



# Stress Testing Analysis

Pennsylvania Public School Employees' Retirement System (PSERS)  
December 2022

Investment advice and consulting services provided by Aon Investments USA Inc.

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# Executive Summary

# Executive Summary

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## Purpose

- Per Title 24, § 8510, stress testing of the Pennsylvania Public School Employees' Retirement System is needed for fiscal years beginning after June 30, 2022 and should be comprised of the following:
  - **Scenario analysis:** deterministic projections based on the Society of Actuaries' Blue Ribbon Panel
  - **Sensitivity analysis:** impact of the changes to the actuarial assumed rate of return on the plan liabilities, as documented by the plan actuary
  - **Simulation analysis:** stochastic projections providing a wide range of potential future outcomes, preparing PSERS for the uncertainty that lies ahead

## Summary of Results

- Overall results are similar across both stochastic and deterministic projections
  - Employer contributions are expected to increase over the next decade, decreasing (or increasing) from baseline expectations depending on actual versus expected asset performance
  - The 30-year ending funded ratio in the Low Return deterministic scenario (78%) falls between the 5<sup>th</sup> and 25<sup>th</sup> percentile outcomes under our stochastic analysis (42% and 88% respectively) for PSERS' Current Long-Term Policy
    - This means that Aon's stochastic scenarios show a worse downside than the Low Return deterministic scenario, making for an even more conservative stress testing approach



# Analysis

- Scenario Analysis

# Scenario Analysis

## Deterministic Projections

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- Deterministic projections were conducted in accordance with the Society of Actuaries' Blue Ribbon Panel recommendations, covering the following scenarios:
  - **Baseline** – assumes the pension plan earns its expected return assumption for the next 30 years
  - **Excess Return** – assumes the pension plan annually earns 2% higher than its expected return assumption for 20 years and then the baseline assumption for the next 10 years
  - **Low Return** – assumes the pension plan annually earns 2% lower than its expected return assumption for 20 years and then the baseline assumption for the next 10 years
  - **Low Contribution** – assumes the pension plan is funded with 80% of the actuarially-determined contributions for 20 years followed by the full amounts for the next 10 years
  
- The variables documented in these projections include the following<sup>1</sup>:
  - Market Value of Assets (MVA)
  - Actuarial Liability (AL)
  - Unfunded Actuarial Accrued Liability (UAAL)
  - Change in Unfunded Actuarial Accrued Liability (UAAL  $\Delta$ )
  - Benefit Payments
  - Normal Cost
  - Payroll
  - Net Outflow
  - Employer Contributions (in dollars)
  - Employer Contributions (as a percent of payroll)
  - Funded Ratio

<sup>1</sup> The list of variables does not include the ratio of projected employer pension contributions to projected State revenues

# Scenario Analysis

## Summary of Results

Scenario	5 Years				10 Years				30 Years			
	Cumulative Employer Contributions		Funded Ratio		Cumulative Employer Contributions		Funded Ratio		Cumulative Employer Contributions		Funded Ratio	
	\$ (in billions)	Δ (from Baseline)	%	Δ (from Baseline)	\$ (in billions)	Δ (from Baseline)	%	Δ (from Baseline)	\$ (in billions)	Δ (from Baseline)	%	Δ (from Baseline)
<b>1. Baseline</b>	\$25.5	N/A	67.7%	N/A	\$54.3	N/A	80.0%	N/A	\$90.2	N/A	105.5%	N/A
<b>2. Excess Return</b>	\$25.4	(\$0.1)	73.1%	5.4%	\$52.5	(\$1.8)	94.9%	14.9%	\$74.4	(\$15.8)	203.5%	98.0%
<b>3. Low Return</b>	\$25.6	\$0.1	62.6%	(5.1%)	\$56.1	\$1.8	67.3%	(12.7%)	\$142.8	\$52.6	78.0%	(27.5%)
<b>4. Low Contribution</b>	\$20.7	(\$4.8)	64.1%	(3.6%)	\$45.8	(\$8.5)	71.6%	(8.4%)	\$105.0	\$14.8	97.6%	(7.9%)

### Key Takeaways:

- Greater return on plan assets will lead to lower future contributions and higher funded ratio; and vice versa
- Funding less than the full actuarially-determined amount will lead to lower funded ratios and higher contribution amounts

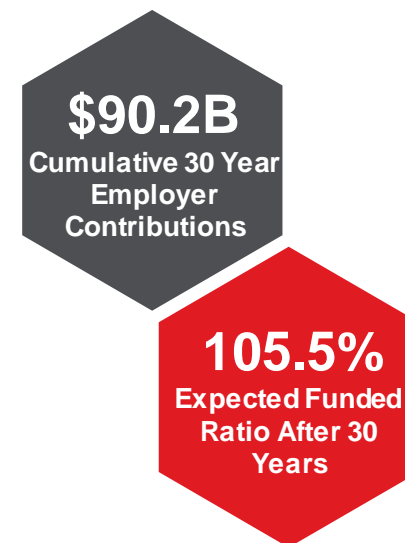
# Detailed Stress Test Scenario

## 1. Baseline Scenario

June 30 <sup>m</sup>	Return <sup>1</sup>	MVA <sup>2</sup>	AL <sup>2</sup>	UAAL	UAAL Δ	Benefit Pmts. <sup>2</sup>	Normal Cost <sup>2</sup>	Payroll <sup>2</sup>	Net Outflow	ER Contr. <sup>2</sup>	ER Contr. (% of Payroll)	Funded Ratio (MVA / AL)
2021	2.23%	\$71.97	\$112.65	\$40.68	--	\$7.13	\$2.11	\$14.08	\$1.29	\$4.76	33.8%	63.9%
2022	7.00%	\$69.75	\$115.24	\$45.49	\$4.81	\$7.61	\$1.97	\$14.29	\$1.68	\$4.98	34.8%	60.5%
2023	7.00%	\$72.89	\$117.49	\$44.60	(\$0.89)	\$7.72	\$1.95	\$14.50	\$1.55	\$5.10	35.2%	62.0%
2024	7.00%	\$76.39	\$119.70	\$43.31	(\$1.29)	\$7.90	\$1.93	\$14.63	\$1.63	\$5.24	35.9%	63.8%
2025	7.00%	\$80.04	\$121.84	\$41.80	(\$1.51)	\$8.10	\$1.90	\$14.76	\$1.68	\$5.40	36.6%	65.7%
2026	7.00%	\$83.91	\$123.91	\$40.00	(\$1.80)	\$8.30	\$1.88	\$14.90	\$1.75	\$5.51	37.0%	67.7%
2027	7.00%	\$87.97	\$125.87	\$37.91	(\$2.09)	\$8.52	\$1.86	\$15.05	\$1.86	\$5.62	37.4%	69.9%
2028	7.00%	\$92.19	\$127.75	\$35.56	(\$2.35)	\$8.71	\$1.83	\$15.19	\$1.94	\$5.79	38.1%	72.2%
2029	7.00%	\$96.64	\$129.52	\$32.88	(\$2.68)	\$8.93	\$1.81	\$15.34	\$2.03	\$5.91	38.5%	74.6%
2030	7.00%	\$101.30	\$131.17	\$29.87	(\$3.01)	\$9.14	\$1.78	\$15.48	\$2.13	\$6.02	38.9%	77.2%
2031	7.00%	\$106.19	\$132.67	\$26.49	(\$3.38)	\$9.36	\$1.76	\$15.62	\$2.25	\$6.25	40.0%	80.0%
2032	7.00%	\$111.30	\$134.03	\$22.73	(\$3.75)	\$9.58	\$1.73	\$15.75	\$2.29	\$6.39	40.6%	83.0%
2033	7.00%	\$116.71	\$135.23	\$18.52	(\$4.21)	\$9.80	\$1.70	\$15.88	\$2.37	\$6.54	41.2%	86.3%
2034	7.00%	\$122.43	\$136.29	\$13.86	(\$4.65)	\$10.00	\$1.66	\$15.99	\$2.44	\$6.64	41.5%	89.8%
2035	7.00%	\$128.48	\$137.17	\$8.70	(\$5.17)	\$10.21	\$1.62	\$16.09	\$2.51	\$3.58	22.2%	93.7%
2036	7.00%	\$134.87	\$137.78	\$2.91	(\$5.78)	\$10.40	\$1.59	\$16.19	\$5.78	\$2.58	15.9%	97.9%
2037	7.00%	\$138.32	\$138.17	(\$0.16)	(\$3.07)	\$10.60	\$1.54	\$16.28	\$7.00	\$0.48	2.9%	100.1%
2038	7.00%	\$140.77	\$138.33	(\$2.43)	(\$2.28)	\$10.79	\$1.50	\$16.37	\$9.24	\$0.44	2.7%	101.8%
2039	7.00%	\$141.06	\$138.26	(\$2.80)	(\$0.37)	\$10.98	\$1.46	\$16.46	\$9.46	\$0.41	2.5%	102.0%
2040	7.00%	\$141.14	\$137.94	(\$3.20)	(\$0.40)	\$11.16	\$1.42	\$16.55	\$9.69	\$0.37	2.2%	102.3%
2041	7.00%	\$141.00	\$137.41	(\$3.58)	(\$0.38)	\$11.29	\$1.37	\$16.64	\$9.86	\$0.33	2.0%	102.6%
2042	7.00%	\$140.66	\$136.68	(\$3.99)	(\$0.40)	\$11.38	\$1.33	\$16.74	\$10.00	\$0.30	1.8%	102.9%
2043	7.00%	\$140.16	\$135.77	(\$4.39)	(\$0.40)	\$11.45	\$1.30	\$16.85	\$10.10	\$0.27	1.6%	103.2%
2044	7.00%	\$139.52	\$134.75	(\$4.77)	(\$0.38)	\$11.46	\$1.26	\$16.98	\$10.16	\$0.24	1.4%	103.5%
2045	7.00%	\$138.78	\$133.67	(\$5.10)	(\$0.34)	\$11.41	\$1.23	\$17.14	\$10.14	\$0.21	1.2%	103.8%
2046	7.00%	\$138.00	\$132.57	(\$5.43)	(\$0.33)	\$11.33	\$1.21	\$17.32	\$10.09	\$0.19	1.1%	104.1%
2047	7.00%	\$137.22	\$131.52	(\$5.70)	(\$0.27)	\$11.16	\$1.19	\$17.53	\$9.94	\$0.17	1.0%	104.3%
2048	7.00%	\$136.54	\$130.54	(\$6.00)	(\$0.30)	\$11.01	\$1.18	\$17.79	\$9.81	\$0.16	0.9%	104.6%
2049	7.00%	\$135.95	\$129.64	(\$6.31)	(\$0.31)	\$10.86	\$1.19	\$18.09	\$9.65	\$0.16	0.9%	104.9%
2050	7.00%	\$135.48	\$128.84	(\$6.64)	(\$0.33)	\$10.70	\$1.19	\$18.43	\$9.49	\$0.15	0.8%	105.2%
2051		\$135.14	\$128.15	(\$6.99)	(\$0.36)							105.5%

### Key Takeaways:

- Contributions are expected to peak in 2034 and decrease thereafter
- Plan reaches 100% funded ratio by 2037



<sup>1</sup> Scenario returns include actual asset experience from 7/1/21 to 6/30/22 (+2.23%) followed by 20 years of the Blue Ribbon Panel recommendations

<sup>2</sup> Figures shown are in \$ billions



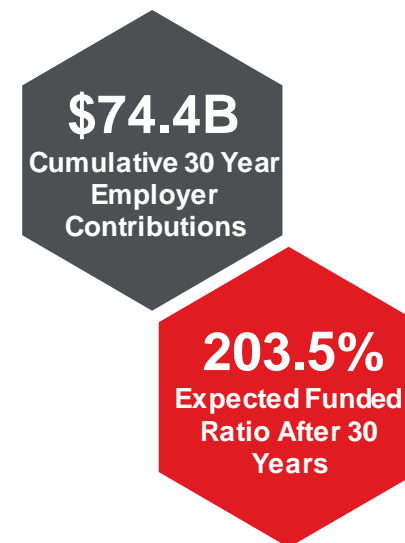
# Detailed Stress Test Scenario

## 2. Excess Return Scenario (Asset Returns Increase by 2% for 20 Years)

June 30 <sup>m</sup>	Return <sup>1</sup>	MVA <sup>2</sup>	AL <sup>2</sup>	UAAL	UAAL Δ	Benefit Pmts. <sup>2</sup>	Normal Cost <sup>2</sup>	Payroll <sup>2</sup>	Net Outflow	ER Contr. <sup>2</sup>	ER Contr. (% of Payroll)	Funded Ratio (MVA / AL)
2021	2.23%	\$71.97	\$112.65	\$40.68	--	\$7.13	\$2.11	\$14.08	\$1.29	\$4.76	33.8%	63.9%
2022	9.00%	\$69.75	\$115.24	\$45.49	\$4.81	\$7.61	\$1.97	\$14.29	\$1.68	\$4.98	34.8%	60.5%
2023	9.00%	\$74.27	\$117.49	\$43.22	(\$2.27)	\$7.72	\$1.95	\$14.50	\$1.55	\$5.09	35.1%	63.2%
2024	9.00%	\$79.33	\$119.70	\$40.37	(\$2.86)	\$7.90	\$1.93	\$14.63	\$1.64	\$5.21	35.6%	66.3%
2025	9.00%	\$84.76	\$121.84	\$37.09	(\$3.28)	\$8.10	\$1.90	\$14.76	\$1.72	\$5.32	36.0%	69.6%
2026	9.00%	\$90.59	\$123.91	\$33.32	(\$3.77)	\$8.30	\$1.88	\$14.90	\$1.83	\$5.37	36.0%	73.1%
2027	9.00%	\$96.83	\$125.87	\$29.04	(\$4.27)	\$8.52	\$1.86	\$15.05	\$2.01	\$5.40	35.9%	76.9%
2028	9.00%	\$103.44	\$127.75	\$24.31	(\$4.74)	\$8.71	\$1.83	\$15.19	\$2.16	\$5.46	35.9%	81.0%
2029	9.00%	\$110.49	\$129.52	\$19.03	(\$5.28)	\$8.93	\$1.81	\$15.34	\$2.36	\$5.46	35.6%	85.3%
2030	9.00%	\$117.97	\$131.17	\$13.20	(\$5.83)	\$9.14	\$1.78	\$15.48	\$2.58	\$5.42	35.0%	89.9%
2031	9.00%	\$125.89	\$132.67	\$6.78	(\$6.41)	\$9.36	\$1.76	\$15.62	\$2.85	\$5.47	35.1%	94.9%
2032	9.00%	\$134.24	\$134.03	(\$0.21)	(\$7.00)	\$9.58	\$1.73	\$15.75	\$3.07	\$5.42	34.4%	100.2%
2033	9.00%	\$143.12	\$135.23	(\$7.88)	(\$7.67)	\$9.80	\$1.70	\$15.88	\$3.35	\$5.35	33.7%	105.8%
2034	9.00%	\$152.50	\$136.29	(\$16.20)	(\$8.32)	\$10.00	\$1.66	\$15.99	\$3.63	\$5.64	4.0%	111.9%
2035	9.00%	\$162.43	\$137.17	(\$25.25)	(\$9.05)	\$10.21	\$1.62	\$16.09	\$8.54	\$0.61	3.8%	118.4%
2036	9.00%	\$168.12	\$137.78	(\$30.34)	(\$5.09)	\$10.40	\$1.59	\$16.19	\$8.77	\$0.58	3.6%	122.0%
2037	9.00%	\$174.10	\$138.17	(\$35.93)	(\$5.59)	\$10.60	\$1.54	\$16.28	\$9.01	\$0.48	2.9%	126.0%
2038	9.00%	\$180.36	\$138.33	(\$42.03)	(\$6.10)	\$10.79	\$1.50	\$16.37	\$9.24	\$0.44	2.7%	130.4%
2039	9.00%	\$186.95	\$138.26	(\$48.69)	(\$6.66)	\$10.98	\$1.46	\$16.46	\$9.46	\$0.41	2.5%	135.2%
2040	9.00%	\$193.89	\$137.94	(\$55.95)	(\$7.26)	\$11.16	\$1.42	\$16.55	\$9.69	\$0.37	2.2%	140.6%
2041	9.00%	\$201.22	\$137.41	(\$63.81)	(\$7.86)	\$11.29	\$1.37	\$16.64	\$9.86	\$0.33	2.0%	146.4%
2042	7.00%	\$209.03	\$136.68	(\$72.36)	(\$8.55)	\$11.38	\$1.33	\$16.74	\$10.00	\$0.30	1.8%	152.9%
2043	7.00%	\$213.32	\$135.77	(\$77.54)	(\$5.19)	\$11.45	\$1.30	\$16.85	\$10.10	\$0.27	1.6%	157.1%
2044	7.00%	\$217.80	\$134.75	(\$83.04)	(\$5.50)	\$11.46	\$1.26	\$16.98	\$10.16	\$0.24	1.4%	161.6%
2045	7.00%	\$222.53	\$133.67	(\$88.86)	(\$5.82)	\$11.41	\$1.23	\$17.14	\$10.14	\$0.21	1.2%	166.5%
2046	7.00%	\$227.62	\$132.57	(\$95.05)	(\$6.19)	\$11.33	\$1.21	\$17.32	\$10.09	\$0.19	1.1%	171.7%
2047	7.00%	\$233.11	\$131.52	(\$101.59)	(\$6.54)	\$11.16	\$1.19	\$17.53	\$9.94	\$0.17	1.0%	177.2%
2048	7.00%	\$239.15	\$130.54	(\$108.61)	(\$7.01)	\$11.01	\$1.18	\$17.79	\$9.81	\$0.16	0.9%	183.2%
2049	7.00%	\$245.74	\$129.64	(\$116.10)	(\$7.49)	\$10.86	\$1.19	\$18.09	\$9.65	\$0.16	0.9%	189.5%
2050	7.00%	\$252.95	\$128.84	(\$124.11)	(\$8.01)	\$10.70	\$1.19	\$18.43	\$9.49	\$0.15	0.8%	196.3%
2051		\$260.84	\$128.15	(\$132.69)	(\$8.58)							203.5%

### Key Takeaways:

- Contributions are expected to peak in 2031 and decrease thereafter
- Plan reaches 100% funded ratio by 2032



<sup>1</sup> Scenario returns include actual asset experience from 7/1/21 to 6/30/22 (+2.23%) followed by 20 years of the Blue Ribbon Panel recommendations

<sup>2</sup> Figures shown are in \$ billions

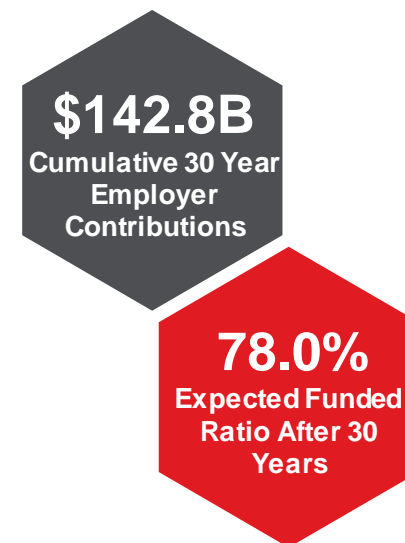
# Detailed Stress Test Scenario

## 3. Low Return Scenario (Asset Returns Decrease by 2% for 20 Years)

June 30 <sup>th</sup>	Return <sup>1</sup>	MVA <sup>2</sup>	AL <sup>2</sup>	UAAL	UAAL Δ	Benefit Pmts. <sup>2</sup>	Normal Cost <sup>2</sup>	Payroll <sup>2</sup>	Net Outflow	ER Contr. <sup>2</sup>	ER Contr. (% of Payroll)	Funded Ratio (MVA / AL)
2021	2.23%	\$71.97	\$112.65	\$40.68	--	\$7.13	\$2.11	\$14.08	\$1.29	\$4.76	33.8%	63.9%
2022	5.00%	\$69.75	\$115.24	\$45.49	\$4.81	\$7.61	\$1.97	\$14.29	\$1.68	\$4.98	34.8%	60.5%
2023	5.00%	\$71.51	\$117.49	\$45.98	\$0.49	\$7.72	\$1.95	\$14.50	\$1.55	\$5.11	35.3%	60.9%
2024	5.00%	\$73.50	\$119.70	\$46.20	\$0.22	\$7.90	\$1.93	\$14.63	\$1.62	\$5.28	36.1%	61.4%
2025	5.00%	\$75.51	\$121.84	\$46.34	\$0.13	\$8.10	\$1.90	\$14.76	\$1.64	\$5.48	37.1%	62.0%
2026	5.00%	\$77.59	\$123.91	\$46.31	(\$0.02)	\$8.30	\$1.88	\$14.90	\$1.67	\$5.64	37.9%	62.6%
2027	5.00%	\$79.76	\$125.87	\$46.12	(\$0.20)	\$8.52	\$1.86	\$15.05	\$1.73	\$5.84	38.8%	63.4%
2028	5.00%	\$81.97	\$127.75	\$45.78	(\$0.34)	\$8.71	\$1.83	\$15.19	\$1.72	\$6.09	40.1%	64.2%
2029	5.00%	\$84.30	\$129.52	\$45.22	(\$0.56)	\$8.93	\$1.81	\$15.34	\$1.72	\$6.33	41.3%	65.1%
2030	5.00%	\$86.75	\$131.17	\$44.41	(\$0.80)	\$9.14	\$1.78	\$15.48	\$1.71	\$6.56	42.4%	66.1%
2031	5.00%	\$89.34	\$132.67	\$43.33	(\$1.08)	\$9.36	\$1.76	\$15.62	\$1.69	\$6.94	44.4%	67.3%
2032	5.00%	\$92.07	\$134.03	\$41.96	(\$1.37)	\$9.58	\$1.73	\$15.75	\$1.59	\$7.25	46.0%	68.7%
2033	5.00%	\$95.03	\$135.23	\$40.20	(\$1.76)	\$9.80	\$1.70	\$15.88	\$1.51	\$7.57	47.7%	70.3%
2034	5.00%	\$98.24	\$136.29	\$38.05	(\$2.15)	\$10.00	\$1.66	\$15.99	\$1.39	\$7.85	49.1%	72.1%
2035	5.00%	\$101.72	\$137.17	\$35.45	(\$2.60)	\$10.21	\$1.62	\$16.09	\$1.29	\$4.99	31.0%	74.2%
2036	5.00%	\$105.48	\$137.78	\$32.30	(\$3.15)	\$10.40	\$1.59	\$16.19	\$4.36	\$4.20	25.9%	76.6%
2037	5.00%	\$106.29	\$138.17	\$31.88	(\$0.42)	\$10.60	\$1.54	\$16.28	\$5.37	\$3.93	24.1%	76.9%
2038	5.00%	\$106.10	\$138.33	\$32.23	\$0.35	\$10.79	\$1.50	\$16.37	\$5.77	\$3.70	22.6%	76.7%
2039	5.00%	\$105.49	\$138.26	\$32.77	\$0.54	\$10.98	\$1.46	\$16.46	\$6.18	\$3.56	21.6%	76.3%
2040	5.00%	\$104.42	\$137.94	\$33.52	\$0.75	\$11.16	\$1.42	\$16.55	\$6.52	\$3.46	20.9%	75.7%
2041	5.00%	\$102.96	\$137.41	\$34.45	\$0.93	\$11.29	\$1.37	\$16.64	\$6.76	\$2.85	17.1%	74.9%
2042	7.00%	\$101.18	\$136.68	\$35.50	\$1.04	\$11.38	\$1.33	\$16.74	\$7.47	\$2.79	16.6%	74.0%
2043	7.00%	\$100.53	\$135.77	\$35.24	(\$0.26)	\$11.45	\$1.30	\$16.85	\$7.60	\$2.93	17.4%	74.0%
2044	7.00%	\$99.71	\$134.75	\$35.04	(\$0.20)	\$11.46	\$1.26	\$16.98	\$7.48	\$3.20	18.9%	74.0%
2045	7.00%	\$98.95	\$133.67	\$34.72	(\$0.32)	\$11.41	\$1.23	\$17.14	\$7.15	\$3.29	19.2%	74.0%
2046	7.00%	\$98.48	\$132.57	\$34.08	(\$0.64)	\$11.33	\$1.21	\$17.32	\$6.98	\$3.48	20.1%	74.3%
2047	7.00%	\$98.16	\$131.52	\$33.37	(\$0.72)	\$11.16	\$1.19	\$17.53	\$6.61	\$3.59	20.5%	74.6%
2048	7.00%	\$98.19	\$130.54	\$32.35	(\$1.01)	\$11.01	\$1.18	\$17.79	\$6.34	\$3.64	20.5%	75.2%
2049	7.00%	\$98.50	\$129.64	\$31.14	(\$1.21)	\$10.86	\$1.19	\$18.09	\$6.11	\$3.69	20.4%	76.0%
2050	7.00%	\$99.07	\$128.84	\$29.77	(\$1.37)	\$10.70	\$1.19	\$18.43	\$5.89	\$3.75	20.4%	76.9%
2051		\$99.91	\$128.15	\$28.24	(\$1.54)							78.0%

### Key Takeaways:

- Contributions are expected to peak in 2034 and decrease thereafter
- Plan does not attain full funding over the projection period



<sup>1</sup> Scenario returns include actual asset experience from 7/1/21 to 6/30/22 (+2.23%) followed by 20 years of the Blue Ribbon Panel recommendations

<sup>2</sup> Figures shown are in \$ billions

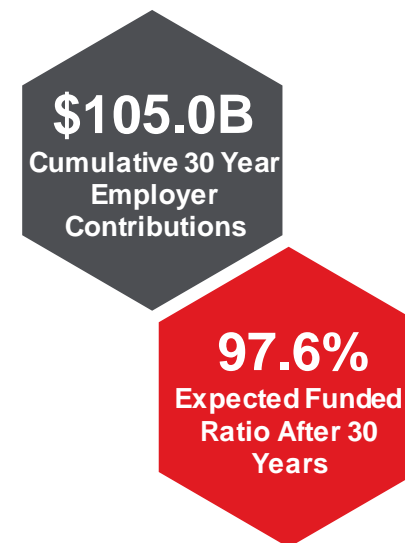
# Detailed Stress Test Scenario

## 4. Low Contribution Scenario (Contribute 80% of ADC for 20 Years)

June 30 <sup>m</sup>	Return <sup>1</sup>	MVA <sup>2</sup>	AL <sup>2</sup>	UAAL	UAAL Δ	Benefit Pmts. <sup>2</sup>	Normal Cost <sup>2</sup>	Payroll <sup>2</sup>	Net Outflow	ER Contr. <sup>2</sup>	ER Contr. (% of Payroll)	Funded Ratio (MVA / AL)
2021	2.23%	\$71.97	\$112.65	\$40.68	--	\$7.13	\$2.11	\$14.08	\$1.29	\$3.81	27.0%	63.9%
2022	7.00%	\$69.75	\$115.24	\$45.49	\$4.81	\$7.61	\$1.97	\$14.29	\$2.65	\$3.98	27.9%	60.5%
2023	7.00%	\$71.89	\$117.49	\$45.60	\$0.11	\$7.72	\$1.95	\$14.50	\$2.56	\$4.14	28.5%	61.2%
2024	7.00%	\$74.27	\$119.70	\$45.43	(\$0.17)	\$7.90	\$1.93	\$14.63	\$2.61	\$4.31	29.5%	62.0%
2025	7.00%	\$76.77	\$121.84	\$45.07	(\$0.36)	\$8.10	\$1.90	\$14.76	\$2.62	\$4.50	30.5%	63.0%
2026	7.00%	\$79.43	\$123.91	\$44.47	(\$0.60)	\$8.30	\$1.88	\$14.90	\$2.66	\$4.65	31.2%	64.1%
2027	7.00%	\$82.24	\$125.87	\$43.63	(\$0.84)	\$8.52	\$1.86	\$15.05	\$2.73	\$4.82	32.0%	65.3%
2028	7.00%	\$85.17	\$127.75	\$42.58	(\$1.05)	\$8.71	\$1.83	\$15.19	\$2.75	\$5.03	33.1%	66.7%
2029	7.00%	\$88.29	\$129.52	\$41.23	(\$1.35)	\$8.93	\$1.81	\$15.34	\$2.80	\$5.21	34.0%	68.2%
2030	7.00%	\$91.57	\$131.17	\$39.59	(\$1.64)	\$9.14	\$1.78	\$15.48	\$2.83	\$5.38	34.8%	69.8%
2031	7.00%	\$95.05	\$132.67	\$37.63	(\$1.97)	\$9.36	\$1.76	\$15.62	\$2.88	\$5.66	36.2%	71.6%
2032	7.00%	\$98.71	\$134.03	\$35.31	(\$2.31)	\$9.58	\$1.73	\$15.75	\$2.88	\$5.87	37.3%	73.7%
2033	7.00%	\$102.64	\$135.23	\$32.59	(\$2.72)	\$9.80	\$1.70	\$15.88	\$2.89	\$6.10	38.4%	75.9%
2034	7.00%	\$106.83	\$136.29	\$29.46	(\$3.13)	\$10.00	\$1.66	\$15.99	\$2.88	\$6.29	39.3%	78.4%
2035	7.00%	\$111.33	\$137.17	\$25.84	(\$3.62)	\$10.21	\$1.62	\$16.09	\$2.86	\$3.96	24.6%	81.2%
2036	7.00%	\$116.16	\$137.78	\$21.62	(\$4.22)	\$10.40	\$1.59	\$16.19	\$5.40	\$3.29	20.3%	84.3%
2037	7.00%	\$118.70	\$138.17	\$19.46	(\$2.16)	\$10.60	\$1.54	\$16.28	\$6.28	\$3.00	18.4%	85.9%
2038	7.00%	\$120.51	\$138.33	\$17.82	(\$1.64)	\$10.79	\$1.50	\$16.37	\$6.71	\$2.72	16.6%	87.1%
2039	7.00%	\$122.01	\$138.26	\$16.25	(\$1.57)	\$10.98	\$1.46	\$16.46	\$7.17	\$2.50	15.2%	88.2%
2040	7.00%	\$123.12	\$137.94	\$14.82	(\$1.44)	\$11.16	\$1.42	\$16.55	\$7.58	\$2.30	13.9%	89.3%
2041	7.00%	\$123.89	\$137.41	\$13.52	(\$1.30)	\$11.29	\$1.37	\$16.64	\$7.92	\$2.12	12.7%	90.2%
2042	7.00%	\$124.37	\$136.68	\$12.30	(\$1.22)	\$11.38	\$1.33	\$16.74	\$8.20	\$1.89	11.3%	91.0%
2043	7.00%	\$124.59	\$135.77	\$11.18	(\$1.12)	\$11.45	\$1.30	\$16.85	\$8.50	\$1.83	10.9%	91.8%
2044	7.00%	\$124.52	\$134.75	\$10.23	(\$0.95)	\$11.46	\$1.26	\$16.98	\$8.58	\$1.93	11.3%	92.4%
2045	7.00%	\$124.35	\$133.67	\$9.32	(\$0.92)	\$11.41	\$1.23	\$17.14	\$8.44	\$1.85	10.8%	93.0%
2046	7.00%	\$124.33	\$132.57	\$8.24	(\$1.08)	\$11.33	\$1.21	\$17.32	\$8.44	\$1.88	10.9%	93.8%
2047	7.00%	\$124.30	\$131.52	\$7.22	(\$1.02)	\$11.16	\$1.19	\$17.53	\$8.23	\$1.73	9.9%	94.5%
2048	7.00%	\$124.49	\$130.54	\$6.05	(\$1.17)	\$11.01	\$1.18	\$17.79	\$8.23	\$1.55	8.7%	95.4%
2049	7.00%	\$124.69	\$129.64	\$4.95	(\$1.10)	\$10.86	\$1.19	\$18.09	\$8.25	\$1.40	7.7%	96.2%
2050	7.00%	\$124.88	\$128.84	\$3.96	(\$0.99)	\$10.70	\$1.19	\$18.43	\$8.23	\$1.31	7.1%	96.9%
2051		\$125.11	\$128.15	\$3.03	(\$0.93)							97.6%

### Key Takeaways:

- Contributions are expected to peak in 2034 and decrease thereafter
- Plan does not attain full funding over the projection period



<sup>1</sup> Scenario returns include actual asset experience from 7/1/21 to 6/30/22 (+2.23%) followed by 20 years of the Blue Ribbon Panel recommendations

<sup>2</sup> Figures shown are in \$ billions



# Analysis

- Sensitivity Analysis

# Sensitivity of the Net Pension Liability to Changes in the Discount Rate

- As provided by the plan actuary in their FYE 2022 GASB 67 actuarial valuation report, the following presents the net pension liability calculated at PSERS' 7.00% actuarial assumed rate of return as well as what it would be using a discount rate +/-1% from the current rate.

	1% Decrease (6.00%)	Current Discount Rate (7.00%)	1% Increase (8.00%)
Net Pension Liability (in \$ billions)	\$57.5	\$44.5	\$33.5



# Analysis

- Simulation Analysis

# Simulation Analysis

## Stochastic Results | Summary of Results

	Portfolio Metrics			Financial Results						
	Expected Nominal Return <sup>1</sup>	Expected Nominal Volatility <sup>1</sup>	Sharpe Ratio	30-year Ending Funded Ratio (MVA / AL)		30-year Present Value of Employer Contributions (\$ billions)		30-year Total Nominal Employer Contributions (\$ billions)		Expected Attainment of Full Funding
				Expected <sup>2</sup>	Downside <sup>3</sup>	Expected <sup>2</sup>	Downside <sup>4</sup>	Expected <sup>2</sup>	Downside <sup>4</sup>	
Current Long-Term Policy	7.85%	13.12%	0.38	168%	42%	\$51.1	\$79.5	\$86.9	\$186.9	FYE 2034

### Key Takeaways:

- Current Policy is expected to reach full funding in the median outcome by FYE 2034
- Optimistic (or pessimistic) asset performance could lead to better (or worse) outcomes than the central expectation

<sup>1</sup> Expected returns based on Aon Investments Q3 2022 30-year Capital Market Assumptions assuming the detailed portfolios found in the Appendix. All expected returns are geometric (long-term compounded; rounded to the nearest decimal) and net of investment fees. Expected returns presented are models and do not represent the returns of an actual client account. Not a guarantee of future results. See Appendix for the Capital Market Assumptions.

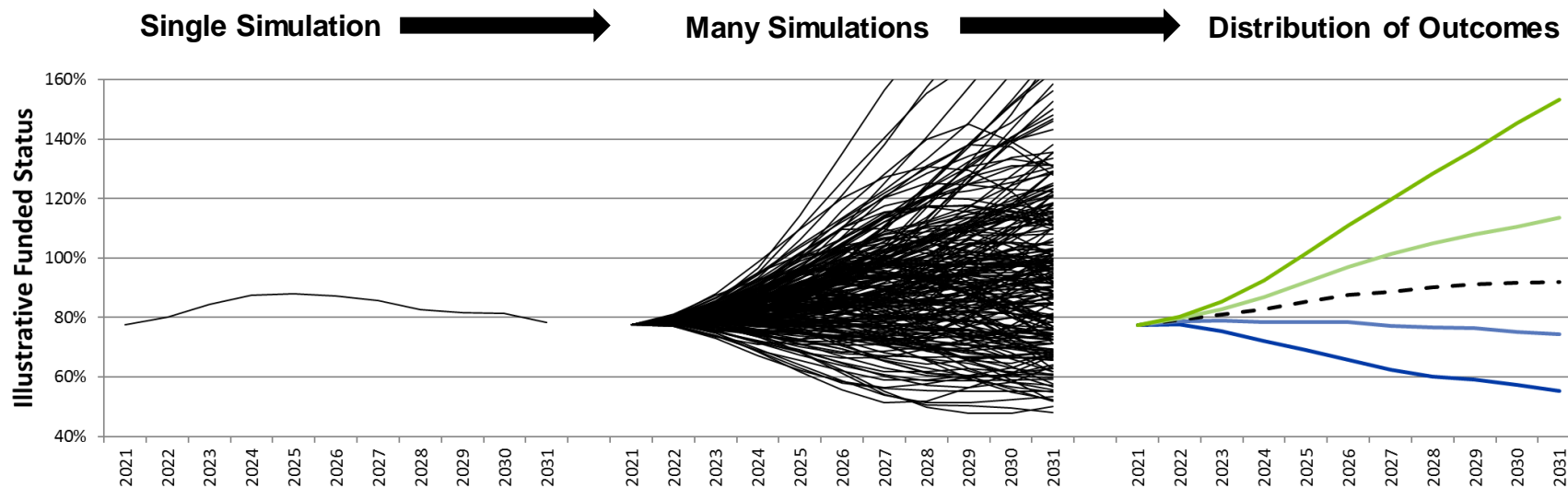
<sup>2</sup> Expected = 50<sup>th</sup> percentile outcome or central expectation across all 5,000 simulations

<sup>3</sup> Downside = 5<sup>th</sup> percentile outcome across all 5,000 simulations

<sup>4</sup> Downside = 95<sup>th</sup> percentile outcome across all 5,000 simulations

# Asset-Liability Simulation Overview

- Thousands of simulations plotted in one graph would be impossible to interpret
- Instead, we rank the simulations at each point over the future
- This produces a distribution of outcomes illustrating the degree of uncertainty of a plan's financial position over the projection period
- Different investment strategies will produce different distributions of outcomes

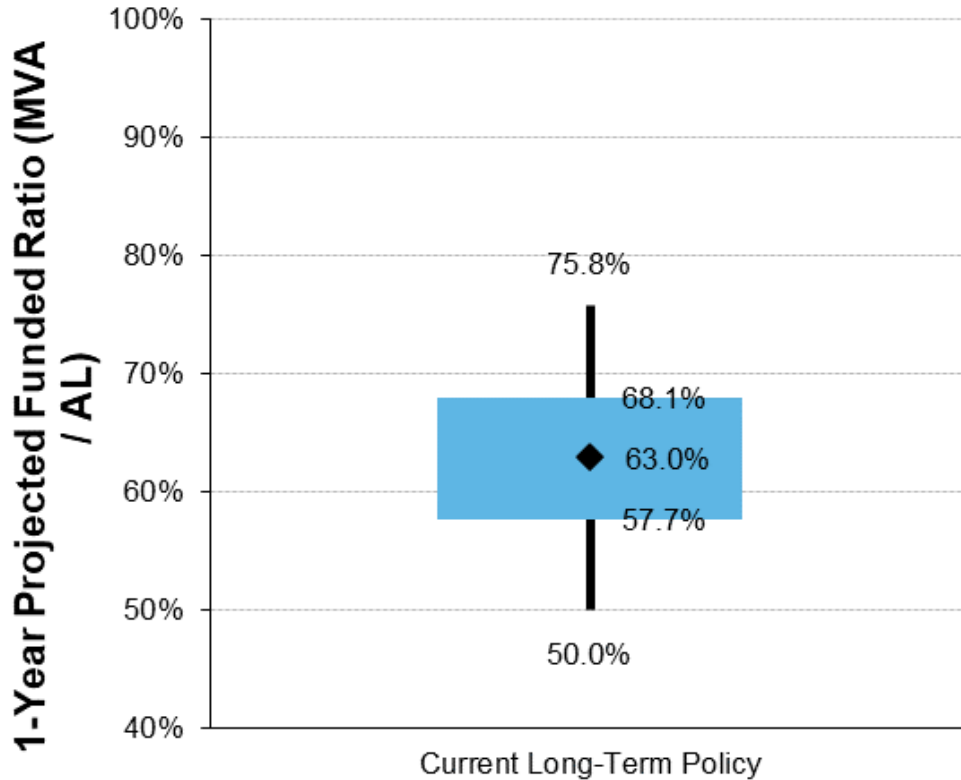


\* The path of a given scenario will follow a much less smooth pattern than the distribution suggests, as illustrated above



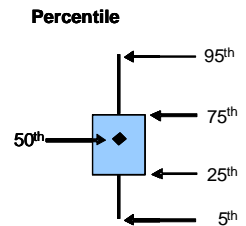
# Asset-Liability Projection Results (Stochastic Results)

## Market Value of Assets / Actuarial Liability Funded Ratio | Short-Term Risk



### Key Takeaway:

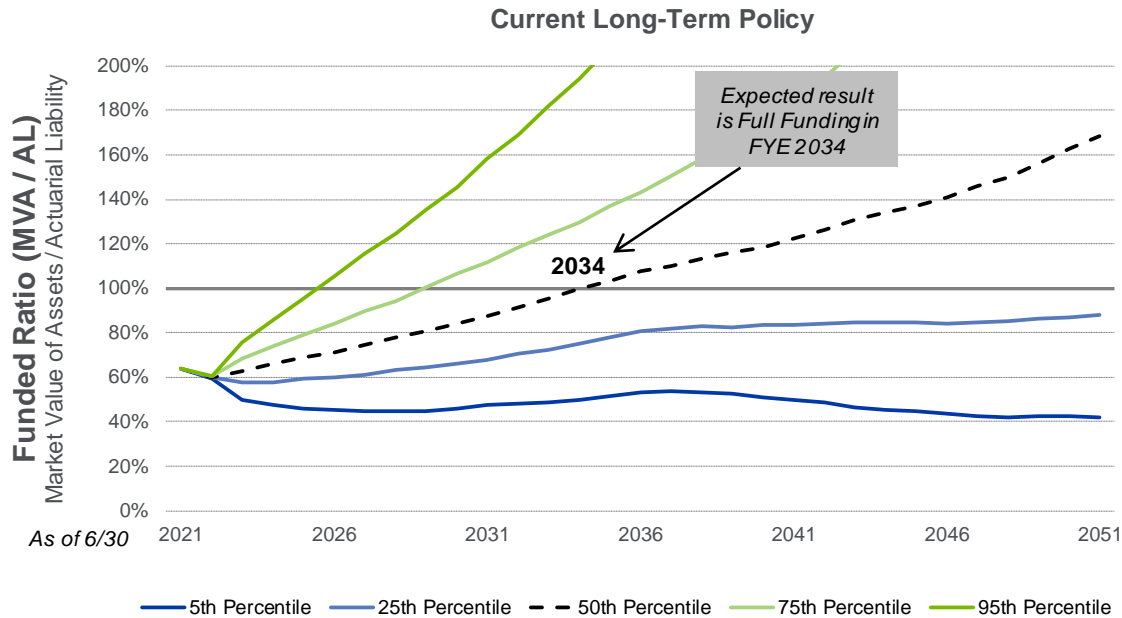
- Over a 1-year time horizon (starting June 30, 2022), the Current Long-Term Policy can experience a wide range of potential funded ratio outcomes



Funded ratio assumes an estimated starting point of June 30, 2022; Liability projections assume discount rate of 7.00%

# Asset-Liability Projection Results (Stochastic Results)

## Market Value of Assets / Actuarial Liability Funded Ratio | Long-Term Trends



### Key Takeaways:

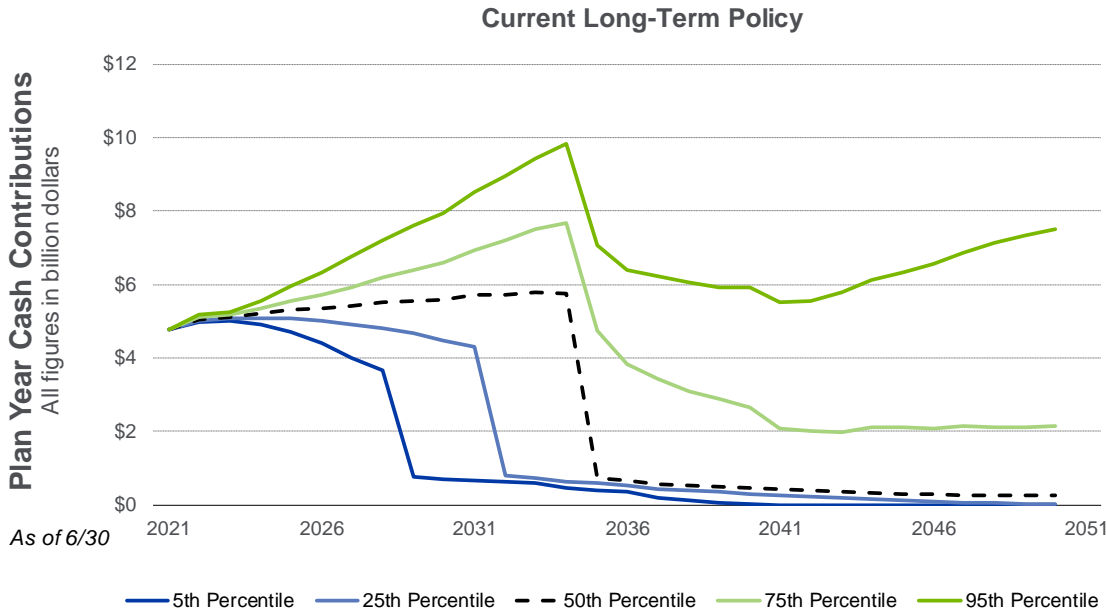
- The funded ratio is projected to trend toward full funding over the course of the projection period
- Adverse market experience could significantly impact the funded status of the Plan

Strategy	Current Long-Term Policy		
Year	2031	2041	2051
5th Percentile	47%	50%	42%
25th Percentile	68%	84%	88%
50th Percentile	88%	122%	168%
75th Percentile	112%	185%	>200%
95th Percentile	158%	>200%	>200%
Probability > 100%	37%	64%	71%

\* Liability projections assume discount rates of 7.00%

# Asset-Liability Projection Results (Stochastic Results)

## Employer Contribution Amount



### Key Takeaway:

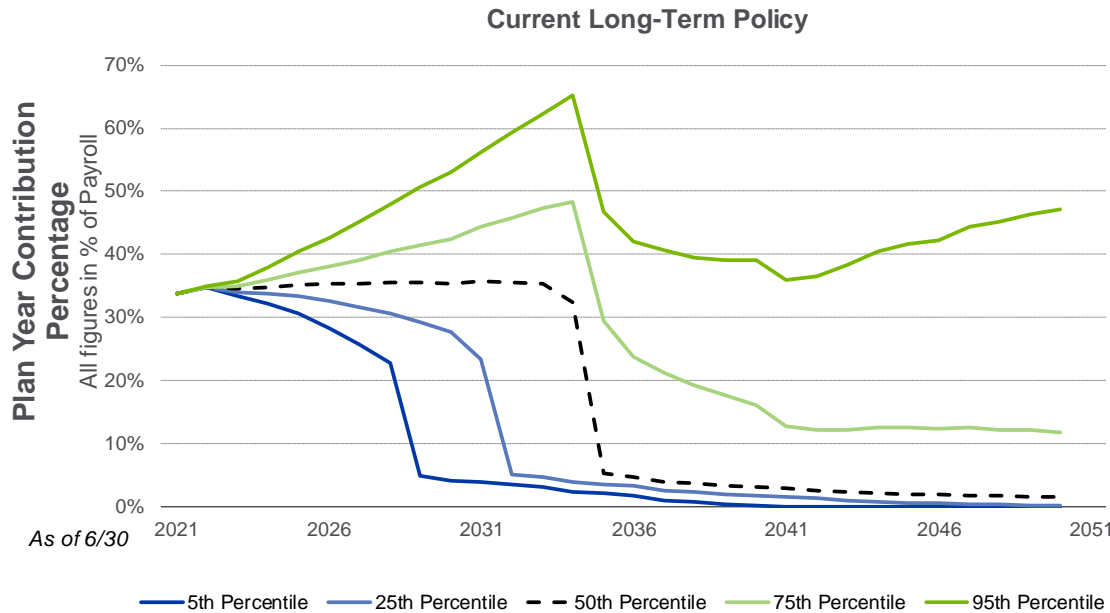
- Contributions in the central expectation (50<sup>th</sup> percentile outcomes) are projected to increase from their current levels until the expiration of individual amortization bases or when the plan reaches a funded status of at least 100% on an actuarial value of assets basis

Strategy	Current Long-Term Policy		
Year	2030	2040	2050
5th Percentile	\$0.68	\$0.01	\$0.00
25th Percentile	\$4.47	\$0.30	\$0.02
50th Percentile	\$5.58	\$0.46	\$0.25
75th Percentile	\$6.59	\$2.64	\$2.16
95th Percentile	\$7.96	\$5.94	\$7.52

\* Liability projections assume discount rates of 7.00%

# Asset-Liability Projection Results (Stochastic Results)

## Employer Contribution Percentage of Payroll



### Key Takeaway:

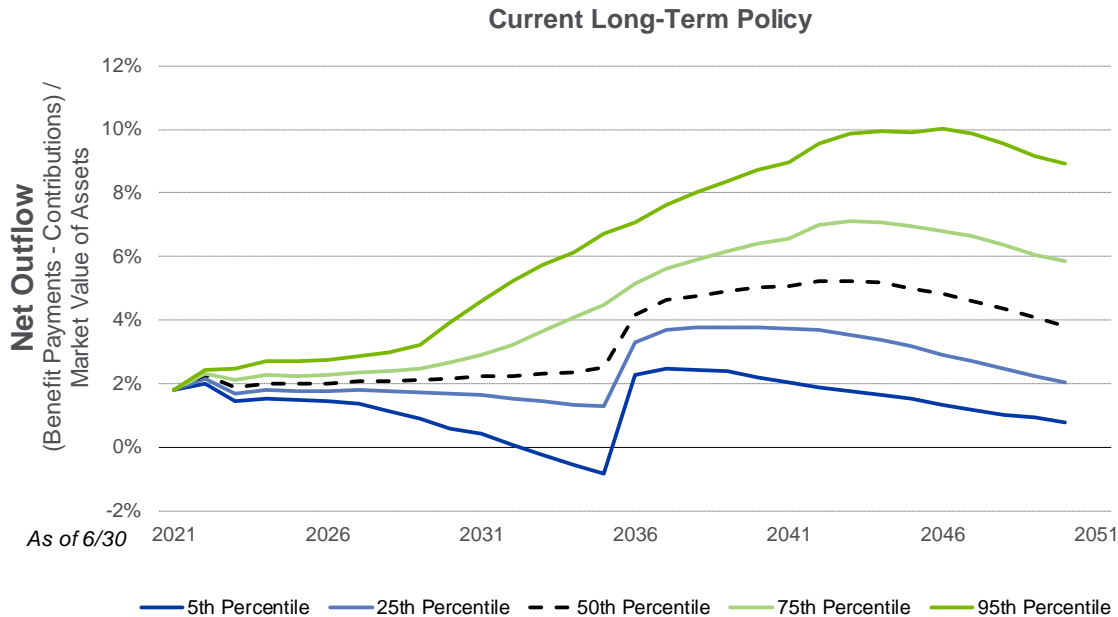
- Contributions in the central expectation (50<sup>th</sup> percentile outcomes) are projected to increase from their current levels until the expiration of individual amortization bases or when the plan reaches a funded status of at least 100% on an actuarial value of assets basis

Strategy	Current Long-Term Policy		
Year	2030	2040	2050
5th Percentile	4%	0%	0%
25th Percentile	28%	2%	0%
50th Percentile	35%	3%	1%
75th Percentile	43%	16%	12%
95th Percentile	53%	39%	47%

\* Liability projections assume discount rates of 7.00%

# Asset-Liability Projection Results (Stochastic Results)

## Net Outflow Analysis: (Benefit Payments less Contributions) / Market Value of Assets



### Key Takeaway:

- Net outflow is expected to be approximately 2% for the next decade before increasing once amortization bases fall out of the contribution calculations and/or the Plan attains a funded status of at least 100% on an actuarial value of assets basis

Strategy	Current Long-Term Policy		
Year	2030	2040	2050
5th Percentile	1%	2%	1%
25th Percentile	2%	4%	2%
50th Percentile	2%	5%	4%
75th Percentile	3%	6%	6%
95th Percentile	4%	9%	9%
Probability > 10%	<1%	2%	3%

\* Liability projections assume discount rates of 7.00%



# Appendix

## Title 24 | § 8510. Stress Test of System

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**(a) General rule.**—The board shall conduct an annual stress test of the system and submit the results of the stress test to the Governor, the General Assembly and the Independent Fiscal Office no later than January 1 of each year. The stress test shall include a scenario analysis, simulation analysis and sensitivity analysis. The board shall disclose in the report of the stress test results which industry standards were used and whether any changes to industry standards have been made.

**(b) Report by Independent Fiscal Office.**—No later than March 1 of each year, the Independent Fiscal Office shall produce a report summarizing the results of the stress test, including a calculation of the ratio of projected employer pension contributions to projected State revenues under a scenario analysis.

**(c) Definitions.**—As used in this section, the following words and phrases shall have the meanings given to them in this subsection unless the context clearly indicates otherwise:

**"Scenario analysis."** Projections of assets, liabilities, unfunded actuarial accrued liabilities, the change in unfunded actuarial accrued liabilities, employer contributions, benefit payments, service costs, payroll and calculations of the ratios of assets to liabilities, employer contributions to payroll and operating cash flow to assets in sufficient number as determined prudent by the board as informed by recognized industry standards.

**"Sensitivity analysis."** The following:

- (1) Estimates of the total normal cost and employer normal cost for new employees, calculated using various investment return assumptions in sufficient number as determined prudent by the board as informed by recognized industry standards.
- (2) Estimates of the unfunded actuarial accrued liability and unfunded liability, calculated using various annual assumed rates of return in sufficient number as determined prudent by the board as informed by recognized industry standards.

**"Simulation analysis."** Projections of the range of required employer contributions for each of the next 20 years, based on analysis that simulates the volatility of annual investment returns above and below the assumed rate of return, applying methodology determined prudent by the board as informed by recognized industry standards.

(Nov. 25, 2020, P.L.1237, No.128, eff. 60 days)

**2020 Amendment.** Act 128 added section 8510. Section 7(1) of Act 128 provided that the addition of section 8510 shall apply to fiscal years beginning after June 30, 2022.

# Portfolio Analysis

## Current Long-Term Policy

	Current Long-Term Policy
US Equity	21.0%
Non-US Dev, Unhedged	5.1%
Non-US Dev, USD Hedged	5.1%
Emerging Markets	4.8%
Private Equity, Unhedged <sup>1</sup>	12.0%
<b>Total Equity</b>	<b>48.0%</b>
US Core Fixed Income	4.0%
US Long-Term Treasury	8.0%
Emerging Markets Debt, Hard	2.0%
High Yield	4.0%
Private Credit	6.0%
US TIPS	10.0%
<b>Total Fixed Income</b>	<b>34.0%</b>
Infrastructure: Private, Hedged	5.0%
Infrastructure: Public, Hedged	5.0%
Commodities: Diversified	2.5%
Commodities: Gold	2.5%
Private Non-Core Real Estate	7.0%
Global REITs, USD Hedged	4.0%
<b>Total Real Assets</b>	<b>26.0%</b>
<b>Net Cash / Financing</b>	<b>-8.0%</b>
<b>Total Plan</b>	<b>100.0%</b>
<b>30-Year Exp. Nom. Return<sup>2</sup></b>	<b>7.85%</b>
<b>30-Year Expected Risk<sup>2</sup></b>	<b>13.12%</b>
<b>Sharpe Ratio</b>	<b>0.38</b>

### Key Takeaway:

- Using Aon's Q3 2022 capital market assumption the Current Policy has an expected return of 7.85% with a volatility of 13.12%

<sup>1</sup> Private Equity assumptions developed as follows: 72% Buyouts, 13% Venture Capital, 15% Distressed Debt

<sup>2</sup> Expected returns based on Aon Investments Q3 2022 30-year Capital Market Assumptions assuming the detailed portfolios found in the Appendix. All expected returns are geometric (long-term compounded; rounded to the nearest decimal) and net of investment fees. Expected returns presented are models and do not represent the returns of an actual client account. Not a guarantee of future results. See Appendix for the Capital Market Assumptions. Percentages in table may not sum to 100% due to rounding



# Aon Investments' Capital Market Assumptions

## As of June 30, 2022 (30 Years)

	Expected Real Return <sup>1</sup>	Expected Nominal Return <sup>1</sup>	Expected Nominal Volatility
<b>Equity</b>			
1 Large Cap U.S. Equity	4.8%	7.3%	17.5%
2 Small Cap U.S. Equity	5.3%	7.8%	23.5%
3 International Equity (Developed) - Hedged	5.2%	7.7%	18.5%
4 International Equity (Developed) - Unhedged	5.1%	7.6%	21.0%
5 Emerging Markets Equity	5.7%	8.2%	24.5%
<b>Fixed Income</b>			
6 TIPS	1.0%	3.4%	3.5%
7 Core Fixed Income	1.3%	3.7%	4.5%
8 Long Duration Bonds – Govt	1.1%	3.5%	9.0%
9 High Yield Bonds	3.3%	5.8%	10.5%
10 Emerging Market Bonds, Hard	3.3%	5.8%	11.5%
<b>Alternatives</b>			
11 REITs	3.9%	6.4%	19.0%
12 Non-Core Real Estate	4.2%	6.7%	25.5%
13 Commodities	3.5%	6.0%	17.0%
14 Private Equity	8.0%	10.6%	26.5%
15 Infrastructure - Private	5.2%	7.7%	15.0%
16 Infrastructure - Public	4.9%	7.4%	17.5%
17 Gold	0.8%	3.2%	19.5%
18 Private Debt	4.6%	7.1%	17.5%
<b>Inflation</b>			
19 Inflation	0.0%	2.4%	2.0%

### Notes:

<sup>1</sup> Expected returns based on Aon Investments Q3 2022 30-year Capital Market Assumptions assuming the detailed portfolios found in the Appendix. All expected returns are geometric (long-term compounded; rounded to the nearest decimal) and net of investment fees. Expected returns presented are models and do not represent the returns of an actual client account. Not a guarantee of future results. See Appendix for the Capital Market Assumptions.

<sup>2</sup> Private Equity assumptions developed as follows: 72% Buyouts, 13% Venture Capital, 15% Distressed Debt

# Aon Investments' Capital Market Assumptions

## As of June 30, 2022

Nominal Correlations	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1 Large Cap U.S. Equity	1.00	0.93	0.87	0.81	0.73	-0.02	0.02	-0.13	0.62	0.45	0.65	0.45	0.46	0.92	0.34	0.90	0.01	0.38	0.07
2 Small Cap U.S. Equity	0.93	1.00	0.81	0.75	0.68	-0.03	0.02	-0.13	0.58	0.43	0.61	0.43	0.41	0.87	0.34	0.85	0.01	0.36	0.07
3 International Equity (Developed) – Hdg	0.87	0.81	1.00	0.89	0.74	-0.01	0.03	-0.14	0.59	0.43	0.59	0.48	0.32	0.80	0.35	0.82	0.01	0.37	0.07
4 International Equity (Developed) – Unhdg	0.81	0.75	0.89	1.00	0.76	-0.02	0.01	-0.13	0.61	0.45	0.54	0.44	0.49	0.75	0.31	0.84	0.02	0.38	0.10
5 Emerging Markets Equity	0.73	0.68	0.74	0.76	1.00	-0.02	0.03	-0.13	0.68	0.49	0.50	0.41	0.35	0.68	0.29	0.75	0.01	0.40	0.07
6 TIPS	-0.02	-0.03	-0.01	-0.02	-0.02	1.00	0.50	0.41	0.08	0.14	0.00	0.02	0.16	-0.03	0.03	0.01	0.05	-0.12	0.39
7 Core Fixed Income	0.02	0.02	0.03	0.01	0.03	0.50	1.00	0.72	0.29	0.47	0.02	0.04	0.03	0.02	0.05	0.03	0.00	0.07	-0.02
8 Long Duration Bonds – Gov't	-0.13	-0.13	-0.14	-0.13	-0.13	0.41	0.72	1.00	-0.15	0.10	-0.09	-0.07	-0.05	-0.13	-0.05	-0.13	-0.02	-0.25	-0.17
9 High Yield Bonds	0.62	0.58	0.59	0.61	0.68	0.08	0.29	-0.15	1.00	0.76	0.41	0.33	0.39	0.59	0.26	0.63	0.02	0.68	0.17
10 Emerging Market Bonds, Hard	0.45	0.43	0.43	0.45	0.49	0.14	0.47	0.10	0.76	1.00	0.30	0.24	0.25	0.43	0.18	0.45	0.01	0.45	0.05
11 REITs	0.65	0.61	0.59	0.54	0.50	0.00	0.02	-0.09	0.41	0.30	1.00	0.47	0.28	0.60	0.24	0.68	0.01	0.25	0.05
12 Non-Core Real Estate	0.45	0.43	0.48	0.44	0.41	0.02	0.04	-0.07	0.33	0.24	0.47	1.00	0.16	0.42	0.22	0.46	0.02	0.19	0.07
13 Commodities	0.46	0.41	0.32	0.49	0.35	0.16	0.03	-0.05	0.39	0.25	0.28	0.16	1.00	0.43	0.09	0.56	0.04	0.18	0.39
14 Private Equity	0.92	0.87	0.80	0.75	0.68	-0.03	0.02	-0.13	0.59	0.43	0.60	0.42	0.43	1.00	0.32	0.83	0.01	0.37	0.06
15 Infrastructure - Private	0.34	0.34	0.35	0.31	0.29	0.03	0.05	-0.05	0.26	0.18	0.24	0.22	0.09	0.32	1.00	0.32	0.01	0.15	0.06
16 Infrastructure - Public	0.90	0.85	0.82	0.84	0.75	0.01	0.03	-0.13	0.63	0.45	0.68	0.46	0.56	0.83	0.32	1.00	0.02	0.37	0.13
17 Gold	0.01	0.01	0.01	0.02	0.01	0.05	0.00	-0.02	0.02	0.01	0.01	0.02	0.04	0.01	0.01	0.02	1.00	0.00	0.12
18 Private Debt	0.38	0.36	0.37	0.38	0.40	-0.12	0.07	-0.25	0.68	0.45	0.25	0.19	0.18	0.37	0.15	0.37	0.00	1.00	0.01
19 Inflation	0.07	0.07	0.07	0.10	0.07	0.39	-0.02	-0.17	0.17	0.05	0.05	0.07	0.39	0.06	0.06	0.13	0.12	0.01	1.00

# Actuarial Assumptions and Methods

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- Actuarial projections were provided by the plan actuary as of the most recent valuation date (June 30, 2021) with key assumptions noted below:
  - Assumed Investment Return: 7.00%
  - Average Salary Increase: 4.50%
  - Payroll Growth: 3.25%
  - Inflation: 2.50%
  
- Additional actuarial assumptions:
  - Actuarial Value of Assets: smooth gains/losses relative to expected valuation rate of interest over 10 years and shall be no less than 70% and no greater than 130% of the market value of assets
  - Projection assumptions from the plan actuary
    - The active workforce size is assumed to remain constant over the projection period;
    - Future new employees have similar characteristics (age/gender/salary) to new employees for the period July 1, 2018 through June 30, 2021
      - ♦ Among new school employees hired on or after July 1, 2021, 98% will become Class T-G members, 1% will elect Class T-H membership, and 1% will elect Class DC participation.

## Actuarial Assumptions and Methods (continued)

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- Additional actuarial assumptions (continued):
  - Projection assumptions from the plan actuary (continued)
    - The projection reflects the ACT 5 risk-sharing provisions for TE/TF/TG/TH members. We caution that while the System assets and projected unfunded accrued liability amortization schedules reflect the under/over contribution from the basic member rate resulting from the assumed asset returns, the corresponding System accrued liabilities do not reflect the increase in the affected members contribution rates. Changes in the member rate influence the System's total liabilities due to incidence of return of contributions for non-vested members, Option 4 lump sum withdrawals, etc.
  - All other assumptions as documented in the Actuarial Valuation Report as of June 30, 2021
- Actuarially-Determined Contribution Calculation = Normal Cost plus a level percent amortization of the unfunded liability with layered 24 year, closed periods, and a 3.25% salary scale
  - Amortization bases developed are projected to continue until either their individual expiry or the plan reaches 100% funded on an actuarial value of assets basis at which point any remaining balance is fully recognized
- Other assumptions
  - Asset figures reflect performance for the period July 1, 2021 – June 30, 2022 resulting in a market asset value of \$69.748 billion as of June 30, 2022
  - Employee contributions are limited to the actuarially-determined contribution
  - The health care premium assistance assets and liabilities have been excluded from this analysis
  - The rate collar provision of Act 120 was not considered in this analysis as it has been deemed to no longer be effective
  - “Shared Risk” provisions of Act 120 have not been considered in this analysis

## About This Material

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This material includes a summary of calculations and consulting related to the finances of Pennsylvania Public School Employees' Retirement System (PSERS). The following variables have been addressed:

- Contributions
- Funded Ratio
- Net Outflow

This analysis is intended to assist the Investment Committee with a review of the associated issues and options, and its use may not be appropriate for other purposes. This analysis has been prepared solely for the benefit of the Investment Committee. Any further dissemination of this report is not allowed without the written consent of Aon Investments USA Inc.

Our calculations were generally based on the methodologies identified in the actuary's valuation report for PSERS. We believe the methodology used in these calculations conforms to the applicable standards identified in the report.

Models are used to develop alternative scenarios based on the underlying valuation model and project financial results under those scenarios. The models were developed by experts outside and within Aon. Where outside models were used, the models were reviewed by experts within Aon. The models were selected as appropriate for these projections by the undersigned.

Experience different than anticipated could have a material impact on the ultimate costs of the benefits. In addition, changes in plan provisions or applicable laws could have a significant impact on cost. Actual experience may differ from our modeling assumptions.

Our calculations were based on data provided by the plan actuary. The actuarial assumptions and methods and plan provisions reflected in these projections are the same as those used for the June 30, 2021 actuarial valuation for PSERS as noted in the actuarial reports, except where noted in this report. Unless specifically noted, our calculations do not reflect any other changes or events after June 30, 2021. Reflecting events after June 30, 2021 would impact the results of the projection.

In conducting these projections, we have relied on plan design, demographic and financial information provided by other parties, including the plan's actuary and plan sponsor. While we cannot verify the accuracy of all of the information, the supplied information was reviewed for consistency and reasonableness. As a result of this review, we have no reason to doubt the substantial accuracy or completeness of the information and believe that it has produced appropriate results.

These projections have been conducted in accordance with generally accepted actuarial principles and practices, including applicable Actuarial Standards of Practice as issued by the Actuarial Standards Board. The undersigned actuary is familiar with the near-term and long-term aspects of pension valuations and meet the Qualification Standards of the American Academy of Actuaries necessary to render the actuarial opinions contained herein. All sections of this report are considered an integral part of the actuarial opinions.

To our knowledge, no colleague of Aon Investments USA Inc. providing services to PSERS has any direct financial interest or indirect material interest in PSERS. Thus, we believe there is no relationship existing that might affect our capacity to prepare and certify this report for PSERS.

Aon Investments USA Inc.

Phil Kivarkis FSA, CFA

# Legal Disclosures and Disclaimers

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