Callan

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North Carolina Retirement System

Asset Allocation and Liability Study: Part 2

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Agenda

- Introduction
  - Goal and Process
- Capital Market Assumptions
- Evaluate Asset Mixes
- Asset-Liability Simulations
  - Current policy Target through time
  - 10 and 30 year forecast horizons
    - *Projected Funded Status (Market Value of Assets / Actuarial Liability)*
    - *Cumulative Contributions*
    - *Ultimate Net Cost (UNC)*
- Employer Contribution Rate Analysis
- Scenario Analysis
- Appendix
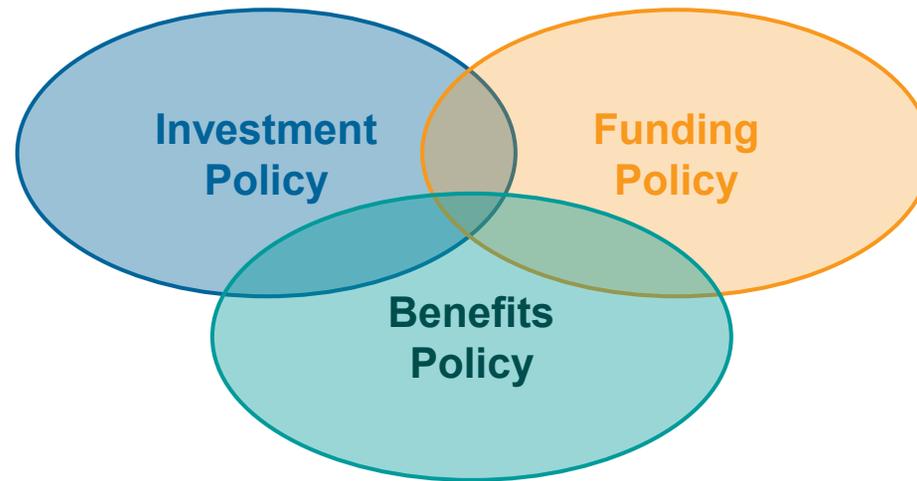
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Goal of the Study

- The goal of this asset-liability study is to establish a long-term strategic asset allocation target for the pension plans managed by the North Carolina Retirement System pension fund (the "Fund")

- An appropriate asset allocation will depend on the Fund's investment objectives.
  – Minimize costs over the long run (long-term goal)
  – How much return generation is necessary to lower costs and/or improve funded status?

- Minimize funded status volatility (short-term goal)
  – How much risk reduction is necessary to reduce funded status volatility?

- Investment solution is an optimal balance between sustainable funded status volatility and minimization of costs over the long run

- Asset allocation will vary by the unique circumstances of the Fund

- No "one-size-fits-all" solution exists

Callan Approach to Asset Allocation

Evaluate the interaction of three key strategic policies than govern a defined benefit plan with the goal of establishing the best investment policy

Investment Policy
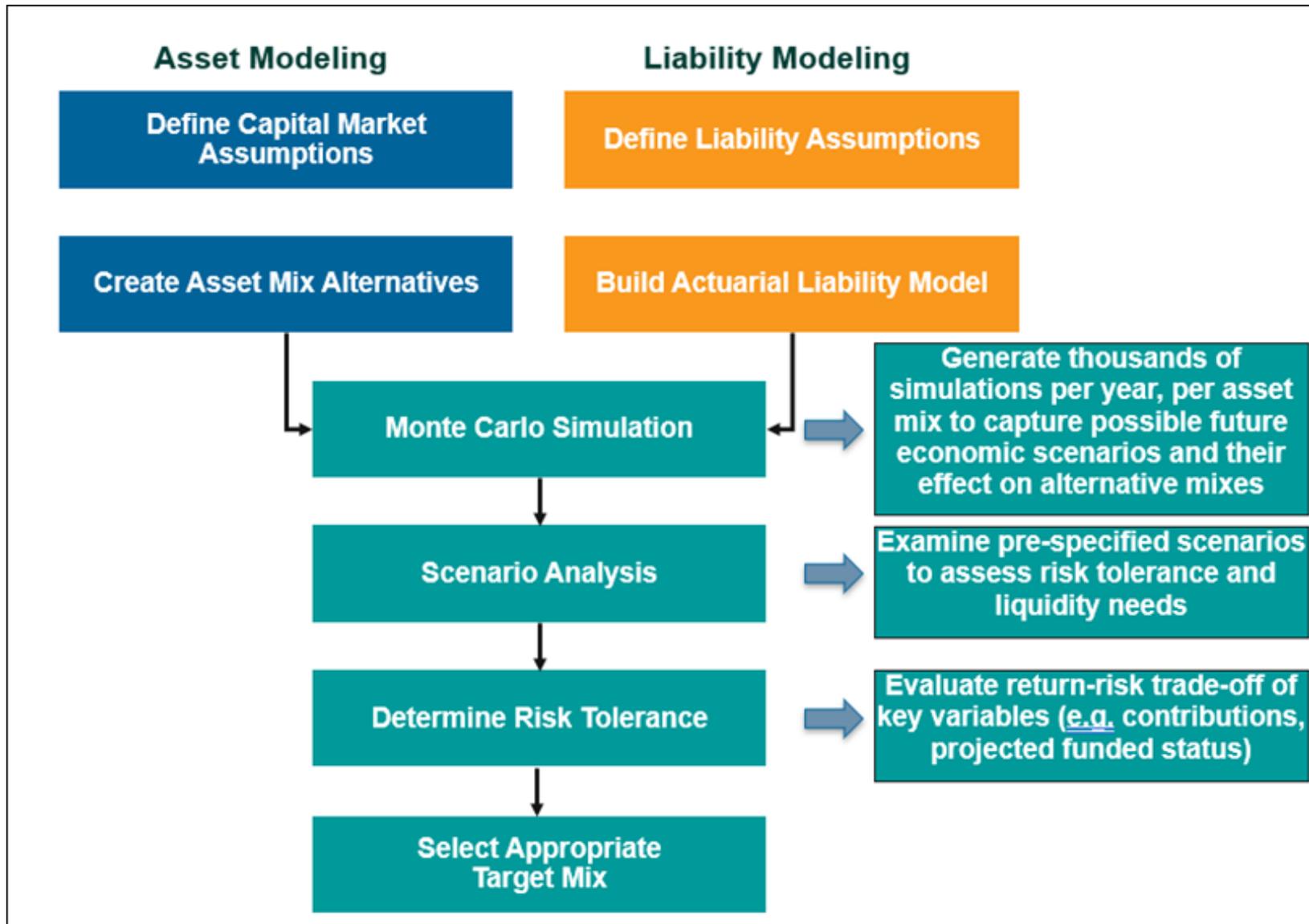– Return objective
– Risk tolerance
– Liquidity needs

Funding Policy
– Assumed investment return
– Actuarial methodologies employed to stabilize contributions

Benefits Policy
– Nature of benefit promise (liability)
– Ongoing cost of benefits (normal cost)
– Plan type: Open, Closed, Frozen

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Callan Asset Liability Process

Asset Modeling

- Define Capital Market Assumptions
- Create Asset Mix Alternatives

Liability Modeling

- Define Liability Assumptions
- Build Actuarial Liability Model

Monte Carlo Simulation → Generate thousands of simulations per year, per asset mix to capture possible future economic scenarios and their effect on alternative mixes

Scenario Analysis → Examine pre-specified scenarios to assess risk tolerance and liquidity needs

Determine Risk Tolerance → Evaluate return-risk trade-off of key variables (e.g. contributions, projected funded status)

Select Appropriate Target Mix

Capital Market Assumptions

Capital Market Assumptions

Asset class expected returns are projected for both the next 10 and 30 years

- These projections reflect the collective view of Callan and NCRS Staff

Equity expected returns incorporate macroeconomic variables such as GDP growth and inflation as well as projected income return and valuation considerations

- Equity returns are forecasted to be relatively modest over the next decade
- Over the longer term, equity returns are projected to be more favorable

Bond asset class expected returns are forecasted by anchoring off current bond yields and the current interest rate term structure and incorporating an increase in interest rates over time

- Rising rates drive low fixed income returns over the next decade
- Higher future yields result in higher expected returns over the 30 year horizon

Alternative asset class expected returns are projected by blending baseline projections with NCRS specific implementation considerations as well as actual historical experience

Forecasts for asset class risks and correlations are also required to understand the behavior of the current portfolio as well the impact of potential asset allocation changes

- Higher asset class expected returns are linked with higher risks

Asset Class Expected Returns and Risks

Table 1: NCRS Asset Class Forecasts	10 Yr Expected Return	30 Yr Expected Return	Risk	Notes on proxy used
Global Equity	7.10%	7.40%	18.25%	MSCI ACWI IMI
Private Equity	9.10%	9.40%	21.50%	Global Equity + 2%
Non Core Real Estate	8.00%	8.40%	18.00%	Private Core RE + 2%; Risk 150% of Private Core RE
Opportunistic Fixed Income	5.80%	6.70%	11.60%	See Table 2 below for detail
IG Fixed Income - Current Duration	1.85%	3.30%	5.05%	90% NC Custom IG BM 5+yr/10% Cash
IG Fixed Income - Agg like Duration	1.65%	2.90%	3.40%	90% Agg BM/10% Cash
Cash	0.75%	1.75%	0.90%	90 Day T-Bill
Core Real Estate	6.25%	6.65%	12.85%	80% NCREIF ODCE/20% REITS
Inflation Sensitive	4.25%	4.80%	7.20%	See Table 3 below for detail
Inflation Sensitive ex Commodities	4.70%	5.30%	7.90%	See Table 4 below for detail
MultiStrategy	4.25%	5.00%	8.00%	CS Hedge Fund Index
Inflation Rate	2.25%	2.25%	1.50%	

Table 2: Opportunistic Fixed Income Components	10 Yr Expected Return	30 Yr Expected Return	Risk	Notes on proxy used
Distressed Debt (50%)	6.50%	6.75%	14.60%	Distressed Loans
High Yield (25%)	4.25%	6.40%	12.90%	Barclays HY Corporate
Bank Loans (25%)	5.15%	6.15%	11.00%	CS Levered Loans

Table 3: Inflation Sensitive Components	10 Yr Expected Return	30 Yr Expected Return	Risk	Notes on proxy used
1-3 yr TIPS (33%)	1.25%	2.25%	1.70%	Bloomberg TIPS 1-3yr
Public Commodities (17%)	2.50%	2.50%	18.00%	Bloomberg Commodity
Infrastructure (25%)	6.25%	6.65%	13.20%	Modeled as Private
Private Core Real Estate (25%)	6.00%	6.40%	12.00%	NCREIF ODCE

Table 4: Inflation Sensitive ex- Comm Components	10 Yr Expected Return	30 Yr Expected Return	Risk	Notes on proxy used
1-3 yr TIPS (33%)	1.25%	2.25%	1.70%	Bloomberg TIPS 1-3yr
Infrastructure (33%)	6.25%	6.65%	13.20%	Modeled as Private
Private Core Real Estate (33%)	6.00%	6.40%	12.00%	NCREIF ODCE

All returns are (geometric) annualized.

Asset Class Correlations by NCRS Asset Classes

| Correlation Matrix	Global Equity	Private Equity	Non Core Real Estate	Opportunistic Fixed Income	Income - Current Duration	IG Fixed Income - Agg like Duration	Cash	Core Real Estate	Inflation Sensitive	Infl Sensitive ex Com	MultiStrategy
Global Equity	1.00										
Private Equity	0.83	1.00									
Non Core Real Estate	0.72	0.63	1.00								
Opportunistic Fixed Income	0.83	0.71	0.61	1.00							
IG Fixed Income - Current Duration	-0.12	-0.19	-0.09	-0.05	1.00						
IG Fixed Income - Agg like Duration	-0.12	-0.19	-0.09	-0.05	0.99	1.00					
Cash	-0.09	0.00	-0.04	-0.08	0.18	0.18	1.00				
Core Real Estate	0.72	0.62	0.80	0.63	-0.08	-0.08	-0.03	1.00			
Inflation Sensitive	0.70	0.58	0.41	0.59	-0.01	-0.01	-0.01	0.86	1.00		
Inflation Sensitive ex Commodities	0.72	0.59	0.39	0.61	0.02	0.02	-0.01	0.93	0.91	1.00	
MultiStrategy	0.81	0.60	0.52	0.68	0.14	0.14	-0.04	0.59	0.54	0.53	1.00

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Asset Class Inputs by Sub Asset Class Components

	10 Yr Arithmetic Expected Return	10 Yr Geometric Expected Return	30 Yr Arithmetic Expected Return	30 Yr Geometric Expected Return	Risk
Global Equity	8.60%	7.10%	8.90%	7.40%	18.25%
Private Equity	11.12%	9.10%	11.42%	9.40%	21.50%
Non Core Real Estate	9.45%	8.00%	9.80%	8.40%	18.00%
Core US Fixed	1.82%	1.75%	3.12%	3.05%	3.75%
Mod Aggregate	2.10%	1.95%	3.60%	3.45%	5.60%
Cash Equivalents	0.75%	0.75%	1.75%	1.75%	0.90%
Core Real Estate	6.67%	6.00%	7.07%	6.40%	12.00%
Hedge Funds	4.55%	4.25%	5.30%	5.00%	8.00%
High Yield	5.03%	4.25%	7.17%	6.40%	12.90%
1-3 TIPS	1.26%	1.25%	2.26%	2.25%	1.70%
Commodities	4.02%	2.50%	4.02%	2.50%	18.00%
Bank Loans	5.72%	5.15%	6.71%	6.15%	11.00%
Private Infrastructure	7.05%	6.25%	7.45%	6.65%	13.20%
US REITs	8.42%	6.50%	8.72%	6.80%	20.70%
Distressed Debt	7.48%	6.50%	7.73%	6.75%	14.60%

	Global Equity	Private Equity	Non Core Real Estate	Core US Fixed	Mod Agg	Cash Equivalents	Private Core Real Estate	Hedge Funds	High Yield	1-3 TIPS	Commodities	Bank Loans	Private Infrastructure	REITS	Distressed Debt
Global Equity	1.00														
Private Equity	0.83	1.00													
Non Core Real Estate	0.72	0.63	1.00												
Core US Fixed	-0.12	-0.19	-0.09	1.00											
Mod Aggregate	-0.12	-0.19	-0.09	0.99	1.00										
Cash Equivalents	-0.09	0.00	-0.04	0.15	0.15	1.00									
Private Core Real Estate	0.60	0.50	0.80	-0.06	-0.06	-0.02	1.00								
Hedge Funds	0.81	0.60	0.52	0.14	0.14	-0.04	0.42	1.00							
High Yield	0.75	0.59	0.56	0.00	0.00	-0.11	0.50	0.64	1.00						
1-3 TIPS	-0.11	-0.12	-0.03	0.64	0.64	0.48	-0.05	0.06	0.01	1.00					
Commodities	0.27	0.23	0.23	-0.10	-0.10	-0.02	0.21	0.23	0.15	0.08	1.00				
Bank Loans	0.66	0.50	0.48	0.00	0.00	0.00	0.34	0.52	0.60	0.00	0.10	1.00			
Private Infrastructure	0.74	0.62	0.70	0.01	0.01	-0.07	0.76	0.47	0.50	-0.04	0.18	0.50	1.00		
REITs	0.83	0.75	0.80	-0.11	-0.11	-0.05	0.70	0.62	0.61	-0.02	0.25	0.61	0.63	1.00	
Distressed Debt	0.76	0.68	0.56	-0.06	-0.06	-0.06	0.50	0.61	0.63	-0.10	0.17	0.57	0.52	0.62	1.00

Return/Risk Characteristics

30 year assumptions
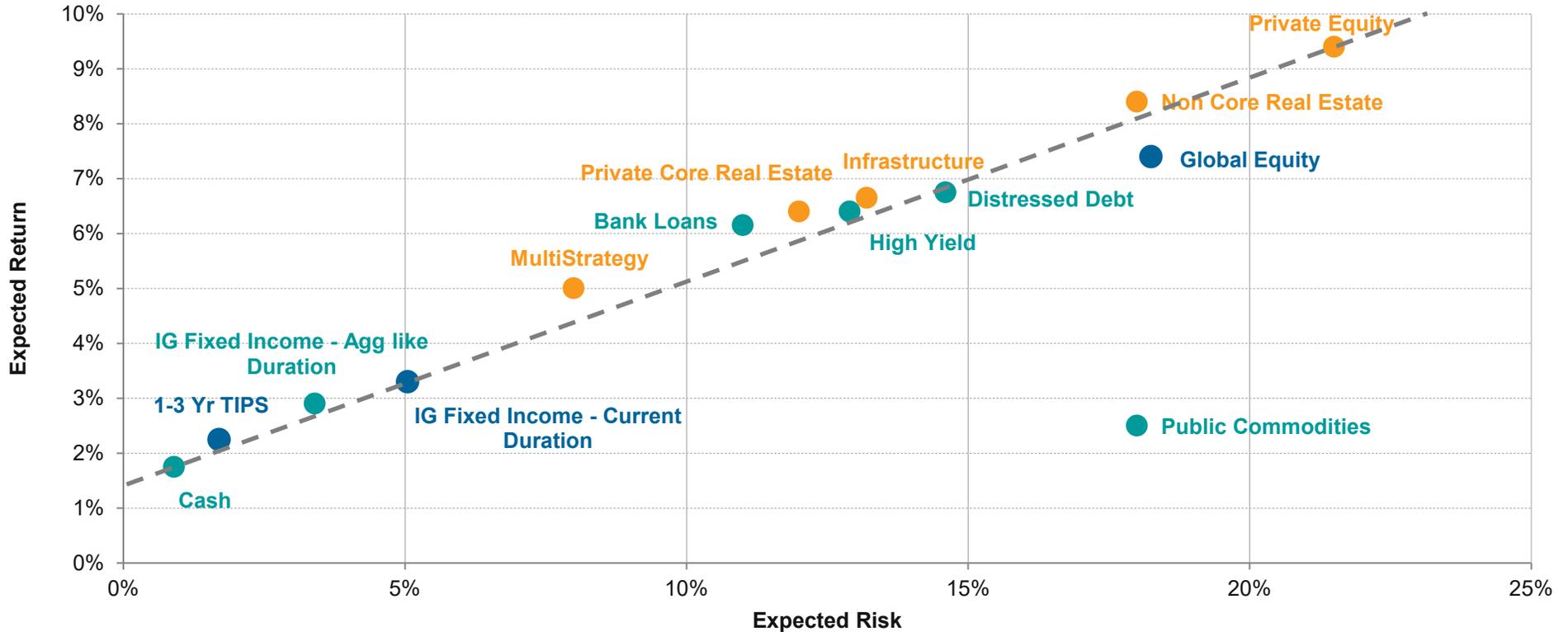
Higher asset class expected returns are linked with higher risks

- For example, non core real estate has both a higher expected return and risk than private core real estate

Evaluate Asset Mixes

Evaluating Asset Mixes

Callan evaluated sixteen candidate asset mixes across a variety of risk/return profiles

Themes included:

- Keeping alternatives at their current policy allocation (29%) throughout
- Incrementally increasing alternatives within statutory constraints to improve risk-adjusted returns
- NCRS staff specified mixes with incremental changes to the current policy target

After thorough review, the set of asset mixes was distilled down to five candidate mixes as well as the actual portfolio and the current policy target

- Actual: Reflects NCRS' actual asset class implementation as of June 30, 2021
- Mix 1: Lower expected return/risk mix significantly increasing defensive assets relative to target
- Mix 5: Higher expected return/risk mix significantly decreasing defensive assets relative to target
- Mix 8: Increases alternatives from 29% to 32% to improve risk-adjusted returns
- Mix 12: Staff specified mix which increases cash from current 1% target to 5%, funded from fixed income
- Mix 16: Staff specified mix which increases cash from current 1% target to 5%, funded from public equity
- Target: Current NCRS policy target

We detail these mixes on the following page and evaluate their impact on funding status and contributions in the study's asset/liability modeling

Asset Mixes Evaluated

	Actual	Target	Mix 1	Mix 5	Mix 8	Mix 12	Mix 16
GROWTH	**50.3%**	**58.0%**	**47.0%**	**67.0%**	**56.5%**	**58.0%**	**55.0%**
Global Equity	36.0%	42.0%	*31.0%*	*51.0%*	39.0%	42.0%	38.0%
Private Equity	6.1%	6.0%	6.0%	6.0%	*7.0%*	6.0%	7.0%
Non Core Real Estate	2.4%	3.0%	3.0%	3.0%	*3.5%*	3.0%	3.0%
Opportunistic Fixed	5.7%	7.0%	7.0%	7.0%	7.0%	7.0%	7.0%
RATES AND LIQUIDITY	**38.6%**	**29.0%**	**40.0%**	**20.0%**	**29.0%**	**29.0%**	**33.0%**
5+ IG Fixed and Cash	27.4%	28.0%	*39.0%*	*19.0%*	28.0%	24.0%	28.0%
Cash	11.1%	1.0%	1.0%	1.0%	1.0%	5.0%	5.0%
INFLATION SENSITIVE AND DIVERSIFIERS	**9.3%**	**11.0%**	**11.0%**	**11.0%**	**13.0%**	**11.0%**	**11.0%**
Inflation Sensitive ex Comm	4.6%	6.0%	6.0%	6.0%	*7.0%*	6.0%	6.0%
Core Real Estate	4.8%	5.0%	5.0%	5.0%	*6.0%*	5.0%	5.0%
MULTISTRATEGY	**1.9%**	**2.0%**	**2.0%**	**2.0%**	*1.5%*	**2.0%**	**1.0%**
	100.00%	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

	Actual	Target	Mix 1	Mix 5	Mix 8	Mix 12	Mix 16
10 yr Expected Annualized Return	5.23%	5.77%	5.21%	6.20%	5.79%	5.72%	5.58%
30 yr Expected Annualized Return	5.99%	6.48%	6.05%	6.81%	6.50%	6.41%	6.31%
Standard Deviation	9.36%	10.75%	8.83%	12.38%	10.59%	10.75%	10.15%
10 yr Sharpe Ratio	0.478	0.467	0.506	0.408	0.475	0.463	0.476
Expense Ratio	0.34%	0.38%	0.37%	0.40%	0.42%	0.38%	0.39%

Statutory Constraints

		Actual	Target	Mix 1	Mix 5	Mix 8	Mix 12	Mix 16
1	Global Equity no more than 65%	36.0%	42.0%	31.0%	51.0%	39.0%	42.0%	38.0%
2	Fixed income + Cash at least 20%	38.6%	29.0%	40.0%	20.0%	29.0%	29.0%	33.0%
3	Alts ≤ 35% (sum of 4 through 8)	27.2%	29.0%	29.0%	29.0%	32.0%	29.0%	30.3%
4	Private Eq + Multistrategy ≤ 8.75%	8.0%	8.0%	8.0%	8.0%	8.5%	8.0%	8.0%
5	Core+ Non Core Real Est ≤ 10%	7.2%	8.0%	8.0%	8.0%	9.5%	8.0%	8.0%
6	Inflation Protection ≤ 7.5%	4.6%	6.0%	6.0%	6.0%	7.0%	6.0%	6.0%
7	Other Fixed Income ≤ 7.5%	5.9%	7.0%	7.0%	7.0%	7.0%	7.0%	7.0%
8	Public Eq Limited Liability ≤ 8.5%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%

Mixes are designed to span the risk/return spectrum and evaluate impact of policy changes

All mixes satisfy NCRS' statutory constraints
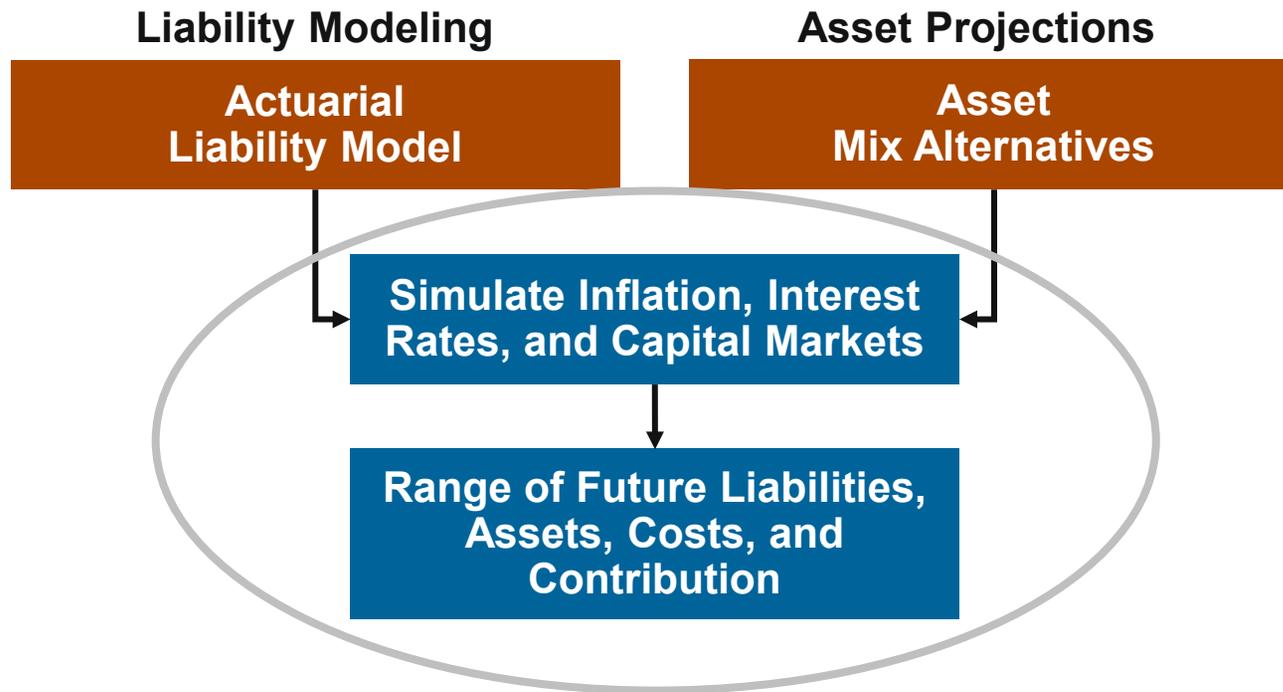
Risk/Return Tradeoff for Asset Mixes
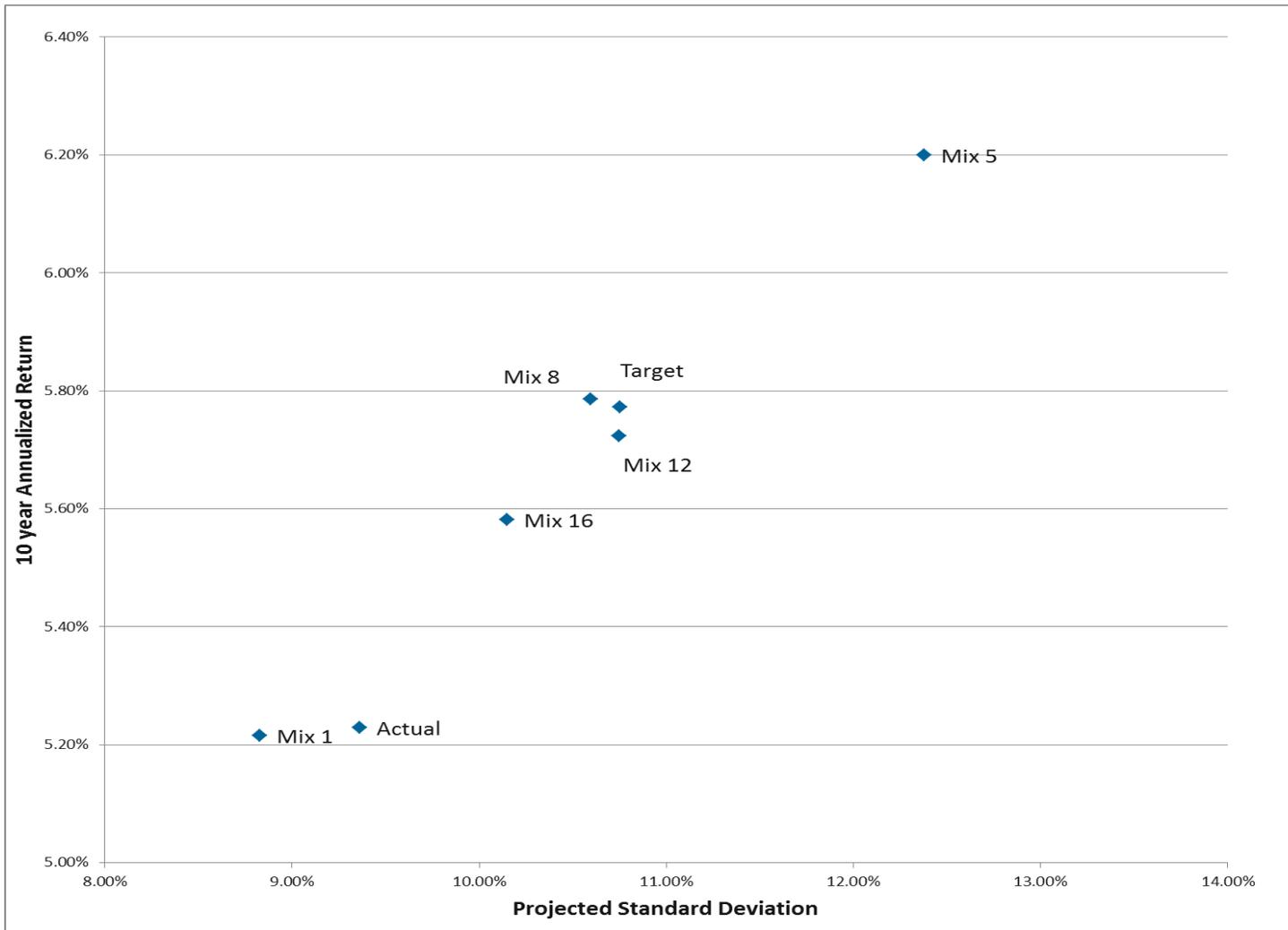
Mix Name	Broad Allocation
Actual	EQ36/ IG27/ Cash 11/Alts 27
Mix 1	EQ31/ IG39/ Cash 1/Alts 29
Mix 5	EQ51/ IG19/ Cash 1/Alts 29
Mix 8	EQ39/ IG28/ Cash 1/Alts 32
Mix 12	EQ42/ IG24/ Cash 5/Alts 29
Mix 16	EQ38/ IG28/ Cash 5/Alts 29
Target	EQ42/IG28/ Cash 1/Alts 29

Mixes have a broad spectrum of risk profiles relative to the current target

The actual allocation has a lower expected return and risk than the current target

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Simulate Financial Condition

Liability Modeling

Asset Projections

| Actuarial Liability Model | Asset Mix Alternatives |

Simulate Inflation, Interest Rates, and Capital Markets

Range of Future Liabilities, Assets, Costs, and Contribution

- Generate 2,000 simulations per year, per asset mix to capture possible future economic scenarios and their effect on the portfolio
- The simulation results are then ranked from highest to lowest to develop probability distributions

TSERS Current Financial Position and Funding Policy

- Liability model is based on the 12/31/2019 and 12/31/2020 TSERS actuarial valuation reports

- Simulations start at 12/31/2021
  - 2020 actual investment experience = 11.12%
  - 2021 actual investment experience = 9.7%

- Callan and Cavanaugh Macdonald utilize the same actuarial software
  - Cavanaugh Macdonald provided Callan with a liability model
  - Callan conducted the asset modelling

- Funding Policy = Normal Cost + Amortization of Unfunded Liability/(Surplus) subject to the Employer Contribution Rate Stabilization Policy (ECRSP) effective through 6/30/2027
  - Amortization bases have been set up every year since 2009 and are paid down over the next 12 years
  - Future unfunded liability/(surplus) that develops in future years is amortized over a closed 12-year period
  - Employer contribution rate minimum = 6.0%

	Reported 12/31/2019	Reported 12/31/2020	Estimated 12/31/2021
Actuarial Accrued Liability	$84,873M	$89,809M	$92,204M
Discount Rate	7.0%	6.5%	6.5%
Market Value of Assets	$75,487M	$81,969M	$87,451M
Actuarial Value of Assets	$73,354M	$77,922M	$83,171M
Market Funded Status (MVA/AL)	88.9%	91.2%	94.9%
Actuarial Funded Status (AVA/AL)	86.4%	86.8%	90.1%
Required Employer Rate NCGS 135-8(d)	15.74%	16.09%	16.44%

|	Actuarial Assumption	Callan 10-year Expectation	Callan 30-year Expectation
Investment Return	6.5%	5.8% *	6.5% *
Price Inflation	2.5%	2.25%	2.25%

Based on current policy target

Simulation Section Summary

1. Variable results <u>through time</u> based on the current policy target

2. 10-Year Forecast Horizon <u>by Mix</u>
    - Projected Funded Status (Market Value of Assets / Actuarial Liability)
    - Cumulative Contributions
    - Contribution Reward vs. Risk
    - Ultimate Net Cost (UNC)
    - UNC Reward vs. Risk

3. 30-Year Forecast <u>by Mix</u>
    - Projected Funded Status (Market Value of Assets / Actuarial Liability)
    - Cumulative Contributions
    - Ultimate Net Cost (UNC)
    - UNC Reward vs. Risk

4. Employer Contribution Rate Analysis <u>by Mix</u>

Current Policy Target Through Time

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Market Value of Assets (Current Policy Target)
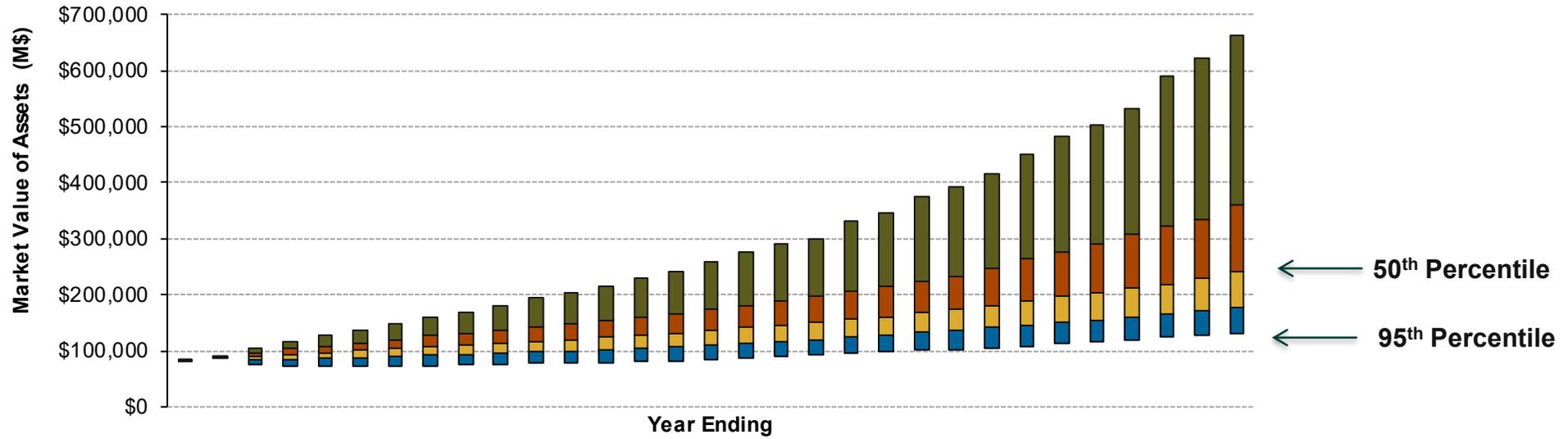
Percentile	2020	2025	2030	2035	2040	2045	2050
5th	81,969	136,452	193,510	258,286	346,913	481,808	664,542
25th	81,969	114,209	142,039	172,988	213,925	276,292	360,792
50th	81,969	100,352	117,225	136,038	161,310	196,546	241,942
75th	81,969	87,092	98,481	110,016	127,991	150,719	178,570
95th	81,969	73,193	77,165	84,795	98,037	112,708	129,347
97.5th	81,969	69,532	72,035	77,915	90,188	104,408	119,276
Range (5th - 95th)		63,260	116,344	173,491	248,876	369,100	535,195

- The expected outcome is the 50th percentile (50-50 chance of occurrence)

- The worse-case scenarios:
  - 95th percentile: 1-in-20 chance (5% probability) that the 12/31/2050 market value of assets will be $126.1B or less
  - 97.5th percentile: 1-in-40 chance (2.5% probability) that the 12/31/2050 market value of assets will be $117.5B or less

- Floating bars illustrate the range of outcomes from the 5th to the 95th

Actuarial Accrued Liability with Ad Hoc COLA
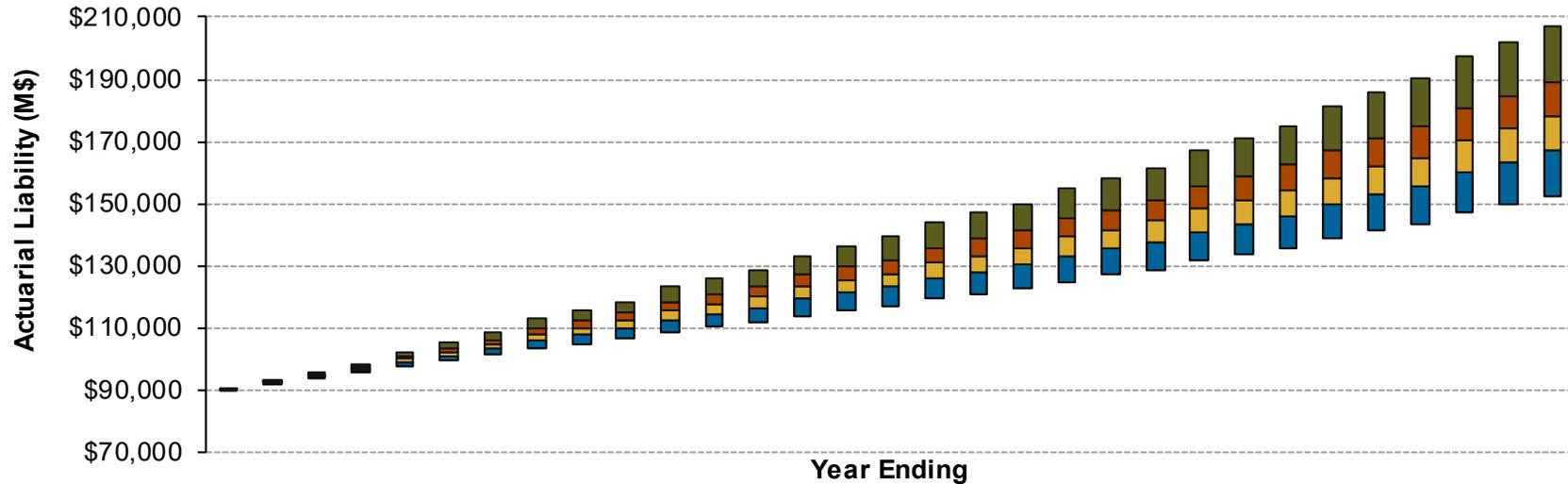
Percentile	2020	2025	2030	2035	2040	2045	2050
97.5th	89,809	105,899	124,401	141,219	162,081	186,187	215,023
95th	89,809	105,254	123,023	139,179	158,283	181,370	207,164
75th	89,809	103,462	118,421	131,969	148,069	167,455	189,333
50th	89,809	102,259	115,407	127,392	141,672	158,304	177,936
25th	89,809	101,084	112,487	123,173	135,279	149,959	167,180
5th	89,809	99,431	108,679	117,112	127,103	138,716	152,301
Range (5th - 95th)		5,822	14,344	22,067	31,180	42,654	54,864

- Plan liabilities are increasing steadily over the next 30 years
  - Liabilities increase with ongoing benefit accrual, passage of time (discount rate) and are reduced by benefit payments
  - 30-Year expected annualized growth in liability is 2.31% per year
 - Discount rate is held constant at 6.5% and ad hoc COLAs are reflected

Simulated Returns (Current Policy Target)
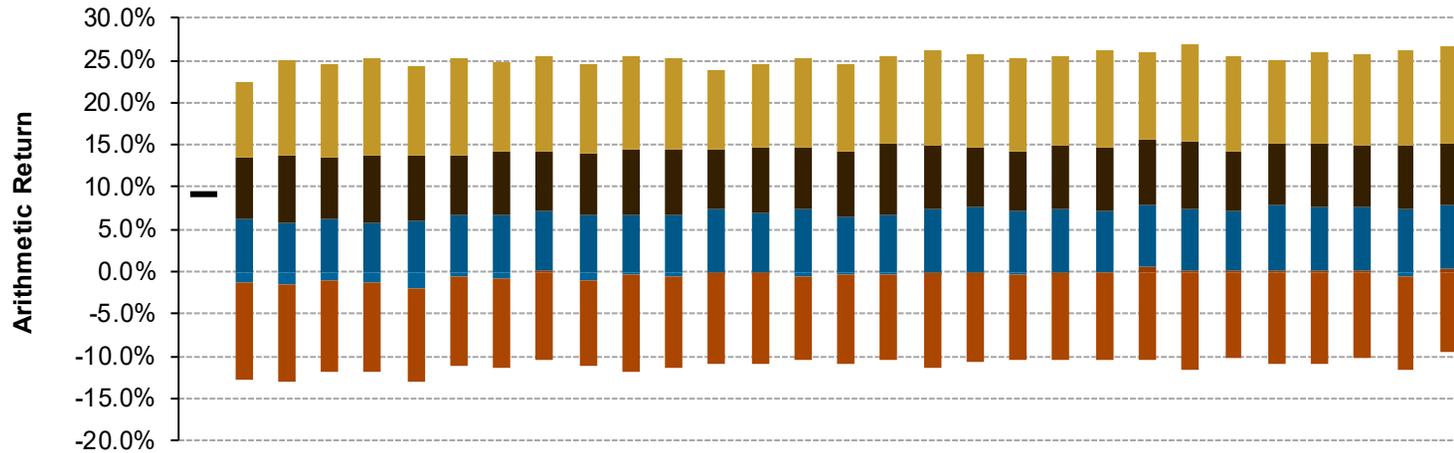
				Arithmetic Return					Annualized Return	
Percentile	2021	2025	2030	2035	2040	2045	2050	10-Year	20-Year	30-Year
5th	9.7%	25.2%	24.6%	25.2%	25.2%	25.5%	26.8%	11.6%	10.1%	9.6%
25th	9.7%	13.9%	14.0%	14.6%	14.2%	14.1%	15.1%	8.1%	7.7%	7.8%
50th	9.7%	5.7%	6.8%	7.4%	7.1%	7.1%	7.8%	5.9%	6.2%	6.5%
75th	9.7%	-1.3%	-1.0%	-0.6%	-0.5%	0.2%	0.5%	3.7%	4.7%	5.2%
95th	9.7%	-11.8%	-11.1%	-10.5%	-10.5%	-10.3%	-9.5%	0.3%	2.4%	3.3%
97.5th	9.7%	-15.8%	-14.9%	-13.6%	-13.6%	-13.9%	-12.5%	-0.6%	1.6%	2.7%
Prob (>= 6.5%)								42%	46%	50%

- In a given year, a worse case return (95th) may be -10% to -12%

- In a 2 standard deviation event (97.5th), worse case return may be -14% to -16%

- The probability of meeting or exceeding a 6.5% return is expected to improve overtime

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Employer Contribution $ (Current Policy Target)
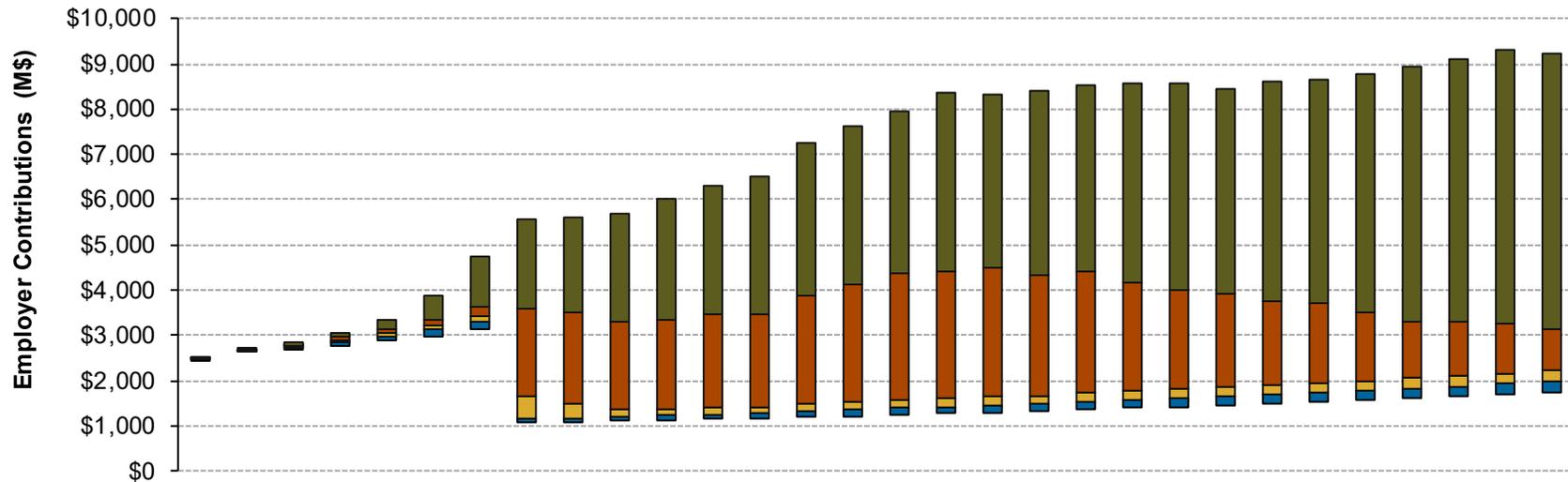
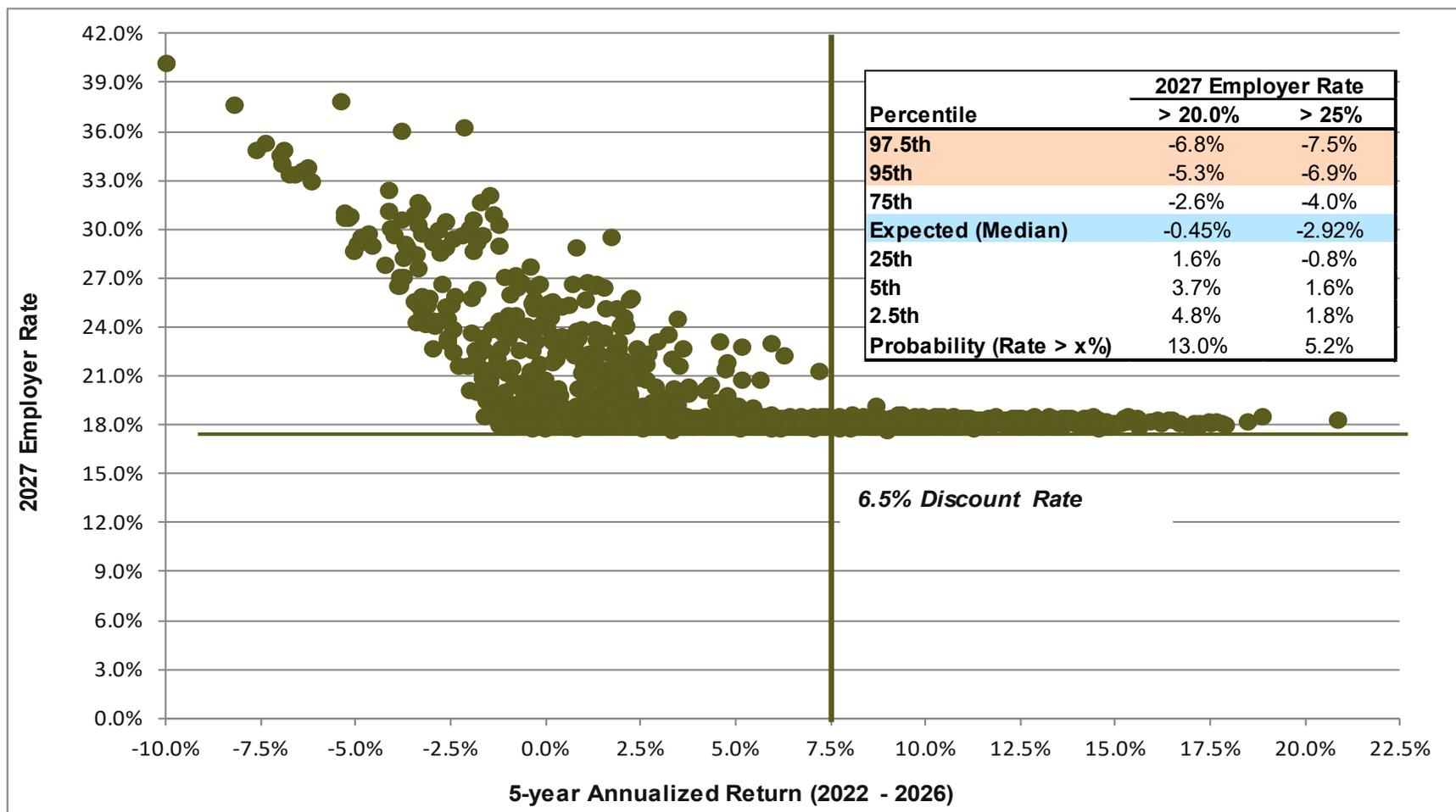|	ECRSP Period											
Percentile	2021	2022	2023	2024	2025	2026	2027	2030	2035	2040	2045	2050
97.5th	2,475	2,663	2,855	3,170	3,834	4,486	5,463	6,325	8,532	9,640	9,857	10,710
95th	2,475	2,663	2,835	3,072	3,356	3,896	4,750	5,700	7,637	8,523	8,666	9,219
75th	2,475	2,663	2,787	2,969	3,156	3,363	3,631	3,288	4,133	4,421	3,713	3,145
50th	2,475	2,663	2,760	2,911	3,069	3,234	3,442	1,362	1,527	1,727	1,948	2,230
25th	2,475	2,663	2,731	2,856	2,985	3,126	3,305	1,207	1,357	1,538	1,746	1,992
5th	2,475	2,663	2,688	2,780	2,881	2,979	3,122	1,111	1,225	1,364	1,540	1,737
Range (5th - 95th)		0	76	161	288	662	1,308	4,338	6,109	6,796	6,718	6,989

- After 2027, ECRSP expires and funding policy is based on normal cost + 12-year closed amortization bases

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# Employer Contribution Rate for the Current Policy Target
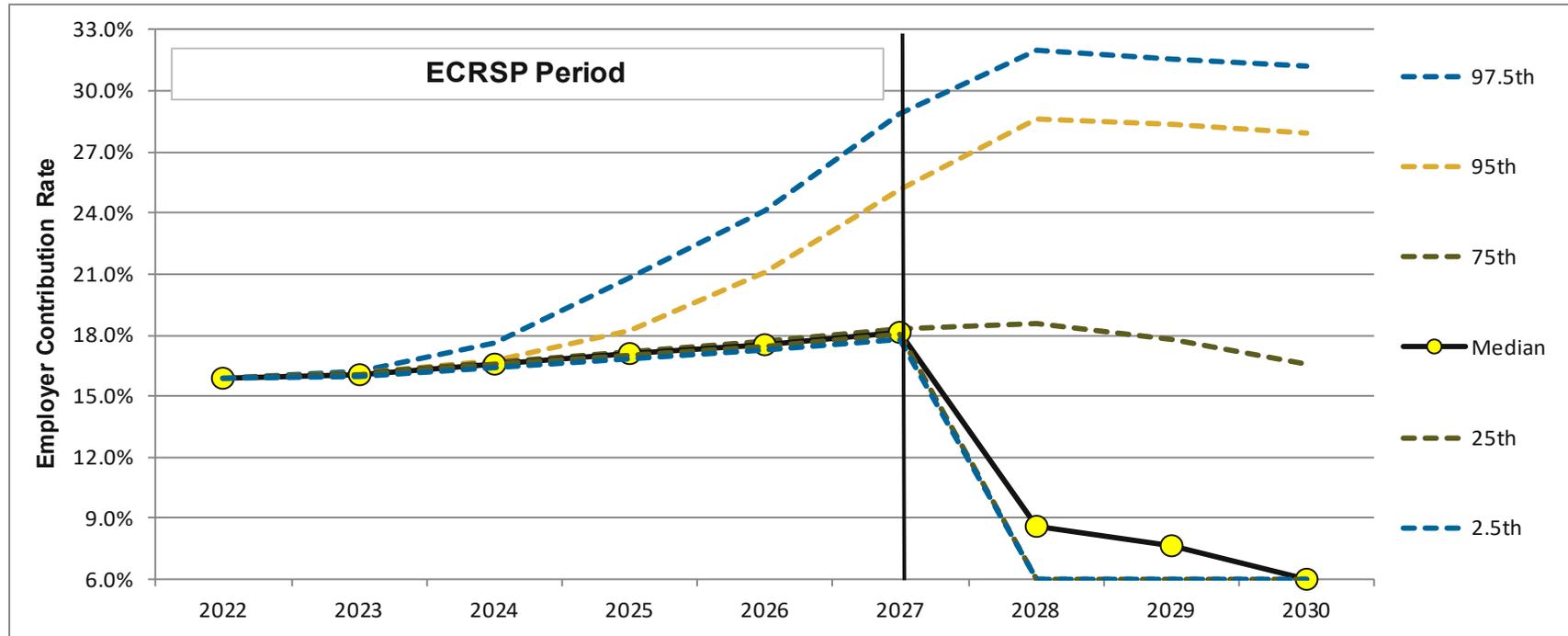
- Employer Contribution Rate Stabilization Policy (ECRSP) is effective through calendar year 2027
  - Annual appropriation recommendation is the greater of (1) and (2) but not greater than (3)
    - (1): Underlying actuarially determined employer contribution rate (ADEC) for upcoming year
    - (2): Current year appropriation + 0.35% of pay
    - (3): Underlying ADEC based on discount rate equal to 30-year Treasury yield
      - *The ceiling is not reflected in modelling since the probability of the 30-year Treasury yield exceeding 6.5% is less than 1.0% in the next five years*
- Employer contributions are expected (median) to plummet when the ECRSP floor is removed. However, in a worse case scenario (97.5[th]), employer contribution rates are 30-33%

Callan

Downside Risk During ECRSP Period

| Percentile | 2027 Employer Rate | |
	> 20.0%	> 25%
97.5th	-6.8%	-7.5%
95th	-5.3%	-6.9%
75th	-2.6%	-4.0%
Expected (Median)	-0.45%	-2.92%
25th	1.6%	-0.8%
5th	3.7%	1.6%
2.5th	4.8%	1.8%
Probability (Rate > x%)	13.0%	5.2%

- The above chart illustrates that poor investment performance over the next 5 years (2022 – 2026) may result in a 2027 employer rate much higher than an expected rate of ~18.0%
  - In the table, is the return distribution associated with a 2027 employer rate larger than 20% (13% chance) or 25% (5% chance) respectively

Worse Case Scenario (97.5th percentile) for 2027 Employer Rate
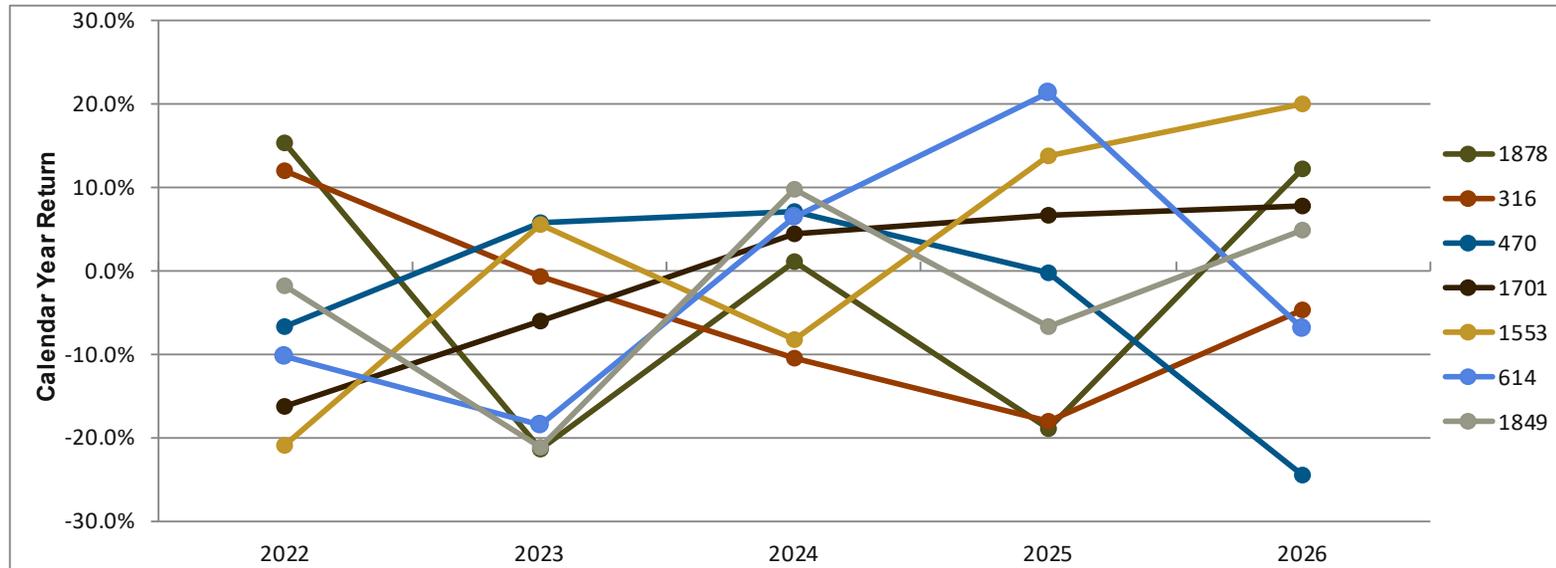
Scenario	2022	2023	2024	2025	2026	5-Year Annualized	2027 Employer Rate
1878	15.2%	-21.5%	1.0%	-18.9%	12.0%	-3.7%	29.0%
316	12.0%	-0.7%	-10.5%	-18.1%	-4.7%	-4.9%	29.0%
470	-6.8%	5.7%	7.0%	-0.3%	-24.6%	-4.6%	28.9%
1701	-16.2%	-6.0%	4.4%	6.5%	7.7%	-1.2%	28.9%
1553	-21.0%	5.4%	-8.2%	13.7%	20.0%	0.9%	28.8%
614	-10.3%	-18.5%	6.4%	21.2%	-7.0%	-2.6%	28.8%
1849	-1.8%	-21.2%	9.8%	-6.7%	4.9%	-3.6%	28.8%

- The worse case scenario (97.5th) is driven by overall poor investment performance over a five year period
  - May be some good years in the scenario (returns above 6.5% are highlighted in light green)
  - However, 2-4 bad years (returns below 0% are highlighted in light red) more than offsets one or two good years

Worse Case Scenario (95th percentile) for 2027 Employer Rate
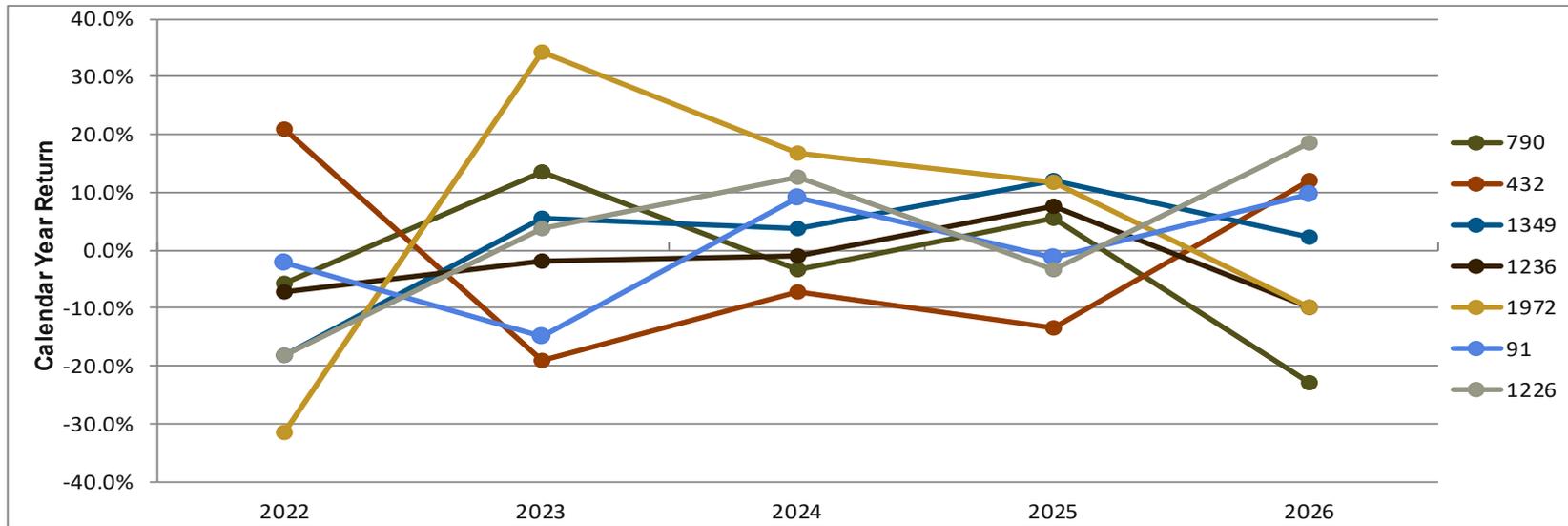
Scenario	2022	2023	2024	2025	2026	5-Year Annualized	2027 Employer Rate
790	-5.6%	13.7%	-3.3%	5.6%	-22.8%	-3.3%	25.2%
432	20.8%	-19.0%	-7.2%	-13.4%	12.1%	-2.5%	25.2%
1349	-18.3%	5.5%	3.6%	12.0%	2.3%	0.5%	25.2%
1236	-7.2%	-1.8%	-0.9%	7.6%	-9.9%	-2.6%	25.2%
1972	-31.4%	34.2%	16.9%	11.7%	-9.9%	1.6%	25.1%
91	-2.0%	-14.8%	9.2%	-1.4%	9.8%	-0.3%	25.1%
1226	-18.1%	3.7%	12.7%	-3.3%	18.5%	1.9%	25.1%

● Same analysis is conducted for the 95th percentile worse case scenario

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Market Funded Status (Current Policy Target)
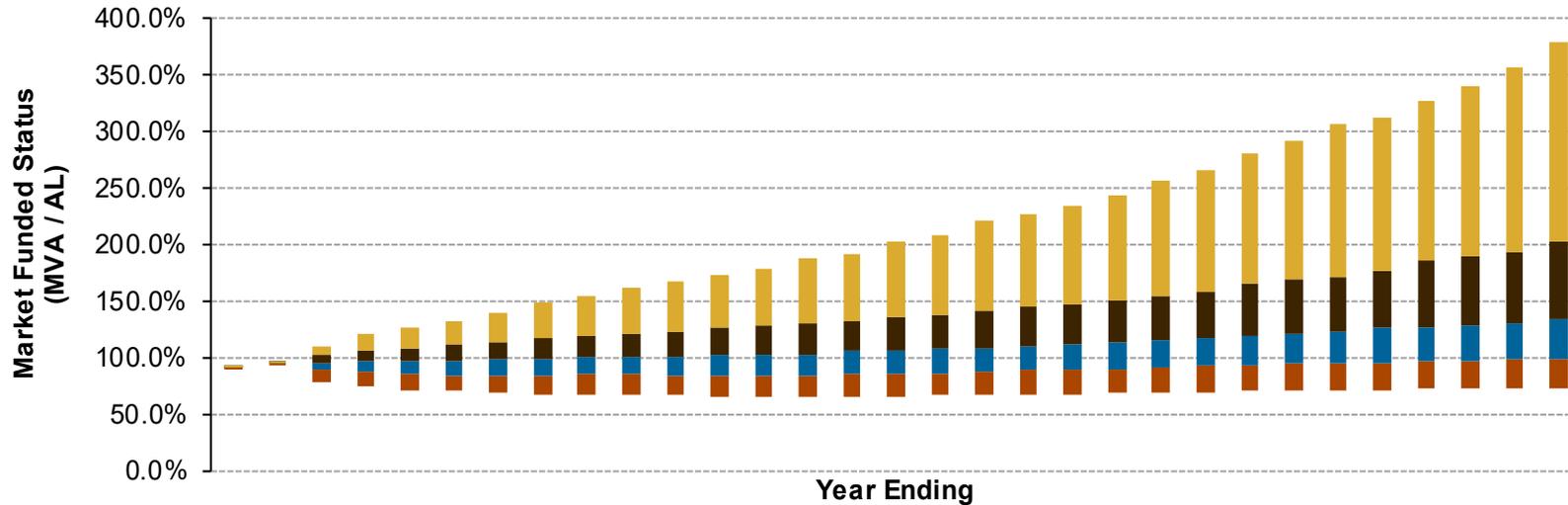
Percentile	2020	2025	2030	2035	2040	2045	2050
5th	91.2%	133.1%	168.7%	203.6%	244.1%	306.9%	380.1%
25th	91.2%	111.8%	123.5%	136.4%	151.7%	171.4%	202.8%
50th	91.2%	98.2%	101.8%	106.7%	113.3%	123.8%	134.4%
75th	91.2%	84.8%	84.7%	85.8%	90.7%	94.8%	99.7%
95th	91.2%	71.6%	66.9%	66.3%	69.4%	71.4%	73.8%
97.5th	91.2%	67.6%	61.7%	62.1%	64.5%	66.7%	68.5%
Prob. 100% Funded	0%	46%	53%	58%	65%	70%	75%

- Market Funded Status = Market Value of Assets / Actuarial Liability

- The Plan is expected to be fully funded in 2027

- Plan may become very overfunded due to minimum employer rate = 6.0% in conjunction with an employee rate = 6.0%

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Net Outflow as a % of Assets (Current Policy Target)

Legend:
- 0% - 7%
- 7% - 10%
- > 10%
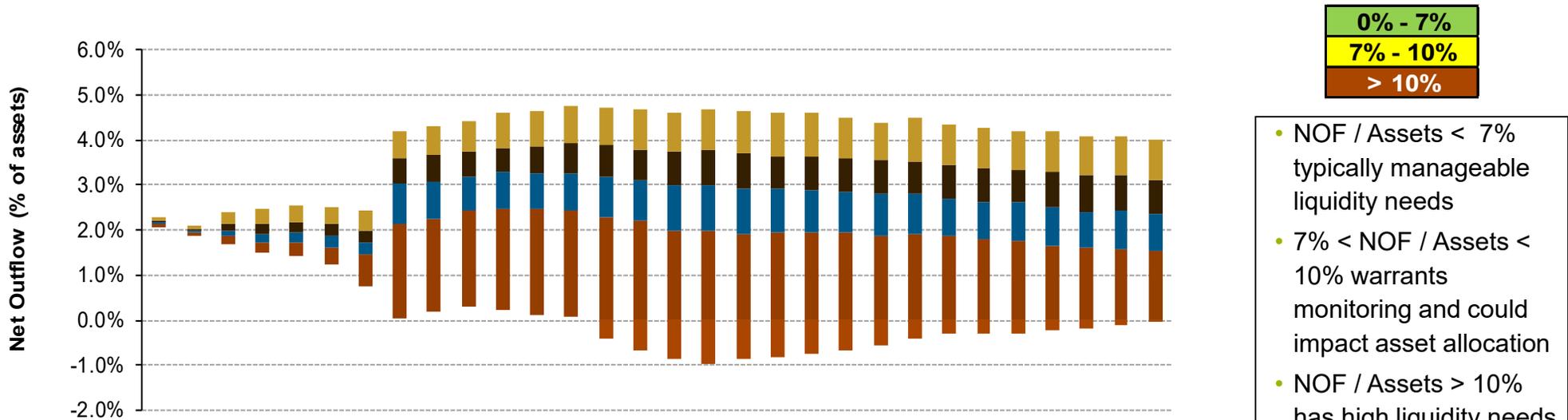
- NOF / Assets < 7% typically manageable liquidity needs
- 7% < NOF / Assets < 10% warrants monitoring and could impact asset allocation
- NOF / Assets > 10% has high liquidity needs and may preclude investment in illiquid investments

Percentile	2021	2025	2030	2035	2040	2045	2050
97.5th	2.2%	2.7%	4.7%	5.0%	4.9%	4.6%	4.3%
95th	2.2%	2.5%	4.4%	4.7%	4.6%	4.3%	4.0%
75th	2.2%	2.2%	3.8%	3.8%	3.7%	3.4%	3.1%
50th	2.2%	2.0%	3.2%	3.1%	2.9%	2.6%	2.4%
25th	2.2%	1.7%	2.4%	2.2%	1.9%	1.8%	1.5%
5th	2.2%	1.4%	0.3%	-0.7%	-0.7%	-0.3%	0.0%

- Net outflow = Benefits + administration expenses – employee contributions - employer contributions
  - NOF / Assets ranges from -1.0% to +5.0% per year
  - Portfolio income (not reflected) can assist with paying benefits

- Fund has manageable liquidity needs that don't preclude an allocation to illiquid investments or warrant a "liquidity sleeve" to pay benefits

10-Year Forecast Horizon

10-Year Annualized Return
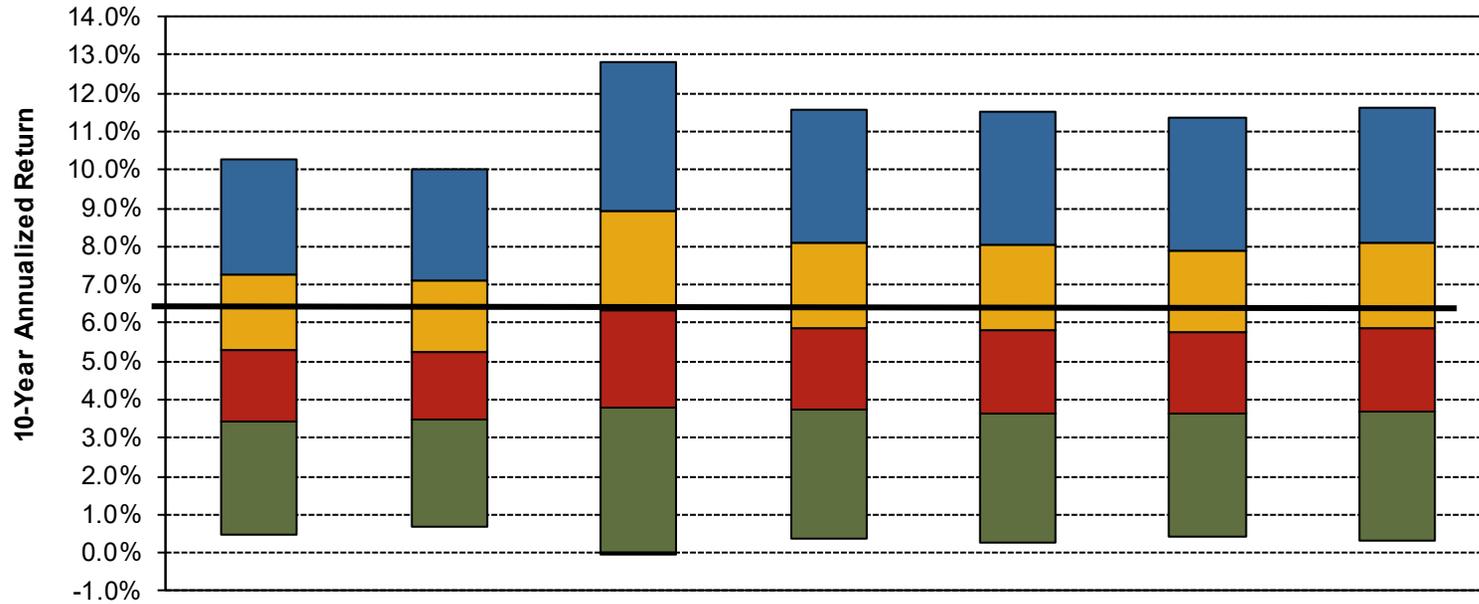
Percentile	Actual	Mix 1	Mix 5	Mix 8	Mix 12	Mix 16	Target
5th	10.3%	10.0%	12.8%	11.6%	11.6%	11.1%	11.6%
25th	7.3%	7.1%	8.9%	8.1%	8.1%	7.8%	8.1%
50th	5.30%	5.26%	6.31%	5.89%	5.84%	5.66%	5.86%
75th	3.4%	3.5%	3.8%	3.7%	3.6%	3.6%	3.7%
95th	0.5%	0.7%	-0.1%	0.4%	0.2%	0.4%	0.3%
97.5th	-0.3%	0.0%	-1.2%	-0.5%	-0.6%	-0.4%	-0.6%
Prob (>=6.5%)	34%	32%	48%	42%	42%	39%	42%
Standard Deviation	9.4%	8.8%	12.4%	10.6%	10.7%	10.2%	10.8%

Mix Name	Broad Allocation
Actual	EQ36/ IG27/ Cash 11/Alts 27
Mix 1	EQ31/ IG39/ Cash 1/Alts 29
Mix 5	EQ51/ IG19/ Cash 1/Alts 29
Mix 8	EQ39/ IG28/ Cash 1/Alts 32
Mix 12	EQ42/ IG24/ Cash 5/Alts 29
Mix 16	EQ38/ IG28/ Cash 5/Alts 29
Target	EQ42/IG28/ Cash 1/Alts 29

- The 50th percentile is the Expected Return over 10 years
  - None of the Mixes are *expected* to achieve the 6.5% actuarial discount rate over the next 10 years
  - However, there is still a 32-48% probability of achieving 6.5% across all the mixes
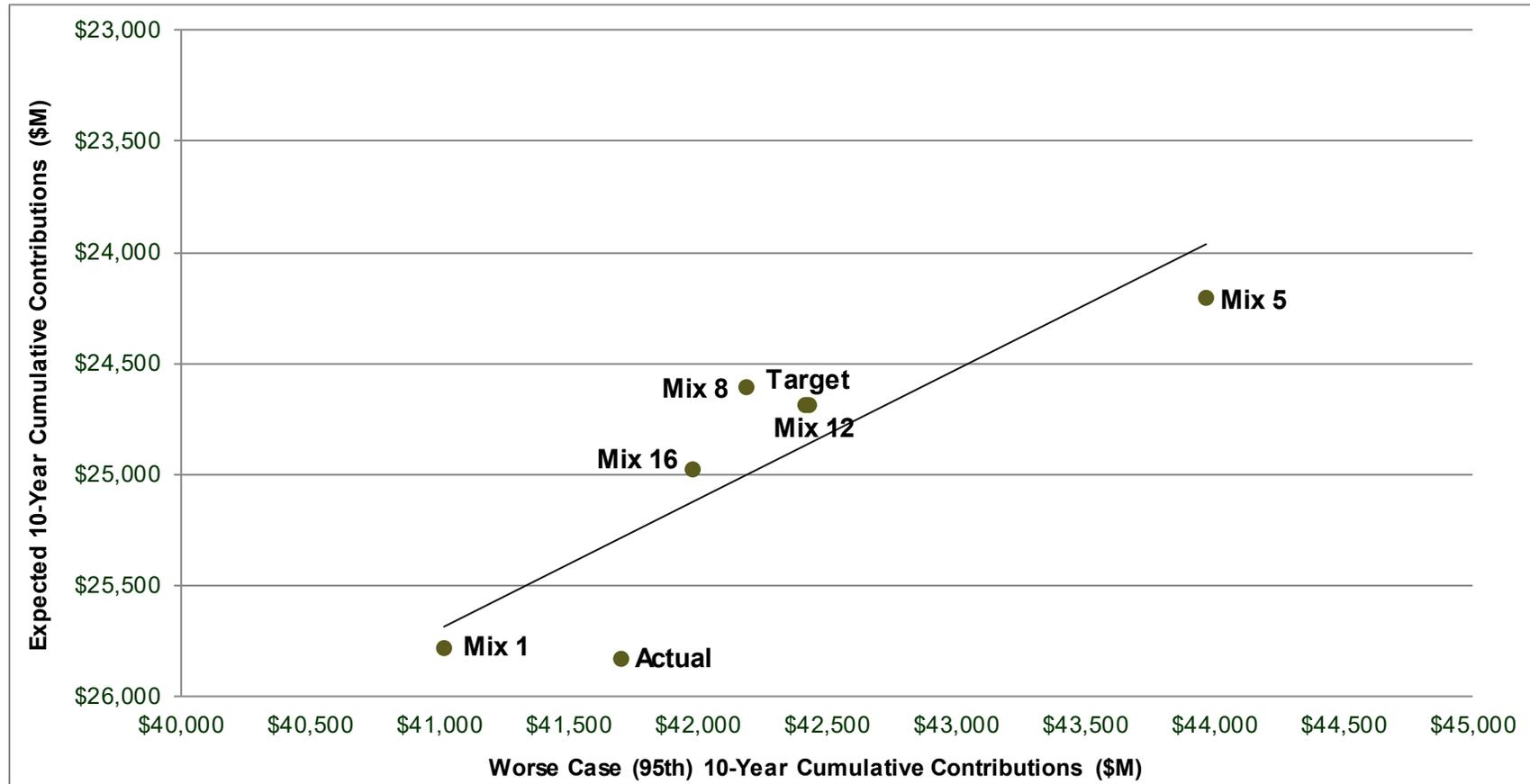
10-Year Cumulative Contributions
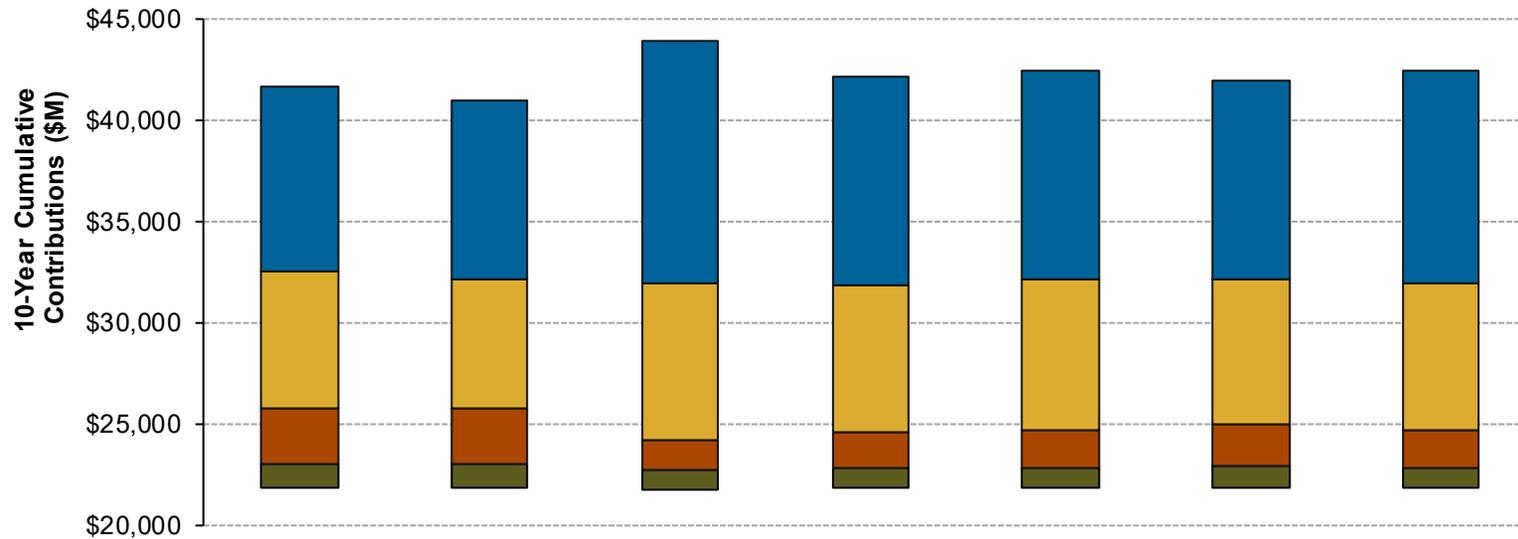
Percentile	Actual	Mix 1	Mix 5	Mix 8	Mix 12	Mix 16	Target
97.5th	$45,654	$43,998	$49,326	$46,662	$47,064	$46,212	$46,868
95th	$41,702	$41,013	$43,964	$42,184	$42,430	$41,979	$42,415
75th	32,535	32,184	32,018	31,882	32,151	32,151	32,013
50th	25,827	25,784	24,205	24,605	24,691	24,974	24,690
25th	23,043	23,047	22,817	22,885	22,896	22,917	22,892
5th	21,881	21,898	21,832	21,849	21,852	21,862	21,843
10-yr Expected Return	5.2%	5.2%	6.2%	5.8%	5.7%	5.6%	5.8%
Standard Deviation	9.4%	8.8%	12.4%	10.6%	10.7%	10.2%	10.8%

- The above chart shows total employer contributions from 2021 to 2030
  - Expected contributions range from $24.2B to $25.8B
  - Worse Case contributions (95th percentile) range from $41.0B to $44.0B

Mix Name	Broad Allocation
Actual	EQ36/ IG27/ Cash 11/Alts 27
Mix 1	EQ31/ IG39/ Cash 1/Alts 29
Mix 5	EQ51/ IG19/ Cash 1/Alts 29
Mix 8	EQ39/ IG28/ Cash 1/Alts 32
Mix 12	EQ42/ IG24/ Cash 5/Alts 29
Mix 16	EQ38/ IG28/ Cash 5/Alts 29
Target	EQ42/IG28/ Cash 1/Alts 29

10-Year Risk-Reward Trade-off in Contribution Space

Chart: X-axis "Worse Case (95th) 10-Year Cumulative Contributions ($M)" ranging from $40,000 to $45,000. Y-axis "Expected 10-Year Cumulative Contributions ($M)" inverted, ranging from $23,000 (top) to $26,000 (bottom).

Data points: Mix 5 (~$44,000, $24,200); Mix 8 (~$42,100, $24,600); Target (~$42,400, $24,700); Mix 12 (~$42,400, $24,700); Mix 16 (~$42,000, $24,980); Mix 1 (~$41,000, $25,800); Actual (~$41,700, $25,850). A linear regression line is fitted through the mixes.

- More aggressive mixes result in lower contributions (vertical axis is inverted)

- In a worse case scenario, more aggressive mixes result in higher contributions

- A linear regression line is fitted to the Mixes

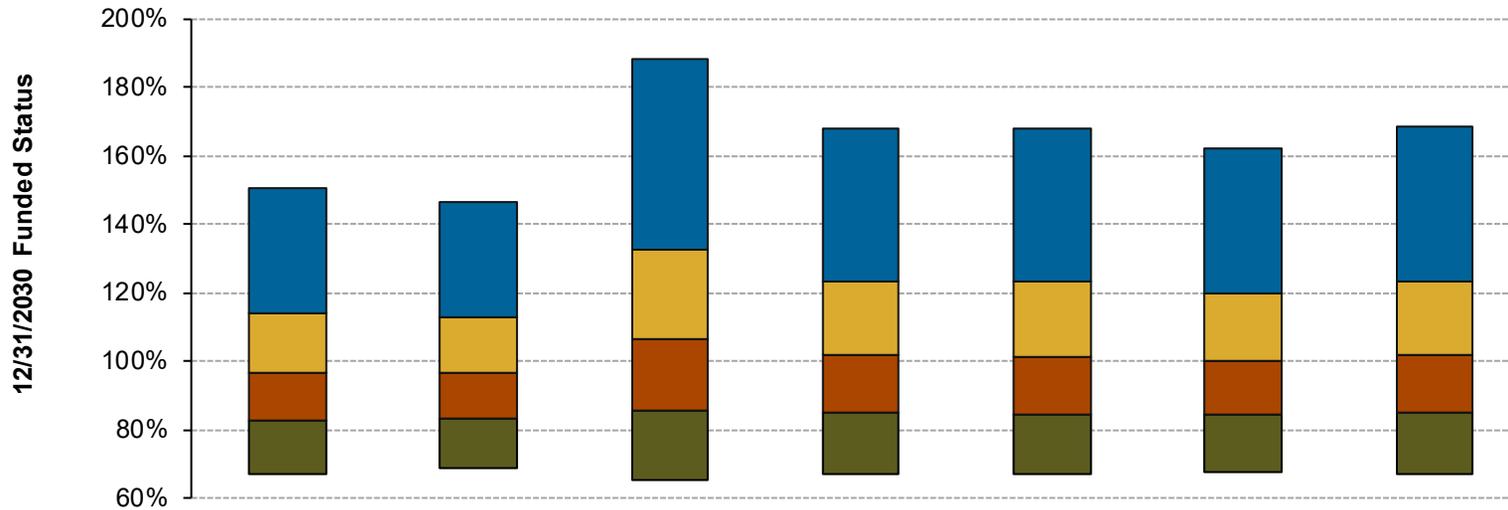| Mix Name	Broad Allocation
Actual	EQ36/ IG27/ Cash 11/Alts 27
Mix 1	EQ31/ IG39/ Cash 1/Alts 29
Mix 5	EQ51/ IG19/ Cash 1/Alts 29
Mix 8	EQ39/ IG28/ Cash 1/Alts 32
Mix 12	EQ42/ IG24/ Cash 5/Alts 29
Mix 16	EQ38/ IG28/ Cash 5/Alts 29
Target	EQ42/IG28/ Cash 1/Alts 29

10-Year Projected Market Funded Status (At 12/31/2030)

12/31/2030 Funded Status (chart, y-axis 60%–200%)

Percentile	Actual	Mix 1	Mix 5	Mix 8	Mix 12	Mix 16	Target
5th	151%	146%	188%	168%	168%	162%	169%
25th	114%	113%	132%	123%	123%	120%	123%
50th	97%	96%	106%	102%	101%	100%	102%
75th	83%	83%	86%	85%	84%	84%	85%
95th	67%	68%	66%	67%	67%	67%	67%
97.5th	63%	64%	60%	62%	62%	62%	62%
10-yr Expected Return	5.2%	5.2%	6.2%	5.8%	5.7%	5.6%	5.8%
Prob. FS = 100%	45%	44%	57%	53%	53%	50%	53%
Expected Cont	$25,827	$25,784	$24,205	$24,605	$24,691	$24,974	$24,690
95th Worse Case Cont	$41,702	$41,013	$43,964	$42,184	$42,430	$41,979	$42,415
97.5th Worse Case Cont	$45,654	$43,998	$49,326	$46,662	$47,064	$46,212	$46,868

- Market Funded Status (Market Value of Assets / Actuarial Liability) is *expected* to improve across all Mixes
  - 12/31/2021 Estimated Funded Status ~ 95%

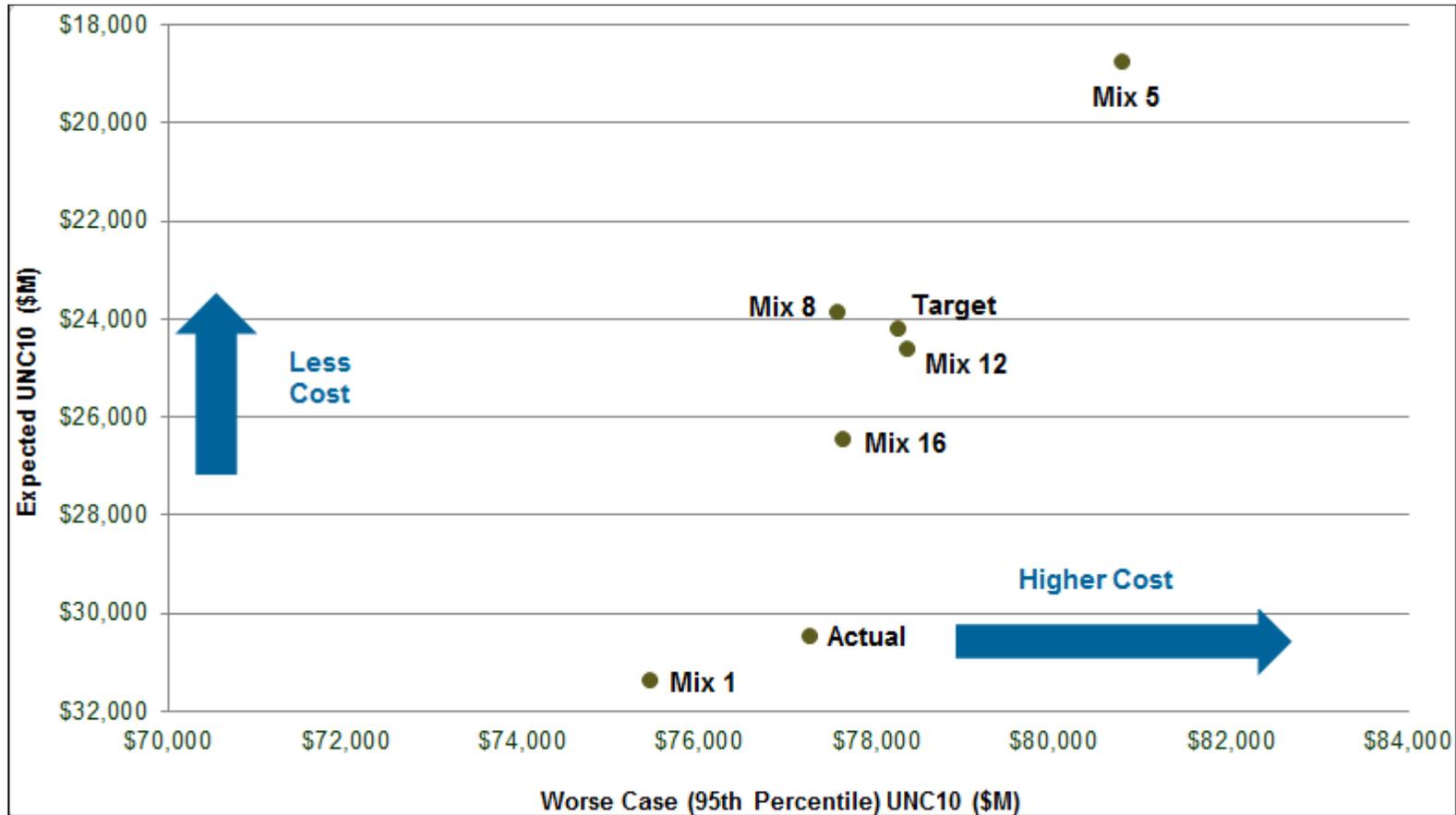| Mix Name	Broad Allocation
Actual	EQ36/ IG27/ Cash 11/Alts 27
Mix 1	EQ31/ IG39/ Cash 1/Alts 29
Mix 5	EQ51/ IG19/ Cash 1/Alts 29
Mix 8	EQ39/ IG28/ Cash 1/Alts 32
Mix 12	EQ42/ IG24/ Cash 5/Alts 29
Mix 16	EQ38/ IG28/ Cash 5/Alts 29
Target	EQ42/IG28/ Cash 1/Alts 29

10-Year Ultimate Net Cost (UNC10)
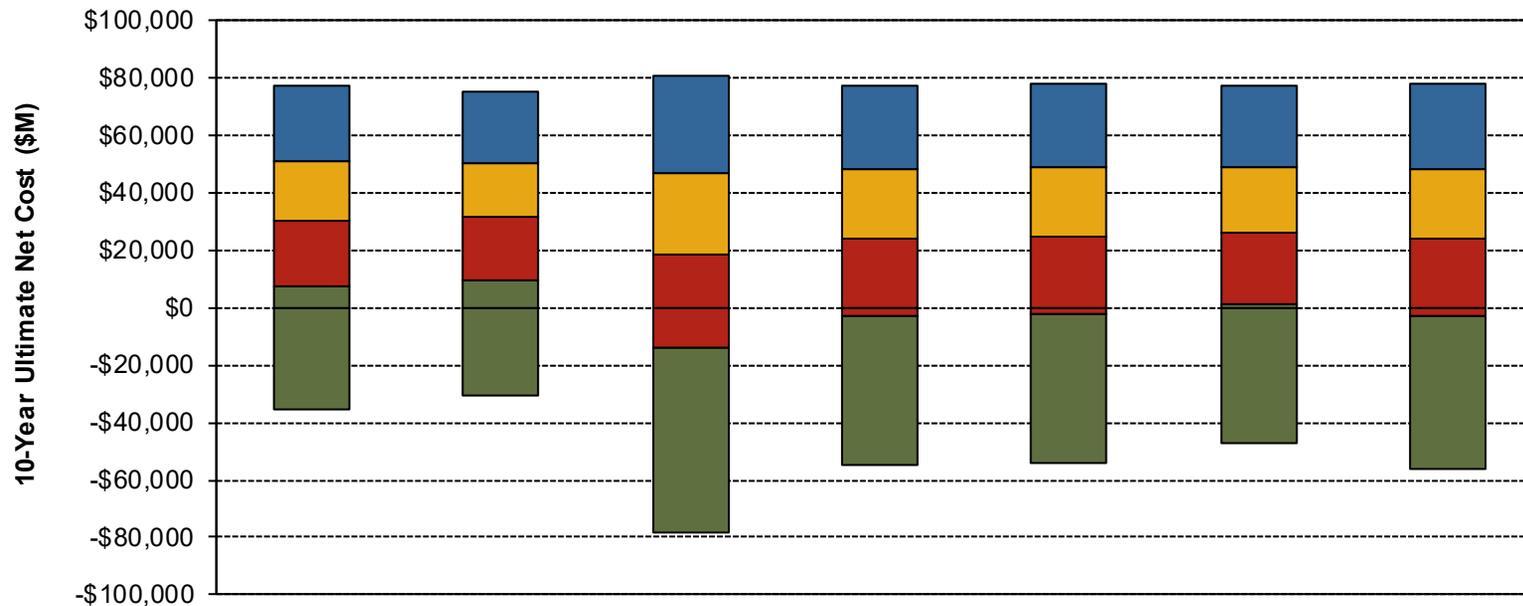
Percentile	Actual	Mix 1	Mix 5	Mix 8	Mix 12	Mix 16	Target
97.5th	$84,717	$81,981	$90,992	$86,467	$87,332	$86,303	$87,236
95th	$77,249	$75,438	$80,782	$77,550	$78,344	$77,621	$78,237
75th	51,022	50,539	46,872	48,143	48,815	49,131	48,445
50th	30,457	31,377	18,739	23,862	24,596	26,460	24,196
25th	7,641	9,229	-13,870	-2,933	-2,273	1,174	-2,936
5th	-35,072	-30,549	-78,265	-54,868	-54,382	-47,423	-55,886
10-yr Expected Return	5.2%	5.2%	6.2%	5.8%	5.7%	5.6%	5.8%
Standard Deviation	9.4%	8.8%	12.4%	10.6%	10.7%	10.2%	10.8%

- UNC10 = 10-Year Cumulative Contributions (2021 – 2030) + 12/31/2030 Unfunded Actuarial Liability
  - UNC captures what is expected to be paid over 10 years plus what is owed at the end of the 10 year period
  - Unfunded Actuarial Liability = Actuarial Liability – Market Value of Assets
- More aggressive mixes lower UNC in the expected case but result in a higher UNC in a worse case scenario

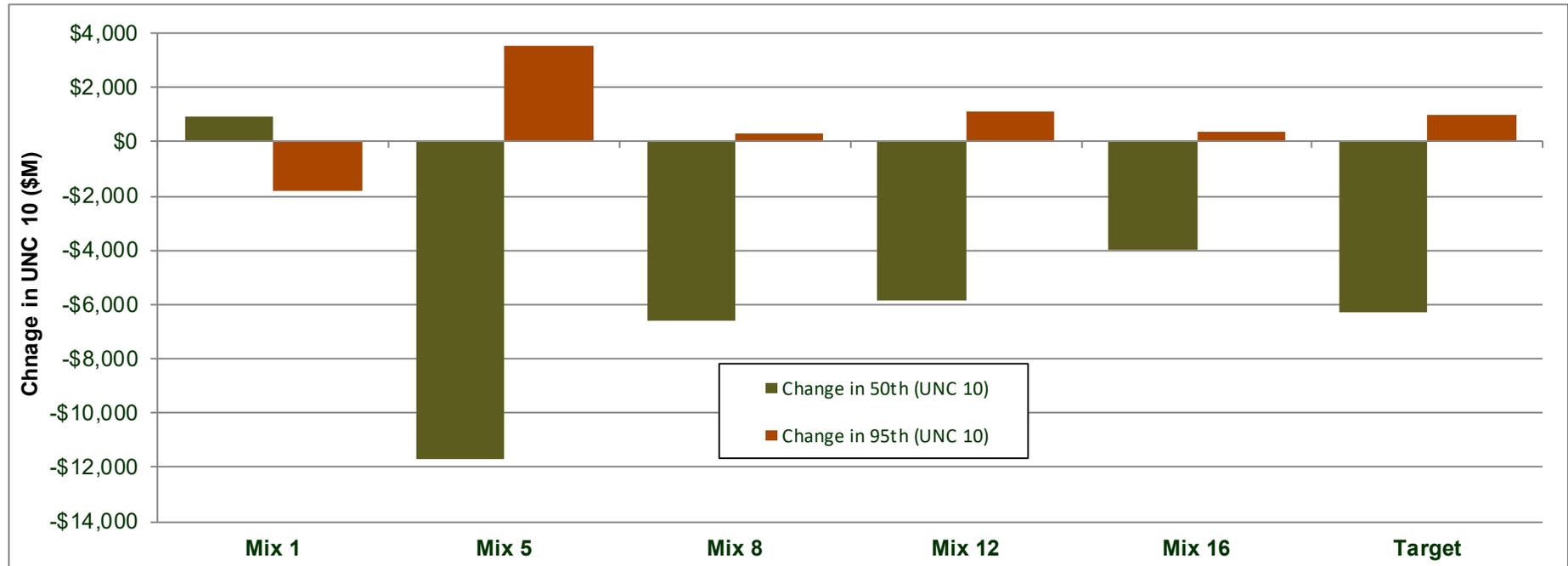| Mix Name	Broad Allocation
Actual	EQ36/ IG27/ Cash 11/Alts 27
Mix 1	EQ31/ IG39/ Cash 1/Alts 29
Mix 5	EQ51/ IG19/ Cash 1/Alts 29
Mix 8	EQ39/ IG28/ Cash 1/Alts 32
Mix 12	EQ42/ IG24/ Cash 5/Alts 29
Mix 16	EQ38/ IG28/ Cash 5/Alts 29
Target	EQ42/IG28/ Cash 1/Alts 29

UNC10: Expected Cost vs. Worse Case Cost

- The above graph contrasts expected UNC10 vs. worse case UNC10

Mix Name	Broad Allocation
Actual	EQ36/ IG27/ Cash 11/Alts 27
Mix 1	EQ31/ IG39/ Cash 1/Alts 29
Mix 5	EQ51/ IG19/ Cash 1/Alts 29
Mix 8	EQ39/ IG28/ Cash 1/Alts 32
Mix 12	EQ42/ IG24/ Cash 5/Alts 29
Mix 16	EQ38/ IG28/ Cash 5/Alts 29
Target	EQ42/IG28/ Cash 1/Alts 29

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UNC 10: Change in Risk-Reward Relative to the Actual Allocation

- The above graph depicts the change in the 50th percentile (Expected Cost) and the 95th percentile (Worse Case Cost) relative to the Actual Allocation
  - A positive (negative) change is an increase (reduction) in cost

- The decrease in expected cost is much larger than the increase in worse case cost in for most mixes (Mix 1 has a small increase in expected cost but with a larger reduction in worse case cost)

| Mix Name	Broad Allocation
Actual	EQ36/ IG27/ Cash 11/Alts 27
Mix 1	EQ31/ IG39/ Cash 1/Alts 29
Mix 5	EQ51/ IG19/ Cash 1/Alts 29
Mix 8	EQ39/ IG28/ Cash 1/Alts 32
Mix 12	EQ42/ IG24/ Cash 5/Alts 29
Mix 16	EQ38/ IG28/ Cash 5/Alts 29
Target	EQ42/IG28/ Cash 1/Alts 29

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30-Year Forecast Horizon

30-Year Annualized Return
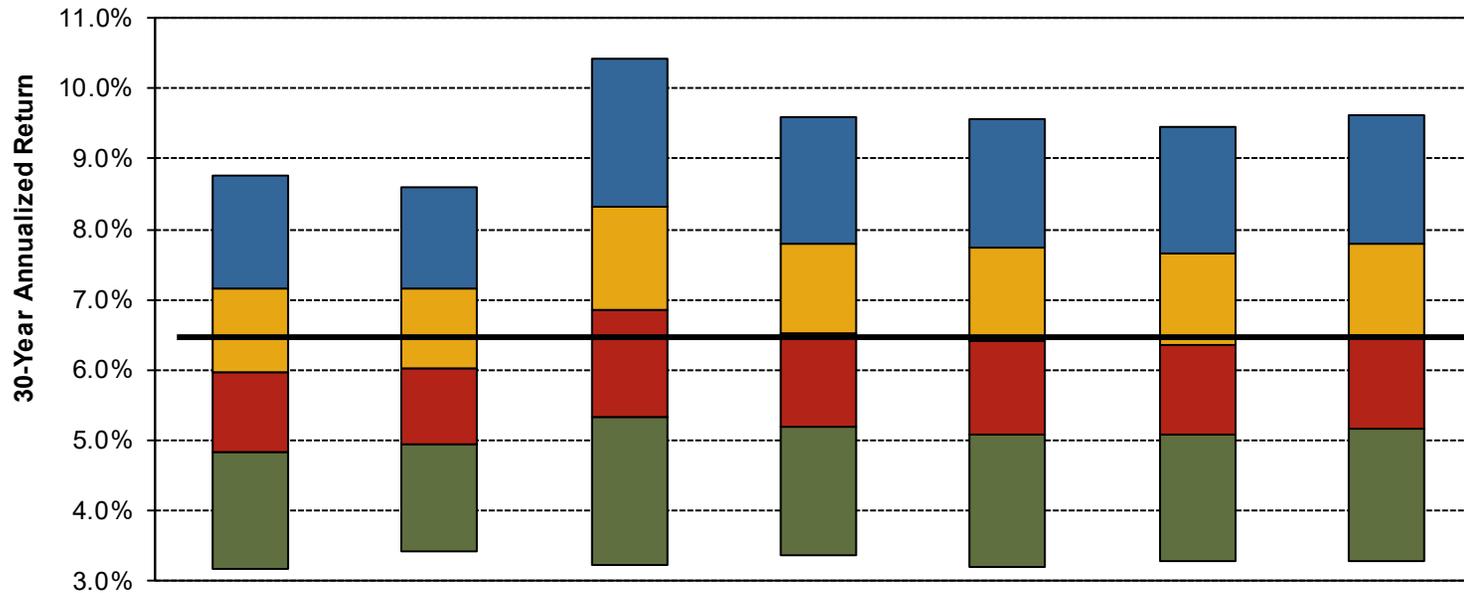
Percentile	Actual	Mix 1	Mix 5	Mix 8	Mix 12	Mix 16	Target
5th	8.8%	8.6%	10.4%	9.6%	9.6%	9.3%	9.6%
25th	7.2%	7.1%	8.3%	7.8%	7.7%	7.6%	7.8%
50th	5.98%	6.03%	6.86%	6.52%	6.44%	6.33%	6.51%
75th	4.8%	5.0%	5.3%	5.2%	5.1%	5.1%	5.2%
95th	3.17%	3.41%	3.22%	3.36%	3.24%	3.30%	3.29%
97.5th	2.70%	2.94%	2.51%	2.76%	2.64%	2.74%	2.70%
Prob (>=6.5%)	39%	39%	56%	50%	49%	46%	50%
Standard Deviation	9.4%	8.8%	12.4%	10.6%	10.7%	10.2%	10.8%

- Mixes that are _expected_ to meet or exceed the 6.5% actuarial discount rate over the next 30 years are highlighted in green

Mix Name	Broad Allocation
Actual	EQ36/ IG27/ Cash 11/Alts 27
Mix 1	EQ31/ IG39/ Cash 1/Alts 29
Mix 5	EQ51/ IG19/ Cash 1/Alts 29
Mix 8	EQ39/ IG28/ Cash 1/Alts 32
Mix 12	EQ42/ IG24/ Cash 5/Alts 29
Mix 16	EQ38/ IG28/ Cash 5/Alts 29
Target	EQ42/IG28/ Cash 1/Alts 29

30-Year Cumulative Contributions
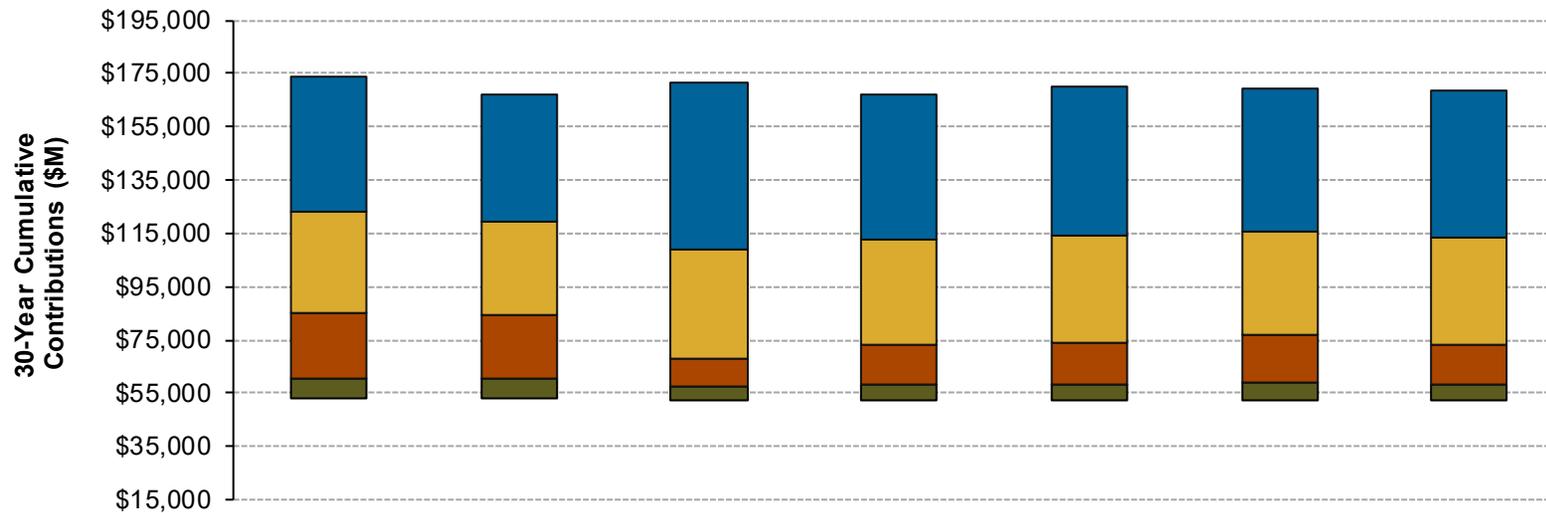
Percentile	Actual	Mix 1	Mix 5	Mix 8	Mix 12	Mix 16	Target
97,5th	$185,991	$180,247	$186,894	$181,978	$184,537	$182,656	$183,207
95th	$173,474	$167,283	$171,532	$166,908	$170,481	$169,126	$168,703
75th	123,261	119,658	109,329	112,397	114,516	116,039	113,196
50th	84,982	84,032	68,089	73,018	74,139	76,955	73,340
25th	60,630	60,767	57,396	58,071	58,324	58,781	58,149
5th	53,131	53,120	52,087	52,384	52,444	52,594	52,384
30-yr Expected Return	6.0%	6.0%	6.8%	6.5%	6.4%	6.3%	6.5%
Standard Deviation	9.4%	8.8%	12.4%	10.6%	10.7%	10.2%	10.8%

- The above chart shows total employer contributions from 2021 to 2050
  - Expected contributions range from $68.1B to $85.0B
  - Worse Case contributions (95th percentile) range from $166.9B to $173.5B

| Mix Name	Broad Allocation
Actual	EQ36/ IG27/ Cash 11/Alts 27
Mix 1	EQ31/ IG39/ Cash 1/Alts 29
Mix 5	EQ51/ IG19/ Cash 1/Alts 29
Mix 8	EQ39/ IG28/ Cash 1/Alts 32
Mix 12	EQ42/ IG24/ Cash 5/Alts 29
Mix 16	EQ38/ IG28/ Cash 5/Alts 29
Target	EQ42/IG28/ Cash 1/Alts 29

30-Year Projected Funded Status (At 12/31/2050)
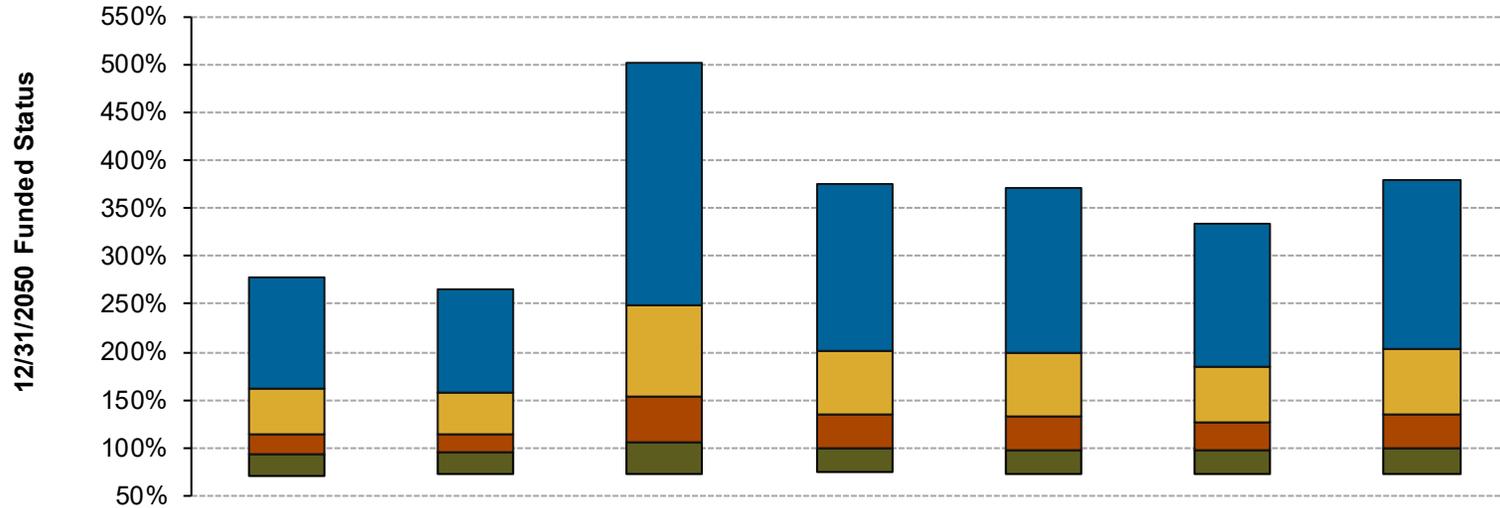
Percentile	Actual	Mix 1	Mix 5	Mix 8	Mix 12	Mix 16	Target
5th	278%	265%	502%	374%	371%	334%	380%
25th	161%	158%	249%	202%	200%	185%	203%
50th	115%	115%	155%	135%	132%	127%	134%
75th	93%	95%	105%	100%	99%	97%	100%
95th	72%	73%	73%	74%	73%	73%	74%
97.5th	68%	70%	68%	69%	68%	69%	69%
30-yr Expected Return	6.0%	6.0%	6.8%	6.5%	6.4%	6.3%	6.5%
Prob. FS >= 100%	67%	68%	78%	75%	74%	72%	75%
Expected Cont	$84,982	$84,032	$68,089	$73,018	$74,139	$76,955	$73,340
95th Worse Case Cont	$173,474	$167,283	$171,532	$166,908	$170,481	$169,126	$168,703
97.5th Worse Case Cont	$185,991	$180,247	$186,894	$181,978	$184,537	$182,656	$183,207

- Large amount of surplus is _expected_ across all Mixes

- Worse case scenario could still be in the low 70s (95th) or high 60s (97.5th)

Mix Name	Broad Allocation
Actual	EQ36/ IG27/ Cash 11/Alts 27
Mix 1	EQ31/ IG39/ Cash 1/Alts 29
Mix 5	EQ51/ IG19/ Cash 1/Alts 29
Mix 8	EQ39/ IG28/ Cash 1/Alts 32
Mix 12	EQ42/ IG24/ Cash 5/Alts 29
Mix 16	EQ38/ IG28/ Cash 5/Alts 29
Target	EQ42/IG28/ Cash 1/Alts 29

30-Year Ultimate Net Cost (UNC30)
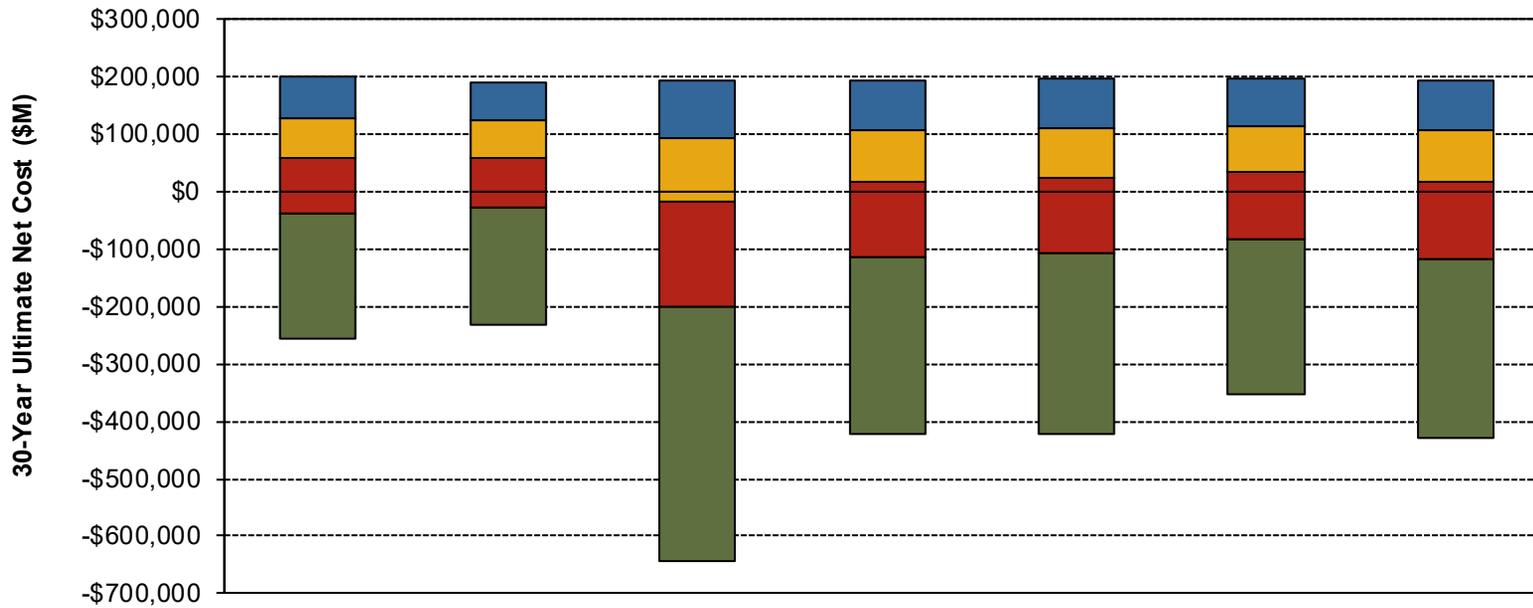
Percentile	Actual	Mix 1	Mix 5	Mix 8	Mix 12	Mix 16	Target
97.5th	$223,917	$216,420	$223,078	$217,200	$220,219	$219,823	$218,259
95th	$200,794	$191,708	$194,189	$192,036	$198,001	$196,723	$194,972
75th	129,288	124,325	94,419	106,431	110,737	114,368	107,827
50th	60,158	57,851	-16,224	17,142	23,970	34,613	18,774
25th	-36,638	-29,414	-202,094	-114,021	-109,034	-83,042	-116,385
5th	-255,123	-231,988	-643,068	-423,403	-420,874	-354,247	-429,117
30-yr Expected Return	6.0%	6.0%	6.8%	6.5%	6.4%	6.3%	6.5%
Standard Deviation	9.4%	8.8%	12.4%	10.6%	10.7%	10.2%	10.8%

● UNC30 = 30-Year Cumulative Contributions (2021 – 2050) + 12/31/2050 Unfunded Actuarial Liability

– UNC captures what is expected to be paid over 30 years plus what is owed at the end of the 30 year period

– Unfunded Actuarial Liability = Actuarial Liability – Market Value of Assets

Mix Name	Broad Allocation
Actual	EQ36/ IG27/ Cash 11/Alts 27
Mix 1	EQ31/ IG39/ Cash 1/Alts 29
Mix 5	EQ51/ IG19/ Cash 1/Alts 29
Mix 8	EQ39/ IG28/ Cash 1/Alts 32
Mix 12	EQ42/ IG24/ Cash 5/Alts 29
Mix 16	EQ38/ IG28/ Cash 5/Alts 29
Target	EQ42/IG28/ Cash 1/Alts 29

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UNC30: Expected Cost vs. Worse Case Cost
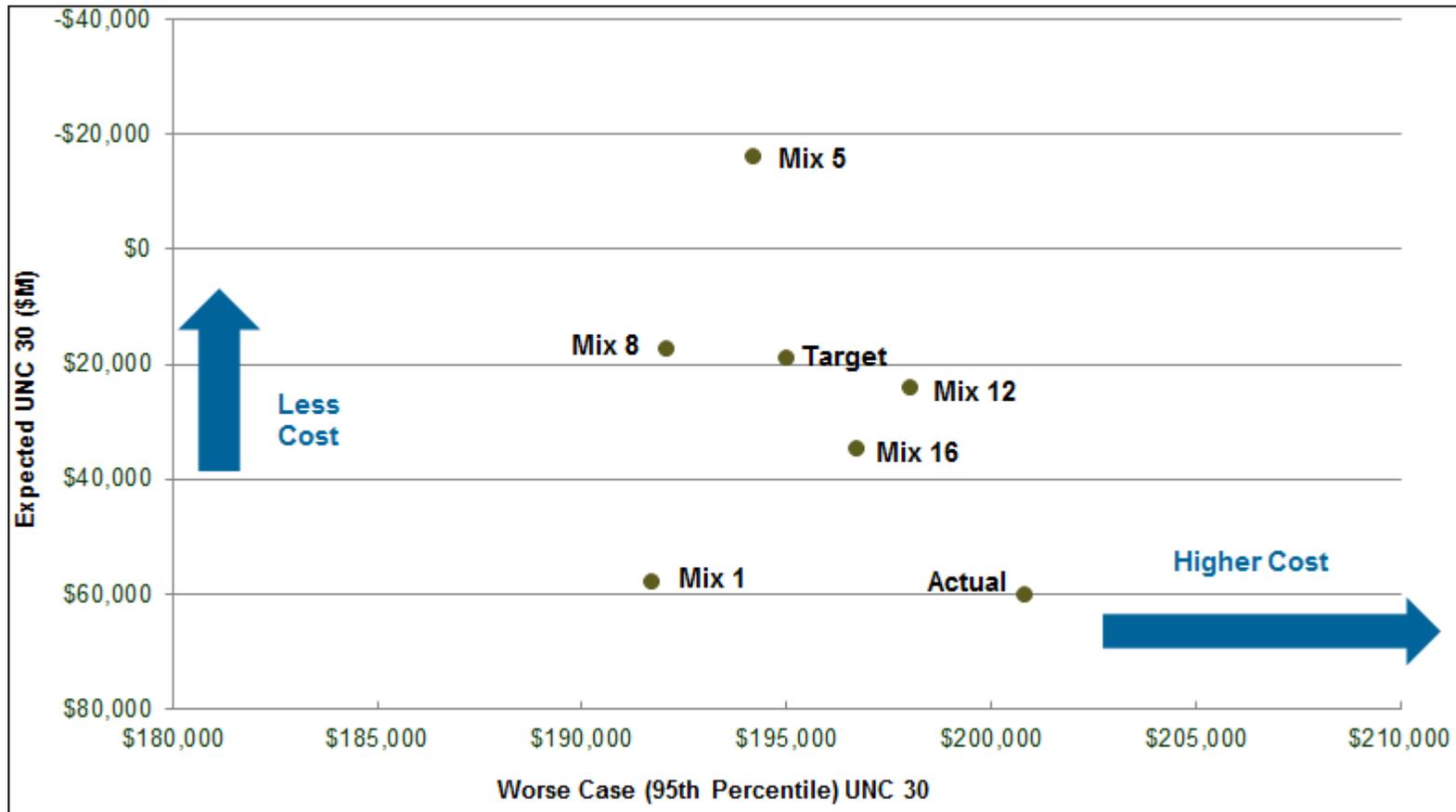
- The above graph contrasts expected UNC30 vs. worse case UNC30

Mix Name	Broad Allocation
Actual	EQ36/ IG27/ Cash 11/Alts 27
Mix 1	EQ31/ IG39/ Cash 1/Alts 29
Mix 5	EQ51/ IG19/ Cash 1/Alts 29
Mix 8	EQ39/ IG28/ Cash 1/Alts 32
Mix 12	EQ42/ IG24/ Cash 5/Alts 29
Mix 16	EQ38/ IG28/ Cash 5/Alts 29
Target	EQ42/IG28/ Cash 1/Alts 29

UNC 30: Change in Risk-Reward Relative to the Actual Allocation
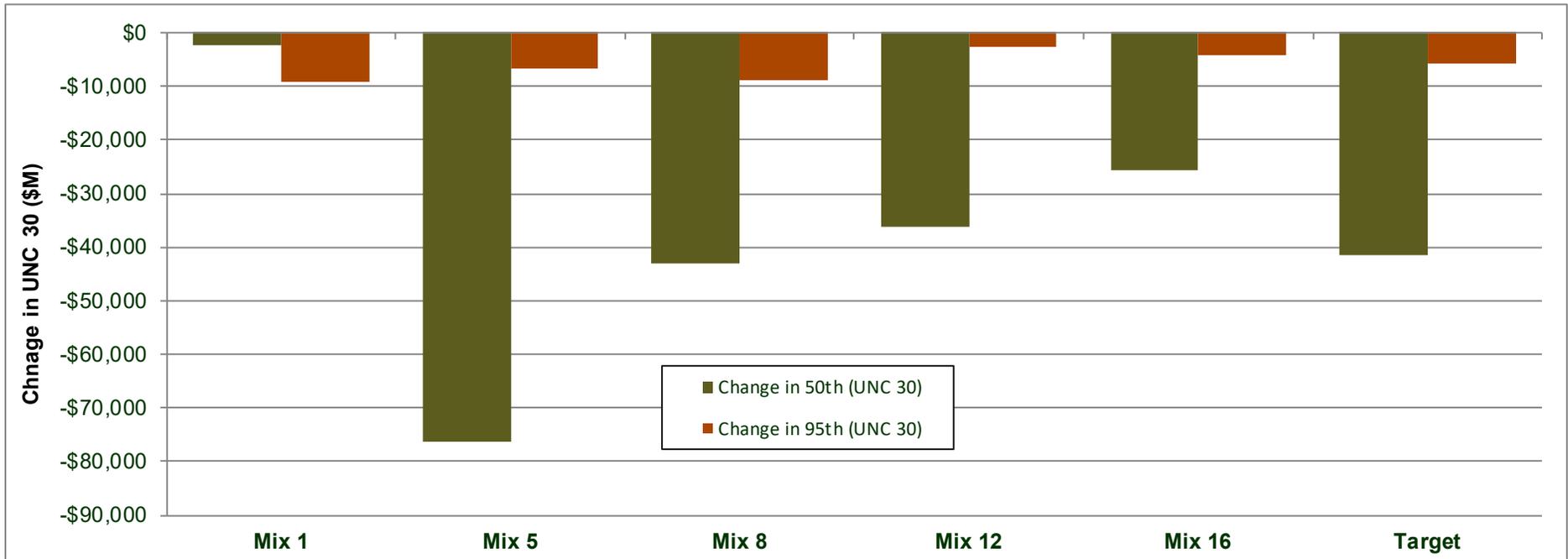
- The above graph depicts the change in the 50th percentile (Expected Cost) and the 95th percentile (Worse Case Cost) relative to the Actual Allocation
  - A positive (negative) change is an increase (reduction) in cost

- Both expected cost and worse case cost are reduced by moving to any alternative mix

Mix Name	Broad Allocation
Actual	EQ36/ IG27/ Cash 11/Alts 27
Mix 1	EQ31/ IG39/ Cash 1/Alts 29
Mix 5	EQ51/ IG19/ Cash 1/Alts 29
Mix 8	EQ39/ IG28/ Cash 1/Alts 32
Mix 12	EQ42/ IG24/ Cash 5/Alts 29
Mix 16	EQ38/ IG28/ Cash 5/Alts 29
Target	EQ42/IG28/ Cash 1/Alts 29

Employer Contribution Rate Analysis

Median Employer Contribution Rate

Mix Name	Broad Allocation
Actual	EQ36/ IG27/ Cash 11/Alts 27
Mix 1	EQ31/ IG39/ Cash 1/Alts 29
Mix 5	EQ51/ IG19/ Cash 1/Alts 29
Mix 8	EQ39/ IG28/ Cash 1/Alts 32
Mix 12	EQ42/ IG24/ Cash 5/Alts 29
Mix 16	EQ38/ IG28/ Cash 5/Alts 29
Target	EQ42/IG28/ Cash 1/Alts 29
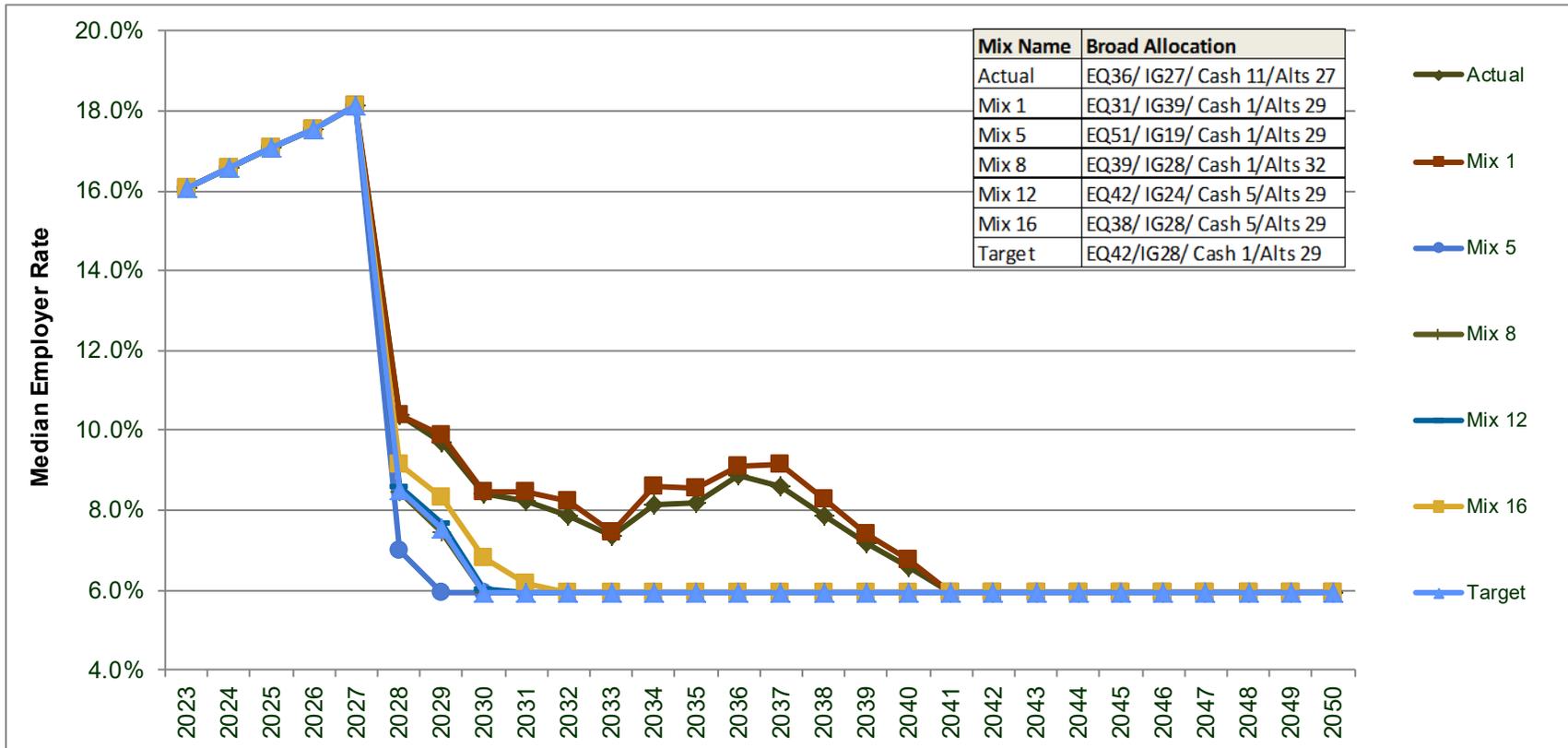
● The above graph illustrates the <u>expected</u> employer contribution rate over the next 30 years

Expected vs. Worse Case Employer Rate (Year 8)

Chart: Expected Employer Rate (8th Year) on the vertical axis (0.00% to 12.00%) versus Worse Case (95th) Employer Rate (8th Year) on the horizontal axis (26.50% to 29.50%).

Data points:
- Mix 1: ~27.1%, ~10.0%
- Actual: ~27.65%, ~9.85%
- Mix 16: ~27.85%, ~8.45%
- Mix 8: ~28.1%, ~7.5%
- Mix 12: ~28.3%, ~7.8%
- Target: ~28.4%, ~7.7%
- Mix 5: ~29.35%, ~6.0%

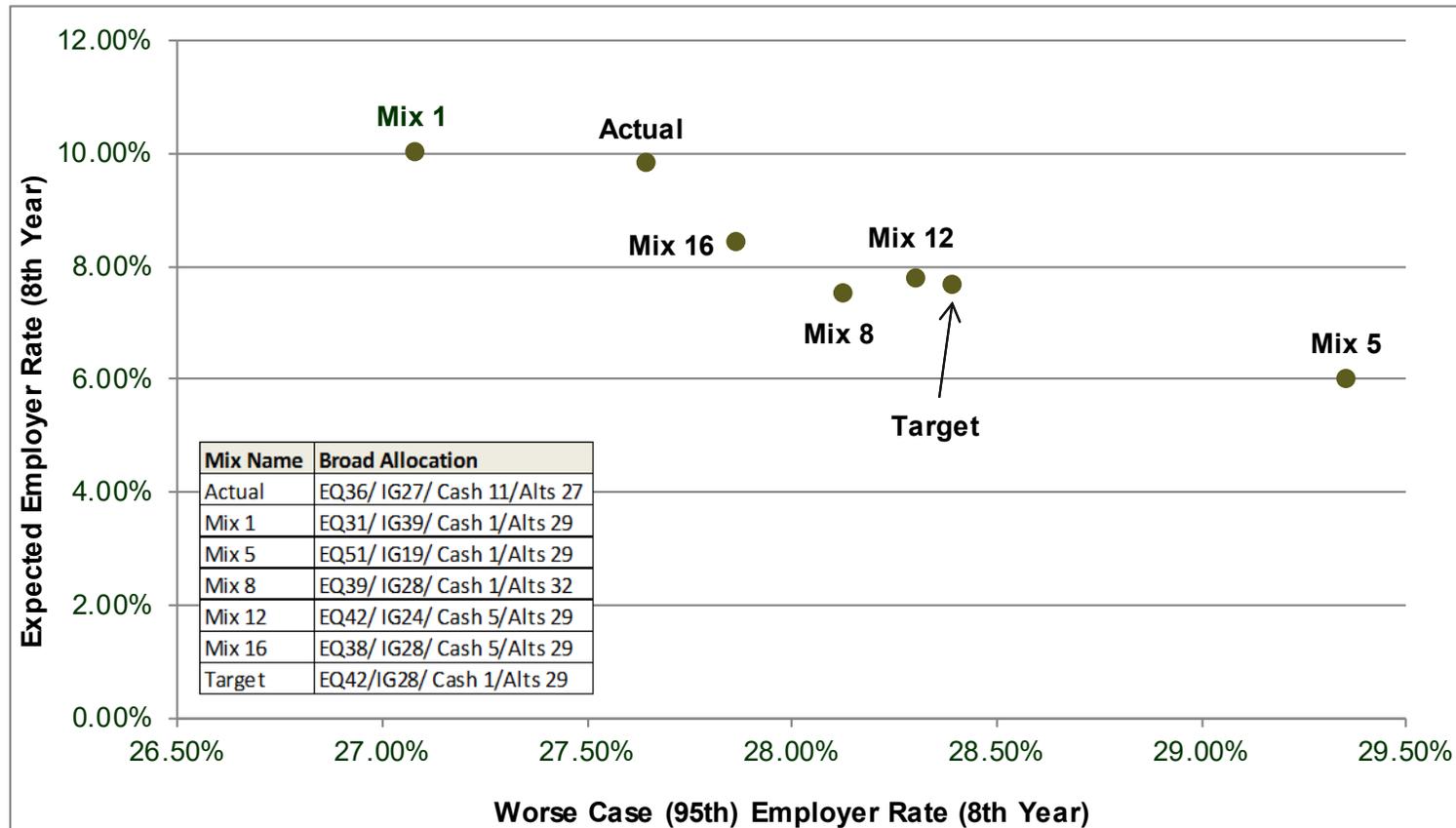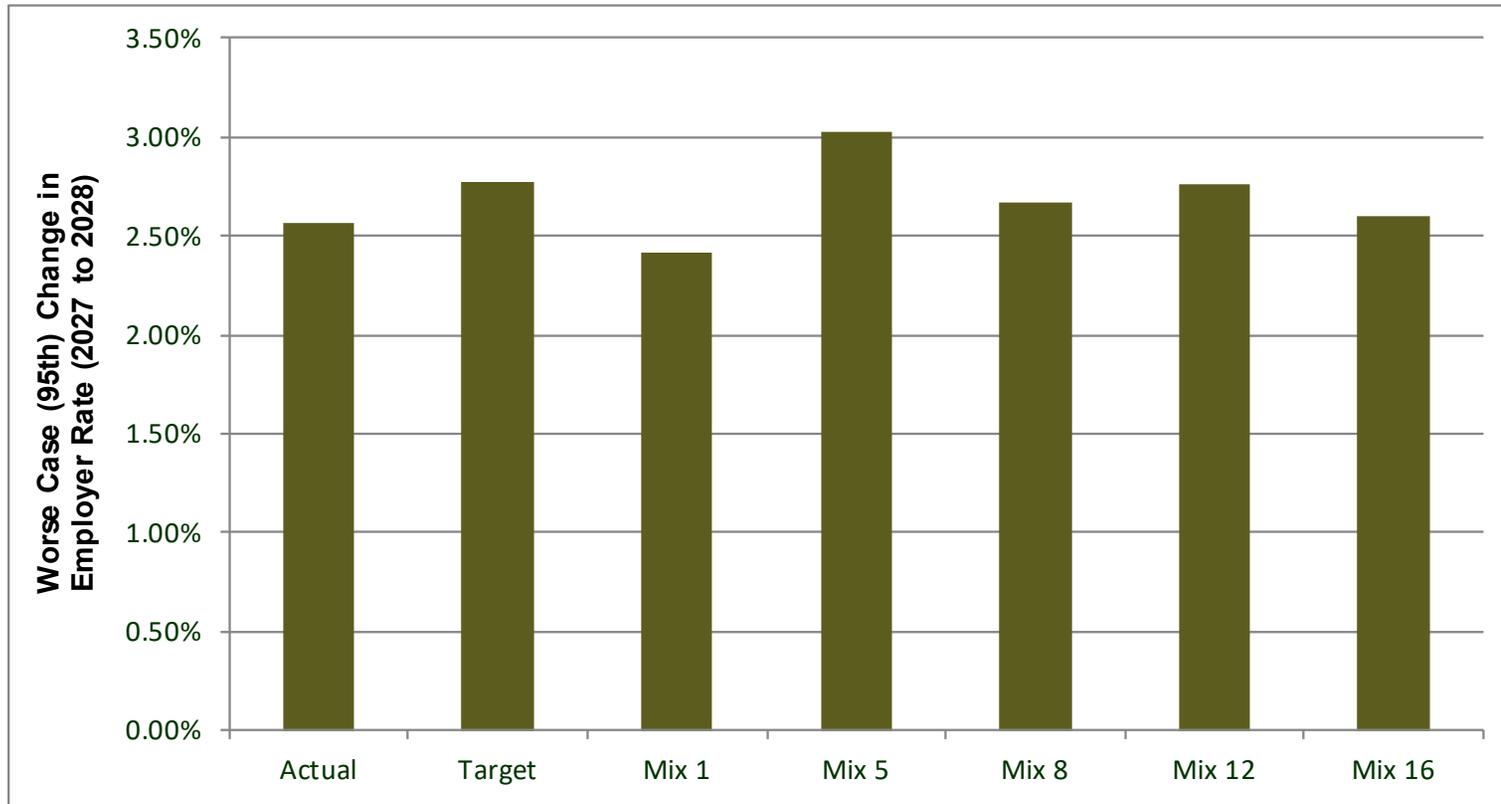| Mix Name	Broad Allocation
Actual	EQ36/ IG27/ Cash 11/Alts 27
Mix 1	EQ31/ IG39/ Cash 1/Alts 29
Mix 5	EQ51/ IG19/ Cash 1/Alts 29
Mix 8	EQ39/ IG28/ Cash 1/Alts 32
Mix 12	EQ42/ IG24/ Cash 5/Alts 29
Mix 16	EQ38/ IG28/ Cash 5/Alts 29
Target	EQ42/IG28/ Cash 1/Alts 29

- The above graph illustrates a reward-risk trade-off in contribution space in year 8 (2028) of the forecast

- More aggressive mixes are _expected_ to lower the employer rate but result in a higher rate in a worse case scenario
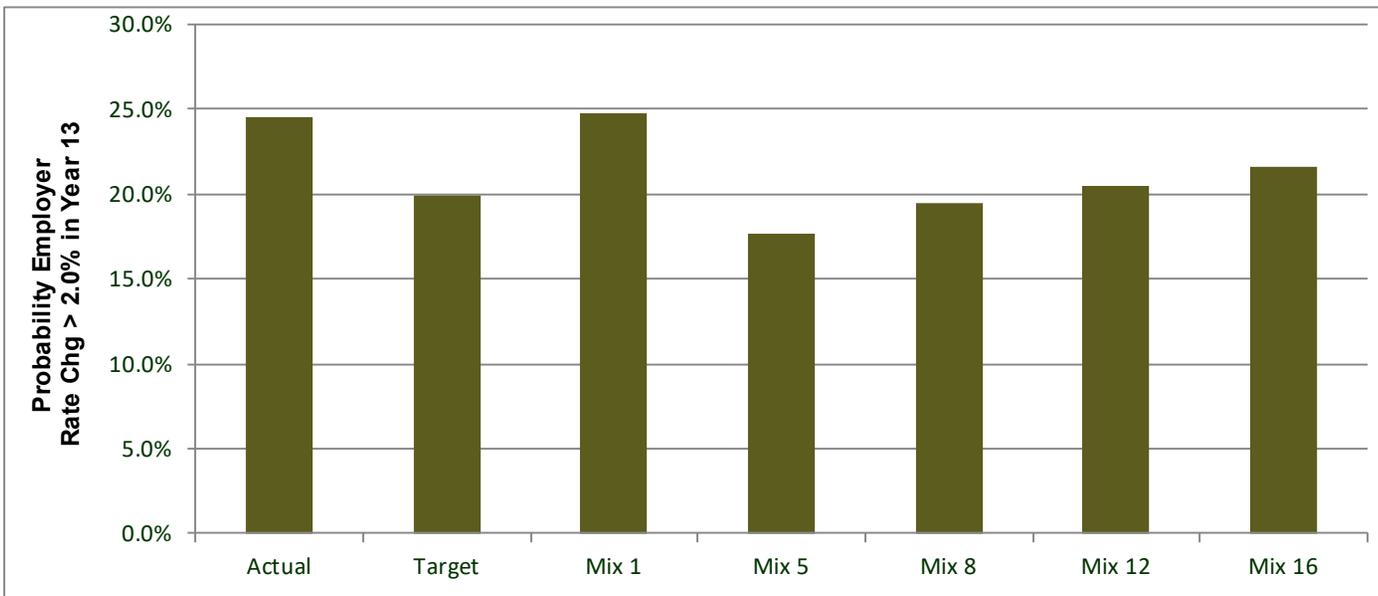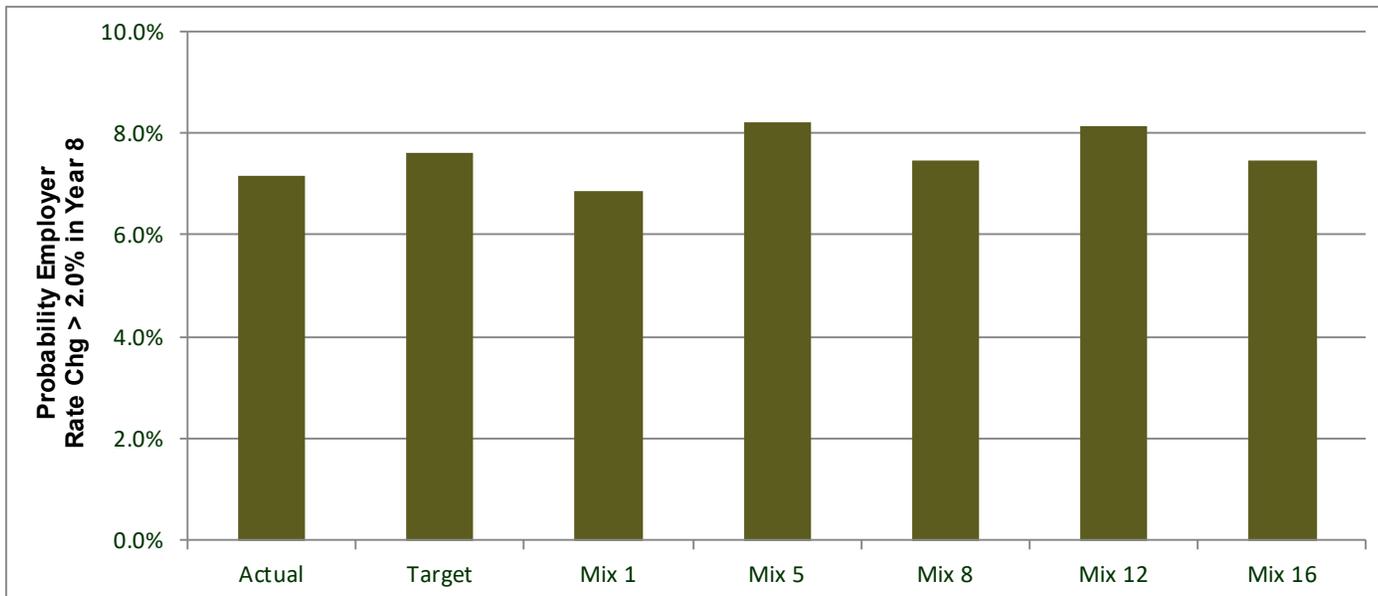
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Worse Case Change in Employer Rate (2027 to 2028)

	Actual	Target	Mix 1	Mix 5	Mix 8	Mix 12	Mix 16
10-Yr Expected Return	5.2%	5.8%	5.2%	6.2%	5.8%	5.7%	5.6%
30-Year Expected Return	5.99%	6.48%	6.05%	6.81%	6.50%	6.41%	6.31%
Standard Deviation	9.4%	10.8%	8.8%	12.4%	10.6%	10.7%	10.15%
Worse Case Chg (2027-2028)	2.56%	2.77%	2.41%	3.03%	2.67%	2.76%	2.60%

Mix Name	Broad Allocation
Actual	EQ36/ IG27/ Cash 11/Alts 27
Mix 1	EQ31/ IG39/ Cash 1/Alts 29
Mix 5	EQ51/ IG19/ Cash 1/Alts 29
Mix 8	EQ39/ IG28/ Cash 1/Alts 32
Mix 12	EQ42/ IG24/ Cash 5/Alts 29
Mix 16	EQ38/ IG28/ Cash 5/Alts 29
Target	EQ42/IG28/ Cash 1/Alts 29

- Bar chart shows the worse case (95th) change in the employer contribution rate from 2027 to 2028

- Portfolio risk (standard deviation) is highly correlated with annual contribution volatility

Probability of Employer Rate Spike (>2.0%) Over One Year

Chart (top): Probability Employer Rate Chg > 2.0% in Year 8

Category	Value
Actual	~7.1%
Target	~7.6%
Mix 1	~6.8%
Mix 5	~8.2%
Mix 8	~7.4%
Mix 12	~8.1%
Mix 16	~7.4%

Chart (bottom): Probability Employer Rate Chg > 2.0% in Year 13

Category	Value
Actual	~24.5%
Target	~20.0%
Mix 1	~24.7%
Mix 5	~17.6%
Mix 8	~19.5%
Mix 12	~20.5%
Mix 16	~21.5%

- The probability of an employer rate spike (>2.0%) depends on the year
  - Year 8 (2028) and 13 (2033) are shown on the left
  - Probability ranges from 7% to 25% over time
  - Year 13 (2033) is the most volatile year in the 30-year forecast horizon

- Probability may not vary much across the mixes in some years

- A conservative mix may have a higher probability of a rate spike than an aggressive mix
  - Actual and Mix 1 in Year 13 have a higher probability

Mix Name	Broad Allocation
Actual	EQ36/ IG27/ Cash 11/Alts 27
Mix 1	EQ31/ IG39/ Cash 1/Alts 29
Mix 5	EQ51/ IG19/ Cash 1/Alts 29
Mix 8	EQ39/ IG28/ Cash 1/Alts 32
Mix 12	EQ42/ IG24/ Cash 5/Alts 29
Mix 16	EQ38/ IG28/ Cash 5/Alts 29
Target	EQ42/IG28/ Cash 1/Alts 29

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Employer Contribution Rate Per Unit of Excess Return Over 30 Years

Mix Name	Broad Allocation
Actual	EQ36/ IG27/ Cash 11/Alts 27
Mix 1	EQ31/ IG39/ Cash 1/Alts 29
Mix 5	EQ51/ IG19/ Cash 1/Alts 29
Mix 8	EQ39/ IG28/ Cash 1/Alts 32
Mix 12	EQ42/ IG24/ Cash 5/Alts 29
Mix 16	EQ38/ IG28/ Cash 5/Alts 29
Target	EQ42/IG28/ Cash 1/Alts 29
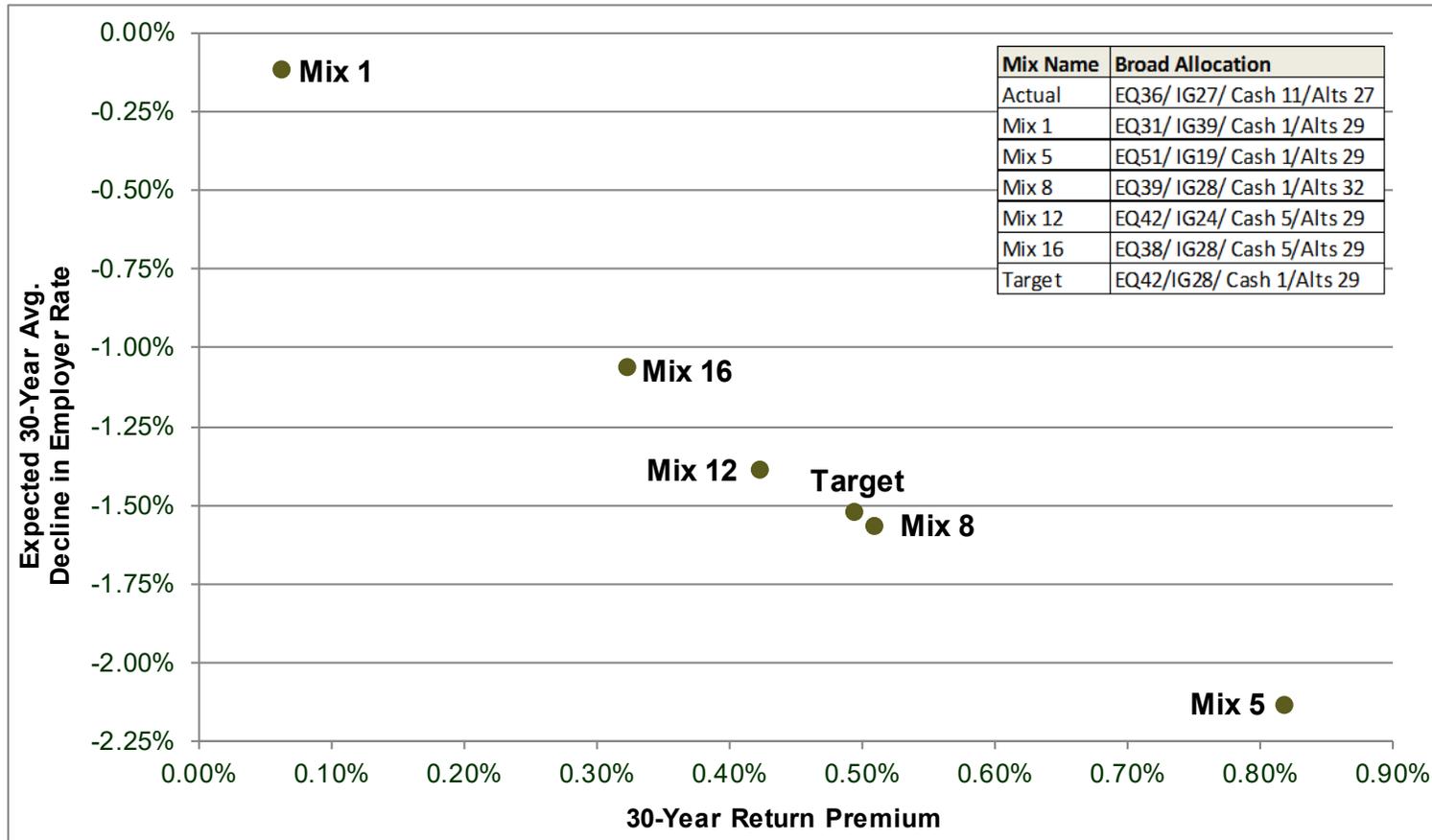
- The graph illustrates the *expected* reduction in the employer rate per unit of additional return
  - The vertical axis is the *expected* 30-year average employer rate relative to the Actual Mix
  - The horizontal axis is the difference in 30-year return between the illustrated Mix and the Actual Mix (i.e., a return premium)

- For example, the expected return for Mix 5 is 0.82% higher than the Actual Mix and is expected to result in an average annual employer rate that is 2.1% lower

Employer Contribution Required to Achieve 100% Funded Status at 12/31/2030
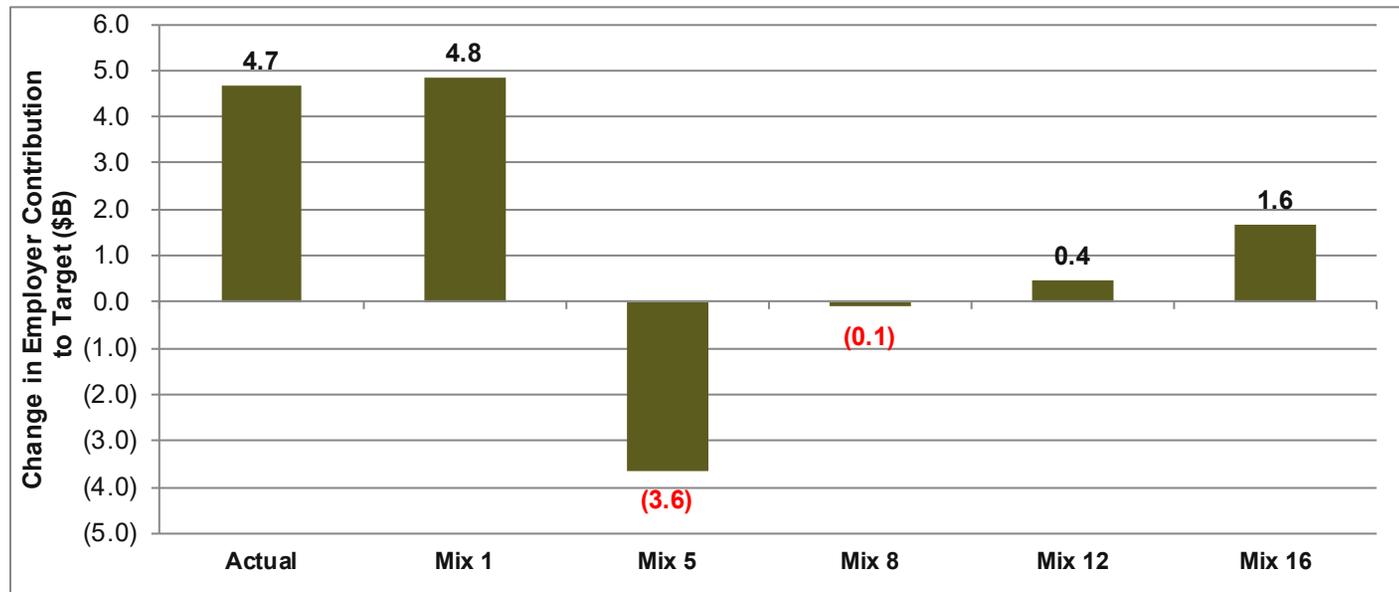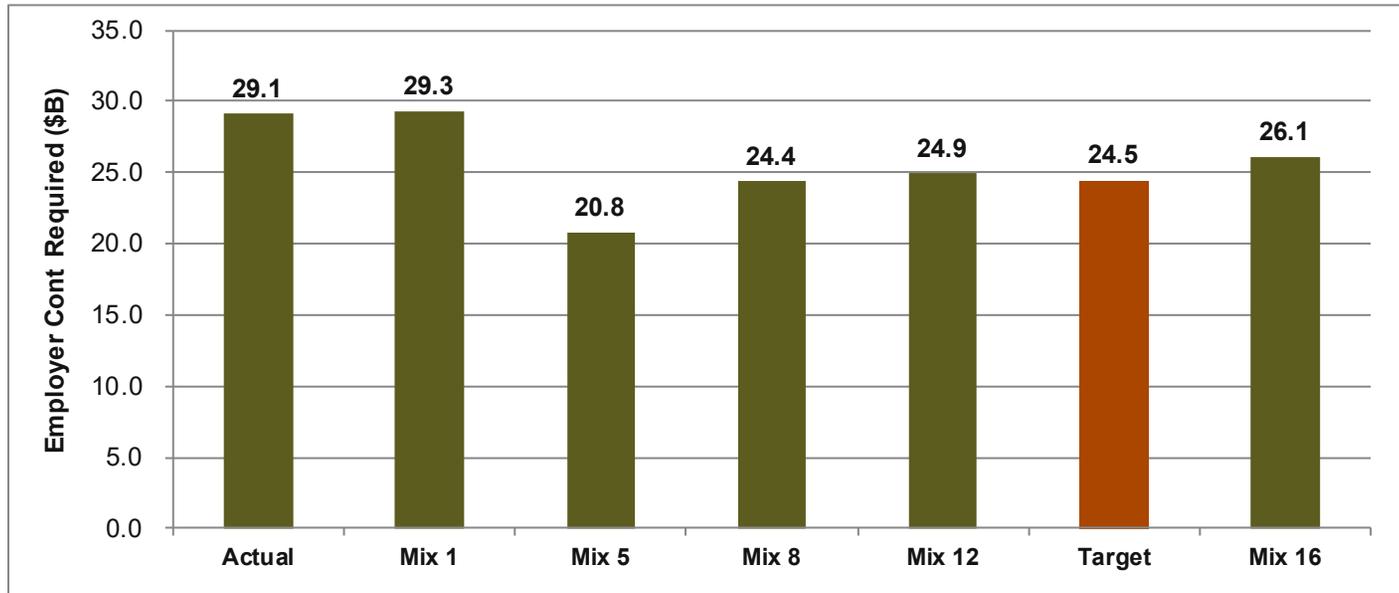
- The top graph shows the employer contribution required to be 100% funded at the end of 10 years given the 10-year expected return is realized every year
  - Employer contribution is determined as a level $ amount over 10 years

- The bottom graph shows the difference in required contribution relative to the current policy target

- Mixes with higher expected return than the current policy reduce contributions – Mix 5 and 8

- The Actual Allocation and Mix 1 require $4.7-4.8B more in contributions over the next 10 years

Employer Contribution Required to Achieve 100% Funded Status at 12/31/2050

Employer Cont Required ($B)

	Actual	Mix 1	Mix 5	Mix 8	Mix 12	Target	Mix 16
	68.9	66.3	42.1	51.5	55.2	51.9	58.5

Change in Employer Contribution to Target ($B)

	Actual	Mix 1	Mix 5	Mix 8	Mix 12	Mix 16
	16.9	14.4	(9.8)	(0.4)	3.3	6.5
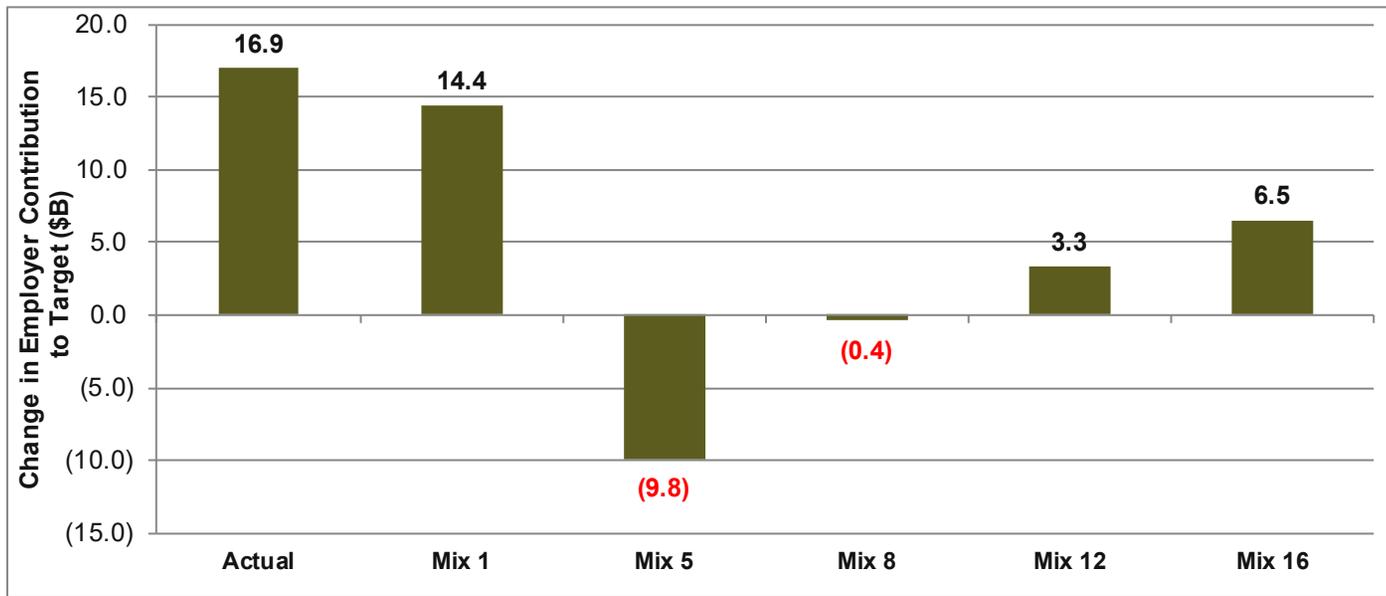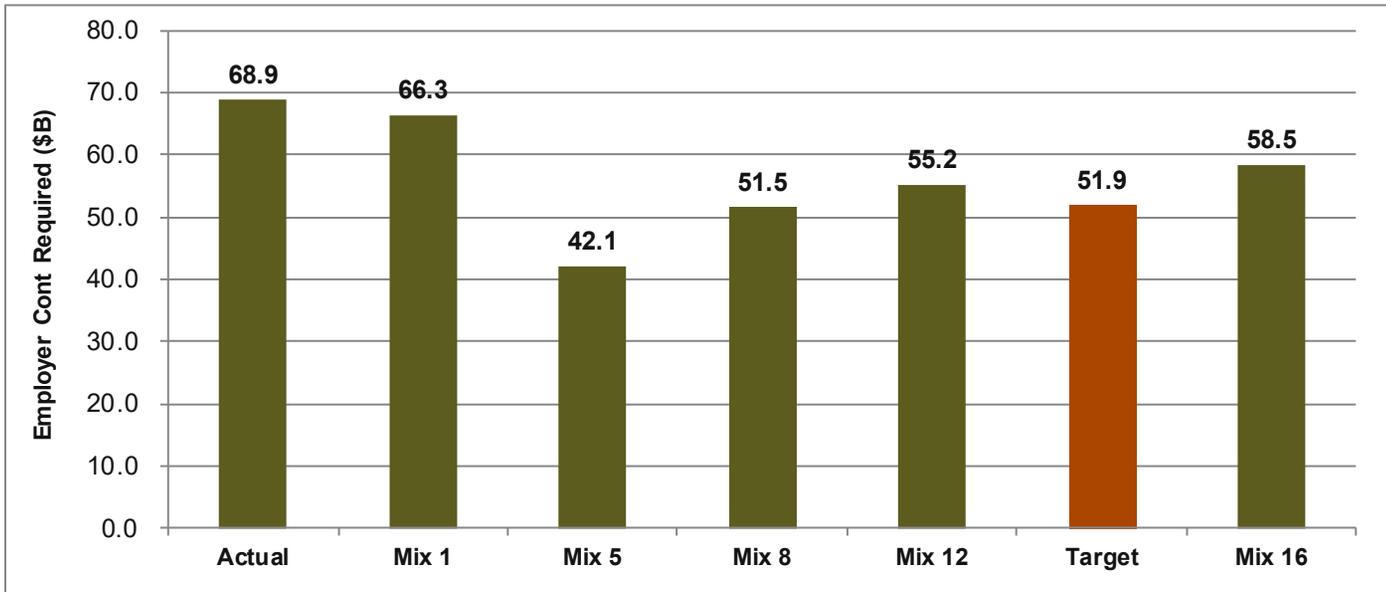
- The top graph shows the employer contribution required to be 100% funded at the end of 30 years given the 30-year expected return is realized every year
  - Employer contribution is determined as a level $ amount over 30 years

- Savings or cost relative to the current policy target are exacerbated over a longer time horizon

- Mix 5 and 8 reduce contributions relative to the current target

- The Actual Allocation and Mix 1 require $14-17B more in contributions over the next 30 years

10-Year Scenario Analysis

Scenario Development

	Number of Scenarios				10-Year Annualized Inflation				10-Year Annualized Global Equity		
	Low Growth	Moderate	High Growth		Low Growth	Moderate	High Growth		Low Growth	Moderate	High Growth
Low Inflation	16	167	17		0.89%	0.95%	0.85%		-2.60%	7.34%	15.78%
Moderate	160	1,281	159		2.27%	2.23%	2.28%		-2.33%	7.21%	16.95%
High Inflation	24	152	24		3.61%	3.59%	3.48%		-2.64%	7.22%	17.04%

- Simulations are sorted into economic regimes based on simulated inflation and global equity
  - Low Inflation = Below 10th percentile (200 scenarios)
  - Moderate inflation = 10th - 90th percentile (1,600 scenarios)
  - High Inflation = Above 90th percentile (200 Scenarios)
  - Low Growth = Global equity returns below 10th percentile (200 scenarios)
  - Moderate Growth = Global equity returns between 10th and 90th percentile (1,600 scenarios)
  - High Growth = Global equity returns above 90th percentile (200 Scenarios)

- Scenarios are based on 10 years of simulated inflation and equity returns
  - 2021 – 2030 contributions
  - 12/31/2030 Funded Status
  - 10-Year Ultimate Net Cost

Mix Name	Broad Allocation
Actual	EQ36/ IG27/ Cash 11/Alts 27
Mix 1	EQ31/ IG39/ Cash 1/Alts 29
Mix 5	EQ51/ IG19/ Cash 1/Alts 29
Mix 8	EQ39/ IG28/ Cash 1/Alts 32
Mix 12	EQ42/ IG24/ Cash 5/Alts 29
Mix 16	EQ38/ IG28/ Cash 5/Alts 29
Target	EQ42/IG28/ Cash 1/Alts 29

10-Year Annualized Returns

	Low Growth				Moderate				High Growth			
Low Inflation	0.38%	0.72%	-0.17%		5.29%	5.28%	6.37%		9.60%	9.30%	12.07%	
	0.38%	0.20%	0.37%	0.25%	5.90%	5.84%	5.67%	5.89%	10.77%	10.79%	10.34%	10.84%
Moderate	0.59%	0.91%	0.01%		5.33%	5.31%	6.34%		10.27%	9.92%	12.89%	
	0.54%	0.38%	0.55%	0.43%	5.90%	5.85%	5.69%	5.89%	11.49%	11.52%	11.05%	11.57%
High Inflation	0.67%	1.03%	0.00%		5.48%	5.44%	6.39%		10.49%	10.13%	13.08%	
	0.63%	0.44%	0.63%	0.48%	5.99%	5.94%	5.80%	5.98%	11.71%	11.73%	11.26%	11.77%

Best Result in Economic Regime

Key:

Actual	Mix 1	Mix 5	
Mix 8	Mix 12	Mix 16	Target

Mix Name	Broad Allocation
Actual	EQ36/ IG27/ Cash 11/Alts 27
Mix 1	EQ31/ IG39/ Cash 1/Alts 29
Mix 5	EQ51/ IG19/ Cash 1/Alts 29
Mix 8	EQ39/ IG28/ Cash 1/Alts 32
Mix 12	EQ42/ IG24/ Cash 5/Alts 29
Mix 16	EQ38/ IG28/ Cash 5/Alts 29
Target	EQ42/IG28/ Cash 1/Alts 29

10-Year Cumulative Contributions (2021 – 2030)

	Low Growth				Moderate				High Growth			
Low Inflation	36.7	35.6	38.8		25.4	25.2	25.1		21.7	21.6	21.6	
	36.9	37.4	36.9	37.3	25.1	25.2	25.2	25.1	21.6	21.6	21.6	21.6
Moderate	38.5	37.6	40.3		27.8	27.6	27.2		23.1	23.1	23.0	
	38.7	39.1	38.6	39.0	27.2	27.3	27.4	27.3	23.0	23.0	23.0	23.0
High Inflation	43.2	42.1	45.5		30.3	30.4	29.4		23.9	24.0	23.9	
	43.5	44.0	43.4	43.9	29.7	29.8	29.9	29.7	23.9	23.9	23.9	23.9

Best Result in Economic Regime

Key:

Actual	Mix 1	Mix 5	
Mix 8	Mix 12	Mix 16	Target

Mix Name	Broad Allocation
Actual	EQ36/ IG27/ Cash 11/Alts 27
Mix 1	EQ31/ IG39/ Cash 1/Alts 29
Mix 5	EQ51/ IG19/ Cash 1/Alts 29
Mix 8	EQ39/ IG28/ Cash 1/Alts 32
Mix 12	EQ42/ IG24/ Cash 5/Alts 29
Mix 16	EQ38/ IG28/ Cash 5/Alts 29
Target	EQ42/IG28/ Cash 1/Alts 29

12/31/2030 Market Funded Status

	Low Growth				Moderate				High Growth			
Low Inflation	69.1%	70.4%	67.7%		103.4%	102.9%	116.3%		151.3%	147.4%	190.6%	
	69.5%	68.8%	69.3%	68.9%	110.2%	109.6%	107.6%	110.1%	169.0%	169.2%	162.3%	170.1%
Moderate	69.6%	70.9%	68.4%		98.7%	98.2%	109.7%		148.8%	144.1%	188.3%	
	70.0%	69.3%	69.8%	69.5%	104.4%	104.0%	102.2%	104.4%	166.2%	166.7%	159.6%	167.3%
High Inflation	66.5%	68.0%	64.5%		94.6%	94.1%	103.6%		146.5%	141.8%	185.3%	
	66.6%	65.8%	66.5%	66.0%	99.2%	98.9%	97.5%	99.2%	163.8%	164.1%	157.3%	164.6%

Best Result in Economic Regime

Key:

Actual	Mix 1	Mix 5	
Mix 8	Mix 12	Mix 16	Target

Mix Name	Broad Allocation
Actual	EQ36/ IG27/ Cash 11/Alts 27
Mix 1	EQ31/ IG39/ Cash 1/Alts 29
Mix 5	EQ51/ IG19/ Cash 1/Alts 29
Mix 8	EQ39/ IG28/ Cash 1/Alts 32
Mix 12	EQ42/ IG24/ Cash 5/Alts 29
Mix 16	EQ38/ IG28/ Cash 5/Alts 29
Target	EQ42/IG28/ Cash 1/Alts 29

10-Year Ultimate Net Cost

	Low Growth				Moderate				High Growth			
Low Inflation	70.1	67.6	73.8		21.7	22.0	7.5		(33.6)	(29.4)	(75.9)	
	69.9	71.3	70.0	70.9	14.1	14.7	17.0	14.1	(52.7)	(52.9)	(45.4)	(53.9)
Moderate	73.6	71.2	76.8		29.3	29.8	16.1		(33.3)	(27.9)	(79.1)	
	73.4	74.6	73.5	74.2	22.2	22.8	24.9	22.3	(53.5)	(54.0)	(45.9)	(54.7)
High Inflation	84.7	81.7	89.4		37.0	37.7	25.1		(32.9)	(27.1)	(80.4)	
	84.8	86.3	84.8	85.9	30.7	31.2	33.1	30.8	(54.1)	(54.5)	(46.1)	(55.1)

Best Result in Economic Regime

Key:

Actual	**Mix 1**	**Mix 5**	
Mix 8	**Mix 12**	**Mix 16**	**Target**

Mix Name	Broad Allocation
Actual	EQ36/ IG27/ Cash 11/Alts 27
Mix 1	EQ31/ IG39/ Cash 1/Alts 29
Mix 5	EQ51/ IG19/ Cash 1/Alts 29
Mix 8	EQ39/ IG28/ Cash 1/Alts 32
Mix 12	EQ42/ IG24/ Cash 5/Alts 29
Mix 16	EQ38/ IG28/ Cash 5/Alts 29
Target	EQ42/IG28/ Cash 1/Alts 29

30-Year Scenario Analysis

Scenario Development

	Number of Scenarios			10-Year Annualized Inflation			10-Year Annualized Global Equity		
	Low Growth	Moderate	High Growth	Low Growth	Moderate	High Growth	Low Growth	Moderate	High Growth
Low Inflation	23	163	14	1.40%	1.45%	1.47%	2.20%	7.13%	13.10%
Moderate	153	1,275	172	2.28%	2.23%	2.25%	1.85%	7.51%	12.89%
High Inflation	24	162	14	3.05%	3.04%	3.00%	1.90%	7.43%	12.67%

- Simulations are sorted into economic regimes based on simulated inflation and global equity
  - Low Inflation = Below 10th percentile (200 scenarios)
  - Moderate inflation = 10th - 90th percentile (1,600 scenarios)
  - High Inflation = Above 90th percentile (200 Scenarios)
  - Low Growth = Global equity returns below 10th percentile (200 scenarios)
  - Moderate Growth = Global equity returns between 10th and 90th percentile (1,600 scenarios)
  - High Growth = Global equity returns above 90th percentile (200 Scenarios)
- Scenarios are based on 30 years of simulated inflation and equity returns
  - 2021 – 2050 contributions
  - 12/31/2050 Funded Status
  - 30-Year Ultimate Net Cost

Mix Name	Broad Allocation
Actual	EQ36/ IG27/ Cash 11/Alts 27
Mix 1	EQ31/ IG39/ Cash 1/Alts 29
Mix 5	EQ51/ IG19/ Cash 1/Alts 29
Mix 8	EQ39/ IG28/ Cash 1/Alts 32
Mix 12	EQ42/ IG24/ Cash 5/Alts 29
Mix 16	EQ38/ IG28/ Cash 5/Alts 29
Target	EQ42/IG28/ Cash 1/Alts 29

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30-Year Annualized Returns

	Low Growth				Moderate				High Growth			
Low Inflation	3.12%	3.35%	3.17%		5.76%	5.83%	6.59%		8.79%	8.66%	10.72%	
	3.34%	3.20%	3.26%	3.27%	6.29%	6.20%	6.10%	6.26%	9.77%	9.74%	9.41%	9.80%
Moderate	3.19%	3.42%	3.11%		6.03%	6.07%	6.87%		8.77%	8.63%	10.50%	
	3.34%	3.21%	3.28%	3.27%	6.54%	6.47%	6.36%	6.53%	9.65%	9.62%	9.33%	9.68%
High Inflation	3.52%	3.77%	3.35%		5.97%	6.01%	6.77%		8.59%	8.46%	10.30%	
	3.63%	3.49%	3.59%	3.56%	6.46%	6.38%	6.28%	6.45%	9.45%	9.43%	9.13%	9.49%

Best Result in Economic Regime

Key:

Actual	Mix 1	Mix 5	
Mix 8	Mix 12	Mix 16	Target

Mix Name	Broad Allocation
Actual	EQ36/ IG27/ Cash 11/Alts 27
Mix 1	EQ31/ IG39/ Cash 1/Alts 29
Mix 5	EQ51/ IG19/ Cash 1/Alts 29
Mix 8	EQ39/ IG28/ Cash 1/Alts 32
Mix 12	EQ42/ IG24/ Cash 5/Alts 29
Mix 16	EQ38/ IG28/ Cash 5/Alts 29
Target	EQ42/IG28/ Cash 1/Alts 29

30-Year Cumulative Contributions (2021 – 2050)

	Low Growth				Moderate				High Growth			
Low Inflation	139.0	133.6	135.0		81.8	80.2	73.6		51.6	51.6	51.5	
	132.3	135.7	134.8	134.0	75.1	76.4	77.3	75.6	51.5	51.5	51.5	51.5
Moderate	164.8	159.3	163.7		91.1	89.8	81.1		59.8	59.9	58.1	
	159.6	162.9	161.5	161.3	83.5	84.8	86.0	83.9	58.6	58.6	58.9	58.5
High Inflation	174.3	168.6	173.7		109.3	108.0	96.7		68.4	68.3	65.5	
	169.1	172.6	171.0	170.9	100.0	101.4	103.0	100.3	66.5	66.7	67.2	66.6

Best Result in Economic Regime

Key:

Actual	Mix 1	Mix 5	
Mix 8	Mix 12	Mix 16	Target

Mix Name	Broad Allocation
Actual	EQ36/ IG27/ Cash 11/Alts 27
Mix 1	EQ31/ IG39/ Cash 1/Alts 29
Mix 5	EQ51/ IG19/ Cash 1/Alts 29
Mix 8	EQ39/ IG28/ Cash 1/Alts 32
Mix 12	EQ42/ IG24/ Cash 5/Alts 29
Mix 16	EQ38/ IG28/ Cash 5/Alts 29
Target	EQ42/IG28/ Cash 1/Alts 29

12/31/2050 Market Funded Status

	Low Growth				Moderate				High Growth			
Low Inflation	81.7%	83.1%	83.9%		130.6%	130.2%	185.0%		345.1%	324.9%	693.4%	
	83.9%	83.0%	83.0%	83.5%	158.3%	154.8%	147.2%	157.8%	495.3%	490.4%	433.9%	501.0%
Moderate	83.9%	85.4%	85.5%		128.5%	127.6%	178.7%		290.4%	273.6%	538.3%	
	85.7%	84.8%	85.1%	85.4%	153.1%	150.5%	143.3%	153.1%	397.6%	394.4%	355.1%	401.8%
High Inflation	79.9%	82.2%	79.8%		116.5%	115.5%	156.8%		231.8%	220.0%	418.4%	
	81.3%	80.0%	80.8%	80.7%	135.6%	133.7%	128.0%	135.7%	313.1%	310.8%	280.6%	316.9%

Best Result in Economic Regime

Key:

Actual	Mix 1	Mix 5	
Mix 8	Mix 12	Mix 16	Target

Mix Name	Broad Allocation
Actual	EQ36/ IG27/ Cash 11/Alts 27
Mix 1	EQ31/ IG39/ Cash 1/Alts 29
Mix 5	EQ51/ IG19/ Cash 1/Alts 29
Mix 8	EQ39/ IG28/ Cash 1/Alts 32
Mix 12	EQ42/ IG24/ Cash 5/Alts 29
Mix 16	EQ38/ IG28/ Cash 5/Alts 29
Target	EQ42/IG28/ Cash 1/Alts 29

30-Year Ultimate Net Cost

	Low Growth				Moderate				High Growth			
Low Inflation	166.7	159.2	159.3		35.8	34.7	(54.4)		(321.2)	(290.4)	(852.4)	
	156.6	161.4	160.4	158.9	(12.6)	(6.1)	6.2	(11.4)	(550.0)	(542.6)	(456.5)	(558.8)
Moderate	193.3	185.2	189.2		40.7	41.0	(58.0)		(280.4)	(250.2)	(724.6)	
	184.9	189.7	187.9	187.2	(10.3)	(4.5)	9.4	(9.9)	(472.9)	(467.1)	(396.7)	(480.4)
High Inflation	216.6	206.1	216.1		74.8	75.4	(22.1)		(206.0)	(181.6)	(598.7)	
	208.5	214.5	211.5	211.5	25.4	30.9	44.4	25.5	(377.8)	(372.9)	(309.1)	(385.8)

Best Result in Economic Regime

Key:

Actual	Mix 1	Mix 5	
Mix 8	Mix 12	Mix 16	Target

Mix Name	Broad Allocation
Actual	EQ36/ IG27/ Cash 11/Alts 27
Mix 1	EQ31/ IG39/ Cash 1/Alts 29
Mix 5	EQ51/ IG19/ Cash 1/Alts 29
Mix 8	EQ39/ IG28/ Cash 1/Alts 32
Mix 12	EQ42/ IG24/ Cash 5/Alts 29
Mix 16	EQ38/ IG28/ Cash 5/Alts 29
Target	EQ42/IG28/ Cash 1/Alts 29

Appendix

Equity Model

Overview

Fundamental Relationship:

Equity Return =   **Capital Appreciation**   **+ Income**   **+/- Valuation Adjustment**

Real Earnings Growth + Inflation

**Over the next decade, U.S. Equity (S&P 500) forecasted at 6.75%; Global Equity (ACWI IMI) forecasted at 7.10%**

- Building up US equity returns from long-term fundamentals results in a 6.75% annualized return
  - *Real earnings growth is linked to real GDP growth over long horizons; we forecast US real GDP of 2.25% over the next decade*
  - *Inflation(CPI-U) forecasted at 2.25%*
    - *Consistent with Fed's inflation target*
    - *Consistent with realized inflation over the past three decades*
    - *In line with the market-based forecast of breakeven inflation (yield difference between Treasuries and TIPS)*
  - *Income return of 2.50% from dividend yield and net share buybacks*
  - *0.25% reduction based on high current US valuations*

- Small return premium for global equity over US equity stems from valuation considerations, higher international dividends and emerging market growth potential

Over the 30 year horizon, Global Equity is forecasted at 7.40%

- Global equities have returned 5.3% above inflation/year from 1900-2020

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Bond Model: Expected Returns Are Driven by the Path of Treasury Yields

Smoothed Yield Paths
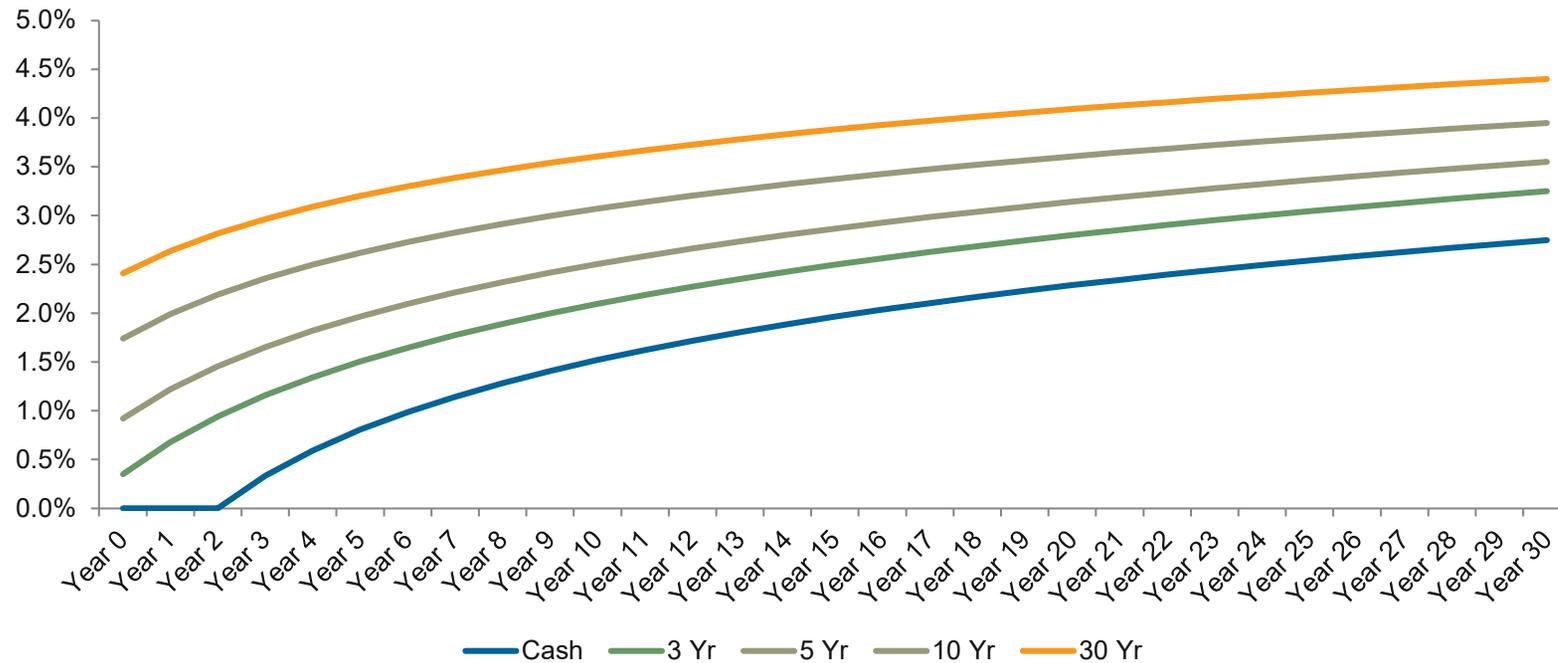
Rising yield projections translate into low bond returns over the next decade, higher returns thereafter

Cash at end of the 30-year horizon is 2.75%

- Reflects a 50 basis point premium over projected inflation which is consistent with long-term US interest rate history

- Cash projected to start to increase from current 0% in Year 2 in line with market expectations

Term premiums are consistent with long-term historical averages

- For example, in Year 30, the 30-year Treasury yield is 4.4%, or 1.65% above cash

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Bond Model: Results

Expected return forecasts

	10 Year Expected Return	30 Year Expected Return
Cash	0.75%	1.75%
1-3 Year TIPS	1.25%	2.25%
Investment Grade Bonds (Aggregate)	1.75%	3.05%
Custom Investment Grade (5+ years)	1.95%	3.45%
High Yield	4.25%	6.40%
Bank Loans	5.15%	6.15%

10-year bond projections are lower than the 30-year projections

- Rising rates drive low fixed income returns over the next decade

- Higher future yields result in higher expected returns over the 30 year horizon

NCRS currently has a custom investment grade (IG) allocation composed of 5+ year maturity bonds

- In the asset-liability study, custom IG bond asset class characteristics will be assessed relative to a shorter maturity IG Aggregate allocation

Alternative Investment Modeling

Private equity, private real estate, opportunistic fixed, inflation sensitive, and hedge funds

Private equity projected with a 2% return premium over global equity

- Premium is consistent with NCRS historical program results

- Private equity is driven by similar economic factors as global equity but modelled with a higher risk

Private core real estate projected at 6.00% return over next decade, 6.40% over 30 years

- Based on projections for income and capital appreciation

- Asset class characteristics fall in between public equity and fixed income

Non core real estate modeled with a 2% premium over private core real estate

- Consistent with NCRS historical program results and well as adjusting expected returns for greater risk

- Asset class risks are scaled upward accordingly as well

Opportunistic fixed income projected at 5.80% return over next decade, 6.75% over 30 years

- Modeled as 50% distressed debt, 25% high yield, and 25% bank loans

- As a component of NCRS's growth allocation, primary role is to grow the asset pool rather than provide defensive characteristics

Inflation sensitive projected at a 4.25% return over next decade; 4.80% over 30 years

- Currently modeled as 33% 1-3 TIPS, 17% Public Commodities, 25% Infrastructure, 25% Private Real Estate

- Will also evaluate this bucket without the commodities allocation, which will increase both expected return and risk

Multistrategy (Hedge Funds) projected at 4.25% return over next decade; 5.00% over 30 years

- Modeled as cash returns plus an equity beta of 0.4 from market exposure and 1% return from non-conventional market exposure
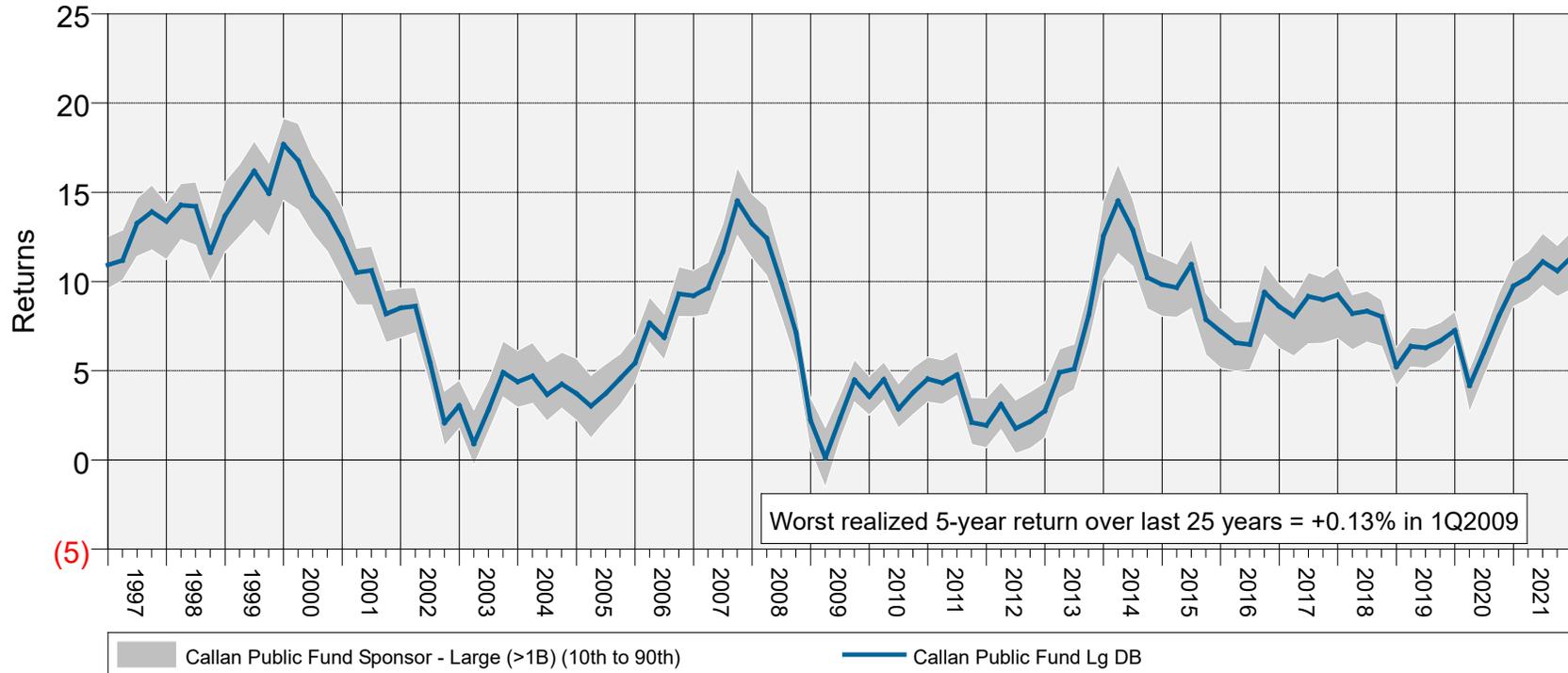
Asset Class Fee Estimates

Asset Class	Fees		
	Mgt	Incentive	Total
Global Equity	0.13%	0.00%	0.13%
Private Equity	0.80%	0.90%	1.70%
Non Core Real Estate	1.25%	0.60%	1.85%
Opportunistic Fixed Income	0.66%	0.34%	1.00%
IG Fixed Income - Current Duration	0.00%	0.00%	0.00%
IG Fixed Income - Agg like Duration	0.00%	0.00%	0.00%
Cash	0.00%	0.00%	0.00%
Core Real Estate	0.60%	0.15%	0.75%
Inflation Sensitive ex Commodities	0.65%	0.35%	1.00%
MultiStrategy	0.25%	0.00%	0.25%

Source: NCRS staff

Public Plan Return Experience

Rolling 5 Year Large Public Fund Median Returns
for 25 Years Ended December 31, 2021

Worst realized 5-year return over last 25 years = +0.13% in 1Q2009

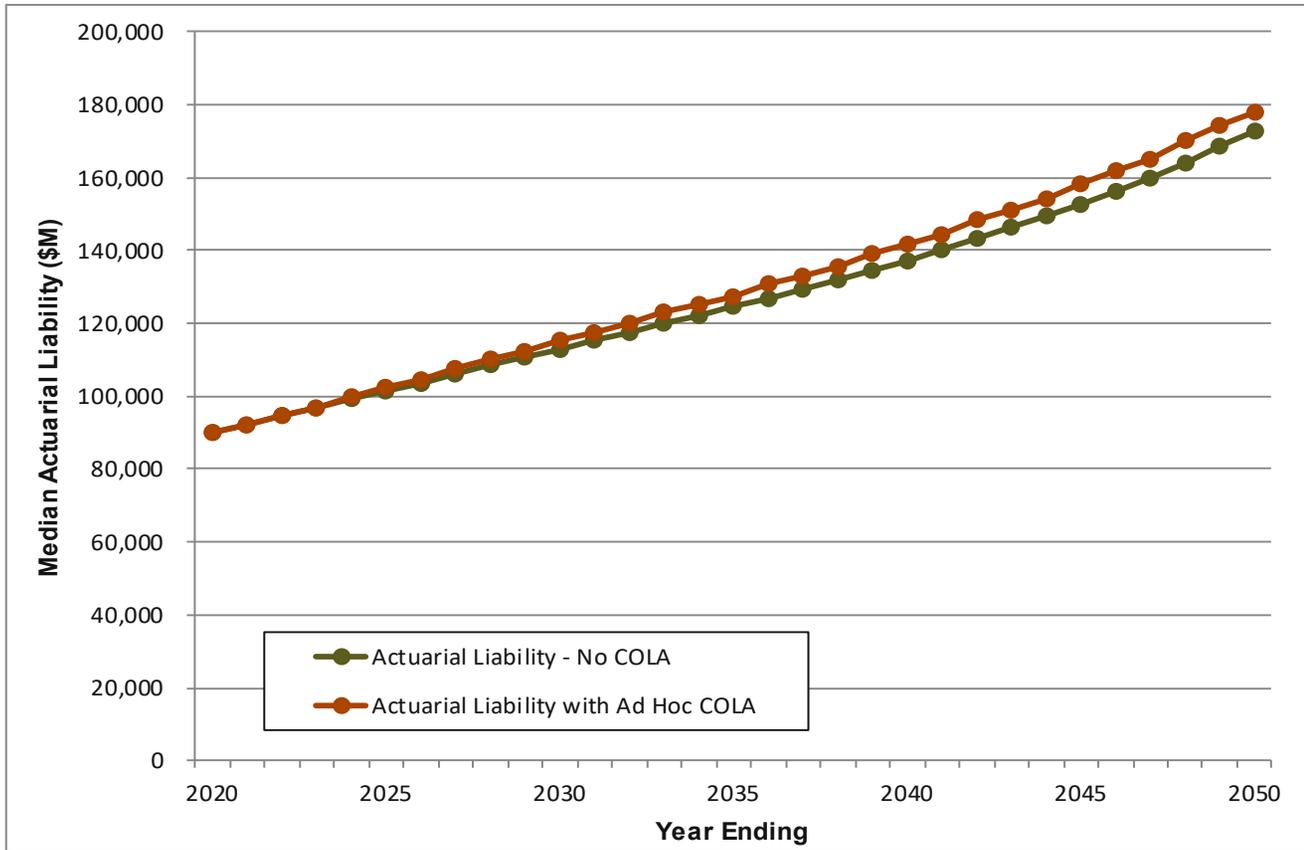Legend: Callan Public Fund Sponsor - Large (>1B) (10th to 90th) | Callan Public Fund Lg DB

To provide additional context around worse case scenarios, the blue line above shows the historical median rolling 5-year return for Large Public Pension Plans in the Callan database

Plan Membership
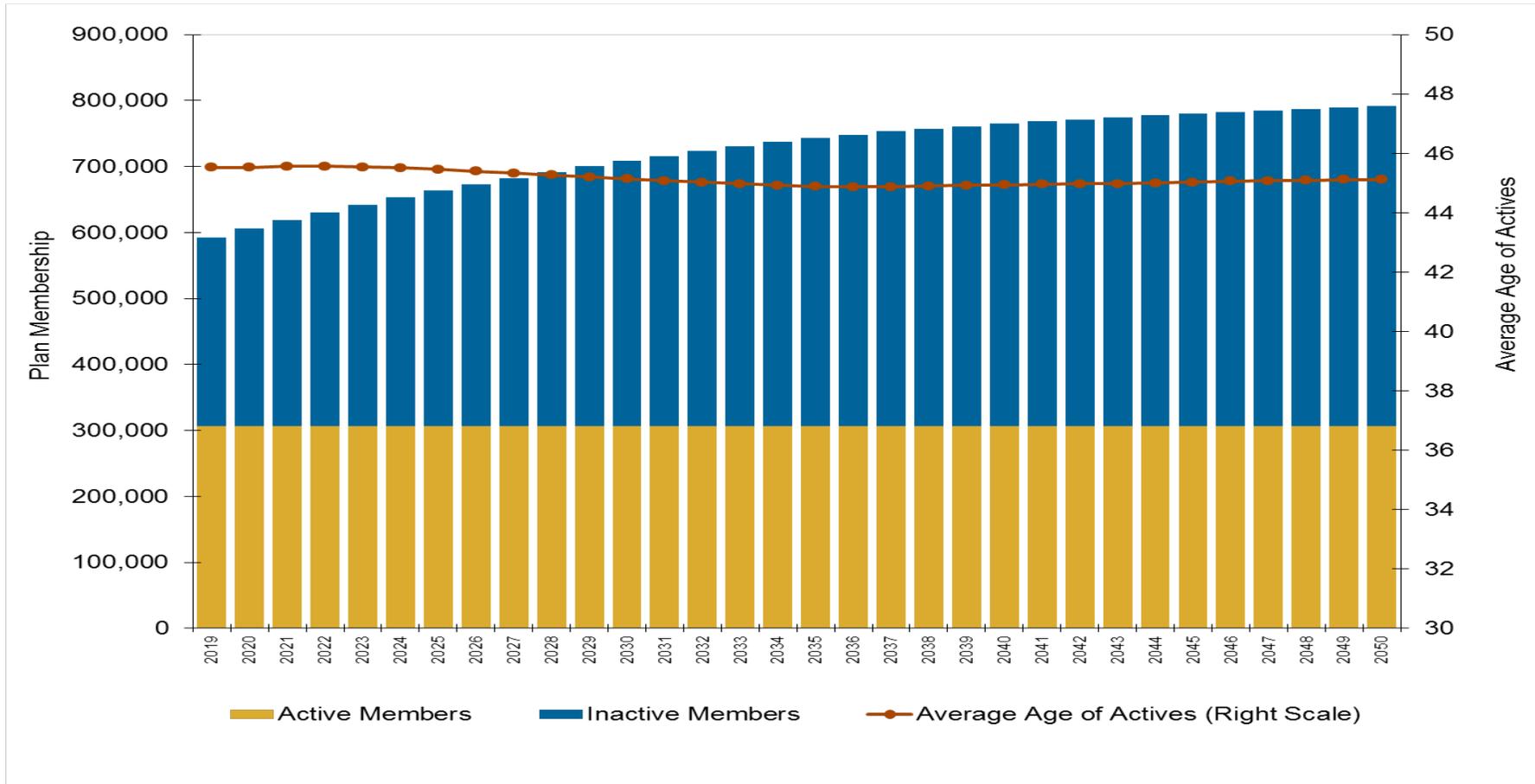
- Active members are held constant at 305,962
  - Future new hires replace exits due to retirement, death, disability, and withdrawal.
  - A constant active membership implies 0% workforce growth
  - Average age of actives is constant over the forecast horizon ~ age 45

Ad Hoc COLA Assumptions

	Total Allowance Increase	National CPI-U
1989	6.70%	4.60%
1990	0.00%	6.10%
1991	5.20%	3.10%
1992	2.20%	2.90%
1993	4.70%	2.70%
1994	3.20%	2.70%
1995	4.40%	2.50%
1996	6.20%	3.30%
1997	2.50%	1.70%
1998	2.30%	1.60%
1999	4.20%	2.70%
2000	2.00%	3.40%
2001	2.00%	2.60%
2002	1.30%	2.40%
2003	1.70%	1.90%
2004	2.00%	3.30%
2005	3.00%	3.40%
2006	2.20%	2.50%
2007	2.20%	4.10%
2008	0.00%	0.10%
2009	0.00%	2.70%
2010	0.00%	1.50%
2011	1.00%	3.00%
2012	0.00%	1.70%
2013	1.00%	1.50%
2014	0.00%	0.80%
2015	0.00%	0.70%
2016	1.00%	2.10%
2017	0.00%	2.10%
2018	0.00%	1.90%
2019	0.00%	2.30%

* Page 85 of TSERS 12/31/2019 Actuarial Report

Chart: Median Actuarial Liability ($M) vs Year Ending (2020–2050), with series "Actuarial Liability - No COLA" and "Actuarial Liability with Ad Hoc COLA".
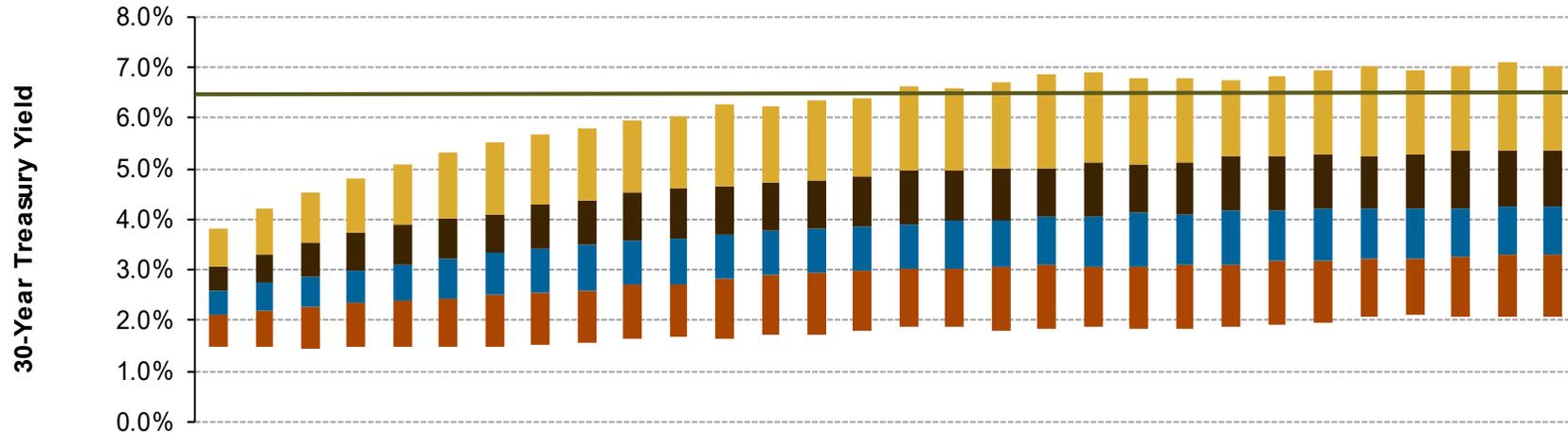
- Ad Hoc COLA assumptions based on last 10 years of TSERS history:
  - Target 20% of cumulative inflation overtime
  - Maximum COLA per year = 1.0%; Minimum COLA per year = 0.0%
  - Granted once every 3 years
- 30-year annualized growth rate in median actuarial liability:
  - No COLA = 2.20% per year
  - With Ad Hoc COLA = 2.31% per year

Simulated 30-Year Treasury Yield

Percentile	ECRSP Period			2030	2035	2040	2045	2050
	2021	2025	2027					
5th	3.8%	5.1%	5.5%	6.0%	6.4%	6.9%	7.0%	7.0%
25th	3.1%	3.9%	4.1%	4.5%	4.9%	5.1%	5.3%	5.3%
50th	2.6%	3.1%	3.3%	3.6%	3.9%	4.1%	4.2%	4.3%
75th	2.1%	2.4%	2.5%	2.7%	3.0%	3.1%	3.2%	3.3%
95th	1.5%	1.5%	1.5%	1.6%	1.8%	1.9%	2.0%	2.1%
Prob (> 6.5%)	0.0%	0.6%	0.8%	2.6%	4.4%	7.0%	8.0%	9.5%

- Probability of a contribution cap on employer contributions is less than 1% over the next 5 years

- Yields are expected to gradually rise in the baseline

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Simulated Price Inflation
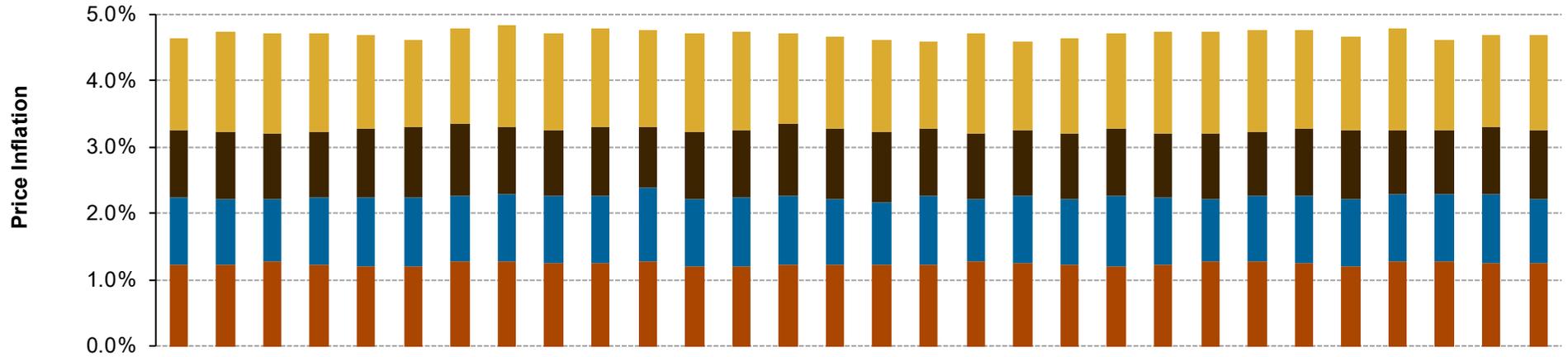
Percentile	2021	2025	2030	2035	2040	2045	2050	Annualized 10-Year	20-Year	30-Year
97.5th	5.12%	5.18%	5.33%	5.13%	5.19%	5.22%	5.17%	3.74%	3.31%	3.14%
95th	4.64%	4.69%	4.78%	4.65%	4.65%	4.76%	4.68%	3.51%	3.15%	2.98%
75th	3.26%	3.28%	3.30%	3.27%	3.19%	3.28%	3.25%	2.75%	2.62%	2.55%
50th	2.23%	2.24%	2.26%	2.21%	2.22%	2.26%	2.22%	2.23%	2.25%	2.24%
25th	1.23%	1.20%	1.26%	1.24%	1.24%	1.24%	1.25%	1.74%	1.85%	1.94%
5th	-0.10%	-0.23%	-0.32%	-0.18%	-0.08%	-0.34%	-0.13%	1.05%	1.31%	1.49%

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