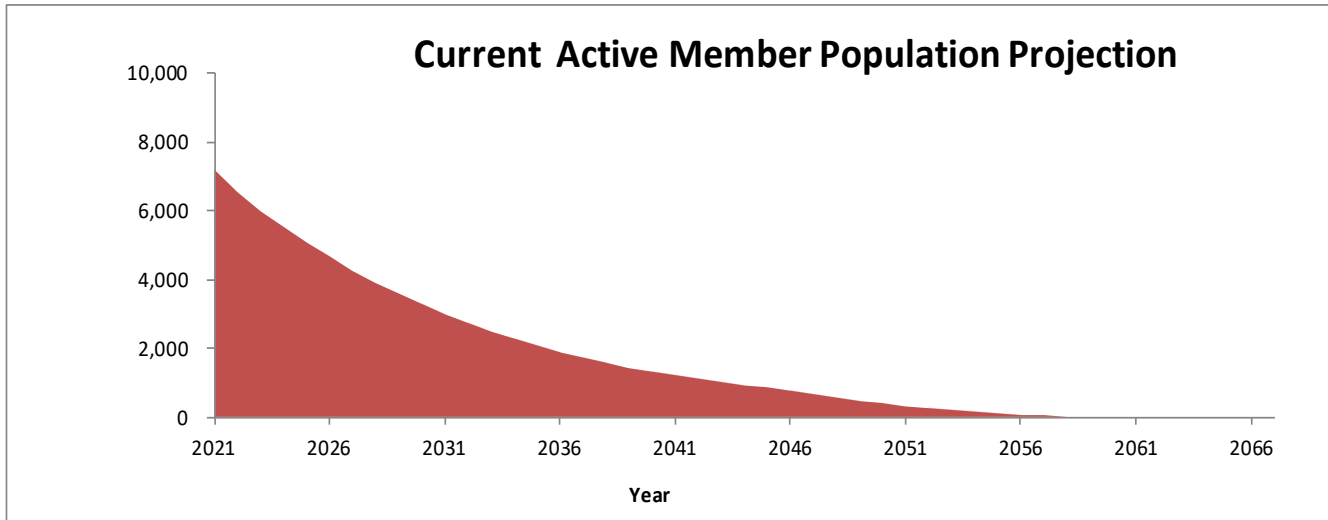
Using an interest rate of 1.92%, the PVFB is \$9.7 billion and the AAL is \$7.8 billion. The 1.92% interest rate is shown as an estimate of the return that might be achieved with “risk free” investments (U.S. Treasuries and their “safe” fixed income securities) in a 2.25% inflationary environment. The 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 Low-Default-Risk Obligation Measure 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 \$6.7 billion PVFB and \$5.8 billion AAL.

Using an investment return of 6.50% (the current valuation assumed investment return based on the current investment portfolio), the PVFB is \$4.7 billion and the AAL is \$4.3 billion. The difference between the 2nd and 3rd measures (1.92% interest and 6.50% 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.

Notes: 6.50% is the current assumed rate of return; 4.00% is an estimated return of a low risk/low volatility portfolio and is intended to only change when the valuation assumption is changed for consistency of year to year measurements; 3.00% is the assumed wage inflation; 1.92% is the June 2021 AA municipal bond rate that will be used/referenced in the GASB valuations and is used herein as a proxy for a risk-free investment portfolio.

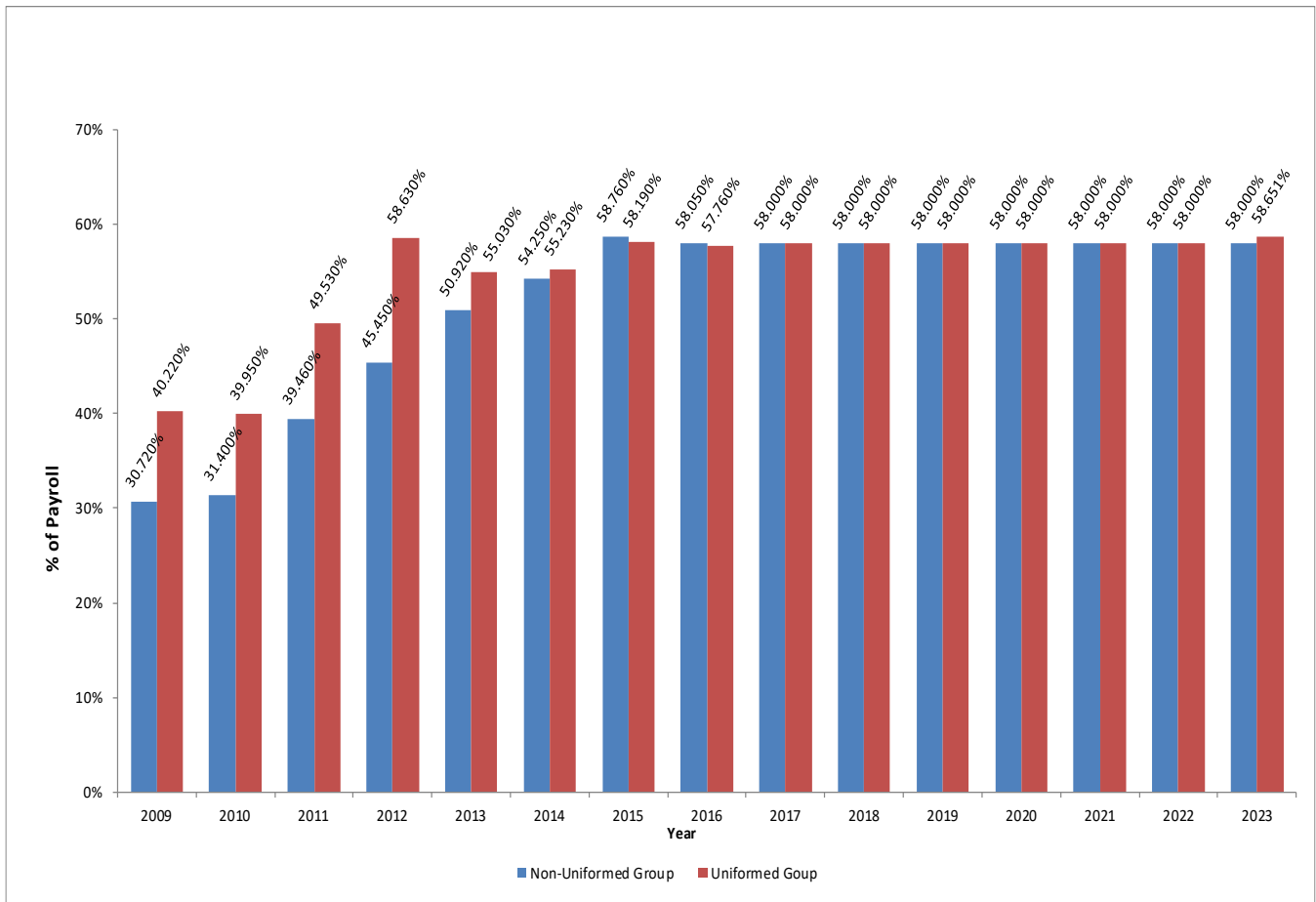
Expected Development of Present Populations as of June 30, 2021



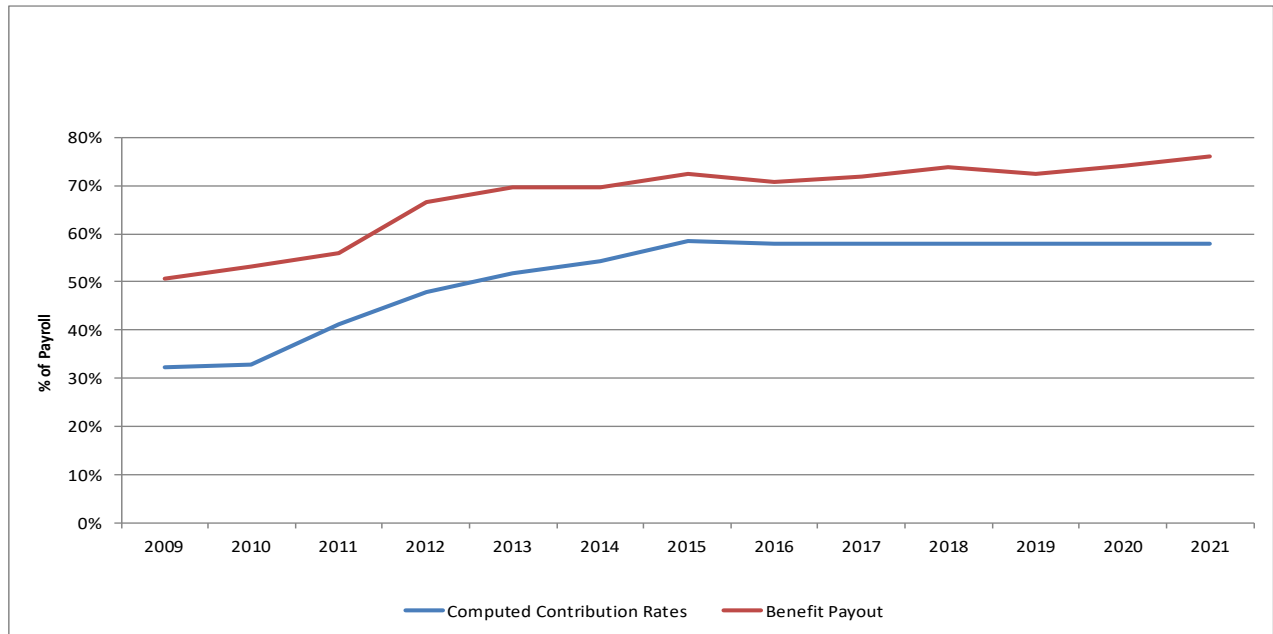
The charts above show the expected future development of the present population in simplified terms. The Retirement System presently covers 7,219 active members. Eventually, 5% of the population is expected to terminate covered employment prior to retirement and forfeit eligibility for an employer provided benefit. Of the present population, 91% 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.

Historical Contribution Rates and Benefit Payouts

Computed Contribution Rates

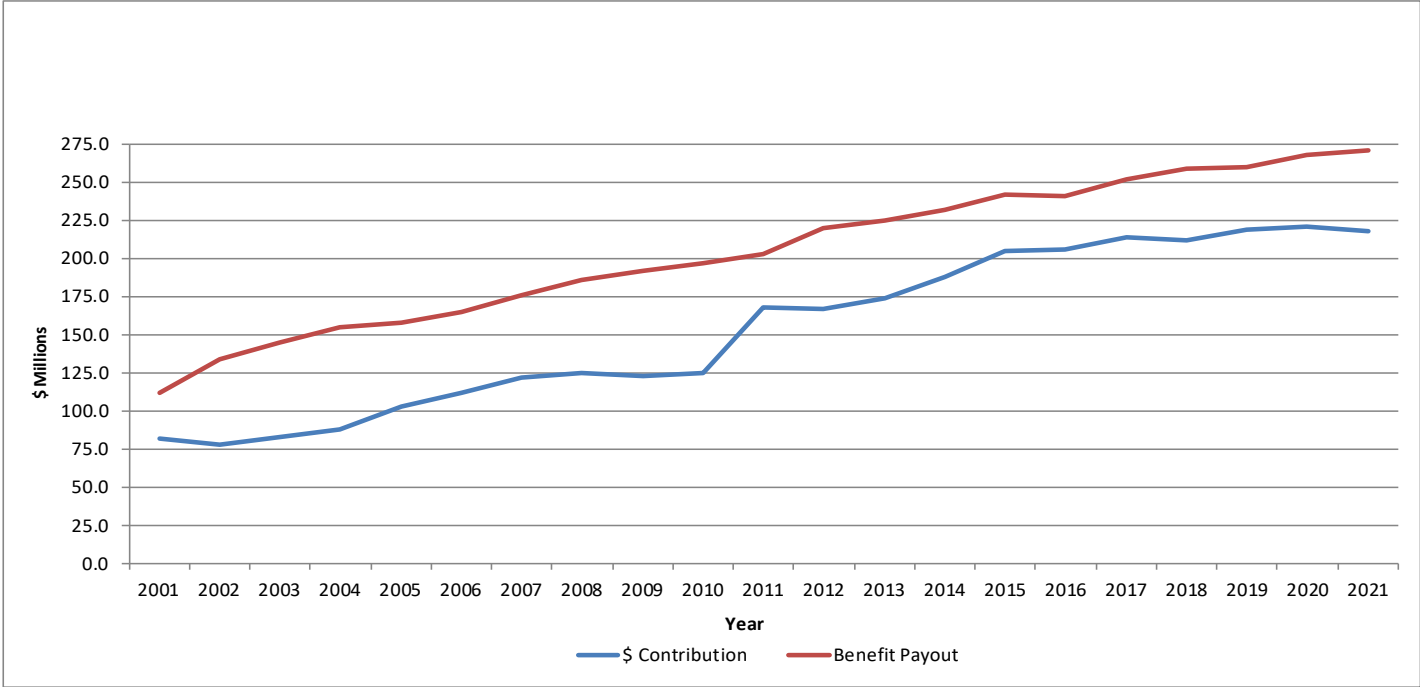


Contribution Rates vs. Benefit Payout



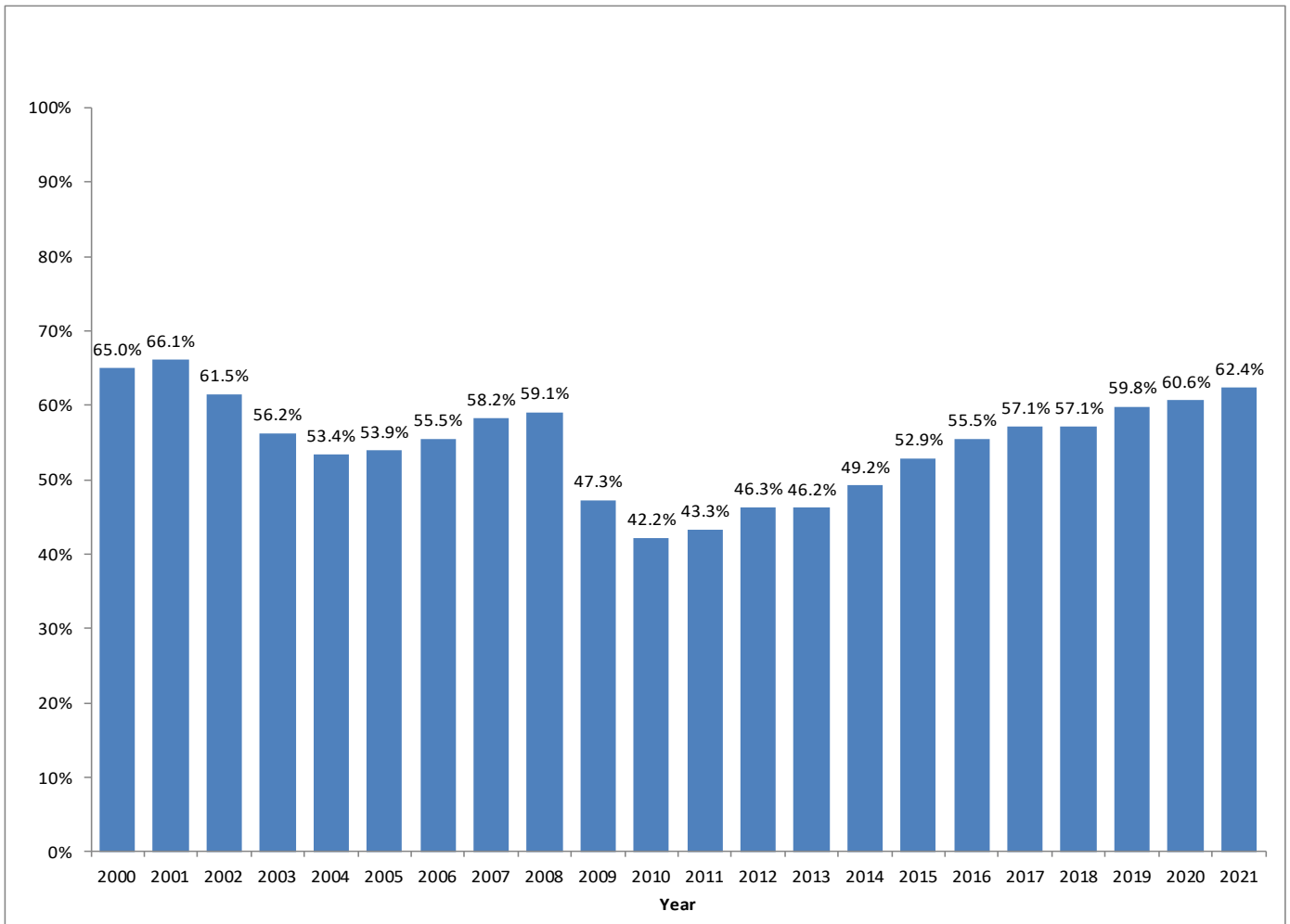
Historical Contribution Rates and Benefit Payouts (Concluded)

Contribution Dollars vs. Benefit Payout Dollars (in Millions)



Historical Funded Ratios

Actuarial Value of Assets as Percents of Accrued Liabilities (Funded Ratio)



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 2023 Contributions Computed as of June 30, 2021

Contributions for	Non-Uniformed Employees			Uniformed Patrol			MPERS Total
	Closed & Year 2000	2011 Tier	Total	Closed & Year 2000	2011 Tier	Total	
Normal Cost							
Age & service benefits	9.100%	7.150%	8.280%	18.370%	13.800%	17.040%	10.460%
Disability benefits #	0.720%	1.050%	0.860%	0.430%	0.330%	0.400%	0.750%
Survivor benefits	0.180%	0.250%	0.210%	0.280%	0.230%	0.270%	0.220%
Separation benefits	1.710%	1.380%	1.570%	0.820%	0.340%	0.680%	1.350%
Total Normal Cost	11.710%	9.830%	10.920%	19.900%	14.700%	18.390%	12.780%
Member Contributions	0.000%	4.000%	1.670%	0.000%	4.000%	1.160%	1.540%
Employer Normal Cost	11.710%	5.830%	9.250%	19.900%	10.700%	17.230%	11.240%
Unfunded Actuarial Accrued Liabilities*			47.055%			39.726%	45.227%
Expense Provision			1.220%			1.220%	1.220%
Subtotal			57.525%			58.176%	57.687%
Disability Insurance			0.475%			0.475%	0.475%
Total Contribution Rate			58.000%			58.651%	58.162%
Projected Dollar Contribution			\$ 165,354,983			\$ 53,801,220	\$ 219,156,203
Prior Year							
Total Contribution Rate			58.000%			58.000%	58.000%
Projected Dollar Contribution			\$ 170,283,249			\$ 51,756,645	\$ 222,039,894

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 3-year amortization period for unfunded retiree liabilities and a 18-year amortization period for other unfunded liabilities from July 1, 2022 and then increased to achieve a minimum of 58% total employer contribution rate.



Development of Contribution Stabilization Reserve Fund as of June 30, 2021

	Non-Uniformed		Total
	Employees	Uniformed Patrol	
Beginning of Year Contribution Stabilization Reserve Fund	\$ 116,775,754	\$ 27,087,846	\$ 143,863,600
Growth (to maintain contribution rate)	-	-	-
Reduction (to match contribution rate)	(20,755,137)	(27,087,846)	(47,842,983)
End of Year Contribution Stabilization Reserve Fund	\$ 96,020,617	\$ -	\$ 96,020,617

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 minimum 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 reduction needed to achieve a 58.00% contribution rate for each group.

Development of Liabilities as of June 30, 2021

	Non-Uniformed Employees	Uniformed Patrol	Total
Present Value of Future Benefits - Inactives			
Retirees and Survivors	\$2,059,460,490	\$ 803,013,594	\$2,862,474,084
Disability Pensioners	17,169,302	2,232,811	19,402,113
Vested Terminated Employees	99,569,803	17,647,079	117,216,882
Subtotal PVFB - Inactives	2,176,199,595	822,893,484	2,999,093,079
Present Value of Future Benefits - Actives			
Age & Service benefits	993,920,065	596,251,970	1,590,172,035
Normal and Work Related Disability benefits	29,608,557	3,608,700	33,217,257
Survivor benefits	12,274,908	5,160,516	17,435,424
Separation benefits	53,041,129	4,605,226	57,646,355
Subtotal PVFB - Actives	1,088,844,659	609,626,412	1,698,471,071
Total Present Value of Future Benefits	3,265,044,254	1,432,519,896	4,697,564,150
Less Present Value of Future Entry Age Normal Costs	210,271,126	143,220,112	353,491,238
Equals Actuarial Accrued Liability	3,054,773,128	1,289,299,784	4,344,072,912
Less Actuarial Value of Assets	1,911,807,306	799,465,197	2,711,272,503
Equals Unfunded Actuarial Accrued Liability	1,142,965,822	489,834,587	1,632,800,409
Plus Contribution Stabilization Reserve Fund	96,020,617	-	96,020,617
Equals Total Amount Financed	1,238,986,439	489,834,587	1,728,821,026
Amortization Payment on UAAL*	\$ 134,151,358	\$ 36,441,474	\$ 170,592,832
as a % of Projected Payroll	47.06%	39.73%	45.23%

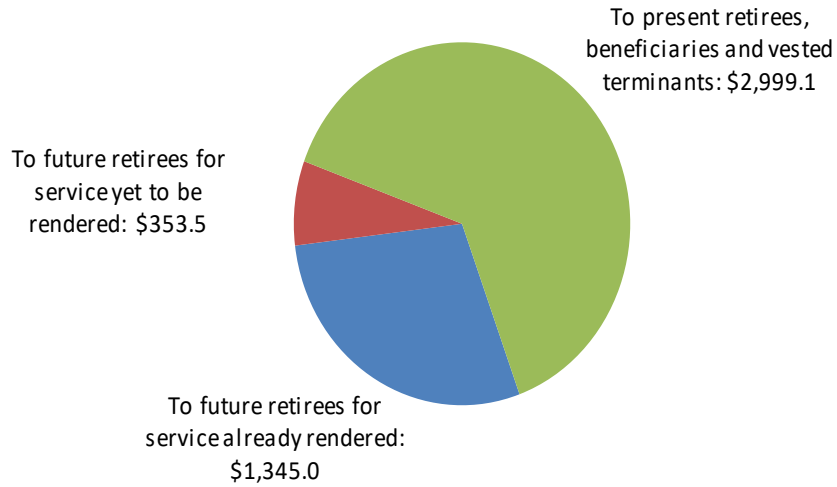
* Amortized as a level-percentage of payroll over a 3-year amortization period for unfunded retiree liabilities and a 18-year amortization period for other unfunded liabilities from July 1, 2022 and then increased to achieve a minimum of 58% total employer contribution rate.



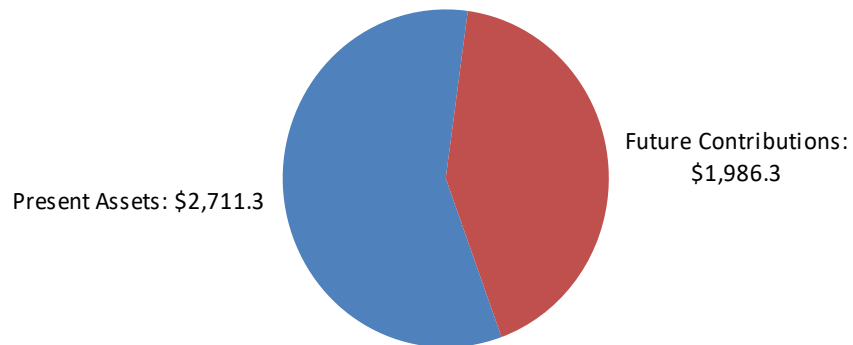
System Resources and Obligations Sources and Uses of \$4,697.6 Million as of June 30, 2021

(\$ Millions)

Uses of Funds



Sources of Funds



Financing Unfunded Actuarial Accrued Liabilities (UAAL) Which Were Calculated Using a Wage Inflation Assumption of 3.00%* and an Investment Return Assumption of 6.50% Compounded Annually 3/18-Year Amortization*

Fiscal Year Ending June 30	Active Employee Payroll	Unfunded Actuarial Accrued Liability at End of Year	Annual UAAL Contributions During Fiscal Year		UAAL at Year End as % of Payroll
			Dollars	% of Payroll	
2021	\$ 355,194,571	\$ 1,632,800,409			
2022	365,850,407	1,563,227,824	\$ 170,230,194	46.530%	427.3%
2023	376,825,919	1,488,929,826	170,427,058	45.227%	395.1%
2024	388,130,697	1,404,525,224	175,539,870	45.227%	361.9%
2025	399,774,618	1,309,198,772	180,806,066	45.227%	327.5%
2026	411,767,857	1,273,847,465	116,696,398	28.340%	309.4%
2027	424,120,893	1,232,584,847	120,197,290	28.340%	290.6%
2028	436,844,520	1,184,918,277	123,803,209	28.340%	271.2%
2029	449,949,856	1,130,319,842	127,517,306	28.340%	251.2%
2030	463,448,352	1,068,223,965	131,342,825	28.340%	230.5%
2031	477,351,803	998,024,855	135,283,110	28.340%	209.1%
2032	491,672,357	919,073,794	139,341,603	28.340%	186.9%
2033	506,422,528	830,676,233	143,521,851	28.340%	164.0%
2034	521,615,204	732,088,710	147,827,507	28.340%	140.4%
2035	537,263,660	622,515,554	152,262,332	28.340%	115.9%
2036	553,381,570	501,105,375	156,830,202	28.340%	90.6%
2037	569,983,017	366,947,324	161,535,108	28.340%	64.4%
2038	587,082,508	219,067,102	166,381,161	28.340%	37.3%
2039	604,694,983	56,422,712	171,372,596	28.340%	9.3%
2040	622,835,832	-122,100,076	176,513,774	28.340%	-19.6%

* Amortized as a level-percentage of payroll over a 3-year amortization period for unfunded retiree liabilities and a 18-year amortization period for other unfunded liabilities from July 1, 2022 and then increased to achieve a 58% minimum 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 Ending June 30	Active Employee Payroll	Annual Employer Contributions During Fiscal Year	
		Dollars	% of Payroll
2021	\$ 355,194,571		
2022	365,850,407	\$ 217,552,945	59.465%
2023	376,825,919	219,169,491	58.162%
2024	388,130,697	225,744,576	58.162%
2025	399,774,618	232,516,913	58.162%
2026	411,767,857	169,958,571	41.275%
2027	424,120,893	175,057,328	41.275%
2028	436,844,520	180,309,048	41.275%
2029	449,949,856	185,718,319	41.275%
2030	463,448,352	191,289,869	41.275%
2031	477,351,803	197,028,565	41.275%
2032	491,672,357	202,939,422	41.275%
2033	506,422,528	209,027,605	41.275%
2034	521,615,204	215,298,433	41.275%
2035	537,263,660	221,757,386	41.275%
2036	553,381,570	228,410,108	41.275%
2037	569,983,017	235,262,411	41.275%
2038	587,082,508	242,320,284	41.275%
2039	604,694,983	249,589,892	41.275%
2040	622,835,832	257,077,589	41.275%
2041	641,520,907	200,980,871	31.329%
2042	660,766,534	69,726,452	10.552%
2043	680,589,530	72,290,556	10.622%
2044	701,007,216	74,931,584	10.689%
2045	722,037,432	77,651,842	10.755%
2046	743,698,555	80,453,708	10.818%
2047	766,009,512	83,339,631	10.880%
2048	788,989,797	86,312,131	10.940%
2049	812,659,491	89,373,806	10.998%
2050	837,039,276	92,527,331	11.054%
2051	862,150,454	95,775,462	11.109%

Projected Employer Contributions and Benefit Payments, 5 Years

Fiscal Year Ending June 30	Projected Annual Employer Contributions During Fiscal Year	Projected Annual Benefit Payments During Fiscal Year *
	Dollars	Dollars
2021		
2022	\$ 217,552,945	\$ 290,233,136
2023	219,169,491	297,211,906
2024	225,744,576	304,303,351
2025	232,516,913	312,657,650
2026	169,958,571	320,913,286

* *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, 2021

Year Ending June 30	Actuarial Asset Value	Entry Age Accrued Liability	Unfunded Accrued Liability (UAAL)	Funded Ratio	Estimated Covered Payroll**	UAAL as a Percentage of Covered Payroll
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%
2020	2,481,329,531	4,092,097,897	1,610,768,366	60.64%	363,572,158	443.04%
2021	2,711,272,503	4,117,753,237	1,406,480,734	65.84%	358,987,667	391.79%
2021#	2,711,272,503	4,344,072,912	1,632,800,409	62.41%	358,987,667	454.83%

** Values are estimated from contribution rate and amount.

New assumptions and/or methods adopted.

Historical Employer Contributions Non-Uniformed Group ## June 30, 2021

Valuation Date	Fiscal Year Ending June 30,	Estimated Covered Payroll**	Actual Employer Contributions	Actual Employer Contribution %	Annually Determined Employer Contribution (ADEC) %	Annually Determined Employer Contribution (ADEC) \$	Percentage of ADEC Contributed
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%
June 30, 2018	2020	278,280,036	161,402,421	58.00%	58.00%	161,402,421	100.00%
June 30, 2019	2021#	272,509,434	158,055,472	58.00%	58.00%	158,055,472	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, 2021

Valuation Date	Fiscal Year Ending June 30,	Estimated Covered Payroll**	Actual Employer Contributions	Actual Employer Contribution %	Annually Determined Employer Contribution (ADEC) %	Annually Determined Employer Contribution (ADEC) \$	Percentage of ADEC Contributed
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%
June 30, 2018	2020	85,292,122	49,469,431	58.00%	58.00%	49,469,431	100.00%
June 30, 2019	2021#	86,478,233	50,157,375	58.00%	58.00%	50,157,375	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, 2020 to June 30, 2021

	UAAL =	AAL -	Assets
Beginning of Year Values (at July 1)	\$ 1,610,768,366	\$ 4,092,097,897	\$ 2,481,329,531
Normal Cost	47,889,669	47,889,669	0
Transfer In and Service Purchase - Liability	3,842,178	3,842,178	0
Contributions	(217,389,127)	0	217,389,127
Disbursements	0	(274,708,324)	(274,708,324)
Interest	106,955,781	278,642,676	171,686,895
Expected Value Before Any Changes	1,552,066,867	4,147,764,096	2,595,697,229
Effect of Benefit Changes	0	0	0
Effect of Changes in Assumptions & Methods	226,319,675	226,319,675	0
Effect of Adjustment	0	0	0
Expected Value After Changes	1,778,386,542	4,374,083,771	2,595,697,229
End of Year Values (at June 30)	1,632,800,409	4,344,072,912	2,711,272,503
Gain/(Loss) for Year	\$ 145,586,133	\$ 30,010,859	\$ 115,575,274

Development of Gain/(Loss) July 1, 2020 to June 30, 2021

	Total	Non-Uniformed	Uniformed
Beginning of Year UAAL (at July 1)	\$ 1,610,768,366	\$ 1,158,661,344	\$ 452,107,022
Normal Cost	47,889,669	32,295,099	15,594,570
Transfer In and Service Purchase - Liability	3,842,178	2,627,201	1,214,977
Contributions	(217,389,127)	(165,069,974)	(52,319,153)
Interest	106,955,781	76,551,125	30,404,656
Net Change in LTD Assets	0	0	0
Expected Value Before Any Changes	1,552,066,867	1,105,064,795	447,002,072
Effect of Benefit Changes	0	0	0
Effect of Changes in Assumptions & Methods	226,319,675	155,193,187	71,126,488
Effect of Adjustment	0	0	0
Expected Value After Changes	1,778,386,542	1,260,257,982	518,128,560
End of Year UAAL (at June 30)	1,632,800,409	1,142,965,822	489,834,587
Aggregate Gain/(Loss) for Year	\$ 145,586,133	\$ 117,292,160	\$ 28,293,973
Gain/(Loss) as a % of Beginning of Year Liabilities	3.56%	4.03%	2.40%
Asset Gain/(Loss) for Year	\$ 115,575,274	\$ 81,657,485	\$ 33,917,789
Liability Gain/(Loss) for Year	30,010,859	35,634,675	(5,623,816)
Aggregate Gain/(Loss) for Year	\$ 145,586,133	\$ 117,292,160	\$ 28,293,973

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>2021</u>	<u>2020</u>
Ratio of the market value of assets to total payroll	8.46	6.54
Ratio of actives to retirees and beneficiaries	1.28	1.25
Duration of the actuarial liability	11.72	11.36

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) volatility in plan sponsor contributions as a percentage 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 actives 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)

Valuation Date June 30	(1) Accrued Liabilities (AAL)	(2) Market Value of Assets	(3) Unfunded AAL (1)-(2)	(4) Valuation Payroll	(5) Funded Ratio (2)/(1)	(6) Liability/ Payroll (1)/(4)	(7) Assets/ Payroll (2)/(4)	(8) Unfunded/ Payroll (3)/(4)	(9) Portfolio Rate of Return	(10) 10-Year Trailing Average	(11) Non-Investment Net Cash Flow	(12) Non-Investment Net Cash Flow Percent of Beginning of Year Assets (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)%
2020	4,092,098	2,361,600	1,730,498	360,852	57.7%	1,134.0%	654.4%	479.6%	-0.4%	N/A	(50,994)	(2.1)%
2021	4,344,073	3,003,925	1,340,148	355,195	69.1%	1,223.0%	845.7%	377.3%	30.0%	N/A	(57,319)	(2.4)%

(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, 2021

Closed Plan	Year 2000 Plan	2011 Tier
<p>Participation</p> <p>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.</p>	<p>Participation</p> <p>Participants include:</p> <ol style="list-style-type: none"> 1. All active employees who first became members on or after July 1, 2000 but prior to January 1, 2011. 2. Closed Plan active members and vested former members who elect to transfer to the Year 2000 Plan at retirement. 3. 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 their survivors. 4. 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. 	<p>Participation</p> <p>Participants include:</p> <ol style="list-style-type: none"> 1. All employees who first become members on or after January 1, 2011.



Closed Plan**Year 2000 Plan****2011 Tier****Normal Retirement Eligibility
(unreduced benefit)**

Non-Uniformed Employees: The earlier of attaining:

1. Age 65 with at least 4 years of creditable service.
2. Age 60 with at least 15 years of creditable service.
3. Age 48 with age plus creditable service equal to 80 or more.
4. Age 65 with at least 5 years of service (deferred).*

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.

**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).

**Normal Retirement Eligibility
(unreduced benefit)**

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.

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.

**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).

**Normal Retirement Eligibility
(unreduced benefit)**

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 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).

*See Chapter 104.010.1(32) RSMo.



Closed Plan**Year 2000 Plan****2011 Tier****Normal Retirement Benefit Amount****Non-Uniformed Employees:**

Life Benefit: 1.6% of final average pay times years of creditable service.

Uniformed Patrol Employees:

Life Benefit: 2.1333% of final average pay times years of creditable service.

Special Benefit: \$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)**Eligibility: Non-Uniformed Employees**

Age 55 with at least 10 years of creditable service.

Amount:

Normal retirement amount reduced by 0.6% for each month that retirement precedes eligibility for normal retirement.

Uniformed Patrol members are not eligible for early retirement.

Early Retirement (reduced benefit)**Eligibility: All Employees**

Age 57 with at least 5 years of creditable service.

Amount:

Normal retirement amount reduced by 0.5% for each month that retirement precedes eligibility for normal retirement.

Early Retirement (reduced benefit)**Eligibility: All Active Non-Uniformed Employees**

Age 62 with at least 5 years of creditable service.

Amount:

Normal retirement amount reduced by 0.5% for each month that retirement precedes eligibility for normal retirement.

Uniformed Patrol members are not eligible for early retirement.



Closed Plan

Year 2000 Plan

2011 Tier

Vested Deferred Benefits***Eligibility: All Employees***

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

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.

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.

Vested Deferred Benefits***Eligibility: All Employees***

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

Same.

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 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.

Vested Deferred Benefits***Eligibility: All Employees***

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

Same.

Death Prior to Retirement

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

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.

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.

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 received had he/she not elected a reduced survivor option.

Death After 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.

For period certain annuities, beneficiaries may be changed at any time.

Pop-Up Provision

Same.

Death After 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.

For period certain annuities, beneficiaries may be changed at any time.

Pop-Up Provision

Same.

Closed Plan**Year 2000 Plan****2011 Tier**

\$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.

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 **can** be used to satisfy the vesting requirement. Periods of military service cannot coincide with employment in a state agency.

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.

\$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 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 from which they were honorably discharged. All months the member is eligible for must be purchased. This service credit **cannot** be used to satisfy the vesting requirement. Periods of military service cannot coincide with employment in a state agency.

Police Service: Not available.

\$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 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: Not available.

Police Service: Not available.

Closed Plan**Year 2000 Plan****2011 Tier**

Portability: Section 105.691 allows vested members to acquire (purchase/transfer) service credit for any non-federal, full-time public sector employment within Missouri.

Service may be purchased/transferred by using the member's own money and/or using the value of the retirement benefit in the prior retirement plan if that plan has an agreement with MPERS. Any non-federal public employment **not covered** by a retirement plan must be purchased.

Public Employment Prior Service (Subsidized Purchase)

Section 104.040.6 allows, prior to retirement, members may purchase up to a maximum of 4 years full-time "public employment." Public employment refers to employment with a city, county, municipality, public school, or other political subdivision. Federal and out-of-state employment is not eligible. Members must purchase all months of service they are eligible for up to 4 years.

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.

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 increased by 80% of CPI to the retirement date.

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 increased by 80% of CPI to the retirement date.

Closed Plan**Year 2000 Plan****2011 Tier****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 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.

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%.

Member Contributions

None.

Post-Retirement Benefit Adjustments

Benefits are increased to retired members (including survivors) annually in accordance with the following:

Annual benefit percentage increase equal to the lesser of:

- i) 80% of the CPI-U increase, or
- ii) 5%.

Member Contributions

None.

Post-Retirement Benefit Adjustments

Benefits are increased to retired members (including survivors) annually* in accordance with the following:

Annual benefit percentage increase equal to the lesser of:

- i) 80% of the CPI-U increase, or
- ii) 5%.

** Vested former members and their survivor benefits are increased beginning on the second anniversary of retirement.*

Member Contributions

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 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 12-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, 2021

Non-Uniformed Employee

	Data	Description
A.	\$40,000	Final Average Pay
B.	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: $0.016 \times 20 \times \$40,000 = \$12,800$

Benefit payable to:

F. Retiree while spouse is alive (E)	\$ 12,800
G. Spouse after retiree's death (D x E)	\$ 6,400
H. Retiree after spouse's death	\$ 12,800

Year Ended June 30	Annual Amount Payable if Price Inflation is 2.25% and Post-Retirement Increases are 1.8%
2021	\$12,800
2022	13,030
2023	13,265
2024	13,504
2025	13,747
2026	13,994
2027	14,246
2028	14,503
2029	14,764
2030	15,029



Sample Benefit Computation for Closed Plan Members

Retiring July 1, 2021

Uniformed Patrol

	Data	Description
A.	\$40,000	Final Average Pay
B.	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: $0.021333 \times 20 \times \$40,000 = \$17,066$

Benefit payable to:

F. Retiree while spouse is alive (E)	\$ 17,066
G. Spouse after retiree's death (D x E)	\$ 8,533
H. Retiree after spouse's death	\$ 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%
2021	\$17,066
2022	17,373
2023	17,686
2024	18,004
2025	18,328
2026	18,658
2027	18,994
2028	19,336
2029	19,684
2030	20,038



Sample Benefit Computation for Year 2000 Plan Members Retiring July 1, 2021

	Data	Description
A.	\$40,000	Final Average Pay
B.	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:		$0.017 \times 20 \times \$40,000 = \$13,600$
E2. Supplemental Benefit Formula:		$.008 \times 20 \times \$40,000 = \$6,400$

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%
2021	\$20,000
2022	20,360
2023	14,094
2024	14,348
2025	14,606
2026	14,869
2027	15,137
2028	15,409
2029	15,686
2030	15,969



SECTION C

FINANCIAL INFORMATION

Summary of Fund Operations

	2021	2020
Market Value of Fund Beginning of Fiscal Year	\$2,361,599,888	\$2,423,261,830
Post Valuation Audit Adjustment	0	0
Contributions		
Employer	208,212,848	210,871,852
Employee	5,334,102	4,983,989
Transfer from MOSERS	2,080,317	3,483,574
Service Purchase (Employee)	1,761,861	1,563,362
Total Contributions	\$ 217,389,128	\$ 220,902,777
Investment Return		
Interest	\$ 15,756,734	\$ 27,545,526
Dividends	5,536,749	11,185,634
Real Estate	31,450,016	23,258,476
Realized Capital Gains	870,957,242	896,353,383
Realized Capital Losses	(558,049,010)	(795,666,529)
Miscellaneous Income	0	0
Securities Lending Income	130,655	193,392
Other	0	0
Total Investment Return	\$ 365,782,386	\$ 162,869,882
Other Income (Rental Income and Misc)	286	5,412
Increase (Decrease) in Unrealized Appreciation	408,465,824	(151,844,475)
Benefit Payments		
Retirement Payments	\$ 251,246,812	\$ 246,007,290
Retirement Payments - BackDROP	13,585,356	15,787,033
Death Benefits	1,255,000	890,000
Long-Term Disability Payments	21,023	26,488
Insured Disability Program	1,600,628	1,640,971
Employee Contribution Refunds	611,132	796,107
Service Transfer Payments - Employer	1,802,900	2,457,945
Total Benefit Payments	\$ 270,122,850	\$ 267,605,833
Expenses		
Investment	\$ 74,603,961	\$ 21,698,677
Other	4,585,473	4,291,028
Total Expenses	\$ 79,189,434	\$ 25,989,705
Market Value of Fund End of Fiscal Year	\$3,003,925,228	\$2,361,599,888



Missouri MPERS

Development of Actuarial Value of Assets

Valuation Date of June 30	2016	2017	2018	2019	2020	2021	2022	2023
A. Actuarial value at beginning of year	\$1,967,001,509	\$2,086,654,348	\$2,172,787,144	\$2,274,248,122	\$2,415,343,431	\$2,481,329,531		
B. Market value at end of year	1,992,073,946	2,169,775,040	2,314,530,148	2,423,261,830	2,361,599,888	3,003,925,228		
C. Market value at beginning of year	2,009,367,134	1,992,073,946	2,169,775,040	2,314,530,148	2,423,261,830	2,361,599,888		
D. Cash flow								
D1. Contributions	205,821,588	213,198,963	211,824,043	218,595,641	220,902,777	217,389,128		
D2. Benefit Payments	(240,176,011)	(251,284,152)	(259,058,863)	(259,817,811)	(267,605,833)	(270,122,850)		
D3. Administrative Expenses	(4,370,860)	(4,515,458)	(4,693,492)	(4,372,966)	(4,291,028)	(4,585,473)		
D4. Non-Investment Net Cash Flow	(38,725,283)	(42,600,647)	(51,928,312)	(45,595,136)	(50,994,084)	(57,319,195)		
E. Investment income								
E1. Market total (B - C - D4)	21,432,095	220,301,741	196,683,420	154,326,818	(10,667,858)	699,644,535		
E2. Assumed Rate of Return	7.75%	7.75%	7.75%	7.00%	7.00%	7.00%	6.50%	
E3. Amount for Immediate Recognition (A+.5xD4)xE2	150,942,012	160,064,937	166,378,782	157,601,539	167,289,247	171,686,895		
E4. Amount for Phased-In Recognition	(129,509,917)	60,236,804	30,304,638	(3,274,721)	(177,957,105)	527,957,640		
F. Phased in recognition of investment income								
F1. Current Year (33 1/3% of E4)	(43,169,972)	20,078,935	10,101,546	(1,091,574)	(59,319,035)	175,985,880		
F2. First Prior Year	(8,240,457)	(43,169,972)	20,078,935	10,101,546	(1,091,574)	(59,319,035)	\$ 175,985,880	
F3. Second Prior Year	58,846,539	(8,240,457)	(43,169,973)	20,078,934	10,101,546	(1,091,573)	(59,319,035)	\$ 175,985,880
F4. Total Recognized Investment Gain (F1 + F2 + F3)	7,436,110	(31,331,494)	(12,989,492)	29,088,906	(50,309,063)	115,575,272	116,666,845	175,985,880
G. Actuarial value at end of year (A + D4 + E3 + F4)	2,086,654,348	2,172,787,144	2,274,248,122	2,415,343,431	2,481,329,531	2,711,272,503		
Less LTD Assets	0	0	0	0	0	0		
H. Preliminary Plan AVA	2,086,654,348	2,172,787,144	2,274,248,122	2,415,343,431	2,481,329,531	2,711,272,503		
I. Corridor (Maximum of 120% of Market Value)	2,390,488,735	2,603,730,048	2,777,436,178	2,907,914,196	2,833,919,866	3,604,710,274		
J. Corridor Minimum of 80% of Market Value)	1,593,659,157	1,735,820,032	1,851,624,118	1,938,609,464	1,889,279,910	2,403,140,182		
K. Additional Investment Gain/(Loss) recognized due to corridor	0	0	0	0	0	0		
L. Final Plan AVA after corridor adjustment, if any	2,086,654,348	2,172,787,144	2,274,248,122	2,415,343,431	2,481,329,531	2,711,272,503		
Difference between market and actuarial values	(94,580,402)	(3,012,104)	40,282,026	7,918,399	(119,729,643)	292,652,725		
Market Rate of Return	1.08%	11.18%	9.17%	6.73%	(0.44)%	29.99%		
Ratio of Actuarial Value to Market Value	104.75%	100.14%	98.26%	99.67%	105.07%	90.26%		
Recognized actuarial rate of return	8.13%	6.23%	7.14%	8.29%	4.89%	11.71%		



Allocation of Assets between Groups

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

<u>Allocation of Actuarial Value of Assets</u>	<u>June 30</u>	
	<u>2021</u>	<u>2020</u>
1. Actuarial Value of Assets	\$2,711,272,503	\$2,481,329,531
2. Reported Market Value of Assets		
a) Uniformed Patrol	885,758,872	692,823,906
b) Non-Uniformed Employees	2,118,166,356	1,668,775,982
c) Total	<u>3,003,925,228</u>	<u>2,361,599,888</u>
3. Actuarial Value of Assets Split		
a) Uniformed Patrol		
(2a) / (2c) x (1)	799,465,197	727,949,060
b) Non-Uniformed Employees		
(2b) / (2c) x (1)	<u>1,911,807,306</u>	<u>1,753,380,471</u>
4. Total Assets Allocated	2,711,272,503	2,481,329,531

SECTION D

SUMMARY OF MEMBER DATA

Civilian Patrol Closed Active Members as of June 30, 2021 by Attained Age and Years of Service

Attained Age	Count by Complete Years of Service to Valuation Date							Totals	
	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									
40-44					13	1		14	\$ 705,934
45-49		1			23	19		43	2,393,496
50-54		1	3	1	21	26	13	65	3,567,264
55-59			1	2	16	18	18	55	3,107,876
60			1	1		5	1	8	413,071
61					3	2	3	8	376,727
62			1		1	2	3	7	367,420
63					2	2		4	160,722
64						1	1	2	98,361
65					1	2		3	149,548
66					1	1	2	4	267,270
67									
68									
69									
70									
Over 70							1	1	38,040
Totals		2	6	4	81	79	42	214	\$11,645,729

Average Age: 53.7 years

Average Service: 26.1 years

Average Pay: \$54,419



**Civilian Patrol Year 2000 Active Members
as of June 30, 2021
by Attained Age and Years of Service**

Attained Age	Count by Complete Years of Service to Valuation Date							Totals	
	0-4	5-9	10-14	15-19	20-24	25-29	30+	No.	Valuation Payroll
Under 20									
20-24									
25-29									
30-34		4	6					10	\$ 429,970
35-39		3	38	14				55	2,888,241
40-44	3	6	27	48	9			93	5,026,930
45-49		1	20	22	10			53	2,703,102
50-54		5	20	29	4			58	2,775,454
55-59	3	1	19	18	11			52	2,483,369
60			2	1	3			6	264,277
61			3	7				10	512,531
62			3	2		1		6	245,093
63			2	2				4	162,167
64				1				1	35,625
65			2		1			3	113,818
66			4					4	163,026
67									
68		2						2	72,024
69									
70			1					1	39,456
Over 70			1	1				2	46,896
Totals	6	22	148	145	38	1		360	\$17,961,979

Average Age: 47.7 years

Average Service: 15.0 years

Average Pay: \$49,894



Civilian Patrol 2011 Tier Active Members as of June 30, 2021 by Attained Age and Years of Service

Attained Age	Count by Complete Years of Service to Valuation Date							Totals	
	0-4	5-9	10-14	15-19	20-24	25-29	30+	No.	Valuation Payroll
Under 20	1							1	\$ 22,344
20-24	18							18	675,686
25-29	85	24						109	4,635,568
30-34	42	50	3					95	4,164,187
35-39	27	26	6					59	2,527,559
40-44	28	16	2					46	1,809,985
45-49	20	23	3					46	1,811,397
50-54	26	22	3					51	1,989,307
55-59	19	15	2					36	1,343,452
60	6	4						10	290,892
61	4	4						8	282,624
62	1	2						3	96,371
63	2	3						5	172,763
64	2	5						7	248,996
65	1	1	1					3	102,312
66		1						1	39,198
67		2						2	59,184
68		1						1	34,296
69									
70		1						1	44,880
Over 70									
Totals	282	200	20					502	\$20,351,001

Average Age: 39.7 years

Average Service: 4.6 years

Average Pay: \$40,540



MoDOT Closed Active Members as of June 30, 2021 by Attained Age and Years of Service

Attained Age	Count by Complete Years of Service to Valuation Date							Totals	
	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	\$ 41,170
40-44		1	2	1	80	2		86	4,241,868
45-49				2	142	101	1	246	13,642,429
50-54		1	4	7	132	202	54	400	22,385,268
55-59	1	2	3	3	73	86	86	254	13,884,571
60					16	8	11	35	1,874,580
61				1	13	14	10	38	1,892,461
62					8	11	6	25	1,293,473
63		1			4	5	5	15	727,718
64					3	6	3	12	588,594
65					4	6	1	11	585,107
66					4	2	4	10	506,542
67					1	3	2	6	332,108
68					1	1		2	124,927
69						1	1	2	107,341
70							1	1	47,441
Over 70							2	2	221,684
Totals	1	5	9	14	482	448	187	1,146	\$62,497,282

Average Age: 52.7 years

Average Service: 26.0 years

Average Pay: \$54,535



MoDOT Year 2000 Active Members as of June 30, 2021 by Attained Age and Years of Service

Attained Age	Count by Complete Years of Service to Valuation Date							Totals	
	0-4	5-9	10-14	15-19	20-24	25-29	30+	No.	Valuation Payroll
Under 20									
20-24									
25-29									
30-34	2	5	30	1				38	\$ 1,588,659
35-39	6	6	112	89	2			215	10,328,001
40-44	3	12	73	165	46			299	14,652,042
45-49	4	16	77	103	49			249	11,376,227
50-54	10	8	71	112	30			231	10,128,400
55-59	8	6	61	100	45		1	221	9,399,076
60	1	3	19	16	7			46	2,014,926
61		2	9	15	8	1		35	1,545,864
62		1	8	15	4			28	1,151,528
63			12	8	3			23	961,408
64			11	10	3			24	967,949
65		1	5	3	4			13	572,142
66			4	5	2			11	549,560
67			3	2	1			6	288,552
68			2	4				6	267,819
69				2				2	84,406
70									
Over 70				2				2	97,630
Totals	34	60	497	652	204	1	1	1,449	\$65,974,189

Average Age: 48.6 years

Average Service: 15.6 years

Average Pay: \$45,531



MoDOT 2011 Tier Active Members as of June 30, 2021 by Attained Age and Years of Service

Attained Age	Count by Complete Years of Service to Valuation Date							Totals	
	0-4	5-9	10-14	15-19	20-24	25-29	30+	No.	Valuation Payroll
Under 20	7							7	\$ 199,723
20-24	191							191	6,352,987
25-29	363	96						459	18,798,595
30-34	252	168	1					421	16,799,659
35-39	194	125	2					321	12,127,830
40-44	166	94	1					261	9,919,648
45-49	137	75	1					213	8,094,324
50-54	112	77	2					191	7,218,342
55-59	84	79	1	1				165	6,357,456
60	10	12						22	846,684
61	12	12						24	879,244
62	8	17						25	939,980
63	6	8						14	495,543
64	5	2						7	273,984
65	1	6						7	298,189
66	6	4						10	370,354
67		2						2	81,459
68	1							1	31,553
69	2	1						3	103,632
70		1						1	34,019
Over 70	1	1						2	75,807
Totals	1,558	780	8	1				2,347	\$90,299,012

Average Age: 38.2 years

Average Service: 3.8 years

Average Pay: \$38,474



Uniformed Patrol Closed Active Members as of June 30, 2021 by Attained Age and Years of Service

Attained Age	Count by Complete Years of Service to Valuation Date							Totals	
	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									
40-44			1		14			15	\$ 1,222,136
45-49				1	81	52		134	11,401,055
50-54	1			1	34	143	23	202	17,328,138
55-59					6	25	27	58	4,981,461
60						1	1	2	154,681
61									
62									
63									
64									
65									
66									
67									
68									
69									
70									
Over 70									
Totals	1		1	2	135	221	51	411	\$35,087,471

Average Age: 50.8 years

Average Service: 26.2 years

Average Pay: \$85,371



Uniformed Patrol Year 2000 Active Members as of June 30, 2021 by Attained Age and Years of Service

Attained Age	Count by Complete Years of Service to Valuation Date							Totals	
	0-4	5-9	10-14	15-19	20-24	25-29	30+	No.	Valuation Payroll
Under 20									
20-24									
25-29									
30-34		3	31					34	\$ 2,224,573
35-39			74	30				104	7,477,161
40-44			27	88	15			130	10,305,020
45-49		1	12	38	14			65	4,885,158
50-54			4	9	6			19	1,421,750
55-59			2	3	2			7	532,244
60									
61									
62									
63									
64									
65									
66									
67									
68									
69									
70									
Over 70									
Totals		4	150	168	37			359	\$26,845,906

Average Age: 41.4 years

Average Service: 15.7 years

Average Pay: \$74,780



Uniformed Patrol 2011 Tier Active Members as of June 30, 2021 by Attained Age and Years of Service

Attained Age	Count by Complete Years of Service to Valuation Date							Totals	
	0-4	5-9	10-14	15-19	20-24	25-29	30+	No.	Valuation Payroll
Under 20									
20-24	54							54	\$ 2,958,952
25-29	120	36						156	8,677,309
30-34	46	89	19					154	8,938,754
35-39	6	26	10					42	2,492,260
40-44	5	10	5					20	1,167,646
45-49			1					1	61,955
50-54		2	1					3	175,742
55-59		1						1	59,385
60									
61									
62									
63									
64									
65									
66									
67									
68									
69									
70									
Over 70									
Totals	231	164	36					431	\$24,532,003

Average Age: 30.2 years

Average Service: 5.0 years

Average Pay: \$56,919



Growth of Active Member Payroll

Actuarial Valuation for June 30,	Number	Covered Payroll	Average Pay	% Change in Average Pay 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 %
2020	7,355	360,851,545	49,062	1.3 %
2021	7,219	355,194,571	49,203	0.3 %
Ten-Year Average:				1.1 %



**Count and Total Monthly Benefits
Civilian Patrol Closed Retired (Non-Disabled)
Members and Survivors
as of June 30, 2021
by Attained Age**

Age	Number	Monthly Benefit Amount
Less than 20		
20-24		
25-29		
30-34		
35-39		
40-44		
45-49	1	\$ 690
50-54	2	3,904
55-59	30	61,789
60-64	54	97,084
65-69	82	149,074
70-74	80	134,042
75-79	62	98,544
80-84	73	149,064
85-89	67	122,041
90-94	30	50,306
95-99	2	1,159
100-104		
105 & Over		
TOTAL	483	\$ 867,697

**Count and Total Monthly Benefits of
Civilian Patrol Year 2000 Retired (Non-Disabled)
Members and Survivors
as of June 30, 2021
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	10	\$ 25,273
55-59	50	122,886
60-64	135	217,618
65-69	156	220,308
70-74	153	218,270
75-79	105	165,780
80-84	16	17,905
85-89	3	1,074
90-94	1	2,343
95-99		
100-104		
105 & Over		
TOTAL	629	\$ 991,457

**Count and Total Monthly Benefits of
Civilian Patrol 2011 Tier Retired (Non-Disabled)
Members and Survivors
as of June 30, 2021
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		
55-59		
60-64	1	\$ 371
65-69	5	1,461
70-74	1	222
75-79		
80-84		
85-89		
90-94		
95-99		
100-104		
105 & Over		
TOTAL	7	\$ 2,054

**Count and Total Monthly Benefits of
MoDOT Closed Retired (Non-Disabled)
Members and Survivors
as of June 30, 2021
by Attained Age**

Age	Number	Monthly Benefit Amount
Less than 20	1	\$ 472
20-24		
25-29		
30-34	1	197
35-39		
40-44	3	1,968
45-49	9	5,025
50-54	34	51,739
55-59	154	265,026
60-64	345	593,111
65-69	385	644,212
70-74	394	646,532
75-79	426	874,312
80-84	681	1,820,579
85-89	528	1,280,051
90-94	223	491,432
95-99	50	80,729
100-104	4	2,901
105 & Over		
TOTAL	3,238	\$ 6,758,286

**Count and Total Monthly Benefits of
MoDOT Year 2000 Retired (Non-Disabled)
Members and Survivors
as of June 30, 2021
by Attained Age**

Age	Number	Monthly Benefit Amount
Less than 20	9	\$ 2,127
20-24		
25-29	2	481
30-34	1	311
35-39	2	1,372
40-44	4	3,538
45-49	6	4,149
50-54	103	317,331
55-59	426	1,220,848
60-64	886	1,748,490
65-69	875	1,297,858
70-74	808	1,396,165
75-79	468	912,331
80-84	84	141,317
85-89	14	20,793
90-94	10	18,289
95-99	4	6,281
100-104		
105 & Over		
TOTAL	3,702	\$ 7,091,681

**Count and Total Monthly Benefits of
MoDOT Year 2011 Tier Retired (Non-Disabled)
Members and Survivors
as of June 30, 2021
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		
55-59		
60-64	2	\$ 447
65-69	5	2,041
70-74	4	1,178
75-79		
80-84		
85-89		
90-94		
95-99		
100-104		
105 & Over		
TOTAL	11	\$ 3,666

**Count and Total Monthly Benefits of
Uniformed Patrol Closed Retired (Non-Disabled)
Members and Survivors
as of June 30, 2021
by Attained Age**

Age	Number	Monthly Benefit Amount
Less than 20	1	\$ 535
20-24	2	3,779
25-29		
30-34		
35-39	1	1,521
40-44	2	4,697
45-49	9	24,373
50-54	36	160,885
55-59	160	679,157
60-64	152	790,619
65-69	160	882,138
70-74	158	801,217
75-79	153	793,803
80-84	112	542,591
85-89	53	254,222
90-94	25	120,970
95-99	8	21,787
100-104	1	4,259
105 & Over		
TOTAL	1,033	\$ 5,086,553

**Count and Total Monthly Benefits of
Uniformed Patrol Year 2000 Retired (Non-Disabled)
Members and Survivors
as of June 30, 2021
by Attained Age**

Age	Number	Monthly Benefit Amount
Less than 20	2	\$ 423
20-24		
25-29		
30-34		
35-39	1	1,722
40-44		
45-49	2	2,699
50-54		
55-59	2	4,999
60-64	1	2,233
65-69	1	944
70-74		
75-79		
80-84		
85-89		
90-94		
95-99		
100-104		
105 & Over		
TOTAL	9	\$ 13,020

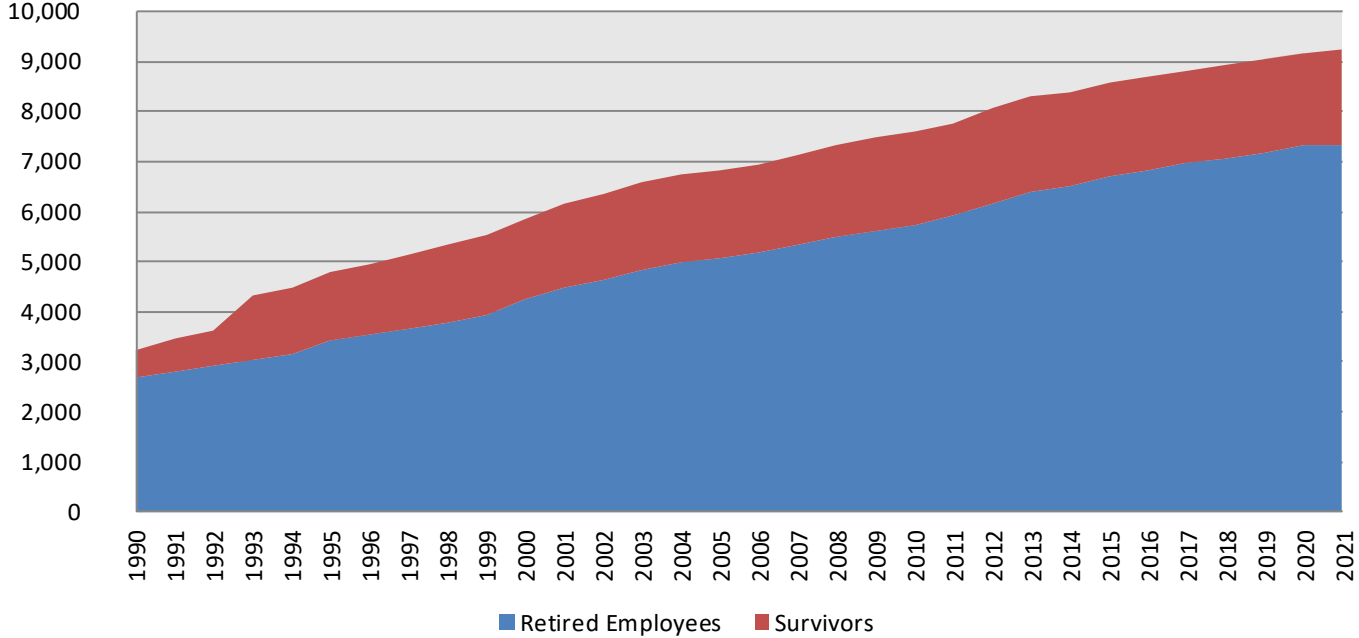
Growth of Pension Population by Year

Year	Retired Employees	Survivors	Total	% Increase	Annual Benefits	Active Payroll	Benefits as a % of Payroll
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%
2020	7,318	1,864	9,182	1.6%	249,197,664	360,851,545	69.1%
2021	7,339	1,896	9,235	0.6%	252,148,236	355,194,571	71.0%



Growth of Pension Population by Year

Number of Pensioners by Year



Self-Insured Disabled Retired Members as of June 30, 2021

Age	Number	Monthly Benefit Amount
Less than 20		
20-24		
25-29		
30-34		
35-39		
40-44		
45-49	2	\$ 6,737
50-54	3	3,471
55-59	6	6,732
60-64	9	18,874
65-69	9	15,425
70-74	8	8,936
75-79	4	7,439
80-84	2	2,810
85-89		
90-94	1	117
95-99		
100-104		
105 & Over		
TOTAL	44	\$ 70,541

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, 2021

Age	Number	Monthly Benefit Amount
Less than 20		
20-24		
25-29		
30-34	1	\$ 2,371
35-39	4	7,832
40-44	4	9,874
45-49	14	28,401
50-54	15	29,662
55-59	24	33,953
60-64	15	14,206
65-69	2	1,099
70-74		
75-79		
80-84		
85-89		
90-94		
95-99		
100-104		
105 & Over		
TOTAL	79	\$ 127,398

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, 2021

Non-Uniformed	Active Members	Vested Terminated Members	Retired *
Number at Start of Year	6,151	1,917	8,164
Increase (Decrease) From			
New Entrants/Rehires	516	(16)	(3)
Service Retirement	(221)	(52)	274
Vested Terminations	(126)	130	(4)
Deaths/Removals	(1)	(22)	(252)
Disability Retirement	(8)		8
Non-Vested Terminations	(293)		
Number at End of Year	6,018	1,957	8,187

Uniformed	Active Members	Vested Terminated Members	Retired *
Number at Start of Year	1,204	177	1,018
Increase (Decrease) From			
New Entrants/Rehires	59		
Service Retirement	(41)	(8)	49
Vested Terminations	(10)	12	(2)
Deaths/Removals		(5)	(17)
Disability Retirement			
Non-Vested Terminations	(11)		
Number at End of Year	1,201	176	1,048

* Including disability participants.

SECTION E

ASSUMPTIONS USED IN THE VALUATION AND GLOSSARY

Summary of Valuation Method and Assumptions

June 30, 2021

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. The valuation interest rate was updated after a review preceding the 2021 valuation. Assumptions 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 6.50% 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 6.50% investment return rate and 3.00% wage inflation rate translates to an assumed real rate of return over wage growth net of expenses of 3.50%. Based upon other assumptions, the net real rate of return over price inflation is 4.25%.

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 post-retirement 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, 2021 (Continued)

Reviewing the Investment Return Assumption

The analysis of the investment return assumption in this report is based on forward-looking measures of expected investment return outcomes for the asset classes in the System's current investment policy. For purposes of this analysis, we have analyzed the System's investment policy with the capital market assumptions from twelve nationally recognized investment advisors.

Our analysis is based on the GRS Capital Market Assumption Modeler (CMAM). Because GRS is a benefits consulting firm and does not develop or maintain our own capital market expectations, we request and monitor forward-looking expectations developed by several major investment advisory firms. We update our CMAM on an annual basis. The capital market assumptions in the 2021 CMAM are from the following investment firms (in alphabetical order): Aon Hewitt, Blackrock, BNY Mellon, Callan, Cambridge, JPMorgan, Meketa, Mercer, NEPC, RVK, Verus, and Wilshire. We believe that the benefit of performing this analysis using multiple investment advisory firms is to recognize the uncertain nature of the items affecting the selection of the investment return assumption. While there may be differences in asset classes, investment horizons, inflation assumptions, treatment of investment expenses, excess manager performance (i.e., alpha), etc., we have attempted to align the various assumption sets from the different investment advisors to be as consistent as possible.

To the best of our ability, we have adapted the System's investment policy to fit with the advisors' assumptions adjusting for these known differences in assumptions and methodology. In the following charts, to the extent possible all returns are net of passive investment expenses and have no assumption for excess manager performance (alpha) in excess of active management fees.

For purposes of this analysis, we have been provided with the following asset allocation from System staff:

Asset Classes	Current Policy
Cash	0.00%
US Stock - Large Cap	20.30%
US Stock - Small Cap	2.70%
Int'l Equity	12.00%
Emerging Mkts Eq	5.00%
US Corporate Bonds	9.00%
Government Bonds	13.50%
TIPS	0.00%
High Yield	7.50%
Int'l Debt	0.00%
Real Estate	20.00%
Private Equity	10.00%
Hedge Funds	0.00%
Other Alternatives	0.00%
Total	100.00%

Summary of Valuation Method and Assumptions June 30, 2021 (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	5.56%	2.21%	3.35%	2.25%	5.60%	0.00%	5.60%
2	5.67%	2.40%	3.27%	2.25%	5.52%	0.00%	5.52%
3	5.75%	2.15%	3.60%	2.25%	5.85%	0.00%	5.85%
4	5.72%	2.00%	3.72%	2.25%	5.97%	0.00%	5.97%
5	5.62%	2.00%	3.62%	2.25%	5.87%	0.00%	5.87%
6	5.76%	2.00%	3.76%	2.25%	6.01%	0.00%	6.01%
7	5.71%	2.01%	3.70%	2.25%	5.95%	0.00%	5.95%
8	6.32%	2.34%	3.98%	2.25%	6.23%	0.00%	6.23%
9	7.08%	3.10%	3.98%	2.25%	6.23%	0.00%	6.23%
10	6.06%	2.11%	3.95%	2.25%	6.20%	0.00%	6.20%
11	6.37%	2.01%	4.36%	2.25%	6.61%	0.00%	6.61%
12	6.42%	1.92%	4.50%	2.25%	6.75%	0.00%	6.75%
Average	6.00%	2.19%	3.82%	2.25%	6.07%	0.00%	6.07%
Average from last 3 CMAMs							6.55%

Investment Consultant	Distribution of 20-Year Average Geometric Net Nominal Return			Probability of Exceeding	Probability of Exceeding	Probability of Exceeding
	40th	50th	60th	6.50%	6.25%	6.00%
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1	4.32%	4.97%	5.62%	27.68%	30.99%	34.48%
2	4.51%	5.06%	5.62%	25.82%	29.57%	33.57%
3	4.44%	5.13%	5.83%	30.96%	34.22%	37.61%
4	4.68%	5.33%	5.99%	32.70%	36.21%	39.86%
5	4.84%	5.40%	5.97%	31.22%	35.24%	39.44%
6	4.82%	5.44%	6.07%	33.38%	37.14%	41.03%
7	4.94%	5.50%	6.05%	32.46%	36.62%	40.96%
8	4.82%	5.51%	6.21%	36.00%	39.44%	42.97%
9	4.94%	5.59%	6.25%	36.34%	40.00%	43.76%
10	4.97%	5.61%	6.24%	36.10%	39.88%	43.76%
11	5.21%	5.90%	6.60%	41.37%	44.95%	48.59%
12	5.42%	6.09%	6.76%	43.85%	47.58%	51.35%
Average	4.83%	5.46%	6.10%	33.99%	37.66%	41.45%
Average from last 3 CMAMs		5.96%				
Current CMAM average over 20- to 30-year		6.48%				

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.

With Policy Allocation		
CMAM Year	Mean	Median
2015	6.73%	6.15%
2016	7.13%	6.55%
2017	6.59%	6.03%
2018	6.53%	5.94%
2019	7.02%	6.44%
2020	6.54%	5.96%
2021	6.07%	5.46%

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, 2021 (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

Age	% Dying Next Year		Age	% Dying Next Year		Age	% Dying Next Year	
	Male	Female		Male	Female		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%			
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%			



Post-Retirement Mortality (Disability)

Disabled Retired Lives Mortality Rates

Age	% Dying Next Year		Age	% Dying Next Year		Age	% Dying Next Year	
	Male	Female		Male	Female		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%			



Pre-Retirement Mortality

Death-in-Service Mortality Rates

Age	% Dying Next Year		Age	% Dying Next Year		Age	% Dying Next Year	
	Male	Female		Male	Female		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 (6.50% Interest)

Sample Attained Ages	Single Life Retirement Values					
	Present Value of \$1 Monthly for Life		Percent Dying Next Year		Future Life Expectancy (years)	
	Men	Women	Men	Women	Men	Women
50	\$157.18	\$162.18	0.3922%	0.2660%	32.36	34.85
55	148.88	154.45	0.5582%	0.3734%	28.05	30.34
60	138.85	144.94	0.7938%	0.5667%	23.89	25.97
65	126.89	133.47	1.1511%	0.8398%	19.90	21.76
70	112.78	119.67	1.7034%	1.2770%	16.11	17.74
75	96.54	103.58	2.6823%	2.0723%	12.58	13.97
80	78.84	85.72	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

Age	% of Active Participants Retiring								
	Closed and Year 2000 Plans					2011 Tier			
	Non-Uniformed Members				Uniformed	Non-Uniformed			Uniformed
	Male		Female			Normal		Early	
	Normal	Early	Normal	Early	Normal	Age & Service	Rule of 90		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

Age	% of Active Participants Becoming Disabled			
	Uniformed Members		Non-Uniformed Members	
	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%
56	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	0.10%	0.10%	1.49%	1.49%
61	0.10%	0.10%	1.64%	1.64%
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%

Rates of Separation from Active Employment

All Plan Participants

Age	Service	% of Active Participants Withdrawing			
		Uniformed Members		Non-Uniformed Members	
		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%	



Miscellaneous and Technical Assumptions

Administrative Expenses:	1.22% of payroll, based upon actual results from previous year.
Disability Expenses:	0.475% 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 retiree liabilities are increased by 12% to account for future survivor benefits.



Miscellaneous and Technical Assumptions

Contribution Stabilization

Miscellaneous Adjustments:	Liabilities for future deferred members were increased by 2% to account for potential survivor benefits payable if the member dies during the deferred period. We have otherwise not modeled this benefit for future deferred members.
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:	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.

Active Member Data: Active membership excludes one member in the data that was listed as having terminated prior to the valuation date.

Salary Adjustments: Salary from data as provided in prior valuations was used for nineteen 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.

Deferred Member Data: Six Terminated Vested members were indicated to have a refund request in progress and one was indicated to have a service transfer to LAGERS in progress. As a result, we removed them from the Terminated Vested data file.

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, 2021, 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 14-year amortization of unfunded actuarial accrued liabilities. The amortization period is a closed 14-year period starting July 1, 2022.

Temporary Accelerated Policy: The total contribution is based on normal cost plus a 3-year amortization period for unfunded retiree liabilities and a 18-year amortization period for other unfunded liabilities. Both amortization periods are closed periods starting July 1, 2022.

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, 2021 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, 2021 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 1970s. 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



September 15, 2021

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, 2021. This valuation indicates that contribution rates for the period beginning July 1, 2022 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 6,018 Non-Uniformed employees and 58.65% of payroll for the 1,201 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.

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 and 2021 review of economic assumptions. Gabriel, Roeder, Smith & Company has produced the following reports as of June 30, 2021:

- 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.



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 4 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 actuaries 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 actuaries 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 G. Barry, ASA, FCA, MAAA



Jamal Adora, ASA, MAAA



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.

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

Val. Date June 30	(1) Member Contributions	(2) Retirees and Benef.	(3) Active and Inactive Members	Present Valuation Assets	Portion of Present Values Covered by Present Assets			
					(1)	(2)	(3)	Total
	-----\$ Millions-----							
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%
2020	18	2,726	1,348	2,481	100%	90%	0%	61%
2021#	21	2,882	1,441	2,711	100%	93%	0%	62%

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)	\$ 1,610,768,366
Normal Cost	47,889,669
Transfer In and Service Purchase - Liability	3,842,178
Contributions	(217,389,127)
Interest	106,955,781
Net Change in LTD Assets	-
Expected UAAL Before Any Changes	1,552,066,867
Effect of Benefit Changes	-
Effect of Changes in Assumptions & Methods	226,319,675
Effect of Adjustment	-
Expected UAAL After Changes	1,778,386,542
End of Year UAAL (at June 30)	\$ 1,632,800,409
Gain/(Loss) for Year	\$ 145,586,133
Gain/(Loss) as a percent of actuarial accrued liabilities at start of year (\$4,092.1 million)	3.6%

Valuation Date June 30	Experience Gain/(Loss) as % of Beginning Accrued Liability
2012	3.2 %
2013	2.1 %
2014	2.1 %
2015	2.4 %
2016	1.1 %
2017	0.1 %
2018	0.6 %
2019	0.7 %
2020	(1.2)%
2021	3.6 %

Summary of Actuarial Assumptions and Methods

Valuation Date:	June 30, 2021
Actuarial Cost Method:	Entry Age
Amortized Method:	Closed, level percent-of-payroll
Remaining Amortization Period:	12 years#
Asset Valuation Method:	3-year smoothing
Actuarial Assumptions:	
Investment Rate of Return:	6.50%
Projected Salary Increase:	3.00% to 12.45%
Cost-of-Living Adjustments:	1.80% Compound
Includes Wage Inflation at:	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 and a 2021 review of economic assumptions. 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 6.50% 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 6.50% rate translates to an assumed real rate of return over wage inflation of 3.50%. This rate was first used for the **June 30, 2021** 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 I
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%

Table II Post-Retirement Mortality

Retired Lives Mortality Rates

Age	% Dying Next Year		Age	% Dying Next Year		Age	% Dying Next Year	
	Male	Female		Male	Female		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%			
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

Age	% Dying Next Year		Age	% Dying Next Year		Age	% Dying Next Year	
	Male	Female		Male	Female		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

Age	% Dying Next Year		Age	% Dying Next Year		Age	% Dying Next Year	
	Male	Female		Male	Female		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%			

Table V Joint Life Retirement Values (6.50% Interest)

Sample Attained Ages	Single Life Retirement Values					
	Present Value of \$1 Monthly for Life		Percent Dying Next Year		Future Life Expectancy (years)	
	Men	Women	Men	Women	Men	Women
50	\$157.18	\$162.18	0.3922%	0.2660%	32.36	34.85
55	148.88	154.45	0.5582%	0.3734%	28.05	30.34
60	138.85	144.94	0.7938%	0.5667%	23.89	25.97
65	126.89	133.47	1.1511%	0.8398%	19.90	21.76
70	112.78	119.67	1.7034%	1.2770%	16.11	17.74
75	96.54	103.58	2.6823%	2.0723%	12.58	13.97
80	78.84	85.72	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

Age	% of Active Participants Retiring								
	Closed and Year 2000 Plans					2011 Tier			
	Non-Uniformed Members				Uniformed	Non-Uniformed			Uniformed
	Male		Female			Normal		Early	
	Normal	Early	Normal	Early	Normal	Age & Service	Rule of 90		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

Age	% of Active Participants Becoming Disabled			
	Uniformed Members		Non-Uniformed Members	
	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%
56	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	0.10%	0.10%	1.49%	1.49%
61	0.10%	0.10%	1.64%	1.64%
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 VIII

Table Rates of Separation from Active Employment

All Plan Participants

Age	Service	% of Active Participants Withdrawing			
		Uniformed Members		Non-Uniformed Members	
		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%