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North Dakota Teachers Fund for Retirement

2020 Asset -Liability Study

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Callan

Introduction and Process Overview

Introduction

The goal of the asset-liability study is to determine an appropriate long-term mix between return-seeking assets (e.g., equities, real assets, alternatives) and risk-mitigating assets (cash, fixed income)

- 80-90% of funded status volatility is driven by the broad asset allocation decision

Asset allocation will vary by the unique circumstances of the plan

- No “one-size-fits-all” solution exists

The asset-liability study helps the North Dakota Teachers Fund for Retirement (NDTFFR) quantify the impact that different strategies might have on relevant metrics

Factors to consider:

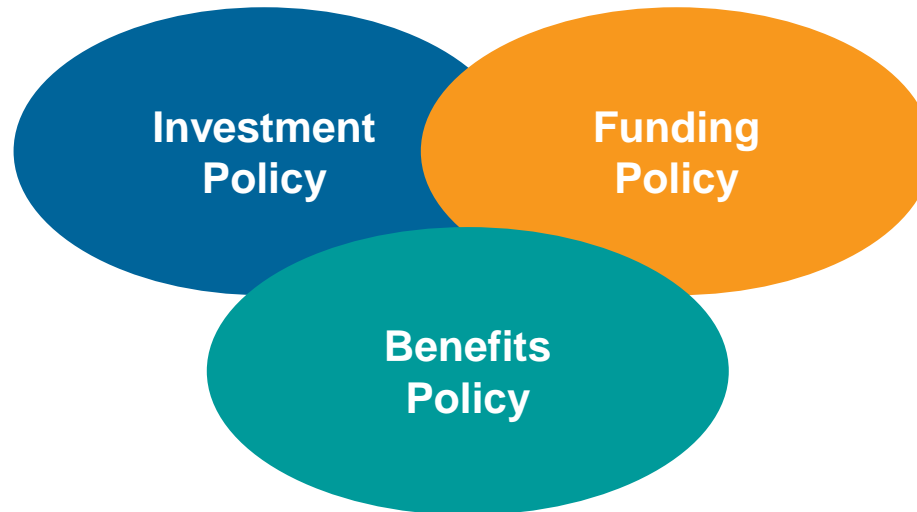
- Liability characteristics
- Funded status
- Contribution policy
- Time horizon
- Liquidity needs

Where Does Asset Allocation Fit In?

Evaluate the interaction of three key policies to identify the optimal investment policy

Investment Policy

- How will the assets supporting the benefits be invested?
- What risk and return objectives?
- How to manage cash flows?



Funding Policy

- How will the benefits/deficits be paid for (funded)?
- What are the actuarial assumptions to use?

Benefits Policy

- What type/kind of benefits?
- What level of benefit?
- When and to whom are they payable?

Callan Asset-Liability Modeling Process

Asset Modeling

Define Capital Market Assumptions

Create Asset Mix Alternatives

Liability Modeling

Define Liability Assumptions

Build Actuarial Liability Model

Simulate Financial Conditions

Define Risk Tolerance

Select Appropriate Target Mix

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Asset Allocation

Callan Capital Market Process and Philosophy

Underlying beliefs guide the development of the projections

- An initial bias toward long-run averages
- An awareness of risk premiums
- A presumption that markets ultimately clear and are rational

Reflect our belief that long-term equilibrium relationships between the capital markets and lasting trends in global economic growth are key drivers to setting capital market expectations

Long-term compensated risk premiums represent “beta”—exposure to each broad market, whether traditional or “exotic,” with limited dependence on successful realization of alpha

The projection process is built around several key building blocks

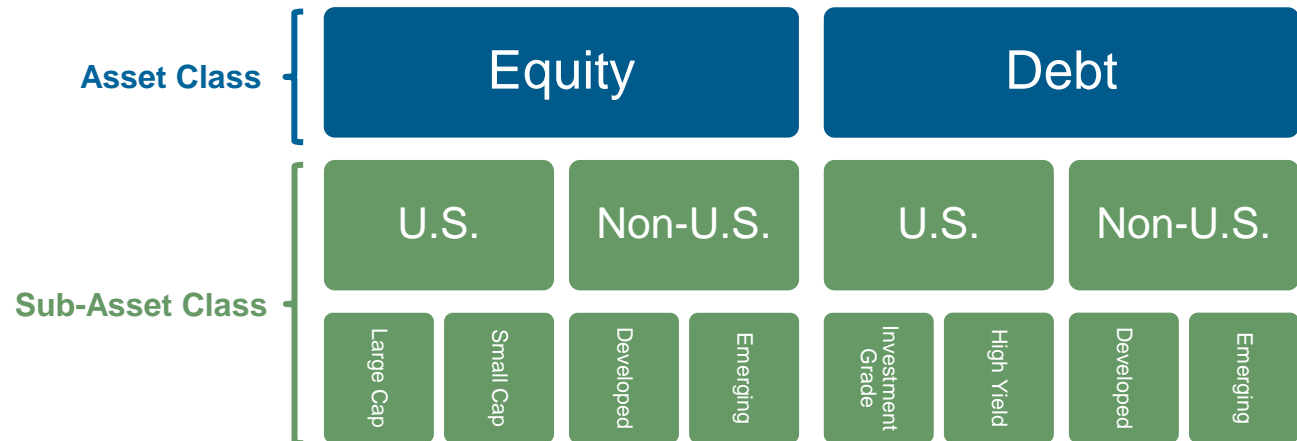
- Advanced modeling at the individual asset class level (e.g., a detailed bond model, an equity model)
- Pathways for both interest rates and inflation
- A cohesive economic outlook
- A framework that encompasses Callan’s beliefs about the long-term operation and efficiencies of the capital markets

The Focus is on Broad Asset Classes

Breakdowns between investment styles within asset classes (growth vs. value, large cap vs. small cap) are best addressed in a manager structure analysis

Primary asset classes and important sub-asset classes include:

- U.S. Stocks
- U.S. Bonds
- Non-U.S. Stocks
- Non-U.S. Bonds
- Real Estate
- Private Equity
- Absolute Return
- Cash



Callan Capital Market Assumptions

Risk and return: 2020–2029

Asset Class	Index	Projected Return*	Projected Risk
Equities			
Broad U.S. Equity	Russell 3000	7.15%	18.10%
Large Cap U.S. Equity	S&P 500	7.00%	17.70%
Small/Mid Cap U.S. Equity	Russell 2500	7.25%	21.20%
Global ex-U.S. Equity	MSCI ACWI ex USA	7.25%	20.50%
Developed ex-U.S. Equity	MSCI World ex USA	7.00%	19.70%
Emerging Market Equity	MSCI Emerging Markets	7.25%	25.70%
Fixed Income			
Short Duration Govt/Credit	Bloomberg Barclays 1-3 Yr G/C	2.70%	2.10%
Core U.S. Fixed	Bloomberg Barclays Aggregate	2.75%	3.75%
Long Government/Credit	Bloomberg Barclays Long G/C	2.75%	10.60%
TIPS	Bloomberg Barclays TIPS	2.40%	5.05%
High Yield	Bloomberg Barclays High Yield	4.65%	10.25%
Global ex-U.S. Fixed	Bloomberg Barclays Gbl Agg xUSD	0.90%	9.20%
Emerging Market Sovereign Debt	EMBI Global Diversified	4.35%	9.50%
Other			
Core Real Estate	NCREIF ODCE	6.25%	14.00%
Timberland	NCREIF Timberland	6.05%	14.60%
Farmland	NCREIF Farmland	6.10%	15.00%
Private Infrastructure	DJB Glob Infr / FTSE Dev Core Infr 50/50	6.60%	15.20%
Private Equity	Cambridge Private Equity	8.50%	27.80%
Hedge Funds	Callan Hedge FoF Database	5.00%	8.70%
Commodities	Bloomberg Commodity	2.75%	18.00%
Cash Equivalents	90-Day T-Bill	2.25%	0.90%
Inflation	CPI-U	2.25%	1.50%

* Geometric returns are derived from arithmetic returns and the associated risk (standard deviation).

- Most capital market expectations represent passive exposure (beta only); however, return expectations for private market investments reflect active management premiums
- Return expectations are net of fees

Policy Target Allocation

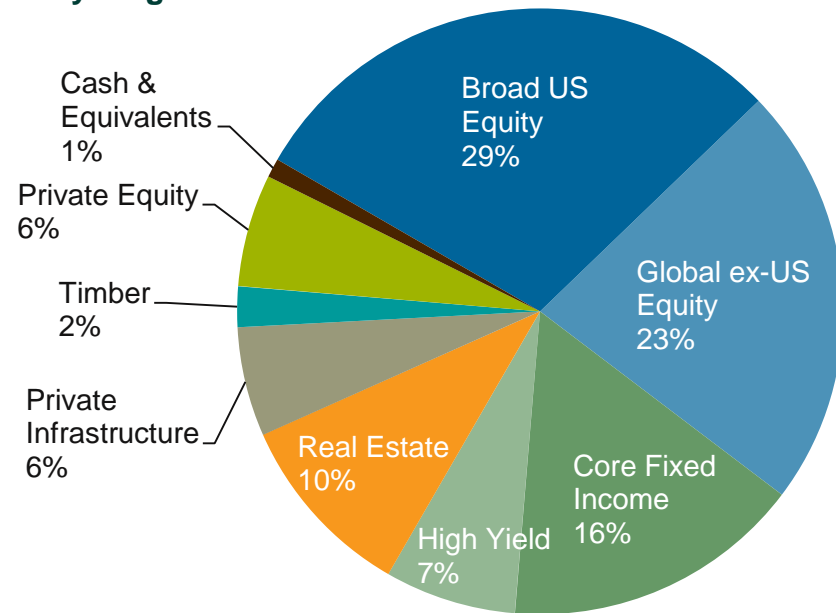
The target asset allocation consists of 52% public equity, 24% fixed income and cash, and 24% alternatives

- Alternatives include real estate, private infrastructure, timber, and private equity

While the Fund's target allocation is projected to return 6.7% over the next 10 years versus an actuarial discount rate of 7.25%, two key items should be noted

- Callan's public market return projections do not incorporate active management premiums
 - Active management premiums accrue when investment firms selected by the State Investment Board outperform their passive benchmarks
 - *It is important to note, though, that investment firms will at times underperform their passive benchmarks*
 - The Plan's public market returns have benefitted from active management by ~16 basis points net of fees (annualized) over the past five years ended 6/30/20
- Callan's 10-year projections are below longer-term expectations due to the current economic environment and the forecast for the next several years

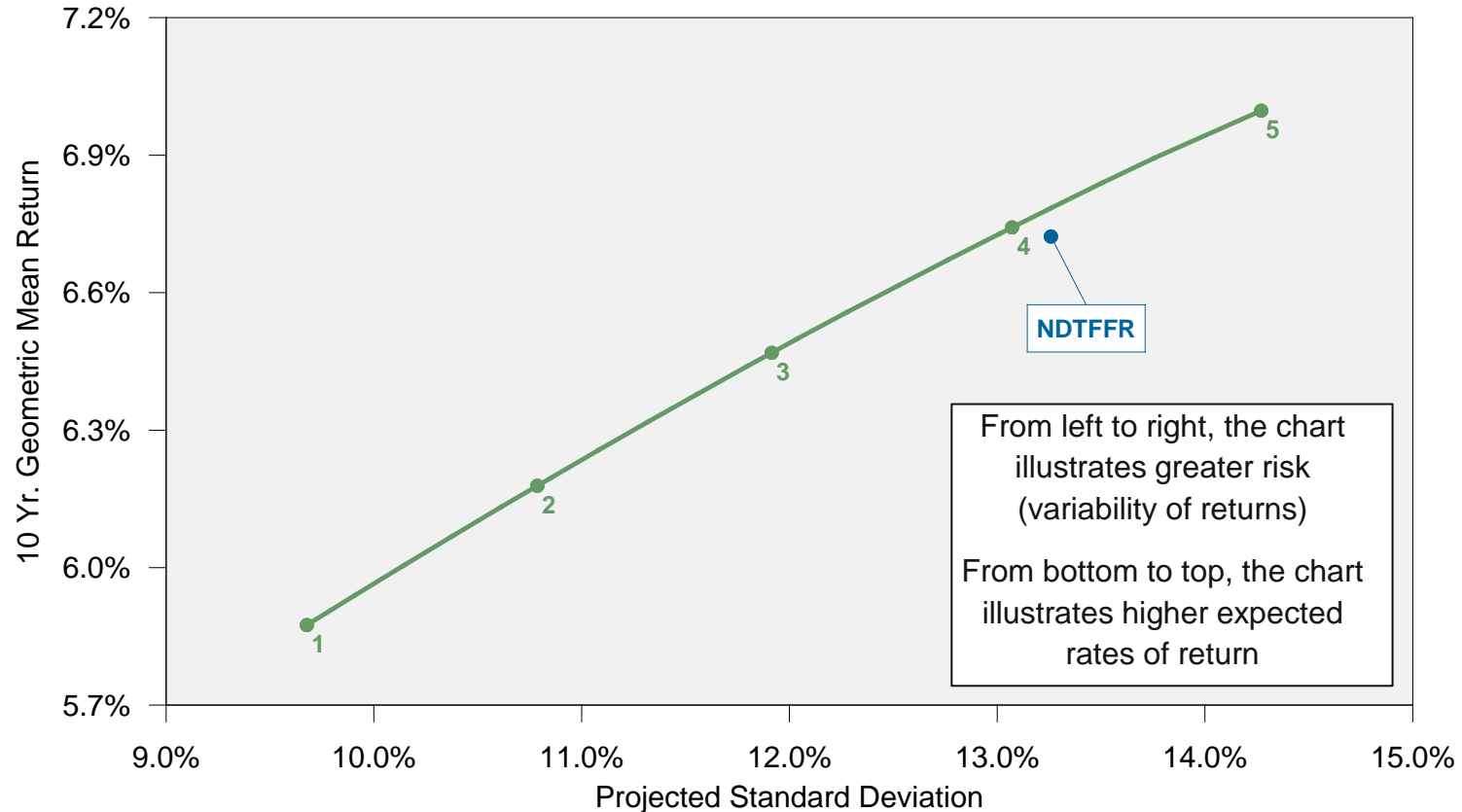
Policy Target



Expected Geometric Mean Return = 6.7%
Expected Standard Deviation = 13.3%

Efficient Frontier

Efficient Frontier



- A series of optimal mixes at different levels of expected return and risk is depicted above
 - Optimal mixes generate the greatest return for a given level of risk, or conversely, the lowest risk for a given level of return
 - Five efficient mixes are numbered and described in more detail on the following page
- The current target portfolio is modestly below the efficient frontier near mix 4

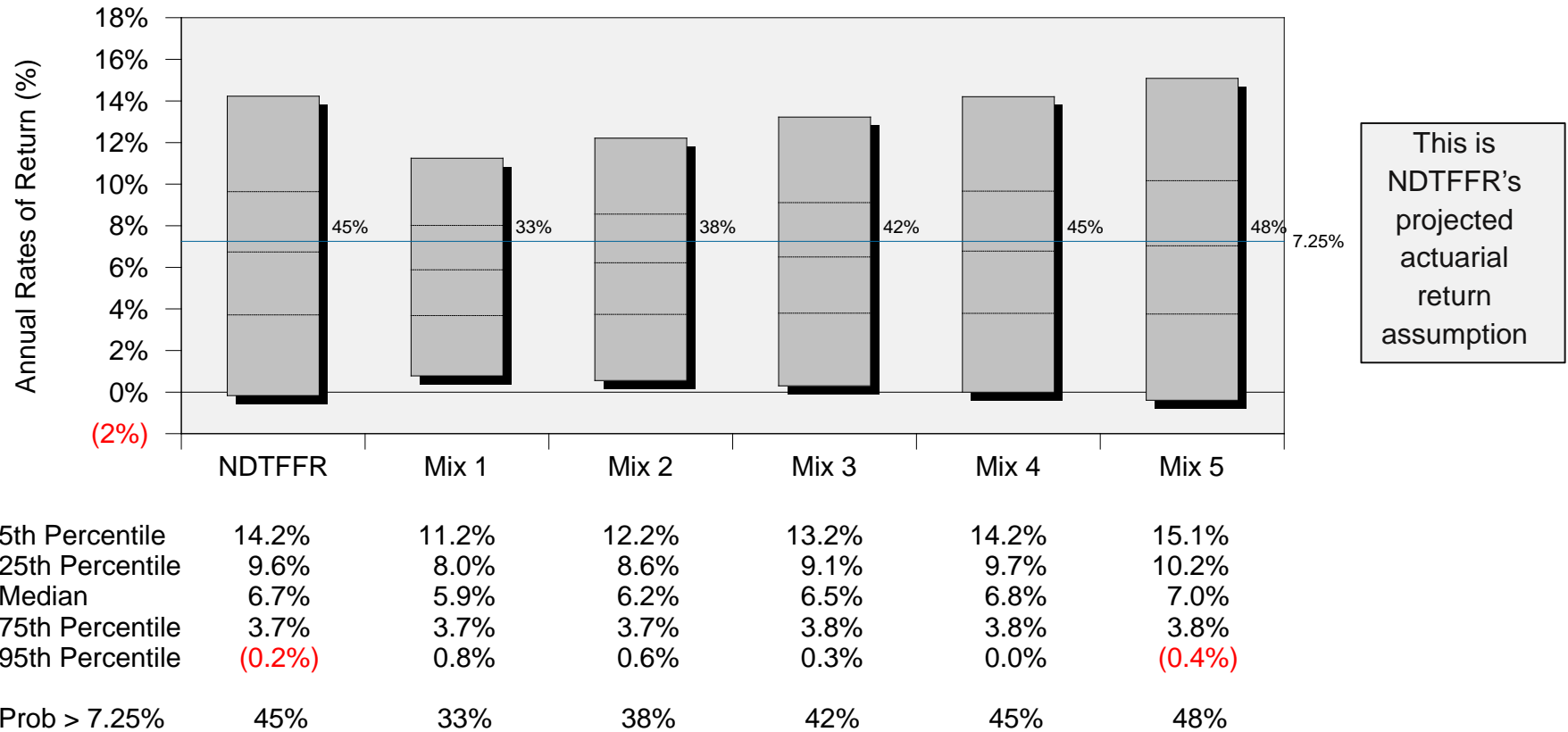
Alternative Asset Mixes

Asset Class	Policy Target	Min	Max	Mix 1	Mix 2	Mix 3	Mix 4	Mix 5
Public Equity	52%			31%	35%	39%	45%	51%
Broad U.S. Equity	29%	0%	100%	19%	21%	24%	27%	30%
Global ex-U.S. Equity	23%	0%	100%	12%	14%	15%	18%	21%
Fixed Income & Cash	24%			49%	42%	35%	27%	19%
Core Fixed Income	16%	0%	100%	34%	29%	24%	18%	13%
High Yield	7%	0%	100%	14%	12%	10%	8%	5%
Cash Equivalents	1%	1%	100%	1%	1%	1%	1%	1%
Alternatives	24%			20%	23%	26%	28%	30%
Real Estate	10%	0%	100%	6%	7%	8%	9%	10%
Private Infrastructure	6%	0%	100%	6%	7%	8%	9%	10%
Timber	2%	0%	0%	0%	0%	0%	0%	0%
Private Equity	6%	0%	10%	8%	9%	10%	10%	10%
Expected Return	6.7%			5.9%	6.2%	6.5%	6.8%	7.0%
Expected Standard Deviation	13.3%			9.7%	10.8%	11.9%	13.1%	14.3%
Probability >7.25%	45%			33%	38%	42%	45%	48%

- The optimal mixes are constructed with decreasing allocations to fixed income (from 48% to 18%)
 - High yield equals 30% of total fixed income, 1% cash allocation, private equity is constrained to a maximum of 10%, equal allocations are made to real estate and private infrastructure, and timber is eliminated, as a result of discussions with SIB
 - In an unconstrained setting, allocations to real estate and private infrastructure are ~75/25, respectively
- As fixed income decreases, the expected return increases and annual portfolio risk reaches over 14%
- The policy target's risk and return profile is similar to that of mix 4
- Large allocations to alternatives will require stress-testing to determine if the amount of illiquidity is tolerable

Projected Rates of Return (10 Years)

Range of Projected Rates of Return
Projection Period: 10 Years



- Chart reflects annualized return distribution over the next ten years
- Bar heights proportional to return volatility
 - Higher expected (median) returns associated with higher volatilities
 - Increased volatility leads to lower worse-case (95th percentile) returns
- The current policy has a 45% probability of earning 7.25% or better over the next 10 years

Callan

Asset-Liability Modeling

Current Conditions

Build Actuarial Liability Model

Callan’s liability model is based on Segal’s July 1, 2019 actuarial valuation and the changes adopted as a result of the experience review

Model used to forecast future liabilities

Assets rolled forward using June 30, 2020 actual asset values

Additional forecast assumptions

- Open to new entrants
- 0% workforce growth

Contributions (employer and employee) are set by statute

The current employer and employee contribution rates are shown to the right along with the employer actuarial contribution requirement

Both employer and employee contribution rates drop to 7.75% when the Plan becomes 100% funded on an actuarial basis

July 1, 2019 Actuarial Valuation	All Plans
Actuarial Accrued Liability	\$3,993 mm
Market Value of Assets	\$2,616 mm
Actuarial Value of Assets	\$2,636 mm
Market Funded Status (MVA/AL)	65.5%
Actuarial Funded Status (AVA/AL)	66.0%

Key Assumptions	Actuarial Assumption*	Callan 10-year Expectation
Investment Return	7.25%	6.7%**
Price Inflation	2.3%	2.25%

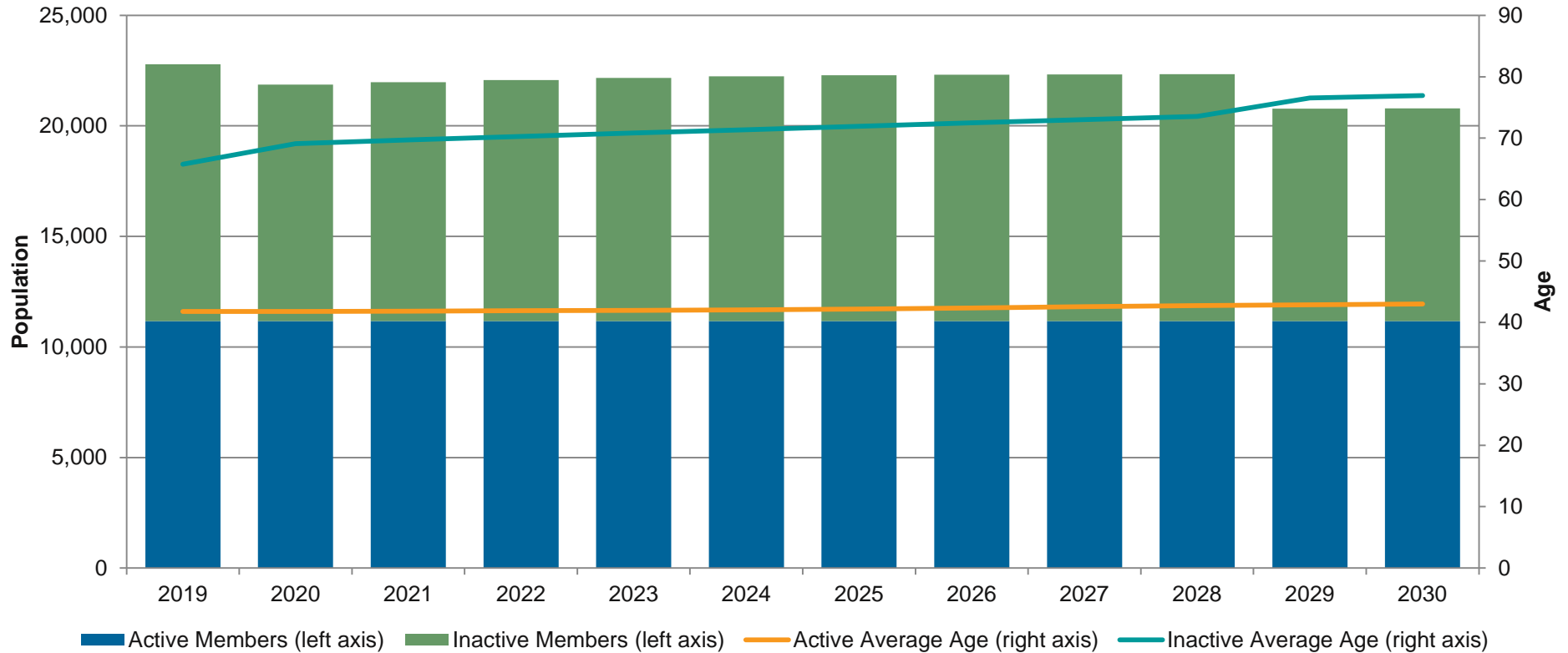
Contribution Rates	Employer	Employee
Statutory	12.75%	11.75%
Actuarial Requirement	12.84%	n/a

*As of July 1, 2020

**Based on Callan’s capital market assumptions applied to NDTFFR’s target asset allocation; used throughout the remainder of the study

Member Numbers

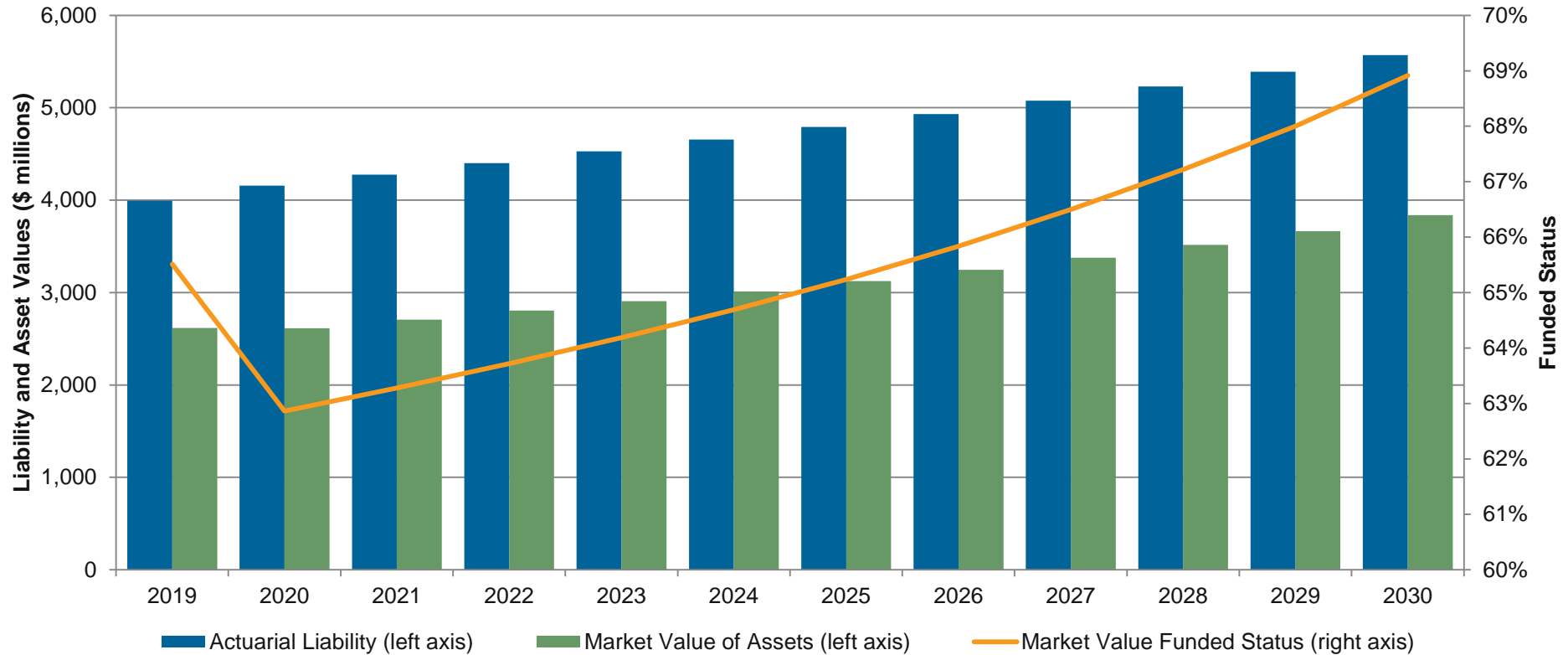
Deterministic Forecast



- Number of active members assumed to remain constant (0% workforce growth)
 - Future new hires replace exits due to retirement, death, disability, and withdrawal
 - Stable active age reflects Plan maturity
- The drop in the number of inactive members from 2028 to 2029 is due to the lump sum refund for current terminated vested participants
 - Instead of one enormous payout in the first year, refunds were spread over ten years and fall off after 2028

Funding

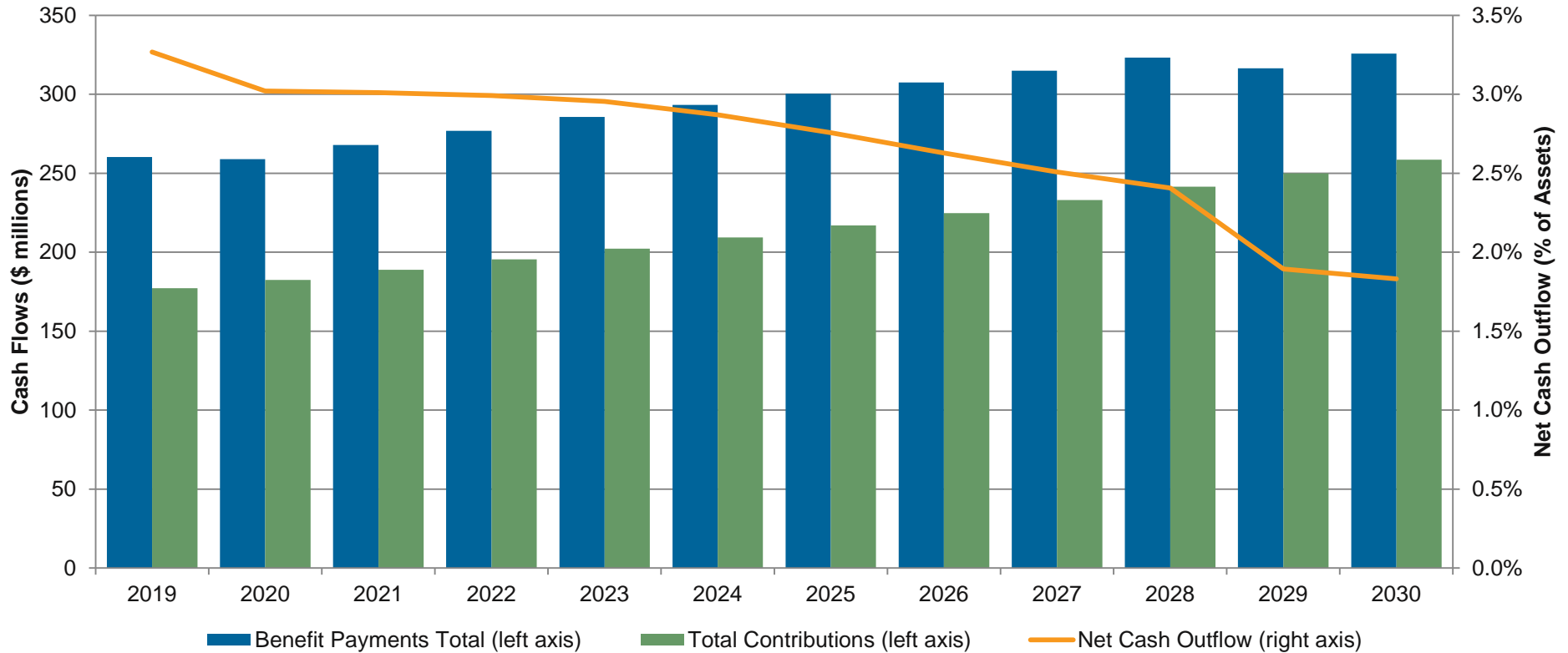
Deterministic Forecast



- Assets increase faster than the liabilities, closing the funding gap
 - Change in assets due to both investment returns and net cash flows (contributions net of benefit payments and expenses)
 - Assumes assets earn 6.7%
- Projected funding depends on adherence to the contribution policy
- Funded status decline in 2020 is due to the changes adopted as a result of the experience review and the asset value override

Cash Flows and Liquidity

Deterministic Forecast



- Net Cash Outflow = Benefit Payments + Expenses – Employer Contributions – Employee Contributions
- Plan is expected to have declining net outflow as a percentage of assets over the coming decade
- Cash flow is a factor used to determine a cap on the level of private investments
- Net outflow as a percentage of assets under 7% should be manageable as long as TFFR adheres to the current funding policy

Actuarial Liability, 2020-2030

Stochastic Forecast

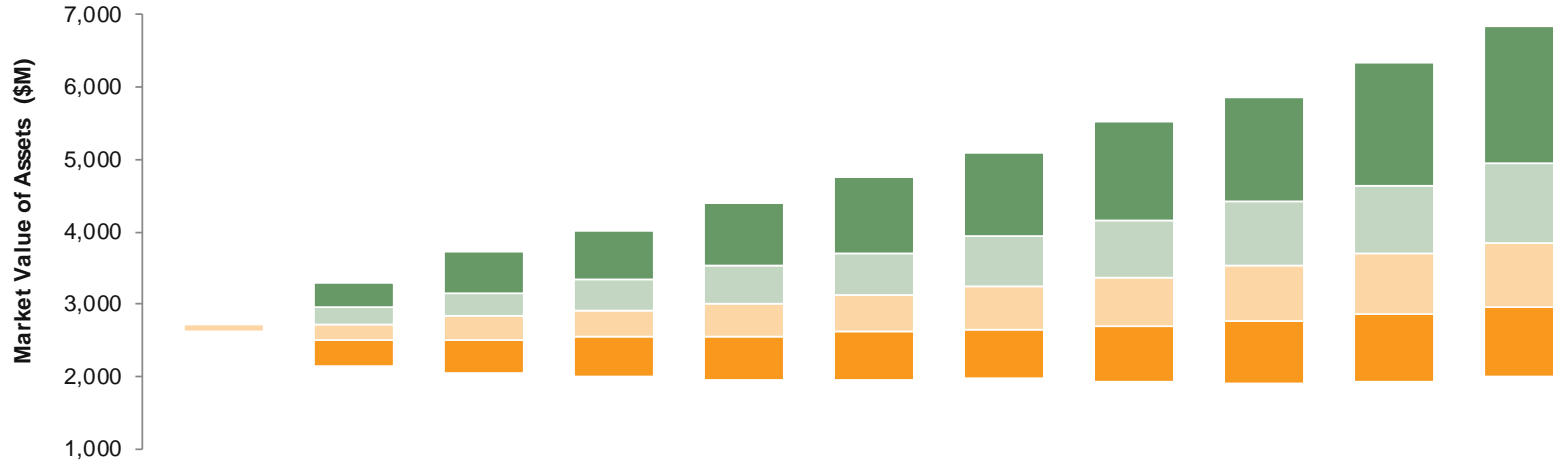


Pctl	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
95	4,190	4,348	4,506	4,674	4,843	5,015	5,197	5,392	5,594	5,808	6,042
75	4,169	4,305	4,443	4,586	4,732	4,881	5,036	5,202	5,373	5,558	5,759
50	4,156	4,276	4,402	4,528	4,655	4,792	4,933	5,080	5,229	5,389	5,571
25	4,142	4,250	4,359	4,472	4,586	4,699	4,826	4,953	5,087	5,229	5,392
5	4,120	4,208	4,302	4,390	4,482	4,579	4,678	4,793	4,905	5,016	5,154
Range	70	140	204	284	360	436	519	599	689	791	888

- Plan liabilities are increasing at a steady pace which is typical for an open plan
 - Median increasing at an annual rate of 3%
- Driver is wage growth for current employees
 - Inflation flows through to member compensation which is a component of the retirement benefit formula

Market Value of Assets (Target), 2020-2030

Stochastic Forecast



Pctl	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
5	2,613	3,282	3,713	4,003	4,389	4,758	5,097	5,519	5,861	6,330	6,834
25	2,613	2,947	3,148	3,331	3,532	3,709	3,947	4,166	4,409	4,642	4,938
50	2,613	2,729	2,827	2,899	3,016	3,128	3,254	3,377	3,543	3,696	3,855
75	2,613	2,500	2,496	2,541	2,563	2,622	2,644	2,693	2,769	2,872	2,969
95	2,613	2,139	2,053	2,006	1,951	1,954	1,977	1,940	1,905	1,937	1,991
Range	0	1,144	1,661	1,997	2,438	2,805	3,120	3,579	3,955	4,394	4,842

- Plan assets are expected to grow by over \$1.2 billion in the median (50th percentile) outcome
 - 4% annual growth rate
- In the 95th percentile outcome, assets are projected to decline by more than \$600 million by 2030

$$\text{Asset Change} = \text{Contributions} + \text{Investment Earnings} - \text{Benefit Payments \& Expenses}$$

Funded Ratio in 2030 (10 Years)

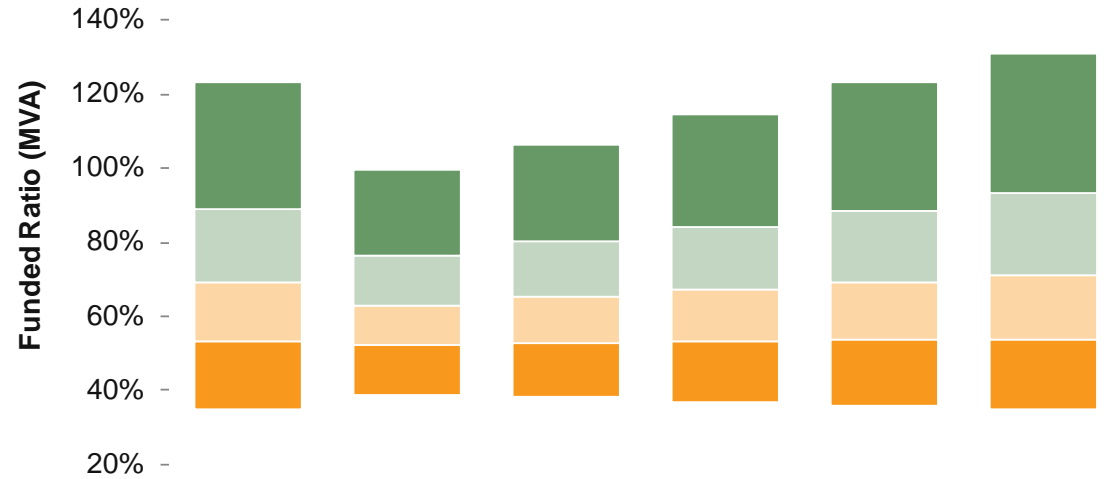
Stochastic Forecast

Starting funded status = 65.5%

The Plan's funded status is expected (50th percentile) to decline over the next ten years under the current funding policy and target allocation

Funding ratios in worse-case scenarios are particularly low because the contribution policy is not impacted by a declining funded status

More aggressive mixes are expected to have higher funded ratios at the end of 10 years relative to more conservative mixes but have lower funded ratios in worse-case scenarios (95th percentile)



Pctl	Target	Mix 1	Mix 2	Mix 3	Mix 4	Mix 5
5	123.1%	99.2%	105.9%	114.1%	122.9%	130.7%
25	89.1%	76.3%	80.3%	84.2%	88.6%	93.0%
50	69.4%	63.2%	65.2%	67.2%	69.1%	71.3%
75	53.4%	52.4%	53.0%	53.4%	53.8%	53.9%
95	35.5%	39.2%	38.4%	37.4%	36.3%	35.2%
Range	87.6%	60.0%	67.6%	76.8%	86.6%	95.5%

Funded Status = Market Value of Assets / Actuarial Liability

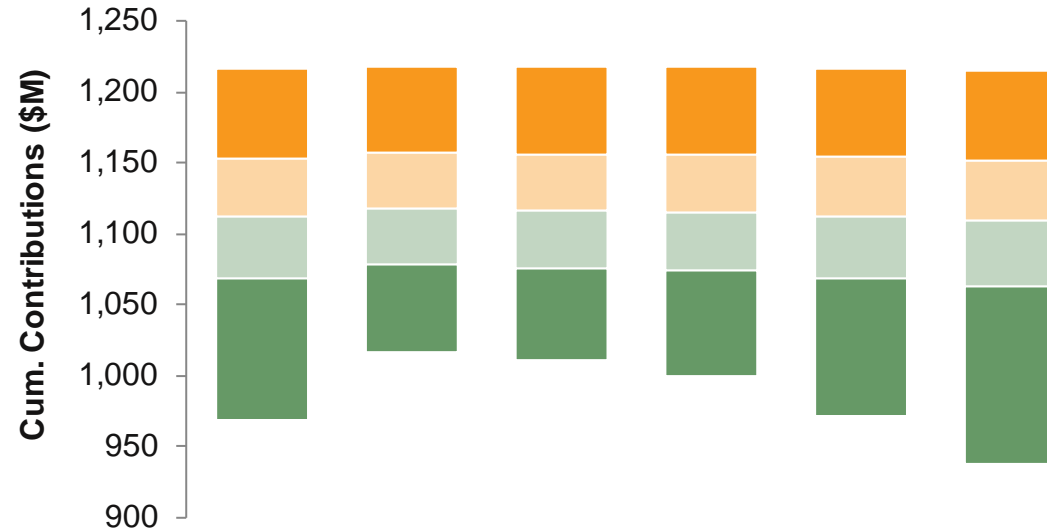
Cumulative Contributions through 2030 (10 Years)

Stochastic Forecast

There is little contribution variability across the asset mixes in most scenarios due to the statutory percentage of pay policy

Only in better-case scenarios does variability emerge as the Plan has a greater probability of becoming fully funded prompting a decline in the employer contribution rate from 12.75% to 7.75%

Contribution volatility within an asset mix stems from simulated inflation which impacts salaries and the potential for a decline in the employer contribution rate as full funding is achieved



Pctl	Target	Mix 1	Mix 2	Mix 3	Mix 4	Mix 5
95	1,216	1,217	1,216	1,216	1,216	1,215
75	1,153	1,156	1,155	1,155	1,153	1,151
50	1,111	1,118	1,116	1,114	1,112	1,110
25	1,068	1,079	1,076	1,074	1,069	1,063
5	969	1,018	1,011	1,001	973	940
Range	247	199	205	215	243	275

Ultimate Net Cost in 2030 (10 Years)

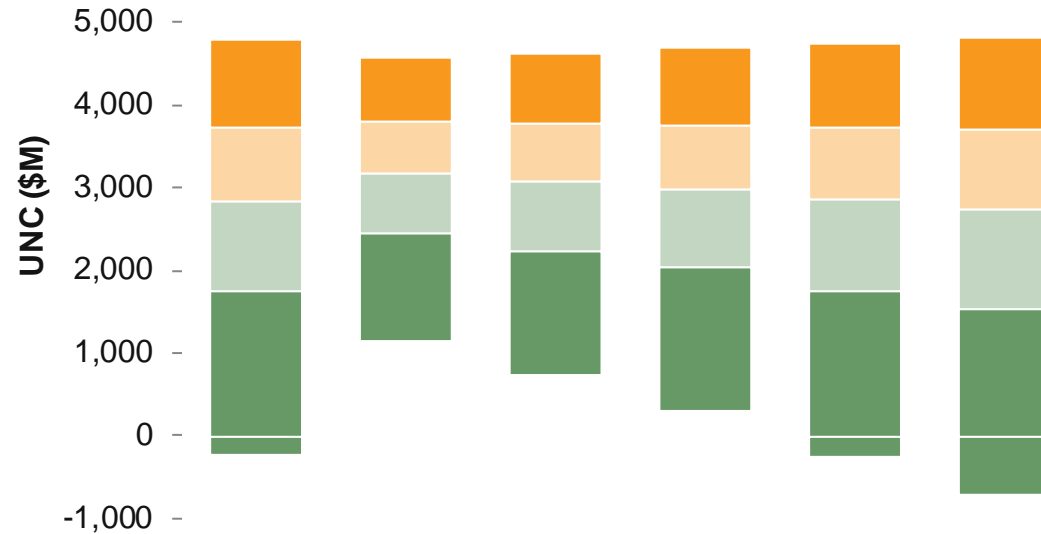
Stochastic Forecast

Ultimate net cost (UNC) = 10-Year cumulative contributions + 7/1/2030 unfunded actuarial liability

UNC is a more complete measure of the cost to the employer since it captures what is expected to be paid over 10 years plus what is owed at the end of the 10-year period

- Negative numbers indicate the Plan is in a surplus position at 7/1/2030

More aggressive mixes lower UNC in the expected case but result in greater UNC in a worse-case scenario



Pctl	Target	Mix 1	Mix 2	Mix 3	Mix 4	Mix 5
95	4,760	4,560	4,603	4,665	4,722	4,793
75	3,718	3,782	3,749	3,729	3,702	3,685
50	2,829	3,171	3,063	2,960	2,838	2,732
25	1,739	2,443	2,227	2,025	1,759	1,523
5	-219	1,155	734	308	-240	-686
Range	4,980	3,405	3,870	4,357	4,962	5,478

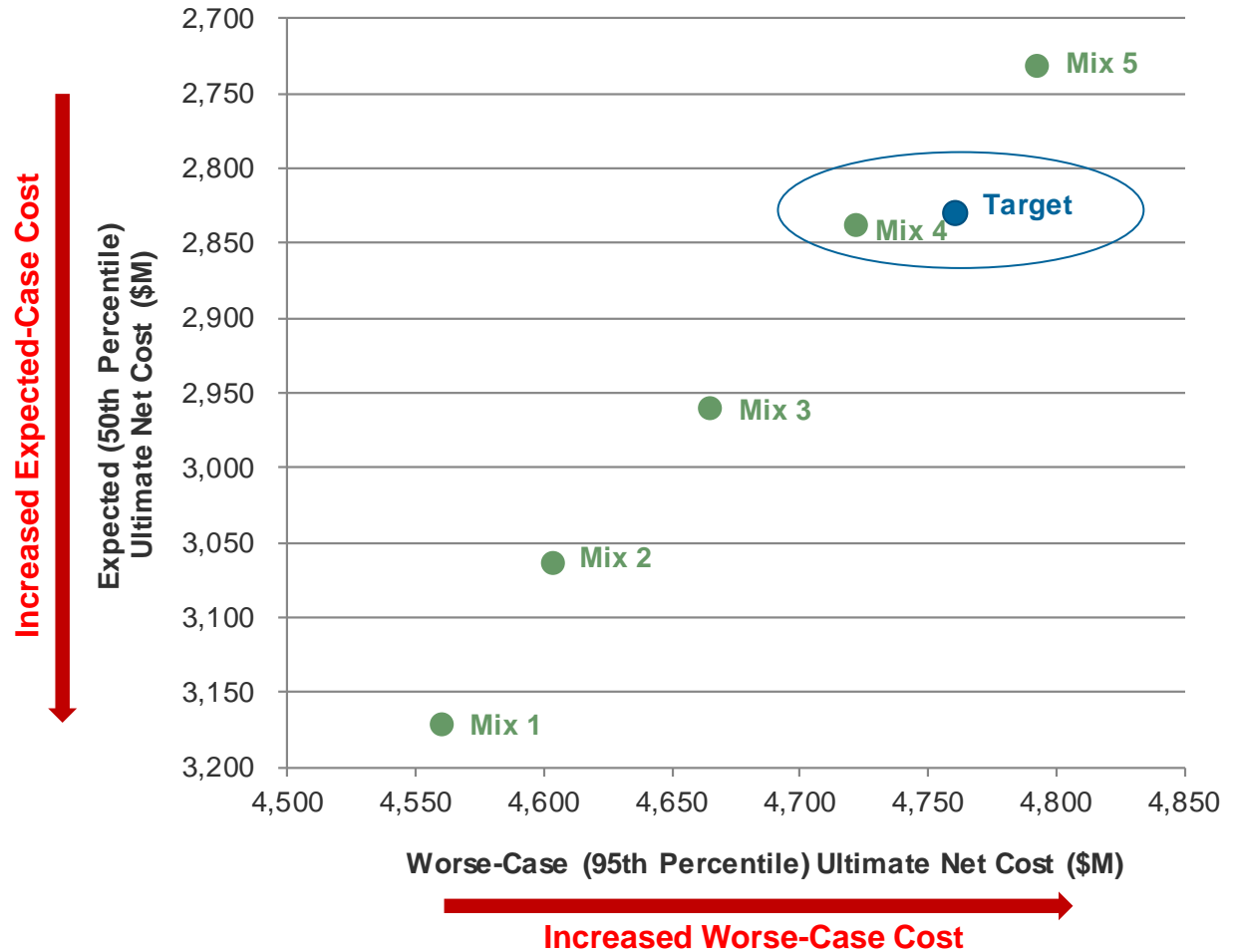
UNC = Cumulative Contributions + Unfunded Liability

Ultimate Net Cost in 2030 (10 Years): Expected (50th) vs Worse Case (95th)

Stochastic Forecast

Tradeoff is roughly linear for optimal mixes

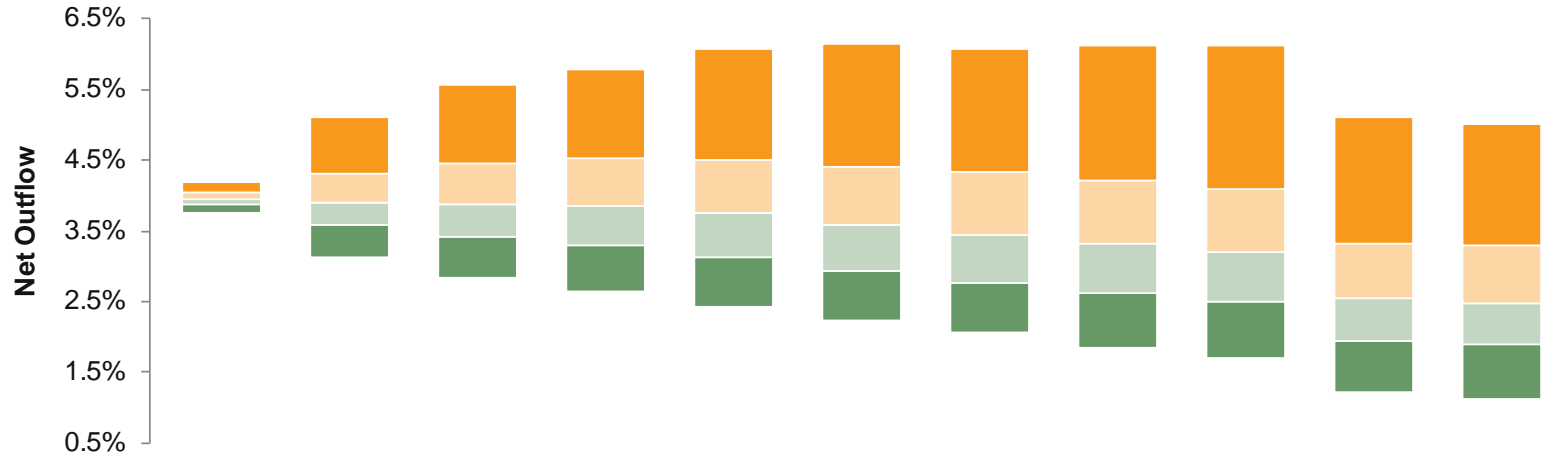
Mix 4 reduces worse-case ultimate net cost by \$38 million relative to current target with slightly more cost in the expected case



Liquidity and Stress Testing

Net Outflow as a Percentage of Liquid Assets (Target), 2020-2030

Stochastic Forecast



Pctl	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
95	4.2%	5.1%	5.5%	5.8%	6.0%	6.1%	6.1%	6.1%	6.1%	5.1%	5.0%
75	4.0%	4.3%	4.4%	4.5%	4.5%	4.4%	4.3%	4.2%	4.1%	3.3%	3.3%
50	4.0%	3.9%	3.9%	3.8%	3.8%	3.6%	3.4%	3.3%	3.2%	2.6%	2.5%
25	3.9%	3.6%	3.4%	3.3%	3.1%	2.9%	2.8%	2.6%	2.5%	2.0%	1.9%
5	3.7%	3.1%	2.8%	2.7%	2.4%	2.2%	2.1%	1.9%	1.7%	1.2%	1.1%
Range	0.4%	2.0%	2.7%	3.1%	3.6%	3.9%	4.0%	4.3%	4.4%	3.8%	3.9%

- Net Outflow = Benefit Payments & Expenses – Employee & Employer Contributions
 - A useful indicator of ongoing liquidity needs
 - Ratio < 7.0% is typically manageable; >10% presents high liquidity pressure and illiquid investments may need to be reduced
 - Based on our experience, most public funds have net outflow of 4-7% depending on funded status, funding policy, and plan maturity
- For the current target (76% liquid assets), liquidity needs are expected to be manageable even in worse-case (95th percentile) scenarios
- The liquidity analysis assumes the funding policy is adhered to

Stress Testing

The current target and mixes 4 and 5 were subjected to six investment scenarios to gauge the impact on investment performance, funding, and net outflow

The six scenarios include three historical and three hypothetical

- Historical

- Global Financial Crisis (GFC): October 2007 – February 2009
- Black Monday: October 1987
- U.S. Debt Ceiling Crisis and Downgrade: June – September 2011

- Hypothetical

- Equities Decline 20% for 1 Year (bear market definition)
- Perfect Storm for 1 Year (equities decline 20%, Treasuries and spreads increase 1%)
- Perfect Storm for 3 Years (equities decline 15% annually, Treasuries and spreads increase 1% annually)

Findings

- Performance

- Mix 4 outperforms the target and mix 5, which is not surprising given it is the most conservative of the three portfolios

- Funding

- Funded status drops by ~20% in nominal terms for the GFC and ~25% for the Perfect Storm for 3 Years

- Net Outflow

- Net outflow as a percentage of liquid assets hovers between 6-7.5% under most scenarios while reaching 8.5-10% for the GFC and 10-11.5% under the Perfect Storm for 3 Years

The findings support the ability of the Fund to implement investment policies such as the current target and mixes 1 through 5 and the relatively large illiquid allocations they employ

Callan

Recommendation

Recommendation

A modestly improving funded status in the median (50th percentile) outcome is due in large part to a combined (employer plus employee) statutory contribution rate of 24.5% of pay which leads to assets outpacing liabilities

Many factors support an asset allocation with a risk posture similar to the current target

- Pursuit of a 7.25% return; long time horizon; actuarial methodology (static contribution rate and asset smoothing)

While moving to a more aggressive asset allocation is expected to generate greater returns and a higher funded status, it also increases the risk of “bad investment outcomes” which in turn could result in further deterioration of the Plan’s funded status and the need for higher contribution rates

The statutory contribution policy combined with the relatively large illiquid allocation leads us to recommend maintaining the current risk posture (mix 4a as depicted on the following page) or moving to a slightly less aggressive asset allocation (mix 4)

- Reduces reliance on public equity markets
- Increase to alternatives which can provide a source of uncorrelated returns and potential for alpha generation and fixed income which provides downside protection in the event of a large equity drawdown
 - A high allocation to illiquid investments is suitable for a long-term investor with an actuarially sound funding policy
 - Potential sources of liquidity in a crisis include a long Treasury mandate (1.6% of the total fund at June 30, 2020), cash account (1% target allocation), the Treasury allocations within some of the other fixed income managers, and the cash flows coming from some of the real estate and infrastructure funds

Recommendation

Finally, while the target and mixes 4 and 4a have expected returns over the next 10 years that fall short of the 7.25% return assumption, there are mitigating factors that offset the projected returns

- Callan's public market return projections are based on passive (i.e., index fund) implementation and do not incorporate active management premiums
- Callan's 10-year projections are cyclically lower than our longer-term (i.e., greater than 10 years) expectations
- The target and mixes 4 and 4a have a 45-46% probability of achieving a 7.25% return over the next 10 years

Asset Class	Policy Target	Lower Risk			Same Risk		
		Mix 4	% Change	\$M Change	Mix 4a	% Change	\$M Change
Public Equity	52%	45%	-7%	(\$183)	45%	-7%	(\$183)
Broad U.S. Equity	29%	27%	-2%	(\$52)	27%	-2%	(\$52)
Global ex-U.S. Equity	23%	18%	-5%	(\$131)	18%	-5%	(\$131)
Fixed Income	24%	27%	3%	\$78	25%	1%	\$26
Core Fixed Income	16%	18%	2%	\$52	17%	1%	\$26
High Yield	7%	8%	1%	\$26	7%	0%	\$0
Cash Equivalents	1%	1%			1%		
Alternatives	24%	28%	4%	\$105	30%	6%	\$157
Real Estate	10%	9%	-1%	(\$26)	10%	0%	\$0
Private Infrastructure	6%	9%	3%	\$78	10%	4%	\$105
Timber	2%	0%	-2%	(\$52)	0%	-2%	(\$52)
Private Equity	6%	10%	4%	\$105	10%	4%	\$105
Expected Return	6.7%	6.8%			6.8%		
Expected Standard Deviation	13.3%	13.1%			13.3%		
Probability >7.25%	45%	45%			46%		

Note: Dollar changes based on June 30, 2020 asset value

Callan

Next Steps and Timeline

Next Steps

Incorporate feedback from today's meeting

Deliver the final study to NDTFFR in November

Timeline

Asset-Liability Kickoff **COMPLETED**

Meeting Date: September 24

Preliminary Asset-Liability Results **COMPLETED**

Meeting Date: October 29

Final Asset-Liability Results **IN PROGRESS**

Meeting Date: November 19

Callan

Appendix

Stress Tests

Six Scenarios

Historical Scenarios

- (1) 2008 Financial Crisis (October 2007 – February 2009)
- (2) Black Monday (October 1987)
- (3) 2011 U.S. Debt Ceiling Crisis and Downgrade (June – September 2011)

Parametric Scenarios

- (4) Equities Decline 20% for 1 Year (bear market definition)
- (5) Perfect Storm for 1 Year (equities decline 20%, Treasuries and spreads increase 1%)
- (6) Perfect Storm for 3 Years (equities decline 15% annually, Treasuries and spreads increase 1% annually)

Asset Mixes Tested

- Current Target:
 - 52% Public equity, 24% fixed income and cash, 24% alts
- Mix 4:
 - 45% public equity, 27% fixed income and cash, 28% alts
- Mix 5:
 - 51% public equity, 19% fixed income, 30% alts

Stress Tests

Drawdowns

	(1)	(2)	(3)	(4)	(5)	(6)
Asset Class	2008 Financial Crisis	Black Monday	2011 U.S. Debt Ceiling Crisis and Downgrade	Equities Decline 20% for 1 Year	Perfect Storm for 1 Year	Perfect Storm for 3 Years
U.S. Equity	-42%	-22%	-15%	-20%	-20%	-45%
Global ex-US Equity	-48%	-15%	-20%	-20%	-20%	-45%
U.S. Fixed Income	5%	4%	4%	0%	-8%	-27%
Cash Equivalents	2%	1%	0%	0%	0%	0%
High Yield Fixed Income	-20%	-3%	-6%	-5%	-11%	-32%
Real Estate / Timber	-21%	-11%	-8%	-10%	-10%	-23%
Private Equity	-21%	-11%	-8%	-10%	-10%	-23%
Infrastructure	-21%	-11%	-8%	-10%	-10%	-23%

Total Drawdown	2008 Financial Crisis	Black Monday	2011 U.S. Debt Ceiling Crisis and Downgrade	Equities Decline 20% for 1 Year	Perfect Storm for 1 Year	Perfect Storm for 3 Years
Target (24% Alts)	-28.7%	-12.2%	-10.6%	-13.2%	-14.9%	-35.4%
Mix 4 (28% Alts)	-26.4%	-11.4%	-9.6%	-12.2%	-14.2%	-34.0%
Mix 5 (30% Alts)	-29.1%	-12.8%	-10.9%	-13.5%	-14.8%	-34.8%

- Returns shown represent index performance
 - Public Asset Classes: Russell 3000, MSCI ACWI ex-US IMI, Bloomberg Barclays Aggregate, Bloomberg High Yield, 90-Day T-Bill
 - Private Asset Classes: 0.5 * Russell 3000
 - Estimate based on Cambridge PE Fund and NCREIF ODCE Index Data
- 2008 Financial Crisis and Perfect Storm for 3 Years are the most extreme stress tests
- Equities Decline 20% for 1 Year is the most similar scenario to recent events

Stress Tests

Additional Metrics

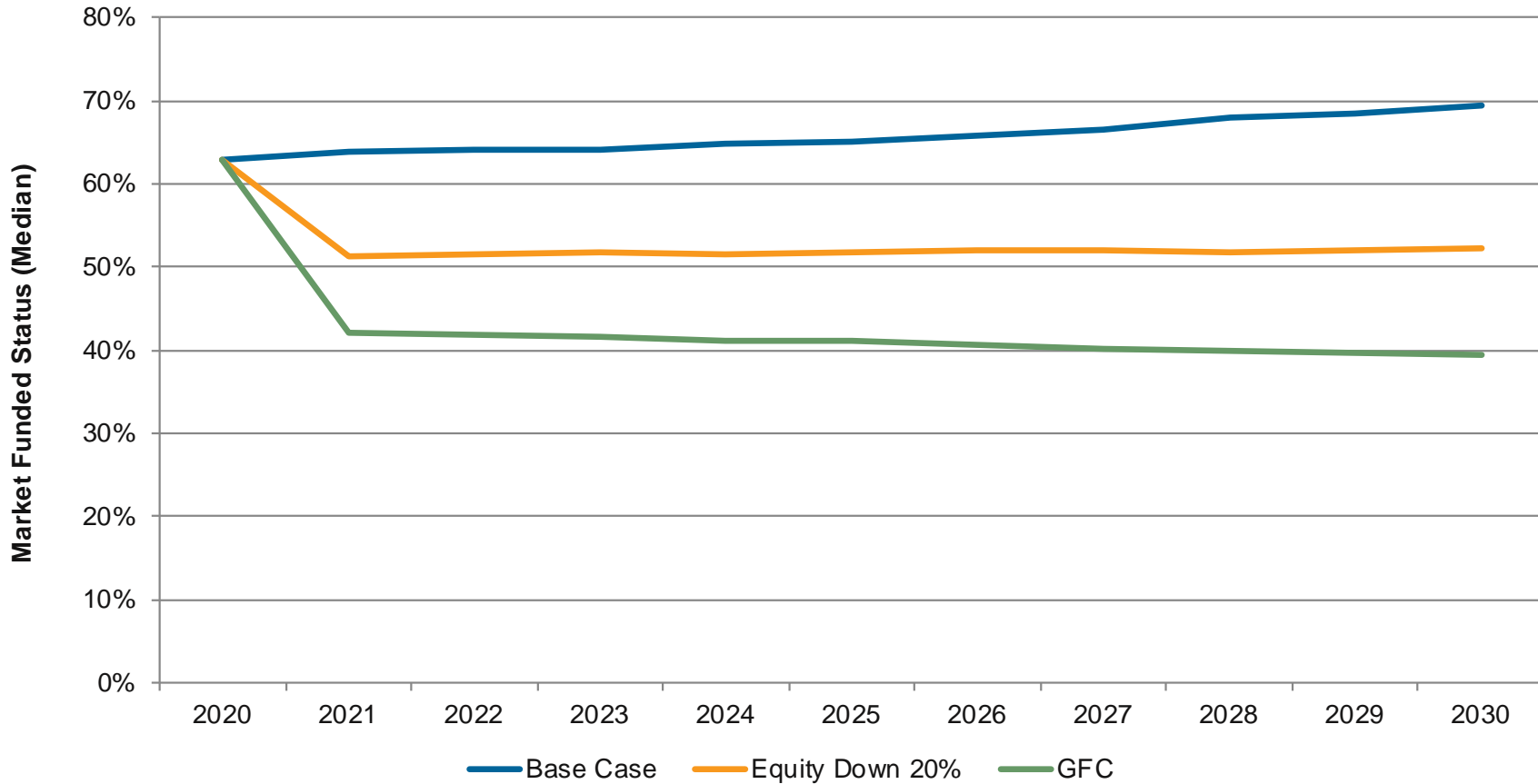
	(1)	(2)	(3)	(4)	(5)	(6)
	2008 Financial Crisis	Black Monday	2011 U.S. Debt Ceiling Crisis and Downgrade	Equities Decline 20% for 1 Year	Perfect Storm for 1 Year	Perfect Storm for 3 Years
7/1/20 Funded Ratio	62.9%	62.9%	62.9%	62.9%	62.9%	62.9%
7/1/21 Funded Ratio						
Target (24% Alts)	41.7%	51.7%	52.7%	51.1%	50.1%	37.6%
Mix 4 (28% Alts)	43.0%	52.2%	53.3%	51.7%	50.5%	38.4%
Mix 5 (30% Alts)	41.4%	51.3%	52.5%	51.0%	50.1%	37.9%
6/30/20 Alternatives Allocation						
Target (24% Alts)	45.8%	41.0%	41.0%	41.7%	42.0%	48.8%
Mix 4 (28% Alts)	51.6%	47.2%	47.1%	47.9%	48.4%	55.5%
Mix 5 (30% Alts)	53.2%	47.3%	47.3%	48.0%	48.4%	56.3%
2020 Net Outflow (% Liquid)						
Target (24% Alts)	8.4%	6.2%	6.1%	6.4%	6.6%	9.9%
Mix 4 (28% Alts)	9.1%	6.9%	6.8%	7.1%	7.3%	11.1%
Mix 5 (30% Alts)	9.8%	7.0%	6.9%	7.2%	7.4%	11.5%

- Assuming scenarios transpire over a one-year period, funded status declines from starting point of 62.9%
 - Well below 50% for GFC and Perfect Storm for 3 Years
- Alternative allocations can reach high levels during a crisis due to a combination of the following:
 - Benefit payments funded from liquid asset classes
 - Muted losses from alternatives due to valuation smoothing
 - Capital calls for existing private asset class commitments
- Net outflow (% of liquid assets) can reach relatively high levels (>10% under the Perfect Storm for 3 Years)

Notes: 7/1/21 Funded Ratio estimate reflects \$270M in benefit payments/expenses, \$189M in total contributions, and a liability estimate of \$4.3B; High yield considered illiquid in stressed environments

Stress Tests

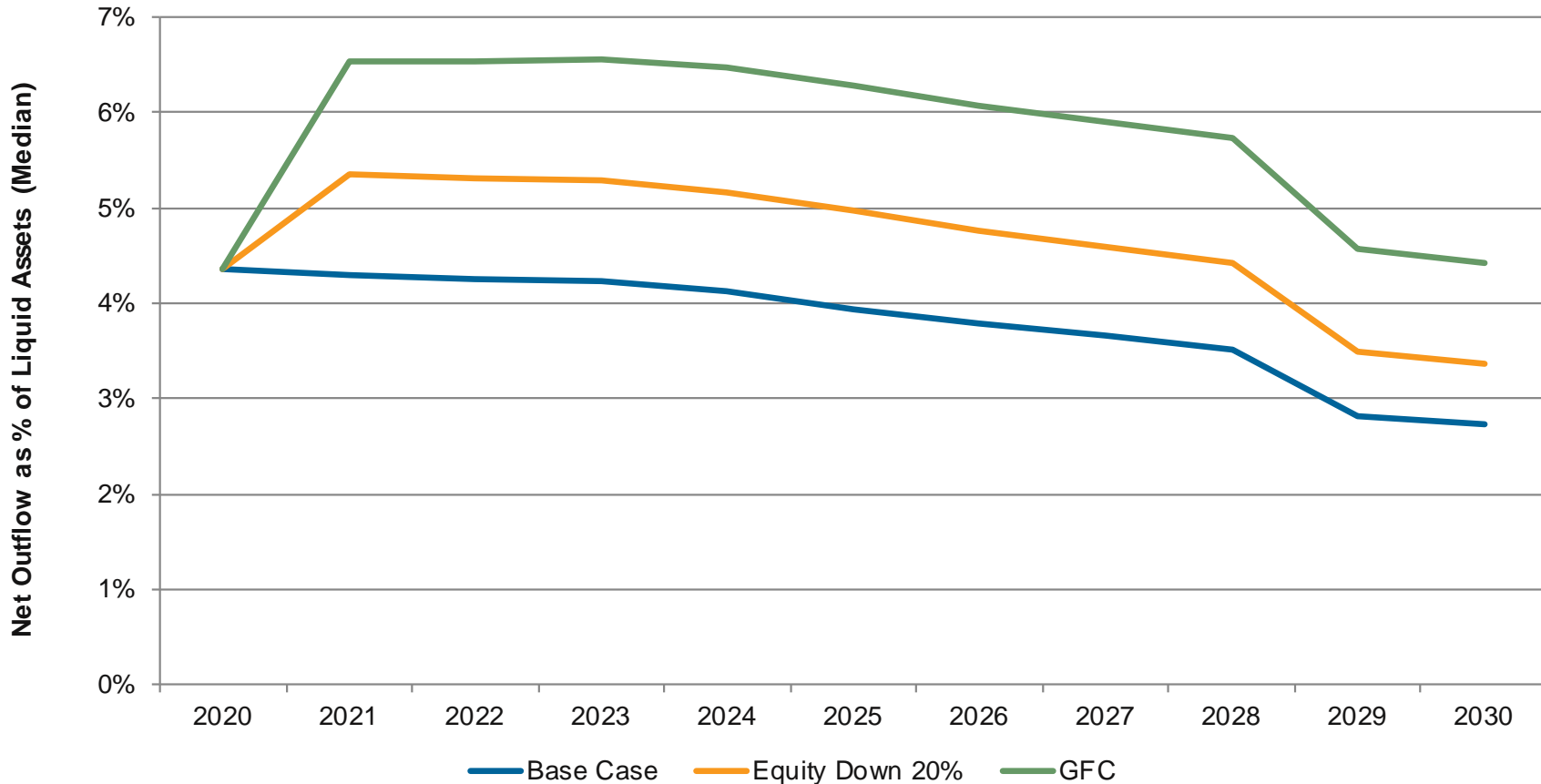
Market Funded Status (2020 = 63%)



- Base case funded status gradually rises to almost 70% by 2030
- With equities down 20% , the funded status drops to 51% in 2021 and rises to just 52% by 2030
- In a GFC scenario, the funded status drops to 42% in 2021 and falls to just under 40% by 2030

Stress Tests

Net Outflow as a % of Liquid Assets (2020 = 4.4%)



- Base case net outflow falls to 2.7% by 2030
- With equities down 20% , net outflow jumps 5.4% in 2021 before dropping to 3.4% by 2030
- In a GFC scenario, net outflow rises to 6.5% in 2021 before falling to 4.4% by 2030
- Outcomes are heavily contingent upon adherence to the funding policy

Note: High yield considered illiquid in stressed environments

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