



# State of Wisconsin Investment Board (SWIB)

Wisconsin Retirement System  
Actuarial Overview and Stress Testing  
Scenarios

October 2023



# Topics

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1 Executive Summary

2 WRS – The Big Picture

3 Understanding Dividend Liability

4 Stress Testing Results – Deterministic

5 Stress Testing Results – Stochastic

6 Appendix

# SECTION 1

## Executive Summary

# Objectives of this Presentation

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- Provide an overview of the WRS
  - Relationship of Investment Return to Success Measures
  - Effects of bad outcomes
- Evaluate several points along the asset allocation spectrum against the measures of success
  - Deterministic stress tests
  - Stochastic simulations
- Find the “Sweet Spot” if it exists



# 2023 Executive Summary

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- Deterministic stress test of WRS

Single year Black Swan investment scenarios show:

- Contribution rate increases by up to ~ 2.5%-4% of payroll once loss fully works into the Market Recognition Account
- Series of negative dividends, depletion of dividend liability and several years until dividends resume
  - Dividend depletion at -15% return (vs. -30% return in 2021 study)
- Contribution rates are generally more stable than retiree dividends



# 2023 Executive Summary

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- Changes from 2021 Study:
  - Market returns varied during 2021-2022
  - Much lower standard deviation of future returns
  - Smaller ultimate dividend liability ‘cushion’
  - Evaluated smaller intervals of expected return (50 basis points) to refine sweet spot
  - Updated actuarial assumptions (primarily 6.8% investment return)

# 2023 Observations

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- Overall results are similar to 2021 study
  - Stochastic probability of depleting dividend liability varies due to factors above
  - Smaller range of dividend/contribution results due to lower standard deviation of returns
  - Wider range of goldilocks zone due to additional incremental scenarios studied



# 2023 Executive Summary

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## Result of this year's stress testing of the Wisconsin Retirement System

- Continue to target 'Goldilocks zone' that provides for positive return with appropriate downside protection
  - Expected Rate of Return = 6.0%-7.5%
    - Corresponding Standard Deviations of Returns = 9.4%-17.1%





# BIG PICTURE

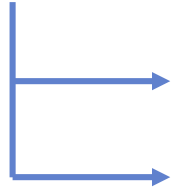


## SECTION 2

# WRS – The Big Picture

# All Participants at December 31, 2022

Active Lives  
Valuation



Valuation Group	Number	Average Annual Earnings/Benefits <sup>1</sup>
Actives	259,592	\$61,735
Inactives	181,758	\$20,892
Retirees & Beneficiaries	233,804	\$29,889
<b>Total Participants</b>	<b>675,154</b>	

Retired Lives  
Valuation



<sup>1</sup> For inactives, average money purchase balance.

# WRS Benefits

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- Defined Benefit Plan:
  - $1.6\% \times \text{Final Average Compensation} \times \text{Service}$  (most participants)
  - Different benefits for protective occupations
  - Provides benefits in the case of death or disability prior to retirement

# WRS Investments

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- Core Fund (Most Assets)
  - Diversified portfolio with results smoothed for WRS purposes via the Market Recognition Account (MRA)
- Variable Fund (Some Assets)
  - 100% Common Stock -- no smoothing of results
  - Participants can choose to invest up to half of their own contributions in this fund
    - They bear the risks and reap the rewards of this choice



# WRS Actuarial Assumptions

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- Non-Retired Assets: 6.8%
- Retired Assets: 5%
  - A statutory assumption that is really a benefit condition
- Other assumptions relate to active participants salary, rates of turnover, disability, mortality, etc.
- Investment return assumption (6.8%) is the most important

# WRS Risk Sharing

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- Investment earnings increase (or decrease) active and inactive member account balances
  - Potentially affects their benefits when they retire via the operation of the Money Purchase Minimum benefit (MPM)
- Investment earnings (smoothed) above or below 5% affect dividends paid to retirees
- Active members and employers share in contribution rate changes





# SECTION 3

## Understanding Dividend Liability

# Understanding Dividend Liability

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- Retirees share in investment gains, but also share in investment losses
  - Prior dividends can be reduced if less than 5% is credited to the Core Annuity Division
- Only dividends can be reduced, the original core benefit is protected
- The present value of the excess of total core benefits over original benefits is called the “Dividend Liability”





# Liability Attributable to Dividends – “Dividend Liability”

<b>Valuation</b>	<b>Liability for Dividend Remaining (billions)</b>	<b>Liability for Dividend Adjustment (billions)</b>	<b>Liability after Dividend Adjustment (billions)</b>
12/31/2013	\$3.0	\$2.0	\$5.0
12/31/2014	4.6	1.3	5.9
12/31/2015	5.5	0.2	5.7
12/31/2016	5.4	1.0	6.4
12/31/2017	6.1	1.3	7.4
12/31/2018	6.9	0.0	6.9
12/31/2019	6.5	1.0	7.5
12/31/2020	7.0	3.1	10.1
12/31/2021	9.4	4.8	14.2
12/31/2022	13.4	1.1	14.5

- “Liability for dividend remaining” = value of all previously granted dividends (=\$9.2B at 12/31/2008)
- 2023 “liability for dividend remaining” is >2008, BUT as a percentage of total liabilities, it is smaller
- Substantial asset losses could decrease the “liability for dividend remaining” to low levels

# Dividend Liability Measure – MRA Basis

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- Dividend Liability as a % of Base Liability
- Dividend Liability (MRA basis)
  - Total Retiree Assets (Core MRA) = 72.1 billion
  - Base Benefit Liability = 57.6 billion
  - Dividend Liability =  $(72.1 - 57.6) = 14.5$  billion
  - Dividend Liability % =  $14.5\text{B}/57.6\text{B} = 25.2\%$
- In other words, there is a 25.2% ‘cushion’ before Dividend Liability is depleted

# Dividend Liability Measure – MVA Basis

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- However, this is on an MRA (smoothed) basis
- Dividend Liability (MVA basis)
  - Total Retiree Assets (Core MVA) ~ 68.0 billion
  - Base Benefit Liability = 57.6 billion
  - Dividend Liability (MVA) ~  $(68.0 - 57.6) = 10.4$  billion
  - Dividend Liability (MVA) % ~  $10.4\text{B}/57.6\text{B} = 18.0\%$
- Given all assumptions are met, over time, on a market value basis the cushion will decrease to 18% with Phase-in of unrecognized losses

# Dividend Liability Measure

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- On MRA basis, 2023 dividend liability results look better than 2021, however:
  - At 12/31/2020 there were \$11.1B in deferred asset gains – looking forward things are better than they appear
  - At 12/31/2022 there are \$7.0B in deferred asset losses – looking forward things are worse than they appear

Dividend Liability %	2021	2023
MRA basis	18.6%	25.2%
MVA basis	30.7%	18.0%

- The ultimate dividend liability ‘cushion’ decreased from 30.7% to 18.0%



**Stress**

**Testing**

## **SECTION 4**

**Stress Testing Results - Deterministic**

# Deterministic Stress Testing

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- Stress testing provides insight into how the System would respond to severely unfavorable markets
- For WRS, stress testing can answer questions:
  - What would it take to deplete the dividend liability?
  - What would it take to increase contribution rates 25%?

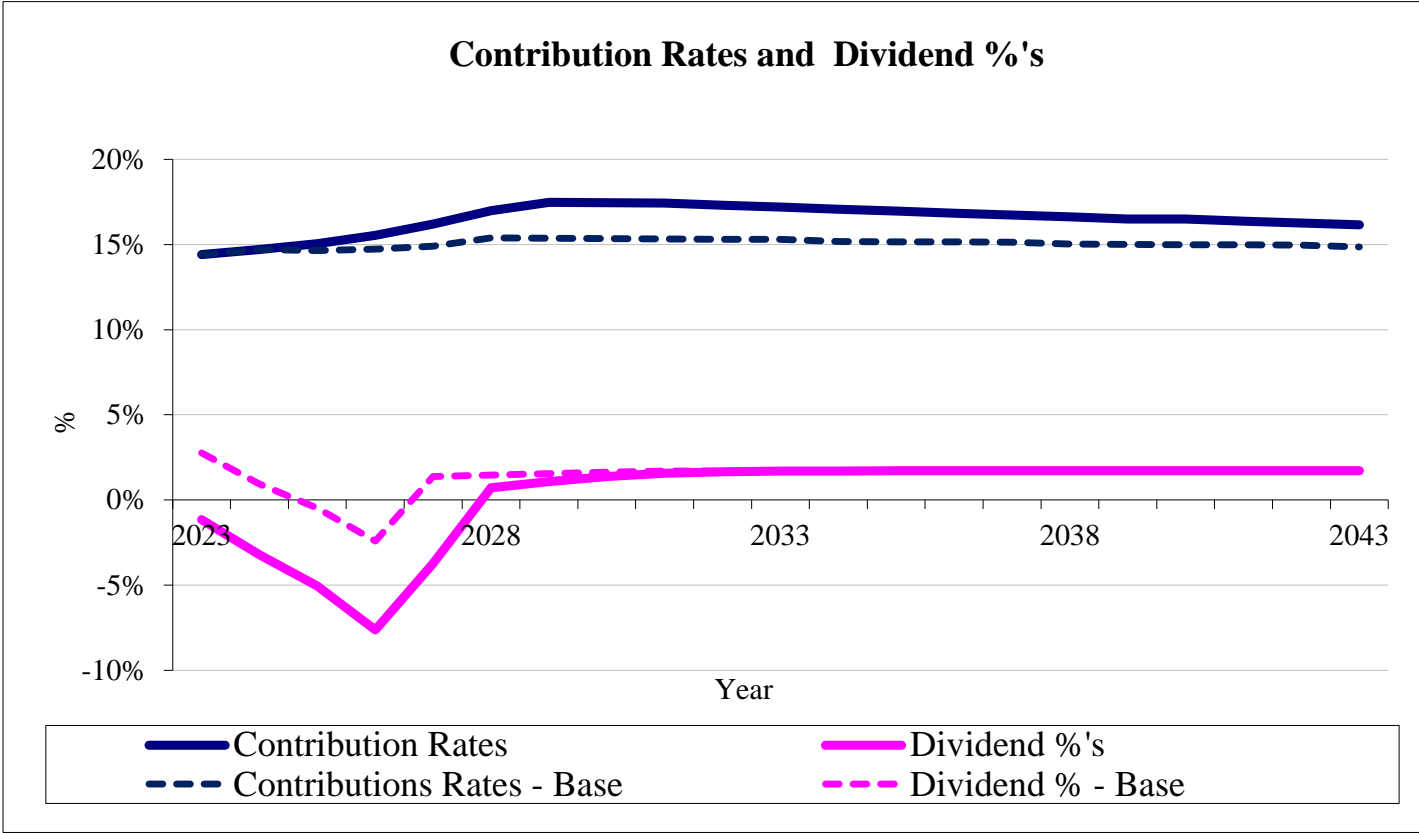
# Deterministic Stress Testing

- Deterministic stress tests studied herein:

Stress Test	Asset Return Year 1	Asset Return Year 2	Asset Return Thereafter
1	-15%	6.8%	6.8%
2	-20%	6.8%	6.8%
3 Bounce Back	-20%	20%	6.8%
4	-30%	6.8%	6.8%

Underlying valuation assumptions held constant, including 6.8% investment return and 3.0% wage inflation assumptions

# Stress Test 1 – Negative 15% Return in 2023 Followed by 6.8% Thereafter



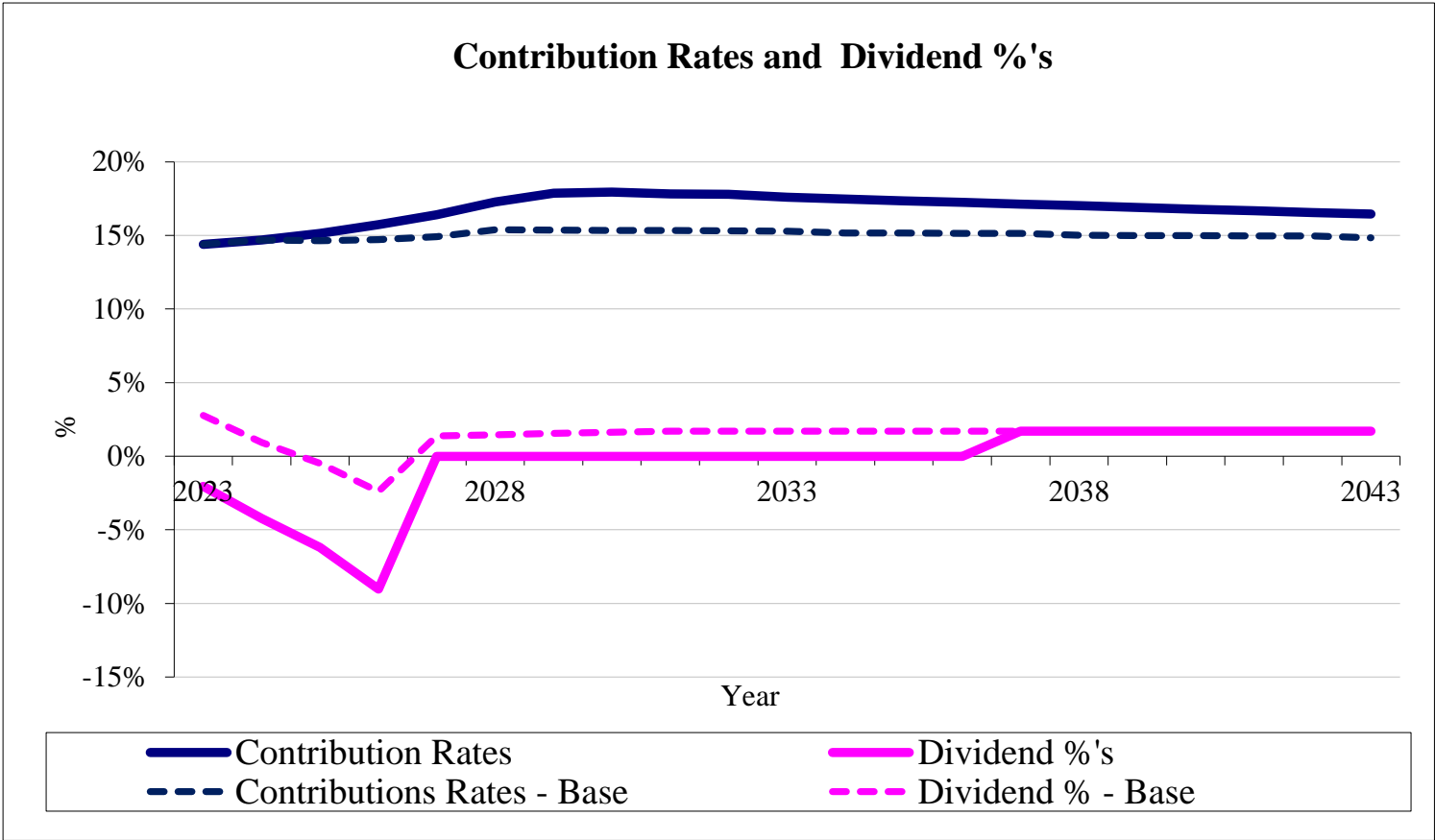


## Stress Test 1 – Negative 15% Return in 2023 Followed by 6.8% Thereafter

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- Dividend Liability is depleted by 2027
- There will be a series of negative dividends, until most people are at the floor
- Positive dividends would resume in 2028
- Contribution Rate gradually increases by about 2.5% of payroll in year 5 and slowly declines thereafter

# Stress Test 2 – Negative 20% Return in 2023 Followed by 6.8% Thereafter

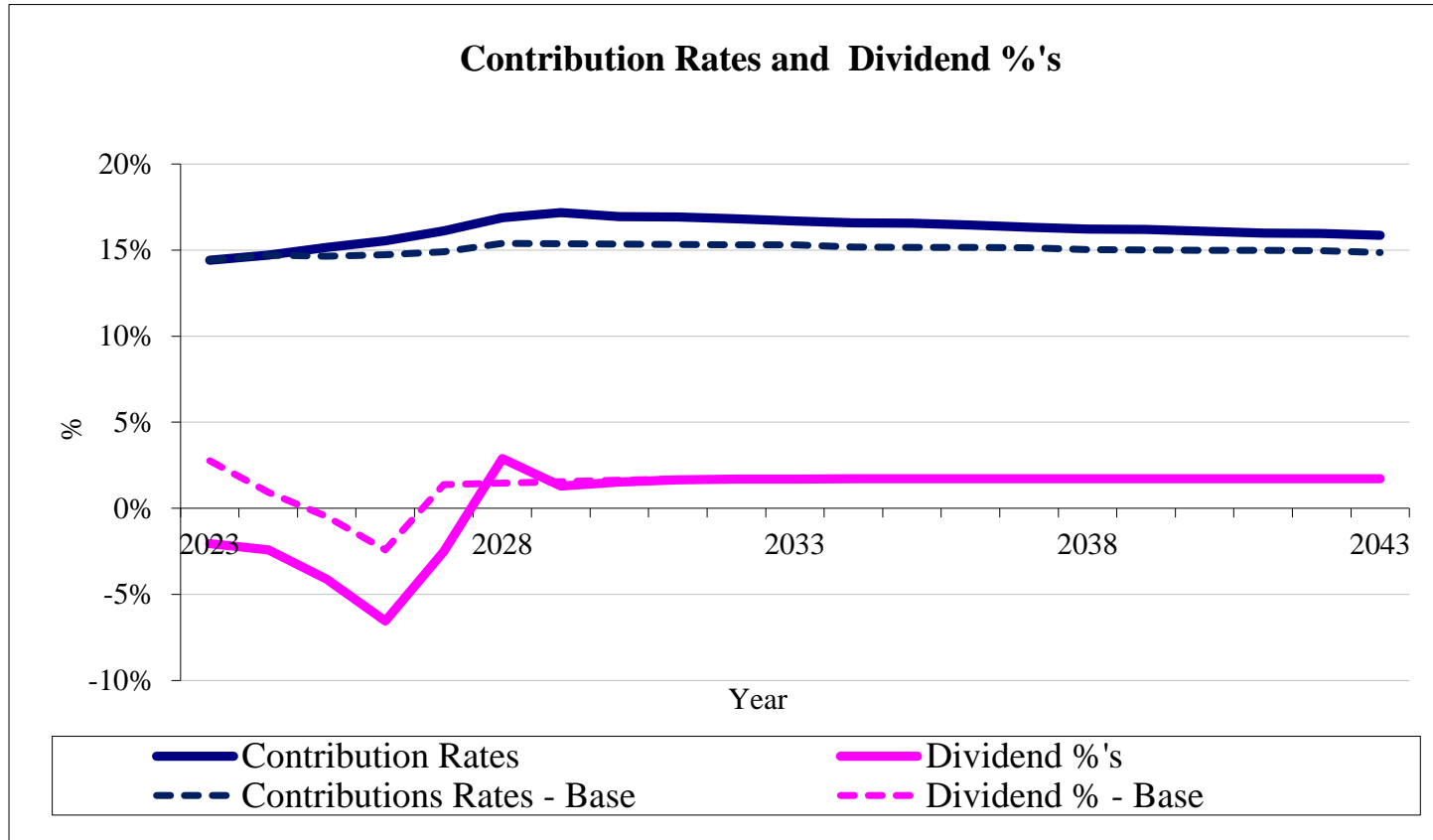


## Stress Test 2 – Negative 20% Return in 2023 Followed by 6.8% Thereafter

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- Dividend Liability is depleted by 2026
- Retiree Liability becomes underfunded
- There will be a series of negative dividends, until all retirees are at the floor, followed by an extended period of no dividends
- Dividends could resume in 2037
- Contribution Rate gradually increases by about 3% of payroll in year 5 and slowly declines thereafter

# Stress Test 3 – Negative 20% Return in 2023, Positive 20% in 2024 and 6.8% thereafter

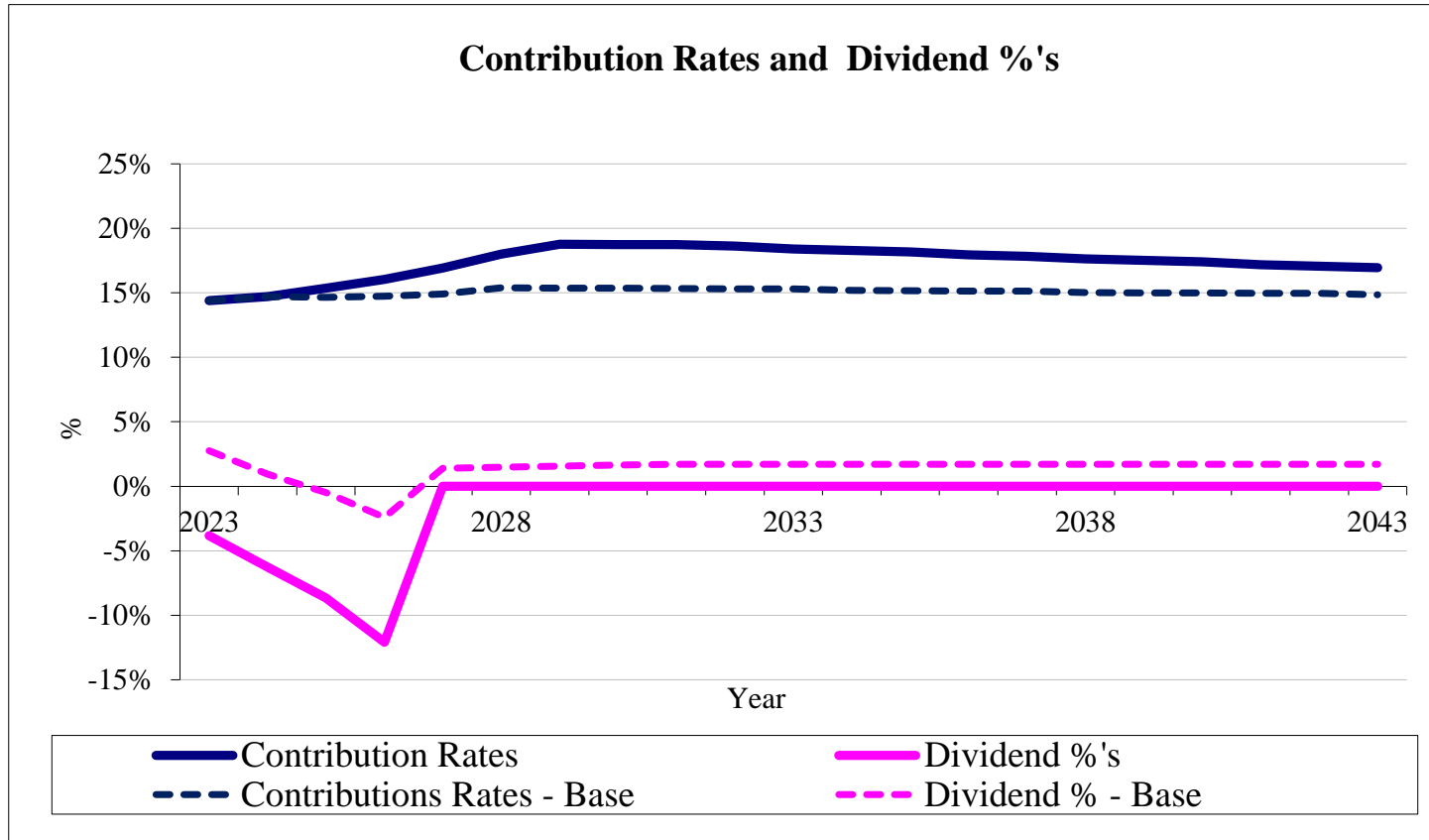


## Stress Test 3 – Negative 20% Return in 2023, Positive 20% in 2024 and 6.8% thereafter

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- Dividend Liability is not depleted, but Dividend Liability “cushion” falls to 3% in 2027
- There will be a series of negative dividends, pushing some retirees to the floor, followed by a rebuild of dividends for all retirees
- Contribution Rate gradually increases by about 2% of payroll in year 5 and slowly declines thereafter

# Stress Test 4 – Negative 30% Return in 2023 Followed by 6.8% Thereafter



## Stress Test 4 – Negative 30% Return in 2023 Followed by 6.8% Thereafter

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- Dividend Liability is depleted by 2026
- Retiree Liability becomes underfunded
- There will be a series of negative dividends, until all people are at the floor, followed by a long period of no dividends
- Dividends could resume in 2049
- Contribution Rate gradually increases by about 4% of payroll in year 5 and slowly declines thereafter

# Deterministic Stress Test Summary

All tests show a 4-year negative dividend period

Stress Test/MVA Return	Year Dividend Liability Depleted	Year Positive Dividends Resume	Retiree Liability Underfunded	Year 5 Projected Contribution Rate Increase
1/-15%	2027	2028	No	2.5% of Payroll
2/-20%	2026	2037	Yes	3.0% of Payroll
3/-20% +20%	N/A	2028	No	2.0% of Payroll
4/-30%	2026	2049	Yes	4.0% of Payroll

Given all assumptions are met, including 6.8% return after shocks and bounceback





# Stress Test Observations

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- Contribution rates are generally more stable than dividend rates
- A large negative return would be detrimental to retirees (dividends are depleted)
- Retiree assets are almost 65% of the total
- Proportions allocated to retiree reserve, money purchase minimum and EAR evolve over time



# SECTION 5

## Stress Testing Results - Stochastic

# Monte Carlo Simulations

- Based on 10,000 random trials (normal distribution)
- Valuation Assumptions held constant
- Assumes nine sets of expected return/standard deviations (provided by NEPC)

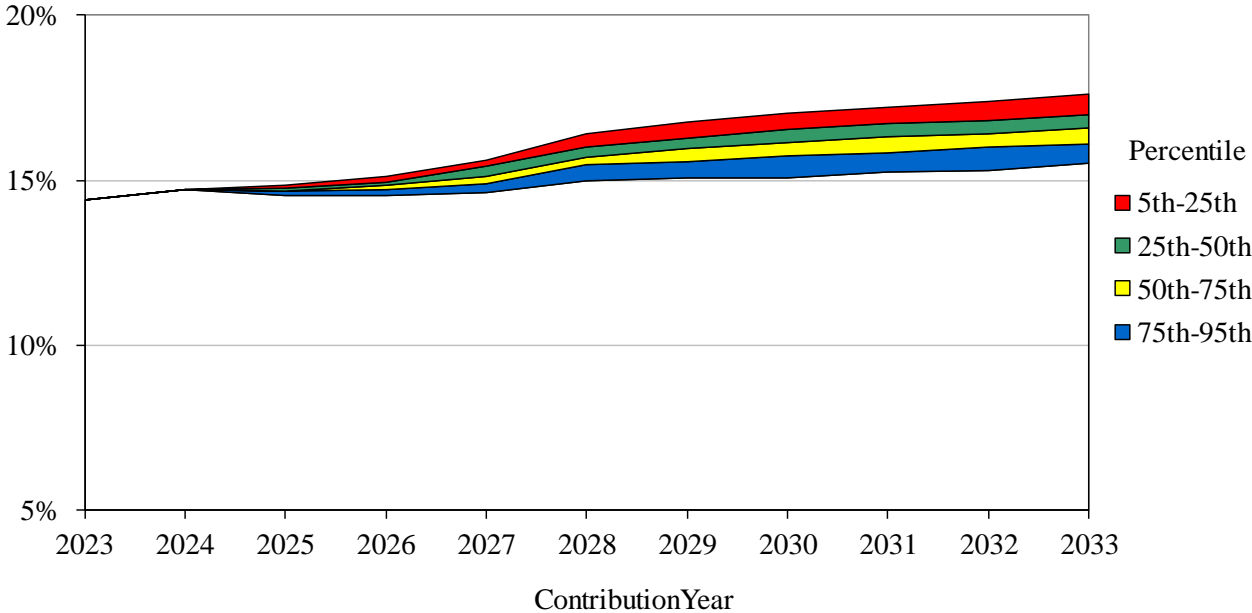
Actuarial  
Rate 6.8%



	Expected Return		Standard Deviation	
	Geometric	Arithmetic	2023	2021
Scenario 1	4.0%	4.1%	3.8%	6.9%
Scenario 2	5.0%	5.1%	4.6%	11.3%
Scenario 3	5.5%	5.6%	5.5%	N/A
Scenario 4	6.0%	6.4%	9.4%	15.5%
Scenario 5	6.5%	7.2%	12.9%	N/A
Scenario 6	7.0%	7.8%	13.6%	20.4%
Scenario 7	7.5%	8.7%	17.1%	N/A
Scenario 8	8.0%	10.0%	22.4%	26.3%
Scenario 9	9.0%	12.1%	28.1%	33.7%

# Contribution as a % of Payroll

## Scenario 2 – 5.0% Return, 4.6% Volatility

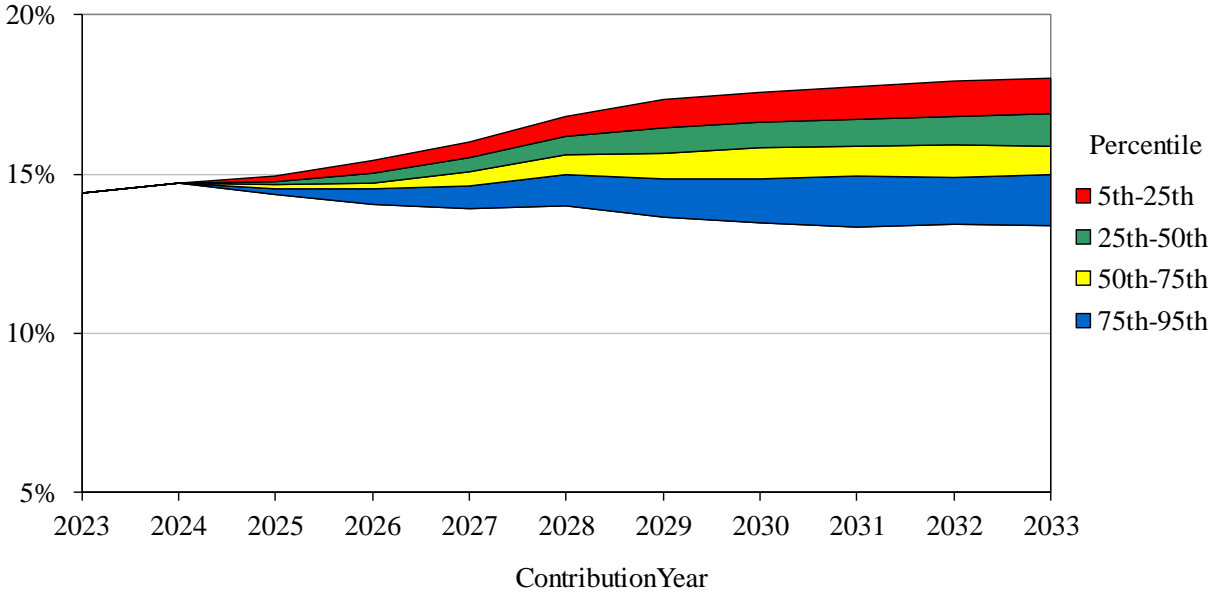


<b>5th Percentile</b>	14.4%	14.7%	14.9%	15.1%	15.6%	16.4%	16.8%	17.0%	17.2%	17.4%	17.6%
<b>25th Percentile</b>	14.4%	14.7%	14.8%	14.9%	15.4%	16.0%	16.3%	16.5%	16.7%	16.8%	17.0%
<b>Median</b>	14.4%	14.7%	14.7%	14.8%	15.1%	15.7%	16.0%	16.1%	16.3%	16.4%	16.6%
<b>75th Percentile</b>	14.4%	14.7%	14.7%	14.7%	14.9%	15.5%	15.6%	15.7%	15.8%	16.0%	16.1%
<b>95th Percentile</b>	14.4%	14.7%	14.6%	14.5%	14.6%	15.0%	15.1%	15.0%	15.2%	15.3%	15.5%



# Contribution as a % of Payroll

## Scenario 4 – 6.0% Return, 9.4% Volatility

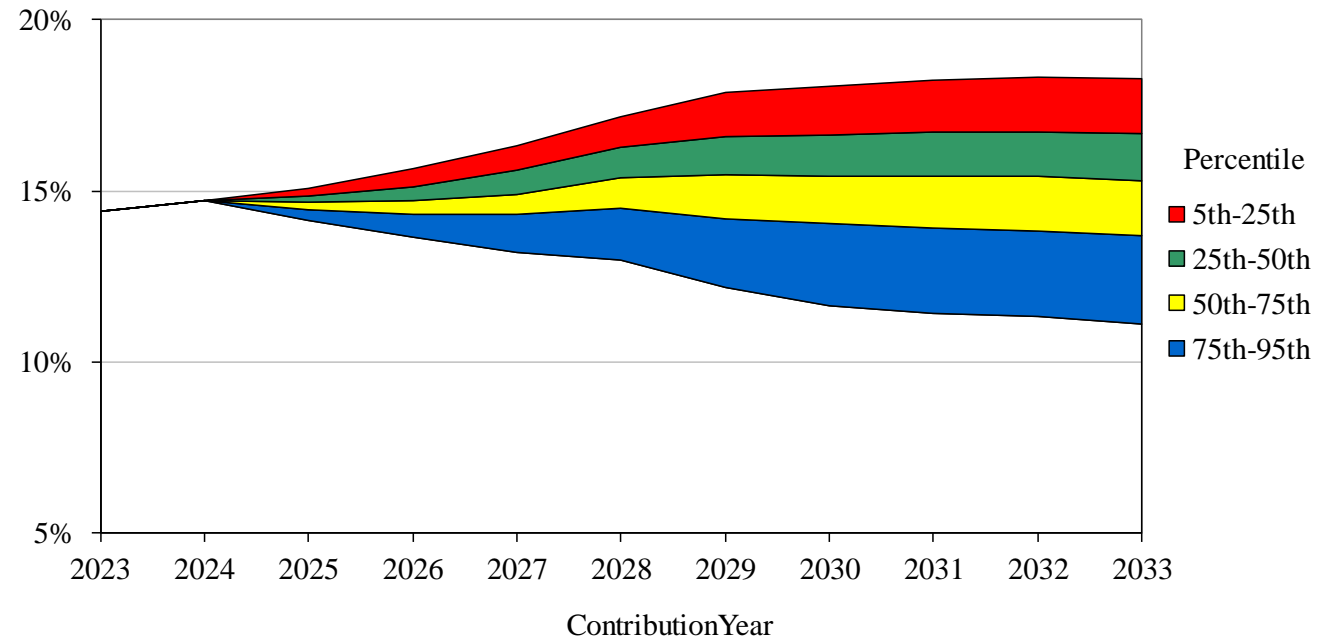


<b>5th Percentile</b>	14.4%	14.7%	15.0%	15.4%	16.0%	16.8%	17.4%	17.5%	17.7%	17.9%	18.0%
<b>25th Percentile</b>	14.4%	14.7%	14.8%	15.0%	15.5%	16.2%	16.5%	16.6%	16.7%	16.8%	16.9%
<b>Median</b>	14.4%	14.7%	14.7%	14.7%	15.1%	15.6%	15.7%	15.8%	15.9%	15.9%	15.9%
<b>75th Percentile</b>	14.4%	14.7%	14.6%	14.5%	14.6%	15.0%	14.9%	14.8%	14.9%	14.9%	15.0%
<b>95th Percentile</b>	14.4%	14.7%	14.4%	14.0%	13.9%	14.0%	13.7%	13.4%	13.3%	13.4%	13.4%



# Contribution as a % of Payroll

## Scenario 6 – 7.0% Return, 13.6% Volatility

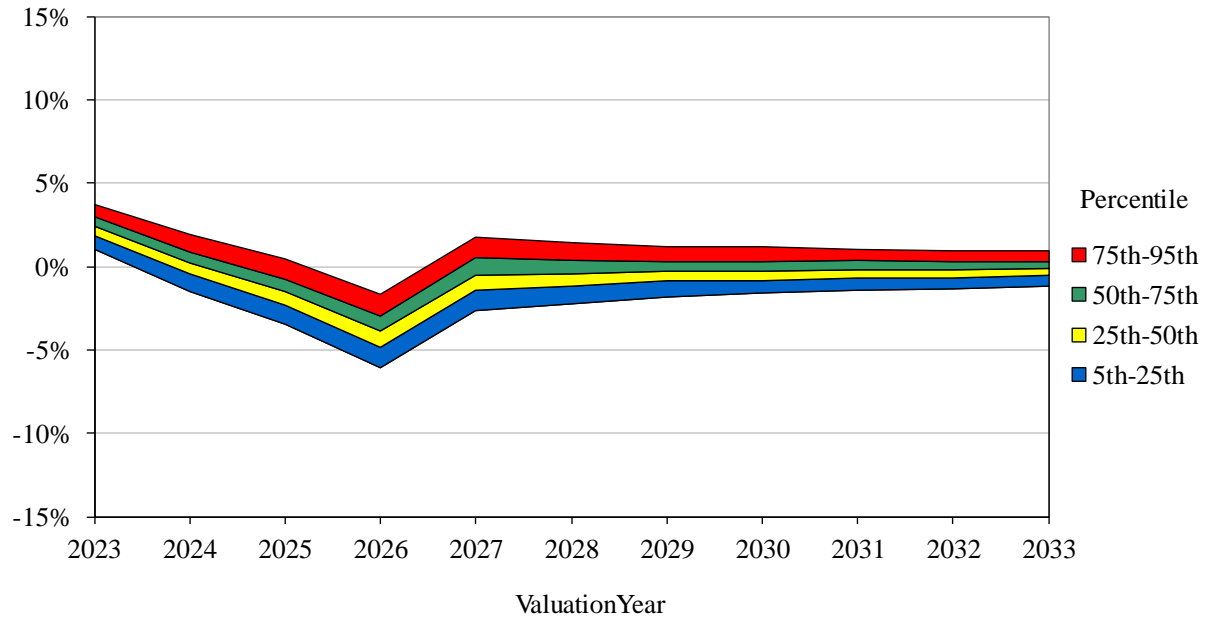


	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
<b>5th Percentile</b>	14.4%	14.7%	15.1%	15.6%	16.3%	17.2%	17.9%	18.0%	18.2%	18.3%	18.3%
<b>25th Percentile</b>	14.4%	14.7%	14.9%	15.1%	15.6%	16.3%	16.6%	16.6%	16.7%	16.7%	16.7%
<b>Median</b>	14.4%	14.7%	14.7%	14.7%	14.9%	15.4%	15.5%	15.4%	15.4%	15.4%	15.3%
<b>75th Percentile</b>	14.4%	14.7%	14.5%	14.3%	14.3%	14.5%	14.2%	14.0%	13.9%	13.8%	13.7%
<b>95th Percentile</b>	14.4%	14.7%	14.2%	13.6%	13.2%	13.0%	12.2%	11.6%	11.4%	11.3%	11.1%



# Dividend Rates

## Scenario 2 – 5.0% Return, 4.6% Volatility

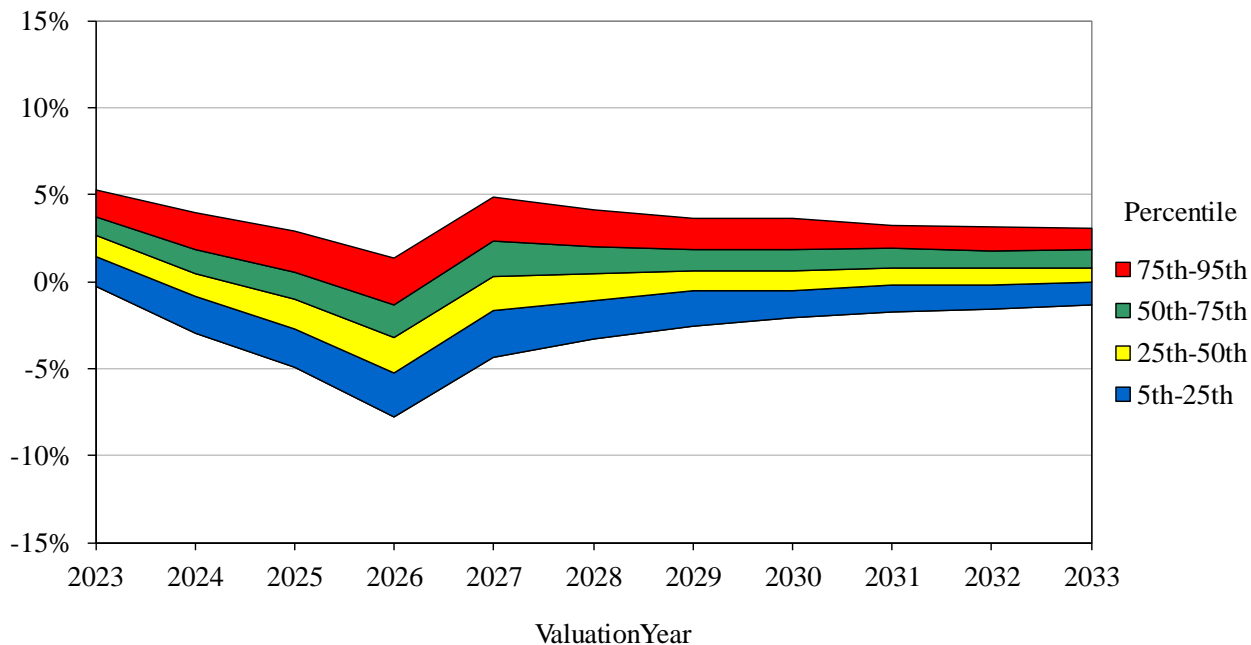


<b>5th Percentile</b>	1.0%	-1.5%	-3.4%	-6.1%	-2.7%	-2.2%	-1.8%	-1.6%	-1.4%	-1.3%	-1.2%
<b>25th Percentile</b>	1.9%	-0.4%	-2.3%	-4.9%	-1.4%	-1.2%	-0.9%	-0.8%	-0.7%	-0.7%	-0.5%
<b>Median</b>	2.4%	0.2%	-1.5%	-3.9%	-0.5%	-0.4%	-0.3%	-0.3%	-0.2%	-0.2%	-0.1%
<b>75th Percentile</b>	3.0%	0.9%	-0.8%	-3.0%	0.5%	0.4%	0.3%	0.3%	0.4%	0.3%	0.3%
<b>95th Percentile</b>	3.7%	1.9%	0.4%	-1.7%	1.8%	1.4%	1.2%	1.2%	1.0%	1.0%	1.0%



# Dividend Rates

## Scenario 4 – 6.0% Return, 9.4% Volatility



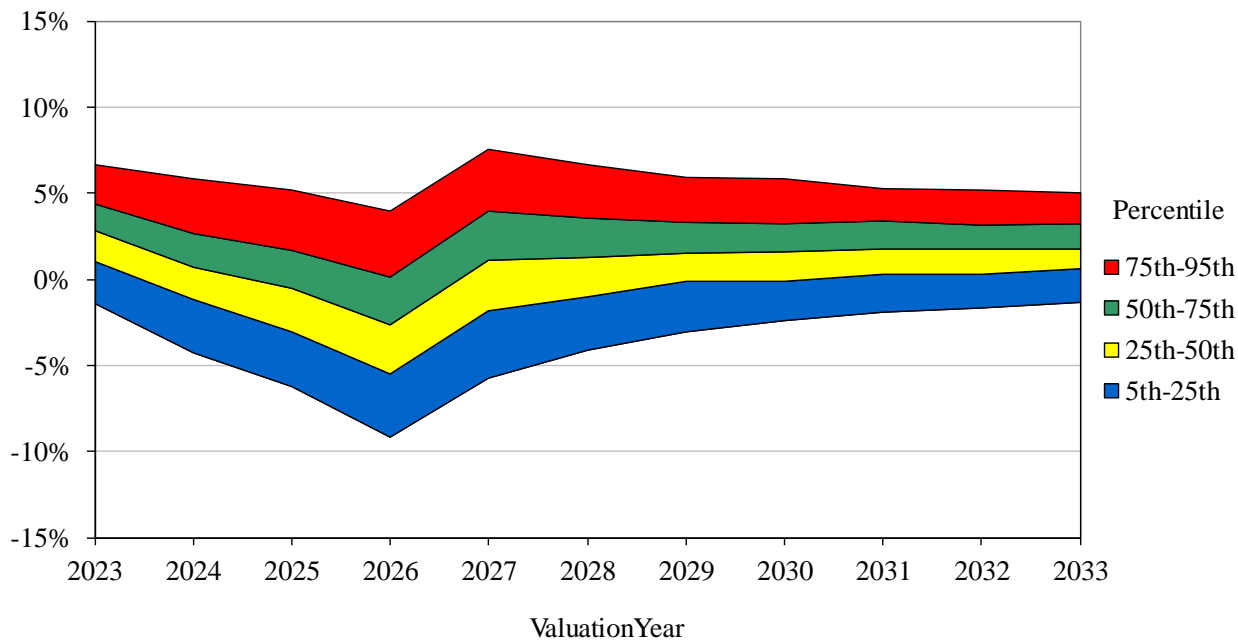
	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
<b>5th Percentile</b>	-0.3%	-3.0%	-4.9%	-7.7%	-4.3%	-3.3%	-2.5%	-2.1%	-1.7%	-1.6%	-1.3%
<b>25th Percentile</b>	1.4%	-0.9%	-2.8%	-5.2%	-1.7%	-1.1%	-0.5%	-0.5%	-0.2%	-0.2%	0.0%
<b>Median</b>	2.6%	0.5%	-1.0%	-3.2%	0.3%	0.5%	0.6%	0.7%	0.8%	0.8%	0.8%
<b>75th Percentile</b>	3.7%	1.8%	0.5%	-1.3%	2.3%	2.0%	1.8%	1.8%	1.9%	1.8%	1.8%
<b>95th Percentile</b>	5.3%	4.0%	2.9%	1.3%	4.9%	4.2%	3.7%	3.7%	3.3%	3.2%	3.1%





# Dividend Rates

## Scenario 6 – 7.0% Return, 13.6% Volatility



	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
<b>5th Percentile</b>	-1.4%	-4.3%	-6.2%	-9.2%	-5.7%	-4.1%	-3.0%	-2.4%	-1.9%	-1.7%	-1.4%
<b>25th Percentile</b>	1.1%	-1.2%	-3.1%	-5.5%	-1.8%	-1.0%	-0.1%	-0.1%	0.3%	0.3%	0.6%
<b>Median</b>	2.8%	0.7%	-0.5%	-2.6%	1.1%	1.3%	1.5%	1.6%	1.8%	1.8%	1.8%
<b>75th Percentile</b>	4.4%	2.7%	1.7%	0.2%	4.0%	3.6%	3.3%	3.3%	3.4%	3.2%	3.2%
<b>95th Percentile</b>	6.7%	5.9%	5.2%	4.0%	7.6%	6.6%	5.9%	5.9%	5.2%	5.2%	5.0%



# Stress Testing Dividend Depletion and Retiree Funded Status

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- Definitions
  - Dividend Liability = Total Retiree Liability (w/div.)  
less Base Benefit Liability (w/o div.)
  - Retiree Funded Status =  
Total Retiree Liability (w/div.) / Base Benefit Liability  
(w/o div.)
- Dividend Stress Test studied
  - Probability that dividend liability will be depleted
  - Number of paths leading to Dividend Depletion
  - Worst case scenario of Retiree Funded Status
  - Depletion Severity measure



# Stress Testing Dividend Depletion and Retiree Funded Status



Probability {Dividend Depletion in  
Year  $i$ }

Represents the number of times the Retiree Funded Status is less than 1 in year  $i$  divided by 10,000 (allows for recovery in future years)

# Dividend Stress Test

**Probability That Dividend Liability Will Be Depleted in Year  
(allows for recovery in future year)**

Actuarial  
Rate 6.8%  
→

	Expected ROR	Standard Deviation	Year				
			1	5	10	20	50
1	4.0%	3.8%	0%	0%	20%	91%	100%
2	5.0%	4.6%	0%	0%	4%	18%	71%
3	5.5%	5.5%	0%	0%	3%	6%	12%
4	6.0%	9.4%	0%	5%	10%	8%	5%
5	6.5%	12.9%	0%	10%	14%	10%	3%
6	7.0%	13.6%	0%	10%	12%	7%	1%
7	7.5%	17.1%	0%	15%	15%	8%	1%
8	8.0%	22.4%	0%	22%	21%	12%	2%
9	9.0%	28.1%	0%	25%	24%	13%	2%



# Stress Testing Dividend Depletion and Retiree Funded Status



Percentage of Paths Leading to  
Dividend Depletion on or before  $i$

Counts the number of times on or before year  $i$  the Retiree Funded Status is less than 1 (does not allow for recovery in future years)

# Dividend Stress Test

## Percentage of Paths Leading to Dividend Depletion on or before Year $i$

Actuarial Rate 6.8% →

	Expected ROR	Standard Deviation	Year				
			1	5	10	20	50
1	4.0%	3.8%	0%	0%	20%	91%	100%
2	5.0%	4.6%	0%	0%	4%	18%	73%
3	5.5%	5.5%	0%	0%	3%	7%	18%
4	6.0%	9.4%	0%	5%	12%	14%	18%
5	6.5%	12.9%	0%	10%	17%	20%	21%
6	7.0%	13.6%	0%	10%	16%	17%	18%
7	7.5%	17.1%	0%	15%	21%	22%	23%
8	8.0%	22.4%	0%	22%	28%	29%	29%
9	9.0%	28.1%	0%	25%	32%	32%	33%

# Stress Testing Dividend Depletion and Retiree Funded Status



## Worst Case Scenario of Retiree Funded Status

Finds the 5<sup>th</sup> percentile of retiree funded status for any given year in any given scenario (very unlikely scenario)

# Dividend Stress Test

## Worst Case Scenario of Retiree Funded Status (% of Floor Benefit That Is Funded)

	Expected ROR	Standard Deviation	Year				
			1	5	10	20	50
1	4.0%	3.8%	126%	107%	96%	81%	51%
2	5.0%	4.6%	126%	108%	101%	94%	78%
3	5.5%	5.5%	126%	108%	103%	100%	95%
4	6.0%	9.4%	124%	100%	95%	96%	101%
5	6.5%	12.9%	123%	94%	89%	91%	108%
6	7.0%	13.6%	123%	94%	91%	97%	131%
7	7.5%	17.1%	122%	88%	84%	92%	139%
8	8.0%	22.4%	120%	77%	73%	80%	131%
9	9.0%	28.1%	118%	67%	64%	74%	148%

Actuarial Rate 6.8% →

Worst Case Scenario based on 5<sup>th</sup> percentile (i.e., 5% probability)





# Stress Testing Dividend Depletion and Retiree Funded Status

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## Depletion Severity Measure

Of the stress test simulations that result in a Retiree Funded Status of less than 1, finds the average Retiree Funded Status (or degree of depletion)

# Dividend Stress Test

## Depletion Severity Measure

### Average Retiree Funded Status for Depletion Scenarios

Actuarial  
Rate 6.8%  
→

	Expected ROR	Standard Deviation	Year				
			1	5	10	20	50
1	4.0%	3.8%	N/A	97%	96%	90%	60%
2	5.0%	4.6%	N/A	98%	97%	95%	89%
3	5.5%	5.5%	N/A	96%	96%	95%	93%
4	6.0%	9.4%	N/A	94%	93%	92%	89%
5	6.5%	12.9%	N/A	91%	89%	88%	87%
6	7.0%	13.6%	N/A	91%	89%	89%	91%
7	7.5%	17.1%	N/A	88%	85%	85%	87%
8	8.0%	22.4%	N/A	84%	80%	81%	80%
9	9.0%	28.1%	N/A	79%	75%	76%	77%



# Dividend Stress Test Observations

---

- The low risk scenarios are actually risky in the sense that, for example, 4% and 5% expected return has a much higher chance of dividend depletion in later years than higher risk scenarios
- Must balance short and long term volatility
- Consider probability of dividend depletion
- Consider level of worst case scenario that is acceptable

# Combination of All Scenarios

## 2033 Results by %-tile of Investment Return Outcomes

	ROR	StdDev	Contribution Rates			Dividend Rates			Highest	Worst Retiree
			95th	50th	5th	95th	50th	5th	Div. Dep. PRB	Funded %
1	4.0%	3.8%	16.4%	17.2%	18.0%	-0.2%	-1.1%	-2.0%	100%/Year50	51%/Year50
2	5.0%	4.6%	15.5%	16.6%	17.6%	1.0%	-0.1%	-1.2%	73%/Year50	78%/Year50
3	5.5%	5.5%	14.9%	16.2%	17.5%	1.7%	0.4%	-0.9%	18%/Year50	95%/Year50
4	6.0%	9.4%	13.4%	15.9%	18.0%	3.1%	0.8%	-1.3%	18%/Year50	95%/Year10
5	6.5%	12.9%	11.9%	15.6%	18.4%	4.4%	1.3%	-1.7%	21%/Year50	89%/Year10
6	7.0%	13.6%	11.1%	15.3%	18.3%	5.0%	1.8%	-1.4%	18%/Year50	91%/Year10
7	7.5%	17.1%	9.3%	15.0%	18.7%	6.3%	2.3%	-1.7%	23%/Year50	84%/Year10
8	8.0%	22.4%	6.5%	14.7%	19.4%	8.0%	2.7%	-2.5%	29%/Year50	73%/Year10
9	9.0%	28.1%	2.1%	14.1%	20.0%	10.3%	3.5%	-3.0%	33%/Year50	64%/Year10

Actuarial  
Rate 6.8%



Portfolios with lower expected return result in higher expected contributions and lower expected dividends

Higher assumed rates of return are associated with higher standard deviation (i.e., risk) and 5<sup>th</sup> percentile scenario for retiree dividend pool falling below 75% (Worst Retiree Funded %)

Scenarios 4 through 7 represent potential 'Goldilocks Zone'



# 2023 Observations

---

- Changes from 2021 Study
  - Returns over 2021 and 2022 were 16.9% and (12.9)%
    - MRA returns of 12.9% and 6.5%
    - 2021 – 11B in unrecognized gains, 2023 – 7B in unrecognized losses
  - Much lower Standard Deviation than 2021 Study
  - Changes in assumptions (7.0% to 6.8%, mortality, retirement)
  - Additional return breakpoint scenarios (50 bp increments)

# 2023 Observations

---

- Overall results are similar to 2021 study
  - Probability of depleting dividend liability varies due to factors on previous slide
  - Smaller range of dividend/contribution results due to lower standard deviation
- ‘Goldilocks zone’ has widened to 6.0% to 7.5%
  - Provides for positive return with appropriate downside protection



# THANK YOU

**Questions**



# SECTION 6

## Appendix

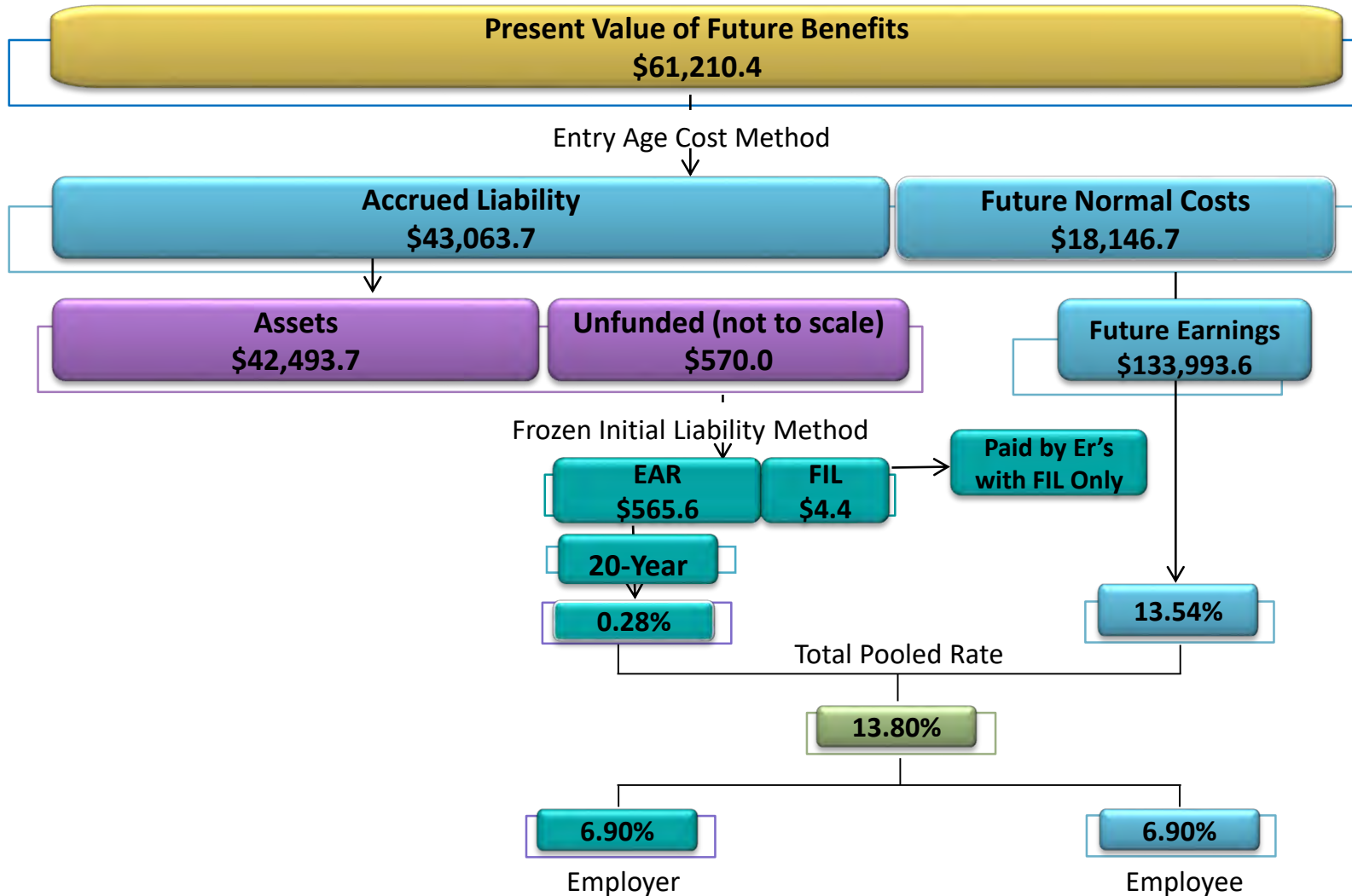


# Operation of Market Recognition Account (MRA) – \$ Millions 2022 Valuation

	<u>2022</u>	<u>2023</u>	<u>2024</u>	<u>2025</u>	<u>2026</u>
Actual Investment Earnings	\$ (17,445)				
Assumed Investment Earnings	7,894				
Gain/(Loss) to be phased-in	(25,339)				
Phased-in recognition					
• Current year	\$ (5,068)	?	?	?	?
• First prior year	2,495	\$ (5,068)	?	?	?
• Second prior year	1,774	2,495	\$(5,068)	?	?
• Third prior year	2,204	1,774	2,495	\$ (5,068)	?
• Fourth prior year	<u>(2,049)</u>	<u>2,204</u>	<u>1,774</u>	<u>2,495</u>	<u>\$ (5,068)</u>
Total recognized gain (loss)	\$ (644)	\$ 1,405	\$ (799)	\$ (2,573)	\$ (5,068)

**2023-2026: Expect \$7.0 billion in deferred asset LOSSES  
-- Shared by annuitants, actives and employers**

## Actuarial Valuation Process Illustration for General/Elected Group (\$ Millions)

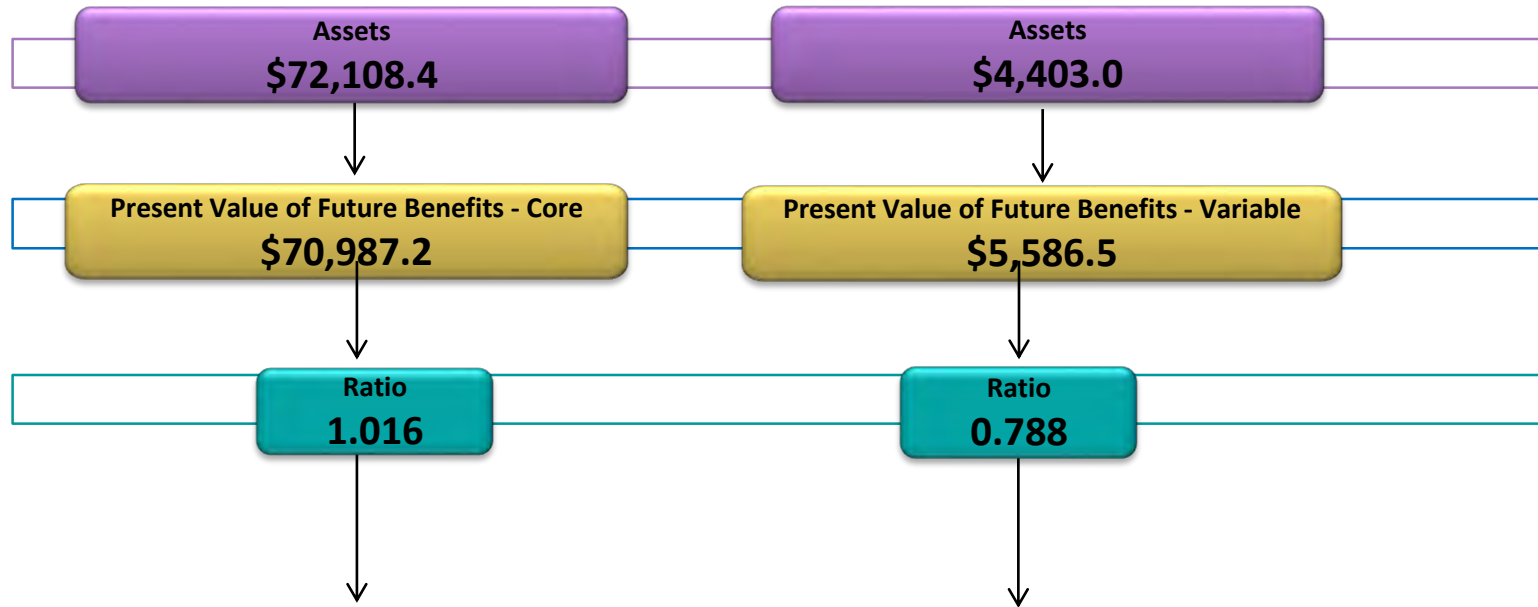


# Comparative Statement of Total Average Contribution Rates

<b>Valuation 12/31</b>	<b>General</b>	<b>Executive &amp; Elected</b>	<b>Protective with Soc. Sec.</b>	<b>Protective without Soc. Sec.</b>
2002	10.82%	11.51%	12.52%	15.01%
2007	10.58%	11.55%	13.15%	14.09%
2012	14.00%	15.50%	17.10%	21.00%
2017	13.12%	13.12%	17.10%	21.59%
2018	13.54%	13.54%	18.41%	23.02%
2019	13.53%	13.53%	18.51%	23.11%
2020	13.00%	13.00%	18.52%	23.86%
2021	13.60%	13.60%	20.03%	24.90%
2022	13.81%	13.81%	21.20%	26.00%

Executive and Elected employee and employer rates for CY 2016 and beyond are made in accordance with the combined General/Exec & Elected results.

## Actuarial Valuation Process – 2022 Retired Lives Valuation Illustration (\$ Millions)



Core effective earnings rate = 6.5%, dividend adjustment = 1.6%  
Variable effective earnings rate = -18.0%, and the variable adjustment = -21.0%

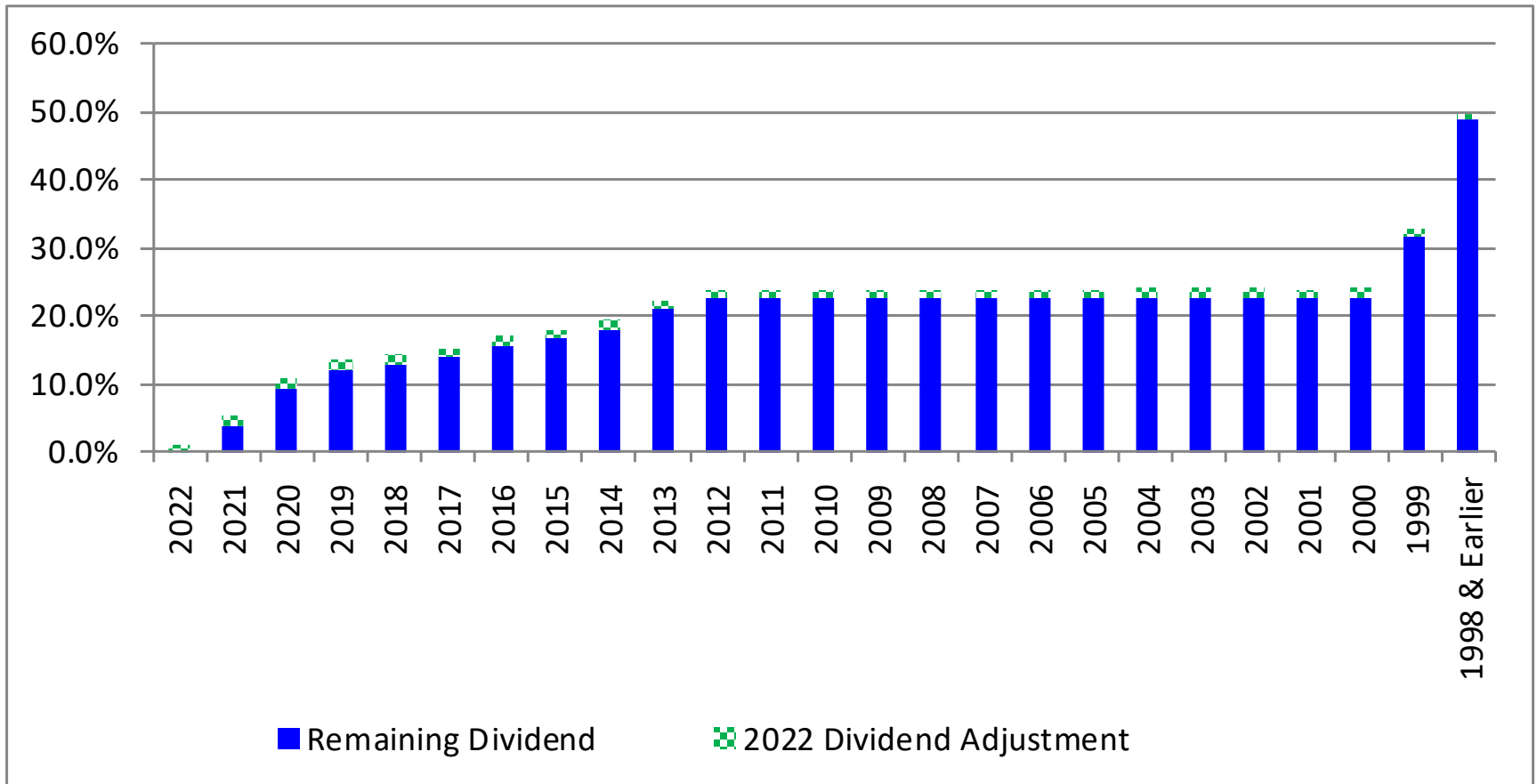
# Primary Sources of Core Dividend

	<u>% of APV<sup>(1)</sup></u>
1. SWIB net of fee investment return	(12.92)%
2. MRA adjustment	19.42%
3. Published effective earnings rate	6.50%
4. Adjustment to relate earnings to average core annuity fund balance	(0.30)%
5. Earnings rate based on average balance	6.20%
6. Expected dividend before adjustments: 1.062/1.05-1	1.14%
7. Adjustment to relate average asset to ending liability	0.05%
8. Carryover from last year due to timing of dividend, accounting adjustments and rounding	0.34%
9. Experience study adjustment	0.00%
10. Experience and other effects	0.05%
11. Statutory adjustment to round to nearest one-tenth percent	0.02%
12. <b>Computed average dividend rate: (6)+(7)+(8)+(9)+(10)+(11)</b>	<b>1.6%</b>
13. Adjustment for members at or near the statutory floor	0.0%
14. <b>Final computed dividend rate: (12)+(13), if greater than 0.5% (or less than -0.5%) of core annuities, otherwise 0%</b>	<b>1.6%</b>

<sup>(1)</sup> Actuarial Present Value



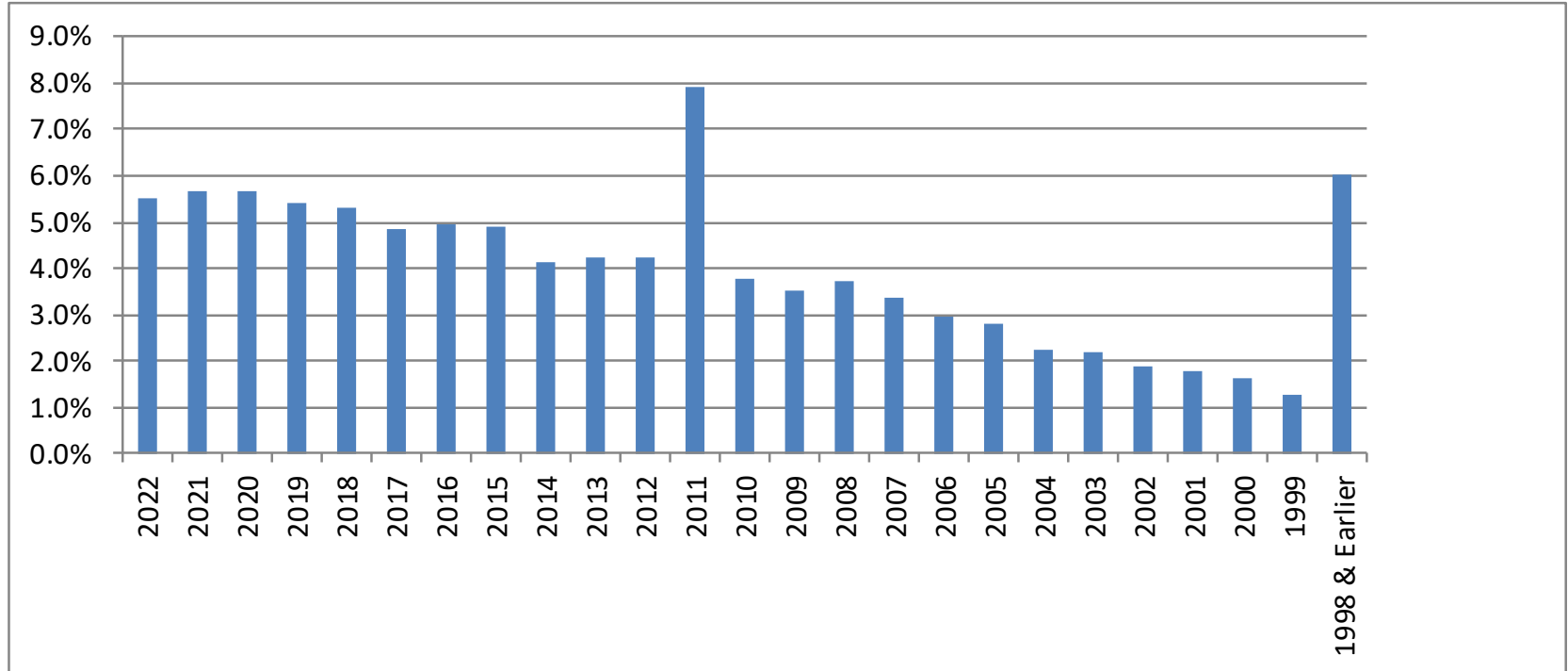
# Dividend Remaining (as a Percentage of Total Benefit) by Year of Retirement



(Report-7)



# Liabilities (as a Percentage of Total) by Year of Retirement

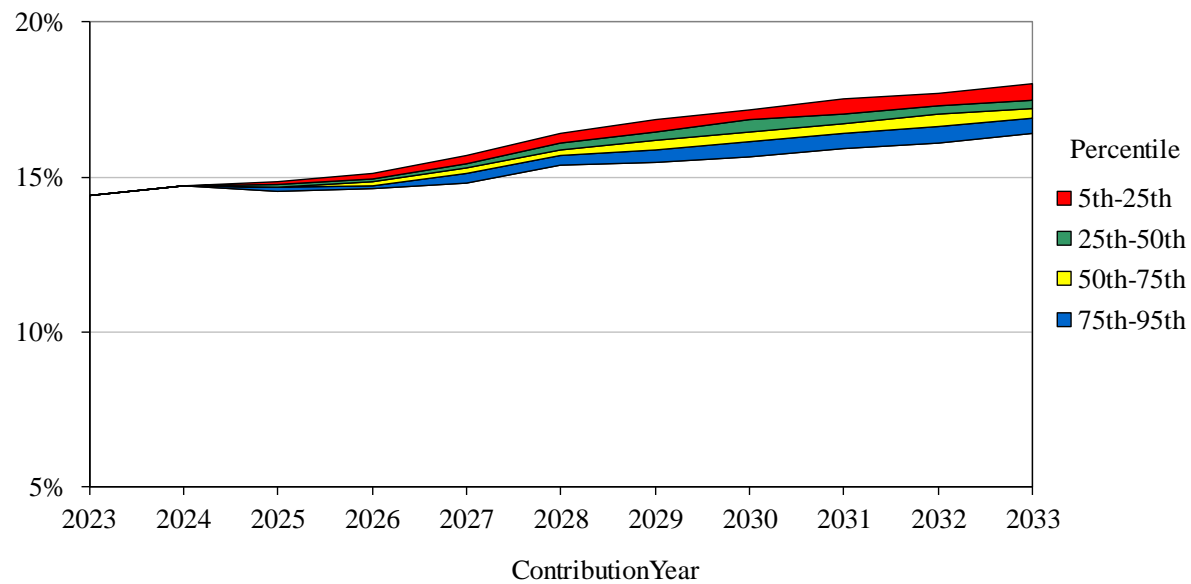


(Report-7)



# Contribution as a % of Payroll

## Scenario 1 – 4.0% Return, 3.8% Volatility



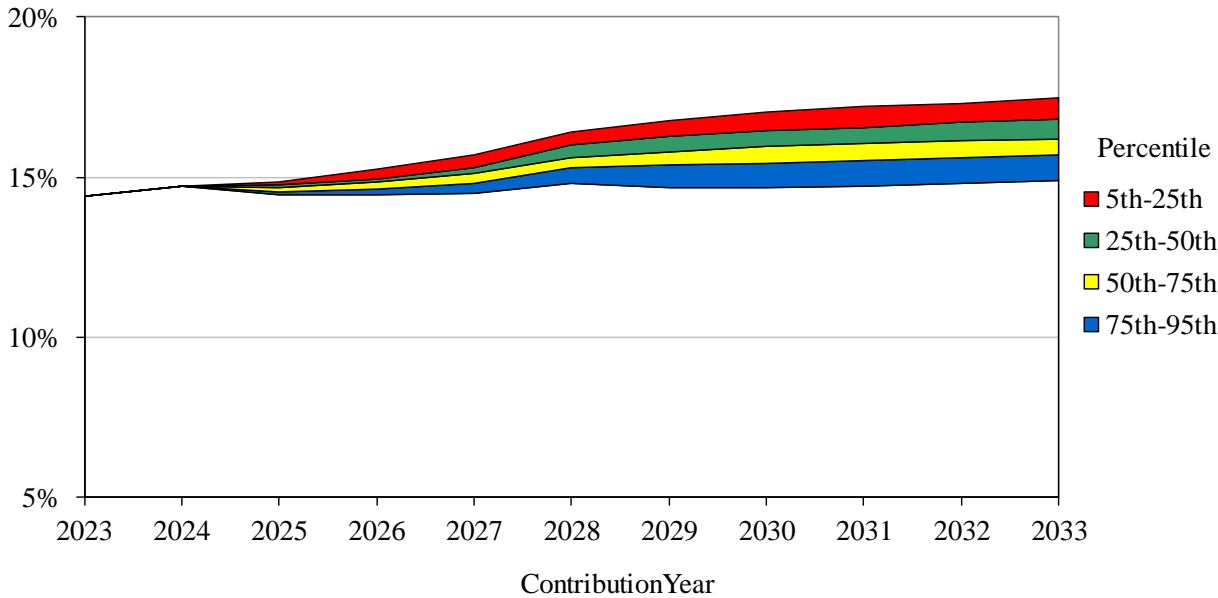
	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
<b>5th Percentile</b>	14.4%	14.7%	14.9%	15.1%	15.7%	16.4%	16.9%	17.1%	17.5%	17.7%	18.0%
<b>25th Percentile</b>	14.4%	14.7%	14.8%	14.9%	15.4%	16.1%	16.5%	16.8%	17.0%	17.3%	17.5%
<b>Median</b>	14.4%	14.7%	14.7%	14.8%	15.3%	15.9%	16.2%	16.4%	16.7%	17.0%	17.2%
<b>75th Percentile</b>	14.4%	14.7%	14.7%	14.7%	15.1%	15.7%	15.9%	16.1%	16.4%	16.6%	16.9%
<b>95th Percentile</b>	14.4%	14.7%	14.6%	14.6%	14.8%	15.4%	15.5%	15.6%	15.9%	16.1%	16.4%





# Contribution as a % of Payroll

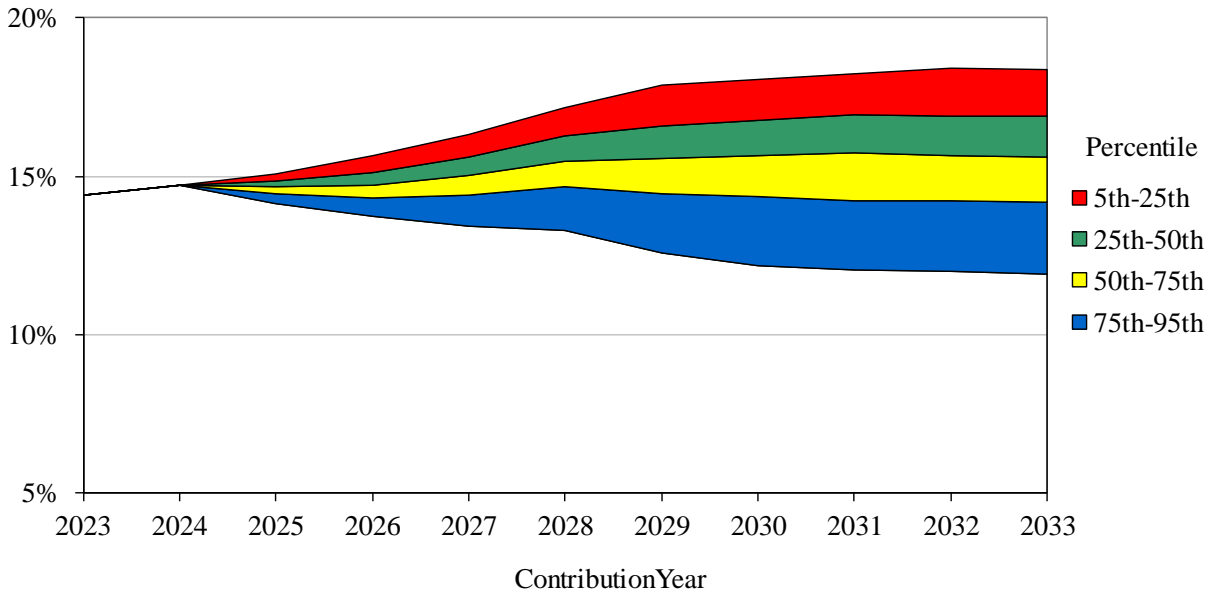
## Scenario 3 – 5.5% Return, 5.5% Volatility



<b>5th Percentile</b>	14.4%	14.7%	14.9%	15.2%	15.7%	16.4%	16.8%	17.0%	17.2%	17.3%	17.5%
<b>25th Percentile</b>	14.4%	14.7%	14.8%	14.9%	15.3%	16.0%	16.3%	16.4%	16.5%	16.7%	16.8%
<b>Median</b>	14.4%	14.7%	14.7%	14.8%	15.1%	15.6%	15.8%	15.9%	16.0%	16.2%	16.2%
<b>75th Percentile</b>	14.4%	14.7%	14.6%	14.6%	14.8%	15.3%	15.4%	15.4%	15.5%	15.6%	15.7%
<b>95th Percentile</b>	14.4%	14.7%	14.5%	14.4%	14.5%	14.8%	14.7%	14.6%	14.7%	14.8%	14.9%

# Contribution as a % of Payroll

## Scenario 5 – 6.5% Return, 12.9% Volatility

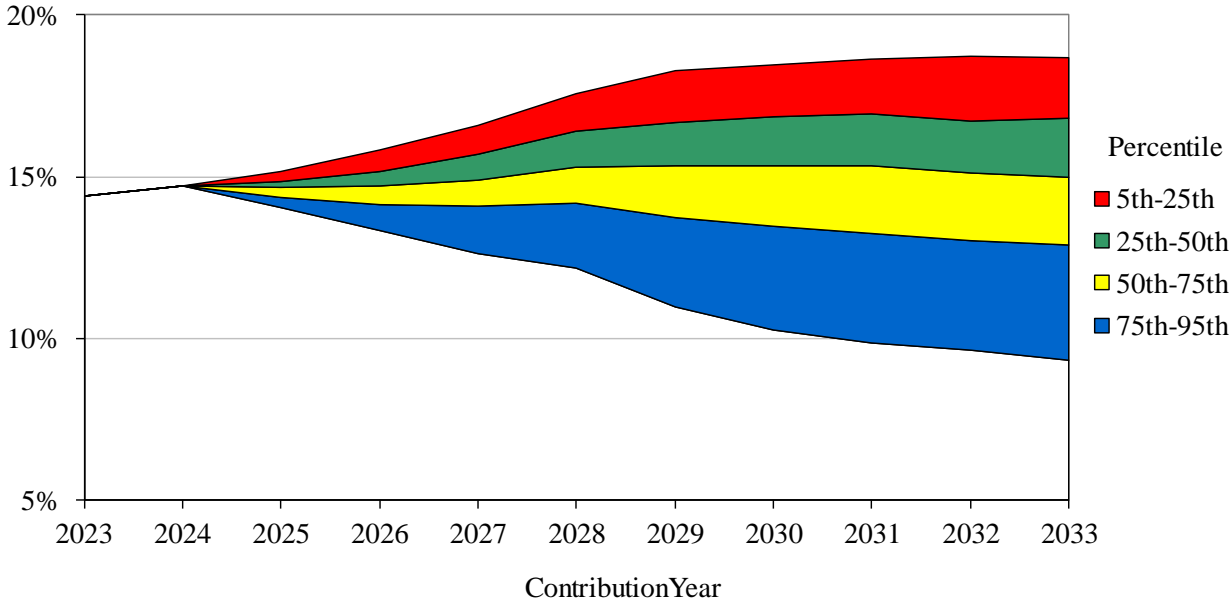


	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
<b>5th Percentile</b>	14.4%	14.7%	15.1%	15.6%	16.3%	17.2%	17.9%	18.0%	18.2%	18.4%	18.4%
<b>25th Percentile</b>	14.4%	14.7%	14.9%	15.1%	15.6%	16.3%	16.6%	16.7%	16.9%	16.9%	16.9%
<b>Median</b>	14.4%	14.7%	14.7%	14.7%	15.0%	15.5%	15.6%	15.6%	15.7%	15.7%	15.6%
<b>75th Percentile</b>	14.4%	14.7%	14.5%	14.3%	14.4%	14.7%	14.5%	14.3%	14.2%	14.2%	14.2%
<b>95th Percentile</b>	14.4%	14.7%	14.2%	13.7%	13.4%	13.3%	12.6%	12.1%	12.0%	12.0%	11.9%



# Contribution as a % of Payroll

## Scenario 7 – 7.5% Return, 17.1% Volatility

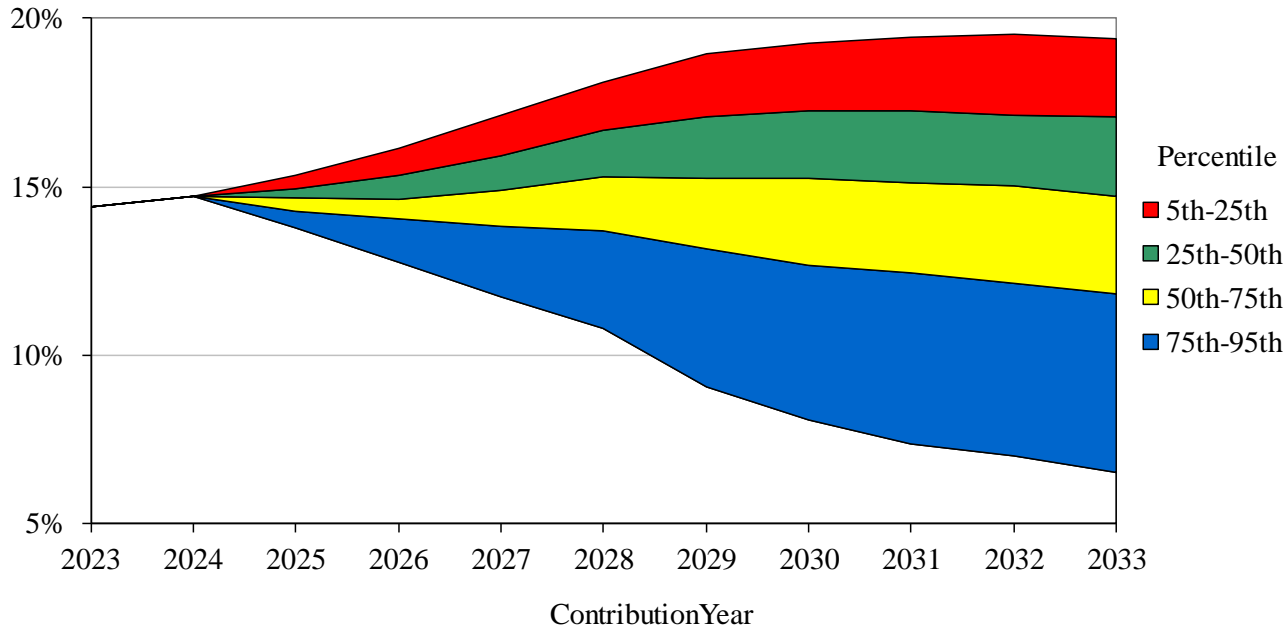


<b>5th Percentile</b>	14.4%	14.7%	15.2%	15.8%	16.6%	17.6%	18.3%	18.5%	18.6%	18.7%	18.7%
<b>25th Percentile</b>	14.4%	14.7%	14.9%	15.2%	15.7%	16.4%	16.7%	16.8%	16.9%	16.7%	16.8%
<b>Median</b>	14.4%	14.7%	14.7%	14.7%	14.9%	15.3%	15.3%	15.3%	15.3%	15.1%	15.0%
<b>75th Percentile</b>	14.4%	14.7%	14.4%	14.1%	14.1%	14.2%	13.7%	13.4%	13.2%	13.0%	12.9%
<b>95th Percentile</b>	14.4%	14.7%	14.0%	13.3%	12.6%	12.2%	11.0%	10.2%	9.8%	9.6%	9.3%



# Contribution as a % of Payroll

## Scenario 8 – 8.0% Return, 22.4% Volatility

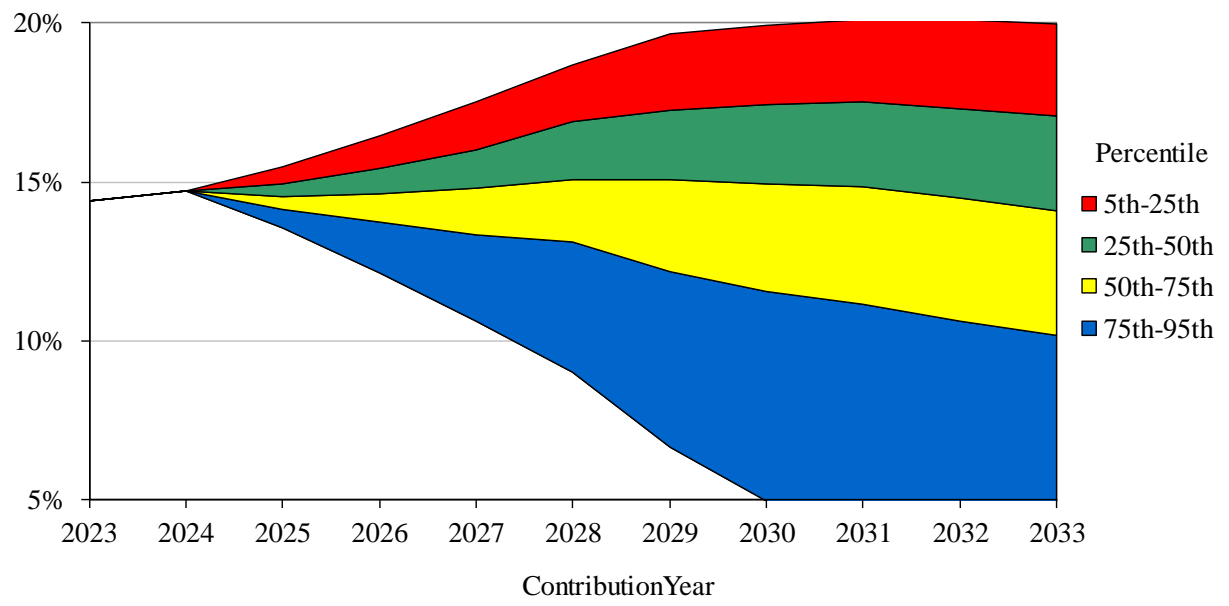


<b>5th Percentile</b>	14.4%	14.7%	15.4%	16.1%	17.1%	18.1%	19.0%	19.2%	19.4%	19.5%	19.4%
<b>25th Percentile</b>	14.4%	14.7%	15.0%	15.3%	15.9%	16.7%	17.1%	17.2%	17.3%	17.1%	17.1%
<b>Median</b>	14.4%	14.7%	14.7%	14.6%	14.9%	15.3%	15.3%	15.2%	15.1%	15.0%	14.7%
<b>75th Percentile</b>	14.4%	14.7%	14.3%	14.0%	13.8%	13.7%	13.1%	12.6%	12.4%	12.1%	11.8%
<b>95th Percentile</b>	14.4%	14.7%	13.8%	12.7%	11.7%	10.8%	9.1%	8.0%	7.3%	7.0%	6.5%



# Contribution as a % of Payroll

## Scenario 9 – 9.0% Return, 28.1% Volatility

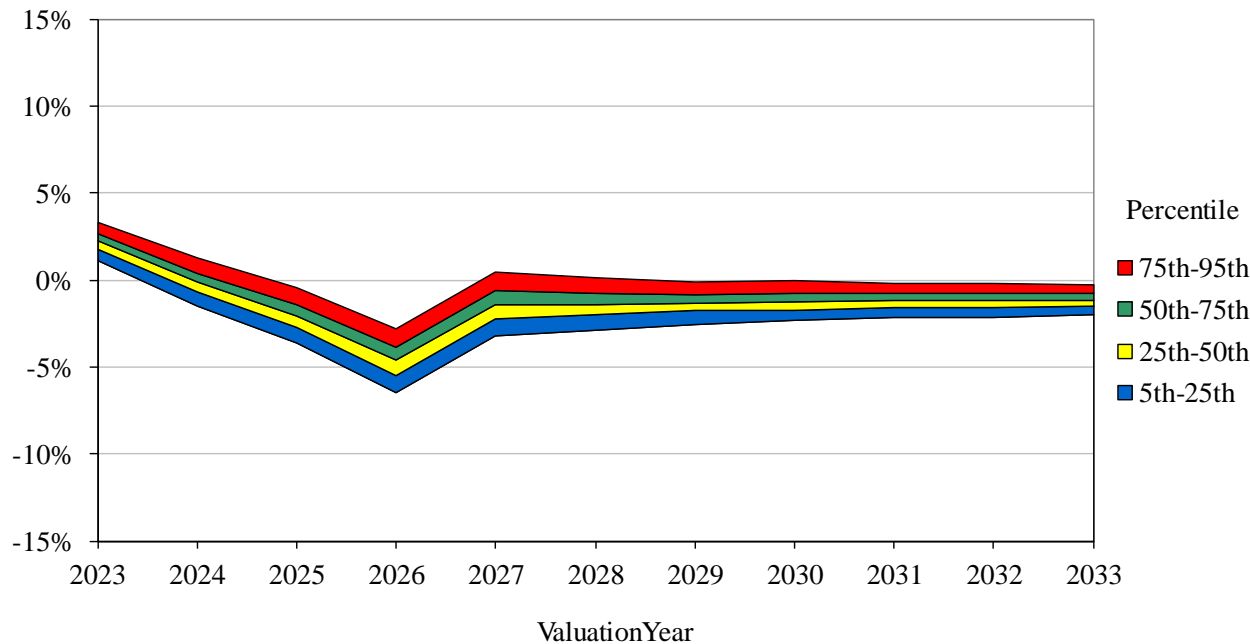


	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
<b>5th Percentile</b>	14.4%	14.7%	15.5%	16.4%	17.5%	18.7%	19.7%	19.9%	20.1%	20.1%	20.0%
<b>25th Percentile</b>	14.4%	14.7%	15.0%	15.4%	16.0%	16.9%	17.3%	17.4%	17.5%	17.3%	17.1%
<b>Median</b>	14.4%	14.7%	14.6%	14.6%	14.8%	15.1%	15.1%	14.9%	14.8%	14.5%	14.1%
<b>75th Percentile</b>	14.4%	14.7%	14.2%	13.7%	13.3%	13.1%	12.2%	11.5%	11.1%	10.6%	10.2%
<b>95th Percentile</b>	14.4%	14.7%	13.6%	12.1%	10.6%	9.0%	6.7%	4.9%	3.9%	3.1%	2.1%



# Dividend Rates

## Scenario 1 – 4.0% Return, 3.8% Volatility

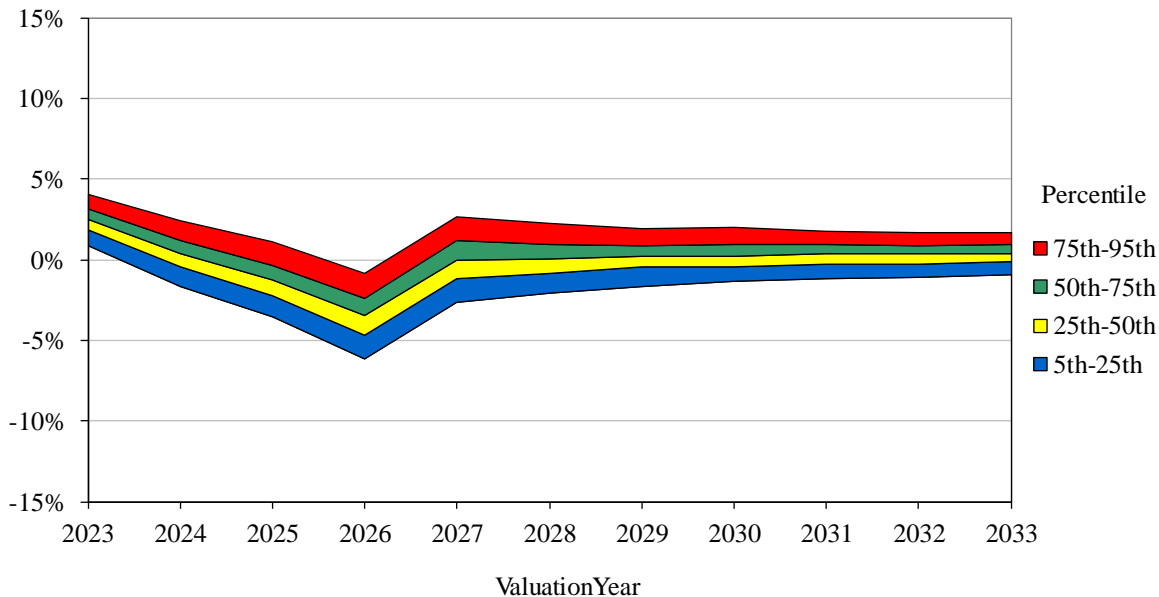


<b>5th Percentile</b>	1.1%	-1.5%	-3.6%	-6.5%	-3.2%	-2.9%	-2.6%	-2.3%	-2.2%	-2.1%	-2.0%
<b>25th Percentile</b>	1.8%	-0.7%	-2.7%	-5.5%	-2.2%	-2.0%	-1.8%	-1.7%	-1.6%	-1.6%	-1.5%
<b>Median</b>	2.3%	-0.1%	-2.0%	-4.6%	-1.4%	-1.4%	-1.3%	-1.3%	-1.2%	-1.2%	-1.1%
<b>75th Percentile</b>	2.7%	0.4%	-1.4%	-3.9%	-0.6%	-0.8%	-0.8%	-0.8%	-0.7%	-0.8%	-0.8%
<b>95th Percentile</b>	3.3%	1.3%	-0.5%	-2.8%	0.5%	0.1%	-0.1%	0.0%	-0.2%	-0.2%	-0.2%



# Dividend Rates

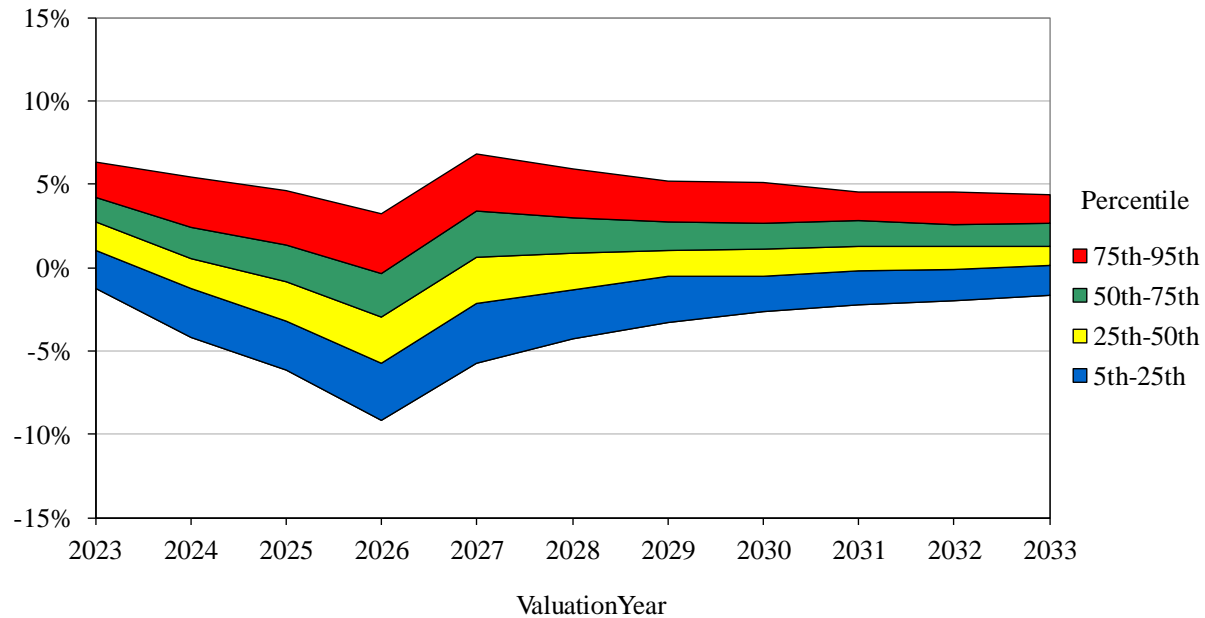
## Scenario 3 – 5.5% Return, 5.5% Volatility



<b>5th Percentile</b>	0.8%	-1.6%	-3.5%	-6.2%	-2.6%	-2.1%	-1.6%	-1.3%	-1.1%	-1.1%	-0.9%
<b>25th Percentile</b>	1.8%	-0.4%	-2.2%	-4.7%	-1.2%	-0.8%	-0.5%	-0.4%	-0.3%	-0.2%	-0.1%
<b>Median</b>	2.5%	0.4%	-1.2%	-3.5%	0.0%	0.1%	0.2%	0.2%	0.3%	0.3%	0.4%
<b>75th Percentile</b>	3.2%	1.2%	-0.3%	-2.4%	1.2%	1.0%	0.9%	0.9%	1.0%	0.9%	0.9%
<b>95th Percentile</b>	4.1%	2.4%	1.1%	-0.9%	2.7%	2.2%	2.0%	2.0%	1.8%	1.7%	1.7%

# Dividend Rates

## Scenario 5 – 6.5% Return, 12.9% Volatility



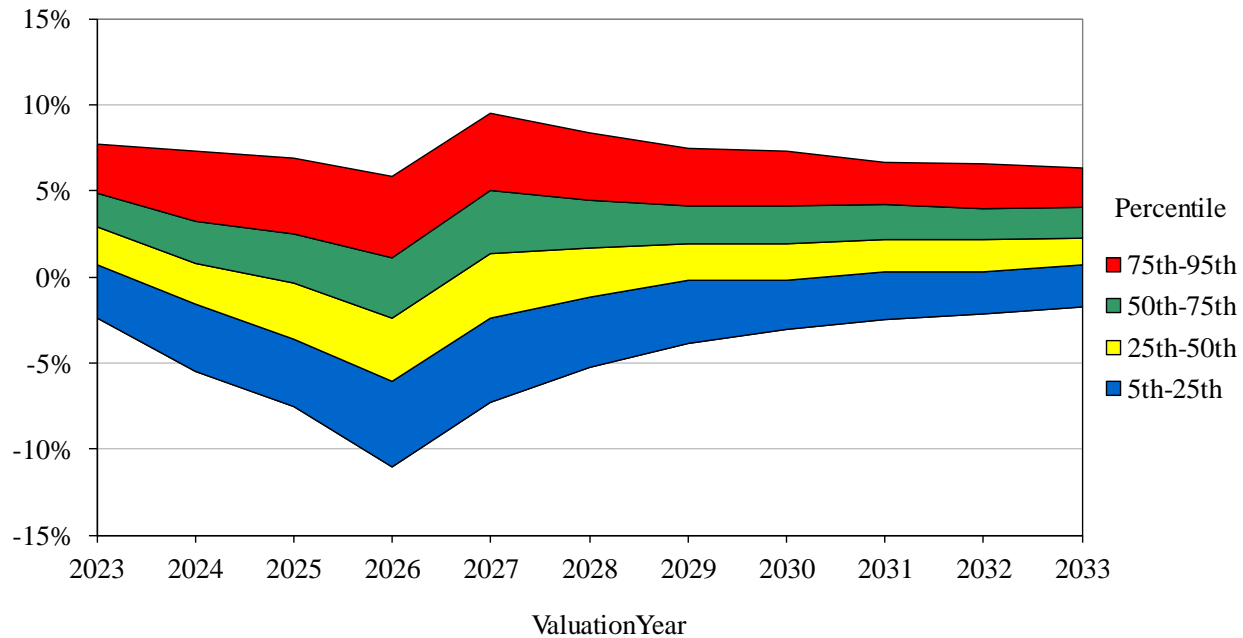
<b>5th Percentile</b>	-1.2%	-4.2%	-6.2%	-9.2%	-5.8%	-4.3%	-3.3%	-2.6%	-2.2%	-2.0%	-1.7%
<b>25th Percentile</b>	1.1%	-1.3%	-3.2%	-5.7%	-2.1%	-1.3%	-0.5%	-0.5%	-0.2%	-0.1%	0.2%
<b>Median</b>	2.7%	0.6%	-0.8%	-2.9%	0.6%	0.8%	1.0%	1.1%	1.3%	1.3%	1.3%
<b>75th Percentile</b>	4.2%	2.4%	1.3%	-0.4%	3.4%	3.0%	2.7%	2.7%	2.8%	2.6%	2.7%
<b>95th Percentile</b>	6.4%	5.4%	4.6%	3.3%	6.8%	5.9%	5.2%	5.2%	4.6%	4.5%	4.4%





# Dividend Rates

## Scenario 7 – 7.5% Return, 17.1% Volatility

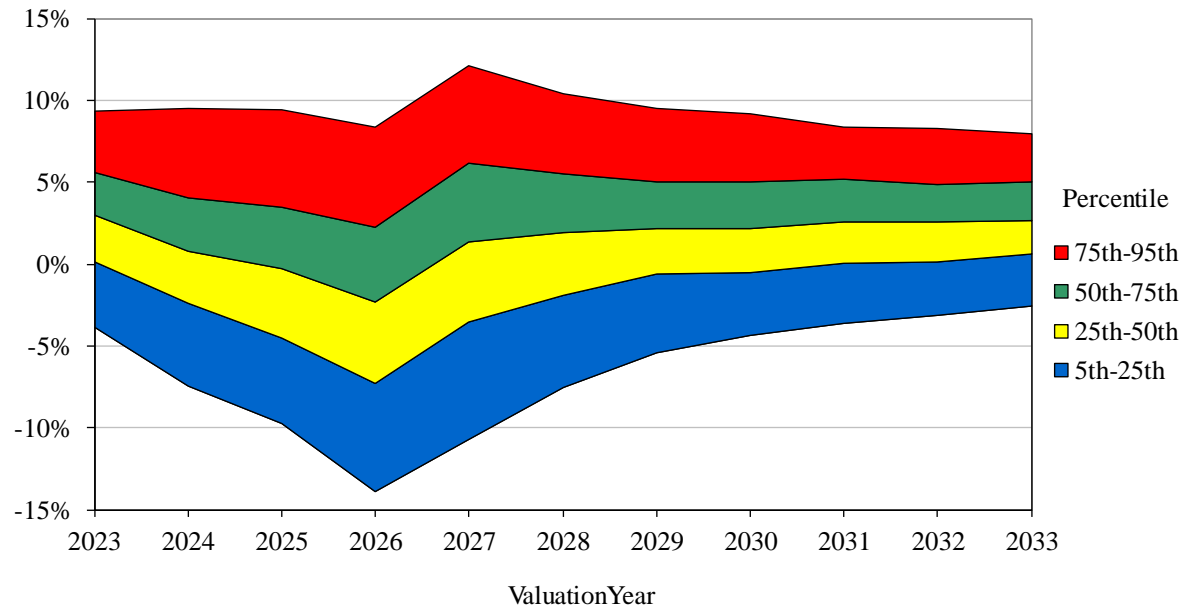


<b>5th Percentile</b>	-2.4%	-5.5%	-7.5%	-11.1%	-7.3%	-5.3%	-3.8%	-3.1%	-2.5%	-2.1%	-1.7%
<b>25th Percentile</b>	0.7%	-1.6%	-3.6%	-6.1%	-2.4%	-1.2%	-0.2%	-0.2%	0.3%	0.3%	0.7%
<b>Median</b>	2.9%	0.8%	-0.3%	-2.4%	1.3%	1.7%	1.9%	2.0%	2.2%	2.2%	2.3%
<b>75th Percentile</b>	4.9%	3.3%	2.5%	1.1%	5.0%	4.5%	4.1%	4.1%	4.2%	4.0%	4.0%
<b>95th Percentile</b>	7.7%	7.4%	6.9%	5.8%	9.5%	8.3%	7.5%	7.3%	6.6%	6.6%	6.3%



# Dividend Rates

## Scenario 8 – 8.0% Return, 22.4% Volatility

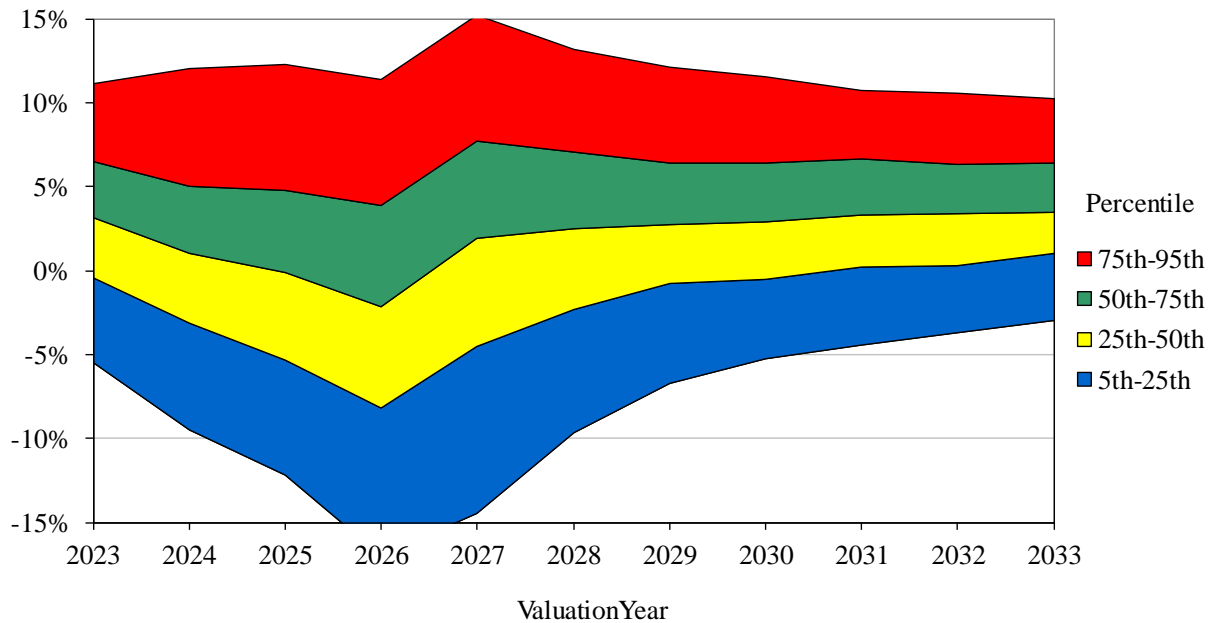


<b>5th Percentile</b>	-3.9%	-7.5%	-9.7%	-13.9%	-10.7%	-7.5%	-5.4%	-4.3%	-3.6%	-3.1%	-2.5%
<b>25th Percentile</b>	0.1%	-2.4%	-4.5%	-7.3%	-3.6%	-1.9%	-0.6%	-0.5%	0.1%	0.1%	0.7%
<b>Median</b>	3.0%	0.8%	-0.3%	-2.3%	1.4%	1.9%	2.1%	2.2%	2.6%	2.6%	2.7%
<b>75th Percentile</b>	5.6%	4.0%	3.5%	2.3%	6.2%	5.5%	5.1%	5.0%	5.2%	4.9%	5.0%
<b>95th Percentile</b>	9.3%	9.5%	9.4%	8.4%	12.1%	10.5%	9.5%	9.2%	8.4%	8.3%	8.0%



# Dividend Rates

## Scenario 9 – 9.0% Return, 28.1% Volatility



<b>5th Percentile</b>	-5.5%	-9.5%	-12.2%	-17.0%	-14.5%	-9.6%	-6.7%	-5.2%	-4.5%	-3.7%	-3.0%
<b>25th Percentile</b>	-0.4%	-3.1%	-5.3%	-8.2%	-4.5%	-2.3%	-0.7%	-0.5%	0.2%	0.3%	1.0%
<b>Median</b>	3.2%	1.0%	-0.1%	-2.2%	1.9%	2.5%	2.8%	2.9%	3.4%	3.4%	3.5%
<b>75th Percentile</b>	6.5%	5.0%	4.8%	3.9%	7.8%	7.1%	6.5%	6.4%	6.6%	6.3%	6.4%
<b>95th Percentile</b>	11.1%	12.1%	12.3%	11.4%	15.2%	13.2%	12.2%	11.6%	10.8%	10.6%	10.3%



# WRS Stress Testing

## (Limitations and Simplifications)

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- Goal is to understand the potential effect of various levels of stress on the system (not calculate exact predictions)
- Simplifying assumptions
  - Retiree funded status allowed to become negative and recover over time
  - Typical dividend adjustments (mortality improvements, carryover, timing, etc.) assumed to average to zero
  - Iterative impact between Money Purchase Minimum and contribution rates assumed to average to zero
  - Modified Normal Distribution in future years (standard deviation gradually declines in future years)

# Combination of All Scenarios

## 2043 Results by %-tile of Investment Return Outcomes

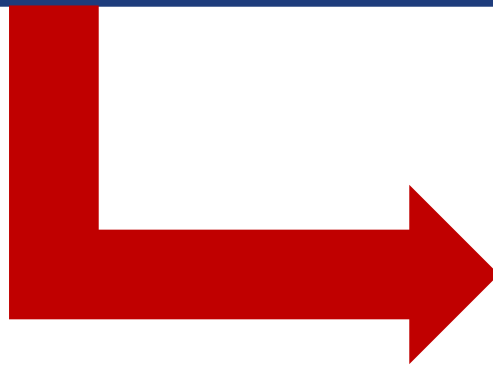
	ROR	StdDev	Contribution Rates			Dividend Rates			Highest	Worst Retiree
			95th	50th	5th	95th	50th	5th	Div. Dep. PRB	Funded %
1	4.0%	3.8%	18.4%	19.1%	19.8%	-0.2%	-1.0%	-1.9%	100%/Year50	51%/Year50
2	5.0%	4.6%	16.8%	17.8%	18.7%	1.0%	0.0%	-1.1%	73%/Year50	78%/Year50
3	5.5%	5.5%	15.7%	17.1%	18.2%	1.7%	0.5%	-0.8%	18%/Year50	95%/Year50
4	6.0%	9.4%	13.8%	16.4%	18.3%	3.2%	1.0%	-1.2%	18%/Year50	95%/Year10
Actuarial Rate → 5	6.5%	12.9%	11.6%	15.6%	18.4%	4.5%	1.5%	-1.5%	21%/Year50	89%/Year10
6	7.0%	13.6%	10.1%	14.7%	17.8%	5.2%	2.0%	-1.2%	18%/Year50	91%/Year10
7	7.5%	17.1%	7.4%	13.8%	17.9%	6.6%	2.6%	-1.6%	23%/Year50	84%/Year10
8	8.0%	22.4%	3.2%	13.0%	18.4%	8.4%	3.1%	-2.3%	29%/Year50	73%/Year10
9	9.0%	28.1%	0.0%	11.0%	18.4%	10.8%	4.1%	-2.9%	33%/Year50	64%/Year10

# Follow up from August 21 Discussion

## Present Value – Active Member (6.8%)

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Active member has accrued \$1,000 benefit. What is the Present Value based on benefit payable at end of the year with a 1.7% dividend?



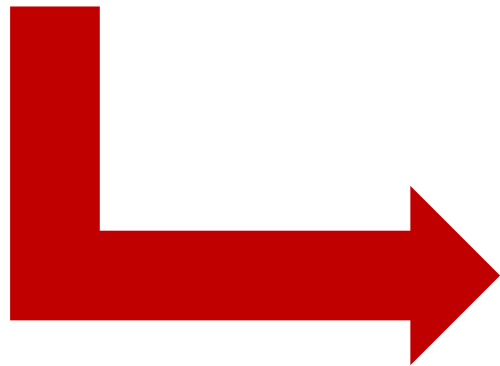
$$\frac{\$1,000 \times 1.017}{1.068} = \$952$$

Observation: As an active member, we fund for and assume a 1.7% dividend based on earning 6.8% on the Fund?

# Follow up from August 21 Discussion

## Present Value – Retired Member (5%)

The active member retires the very next day with \$1,000 accrued benefit. What is the present value at 5% (assuming no dividend)?



$$\frac{\$1,000}{1.05} = \$952$$

Observation: At retirement, the present value of the \$952 annuity at 5% is transferred to the retiree reserve account and ultimately compared to assets to derive the actual dividend

# Disclaimers

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- This presentation shall not be construed to provide tax advice, legal advice or investment advice.
- Mark Buis, James Anderson and Rich Koch are Members of the American Academy of Actuaries and meet the Qualification Standards of the American Academy of Actuaries to render the actuarial opinions contained herein.
- This is one of multiple documents comprising the actuarial report. Additional information regarding actuarial assumptions and methods, and important additional disclosures are provided in the full report entitled “Forty-Second Annual Actuarial Valuation and Gain Loss Analysis.”
- If you need additional information to make an informed decision about the contents of this presentation or the contents of the full report, or if anything appears to be missing or incomplete, please contact us before making use of the information.

