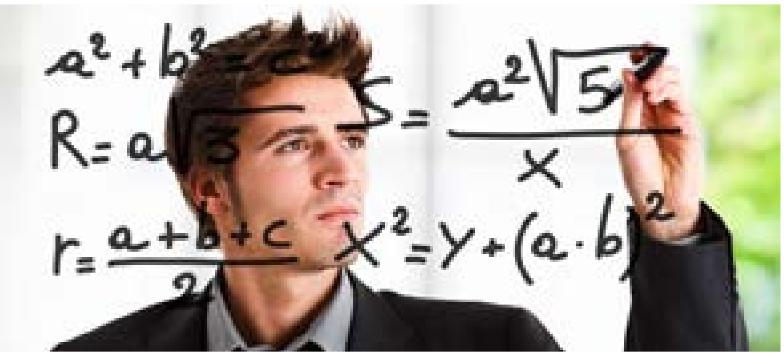
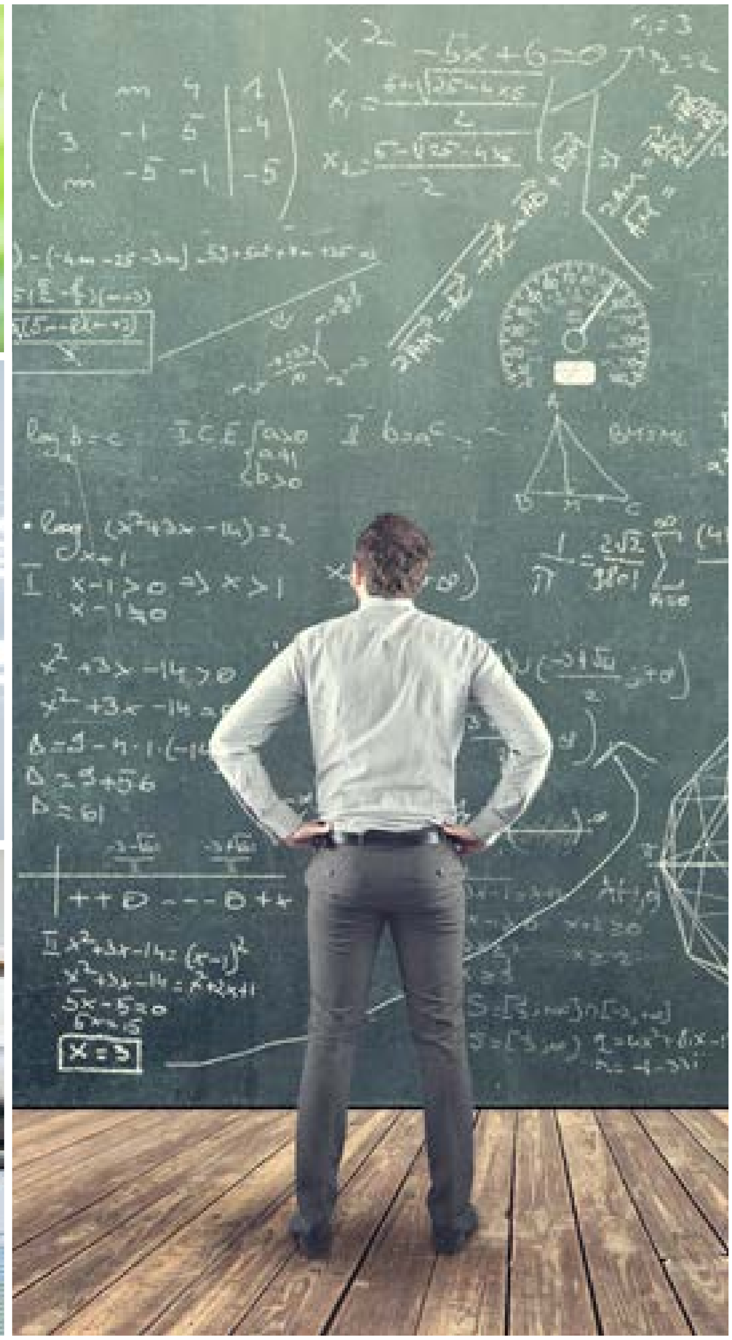
Washington State

2016 Risk Assessment Assumptions Study





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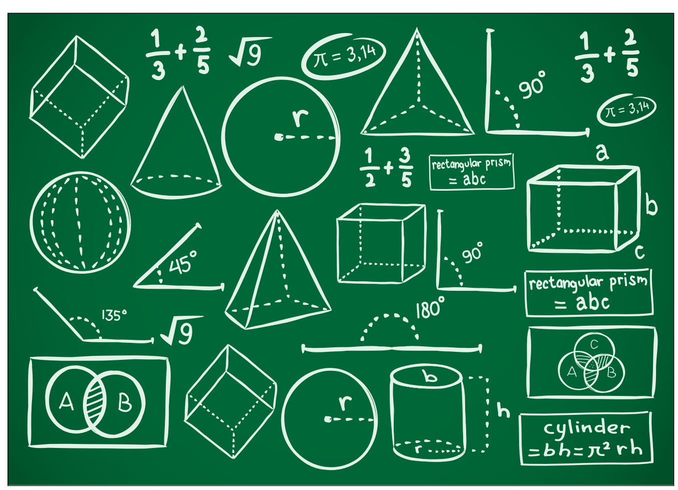

RISK ASSESSMENT ASSUMPTIONS STUDY (RAAS)

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Letter of Introduction
Risk Assessment Assumptions Study

December 2016

This report documents the results of a study on the assumptions we use to perform risk assessments on the following Washington State retirement systems.

- Public Employees' Retirement System (PERS).
- Teachers' Retirement System (TRS).
- School Employees' Retirement System (SERS).
- Public Safety Employees' Retirement System (PSERS).
- Law Enforcement Officers' and Fire Fighters' Retirement System (LEOFF).
- Washington State Patrol Retirement System (WSPRS).

The primary purpose of this study is to review and update the assumptions we use in our on-going risk assessments to ensure they remain reasonable and consistent with the purpose of the risk assessment. This study should not be used for other purposes.

This report is organized in the following four sections.

- General Approach to Study.
- Model Overview and Methods.
- Assumptions.
- Certification Letter.

The **General Approach to Study** section provides some background on risk assessments and outlines our approach to this study. The next section provides an overview of our risk assessment model and context for the **Assumptions** section. The last section of the report contains the actuarial certification letter.

We encourage you to submit any questions you might have concerning this report to our regular address or our e-mail address at state.actuary@leg.wa.gov. We also invite you to visit our website (osa.leg.wa.gov), for further information regarding the actuarial funding of the Washington State retirement systems.

Sincerely,

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GENERAL APPROACH TO THE STUDY

Measuring pension obligations and determining plan costs or contributions requires the use of assumptions regarding future events. For example, we determine the present value of future benefit payments and contribution rates based on an expected long-term rate of investment return. Because future events are uncertain, such measurements and determinations are also uncertain and expose multiple parties to risk.

Risk assessments allow actuaries to demonstrate and assess the effect of unexpected experience on pension plans. To perform risk assessments for our state pension plans, we employ a range of assumptions in our model that differ from the assumptions we use to determine expected results. For example, we may expect a 7.5 percent long-term rate of investment return for the state's pension systems, but we don't expect that return each year and we can't guarantee the systems will earn that rate in the long-term. Our risk assessment allows us to demonstrate the risk of investments not earning what we assume along with other key risks. Please see the body of this report for additional information on the key risks we include in our risk assessment model.

For this assumption study, we reviewed all the assumptions we use in our risk assessment model and updated them to ensure they remain reasonable and consistent with the purpose of the risk assessment. Going forward, we plan to perform a full risk assessment assumption study at least once every six years.

To perform this assumption study, we followed the general guidance of Actuarial Standard of Practice (ASOP) Number 27, titled Selection of Economic Assumptions for Measuring Pension Obligations, and applied our professional judgment. ASOP 27 identifies the following process for selecting economic assumptions:

- Identify components, if any, of the assumption;
- Evaluate relevant data;
- Consider factors specific to the measurement;
- Consider other general factors; and
- Select a reasonable assumption.

For this study, instead of selecting a single best estimate and deterministic assumption like we do for the biennial Economic Experience Study, we select a best estimate, standard deviation (where applicable) and distribution for each assumption. The distribution defines the volatility we expect around the best estimate.

MODEL OVERVIEW AND METHODS

Our original risk assessment required OSA to build a customized asset-liability model. We are updating that model, the assumptions, and some methods with this study. Before explaining what the model is, we believe it's important to consider the context around the model's purpose. We will:

- ❖ Explain where this model fits into decision making.
- ❖ Show a high-level overview of the model's pieces.
- ❖ Explain how the model works.
- ❖ Explain what goes into the model.
- ❖ Explain what the model provides.

RECIPE FOR A GOOD DECISION

Consider an aeronautical engineer building an airplane, or a structural engineer building a skyscraper. Would you like to hear them say, "I put a lot of nails in there and my gut is telling me it will hold up"?

Would you like to hear them say, "Based on expected weather conditions, it will hold up"?

Probably not. You want to know that they've built their product with information and decisions that reduce the likelihood of "failure" to an acceptable level.

Information has evolved over time with decision-makers demanding more, and information-providers having more tools available. Actuarial information has followed a similar path.

Intuition: A long time ago, decision-makers made decisions solely on intuition. We've all made mistakes implementing this method. So, we easily see the need for information to inform our decision.

Best Estimate: A decision-maker could create a model based on their expectations for the future. The model outcomes are the most common information used to help make decisions. This approach is regularly used in making decisions such as:

- ❖ A family's budget.
- ❖ An individual's retirement plan.
- ❖ The cost provided in fiscal notes for legislation.

Unfortunately, the actual result usually does not end up matching the estimate. The best-estimate can almost be misleading and can lead to a sense of control that isn't really there. This creates a need for information about the impact if things turn out differently from what is expected.

Scenarios: Sometimes called "sensitivity analysis", other possible paths are determined. This gives the decision-maker extra information for how things could turn out differently from the best-estimate. However, the scenarios can never be exhaustive, and the decision-maker lacks information about the likelihood or chances these scenarios will occur.

Simulation: Sometimes called "stochastic projections," "dynamic projections," or "Monte Carlo simulation," many statistically equally likely paths are created. This provides the decision-maker with all known information at this point in time. Namely, it provides:

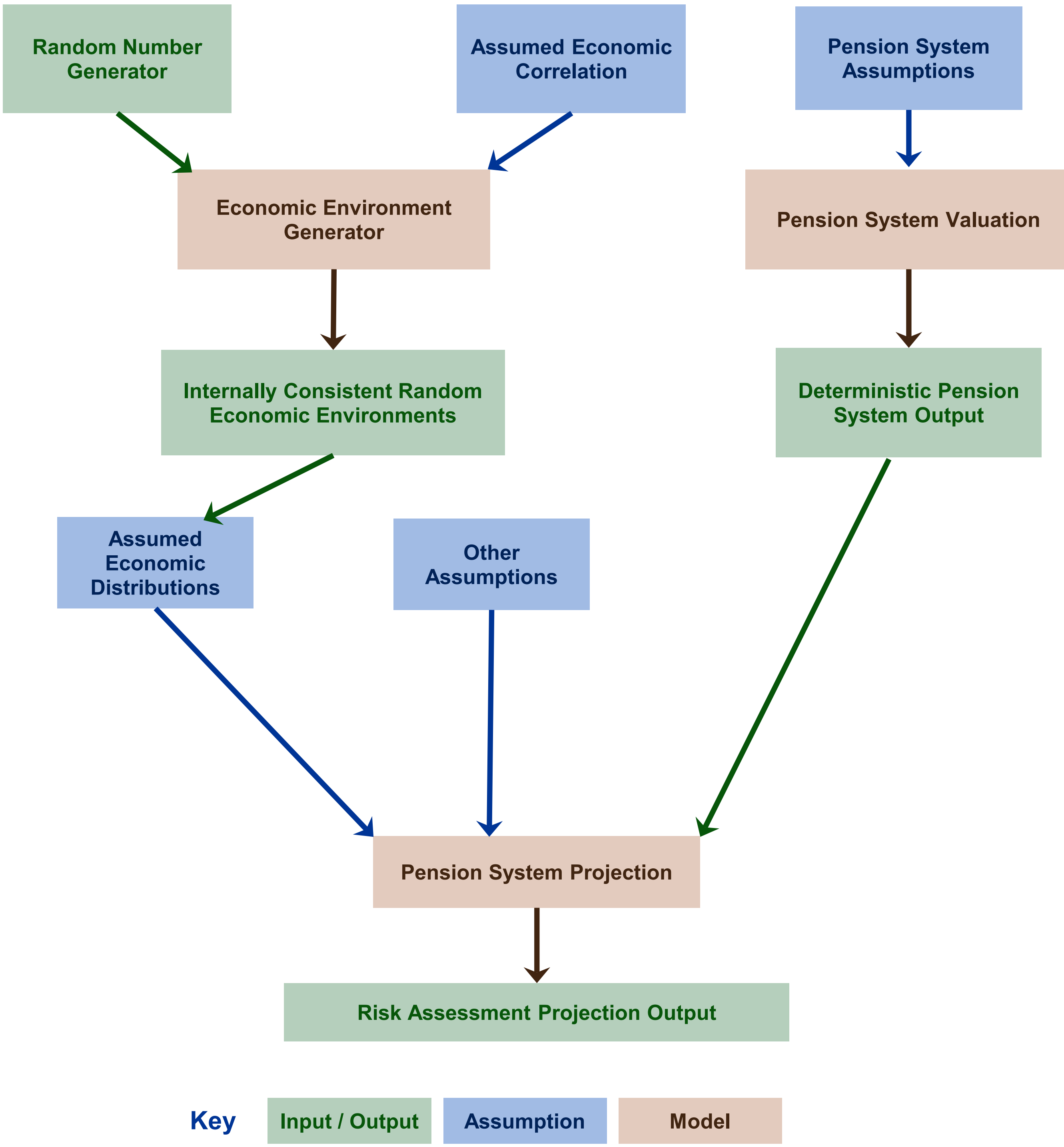
- ❖ The best guess at what will occur based on expectations for the future (deterministic simulation).
- ❖ The range of outcomes that could occur under the assumptions selected.
- ❖ The likelihood of the range of outcomes occurring under the assumptions selected.

Both types of engineers mentioned at the beginning of this section use simulation to inform their decisions. Actuaries have begun using simulation more and more over the past few decades. Of course, extra information comes at a cost, and the bigger the decision (peoples' lives, large amounts of money at stake), the more necessary complete information becomes.

A model is a decision aid, not a decision maker. A model will never forecast the future perfectly. However, a good model is another tool a decision-maker can use to inform their decision making.

RISK ASSESSMENT MODEL OVERVIEW

The following flowchart shows the major pieces of the model. We describe each of these major pieces below.



HOW THE MODEL WORKS AND WHAT IS NEEDED

In this section, we explain the model in three levels of increasing detail **– Basic, Intermediate,** and **Advanced**.

Basic

We created a dynamic projection of the pension system using simulation. The purpose of this model is to create a large number (2,000) of equally likely 50-year economic environments, and see how the pension system responds. Since each of the paths is assumed to be equally likely, comments can be made about the probability of certain events occurring.

To accomplish this goal, the model has two parts.

1. The **economic environment generator**, which randomly selects 2,000 equally likely economic environments that the pension system could encounter.
2. The **pension system projection**, which models how the systems would react when they encounter each of these economic environments.

Intermediate

The general process we follow to create randomized simulations that are equally likely is called "Monte Carlo simulation." We provide an example of how we implement Monte Carlo simulation below.

We start with our projection spreadsheet and allow economic environments to occur randomly within a specified reasonable range. For example, if inflation were to occur randomly in our model, we would measure past inflation and make a reasonable prediction about the likelihood of future inflation levels. A simplified example would be that inflation could take one of three equally likely future values: 2.5 percent, 3.5 percent, or 4.5 percent per year. Excel would generate a random number between zero and one for each year of the projection from the economic environment generator. The number from the economic environment generator (rounded to the nearest percentile) is used to determine a value from the applicable assumption's distribution table. For this example, we would observe the following outcomes in year one:

- ❖ If the number was between 0 and 0.33, we would assign 2.5 percent inflation for the year.
- ❖ If the number was between 0.33 and 0.67, we would assign 3.5 percent inflation for the year.
- ❖ If the number was between 0.67 and 1, we would assign 4.5 percent inflation for the year.

We would repeat the process in year two (and future years). After this process is complete for each year in the projection and the results have been recorded, a simulation has been run.

Then, this process is repeated so that a large number of simulations have been run (generally between 1,000 and 10,000). The idea is that each of these path-dependent simulations is equally likely to occur. For this analysis, we run 2,000 simulations because it provides a wide range of outcomes while keeping model run time low.

We then sort these simulations so that we can see how many behave a certain way.

Advanced

Economic Environment Generator

For each 50-year economic environment, we begin by generating 50 random numbers (between zero and one) for investment returns, inflation, and real revenue growth. These random numbers represent random economic events during the 50-year projection.

If these economic variables were truly random (no correlation to other economic variables), we would stop here. However, we assume inflation is 65 percent correlated with the prior year's inflation and real revenue growth is 70 percent correlated with the current year's investment returns.

The randomly generated numbers for inflation and real revenue growth were modified to reflect their assumed correlation. We do this using Cholesky Decomposition. The Cholesky Decomposition is a statistical technique used for correlating two independent, normally distributed random variables. A general description of the decomposition can be found at Wikipedia: Cholesky Decomposition.

As an example, consider investment returns and real revenue growth. Assume the investment return's random number for year one is 0.90, and real revenue growth's random number for year one is 0.20. We found that real revenue growth increases and decreases similarly to investment returns in the same year (positive correlation with no lag). The Cholesky Decomposition is used to alter the 0.20 random number for real revenue growth upward toward 0.90. The magnitude of the change would depend on the magnitude of the correlation (stronger correlation would lead to more change).

A numerical example can help explain:

1. Both random numbers would be converted to Z-Values. A Z-Value is a test statistic that measures the numerical relationship to the mean.
   a. Investment random number = 0.90 ➔ Z-Value = 1.28
   b. Real Revenue Growth random number = 0.20 ➔ Z-Value = -0.84
2. The 2-Variable simplifying equation for Cholesky Decomposition can be used to correlate the real revenue growth to investment returns [Correlated Z Value = Correlation x Investment Z Value + Square Root (1 - Correlation^2) x Real Revenue Z-Value].
   a. Correlated Revenue

      Z-Value = 0.30 x 1.28 + Square Root (1 – 0.30^2) x -0.84 = -0.42.
3. The correlated Z-Values are converted back to correlated random numbers.
   a. Investment Z-Value = 1.28 ➔ correlated random number = 0.90.
   b. Real Revenue Z-Value = -0.42 ➔ correlated random number = 0.34.

Not all of our assumptions are normally distributed. However, we still rely on the Cholesky Decomposition to reflect an assumed correlation between randomly generated numbers and we believe the results are reasonable based on the purpose of our risk assessment. Based on previous analysis and modeling in this area, any additional precision gained by further adjusting the Cholesky Decomposition for non-normally distributed variables would complicate our modeling and would not materially change the results of our analysis.

After this adjustment process, the end result is fifty economic variables that are internally consistent (correlated) and in the form of a percentile (number between zero and one). We then use these percentiles to select a value from the assumed distribution table of each economic variable to produce a single fifty-year economic environment.

Pension System Projection

The projection model forecasts the status of the pension system over a fifty-year period, given an economic environment.

The required inputs for the projection model include the following items:

- ❖ Random Economic Environment: The economic environment (generated from the economic environment generator) will be used to determine the expected annual economic outcomes for investment returns, inflation, and real revenue growth assumptions.
- ❖ Other Assumptions: All other assumptions, developed in the **Assumptions and Data** section, will be either static (or fixed) or a function of another assumption. This includes population growth, percent of recommended contributions made, benefit improvements, salary growth from productivity, and nominal revenue growth.
- ❖ Pension System Output: We use deterministically projected benefit payments, salaries, and liabilities from our most recent annual actuarial valuation of the pension system. This output is generated using data, assumptions, and methods consistent with the *June 30, 2015, Actuarial Valuation Report* on our website.

In each year of the projection:

1. First we run the annual actuarial valuation. The most pertinent measures are calculated (point in time calculation using an "as of" date). Examples include (but not limited to):
   a. Liabilities.
   b. Assets.
   c. Funded Status.
   d. Recommended Contribution Rate.
2. Next we input an internally consistent economic environment (from the economic environment generator):
   a. Nominal investment return for the year.
   b. Inflation for the year.
   c. Real revenue growth (adjusted for population) for the year.
3. Pension system cash flows will vary based on the economic environment, recommended contribution rate, and other assumptions developed during this study.
   a. Percent of recommended contributions made is a function of the real revenue growth developed from the economic environment. The actual contribution rate that is made, paid over all salary, is the amount of cash inflow.
   b. Benefits are paid and are a cash outflow.
      i. If not enough assets are available to cover benefit payments, we assume a mandatory contribution from the state is made to cover the excess of the benefit

payments over the assets on hand.

ii. We adjust Law Enforcement and Fire Fighters' Retirement System (LEOFF) Plan 1 benefit payments based on actual inflation observed in the model. LEOFF 1 is the exception since they have an uncapped post-retirement Cost-of-Living-Adjustment and almost the entire population is retired.

c. The investment return cash flow is based on the random investment return developed from the economic environment, the market value of assets, contributions, and benefit payments for the year.

d. If benefit increases are assumed then the model applies a percent increase in liabilities. The value of liabilities, benefit payments, and supplemental rate increases are all affected by the benefit increase assumptions.

This process is repeated 50 times to get one 50-year projection. We save statistics and measurements for risk analysis. At this point one simulation has been run and saved. We repeat this process 2,000 times, so that we have 2,000 simulations and we save the same output data for each simulation.

In the 2010 RA Report, we assumed an adjustment to liabilities and salaries dependent upon actual versus expected annual inflation. We will no longer make this adjustment. We performed analysis on this adjustment and did not believe the added complexity would provide significant accuracy. Additionally, the removal of these adjustments did not materially impact our risk measures.

WHAT THE MODEL PROVIDES

We have saved 2,000 50-year strings of each statistic or variable that was of interest from the simulations. Examples include (but are not limited to):

- ❖ Contribution rates.
- ❖ Funded status.
- ❖ Pay-as-you-go contributions.
- ❖ Percent of General-Fund State revenue used by contributions.

Since each of these 50-year strings are assumed to be equally likely to occur, we can start to analyze how often particular events occur and why they occur. We can analyze the output in two ways:

- ❖ Forward Looking: You ask the question, "How likely is a particular event to occur?" For example, if the funded status is above 110 percent in 6,000 of the 10,000 simulations we conclude that there is approximately a 60 percent chance of this event occurring.
- ❖ Backward Looking: You ask the question, "Given that the funded status goes above 110 percent, what had to take place for that to happen?" For example, we can look at the simulations that had the event occur and determine what generally happened to achieve that metric.

CERTIFICATION LETTER

Office of the State Actuary
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Actuarial Certification
Risk Assessment Assumptions Study

December 2016

This report documents the results of a study of the assumptions we use to perform an actuarial assessment of the financial risks of the retirement plans defined under Chapters 41.26, 41.32, 41.35, 41.37, 41.40, and 41.43 of the Revised Code of Washington. The primary purpose of this assumptions study is to compare current assumptions to actual experience of the plans, review data and trends that provide insights for future expectations, and apply this information, along with our professional judgment, to develop new assumptions for future risk assessments. This report should not be used for other purposes.

The results of this analysis will change in the future as actual experience emerges. We plan to monitor this experience and update our model and assumptions as necessary. Please replace this report in the future when the results of a more recent risk assessment assumptions study become available.

The assumptions study results summarized in this report involve methods for analyzing past experience and setting new assumptions for future risk assessments. We believe that the methods used and the assumptions developed in this study are reasonable and in conformity with generally accepted actuarial principles and standards of practice as of the date of this publication.

We relied on data from the following entities to perform this study:

- Bureau of Labor Statistics (BLS).
- Department of Retirement Systems (DRS).
- Economic & Revenue Forecast Council (ERFC).
- Office of Financial Management (OFM).
- Washington State Investment Board (WSIB).

We checked the data for reasonableness as appropriate based on the purpose of this study. An audit of the data was not performed. We relied on all the information provided as complete and accurate. In our opinion, this information is adequate and substantially complete for purposes of this study.

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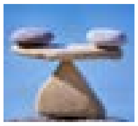


Certification Letter
Page 2 of 2

The undersigned, with actuarial credentials, meet the Qualifications Standards of the American Academy of Actuaries to render the actuarial opinions contained herein. While this report is intended to be complete, we are available to provide extra advice and explanations as needed.

Sincerely,

Matthew M. Smith, FCA, EA, MAAA	Lisa A. Won, ASA, FCA, MAAA
State Actuary	Deputy State Actuary

ASSUMPTIONS

INVESTMENT RETURNS

How We Use the Assumption

This assumption is used to model actual investment returns in our projections.

Data We Used to Set the Assumption

To study this assumption, we relied on the Capital Market Assumptions (CMAs) from the Washington State Investment Board (WSIB) to determine future investment returns. We provide portfolio statistics and the CMA's in the following table. Please see the 2015 Economic Experience Study (EES) for further information.

Portfolio Statistics & Capital Market Assumptions			
2015 Asset Class	Target Allocation	Expected 1-Year Return	Standard Deviation
Global Equity	37%	8.80%	18.85%
Tangible Assets	5%	6.60%	8.60%
Fixed Income	20%	3.90%	5.25%
Private Equity	23%	11.80%	25.00%
Real Estate	15%	8.00%	15.70%
Cash	0%	2.30%	2.00%
Total 2015 Target CTF	100%		

We also used a 90-year history of investment returns. We did not use this data to set an assumption, but instead relied on this data to review WSIB's CMAs for reasonability. Returns from 1926 through 1981 are estimated based on WSIB's current asset allocation. Returns from 1982 through the present are based on actual returns.

Historical Investment Returns*		
Investment Return Range*	Number of Data Points	Percent of Data in Range
(32%) to (29%)	0	0.0%
(29%) to (26%)	1	1.1%
(26%) to (23%)	1	1.1%
(23%) to (20%)	1	1.1%
(20%) to (17%)	0	0.0%
(17%) to (14%)	2	2.2%
(14%) to (11%)	3	3.4%
(11%) to (8%)	0	0.0%
(8%) to (5%)	4	4.5%
(5%) to (2%)	4	4.5%
(2%) to 1%	4	4.5%
1% to 4%	12	13.5%
4% to 7%	2	2.2%
7% to 10%	9	10.1%
10% to 13%	5	5.6%
13% to 16%	10	11.2%
16% to 19%	10	11.2%
19% to 22%	8	9.0%
22% to 25%	0	0.0%
25% to 28%	3	3.4%
28% to 31%	7	7.9%
31% to 34%	1	1.1%
34% to 37%	1	1.1%
37% to 40%	0	0.0%
40% to 43%	0	0.0%
43% to 46%	0	0.0%
46% to 49%	1	1.1%
49% to 52%	0	0.0%
Total		

**Investment returns prior to 1982 are estimated based on WSIB's current target asset allocation.*

Expected Value and Standard Deviation

The new log stable distribution provided by WSIB increased the expected value to 8.42 and decreased the standard deviation to 10.98. The current model assumes 8.19 and 12.20 for the expected value and the standard deviation, respectively. The expected value represents a one-year return. When you simulate the one-year returns from the entire distribution over a long period of time, similar to the duration of pension payments, the median return drops because of the negative returns in the tail of the distribution that occur over the period. When setting a single, long-term rate of return assumption for pension funding, we rely on these longer term returns not the one-year expected value.

The median return over a 50-year period equals 7.74 percent under this new distribution. That median is also consistent with the current 7.7 percent long-term rate of investment return we use to calculate pension funding requirements under current law (for all plans except LEOFF 2). Please see the 2015 EES for additional information on how we arrive at a recommended long-term rate of investment return assumption of 7.50 for pension funding.

Assumed Distribution

The following table shows a sample of the new investment return distribution.

Assumed Investment Distribution		
Likelihood	Percentile	Annual Investment Return
1 in 10,000	MIN	(83.60%)
1 in 100	1	(20.70%)
1 in 20	5	(8.71%)
1 in 10	10	(4.46%)
1 in 4	25	1.71%
1 in 2	50	8.35%
1 in 4	75	15.14%
1 in 10	90	22.24%
1 in 20	95	26.22%
1 in 100	99	34.91%
1 in 10,000	MAX	59.38%

The table below compares the current and new distributions at different percentile ranges. The distribution tails (upper and lower percentiles) are thinner under the new distribution relative to the current distribution. The new distribution is also more tightly dispersed around the average, which resulted in a lower standard deviation.

Average Investment Return			
Percentile	Current	New	Percent Change
x = 0	(87%)	(84%)	3%
1 <= x < 25	(7%)	(5%)	31%
25<= x < 50	4%	5%	17%
50<= x < 75	12%	11%	(3%)
75<= x <= 99	23%	21%	(6%)
x = 100	96%	59%	(38%)

Assumed Correlation

None. We assumed investment returns are not correlated to any other variable we are modeling.

INFLATION

How We Use the Assumption

We use the inflation assumption to model post-retirement Cost-of-Living-Adjustments (COLAs). Inflation is also used as a building block for nominal revenue growth (population growth + inflation + real revenue growth).

Data We Used to Set the Assumption

In studying this assumption, we relied upon a 66-year history (dating back to 1950) of the regional (Seattle-Tacoma-Bremerton) Consumer Price Index for Urban Wage Earners and Clerical Workers (CPI-W). This data came from the Bureau of Labor Statistics (BLS) and is summarized below.

Historical Inflation		
Annual Inflation Range	Number of Data Points	Percent of Data in Range
0% to 2%	22	33%
2% to 4%	25	38%
4% to 6%	8	12%
6% to 8%	5	8%
8% to 10%	1	2%
10% to 12%	4	6%
12% to 14%	0	0%
14% to 16%	0	0%
16% to 18%	1	2%
Total	**66**	**100%**

We reviewed the table above and made adjustments that reflect our expectations for the future. Since 1950, we did not observe any occurrences of deflation. A distribution based on such a history of non-negative inflation data would result in a zero probability of deflation occurring. However, we believe inflation below zero percent is a reasonable outcome in the future. For this reason, we added three deflation values to our data. We also removed three abnormally high inflation occurrences ("outliers") that occurred between 1979 and 1981 that we don't expect to occur in the future. The resulting Expected Inflation dataset is summarized on the next page.

Expected Inflation		
Annual Inflation Range	Number of Data Points	Percent of Data in Range
(6%) to (4%)	1	2%
(4%) to (2%)	0	0%
(2%) to 0%	2	3%
0% to 2%	22	33%
2% to 4%	25	38%
4% to 6%	8	12%
6% to 8%	5	8%
8% to 10%	1	2%
10% to 12%	1	2%
12% to 14%	1	2%
Total	**66**	**100%**

Expected Value

Consistent with the 2015 EES, we lowered the expected value for inflation from 3.5 to 3 percent. Please see the EES for further background on this assumption change.

Assumed Distribution or Formula

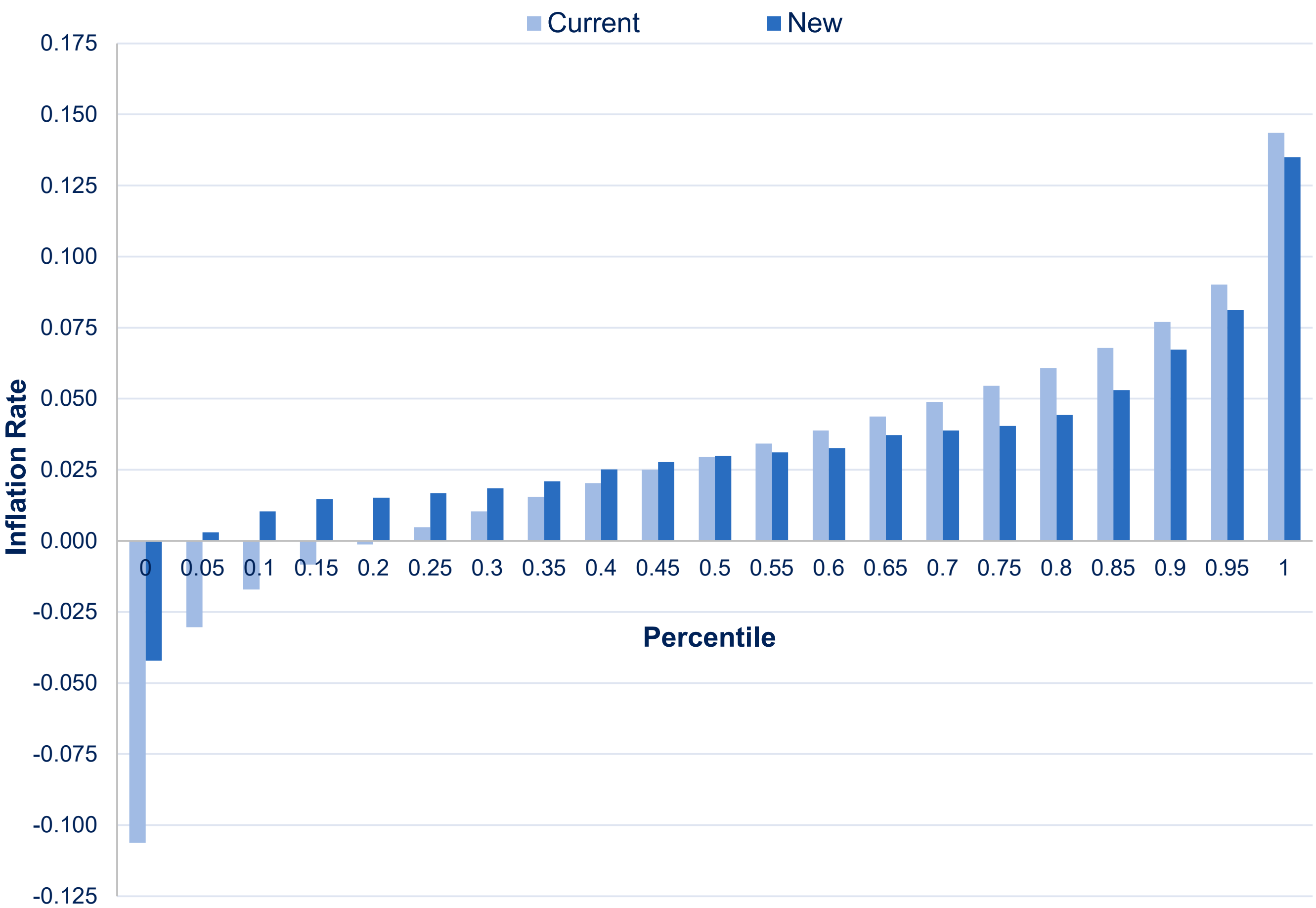
In the 2010 RA Report, we modeled inflation with an autoregressive time series formula. We have updated this assumption based on this study and replaced the previous formula with a new assumed distribution based on the Expected Inflation dataset described above. This updated distribution is displayed in the **New Distribution Table**. We made this change to simplify and increase the transparency of the inflation assumption in our model.

New Distribution Table*							
Percentile	Inflation	Percentile	Inflation	Percentile	Inflation	Percentile	Inflation
0.00	(4.21%)	0.26	1.68%	0.51	3.02%	0.76	4.18%
0.01	(1.96%)	0.27	1.76%	0.52	3.05%	0.77	4.33%
0.02	(0.59%)	0.28	1.82%	0.53	3.06%	0.78	4.35%
0.03	(0.23%)	0.29	1.82%	0.54	3.07%	0.79	4.38%
0.04	0.06%	0.30	1.85%	0.55	3.11%	0.80	4.43%
0.05	0.30%	0.31	1.89%	0.56	3.16%	0.81	4.56%
0.06	0.49%	0.32	1.90%	0.57	3.22%	0.82	4.72%
0.07	0.64%	0.33	1.98%	0.58	3.24%	0.83	4.92%
0.08	0.75%	0.34	2.08%	0.59	3.25%	0.84	5.05%
0.09	0.80%	0.35	2.10%	0.60	3.26%	0.85	5.30%
0.10	1.03%	0.36	2.13%	0.61	3.42%	0.86	5.75%
0.11	1.28%	0.37	2.18%	0.62	3.55%	0.87	5.90%
0.12	1.38%	0.38	2.29%	0.63	3.65%	0.88	6.12%
0.13	1.42%	0.39	2.40%	0.64	3.69%	0.89	6.59%
0.14	1.45%	0.40	2.51%	0.65	3.72%	0.90	6.72%
0.15	1.47%	0.41	2.59%	0.66	3.73%	0.91	6.87%
0.16	1.48%	0.42	2.66%	0.67	3.81%	0.92	7.40%
0.17	1.50%	0.43	2.73%	0.68	3.87%	0.93	7.72%
0.18	1.50%	0.44	2.75%	0.69	3.88%	0.94	7.94%
0.19	1.50%	0.45	2.77%	0.70	3.89%	0.95	8.12%
0.20	1.52%	0.46	2.78%	0.71	3.90%	0.96	8.88%
0.21	1.57%	0.47	2.85%	0.72	3.91%	0.97	9.94%
0.22	1.61%	0.48	2.92%	0.73	3.92%	0.98	10.21%
0.23	1.64%	0.49	2.97%	0.74	3.95%	0.99	11.44%
0.24	1.66%	0.50	3.00%	0.75	4.05%	1.00	13.50%
0.25	1.68%						

**The nth percentile indicates the inflation rate below which n-percent of the Expected Inflation dataset falls.*

We compare the current and new assumptions in the **Comparison of Distributions Graph** below.

Comparison of Distributions Graph



Assumed Correlation

We assumed inflation in a given year would have a 0.65 correlation factor to the previous year's inflation. This factor was developed by considering both long-term and short-term correlations as well as future expectations. We observed a 0.74 correlation factor since 1950 and a 0.61 correlation factor over the past 30 years.

The 0.65 correlation factor is higher than the correlation factor used in the 2010 RA Report (0.54 correlation factor). The reason for this is because our previous factor looked at inflation correlations dating back to 1916 which included highly volatile data leading to a weaker correlation. As noted above, for this study we relied on historical inflation dating back to 1950 only.

We have no reason to believe that our correlation factor will change significantly in the future, but we will continue to monitor this trend.

We also considered whether a correlation existed between inflation and investment returns. Correlation calculations with and without lags were performed, but each revealed correlations of at most 0.33. Therefore, we did not include such a correlation in our model.

POPULATION GROWTH

How We Use the Assumption

Population growth is one of three building block components used for nominal revenue growth (inflation + population growth + real revenue growth = nominal revenue growth). We use nominal revenue growth to model annual changes in the projected General Fund State budget.

Data We Used to Set the Assumption

In studying this assumption, we relied upon historical and projected Washington State population growth data from the Office of Financial Management (OFM).

OFM's website provides the historical Washington State population growth since 1970. We collected the data from the November 2015 OFM State Population Forecast Report which provided historical information from 1970-2015. We summarize the historical data in the table below.

Historical Washington Population Growth		
Population Growth Range	Number of Data Points	Percent of Data in Range
(0.4%) to (0.2%)	0	0.0%
(0.2%) to 0%	1	2.2%
0% to 0.2%	0	0.0%
0.2% to 0.4%	0	0.0%
0.4% to 0.6%	1	2.2%
0.6% to 0.8%	5	11.1%
0.8% to 1%	2	4.4%
1% to 1.2%	5	11.1%
1.2% to 1.4%	5	11.1%
1.4% to 1.6%	6	13.3%
1.6% to 1.8%	4	8.9%
1.8% to 2%	6	13.3%
2% to 2.2%	0	0.0%
2.2% to 2.4%	3	6.7%
2.4% to 2.6%	2	4.4%
2.6% to 2.8%	0	0.0%
2.8% to 3%	1	2.2%
3% to 3.2%	1	2.2%
3.2% to 3.4%	1	2.2%
3.4% to 3.6%	0	0.0%
3.6% to 3.8%	1	2.2%
3.8% to 4%	1	2.2%
4% to 4.2%	0	0.0%
Total	**45**	

On average, annual population growth from 1970 to 2015 was approximately 1.6 percent due to periods of growth above 2 percent prior to 2000.

We also studied projected population growth to help develop our assumption. OFM's State Population Forecast Report provides the projected Washington State population growth for the next 25 years in addition to historical population growth. The projected population growth is summarized in the table below.

Projected Washington Population Growth					
Year	% Increase	Year	% Increase	Year	% Increase
2016	1.33%	2025	1.01%	2034	0.83%
2017	1.29%	2026	0.99%	2035	0.81%
2018	1.20%	2027	0.97%	2036	0.79%
2019	1.13%	2028	0.96%	2037	0.78%
2020	1.09%	2029	0.94%	2038	0.76%
2021	1.05%	2030	0.92%	2039	0.75%
2022	1.04%	2031	0.90%	2040+	0.74%
2023	1.04%	2032	0.88%		
2024	1.02%	2033	0.85%		

Our projections used for this risk assessment span a 50-year period and require assumptions on population growth from 2016-2065. OFM's forecast ends at 2040. We assumed the 2040 annual population growth rate of 0.74 percent as the ultimate annual rate for the final 25 years of the projection period.

Based on our analysis of projected population growth, we would expect an average population growth rate of approximately 0.85 percent per year from 2016-2065.

Expected Value

We believe future population growth will be lower than historical population growth and gradually trend down consistent with the population growth rates presented in the Projected Washington Population Growth table. We assume a fixed annual population growth rate of 0.85 percent from 2016-2065.

Assumed Distribution or Formula

In the 2010 RA Report, we modeled population growth with an autoregressive time series formula (long-term average of 1.10 percent with a mean reversion rate of 35 percent and a random standard deviation of 0.80 percent). Based on our latest analysis, we elected to replace the autoregressive time series formula with a single, fixed rate of 0.85 percent (consistent with the expected value above).

We decided to use a fixed rate for the following reasons:

- ❖ Annual population growth rates do vary and an autoregressive time series model is one way to model this assumption, but we found that our risk measures do not materially change based on reasonable changes to this assumption (including assumed volatility).
- ❖ Underlying assumptions will become more transparent and this change simplifies our model by reducing the sources of variability in nominal revenue growth from three sources (inflation, population growth, and real revenue growth) to two sources (inflation and real revenue growth).

Assumed Correlation

In the 2010 RA Report, we assumed population growth had a 0.78 correlation with the prior year's value. After performing analysis, we observed a similar strong correlation with the prior year's population growth of 0.80.

For this study, we did not develop a correlation assumption for population growth since we replaced the previous methodology with a single and static assumption. Also, as noted above, any assumed correlation would not materially change the results of our risk measures.

REAL REVENUE GROWTH

How We Use the Assumption

This assumption serves as one of three building block components for modeling projected nominal General Fund State (GF-S) revenue growth (population growth + inflation + real revenue growth).

In our risk assessment model, we compare projected GF-S revenues to projected pension contributions. This comparison allows us to measure the long-term affordability of these contributions and the pension benefits themselves.

Data We Used to Set the Assumption

We relied on data from the Economic & Revenue Forecast Council (ERFC), data from the Office of Financial Management (OFM), and data from the Washington State Investment Board (WSIB, see the **Assumed Correlation** section) in setting this assumption.

The ERFC provided historical nominal GF-S revenues back to 1970 (along with historical and projected Real National Gross Domestic Product [GDP], see the **Expected Value** section). We also received historical data on inflation and Washington State population growth from OFM for the same time period.

Historical Growth Data							
Fiscal Year	GF-S	Inflation	Population	Fiscal Year	GF-S	Inflation	Population
1971	17.6%	2.1%	0.7%	1994	5.9%	3.5%	1.9%
1972	(2.0%)	2.8%	(0.2%)	1995	9.8%	3.0%	2.0%
1973	9.4%	6.5%	0.4%	1996	1.5%	3.4%	1.8%
1974	9.8%	11.0%	1.9%	1997	5.8%	3.5%	1.7%
1975	15.3%	10.1%	1.7%	1998	6.4%	2.9%	1.5%
1976	23.1%	5.6%	1.9%	1999	3.6%	3.0%	1.4%
1977	17.1%	8.0%	2.2%	2000	6.3%	3.7%	1.1%
1978	15.2%	9.7%	3.3%	2001	4.4%	3.6%	1.3%
1979	12.8%	11.0%	3.7%	2002	0.6%	1.9%	1.5%
1980	6.0%	16.6%	3.8%	2003	0.8%	1.6%	1.1%
1981	12.4%	10.9%	2.4%	2004	5.4%	1.2%	1.3%
1982	6.9%	6.5%	1.1%	2005	5.5%	2.8%	1.5%
1983	24.5%	1.7%	0.7%	2006	9.8%	3.7%	1.9%
1984	4.1%	3.7%	1.1%	2007	8.0%	3.9%	1.6%
1985	8.8%	2.5%	1.4%	2008	1.2%	4.2%	1.3%
1986	6.8%	1.0%	1.1%	2009	(9.6%)	0.6%	1.0%
1987	9.7%	2.4%	1.5%	2010	(4.1%)	0.3%	0.8%
1988	4.8%	3.3%	2.0%	2011	7.9%	2.7%	0.6%
1989	8.3%	4.7%	2.4%	2012	1.5%	2.5%	0.7%
1990	14.4%	7.3%	2.9%	2013	6.1%	1.2%	0.9%
1991	4.6%	5.7%	3.2%	2014	3.8%	1.8%	1.2%
1992	7.3%	3.6%	2.4%	2015	5.5%	1.4%	1.2%
1993	3.7%	2.8%	2.4%				

Using this data, we solved for real revenue growth using the relationship we previously identified (real GF-S revenue growth = nominal GF-S revenue growth – inflation – population growth). The results of this calculation are summarized in the following table.

Historical Real GF-S Revenue Growth		
Annual Real Revenue Growth Range	Number of Data Points	Percent of Data in Range
Less Than (4%)	6	13%
(4%) to (2%)	3	7%
(2%) to 0%	10	22%
0% to 2%	7	16%
2% to 4%	8	18%
4% to 6%	7	16%
6% to 8%	1	2%
Greater Than 8%	3	7%
Total	**45**	**100%**

Expected Value

In modeling future nominal GF-S revenues, we use the ERFC short-term projections as the base for the next six years. The following table provides this data as of their February 2016 report.

Projected Nominal Growth		
Fiscal Year	GF-S Revenue *(Dollars in Millions)*	GF-S Growth
2015	$17,283	
2016	$18,326	6.0%
2017	$18,812	2.7%
2018	$19,651	4.5%
2019	$20,474	4.2%
2020	$21,311	4.1%
2021	$22,130	3.8%

Beyond the first six years, our best estimate nominal GF-S revenue growth assumption is 4.85 percent. Taking into account our best estimates for inflation (3.0 percent) and population growth (0.85 percent), this results in an expected real GF-S revenue growth assumption of 1.0 percent annually.

We also considered the relationship between historical real national GDP growth and historical real GF-S revenue growth, along with the ERFC's long-term projected real national GDP growth (see the table on the next page). We observed that the average real GF-S revenue growth rate was 65 percent of the average real national GDP growth rate, per year, when calculated from 1970 to 2015. Our updated 1.0 percent expected future value for real GF-S revenue growth is about 50 percent of the long-term projected national GDP rates in the table on the next page.

Historical and Projected Real National GDP Growth								
Fiscal Year	Real GDP *(Dollars in Billions)*	Real GDP Growth	Fiscal Year	Real GDP *(Dollars in Billions)*	Real GDP Growth	Fiscal Year	Real GDP *(Dollars in Billions)*	Real GDP Growth
1970	$4,722		1996	$10,561	3.8%	2022	$19,487	2.2%
1971	$4,878	3.3%	1997	$11,035	4.5%	2023	$19,919	2.2%
1972	$5,134	5.3%	1998	$11,526	4.4%	2024	$20,356	2.2%
1973	$5,424	5.6%	1999	$12,066	4.7%	2025	$20,786	2.1%
1974	$5,396	(0.5%)	2000	$12,560	4.1%	2026	$21,233	2.1%
1975	$5,385	(0.2%)	2001	$12,682	1.0%	2027	$21,694	2.2%
1976	$5,675	5.4%	2002	$12,909	1.8%	2028	$22,169	2.2%
1977	$5,937	4.6%	2003	$13,271	2.8%	2029	$22,655	2.2%
1978	$6,267	5.6%	2004	$13,774	3.8%	2030	$23,148	2.2%
1979	$6,466	3.2%	2005	$14,234	3.3%	2031	$23,649	2.2%
1980	$6,450	(0.2%)	2006	$14,614	2.7%	2032	$24,156	2.1%
1981	$6,618	2.6%	2007	$14,874	1.8%	2033	$24,682	2.2%
1982	$6,491	(1.9%)	2008	$14,830	(0.3%)	2034	$25,225	2.2%
1983	$6,792	4.6%	2009	$14,419	(2.8%)	2035	$25,779	2.2%
1984	$7,285	7.3%	2010	$14,784	2.5%	2036	$26,332	2.1%
1985	$7,594	4.2%	2011	$15,021	1.6%	2037	$26,894	2.1%
1986	$7,861	3.5%	2012	$15,355	2.2%	2038	$27,478	2.2%
1987	$8,133	3.5%	2013	$15,583	1.5%	2039	$28,068	2.1%
1988	$8,475	4.2%	2014	$15,962	2.4%	2040	$28,662	2.1%
1989	$8,786	3.7%	2015	$16,345	2.4%	2041	$29,262	2.1%
1990	$8,955	1.9%	2016	$16,816	2.9%	2042	$29,882	2.1%
1991	$8,948	(0.1%)	2017	$17,292	2.8%	2043	$30,521	2.1%
1992	$9,267	3.6%	2018	$17,754	2.7%	2044	$31,174	2.1%
1993	$9,521	2.7%	2019	$18,209	2.6%	2045	$31,829	2.1%
1994	$9,905	4.0%	2020	$18,663	2.5%			
1995	$10,175	2.7%	2021	$19,072	2.2%			

Our new best estimate real GF-S revenue growth assumption has decreased compared to our current assumption of 1.5 percent. This assumption has declined primarily due to lower observed real GF-S revenue growth and our revised expectations for the future.

More recent actual historical experience could suggest that an even lower best estimate may be reasonable as well. We will continue to monitor this assumption as part of future risk assessment assumption studies. If we continue to see a decline in real revenue growth below our new expected value, we will adjust this assumption in the future accordingly.

Standard Deviation

Based on our review of historical real GF-S revenue growth data, we developed a new standard deviation assumption of 3.5 percent. Note that we do not model or assume any change in Washington State tax policy.

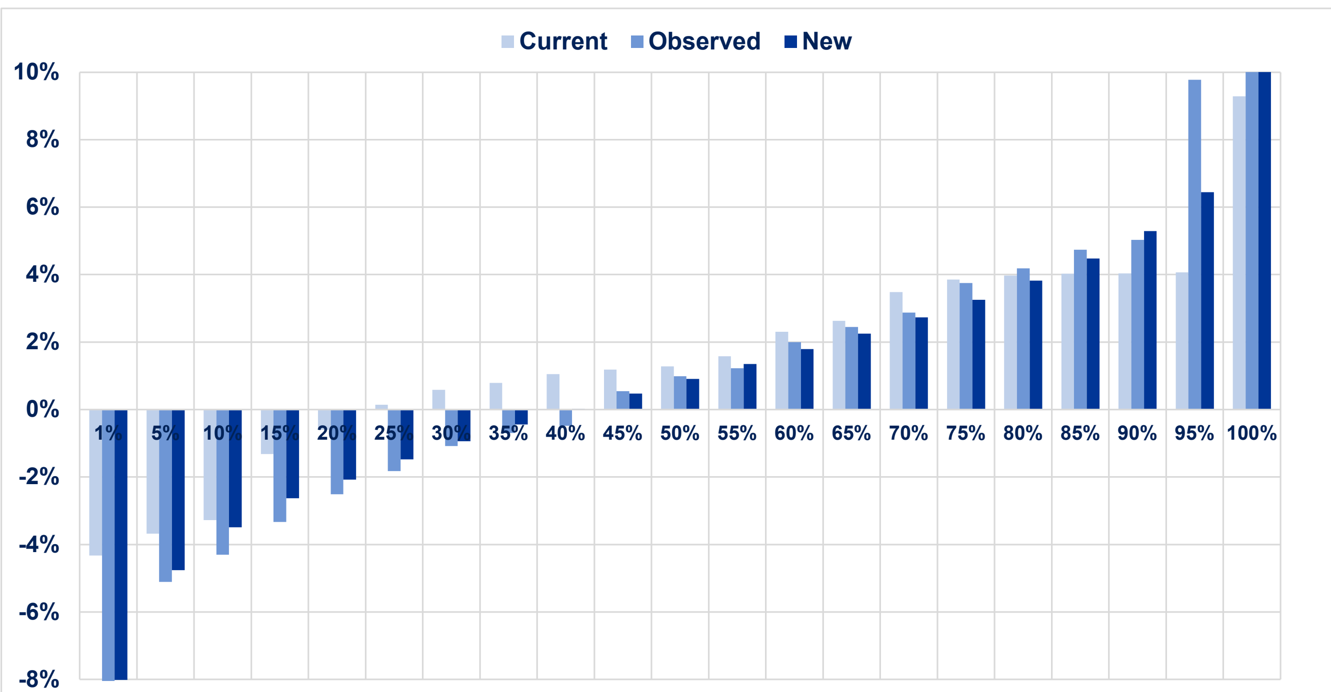
For our current assumption, the distribution didn't require use of a standard deviation. For this study, we changed our methodology and chose to use an inverse normal function that requires a mean and standard deviation to develop the distribution. This method allowed us to fit the historical data well and increased the transparency of our assumption and method.

Assumed Distribution or Formula

The following table summarizes our new real GF-S revenue growth distribution. Due to the lower new best estimate real GF-S revenue growth assumption, the new distribution is generally lower than the current distribution.

Real GF-S Revenue Growth Distribution		
Likelihood	Percentile	Real Revenue Growth Assumption
1 in 200	MIN	(8.0%)
1 in 100	1	(7.1%)
1 in 20	5	(4.8%)
1 in 10	10	(3.5%)
1 in 4	25	(1.4%)
1 in 2	50	1.0%
1 in 4	75	3.4%
1 in 10	90	5.5%
1 in 20	95	6.8%
1 in 100	99	9.1%
1 in 200	MAX	10.0%

The following graph provides a high-level overview of the Current assumption, the Observed percentiles within the data for years 1970 through 2015, and our New distribution.



Please see the 2010 RA Report for more details on the current distribution.

Assumed Correlation

We relied on nominal annual investment rates of return since 1982 from WSIB in establishing a correlation to same-year real GF-S revenue growth. This data is available on our website.

In studying the correlation between these two variables, we reviewed the observed correlation over several time periods. Our best estimate is a 0.70 correlation, indicating that our assumed real GF-S revenue growth will be largely tied to same-year investment return percentiles when modeled stochastically.

The prior correlation assumption was 0.30 and has increased based upon a review of more recent data and our revised expectations for the future. We considered a potential correlation to Washington State real GDP growth, but adequate data was not available.

PERCENT OF CONTRIBUTIONS MADE

How We Use the Assumption

We use this assumption, in combination with an assumed maximum contribution rate, to estimate the amount of contributions made each year if the past practices of the Legislature regarding funding shortfalls continue in the future. We are not attempting to model or predict the level of funding shortfalls in the future, nor the practices of future Legislatures. In addition to modeling past practices, we can also turn off this assumption in our model for what we call "current law" projections. A current law projection would assume no funding shortfalls (100 percent of recommended contributions made).

In our risk assessment model, we apply this assumption as a percentage of the contribution rate calculated under current funding policy. We also make an assumption on the maximum contribution rate an employer can afford in a single year. We assume no contributions above the maximum contribution rate.

Data We Used to Set the Assumption

We prepared a 26-year history of recommended and adopted employer contribution rates for PERS, TRS, LEOFF, and WSPRS from the year 1991 through 2016. We also prepared a 13-year and 10-year history for SERS and PSERS, respectively. This shorter history is consistent with the more recent dates of inception for these plans.

For this analysis, the "recommended" rate represents the total employer contribution rate which includes the Plan 2/3 employer normal cost rate and the Plan 1 UAAL rate (where applicable). Recommended rates are consistent with the rates calculated in the *Actuarial Valuation Report* (AVR) and represent the rates that would apply for the subsequent and applicable state budgeting period. Unless noted otherwise, recommended rates are based on the funding policy at the time of the calculation. The adopted rates for this analysis were defined as the contribution rate collected for the given state budgeting period. The percent of recommended contributions made equals the ratio of the adopted contribution rate to the recommended contribution rate.

Some recommended contribution rates will not match the applicable AVR due to data adjustments we found necessary to complete the analysis. Please see the **Data Adjustments** section for additional detail.

The following table displays the historical recommended and adopted employer contribution rates by system.

Recommended and Adopted Employer Contribution Rates [1]																		
	PERS			TRS			SERS			PSERS			LEOFF			WSPRS		
	Rec. Rate[2]	Adopt. Rate[3]	%Rec.[4]	Rec. Rate[2]	Adopt. Rate[3]	%Rec.[4]	Rec. Rate[2]	Adopt. Rate[3]	%Rec.[4]	Rec. Rate[2]	Adopt. Rate[3]	%Rec.[4]	Rec. Rate[2]	Adopt. Rate[3]	%Rec.[4]	Rec. Rate[2]	Adopt. Rate[3]	%Rec.[4]
1991	7.10%	7.10%	100%	12.60%	12.60%	100%							16.88%	16.88%	100%	21.47%	21.47%	100%
1992	7.47%	7.47%	100%	12.60%	12.60%	100%							16.44%	16.44%	100%	15.53%	15.53%	100%
1993	7.47%	7.27%	97%	12.60%	12.08%	96%							16.44%	12.99%	79%	15.53%	17.16%	110%
1994	7.19%	7.19%	100%	12.43%	12.43%	100%							13.54%	13.54%	100%	16.02%	16.02%	100%
1995	7.19%	7.19%	100%	12.43%	12.43%	100%							13.54%	13.54%	100%	16.02%	16.02%	100%
1996	7.21%	7.21%	100%	12.05%	12.05%	100%							13.22%	13.22%	100%	14.56%	14.56%	100%
1997	7.21%	7.21%	100%	12.05%	12.05%	100%							13.22%	13.22%	100%	14.56%	14.56%	100%
1998	7.32%	7.32%	100%	11.75%	11.75%	100%							9.20%	9.20%	100%	11.01%	11.01%	100%
1999	7.32%	7.32%	100%	11.75%	11.75%	100%							9.20%	9.20%	100%	11.01%	11.01%	100%
2000	4.36%	4.36%	100%	8.38%	8.38%	100%							2.33%	2.33%	100%	0.00%	0.00%	100%
2001	4.36%	3.58%	82%	8.38%	6.03%	72%							2.33%	2.16%	93%	0.00%	0.00%	100%
2002	3.21%	1.54%	48%	5.38%	2.57%	48%							2.31%	1.80%	78%	0.00%	0.00%	100%
2003	3.21%	1.10%	34%	5.38%	1.05%	20%							2.31%	2.02%	87%	0.00%	0.00%	100%
2004	2.05%	1.18%	58%	2.22%	1.17%	53%	1.74%	0.85%	49%				2.02%	2.02%	100%	0.00%	0.00%	100%
2005	2.05%	1.18%	58%	2.22%	1.17%	53%	1.74%	0.85%	49%				2.02%	2.02%	100%	0.00%	0.00%	100%
2006	5.73%	2.25%	39%	6.74%	2.73%	41%	7.56%	2.75%	36%				2.88%	2.70%	94%	4.51%	4.51%	100%
2007	5.73%	5.27%	92%	6.74%	4.54%	67%	7.56%	4.62%	61%	8.35%	5.27%	63%	2.88%	3.11%	108%	4.51%	4.51%	100%
2008	7.73%	6.46%	84%	9.93%	7.38%	74%	9.22%	7.76%	84%	9.70%	8.66%	89%	3.50%	3.43%	98%	8.79%	7.75%	88%
2009	7.73%	8.02%	104%	9.93%	9.15%	92%	9.22%	9.06%	98%	9.70%	9.54%	98%	3.50%	3.51%	100%	8.79%	7.75%	88%
2010	7.84%	5.13%	65%	10.79%	5.98%	55%	8.12%	5.27%	65%	10.06%	7.68%	76%	3.04%	3.38%	111%	8.57%	6.17%	72%
2011	7.84%	5.13%	65%	10.79%	5.98%	55%	8.12%	5.27%	65%	10.06%	7.68%	76%	3.04%	3.38%	111%	8.57%	6.17%	72%
2012	7.60%	6.91%	91%	8.09%	7.74%	96%	7.98%	7.29%	91%	9.26%	8.57%	93%	2.93%	3.38%	115%	7.92%	7.91%	100%
2013	7.60%	6.91%	91%	8.09%	7.74%	96%	7.98%	7.29%	91%	9.26%	8.57%	93%	2.93%	3.38%	115%	7.92%	7.91%	100%
2014	9.03%	9.03%	100%	10.21%	10.21%	100%	9.64%	9.64%	100%	10.36%	10.36%	100%	3.03%	3.36%	111%	7.91%	7.91%	100%
2015	9.03%	9.03%	100%	10.21%	10.21%	100%	9.64%	9.64%	100%	10.36%	10.36%	100%	3.03%	3.36%	111%	7.91%	7.91%	100%
2016	12.29%	11.00%	90%	14.47%	12.95%	89%	12.88%	11.40%	89%	12.07%	11.36%	94%	3.19%	3.36%	105%	8.79%	8.01%	91%

[1] This table presents data used to develop our assumption on future contributions and is not intended to be a history of actual rates collected.

[2] Initial total employer contribution rates (state contribution rate for LEOFF) recommended in the actuarial valuation before any assumption or policy changes.

[3] Total employer contribution rate (state contribution rate for LEOFF) adopted.

[4] Percent of recommended rate adopted.

In general, we observed three distinct periods for the percent of recommended contributions made:

- ❖ During 1991 through 2000, we observed full funding in most years.
- ❖ From 2001 through 2011, we observed a period of funding shortfalls. During this period, recommended contribution rates trended downward in the early 2000s but steadily increased after 2005.
- ❖ During 2012 through 2016, adopted contribution rates have trended back to the full recommended rates.

In addition to the percent of recommended contributions made, we assume that the collected total employer contribution rate will not exceed a maximum rate for each system. In our model, this maximum rate represents the highest assumed contribution rate an employer can afford in a single year.

To help set this assumption, we reviewed historical contribution rates found on the Department of Retirement Systems' (DRS) website. In the table below, we summarize our current assumption as well as the maximum total employer rate that has been collected over the system's history.

Historical Total Employer Maximum Rate*						
	PERS	SERS	PSERS	TRS	LEOFF 2	WSPRS
Current Assumption	13.50%	13.50%	30.00%	18.00%	30.00%	50.00%
Max Collected	11.00%	11.40%	11.36%	13.10%	8.83%	23.89%

**Total employer rates assumes a 0.18% DRS administrative expense. We excluded the DRS administrative expense for this analysis.*

Data Adjustments

As noted above, we needed to make some adjustments to the recommended rates calculated in the AVRs to complete this analysis. In these cases, the recommended rates will not match the rates in the applicable AVR. The reasons for the adjustments follow:

- ❖ **2007-2009 Biennium:** The Legislature adopted rates that excluded the cost of assumed improvements in mortality. The final 2005 AVR was revised to match the Legislature's action. For this study, we included the cost of assumed mortality improvements in the recommended rates.
- ❖ **2011-13 Biennium:** The Legislature repealed the Uniform Cost of Living Adjustment (UCOLA) for PERS 1 and TRS 1 after the completion of the final AVR. The recommended rates for this study reflect the removal of the UCOLA.
- ❖ **2013-15 Biennium:** Contribution rates for PSERS and WSPRS were projected to fall for 2013-2015 and then increase in subsequent biennia. The State Actuary recommended that rates for 2013-15 remain at 2011-13 levels for these systems. The recommended rates for PSERS and WSPRS for this study match that recommendation, which is also consistent with the Legislature's adoption.

Unless noted otherwise, recommended rates reflect "basic rates" as defined under Chapter 41.45 RCW, include minimum rates, but exclude rate ceilings, supplemental contribution rates as defined under RCW 41.45.070 for off cycle years, and contribution rate phase-ins.

Expected Value

Based on the data and experience noted above, we identified the following minimum, average, and maximum percent of the recommended contributions made for each system.

Historical Percent of Recommended Contributions Made						
	PERS	SERS	PSERS	TRS	LEOFF	WSPRS
Min	34%	36%	63%	20%	78%	72%
Avg	85%	75%	88%	81%	101%	97%
Max	104%	100%	100%	100%	115%	110%

Our new expected value matches the average value noted above except for SERS and PSERS. We relied upon PERS historical experience for SERS and PSERS due to the shorter histories available for these two systems.

The average percent recommended has generally increased since the 2010 RA Report. This is primarily attributable to recent past practices by the Legislature which resulted in collecting a higher percent of the recommended contributions.

To develop the assumed system maximum contribution rates for our model we considered the historical rates noted above as well as projected total employer rates. The following table compares our new assumed system maximum contribution rates to the current assumption.

Assumed System Maximum Contribution Rates						
	PERS	SERS	PSERS	TRS	LEOFF	WSPRS
Current Assumption	13.50%	13.50%	30.00%	18.00%	30.00%	50.00%
New Assumption	15.00%	15.00%	15.00%	18.00%	27.00%	50.00%

New with this RAAS, we developed and now apply maximum contribution rates at the plan level instead of the system level only. The plan level maximum rates are a subset of the maximum rates by system documented above. The plan level maximum contribution rates are comprised of an assumed maximum contribution to the Plan 1 UAAL (where applicable) and an assumed maximum normal cost contribution to the open plans. The sum of both components equals the assumed maximum contribution rate at the system level. The table below summarizes our new plan maximum contribution rate assumptions.

Assumed Plan 1 Maximum Contribution Rates*			
	FY < 2030	2030-2045	FY > 2045
PERS	5.50%	2.50%	0.00%
SERS	5.50%	2.50%	0.00%
PSERS	5.50%	2.50%	0.00%
TRS	7.50%	3.50%	0.00%
LEOFF	6.00%	6.00%	6.00%
WSPRS	N/A	N/A	N/A

**The Plans 2/3 maximum contribution rates is the difference between the system maximum contribution rate and the plan 1 maximum contribution rate.*

In general, we assume the funding of the open plans will become a higher priority as those plans become significantly larger than the older and closed plans. Beginning in FY 2046, we assume no contributions to the PERS and TRS closed plans other than any contributions required to pay the remaining unfunded benefits when due. We assume contributions to the

LEOFF closed plan will continue past FY 2045 due to a different funding policy than other closed plans.

In general, when updating this assumption we considered recently adopted employer contribution rates (which have increased for PERS and TRS due to higher funding commitments to the Plan 1 UAAL) and considered projected contribution rates. We compared our assumed maximum rates to projected total employer rates from our most recent simulations where we assume the continuation of the Legislature's past practices regarding benefit enhancements and further assume no future funding shortfalls. The new assumed maximum employer rates approximate the 80th percentile of projected total employer rates from our most recent simulations (under the assumptions outlined above). As noted above, we now rely on the maximum rate in PERS for SERS and PSERS.

We believe the assumed system and plan maximum rates are reasonable. Higher system maximum rates and different plan maximum rates could also be reasonable. However, we don't believe the removal of this assumption would be reasonable. In essence, without this assumption, any contribution requirement, no matter how large, would be assumed affordable and funded in our model.

Assumed Distribution or Formula

In the 2010 RA Report, we modeled the percent of recommended contributions made with distribution tables. We modeled a distribution table for PERS, SERS, and PSERS together as well as modeled distribution tables for TRS, LEOFF and WSPRS individually. Those distribution tables contained expected values, standard deviations and assumed correlations with other variables.

For this study, we reviewed and updated the prior methodology. We also reviewed and considered a new inverse normal distribution. In the end, we landed on a simplified function that approximated both the prior methodology and an inverse normal distribution. We prefer the simplified approach for ease of understanding, increased transparency, and the direct relationship with other variables.

We have replaced the prior distribution of percent of recommended contributions made with a function that varies based on real revenue growth. Specifically, we now assume the percent of recommended contributions in any given year will equal the following function:

Percent of Recommended Contributions Made = Mean + Deviation from Mean

The "mean" in the formula above reflects the historical average percent of recommended contributions made. The "deviation from mean" in the formula above reflects the following equation: (maximum – minimum) × (simulated percentile of real revenue growth – 0.5). The maximum and minimum values relate to the historical percentage of contributions made and the simulated percentiles of real revenue growth (values from 0 to 1) are lagged two years.

Under this function, we expect the systems to contribute a higher percent of recommended contributions during favorable economic environments and a lower percentage of recommended contributions during less favorable economic environments. The two-year lag on real revenue growth reflects the actual time lag between contribution rate adoption (budget adoption) and actual contribution rate collection.

We also limit the output of the function with minimum and maximum values. The minimum values match the values noted above under the Expected Value section. We set the maximum value at 100 percent for all systems except LEOFF. For LEOFF, we set the maximum value at 115 percent. Consistent with the LEOFF Plan 2 Retirement Board's stable rate policy, adopted contribution rates in LEOFF 2 have exceeded the rates required from the underlying actuarial cost method and the long-term minimum rates every year since 2010. Please see the Actuarial Certification Letter from the June 30, 2014, LEOFF 2 Actuarial Valuation Report for additional background. Adopted contribution rates in PERS and WSPRS exceeded recommended rates only once during our period of study. No other systems had adopted contribution rates above recommended rates during our period of study.

Please note that the percent of recommended contribution made is applied to the recommended rate prior to the application of the assumed maximum contribution rate.

Assumed Correlation

As noted above, we replaced the prior distribution (which had an assumed correlation to the prior year's variable) with a new function based on an expected value and correlation to real revenue growth. This new function has a direct relationship with the real revenue growth (input to the new function) instead of an assumed correlation between two random variables.

BENEFIT IMPROVEMENTS

How We Use the Assumption

We use this assumption to estimate the increase in future benefit payments that would occur if the past practices of the Legislature regarding benefit enhancements continue in the future. We are not attempting to model or predict the level of benefit improvements in the future, nor the practices of future Legislatures. In addition to modeling past practices, we can also turn off this assumption in our model for what we call "current law" projections. A current law projection would assume no future benefit improvements.

In our risk assessment model, we apply this assumption by plan as a cumulative increase in liabilities over time. This application increases today's value of future pension benefits, the portion of those benefits that have been earned through past service, and the annual cash outflows for future pension payments.

Data We Used to Set the Assumption

We prepared a 27-year history of pension bills that passed the Legislature for PERS, TRS, LEOFF, and WSPRS from the years 1989 through 2015. We also prepared a 14-year and 8-year history for SERS and PSERS, respectively.

We excluded several pension bills from our dataset for a variety of reasons. For example, we eliminated plan spin-offs (e.g., the creation of SERS and PSERS) or similar smaller shifts in plan membership and changes to plan funding methods or assumptions set by the Legislature.

We also relied on our 2010 RA Report dataset for the year 2007 because in the publicly available fiscal note we were not able to delineate between the savings from the repeal of gainsharing (which we excluded because the cost, prior to repeal, was not recognized by the Legislature as a benefit improvement) and the costs from adding the replacement benefits. Finally, we ensured the liability decreases for the repeal of the PERS 1 and TRS 1 UCOLA in 2011 directly offset the liability increases from when the benefit was originally implemented.

The following table provides the historical percentage increases in liabilities we observed by plan after we applied the data adjustments as previously outlined.

Percent Liability Increase From Benefit Improvements By Plan*									
Year	PERS 1	PERS 2/3	TRS 1	TRS 2/3	SERS 2/3	PSERS 2	LEOFF 1	LEOFF 2	WSPRS
1989	2.95%	0.00%	2.24%	0.00%			0.00%	0.00%	0.00%
1990	0.00%	0.00%	0.00%	0.00%			0.00%	0.00%	0.00%
1991	0.00%	0.00%	0.00%	0.00%			0.00%	0.00%	0.00%
1992	0.64%	0.00%	0.49%	0.00%			0.00%	0.00%	0.00%
1993	0.55%	0.00%	0.56%	0.00%			0.00%	20.94%	0.00%
1994	0.23%	0.00%	0.32%	0.00%			0.00%	0.00%	0.00%
1995	2.08%	0.00%	0.93%	0.00%			0.00%	0.00%	0.00%
1996	0.00%	0.00%	0.11%	0.00%			0.00%	0.00%	0.03%
1997	0.00%	0.00%	0.00%	0.00%			0.05%	0.00%	0.00%
1998	1.20%	0.00%	1.19%	0.00%			0.00%	0.00%	0.00%
1999	0.00%	0.00%	0.00%	0.50%			0.00%	0.00%	1.03%
2000	0.00%	6.45%	0.00%	7.67%			0.00%	2.91%	0.00%
2001	0.00%	0.00%	0.00%	0.00%			0.00%	0.00%	8.07%
2002	0.04%	0.00%	0.00%	0.00%	0.00%		0.03%	0.00%	0.00%
2003	0.00%	0.03%	0.00%	0.01%	0.08%		0.00%	0.30%	0.00%
2004	0.01%	0.00%	0.01%	0.00%	0.00%		0.00%	0.10%	0.00%
2005	0.00%	0.00%	0.02%	0.00%	0.00%		0.21%	1.14%	0.00%
2006	0.10%	0.10%	0.03%	0.11%	0.24%		0.51%	0.31%	1.08%
2007	3.28%	3.89%	3.31%	6.20%	4.26%		0.00%	0.15%	0.00%
2008	0.02%	0.03%	0.08%	0.65%	0.00%	0.00%	0.00%	0.00%	0.00%
2009	0.05%	0.08%	0.00%	0.02%	0.04%	0.00%	0.39%	0.02%	0.42%
2010	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.90%	0.02%
2011	(4.10%)	0.26%	(2.66%)	0.06%	0.04%	0.05%	0.02%	0.08%	0.00%
2012	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.02%	0.00%
2013	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%	0.00%
2014	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
2015	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.34%	0.20%
Average	**0.26%**	**0.40%**	**0.25%**	**0.56%**	**0.33%**	**0.01%**	**0.04%**	**1.01%**	**0.40%**

**The liability measurement reflects the change in the Present Value of Fully Projected Benefits.*

Expected Value

In reviewing the benefit improvement history, we found the data contained a general small "creep", which we defined as benefit improvements up to 0.20 percent of liabilities, with occasional large "spikes" in excess of 0.20 percent of liabilities. We also calculated how often we observed the occasional spikes in terms of years (or inversely in terms of annual probabilities).

Based upon historical experience, we identified the following average Annual Creep and Spike Amount in liabilities, along with the average Frequency for how often these spikes occur. We decided to combine the impacts we observed for PERS 1 and TRS 1 because of their plan similarities. Also, due to the short histories available for SERS 2/3 and PSERS 2, we relied on PERS 2/3 historical experience for these systems. Prior to the creation of SERS and PSERS, both populations were covered under PERS.

Average Historical Creep And Spike In Liabilities from 1989 - 2015						
	PERS/TRS Plans 1	PERS 2/3, SERS 2/3, PSERS 2	TRS 2/3	LEOFF 1	LEOFF 2	WSPRS 1/2
Annual Creep	0.01%	0.01%	0.01%	0.01%	0.02%	0.01%
Spike Amount and	0.8%	3.5%	3.8%	0.4%	3.8%	2.7%
Frequency (In Years)	4	9	7	9	4	7
Spike Probability	25%	11%	14%	11%	25%	14%

These observations have generally declined compared to the 2010 RA Report. This change is primarily attributable to recent past practices where relatively fewer benefit improvements were enacted by the Legislature. Also, the repeal of the UCOLA had a significant impact on the spike assumptions for PERS 1 and TRS 1.

Assumed Distribution or Formula

We also considered the average annual percentage change in liabilities without attempting to make a distinction between a creep and a spike. A summary of our historical data is shown in the table below where we again combined certain plans as previously described.

Average Annual Percentage Change In Liabilities						
	PERS/TRS Plans 1	PERS 2/3, SERS 2/3, PSERS 2	TRS 2/3	LEOFF 1	LEOFF 2	WSPRS 1/2
Years 1989 - 2015	0.25%	0.40%	0.56%	0.04%	1.01%	0.40%

Although we believe actual past practices in terms of benefit improvements materialize in the creep and spike fashion, we analyzed how the results of our risk assessment change when applying a constant increase in liabilities. We determined that the model produces the same total weighted score for the pension score card under either the constant increase or the creep and spike approaches.

Thus for simplicity purposes, we decided to eliminate the more complex creep and spike methodology. We anticipate this constant percentage increase in liabilities approach will increase the transparency of the underlying assumption and improve our ability to more easily interpret the results of our stochastic analysis.

Assumed Correlation

None. We removed the relationship we previously assumed between this assumption and economic conditions.

Due to the limited number of spikes (a lack of adequate historical data), we did not observe a strong statistical correlation between benefit improvements and any other variable we are modeling. Even though we did not observe a strong correlation, as part of the 2010 RA Report, we implemented a formula based on economic conditions to model future benefit improvements. Under that approach, if past practices continue, we assumed the Legislature would adopt more benefit improvements during good economic times and fewer during bad economic times.

We still believe that is a valid approach to modeling future benefit improvements. However, as noted above, we found that we can produce similar risk measures without this added complexity. As a result, we removed this relationship from the new assumption and assume no correlation with any other variable in our model.

SALARY GROWTH FROM PRODUCTIVITY

How We Use the Assumption

Salary growth from productivity is one of two building block components used for general salary growth (inflation + salary growth from productivity = general salary growth). We use general salary growth to model annual changes in salary.

In the 2010 Risk Assessment Report (RA Report), we studied a similar but different assumption, real salary growth. Real salary growth measures the difference in total salary growth and inflation. The salary growth from productivity assumption will replace the real salary growth assumption within our model. For purposes of this study, salary growth from productivity measures the difference in total salary growth and both inflation and service-based salary increases.

Data We Used to Set the Assumption

In studying this assumption, we relied on data consistent with our 2015 Economic Experience Study (EES). The 2015 EES included observed inflation data from the Bureau of Labor Statistics (BLS) and observed salary increase data from the Department of Retirement Systems (DRS). The study observed the change in total salary, per service level, among active members who worked full-time for at least two consecutive years. For additional detail on data used in the 2015 EES please see the report on our website.

For this analysis, we have to estimate salary growth from productivity because we don't receive data on salary increases by source of the increase. To estimate salary growth from productivity, we begin with observed total salary growth and subtract (1) observed inflation and (2) assumed service-based salary increases. We attribute what's left to salary growth from productivity.

We considered the annual salary growth from productivity under two different approaches for assumed service-based salary increases:

- **Approach 1:** The assumed service-based salary increase was determined using observed headcounts and service-based salary increase assumptions (consistent with the *2014 Actuarial Valuation Report*).
- **Approach 2:** Adjusts Approach 1 for variability between actual total salary growth and expected total salary growth.

A hypothetical example has been provided to further explain the difference between the two approaches if a given year has the following information:

- 5 percent observed total salary growth,
- 4.75 percent expected total salary growth,
- 3 percent observed inflation,
- 1.5 percent assumed service-based salary increase.

The resulting salary growth from productivity would be the following:

- ❖ Approach 1 = 5% - 3% - 1.5% = 0.5%
- ❖ Approach 2 = 5% - 3% - 1.5%*(5% / 4.75%) = 0.42%

Under Approach 1, any total salary growth above/below expected would be attributed to changes in productivity even when service-based increases may have changed. Approach 2 adjusts the service-based salary increase assumption when total salary growth varies from expected total salary growth. As a result of this adjustment, only a portion of total salary growth above/below expected would be attributed to changes in productivity.

We observed the salary growth from productivity from 1984 through 2014 under the two different approaches for assumed service-based salary increases and summarized the results in the table below.

Salary Growth from Productivity by System

	Approach 1					Approach 2				
Year	PERS	SERS	TRS	LEOFF	WSPRS	PERS	SERS	TRS	LEOFF	WSPRS
1984	1.24%	2.19%	4.32%	1.09%	5.33%	1.04%	1.48%	3.13%	0.89%	4.10%
1985	5.31%	5.36%	2.49%	1.27%	(0.42%)	4.27%	3.76%	2.25%	1.45%	0.17%
1986	2.45%	1.22%	2.74%	3.14%	(3.50%)	2.64%	2.05%	2.86%	3.14%	(2.02%)
1987	1.31%	1.98%	0.20%	(0.36%)	4.43%	1.36%	1.79%	0.58%	0.36%	3.54%
1988	1.13%	1.71%	1.80%	(0.14%)	(0.40%)	0.95%	1.25%	1.42%	0.11%	(0.14%)
1989	0.27%	(0.40%)	1.01%	(0.72%)	(0.82%)	(0.06%)	(0.57%)	0.46%	(0.77%)	(0.84%)
1990	(2.03%)	(1.19%)	(0.34%)	(0.51%)	(0.77%)	(2.40%)	(1.95%)	(1.24%)	(1.52%)	(1.54%)
1991	2.42%	0.55%	3.37%	(2.43%)	4.31%	1.20%	(0.27%)	1.79%	(2.15%)	2.50%
1992	1.80%	0.42%	2.68%	1.33%	(0.88%)	1.33%	0.37%	1.92%	0.92%	(0.55%)
1993	1.60%	2.53%	1.71%	1.13%	0.41%	1.37%	1.95%	1.43%	1.03%	0.55%
1994	(1.67%)	(3.02%)	(2.60%)	0.05%	(1.72%)	(1.15%)	(1.95%)	(1.69%)	0.10%	(1.12%)
1995	0.26%	(0.36%)	(1.35%)	0.47%	0.54%	0.43%	0.05%	(0.61%)	0.64%	0.66%
1996	0.64%	1.06%	0.96%	(0.35%)	3.30%	0.61%	0.89%	0.82%	(0.02%)	2.45%
1997	0.11%	(1.14%)	(2.26%)	(0.04%)	5.42%	0.26%	(0.61%)	(1.31%)	0.24%	4.17%
1998	1.08%	(0.19%)	1.26%	1.78%	2.92%	1.10%	0.21%	1.23%	1.57%	2.45%
1999	0.89%	0.44%	(2.42%)	0.51%	3.56%	0.84%	0.53%	(1.41%)	0.59%	2.78%
2000	0.62%	1.37%	2.62%	(0.90%)	(1.69%)	0.48%	0.99%	1.79%	(0.54%)	(1.15%)
2001	(0.23%)	(0.20%)	1.09%	(1.54%)	(1.67%)	(0.10%)	(0.06%)	0.82%	(0.87%)	(1.05%)
2002	2.99%	2.85%	2.08%	2.39%	1.01%	2.73%	2.58%	2.06%	2.25%	1.35%
2003	1.01%	2.80%	3.00%	0.82%	0.32%	1.37%	2.68%	2.80%	1.40%	0.97%
2004	0.58%	(0.34%)	(0.34%)	1.23%	(2.60%)	1.00%	0.42%	0.52%	1.59%	(1.01%)
2005	(0.56%)	(0.69%)	(0.92%)	0.37%	0.98%	(0.24%)	(0.27%)	(0.36%)	0.52%	0.92%
2006	0.82%	(1.00%)	(1.53%)	(0.43%)	2.04%	0.64%	(0.70%)	(1.00%)	(0.26%)	1.49%
2007	(0.87%)	(0.06%)	(0.26%)	(1.64%)	(1.34%)	(0.66%)	(0.04%)	(0.17%)	(1.09%)	(1.01%)
2008	2.44%	1.21%	0.85%	0.80%	1.98%	1.69%	0.76%	0.43%	0.31%	1.30%
2009	2.68%	4.40%	5.09%	3.87%	3.57%	2.85%	4.15%	4.60%	3.70%	3.52%
2010	0.37%	(0.51%)	(0.93%)	2.25%	(0.92%)	1.03%	0.33%	0.37%	2.52%	0.16%
2011	(2.58%)	(2.20%)	(2.02%)	(1.75%)	(3.41%)	(1.83%)	(1.55%)	(1.19%)	(0.95%)	(2.35%)
2012	(1.81%)	(2.48%)	(3.26%)	(1.15%)	(1.58%)	(1.15%)	(1.67%)	(1.87%)	(0.39%)	(0.80%)
2013	0.44%	0.34%	0.19%	0.97%	0.36%	0.87%	0.81%	0.93%	1.44%	0.95%
2014	1.64%	1.19%	0.73%	1.65%	2.18%	1.68%	1.33%	1.13%	1.72%	2.09%
Avg	0.79%	0.58%	0.64%	0.42%	0.67%	0.78%	0.60%	0.73%	0.58%	0.73%

We reviewed the table above, for all years, and observed the average salary growth from productivity will range from 0.42 percent to 0.79 percent under Approach 1 and range from 0.58 percent to 0.78 percent under Approach 2. The average salary growth from productivity, for all systems, was 0.62 percent under Approach 1 and 0.68 percent under Approach 2.

The average salary growth from productivity above includes lower than expected salary growth from 2010 through 2013 which is the result of temporary salary practices that occurred during the 2009-11 and 2011-13 Biennia in response to the Great Recession. We believe these temporary salary practices do not reflect future long-term salary experience.

We reviewed the table above, for years prior to 2010, and observed the average salary growth from productivity will range from 0.43 percent to 1.01 percent under Approach 1 and range from 0.52 percent to 0.90 percent under Approach 2. The average salary growth from productivity, for all systems, was 0.83 percent under Approach 1 and 0.79 percent under Approach 2.

Please note that PSERS was excluded from this analysis due to a lack of adequate experience data.

Expected Value

The average salary growth from productivity, for all systems, is either 0.79 percent or 0.83 percent depending on the selected approach for assumed service-based salary increases. We believe the current assumption of 0.75 percent developed as part of the 2015 EES remains appropriate.

Assumed Distribution or Formula

In the 2010 RA Report, we modeled real salary growth with distribution tables. We modeled the distribution table for PERS, SERS, and PSERS together as well as modeled distribution tables for TRS, LEOFF and WSPRS individually.

As noted above, we replaced real salary growth in our model with salary growth from productivity. We have also removed distribution tables for salary growth from productivity and replaced them with a single, fixed rate for all systems. The fixed rate is based on our expected value of 0.75 percent.

We decided to use a fixed rate for the following reasons:

- ❖ We determined that reasonable changes to this assumption (including assumed variability) did not have a material impact on our risk metrics. This is due, in part, to both the liabilities and salaries changing as a result of changes in this assumption and partially offsetting each other.
- ❖ Underlying assumptions will become more transparent and this change simplifies our model by reducing the sources of variability in general salary growth from two sources (inflation and salary growth from productivity) to a single and primary source (inflation).

Assumed Correlation

In the 2010 RA Report, we assumed real salary growth had a 0.60 correlation with a two year lagged real revenue growth. After performing analysis, we did not observe a strong correlation between salary growth from productivity and two year lagged real revenue growth. We also considered a correlation between salary growth from productivity and two year lagged investment returns, however, we did not observe a strong correlation with these measures either.

We believe a correlation between salary growth from productivity and either two year lagged real revenue growth or two year lagged investment returns makes sense, but the data does not support this assumption. We will continue to monitor correlations in the future.

For this study, we did not develop a correlation assumption for salary growth from productivity since we replaced the previous distributions with a single and static assumption. We also observed a strong correlation between PERS, SERS, TRS, and LEOFF salary growth from productivity which provides further support for a single assumption across all retirement systems.

MISCELLANEOUS ASSUMPTIONS

We studied three assumptions that are required to perform the underlying projections that inform our risk assessment, but the assumptions themselves are not necessary for our risk assessment. These assumptions include plan choice, system growth for open plans, and new entrant demographics.

Given the nature of these assumptions, we did not develop distribution tables or correlations for these three assumptions.

Plan Choice

How We Use the Assumption

When hired, new entrants of PERS, TRS, and SERS have the option to participate in either Plan 2 or Plan 3. We use the plan choice assumption to estimate the likelihood of a new entrant electing to join either Plan 2 or Plan 3.

Data We Used to Set the Assumption

In studying this assumption, we relied on data from the Department of Retirement Systems (DRS). DRS provided us with data from 2002 through 2015.

A new entrant has three options upon entering PERS, TRS, or SERS. They could elect to join Plan 2, elect to join Plan 3, or make no decision and join Plan 3 by default after ninety days. The data has been summarized in the table on the next page.

Year	PERS 2 Choice	PERS 3 Choice	PERS 3 Default	SERS 2 Choice	SERS 3 Choice	SERS 3 Default	TRS 2 Choice	TRS 3 Choice	TRS 3 Default
2002	64%	18%	18%						
2003	63%	15%	22%						
2004	63%	17%	19%						
2005	64%	17%	19%						
2006	66%	17%	16%						
2007	65%	17%	18%	51%	33%	16%	39%	46%	16%
2008	62%	17%	20%	48%	27%	25%	42%	37%	21%
2009	64%	15%	21%	51%	21%	28%	45%	33%	21%
2010	63%	14%	23%	50%	22%	28%	48%	29%	23%
2011	62%	14%	23%	50%	21%	28%	48%	30%	22%
2012	63%	15%	23%	53%	21%	26%	49%	30%	20%
2013	63%	14%	22%	51%	22%	27%	48%	30%	22%
2014	65%	16%	20%	51%	22%	27%	47%	30%	23%
2015	66%	15%	18%	50%	24%	26%	51%	31%	19%
Total	**64%**	**16%**	**20%**	**51%**	**23%**	**26%**	**47%**	**33%**	**21%**

The default plan is currently Plan 3 for PERS, TRS, and SERS. For this reason, we assume the likelihood of entering Plan 3 for each system is the sum of Plan 3 choice and the default percentage.

Expected Value

We currently assume two-thirds of new entrants will elect to join Plan 2 and one-third of new entrants will elect to join Plan 3 for PERS, TRS, and SERS. After analyzing the data, we expect no change in the PERS assumption. For TRS and SERS new entrants, however, we now expect a 50 percent likelihood of electing either Plan 2 or Plan 3.

Plan Choice Assumption*			
	PERS 2	TRS 2	SERS 2
Current Assumption	67%	67%	67%
New Assumption	67%	50%	50%

**Plan 3 choice assumption is 1 - Plan 2 choice.*

We assume future new entrants will have similar plan choice behavior as the historical data. The Legislature has considered changing the plan default from Plan 3 to Plan 2. Should that change occur in the future, we would update this analysis and assumptions.

System Growth for Open Plans

How We Use the Assumption

This assumption represents the annual percent increase in system membership over a 50 year period. The application of this assumption in our modeling, along with other demographic assumptions, allows us to estimate the total number of active members in each system for each year under a 50-year projection.

We also use this assumption to calculate Unfunded Actuarial Accrued Liability (UAAL) rates for PERS 1 and TRS 1. However, when used for this purpose, we apply the assumption over a ten-year period only.

Data We Used to Set the Assumption

In developing this assumption, we relied on system membership data from the DRS and Washington State historical and projected population data from the Office of Financial Management (OFM).

The DRS data was collected from prior valuations. We summarized each system individually.

OFM's website provides the historical Washington State population growth since 1970. We collected the data from the *November 2015 OFM State Population Forecast Report* which provided historical information from 1970 through 2015. For this analysis, we considered the data for all ages as well as ages 5 through 17 (the "school age" population).

The table below summarizes the historical growth from 1981 through 2015 for the Washington State retirement systems and the Washington State populations.

Historical Growth in WA Retirement System Data and WA Population									
Year	PERS	SERS	PSERS	PERS 1 UAAL*	TRS	LEOFF	WSPRS	All Ages WA Pop	Ages 5-17 WA Pop
1981	(4.17%)			(4.17%)	(0.11%)	1.12%		2.35%	(0.43%)
1982	(2.68%)			(2.68%)	(3.87%)	0.71%	(9.20%)	1.12%	(1.36%)
1983	4.35%			4.35%	(2.16%)	2.36%	4.32%	0.72%	(1.10%)
1984	4.60%			4.60%	3.15%	2.04%	(3.89%)	1.09%	0.01%
1985	3.88%			3.88%	1.94%	2.40%	(1.89%)	1.42%	1.31%
1986	2.01%			2.01%	1.76%	1.26%	11.95%	1.05%	0.78%
1987	5.12%			5.12%	1.55%	3.03%	3.56%	1.45%	1.14%
1988	6.07%			6.07%	2.43%	4.38%	1.90%	1.98%	1.41%
1989	4.46%			4.46%	1.72%	3.17%	0.70%	2.41%	1.77%
1990	7.97%			7.97%	4.34%	4.40%	3.58%	2.93%	3.54%
1991	9.83%			9.83%	2.84%	4.23%	10.70%	3.18%	4.21%
1992	4.21%			4.21%	4.73%	2.07%	1.91%	2.39%	3.17%
1993	1.53%			1.53%	2.34%	2.30%	(3.56%)	2.42%	3.31%
1994	1.65%			1.65%	2.05%	3.84%	(1.84%)	1.87%	2.83%
1995	0.78%			0.78%	2.38%	3.14%	(5.95%)	1.97%	2.99%
1996	2.11%			2.11%	0.54%	2.25%	1.78%	1.79%	2.54%
1997	2.10%			2.10%	2.34%	2.19%	1.09%	1.72%	2.21%
1998	2.90%			2.90%	1.67%	1.04%	0.22%	1.52%	1.12%
1999	2.36%			2.36%	1.38%	4.33%	4.20%	1.41%	0.57%
2000				1.84%	1.87%	1.22%	4.65%	1.09%	(0.03%)
2001	0.44%	1.30%		0.65%	3.70%	1.83%	1.38%	1.29%	0.14%
2002	0.82%	2.99%		1.34%	(0.24%)	1.73%	0.78%	1.49%	0.41%
2003	0.24%	(1.16%)		(0.10%)	0.02%	2.59%	4.25%	1.12%	(0.02%)
2004	1.10%	1.30%		1.15%	0.85%	0.33%	(2.04%)	1.33%	0.20%
2005	(0.43%)	0.99%		(0.09%)	0.95%	1.85%	(3.31%)	1.45%	0.39%
2006		0.93%		0.97%	0.69%	2.66%	0.00%	1.93%	1.00%
2007	1.93%	0.01%	32.90%	1.77%	(4.13%)	1.83%	1.47%	1.63%	0.44%
2008	2.31%	1.87%	44.50%	2.75%	2.44%	2.62%	4.63%	1.27%	(0.26%)
2009	(1.50%)	1.35%	9.02%	(0.63%)	1.30%	1.53%	0.83%	0.97%	(0.46%)
2010	(1.70%)	(0.26%)	(3.00%)	(1.38%)	(1.58%)	(1.33%)	(0.64%)	0.79%	0.12%
2011	(2.63%)	(0.01%)	(0.55%)	(1.94%)	(0.18%)	(0.12%)	(0.46%)	0.64%	(0.55%)
2012	(1.20%)	(1.48%)	1.50%	(1.21%)	(1.28%)	(0.87%)	(1.48%)	0.74%	0.04%
2013	0.08%	1.43%	6.19%	0.54%	0.88%	(0.45%)	0.00%	0.95%	0.52%
2014	1.16%	2.84%	6.80%	1.71%	2.06%	0.37%	(2.06%)	1.25%	0.85%
2015	0.55%	3.76%	7.93%	1.54%	2.27%	1.23%	(0.86%)	1.34%	0.94%

**Reflects the annual change in growth for PERS, SERS, and PSERS combined.*

The PERS data for 2000 and 2006 has been removed from the table as a result of some eligible PERS members transferring to SERS (2000) and PSERS (2006).

The average system growth and population growth, over varying time periods, is summarized in the table on the next page.

Average System Growth									
	PERS	SERS	PSERS	P1 UAAL	TRS	LEOFF	WSPRS	All Ages WA Pop	Ages 5-17 WA Pop
Last 30 years	1.94%			2.07%	1.39%	1.95%	1.25%	1.58%	1.18%
Last 20 years	0.59%	1.06%		0.92%	0.78%	1.34%	0.72%	1.29%	0.51%
Last 10 years	(0.11%)	1.04%	11.70%	0.41%	0.25%	0.75%	0.14%	1.15%	0.27%
Last 5 years	(0.41%)	1.31%	4.37%	0.13%	0.75%	0.03%	(0.97%)	0.98%	0.36%

Note: P1 UAAL reflects the annual change for PERS, SERS, and PSERS combined.

In general, we observed a downward trend in system growth among the Washington State retirement systems due to relatively low system growth rates during the 2009-11 and 2011-13 Biennia. The 2009-11 and 2011-13 Biennia reflect temporary legislative practices that impacted system growth such as hiring freezes as a result of the Great Recession.

We also observed a downward trend in Washington State population growth rates similar to the Washington State retirement systems. OFM expects the downward trend to continue into the future as summarized in the table below.

Projected Washington Population Growth								
Year	All Ages	Ages 5-17	Year	All Ages	Ages 5-17	Year	All Ages	Ages 5-17
2016	1.33%	0.87%	2025	1.01%	0.51%	2034	0.83%	0.65%
2017	1.29%	0.89%	2026	0.99%	0.45%	2035	0.81%	0.55%
2018	1.20%	0.74%	2027	0.97%	0.58%	2036	0.79%	0.50%
2019	1.13%	0.65%	2028	0.96%	0.63%	2037	0.78%	0.47%
2020	1.09%	0.87%	2029	0.94%	0.71%	2038	0.76%	0.46%
2021	1.05%	0.82%	2030	0.92%	0.63%	2039	0.75%	0.46%
2022	1.04%	0.80%	2031	0.90%	0.63%	2040+	0.74%	0.46%
2023	1.04%	0.75%	2032	0.88%	0.69%			
2024	1.02%	0.75%	2033	0.85%	0.63%			

Our projections for the Washington State retirement systems span a 50-year period and require assumptions on system growth from 2016 through 2065. For this analysis we relied upon OFM's projected Washington State population growth. OFM's forecast ends at 2040. We assumed annual population growth rates of 0.74 percent (all ages) and 0.46 percent (ages 5 through 17) for 2041 through 2065. This matches the annual population growth rate at 2040 from OFM's forecast.

Expected Value

We developed this assumption under a "select and ultimate" format. A select and ultimate format allows us to vary the assumption by time period. The select period represents a shorter time period and the ultimate period represents all time periods after the select period. For this assumption, we set the growth rates in the select period equal to the system growth rates we apply under the Plan 1 funding method to maintain consistency between the two assumptions.

As part of the 2015 Economic Experience Study (EES), we determined a ten-year assumption for system growth (Growth in System Membership assumption) which is used to project payroll for amortizing the Plan 1 UAAL over a rolling ten-year period. We recommended a 0.95 percent assumption for systems that contribute to PERS 1 UAAL payroll (PERS, SERS, PSERS) and a 1.25 percent assumption for TRS. The recommendations during the 2015 EES will represent our select time period assumption and will apply from 2016 through 2025.

To determine the ultimate time period assumption we followed the approach described below.

1. **We reviewed the annual magnitude of system growth relative to state population growth.** Using historical data we calculated system growth as a percent of population growth. The system growth as a percent of population growth represents our magnitude factor over a designated time period. In this approach the magnitude factor tells us how the system growth moves in relation to the population growth. We divided the average system growth by the applicable average population growth for the same period.

Magnitude Factor						
	PERS*	SERS*	PSERS*	TRS	LEOFF	WSPRS
Time Period	1993-2009	1993-2009	1993-2009	1990-2015	1990-2015	1982-2009
Average Growth						
System Growth	1.36%	1.36%	1.36%	1.32%	1.80%	1.15%
Population Growth	1.55%	1.55%	1.55%	1.16%	1.56%	1.64%
Magnitude Factor	88%	88%	88%	113%	116%	70%

**Consistent with the 2015 EES, the historical system growth for PERS, SERS, and PSERS were combined to determine the magnitude factor. Current positions under SERS and PSERS were previously covered under PERS.*

The average system growth for all systems, except TRS, were compared to the general Washington State population growth. The average system growth for TRS was compared to the Washington State ages 5 through 17 population growth since we assume TRS will grow comparable to the growth rate of school age children.

2. **We used OFM's population projections to determine future system growth prior to any adjustments for future expectations.** We relied on OFM's state population forecasts for our assumed population growth. Our method for calculating our projected average annual system growth is as follows: We used OFM's average projected population growth and multiplied it by our assumed long-term ratio of system growth as a percent of state population growth (Step 1).

Ultimate Rate (Unadjusted)						
	PERS	SERS	PSERS	TRS	LEOFF	WSPRS
Time Period	2026-2065	2026-2065	2026-2065	2026-2065	2016-2065	2016-2065
Avg Population Growth	0.78%	0.50%	0.78%	0.50%	0.85%	0.85%
Magnitude Factor	88%	88%	88%	113%	116%	70%
Ultimate Rate (unadjusted)	0.69%	0.44%	0.69%	0.57%	0.98%	0.59%

The ultimate time periods for LEOFF and WSPRS are ten years longer than the other systems because we do not apply a select period format for those systems. In other words, the assumptions under the select and ultimate periods do not vary for those two systems.

We used general Washington State population growth for PERS, PSERS, LEOFF, and WSPRS. For TRS and SERS, we used Washington State ages 5 through 17 population growth. We assume there will be a relationship between the school age population and the number of school employees.

3. **Adjustments for future expectations.** We now had the projected ultimate system growth rate based on the long-term magnitude of system growth relative to state population growth, however, we applied downward (or upward) adjustments to reflect our expectations on future system growth.

PERS and PSERS

In the 2004 Legislative Session, House Bill 2537 allowed certain members of PERS to transfer to a recently created plan (PSERS). We estimated 7,200 PERS members were eligible to transfer to PSERS under the bill. DRS reported that 1,857 of the eligible members had elected to transfer to PSERS. The future replacements of the remaining PERS members who were eligible to transfer will be placed in PSERS. As a result, PSERS will continue to see higher than expected system growth in the future as the eligible members continue to be replaced.

We estimate 2,700 PERS members are currently active who were previously eligible to transfer to PSERS. We determined this estimate using average member demographic data (at June 30, 2002) as well as assumptions consistent with the *2014 Actuarial Valuation Report* (AVR).

We applied a -3 percent adjustment to PERS and a 110 percent adjustment to PSERS such that the 2065 projected headcount changed by approximately 2,700 members.

LEOFF and WSPRS

Historically, LEOFF has displayed greater system growth than the general Washington State population growth. In our opinion, the state economy and current taxing structure cannot support the continuation of this trend in the long run. As a result, we applied a -18 percent adjustment to LEOFF such that LEOFF is projected to grow at a rate 5 percent less than the projected 50-year average Washington State population growth.

WSPRS has not had a system growth rate above zero percent in six years. We expect higher system growth rates in WSPRS as a result of new recruiting and salary policies designed to help increase the number of active members. Furthermore, we believe some of the expected decline in the growth of LEOFF membership could provide an additional source of future growth in WSPRS membership. For this reason, we applied a 43 percent adjustment to WSPRS such that the WSPRS system growth is consistent with the projected 50-year average Washington State population growth.

TRS and SERS

Historically, TRS has displayed greater system growth than the Washington State ages 5 through 17 population growth. As noted in the EES, we expect this trend to continue over the next ten years and we include higher system growth rates for TRS during the select period. However, for reasons similar to the reasons we noted above for LEOFF, we do not expect this trend to continue in the long run. As a result, we applied a -11 percent adjustment to the TRS ultimate rate such that TRS is projected to grow at a rate consistent with the 2026 through 2065 average projected Washington State ages 5 through 17 population growth.

We made no adjustments to SERS.

The calculated ultimate rates (after application of adjustment) are summarized in the table below.

Ultimate Rate						
	PERS	SERS	PSERS	TRS	LEOFF	WSPRS
Time Period	2026-2065	2026-2065	2026-2065	2026-2065	2016-2065	2016-2065
Ultimate Rate (unadjusted)	0.69%	0.44%	0.69%	0.57%	0.98%	0.59%
Adjustment	(3%)	0%	110%	(11%)	(18%)	43%
Ultimate Rate	0.66%	0.44%	1.44%	0.50%	0.80%	0.85%

The final select and ultimate time period assumptions are summarized in the table below. Please note that for simplicity we rounded the ultimate time period system growth rate to the nearest 5 percent. For comparison, we also provided the current assumption.

System Growth for Open Plans Assumption						
	PERS	SERS	PSERS	TRS	LEOFF	WSPRS
Current Assumption	0.95%	0.95%	0.95%	0.80%	1.25%	0.95%
New Assumption						
Select Period	0.95%	0.95%	0.95%	1.25%	N/A	N/A
Ultimate Period	0.65%	0.45%	1.45%	0.50%	0.80%	0.85%

New Entrant Demographics

How We Use the Assumption

We use this assumption to estimate the demographic characteristics (or demographics) of future new entrants in the Washington State retirement systems. This assumption is required to perform an open-group projection of the retirement systems. We use open-group projections for our risk assessment.

To model new entrants, we develop assumptions for each new entrant age cohort by gender. For each age cohort, we estimate the percentage of new entrants that comprise the cohort (the "weighting" or "weight") and their average entry age and average annual salary.

Data We Used to Set the Assumption

To study the new entrant demographics, we relied on valuation data from DRS. We began with valuation data from 2000 through 2015. We considered a new entrant to be a member who ended the valuation year as "active" but began the valuation year as either "terminated" or had no prior history in the plan. Additionally, we assumed a new entrant would have less than one year of service in the given valuation year.

We summarized the new entrant data into seven age-based cohorts (age < 25, age 25 to 30, age 30 to 35, age 35 to 40, age 40 to 45, age 45 to 50, and age > 50). We studied males and females together and developed blended cohorts for age and salary. The weightings by cohort, however, do vary by gender based on our percent male assumption.

We considered all years of data but ultimately decided to remove some data. Members of TRS and SERS did not have the option to elect to join Plan 2 from 2000 through 2007. We did not include this data since new entrant demographics in Plan 3 may not be representative of the typical Plan 3 population. We also did not include valuation year 2008 for TRS and SERS since this is the first year of available data (after the re-opening of Plan 2) for both plans and there is no salary increase from the prior year. We considered the inclusion of all years of data in PERS but ultimately decided to keep a time period consistent with TRS and SERS due to the relatively small impact of including additional years of data on our expected values. For PSERS, we also studied a time period consistent with PERS, TRS, and SERS due to the early fluctuations in new entrant headcounts as a result of the opening of the plan. Lastly, we removed valuation year 2000 for LEOFF since this is the first year of data for our study and we did not have a percent salary increase from the prior year.

Observed Time Period for Each System					
PERS	TRS	SERS	PSERS	LEOFF	WSPRS*
2009-2015	2009-2015	2009-2015	2009-2015	2001-2015	2003-2015

No observed new entrants in WSPRS from 2000 through 2002.

Expected Value

The three new entrant demographic assumptions for each plan were determined as follows:

- **Percent of the New Entrant Population ("Weight"):** This represents the observed number of new entrants, within each cohort, divided by the plan's total observed number of new entrants.
- **Salary:** Unless noted otherwise, this reflects the annual salary from the 2015 valuation data file for each cohort. The salary was rounded to the nearest $1,000.
- **Entry Age:** This reflects the entry age from the 2015 valuation data file for each cohort.

New Entrant Profiles											
PERS 2				PERS 3				TRS 2			
Age	Salary	Sex	Weight*	Age	Salary	Sex	Weight*	Age	Salary	Sex	Weight*
22.0	$36,000	M	8.7%	22.0	$33,000	M	11.9%	23.1	$51,000	M	7.0%
22.0	$36,000	F	8.7%	22.0	$33,000	F	11.9%	23.1	$51,000	F	16.4%
27.0	$40,000	M	9.9%	27.0	$37,000	M	10.9%	26.8	$55,000	M	8.3%
27.0	$40,000	F	9.9%	27.0	$37,000	F	10.9%	26.8	$55,000	F	19.3%
31.9	$44,000	M	7.7%	31.9	$42,000	M	7.6%	31.8	$58,000	M	5.0%
31.9	$44,000	F	7.7%	31.9	$42,000	F	7.6%	31.8	$58,000	F	11.7%
37.0	$46,000	M	5.8%	36.9	$43,000	M	5.2%	36.9	$59,000	M	3.1%
37.0	$46,000	F	5.8%	36.9	$43,000	F	5.2%	36.9	$59,000	F	7.3%
41.9	$47,000	M	5.0%	42.1	$45,000	M	4.4%	41.9	$60,000	M	2.5%
41.9	$47,000	F	5.0%	42.1	$45,000	F	4.4%	41.9	$60,000	F	5.8%
46.9	$45,000	M	4.4%	46.9	$47,000	M	3.7%	46.8	$62,000	M	1.8%
46.9	$45,000	F	4.4%	46.9	$47,000	F	3.7%	46.8	$62,000	F	4.2%
55.7	$47,000	M	8.4%	56.2	$47,000	M	6.2%	55.0	$64,000	M	2.3%
55.7	$47,000	F	8.4%	56.2	$47,000	F	6.2%	55.0	$64,000	F	5.3%

Weighted totals may not sum to 100% due to rounding.

New Entrant Profiles											
TRS 3				SERS 2				SERS 3			
Age	Salary	Sex	Weight*	Age	Salary	Sex	Weight*	Age	Salary	Sex	Weight*
23.1	$51,000	M	7.1%	21.8	$21,000	M	2.4%	21.8	$20,000	M	2.9%
23.1	$51,000	F	16.6%	21.8	$21,000	F	9.6%	21.8	$20,000	F	11.7%
26.8	$55,000	M	8.7%	26.9	$23,000	M	2.2%	27.0	$23,000	M	2.7%
26.8	$55,000	F	20.4%	26.9	$23,000	F	8.9%	27.0	$23,000	F	10.9%
31.8	$58,000	M	4.7%	32.2	$22,000	M	2.5%	32.1	$22,000	M	2.6%
31.8	$58,000	F	10.9%	32.2	$22,000	F	9.9%	32.1	$22,000	F	10.3%
36.9	$60,000	M	3.2%	37.0	$21,000	M	3.0%	37.0	$20,000	M	3.0%
36.9	$60,000	F	7.6%	37.0	$21,000	F	11.9%	37.0	$20,000	F	12.1%
42.0	$61,000	M	2.6%	42.0	$21,000	M	3.1%	42.0	$21,000	M	3.1%
42.0	$61,000	F	6.0%	42.0	$21,000	F	12.2%	42.0	$21,000	F	12.4%
46.8	$61,000	M	1.7%	46.8	$22,000	M	2.4%	46.8	$21,000	M	2.4%
46.8	$61,000	F	4.0%	46.8	$22,000	F	9.8%	46.8	$21,000	F	9.8%
54.7	$68,000	M	1.9%	55.9	$22,000	M	4.4%	55.9	$22,000	M	3.2%
54.7	$68,000	F	4.5%	55.9	$22,000	F	17.7%	55.9	$22,000	F	12.8%

Weighted totals may not sum to 100% due to rounding.

New Entrant Profiles											
PSERS 2				LEOFF 2				WSPRS 2			
Age	Salary	Sex	Weight*	Age	Salary	Sex	Weight*	Age	Salary	Sex	Weight*
22.8	$42,000	M	14.2%	23.1	$60,000	M	16.7%	23.0	$48,000	M	27.7%
22.8	$42,000	F	6.1%	23.1	$60,000	F	1.9%	23.0	$48,000	F	3.1%
26.8	$43,000	M	20.7%	27.0	$64,000	M	31.9%	26.1	$48,000	M	32.7%
26.8	$43,000	F	8.9%	27.0	$64,000	F	3.5%	26.1	$48,000	F	3.6%
32.0	$44,000	M	11.7%	31.7	$64,000	M	21.3%	31.6	$48,000	M	20.5%
32.0	$44,000	F	5.0%	31.7	$64,000	F	2.4%	31.6	$48,000	F	2.3%
37.0	$44,000	M	7.9%	36.6	$65,000	M	10.8%	36.9	$48,000	M	4.1%
37.0	$44,000	F	3.4%	36.6	$65,000	F	1.2%	36.9	$48,000	F	0.5%
42.0	$44,000	M	6.9%	41.6	$65,000	M	5.1%	41.5	$48,000	M	2.7%
42.0	$44,000	F	2.9%	41.6	$65,000	F	0.6%	41.5	$48,000	F	0.3%
46.8	$46,000	M	4.6%	47.0	$72,000	M	2.2%	46.3	$48,000	M	1.8%
46.8	$46,000	F	2.0%	47.0	$72,000	F	0.2%	46.3	$48,000	F	0.2%
55.7	$48,000	M	4.0%	53.7	$90,000	M	2.1%	50.0	$48,000	M	0.5%
55.7	$48,000	F	1.7%	53.7	$90,000	F	0.2%	50.0	$48,000	F	0.1%

Weighted totals may not sum to 100% due to rounding.

After determining the total weighting for each cohort (males and females combined), we determined the weighting for each gender by applying our current percent male assumption to the total weighting. We developed the percent male assumption as part of the 2007-12 Demographic Experience Study. Please see the table below for the percent male assumption for each system.

Percent Male Assumption					
PERS	TRS	SERS	PSERS	LEOFF	WSPRS
50%	30%	20%	70%	90%	90%

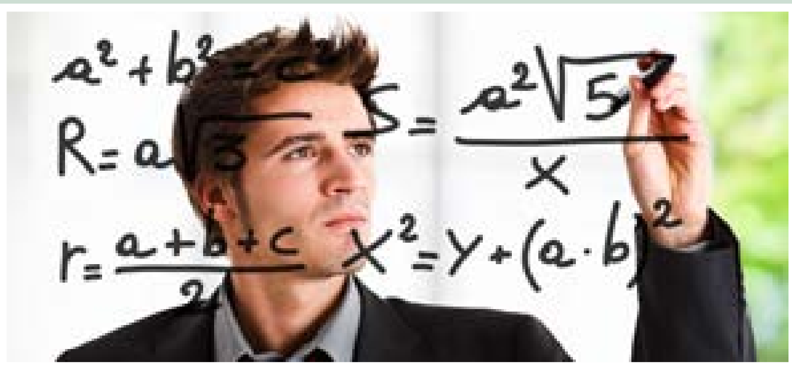
We made some adjustments to observed salary for LEOFF and WSPRS as noted below:

- **LEOFF:** We observed an approximate 34 percent increase in average salary from the prior year for the "age >50" cohort. We chose an average salary increase from the prior year that was approximately half of that for the "age >50" cohort's 2015 valuation new entrant salary. The "age > 50" cohort's average salary can fluctuate as a result of low new entrant headcounts (less than twenty new entrants annually).

- **WSPRS:** We observed the number of WSPRS new entrants to be volatile from one year to the next and the observed number of new entrants are low relative to other systems. For this reason, we assumed the 2015 valuation average new entrant salary for all age based cohorts.

We considered additional approaches to our new entrant demographics including:

- To address the volatility of new entrant salaries we observe each year, we considered an approach that applies a trend line to future new entrant salaries based on observed salary increases. We decided to develop a simplified approach that accomplishes a similar outcome with less work and complication.
- We currently age our new entrant demographics (assume a group older than what we currently observe) to estimate the aging we expect to see for future new entrants. We reviewed our current "aging" assumption during this study and decided to remove it. With the exception of the "age > 50" cohort, we expect the age cohorts to remain relatively stable because the working age population is not aging like the overall population. We will continue to monitor this assumption and will reflect any aging that may occur as it occurs over time instead of anticipating a certain degree of aging today.



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