Valuations Methods & Assumptions

OREGON PUBLIC EMPLOYEES RETIREMENT SYSTEM

Presented by:

Matt Larrabee, FSA, EA

Scott Preppernau, FSA, EA

July 28, 2017

Agenda

- Background
- Overview of demographic assumptions
  - Mortality
  - Other
- Recap of economic assumptions and actuarial methods
  - Reviewed at last Board meeting
- Review of long-term investment return assumption
- Estimated effect of assumptions
- Adoption of assumptions

Milliman

Executive Summary

- Based on our system experience review, we are recommending updates to various demographic assumptions, which result in the following net effects:
  - No appreciable change in UAL
  - Decrease of 0.2% of payroll in uncollared system average base contribution rates, driven by a modest decrease in assumed future individual member salary increases for non-school district employers
- Illustrating the effect of lowering the system's assumed rate from 7.50% to an 7.10% (as an example):
  - UAL increases by $3.2 billion
  - Uncollared system average base contribution rates increase by 2.8% of payroll
  - Other assumed rates would have a pro-rata effect
- The return assumption selected does not affect actual future returns
- 50th percentile returns in outlook models look to be lower for the next ten years than in the following decade

Milliman

Background Information
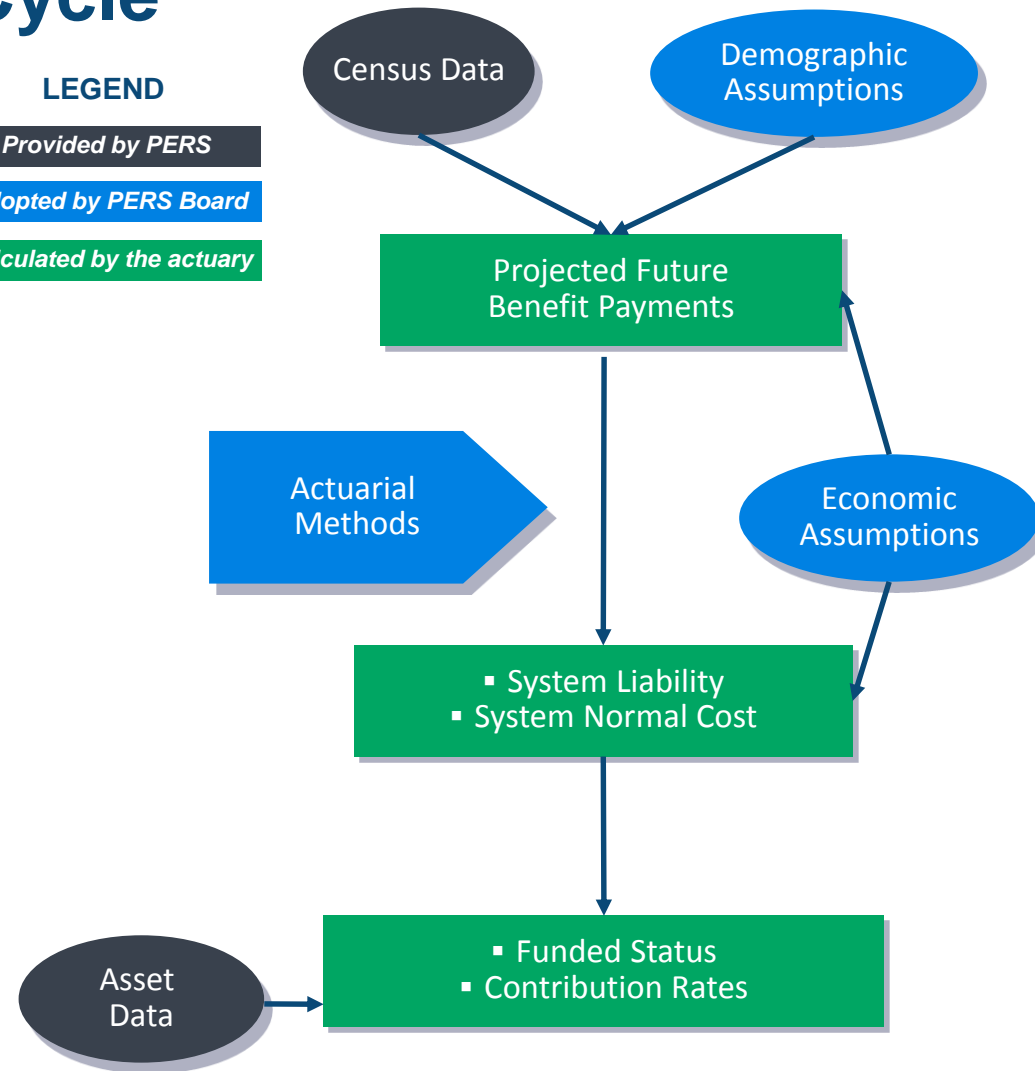
Two-Year Rate-Setting Cycle

- July 2017: Assumptions & methods adopted by Board in consultation with the actuary

- September 2017: System-wide 12/31/16 actuarial valuation results

- November 2017: Advisory 2019-2021 employer-specific contribution rates

- July 2018: System-wide 12/31/17 actuarial valuation results

- September 2018: Disclosure & adoption of employer-specific **2019-2021** contribution rates

LEGEND

- *Provided by PERS*
- *Adopted by PERS Board*
- *Calculated by the actuary*

Census Data

Demographic Assumptions

Projected Future Benefit Payments

Actuarial Methods

Economic Assumptions

- System Liability
- System Normal Cost

Asset Data

- Funded Status
- Contribution Rates

Milliman

Board Objectives - Methods & Assumptions

- Transparent

- Predictable and stable rates

- Protect funded status

- Equitable across generations

- Actuarially sound

- GASB compliant

Some of the objectives can conflict, particularly in periods with significant volatility in investment return or projected benefit levels. Overall system funding policies should seek an appropriate balance between conflicting objectives.

Milliman

The Fundamental Cost Equation

- Long-term program costs are the contributions, which are governed by the "fundamental cost equation":

BENEFITS =

EARNINGS +

CONTRIBUTIONS

Milliman

Governance Structure

- Benefits:
  - Plan design set by Oregon Legislature
  - Subject to judicial review

- Earnings:
  - Asset allocation set by OIC
  - Actual returns determined by market

- Contributions:
  - Funding, including methods & assumptions, set by PERS Board
  - Since contributions are the balancing item in the fundamental cost equation, PERS Board policies primarily affect the **timing** of contributions
  - Different actuarial methods and assumptions produce different projected future contribution patterns

Milliman

Demographic Assumptions

Demographic Assumptions

- We have statistically analyzed member data provided by PERS
  - Four years of data for most assumptions
  - Eight years of data for salary increases
- Recommended demographic assumptions were developed based on the statistical analysis
- Full details of the analysis are in our formal experience study report

Milliman

Summary of Demographic Assumptions

- Update mortality assumptions to reflect new set of mortality tables and projections regarding future mortality improvement

- Adjust retirement rates to reflect recent experience

- Reduce merit portion of salary assumption for two groups

- Adjust pre-retirement termination assumptions for three groups

- Update assumed final average salary adjustments for factors such as unused vacation and sick leave for several groups

- Adjust post-retirement medical program assumptions
  - Participation levels (RHIA & RHIPA)
  - Healthcare inflation assumption for RHIPA program

Milliman

Mortality Assumptions

Mortality Assumption

- For each group, the mortality assumption consists of two parts:

  1) A *base table* – for a given age, lists a probability of death at that age

  2) A *projection scale* – modifies base table entries to reflect anticipated continued mortality improvement over time

     - Reflects common-sense understanding that a new retiree today has a longer life expectancy than a new retiree 25 years ago…and that a new retiree 25 years from now is reasonably anticipated to have a longer life expectancy than a new retiree today

- We are recommending base table and projection scale updates:

  - Increase in liability of less than $200 million

  - Increase in uncollared base contribution rate of 0.1% of payroll

- The prior valuation's assumptions reflect base tables and projection scales published by the Society of Actuaries (SOA):

  - Base tables: Versions of standard RP-2000 mortality tables (published in 2000)

  - Projection scale: Scale BB (published Sept. 2012, adopted by PERS in 2015)

Mortality Assumption

- ORS 238.607: adopted actuarial equivalency factors *must use the best actuarial information on mortality available at the time*
  - We separately reviewed police and fire mortality per ORS 238.608, and our review indicated recent experience for male PERS police and fire retirees was similar to that of male PERS non-school district general service members
- We matched PERS experience to the SOA's RP-2014 base tables
  - Blending white, blue collar tables and using "set-backs" tightens calibration to PERS
- SOA currently conducting a public plan-specific mortality study
  - By the time of the next experience study, new base tables should be available
  - Study committee has stated observed experience is similar to the RP-2014 tables
- Updating the base tables from RP-2000 to RP-2014 suggests also updating the projection scale assumption
  - Scale BB is intended specifically for use with RP-2000 tables

Technical details on our recommendation and more information on the mortality assumption are in the Appendix and in the formal Experience Study report

Milliman

Historical Mortality Improvement – Soc. Sec. Data

Weighted Average Annual Improvement Over Ages 60 - 90 for Prior 10 Years
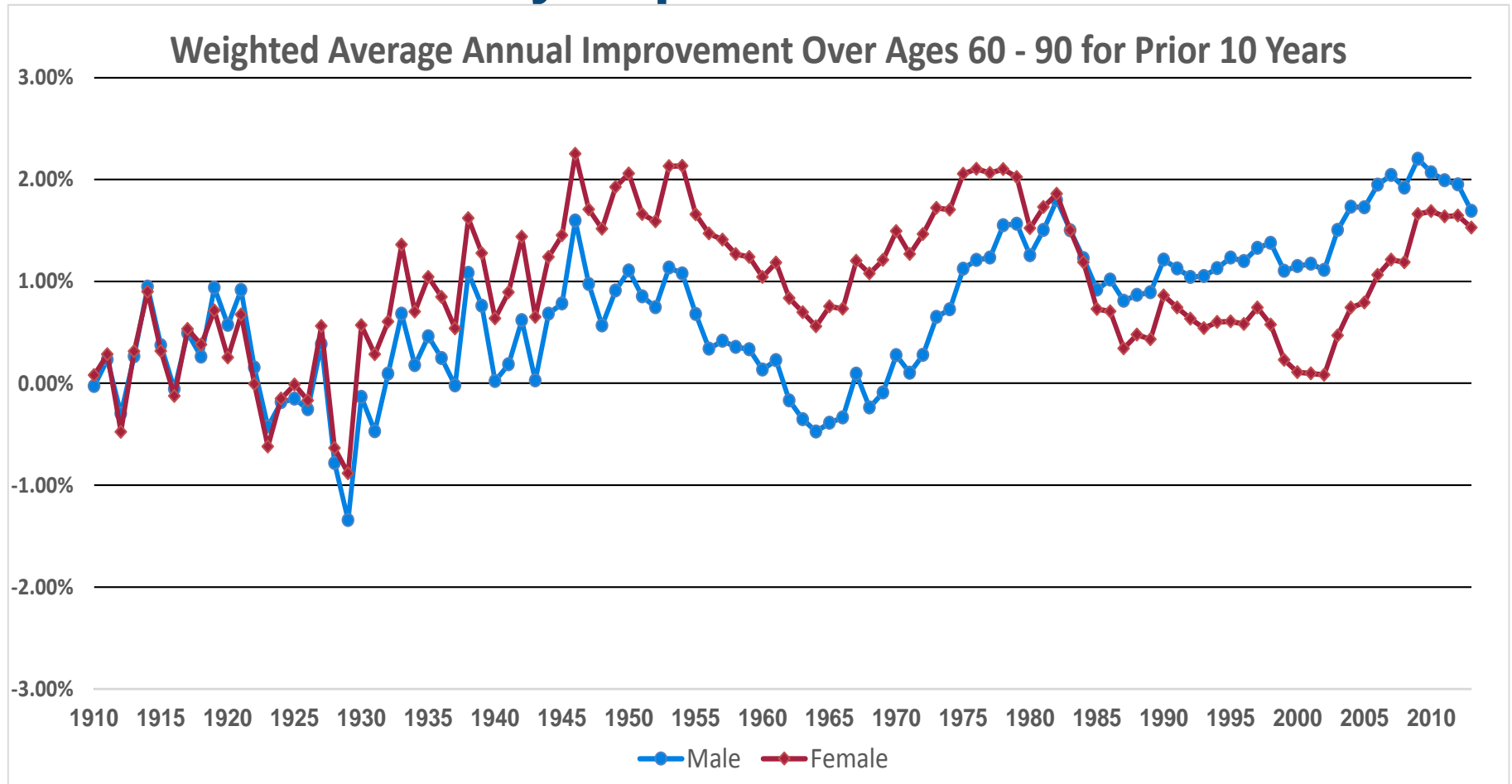
- We don't know whether male or female mortality will improve faster
- We don't know from one decade what the next will be like

Mortality Projection Scale

- SOA published four (!) mortality projection scales in five years
  - BB, MP-2014, MP-2015, MP-2016
  - The MP scales are profoundly complex (concern about misreading noise for signal)
  - Scales make assumptions about one gender improving faster than the other
  - The scales produce noticeably different results from each other
- As a firm, Milliman reviewed Social Security experience and relevant literature to develop an alternative mortality projection scale
  - Scale set equal to 60-year average of observed Social Security improvement
  - Uses large, credible, publically available dataset
  - Mortality projection scale's improvement varies by age, but does <u>not</u> vary by gender
- We recommend adopting this alternative mortality projection scale for PERS
  - Reasonably anticipates the effects of continuing future mortality improvement
  - Provides a more stable and understandable assumption than the SOA's approach
  - Doesn't prognosticate about one gender's improvement outpacing the other's

Milliman

Mortality Assumption

- Illustrative effect of assumption changes for non-disabled retiree:

Future Life Expectancy (in years)	Retires at Age 60 in 2017			Retires at Age 60 in 2037		
	Current	New	Change	Current	New	Change
School District Male	27.6	28.1	0.5	29.7	29.5	-0.2
Other Male	26.9	26.7	-0.2	29.0	28.2	-0.8
School District Female	29.9	29.8	-0.1	31.8	31.1	-0.7
Other Female	28.2	28.0	-0.2	30.1	29.4	-0.7

- Combination of updates to base tables and improvement scales increases life expectancy for some and decreases for others

- The table above has three assumed preconditions, all of which serve to increase the life expectancy:
  - The individual is assumed to have already survived to age 60
  - The individual is assumed to have served in PERS-covered employment
  - The individual is assumed to not be disabled as of age 60

Milliman

Other Demographic Assumptions

Rate of Retirement Assumption

- The likelihood that an eligible member retires in a given year

- Structure:
  - School District
  - Other General Service
  - Police & Fire
  - Divided into 3 service bands
  - Tier 1/Tier 2 vs. OPSRP

- Modifications made to assumptions at certain ages to more closely align with recent experience
  - Typically, lowering assumptions at some earlier retirement ages
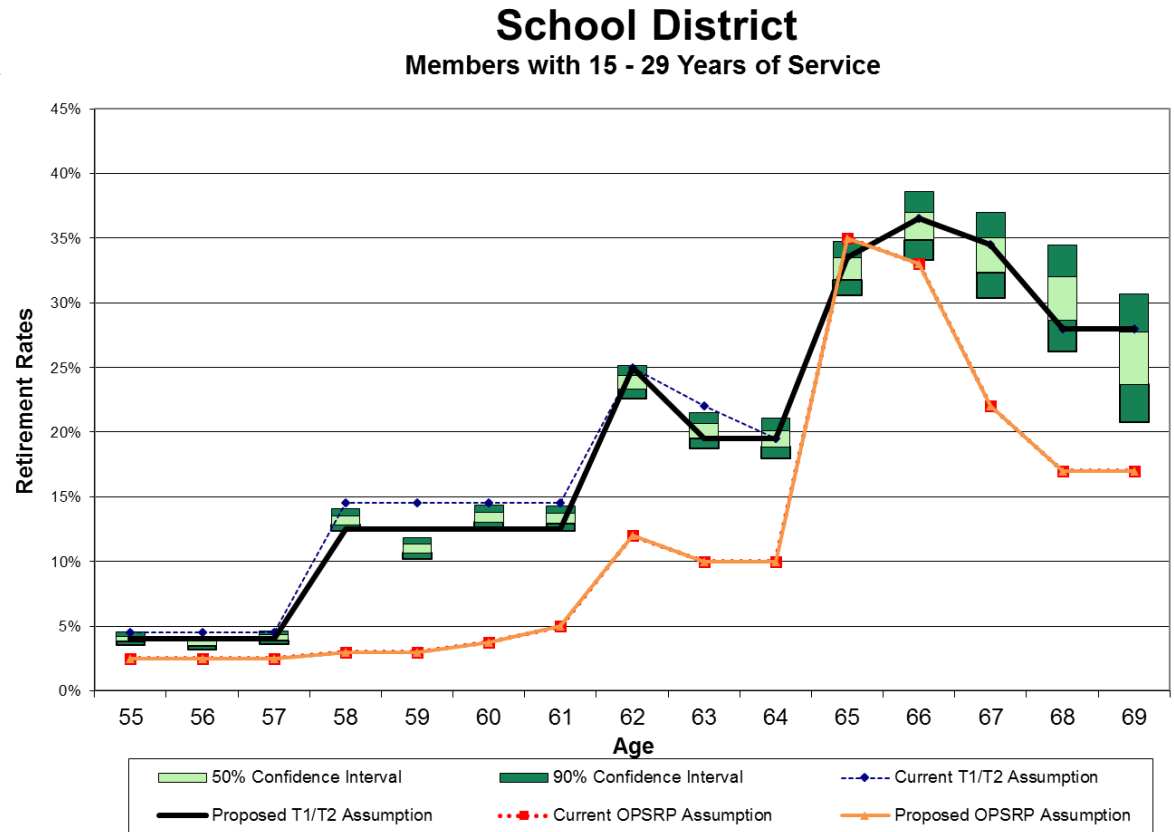
School District
Members with 15 - 29 Years of Service

Example shown above. Recommendations for other groups shown in detailed Experience Study report.

Milliman

Individual Member Salary Increase Assumption

- Reflects combined effects of merit/longevity, general wage growth and inflation assumptions

  - Analyzed eight years of individual pay increases, then back out assumed inflation and general wage growth to isolate the merit/longevity component

- Structure:
  - School District
  - Other General Service
  - Police & Fire
- School Districts matched current assumption well

School Districts

Milliman
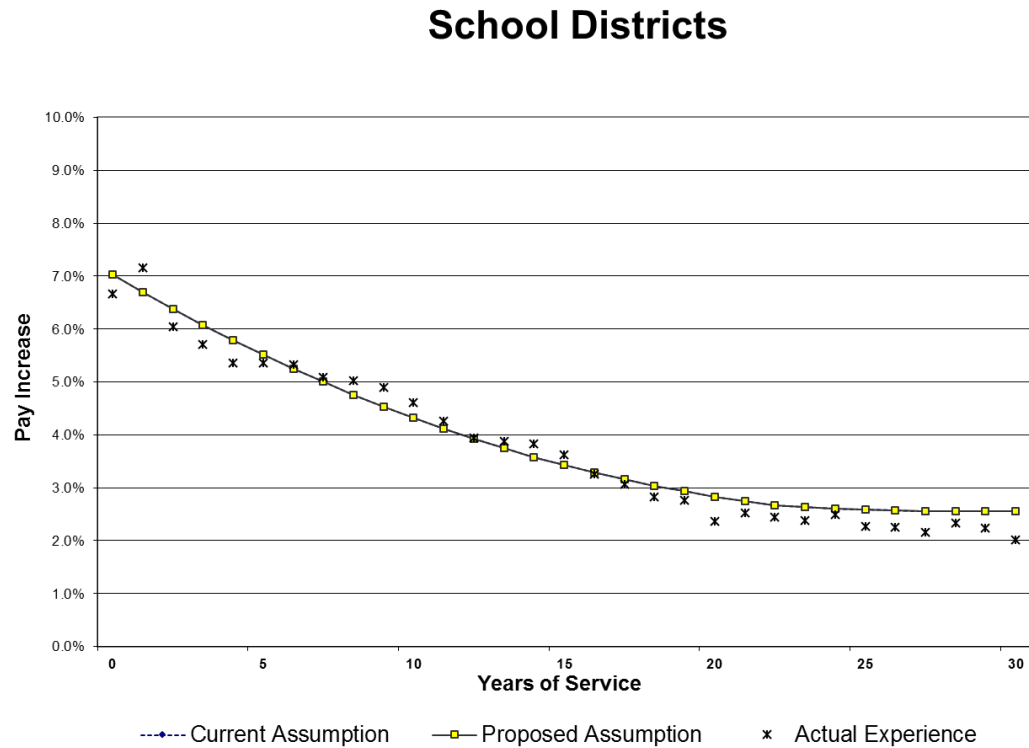
Individual Member Salary Increase Assumption

- Police & Fire and Other General Service had lower increases than assumed
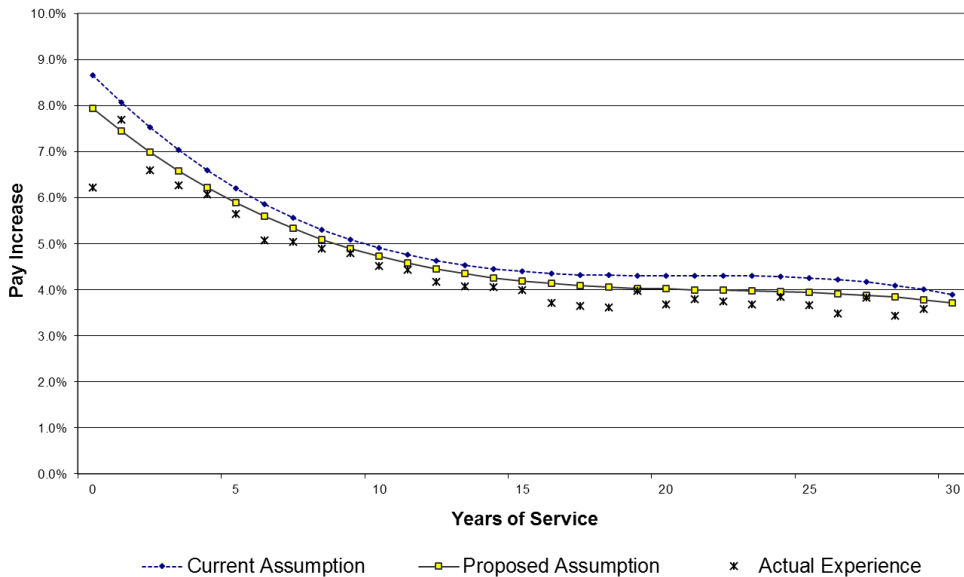
Other General Service

Police & Fire
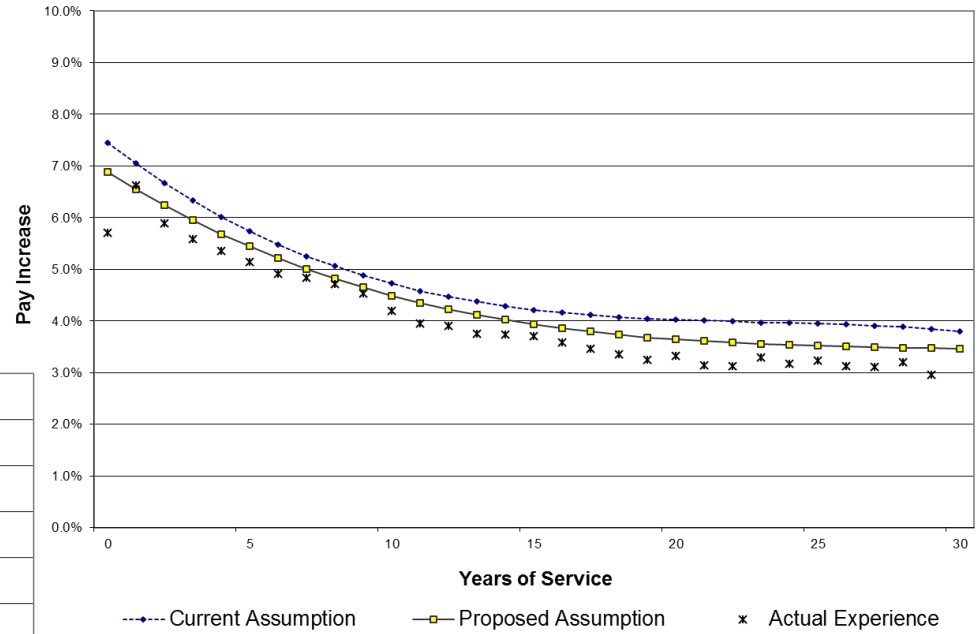
- Assumptions updated reflecting a blend of current assumption and recent observed experience

Pre-Retirement Employment Termination Assumption

- The likelihood that a member leaves employment in a given year prior to retirement eligibility for reasons other than death or disability

- We recommend adjustments to the assumption for three of five groups for relatively minor, but statistically significant, differences between the current assumption and observed experience

Other General Service Male
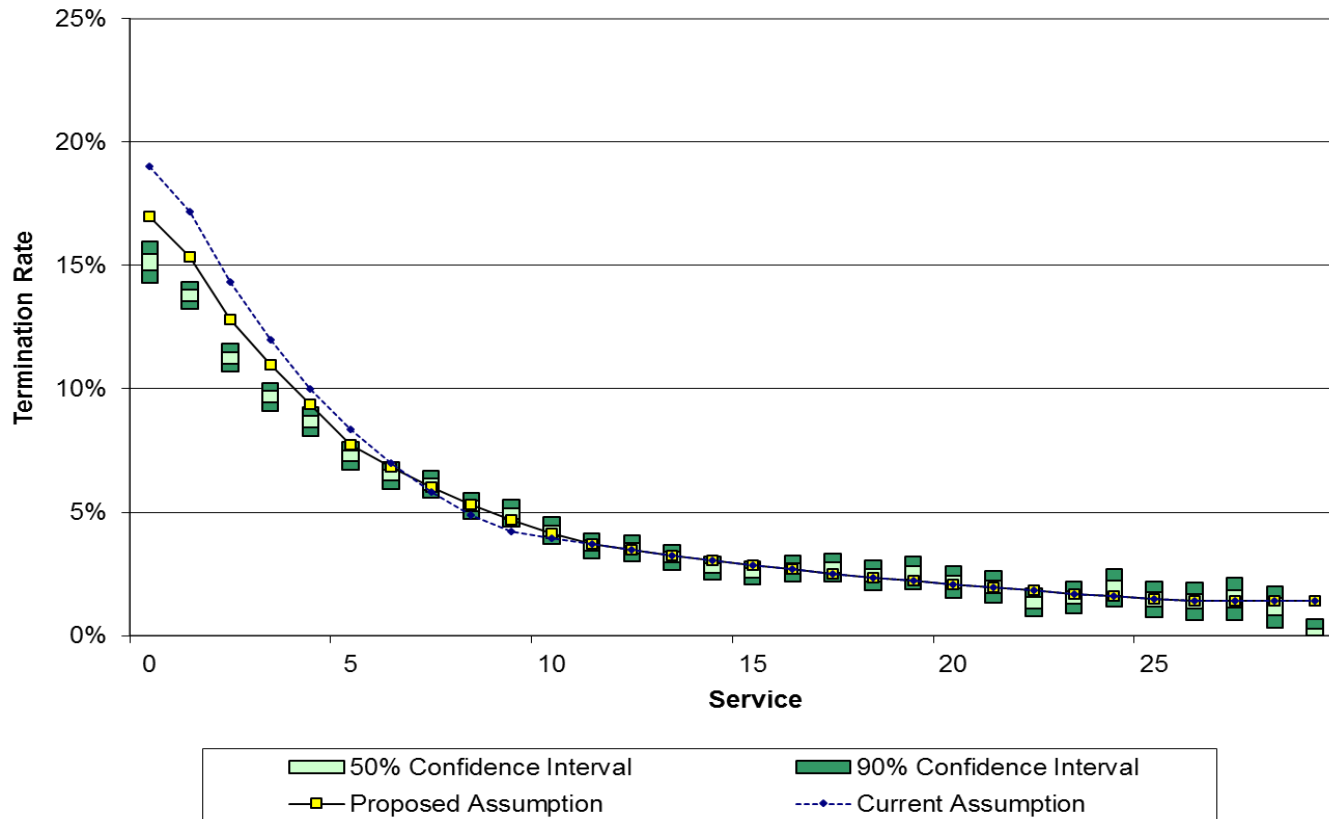
Example shown above. Recommendations for other groups shown in detailed Experience Study report.

Final Average Salary Adjustments

- In the valuation, we apply assumptions regarding the increase in final average salary for Tier 1/Tier 2 members attributable to:
  - Unused sick leave
  - Lump sum distribution of vacation pay (only affects Tier 1)
- Only relevant when benefits are calculated using Full Formula or Formula Plus Annuity
- We recommend some adjustments to more closely track recent experience:

Unused Sick Leave	Current Assumption	Proposed Assumption
State GS Male	6.25%	6.25%
State GS Female	3.75%	3.75%
School District Male	7.25%	**7.50%**
School District Female	5.75%	5.75%
Local GS Male	4.75%	4.75%
Local GS Female	3.25%	3.25%
State Police & Fire	4.75%	4.75%
Local Police & Fire	7.50%	**7.25%**
Inactive Members	3.00%	**3.25%**

Tier 1 Vacation Cash Out	Current Assumption	Proposed Assumption
State GS	1.60%	**2.00%**
School District	0.25%	0.25%
Local GS	2.20%	**2.75%**
State Police & Fire	1.80%	**2.50%**
Local Police & Fire	2.90%	**3.75%**

Milliman

RHIA and RHIPA Assumptions

- Updates to retiree healthcare participation:
  - Healthy RHIA: Lower participation rates
  - Disabled RHIA: No change
  - RHIPA: Minor change in one category
- Health care cost trend assumption applied to RHIPA full subsidy amount was also updated
  - Based on analysis by Milliman health actuaries

RHIA Participation Rates
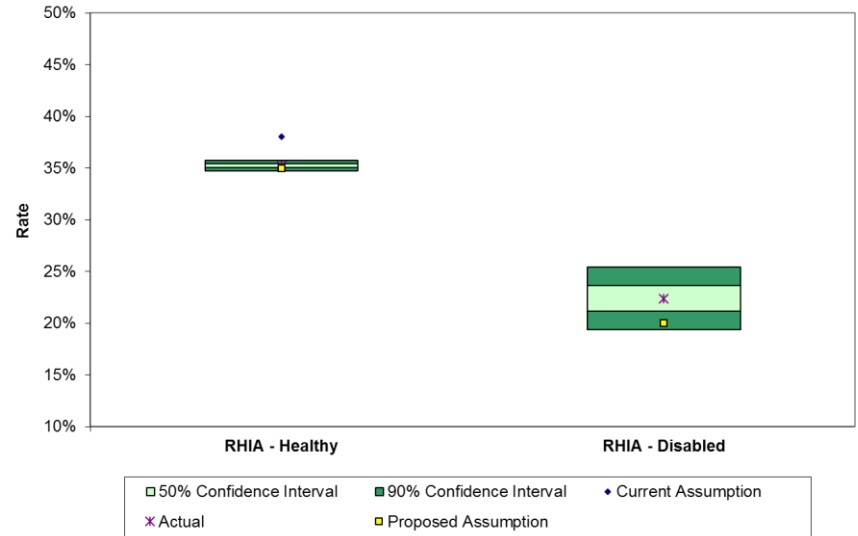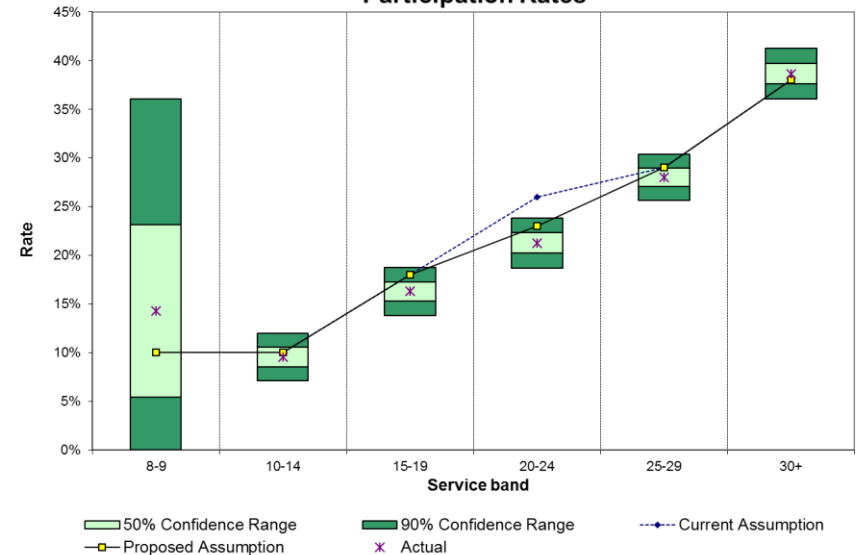
50% Confidence Interval   90% Confidence Interval   Current Assumption
Actual   Proposed Assumption

RHIPA Participation Rates

50% Confidence Range   90% Confidence Range   Current Assumption
Proposed Assumption   Actual

Milliman

Economic Assumptions and Actuarial Methods

Economic Assumptions and Actuarial Methods

- At the May 26, 2017 meeting, the Board reviewed
    - Non-investment economic assumptions
    - Actuarial methods
    - Investment return assumption
- Our recommendations regarding economic assumptions and actuarial methods are unchanged since the May meeting

Milliman

Economic Assumptions

	12/31/2015 Valuation Assumptions	12/31/2016 Valuation Proposed Assumptions
Inflation	2.5%	2.5%
Real Wage Growth	1.0%	1.0%
Payroll Growth	3.5%	3.5%
Administrative Expenses:		
- OPSRP	$5.5 million	$6.5 million
- Tier 1/Tier 2	$33.0 million	$37.5 million

No explicit assumption is made for investment-related expenses, which are accounted for implicitly in the analysis of the long-term investment return assumption.

Milliman

Key Actuarial Methods

	12/31/2015 Valuation Methods	12/31/2016 Valuation Proposed Methods
Cost Allocation Method	Entry Age Normal	No change
Shortfall Amortization Method	Level percent of pay, layered fixed periods: Tier 1/Tier 2: 20 years OPSRP: 16 years RHIA/RHIPA: 10 Years	No change
Rate Collar	Limits change in based contribution rate to larger of 20% of current rate or 3.00% of payroll; Collar widens incrementally when funded status below 70%	No change

Milliman

Long-Term Investment Return Assumption

- Uses of the investment return assumption
  - As a "discount rate" for establishing the:
    - Actuarial accrued liability, which is a net present value
    - Associated unfunded actuarial liability, also called the UAL or actuarial shortfall
  - Guaranteed crediting level for regular Tier 1 active member account balances
  - Annuitization rate for converting member account balances to lifetime money match monthly benefits

Reflecting expectations for both investment earnings and benefit levels for certain members, the assumption helps set a reasonable and appropriate budgeting glide path for projected employer contribution rates

Investment Return Estimates

- We applied a standard mean/variance model to calculate 50th percentile return estimates based on capital market outlook assumptions from four sources
  - Milliman
  - Callan – Consultant to OIC
  - Pension Consulting Alliance (PCA) – Consultant to OIC
  - 2016 Horizon survey of capital market assumptions (survey of 35 advisors)
- At May meeting, showed 20 year estimate for Milliman, 10 year for others
  - Today we also have a 10 year Milliman estimate and a 20 year PCA estimate
- Estimates do not reflect any possible "alpha" due to selected managers potentially outperforming market benchmarks over the long term, net of fees
- Today's speakers are not credentialed investment advisors
  - We are presenting Milliman capital market outlook model results based on assumptions developed by Milliman's credentialed investment professionals

Details on each set of capital market outlook assumptions are in the Appendix

Milliman

50th Percentile Investment Returns Over 10 Years

- Modeling based on OIC's target long-term asset allocation
  - Current actual allocation differs somewhat from the target allocation

	Callan	Milliman	PCA	Horizon
Median Annualized Return	**7.05%**	**6.33%**	**7.40%**	**7.24%**
Assumed Inflation	2.25%	2.30%	2.25%	2.16%
Real Return	4.80%	4.03%	5.15%	5.08%
Timeframe Modeled	10 years	10 years	10 years	10 years

The median returns shown above are geometric annualized average returns over the timeframes indicated above for each provided set of capital market assumptions

Milliman

50th Percentile Investment Returns Over 20 Years

- Modeling based on OIC's target long-term asset allocation
  - Current actual allocation differs somewhat from the target allocation

	Milliman	PCA
Median Annualized Return	**6.70%**	**7.60%**
Assumed Inflation	2.50%	2.25%
Real Return	4.20%	5.35%
Timeframe Modeled	20 years	20 years

The median returns shown above are geometric annualized average returns over the timeframes indicated above for each provided set of capital market assumptions

Milliman

Comparison to Peer Systems

- There is a downward trend in public plan return assumptions
- Over 50% of the 127 systems tracked by the NASRA Public Fund Survey reduced their assumption over last 2-3 years

Distribution of Investment Return Assumption
NASRA Public Survey

Source: NASRA (July 19, 2017)

■ May 2015 Survey ■ Latest
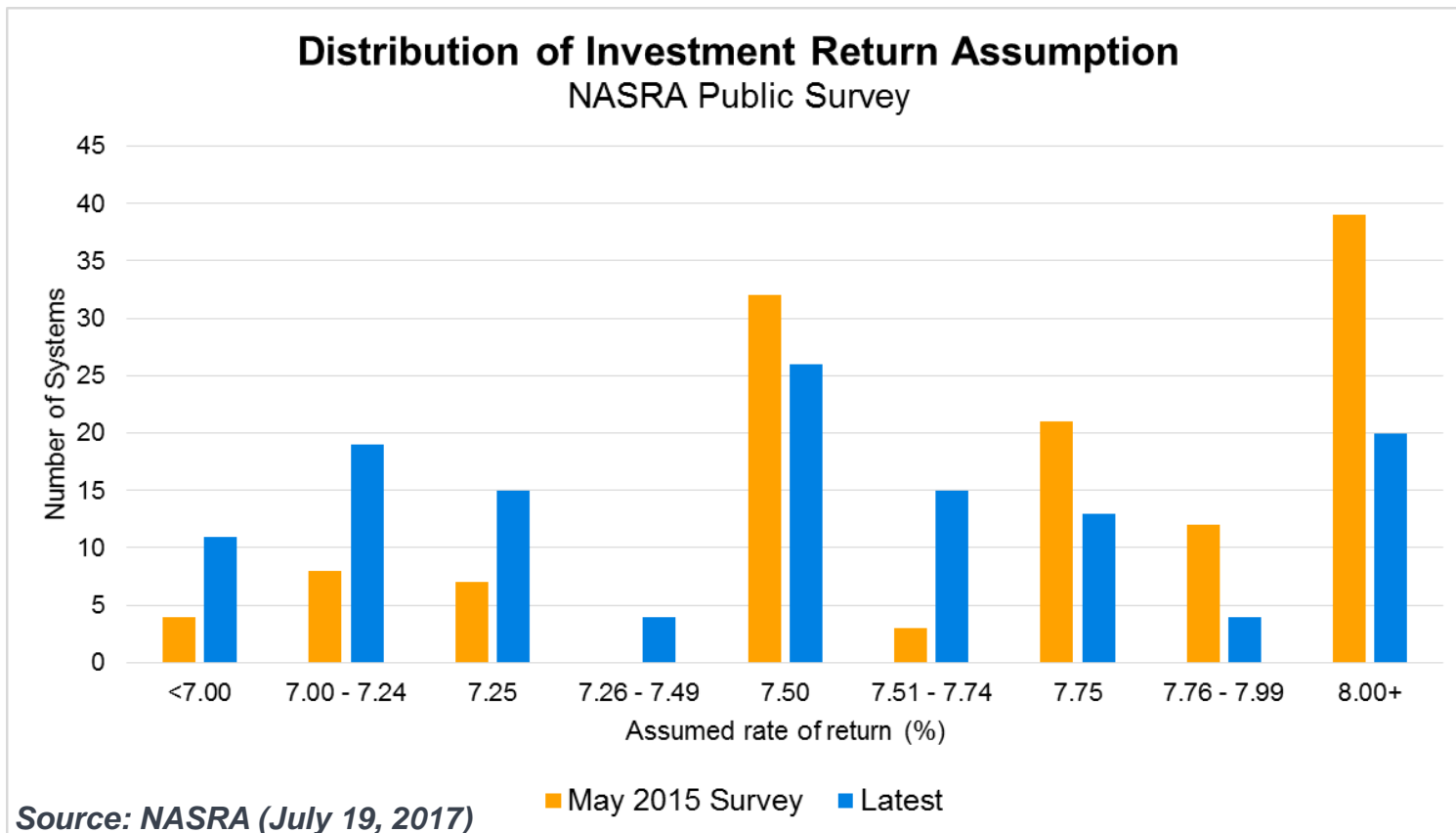
Effects of Lowering the Assumed Return

- A lower investment return assumption would produce higher calculated liabilities and contribution rates

- Liabilities are net present values, as of the valuation date, of a benefit payment projection that stretches far into the future

  - Changing the assumption modifies the projected balance of the fundamental cost equation between future investment earnings and future contributions

    - The actual balance will depend on actual investment earnings, not on the assumed return adopted by the PERS Board

- For PERS, such an assumption change would also lower benefits for future retirements calculated under Money Match

  - From "PERS by the Numbers", in 2016 the Money Match formula determined benefits for 34% of retirees (typically long-service General Service members)

  - Illustration for a hypothetical Tier 1 member shown in Appendix

Milliman

Considerations in Setting the Return Assumption

- In our opinion, the long-term future investment return assumption should be lowered based on the current data from the capital market outlook models, review of the guiding principles, and our perspective regarding Actuarial Standards of Practice

- Actual investment returns are not determined by the assumed return

- Selecting an assumed return above the median annualized return implies a greater than 50% expectation of actual experience falling short of the selected assumption

Estimated Effect of Assumption Changes

Preliminary Effect of Changes – Liability

- Estimated effect on combined Tier 1, Tier 2, and OPSRP liabilities based on preliminary valuation work
  - For illustration, considers investment return assumption of 7.10%

	12/31/2016 Accrued Liability
Current assumptions	$78.7 B
Mortality	$0.2 B
Merit	($0.2 B)
Other demographic assumptions	($0.1 B)
Assumed return - 7.10%	$3.2 B
Revised assumptions	$81.8 B

(Amounts in billions)

Combined effect of illustrated changes: $3.1 billion

An assumed return other than 7.10% would have a liability change proportional to that shown above (e.g., a 7.30% return would have a $1.6 billion effect)

Milliman

Preliminary Effect of Changes – Uncollared Rates

▪ Estimated impact on <u>uncollared</u> system-average advisory pension rates for 2019-2021 based on preliminary valuation work

	Tier 1 / Tier 2 / OPSRP	
	UAL	Normal Cost
Mortality	0.1%	0.0%
Merit salary increase	(0.1%)	(0.3%)
Other demographic assumptions	(0.0%)	0.1%
Assumed return - 7.10%	<u>1.8%</u>	<u>1.0%</u>
Total	1.8%	0.8%

Total effect: 2.6% of payroll

Changes shown are stated as a percent of payroll and exclude changes for the RHIA & RHIPA retiree healthcare programs

Milliman

Preliminary Effect of Changes – Collared Rates

▪ The size of 2019 base rate increases will very likely be set by the rate collar

  ▪ If the 2019-2021 uncollared rate is greater than the 2019 increase allowed by the rate collar, a portion of the increase will be deferred to 2021
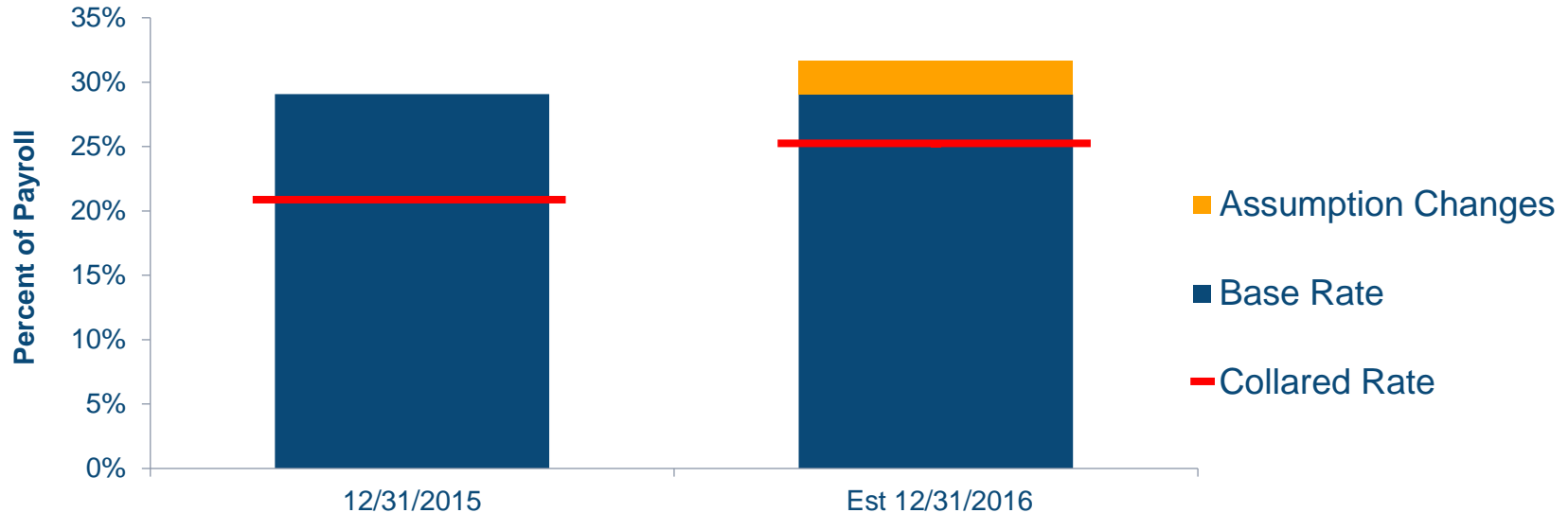
Rates shown are system-average base employer contribution rates and exclude contributions for the Individual Account Program (IAP) and the RHIA and RHIPA retiree healthcare programs

Milliman

Agenda Items – Remaining 2017 Meetings

- July action item:
  - Adoption of assumptions and methods for use in the following valuations:
    - December 31, 2016 "advisory" valuation that estimates 2019-2021 rates
    - December 31, 2017 valuation that calculates recommended 2019-2021 rates

- September meeting:
  - Presentation of system-level December 31, 2016 actuarial valuation results
  - Adoption of actuarial equivalency factors effective January 1, 2018

- December meeting:
  - Acceptance of the December 31, 2016 actuarial valuation report and employer-specific advisory 2019-2021 contribution rates
  - Financial modeling over the next twenty years under a variety of possible future scenarios for actual investment return

Milliman

Appendix

Caveats and Disclaimers

This presentation discusses actuarial methods and assumptions for use in the valuation of the Oregon Public Employees Retirement System ("PERS" or "the System"). For the most recent complete actuarial valuation results, including cautions regarding the limitations of use of valuation calculations, please refer to our formal Actuarial Valuation Report as of December 31, 2015 ("the Valuation Report") published on September 27, 2016. The Valuation Report, including all supporting information regarding data, assumptions, methods, and provisions, is incorporated by reference into this presentation. The statements of reliance and limitations on the use of this material is reflected in the actuarial report and still apply to this presentation.

In preparing this presentation, we relied, without audit, on information (some oral and some in writing) supplied by the System's staff, as well as capital market expectations provided by Callan and information presented to the Oregon Investment Council. This information includes, but is not limited to, statutory provisions, employee data, and financial information. We found this information to be reasonably consistent and comparable with information used for other purposes. The results depend on the integrity of this information. If any of this information is inaccurate or incomplete our results may be different and our calculations may need to be revised.

Milliman's work product was prepared exclusively for Oregon PERS for a specific and limited purpose. It is a complex, technical analysis that assumes a high level of knowledge concerning PERS' operations, and uses PERS' data, which Milliman has not audited. It is not for the use or benefit of any third party for any purpose. To the extent that Milliman's work is not subject to disclosure under applicable public records laws, Milliman's work may not be provided to third parties without Milliman's prior written consent. Milliman does not intend to benefit or create a legal duty to any third party recipient of its work product. Any third party recipient of Milliman's work product who desires professional guidance should not rely upon Milliman's work product, but should engage qualified professionals for advice appropriate to its own specific needs.

The consultants who worked on this assignment are pension actuaries. Milliman's advice is not intended to be a substitute for qualified legal or accounting counsel. The signing actuaries are independent of the plan sponsors. We are not aware of any relationship that would impair the objectivity of our work.

On the basis of the foregoing, we hereby certify that, to the best of our knowledge and belief, this report is complete and accurate and has been prepared in accordance with generally recognized and accepted actuarial principles and practices. We are members of the American Academy of Actuaries and meet the Qualification Standards to render the actuarial opinion contained herein.

Milliman

Appendix - Mortality Assumption

	Current Assumption	Proposed Changes
Healthy Retired	RP 2000, Generational, with Scale BB Combined Active/Healthy Retired, Sex distinct	RP 2014 Generational, with unisex Social Security scale Healthy Annuitant, Sex distinct
▪ School district male ▪ Other GS male ▪ P&F male	No collar, set back 2 years 25% blue/75% white collar, set back 1 year 25% blue/75% white collar, set back 1 year	White collar, set back 1 year 50% blue/50% white collar, set back 1 year 50% blue/50% white collar, set back 1 year
▪ School district female ▪ Other female	No collar, set back 2 years Blend 25% blue/75% white collar, no set back	White collar, set back 1 year 50% blue/50% white collar, no set back
Disabled Retired	RP 2000 Disabled, Generational with BB Sex distinct	RP 2014 Disabled, Generational with unisex Social Security scale Sex distinct
▪ Male ▪ Female	70% of rates 90% of rates	100% of rates 100% of rates
Non-Retired Mortality	% of Healthy Retired Mortality	RP 2014 Generational, with unisex Social Security scale Employee (Non-Annuitant), Sex distinct
▪ School district male ▪ Other GS male ▪ P&F male	60% 75% 75%	White collar, set back 1 year 50% blue/50% white collar, set back 1 year 50% blue/50% white collar, set back 1 year
▪ School district female ▪ Other female	55% 60%	White collar, set back 1 year 50% blue/50% white collar, no set back

▢ Milliman

Mortality Assumption

- PERS-specific mortality experience is analyzed separately for:
  - Healthy annuitant mortality
  - Disabled retiree mortality
  - Non-retired mortality

- Assumptions are grouped by gender and employment category

- In past, PERS mortality assumption analysis focused primarily on headcount-weighted analysis
  - Current assumption matches experience well on this basis

- Emerging preference for "benefits-weighted" or "amounts-weighted" mortality analysis
  - Benefits-weighted analysis reflects relative importance of experience of higher-benefit retirees on liabilities
  - In general, members with larger benefits experience lower mortality (higher life expectancies) than average
  - Benefits-weighted analysis was used in this year's Experience Study

Milliman

Appendix – Mortality Assumption

- Analysis shown is based on benefits weighting

- New base tables reflect lower mortality assumption for each group

- Updated projection scale anticipates less improvement in future

  - Combined effect will be increases in life expectancy for some groups and decreases for others

Healthy Retiree Mortality
Aggregate Confidence Intervals and Rates
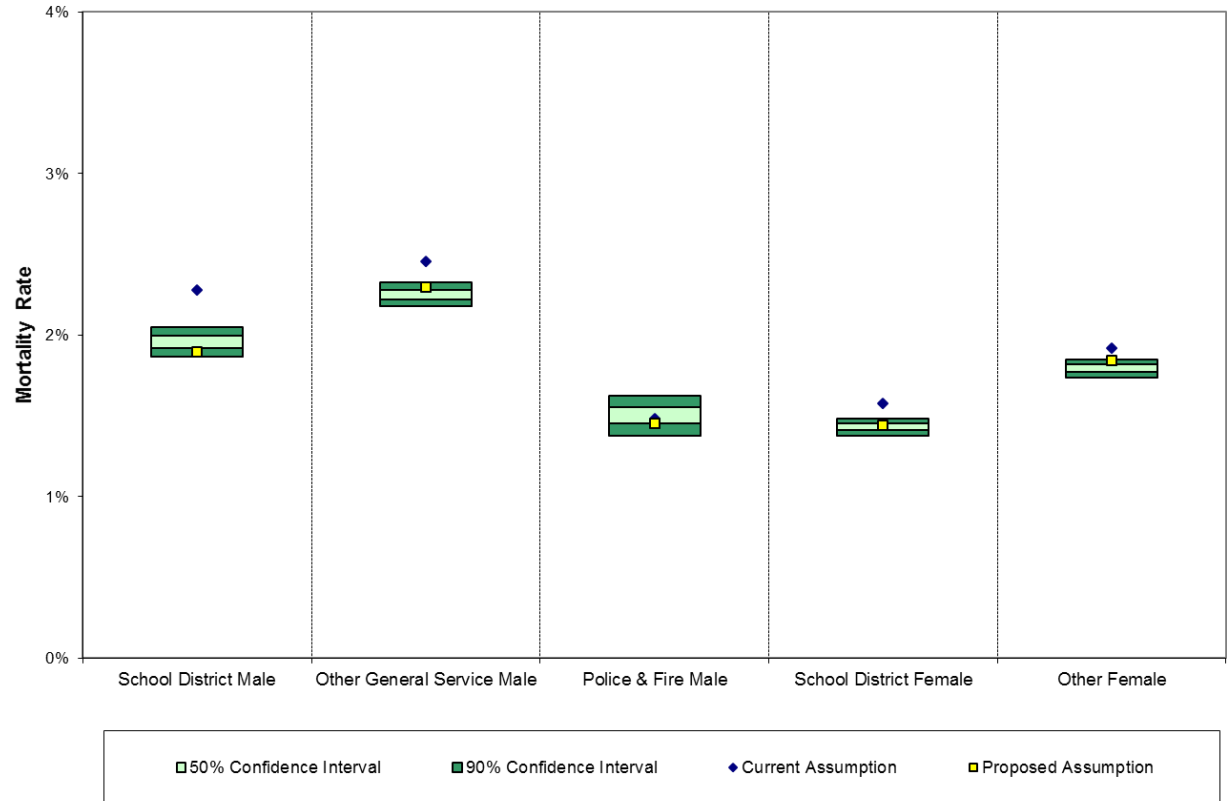
Aggregate mortality rates shown are functions of both mortality rates and the ages of members of the group. Since average ages differ by group, you cannot conclude from the graph that, for example, Police & Fire males have lower mortality than other groups.

Milliman

Mortality Projection Scales – Female
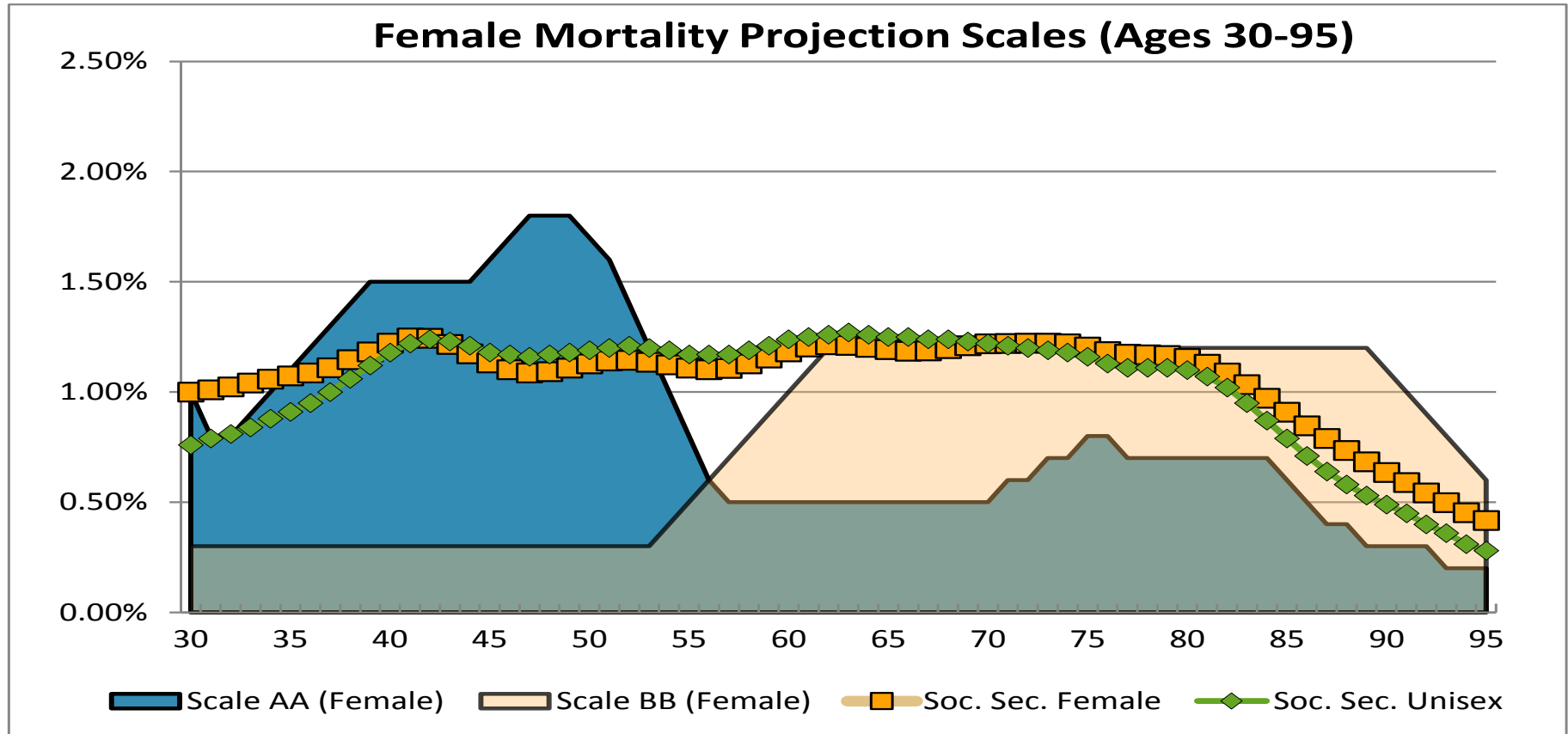
Female Mortality Projection Scales (Ages 30-95)

Legend: Scale AA (Female), Scale BB (Female), Soc. Sec. Female, Soc. Sec. Unisex

- Social Security 60-Year Unisex is our proposed mortality projection scale

- PERS adopted Scale BB in 2015 and used Scale AA (published 2000) prior to that

- The MP 2014, 2015 and 2016 scales are too technically complex to depict above

Milliman

Mortality Projection Scales – Male

Male Mortality Projection Scales (Ages 30-95)

Legend: Scale AA (Male), Scale BB (Male), Soc. Sec. Male, Soc. Sec. Unisex

- Social Security 60-Year Unisex is our proposed mortality projection scale

- PERS adopted Scale BB in 2015 and used Scale AA (published 2000) prior to that

- The MP 2014, 2015 and 2016 scales are too technically complex to depict above

Milliman
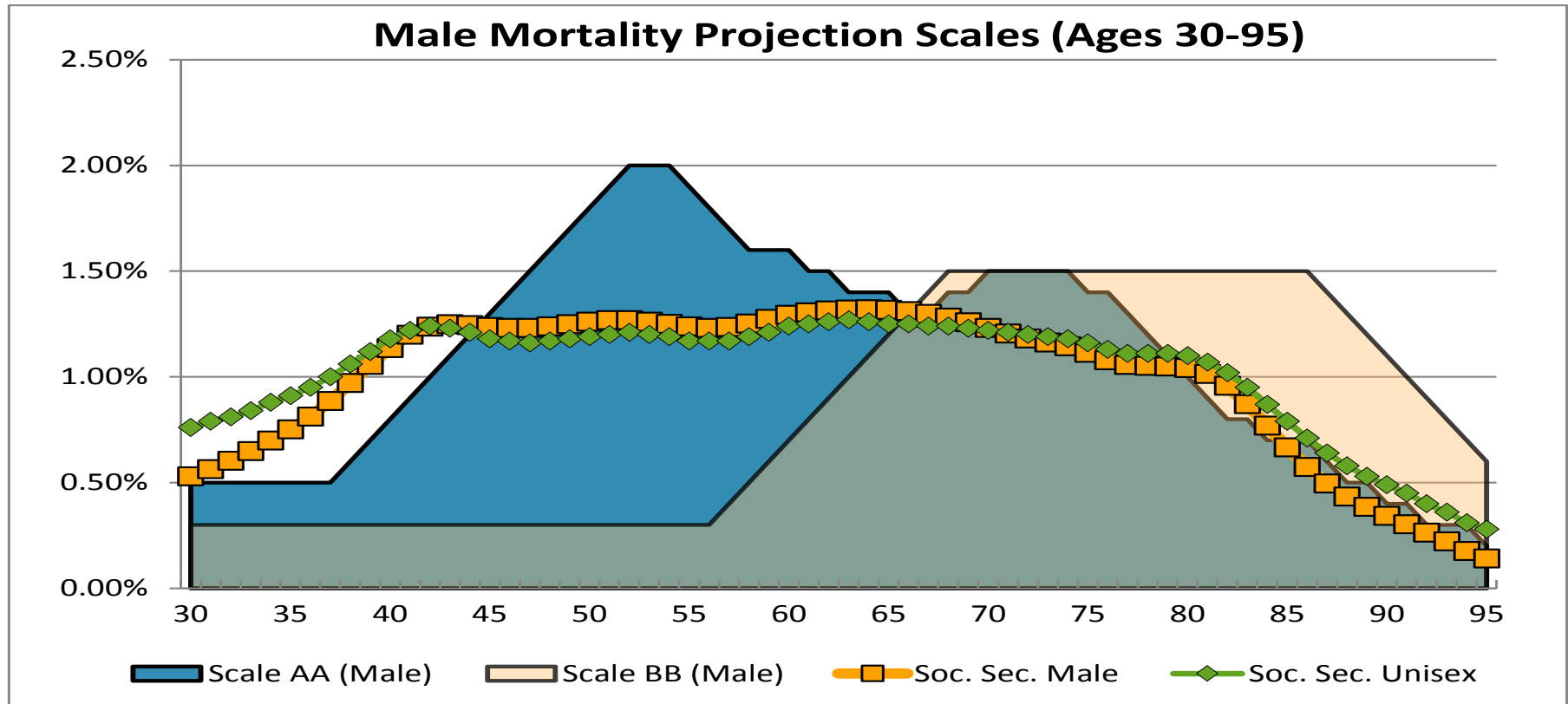
Effects of Lowering the Assumed Return

- Lowering the assumption to either 7.00% or 7.25% would affect the Money Match calculation for a member age 59½ with a $135,000 member account balance as of 6/30/2017 as shown:

Benefit Commencement	Starting Benefit Under Assumed Rate*		
	7.50%	**7.25%**	**7.00%**
7/1/2017	$1,963		
12/1/2017	$2,031		
1/1/2018		$1,999	$1,954
3/1/2018		$2,028	$1,982
6/1/2018		$2,069	$2,021

* Illustration uses 2018 actuarial equivalency mortality in calculation of all benefits

- At a 7.00% assumption, it would take about six months without retirement for the December 2017 initial benefit level to be reached

  - At a 7.25% assumed return, it would take about three months

  - Illustration ignores Full Formula "floor", which may mitigate any benefit decrease

Milliman

Appendix
Actuarial Basis

Capital Market Assumptions – Milliman 20 year

For assessing the expected portfolio return under Milliman's capital market assumptions, we considered the Oregon PERS Fund to be allocated among the model's asset classes as shown below. This allocation is based on the Oregon Investment Council's Statement of Investment Objectives and Policy Framework for the Oregon PERS Fund, as revised December 3, 2014, and changes adopted in June 2015.

	Annual Arithmetic Mean	20-Year Annualized Geometric Mean	Annual Standard Deviation	Policy Allocation
US Large/Mid-Cap Equity	7.45%	6.30%	16.25%	15.75%
US Small Cap Equity	8.49%	6.69%	20.55%	1.31%
US Micro-Cap Equity	9.01%	6.80%	22.90%	1.31%
Non-US Developed Equity	8.21%	6.71%	18.70%	13.13%
Emerging Markets Equity	10.53%	7.45%	27.35%	4.13%
Non-US Small Cap Equity	8.67%	7.01%	19.75%	1.88%
Private Equity	11.45%	7.82%	30.00%	17.50%
US Core Fixed Income	3.59%	3.49%	4.55%	8.00%
US Short-Term Bonds	3.42%	3.38%	2.70%	8.00%
US Bank/Leveraged Loans	5.34%	5.09%	7.50%	3.00%
High Yield Bonds	6.90%	6.45%	10.00%	1.00%
Real Estate	6.15%	5.51%	12.00%	10.00%
Global REITs	8.26%	6.37%	21.00%	2.50%
Timber	6.37%	5.62%	13.00%	1.88%
Farmland	6.90%	6.15%	13.00%	1.88%
Infrastructure	7.54%	6.60%	14.65%	3.75%
Commodities	5.43%	3.84%	18.95%	1.88%
Hedge Fund of Funds - Diversified	4.36%	4.09%	7.80%	2.50%
Hedge Fund Event-Driven	6.21%	5.86%	8.90%	0.63%
US Inflation (CPI-U)		2.50%	1.85%	N/A
Fund Total (reflecting asset class correlations)	**7.48%**	**6.74%***	**12.97%**	**100.00%**

* Reflects 0.10% average reduction to model passive investment expenses. The model does not try to assess the actual investment expenses for active management. The model's 20-year annualized geometric median is **6.70%**.

Milliman

Appendix
Actuarial Basis

Capital Market Assumptions – Milliman 10 year

For assessing the expected portfolio return under Milliman's capital market assumptions, we considered the Oregon PERS Fund to be allocated among the model's asset classes as shown below. This allocation is based on the Oregon Investment Council's Statement of Investment Objectives and Policy Framework for the Oregon PERS Fund, as revised December 3, 2014, and changes adopted in June 2015.

	Annual Arithmetic Mean	10-Year Annualized Geometric Mean	Annual Standard Deviation	Policy Allocation
US Large/Mid-Cap Equity	7.19%	6.09%	16.25%	15.75%
US Small Cap Equity	8.16%	6.44%	20.55%	1.31%
US Micro-Cap Equity	8.65%	6.54%	22.90%	1.31%
Non-US Developed Equity	7.88%	6.45%	18.70%	13.13%
Emerging Markets Equity	10.07%	7.15%	27.35%	4.13%
Non-US Small Cap Equity	8.34%	6.75%	19.75%	1.88%
Private Equity	10.95%	7.50%	30.00%	17.50%
US Core Fixed Income	2.89%	2.80%	4.55%	8.00%
US Short-Term Bonds	2.73%	2.70%	2.70%	8.00%
US Bank/Leveraged Loans	4.89%	4.65%	7.50%	3.00%
High Yield Bonds	5.83%	5.40%	10.00%	1.00%
Real Estate	6.11%	5.50%	12.00%	10.00%
Global REITs	7.90%	6.10%	21.00%	2.50%
Timber	6.31%	5.60%	13.00%	1.88%
Farmland	6.81%	6.10%	13.00%	1.88%
Infrastructure	7.29%	6.40%	14.65%	3.75%
Commodities	5.26%	3.75%	18.95%	1.88%
Hedge Fund of Funds - Diversified	4.26%	4.00%	7.80%	2.50%
Hedge Fund Event-Driven	6.09%	5.75%	8.90%	0.63%
US Inflation (CPI-U)		2.30%	1.85%	N/A
Fund Total (reflecting asset class correlations)	**7.10%**	**6.40%***	**12.97%**	**100.00%**

* Reflects 0.10% average reduction to model passive investment expenses. The model does not try to assess the actual investment expenses for active management. The model's 10-year annualized geometric median is **6.33%**.

Milliman

Appendix
Actuarial Basis

Capital Market Assumptions - Callan

For assessing the expected portfolio return under Callan's capital market assumptions, we applied the assumptions shown below provided by Callan.

	10-Year Annualized Geometric Mean	Annual Standard Deviation	Policy Allocation
Large Cap Equity	6.68%	17.40%	**15.38%**
Small/Mid Cap Equity	7.04%	22.60%	**3.00%**
Emerging Markets Equity	7.24%	27.45%	**4.50%**
Global ex-US Equity	6.98%	21.00%	**12.75%**
International Small Cap Equity	7.00%	24.30%	**1.88%**
OIC Private Equity	9.50%	26.30%	**17.50%**
US Fixed Income	2.98%	3.75%	**20.00%**
Diversifying Strategies	6.25%	11.00%	**5.00%**
OIC Real Assets	6.60%	15.00%	**20.00%**
Inflation	2.25%	1.50%	**N/A**
Fund Total (reflecting asset class correlations)	**7.15%***	**14.11%**	**100.00%**

* 10-year annualized geometric median is **7.05%**.

Milliman

Appendix
Actuarial Basis

Capital Market Assumptions - PCA

For assessing the expected portfolio return under PCA's capital market assumptions, we applied the assumptions shown below provided by PCA in their April 26 presentation to OIC.

	10-Year Annualized Geometric Mean	20-Year Annualized Geometric Mean	Annual Standard Deviation	Policy Allocation
Global Equity	7.15%	7.15%	20.00%	**37.50%**
Private Equity	8.50%	8.50%	27.00%	**17.50%**
OIC Real Estate	7.90%	8.20%	21.00%	**12.50%**
OIC Fixed Income	2.90%	3.50%	7.70%	**20.00%**
OIC Liquid Alternatives	6.10%	6.70%	14.00%	**6.00%**
OIC Illiquid Alternatives	6.80%	6.80%	14.90%	**6.50%**
Inflation	2.25%	2.25%	1.50%	**N/A**
Fund Total (reflecting asset class correlations)	**7.49%***	**7.68%****	**13.51%**	**100.00%**

* 10-year annualized geometric median is **7.40%**.

** 20-year annualized geometric median is **7.60%**.

Appendix
Actuarial Basis

Capital Market Assumptions - Horizon

For assessing the expected portfolio return under an additional set of capital market assumptions, we applied the assumptions from the 2016 Survey of Capital Market Assumptions published by Horizon Actuarial Services, LLC. According to the survey report, the 10-year return assumptions shown below represent an average of the expectations for 35 investment advisors responding to the survey.

	10-Year Annualized Geometric Mean	Annual Standard Deviation	Policy Allocation
US Equity – Large Cap	6.64%	16.92%	**15.75%**
US Equity – Small/Mid Cap	7.00%	21.01%	**5.13%**
Non-US Equity – Developed	7.12%	19.50%	**15.00%**
Non-US Equity – Emerging	8.48%	26.35%	**4.13%**
US Corporate Bonds – Core	3.41%	5.96%	**12.00%**
US Corporate Bonds – High Yield	5.90%	11.01%	**4.00%**
US Treasuries (Cash Equivalents)	2.14%	2.79%	**4.00%**
Real Estate	6.36%	14.74%	**13.75%**
Hedge Funds	5.41%	8.39%	**3.13%**
Commodities	3.98%	18.50%	**1.88%**
Infrastructure	6.59%	13.78%	**3.75%**
Private Equity	9.22%	23.12%	**17.50%**
Inflation	2.16%	1.78%	**N/A**
Fund Total (reflecting asset class correlations)	**7.31%***		**100.00%**

* 10-year annualized geometric median is **7.24%**.

GASB and Actuarial Assumptions

- GASB Statements 67 & 68 require financial reporting actuarial assumptions to follow Actuarial Standards of Practice (ASOPs)

- Under ASOPs, if a selected assumption "*significantly conflicts*" with what the actuary considers reasonable, the actuary must make a statement to this effect in the report

- GASB recently published Statement 82 amending (or clarifying) how GASB 67 & 68 apply in such a situation

  - Per GASB 82, employer financial reporting produced using a disclaimed assumption might not be considered GAAP-compliant

- Assumptions requiring disclaimer language could lead to:

  - Need for second set of results on different assumption basis, or

  - Potential for modified audit opinions

Financial Modeling & The Return Assumption

- Milliman prepared additional financial modeling projections, building on work from the November 2016 Board meeting

- Includes projections under both:

  - 7.5% investment return assumption (as presented in November 2016)

  - 7.0% investment return assumption (as requested for subsequent analysis)

- Results are illustrative, not presuming a specific Board decision on investment return assumption

- See November 2016 Board materials for discussion of modeling basis and assumptions

Milliman

Actual Return 7.0%; Assumption either 7.0% or 7.5%
Employer Contribution Rates

System Average Employer Collared Base Pension Rates

	2015-2017	2017-2019	2019-2021	2021-2023	2023-2025	2025-2027	2027-2029	2029-2031	2031-2033	2033-2035	2035-2037
7.0% Assumption	17.5%	20.8%	26.8%	34.2%	34.3%	33.9%	33.1%	32.6%	31.8%	30.7%	23.6%
7.5% Assumption	17.5%	20.8%	25.4%	30.7%	31.0%	31.0%	30.8%	30.7%	30.3%	29.7%	23.3%

7.0% Assumption   7.5% Assumption
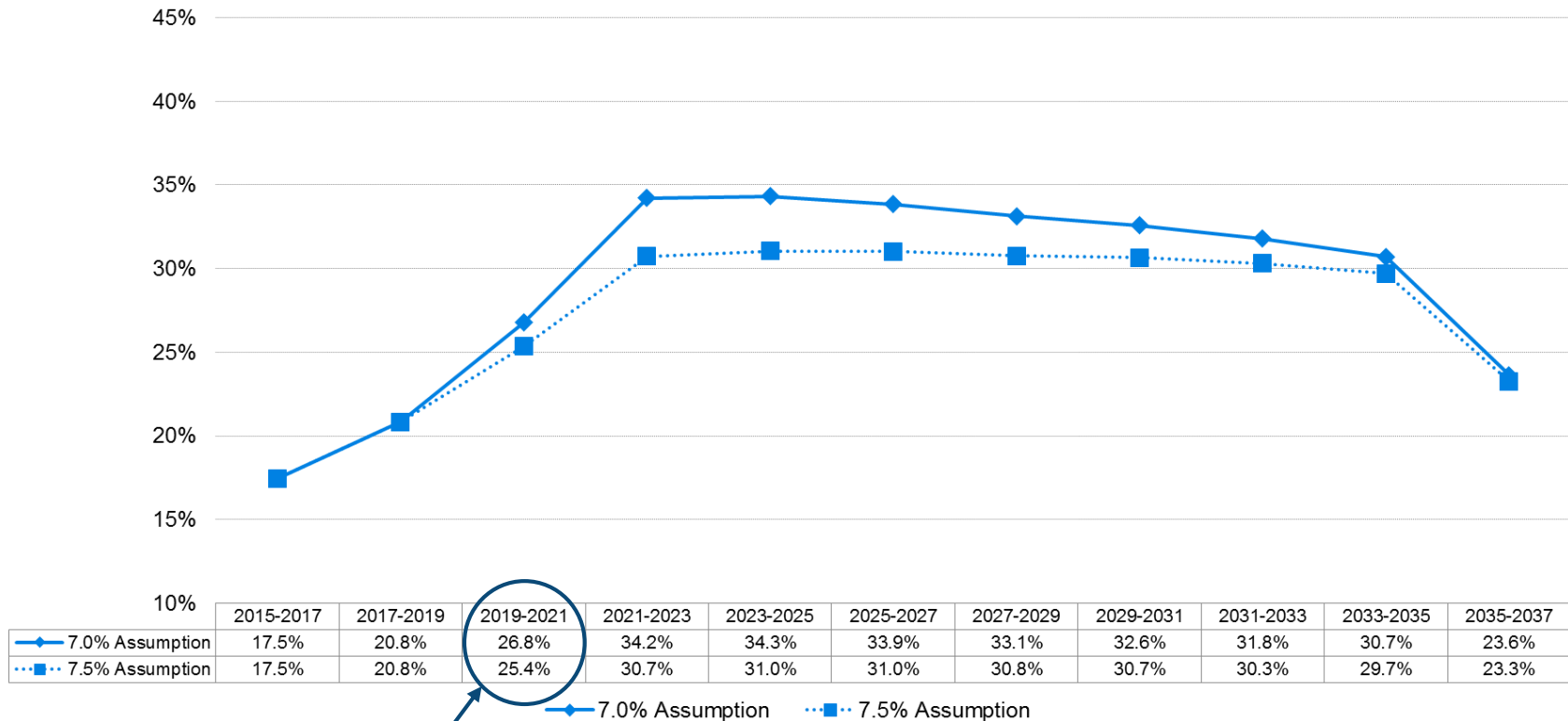
Contribution rates for 2019-2021 will be calculated in the rate-setting actuarial valuation as of year-end 2017, summary results of which will be presented to the Board in July 2018.

Milliman

Actual Return 7.0%; Assumption either 7.0% or 7.5%
Year-End Funded Status

System Average Funded Status (Excluding Side Accounts)

The funded status is initially lower using a 7.0% assumption due to an increase in the calculated liability. Over time the 7.0% assumption achieves the higher funded status because of:
- Larger contributions under 7.0% assumption
- Persistent investment losses under 7.5% assumption

The difference in the funded status in the 20th year is 4%.

	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
7.0% Assumption	71%	68%	67%	67%	67%	67%	68%	70%	72%	74%	75%	78%	80%	82%	85%	87%	90%	93%	96%	99%
7.5% Assumption	71%	71%	70%	70%	70%	70%	71%	72%	73%	75%	76%	78%	79%	81%	83%	85%	87%	90%	92%	95%

Valuation as of 12/31

The year-end 2017 valuation will calculate 2019-2021 rates. The largest potential variability source from the above projections is likely to be actual investment returns through year-end 2017. For example, actual 2017 return differing from assumption by +/-5% would modify funded status by 3%-4%.

Milliman

Actual Return 7.0%; Assumption either 7.0% or 7.5%
Valuation Assets (Excluding Side Accounts)

System Total Pension Assets
(Tier 1/Tier 2/OPSRP)

The difference in assets accumulated by the 20th year is 9%-10%.
[*$110.0 vs. $100.5 billion*]

$ Billions

Valuation as of 12/31

····◆···· 7.5% Assumption selected   ──×── 7.0% Assumption selected

Milliman

Financial Modeling: 7.0% Return Assumption

System Average Employer Collared Base Pension Rates

	2015-2017	2017-2019	2019-2021	2021-2023	2023-2025	2025-2027	2027-2029	2029-2031	2031-2033	2033-2035	2035-2037
7.0% actual ROR	17.5%	20.8%	26.8%	34.2%	34.3%	33.9%	33.1%	32.6%	31.8%	30.7%	23.6%
7.5% actual ROR	17.5%	20.8%	26.3%	33.5%	33.4%	32.5%	31.3%	30.3%	29.0%	27.5%	19.9%
5.0% actual ROR	17.5%	20.8%	27.3%	36.6%	38.3%	39.4%	40.2%	41.1%	41.9%	42.3%	36.7%
9.0% actual ROR	17.5%	20.8%	25.8%	31.1%	30.2%	28.0%	25.3%	22.7%	19.6%	16.3%	7.1%

■ 7.0% actual ROR ● 7.5% actual ROR ✳ 5.0% actual ROR ▲ 9.0% actual ROR

Milliman

Financial Modeling: 7.0% Return Assumption

System Average Funded Status (Excluding Side Accounts)

	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
7.0% actual ROR	71%	68%	67%	67%	67%	67%	68%	70%	72%	74%	75%	78%	80%	82%	85%	87%	90%	93%	96%	99%
7.5% actual ROR	71%	68%	67%	68%	68%	69%	70%	72%	74%	76%	79%	81%	84%	86%	89%	92%	95%	98%	102%	105%
5.0% actual ROR	71%	67%	66%	64%	63%	62%	62%	62%	62%	63%	64%	65%	66%	67%	69%	70%	72%	74%	77%	79%
9.0% actual ROR	71%	68%	69%	70%	71%	73%	75%	78%	82%	85%	89%	92%	96%	100%	104%	109%	113%	118%	122%	127%

Valuation as of 12/31

- 7.0% actual ROR
- 7.5% actual ROR
- 5.0% actual ROR
- 9.0% actual ROR

Milliman

Financial Modeling: 7.5% Return Assumption

System Average Employer Collared Base Pension Rates

	2015-2017	2017-2019	2019-2021	2021-2023	2023-2025	2025-2027	2027-2029	2029-2031	2031-2033	2033-2035	2035-2037
7.0% actual ROR	17.5%	20.8%	25.4%	30.7%	31.0%	31.0%	30.8%	30.7%	30.3%	29.7%	23.3%
7.5% actual ROR	17.5%	20.8%	25.3%	30.1%	30.0%	29.5%	28.8%	28.3%	27.5%	26.4%	19.5%
5.0% actual ROR	17.5%	20.8%	25.9%	33.3%	35.2%	36.7%	38.0%	39.3%	40.4%	41.2%	36.1%
9.0% actual ROR	17.5%	20.8%	25.3%	28.2%	26.6%	24.7%	22.5%	20.4%	17.9%	15.2%	7.0%

■ 7.0% actual ROR ● 7.5% actual ROR ✳ 5.0% actual ROR ▲ 9.0% actual ROR

Milliman

Financial Modeling: 7.5% Return Assumption

System Average Funded Status (Excluding Side Accounts)

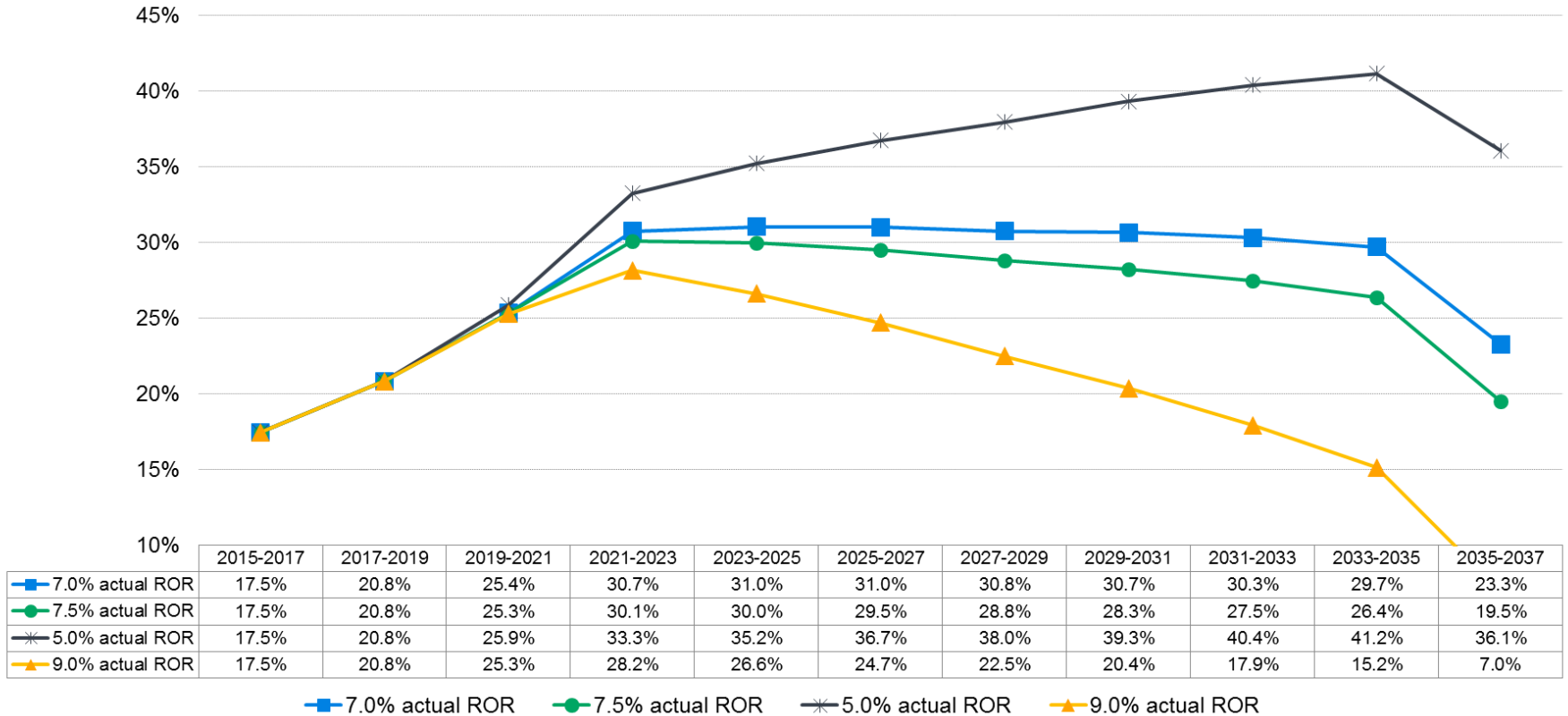|	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
7.0% actual ROR	71%	71%	70%	70%	70%	70%	71%	72%	73%	75%	76%	78%	79%	81%	83%	85%	87%	90%	92%	95%
7.5% actual ROR	71%	71%	71%	71%	71%	72%	73%	74%	76%	78%	79%	81%	83%	85%	87%	90%	92%	95%	98%	101%
5.0% actual ROR	71%	71%	69%	67%	66%	65%	64%	64%	64%	64%	64%	64%	65%	66%	67%	68%	70%	71%	73%	75%
9.0% actual ROR	71%	71%	72%	73%	75%	76%	79%	81%	84%	87%	90%	93%	96%	100%	103%	107%	111%	114%	118%	123%

Valuation as of 12/31

Legend: 7.0% actual ROR — 7.5% actual ROR — 5.0% actual ROR — 9.0% actual ROR

Milliman