



# North Carolina Department of State Treasurer

## Investment Management Division

### Risk Analysis

*Report to Investment Advisory Committee*  
*November 14, 2012*

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- Stochastic discount rate analysis: 7.00% & 6.75%	
- Capital markets model	

# Project Purpose

- Analyze the range of asset, liability, and cost outcomes with a stochastic modeling process using the Plan's target investment strategy and Buck Consultants' asset-liability modeling techniques
- Conduct a sensitivity analysis of key funding metrics related to:
  - large market decline
  - low return environment
  - discount rates of 7.25%, 7.00% and 6.75%
- Evaluate the information within the context of the Plan's portfolio and risk management processes

# Project Approach

## Identify Retirement System Risk Factors

- Liability
  - Benefit formula
  - COLAs
  - Discount rate
- Investment
  - Asset allocation
  - Equity market risk
  - Interest rates
  - Low return environment

## Construct Model / Perform Modelling

- 30-year liability and portfolio return forecasts
- Forecast portfolio returns under 999 GEMS® economic and capital market scenarios
- Scenario analysis
- Perform 30 years of actuarial valuations and compute key financial metrics

## Summarize / Evaluate Results

- Impact on key financial metrics
  - Annual state contributions (\$)
  - Annual state contributions (% of pay)
  - Accumulated state contributions (\$)
  - Actuarial funded ratios

# Risk Modeling Framework

- Asset Mix
- Actuarial Methodologies
- Risk Metrics

# Asset Mix

TSERS Asset Class	Strategic Target
Global Equity	40.5%
Fixed Income	36.0%
Alternatives	6.5%
Private Equity	--
Hedge Funds	--
Real Estate	8.0%
Credit	4.5%
Inflation	4.5%

# Actuarial Methodologies

Item	Methodology
Assumed Portfolio Return	7.25%
Actuarial Funding Method	<ul style="list-style-type: none"> <li>Actuarial cost method: Individual entry age normal cost method</li> <li>Asset smoothing: The actuarial value recognizes 20% of the difference between market value and the expected actuarial value that assumes a rate of return of 7.25%</li> </ul>
Funding Policy	<ul style="list-style-type: none"> <li>Two components, stated as a percentage of payroll                             <ul style="list-style-type: none"> <li>Normal cost: uniform percentage of pay from new entrant to termination or retirement</li> <li>Accrued liability: amortization of unfunded actuarial accrued liability over 12 years</li> </ul> </li> </ul>
Future Population	Level future population
Mortality	Current mortality improvements
Benefit Provisions	Benefit provisions currently in effect <u>with and without an assumed COLA</u> . COLA granted annually to the extent that the COLA could be fully funded from the gain on the Actuarial Value of Assets, but limited to the increase in CPI-U for the year.

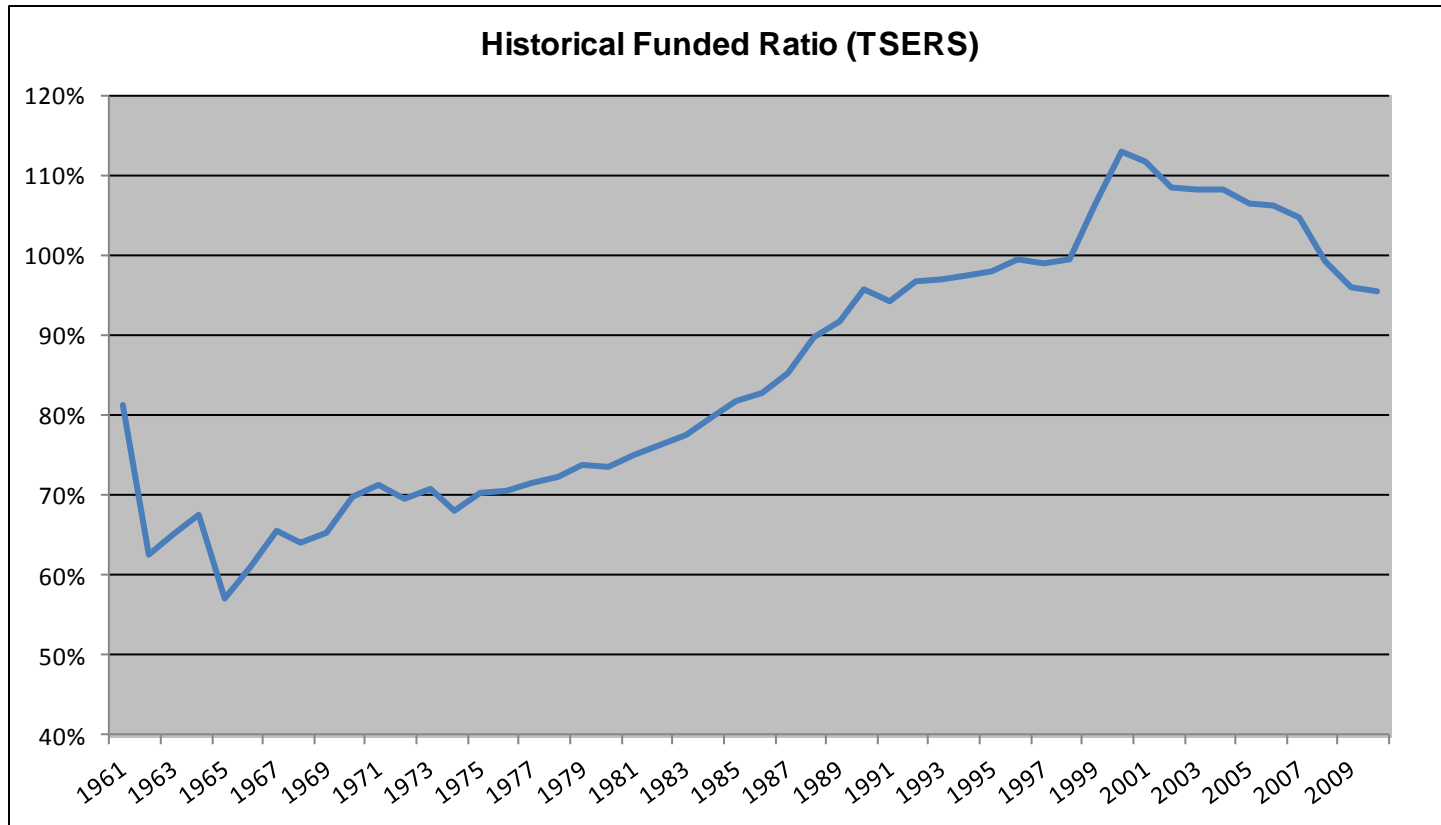


# Risk Metrics

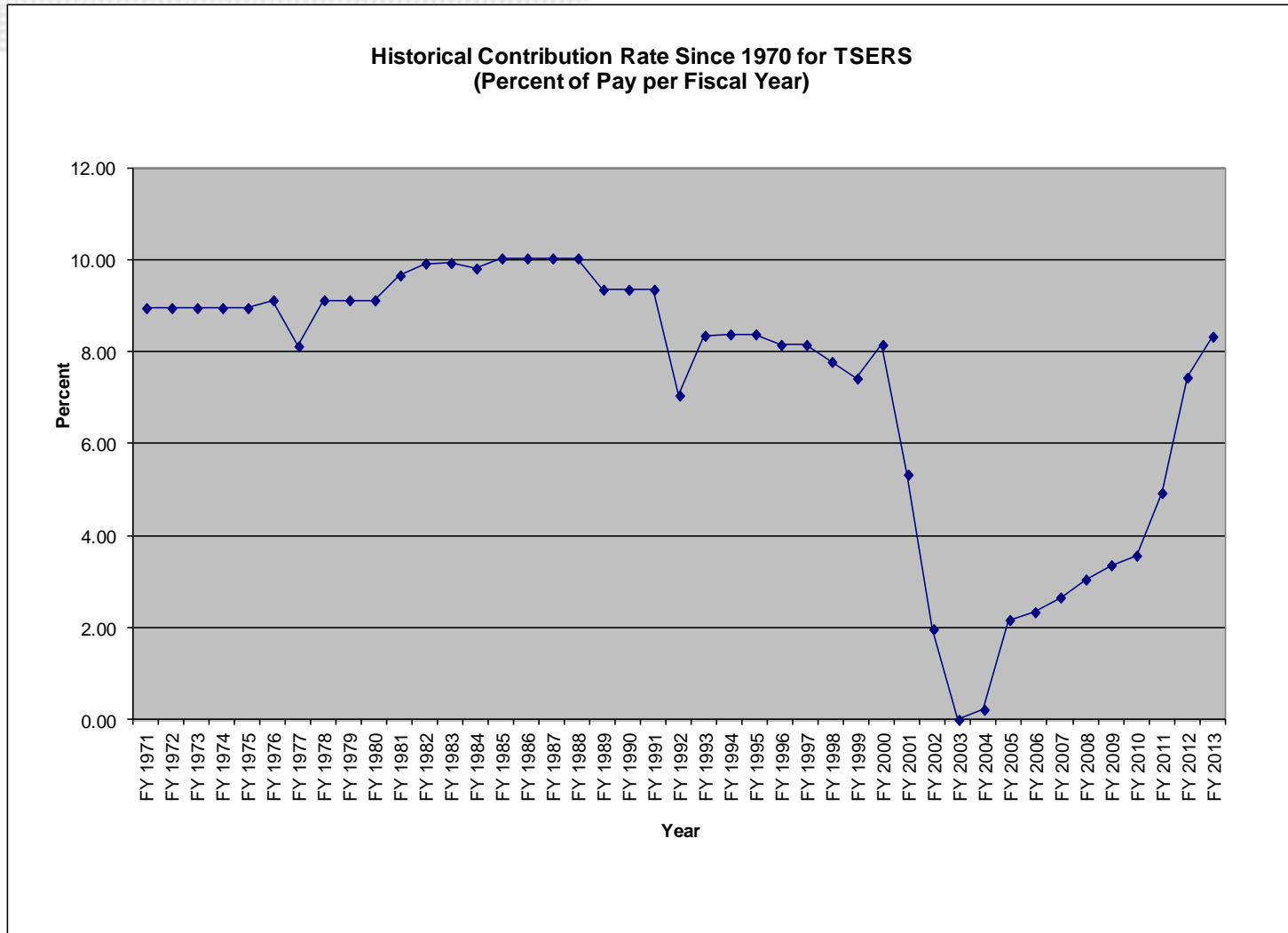
Metric Type	Metric
General Asset or Liability	Portfolio Nominal Return
	Portfolio Geometric Average Return
	Actuarial Liability
	Market Value of Assets
	Actuarial Value of Assets
Cash Funding	Annual and Accumulated Contributions (\$)
	Fiscal Year Contribution (% of Pay)
	Actuarial Funded Ratio



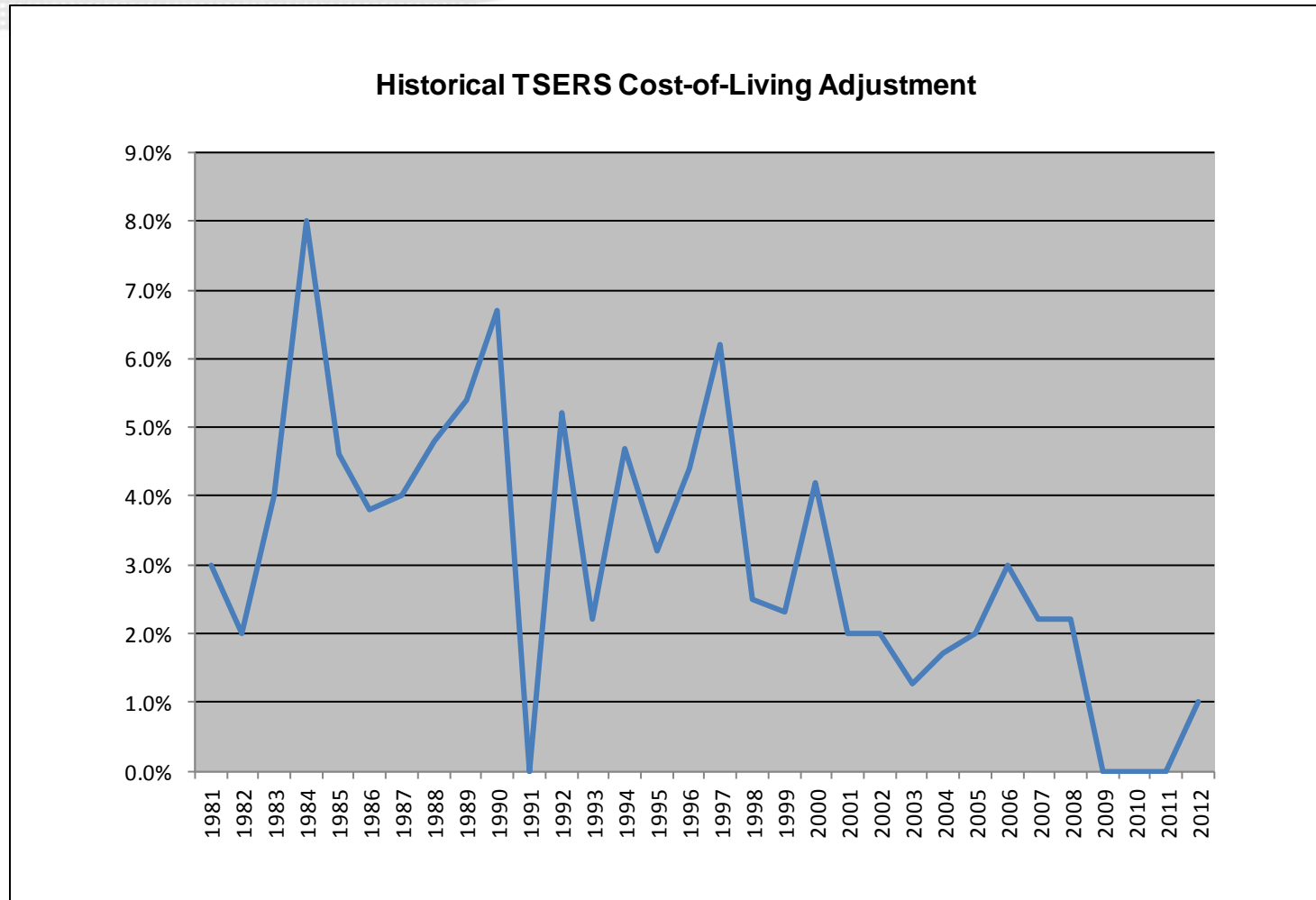
# Historical Results



# Historical Results



# Historical Results



# Risk Modeling Results

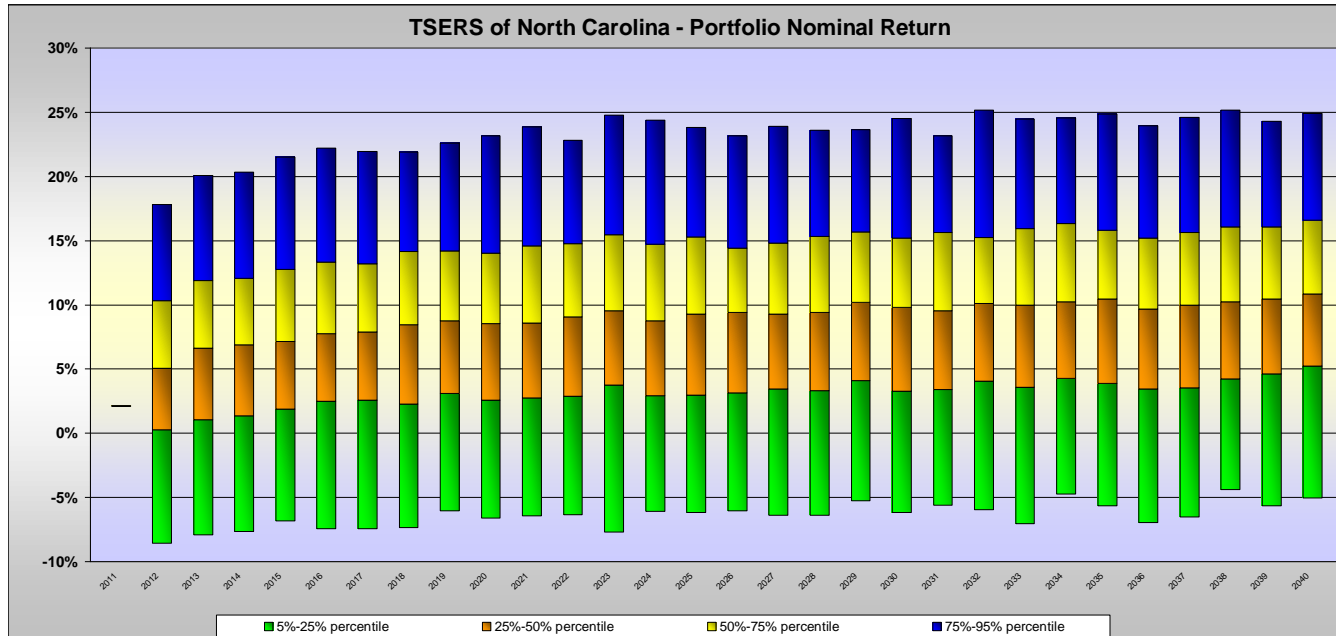
- Base Case Analysis (Stochastic)
- Scenario Analysis
  - Base case median scenario
  - Negative 20% total portfolio return in 2012
  - Weak markets for 10 years followed by median market conditions in years 11-30

## **Base Case Analysis – 7.25% Discount Rate**

- Strategic asset allocation
- 30-Year Forecast of Valuation Results
- Summaries of Key Financial Metrics
- 999 Inter-related Economic and Capital Market Scenarios

# TSERS of North Carolina

## Portfolio Nominal Return



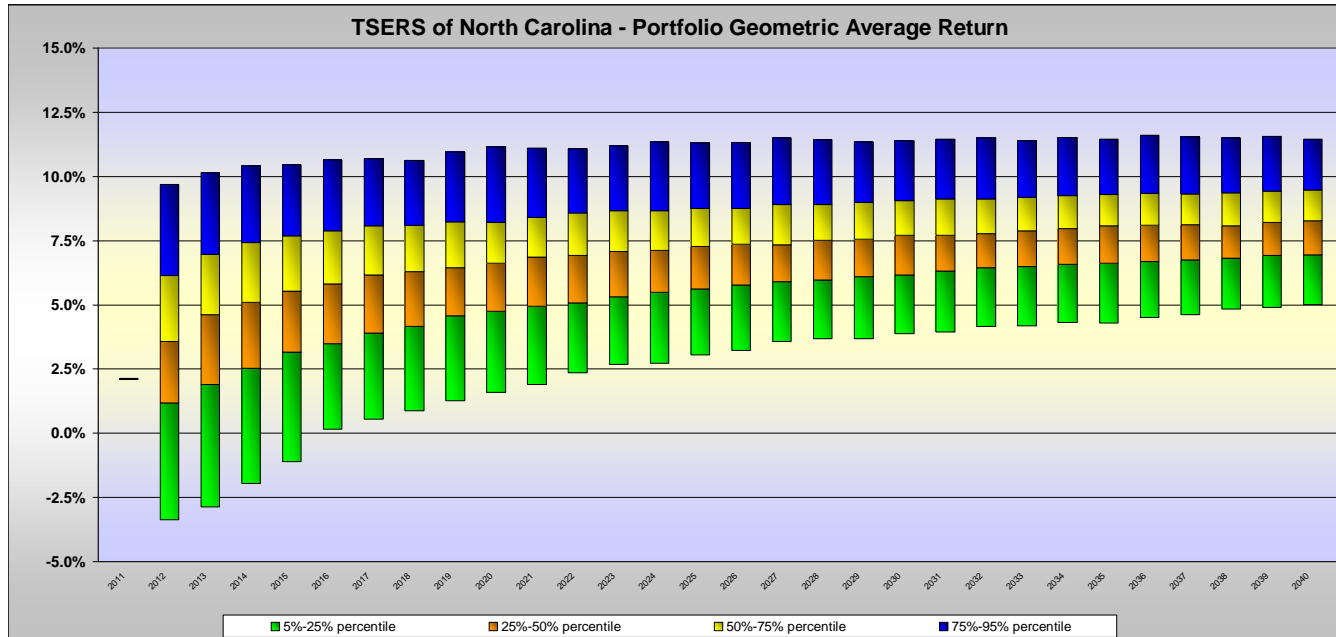
Portfolio Nominal Return

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
95th percentile	2.1%	17.8%	20.1%	20.3%	21.5%	22.2%	21.9%	21.9%	22.6%	23.2%	23.9%	22.8%	24.8%	24.4%	23.8%
75th percentile	2.1%	10.3%	11.9%	12.1%	12.8%	13.3%	13.2%	14.2%	14.2%	14.0%	14.6%	14.8%	15.5%	14.7%	15.3%
50th percentile	2.1%	5.1%	6.6%	6.9%	7.1%	7.8%	7.9%	8.5%	8.8%	8.5%	8.6%	9.1%	9.5%	8.8%	9.3%
25th percentile	2.1%	0.3%	1.1%	1.4%	1.9%	2.5%	2.6%	2.3%	3.1%	2.6%	2.7%	2.9%	3.7%	2.9%	3.0%
5th percentile	2.1%	-8.6%	-7.9%	-7.7%	-6.8%	-7.4%	-7.4%	-7.3%	-6.1%	-6.6%	-6.5%	-6.3%	-7.7%	-6.1%	-6.1%

	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
95th percentile	23.2%	23.9%	23.6%	23.7%	24.5%	23.2%	25.2%	24.5%	24.6%	24.9%	23.9%	24.6%	25.2%	24.3%	24.9%
75th percentile	14.4%	14.8%	15.3%	15.7%	15.2%	15.6%	15.2%	15.9%	16.3%	15.8%	15.2%	15.7%	16.1%	16.1%	16.6%
50th percentile	9.4%	9.3%	9.4%	10.2%	9.8%	9.5%	10.1%	10.0%	10.3%	10.4%	9.7%	10.0%	10.2%	10.4%	10.8%
25th percentile	3.1%	3.5%	3.3%	4.1%	3.3%	3.4%	4.1%	3.6%	4.3%	3.9%	3.5%	3.5%	4.2%	4.6%	5.2%
5th percentile	-6.0%	-6.4%	-6.4%	-5.3%	-6.2%	-5.6%	-6.0%	-7.0%	-4.7%	-5.6%	-7.0%	-6.5%	-4.4%	-5.7%	-5.0%

# TSERS of North Carolina

## Portfolio Geometric Average Return



Portfolio Geometric Average Return

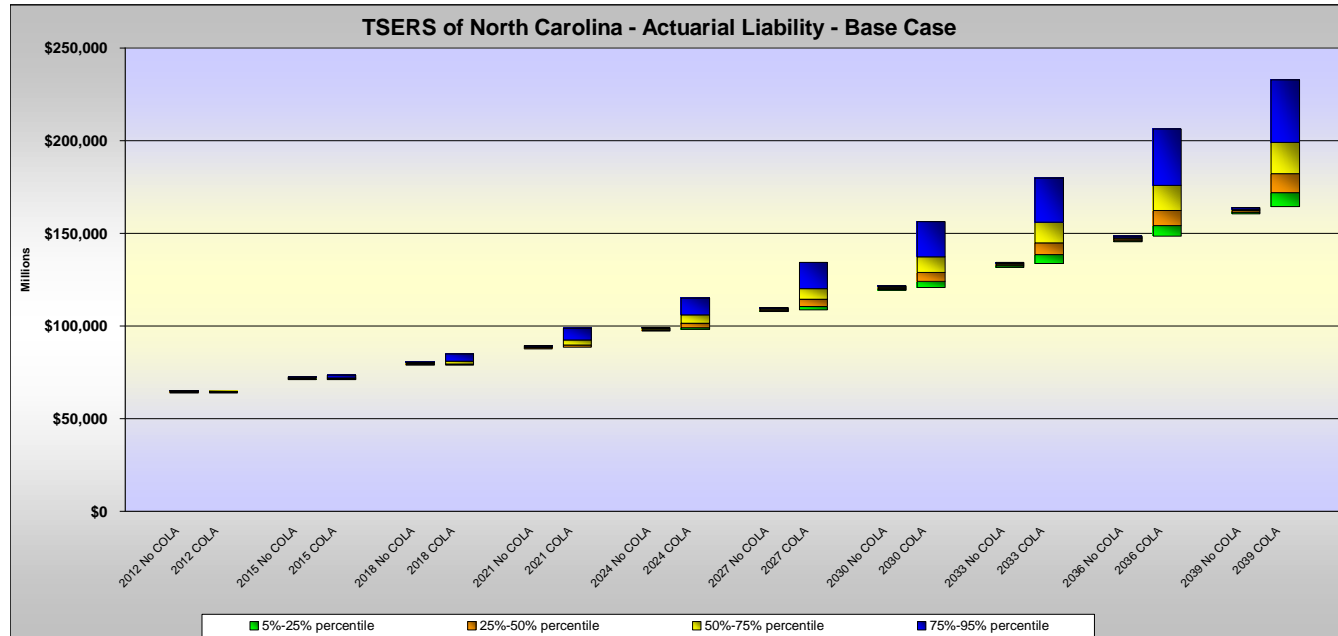
	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
95th percentile	2.1%	9.7%	10.2%	10.4%	10.5%	10.6%	10.7%	10.6%	11.0%	11.1%	11.1%	11.1%	11.2%	11.3%	11.3%
75th percentile	2.1%	6.1%	7.0%	7.4%	7.7%	7.9%	8.1%	8.1%	8.2%	8.2%	8.4%	8.6%	8.7%	8.7%	8.7%
50th percentile	2.1%	3.6%	4.6%	5.1%	5.5%	5.8%	6.2%	6.3%	6.4%	6.6%	6.9%	6.9%	7.1%	7.1%	7.3%
25th percentile	2.1%	1.2%	1.9%	2.5%	3.2%	3.5%	3.9%	4.2%	4.6%	4.8%	4.9%	5.1%	5.3%	5.5%	5.6%
5th percentile	2.1%	-3.4%	-2.9%	-1.9%	-1.1%	0.2%	0.5%	0.9%	1.3%	1.6%	1.9%	2.3%	2.7%	2.7%	3.0%

	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
95th percentile	11.3%	11.5%	11.4%	11.3%	11.4%	11.5%	11.5%	11.4%	11.5%	11.5%	11.6%	11.5%	11.5%	11.6%	11.5%
75th percentile	8.7%	8.9%	8.9%	9.0%	9.1%	9.1%	9.1%	9.2%	9.2%	9.3%	9.3%	9.3%	9.4%	9.4%	9.5%
50th percentile	7.4%	7.3%	7.5%	7.6%	7.7%	7.7%	7.8%	7.9%	8.0%	8.1%	8.1%	8.1%	8.1%	8.2%	8.3%
25th percentile	5.8%	5.9%	6.0%	6.1%	6.2%	6.3%	6.5%	6.5%	6.6%	6.6%	6.7%	6.8%	6.8%	6.9%	7.0%
5th percentile	3.2%	3.6%	3.7%	3.7%	3.9%	3.9%	4.2%	4.2%	4.3%	4.3%	4.5%	4.6%	4.8%	4.9%	5.0%



# TSERS of North Carolina

## Actuarial Liability (\$ millions) – Base Case – 7.25% discount



Variability in liabilities that assume a COLA results from a dynamic inflation model

### Actuarial Liability as of 12/31

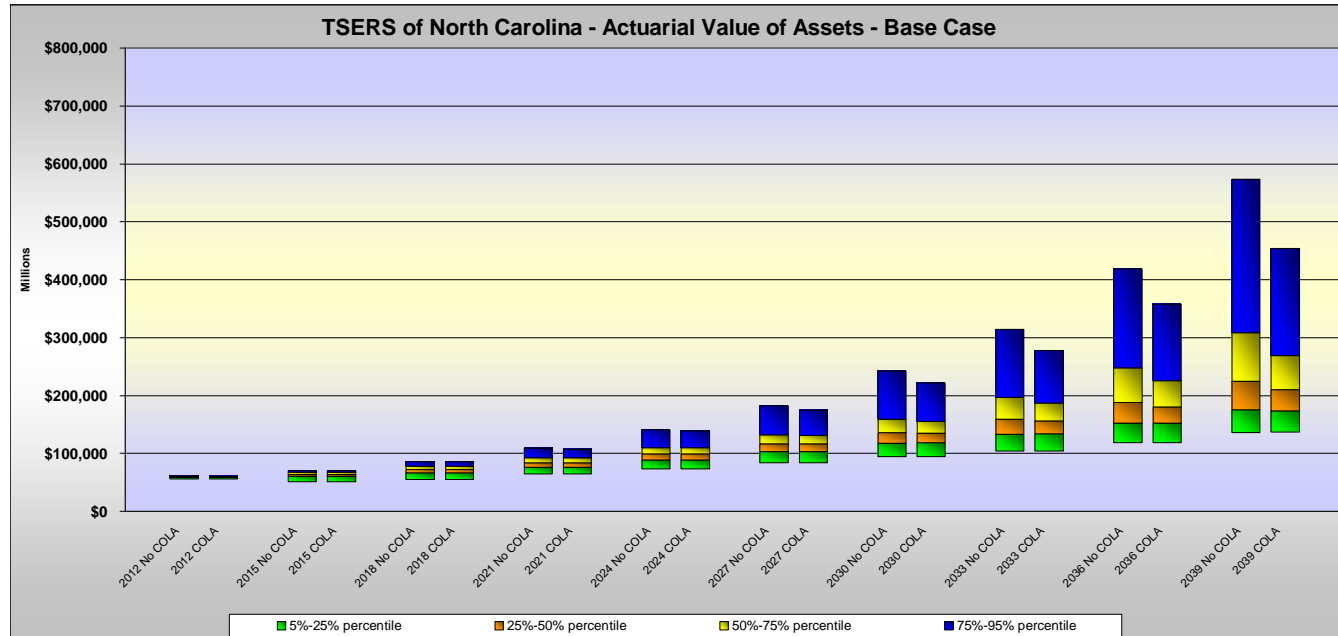
	2012		2015		2018		2021		2024	
	No COLA	COLA	No COLA	COLA	No COLA	COLA	No COLA	COLA	No COLA	COLA
95th percentile	\$64,522.0	\$64,540.3	\$71,764.6	\$73,639.1	\$79,733.3	\$85,204.8	\$88,461.5	\$98,807.1	\$98,159.6	\$115,113.8
75th percentile	\$64,522.0	\$64,522.0	\$71,764.6	\$72,102.5	\$79,733.3	\$81,385.2	\$88,461.5	\$92,615.6	\$98,159.6	\$105,881.7
50th percentile	\$64,522.0	\$64,522.0	\$71,764.6	\$71,764.6	\$79,733.3	\$80,055.5	\$88,461.5	\$89,862.1	\$98,159.6	\$101,379.5
25th percentile	\$64,522.0	\$64,522.0	\$71,764.6	\$71,764.6	\$79,733.3	\$79,733.3	\$88,461.5	\$88,609.7	\$98,159.6	\$98,963.2
5th percentile	\$64,522.0	\$64,522.0	\$71,764.6	\$71,764.6	\$79,733.3	\$79,733.3	\$88,461.5	\$88,461.5	\$98,159.6	\$98,159.6

	2027		2030		2033		2036		2039	
	No COLA	COLA	No COLA	COLA	No COLA	COLA	No COLA	COLA	No COLA	COLA
95th percentile	\$108,811.5	\$134,386.6	\$120,439.0	\$156,220.1	\$133,068.3	\$179,770.1	\$146,921.7	\$206,237.5	\$162,247.3	\$232,979.9
75th percentile	\$108,811.5	\$120,287.9	\$120,439.0	\$137,355.9	\$133,068.3	\$155,895.1	\$146,921.7	\$176,015.7	\$162,247.3	\$199,007.7
50th percentile	\$108,811.5	\$114,424.8	\$120,439.0	\$128,978.8	\$133,068.3	\$144,862.5	\$146,921.7	\$162,487.7	\$162,247.3	\$182,117.8
25th percentile	\$108,811.5	\$110,660.7	\$120,439.0	\$123,997.0	\$133,068.3	\$138,486.5	\$146,921.7	\$154,225.0	\$162,247.3	\$172,003.1
5th percentile	\$108,811.5	\$108,811.5	\$120,439.0	\$120,720.9	\$133,068.3	\$133,728.3	\$146,921.7	\$148,360.8	\$162,247.3	\$164,510.9

# TSERS of North Carolina

## Actuarial Value of Assets (\$ millions) – Base Case – 7.25% discount



### Actuarial Value of Assets as of 12/31

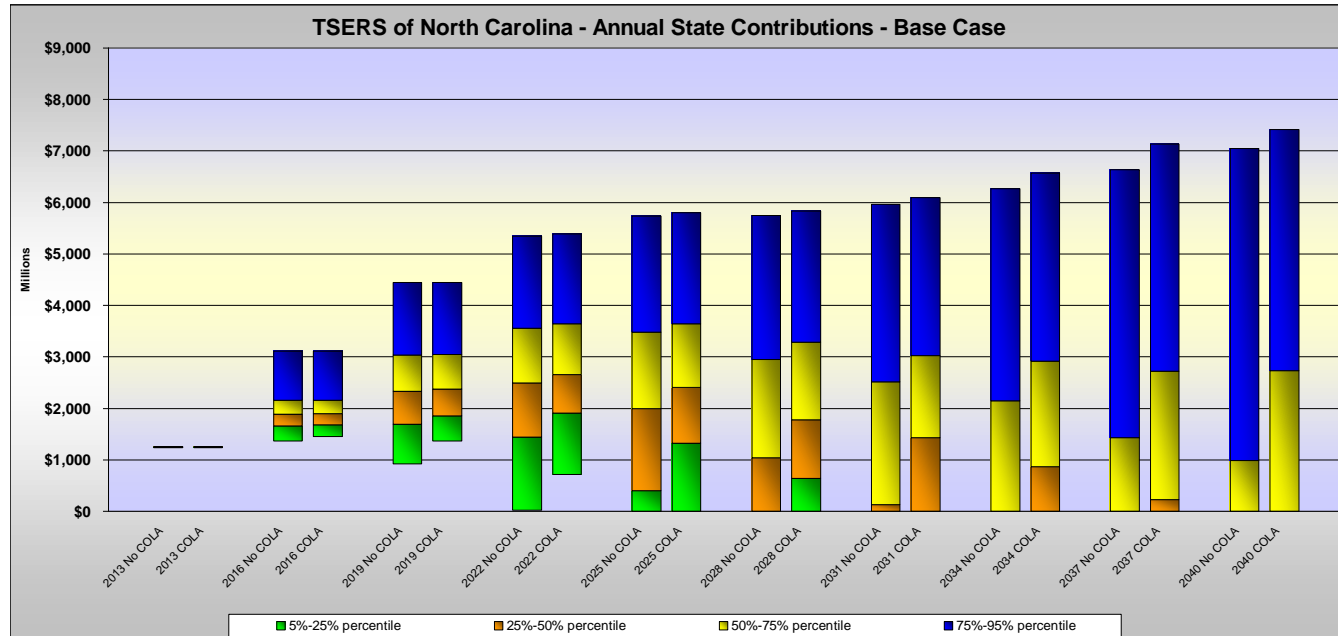
	2012		2015		2018		2021		2024	
	No COLA	COLA	No COLA	COLA	No COLA	COLA	No COLA	COLA	No COLA	COLA
95th percentile	\$60,394.2	\$60,394.2	\$70,842.7	\$70,698.9	\$86,023.8	\$85,758.2	\$108,440.0	\$107,411.6	\$140,303.3	\$138,874.5
75th percentile	\$59,606.4	\$59,606.4	\$67,054.8	\$67,031.6	\$77,924.9	\$77,823.7	\$92,186.2	\$92,108.1	\$110,184.9	\$109,750.3
50th percentile	\$59,053.3	\$59,053.3	\$64,034.9	\$64,034.9	\$72,473.1	\$72,427.5	\$83,956.8	\$83,896.7	\$99,323.7	\$99,218.5
25th percentile	\$58,551.4	\$58,551.4	\$60,962.9	\$60,962.9	\$66,071.4	\$66,071.4	\$76,205.8	\$76,231.8	\$88,816.2	\$88,905.3
5th percentile	\$56,324.9	\$56,324.9	\$51,155.4	\$51,155.4	\$54,779.9	\$54,779.9	\$64,407.3	\$64,407.3	\$73,655.4	\$73,655.4

	2027		2030		2033		2036		2039	
	No COLA	COLA	No COLA	COLA	No COLA	COLA	No COLA	COLA	No COLA	COLA
95th percentile	\$182,191.0	\$174,297.2	\$241,610.2	\$221,694.2	\$314,556.6	\$277,629.5	\$417,909.1	\$357,751.3	\$573,621.5	\$453,928.5
75th percentile	\$131,642.6	\$130,747.3	\$158,613.2	\$154,746.1	\$197,060.5	\$186,625.5	\$247,430.2	\$225,211.4	\$308,798.7	\$269,002.4
50th percentile	\$116,295.0	\$116,596.8	\$135,985.9	\$135,280.5	\$158,775.2	\$156,099.9	\$188,117.8	\$180,401.7	\$224,679.9	\$210,161.7
25th percentile	\$103,390.4	\$103,571.3	\$117,771.2	\$118,120.3	\$133,436.4	\$133,993.0	\$152,465.3	\$152,087.2	\$175,791.1	\$173,422.5
5th percentile	\$83,891.4	\$84,036.9	\$94,409.9	\$94,928.6	\$104,402.9	\$104,517.2	\$118,650.2	\$118,295.7	\$136,173.3	\$137,176.4

# TSERS of North Carolina

## Annual State Contrib. (\$millions) – Base Case – 7.25% discount



### Annual State Contributions

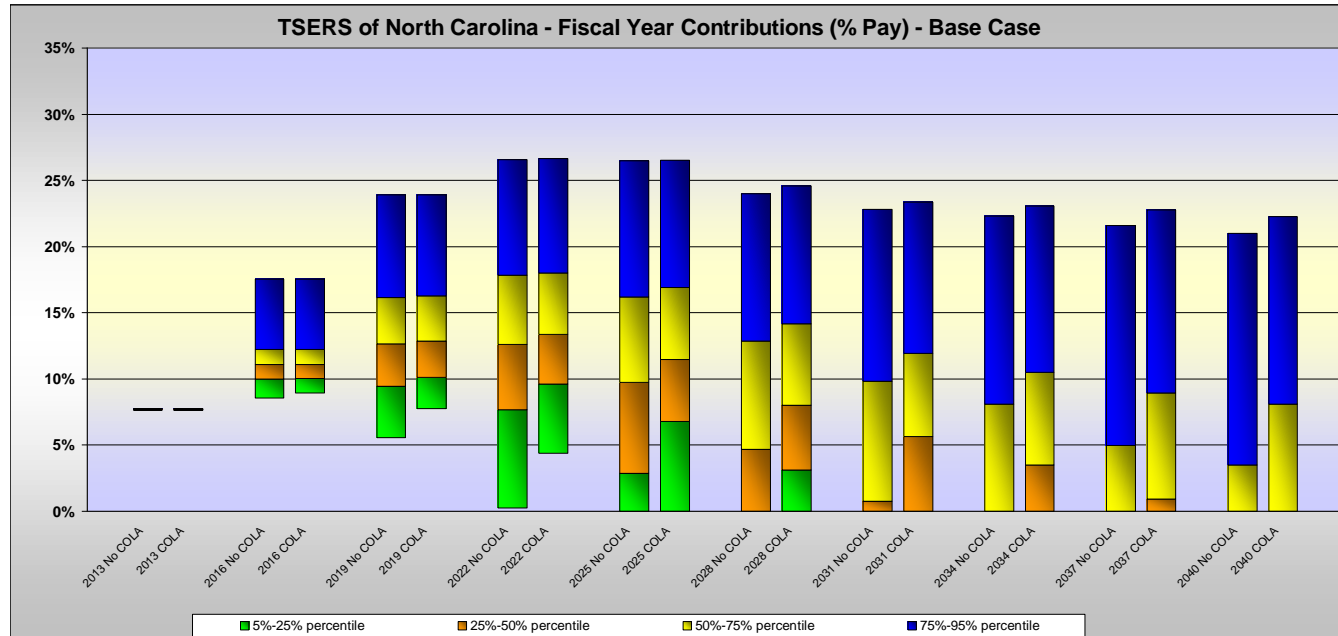
	2013		2016		2019		2022		2025	
	No COLA	COLA	No COLA	COLA	No COLA	COLA	No COLA	COLA	No COLA	COLA
95th percentile	\$1,248.8	\$1,248.8	\$3,109.6	\$3,109.6	\$4,442.9	\$4,442.9	\$5,343.6	\$5,387.5	\$5,734.2	\$5,806.5
75th percentile	\$1,248.8	\$1,248.8	\$2,153.5	\$2,153.5	\$3,038.0	\$3,048.9	\$3,553.0	\$3,640.4	\$3,484.4	\$3,642.9
50th percentile	\$1,248.8	\$1,248.8	\$1,886.9	\$1,892.8	\$2,327.2	\$2,369.7	\$2,491.8	\$2,661.2	\$1,999.6	\$2,402.0
25th percentile	\$1,248.8	\$1,248.8	\$1,658.9	\$1,675.5	\$1,696.1	\$1,859.6	\$1,440.3	\$1,913.3	\$397.1	\$1,317.7
5th percentile	\$1,248.8	\$1,248.8	\$1,365.0	\$1,458.0	\$925.6	\$1,367.5	\$25.4	\$713.6	\$0.0	\$0.0

	2028		2031		2034		2037		2040	
	No COLA	COLA	No COLA	COLA	No COLA	COLA	No COLA	COLA	No COLA	COLA
95th percentile	\$5,749.2	\$5,837.5	\$5,958.6	\$6,093.9	\$6,266.2	\$6,566.7	\$6,633.4	\$7,131.7	\$7,045.5	\$7,416.3
75th percentile	\$2,953.1	\$3,284.2	\$2,511.5	\$3,030.6	\$2,147.7	\$2,919.4	\$1,433.0	\$2,726.5	\$986.8	\$2,734.5
50th percentile	\$1,036.9	\$1,779.8	\$134.2	\$1,433.5	\$0.0	\$867.4	\$0.0	\$231.2	\$0.0	\$0.0
25th percentile	\$0.0	\$642.7	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0
5th percentile	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0

# TSERS of North Carolina

## *Fiscal Year Contribution (% of Pay) – Base Case – 7.25% discount*



Fiscal Year Contribution (% of Pay)

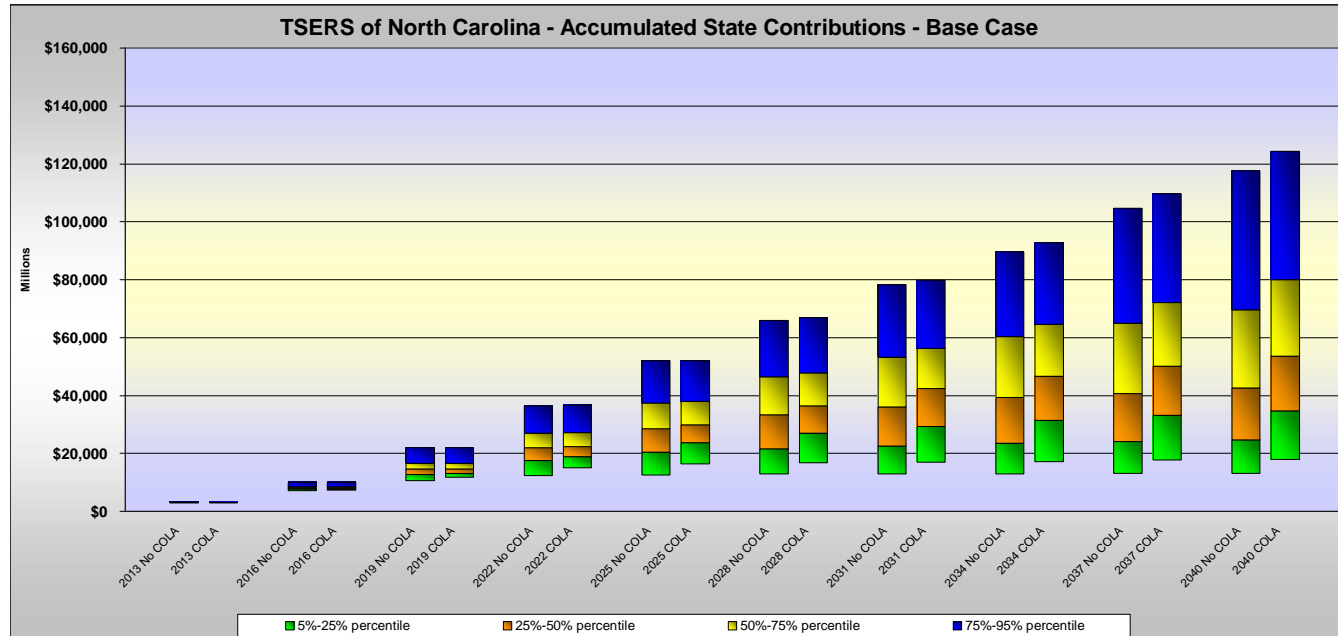
	2013		2016		2019		2022		2025	
	No COLA	COLA	No COLA	COLA	No COLA	COLA	No COLA	COLA	No COLA	COLA
95th percentile	7.7%	7.7%	17.6%	17.6%	23.9%	23.9%	26.6%	26.6%	26.5%	26.5%
75th percentile	7.7%	7.7%	12.2%	12.2%	16.2%	16.3%	17.9%	18.0%	16.2%	16.9%
50th percentile	7.7%	7.7%	11.1%	11.1%	12.7%	12.9%	12.6%	13.4%	9.7%	11.5%
25th percentile	7.7%	7.7%	10.0%	10.0%	9.4%	10.1%	7.7%	9.6%	2.9%	6.8%
5th percentile	7.7%	7.7%	8.6%	8.9%	5.6%	7.7%	0.3%	4.4%	0.0%	0.0%

	2028		2031		2034		2037		2040	
	No COLA	COLA	No COLA	COLA	No COLA	COLA	No COLA	COLA	No COLA	COLA
95th percentile	24.0%	24.6%	22.8%	23.4%	22.3%	23.0%	21.6%	22.8%	21.0%	22.3%
75th percentile	12.9%	14.2%	9.8%	12.0%	8.1%	10.5%	5.0%	9.0%	3.5%	8.1%
50th percentile	4.7%	8.0%	0.8%	5.6%	0.0%	3.5%	0.0%	0.9%	0.0%	0.0%
25th percentile	0.0%	3.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
5th percentile	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

# TSERS of North Carolina

**Accum. State Contrib. (\$ millions) – Base Case – 7.25% discount**



## Accumulated State Contributions

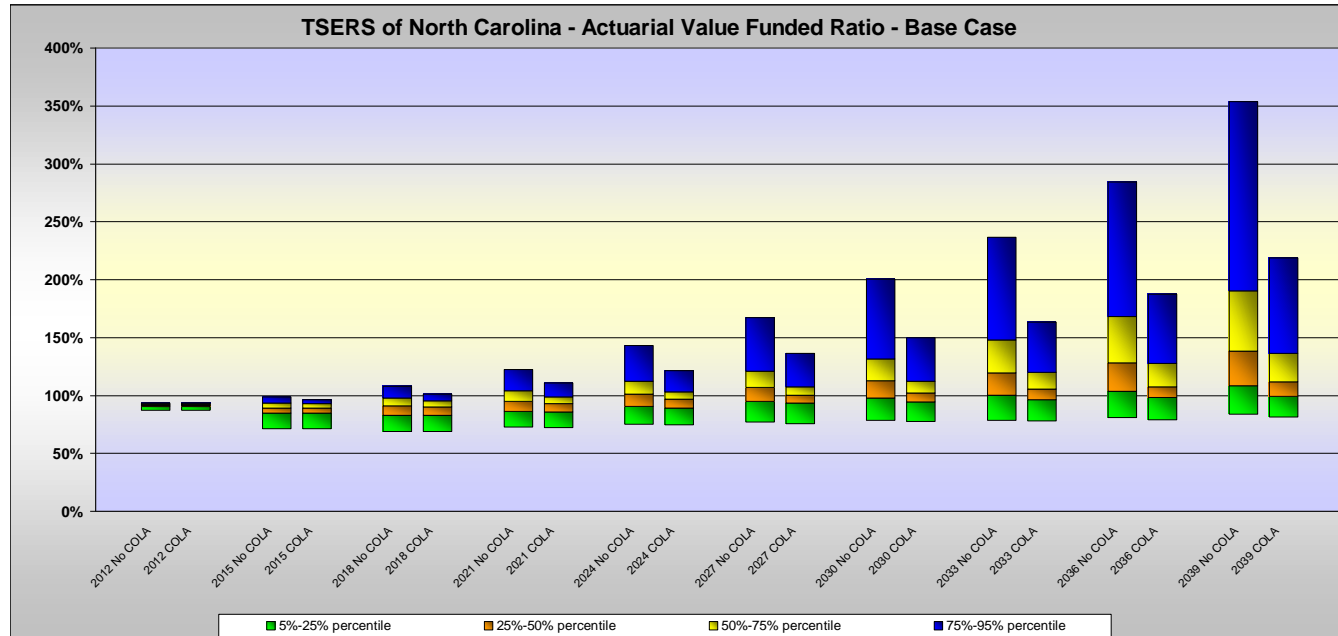
	2013		2016		2019		2022		2025	
	No COLA	COLA	No COLA	COLA	No COLA	COLA	No COLA	COLA	No COLA	COLA
95th percentile	\$2,969.1	\$2,969.1	\$10,082.4	\$10,082.4	\$22,017.1	\$22,018.1	\$36,342.7	\$36,674.1	\$51,996.6	\$52,053.2
75th percentile	\$2,969.1	\$2,969.1	\$8,498.2	\$8,498.2	\$16,641.9	\$16,670.2	\$26,968.5	\$27,185.2	\$37,314.0	\$38,024.6
50th percentile	\$2,969.1	\$2,969.1	\$8,037.6	\$8,037.9	\$14,682.9	\$14,721.5	\$21,880.3	\$22,413.4	\$28,538.1	\$29,908.9
25th percentile	\$2,969.1	\$2,969.1	\$7,660.3	\$7,680.4	\$12,725.3	\$13,100.0	\$17,627.5	\$18,874.7	\$20,469.4	\$23,765.8
5th percentile	\$2,969.1	\$2,969.1	\$7,127.4	\$7,261.5	\$10,681.3	\$11,688.2	\$12,430.3	\$15,092.6	\$12,485.8	\$16,323.4

	2028		2031		2034		2037		2040	
	No COLA	COLA	No COLA	COLA	No COLA	COLA	No COLA	COLA	No COLA	COLA
95th percentile	\$65,961.1	\$66,942.8	\$78,229.1	\$79,775.4	\$89,686.2	\$92,644.7	\$104,683.5	\$109,617.1	\$117,616.8	\$124,324.0
75th percentile	\$46,425.9	\$47,726.5	\$53,126.7	\$56,265.3	\$60,360.3	\$64,668.5	\$65,006.0	\$72,187.9	\$69,685.0	\$80,008.6
50th percentile	\$33,430.9	\$36,461.7	\$36,076.8	\$42,442.7	\$39,295.0	\$46,745.0	\$40,606.6	\$50,135.3	\$42,586.9	\$53,594.4
25th percentile	\$21,609.9	\$26,984.5	\$22,621.9	\$29,255.9	\$23,562.2	\$31,424.8	\$24,172.3	\$33,225.9	\$24,741.8	\$34,729.6
5th percentile	\$12,878.4	\$16,839.2	\$12,916.0	\$16,881.2	\$12,916.0	\$17,195.1	\$13,154.2	\$17,762.6	\$13,168.8	\$17,869.6

# TSERS of North Carolina

## Actuarial Value Funded Ratio – Base Case – 7.25% discount



Actuarial Value Funded Ratio as of 12/31

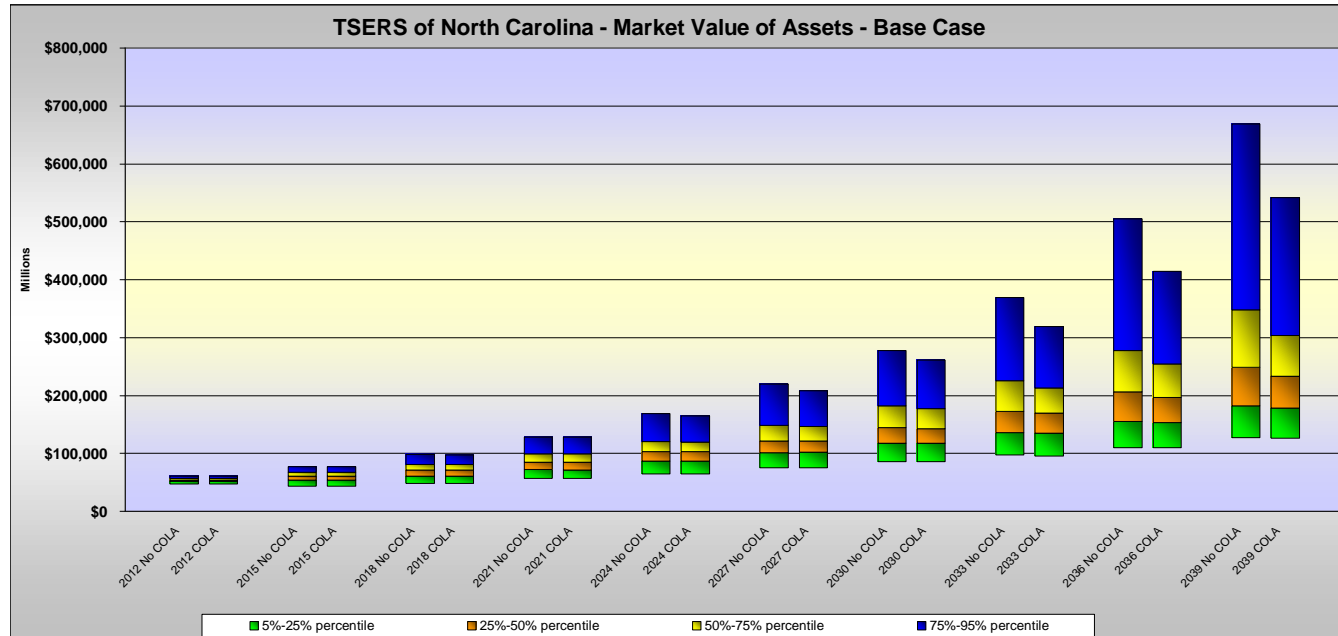
	2012		2015		2018		2021		2024	
	No COLA	COLA	No COLA	COLA	No COLA	COLA	No COLA	COLA	No COLA	COLA
95th percentile	93.6%	93.5%	98.7%	96.3%	107.9%	101.4%	122.6%	111.0%	142.9%	121.6%
75th percentile	92.4%	92.4%	93.4%	92.9%	97.7%	95.5%	104.2%	99.0%	112.3%	103.1%
50th percentile	91.5%	91.5%	89.2%	89.2%	90.9%	90.2%	94.9%	92.8%	101.2%	97.1%
25th percentile	90.7%	90.7%	84.9%	84.9%	82.9%	82.8%	86.1%	85.8%	90.5%	89.3%
5th percentile	87.3%	87.3%	71.3%	71.3%	68.7%	68.7%	72.8%	72.4%	75.0%	74.8%

	2027		2030		2033		2036		2039	
	No COLA	COLA	No COLA	COLA	No COLA	COLA	No COLA	COLA	No COLA	COLA
95th percentile	167.4%	136.5%	200.6%	149.9%	236.4%	163.5%	284.4%	187.6%	353.5%	218.7%
75th percentile	121.0%	107.6%	131.7%	112.5%	148.1%	119.9%	168.4%	127.8%	190.3%	136.5%
50th percentile	106.9%	100.3%	112.9%	102.4%	119.3%	105.4%	128.0%	107.7%	138.5%	112.0%
25th percentile	95.0%	93.3%	97.8%	94.5%	100.3%	96.3%	103.8%	98.2%	108.3%	99.2%
5th percentile	77.1%	75.6%	78.4%	77.8%	78.5%	77.9%	80.8%	78.9%	83.9%	81.7%

# TSERS of North Carolina

## Market Value of Assets (\$ millions) – Base Case – 7.25% discount



### Market Value of Assets as of 12/31

	2012		2015		2018		2021		2024	
	No COLA	COLA	No COLA	COLA	No COLA	COLA	No COLA	COLA	No COLA	COLA
95th percentile	\$60,783.0	\$60,783.0	\$76,706.5	\$76,638.2	\$98,209.2	\$97,779.2	\$128,570.5	\$128,196.1	\$168,585.2	\$164,848.0
75th percentile	\$56,843.9	\$56,843.9	\$67,400.7	\$67,356.5	\$80,882.8	\$80,787.8	\$99,366.7	\$99,162.9	\$120,468.0	\$119,972.5
50th percentile	\$54,078.7	\$54,078.7	\$60,571.4	\$60,571.4	\$70,897.0	\$70,876.5	\$85,007.8	\$84,962.1	\$102,883.5	\$102,720.0
25th percentile	\$51,569.0	\$51,569.0	\$53,760.8	\$53,760.8	\$60,778.5	\$60,778.3	\$71,832.0	\$71,807.0	\$86,367.1	\$86,382.2
5th percentile	\$46,937.5	\$46,937.5	\$43,419.9	\$43,419.9	\$47,956.6	\$47,956.6	\$56,944.1	\$56,943.0	\$64,466.4	\$64,545.2

	2027		2030		2033		2036		2039	
	No COLA	COLA	No COLA	COLA	No COLA	COLA	No COLA	COLA	No COLA	COLA
95th percentile	\$219,867.7	\$207,987.3	\$277,287.0	\$260,748.2	\$369,570.0	\$319,285.3	\$505,148.9	\$414,583.1	\$668,514.5	\$541,807.9
75th percentile	\$148,314.8	\$146,843.5	\$181,703.7	\$177,080.8	\$225,624.2	\$213,079.5	\$277,490.0	\$254,168.4	\$347,995.1	\$303,829.6
50th percentile	\$121,178.0	\$121,292.7	\$144,977.5	\$143,113.3	\$172,427.8	\$169,723.2	\$205,812.9	\$196,884.8	\$248,340.8	\$233,047.4
25th percentile	\$101,536.5	\$101,854.2	\$117,449.8	\$117,840.4	\$135,994.5	\$135,291.8	\$155,637.0	\$152,843.2	\$182,138.1	\$178,678.1
5th percentile	\$75,158.9	\$75,181.6	\$85,355.5	\$86,047.0	\$96,882.2	\$95,828.0	\$109,823.8	\$110,174.2	\$126,788.0	\$126,410.3



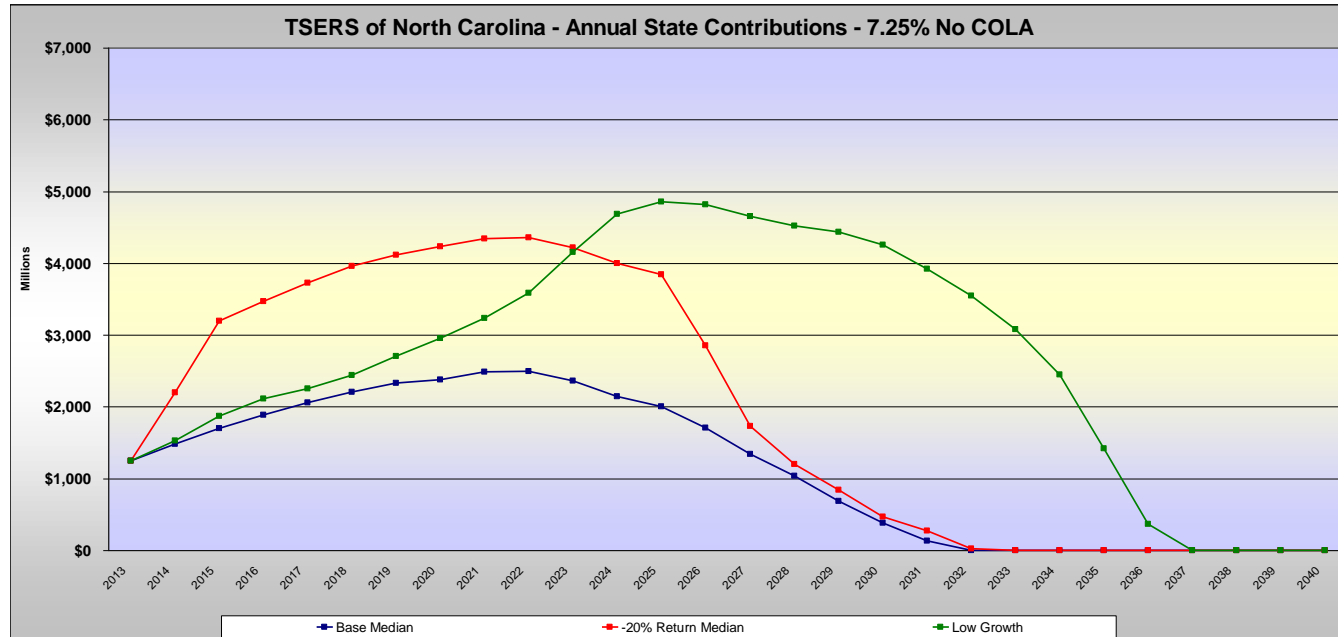
## Scenario Analysis - 7.25% Discount Rate

- Base Case\*
- Negative 20% total portfolio return in 2012\*
- Low Growth Scenario: Weak markets for 10 years followed by median market conditions in years 11-30. Maximum nominal return in years 1-10 of:
  - 5% return for Equity
  - 2.5% return for Fixed Income
  - 7% return for Private Equity

\* Median result from stochastic analysis

# TSERS of North Carolina

## Annual State Contributions (\$ millions) – 7.25% discount / No COLA



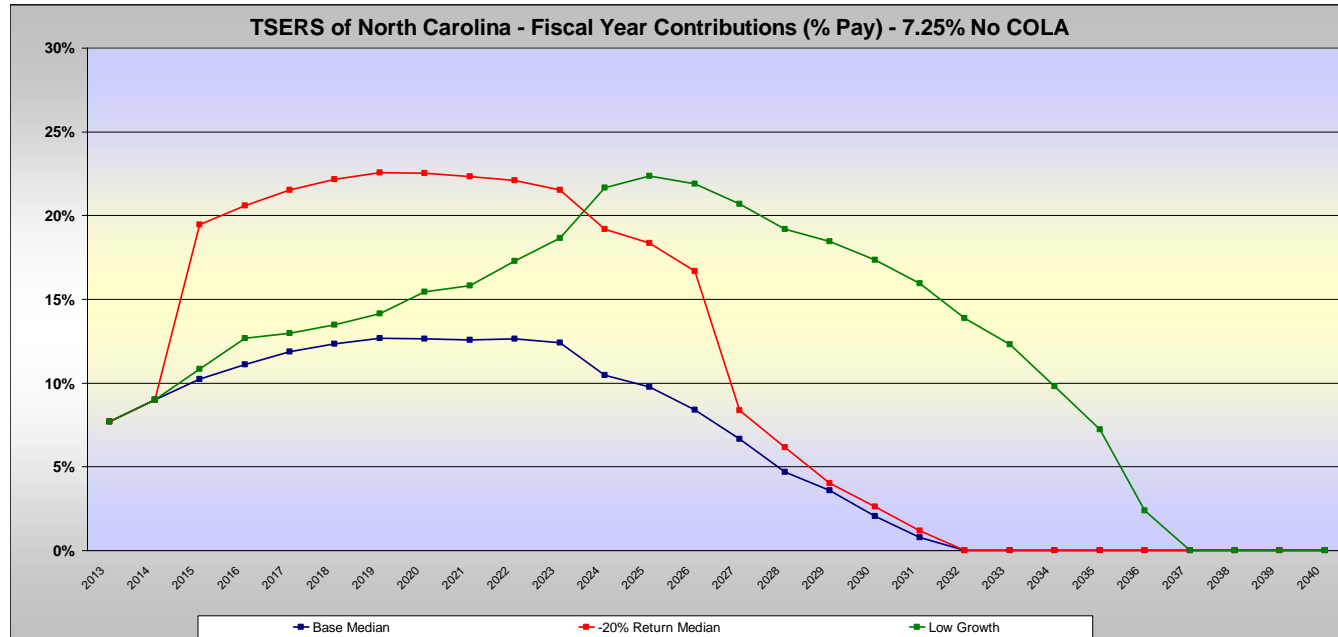
Annual State Contributions

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Base Median	\$1,248.8	\$1,484.3	\$1,699.8	\$1,886.9	\$2,057.4	\$2,208.8	\$2,327.2	\$2,379.2	\$2,486.2	\$2,491.8	\$2,363.1	\$2,139.8	\$1,999.6	\$1,707.0
-20% Return Median	\$1,248.8	\$2,195.9	\$3,194.7	\$3,472.3	\$3,725.0	\$3,956.9	\$4,115.0	\$4,234.8	\$4,344.3	\$4,358.3	\$4,219.7	\$4,000.9	\$3,841.8	\$2,856.8
Low Growth	\$1,248.8	\$1,529.7	\$1,873.7	\$2,114.5	\$2,256.0	\$2,437.7	\$2,702.8	\$2,953.4	\$3,236.6	\$3,588.7	\$4,153.5	\$4,681.3	\$4,857.8	\$4,821.2

	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Base Median	\$1,342.5	\$1,036.9	\$684.5	\$381.0	\$134.2	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0
-20% Return Median	\$1,733.9	\$1,197.4	\$841.7	\$468.1	\$270.4	\$24.4	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0
Low Growth	\$4,652.3	\$4,522.8	\$4,434.9	\$4,253.6	\$3,924.7	\$3,545.4	\$3,081.6	\$2,445.9	\$1,422.5	\$363.5	\$0.0	\$0.0	\$0.0	\$0.0

# TSERS of North Carolina

## *Fiscal Year Contribution (% of Pay) – 7.25% discount / No COLA*



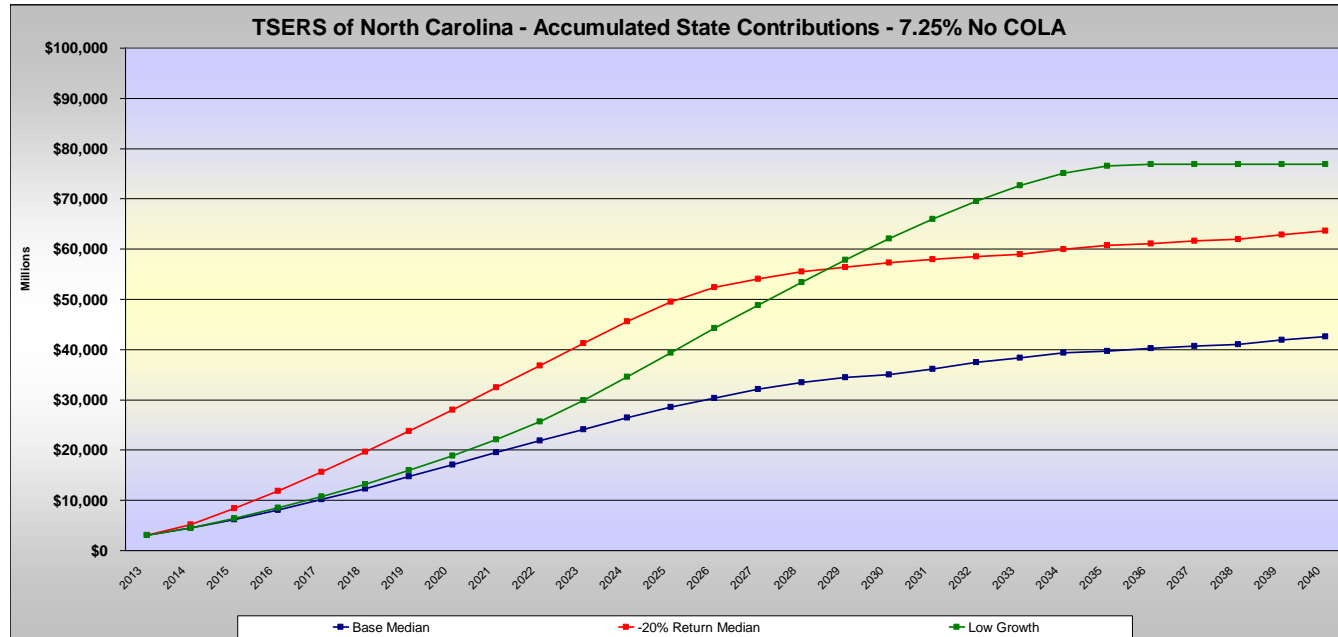
Fiscal Year Contribution (% of Pay)

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Base Median	7.7%	9.0%	10.2%	11.1%	11.9%	12.3%	12.7%	12.6%	12.6%	12.6%	12.4%	10.4%	9.7%	8.4%
-20% Return Median	7.7%	9.0%	19.4%	20.6%	21.5%	22.2%	22.5%	22.5%	22.3%	22.1%	21.5%	19.2%	18.3%	16.7%
Low Growth	7.7%	9.0%	10.8%	12.7%	13.0%	13.5%	14.1%	15.4%	15.8%	17.3%	18.6%	21.6%	22.4%	21.9%

	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Base Median	6.6%	4.7%	3.6%	2.0%	0.8%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
-20% Return Median	8.4%	6.1%	4.0%	2.6%	1.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Low Growth	20.7%	19.2%	18.4%	17.3%	15.9%	13.9%	12.3%	9.8%	7.2%	2.4%	0.0%	0.0%	0.0%	0.0%

# TSERS of North Carolina

**Accum. State Contribs. (\$ millions) – 7.25% discount / No COLA**



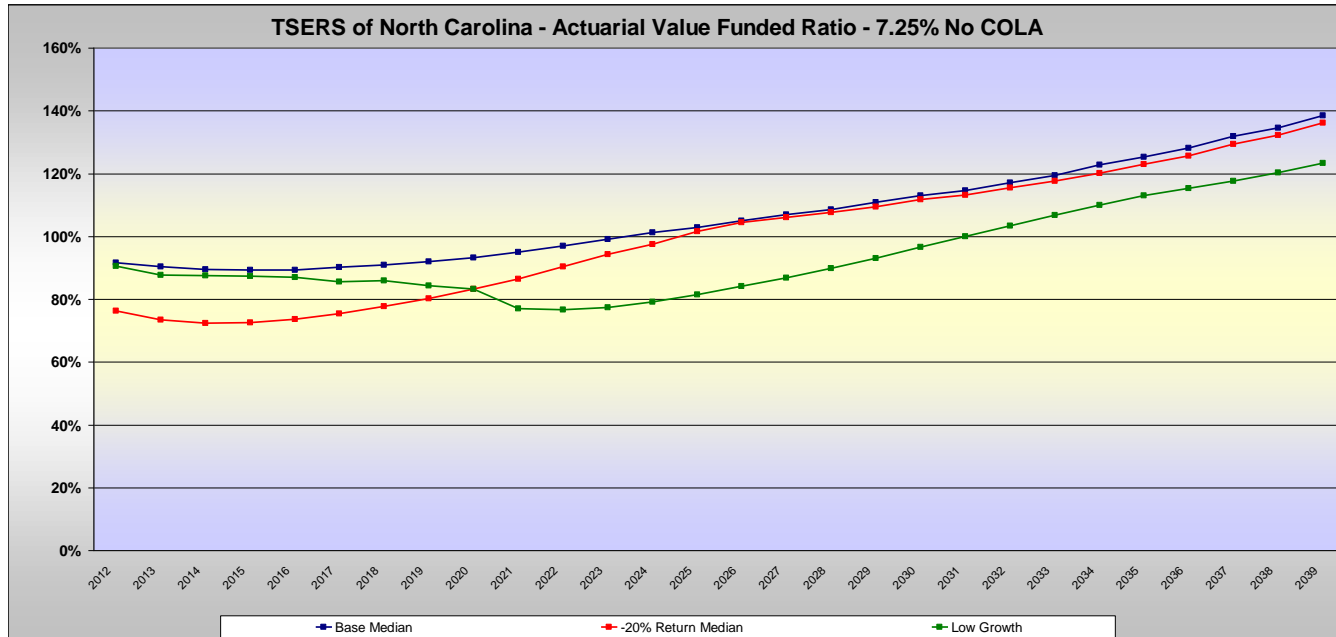
Accumulated State Contributions

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Base Median	\$2,969.1	\$4,453.4	\$6,155.1	\$8,037.6	\$10,096.9	\$12,299.6	\$14,682.9	\$17,092.1	\$19,502.0	\$21,880.3	\$24,102.0	\$26,412.0	\$28,538.1	\$30,274.6
-20% Return Median	\$2,969.1	\$5,165.0	\$8,359.7	\$11,834.9	\$15,573.2	\$19,552.1	\$23,689.2	\$28,002.3	\$32,363.9	\$36,740.0	\$41,199.1	\$45,505.8	\$49,481.9	\$52,296.8
Low Growth	\$2,969.1	\$4,498.8	\$6,372.5	\$8,487.0	\$10,743.0	\$13,180.7	\$15,883.5	\$18,836.9	\$22,073.5	\$25,662.3	\$29,815.8	\$34,497.1	\$39,354.9	\$44,176.1

	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Base Median	\$32,041.1	\$33,430.9	\$34,383.8	\$34,996.6	\$36,076.8	\$37,389.5	\$38,324.8	\$39,295.0	\$39,613.5	\$40,248.4	\$40,606.6	\$41,016.1	\$41,833.5	\$42,586.9
-20% Return Median	\$54,007.3	\$55,459.0	\$56,399.8	\$57,227.3	\$57,897.3	\$58,452.5	\$58,860.5	\$59,890.4	\$60,739.5	\$61,021.8	\$61,561.4	\$61,904.8	\$62,857.6	\$63,592.5
Low Growth	\$48,828.4	\$53,351.2	\$57,786.0	\$62,039.6	\$65,964.4	\$69,509.8	\$72,591.4	\$75,037.3	\$76,459.8	\$76,823.3	\$76,823.3	\$76,823.3	\$76,823.3	\$76,823.3

# TSERS of North Carolina

## Actuarial Value Funded Ratio – 7.25% discount / No COLA



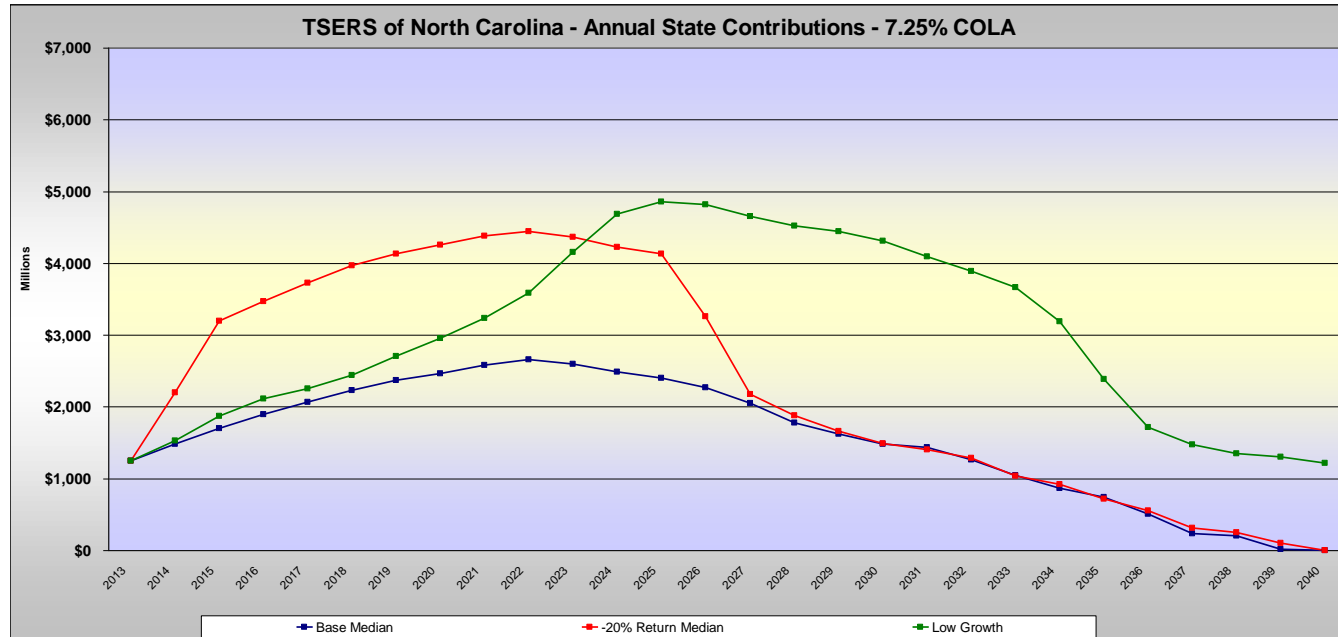
Actuarial Value Funded Ratio as of 12/31

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Base Median	91.5%	90.3%	89.5%	89.2%	89.3%	90.1%	90.9%	92.0%	93.2%	94.9%	97.0%	99.1%	101.2%	102.8%
-20% Return Median	76.2%	73.5%	72.3%	72.6%	73.6%	75.4%	77.6%	80.1%	83.2%	86.5%	90.4%	94.2%	97.5%	101.5%
Low Growth	90.5%	87.6%	87.4%	87.2%	86.9%	85.6%	85.8%	84.4%	83.1%	77.0%	76.6%	77.4%	79.1%	81.4%

	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
Base Median	105.0%	106.9%	108.5%	110.8%	112.9%	114.6%	117.1%	119.3%	122.8%	125.2%	128.0%	131.8%	134.6%	138.5%
-20% Return Median	104.4%	106.0%	107.6%	109.4%	111.8%	113.1%	115.4%	117.5%	120.1%	123.0%	125.6%	129.3%	132.2%	136.2%
Low Growth	84.1%	86.8%	89.8%	93.1%	96.5%	99.9%	103.3%	106.7%	110.0%	112.9%	115.3%	117.7%	120.3%	123.4%

# TSERS of North Carolina

## Annual State Contributions (\$ millions) – 7.25% discount / COLA



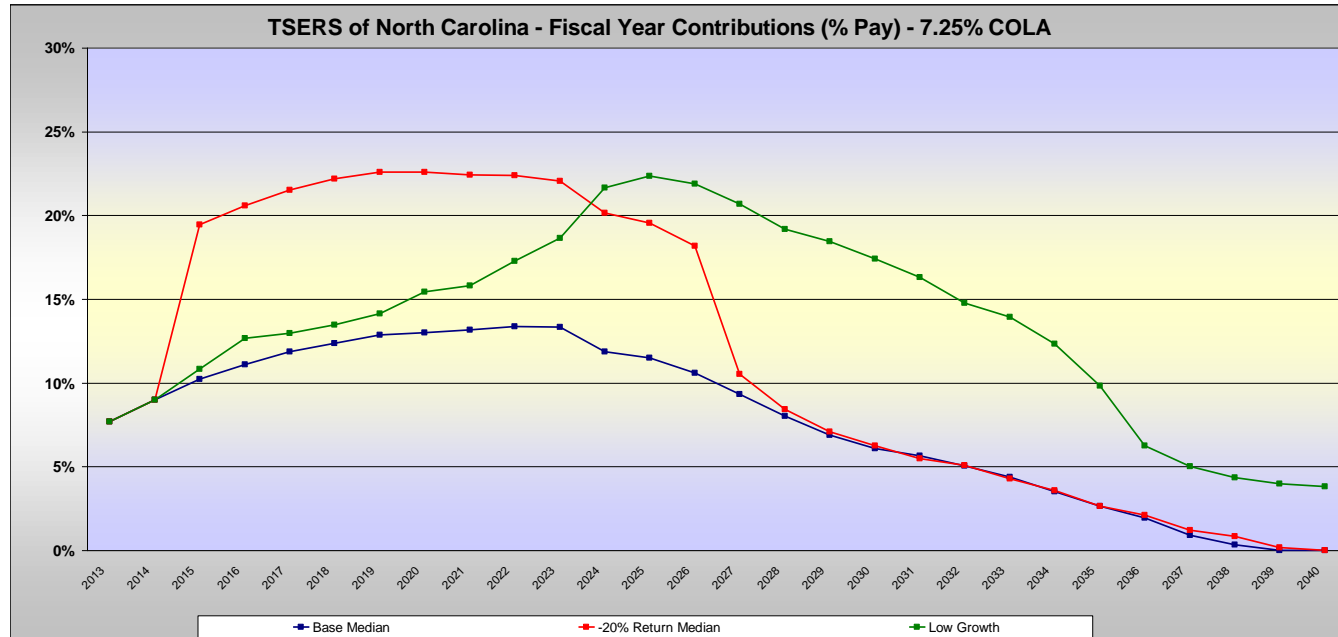
Annual State Contributions

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Base Median	\$1,248.8	\$1,484.3	\$1,701.3	\$1,892.8	\$2,065.0	\$2,226.1	\$2,369.7	\$2,461.1	\$2,582.7	\$2,661.2	\$2,591.9	\$2,488.0	\$2,402.0	\$2,264.8
-20% Return Median	\$1,248.8	\$2,195.9	\$3,194.7	\$3,472.3	\$3,725.0	\$3,964.3	\$4,130.6	\$4,253.8	\$4,381.3	\$4,442.2	\$4,368.4	\$4,225.3	\$4,131.3	\$3,260.5
Low Growth	\$1,248.8	\$1,529.7	\$1,873.7	\$2,114.5	\$2,256.0	\$2,437.7	\$2,702.8	\$2,953.4	\$3,236.6	\$3,588.7	\$4,153.5	\$4,681.3	\$4,857.8	\$4,821.2

	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Base Median	\$2,051.5	\$1,779.8	\$1,617.8	\$1,481.0	\$1,433.5	\$1,260.8	\$1,047.4	\$867.4	\$738.1	\$509.0	\$231.2	\$203.2	\$12.4	\$0.0
-20% Return Median	\$2,173.2	\$1,878.7	\$1,659.7	\$1,485.6	\$1,405.2	\$1,286.2	\$1,039.5	\$919.5	\$720.5	\$553.0	\$312.1	\$251.1	\$104.5	\$0.0
Low Growth	\$4,652.3	\$4,522.8	\$4,443.1	\$4,306.9	\$4,090.5	\$3,893.1	\$3,666.7	\$3,187.9	\$2,383.4	\$1,718.0	\$1,473.9	\$1,350.3	\$1,299.0	\$1,216.1

# TSERS of North Carolina

## *Fiscal Year Contribution (% of Pay) – 7.25% discount / COLA*



Fiscal Year Contribution (% of Pay)

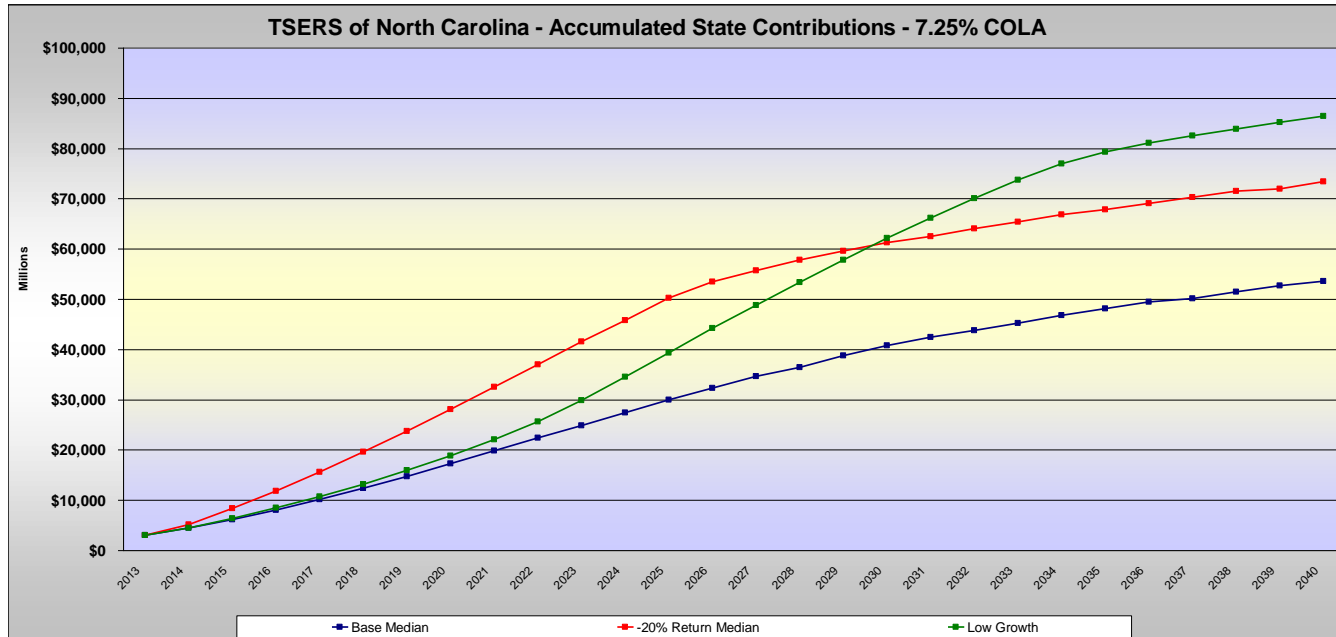
	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Base Median	7.7%	9.0%	10.2%	11.1%	11.9%	12.4%	12.9%	13.0%	13.1%	13.4%	13.3%	11.9%	11.5%	10.6%
-20% Return Median	7.7%	9.0%	19.4%	20.6%	21.5%	22.2%	22.6%	22.6%	22.4%	22.4%	22.0%	20.1%	19.6%	18.2%
Low Growth	7.7%	9.0%	10.8%	12.7%	13.0%	13.5%	14.1%	15.4%	15.8%	17.3%	18.6%	21.6%	22.4%	21.9%

	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Base Median	9.3%	8.0%	6.9%	6.1%	5.6%	5.1%	4.4%	3.5%	2.6%	1.9%	0.9%	0.3%	0.0%	0.0%
-20% Return Median	10.5%	8.4%	7.1%	6.2%	5.5%	5.1%	4.3%	3.6%	2.6%	2.1%	1.2%	0.8%	0.2%	0.0%
Low Growth	20.7%	19.2%	18.4%	17.4%	16.3%	14.8%	13.9%	12.3%	9.8%	6.2%	5.0%	4.4%	4.0%	3.8%



# TSERS of North Carolina

## Accum. State Contribs. (\$ millions) – 7.25% discount / COLA



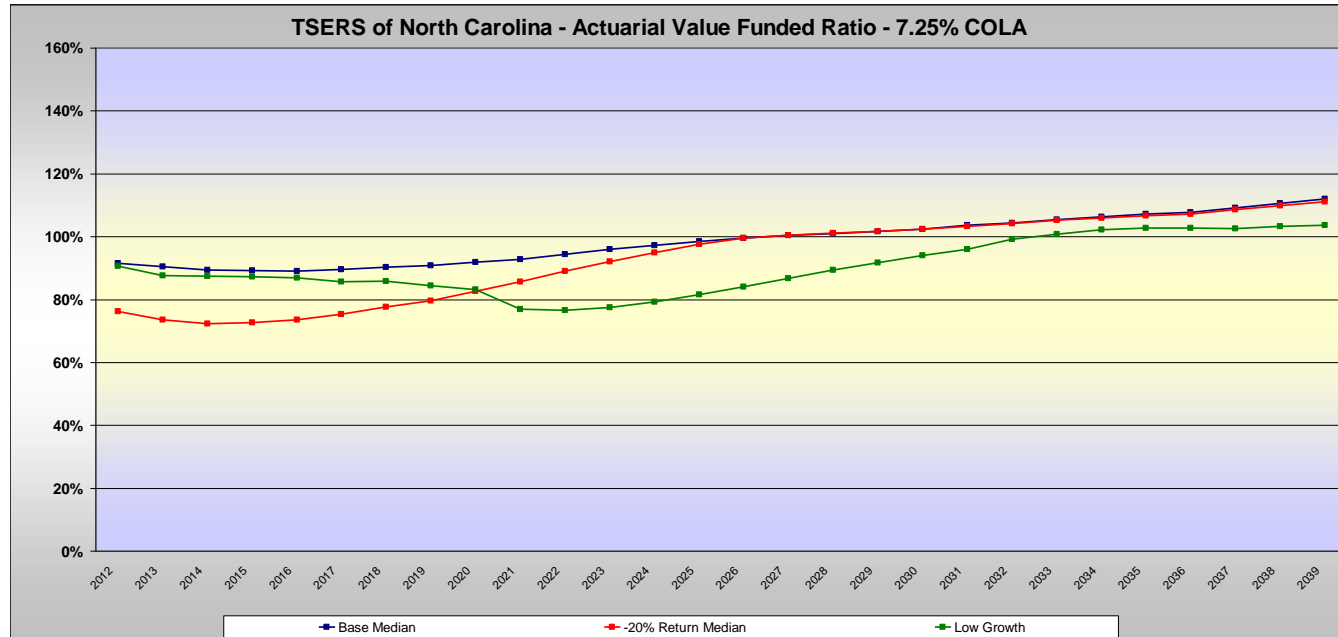
Accumulated State Contributions

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Base Median	\$2,969.1	\$4,453.4	\$6,155.3	\$8,037.9	\$10,119.3	\$12,339.1	\$14,721.5	\$17,264.1	\$19,853.1	\$22,413.4	\$24,884.5	\$27,404.0	\$29,908.9	\$32,293.7
-20% Return Median	\$2,969.1	\$5,165.0	\$8,359.7	\$11,834.9	\$15,573.8	\$19,552.1	\$23,716.8	\$28,072.9	\$32,522.1	\$37,016.2	\$41,487.1	\$45,807.1	\$50,230.1	\$53,507.2
Low Growth	\$2,969.1	\$4,498.8	\$6,372.5	\$8,487.0	\$10,743.0	\$13,180.7	\$15,883.5	\$18,836.9	\$22,073.5	\$25,662.3	\$29,815.8	\$34,497.1	\$39,354.9	\$44,176.1

	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Base Median	\$34,585.0	\$36,461.7	\$38,801.6	\$40,805.3	\$42,442.7	\$43,811.3	\$45,166.6	\$46,745.0	\$48,089.0	\$49,441.1	\$50,135.3	\$51,458.6	\$52,625.8	\$53,594.4
-20% Return Median	\$55,660.4	\$57,787.8	\$59,585.9	\$61,282.5	\$62,461.5	\$64,005.8	\$65,328.7	\$66,821.2	\$67,786.1	\$69,064.7	\$70,229.6	\$71,442.0	\$71,909.8	\$73,339.1
Low Growth	\$48,828.4	\$53,351.2	\$57,794.2	\$62,101.1	\$66,191.6	\$70,084.7	\$73,751.4	\$76,939.3	\$79,322.7	\$81,040.7	\$82,514.6	\$83,865.0	\$85,163.9	\$86,380.1

# TSERS of North Carolina

## Actuarial Value Funded Ratio – 7.25% discount / COLA



Actuarial Value Funded Ratio as of 12/31

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Base Median	91.5%	90.3%	89.4%	89.2%	88.9%	89.5%	90.2%	90.7%	91.8%	92.8%	94.4%	95.9%	97.1%	98.5%
-20% Return Median	76.2%	73.5%	72.3%	72.6%	73.5%	75.3%	77.5%	79.6%	82.6%	85.7%	88.9%	92.0%	94.8%	97.4%
Low Growth	90.5%	87.6%	87.4%	87.2%	86.9%	85.6%	85.8%	84.4%	83.1%	77.0%	76.6%	77.4%	79.1%	81.4%

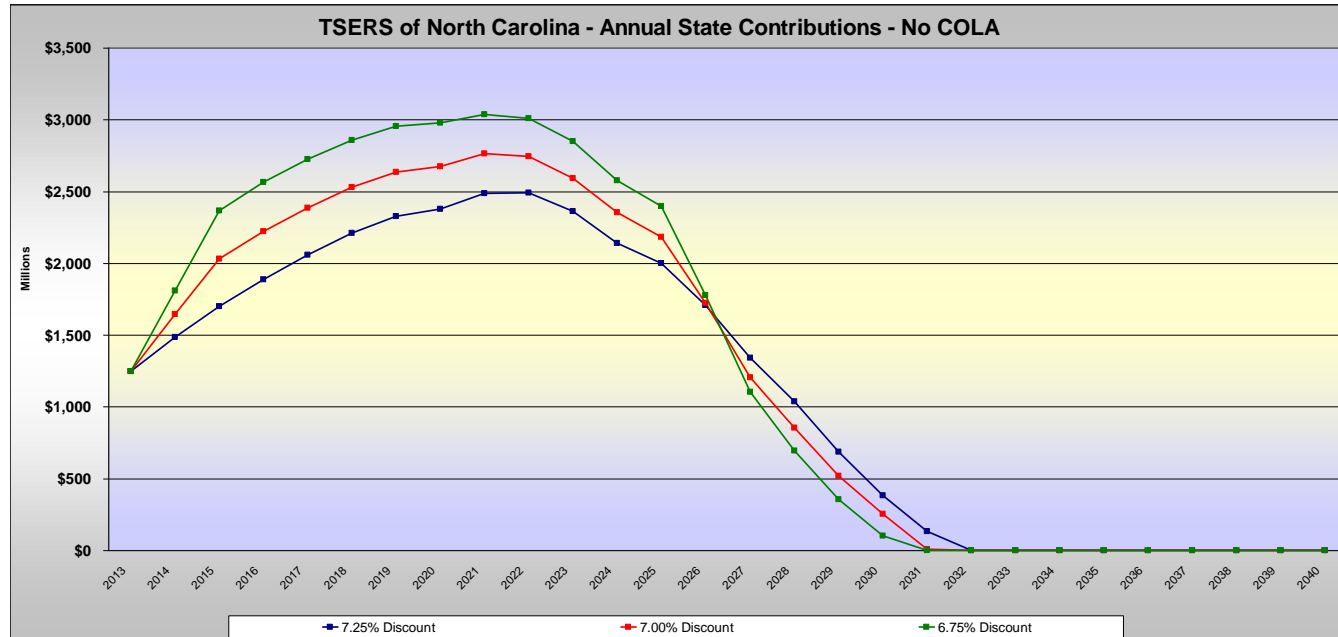
	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
Base Median	99.5%	100.3%	100.9%	101.6%	102.4%	103.6%	104.3%	105.4%	106.2%	107.2%	107.7%	109.1%	110.6%	112.0%
-20% Return Median	99.5%	100.4%	101.1%	101.7%	102.3%	103.3%	104.2%	105.2%	105.9%	106.7%	107.1%	108.6%	109.7%	111.1%
Low Growth	84.1%	86.7%	89.3%	91.7%	94.0%	95.9%	99.1%	100.7%	102.1%	102.6%	102.7%	102.6%	103.2%	103.5%

## Discount Rate Analysis

- Comparison of current 7.25% discount rate with 7.00% and 6.75%
- Median stochastic result for each financial metric

# TSERS of North Carolina

## Annual State Contributions (\$ millions) – No COLA



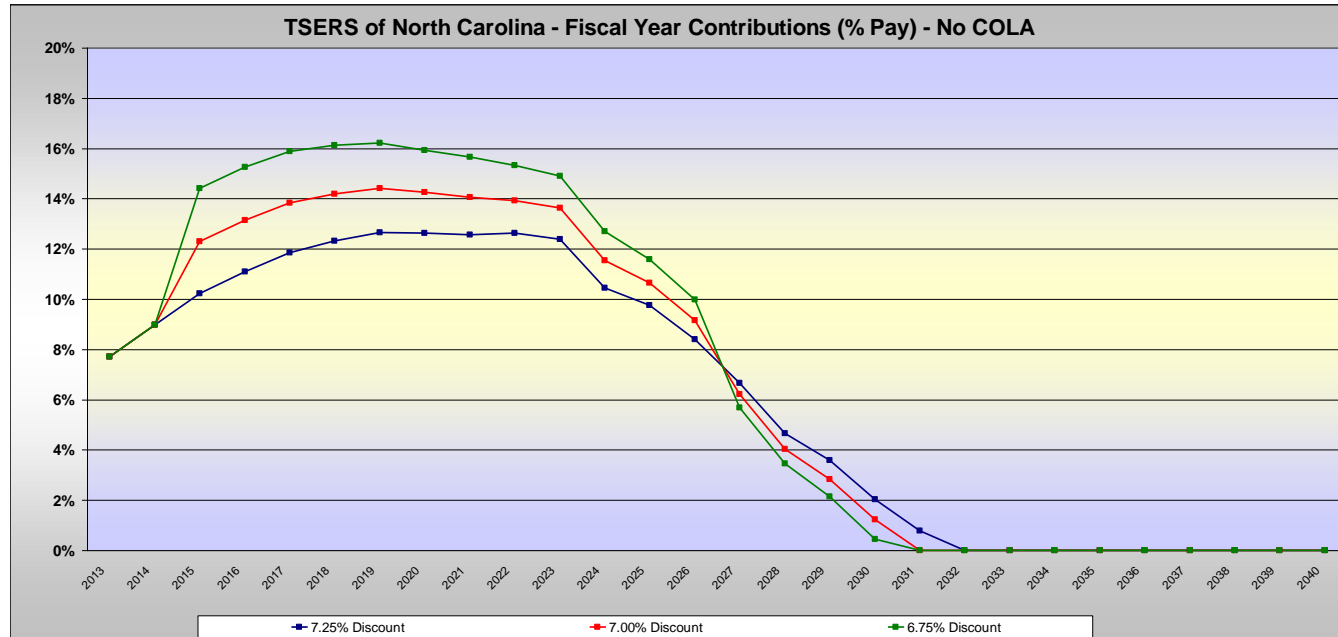
Annual State Contributions

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
7.25% Discount	\$1,248.8	\$1,484.3	\$1,699.8	\$1,886.9	\$2,057.4	\$2,208.8	\$2,327.2	\$2,379.2	\$2,486.2	\$2,491.8	\$2,363.1	\$2,139.8	\$1,999.6	\$1,707.0
7.00% Discount	\$1,248.8	\$1,644.1	\$2,028.9	\$2,220.4	\$2,385.8	\$2,527.7	\$2,634.0	\$2,672.7	\$2,762.5	\$2,743.3	\$2,591.7	\$2,354.1	\$2,182.9	\$1,723.4
6.75% Discount	\$1,248.8	\$1,808.4	\$2,367.4	\$2,563.6	\$2,725.2	\$2,857.4	\$2,953.0	\$2,977.4	\$3,034.3	\$3,008.3	\$2,848.1	\$2,577.9	\$2,397.3	\$1,776.9

	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
7.25% Discount	\$1,342.5	\$1,036.9	\$684.5	\$381.0	\$134.2	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0
7.00% Discount	\$1,202.6	\$852.0	\$519.5	\$252.7	\$6.5	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0
6.75% Discount	\$1,101.1	\$694.3	\$353.1	\$103.1	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0

# TSERS of North Carolina

## *Fiscal Year Contribution (% of Pay) – No COLA*



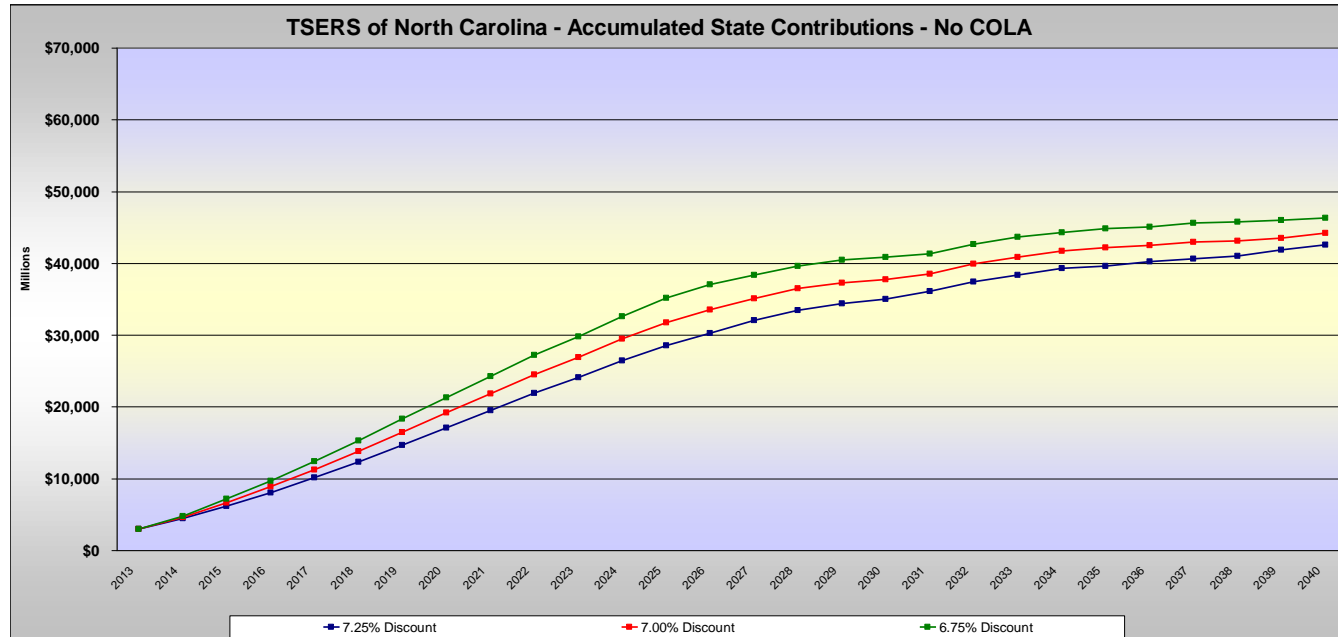
Fiscal Year Contribution (% of Pay)

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
7.25% Discount	7.7%	9.0%	10.2%	11.1%	11.9%	12.3%	12.7%	12.6%	12.6%	12.6%	12.4%	10.4%	9.7%	8.4%
7.00% Discount	7.7%	9.0%	12.3%	13.1%	13.8%	14.2%	14.4%	14.2%	14.1%	13.9%	13.6%	11.5%	10.7%	9.2%
6.75% Discount	7.7%	9.0%	14.4%	15.3%	15.9%	16.1%	16.2%	15.9%	15.7%	15.3%	14.9%	12.7%	11.6%	10.0%

	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
7.25% Discount	6.6%	4.7%	3.6%	2.0%	0.8%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
7.00% Discount	6.2%	4.0%	2.8%	1.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
6.75% Discount	5.7%	3.5%	2.1%	0.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

# TSERS of North Carolina

## Accumulated State Contributions (\$ millions) – No COLA



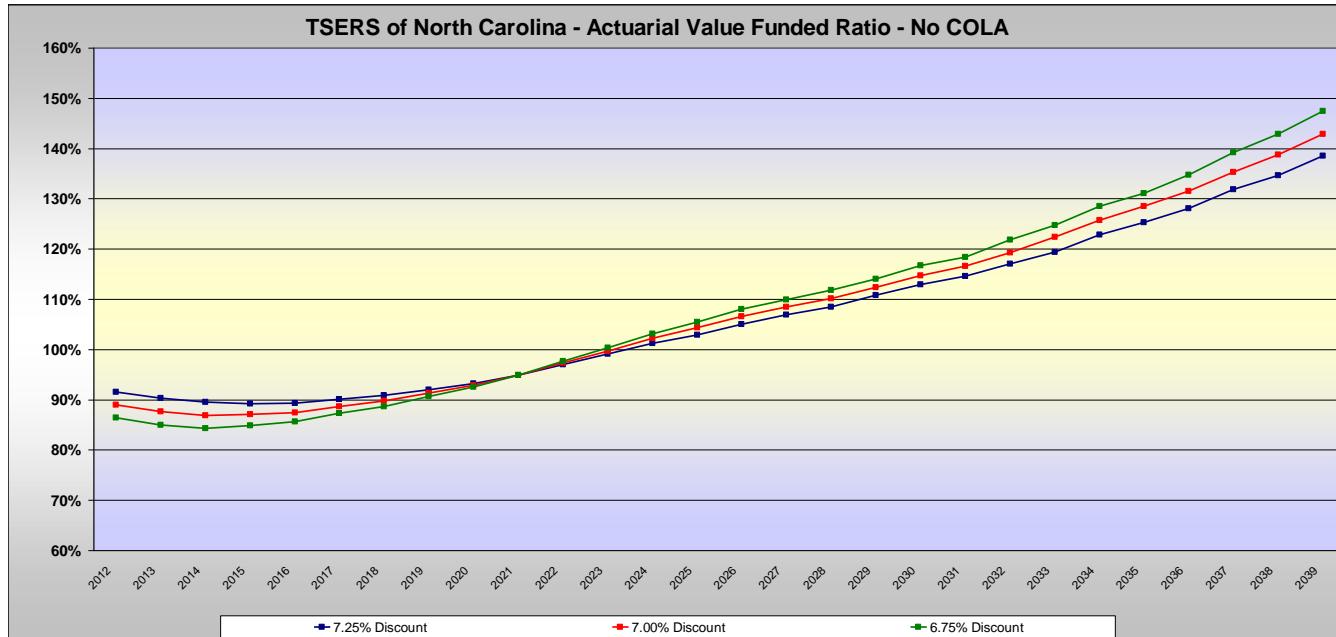
Accumulated State Contributions

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
7.25% Discount	\$2,969.1	\$4,453.4	\$6,155.1	\$8,037.6	\$10,096.9	\$12,299.6	\$14,682.9	\$17,092.1	\$19,502.0	\$21,880.3	\$24,102.0	\$26,412.0	\$28,538.1	\$30,274.6
7.00% Discount	\$2,969.1	\$4,613.2	\$6,643.9	\$8,860.0	\$11,246.6	\$13,769.4	\$16,458.3	\$19,149.8	\$21,847.7	\$24,480.0	\$26,880.0	\$29,473.6	\$31,748.2	\$33,536.8
6.75% Discount	\$2,969.1	\$4,777.5	\$7,146.7	\$9,703.0	\$12,430.8	\$15,286.0	\$18,291.3	\$21,290.2	\$24,271.8	\$27,171.2	\$29,787.1	\$32,622.2	\$35,131.5	\$37,038.5

	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
7.25% Discount	\$32,041.1	\$33,430.9	\$34,383.8	\$34,996.6	\$36,076.8	\$37,389.5	\$38,324.8	\$39,295.0	\$39,613.5	\$40,248.4	\$40,606.6	\$41,016.1	\$41,833.5	\$42,586.9
7.00% Discount	\$35,102.0	\$36,460.4	\$37,290.2	\$37,761.4	\$38,498.7	\$39,948.0	\$40,856.9	\$41,701.2	\$42,142.0	\$42,504.3	\$42,986.1	\$43,073.6	\$43,529.4	\$44,181.6
6.75% Discount	\$38,390.2	\$39,600.6	\$40,424.0	\$40,812.8	\$41,313.2	\$42,635.7	\$43,656.7	\$44,259.4	\$44,807.9	\$45,030.2	\$45,626.7	\$45,746.1	\$45,954.8	\$46,290.1

# TSERS of North Carolina

## Actuarial Value Funded Ratio – No COLA



Actuarial Value Funded Ratio as of 12/31

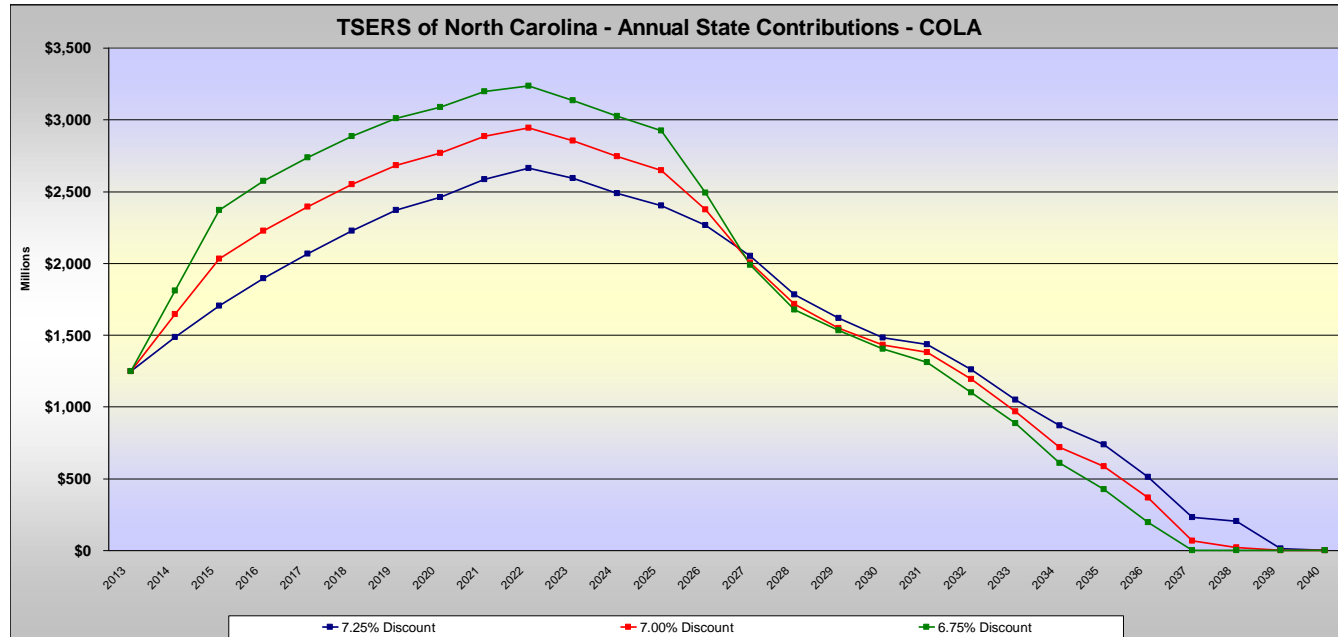
	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
7.25% Discount	91.5%	90.3%	89.5%	89.2%	89.3%	90.1%	90.9%	92.0%	93.2%	94.9%	97.0%	99.1%	101.2%	102.8%
7.00% Discount	89.0%	87.6%	86.9%	87.0%	87.4%	88.6%	89.8%	91.3%	92.8%	94.9%	97.3%	99.7%	102.2%	104.3%
6.75% Discount	86.4%	85.0%	84.3%	84.8%	85.6%	87.3%	88.7%	90.6%	92.5%	94.9%	97.6%	100.3%	103.1%	105.5%

	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
7.25% Discount	105.0%	106.9%	108.5%	110.8%	112.9%	114.6%	117.1%	119.3%	122.8%	125.2%	128.0%	131.8%	134.6%	138.5%
7.00% Discount	106.6%	108.4%	110.1%	112.3%	114.7%	116.5%	119.3%	122.4%	125.7%	128.4%	131.5%	135.2%	138.7%	142.8%
6.75% Discount	108.0%	109.9%	111.7%	114.0%	116.6%	118.4%	121.8%	124.7%	128.5%	131.0%	134.7%	139.2%	142.9%	147.5%



# TSERS of North Carolina

## Annual State Contributions (\$ millions) – COLA



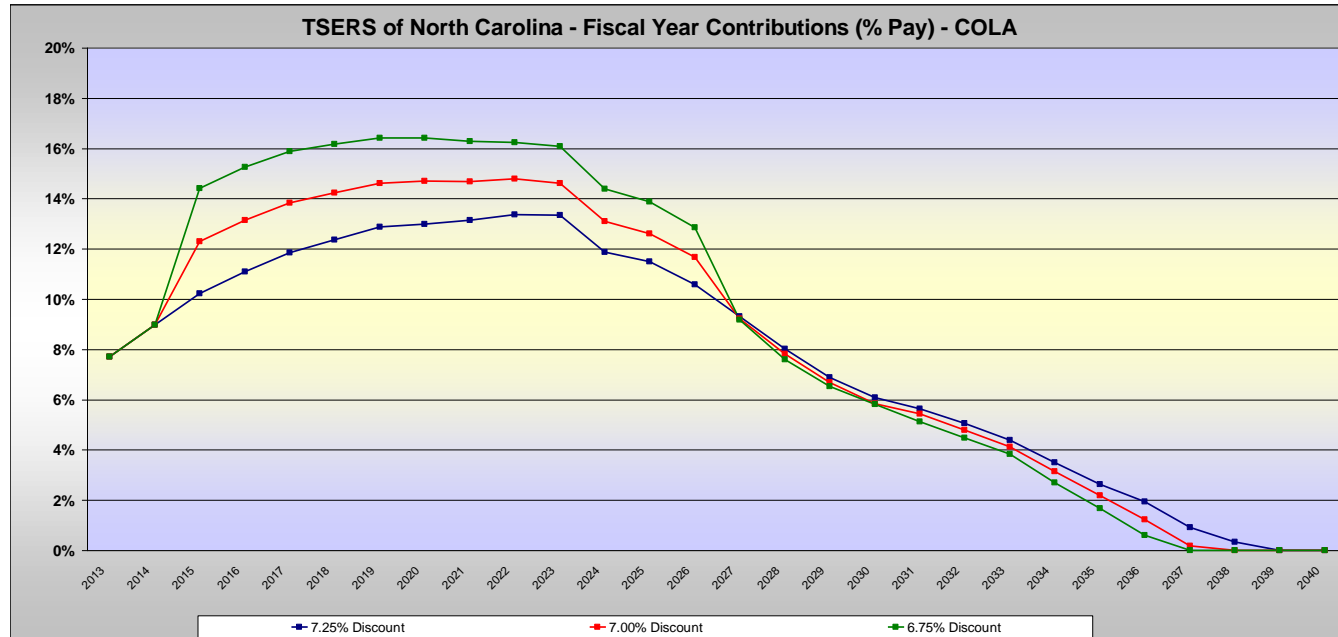
Annual State Contributions

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
7.25% Discount	\$1,248.8	\$1,484.3	\$1,701.3	\$1,892.8	\$2,065.0	\$2,226.1	\$2,369.7	\$2,461.1	\$2,582.7	\$2,661.2	\$2,591.9	\$2,488.0	\$2,402.0	\$2,264.8
7.00% Discount	\$1,248.8	\$1,644.1	\$2,030.4	\$2,226.2	\$2,394.1	\$2,549.5	\$2,680.5	\$2,766.0	\$2,884.1	\$2,942.1	\$2,851.9	\$2,744.3	\$2,646.1	\$2,374.1
6.75% Discount	\$1,248.8	\$1,808.4	\$2,368.9	\$2,570.8	\$2,735.3	\$2,883.2	\$3,007.3	\$3,087.1	\$3,194.9	\$3,233.9	\$3,133.1	\$3,023.7	\$2,923.8	\$2,489.7

	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
7.25% Discount	\$2,051.5	\$1,779.8	\$1,617.8	\$1,481.0	\$1,433.5	\$1,260.8	\$1,047.4	\$867.4	\$738.1	\$509.0	\$231.2	\$203.2	\$12.4	\$0.0
7.00% Discount	\$2,004.8	\$1,715.0	\$1,546.3	\$1,431.9	\$1,380.5	\$1,192.0	\$968.4	\$717.1	\$582.7	\$366.1	\$66.5	\$20.6	\$0.0	\$0.0
6.75% Discount	\$1,989.2	\$1,674.2	\$1,532.7	\$1,401.3	\$1,308.0	\$1,099.0	\$882.9	\$608.0	\$426.3	\$196.8	\$0.0	\$0.0	\$0.0	\$0.0

# TSERS of North Carolina

## Fiscal Year Contribution (% of Pay) – COLA



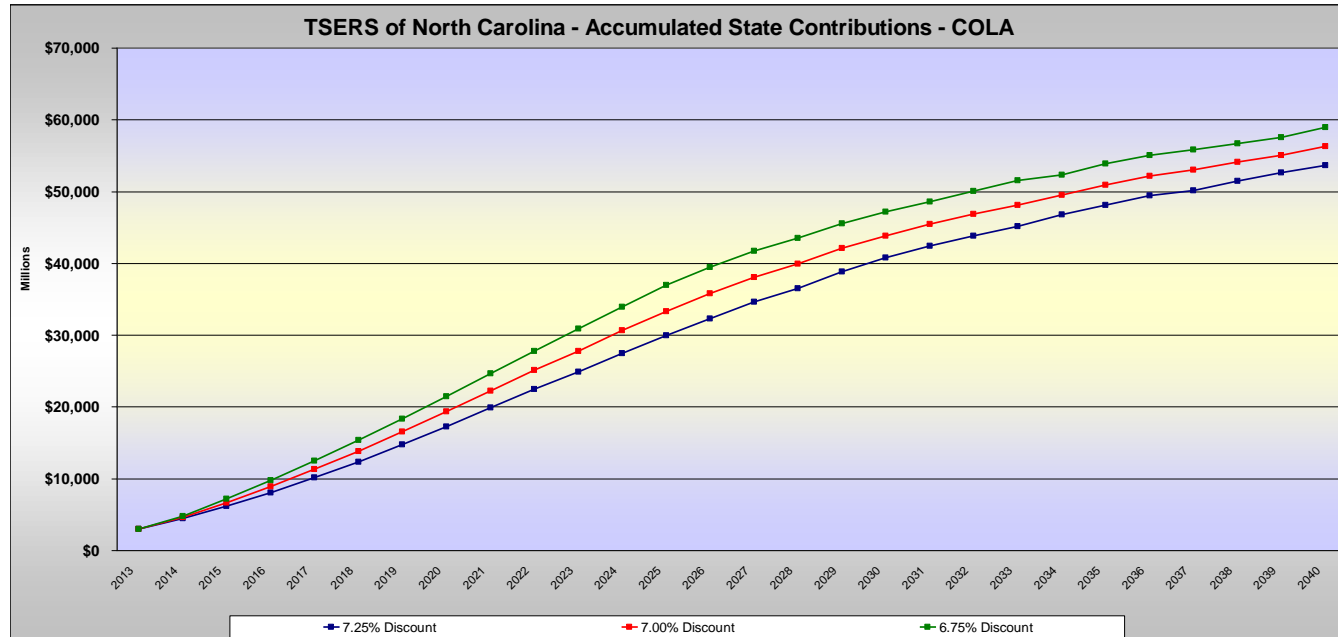
Fiscal Year Contribution (% of Pay)

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
7.25% Discount	7.7%	9.0%	10.2%	11.1%	11.9%	12.4%	12.9%	13.0%	13.1%	13.4%	13.3%	11.9%	11.5%	10.6%
7.00% Discount	7.7%	9.0%	12.3%	13.1%	13.8%	14.2%	14.6%	14.7%	14.7%	14.8%	14.6%	13.1%	12.6%	11.7%
6.75% Discount	7.7%	9.0%	14.4%	15.3%	15.9%	16.2%	16.4%	16.4%	16.3%	16.2%	16.1%	14.4%	13.9%	12.9%

	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
7.25% Discount	9.3%	8.0%	6.9%	6.1%	5.6%	5.1%	4.4%	3.5%	2.6%	1.9%	0.9%	0.3%	0.0%	0.0%
7.00% Discount	9.2%	7.8%	6.7%	5.8%	5.4%	4.8%	4.1%	3.1%	2.2%	1.2%	0.2%	0.0%	0.0%	0.0%
6.75% Discount	9.2%	7.6%	6.5%	5.8%	5.1%	4.5%	3.8%	2.7%	1.7%	0.6%	0.0%	0.0%	0.0%	0.0%

# TSERS of North Carolina

## Accumulated State Contributions (\$ millions) – COLA



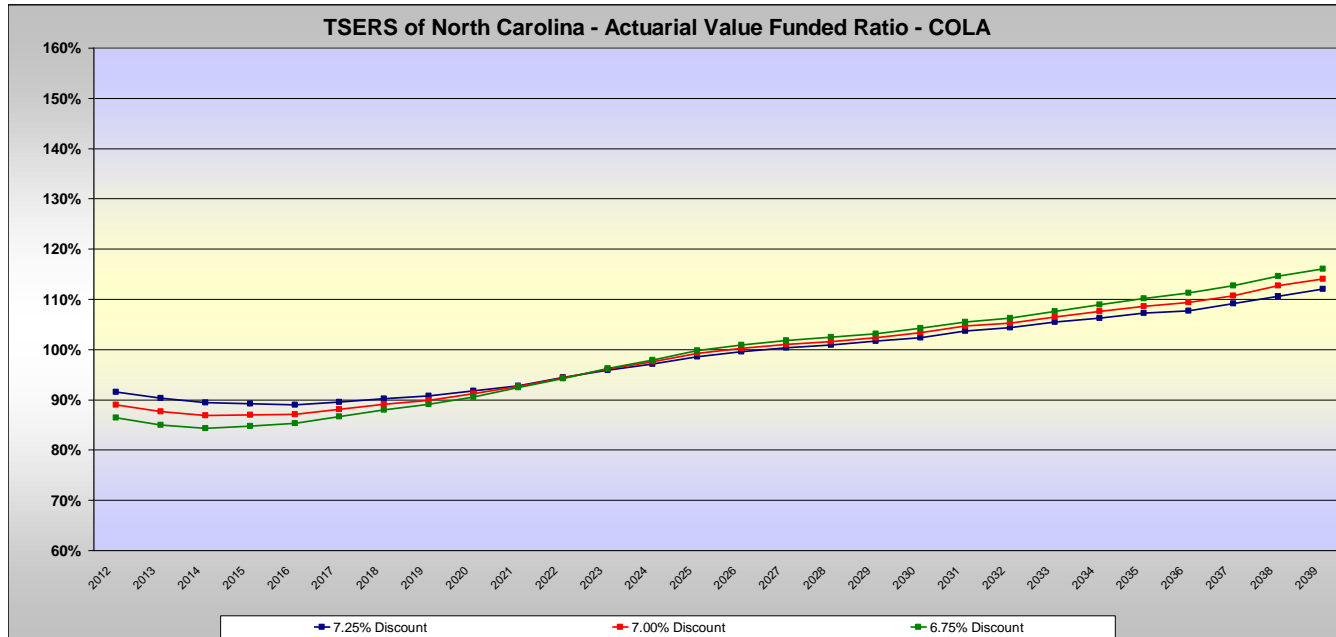
Accumulated State Contributions

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
7.25% Discount	\$2,969.1	\$4,453.4	\$6,155.3	\$8,037.9	\$10,119.3	\$12,339.1	\$14,721.5	\$17,264.1	\$19,853.1	\$22,413.4	\$24,884.5	\$27,404.0	\$29,908.9	\$32,293.7
7.00% Discount	\$2,969.1	\$4,613.2	\$6,644.1	\$8,860.3	\$11,269.7	\$13,820.7	\$16,504.6	\$19,319.3	\$22,216.8	\$25,080.7	\$27,774.9	\$30,626.1	\$33,258.7	\$35,796.4
6.75% Discount	\$2,969.1	\$4,777.5	\$7,146.9	\$9,706.6	\$12,461.4	\$15,340.4	\$18,340.4	\$21,471.2	\$24,668.4	\$27,766.0	\$30,876.4	\$33,887.9	\$36,922.0	\$39,437.6

	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
7.25% Discount	\$34,585.0	\$36,461.7	\$38,801.6	\$40,805.3	\$42,442.7	\$43,811.3	\$45,166.6	\$46,745.0	\$48,089.0	\$49,441.1	\$50,135.3	\$51,458.6	\$52,625.8	\$53,594.4
7.00% Discount	\$38,028.3	\$39,902.9	\$42,059.8	\$43,800.9	\$45,441.5	\$46,871.3	\$48,118.7	\$49,492.8	\$50,929.0	\$52,138.8	\$53,006.1	\$54,092.3	\$55,060.5	\$56,247.0
6.75% Discount	\$41,726.1	\$43,515.3	\$45,546.2	\$47,152.9	\$48,578.9	\$50,053.6	\$51,530.6	\$52,290.5	\$53,834.1	\$55,024.2	\$55,850.3	\$56,642.4	\$57,547.2	\$58,940.4

# TSERS of North Carolina

## Actuarial Value Funded Ratio – COLA



Actuarial Value Funded Ratio as of 12/31

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
7.25% Discount	91.5%	90.3%	89.4%	89.2%	88.9%	89.5%	90.2%	90.7%	91.8%	92.8%	94.4%	95.9%	97.1%	98.5%
7.00% Discount	89.0%	87.6%	86.9%	87.0%	87.1%	88.1%	89.0%	89.8%	91.2%	92.6%	94.3%	96.1%	97.5%	99.1%
6.75% Discount	86.4%	85.0%	84.3%	84.7%	85.3%	86.6%	87.9%	89.0%	90.5%	92.5%	94.2%	96.2%	97.9%	99.8%

	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
7.25% Discount	99.5%	100.3%	100.9%	101.6%	102.4%	103.6%	104.3%	105.4%	106.2%	107.2%	107.7%	109.1%	110.6%	112.0%
7.00% Discount	100.3%	101.0%	101.6%	102.3%	103.3%	104.6%	105.2%	106.4%	107.5%	108.6%	109.4%	110.7%	112.6%	114.0%
6.75% Discount	100.9%	101.7%	102.5%	103.1%	104.2%	105.4%	106.3%	107.6%	108.9%	110.1%	111.3%	112.7%	114.6%	116.0%

# Conclusion

- The Plan's assets and key funding metrics remain highly sensitive to large equity declines and low return environments
- Portfolio and Risk Management Considerations
  - Continue to reduce the Plan's public equity beta through its hedged-equity allocation within global equity
  - Evaluate alternative asset mixes that reduce the reliance on expected low return asset classes
  - Incorporate the analysis in the asset allocation and portfolio construction process, and when considering tail-risk mitigation strategies
  - Utilizing the Plan's risk and performance management system, decompose and manage the common factor risks embedded across the total portfolio

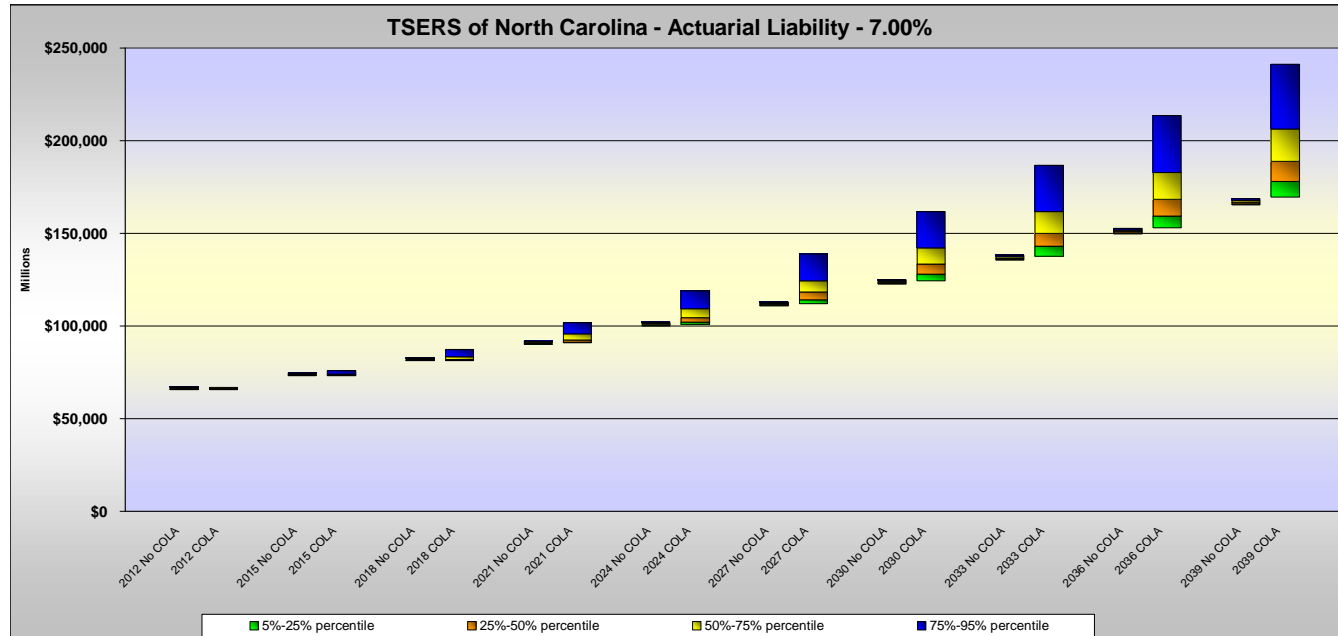
# Appendix

## **7.00% Discount Rate Analysis**

- Assumed effective 12/31/2012
- 30-Year Forecast of Valuation Results
- Summaries of Key Financial Metrics
- 999 Inter-related Economic and Capital Market Scenarios

# TSERS of North Carolina

## Actuarial Liability (\$ millions) – 7.00% discount



Variability in liabilities that assume a COLA results from a dynamic inflation model

### Actuarial Liability as of 12/31

	2012		2015		2018		2021		2024	
	No COLA	COLA	No COLA	COLA	No COLA	COLA	No COLA	COLA	No COLA	COLA
95th percentile	\$66,385.1	\$66,407.1	\$73,831.8	\$75,805.4	\$82,027.7	\$87,806.4	\$91,005.2	\$101,936.1	\$100,979.9	\$118,904.8
75th percentile	\$66,385.1	\$66,385.1	\$73,831.8	\$74,239.6	\$82,027.7	\$83,851.0	\$91,005.2	\$95,658.6	\$100,979.9	\$109,275.1
50th percentile	\$66,385.1	\$66,385.1	\$73,831.8	\$73,831.8	\$82,027.7	\$82,460.6	\$91,005.2	\$92,577.9	\$100,979.9	\$104,640.3
25th percentile	\$66,385.1	\$66,385.1	\$73,831.8	\$73,831.8	\$82,027.7	\$82,027.7	\$91,005.2	\$91,295.2	\$100,979.9	\$101,999.7
5th percentile	\$66,385.1	\$66,385.1	\$73,831.8	\$73,831.8	\$82,027.7	\$82,027.7	\$91,005.2	\$91,005.2	\$100,979.9	\$100,979.9

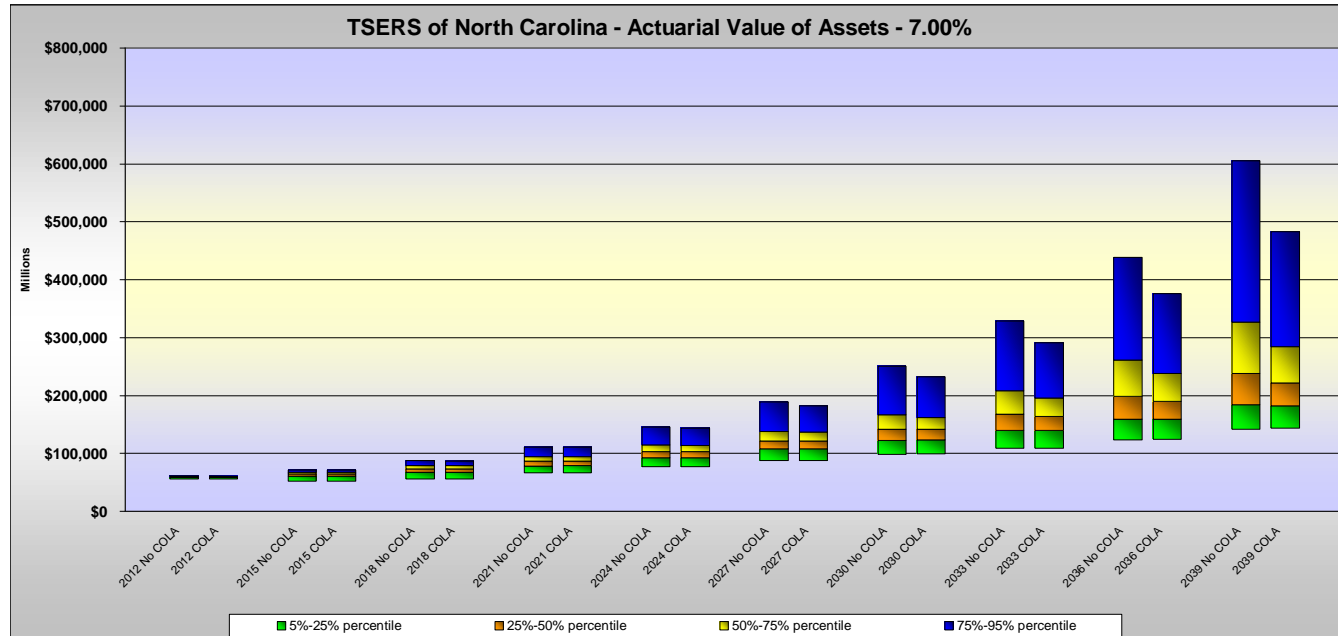
  

	2027		2030		2033		2036		2039	
	No COLA	COLA	No COLA	COLA	No COLA	COLA	No COLA	COLA	No COLA	COLA
95th percentile	\$111,935.7	\$138,724.6	\$123,893.0	\$161,632.3	\$136,881.5	\$186,894.4	\$151,143.0	\$213,633.7	\$166,898.8	\$241,252.3
75th percentile	\$111,935.7	\$124,427.8	\$123,893.0	\$142,036.2	\$136,881.5	\$161,641.0	\$151,143.0	\$182,695.3	\$166,898.8	\$206,471.4
50th percentile	\$111,935.7	\$118,343.8	\$123,893.0	\$133,439.2	\$136,881.5	\$150,054.4	\$151,143.0	\$168,248.5	\$166,898.8	\$188,793.3
25th percentile	\$111,935.7	\$114,225.1	\$123,893.0	\$128,031.4	\$136,881.5	\$143,033.3	\$151,143.0	\$159,421.3	\$166,898.8	\$178,132.2
5th percentile	\$111,935.7	\$111,935.7	\$123,893.0	\$124,358.8	\$136,881.5	\$137,753.1	\$151,143.0	\$153,033.8	\$166,898.8	\$169,667.4



# TSERS of North Carolina

## Actuarial Value of Assets (\$ millions) – 7.00% discount



Actuarial Value of Assets as of 12/31

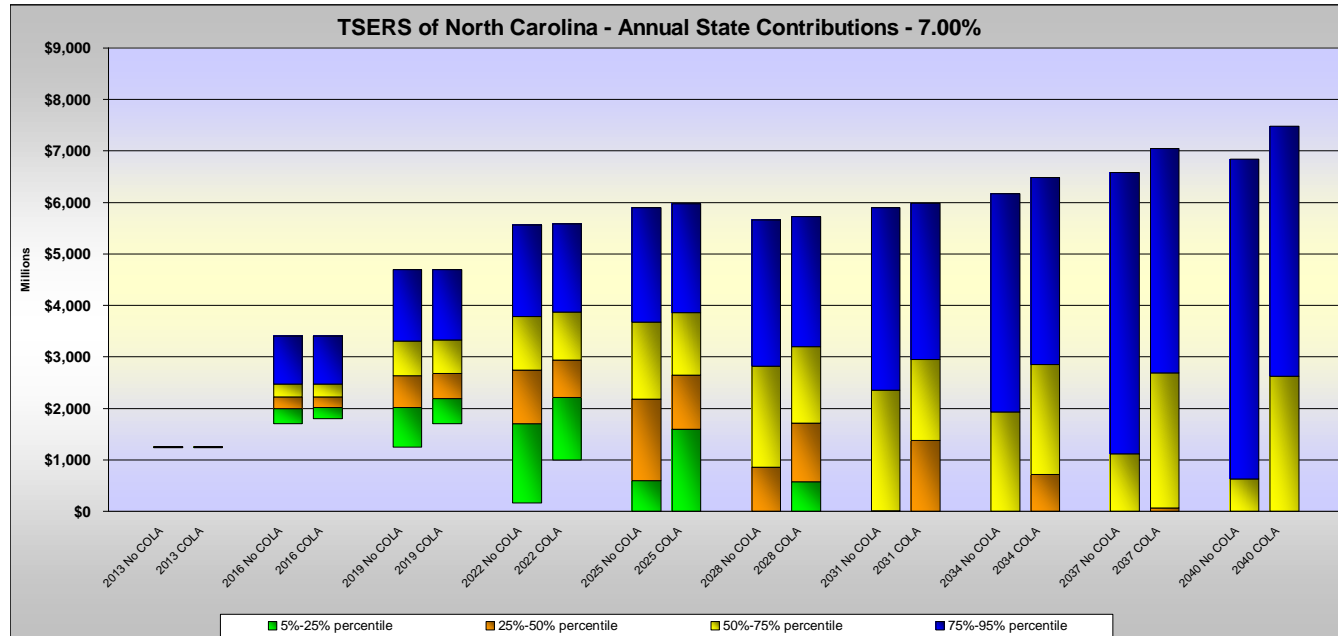
	2012		2015		2018		2021		2024	
	No COLA	COLA	No COLA	COLA	No COLA	COLA	No COLA	COLA	No COLA	COLA
95th percentile	\$60,394.2	\$60,394.2	\$71,046.7	\$70,891.2	\$87,261.6	\$86,996.5	\$111,260.8	\$110,372.4	\$145,900.3	\$144,025.7
75th percentile	\$59,606.4	\$59,606.4	\$67,267.8	\$67,231.1	\$79,136.3	\$79,059.6	\$94,779.6	\$94,648.4	\$114,261.4	\$113,878.8
50th percentile	\$59,053.3	\$59,053.3	\$64,243.3	\$64,243.3	\$73,630.0	\$73,633.0	\$86,370.2	\$86,291.3	\$103,157.8	\$103,181.5
25th percentile	\$58,551.4	\$58,551.4	\$61,185.0	\$61,185.0	\$67,404.0	\$67,404.0	\$78,547.4	\$78,557.0	\$92,454.0	\$92,624.6
5th percentile	\$56,324.9	\$56,324.9	\$51,651.9	\$51,651.9	\$56,129.3	\$56,129.3	\$66,519.9	\$66,519.9	\$76,903.9	\$77,149.0

	2027		2030		2033		2036		2039	
	No COLA	COLA	No COLA	COLA	No COLA	COLA	No COLA	COLA	No COLA	COLA
95th percentile	\$189,242.7	\$182,258.7	\$250,815.8	\$232,003.9	\$328,682.5	\$291,333.1	\$438,354.4	\$376,069.5	\$605,010.7	\$482,697.4
75th percentile	\$137,375.8	\$136,521.2	\$166,426.5	\$162,098.2	\$207,741.6	\$196,098.1	\$261,316.1	\$238,251.8	\$327,089.4	\$284,331.5
50th percentile	\$121,345.9	\$121,613.1	\$142,097.4	\$141,260.7	\$167,507.0	\$163,701.2	\$198,703.6	\$189,550.2	\$238,391.8	\$222,072.8
25th percentile	\$108,061.3	\$108,252.6	\$122,847.1	\$123,083.4	\$139,434.8	\$139,981.9	\$159,446.0	\$159,124.0	\$184,378.7	\$181,775.5
5th percentile	\$87,665.8	\$87,725.3	\$98,634.0	\$99,324.5	\$108,996.4	\$109,334.7	\$123,337.9	\$123,938.9	\$141,937.2	\$143,354.3

# TSERS of North Carolina

## Annual State Contributions (\$ millions) – 7.00% discount



### Annual State Contributions

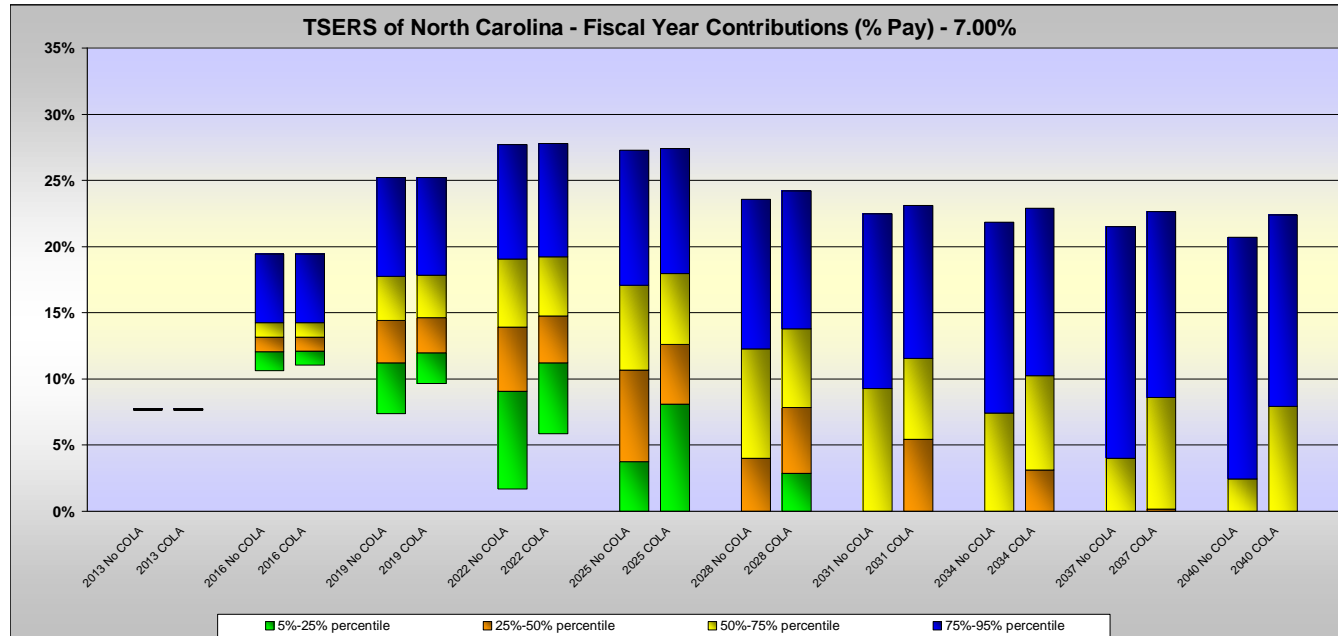
	2013		2016		2019		2022		2025	
	No COLA	COLA	No COLA	COLA	No COLA	COLA	No COLA	COLA	No COLA	COLA
95th percentile	\$1,248.8	\$1,248.8	\$3,400.4	\$3,400.4	\$4,693.8	\$4,693.8	\$5,561.6	\$5,585.5	\$5,900.9	\$5,972.3
75th percentile	\$1,248.8	\$1,248.8	\$2,474.9	\$2,474.9	\$3,309.8	\$3,327.2	\$3,783.7	\$3,874.6	\$3,680.1	\$3,856.4
50th percentile	\$1,248.8	\$1,248.8	\$2,220.4	\$2,226.2	\$2,634.0	\$2,680.5	\$2,743.3	\$2,942.1	\$2,182.9	\$2,646.1
25th percentile	\$1,248.8	\$1,248.8	\$1,995.7	\$2,012.8	\$2,012.2	\$2,187.7	\$1,699.6	\$2,215.8	\$600.4	\$1,593.1
5th percentile	\$1,248.8	\$1,248.8	\$1,706.4	\$1,800.6	\$1,250.4	\$1,707.5	\$168.0	\$995.5	\$0.0	\$0.0

	2028		2031		2034		2037		2040	
	No COLA	COLA	No COLA	COLA	No COLA	COLA	No COLA	COLA	No COLA	COLA
95th percentile	\$5,655.1	\$5,729.7	\$5,898.6	\$5,981.4	\$6,166.1	\$6,487.3	\$6,576.7	\$7,051.7	\$6,844.4	\$7,486.0
75th percentile	\$2,817.4	\$3,201.1	\$2,349.1	\$2,949.0	\$1,933.0	\$2,855.2	\$1,120.2	\$2,689.2	\$630.1	\$2,627.5
50th percentile	\$852.0	\$1,715.0	\$6.5	\$1,380.5	\$0.0	\$717.1	\$0.0	\$66.5	\$0.0	\$0.0
25th percentile	\$0.0	\$576.6	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0
5th percentile	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0

# TSERS of North Carolina

## *Fiscal Year Contribution (% of Pay) – 7.00% discount*



### Fiscal Year Contribution (% of Pay)

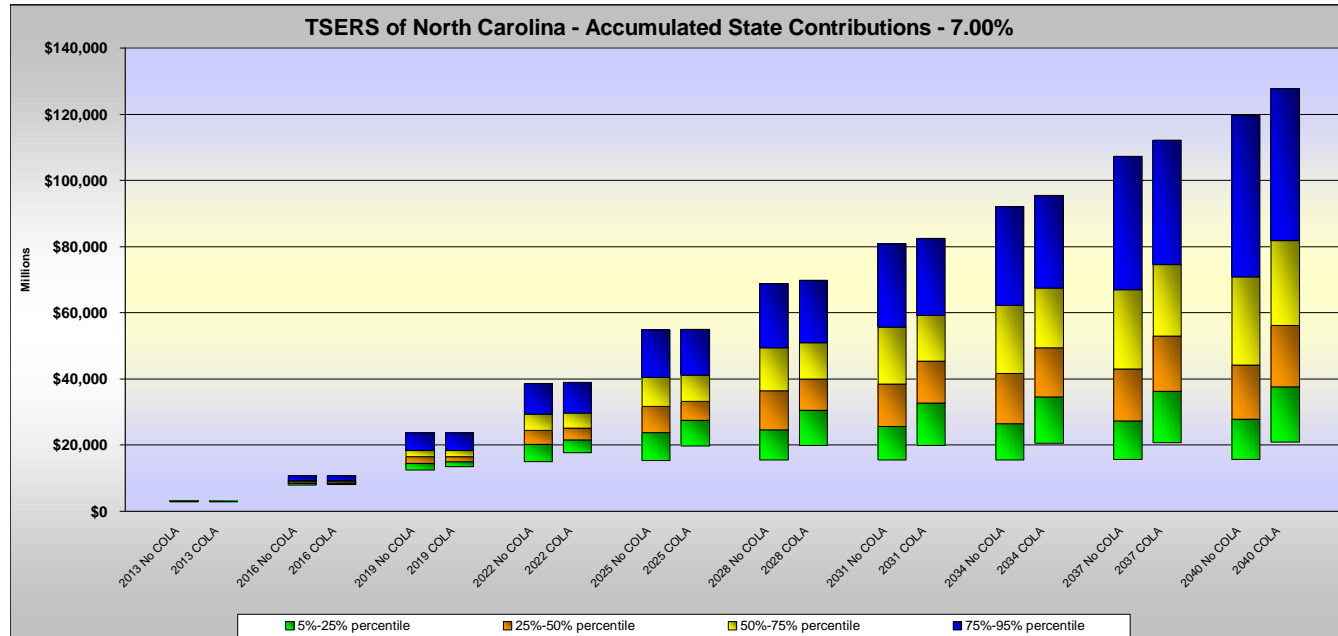
	2013		2016		2019		2022		2025	
	No COLA	COLA	No COLA	COLA	No COLA	COLA	No COLA	COLA	No COLA	COLA
95th percentile	7.7%	7.7%	19.4%	19.4%	25.2%	25.2%	27.7%	27.8%	27.3%	27.4%
75th percentile	7.7%	7.7%	14.3%	14.3%	17.8%	17.9%	19.1%	19.2%	17.1%	17.9%
50th percentile	7.7%	7.7%	13.1%	13.1%	14.4%	14.6%	13.9%	14.8%	10.7%	12.6%
25th percentile	7.7%	7.7%	12.1%	12.1%	11.2%	12.0%	9.1%	11.2%	3.7%	8.1%
5th percentile	7.7%	7.7%	10.6%	11.0%	7.4%	9.7%	1.7%	5.8%	0.0%	0.0%

	2028		2031		2034		2037		2040	
	No COLA	COLA	No COLA	COLA	No COLA	COLA	No COLA	COLA	No COLA	COLA
95th percentile	23.6%	24.2%	22.5%	23.1%	21.9%	22.9%	21.5%	22.6%	20.7%	22.4%
75th percentile	12.3%	13.8%	9.3%	11.5%	7.4%	10.3%	4.0%	8.6%	2.4%	7.9%
50th percentile	4.0%	7.8%	0.0%	5.4%	0.0%	3.1%	0.0%	0.2%	0.0%	0.0%
25th percentile	0.0%	2.9%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
5th percentile	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

# TSERS of North Carolina

## Accumulated State Contributions (\$ millions) – 7.00% discount



### Accumulated State Contributions

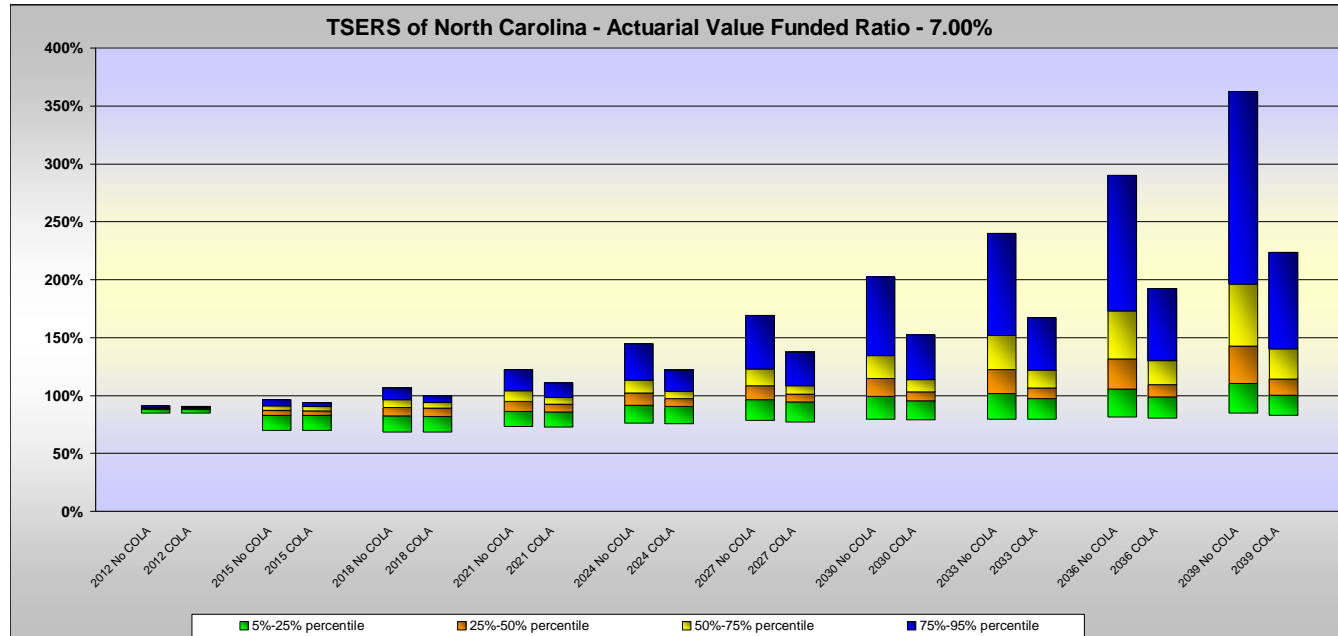
	2013		2016		2019		2022		2025	
	No COLA	COLA	No COLA	COLA	No COLA	COLA	No COLA	COLA	No COLA	COLA
95th percentile	\$2,969.1	\$2,969.1	\$10,850.4	\$10,850.4	\$23,576.8	\$23,589.7	\$38,655.0	\$38,970.6	\$54,860.7	\$54,959.6
75th percentile	\$2,969.1	\$2,969.1	\$9,302.4	\$9,302.4	\$18,320.6	\$18,373.1	\$29,428.4	\$29,657.5	\$40,421.0	\$41,085.4
50th percentile	\$2,969.1	\$2,969.1	\$8,860.0	\$8,860.3	\$16,458.3	\$16,504.6	\$24,480.0	\$25,080.7	\$31,748.2	\$33,258.7
25th percentile	\$2,969.1	\$2,969.1	\$8,484.4	\$8,509.8	\$14,536.0	\$14,939.3	\$20,282.5	\$21,642.0	\$23,749.5	\$27,422.7
5th percentile	\$2,969.1	\$2,969.1	\$7,963.7	\$8,106.0	\$12,509.0	\$13,552.5	\$15,015.6	\$17,773.1	\$15,405.3	\$19,680.6

	2028		2031		2034		2037		2040	
	No COLA	COLA	No COLA	COLA	No COLA	COLA	No COLA	COLA	No COLA	COLA
95th percentile	\$68,758.3	\$69,778.7	\$80,812.1	\$82,524.1	\$92,078.9	\$95,455.8	\$107,262.1	\$112,135.2	\$119,517.7	\$127,707.2
75th percentile	\$49,366.9	\$50,914.8	\$55,607.3	\$59,132.6	\$62,195.4	\$67,475.4	\$66,904.0	\$74,551.2	\$70,887.8	\$81,787.2
50th percentile	\$36,460.4	\$39,902.9	\$38,498.7	\$45,441.5	\$41,701.2	\$49,492.8	\$42,986.1	\$53,006.1	\$44,181.6	\$56,247.0
25th percentile	\$24,643.8	\$30,612.6	\$25,677.0	\$32,646.9	\$26,445.6	\$34,625.2	\$27,315.4	\$36,253.1	\$27,874.5	\$37,562.4
5th percentile	\$15,438.0	\$19,913.9	\$15,452.7	\$19,913.9	\$15,452.7	\$20,525.8	\$15,677.2	\$20,761.7	\$15,730.6	\$20,897.3

# TSERS of North Carolina

## Actuarial Value Funded Ratio – 7.00% discount



Actuarial Value Funded Ratio as of 12/31

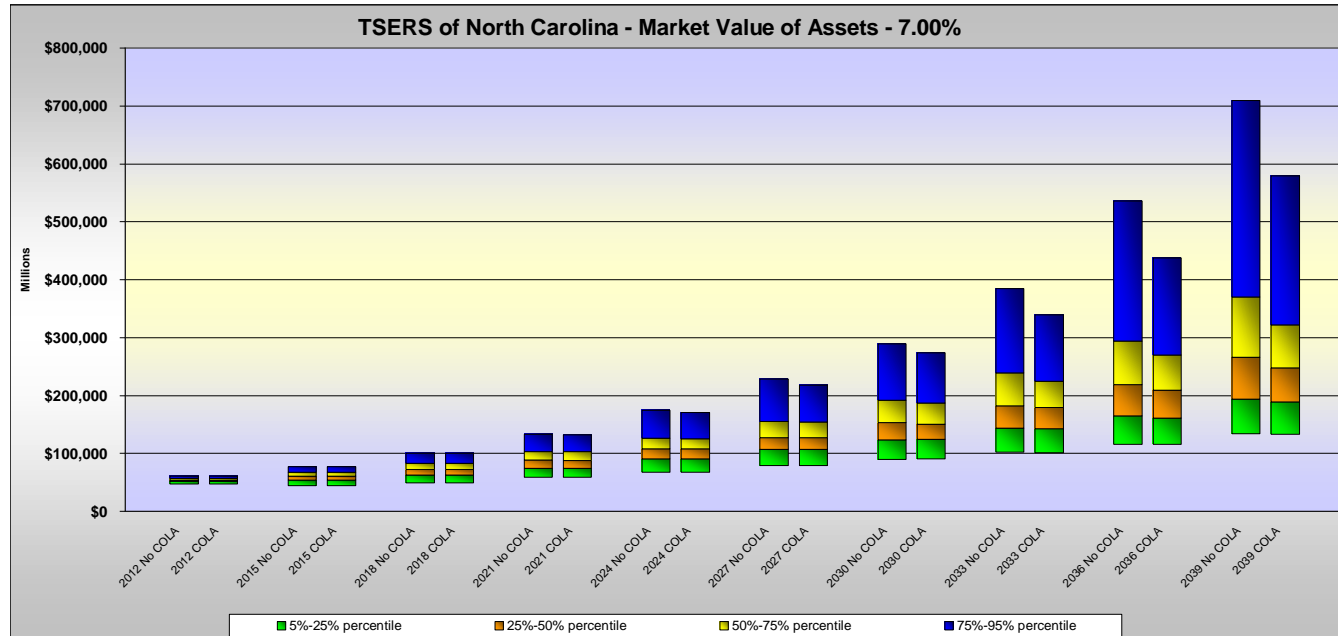
	2012		2015		2018		2021		2024	
	No COLA	COLA	No COLA	COLA	No COLA	COLA	No COLA	COLA	No COLA	COLA
95th percentile	91.0%	90.8%	96.2%	93.8%	106.4%	99.8%	122.3%	110.8%	144.5%	122.1%
75th percentile	89.8%	89.8%	91.1%	90.5%	96.5%	94.0%	104.1%	98.5%	113.2%	103.5%
50th percentile	89.0%	89.0%	87.0%	87.0%	89.8%	89.0%	94.9%	92.6%	102.2%	97.5%
25th percentile	88.2%	88.2%	82.9%	82.9%	82.2%	82.0%	86.3%	85.9%	91.6%	90.4%
5th percentile	84.8%	84.8%	70.0%	70.0%	68.4%	68.4%	73.1%	72.7%	76.2%	75.8%

	2027		2030		2033		2036		2039	
	No COLA	COLA	No COLA	COLA	No COLA	COLA	No COLA	COLA	No COLA	COLA
95th percentile	169.1%	137.5%	202.4%	152.1%	240.1%	167.1%	290.0%	192.1%	362.5%	223.6%
75th percentile	122.7%	108.4%	134.3%	113.8%	151.8%	121.9%	172.9%	130.1%	196.0%	140.0%
50th percentile	108.4%	101.0%	114.7%	103.3%	122.4%	106.4%	131.5%	109.4%	142.8%	114.0%
25th percentile	96.5%	94.2%	99.2%	95.3%	101.9%	97.2%	105.5%	98.7%	110.5%	100.2%
5th percentile	78.3%	77.0%	79.6%	79.1%	79.6%	79.3%	81.6%	80.5%	85.0%	82.8%

# TSERS of North Carolina

## Market Value of Assets (\$ millions) – 7.00% discount



Market Value of Assets as of 12/31

	2012		2015		2018		2021		2024	
	No COLA	COLA	No COLA	COLA	No COLA	COLA	No COLA	COLA	No COLA	COLA
95th percentile	\$60,783.0	\$60,783.0	\$77,281.2	\$77,184.1	\$100,220.8	\$99,839.1	\$132,690.0	\$132,336.0	\$174,928.9	\$170,422.4
75th percentile	\$56,843.9	\$56,843.9	\$67,924.1	\$67,882.1	\$82,802.4	\$82,620.5	\$102,859.4	\$102,667.8	\$126,039.8	\$125,293.6
50th percentile	\$54,078.7	\$54,078.7	\$61,074.0	\$61,074.0	\$72,649.4	\$72,649.4	\$88,236.4	\$88,035.7	\$107,739.1	\$107,643.3
25th percentile	\$51,569.0	\$51,569.0	\$54,304.7	\$54,304.7	\$62,407.2	\$62,407.2	\$74,609.4	\$74,586.5	\$90,681.9	\$90,707.2
5th percentile	\$46,937.5	\$46,937.5	\$43,890.3	\$43,890.3	\$49,324.7	\$49,324.7	\$59,169.5	\$59,171.0	\$67,880.7	\$67,882.4

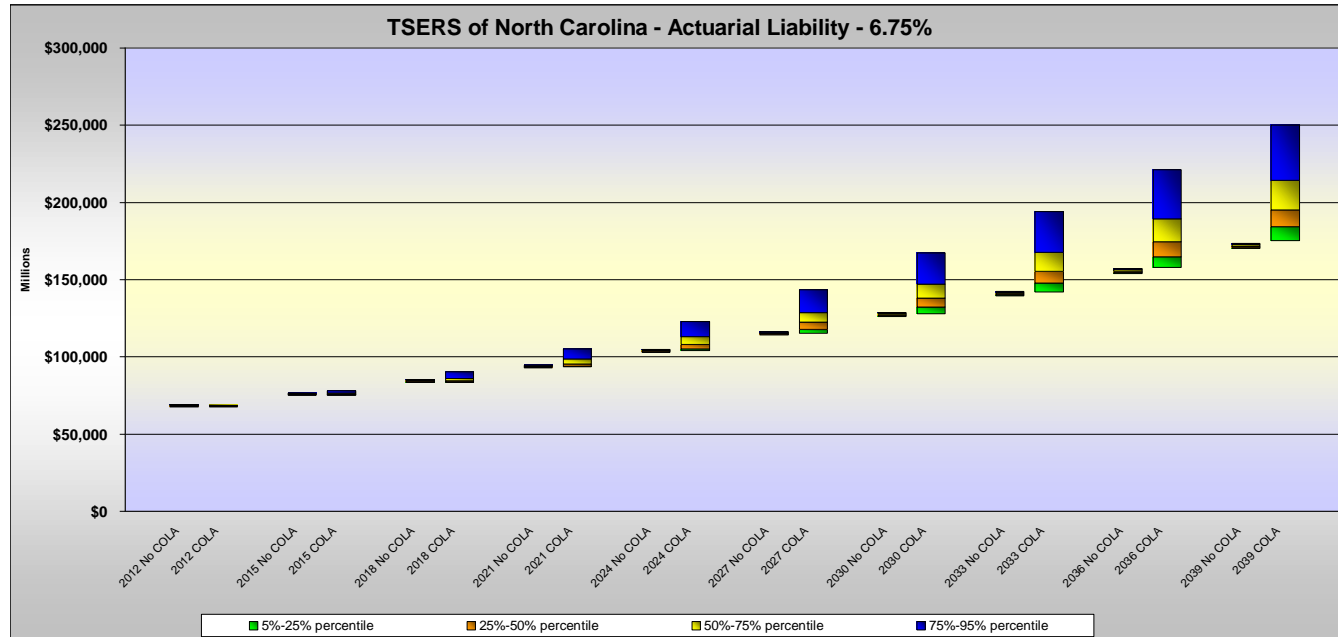
	2027		2030		2033		2036		2039	
	No COLA	COLA	No COLA	COLA	No COLA	COLA	No COLA	COLA	No COLA	COLA
95th percentile	\$228,568.4	\$217,846.5	\$288,878.5	\$274,059.1	\$384,667.9	\$339,085.7	\$535,700.6	\$437,427.2	\$709,824.5	\$578,820.4
75th percentile	\$155,625.0	\$154,569.8	\$191,601.3	\$187,089.6	\$238,889.5	\$225,010.6	\$293,724.5	\$270,021.8	\$370,377.3	\$322,293.2
50th percentile	\$127,519.6	\$127,471.5	\$152,854.2	\$150,429.4	\$182,511.6	\$179,449.7	\$219,232.5	\$209,083.8	\$265,813.5	\$247,767.0
25th percentile	\$106,899.0	\$106,964.0	\$123,846.9	\$124,389.0	\$143,549.1	\$142,898.3	\$165,138.8	\$161,418.0	\$193,597.8	\$189,068.7
5th percentile	\$78,672.7	\$78,746.2	\$89,784.8	\$90,751.1	\$101,706.9	\$101,449.0	\$115,818.8	\$115,848.6	\$134,422.4	\$132,785.1

## **6.75% Discount Rate Analysis**

- Assumed effective 12/31/2012
- 30-Year Forecast of Valuation Results
- Summaries of Key Financial Metrics
- 999 Inter-related Economic and Capital Market Scenarios

# TSERS of North Carolina

## Actuarial Liability (\$ millions) – 6.75% discount



Variability in liabilities that assume a COLA results from a dynamic inflation model

### Actuarial Liability as of 12/31

	2012		2015		2018		2021		2024	
	No COLA	COLA	No COLA	COLA	No COLA	COLA	No COLA	COLA	No COLA	COLA
95th percentile	\$68,342.7	\$68,364.7	\$76,005.8	\$78,086.2	\$84,435.9	\$90,604.9	\$93,676.7	\$105,212.7	\$103,936.4	\$122,855.7
75th percentile	\$68,342.7	\$68,342.7	\$76,005.8	\$76,459.9	\$84,435.9	\$86,459.0	\$93,676.7	\$98,801.5	\$103,936.4	\$113,044.4
50th percentile	\$68,342.7	\$68,342.7	\$76,005.8	\$76,005.8	\$84,435.9	\$84,957.8	\$93,676.7	\$95,579.9	\$103,936.4	\$108,031.1
25th percentile	\$68,342.7	\$68,342.7	\$76,005.8	\$76,005.8	\$84,435.9	\$84,435.9	\$93,676.7	\$94,060.0	\$103,936.4	\$105,167.8
5th percentile	\$68,342.7	\$68,342.7	\$76,005.8	\$76,005.8	\$84,435.9	\$84,435.9	\$93,676.7	\$93,676.7	\$103,936.4	\$103,936.4

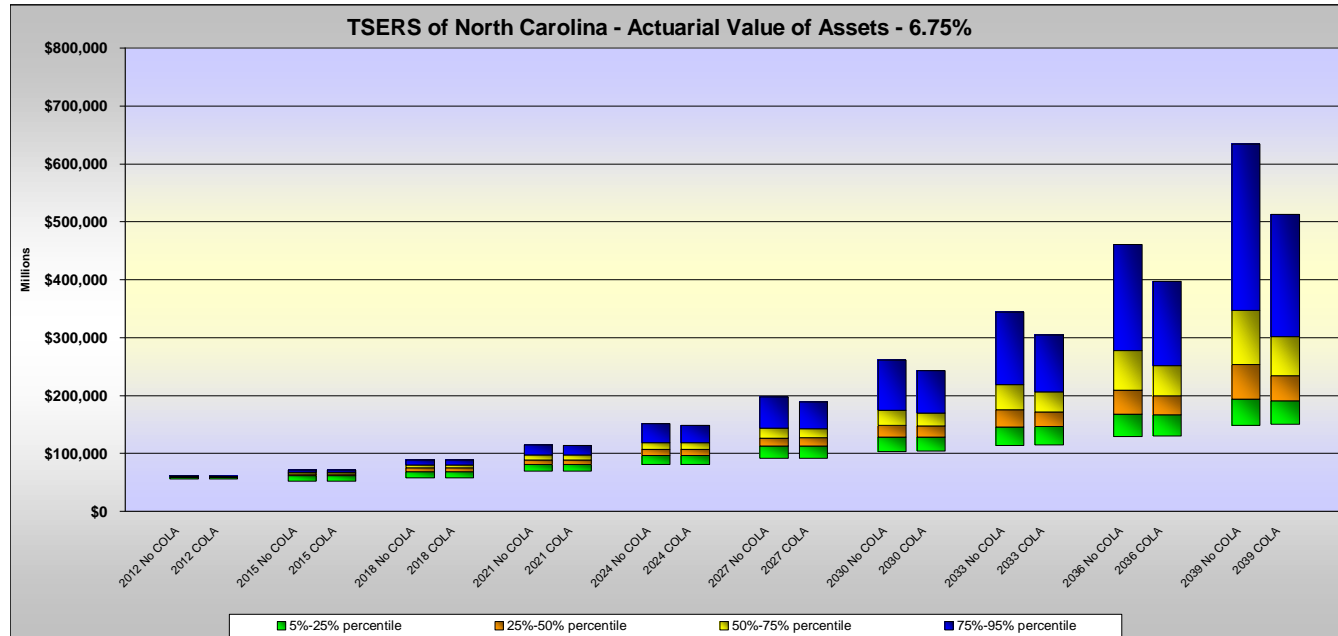
  

	2027		2030		2033		2036		2039	
	No COLA	COLA	No COLA	COLA	No COLA	COLA	No COLA	COLA	No COLA	COLA
95th percentile	\$115,211.0	\$143,476.8	\$127,513.5	\$167,499.9	\$140,890.5	\$194,108.9	\$155,560.1	\$221,325.1	\$171,782.0	\$250,269.2
75th percentile	\$115,211.0	\$128,810.1	\$127,513.5	\$147,255.0	\$140,890.5	\$167,740.3	\$155,560.1	\$189,452.3	\$171,782.0	\$214,470.6
50th percentile	\$115,211.0	\$122,356.8	\$127,513.5	\$138,072.5	\$140,890.5	\$155,431.4	\$155,560.1	\$174,500.1	\$171,782.0	\$195,246.9
25th percentile	\$115,211.0	\$117,917.2	\$127,513.5	\$132,343.3	\$140,890.5	\$147,935.5	\$155,560.1	\$164,847.3	\$171,782.0	\$184,417.9
5th percentile	\$115,211.0	\$115,252.6	\$127,513.5	\$128,111.8	\$140,890.5	\$142,036.4	\$155,560.1	\$157,996.4	\$171,782.0	\$175,201.0



# TSERS of North Carolina

## Actuarial Value of Assets (\$ millions) – 6.75% discount



Actuarial Value of Assets as of 12/31

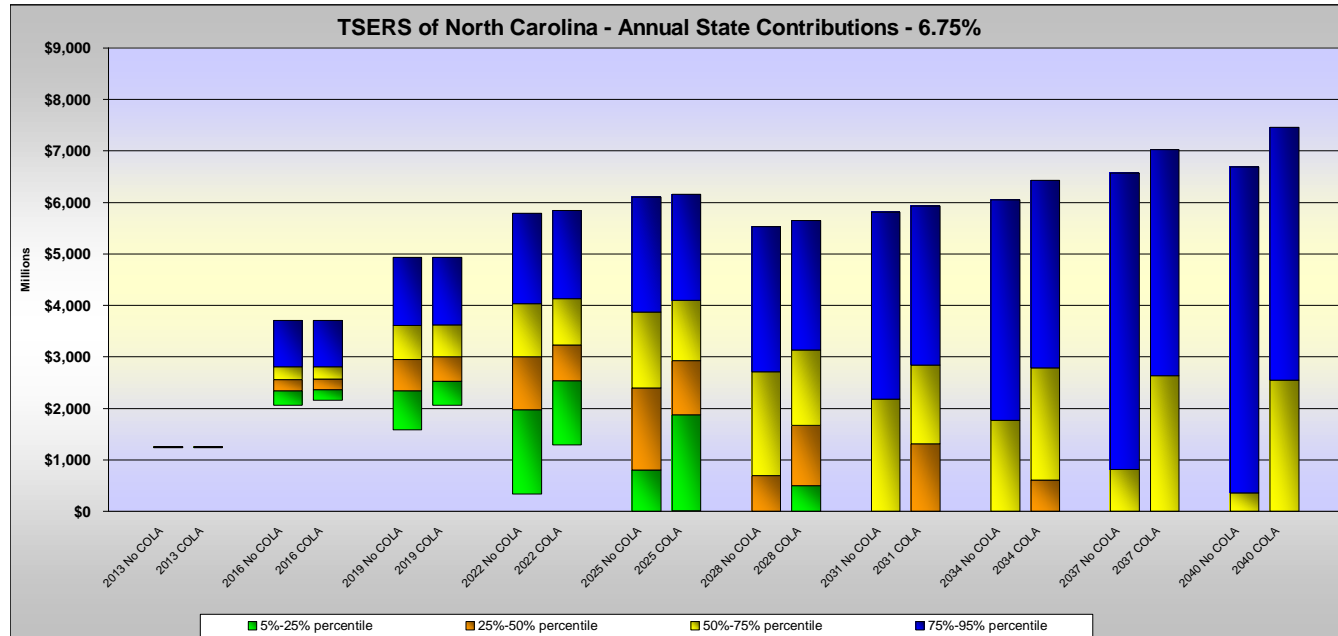
	2012		2015		2018		2021		2024	
	No COLA	COLA	No COLA	COLA	No COLA	COLA	No COLA	COLA	No COLA	COLA
95th percentile	\$60,394.2	\$60,394.2	\$71,265.2	\$71,106.3	\$88,546.9	\$88,281.8	\$114,396.4	\$113,717.4	\$151,307.6	\$148,722.0
75th percentile	\$59,606.4	\$59,606.4	\$67,485.8	\$67,452.2	\$80,432.7	\$80,325.4	\$97,399.5	\$97,226.8	\$118,448.4	\$118,194.0
50th percentile	\$59,053.3	\$59,053.3	\$64,475.4	\$64,475.4	\$74,864.9	\$74,864.9	\$88,869.5	\$88,779.5	\$107,193.5	\$107,086.8
25th percentile	\$58,551.4	\$58,551.4	\$61,439.9	\$61,423.8	\$68,777.4	\$68,777.4	\$80,976.5	\$80,996.9	\$96,268.6	\$96,396.4
5th percentile	\$56,324.9	\$56,324.9	\$52,029.7	\$52,029.7	\$57,527.0	\$57,527.0	\$68,998.9	\$68,998.9	\$80,579.1	\$80,750.4

	2027		2030		2033		2036		2039	
	No COLA	COLA	No COLA	COLA	No COLA	COLA	No COLA	COLA	No COLA	COLA
95th percentile	\$197,554.4	\$189,060.1	\$261,675.1	\$242,649.2	\$344,280.3	\$304,993.1	\$460,475.0	\$397,020.9	\$634,596.0	\$512,793.1
75th percentile	\$143,237.6	\$142,609.3	\$174,685.0	\$169,852.9	\$219,038.4	\$206,193.0	\$277,873.5	\$251,360.1	\$347,417.7	\$301,750.4
50th percentile	\$126,629.3	\$126,829.8	\$148,741.6	\$147,665.5	\$175,700.5	\$171,474.2	\$209,616.4	\$199,404.8	\$253,319.2	\$233,919.1
25th percentile	\$112,914.2	\$113,191.2	\$128,289.6	\$128,605.0	\$145,766.9	\$146,418.4	\$168,014.5	\$167,020.5	\$193,915.2	\$190,923.8
5th percentile	\$91,706.9	\$91,944.7	\$102,942.4	\$103,814.1	\$113,742.0	\$114,283.9	\$129,592.2	\$130,075.5	\$148,538.1	\$150,628.3

# TSERS of North Carolina

## Annual State Contributions (\$ millions) – 6.75% discount



### Annual State Contributions

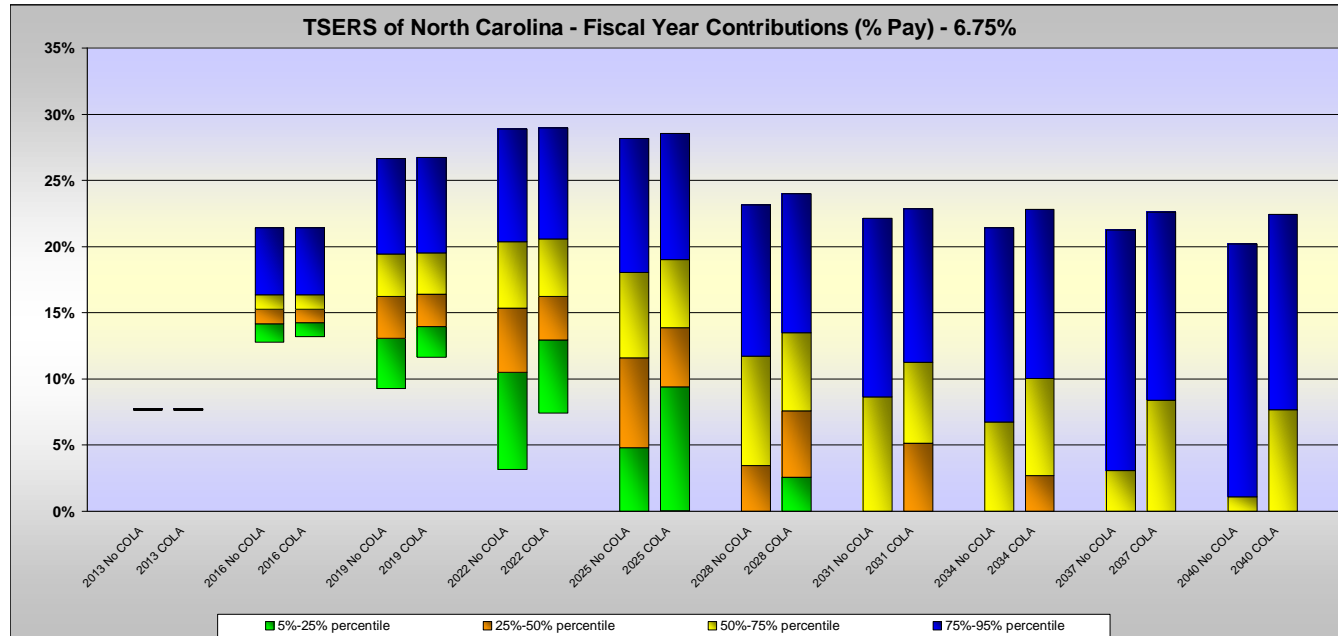
	2013		2016		2019		2022		2025	
	No COLA	COLA	No COLA	COLA	No COLA	COLA	No COLA	COLA	No COLA	COLA
95th percentile	\$1,248.8	\$1,248.8	\$3,703.8	\$3,703.8	\$4,937.2	\$4,937.2	\$5,790.6	\$5,840.0	\$6,102.4	\$6,160.4
75th percentile	\$1,248.8	\$1,248.8	\$2,811.3	\$2,813.5	\$3,605.8	\$3,618.3	\$4,033.6	\$4,129.8	\$3,873.0	\$4,097.9
50th percentile	\$1,248.8	\$1,248.8	\$2,563.6	\$2,570.8	\$2,953.0	\$3,007.3	\$3,008.3	\$3,233.9	\$2,397.3	\$2,923.8
25th percentile	\$1,248.8	\$1,248.8	\$2,342.6	\$2,361.9	\$2,338.1	\$2,530.3	\$1,972.1	\$2,533.9	\$802.8	\$1,878.2
5th percentile	\$1,248.8	\$1,248.8	\$2,057.7	\$2,154.8	\$1,587.8	\$2,057.8	\$334.3	\$1,290.6	\$0.0	\$6.3

	2028		2031		2034		2037		2040	
	No COLA	COLA	No COLA	COLA	No COLA	COLA	No COLA	COLA	No COLA	COLA
95th percentile	\$5,526.1	\$5,645.7	\$5,808.7	\$5,928.2	\$6,049.0	\$6,425.2	\$6,570.9	\$7,026.3	\$6,685.2	\$7,457.2
75th percentile	\$2,710.1	\$3,129.6	\$2,178.2	\$2,845.8	\$1,769.0	\$2,789.5	\$818.6	\$2,636.8	\$353.4	\$2,545.0
50th percentile	\$694.3	\$1,674.2	\$0.0	\$1,308.0	\$0.0	\$608.0	\$0.0	\$0.0	\$0.0	\$0.0
25th percentile	\$0.0	\$499.4	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0
5th percentile	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0

# TSERS of North Carolina

## *Fiscal Year Contribution (% of Pay) – 6.75% discount*



### Fiscal Year Contribution (% of Pay)

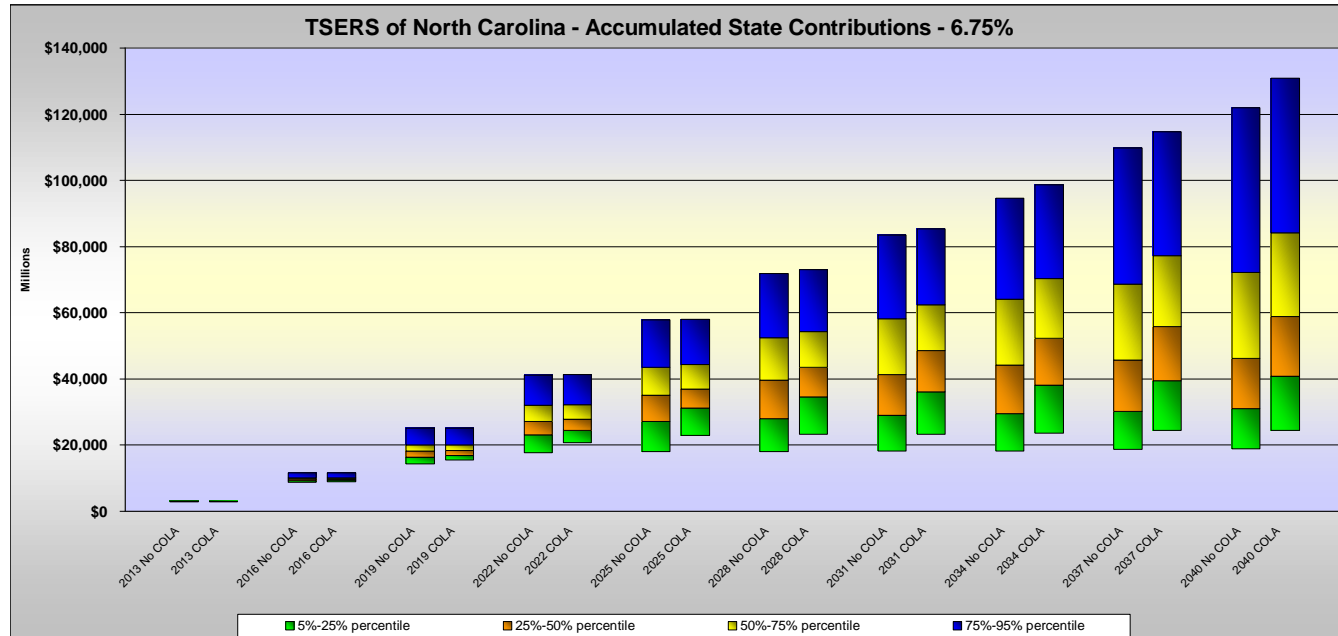
	2013		2016		2019		2022		2025	
	No COLA	COLA	No COLA	COLA	No COLA	COLA	No COLA	COLA	No COLA	COLA
95th percentile	7.7%	7.7%	21.4%	21.4%	26.6%	26.7%	28.9%	29.0%	28.2%	28.5%
75th percentile	7.7%	7.7%	16.3%	16.3%	19.5%	19.5%	20.4%	20.6%	18.1%	19.0%
50th percentile	7.7%	7.7%	15.3%	15.3%	16.2%	16.4%	15.3%	16.2%	11.6%	13.9%
25th percentile	7.7%	7.7%	14.2%	14.2%	13.1%	13.9%	10.5%	12.9%	4.8%	9.4%
5th percentile	7.7%	7.7%	12.8%	13.2%	9.3%	11.7%	3.2%	7.4%	0.0%	0.1%

	2028		2031		2034		2037		2040	
	No COLA	COLA	No COLA	COLA	No COLA	COLA	No COLA	COLA	No COLA	COLA
95th percentile	23.2%	24.0%	22.1%	22.8%	21.4%	22.8%	21.3%	22.6%	20.2%	22.4%
75th percentile	11.7%	13.5%	8.6%	11.3%	6.7%	10.0%	3.1%	8.4%	1.1%	7.7%
50th percentile	3.5%	7.6%	0.0%	5.1%	0.0%	2.7%	0.0%	0.0%	0.0%	0.0%
25th percentile	0.0%	2.6%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
5th percentile	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

# TSERS of North Carolina

## Accumulated State Contributions (\$ millions) – 6.75% discount



### Accumulated State Contributions

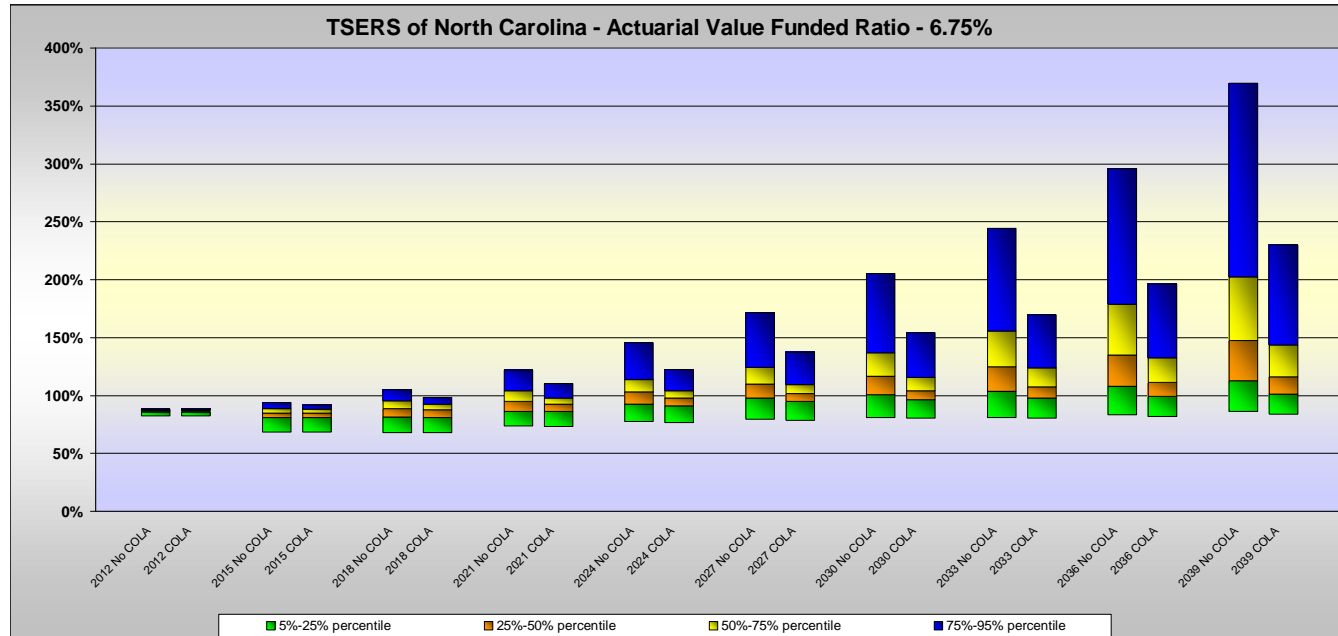
	2013		2016		2019		2022		2025	
	No COLA	COLA	No COLA	COLA	No COLA	COLA	No COLA	COLA	No COLA	COLA
95th percentile	\$2,969.1	\$2,969.1	\$11,649.7	\$11,649.7	\$25,198.4	\$25,210.8	\$41,100.3	\$41,370.6	\$57,882.9	\$57,993.8
75th percentile	\$2,969.1	\$2,969.1	\$10,137.6	\$10,137.6	\$20,104.9	\$20,133.6	\$31,998.1	\$32,285.4	\$43,567.5	\$44,340.9
50th percentile	\$2,969.1	\$2,969.1	\$9,703.0	\$9,706.6	\$18,291.3	\$18,340.4	\$27,171.2	\$27,766.0	\$35,131.5	\$36,922.0
25th percentile	\$2,969.1	\$2,969.1	\$9,336.4	\$9,362.3	\$16,404.7	\$16,829.6	\$23,029.1	\$24,535.5	\$27,143.0	\$31,256.9
5th percentile	\$2,969.1	\$2,969.1	\$8,823.7	\$8,974.0	\$14,394.5	\$15,478.3	\$17,752.2	\$20,716.6	\$18,072.9	\$22,946.1

	2028		2031		2034		2037		2040	
	No COLA	COLA	No COLA	COLA	No COLA	COLA	No COLA	COLA	No COLA	COLA
95th percentile	\$71,788.0	\$73,052.3	\$83,498.0	\$85,334.0	\$94,640.5	\$98,620.2	\$109,883.8	\$114,637.5	\$121,900.4	\$130,882.3
75th percentile	\$52,527.0	\$54,236.9	\$58,257.4	\$62,462.0	\$64,140.0	\$70,404.6	\$68,610.1	\$77,329.6	\$72,187.0	\$84,206.9
50th percentile	\$39,600.6	\$43,515.3	\$41,313.2	\$48,578.9	\$44,259.4	\$52,290.5	\$45,626.7	\$55,850.3	\$46,290.1	\$58,940.4
25th percentile	\$28,039.2	\$34,505.3	\$29,063.9	\$36,172.7	\$29,459.6	\$38,121.4	\$30,239.8	\$39,399.1	\$31,052.7	\$40,900.8
5th percentile	\$18,089.4	\$23,263.3	\$18,133.5	\$23,263.3	\$18,133.5	\$23,673.3	\$18,744.3	\$24,404.9	\$18,808.2	\$24,404.9

# TSERS of North Carolina

## Actuarial Value Funded Ratio – 6.75% discount



Actuarial Value Funded Ratio [as of 12/31](#)

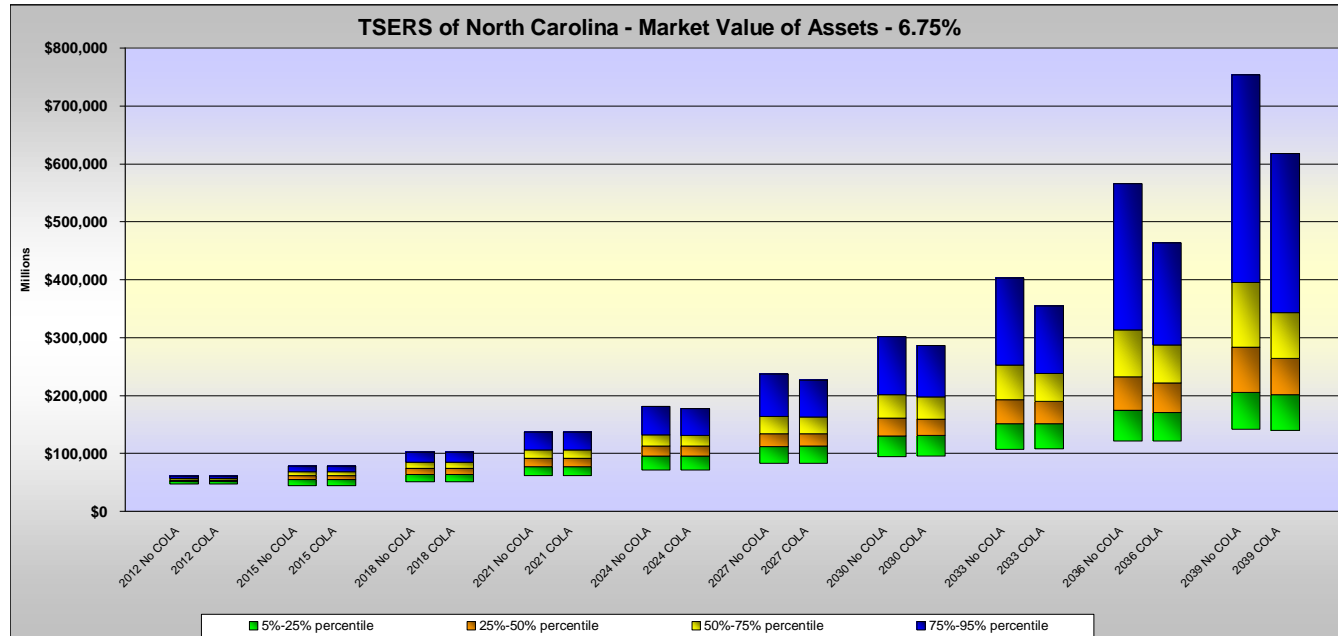
	2012		2015		2018		2021		2024	
	No COLA	COLA	No COLA	COLA	No COLA	COLA	No COLA	COLA	No COLA	COLA
95th percentile	88.4%	88.2%	93.8%	91.3%	104.9%	98.5%	122.1%	110.4%	145.6%	122.5%
75th percentile	87.2%	87.2%	88.8%	88.2%	95.3%	92.6%	104.0%	98.0%	114.0%	103.9%
50th percentile	86.4%	86.4%	84.8%	84.7%	88.7%	87.9%	94.9%	92.5%	103.1%	97.9%
25th percentile	85.7%	85.7%	80.8%	80.8%	81.5%	81.1%	86.4%	86.1%	92.6%	91.2%
5th percentile	82.4%	82.4%	68.5%	68.5%	68.1%	68.1%	73.7%	73.1%	77.5%	76.7%

	2027		2030		2033		2036		2039	
	No COLA	COLA	No COLA	COLA	No COLA	COLA	No COLA	COLA	No COLA	COLA
95th percentile	171.5%	137.1%	205.2%	154.4%	244.4%	169.8%	296.0%	196.1%	369.4%	229.7%
75th percentile	124.3%	109.6%	137.0%	115.6%	155.5%	123.9%	178.6%	132.6%	202.2%	143.5%
50th percentile	109.9%	101.7%	116.6%	104.2%	124.7%	107.6%	134.7%	111.3%	147.5%	116.0%
25th percentile	98.0%	95.1%	100.6%	96.2%	103.5%	98.0%	108.0%	99.5%	112.9%	101.2%
5th percentile	79.6%	78.5%	80.7%	80.2%	80.7%	80.4%	83.3%	81.8%	86.5%	83.9%

# TSERS of North Carolina

## Market Value of Assets (\$ millions) – 6.75% discount



Market Value of Assets as of 12/31

	2012		2015		2018		2021		2024	
	No COLA	COLA	No COLA	COLA	No COLA	COLA	No COLA	COLA	No COLA	COLA
95th percentile	\$60,783.0	\$60,783.0	\$77,844.7	\$77,751.8	\$102,248.4	\$101,891.9	\$136,918.3	\$136,580.6	\$181,163.3	\$177,232.0
75th percentile	\$56,843.9	\$56,843.9	\$68,451.5	\$68,432.0	\$84,672.6	\$84,506.7	\$106,437.7	\$106,289.5	\$131,723.6	\$131,082.3
50th percentile	\$54,078.7	\$54,078.7	\$61,625.6	\$61,625.6	\$74,457.1	\$74,454.1	\$91,446.8	\$91,403.7	\$113,046.0	\$112,970.3
25th percentile	\$51,569.0	\$51,569.0	\$54,858.6	\$54,858.6	\$64,043.8	\$64,035.4	\$77,558.2	\$77,532.2	\$95,206.1	\$95,111.0
5th percentile	\$46,937.5	\$46,937.5	\$44,406.1	\$44,406.1	\$50,821.7	\$50,821.7	\$61,599.6	\$61,598.6	\$71,353.4	\$71,360.8

	2027		2030		2033		2036		2039	
	No COLA	COLA	No COLA	COLA	No COLA	COLA	No COLA	COLA	No COLA	COLA
95th percentile	\$237,243.7	\$226,765.7	\$301,912.7	\$286,651.8	\$403,184.4	\$354,980.5	\$566,224.1	\$463,400.3	\$753,277.2	\$617,356.0
75th percentile	\$163,645.4	\$162,624.3	\$201,890.2	\$197,370.1	\$252,532.1	\$237,809.7	\$312,978.8	\$287,625.7	\$394,759.7	\$343,560.3
50th percentile	\$134,135.7	\$133,813.8	\$161,009.8	\$158,992.5	\$193,156.4	\$189,779.9	\$232,632.6	\$221,445.3	\$283,837.6	\$263,681.9
25th percentile	\$112,273.4	\$112,704.5	\$130,567.8	\$130,959.1	\$151,735.0	\$151,195.1	\$174,613.3	\$170,890.8	\$205,412.3	\$201,105.3
5th percentile	\$82,657.1	\$82,933.6	\$94,622.0	\$95,523.1	\$106,921.3	\$107,557.5	\$121,131.4	\$121,742.7	\$141,451.6	\$139,699.2

# Capital Markets Model

# 2012 Capital Market Assumptions

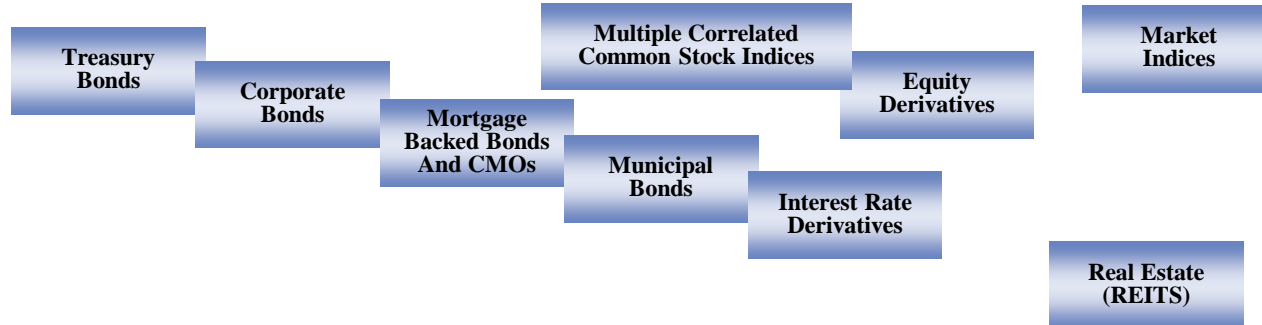
	10 Year		20 Year		30 Year	
Asset Class	Expected Return	Std. Dev.	Expected Return	Std. Dev.	Expected Return	Std. Dev.
Cash	0.58%	0.48%	0.81%	0.58%	0.93%	0.62%
US Large Cap	8.88%	17.13%	9.89%	17.69%	10.55%	17.99%
US Mid Cap	11.08%	18.02%	12.21%	18.73%	12.86%	18.98%
US Small Cap	11.28%	18.30%	12.36%	19.10%	13.00%	19.34%
Global Equity	9.94%	15.77%	10.44%	16.24%	10.81%	16.42%
MSCI EAFE	10.66%	16.69%	10.63%	17.06%	10.69%	17.19%
MSCI Emerging Markets	11.02%	20.25%	11.51%	20.58%	11.99%	20.72%
Aggregate Bonds	2.90%	4.39%	4.41%	4.96%	5.27%	5.17%
Intermediate US Government	2.36%	4.19%	3.90%	4.70%	4.73%	4.94%
Long Corporate	2.69%	9.88%	4.84%	10.33%	5.96%	10.55%
Long Term Government Credit	2.19%	5.66%	3.93%	6.24%	4.85%	6.52%
High Yield	3.51%	7.88%	4.76%	8.08%	5.44%	8.21%
TIPS	2.96%	5.94%	4.34%	6.19%	5.06%	6.28%
Global Treasuries	1.48%	7.91%	3.50%	8.72%	4.58%	9.14%
Direct Real Estate	9.08%	6.60%	9.26%	6.74%	9.41%	6.82%
REIT	6.28%	19.19%	7.28%	19.42%	7.83%	19.55%
Hedge Funds	9.16%	6.20%	10.03%	6.40%	10.53%	6.53%
Commodities	7.67%	24.88%	8.70%	25.52%	9.36%	25.83%
Infrastructure	8.37%	20.15%	9.14%	20.59%	9.71%	20.78%
Private Equity	13.34%	28.15%	15.01%	29.29%	16.00%	29.76%
Mortgage Backed Securities	2.99%	4.30%	4.45%	5.04%	5.31%	5.14%
Inflation	2.61%	2.74%	3.01%	2.92%	3.22%	3.01%



# Capital Markets Model

GEMS®

## Financial Market Variables



## Macroeconomic Variables



- Model calibrated to current economic conditions and recalibrated quarterly
- Economic variables trend toward longer-term equilibrium state
- Simulations reflect many different environments (e.g. high and low equity returns, inflation, and bond yields)
- Asset relationships change based on underlying economic conditions being modeled
  - Dynamic correlations and volatility
- Scalable model that can incorporate new asset classes

\* GEMS, from Conning & Company is an acronym for General Economy and Market Simulator

# Capital Markets Model

## *Additional details on GEMS model*

- GEMS simulates paths of economic and capital market environments. Then results are collected and percentiles computed
- Model incorporates historical data (back to inception of various indices), and uses a multi-factor model to forecast future values
- GEMS captures the real-life fact that means, volatilities and correlations are determined dynamically and can change over time

# Capital Markets Model

## *Additional details on GEMS model*

- Models the economies of the USA, UK, Switzerland, Canada, and Germany in an internally consistent manner
  - Can therefore capture forecast currency effects and interest disparities between and among the U.S. Dollar, Canadian Dollar, Euro, Pound and Swiss Franc
  - Australia, Japan, Norway, Sweden, and Denmark also available

# Capital Markets Model

## *Additional details on GEMS model*

- Cash
  - Cash is modeled as an investment in short term government paper paying a nominal or inflation linked rate
- Treasuries
  - GEMS uses a three factor model of interest rates to model treasuries.

# Capital Markets Model

## *Additional details on GEMS model*

- Corporate Bond Model
  - In the Bond Model, individual bonds are modeled and zero coupon corporate yields are generated by adding the credit spreads to the corresponding zero coupon treasury yield. The credit spread is driven by a default intensity process, which also determines each bond's rating. The evolution of the default intensity determines the migration, if any, of a bond's rating from one class to another.
  - Bond indices are created based on characteristics of bonds currently representing the index in question
    - Throughout a given scenario, bonds that mature or default are replaced by bonds with characteristics expected to prevail at that time

# Capital Markets Model

## *Additional details on GEMS model*

- Equity Indices
  - All equity return series are generated using stochastic volatility with jumps (SVJ). This means that unlike a standard mean-variance model, the simulation incorporates the possibility of large swings in values that would not be anticipated taking values from a standard normal (Gaussian) distribution.
  - The equity models generate extreme behavior (fat tails) via the specification of an independent stochastic jump (SVJ) process. The features of the returns generated by the model include volatility clustering, low frequency/high severity jumps, and jump clustering behaviors, all of which are observed in actual markets.
    - It has been Buck's observation that results at the 5th and 95th percentiles are similar to a pure mean-variance model, but in the extreme tails (1st and 99th percentiles and beyond), the GEMS model can produce fatter tails with more extreme results than a plain mean-variance model

# Capital Markets Model

## *Additional details on GEMS model*

- GEMS includes the major equity indices for all the economies it models. In addition, Buck has created, with guidance from Conning, our own user-specified models of equity sectors, and alternative investment classes (e.g., hedge funds) using the GEMS Market Indices facility.