

**SENSITIVITY ANALYSIS OF
COLORADO PUBLIC EMPLOYEES' RETIREMENT ASSOCIATION
HYBRID DEFINED BENEFIT PLAN
ACTUARIAL ASSUMPTIONS**

October 2015

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October 1, 2015

Members of the Legislative Audit Committee:

This report contains the results of a study of the Sensitivity of Colorado Public Employees' Retirement Association's (PERA) Hybrid Defined Benefit Plan. The study was conducted pursuant to Section 24-51-614, C.R.S., which requires the State Auditor, with the concurrence of PERA, to retain a nationally recognized and enrolled actuarial firm with experience in public sector pension plans to conduct a sensitivity analysis of PERA's actuarial assumptions to determine when from an actuarial perspective, model assumptions are meeting targets and achieving sustainability. The report presents our findings and conclusions.

The work presented herein is based on data furnished by PERA and through actuarial analysis, calculations and research performed by us. We gratefully acknowledge the cooperation of the Office of the State Auditor (OSA) and PERA, without whose assistance this project could not have been completed.

The work presented in this study relies on the actuarial work conducted by PERA's actuaries, and incorporates the actuarial assumptions approved by the PERA Board of Trustees. As with any actuarial study which engages in the prediction of future outcomes, to the extent future experience differs from the assumptions, then the actuarial outcomes will similarly differ.

The actuaries submitting this statement include members of the American Academy of Actuaries and meet all of the Qualification Standards of the American Academy of Actuaries to render the actuarial opinion contained herein. In addition, the undersigned are experienced in performing actuarial valuations for other large public retirement systems.

Respectfully Submitted,

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Table of Contents

Chapter One: Report Highlights.....	1
Chapter Two: Methodology	2
Chapter Three: Background.....	5
3.1 Overview	5
3.2 PERA Divisions.....	5
3.3 PERA is a Hybrid Defined Benefit Plan	6
3.4 PERA Administration and Role of Board of Trustees	8
3.5 PERA Trust Funds	9
3.6 Recent Changes to PERA	9
Chapter Four: PERA Actuarial Funding and Terminology	11
4.1 PERA Contribution Amounts	11
4.2 The Actuarial Valuation Process and Actuarial Assumptions	12
4.3 Actuarial Measures	14
4.4 Current Full Funding Date Measures	16
Chapter Five: Understanding PERA Projections	18
5.1 Projected UAAL	18
5.2 Projected UAAL/Member Pay	19
5.3 Projected Funded Ratios	20
5.4 Resources Available to Amortize the UAAL.....	21
Chapter Six: Recent History and Experience	23
6.1 Recent Funded Status History	24
6.2 Actuarial Assumptions Gain and (Loss) History	25
6.3 History and Comparison of the Increases in the UAAL.....	27
Chapter Seven: One-Year Assumption Variability.....	29
7.1 One-Year Variability	29
Chapter Eight: Actuarial Assumption Sensitivity.....	31
8.1 Actuarial Assumptions	31
8.2 Sensitivity Analysis of Investment Return Assumption	32
8.3 Sensitivity Analysis of Demographic Assumptions	40
8.4 Sensitivity Analysis of Mortality after Retirement Assumption.....	43
8.5 Sensitivity Analysis of Salary Growth Assumptions	45
8.6 Sensitivity Analysis of Member Growth Assumption	49
8.7 Sensitivity Analysis of Statutory Contribution Schedule	53

Chapter Nine: Signal Light for Assessing PERA	55
9.1 Simplified Annual Reporting Objectives	55
9.2 Development of Signal Light	56
9.3 December 31, 2014 Signal Lights	57
9.4 Illustration of Complete Signal Light for State Division	58
9.5 Signal Lights for Other Uncertainties	59
9.6 Combined Signal Lights for Statistical Uncertainties	62
9.7 Five-Year Short Term Signal Light	64
9.8 One-Year Short Term Signal Light	66
9.9 Additional Considerations.....	67
Chapter Ten: Case Study – Application of Signal Lights Beginning in 2008	69
10.1 December 31, 2008 Signals	70
10.2 December 31, 2009 Signals	72
10.3 Summary Signal Lights for December 31, 2010-2014.....	74
10.4 Detailed Signal Lights for December 31, 2010-2014	77
10.5 Summary of Signal Lights for December 31, 2010-2014	83
10.6 Changes in Projected Full Funding Dates from 2009-2014	83
Chapter Eleven: Further Analysis of PERA - Progress toward Full Funding by 2041	84
11.1 Senate Bill 10-001	84
11.2 Full Funding Projections 2009-2014.....	85
11.3 PERA Experience Compared to Assumptions 2010-2014	85
11.4 Analysis of 2010-2014 PERA Experience	87
11.5 Effect of Pay and Population Growth on Projections	87
11.6 Observations	89
Chapter Twelve: Funding Policy and Funding Objective	91
12.1 PERA Funding Policies and Objectives.....	91
12.2 Developing a Sound Coordinated Funding Policy.....	92
Chapter Thirteen: Other Issues.....	95
13.1 DPS Division Adjusted Employer Contributions	95
13.2 Optional Defined Contribution (DC) Plan for Certain State Employees.....	96
13.3 Actuarial Audits.....	96
Chapter Fourteen: Conclusions	98
14.1 Key Findings	98
Appendix A: Historical Gains/Losses All Divisions.....	101
Appendix B: Historical Gains/Losses State and School Divisions	105

Appendix C: Historical Gains/Losses Local Government Division	108
Appendix D: Historical Gains/Losses Judicial Division	111
Appendix E: Historical Gains/Losses Denver Public Schools Division.....	114
Appendix F: Statistical Techniques	117
Appendix G: PERA Funding Policy.....	124
Appendix H: Signal Light Methodology.....	133

REPORT HIGHLIGHTS



SENSITIVITY ANALYSIS OF COLORADO PERA HYBRID DEFINED BENEFIT PLAN ACTUARIAL ASSUMPTIONS, October 2015

KEY FACTS AND FINDINGS

- A determination that a retirement plan will achieve **full funding is the most important indicator** of actuarial soundness and sustainability, because it means benefits are secure and the Plan has met its obligations systematically and responsibly.
- Projections of when full funding will be achieved are based on **actuarial assumptions**, which are:
 - **Key drivers** of the projected full funding date
 - Approved by the PERA Board of Trustees based on PERA experience, professional standards, independent recommendations, and long-term expected results
- The PERA Hybrid Defined Benefit Plan is **currently on track** to be fully funded by 2052-2053 based on current actuarial assumptions. Prior to the changes in Senate Bill 10-001, insolvency was projected.
- Actual **experience may vary** significantly from assumptions — particularly over short periods, resulting in full funding **dates significantly different** (sooner or later) from current projections.
 - **Investment return** has the widest range of variability and has the **biggest impact** on the full funding date.
 - PERA population growth has a significant impact but is more difficult to detect under current reporting.
 - If mortality continues to improve beyond 2020, the full funding date will likely be later than now estimated
 - Other assumption variability has far less impact.
- Even though investment returns have been strong, the current projected full funding dates for the PERA Hybrid Plan are later than projected when Senate Bill 10-001 passed, This is due to:
 - **Reducing the actuarial assumed investment rate to 7.50%**
 - **Lower** than expected **population growth**
- We calculate:
 - **A 33% likelihood of investment returns exceeding 8.6% and the Plan meeting the 2041 target.**
 - **A 51% chance** of investment returns above 7.4%, resulting in the State Division **being fully funded by 2055.**
 - A 28% chance that 40-year average investment returns will be below 6.1%, the **minimum necessary to remain solvent.**

BACKGROUND

This study explores the role and variability of actuarial assumptions in projecting the most likely future funded status of the PERA Hybrid Defined Benefit Plan.

The Plan provides lifetime retirement benefits to its members that are financed by employer and member contributions as well as investment earnings. For the Plan to be sustainable, its resources (contributions and investment return) must equal its liabilities for future benefits for all members. The goal of any retirement system is to accumulate sufficient assets to fully fund all of its future obligations under current law.

This study considers:

- The growth in Unfunded Liabilities over the past 16 years since the Plan was fully funded and the causes of that growth.
- The effect of past and future variability of each actuarial assumption and its likely impact on the date of full funding.
- A signal light format that accomplishes an expanded reporting of the Plan's funded status and includes the likelihood of achieving full funding objectives.
- A look-back at the Plan's progress since the adoption of Senate Bill 10-001, which was intended to result in full funding by 2041.

An equally important objective of this report is to develop an understandable format for communicating the Plan's funding progress. The goal is to provide actionable information that both PERA and the General Assembly will find useful in developing sound public policy with regard to the Plan. Specifically, the signal light format will provide the basis for deciding if, and when, consideration of changes in funding or benefits provided is advisable to accomplish funding objectives.

KEY RECOMMENDATIONS

- 1) PERA should utilize the proposed **signal light reporting** annually to give policymakers an assessment of the current projected full funding dates compared to the objective. The investment return required (and the likelihood) of maintaining, improving, or declining from the current signal should also be determined periodically and whenever significant changes have occurred. Other metrics should also be considered.
- 2) PERA should expand its annual reporting to **include the causes for any changes in the expected full funding dates.**
- 3) PERA should ensure that future actuarial audits include a **confirmation** of the multi-year actuarial **projections** currently used to determine the full funding date.

Chapter Two: Methodology

During the 2014 Legislative Session, the Colorado General Assembly passed Senate Bill 14-214, which required the State Auditor to contract with a nationally recognized and enrolled actuarial firm to conduct a sensitivity analysis of the Colorado Public Employees' Retirement Association's (PERA) Hybrid Defined Benefit Plan (PERA Hybrid Plan or PERA Plan). Specifically, Section 24-51-614(6), C.R.S. requires a study of the PERA Hybrid Plan that "will focus on conducting a sensitivity analysis of PERA's actuarial assumptions to determine when, from an actuarial perspective, model assumptions are meeting targets and achieving sustainability."

In accordance with Senate Bill 14-214, this report will determine when, from an actuarial perspective:

1. Model assumptions will meet targets and achieve sustainability.
2. Deviations in model assumptions have resulted in the existing plan terms and provisions no longer meeting targets and achieving sustainability, which could trigger a potential need for legislative action.

Chapter Three provides **background** information on the PERA Hybrid Plan. It explains the basic provisions of PERA, as well as its governance structure and key pension fund statistics.

Chapter Four builds upon a basic understanding of PERA design and structure and provides basic information on **actuarial funding** of PERA. This chapter also describes various types of actuarial studies and includes key actuarial data such as Unfunded Actuarial Accrued Liability, Amortization Period, and Funding Ratio.

Chapter Five analyzes the **projections** that PERA currently develops and reports and highlights key findings. These projections are a measure of adherence to current funding policy.

Chapter Six analyzes the varied PERA **past experience since 1999** in order to build a foundation for considering potential future experience.

Chapter Seven considers the long term impact that even a **single year** can have on future funding.

Chapter Eight analyzes each area of potential **variability** and its impact on future funding. This is done for each of the major **actuarial assumptions** and considers various possibilities.

Chapter Nine develops a **signal light** methodology and simplified format for reporting the significance of the variability on achieving funding goals so that policymakers have an understandable picture of both the current funded status of PERA and the conditions that will improve, or weaken, that status in the future.

Chapter Ten **looks back over the period since 2008** to analyze what the signal light methodology would have indicated.

Chapter Eleven analyzes and quantifies the **specific causes** for the delay in funding period since Senate Bill 10-001.

Chapter Twelve provides a discussion of **funding policy** and goals and the importance of a well-defined and understood objective.

Chapter Thirteen summarizes **other concerns**, including unique Denver Public Schools (DPS) issues, the Defined Contribution alternative, and actuarial audits.

Chapter Fourteen summarizes **key findings**.

The process used to assess the sustainability of a retirement plan includes an actuarial valuation. Actuarial valuations and related actuarial studies are based on actuarial assumptions. The PERA Board of Trustees, with the recommendation of the PERA actuary, adopts these actuarial assumptions for the PERA Hybrid Plan. The Board of Trustees regularly adopts changes in the actuarial assumptions to reflect future outlooks, including reducing the long-term investment return forecasts from 8.75% in 2002 to 7.50% in 2013.

A sensitivity analysis assesses the historical variability and the likelihood of potential future variability of the actual PERA experience compared to these assumptions, and the impact of that variability on the future funded status of PERA, and is a key part of this review. This analysis will illustrate which assumptions are the most important, which are likely to have the most variability, and their significance.

Additionally, we have developed a simplified annual signal light reporting format that provides policymakers additional information that can be used to assist in assessing the sustainability of PERA, what is required to achieve full funding targets, and the likelihood that full funding targets will be met in the future. The signal light methodology specifically looks at the impact that variances in actual future experience compared to assumptions will have on the sustainability of the PERA Hybrid Plan and on the number of years until 100% funding can be achieved.

Finally, this report reviews the PERA experience since the major reform changes adopted in 2010 under Senate Bill 10-001 and the progress of PERA in achieving the full funding goals set as part of that legislation.

This report and analysis consider the current PERA benefit and funding structure only, since any possible future changes would be speculative and not precisely defined. During the 2015 Colorado Legislative Session, several changes were considered that could have a very significant impact on the PERA Hybrid Plan in the future. These included:

- The possible issuance of Pension Obligation Bonds (not passed)
- An expansion of the option to elect a Defined Contribution plan for new and existing members (not passed)
- Modifications to the Denver Public Schools Division future employer funding schedule (passed)

If significant changes to the current structure like the above are considered in the future, they would require additional analysis as to the specific impact on PERA's expected future funded status and its variability due to the actuarial assumptions.

Chapter Three: Background

This chapter provides a basic understanding of PERA, including its benefits and structure, and provides basic member and pension fund statistics.

3.1 Overview

PERA was established in 1931. The Colorado statute relating to PERA is contained in Title 24, Article 51, of the Colorado Revised Statutes (C.R.S). This statute defines PERA benefits, funding, and administrative provisions and is referred to as “PERA Law” in this report.

PERA provides retirement and other benefits, as described below, to the employees of more than 500 government agencies and public entities in the State of Colorado. Employees of these agencies and most public entities that participate in PERA do not participate in Social Security. PERA administers a number of employee benefit plans for participating employers, including:

- Hybrid, defined benefit retirement plans for five separate employer-based divisions
- Two defined benefit health care post-employment benefit plans—one for most PERA members and a separate plan for Denver Public Schools (DPS) employees
- A life insurance reserve trust
- Two defined contribution retirement plans (Voluntary Investment Plan and the Defined Contribution Retirement Plan)
- The Deferred Compensation Plan

Retirement plans are classified as defined benefit plans when the plan benefits are defined by the plan terms. Defined contribution plans define the contributions made to the plan, but not the benefits. Instead, benefits are based on the contributions made to the plan and investment earnings on those contributions.

3.2 PERA Divisions

PERA has five separate divisions—the State Division (which includes State Troopers), the School Division, the DPS Division, the Local Government Division, and the Judicial Division. The Denver Public Schools Retirement System was merged into PERA effective January 1, 2010. Each division is responsible for the benefits of its members and each one has its own separate funding requirements and trust funds. Statute prohibits one division from subsidizing another division.

Members in the School, DPS, Local Government, and Judicial Divisions must participate in the PERA Hybrid Defined Benefit Plan (referred to as PERA Hybrid Plan or PERA Plan in this report). State of Colorado employees hired after 2005 and certain community college members hired after 2007 may elect to participate in the PERA Defined Contribution Plan, in lieu of participating in the PERA Hybrid Plan. Other State Division members participate in the PERA Hybrid Plan.

As of December 31, 2014, there were about 529,000 members in the PERA Hybrid Plan. PERA members include “active members,” who are employees that are currently working for a PERA employer and “retirees and beneficiaries,” who are employees who have retired from a PERA employer or individuals who are receiving PERA retirement benefits on behalf of a former PERA member due to the member’s death. In addition, PERA members include “terminated vested members,” who terminated employment with a PERA employer with more than 5 years of service and “terminated non-vested members,” who are employees that terminated employment with a PERA employer with less than 5 years of service, but left their employee contributions in the PERA Hybrid Plan after termination. These members are entitled to an immediate refund of their contributions or an annuity based on their account balance at age 65. If terminated vested members keep their member account balance with PERA, they can receive matching contributions. The following table lists the five divisions and the number of PERA Hybrid Plan members within each division.

Exhibit 3.2.1 PERA Hybrid Defined Benefit Plan Membership As of December 31, 2014					
Division	Active Members	Retirees and Beneficiaries	Terminated Vested	Terminated Non-Vested	Total
State	55,300	35,937	5,678	66,330	163,245
School	119,618	58,145	13,807	101,603	293,173
Local Government	12,084	6,466	2,788	20,956	42,294
Judicial	334	331	5	9	679
Denver Public Schools (DPS)	15,414	6,698	850	6,787	29,749
Total	202,750	107,577	23,128	195,685	529,140

Source: Colorado PERA Comprehensive Annual Financial Report (CAFR) for the year ended December 31, 2014

As of December 31, 2014, the State and School Divisions comprised 86% of total PERA active members and 87% of PERA retirees and beneficiaries. Approximately 37% of all PERA members are non-vested terminated members.

3.3 PERA is a Hybrid Defined Benefit Plan

The PERA Hybrid Plan provides members with retirement, disability, survivor, and termination benefits, as well as benefit increases after retirement. Benefits, as defined in PERA Law as generally applicable to most PERA members, include:

- **Service Retirement:** An unreduced benefit payable at age 65 with 5 years of service, or one of the following:
 - Most members eligible for the plan after January 1, 2017 may also receive an unreduced benefit at age 60 if age and service total 90, or after 35 years of service regardless of age.
 - For the School and DPS Divisions, members can receive an unreduced benefit at age 58 if age and service total 88.
 - Members hired before 2017 have a wide variety of retirement eligibility requirements depending on:
 - Whether hired before or after 2005, 2007, or 2011
 - Whether State Trooper, DPS, or other division
- **Reduced Service Retirement:** An actuarially reduced early retirement benefit payable at age 50 with 25 years of service, age 55 with 20 years of service, or age 60 with 5 years of service.
- **Disability Program:** Short-term benefits up to 60% of pay and for up to 22 months plus total and permanent benefits paid for life based on the accrued retirement benefit, or in some cases based on projected service. Members are eligible for disability benefits after 5 years of service.
- **Survivor Benefits:** Benefits are paid to qualified survivors (generally a spouse and minor children) and are based on pay, years of service, and the number of survivors. Members are eligible for survivor benefits after 1 year of service, unless death is job-related.
- **Termination Benefits:** Benefits are paid at retirement based on the Service Retirement Benefit Formula or Money Purchase Formula (as defined below) if the member leaves the member's contributions in the PERA Plan. Alternatively, members may withdraw their account and receive the applicable match.
- **Cost of Living Adjustment (COLA):** Generally, members hired before January 1, 2007 will receive a 2% per year COLA. However, if PERA has a negative investment return, the COLA for the next 3 years is the lesser of 2% or the average Consumer Price Index for Urban Wage Earners and Clerical Workers (CPI-W) increase for the prior year. The 2% may increase based on the funded status of the plan. Employees who become members after January 1, 2007, receive a COLA equal to the lesser of 2% or the CPI-W, but also subject to the assets in the Annual Increase Reserve (a separate fund financed by an allocation of 1% of pay contributions for these members).

Retirement benefits are funded through fixed accumulated member and employer contributions plus an investment return credit and are calculated in one of two ways.

The first way is a Service Retirement Benefit Formula, which is calculated based on a multiplier (2.5%) and a member's years of service and 3-year highest average salary at retirement. For example, a member who retires with a Service Retirement after 25 years of employment with a 3-year highest average salary of \$45,000 would receive the following retirement benefit: $2.5\% \times \$45,000 \times 25 = \$28,125$ per year benefit, or \$2,344 per month. The 2.5% multiplier rate is set in PERA Law, as are all other benefit provisions.

The second way is a Money Purchase Formula, which is calculated by converting the member's accumulated contributions with credited interest, plus a 100% employer match, to a lifetime annuity.

The formula that provides the highest benefit amount for the member is the one that is applied.

In addition, members with more than 5 years of service who terminate employment before retirement may withdraw their own contributions with credited interest, plus a 50% employer match. Members who leave their contributions in the plan until retirement are eligible for the Money Purchase Formula with the full 100% employer match.

Member and employer contributions are fixed in PERA Law and do not adjust to the expected long terms costs of the PERA Hybrid Plan like many defined benefit plans. The fact that benefits are based on accumulated fixed member and matching employer contributions plus an investment return credit is generally associated with a defined contribution plan rather than a defined benefit plan. For this reason, and the availability of the Money Purchase feature at retirement, the PERA Plan is referred to as a hybrid plan.

3.4 PERA Administration and Role of Board of Trustees

The responsibility for the administration, investment management, and financial reporting for PERA rests with a 16 member Board of Trustees. The Board of Trustees includes:

- State Treasurer
- Nine elected PERA members
- Two retired PERA members
- Three appointees of the Governor who are not PERA members and who have experience and expertise in accounting, investments, finance, or actuarial science
- A non-voting member, elected by the Denver Public Schools division members.

PERA Law details the fiduciary responsibility of the Board of Trustees to administer PERA in accordance with PERA Law and for the exclusive benefit of PERA members. The Board of Trustees' responsibility by PERA Law includes the adoption of actuarial assumptions (including the expected investment return on PERA assets) that are necessary to assess the financial condition of PERA. When adopting assumptions, the Board of Trustees considers the

recommendations of PERA's independent actuary. Actuarial assumptions are discussed in more detail later in the report.

The Board of Trustees also adopts a Funding Policy for PERA which includes regular actuarial studies and other measures of funding position. Although PERA has a Funding Policy, the actual funding is governed by statute. See Appendix G for PERA's current funding policy, which was adopted in 2015.

3.5 PERA Trust Funds

PERA Hybrid Plan benefits are advance funded. This means that PERA Hybrid Plan trust funds were created from employer and member contributions made while each member was working. These accumulated contributions are invested and the investment earnings plus the contributions from members and employers provide the funds to pay members' defined benefits and the expenses of administering the plan and investing the assets. The trust funds can only be used for those purposes.

The following table shows the member and employer contributions, investment income, benefit payments, and assets for each Division, as of December 31, 2014.

Exhibit 3.5.1 PERA Hybrid Defined Benefit Plan Contributions, Investment Income, Benefit Payments, and Assets by Division As of December 31, 2014 (In Millions)				
Division	Contributions	Investment Income	Benefit Payments	Assets
State	\$682	\$781	\$1,429	\$14,014
School	1,043	1,275	2,137	22,921
Local Government	304	200	261	3,751
Judicial	12	15	20	279
Denver Public Schools	68	183	259	3,264
Total	\$2,109	\$2,454	\$4,106	\$44,229

Source: Colorado PERA CAFR for the year ended December 31, 2014

3.6 Recent Changes to PERA

In 2010, the Colorado General Assembly passed Senate Bill 10-001, which made significant changes in PERA benefits and funding. The goal of these changes was to help the PERA Hybrid Plan achieve full funding within 30 years of the Bill's implementation, or by 2041. The primary changes of the Bill included the following:

- Increased the Amortization Equalization Disbursement (AED) and Supplemental Amortization Equalization Disbursement (SAED) contribution rates by an additional 2.0% (for the State Division). The AED and SAED are contributions made by PERA employers on behalf of members. Legislation was passed in 2004 regarding AED and 2006 regarding SAED requiring employers to make additional contributions to PERA in order to reduce PERA's unfunded liability and shorten the amortization period to pay off the unfunded liability.
- For employees hired before January 1, 2007, reduced the COLA from 3.5% to 2.0%.
- Reduced the maximum salary increase for the 3-year average highest salary calculation to eliminate salary spiking for most members.
- Reduced benefits for those hired after 2010 by requiring more years of service to earn a full benefit and altering the COLA formula.

Chapter Four: PERA Actuarial Funding and Terminology

This chapter provides a summary of how PERA is funded and actuarial concepts and measures.

4.1 PERA Contribution Amounts

The member and employer contributions to the PERA Hybrid Plan are set in PERA Law and are fixed; they do not fluctuate with the PERA experience. Exhibit 4.1.1 provides the member and employer statutory contribution rates for each Division as of December 31, 2016, as reported by PERA based on the current law and the Actuarial Valuation as of December 31, 2014. PERA's 2014 Actuarial Valuation reports contribution amounts as of 2016. The employer contributions include a base rate, plus contributions for the AED and SAED. From this amount, 1.02% of payroll is allocated into the Health Care Trust Fund to cover the costs of PERACare, which provides a monthly medical premium subsidy to retirees and beneficiaries. The total contribution amount also covers the normal cost for annual benefits and the Annual Increase Reserve (AIR). The normal cost is the annual cost to provide current benefits and the AIR was established so that 1% of the employer's statutory contribution goes to prefund COLA benefits for employees hired after January 1, 2007.

Exhibit 4.1.1 PERA Hybrid Defined Benefit Plan Contribution Rates As of December 31, 2016					
Contributions	State	School	Local	Judicial	DPS
Member Rate	8.05% ¹	8.00%	8.00%	8.00%	8.00%
Employer Contributions					
Base Rate	10.22% ¹	10.15%	10.00%	13.66%	10.15%
AED ²	4.60%	4.50%	2.20%	2.20%	4.50%
SAED ²	4.50%	4.50%	1.50%	1.50%	4.50%
Less PCOP Offset ³	Not Applicable – DPS only				(15.96%)
TOTAL Contribution Amount	27.37%	27.15%	21.70%	25.36%	11.19%
Less Health Care Trust Fund	(1.02%)	(1.02%)	(1.02%)	(1.02%)	(1.02%)
Less AIR	(0.41%)	(0.35%)	(0.42%)	(0.28%)	(0.48%)
TOTAL Pension Contribution	25.94%	25.78%	20.26%	24.06%	9.69%

Source: Colorado PERA CAFR for the year ended December 31, 2014

¹ State Troopers, as members of the State Division contribute 10%; all other State Division members contribute 8%, average is 8.05%. Employer base rate is 12.85% and 10.15% for Troopers and other State Division members, respectively.

² The Amortization Equalization Disbursement (AED) and Supplemental Amortization Equalization Disbursement (SAED) are supplemental contributions that increase according to a schedule. The rates shown are applicable

to 2016 and will increase by 0.9% of pay in 2017 for the State Division and by 0.5% of pay in both 2017 and 2018 for the School and DPS Divisions.

³The Pension Certificates of Participation (PCOP) credit for the DPS Division is specified in PERA Law. See Section 13.1 for a more detailed discussion of the PCOP offset.

4.2 The Actuarial Valuation Process and Actuarial Assumptions

The goal of any retirement plan is to be actuarially sound and sustainable. This means that the plan will be able to pay its provided benefits from the assets that build over time from employer and member contributions, as well as investment earnings. The process used to assess the sustainability of a plan is called an actuarial valuation and is based on actuarial assumptions. The actuarial valuation produces a number of measures used to assess the progress of a plan in meeting its obligations.

Periodic analyses are required by statute and general actuarial standards to assess the adequacy of the fixed funding (through employer and member contributions) to pay for the PERA Hybrid Plan benefits. This process is referred to as an **actuarial valuation**, and includes projecting the future benefits payable from the plan. These projections require a number of **actuarial assumptions** about future events including:

- The investment return earned on plan assets
- Rates of retirement, disability, death, and termination of employment for active members
- Life expectancy for retired members and survivors
- Future pay increases for active members
- Future growth in membership

The annual actuarial valuation is conducted each year based on the data as of December 31 of the previous year. Cavanaugh MacDonald is the current valuation actuary retained by PERA. Actuarial assumptions are recommended by the actuary and adopted by the PERA Board of Trustees. Those considered in the December 31, 2014 actuarial valuation and projections of the PERA Hybrid Plan include:

- 7.5% annual investment rate of return (net of investment expenses)
- Price inflation of 2.8% per year
- Wage inflation of 3.9% per year
- RP-2000 Combined Mortality table with projections and adjustments
 - RP-2000 Combined Mortality is a commonly used mortality table developed by the Society of Actuaries projected to 2000 as a result of the Secretary of Treasury's authority to develop mortality tables under the Retirement Protection Act of 1994
 - For PERA purposes, this table is further projected to 2020
 - For PERA purposes, adjustments are made to the RP-2000 table to better fit historical PERA mortality experience

- 2% COLA per year for members hired prior to January 1, 2007
- Detailed rates of retirement, disability, termination, and annual pay increases based on age, gender, and employee classification
- Future active member growth of 1.5% per year for the State, School, and DPS Divisions and 1% per year for Local Government and Judicial Divisions

The independent actuary retained by PERA also makes long-term **projections** of the benefits that will be payable from PERA compared to the resources that will be available to pay for those benefits. These projections are the basis of determining the PERA Hybrid Plan's likely **date of full funding** and are discussed in more detail in the next section. Periodically, PERA also retains a second independent actuary to **audit** the work of the independent actuary. Actuarial projection results are fully disclosed in the PERA Comprehensive Annual Financial Report (CAFR) and supplemental reports to the Colorado General Assembly. PERA also uses investment and financial consultants to advise the Board of Trustees on the investment return outlook in considering the long-term expected investment return.

The actuarial assumptions which are used in the annual actuarial valuation and projections are based on the past experience of the PERA Hybrid Plan and expectations of how investment markets will perform in the future. They are modified periodically by the Board of Trustees as noted above, based on recommendations of the independent actuary after a detailed multi-year **analysis of the actual experience** compared to the assumptions. The recommended assumptions are based on professional judgment of the actuary following rigorous standards of practice requirements. The goal is for the assumptions, in total, to accurately project the future so the long-term costs of the plan are accurately projected.

To summarize there are six broad classes of actuarial studies shown below in Exhibit 4.2.1.

Exhibit 4.2.1 Actuarial Studies		
Actuarial Study	Last Conducted By	Purpose
Annual Actuarial Valuation	Cavanaugh MacDonald, retained by PERA	Determines current funded status, actuarial required contribution (ARC) and other information in CAFR
Annual Actuarial Projections	Cavanaugh MacDonald, retained by PERA	Determines anticipated date of full funding
Periodic (typically five years) Actuarial Audit	Milliman, retained by PERA	Verify annual actuarial valuation calculations
Periodic (typically five years) Experience Review	Cavanaugh MacDonald, retained by PERA	Analyze recent actuarial experience and compare to assumptions for possible revisions
Study of potential implications of changes	Cavanaugh MacDonald, retained by PERA	Ad hoc special actuarial studies of potential changes
Sensitivity study	Pension Trustee Advisors, retained by State Auditor	Analyze potential implications of actuarial assumptions not being met

4.3 Actuarial Measures

The annual actuarial valuation of the PERA Hybrid Plan provides a number of actuarial measures that are considered when assessing the current funded status and sustainability of the Plan. The most important measures are described below.

Actuarial Accrued Liability

The Actuarial Accrued Liability (AAL) is an allocated value of the benefits earned by members to date that are expected to be paid in the future. For example, as of December 31, 2014, all PERA active, inactive, and retired members have earned benefits totaling \$69 billion that will be paid for many years in the future.

Unfunded Actuarial Accrued Liabilities

Retirement systems are sometimes evaluated by the amount of Unfunded Actuarial Accrued Liabilities (UAAL), which is equal to the Actuarial Accrued Liability (AAL) less the pension fund assets.

The UAAL is a long-term obligation that is to be funded over future years; it can also be thought of as the unfunded current liabilities for benefits to date that are payable for many years in the future. The amount and trend of the UAAL is important information, but in isolation, the UAAL does not provide meaningful information on the sustainability of a retirement system because it does not consider the available future resources to fund the UAAL.

Funded Ratio

Another commonly used measure of the actuarial soundness of a retirement system is the Funded Ratio. The Funded Ratio compares the progress to date in funding the accumulated obligations of the plan. The Funded Ratio is equal to the accumulated assets of the plan divided by the AAL. A fully funded system would have a Funded Ratio of 100% or better.

Typically, retirement systems (including PERA) determine the Funded Ratio by considering the actuarial value of assets. The actuarial value of assets defers recognition of investment returns that are more or less than expected, generally over a period of 5 years or less. PERA determines an actuarial value of assets using a 4-year phase-in basis for the deferred gains or losses.

The market or fair value of assets is the actual price a seller could receive if the assets were sold on that date. The actuarial value of assets may be more or less than the market value of assets at a particular date. When investment returns are favorable, the actuarial value of assets is usually less than the market value of assets because a portion of the recognition of the unanticipated gains has been deferred. Similarly, when investment returns are unfavorable, the actuarial value of assets is typically greater than the market value of assets because the recognition of the unanticipated actuarial investment losses is being deferred.

Funded Ratios are useful in providing a snapshot of the funded status of a retirement system on a particular date and tracking a retirement system's progress in meeting its funding objectives. However, they provide *no* information on either the likelihood of those ratios improving or worsening over the future or the long-term sustainability of the plan.

Exhibit 4.2.1 shows the AAL, UAAL, and Funded Ratio for the last 5 years for all divisions within the PERA Hybrid Plan combined.

Exhibit 4.3.1 PERA Hybrid Defined Benefit Plan Actuarial Measures 2010 Through 2014			
Actuarial Valuation Date	Actuarial Accrued Liability (AAL) (In Billions)	Unfunded Actuarial Accrued Liability (UAAL) (In Billions)	Funded Ratio
12/31/2014	\$69	\$26	62%
12/31/2013	67	26	62%
12/31/2012	62	23	63%
12/31/2011	61	24	61%
12/31/2010	59	20	66%

Source: Colorado PERA Comprehensive Annual Financial Reports for 2010-2014

Amortization Period or Date of Full Funding

The most important measure in assessing the long-term sustainability of PERA is the Amortization Period, or date of Full Funding. The Amortization Period is the number of years anticipated to fully fund any UAAL and achieve a fully funded retirement system. The Amortization Period results in a projected full funding date for each PERA Division after considering all future benefit and contribution changes as explained in the following section. These results are different for each PERA Division because the obligations and resources of each Division are kept separate and the resources of one Division cannot be used to meet the obligations of another Division.

The Amortization Period is particularly important for PERA because contributions are not based on an actuarially calculated rate that explicitly targets full funding at a certain date, but are fixed by statute at a rate which is currently lower than that actuarially calculated rate. Most plans have contribution rates which vary each year based on actuarial results from the annual actuarial valuations.

We believe that the measure of full funding date is the best indicator of PERA's long-term sustainability because it considers all resources and obligations and determines when, and if, full funding can be achieved. Exhibit 4.3.2 shows the projected full funding date for each PERA Division, as of December 31, 2014.

Exhibit 4.3.2 PERA Hybrid Defined Benefit Plan Projected Year of Full Funding by Division	
Division	Projected Year of Full Funding
State Division	2052
School Division	2053
Local Government Division	2040
Judicial Division	2063
DPS Division	2048

Source: PERA December 31, 2014 Actuarial Report Presentation

4.4 Current Full Funding Date Measures

PERA reports the year in which each Division will become fully funded using three different measures as follows:

- Measure A: Current members and benefits applicable to current members only and contribution rates currently payable
- Measure B: Current members and benefits applicable to current members only and the future increasing statutory contribution rates
- Measure C: Current members and expected new members and benefits applicable to current and new members in the future and the future increasing statutory contribution rates

The projected full funding dates vary significantly when none, some, or all future changes are reflected, as noted in Exhibit 4.4.1 from PERA's 2014 Comprehensive Annual Financial Report.

Exhibit 4.4.1 PERA Hybrid Defined Benefit Plan Projected Full Funding Dates Applying Different Measures			
Division	Measure A	Measure B	Measure C
State Division	2066	2060	2052
School Division	2072	2063	2053
Local Government Division	2043	2043	2040
Judicial Division	Never	Never	2063
Denver Public Schools (DPS) Division	Never	Never	2048

Source: Colorado PERA CAFRs for 2014

The reason the projected full funding dates vary significantly under each measurement is because of the differences in benefits for new PERA members since 2007, the increasing employer funding, and the expected growth in PERA membership. The benefit changes for new members will result in a lower expected cost that will only be fully reflected when these changes apply to all active members.

The Governmental Accounting Standards Board (GASB) and Actuarial Standards of Practice (ASOPs) generally require that an actuarial valuation consider only benefit provisions and funding levels currently in effect for accounting reporting and disclosure purposes. However, because of the importance to the actuarial soundness of PERA of future employer contribution increases and benefit changes in PERA Law, the results based only on current conditions do not provide a complete and accurate projection of the system. For this reason, PERA supplements the required disclosure with additional projections.

Projections that consider all future changes and include new members provide a more accurate assessment of the PERA Hybrid Plan. This type of projection results in a more favorable outlook because:

- All the scheduled employer contribution increases are recognized
- The changes to benefits are reflected for new members
- A growth in membership is assumed
- Deferred investment gains are reflected over the next 4 years in the actuarial value of assets

We agree that the projections (Measure C) that consider all statutorily approved changes (as well as expected growth in membership and deferred investment gains or losses) are the most accurate basis to objectively assess the future financial condition of PERA. It is the basis considered in the analyses contained in this report.

Chapter Five: Understanding PERA Projections

This chapter analyzes the projections, which PERA currently develops and reports. Key measures, including against the funding policy are shown.

Key Conclusions

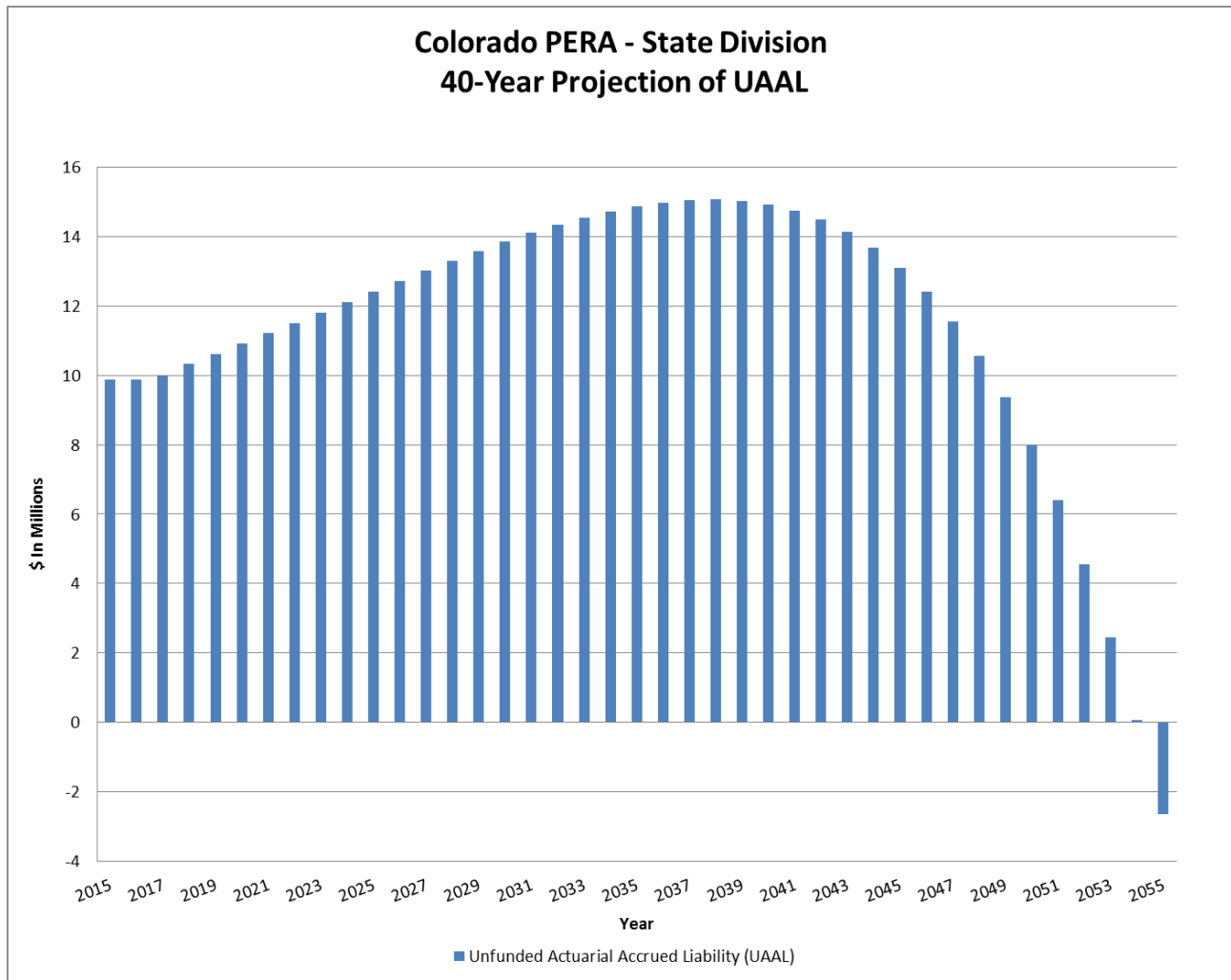
While the current PERA projections result in a fully funded system in the future, the Unfunded Actuarial Accrued Liability (UAAL) is expected to continue to grow for a number of years and the Funded Ratio only very gradually improves until full funding is achieved.

The projection results for the State Division only are shown below for illustration.

5.1 Projected UAAL

Under current assumptions, the UAAL of the PERA Hybrid Plan is expected to continue to grow each year for the next 20 years or more because the interest on the UAAL at the discount rate of 7.5% per year is greater than the contributions made towards the UAAL. In the late years of the 30-year Amortization Period, the UAAL is expected to begin to decline, as shown below. The combination of more members with a lower cost (because of the benefit changes in Senate Bill 10-001 and prior changes) and increasing pay will gradually result in the available contributions becoming greater than the interest on the UAAL at 7.5%. Exhibit 5.1.1 shows the 40-year projection of UAAL for the State Division.

Exhibit 5.1.1

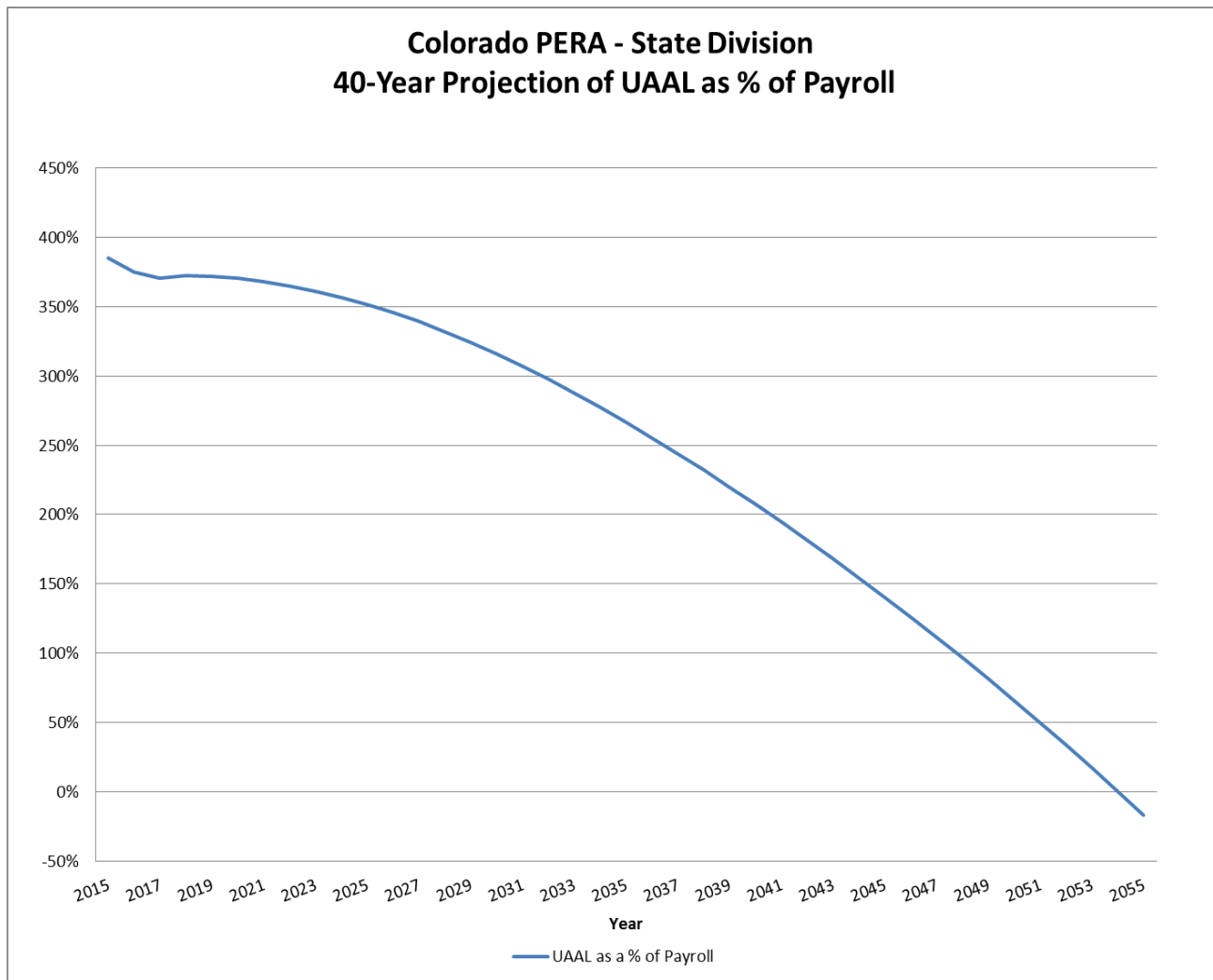


Source: Pension Trustee Advisors based on PERA CAFR

5.2 Projected UAAL/Member Pay

Although the UAAL is expected to grow over the next 20 years, it is also expected to gradually become a smaller multiple of the pay of the membership. This is important because future contributions would increase because they are based on an expected increase in member's pay due to both higher average compensation per member and more members. As a result, the financing available to amortize the UAAL grows at a faster rate than the UAAL itself. This means that the burden of the unfunded liability becomes relatively smaller. Exhibit 5.2.1 shows that the State Division's unfunded liability is expected to fall from nearly 400% of annual payroll to 0% by 2055.

Exhibit 5.2.1

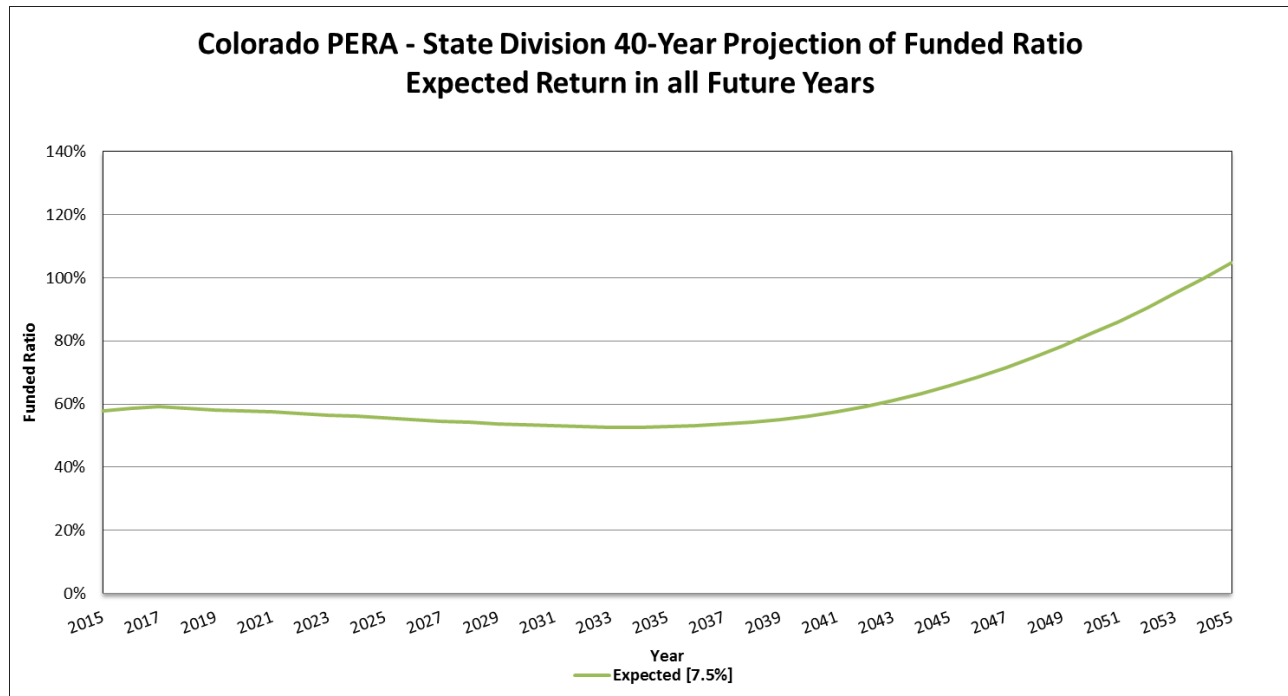


Source: Pension Trustee Advisors based on PERA CAFR

5.3 Projected Funded Ratios

Similarly, the Funded Ratio for the PERA Hybrid Plan is also expected to gradually improve for the next 20 years and then rapidly improve to full funding because of the influx of new members with lower benefits, and thus lower normal costs, which enables more of the contributions to go toward the UAAL. These projections assume the future PERA experience exactly follows the assumptions and there are no other changes. Exhibit 5.3.1 shows how the Funded Ratio is anticipated to improve with the PERA Plan becoming fully funded by 2052 as indicated above.

Exhibit 5.3.1



Source: Pension Trustee Advisors based on PERA CAFR

5.4 Resources Available to Amortize the UAAL

A key factor in determining the time required to fund the UAAL is the amount of statutory employer and member contributions that are available for this purpose. PERA contributions must first pay for the cost of benefits for that year. This cost is called the Normal Cost and is determined based on the PERA provisions applicable to each member, such as retirement eligibility date, the PERA COLA, the actual pay at retirement, etc. In addition, the amount of PERA contributions available to fund the UAAL must be reduced for the cost of the PERA Health Care benefits paid to the separate Health Care Trust Fund and the COLA AIR Reserve.

For PERA, the normal cost is expected to decline in the future because of the lower benefit costs for new members due to the benefit changes adopted by Senate Bill 10-001 and other legislation. As a result, the amount of PERA contributions available to fund the UAAL are expected to increase due to:

- Lower Normal Costs as more new members' benefits reflect the changes in Senate Bill 10-001
- Higher employer contributions due to an increase in the AED and SAED amounts
- Assumed growth in contributions as both pay and membership increase

As an example, the percent of pay contributions available to amortize the UAAL for the State Division based on 2015 calculations compared to 2035 is shown in Exhibit 5.5.1.

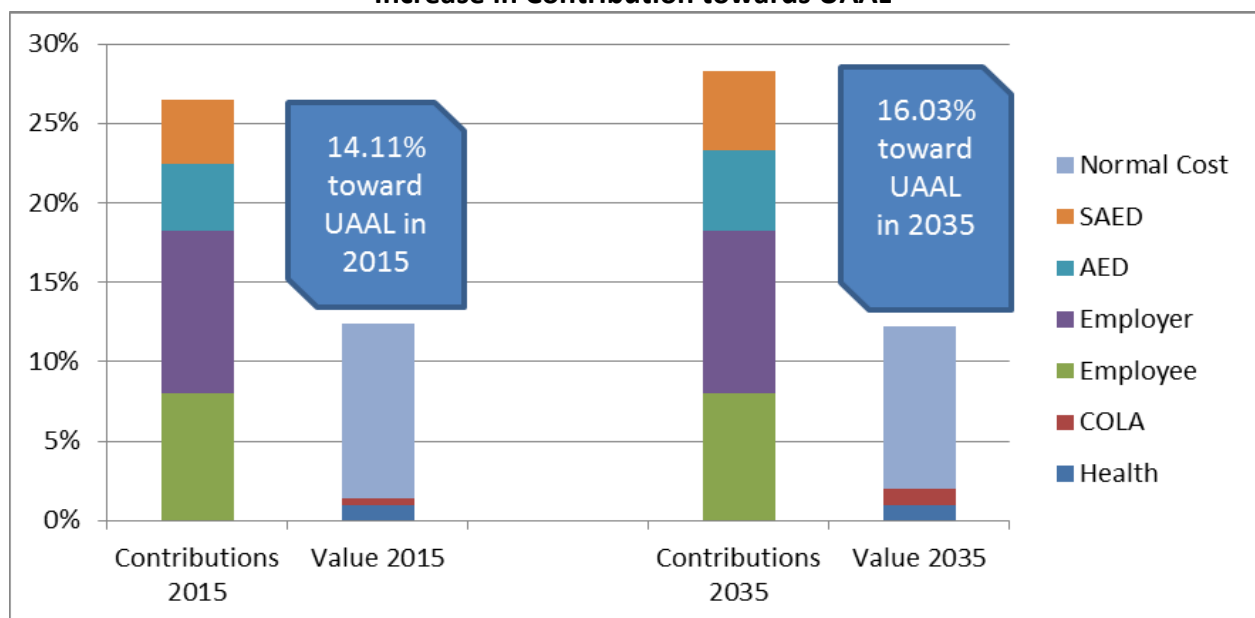
Exhibit 5.5.1
PERA Hybrid Defined Benefit Plan
Percent of Pay Contributions Available to Amortize the UAAL
State Division

Fiscal Year	2015	2035
Employer Contributions (including AED, SAED, and Health Care)	18.42%	20.22%
Member Contributions	8.05%	8.05%
Total Contributions	26.47%	28.27%
Less Total Normal Costs	(10.97%)	(10.22%)
Less Health Care Trust Fund	(1.02%)	(1.02%)
Less Annual Increase (COLA) Reserve	(.37%)	(1.00%)
Amount Available to Amortize UAAL	14.11%	16.03%

Source: Pension Trustee Advisors based on PERA CAFR

As Exhibit 5.5.1 shows, the percent of pay available to amortize the UAAL is expected to increase by nearly 2% of payroll over the next 20 years. However, based on the assumed growth in pay and membership, the dollar amount available to amortize the UAAL is expected to grow even more. The projected dollar growth is 118% over these 20 years (from \$2.6 billion in 2015 to \$5.6 billion in 2035). This expected growth is very beneficial to eventually achieving a fully funded plan, as illustrated by Exhibit 5.5.2.

Exhibit 5.5.2
Increase in Contribution towards UAAL



Source: Pension Trustee Advisors based on PERA CAFR

Chapter Six: Recent History and Experience

This chapter discusses the varied PERA past experience since 1999.

Key Conclusions

The two historically severe investment market declines during the period 1999-2014 were the most significant cause of PERA's decline from a fully funded system to one that is 62% funded.

Actuarial losses (due to experience that was less favorable than the assumptions) were more common than gains during the 15-year period, but the net unfavorable experience was largely due to investment results. This is displayed in Exhibit 6.3.1 and discussed below:

- **The growth in the PERA UAAL was primarily due to investment returns that were less than the assumed rate of return, contributions that were less than interest on the UAAL, and assumption changes. This was partially offset by benefit reductions during the period. Actuarial experience that differed from the assumptions other than investment returns had only a relatively minor impact.**
- **Underperforming investment returns accounted for 51% of the increase in the PERA UAAL compared to 60% for the average public plan.**
- **Contribution deficits accounted for 32% of the increase in the PERA UAAL compared to 24% for the average public plan. This suggests that the PERA employer and member contribution amounts were paying a lower share of the UAAL than the average system.**
- **Changes in the actuarial assumptions accounted for 29% of the increase in the PERA UAAL compared to 7% for the average public plan. For PERA, the Board of Trustees' decision to reduce the investment return assumption from 8.75% to 7.5% during the period accounted for much of the increase.**
- **Changes in benefits decreased the UAAL 36% for PERA compared to only 1% for the average public plan. This indicates that the average public plan did not make as major of changes to its benefit structure during this period as did PERA.**

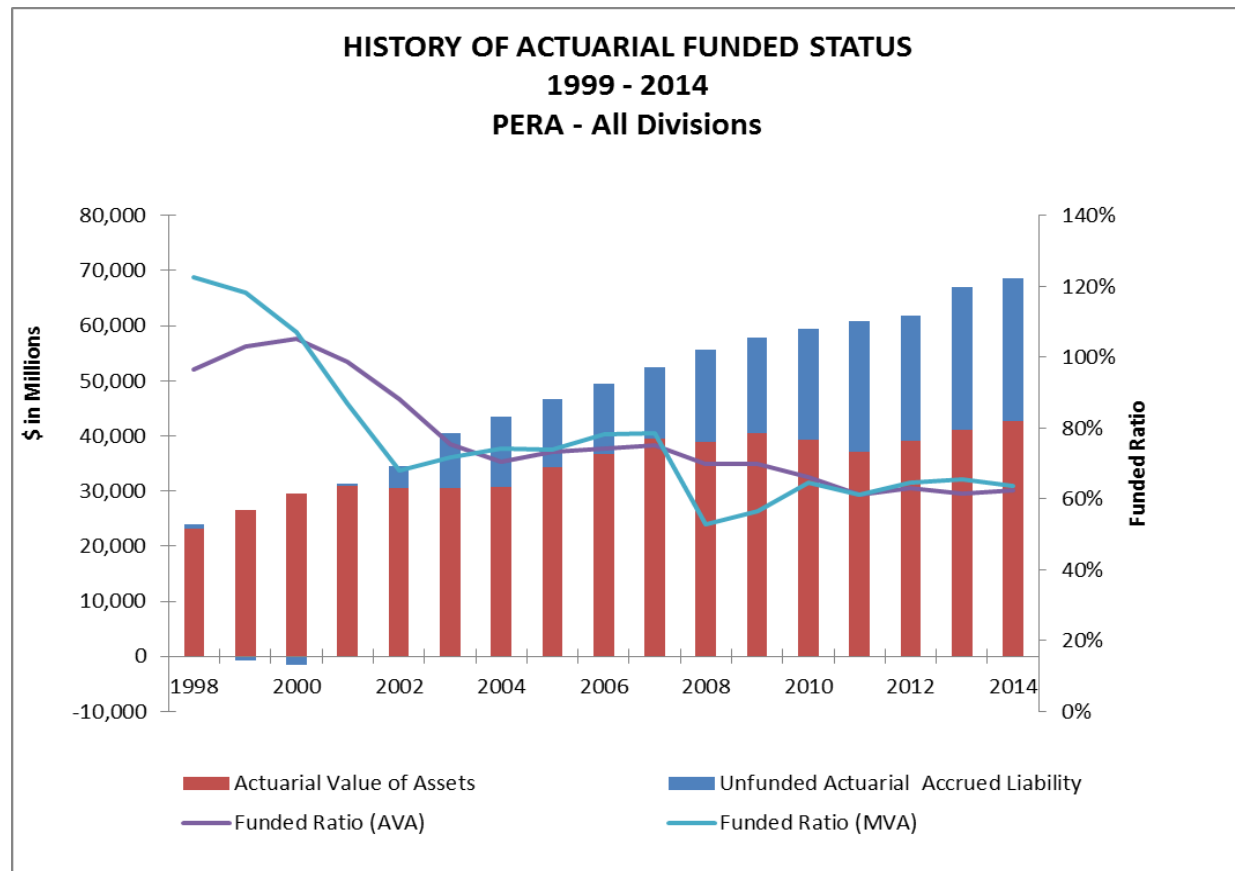
Before considering the potential effect on the current PERA projections due to possible *future* variability in the actuarial assumptions, a look back at *past* variability will illustrate how the PERA funded status has changed and how well the assumptions matched the experience. This analysis covers the 16-year period from January 1, 1999 through December 31, 2014. Our objective was to cover a period that starts after the very positive investment results of the 1990's, include a period when PERA was fully funded, and also include the severe investment climate during the last decade.

6.1 Recent Funded Status History

Exhibit 6.1.1 below shows the changes based on PERA experience for the last 16 years for the combined PERA Divisions for the following:

- Actuarial Accrued Liability
- Actuarial Value of Assets
- Unfunded Actuarial Accrued Liability
- Funded Ratios based on both actuarial and market value of assets

Exhibit 6.1.1



Source: PERA Actuarial Valuation Reports, 1998-2015

At the beginning of 1999, the PERA combined plans were over 96% funded with a UAAL of \$847 million. One year later, actuarial projections showed that PERA was fully funded with a combined Funded Ratio of 103% for the PERA combined plans and statutory contributions that exceeded the current Normal Costs of the System (no part of the contributions was required to amortize the UAAL since the system was fully funded). At that time, the State and School Divisions were combined and reflected the vast majority of PERA Hybrid Plan membership. Their contributions exceeded the Normal Cost by over 3% of pay. This meant that the statutory contributions were in excess of those required to meet the on-going costs of the plan and maintain a fully funded plan. The actuarial assumptions at that time included a long-term

annual investment return of 8.75%. If the investment return assumption had been 7.5%, as it is today, we estimate that the Funded Ratio would have been approximately 90%, rather than 103%.

The fully funded status continued and improved as of January 1, 2001 to a combined Funded Ratio of 105% before the funded status began to steadily decline.

As of December 31, 2014, the combined Funded Ratio was 62% for all PERA Divisions and the statutory contribution amounts were not sufficient to meet the actuarially required contribution (ARC). The ARC is equal to the Normal Costs plus 30-year amortization of the UAAL. PERA has previously set the ARC as the amount required to achieve full funding in 30 years. For 2014, PERA reported that 83% of the ARC was contributed for the State Division, 84% for the School Division, and 81% for the Judicial Division, based on the actuarial valuation 2 years prior. The Denver Public Schools (DPS) Division contributions were 28% of the ARC, which reflects the statutory offset to the DPS contributions due to legislation that gives DPS credit for the DPS Pension Obligation Certificates. Contributions exceeded the ARC by 8% for the Local Government Division. As stated previously, the current actuarial assumptions include a long-term annual investment return of 7.5%, as set by the PERA Board.

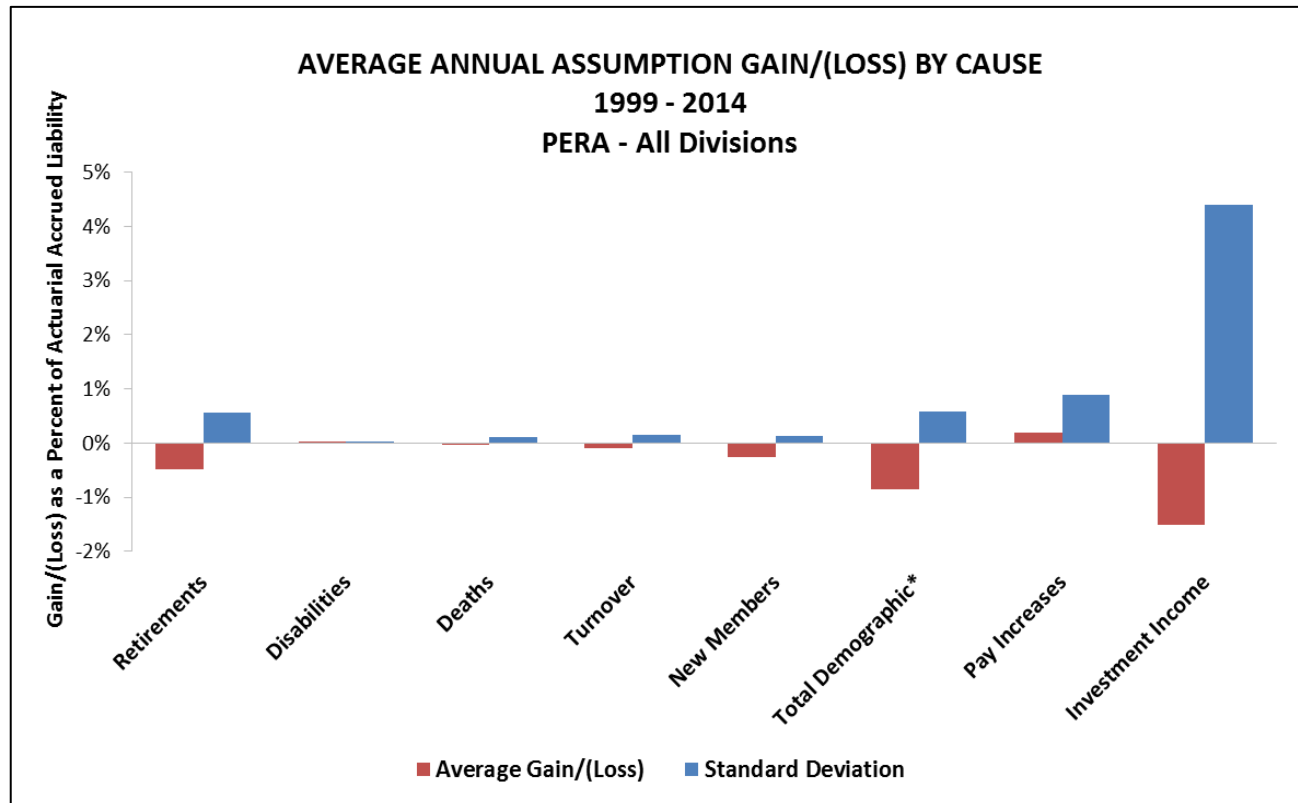
6.2 Actuarial Assumptions Gain and (Loss) History

The average annual gain or loss over the 16-year period 1999 through 2014, due to the combined PERA experience compared to each significant PERA assumption, is illustrated in Exhibit 6.2.1. The average gain or (loss) reflects the actual plan experience compared to each assumption.

For example, the retirement gain or loss is determined by comparing the number of members retiring to the expected number and the value of their benefits compared to the expected value. Generally, when members retire earlier than what is expected or anticipated through the retirement assumption, a plan will suffer a loss because members receive retirement benefits for a longer period of time than was expected. In other words, a plan has to pay retirement benefits for a longer period of time than expected, which results in a loss for the plan.

Exhibit 6.2.1 shows the average annual gain or (loss) for each of the PERA actuarial assumptions compared to the standard deviation for each assumption. Each assumption is important but the average gain or loss for this period illustrates how significant the variation in the assumed experience was for each assumption. Standard Deviation is a statistical measure of variability and it determines how much variability is likely in the future for each assumption. We discuss standard deviation further in Chapter 7, One-Year Assumption and Variability, as well as Appendix F, Statistical Techniques.

Exhibit 6.2.1



Source: PERA Comprehensive Annual Financial Reports and Actuarial Valuation Reports from 1999-2014

*Total Demographic is the sum of Gain/(Loss) by Retirements, Disabilities, Deaths, Turnover and New Members.

This summary illustrates the following:

- The actual experience resulted in losses for the total demographic and investment income assumptions
- Only the pay increase assumption was slightly favorable
- Investment income had by far the most significant loss and variability
- Of the demographic assumptions (retirements, disabilities, deaths, turnover, and new members), retirement experience had the most significant loss and the biggest variability

Detailed annual gains and losses for each assumption for PERA combined and for each PERA Division are shown in Appendices A through E. For this period:

- Demographic losses occurred in 15 of 16 years
- Pay increase gains occurred in 11 of 16 years
- Investment return losses occurred in 8 of 16 years
- Investment return accounted for over 70% of the variability

6.3 History and Comparison of the Increases in the UAAL

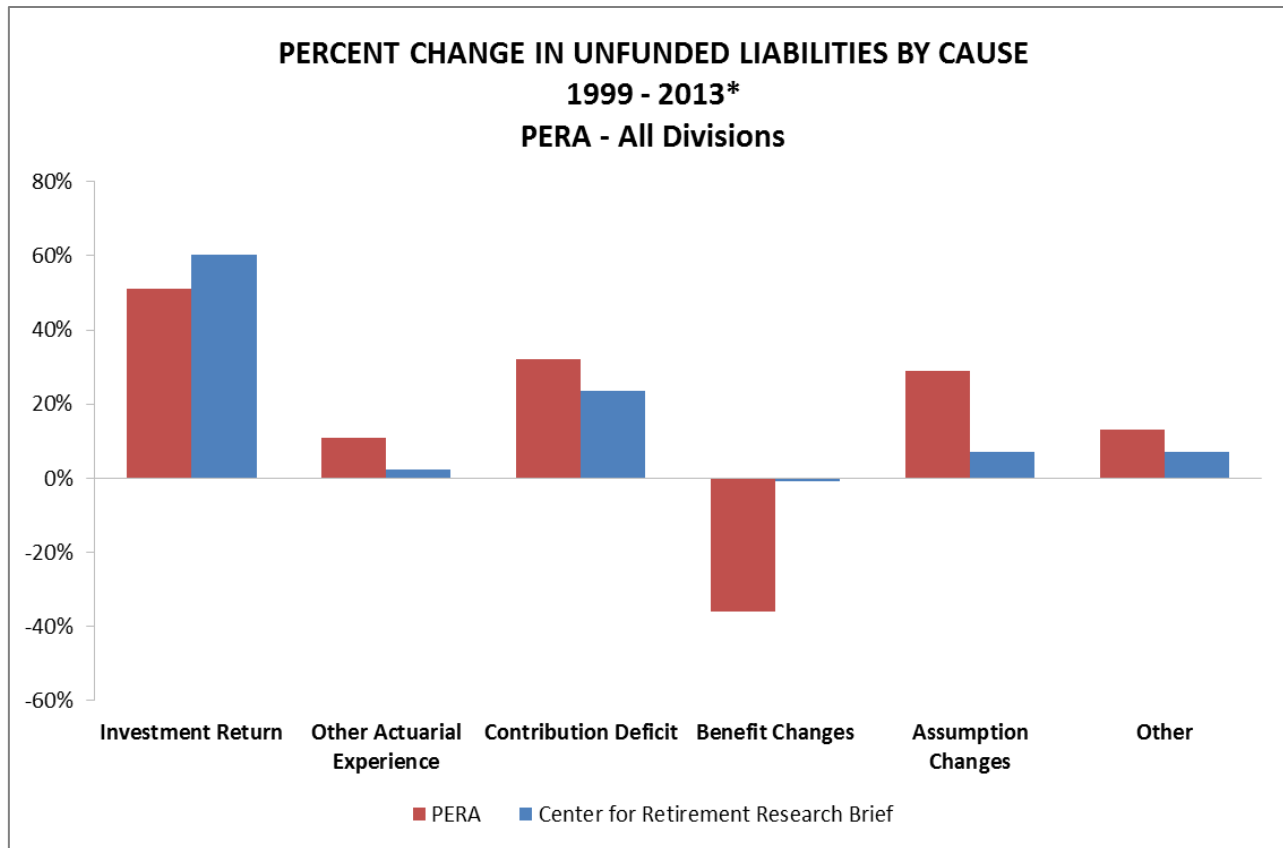
The Center for Retirement Research study of public employee retirement plans for the period 2001-2013 was released in January 2015 to illustrate what factors caused the UAAL of public plans to increase for the period 2001-2013. The survey includes 150 public pension plans in the Public Plan Database. PERA's experience for the period 1999-2013 is compared to those findings below. Because public plans have different fiscal year ends and current results are not always available, the comparison is not an exact match with PERA results beginning in 1999. However, the comparison is nevertheless useful for a general comparison of the PERA experience during the economic downturn compared to other public retirement plans.

Exhibit 6.3.1 shows the percentage change in the UAAL of the average public plan compared to PERA by the cause. Causes include:

- Actual investment return compared to expected
- All other actuarial assumption experience
- Contributions less than interest on the UAAL
- Benefit changes
- Changes in assumptions
- All other causes

Bars above 0% mean that the UAAL increased due to that cause and below mean that the UAAL decreased. For example, the chart shows that 60% of the increase in the UAAL for the average plan for this period was due to unfavorable investment return, compared to 51% for PERA. Conversely, benefit changes caused the UAAL to decrease 36% for PERA compared to a decrease of 1% for other public plans.

Exhibit 6.3.1



Source: "How Did State/Local Plans Become Underfunded?" Center for Retirement Research. Jan. 2015

*Center for Retirement Research Study 2001-2013; PERA CAFRs 1999-2015

PERA's growth in UAAL during this period compared to the average public retirement plan was:

- Less severely impacted by investment experience
- More significantly impacted by the adoption of more conservative actuarial assumptions (most notably a reduction in expected investment return)
- Significantly reduced by benefit changes
- Slightly higher due to actuarial experience other than investment results

Over 80% of the increase in PERA's UAAL caused by the variability of actual experience compared to assumptions was due to investment return, and less than 20% was due to other assumptions. As mentioned above, PERA took larger steps than the typical public plan in decreasing its assumed rate of return from 8.75% to 7.50%. This is not actually adverse experience, but a more conservative outlook on anticipated future investment experience.

Chapter Seven: One-Year Assumption Variability

Although experience can vary greatly over a long period of time, a single year can have a material impact. This chapter considers those possibilities.

Key Conclusions

It would not be unusual for the projected full funding date of any PERA Division to be up to 5 years higher or lower from one year to the next based on 1 years' experience.

7.1 One-Year Variability

The PERA Hybrid Plan's current financial status is reflected in the following statistics, as of December 31, 2014:

- 60% of the present value of future benefits is payable to currently retired and inactive members
- Benefits paid in 2014 were over 9% of PERA assets
- Benefits paid less contributions received in 2014 were 4.5% of PERA assets
- Since PERA is currently 62% funded, an unexpected 5% increase in the AAL results in a 12% increase in the UAAL

Actuarial measures like the Amortization Period are particularly sensitive to experience variations for mature retirement systems such as PERA. Mature plans have a larger portion of their liabilities and assets attributable to retirees with a shorter time horizon.

For example, Exhibit 7.1.1 shows the change in the expected Amortization Period for the State Division, determined as of January 1, 2015, that will occur if PERA's experience in **2015 only** is more or less favorable than assumptions.

Exhibit 7.1.1 PERA Hybrid Defined Benefit Plan Projected Changes in Amortization Period Due to Experience	
Projected Amortization Period as of 2015	38 Years
Projected change in Amortization Period if:*	
Actuarial Accrued Liability grows 1% less than expected	1.5 years sooner
Actuarial Accrued Liability grows 1% more than expected	2.5 years later
Actuarial Accrued Liability grows 3% less than expected	3 years sooner
Actuarial Accrued Liability grows 3% more than expected	6 years later
Investment return is 1% less than expected (i.e., 6.5%)	1 year later
Investment return is 1% more than expected (i.e., 8.5%)	1 year sooner
Investment return is 5% less than expected (i.e., 2.5%)	5 years later
Investment return is 5% more than expected (i.e., 12.5%)	4 years sooner
Total covered PERA payroll does not increase	3 years later*

Source: Pension Trustee Advisors

*This analysis ignores any effect on the AAL.

The above illustrations assume only the event noted occurred. Multiple gains or losses from different sources will likely have a compounding effect on the Amortization Period that generally exceeds their sum.

The combined PERA funding results above are largely a result of the School and State Division because they include 86% of the members and 84% of the assets. For this reason, and to limit the number of illustrations in this report, we will show results in the following sections of the report for the School and State Divisions only and include the results for the other PERA Divisions in Appendices A through E.

Chapter Eight: Actuarial Assumption Sensitivity

Each major actuarial assumption can have an impact on future funding. This chapter analyzes the most important assumptions, their variability, and the potential consequences in terms of date of full funding.

Key Conclusions

- **The projected PERA full funding date could vary significantly in the future due to actual experience that differs from the actuarial assumptions**
 - **For example, there is a 10% chance that 1-year investment returns will exceed 24%, which would move up the anticipated date of full funding to before 2041**
- **The investment return assumption is by far the most significant variable, but population growth assumptions are also very significant**
- **The demographic and pay increase assumptions are much less significant factors**
- **Improving life expectancy will likely have a long-term effect on the full funding date, but its impact will be gradual**

This sensitivity analysis of the PERA Hybrid Plan's actuarial assumptions is the primary purpose of this study. The statute requesting this study specifically requested that the firm conducting the study "perform a sensitivity analysis to determine when, from an actuarial perspective, model assumptions are meeting targets and achieving sustainability."

In order to conduct this analysis, we have:

- Identified the key assumptions that are used to determine the value of benefits to be paid to PERA members.
- Determined how much these assumptions have varied in the past and how much they may vary in the future.
- When possible, determined the range and likelihood of future variability.
- Determined the likely impact of both short-term and long-term variability on the projected full funding date.

8.1 Actuarial Assumptions

The key actuarial assumptions (as discussed in Section 4.2) considered in this analysis include:

- Investment return
- Mortality after retirement

- Demographic:
 - Turnover (leaving employment before retirement)
 - Disability
 - Death
 - Age at Retirement
- Pay increases
- Member growth
- Continued funding of statutory contribution rates

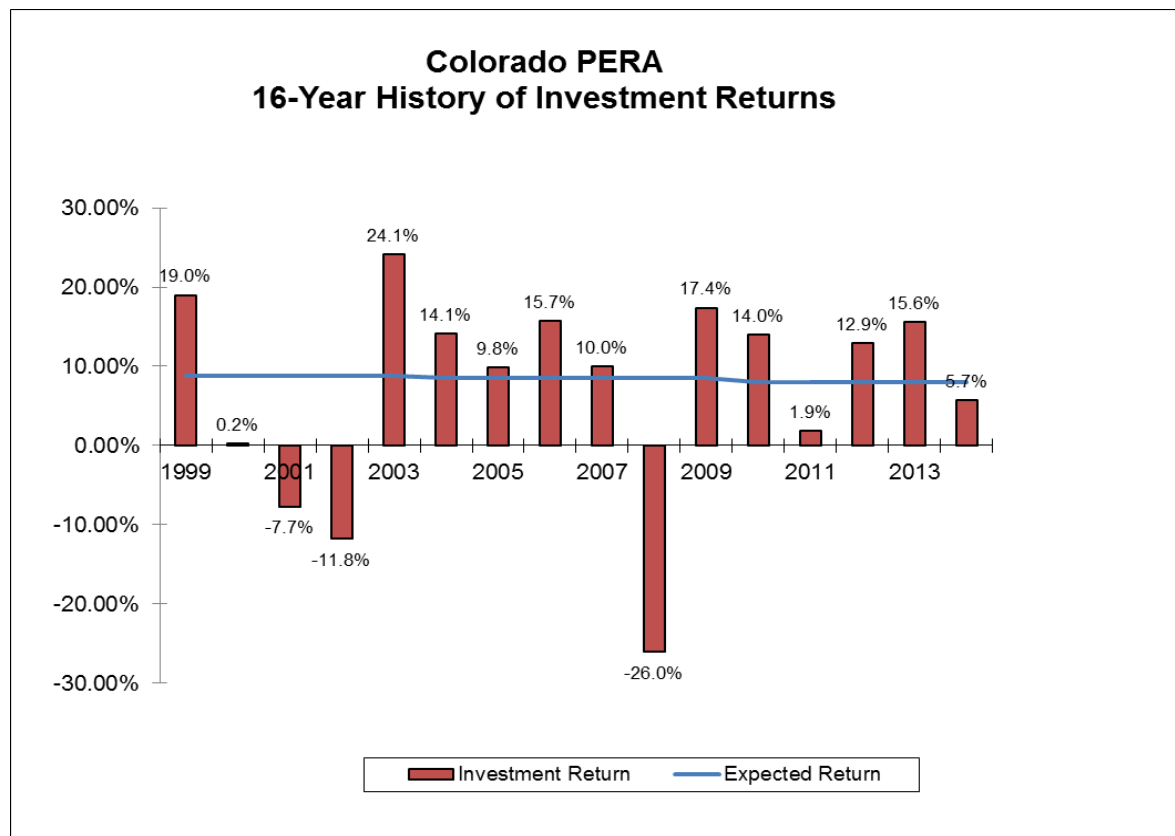
8.2 Sensitivity Analysis of Investment Return Assumption

History and Background

As discussed previously, the current expected investment return assumed by the PERA Hybrid Plan is 7.5% annually. The PERA Board of Trustees set this long-term expected investment return after hearing recommendations from a number of advisors of their future outlook.

However, actual investment returns can vary significantly in any single year. Since 1980, PERA annual investment returns have ranged from a positive return (investment gain) of 31% to a negative return (investment loss) of 26%. The period since 1999 has been particularly volatile as seen in Exhibit 8.2.1:

Exhibit 8.2.1



Source: PERA CAFRs 1999-2014

The actual PERA average annual investment returns for both very long periods as well as shorter, more recent, periods are shown below:

- From 1980 to 2014 (35 years) 9.7%
- From 1999 to 2014 (16 years) 6.3%
- From 2004 to 2014 (10 years) 6.9%
- From 2010 to 2014 (5 Years) 9.9%

Standard deviation (σ) is a statistical measure of variability. It provides a basis for determining how widely the result of any 1 year, or multiple years, could vary from the expected result. It also provides a basis for assessing the likelihood of results being within a certain range. This information is key to performing a sensitivity analysis because it considers both a range of results and the most likely results. For an in depth discussion of the statistical approach used, please see Appendix F, Statistical Techniques.

For example, if the expected investment return is 7.5% annually and the σ is 13%, there is a 68% likelihood that the actual investment results in any one year will be between one σ higher or lower than the expected amount. In other words, there is a 68% likelihood that the actual investment results will range from a loss of 5.5% to a gain of 20.5%. The σ and the range of likely results become smaller based on longer periods.

The PERA Hybrid Plan annual investment return σ since 1980 has been about 11% and about 13% since 1999. This means the volatility has been higher since 1999.

The PERA advisors (actuaries and investment consultants) also implied an expected annual σ of about 13% in their analysis of future investment returns. This is consistent with expectations by other financial and investment firms, as discussed in detail in Appendix F, Statistical Techniques.

Variability Modeled

In order to test the variability of the investment return assumption, we have set the expected experience equal to the current assumption. This means the PERA Hybrid Plan is expected to earn 7.5% per year, but has a σ of 13.2% based on both recent history and current expectation.

Based on the above information, in Exhibit 8.2.2 we have illustrated the effect of investment return variability on the projected full funding date for the PERA Hybrid Plan, based on the range of returns considering those assumptions. For example, there is a 10% likelihood that the 1-year investment return will be either a loss of 9.3% or more, and a 10% likelihood of a gain of 24.3% or more

Exhibit 8.2.2 PERA Hybrid Defined Benefit Plan Investment Return Statistics		
Period	One Year	Forty Years
Standard Deviation (σ)	13.2%	2.1%
10 th percentile worst case	-9.3%	4.8%
25 th percentile bad case	-1.4%	6.1%
Mean expected return	7.5%	7.5%
75 th percentile good case	16.4%	8.9%
90 th percentile best case	24.3%	10.2%

Source: Pension Trustee Advisors based on PERA CAFRs 1999-2014

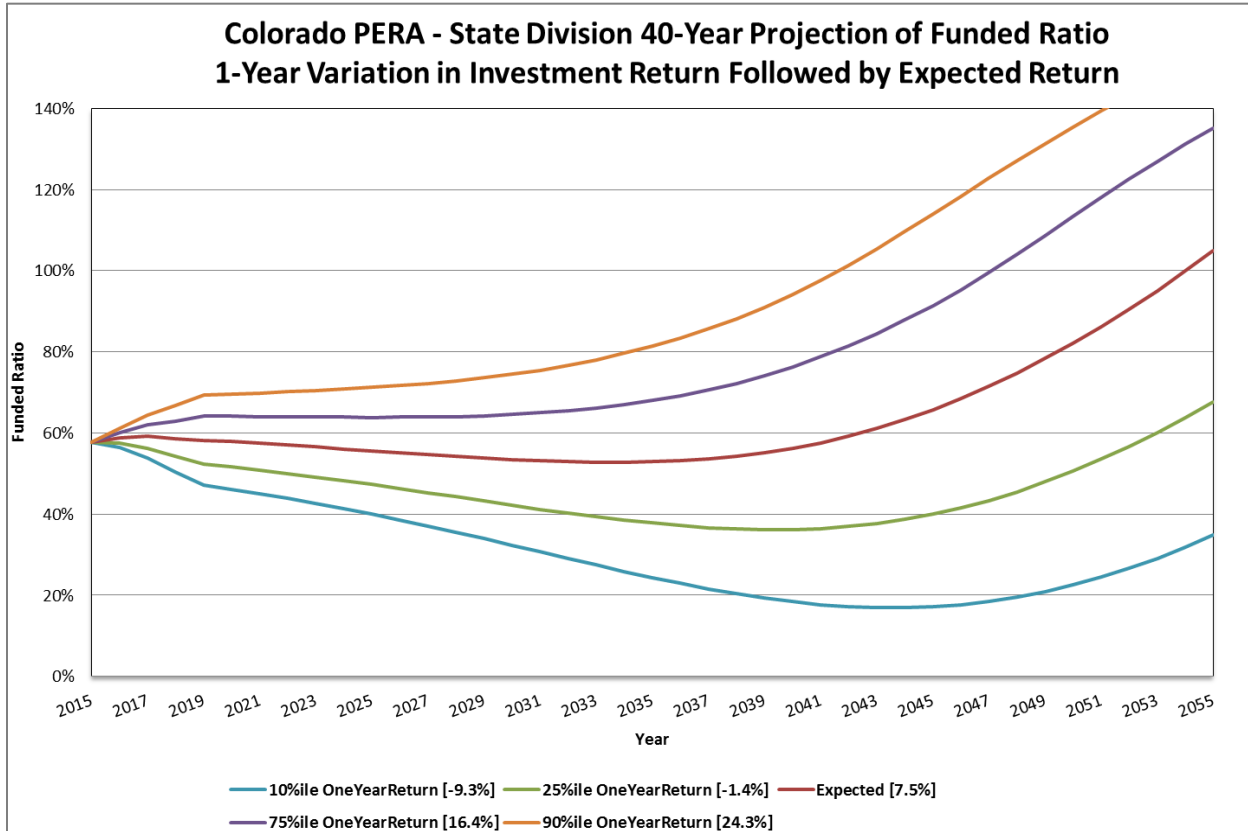
Variability Illustrations

The variability illustrations in this chapter show the change in the Funded Ratio and the expected full funding date for each assumption and the likelihood of the change. For example, each chart shows:

- The expected full funding date in red in the middle of the lines that will occur if the experience exactly meets the assumption. However, there is a 50% likelihood the actual results will be higher and 50% likelihood they will be lower.
- The top orange line represents the best case scenario, but an unlikely one. The actual results have a 90% chance of being at or below that line and only a 10% chance of being at or above the line.
- The purple line also represents favorable results that have a 75% chance of being at or below that line and a 25% chance of being at or above that line.
- The green line represents unfavorable results. There is a 25% likelihood that actual results will be this bad or worse and a 75% chance they will be at this level or better.
- The bottom blue line represents extreme unfavorable results. There is a 10% likelihood that actual results will be this bad or worse and a 90% chance they will be at this level or better.

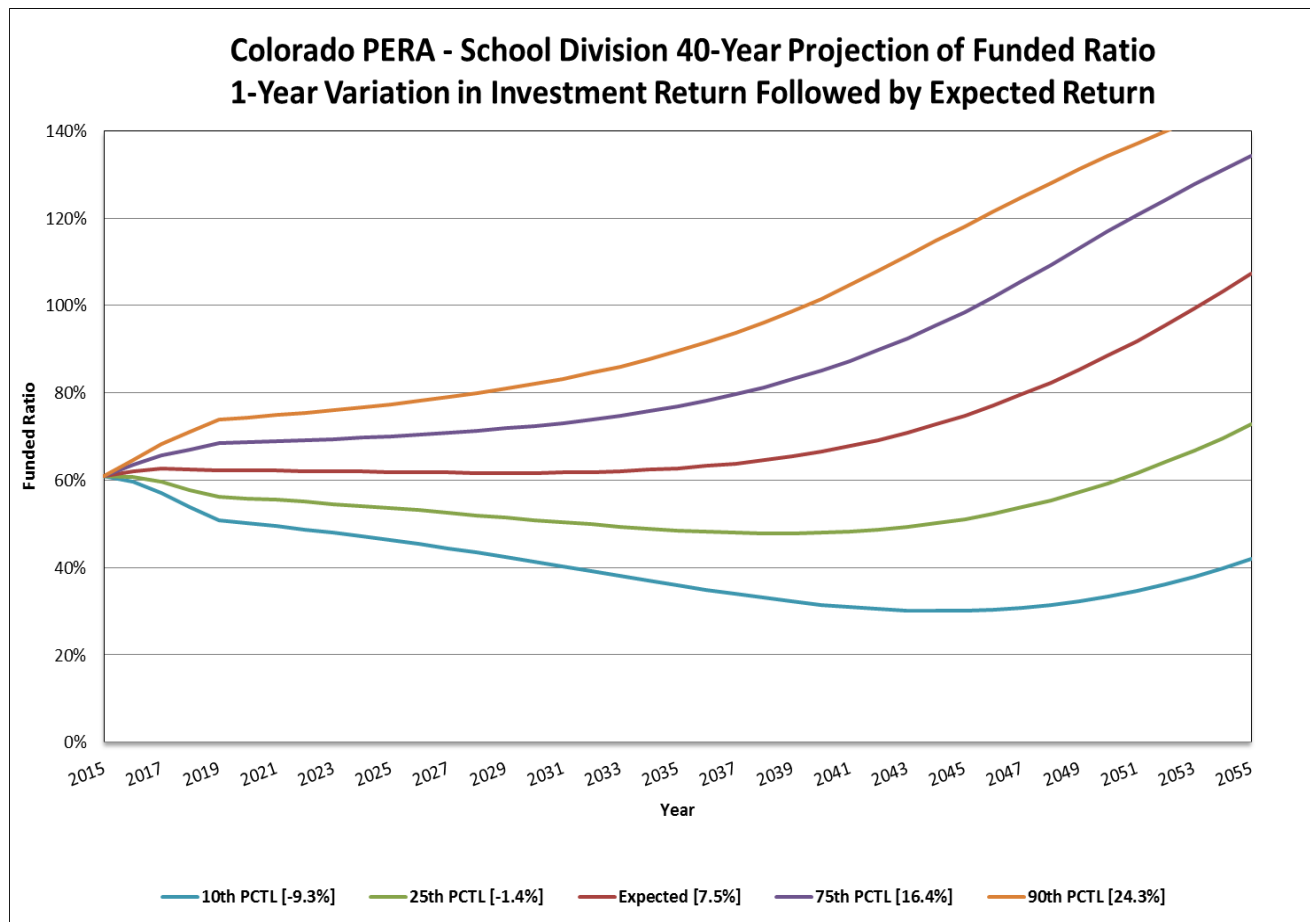
Exhibits 8.2.3 and 8.2.4 illustrate PTA's calculations, which show the impact on the Funded Ratio and the full funding dates for the State and School Divisions when there is 1 year of varied returns, followed by the expected 7.5% investment return for the remainder of the period. Note that the numbers in brackets in the charts below reflect the assumption being analyzed. For example, a 1-year return of -9.3% is the 10th percentile worse return.

Exhibit 8.2.3



Source: Pension Trustee Advisors calculations

Exhibit 8.2.4



Source: Pension Trustee Advisors calculations

Based on 1-year expected variability of investment returns and assumed returns of 7.5% afterwards:

- There is a 50% likelihood that full funding dates will be no more than 9 years earlier or later than expected for the State and School Divisions.
- There is an 80% likelihood that full funding dates will be no more than 15 years earlier or later than expected for the State Division and 20 years for the School Division.

Exhibits 8.2.5 and 8.2.6 show the impact on the Funded Ratio and the full funding dates based on 40 years of consistent returns based on potential variability for the entire period.

Exhibit 8.2.5

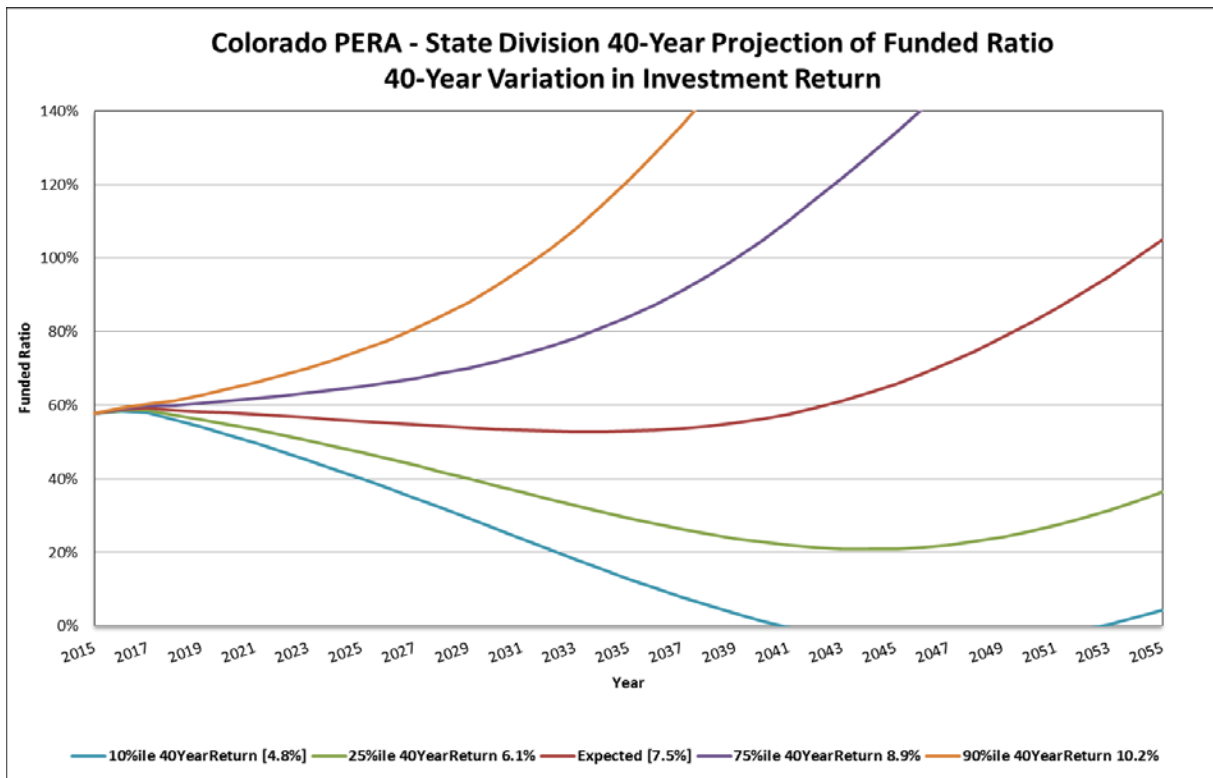
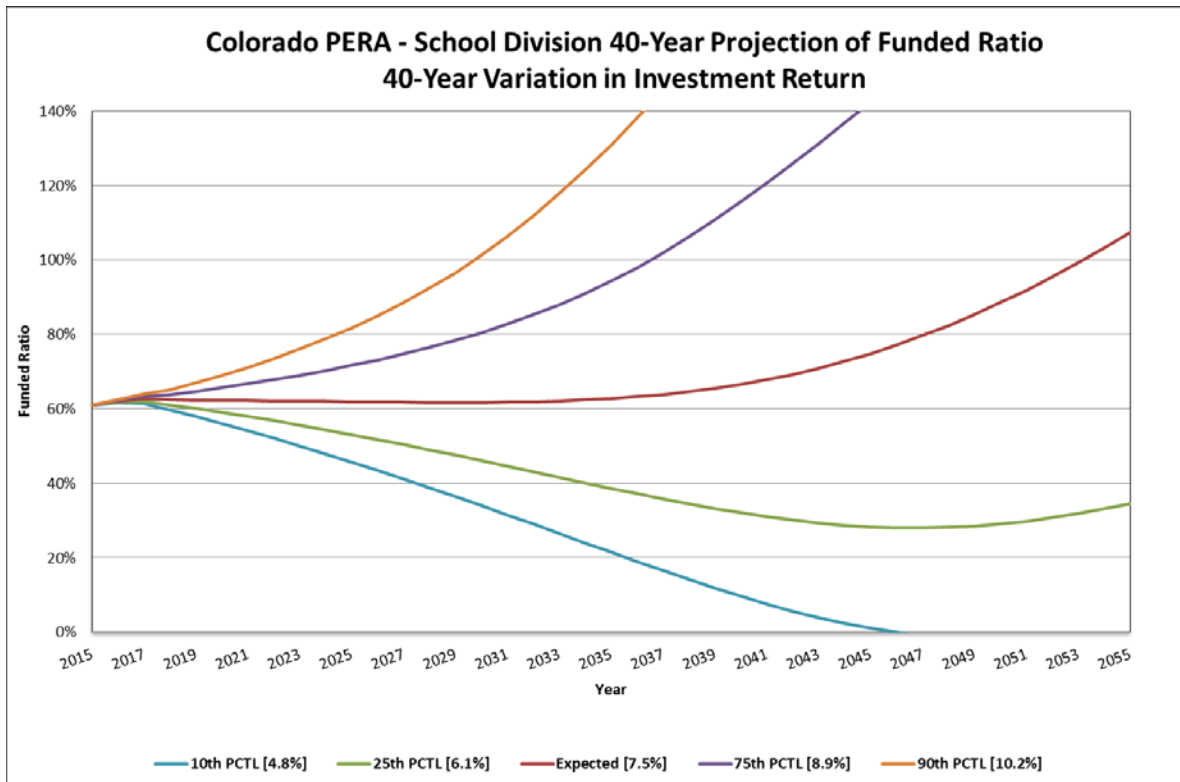


Exhibit 8.2.6

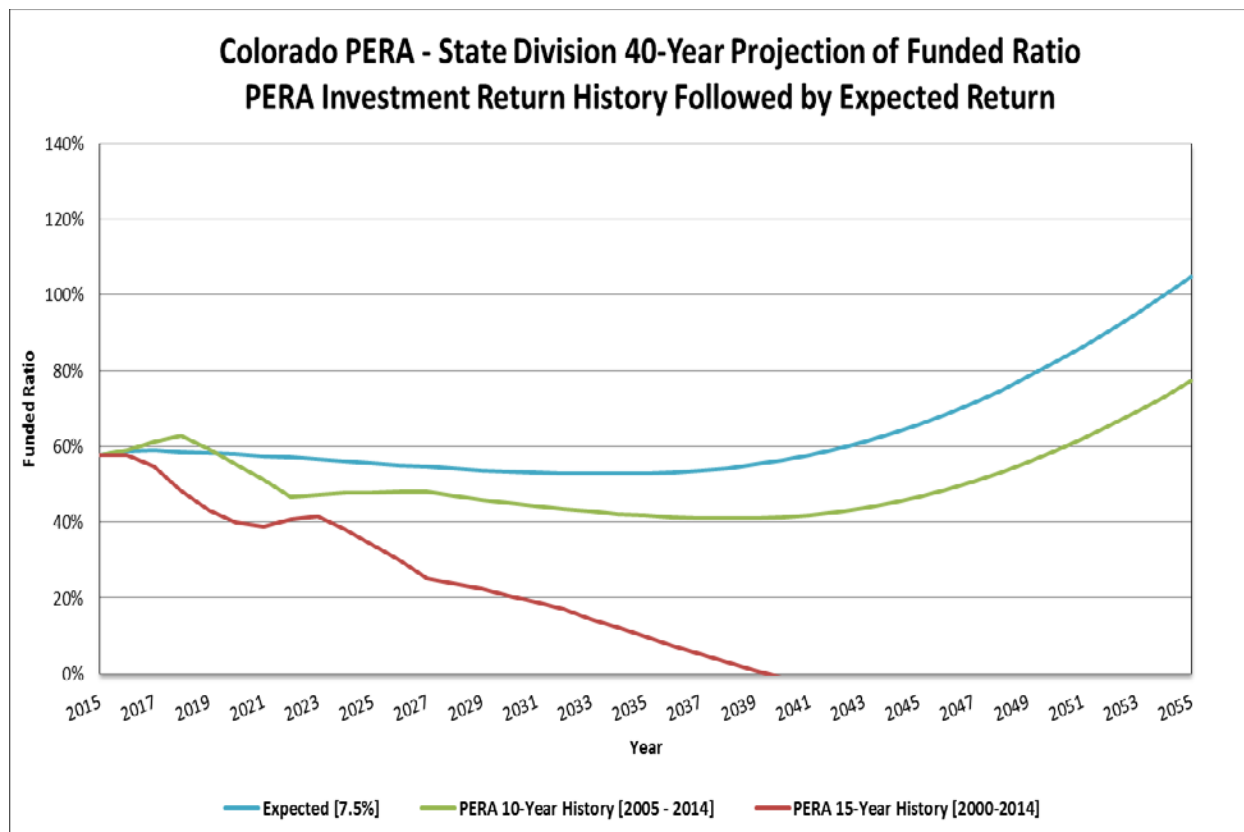


As the graphs show, based on long-term expected variability of investment returns:

- There is a 50% likelihood that full funding dates will be no more than 20 years earlier or later than expected for the State and School Divisions (compare 25th and 75th percentiles).
- There is a 10% likelihood that the divisions will become insolvent during the period (10th percentile) and a 10% likelihood (90th percentile) that full funding could occur by 2031 or earlier.

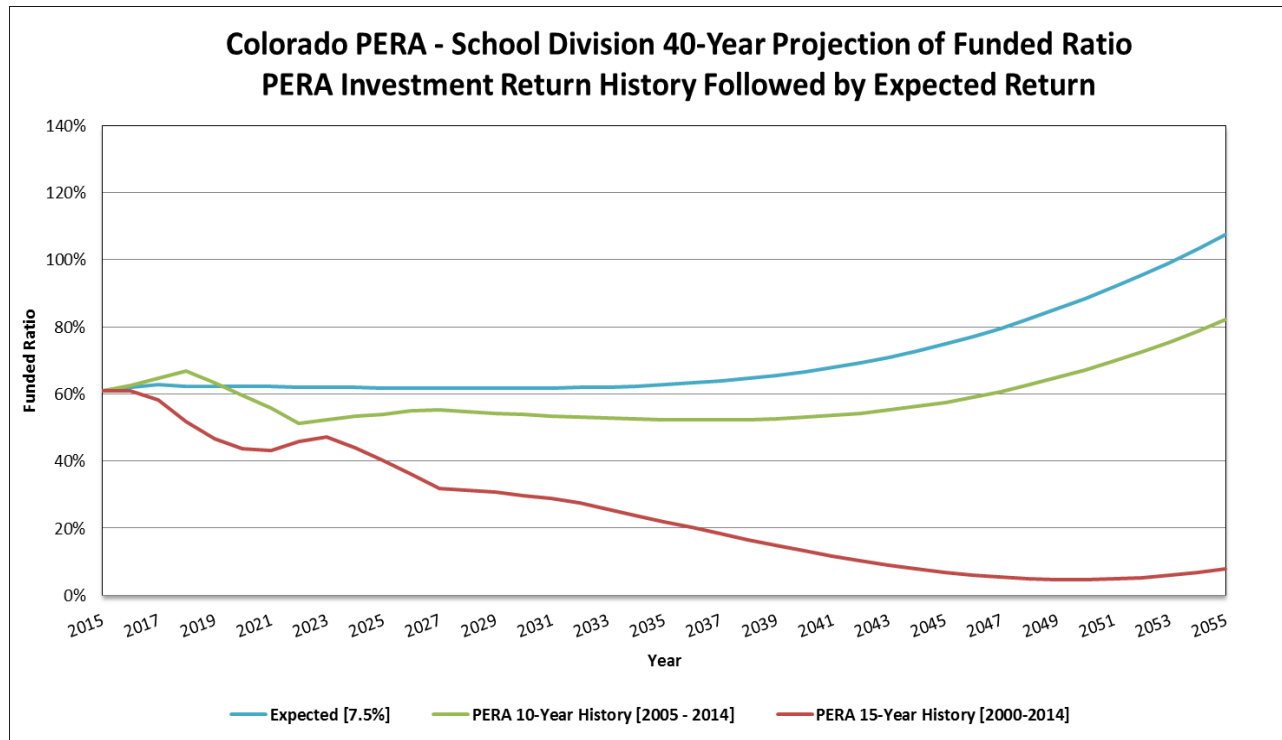
Exhibits 8.2.7 and 8.2.8 show the impact on the Funded Ratio and the full funding dates if there is a repeat of the PERA investment return history from 2000-2014 and from 2005-2014, followed by the expected investment return of 7.5% for the remainder of the period.

Exhibit 8.2.7



Source: Pension Trustee Advisors calculations

Exhibit 8.2.8



Source: Pension Trustee Advisors calculations

As the graphs show:

- Based on a repeat of the PERA actual investment returns for the period 1999-2014 for the next 16 years, and then the expected investment return of 7.5% afterwards, the State Division would become insolvent in 25 years and the School Division would remain only slightly above insolvency.
- Based on a repeat of the PERA actual investment returns for the period 2005-2014 for the next 10 years, and then the expected investment return of 7.5% afterwards, both Divisions would be fully funded about 5 years later than currently expected.

Conclusions

As expected, future investment return variability will have a significant effect on the Funded Ratio and projected full funding date for the PERA Hybrid Plan.

8.3 Sensitivity Analysis of Demographic Assumptions

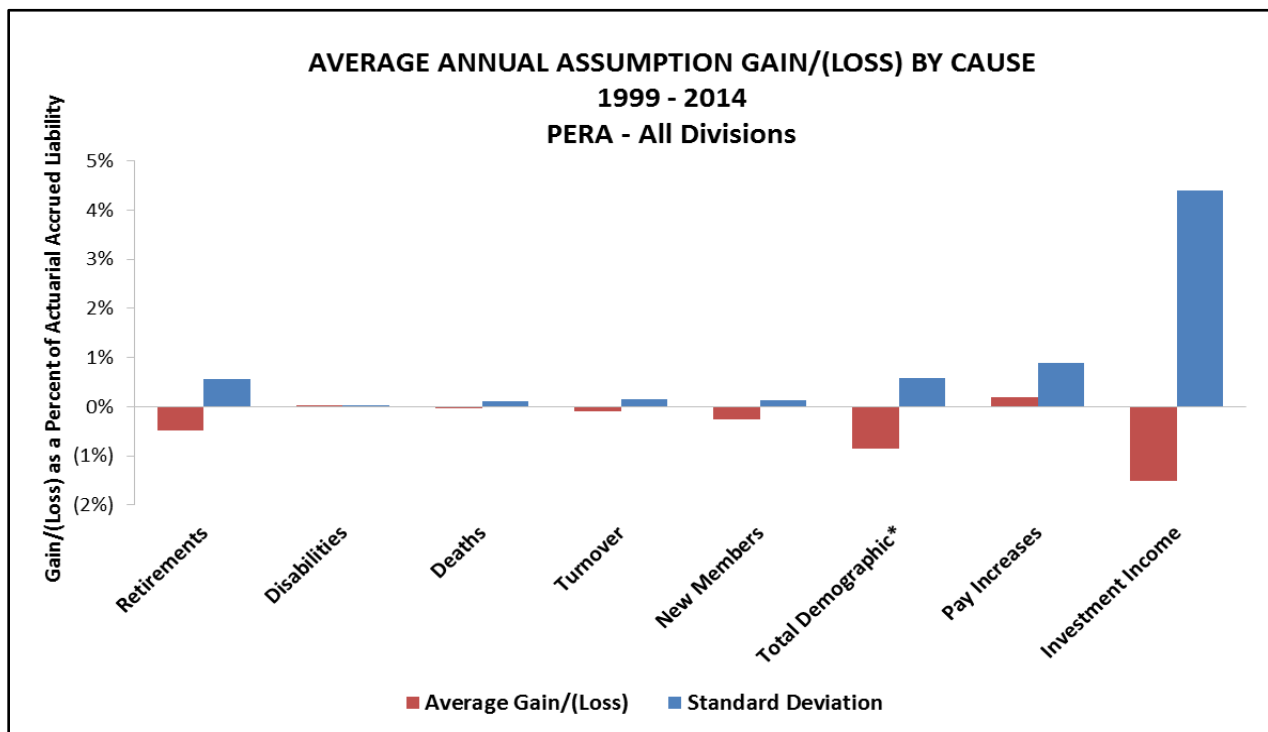
History and Background

Exhibit 8.3.1 shows the average annual gain or (loss) due to the demographic assumptions for the period 1999-2014. Demographic assumptions include rates of retirement; disability; death, both before and after retirement; and separation from employment before retirement. As a comparison, the gains and (losses) for pay increases and investment returns are also included.

Gains occur when the actual experience is more favorable than assumed. Losses occur when the experience is less favorable than assumed. For example, if fewer disabilities occur than assumed, a gain occurs; more disabilities than assumed would create a loss.

Gains (or losses) result in a lower (or higher) AAL. The gain (or loss) is expressed as a percent of the AAL.

Exhibit 8.3.1



Source: Pension Trustee Advisors calculations based on PERA Actuarial Valuation Reports 1999-2014

* Total Demographic is the sum of Gain/(Loss) by Retirements, Disabilities, Deaths, Turnover, and New Members. The average annual assumption gain or loss for pay increases and investment income is provided for comparison purposes only.

This recent actual PERA experience confirms:

- The demographic assumptions resulted in an average annual (loss) of 0.86% of the AAL.
- The annual σ was 0.6% of the AAL.
- The actuarial assumptions have been refined periodically to reflect the actual experience.

Variability Modeled

Our analysis will assume as a baseline that the current collection of demographic actuarial assumptions is the median likely outcome. PERA and their actuaries monitor these assumptions carefully and modify them as necessary following experience studies. The recent actuarial audit, conducted by Milliman, did not uncover any actuarial assumptions that appear to be in need of changing. We are assuming that these demographic assumptions have been appropriately modified so that there will *not* be ongoing demographic actuarial losses in the future, despite the historical average loss of 0.86% of AAL. If this is not the case and demographic losses persist in the future, a modest extension of the full funding date will slowly occur. Because of the relative insignificance of any one demographic assumption, demographic assumptions will be aggregated.

Based on the above information, we have illustrated the effect of demographic assumption variability on the projected full funding date for the PERA Plan, based on the following range of expectations.

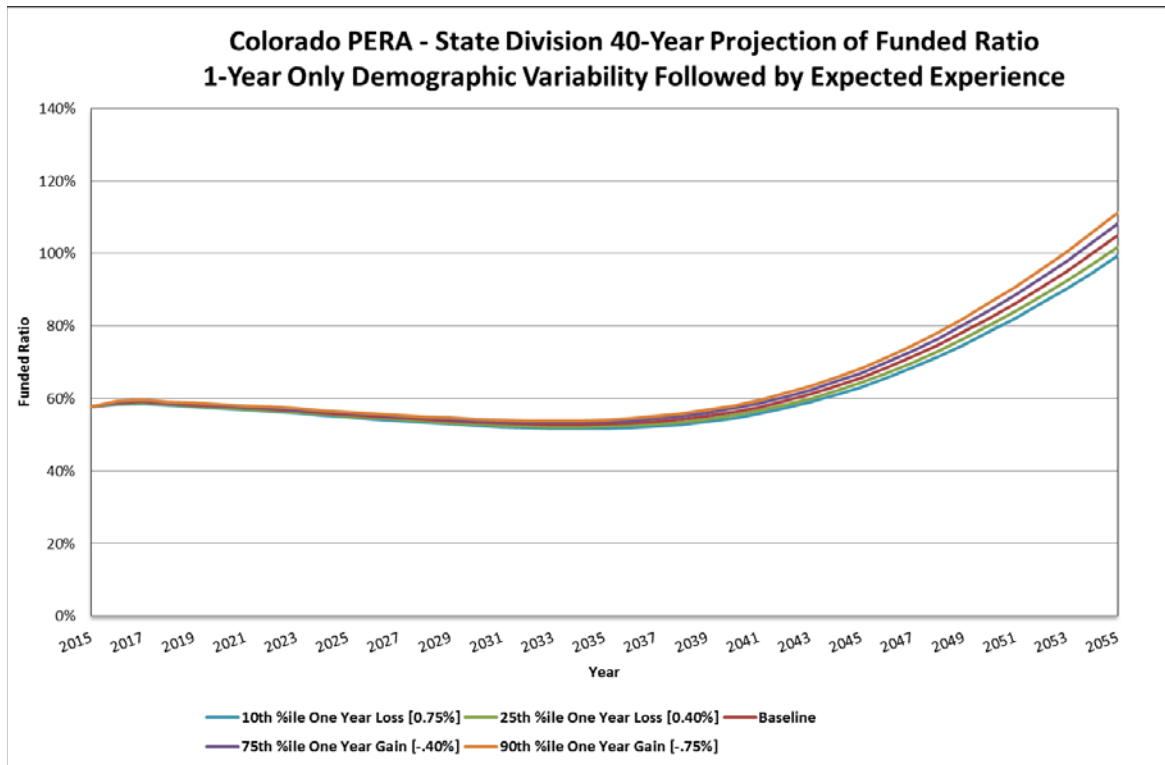
Exhibit 8.3.2 PERA Hybrid Defined Benefit Plan Variability Statistics		
Scenario	1-Year Gain (Loss) as % of AAL	40-Year Gain (Loss) as % of AAL
Plausible worst case (10 th percentile)	0.75%	0.12%
Plausible bad case (25 th percentile)	0.40%	0.06%
Expected	0.00%	0.00%
Plausible good case (75 th percentile)	-0.40%	-0.06%
Plausible best case (90 th percentile)	-0.75%	-0.12%

Source: Pension Trustee Advisors

Variability Illustrations

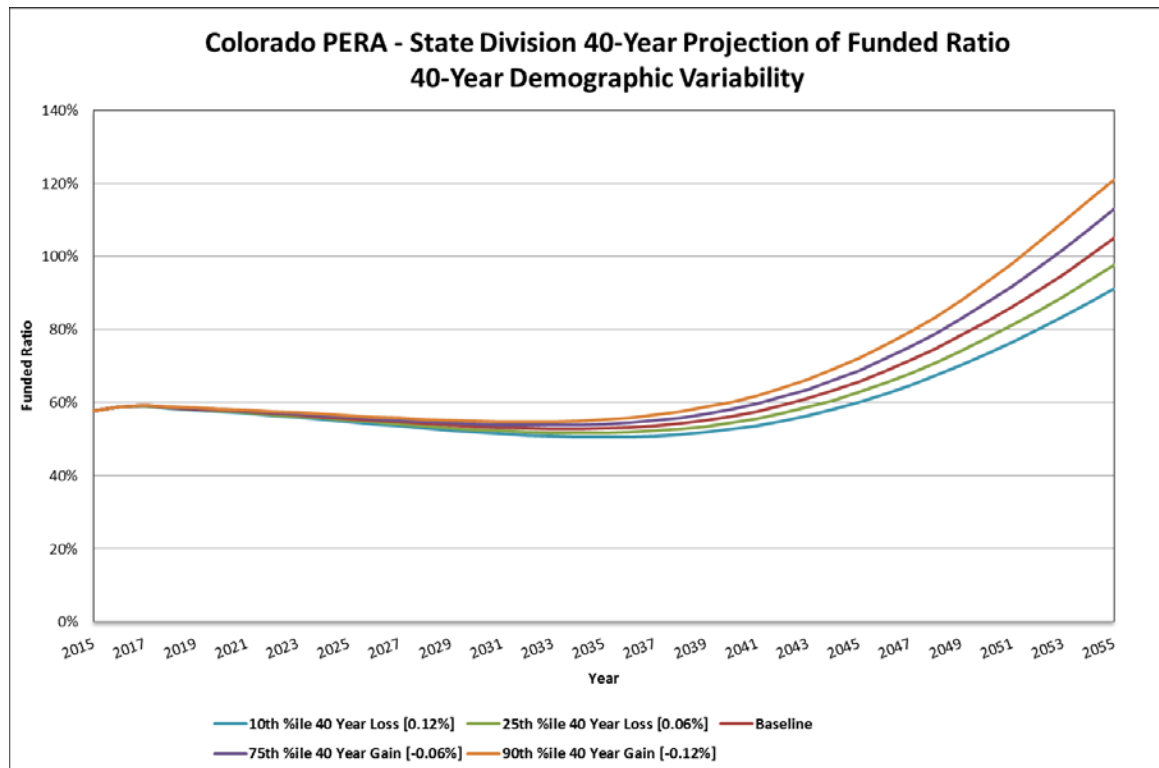
Exhibits 8.3.3 and 8.3.4 show the impact on the Funded Ratio and the full funding dates when there is only 1 year of demographic variability, followed by the expected experience for the remainder of the period and when there is variability over a 40-year period.

Exhibit 8.3.3



Source: Pension Trustee Advisors calculations

Exhibit 8.3.4



Source: Pension Trustee Advisors calculations

Conclusions

As the graphs show:

- Neither 1-year nor multiple years of demographic variability have significant impact on the expected full funding dates.
- Based on long-term expected variability of demographic assumptions:
 - There is a 50% likelihood that full funding dates will be no more than 1 to 2 years earlier or later than expected (between 25th and 75th percentiles).
 - There is a 80% likelihood that full funding dates will be no more than 2 to 3 years earlier or later than expected (between 10th and 90th percentiles).

8.4 Sensitivity Analysis of Mortality after Retirement Assumption

History and Background

As shown in the “Death” tables in Appendix A, Historical Gains/Losses All Divisions, the mortality experience since 1999 has closely followed the assumptions with an average (loss) of about 0.05% of the AAL. The impact of future variability in this assumption was calculated mathematically above along with other demographic assumptions and was not a significant factor.

However, this assumption will likely be much more significant in the future. Continued improvement in life expectancy may increase the liabilities of PERA because members will receive their retirement benefits for a longer period. This in turn would increase the obligations of PERA and could delay the full funding dates.

PERA currently uses the RP-2000 Combined Mortality Table with adjustments, projected for mortality improvement to the year 2020. Most public retirement plans (over 70%) use this table as the base for projecting future life expectancy. A few plans also consider continuing future mortality improvement for all years in the future, not only for a fixed period such as PERA’s 2020. These perpetually increasing mortality tables are known as generational mortality improvement. The Society of Actuaries has released a more current mortality table along with an updated future improvement scale. This table is called the RP-2014 Mortality Table and the improvement scale is called MP-2014.

PERA, like most plans, has a practice of periodically updating the mortality table to one that more closely tracks anticipated future mortality including some improvement. For example, in 2012, PERA adopted the current table that is *projected* to 2020. This means that they expect that it will understate the number of deaths in years before 2020 and overstate the number after 2020. Presumably in 2017 or at the next review of actuarial assumptions, PERA actuaries will recommend and PERA will approve a further extension of the projection of mortality tables, to 2025, for example.

Recent experience has been modest mortality losses (the value of benefits stopping due to deaths slightly less than predicted). This is somewhat unexpected because although the current 2020 table is expected to understate the number of deaths occurring prior to 2020, recent experience has been for even fewer deaths than this understated amount. Although this is a potential long term concern, the experience to date has not been material.

PERA's mortality table practice is very consistent with the majority of public plans. It does anticipate some improvement in mortality (i.e., members will live longer), but it does not anticipate as much improvement as is likely to occur. This is discussed in great detail in PERA's recently completed actuarial audit. Like many plans, PERA also has administrative concerns with the complexity of incorporating a fully generational mortality table which reflects all anticipated future mortality improvement today.

As a result of the realistic possibility that current policy will eventually overstate mortality, we incorporate alternative scenarios and include the current approach as the "best case scenario" from a PERA funding point of view.

Variability Modeled

The possible impact of future mortality improvement is illustrated below assuming:

- Best case: Current PERA table with no changes in the future; no more improvement beyond 2020
- Most likely case: The current practice of extending the mortality projections is followed every 5 years
- Alternative case: The mortality projections are immediately changed to the RP-2014 table with generational projections using standard mortality improvement projection scale MP2014
- Worst case: The mortality projections are changed to the RP-2014 table with generational projections using 25% more improvement than projection scale MP2014

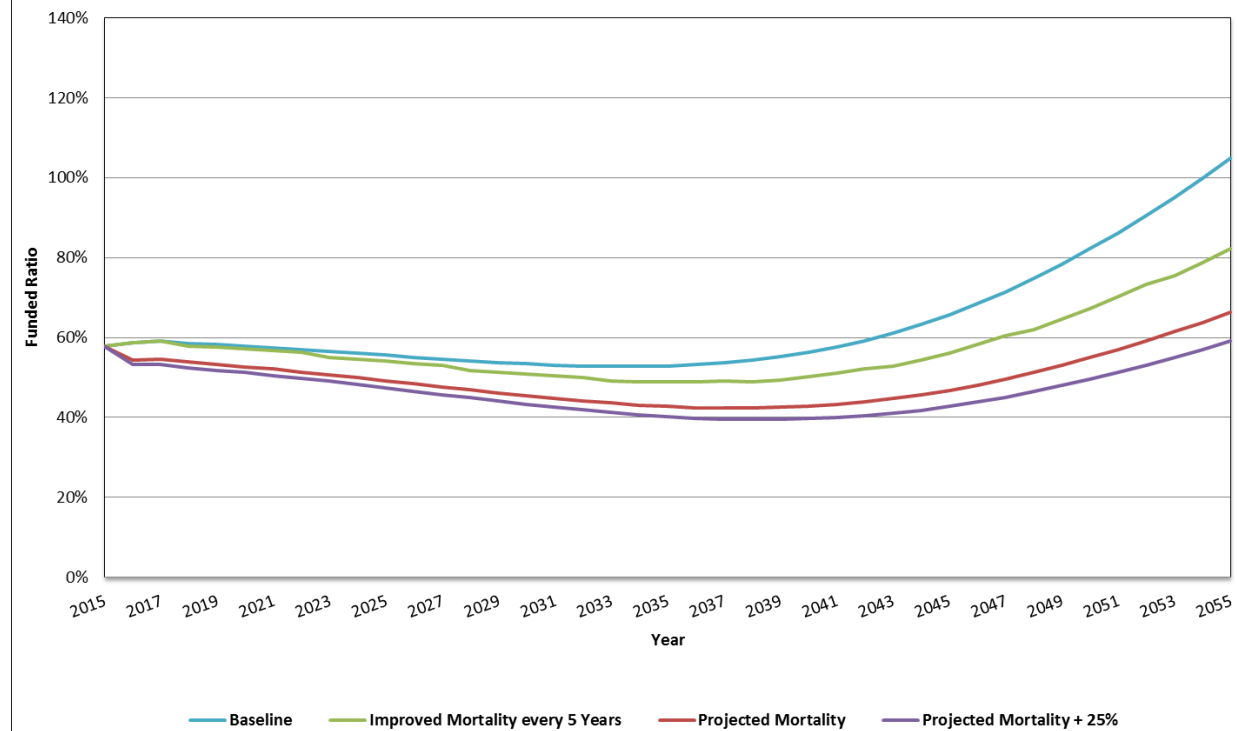
Since continuing improvements in life expectancy are expected and PERA's recent experience has been less favorable (fewer deaths) than the current assumptions, it is unlikely the current mortality table will overstate the future life expectancy. Therefore, we have not illustrated a more favorable mortality scenario. We believe the current table with no future change represents a best-case scenario.

Variability Illustrations

Exhibit 8.4.1 illustrates that improvement in mortality beyond what is currently built into the actuarial assumptions will likely increase the date of full funding by 7 years. A full incorporation of mortality improvement would increase it by a further 7 years. And if mortality improves 25% more than the consensus expert opinion, full funding will not be reached until 2071.

Exhibit 8.4.1

**Colorado PERA - State Division 40-Year Projection of Funded Ratio
Mortality Basis Sensitivity**



Source: Pension Trustee Advisors calculations

Conclusions

We cannot statistically analyze the likelihood of the various alternatives, but we would say that the 2071 scenario is fairly unlikely. Some experts believe that the current baseline scenario is plausible because of a variety of societal factors limiting mortality improvement. Most believe some additional mortality improvement beyond 2020 will occur.

We should expect a modest delay in the funding period every 5 years as PERA actuaries update their mortality assumptions to reflect future anticipated mortality improvement. If PERA were to take a more conservative position and reflect all anticipated mortality improvement now, the funding period would increase by 13 years.

8.5 Sensitivity Analysis of Salary Growth Assumptions

History and Background

The PERA assumptions include an expected annual salary growth for continuing members that includes an annual increase of 3.9% due to inflation and productivity, plus an additional amount due to merit and seniority. The latter amount varies by age (higher at younger ages) and by employee classification.

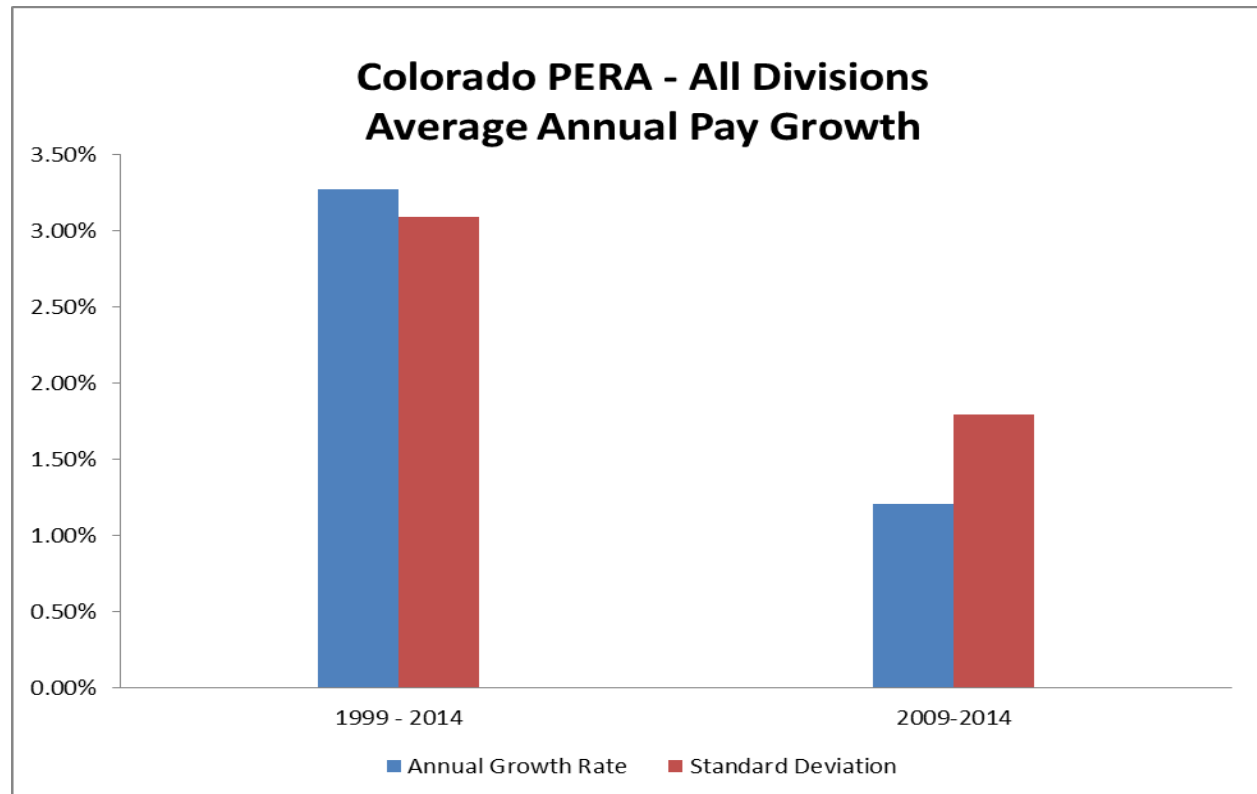
If pay increases more than expected, a loss occurs because member retirement benefits will be higher than expected. This is because benefits are based on pay. Conversely, smaller than expected pay increases create a gain because benefits will be less than expected. The gain or loss due to pay variability is reflected in the AAL.

As shown in Chapter 6, Recent History and Experience, Section 6.2, the PERA experience since 1999 due to this variable has been positive; that is, pay increases have been lower than expected. This has resulted in an average gain over this time of 0.19% of the AAL. Moreover, over the last 5 years, PERA's experience has been considerably more positive—averaging 0.76% of the AAL.

However, the PERA projections are based on expected payroll growth for the continuing members plus new members. This payroll growth projection is also the basis for future member and employer contributions. For this purpose, an opposite result occurs. Lower than expected payroll growth reduces the expected future contributions and potentially extends the full funding date. On the other hand, higher than expected growth results in higher funding and may reduce the full funding date. The total impact of pay increase variability should consider both of these factors.

Exhibit 8.5.1 compares the PERA actual annual growth rate to the standard deviation for the periods 1999-2014 and 2009-2014.

Exhibit 8.5.1



Source: Pension Trustee Advisors calculations based on PERA Actuarial Valuation Reports 1999-2014

Variability Modeled

The illustrations that follow assume variation in future individual salary increases, which result in actuarial gains and losses as follows:

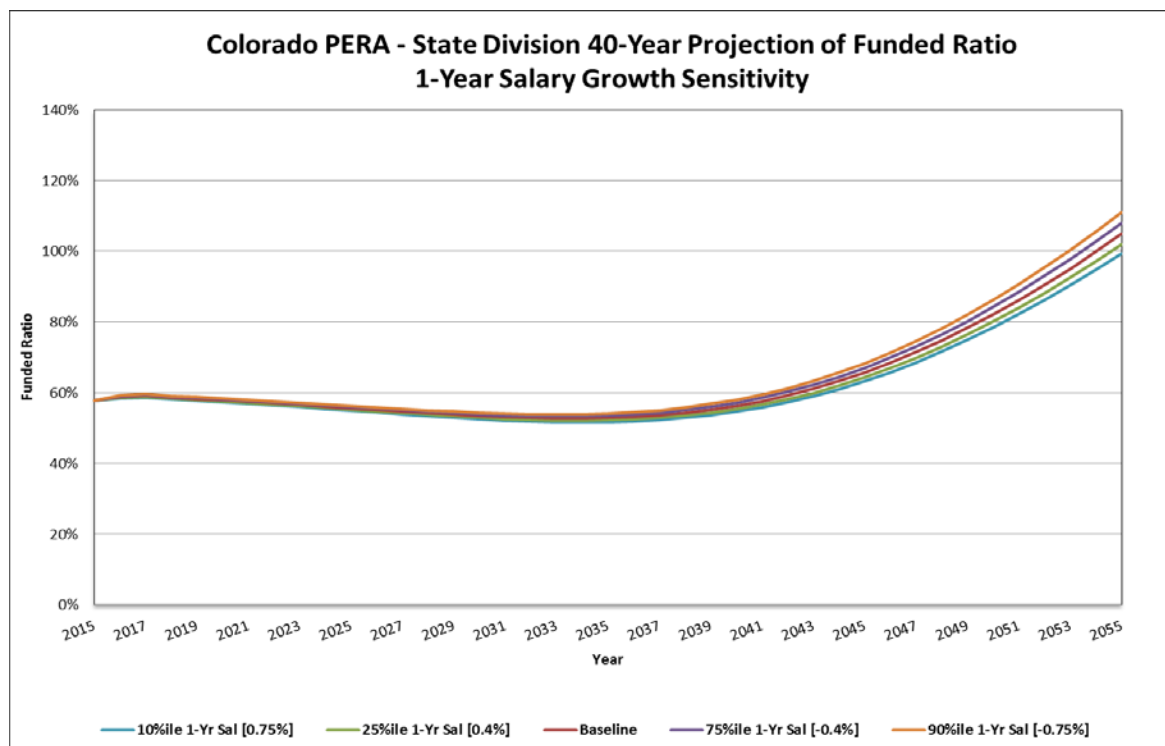
Exhibit 8.5.2 PERA Hybrid Defined Benefit Plan Salary Increase Variability Statistics		
Scenario	1-Year Gain (Loss) as % of AAL	40-Year Gain (Loss) as % of AAL
Plausible worst case (10 th percentile)	0.75%	0.14%
Plausible bad case (25 th percentile)	0.40%	0.07%
Expected	0.00%	0.00%
Plausible good case (75 th percentile)	-0.40%	-0.07%
Plausible best case (90 th percentile)	-0.75%	-0.14%

Source: Pension Trustee Advisors based on PERA CAFR 1999-2014

Variability Illustrations

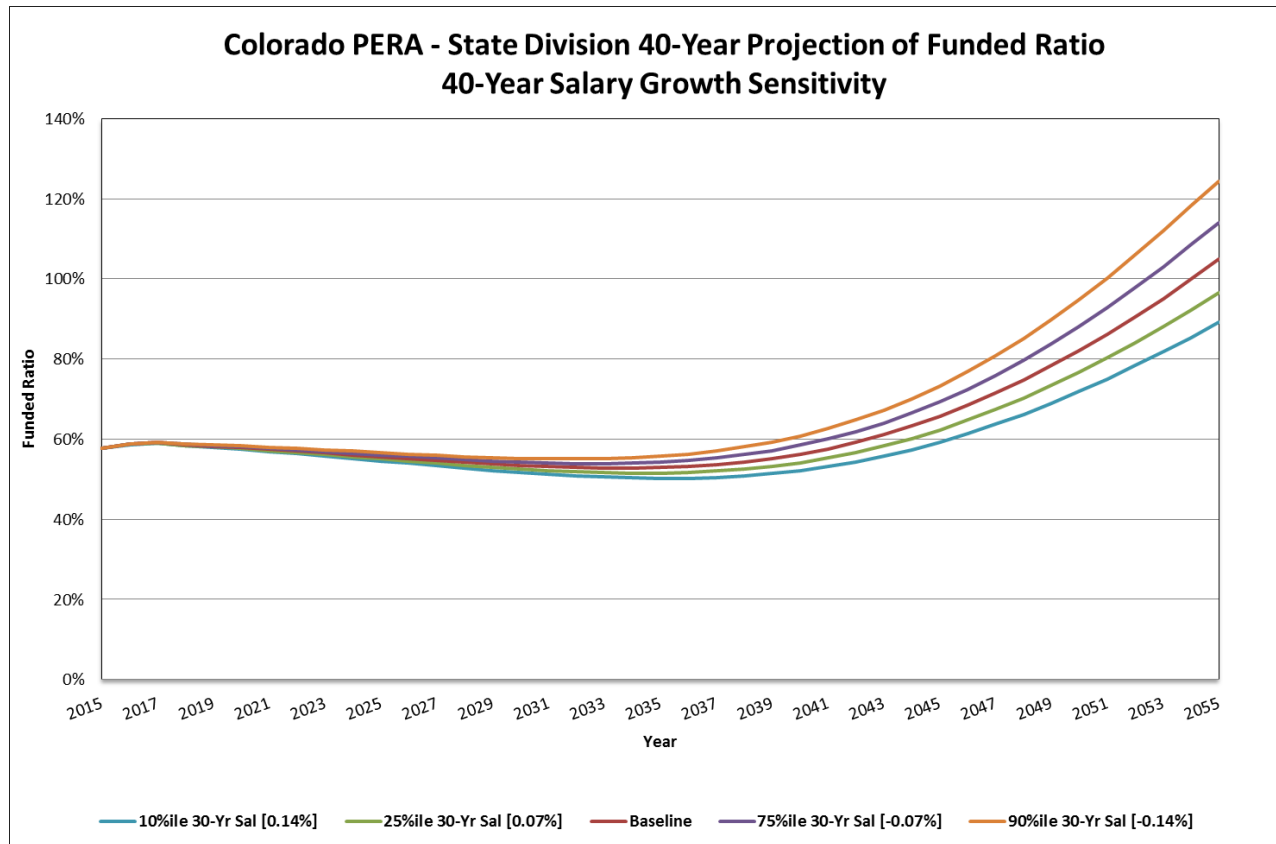
Exhibits 8.5.3 and 8.5.4 illustrate the impact that 1-year and 40-year variations in salary growth have on the Funded Ratio for the State Division.

Exhibit 8.5.3



Source: Pension Trustee Advisors calculations

Exhibit 8.5.4



Source: Pension Trustee Advisors calculations

Conclusions

As the graphs show:

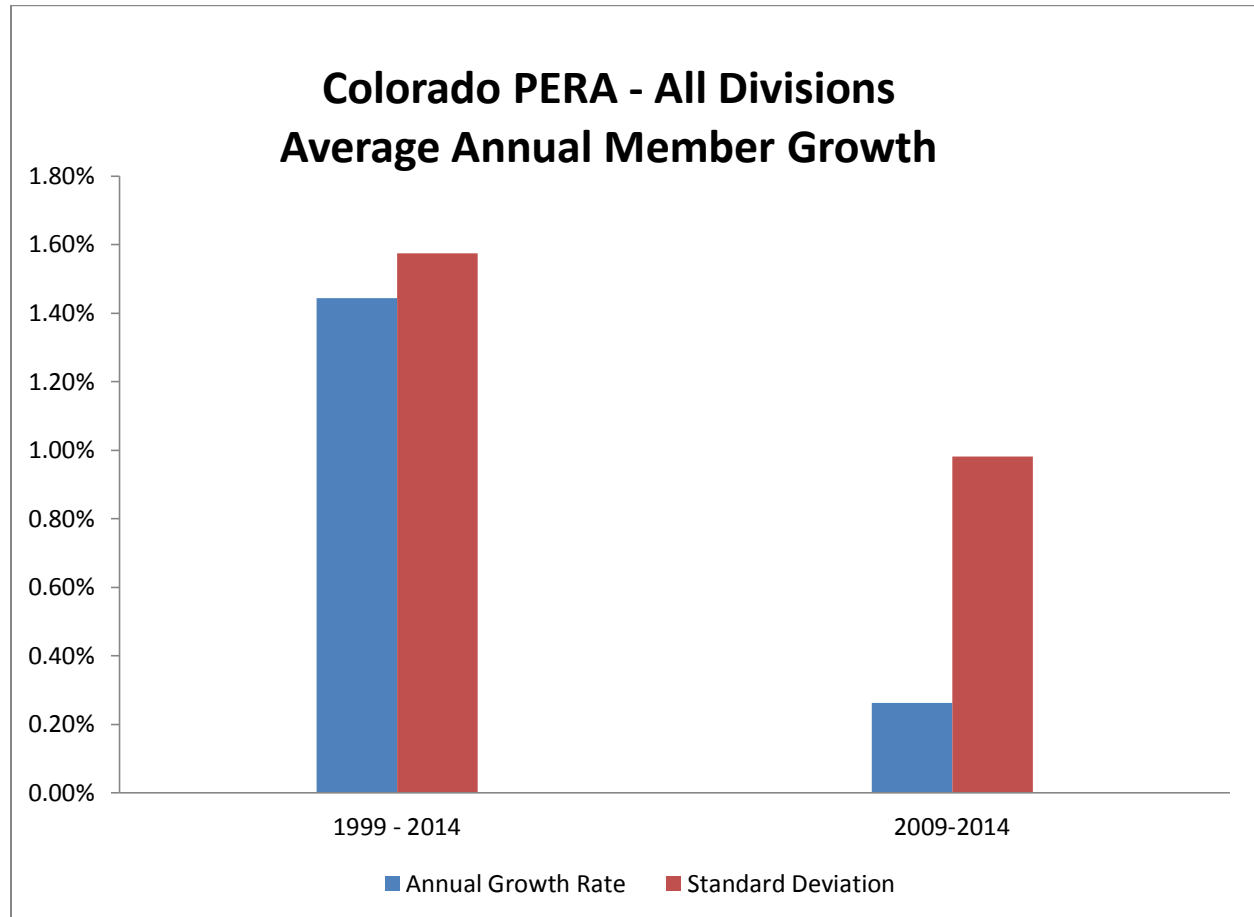
- Salary growth volatility by itself is expected to have only a minor impact on the full funding date based on 1-year or multiple-year variations. This is largely due to the offsetting effect on the AAL and the full funding date described above. While higher than expected salary increases result in an increase in the AAL, it also results in increased contributions.
- Based on long-term expected variability of salary growth assumptions:
 - There is a 50% likelihood that full funding dates will be no more than 1 to 2 years earlier or later than expected.
 - There is a 90% likelihood that full funding dates will be no more than 2 to 3 years earlier or later than expected.

8.6 Sensitivity Analysis of Member Growth Assumption

History and Background

As discussed above, an increasing payroll means that the projected contributions toward payment of the UAAL will be increased. This has a positive impact on the funding of PERA. Payroll can increase by individual salaries increasing, as well as by new workers entering PERA. The analysis that follows reflects the impact of increasing membership:

Exhibit 8.6.1



Source: Pension Trustee Advisors calculations based on PERA Actuarial Valuation Reports 1999-2014

The most recent PERA member growth rate has been significantly less than the longer-term rate since 1999.

Variability Modeled

The illustrations that follow assume variation in future member growth rate increases, which result in actuarial gains and losses as follows:

- Mean expected growth set to match assumptions
- 40-year constant best, bad, and worst-case variability

Exhibit 8.6.2 PERA Hybrid Defined Benefit Plan Illustrations of Population Growth Volatility			
Scenario	<i>One-Year</i> Population Growth	5-Year Average Population Growth	40-Year Average Population Growth
Standard Deviation	1.6%	0.7%	0.2%
10 th percentile worst case	-0.5%	0.6%	1.2%
25 th percentile bad case	0.4%	1.0%	1.4%
Mean expected return	1.5%	1.5%	1.5%
75 th percentile good case	2.6%	2.0%	1.6%
90 th percentile best case	3.5%	2.4%	1.8%

Source: Pension Trustee Advisors calculations based on PERA Actuarial Valuation Reports 1999-2014

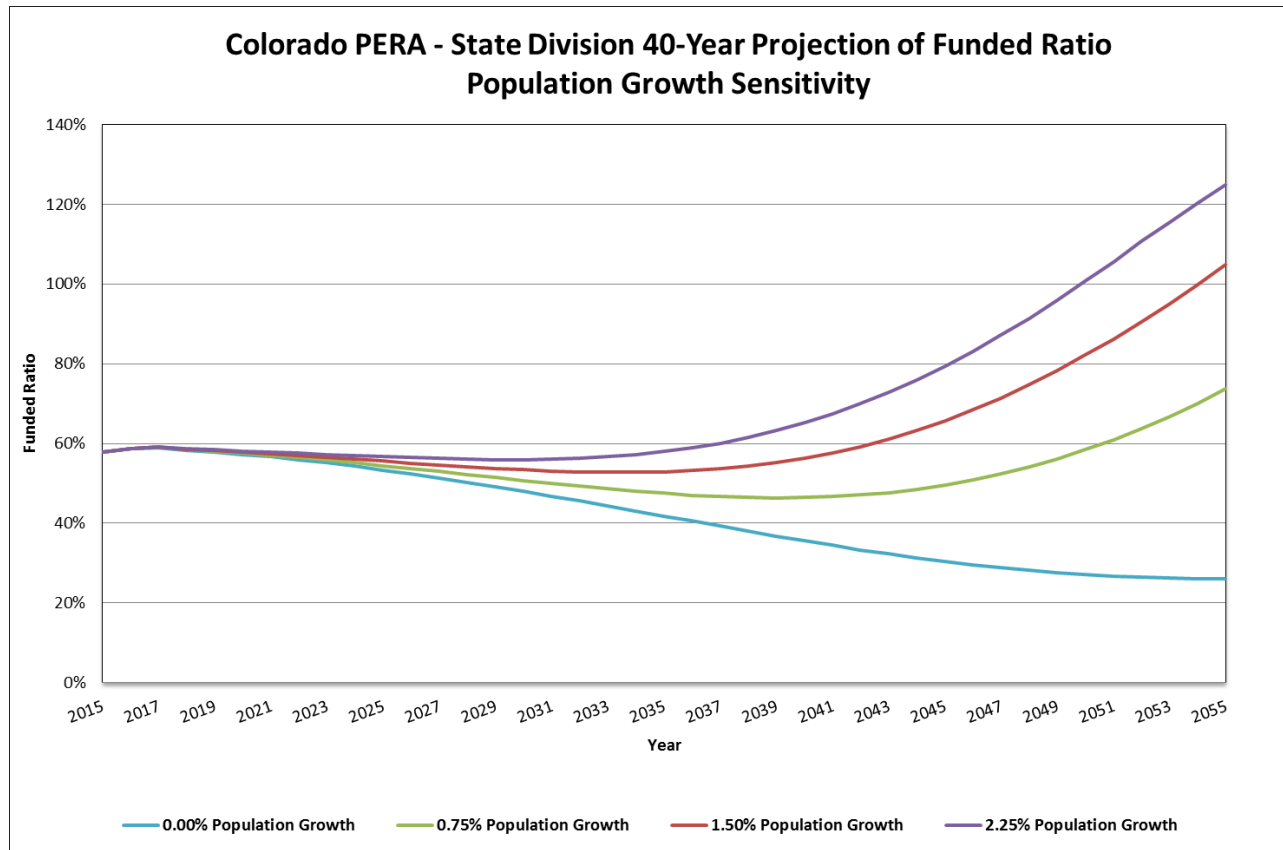
Although these growth rates are based on the statistics over the past 16 years, the future growth rates are dependent on:

- The State of Colorado population growth rate
- Public or school employment relative to the state population
- Relatively more PERA State Division members join the Defined Contribution Plan than are joining currently
- Work force efficiencies and technology changes

Variability Illustrations

As a result of this variability, we illustrate 0% growth, 0.75% growth (half of current expectations), and 2.25% growth (50% above current expectations) as well as the current expected growth of 1.50%. Mathematically, 0% for the next 40 years has an infinitesimally small probability and being outside the range of 0.75% to 2.25% has a probability of less than 1%.

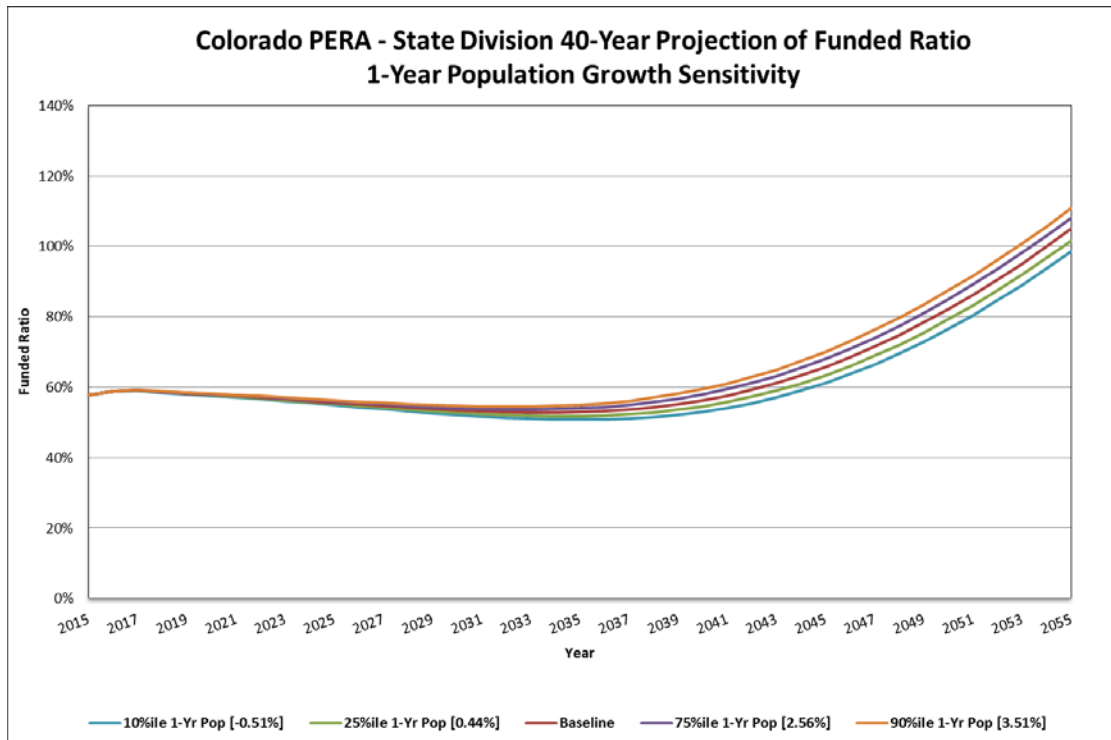
Exhibit 8.6.3



Source: Pension Trustee Advisors calculations

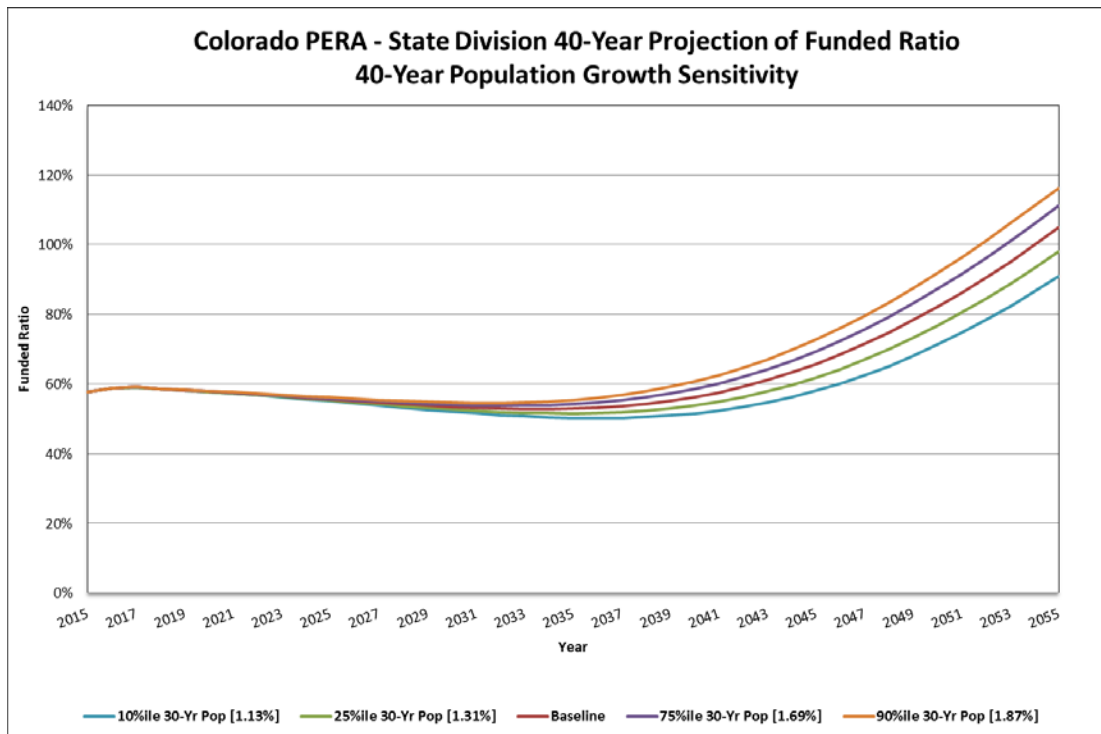
Exhibits 8.6.4 and 8.6.5 show the possibilities based on the statistical analysis:

Exhibit 8.6.4



Source: Pension Trustee Advisors calculations

Exhibit 8.6.5



Source: Pension Trustee Advisors calculations

Conclusions

The graphs show that:

- Based on historical statistics, the impact of future population growth is not expected to be very significant.
- If historical statistics are not continued to be observed, future population growth is potentially a significant variable in both the short-term and the long-term.
- Based on long-term expected variability of population growth assumptions:
 - There is a 50% likelihood that full funding dates will be no more than 1 to 2 years earlier or later than expected and
 - There is a 90% likelihood that full funding dates will be no more than 2 to 3 years earlier or later than expected.
- However, substantially higher or lower population growth rates than expected are much more significant and could result in much greater changes in the full funding dates.

8.7 Sensitivity Analysis of Statutory Contribution Schedule

History and Background

PERA is funded by base and supplemental statutory employer contributions, ultimately increasing to over 20% of pay for the State and School Divisions in 2018 and beyond. The supplemental contributions are fixed at the current statutory schedule until a Division's Funded Ratio reaches 103%. The rates are then reduced by a total of 1% of pay each year.

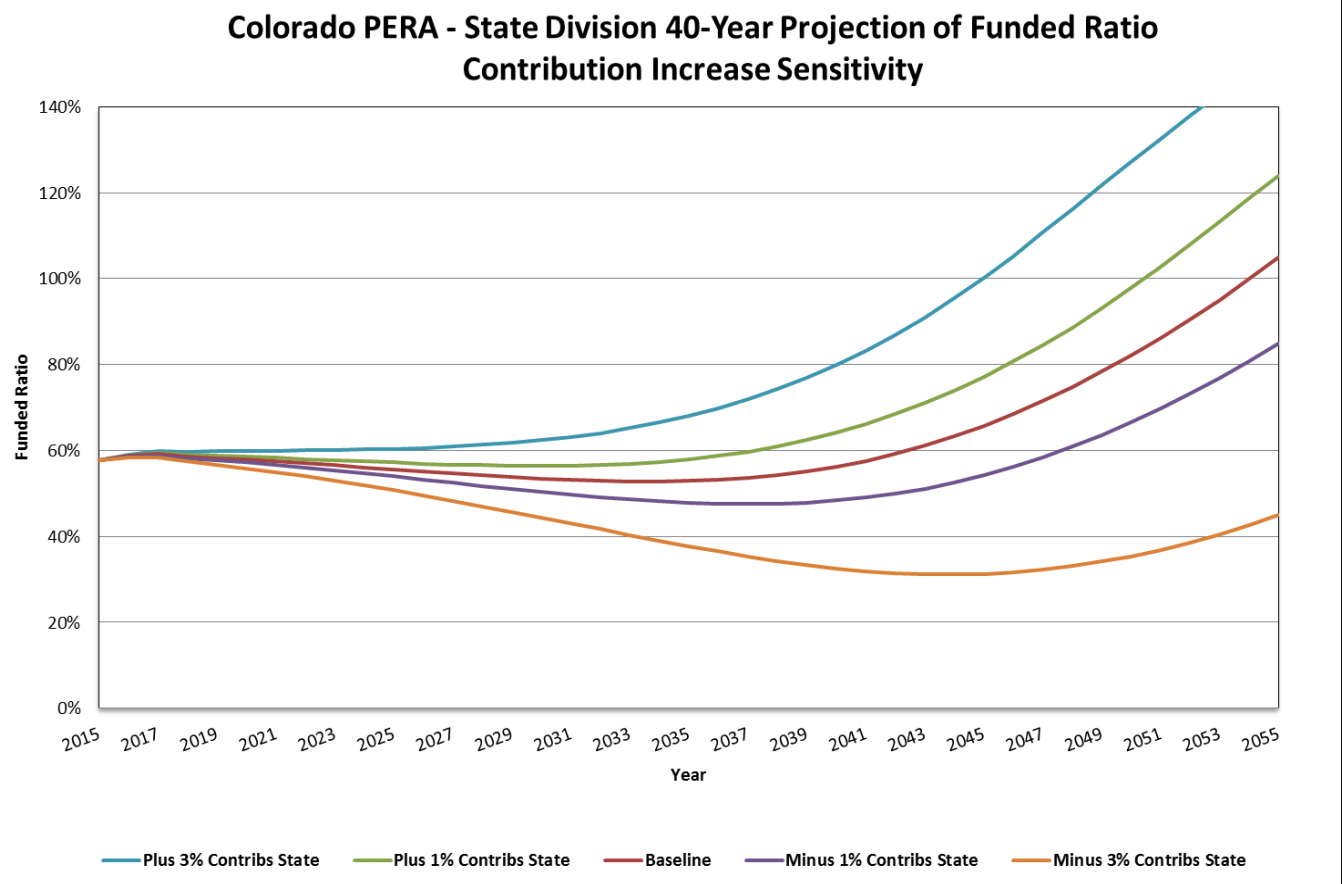
Variability Modeled

Employer contributions are a very important driver of full funding date. We have considered the long-term impact of an immediate increase or decrease in the employer contributions of 1% and 3% of pay on the full funding date. These are not currently contemplated under the law, but are a helpful tool to demonstrate the importance of continuing on the current path and the potential benefits to funding from an increase in employer contributions.

Variability Illustrations

The impact of increasing or decreasing employer contributions by 1% and 3% of pay is illustrated in Exhibit 8.7.1 for the State Division.

Exhibit 8.7.1



Source: Pension Trustee Advisors calculations

Conclusions

The graphs show that:

- Statutory contributions are significant drivers of the projected full funding dates.
- Even relatively modest changes in the contribution rates can change the expected full funding dates several years.

Chapter Nine: Signal Light for Assessing PERA

The prior chapters of this report have identified the impact of the past variability of actual PERA experience compared to the assumptions and the potential for variability in the future.

This chapter develops a methodology and simplified format for reporting the significance of the variability on achieving funding goals so that policymakers have an understandable picture of both the current funded status of PERA and the likelihood of conditions that will improve, or weaken, that status in the future.

Key Conclusions and Recommendation

A simplified signal light reporting will enable policymakers to assess:

- **The current expected full funding date of each Division,**
- **The investment return (or other selected metrics) required to achieve full funding objectives over long and short periods, and**
- **The impact that a change in actual experience from that which is assumed would have on the long term funding period.**

PERA should enhance its monitoring of the Hybrid Defined Benefit Plan's funding status and projected full funding date by updating the following signal light reporting annually and whenever significant changes have occurred. This will provide policymakers with an assessment of the current projected full funding dates of the PERA Hybrid Defined Benefit Plan compared to the funding objective. This reporting should include a review of the investment return and other metrics required (and the likelihood) for the Plan to maintain, improve, or decline from the current signal.

9.1 Simplified Annual Reporting Objectives

Policymakers are concerned about PERA meeting funding objectives and becoming fully funded within a reasonable future time period. However, policymakers may also have different views on acceptable objectives. Current actuarial measures are a point-in-time snapshot based on a single set of actuarial assumptions. These snapshot measures are valuable and important benchmarks, but do not reflect the likelihood of the actual future experience meeting the assumptions, the potential variability, and the consequences.

Our signal light methodology reflects the possibility of actual future experience varying from the assumptions in both the short- and long-term. The assumed investment return is the most important assumption, has the greatest possibility of variability, and has the most significant effect on the PERA Hybrid Plan's funded status. For these reasons, we illustrate the effect of

potential variability in the anticipated 7.5% annual investment return. We also consider the possibility of variability in other assumptions as additional metrics in this report.

An example of this dynamic methodology contrasted to static actuarial measures is described in Appendix H, Signal Light Methodology.

9.2 Development of Signal Light

In the signal light tables that follow, we compare the current projection of each PERA Division to a series of possible positive (Light Green to Dark Green) signals to increasingly negative caution, warning, and danger signals (Yellow to Dark Red) defined as follows:

Exhibit 9.2.1
PERA Hybrid Defined Benefit Plan Signal Light Definitions

Status	Definition
Dark Green	Plan is anticipated to pay off current UAAL by 2041 – Consistent with Senate Bill 10-001
Green	Plan is anticipated to pay off current UAAL by 2045 – Consistent with PERA funding policy adopted in 2015
Light Green	Plan is anticipated to pay off current UAAL by 2055 – A 40-year funding period as of 2015
Yellow	Plan is anticipated to pay off current UAAL by 2065, and never falls below 20% funded in the years between 2015 and 2065
Orange	Plan is anticipated to never dip below 20% funded, then attain an upward trajectory towards 100% funded in the future
Red	Plan is anticipated to become insolvent between 2035 and 2055, or technically insolvent because it falls below 20% funded before 2065
Dark Red	Plan is anticipated to become insolvent by 2035

Source: Pension Trustee Advisors

These categories were chosen either because of their link to certain funding policies (i.e., 30 years from 2011, when Senate Bill 10-001 was implemented or 30, 40, or 50 years from 2015) or to certain threshold events, such as insolvency or technical insolvency.

This current assessment below illustrates for each Division the expected long-term position on the signal light if future experience exactly follows the assumptions, but does not provide information on what is required for the signal to improve or decline.

That information is provided on both a long-term and short-term basis by showing:

- What variability (in terms of investment return) would move the current signal to a more positive or negative signal.
- The likelihood of attaining each possible signal based on higher-than-expected and lower-than-expected investment returns.

This analysis focuses on investment return – the most powerful driver of funded position.

9.3 December 31, 2014 Signal Lights

Exhibit 9.3.1 shows each Division's position on the signal light as of December 31, 2014.

Exhibit 9.3.1
PERA Hybrid Defined Benefit Plan
Division Position as of December 31, 2014

Division	Status	Definition
State	Light Green	100% funded by 2055 (40 years from 2015)
School	Light Green	100% funded by 2055 (40 years from 2015)
Local Government	Dark Green	100% funded by 2041 (30 years from 2011)
Judicial	Yellow	100% funded by 2065, and never as low as 20% funded
Denver Public Schools	Light Green	100% funded by 2055 (40 years from 2015)

Source: Pension Trustee Advisors

These signal lights indicate:

- A dark green signal for the Local Government Division because the expected full funding date is before 2041, the full funding date anticipated by Senate Bill 10-001.
- A light green signal for the State, School, and DPS Divisions because the expected full funding dates are after 2045, but before 2055.
- A yellow signal for the Judicial Division because the expected full funding date is after 2055, but before 2065.

These signals are helpful for a quick understanding of the projected full funding dates but do not provide information on what is required to change the signals in the future or the likelihood that they will change. That information is provided below.

9.4 Illustration of Complete Signal Light for State Division

Exhibit 9.4.1 indicates what likely constant long-term investment return would be required for the State Division in order to move from its current “light green” signal to a more or less favorable position.

Exhibit 9.4.1
Signal Lights for State Division as of 2014
(Based on long-term investment return)

Status	Definition	Annual long-term investment return to get to this status	Likelihood	
Dark Green	100% funded by 2041 (30 years from 2011)	Average 8.6% or more	33%	51%
Green	100% funded by 2045 (30 years from 2015)	Average 8.2% to 8.6%	5%	
Light Green	100% funded by 2055 (40 years from 2015)	Average 7.4% to 8.2%	14%	
Yellow	100% funded by 2065, and never as low as 20% funded	Average 7.3% to 7.4%	3%	21%
Orange	Solvent, and only gets as low as 20% funded	Average 6.1% to 7.3%	18%	
Red	Insolvent or technically insolvent after 2035	Average 3.1% to 6.1%	22%	28%
Dark Red	Insolvent by 2035 (within 20 years)	Average less than 3.1%	6%	

Source: Pension Trustee Advisors. Numbers may not add due to rounding

The signal light for the State Division provides the following information:

- As of 2014, the State Division is projected to be fully funded by 2055. This is shown in the Light Green row. In order to remain at this level, the Division needs to earn between 7.4% and 8.2% annually long-term. Note that this is consistent with the actuarial assumed rate of return of 7.5%. Based on the underlying capital market assumptions, there is a 14% chance that PERA investment returns will be in the range of 7.4% to 8.2% over the next 30 years, and a 51% likelihood of earning 7.4% or better.

- Moving up the table to a more optimistic scenario, if the State Division can earn between 8.2% and 8.6% annually over the next 30 years, it will achieve full funding within that period and the signal becomes Green. There is a 5% likelihood that investment returns will be in this range over the next 30 years and a 38% chance of earning at least 8.2%.
- At the top of the table is Dark Green, which meets the Senate Bill 10-001 objective of paying off the UAAL within 30 years, or by 2041. To meet this goal, investment returns must average 8.6% annually or more between now and 2041. There is a 33% likelihood of annual returns averaging 8.6% or more over this period.
- In summary, there is a 51% (14%+5%+33%) likelihood currently that the State Division will be fully funded by 2055 or earlier and will stay Light Green on the signal light or move up to Green or Dark Green. That leaves a 49% chance that future investment results could turn out to be worse than expected and change to Yellow or lower signals. These are illustrated by the four rows below the current Light Green status.
- There is a 3% probability that investment returns will average 7.3% to 7.4% annually long-term, which would result in the UAAL becoming fully funded after 2055, but before 2065. During the period from now to 2065 under this scenario, the Funded Ratio would deteriorate substantially, but not as low as 20%. This is represented by the Yellow signal light.
- Similarly, there is an 18% probability of annual long-term returns in the 6.1% to 7.3% range. This would result in the State Division Funded Ratio falling dangerously close to zero, but eventually recovering. This result is represented by an Orange signal light.
- The last two scenarios are insolvency cases. In the Red scenario, the State Division remains solvent beyond 2035, but becomes insolvent or technically insolvent by 2055 (because annual investment returns are only 3.1% to 6.1%)—a 22% likelihood.
- And there is a 6% likelihood of the worst case scenario, which is insolvency within the next 20 years because annual investment returns average below 3.1% for an extended period.

9.5 Signal Lights for Other Uncertainties

While investment return is the most critical actuarial assumption, other variables could, by themselves, have an impact on full funding. As shown in Exhibit 9.5.1, there is an 11% probability that reduced population growth would result in the State Division not being fully funded by 2055.

Exhibit 9.5.1
Signal Lights for State Division as of 2014
(Based on long-term population growth)

Status	Definition	Average annual population growth to get to this status in long run	Likelihood	
Dark Green	100% funded by 2041 (30 years from 2011)	Average 4.7% or more	<1%	89%
Green	100% funded by 2045 (30 years from 2015)	Average 3.2% to 4.7%	<1%	
Light Green	100% funded by 2055 (40 years from 2015)	Average 1.2% to 3.2%	89%	
Yellow	100% funded by 2065, and never as low as 20% funded	Average 0.6% to 1.2%	11%	11%
Orange	Solvent, and only gets as low as 20% funded	Average 0.0% to 0.6%	<1%	
Red	Insolvent or technically insolvent after 2035	Average -4.5% to 0.0%	<1%	<1%
Dark Red	Insolvent by 2035 (within 20 years)	Average population loss of more than 4.5%	<1%	

Source: Pension Trustee Advisors

In order for population growth alone to result in a slippage in funding date beyond 2055, we calculate that the annual growth would have to be 1.2% or less. Based on the State Division's past experience, there is an 11% chance of this happening over a 40-year period. Although the statistical analysis results in this low probability, statistical analysis does not consider the likelihood of some extraneous non-recurring event distorting the future Colorado state employment population growth to be inconsistent with historical norms or projections made by the State Demographer.

These might include:

- Lower migration to Colorado than expected
- Lower share of the Colorado populace working in government employment than currently
- Higher selection of PERA Defined Contribution Plan than currently observed

There is also some probability that excessive salary increases could result in slippage beyond the 2055 date. Exhibit 9.5.2 shows that in order for salary increases to have this impact, there would need to be an average actuarial loss of 0.1% year-after-year, which has a probability of 14%.

Exhibit 9.5.2
Signal Lights for State Division as of 2014
(Based on salary growth gains or losses)

Status	Definition	Average annual other actuarial demographic gain or loss to get to this status in long run	Likelihood	
Dark Green	100% funded by 2041 (30 years from 2011)	Average 0.7% or better gain	<1%	86%
Green	100% funded by 2045 (30 years from 2015)	Average 0.4% to 0.7% gain	<1%	
Light Green	100% funded by 2055 (40 years from 2015)	Average 0.1% loss to 0.4% gain	86%	
Yellow	100% funded by 2065, and never as low as 20% funded	Average 0.3% to 0.1% loss	14%	14%
Orange	Solvent, and only gets as low as 20% funded	Average 2.1% to 0.3% loss	<1%	
Red	Insolvent or technically insolvent after 2035	Average 6.0% to 2.1% loss	<1%	<1%
Dark Red	Insolvent by 2035 (within 20 years)	Average actuarial loss of worse than 6% per year	<1%	

Source: Pension Trustee Advisors

Exhibit 9.5.3 illustrates that there is also a 14% probability that other actuarial demographic losses could delay the full funding date beyond 2055.

Exhibit 9.5.3
Signal Lights for State Division as of 2014
(Based on other actuarial demographic gains or losses)

Status	Definition	Average annual other actuarial demographic gain or loss to get to this status in long run	Likelihood	
Dark Green	100% funded by 2041 (30 years from 2011)	Average 0.5% or better gain	<1%	91%
Green	100% funded by 2045 (30 years from 2015)	Average 0.3% to 0.5% gain	<1%	
Light Green	100% funded by 2055 (40 years from 2015)	Average 0.1% loss to 0.3% gain	90%	
Yellow	100% funded by 2065, and never as low as 20% funded	Average 0.3% to 0.1% loss	9%	9%
Orange	Solvent, and only gets as low as 20% funded	Average 2.2% to 0.3% loss	<1%	
Red	Insolvent or technically insolvent after 2035	Average 7.0% to 2.2% loss	<1%	<1%
Dark Red	Insolvent by 2035 (within 20 years)	Average actuarial loss of worse than 7% per year	<1%	

Source: Pension Trustee Advisors

Note that coincidentally, the deviation for salary growth is statistically equivalent to that for other actuarial gains and losses.

9.6 Combined Signal Lights for Statistical Uncertainties

As illustrated above, although investment return has the most significant impact, it is possible that some combination of the four uncertainties could have an impact. These can be analyzed statistically using “multivariate” statistical analysis. The methodology for developing this “multivariate” signal light is discussed in detail in Appendix F, Statistical Techniques.

The following signal light tables illustrate the likelihood of being in various zones based on a combination of:

- Investment Return
- Population Growth
- Salary Growth
- Other Actuarial Demographic Gains and Losses

Exhibit 9.6.1 illustrates, for example, that there is an 8% statistical probability that some combination of poor investment return, low population growth, high salary growth, and other actuarial losses will result in the State Division becoming insolvent by 2035. Based on investment return alone (see Section 9.5 above), there is a 6% likelihood that returns would average less than 3.1% and result in insolvency by 2035.

Exhibit 9.6.1
Long Term Signal Lights for State Division as of 2014

(Based on Investment Return, Salary Growth, Population Growth, and Other Actuarial Experience)

Status	Definition	Possible outcomes to get to this status	Likelihood	
Dark Green	100% funded by 2041 (30 years from 2011)	Earn 8.6% or more or other highly favorable experience	34%	51%
Green	100% funded by 2045 (30 years from 2015)	Earn 8.2% to 8.6% or other favorable experience	5%	
Light Green	100% funded by 2055 (40 years from 2015)	Earn 7.4% to 8.2% with other average experience	13%	
Yellow	100% funded by 2065, and never as low as 20% funded	Earn 7.3% to 7.4% or other unfavorable experience	2%	22%
Orange	Solvent, and only gets as low as 20% funded	Earn 5.9% to 7.3% or other unfavorable experience	20%	
Red	Insolvent or technically insolvent after 2035	Earn 3.1% to 5.9% or other unfavorable experience	19%	27%
Dark Red	Insolvent by 2035 (within 20 years)	Earn less than 3.1% or other unfavorable experience	8%	

Source: Pension Trustee Advisors. Numbers may not add due to rounding

Similarly, there is a 34% statistical probability that some combination of strong investment return, high population growth, low salary growth, and other actuarial gains will result in the State Division becoming 100% funded by 2041. Based on investment return alone (see Section 9.5 above), there was a 33% statistical probability that average returns would exceed 8.6% and result in the 2041 target being met.

Finally, there is a 13% probability that various combinations will result in the full funding date falling between 2045 and 2055. Based on investment return alone, that probability is 14%.

Two key points result from this analysis:

- **Investment return is by far the most important actuarial assumption driver of future funding dates.**
- **Other variables add slightly to the uncertainty, making outcomes that are on the outliers (dark green and dark red) slightly more likely.**

As discussed previously, this statistical analysis is based on the underlying assumptions having a mean (best estimate) equal to the actuarial assumptions. This also does not incorporate potential external factors such as:

- Mortality improvement beyond that currently anticipated
- External factors which reduce Colorado public employee population growth
- Substantial election of the PERA Defined Contribution Plan over the Hybrid Defined Benefit Plan
- Change in laws impacting PERA benefits or contributions

9.7 Five-Year Short Term Signal Light

While the exhibits and discussion above focused on the long-term horizon, it is also helpful to consider how variability over a short-term period affects the signals.

This 5-year analysis is a bit more complex than the long-term analysis. It is based on variable investment returns for the next 5 years only, followed by the expected 7.5% each year beyond 5 years.

Exhibit 9.7.1 shows that there is a 54% likelihood that the State Division will stay in the green signal light, even with investment return variation over a 5-year period.

Exhibit 9.7.1
Signal Lights for State Division as of 2014
(Based on 5-year investment return)

Status	Definition	Average annual investment return to get to this status in 5 years	Likelihood	
Dark Green	100% funded by 2041 (30 years from 2011)	Average 11.2% or more	8%	54%
Green	100% funded by 2045 (30 years from 2015)	Average 10.0% to 11.2%	9%	
Light Green	100% funded by 2055 (40 years from 2015)	Average 7.4% to 10.0%	37%	
Yellow	100% funded by 2065, and never as low as 20% funded	Average 4.9% to 7.4%	30%	39%
Orange	Solvent, and only gets as low as 20% funded	Average 3.7% to 4.9%	9%	
Red	Insolvent or technically insolvent after 2035	Average -0.7% to 3.7%	7%	7%
Dark Red	Insolvent by 2035 (within 20 years)	Average less than -0.7%	<1%	

Source: Pension Trustee Advisors

The State Division signal light under the 5-year look provides the following information:

- There is a much higher chance (37%) the signal light will remain at light green for the period.
- The likelihood of higher than expected annual investment returns over the next 5 years that would result in improving the signal are:
 - Green-9%
 - Dark Green -8%
- Lower than expected annual investment returns over the next 5 years that would result in the State Division's current Light Green signal becoming worse are illustrated above.

The signal light result and likelihood are:

- Yellow-30%
- Orange -9%
- Red-7%
- Dark Red-Less than 1%

In summary, over the next 5 years, the State Division's projected full funding status has a 54% chance of staying the same or improving due to potential investment return variability. Conversely, the chances of the expected full funding status worsening are 46% over this period.

These results illustrate that over a short time period it is much less likely that the signal will improve or decline significantly.

9.8 One-Year Short Term Signal Light

A 1-year signal light for the State Division in Exhibit 9.8.1 illustrates the significance of 1-year investment returns that are much higher or lower than expected.

Exhibit 9.8.1
Signal Lights for State Division as of 2014
(Based on 1-year investment return)

Status	Definition	2015 investment return to get to this status next year	Likelihood	
Dark Green	100% funded by 2041 (30 years from 2011)	Earn 25.4% or more	9%	53%
Green	100% funded by 2045 (30 years from 2015)	Earn 19.4% to 25.4%	9%	
Light Green	100% funded by 2055 (40 years from 2015)	Earn 6.4% to 19.4%	35%	
Yellow	100% funded by 2065, and never as low as 20% funded	Lose 3.5% to Earn 6.4%	27%	35%
Orange	Solvent, and only gets as low as 20% funded	Lose 3.5% to 8.1%	8%	
Red	Insolvent or technically insolvent after 2035	Lose 8.1% to 23.4%	11%	12%
Dark Red	Insolvent by 2035 (within 20 years)	Lose 23.4% or more	1%	

Source: Pension Trustee Advisors

This 1-year analysis might be a good reference point if investment markets are dramatically moving up or down in a given year and there is question on the effect on PERA. For example, based on a blockbuster year and PERA returns exceeding 25.4%, the signal would move all the way to dark green.

Conversely, if markets are very poor and PERA loses 23.4% or more in 1 year, the signal would become dark red and PERA would be projected to be insolvent by 2035. While the extreme positive scenario has about a 9% likelihood, the extreme negative example has only about a 1% chance of occurring.

9.9 Additional Considerations

The signal light chart quantifies the future investment returns required to change signals. Consideration should also be given to expanding the chart in the future, particularly when the current signal has changed dramatically from the prior year or the current signal is deemed too divergent from the Senate Bill 10-001 objective of full funding by 2041 or the PERA funding policy goals.

This would provide policymakers additional information on what is required to change signals due to:

- Employer and/or member funding
- Benefit changes
- Future changes in selected assumption variability like member growth

We recommend that these signals be monitored annually for all divisions. If it appears that the PERA Plan might be moving down (or up), then a more in depth analysis should be conducted. For example, if 2015 investment returns fall between 6.4% and 19.4%, then an updated study would be expected to show that the State Division is still in the light green signal zone. An in depth analysis might not be worthwhile. PERA's regular annual actuarial valuation would confirm this.

Future years might be a bit more complicated, but based on the information in the 5-year signal light table, and the ordinary PERA annual actuarial valuation, it would be possible to anticipate whether the PERA Hybrid Plan is still on track and whether further analysis is likely to be informative.

Central to all of this is that policymakers determine their own comfort levels. Is it necessary to be dark green, or would light green (or even yellow) suffice? Different policymakers would naturally have different levels of tolerance, but it is worthwhile to come to a consensus. The PERA Board of Trustees 2015 funding policy is essentially consistent with the green signal light.

Recommendation No. 1:

The Colorado Public Employees' Retirement Association should enhance its monitoring of the Hybrid Defined Benefit Plan's funding status and projected full funding date by updating the signal light reporting annually and whenever significant changes have occurred, providing policymakers an assessment of the current projected full funding dates of the Plan compared to agreed-upon funding objectives. This reporting should include a review of the investment return and other metrics required (and the likelihood) for the Plan to maintain, improve, or decline from the current signal.

Colorado Public Employees' Retirement Association Response:

Agree. Implementation Date: 2016

Colorado PERA will incorporate the recommendation into its reporting annually beginning with the next reporting cycle based off of Calendar Year 2015 and whenever significant changes occur.

Chapter Ten: Case Study – Application of Signal Lights Beginning in 2008

The following case study shows the signals that would have been indicated in 2008 prior to the enactment of Senate Bill 10-001 and each year thereafter, up to December 31, 2014.

Key Conclusions

- The signal lights would have been dark red or red as of December 31, 2008 (projected to be insolvent or technically insolvent) for all but the Judicial Division, and it would have been orange.
- After the impact of Senate Bill 10-001 and other changes were reflected as of December 31, 2009, the signal lights improved and all have been light green or better since that time.
- Only the Local Government Division has consistently met the 30-year full funding goal of Senate Bill 10-001
- The signals have generally remained light green or better each year since 2009 except for the Judicial Division.
- The full funding dates have slowly increased since 2009 for all divisions except Local Government, but all plans remain targeted to achieve full funding.

The likelihood of earning the various annual investment returns illustrated are based on an expectation of earning the assumed investment return at that time and the same variability as considered earlier in this report. The PERA long-term investment return assumption was 8.5% in 2008, 8% from 2009-2012, and the current 7.5% for 2013 and 2014.

In addition, the various funded status conditions (and applicable dates) shown are the same as developed for the initial signal light methodology based on the December 31, 2014 actuarial valuation and projections.

10.1 December 31, 2008 Signals

The December 31, 2008 actuarial valuation and projections would have indicated the following signals for each Division at that time:

Exhibit 10.1.1
PERA Long-Term Funding Signal Lights Summary as of 2008

Division	Status	Definition
State	Dark Red	Insolvent by 2035
School	Dark Red	Insolvent by 2035
Local	Red	Insolvent by 2055
Judicial	Orange	Solvent, and only gets as low as 20% funded

Source: Pension Trustee Advisors based on PERA 2008 CAFR

The State and School Divisions were expected to be insolvent by 2035 and the Local Government Division by 2055. Only the Judicial Division was projected to remain solvent, and its Funded Ratio would drop to 51% and not become fully funded for well beyond 2041.

The DPS Division did not become part of PERA until January 1, 2010. Benefits for DPS employees before that time were provided by the Denver Public Schools Retirement System. The Denver Public Schools Retirement System also would have shown a dark red signal.

These projections reflect the severe investment market decline due to the recession in 2008, which resulted in an investment loss of 26% in PERA assets. Earlier in the decade, investment returns were also negative for the period 2000-2002.

Future investment return is the most critical factor determining future funded position. This investment analysis focuses the School Division as well as the State Division. The following charts for the State and School Division illustrate the annual future investment return that would have been required to become solvent and achieve full funding in the future.

Exhibit 10.1.2
PERA State Division Funding 2008 Signal Lights

Status	Definition	Annual long-term investment return to get to this status	Likelihood	
Dark Green	100% funded by 2041 (30 years from 2011)	Average 11.5% or more	10%	12%
Green	100% funded by 2045 (30 years from 2015)	Average 11.3% to 11.5%	1%	
Light Green	100% funded by 2055 (40 years from 2015)	Average 11.1% to 11.3%	1%	
Yellow	100% funded by 2065, and never as low as 20% funded	Average 11.1%	1%	4%
Orange	Solvent, and only gets as low as 20% funded	Average 10.8% to 11.1%	3%	
Red	Insolvent or technically insolvent after 2035	Average 9.3% to 10.8%	22%	84%
Dark Red	Insolvent by 2035 (within 20 years)	Average 9.3% or below	62%	

Source: Pension Trustee Advisors based on PERA 2008 CAFR

Exhibit 10.1.3
PERA School Division Funding 2008 Signal Lights

Status	Definition	Annual long-term investment return to get to this status	Likelihood	
Dark Green	100% funded by 2041 (30 years from 2011)	Average 10.9% or more	14%	18%
Green	100% funded by 2045 (30 years from 2015)	Average 10.8% to 10.9%	2%	
Light Green	100% funded by 2055 (40 years from 2015)	Average 10.6% to 10.8%	2%	
Yellow	100% funded by 2065, and never as low as 20% funded	Average 10.6%	1%	5%
Orange	Solvent, and only gets as low as 20% funded	Average 10.2% to 10.6%	4%	
Red	Insolvent or technically insolvent after 2035	Average 8.3% to 10.2%	30%	77%
Dark Red	Insolvent by 2035 (within 20 years)	Average less than 8.3%	47%	

Source: Pension Trustee Advisors based on PERA 2008 CAFR

The signal lights show that without change:

- Insolvency was very likely (84% for the State Division and 77% for the School Division).
- Annual investment returns of about 10%-11% or better would have been required to avoid insolvency and eventually become fully funded (only a 16% probability for the State Division and 23% for the School Division).

10.2 December 31, 2009 Signals

Although the date December 31, 2009 was before the advent of Senate Bill 10-001, because it was passed by the time the actuarial valuation and projections were finalized, the changes made by the bill were reflected in the actuarial valuation and projections. Furthermore, the actuarial assumptions were revised; most notably, the annual investment return assumption was lowered from 8.5% to 8%. The goal of the Senate Bill 10-001 changes was to achieve full funding within 30 years from the effective date of the changes (2011), or by 2041. Although not all of the PERA recommendations were adopted, key changes from Senate Bill 10-001 included:

- Reducing COLA increases from 3.5% to 2.0%
- Increasing AED and SAED
- Reducing benefits for those hired after 2010

These changes and PERA's investment experience during 2009 combined to dramatically improve the signals for each Division as follows:

Exhibit 10.2.1
PERA Long-Term Funding Signal Lights Summary as of 2009

Division	Status	Definition
State	Light Green	100% funded by 2055 (40 years from 2015)
School	Green	100% funded by 2045 (30 years from 2015)
Local	Dark Green	100% funded by 2041 (30 years from 2010)
Judicial	Green	100% funded by 2045 (30 years from 2015)

Source: Pension Trustee Advisors based on PERA 2009 CAFR

However, these projections indicated that only the Local Government Division was expected to meet the 2041 full funding goal.

The following charts for the State and School Divisions illustrate their new signal after the changes, and the annual long-term future investment income required to stay there, or alternatively to move to a more or less favorable signal.

Exhibit 10.2.2

PERA State Division Funding Signal Lights based on 12/31/2009 actuarial valuation

Status	Definition	Annual long-term investment return to get to this status	Likelihood	
Dark Green	100% funded by 2041 (30 years from 2011)	Average 8.5% or more	41%	56%
Green	100% funded by 2045 (30 years from 2015)	Average 8.2% to 8.5%	5%	
Light Green	100% funded by 2055 (40 years from 2015)	Average 7.7% to 8.3%	10%	
Yellow	100% funded by 2065, and never as low as 20% funded	Average 7.5% to 7.7%	5%	25%
Orange	Solvent, and only gets as low as 20% funded	Average 6.0% to 7.5%	20%	
Red	Insolvent or technically insolvent after 2035	Average 4.0% to 6.0%	13%	19%
Dark Red	Insolvent by 2035 (within 20 years)	Average less than 4.0%	6%	

Source: Pension Trustee Advisors based on PERA 2009 CAFR

As of the December 31, 2009 actuarial valuation (which incorporated the Senate Bill 10-001 changes), the State Division was projected to be fully funded by 2046, which was 5 years later than the 2041 objective in Senate Bill 10-001. This is a common phenomenon where legislation developed in one year based on estimates can have slightly different actuarial ramifications when precise calculations are made one year later based on final legislation.

Based on the actuarial valuation as of December 31, 2009:

- Achieving an annual investment return of at least 7.7% (compared to the 8% assumption at that time) would maintain or improve the current light green signal.
- The likelihood of staying at a light green signal or better was 56%.
- The likelihood of becoming fully funded by 2041 was 40% and would require an 8.6% annual investment return or better.
- Insolvency was unlikely, with a 19% likelihood and it would have required an annual investment return of 6% or less.

Exhibit 10.2.3**PERA School Division Funding Signal Lights based on 12/31/2009 actuarial valuation**

Status	Definition	Annual long-term investment return to get to this status	Likelihood	
Dark Green	100% funded by 2041 (30 years from 2011)	Average 8.3% or more	45%	59%
Green	100% funded by 2045 (30 years from 2015)	Average 8.0% to 8.3%	5%	
Light Green	100% funded by 2055 (40 years from 2015)	Average 7.6% to 8.0%	8%	
Yellow	100% funded by 2065, and never as low as 20% funded	Average 7.4% to 7.6%	4%	30%
Orange	Solvent, and only gets as low as 20% funded	Average 5.3% to 7.4%	26%	
Red	Insolvent or technically insolvent after 2035	Average 2.7% to 5.3%	9%	11%
Dark Red	Insolvent by 2035 (within 20 years)	Average less than 2.7%	2%	

Source: Pension Trustee Advisors based on PERA 2009 CAFR

After incorporation of Senate Bill 10-001, the School Division was projected to be fully funded by 2043, two years later than the 2041 objective and:

- Achieving an annual investment return of 7.9% would maintain the green signal or improve it.
- The likelihood of staying at a green signal or better was 58%.
- The likelihood of becoming fully funded by 2041 was 47% and would require annual investment returns of 8.2% or better.
- Insolvency was unlikely, with an 11% likelihood and it would have required annual investment returns of 5.4% or less.

10.3 Summary Signal Lights for December 31, 2010-2014

If summary signal lights for each Division had been determined at December 31 for 2010-2014, the findings would have been as follows:

Exhibit 10.3.1
PERA Long-Term Funding Signal Lights Summary as of December 31, 2010

Division	Status	Definition
State	Light Green	100% funded by 2055 (40 years from 2015)
School	Green	100% funded by 2045 (30 years from 2015)
Local	Dark Green	100% funded by 2041 (30 years from 2011)
Judicial	Light Green	100% funded by 2055 (40 years from 2015)
Denver Public Schools	Dark Green	100% funded by 2041 (30 years from 2011)

Source: Pension Trustee Advisors based on PERA 2010 CAFR

Exhibit 10.3.2
PERA Long-Term Funding Signal Lights Summary as of December 31, 2011

Division	Status	Definition
State	Light Green	100% funded by 2055 (40 years from 2015)
School	Light Green	100% funded by 2055 (40 years from 2015)
Local	Dark Green	100% funded by 2041 (30 years from 2011)
Judicial	Yellow	100% funded by 2065, and never as low as 20% funded
Denver Public Schools	Dark Green	100% funded by 2041 (30 years from 2011)

Source: Pension Trustee Advisors based on PERA 2011 CAFR

Exhibit 10.3.3
PERA Long-Term Funding Signal Lights Summary as of December 31, 2012

Division	Status	Definition
State	Light Green	100% funded by 2055 (40 years from 2015)
School	Green	100% funded by 2045 (30 years from 2015)
Local	Dark Green	100% funded by 2041 (30 years from 2011)
Judicial	Yellow	100% funded by 2065, and never as low as 20% funded
Denver Public Schools	Dark Green	100% funded by 2041 (30 years from 2011)

Source: Pension Trustee Advisors based on PERA 2012 CAFR

Exhibit 10.3.4
PERA Long-Term Funding Signal Lights Summary as of December 31, 2013

Division	Status	Definition
State	Light Green	100% funded by 2055 (40 years from 2015)
School	Light Green	100% funded by 2055 (40 years from 2015)
Local	Green	100% funded by 2045 (30 years from 2015)
Judicial	Yellow	100% funded by 2065, and never as low as 20% funded
Denver Public Schools	Dark Green	100% funded by 2041 (30 years from 2011)

Source: Pension Trustee Advisors based on PERA 2013 CAFR

Exhibit 10.3.5
PERA Long-Term Funding Signal Lights Summary as of December 31, 2014

Division	Status	Definition
State	Light Green	100% funded by 2055 (40 years from 2015)
School	Light Green	100% funded by 2055 (40 years from 2015)
Local	Dark Green	100% funded by 2041 (30 years from 2011)
Judicial	Yellow	100% funded by 2065, and never as low as 20% funded
Denver Public Schools	Light Green	100% funded by 2055 (40 years from 2015)

Source: Pension Trustee Advisors based on PERA 2014 CAFR

Over this period the signal lights:

- Remained light green for the State Division
- Declined from green to light green for the School Division
- Changed from dark green to green and back to dark green for the Local Government Division
- Declined from light green to yellow for the Judicial Division
- Declined from dark green to light green for the DPS Division

Chapter Eleven, Further Analysis of PERA, provides more detail on the causes of the decline in funding positions.

10.4 Detailed Signal Lights for December 31, 2010-2014

As with 2008 and 2009, we determined the investment outlook required to change signals. These are detailed below for each year from 2010-2014.

Exhibit 10.4.1
PERA State Division Funding December 31, 2010 Signal Lights

Status	Definition	Annual long-term investment return to get to this status	Likelihood	
Dark Green	100% funded by 2041 (30 years from 2011)	Average 8.3% or more	45%	60%
Green	100% funded by 2045 (30 years from 2015)	Average 8.0% to 8.3%	5%	
Light Green	100% funded by 2055 (40 years from 2015)	Average 7.5% to 8.0%	10%	
Yellow	100% funded by 2065, and never as low as 20% funded	Average 7.3% to 7.5%	5%	23%
Orange	Solvent, and only gets as low as 20% funded	Average 5.8% to 7.3%	18%	
Red	Insolvent or technically insolvent after 2035	Average 3.8% to 5.8%	12%	17%
Dark Red	Insolvent by 2035 (within 20 years)	Average less than 3.8%	5%	

Source: Pension Trustee Advisors based on PERA 2010 CAFR

Exhibit 10.4.2
PERA State Division Funding December 31, 2011 Signal Lights

Status	Definition	Annual long-term investment return to get to this status	Likelihood	
Dark Green	100% funded by 2041 (30 years from 2011)	Average 8.8% or more	37%	52%
Green	100% funded by 2045 (30 years from 2015)	Average 8.5% to 8.8%	4%	
Light Green	100% funded by 2055 (40 years from 2015)	Average 7.9% to 8.5%	11%	
Yellow	100% funded by 2065, and never as low as 20% funded	Average 7.7% to 7.9%	5%	23%
Orange	Solvent, and only gets as low as 20% funded	Average 6.4% to 7.7%	18%	
Red	Insolvent or technically insolvent after 2035	Average 4.5% to 6.4%	15%	25%
Dark Red	Insolvent by 2035 (within 20 years)	Average less than 4.5%	10%	

Source: Pension Trustee Advisors based on PERA 2011 CAFR

Exhibit 10.4.3
PERA State Division Funding December 31, 2012 Signal Lights

Status	Definition	Annual long-term investment return to get to this status	Likelihood	
Dark Green	100% funded by 2041 (30 years from 2011)	Average 8.7% or more	39%	56%
Green	100% funded by 2045 (30 years from 2015)	Average 8.3% to 8.7%	6%	
Light Green	100% funded by 2055 (40 years from 2015)	Average 7.7% to 8.3%	11%	
Yellow	100% funded by 2065, and never as low as 20% funded	Average 7.5% to 7.7%	6%	21%
Orange	Solvent, and only gets as low as 20% funded	Average 6.3% to 7.5%	15%	
Red	Insolvent or technically insolvent after 2035	Average 4.1% to 6.3%	15%	23%
Dark Red	Insolvent by 2035 (within 20 years)	Average less than 4.1%	8%	

Source: Pension Trustee Advisors based on PERA 2012 CAFR

Exhibit 10.4.4
PERA State Division Funding December 31, 2013 Signal Lights

Status	Definition	Annual long-term investment return to get to this status	Likelihood	
Dark Green	100% funded by 2041 (30 years from 2011)	Average 8.3% or more	37%	58%
Green	100% funded by 2045 (30 years from 2015)	Average 7.9% to 8.3%	6%	
Light Green	100% funded by 2055 (40 years from 2015)	Average 7.1% to 7.9%	15%	
Yellow	100% funded by 2065, and never as low as 20% funded	Average 6.7% to 7.1%	9%	15%
Orange	Solvent, and only gets as low as 20% funded	Average 6.0% to 6.7%	6%	
Red	Insolvent or technically insolvent after 2035	Average 3.8% to 6.0%	17%	27%
Dark Red	Insolvent by 2035 (within 20 years)	Average less than 3.8%	9%	

Source: Pension Trustee Advisors based on PERA 2013 CAFR

Exhibit 10.4.5
PERA State Division Funding December 31, 2014 Signal Lights

Status	Definition	Annual long-term investment return to get to this status	Likelihood	
Dark Green	100% funded by 2041 (30 years from 2011)	Average 8.6% or more	33%	51%
Green	100% funded by 2045 (30 years from 2015)	Average 8.2% to 8.6%	5%	
Light Green	100% funded by 2055 (40 years from 2015)	Average 7.4% to 8.2%	14%	
Yellow	100% funded by 2065, and never as low as 20% funded	Average 7.3% to 7.4%	3%	21%
Orange	Solvent, and only gets as low as 20% funded	Average 6.1% to 7.3%	18%	
Red	Insolvent or technically insolvent after 2035	Average 3.1% to 6.1%	22%	28%
Dark Red	Insolvent by 2035 (within 20 years)	Average less than 3.1%	6%	

Source: Pension Trustee Advisors based on PERA 2014 CAFR

The School Division showed similar results for the period but the signal slipped to light green in 2011, back to green in 2012, and then back to light green in 2013 and 2014.

Exhibit 10.4.6
PERA School Division Funding December 31, 2010 Signal Lights

Status	Definition	Annual long-term investment return to get to this status	Likelihood	
Dark Green	100% funded by 2041 (30 years from 2011)	Average 8.1% or more	48%	60%
Green	100% funded by 2045 (30 years from 2015)	Average 7.9% to 8.1%	3%	
Light Green	100% funded by 2055 (40 years from 2015)	Average 7.5% to 7.9%	8%	
Yellow	100% funded by 2065, and never as low as 20% funded	Average 7.3% to 7.5%	5%	29%
Orange	Solvent, and only gets as low as 20% funded	Average 5.3% to 7.3%	24%	
Red	Insolvent or technically insolvent after 2035	Average 2.5% to 5.3%	9%	11%
Dark Red	Insolvent by 2035 (within 20 years)	Average less than 2.5%	2%	

Source: Pension Trustee Advisors based on PERA 2010 CAFR

Exhibit 10.4.7
PERA School Division Funding December 31, 2011 Signal Lights

Status	Definition	Annual long-term investment return to get to this status	Likelihood	
Dark Green	100% funded by 2041 (30 years from 2011)	Average 8.6% or more	40%	54%
Green	100% funded by 2045 (30 years from 2015)	Average 8.3% to 8.6%	5%	
Light Green	100% funded by 2055 (40 years from 2015)	Average 7.8% to 8.3%	9%	
Yellow	100% funded by 2065, and never as low as 20% funded	Average 7.6% to 7.8%	4%	28%
Orange	Solvent, and only gets as low as 20% funded	Average 6.0% to 7.6%	24%	
Red	Insolvent or technically insolvent after 2035	Average 3.4% to 6.0%	14%	18%
Dark Red	Insolvent by 2035 (within 20 years)	Average less than 3.4%	4%	

Source: Pension Trustee Advisors based on PERA 2011 CAFR

Exhibit 10.4.8
PERA School Division Funding December 31, 2012 Signal Lights

Status	Definition	Annual long-term investment return to get to this status	Likelihood	
Dark Green	100% funded by 2041 (30 years from 2011)	Average 8.2% or more	47%	62%
Green	100% funded by 2045 (30 years from 2015)	Average 7.9% to 8.2%	5%	
Light Green	100% funded by 2055 (40 years from 2015)	Average 7.4% to 7.9%	10%	
Yellow	100% funded by 2065, and never as low as 20% funded	Average 6.9% to 7.4%	11%	23%
Orange	Solvent, and only gets as low as 20% funded	Average 5.8% to 6.9%	12%	
Red	Insolvent or technically insolvent after 2035	Average 2.8% to 5.8%	13%	16%
Dark Red	Insolvent by 2035 (within 20 years)	Average less than 2.8%	3%	

Source: Pension Trustee Advisors based on PERA 2012 CAFR

Exhibit 10.4.9
PERA School Division Funding December 31, 2013 Signal Lights

Status	Definition	Annual long-term investment return to get to this status	Likelihood	
Dark Green	100% funded by 2041 (30 years from 2011)	Average 8.0% or more	42%	58%
Green	100% funded by 2045 (30 years from 2015)	Average 7.7% to 8.0%	5%	
Light Green	100% funded by 2055 (40 years from 2015)	Average 7.1% to 7.7%	11%	
Yellow	100% funded by 2065, and never as low as 20% funded	Average 6.8% to 7.1%	7%	21%
Orange	Solvent, and only gets as low as 20% funded	Average 5.7% to 6.8%	14%	
Red	Insolvent or technically insolvent after 2035	Average 3.0% to 5.7%	16%	21%
Dark Red	Insolvent by 2035 (within 20 years)	Average less than 3.0%	5%	

Source: Pension Trustee Advisors based on PERA 2013 CAFR

Exhibit 10.4.10
PERA School Division Funding December 31, 2014 Signal Lights

Status	Definition	Annual long-term investment return to get to this status	Likelihood	
Dark Green	100% funded by 2041 (30 years from 2011)	Average 8.4% or more	36%	52%
Green	100% funded by 2045 (30 years from 2015)	Average 8.0% to 8.4%	5%	
Light Green	100% funded by 2055 (40 years from 2015)	Average 7.4% to 8.0%	11%	
Yellow	100% funded by 2065, and never as low as 20% funded	Average 7.3% to 7.4%	2%	27%
Orange	Solvent, and only gets as low as 20% funded	Average 5.6% to 7.3%	25%	
Red	Insolvent or technically insolvent after 2035	Average 2.1% to 5.6%	18%	21%
Dark Red	Insolvent by 2035 (within 20 years)	Average less than 2.1%	3%	

Source: Pension Trustee Advisors based on PERA 2014 CAFR

The chances of staying within the green signals have declined slightly during this period as the full funding dates have gradually increased. Similarly, the chances of insolvency have increased marginally for the same reason.

10.5 Summary of Signal Lights for December 31, 2010-2014

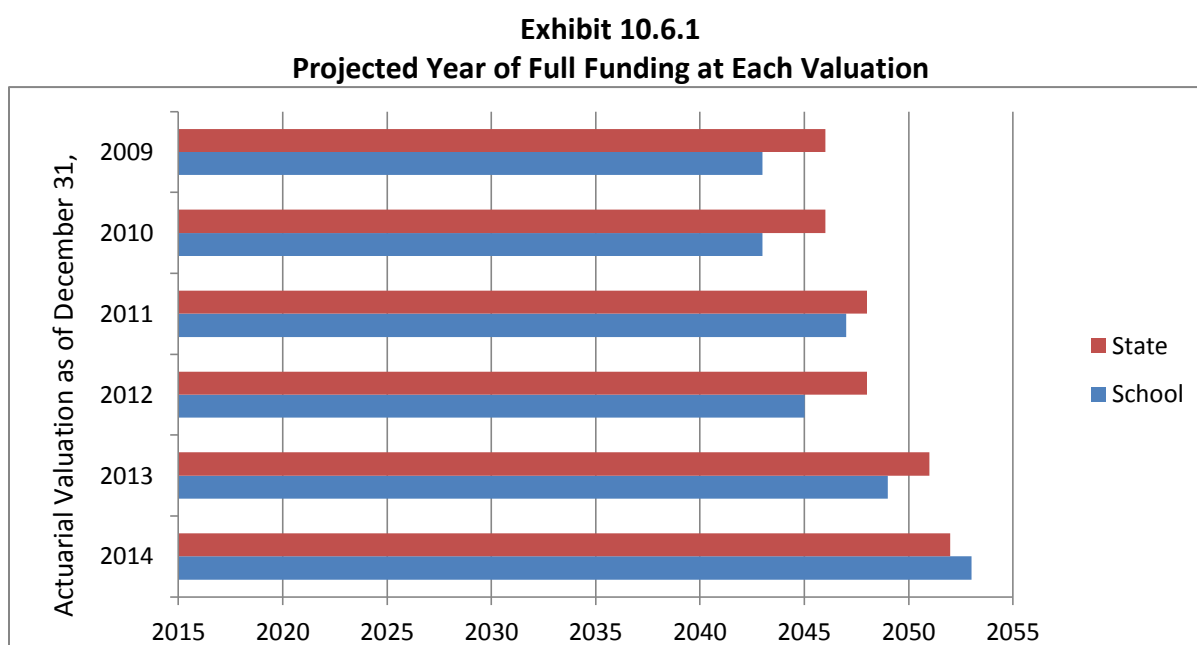
These signal lights would have indicated to policymakers the following for the State and School Divisions:

- **Dark Red in 2008:** PERA was projected to become insolvent within 20 years and actions were required.
- **Light Green or Better in 2009:** The actions taken in Senate Bill 10-001 were first reflected in 2009 and reversed the projections. PERA was on target to be fully funded, but 3 to 5 years later than the 30-year goal (full-funding by 2041).
- **Light Green since 2010:** Full funding is now projected to occur from 2052-2053, rather than 2041.

These signals provide a big picture of the projected funded status each year. Providing the precise change in the projected full funding date each year and the reasons for that change would enhance understanding of the progress, as noted in the following chapter of this report (Chapter Eleven, Further Analysis of PERA).

10.6 Changes in Projected Full Funding Dates from 2009-2014

The following chart summarizes the changes in expected full funding dates since 2009 for each year-end projection. These are based on the actuarial valuations for each year and will be analyzed in detail in Chapter Eleven.



Source: Pension Trustee Advisors based on PERA 2009 - 2014 CAFR

Chapter Eleven: Further Analysis of PERA - Progress toward Full Funding by 2041

Chapter Ten illustrated that the PERA Hybrid Plan's funding position has weakened since Senate Bill 10-001 was incorporated in the December 31, 2009 actuarial valuation. This chapter analyzes the causes of the deterioration.

Key Conclusions and Recommendation

- **The State and School Divisions are not currently projected to meet the 2041 full funding date, but are now at 2052 and 2053, respectively.**
 - The Local Government Division is projected to be fully funded by 2040
 - The Judicial Division is projected to be fully funded by 2063
 - The DPS Division is projected to be fully funded by 2048
- **This result is due to a combination of not meeting the date immediately after Senate Bill 10-001 and a gradual increase in the projected full funding date since that time.**
- **Strong investment return since December 31, 2009 would have resulted in improving the State Division full funding date.**
- **The key factors have been:**
 - Low population growth and payroll increases
 - Changes in actuarial methods and assumptions
 - Increases in the normal cost
 - Other actuarial demographic losses

PERA should expand its annual reporting and reconciliation to include the causes for the changes in expected full funding dates, in addition to the updating of signal light reporting discussed in Recommendation No. 1.

11.1 Senate Bill 10-001

Senate Bill 10-001 included numerous changes to PERA benefits for current and future members as well as future funding, with the intent to reach 100% funding over 30 years, or by 2041.

A complete analysis of PERA's progress toward full funding is required by statute from PERA as of January 1, 2016. However, an interim review of the experience since 2010 may help policymakers understand the results to date, the short-term experience that has contributed to the current projections, and the factors that may influence the future progress.

PERA first recognized the impact of Senate Bill 10-001 in the actuarial valuation and projections as of its actuarial valuation of December 31, 2009, which was conducted in 2010.

11.2 Full Funding Projections 2009-2014

The information below illustrates the projection results for each year since 2009 and has been summarized from PERA's annual CAFR and projection results submitted to the General Assembly. Because of materiality issues discussed earlier, the results are shown only for the State and School Divisions. Each year's projections consider the Divisions' experience since the prior year and assume the future experience exactly meets the assumptions.

Exhibit 11.2.1
Projected Date of Full Funding

Projections as of Actuarial Valuations of December 31:	2009	2010	2011	2012	2013	2014
State Division	2046	2046	2048	2048	2051	2052
School Division	2043	2043	2047	2045	2049	2053

Source: Pension Trustee Advisors based on PERA 2009-2014 CAFR

The initial projections made based on the December 31, 2009 actuarial valuation indicated the full funding goal would be met 2 to 5 years later than the 2041 target date. In addition, the projections since 2011 indicate the period required to reach full funding is now longer than was expected at that time. Therefore, a logical conclusion would be that the experience of PERA has been less favorable than the assumptions since then. To test that premise, the PERA experience is reviewed in the section below.

Please also note that the movement of the projected dates of full funding from 2043-2046 to 2052-2053 does not necessarily mean that full funding will continue to move out and become an infinite period. The current calculations of 2052 and 2053 are PERA's and their actuaries' best estimate forecast of when full funding is anticipated based on the facts as of December 31, 2014. The purpose of this report is to identify what might occur to move these dates forward or backward.

11.3 PERA Experience Compared to Assumptions 2010-2014

The expected growth compared to actual growth in the UAAL is summarized in the PERA actuarial reports and CAFR. The changes from 2010-2014 due to experience gains and losses and assumption/method/programming changes are compared below. Since variations due to experience compared to the assumptions are reflected in the UAAL, it will be the most significant contributor to any changes in the projected date of full funding.

Exhibit 11.3.1
Gains/(Losses) Since 2009 for State Division
Due to Experience Variations and Assumption Changes (\$Millions)

Year	2010	2011	2012	2013	2014	Total
Investment Return*	\$651	(\$737)	\$578	\$935	(\$239)	\$1,188
Demographic	(39)	(96)	(143)	(118)	(198)	(594)
Pay Increases	288	223	107	50	(18)	650
Assumptions/Other Actuarial Changes	-	-	236	(1,035)	194	(605)
Total annual gain/(loss)	\$899	(\$609)	\$777	(\$168)	(\$260)	\$639
Adjustment for Prior year asset smoothing*	(1,602)	(337)	(237)	(570)	423	(2,323)
Total as reported in CAFR	(\$703)	(\$946)	\$541	(\$738)	\$163	(\$1,684)

Source: Pension Trustee Advisors calculations based on PERA CAFR 2011-2014. Numbers may not add due to rounding.

*The investment return gain or (loss) for the year in this exhibit represents the difference between the expected return and the actual return for the year without smoothing, since the projections extend beyond the smoothing period. An adjustment is thus necessary to match the CAFR, which reported this variance using a 4-year smoothed asset value.

Exhibit 11.3.2
Gains/ (Losses) Since 2009 for School Division
Due to Experience Variations and Assumption Changes (\$Millions)

Year	2010	2011	2012	2013	2014	Total
Investment Return*	\$1,040	(\$1,179)	\$932	\$1,522	(\$388)	\$1,928
Demographic	(103)	(170)	(202)	(281)	(328)	(1,084)
Pay Increases	303	617	249	145	61	1,375
Assumptions /Other Actuarial Changes	-	-	343	(1,702)	299	(1,060)
Total annual gain/(loss)	\$1,240	(\$731)	\$1,322	(\$316)	(\$357)	\$1,159
Adjustment for Prior year asset smoothing*	(2,513)	(490)	(390)	(932)	689	(3,637)
Total as reported in CAFR	(\$1,273)	(\$1,221)	\$932	(\$1,248)	\$332	(\$2,477)

Source: Pension Trustee Advisors calculations based on PERA CAFR 2011-2014

*The investment return gain or (loss) for the year in this exhibit represents the difference between the expected return and the actual return for the year without smoothing, since the projections extend beyond the smoothing period. An adjustment is thus necessary to match the CAFR, which reported this variance using a 4-year smoothed asset value.

These actuarial gains and losses explain much of the delay in anticipated full funding date. However, they are changes in the UAAL as of each year, and they do not simply translate into deferral dates of the funding period. These are discussed in the sections below.

11.4 Analysis of 2010-2014 PERA Experience

This summary of the history since Senate Bill 10-001 indicates the following:

- The changes made in 2010 resulted in a very significant improvement and were expected to result in full funding, but the initial projections made based on the December 31, 2009 actuarial valuations indicated full funding would be achieved 2 to 5 years later than the 2041 objective.
- The projected full funding date has not remained at 2041 as expected if the objective had been met, but has gradually increased with the latest projections anticipating full funding by 2052-2053 for the State and School Divisions. The result is full funding which is now projected to be 11-12 years later than originally intended.
- The investment returns earned over this period have been in excess of the assumed returns and in excess of 9% per year compounded.
- Since investment returns are expected to be the most significant factor influencing the date of full funding, and investment returns since December 31, 2009 have been strong, some improvement in the date of full funding might be expected during this period.
- Although the changes in assumptions increased the UAAL, these changes were not as significant as the reduction in the UAAL due to investment return gains.
- The experience for all other demographic and pay increase assumptions was slightly positive.
- Changes in the Normal Cost rate due to experience, method, or programming changes also impact the full funding date.

Considering all of these factors,, we would have expected the current projected date to reach full funding to be equal or slightly sooner than projected in 2009 (as discussed previously, the full funding date was projected to be about 2 to 5 years longer than the 2041 full funding goal at that time) because the net effect of the experience and the assumption changes since that time has been slightly positive. Below we analyze other factors which explain the change.

11.5 Effect of Pay and Population Growth on Projections

The PERA projections assume an annual pay increase (based on tables by age) for continuing members and a replacement of terminating and retiring members with new members, and they also reflect an expected 1.5% per year increase in the number of active members for these Divisions. In combination, this is a 3.9% annual increase in total payroll.

Exhibit 11.5.1 shows the compound annual change in member total pay and active membership that has occurred since 2009.

Exhibit 11.5.1
PERA Hybrid Defined Benefit Plan
Change in Membership and Member Pay 2009-2014

	Annual Change in:	
	Membership	Members' Pay
State Division	0.4%	1.5%
School Division	0.0%	0.7%
Assumed Increase	1.5%	3.9%

Source: Pension Trustee Advisors based on PERA CAFR 2009-2014

The major reason for the unexpected delay in the full funding date may result from the much lower annual changes in membership growth (1.5% expected) and pay increases (3.9% expected) since:

- The actual pay increases have been less than expected, which reduces the expected UAAL because benefits will not be as high as expected (this has been reflected in the chart above).
- However, this also reduces the projected pay increases in the future and the expected contributions to PERA.
- A significant portion of these contributions fund the UAAL, and if they are less than expected, the UAAL funding is delayed.
- The 1.5% annual expected rate of membership growth has not occurred.

This pay growth and membership growth experience does not immediately impact the UAAL except as noted above, but does impact the UAAL in the projections. Its impact is significant, but not readily apparent from the actuarial reports or projections.

11.6 Observations

Exhibits 11.6.1 and 11.6.2 summarize the findings of this chapter and are our estimates of the increase in the full funding date for the State and School Divisions for this period.

Exhibit 11.6.1
Increase in Full Funding Date for State Division

	Full Funding Date
Projected Full Funding Date as of 12/31/2009 Valuation	2046
Projected Full Funding Date as of 12/31/2014 Valuation	2052
Increase in Projected Full Funding Date for the period	+6 years
Causes of Changes from 2010-2014:	
Investment returns	-9 years
Pay increases and population growth	+7 years
Demographic	+4 years
Actuarial assumption changes	+3 years
Actuarial method changes and other	-2 years
Increase in Normal Costs	<u>+3 years</u>
Total	<u>+6 years</u>

Source: Pension Trustee Advisors calculations based on PERA CAFR 2009-2014

Exhibit 11.6.2
Increase in Full Funding Date for School Division

	Full Funding Date
Projected Full Funding Date as of 12/31/2009	2043
Projected Full Funding Date as of 12/31/2014	2053
Increase in Projected Full Funding Date for the period	10 years
Causes of Changes from 2010-2014:	
Investment returns	-8 years
Pay increases and population growth	+9 years
Demographic	+5 years
Actuarial assumption changes	+3 years
Actuarial method changes and other	-1 year
Increase in Normal Costs	<u>+2 years</u>
Total	<u>+10 years</u>

Source: Pension Trustee Advisors calculations based on PERA CAFRs 2009-2014

Based on these observations and consistent with our earlier analysis of the potential variability of the actual experience in the future, the expected future growth of pay and membership are also significant variables. Because the variability effect of these assumptions is not readily ascertainable from the reconciliation of the current UAAL, it would be useful if the following additional information were provided by PERA annually in its report to the General Assembly:

- The specific impact of pay and membership growth experience (and any other assumption variation not otherwise explained by the change in the UAAL) for the past year on the expected date of full funding.
- A reconciliation of the changes in the date of full funding from the prior year identified by cause of change, so that any patterns become apparent.

An example of this type of future reconciliation follows:

Exhibit 11.6.1

Factors Contributing to Increase in Projected Full Funding Date - State Division – Sample

Projected full funding date increased from 20xx to 20yy due to:	
Investment return of xx% -- Less than 7.5% assumed	x.x year increase
Population growth of yy% -- Less than 1.5% assumed	y.y year increase
Demographic experience	z.z year increase
Other	a.a year decrease
Total impact	b.b year increase

Recommendation No. 2:

The Colorado Public Employees' Retirement Association (PERA) should enhance its monitoring of the Hybrid Defined Benefit Plan's funding status and projected full funding date by expanding PERA's annual reporting and reconciliation to include the causes for the changes in the expected full funding dates. This is in addition to the signal light reporting discussed in Recommendation No. 1.

Colorado Public Employees' Retirement Association Response:

Agree. Implementation Date: 2016

Colorado PERA will incorporate the recommendation into its reporting annually beginning with the next reporting cycle based off of Calendar Year 2015.

Chapter Twelve: Funding Policy and Funding Objective

This chapter discusses the PERA funding policy and the importance of a well-defined and understood funding objective to be able to assess the PERA Hybrid Plan's progress in meeting the established objective and determine where the Plan stands on the signal light.

Key Conclusions

The full funding objective established for the PERA Hybrid Plan in Senate Bill 10-001 was not achieved in 2009 (when those changes were first reflected) and has not been achieved since (except for the Local Government Division). Additionally, the PERA Board of Trustees established a revised Funding Policy in 2015, which extended the full funding objective. The lack of a clear and consistent funding objective for the PERA Plan that has been agreed upon by policymakers makes it difficult to assess whether the Plan is on target to achieve full funding by a desired date.

The General Assembly may want to coordinate with the PERA Board of Trustees to reach agreement on the funding objective and then work with PERA to identify benchmarks that can be used with the signal light to indicate to policymakers when the Plan is on track for meeting its objective or when the Plan is off-track significantly enough that some type of action should be taken.

12.1 PERA Funding Policies and Objectives

A funding policy typically establishes a clearly defined objective for a pension plan to attain full funding by a specific date. A definitive and consistent funding objective is a critical tool when measuring a plan's progress in meeting stated objectives.

As discussed previously, the key purpose of this study was to conduct a sensitivity analysis to determine when, from an actuarial perspective, deviations in the PERA Hybrid Plan's actual experience, as compared to its adopted assumptions, could be a cause for concern, and possibly warrant action. To make this determination, there must first be a clear funding objective for the PERA Plan to measure against. However, there are currently several funding objectives for the Plan and it is not clear which of these should take precedence and serve as the basis for assessing PERA's progress in attaining full funding. Specifically:

Senate Bill 10-001 established a 30-year funding objective beginning in 2011. Section 24-51-211, C.R.S., of the PERA Law states that "a maximum Amortization Period of thirty years shall be deemed actuarially sound." In addition, the preamble to Senate Bill 10-001, which was the result of PERA recommendations for comprehensive changes to the Plan to improve its funding status, stated: "Concerning modifications to the Public Employees' Retirement Association necessary to reach a one hundred percent Funded Ratio within the next thirty years." Further, the fiscal note attached to Senate Bill 10-001 also indicated the expected outcome of the passage of this bill would be the attainment of a fully funded system within 30 years. As a

result, it appears the General Assembly's intent was to establish an objective of full funding for the PERA Plan by 2041, which is 30 years from the date Senate Bill 10-001 went into effect.

PERA Board of Trustees established a 30-year funding objective starting in 2015. In 2015, the PERA Board of Trustees adopted a new Funding Policy that establishes funding objectives for the Plan. The primary objective is to reach full funding for the current UAAL within 30 years from December 31, 2014, or by December 31, 2044 (i.e., by 2045). There are secondary objectives that would extend the funding period for up to 30 years from the date of valuation due to any changes, including assumption and benefit changes and future gains or losses. The 2015 Funding Policy also sets an ultimate objective for the PERA Hybrid Plan to obtain a Funded Ratio of 110%, but did not include a time frame for achieving this objective.

In addition, the Funding Policy provides that PERA will annually disclose the amount of contributions required, as compared to the statutory contribution rates, for the PERA Plan to:

- Achieve 100% funding within 30 years, for the UAAL as of December 31, 2014 as described above
- Achieve 100% funding within 15, 20, 25, or 30 years for changes to the UAAL after December 31, 2014

The complete 2015 Funding Policy can be found in Appendix G.

12.2 Developing a Sound Coordinated Funding Policy

Although the PERA Board of Trustees stated in its 2015 PERA Funding Policy that it was not the intention of the Board to circumvent or undermine the provisions of Senate Bill 10-001, the objectives established in the Policy extend the date that the PERA Hybrid Plan should reach full funding past the date referred to in the Bill. Further, as noted in Exhibit 4.2.2 in Chapter 4, the Amortization Period for each PERA Division currently exceeds the 2041 target date established by Senate Bill 10-001 as well as the 2045 target date established by the 2015 PERA Funding Policy, except for the Local Government Division. This is due to the current structure of the PERA Hybrid Plan's funding and the factors outlined in Chapter Eleven. The projected date for full funding will fluctuate from year-to-year based on the Plan's actual experience, regardless of the funding objective, because the employer and employee contribution amounts are set by statute and do not change. This means that the Plan's actual experience, such as actual investment and salary growth experience, has a significant impact on the PERA Hybrid Plan's projected date of full funding. It is not clear if the General Assembly would be in agreement with the 2015 PERA Funding Policy or the current projected full funding dates, which are beyond 2045. To reach agreement, the General Assembly would need to work with the PERA Board of Trustees to clarify the Plan's objective and a targeted full funding date.

Once a clear funding objective has been established, the next step would be to establish benchmarks that indicate to policymakers where the PERA Hybrid Plan is on the signal light basis and whether it is on target to meet its objective or whether the Plan is off-track

significantly enough that some type of action should be considered. For purposes of this report, PTA established definitions for each of the signal lights based on the objectives stated in Senate Bill 10-001 as well as projected full funding dates of both 2045 and 2055, as shown in Exhibit 9.2.1. However, defining those signal lights is a policy decision that should be considered and decided upon by policymakers. Once the signal light definitions have been established, potential benchmarks could include:

- If the Plan is in the red or dark red signal light for even 1 year, meaning that it does not appear to be meeting its full funding date and is on the path toward long-term insolvency, policymakers should consider a corrective action plan immediately.
- If the plan stays in the zone of green signal lights, meaning that it continues to be on a target for full funding by 2055, then due to the long-term nature of the plan, a corrective action should only be considered if the Plan is below the stated objective and stays there for 3 to 5 years.
- If the Plan is in the yellow or orange signal lights, meaning that it is not on target to be fully funded by 2055, a corrective action plan should begin to be developed and considered.
- If the signal lights shows more than a 40% likelihood of falling into one of the red zones, a corrective action plan should also begin to be developed and considered.

When establishing benchmarks and determining when corrective action is advisable, there are other factors that should also be taken into consideration, including:

- A continuing pattern of annual slippage and extension of the full funding dates (i.e., repeated net losses).
- The reasonableness and likelihood of the investment return and other metrics needed to reach the objective.
- A slippage even when investment returns are better than expected, as has occurred over the past five years.
- Legal issues and other potential constraints.
- General economic and fiscal conditions.
- The PERA Board of Trustees' recommendations.

Once a clear and consistent funding objective and benchmarks are established, for them to be useful tools, it will be important for PERA to annually report on where the Plan stands with respect to these items. This could be part of its annual reporting required by the 2015 Funding Policy and could include reporting on:

- Funding dates and the likelihood of moving to a weaker or stronger position.
- The causes for any changes in the projected full funding date.

If the annual reporting indicates, based on the established benchmarks, that corrective action is advisable, the General Assembly could consider changes such as:

- Increasing contributions—this could be through changes such as temporary or permanent increases to employee and/or employer contributions and/or AED and SAED amounts.
- Reducing benefits—this could be through changes such as suspending COLAs for a defined period, indexing COLAs based on meeting the full funding goal, or other changes such as proposed by PERA to the General Assembly as part of the SB 10-001. These included:
 - Limiting COLA to CPI under certain circumstances
 - Further delay in retirement age under certain circumstances
 - Extending the final pay averaging period

If changes are advisable, the General Assembly may wish to instruct PERA to develop a plan such as was done to create SB 10-001. This sensitivity study does not analyze or recommend any particular changes. As these are policy issues, we have no recommendations in this area.

Chapter Thirteen: Other Issues

This chapter discusses three issues that are not mentioned above, but warrant specific attention.

Key Conclusions and Recommendation

- **The DPS Pension Certificates of Participation (PCOP) offset means that its funding position is more uncertain despite its current stronger funding position.**
- **An influx of State members choosing the Defined Contribution alternative could delay the Division's full funding position further.**
- **Periodic actuarial audits currently do not audit the full funding date projections despite their key importance as measures of future solvency.**

PERA should enhance its monitoring of the Hybrid Defined Benefit Plan's funding status and projected full funding date by ensuring that future actuarial audits include a confirmation of the multi-year actuarial projections currently used to determine the full funding date.

13.1 DPS Division Adjusted Employer Contributions

Prior to the merger of the separate retirement system for DPS employees into PERA, DPS used the proceeds (more than \$700 million) from Pension Certificates of Participation (PCOPs) as additional employer contributions to fund the UAAL. PCOPs are similar to Pension Obligation Bonds (POBs). This special funding has contributed to the superior funded status of the DPS Division compared to the other PERA Divisions.

The PCOPs resulted in an advanced funding of the DPS plan and a reduction in the UAAL. Although DPS must repay the amounts borrowed, the deposit of the proceeds into the pension fund results in reduced actuarially calculated contributions to the pension fund since payments would no longer be required for amortizing the reduction in the UAAL. Over time, this transaction will be beneficial to DPS if the amounts deposited in the pension fund earn a better rate of investment return than the cost DPS must pay on the borrowed funds (including refinancing costs).

PERA Law permits the DPS employer-funding rate to be reduced by a proxy of the "cost" to DPS to meet the obligations of the PCOPs from DPS funds, considering refinancing and a fixed annual interest rate of 8.5%. PERA Law also requires the expected funded status of the DPS Division after these offsets to be equal to the School Division over a 30-year period.

Every 5 years, PERA reevaluates the future DPS funding obligations in accordance with the law. House Bill 15-1251 adjusted the future DPS contributions downward by 3.6% of pay as a result of the current reevaluation. As a result of the reevaluation and the merger of the DPS

Retirement System into PERA in 2010, the DPS employer contributions including the AED and the SAED (prior to the offset) are identical to that of the School Division. The offset due to the payment of the PCOPs was not changed.

The current analysis indicated that the DPS employer contribution (before the offset) could have been lowered even more and still result in the stated objective of the DPS Division's expected funding status equating to the expected funded status of the School Division. However, the DPS Division employer contribution rates (prior to the offset) were set equal with that of the School Division in House Bill 15-1251. That is a prudent and consistent policy.

13.2 Optional Defined Contribution (DC) Plan for Certain State Employees

Certain employees in the State Division may opt to participate in the PERA DC plan in lieu of the PERA Hybrid Plan. For employees who make this election:

- The full employer base contribution is allocated to the DC plan.
- The AED and SAED contributions are made to the PERA Hybrid Plan.

These terms provide a strong incentive for members to participate in the DC option in order to receive a 10.15% employer funded benefit compared to the PERA Hybrid Plan benefit with a current employer Normal Cost of 2.96% of pay plus a retiree healthcare benefit with employer funding of 1.02% of pay and an AIR requiring employer funding of 1% of pay. This means that the DC option is arguably worth 10.15% to members, while the PERA Hybrid Plan option is only worth 4.98% (2.96% + 1.02% + 1%). While most members continue to choose the PERA Hybrid Plan over the DC option, this incentive could impact the PERA Plan because:

- The expected growth in PERA Hybrid Plan membership may be reduced.
- The portion of the employer contribution available to fund the UAAL is far less for DC members.
- Career employees may be more inclined to elect the PERA Hybrid Plan resulting in higher plan costs.

Not all new members of PERA are eligible for this election; only state employees hired after 2005 and some community college employees are eligible. The number of eligible employees electing the DC plan to date has been modest (less than 15% of those eligible). However, increased DC participation and/or expansion of the DC option could significantly negatively increase the variability of the PERA funding projections. Conversely, decreased DC participation could enhance Hybrid Plan funding.

13.3 Actuarial Audits

PERA periodically contracts with a second actuarial firm to conduct actuarial audits to review the work of the retained independent actuary. The 2014 actuarial audit independently reviewed and validated the actuarial valuation results and made recommendations for

refinements. However, the scope of the audit did not include a detailed review or independent confirmation of projection results.

Our analysis matched the Cavanaugh MacDonald projection results fairly closely; however since these results are the recommended basis to assess PERA's progress, we recommend that future audits also consider verification of the projection results.

Recommendation No. 3:

The Colorado Public Employees' Retirement Association (PERA) should enhance its monitoring of the Hybrid Defined Benefit Plan's funding status and projected full funding date by ensuring that future actuarial audits include a confirmation of the multi-year actuarial projections currently used to determine the full funding date.

Colorado Public Employees' Retirement Association Response:

Agree. Implementation Date: 2016

Colorado PERA will adjust policy to have all future actuarial audits confirm the reasonableness of the retained actuary's assessment of the projected full funding dates for all divisions. Colorado PERA policy within its Governance Manual dictates that an independent third-party actuarial firm perform an actuarial audit of the retained actuary at least every five years. Such an audit was performed in 2014 on the 2013 actuarial valuation. We are pleased to note that this sensitivity analysis study of actuarial assumptions performed by PTA confirmed the reasonableness of both the actuarial projections of PERA's retained actuary, Cavanaugh Macdonald Consulting and of the 2014 actuarial audit performed by Milliman, Inc.

Chapter Fourteen: Conclusions

This study explored the role and variability of actuarial assumptions in projecting the most likely future funded status of the PERA Hybrid Defined Benefit Plans. Ultimately, the goal of any retirement system is to accumulate sufficient assets to fully fund all of its current obligations.

This review considered:

- The past growth in unfunded liabilities over the past 16 years since the PERA Plan was fully funded and the causes of that growth, including that due to experience not matching the actuarial assumptions.
- The variability of PERA experience compared to each significant actuarial assumption over the same extended period.
- The effect of future variability of each actuarial assumption and its likely impact on the date of full funding.
- A signal light format that accomplishes an expanded reporting of the PERA Plans' funded status and includes the likelihood of achieving full funding objectives.
- A look-back at the PERA Plan's progress since the adoption of Senate Bill 10-001, which was intended to result in full funding by 2041.

An equally important objective of this report was to develop an understandable format for communicating the PERA Hybrid Plan's funding progress. The goal is to provide actionable information that both PERA and the General Assembly will find useful in developing sound public policy with regard to the PERA Plan. Specifically, the signal light format will provide the basis for deciding if, and when, consideration of changes in funding or benefits provided is advisable to accomplish funding objectives.

14.1 Key Findings

Key Findings

- The PERA Hybrid Defined Benefit Plan is currently on track to be fully funded based on current actuarial assumptions. Prior to the changes in Senate Bill 10-001, the PERA Plan was projected to become insolvent.
- A determination that a retirement plan will achieve full funding is the most important indicator of actuarial soundness and sustainability, because achieving that status means the members' benefits are secure and the plan has met its future obligations in a systematic and responsible manner.

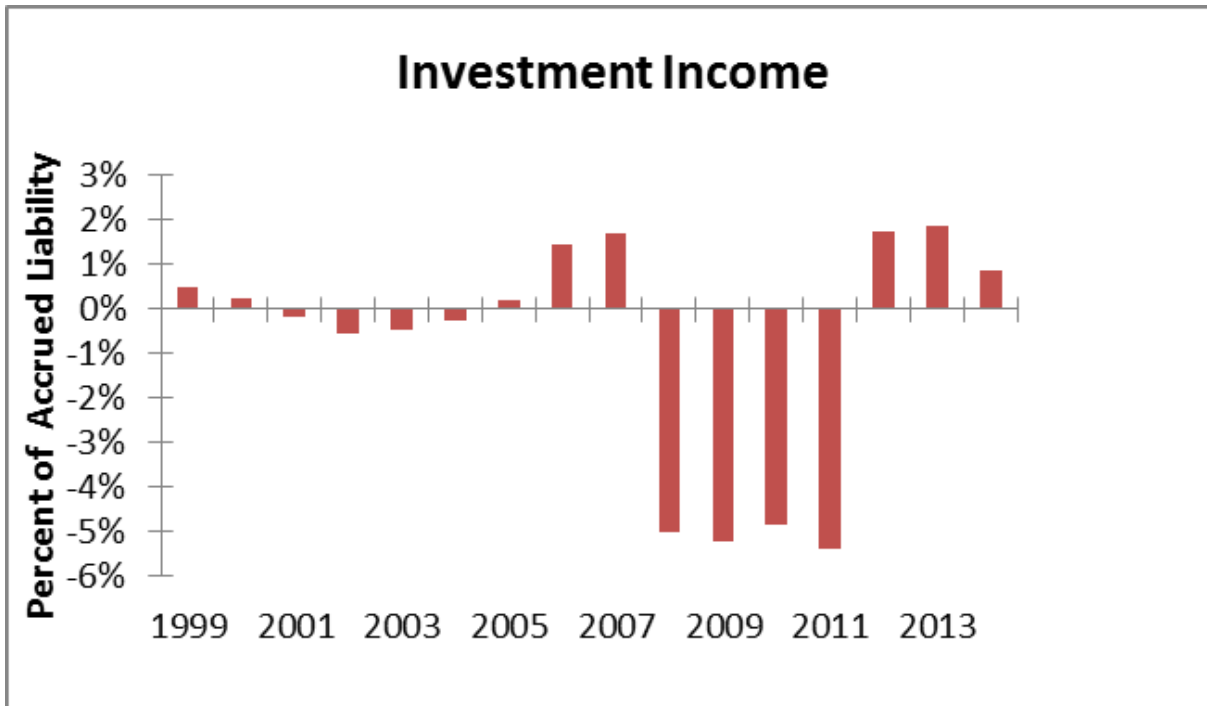
- An equally important measure is the time period in which full funding is likely to occur and how that date compares to objectives. The most recent projected full funding dates determined as of December 31, 2014 are later than the 2041 objective set in Senate Bill 10-001 for all PERA Divisions, except for Local Government.
- The projections are based on actuarial assumptions, which are:
 - Key drivers of the projected full funding date.
 - Approved by the PERA Board of Trustees based on PERA experience, professional standards, and independent recommendations.
 - Based on long-term expected results, but the actual experience may vary from the assumptions significantly—particularly over short periods.
- Because the projections are based on actuarial assumptions, the actual full funding dates may be significantly different (either sooner or later) from the projections if experience differs from the actuarial assumptions.
- The modeling of likely variability of each key assumption shows:
 - The investment return assumption has the widest range of variability, which has the biggest impact on the full funding date.
 - Population growth assumptions are also a significant variable but the impact is more difficult to detect under current reporting.
 - Other assumption variability has far less impact.
- If mortality continues to improve beyond 2020, the full funding date will likely be later than now estimated.
- The PERA Plan's projected full funding date is later than the 2041 objective and the projections in 2009 after the implementation of the Senate Bill 10-001 changes, even though investment returns have been better than expected. This is due to:
 - Not meeting the objective initially after considering the changes of Senate Bill 10-001.
 - Reducing the actuarial assumed investment rate to 7.50%.
 - Lower than expected population growth.
 - An increase in the employee normal cost.
- A simplified signal light reporting has been developed to enable policymakers to assess the current full funding date of each Division and the likelihood of future changes due to investment returns and other metrics.

- We calculate a 49% chance that 40-year average investment return will fall below 7.4%, resulting in the State Division not being fully funded by 2055:
 - This also means a 51% chance of being fully funded by 2055 or before.
 - Additionally, there is a 28% chance that 40-year average returns will be below 6.1%, the minimum necessary to remain solvent.
 - There is a 33% likelihood of exceeding 8.6% and meeting 2041 target.
- Even a 1-year event could be significant. We calculate a 47% chance that a 1-year investment return will fall below 6.4%, resulting in the State Division slipping to the projected status of not being fully funded by 2055.
 - This means there is a 53% chance of remaining in the position of being fully funded by 2055 or better.
 - There is a 12% chance that the return will be worse than a loss of 8.1%, and shift the plan down to the red insolvency or technically insolvent zones.
 - There is a 9% chance of returns exceeding 25.4% and jumping back to the position of meeting the 2041 target.
 - These percentages do not reflect any market returns to date in 2015.

Appendix A: Historical Gains/Losses All Divisions

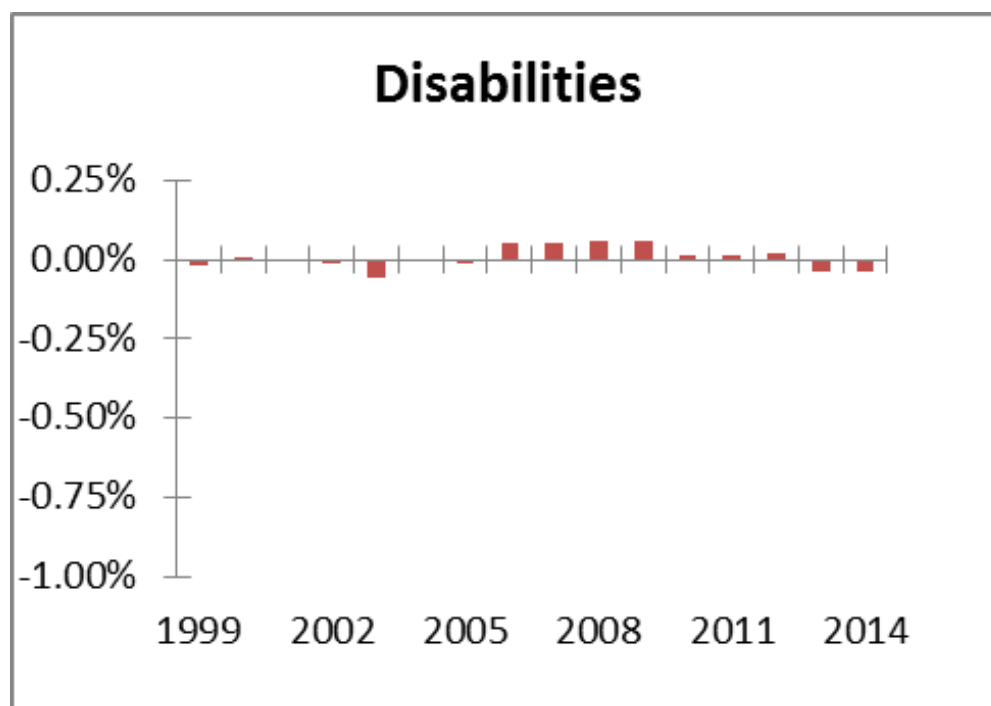
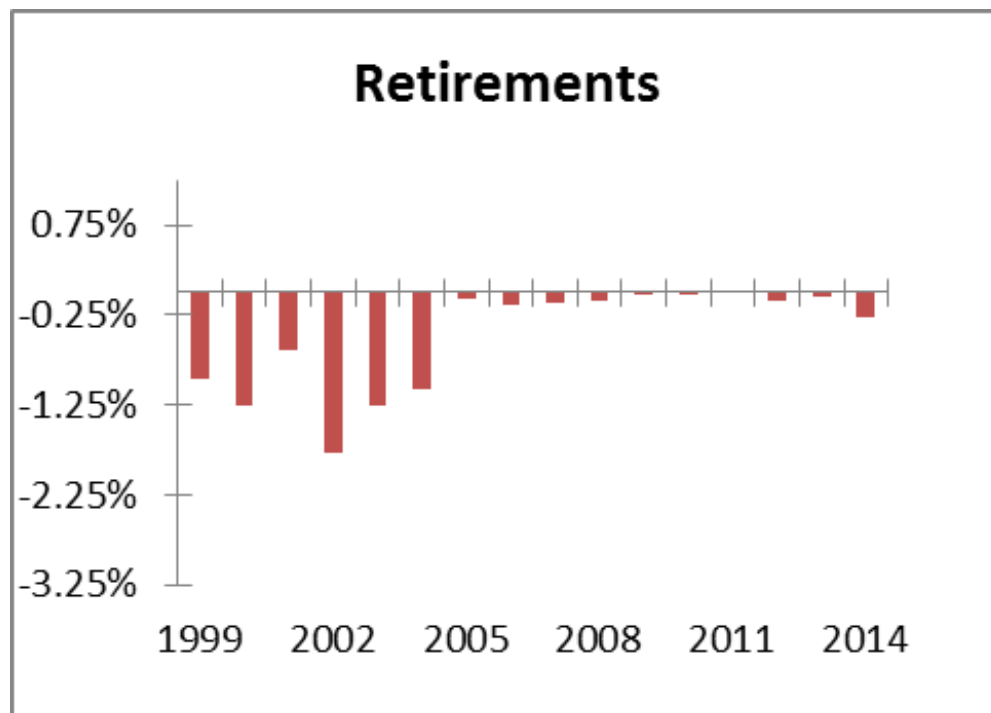
The following charts summarize the historical actuarial gains and losses. They are PTA calculations based on the 1999-2014 PERA Annual Actuarial Valuation reports. The annual gain (positive numbers) or loss (negative numbers) due to Investment Income as a percentage of the actuarial accrued liability (AAL) is illustrated below:

**Actuarial Gains and (Losses) as a Percentage of Actuarial Accrued Liability
1999 – 2014 PERA – All Divisions**



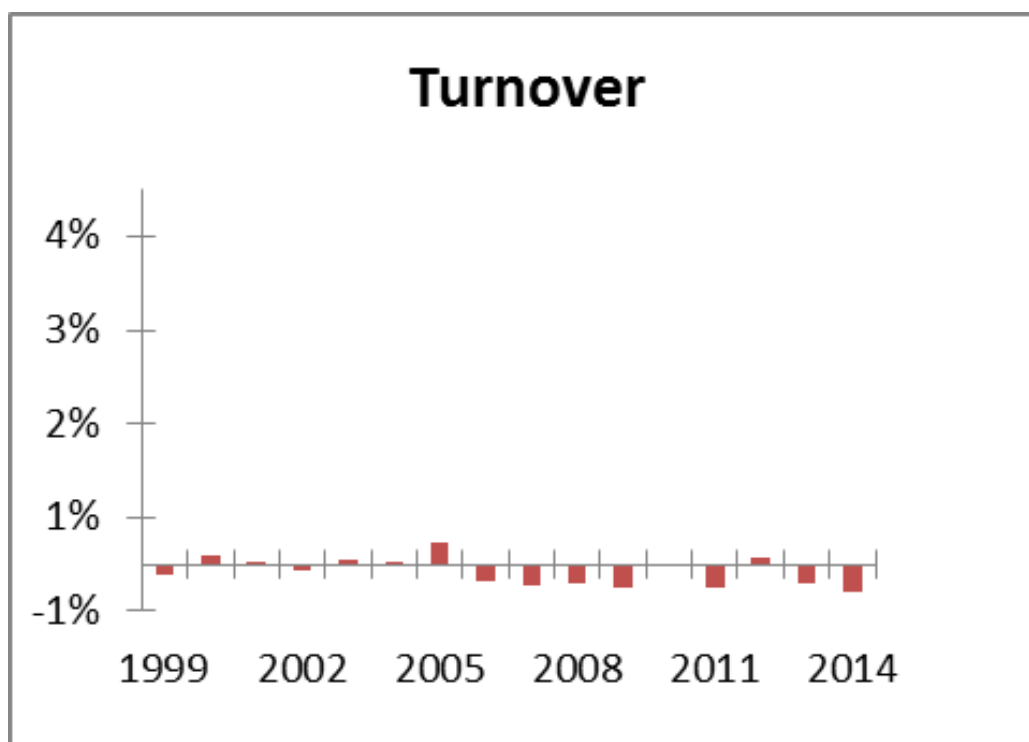
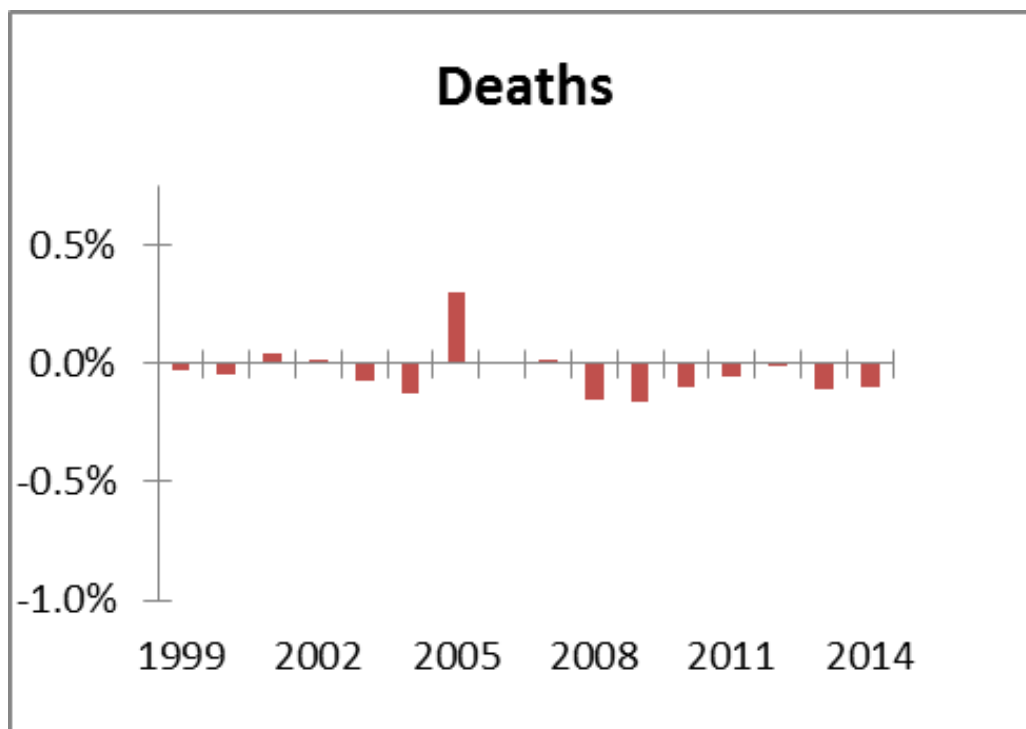
The annual gain (positive) or loss (negative) due to Retirements, Disabilities, Deaths, Turnover, New Members and Pay Increases as a percentage of the AAL is illustrated below:

Actuarial Gains and (Losses) as a Percentage of Actuarial Accrued Liability
PERA – All Divisions 1999 - 2014

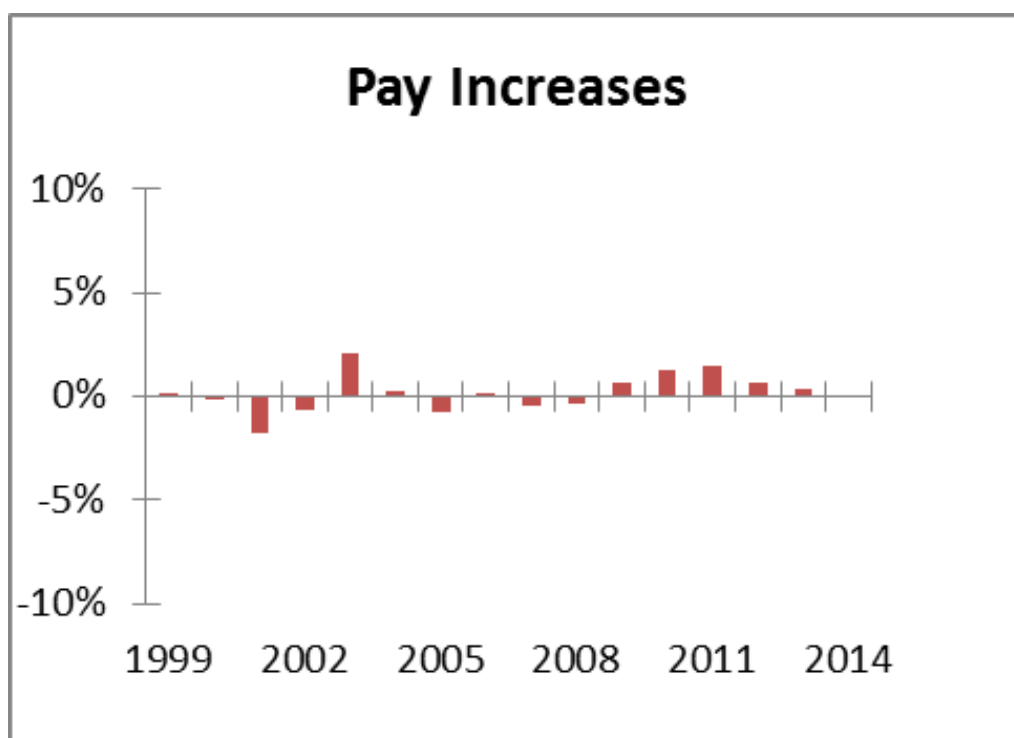
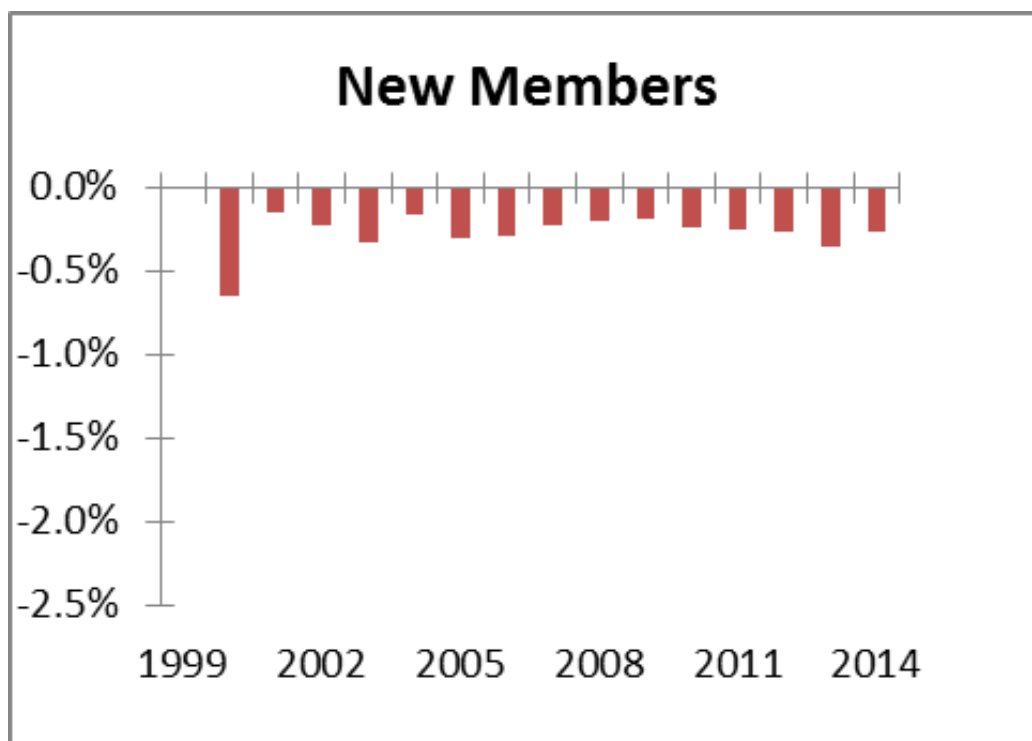


Actuarial Gains and (Losses) as a Percentage of Actuarial Accrued Liability

PERA – All Divisions 1999 – 2014
(cont'd)



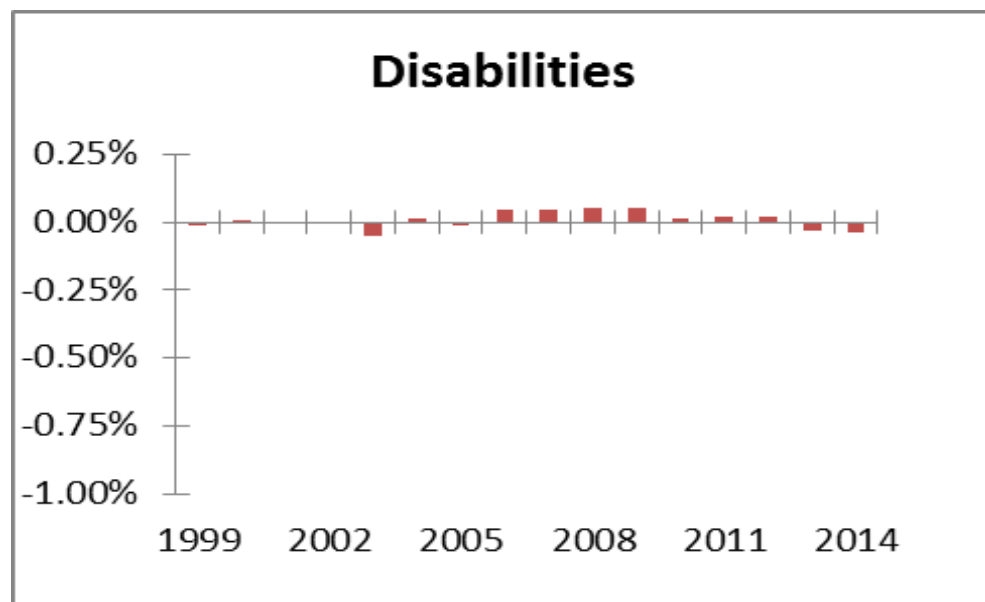
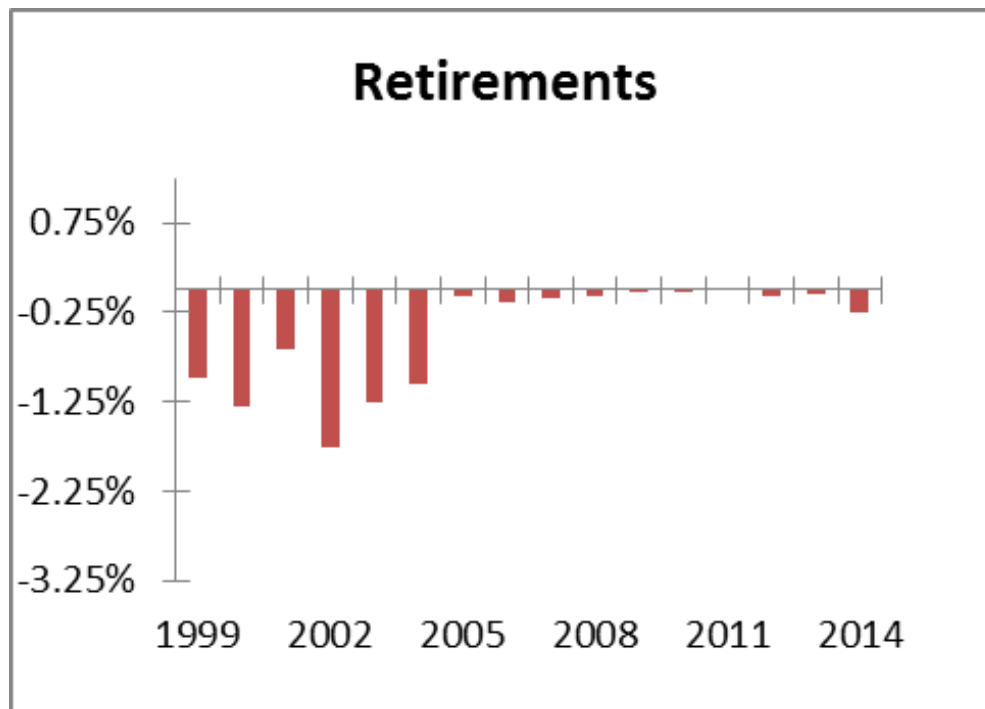
Actuarial Gains and (Losses) as a Percentage of Actuarial Accrued Liability
PERA – All Divisions 1999 – 2014
(cont'd)



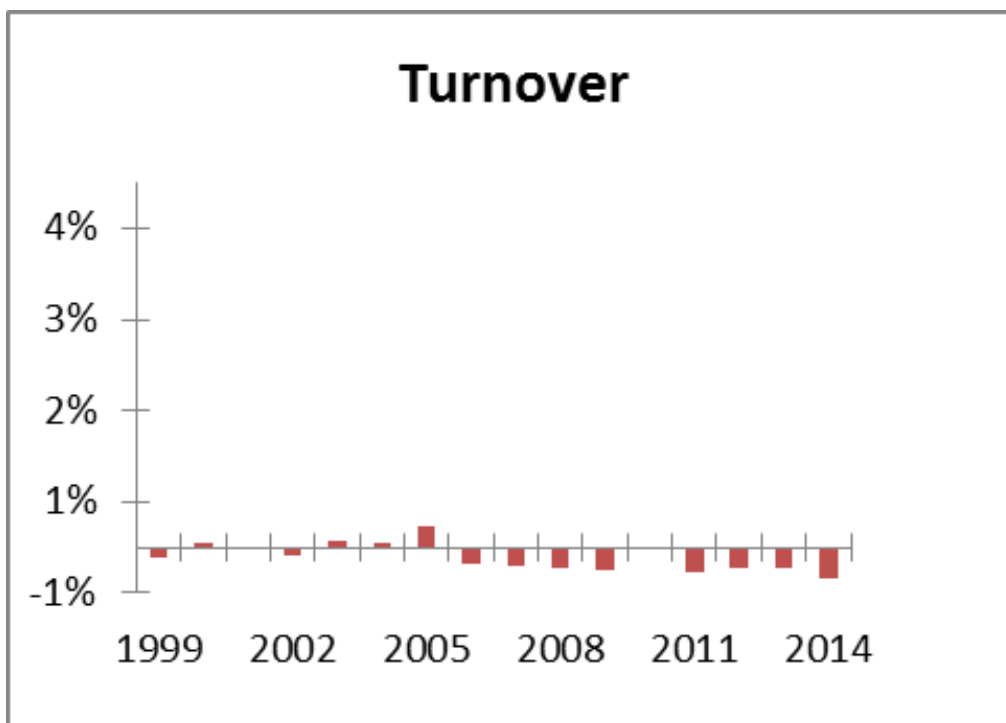
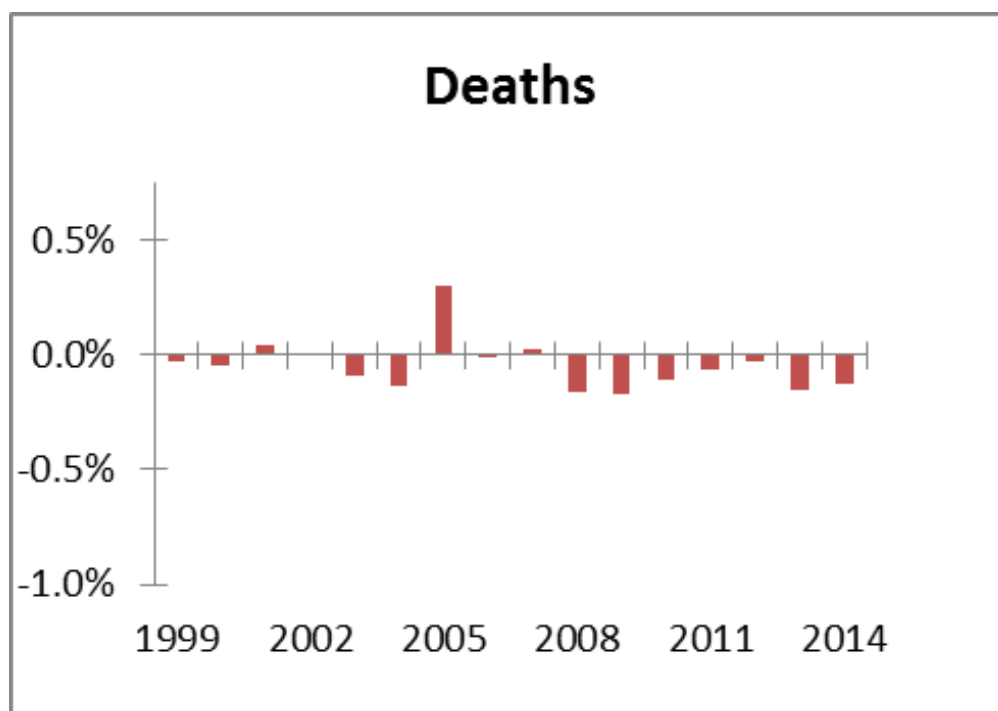
Appendix B: Historical Gains/Losses State and School Divisions

The annual gain or loss due to Retirements, Disabilities, Deaths, Turnover, New Members and Pay Increases as a percentage of the AAL is illustrated below:

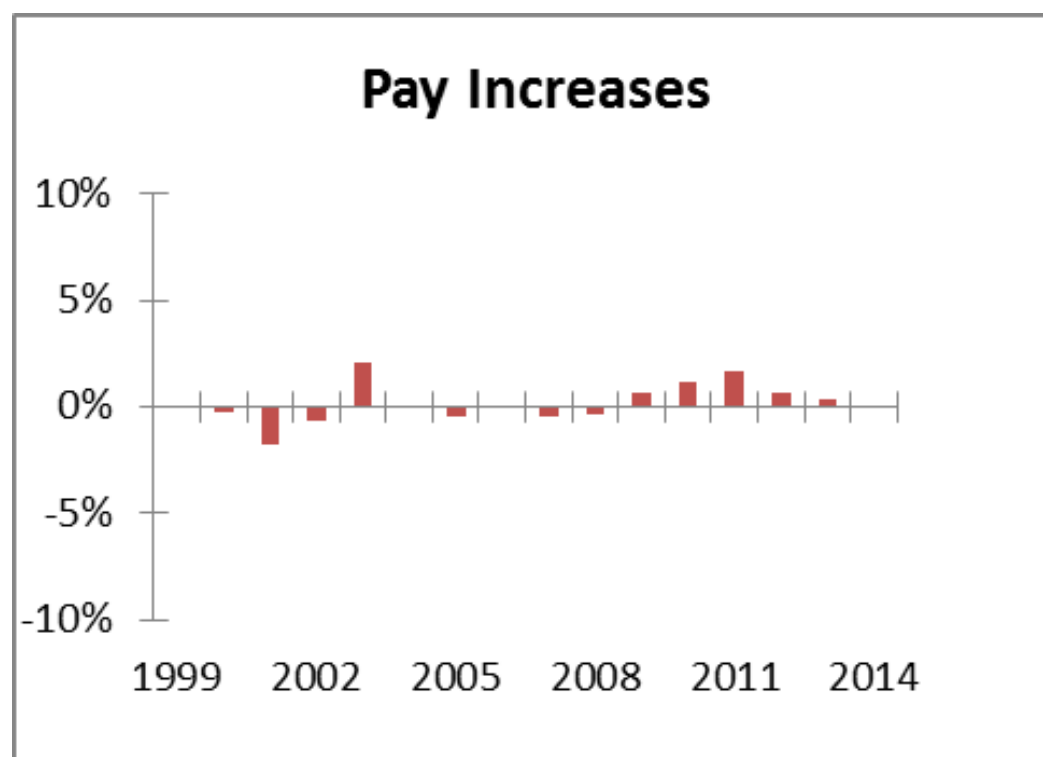
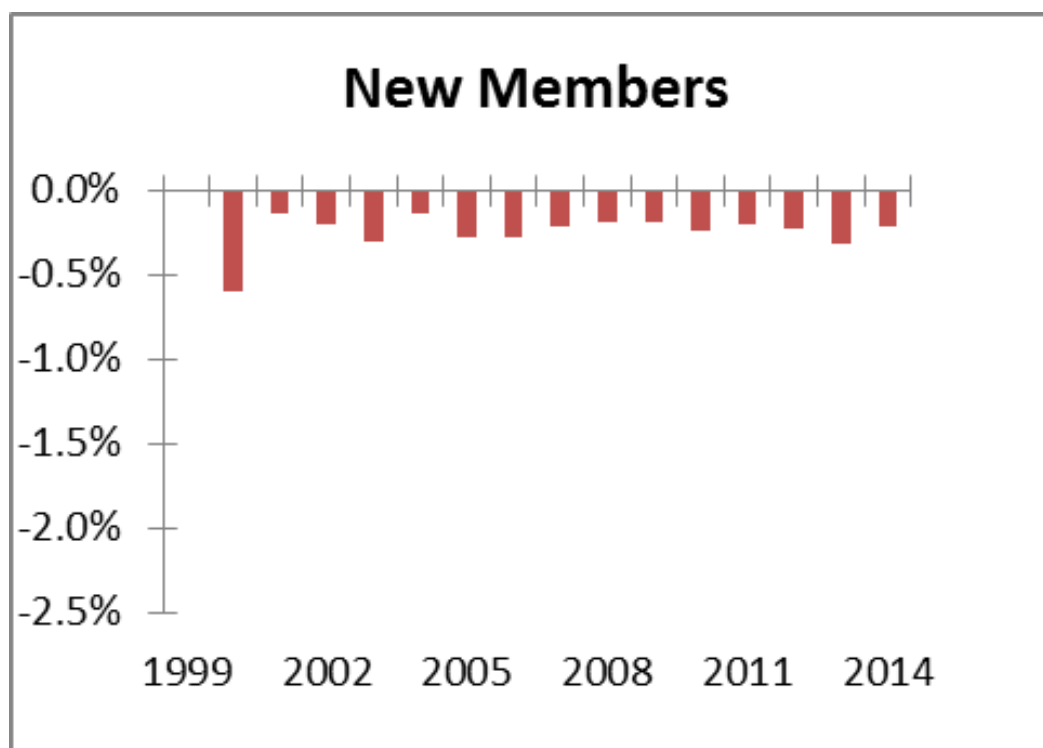
**Actuarial Gains and (Losses) as a Percentage of Actuarial Accrued Liability
1999 – 2014 State and School Divisions**



Actuarial Gains and (Losses) as a Percentage of Actuarial Accrued Liability
1999 – 2014 State and School Divisions
(cont'd)



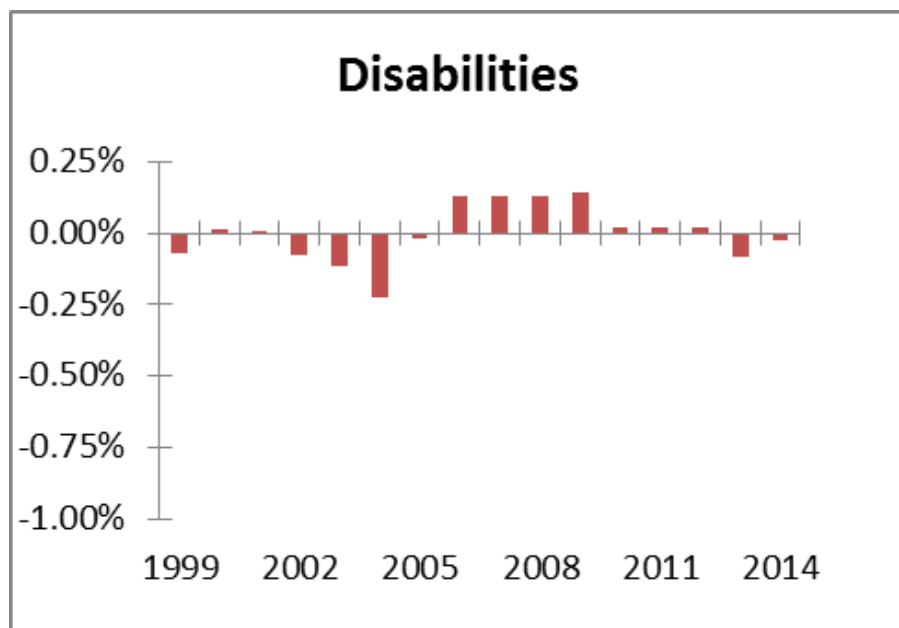
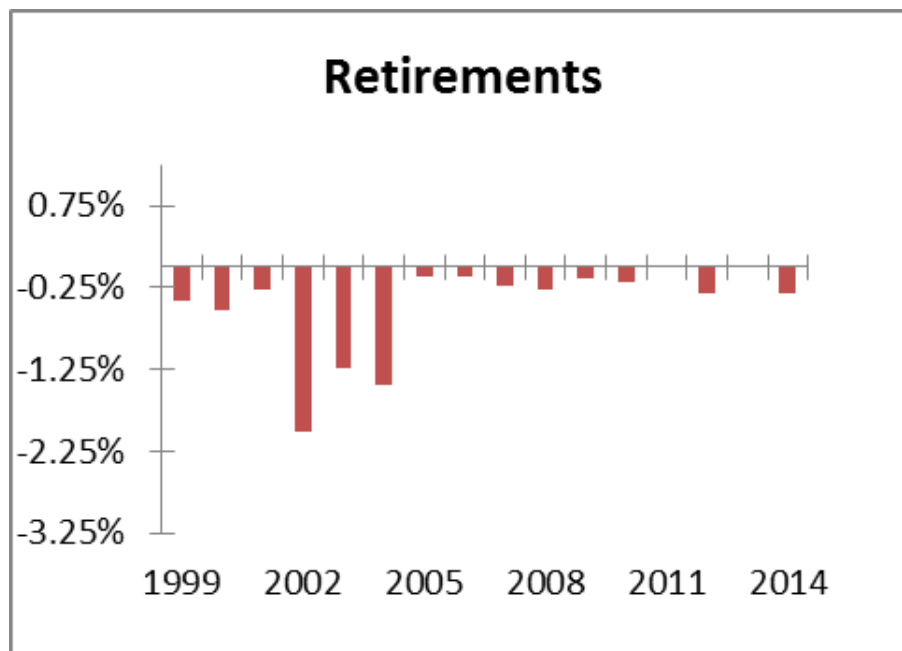
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1999 – 2014 State and School Divisions
(cont'd)



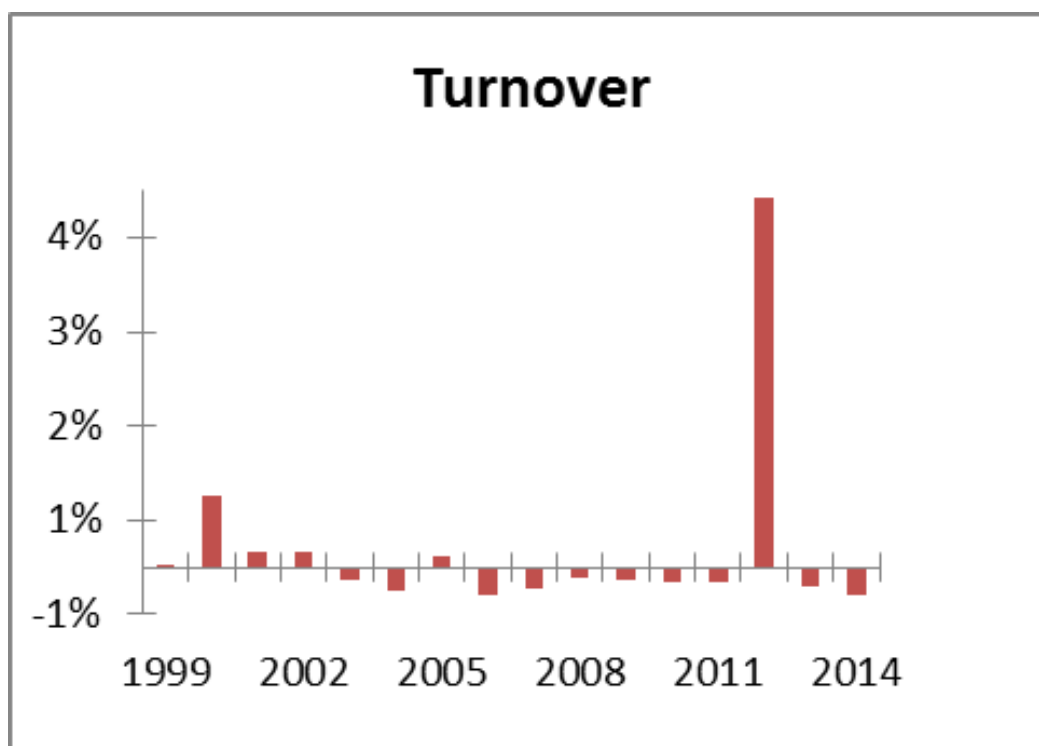
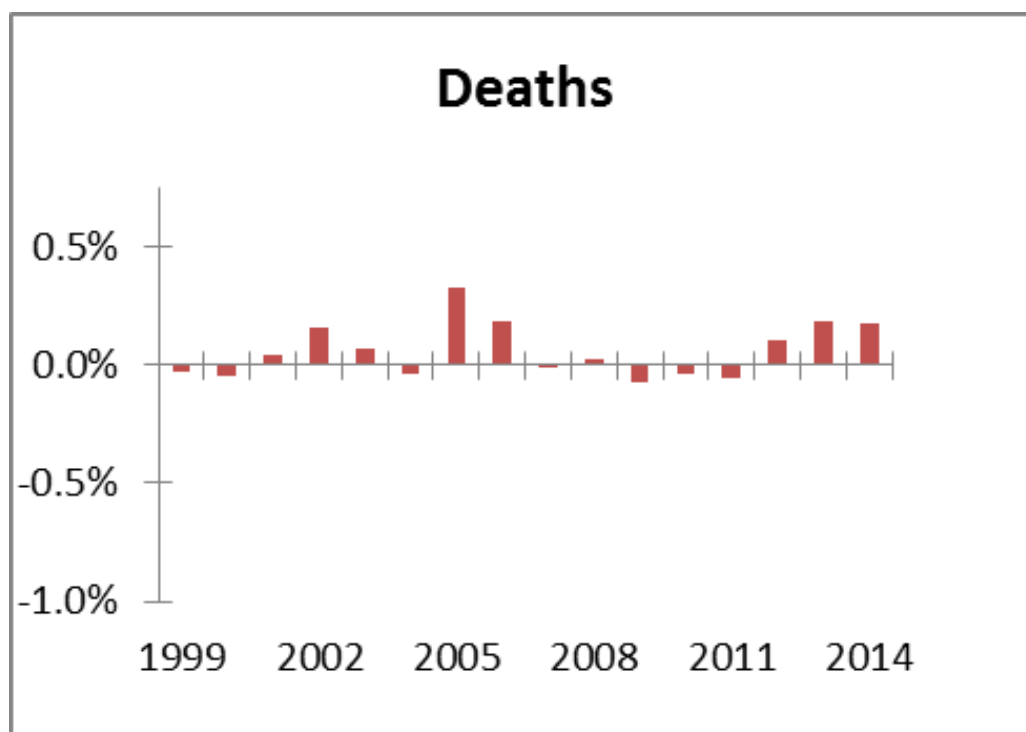
Appendix C: Historical Gains/Losses Local Government Division

The following charts summarize the historical actuarial gains and losses. They are PTA calculations based on the 1999-2014 PERA Annual Actuarial Valuation reports. The annual gain or loss due to Retirements, Disabilities, Deaths, Turnover, New Members, and Pay Increases as a percentage of the AAL is illustrated below:

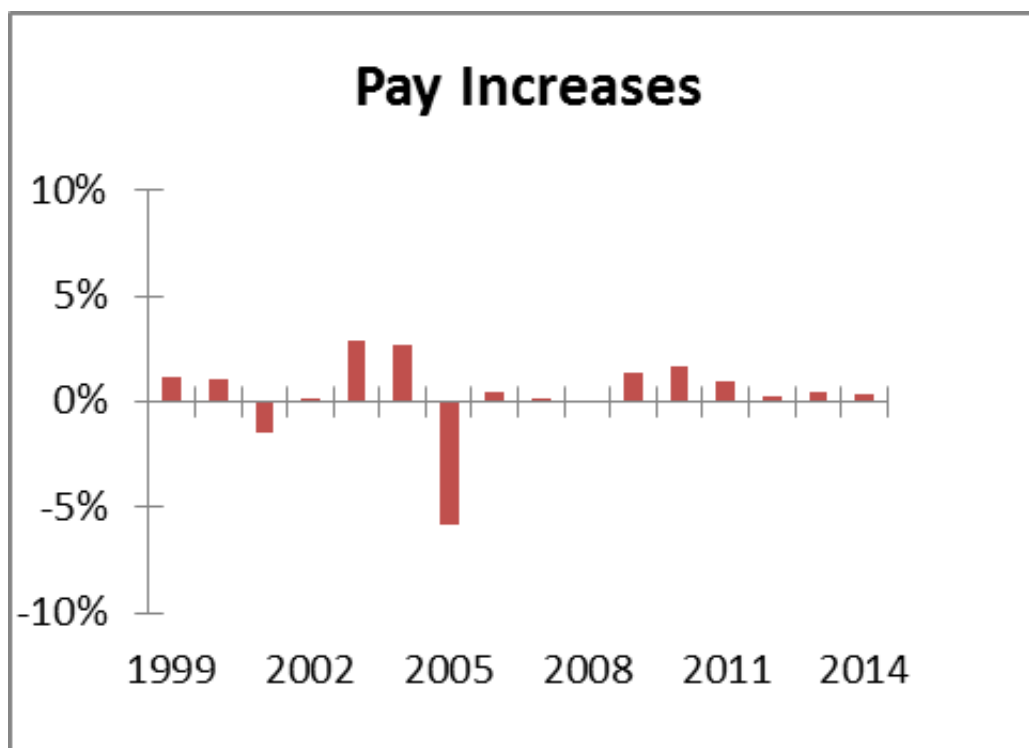
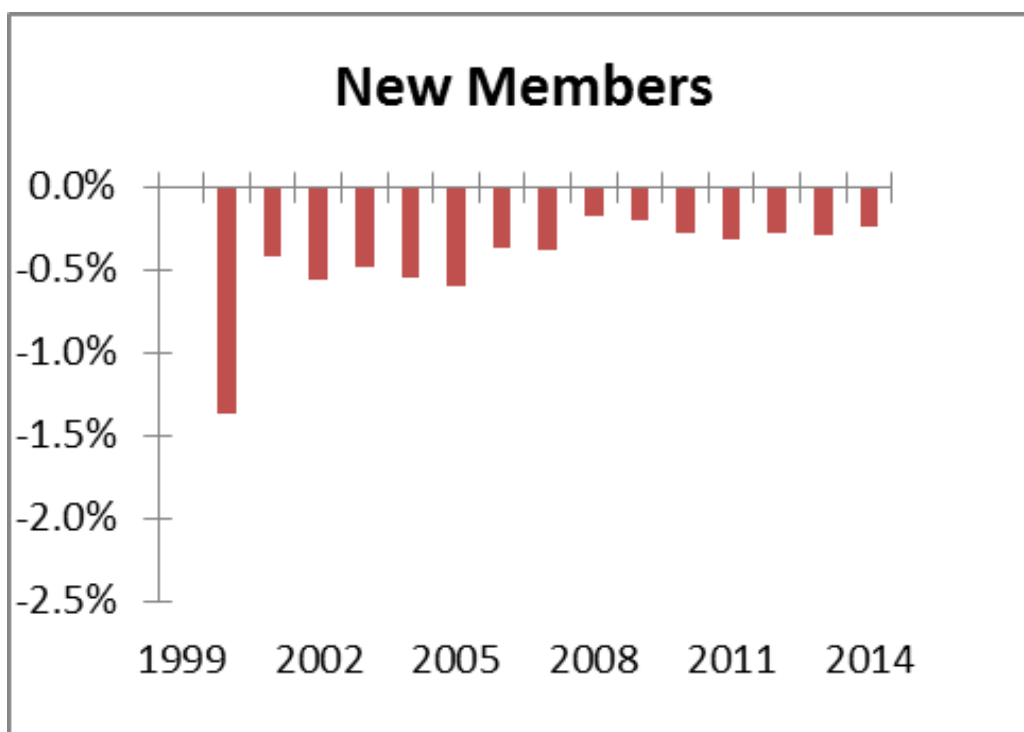
**Actuarial Gains and (Losses) as a Percentage of Actuarial Accrued Liability
1999 – 2014 Local Government Divisions**



Actuarial Gains and (Losses) as a Percentage of Actuarial Accrued Liability
1999 – 2014 Local Government Divisions
(cont'd)



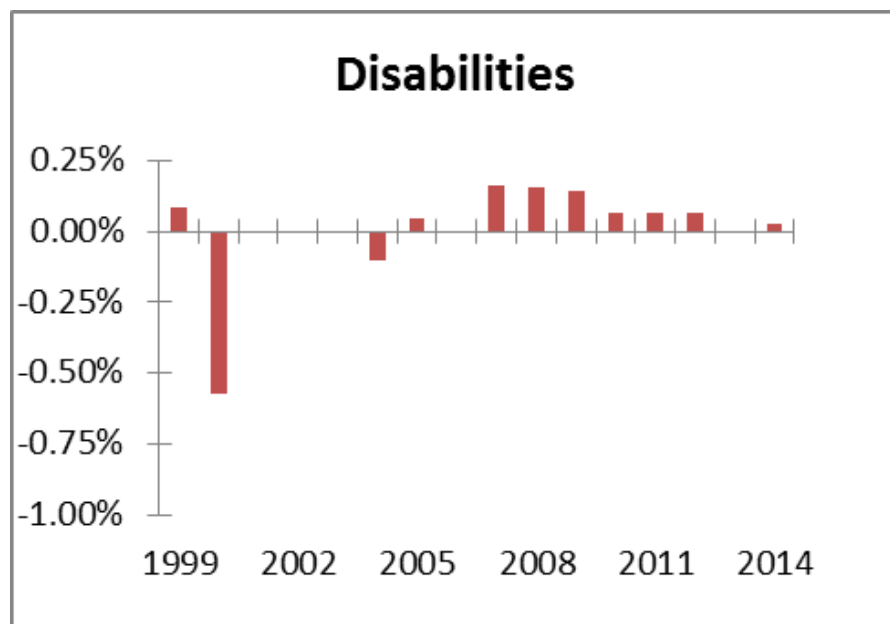
Actuarial Gains and (Losses) as a Percentage of Actuarial Accrued Liability
1999 – 2014 Local Government Divisions
(cont'd)



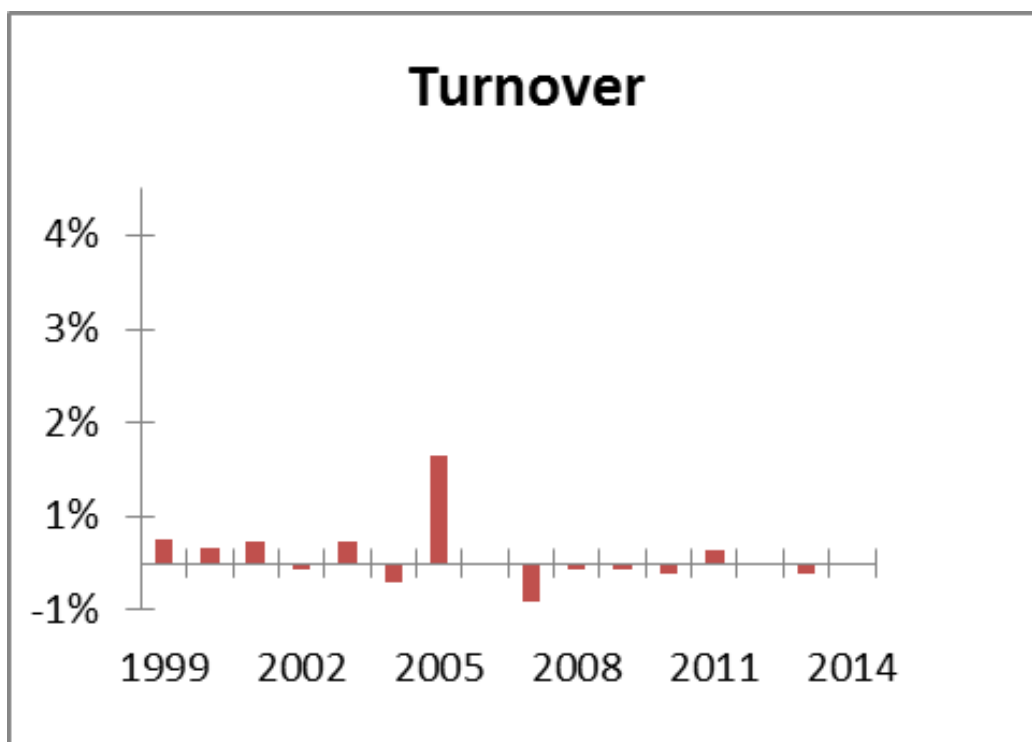
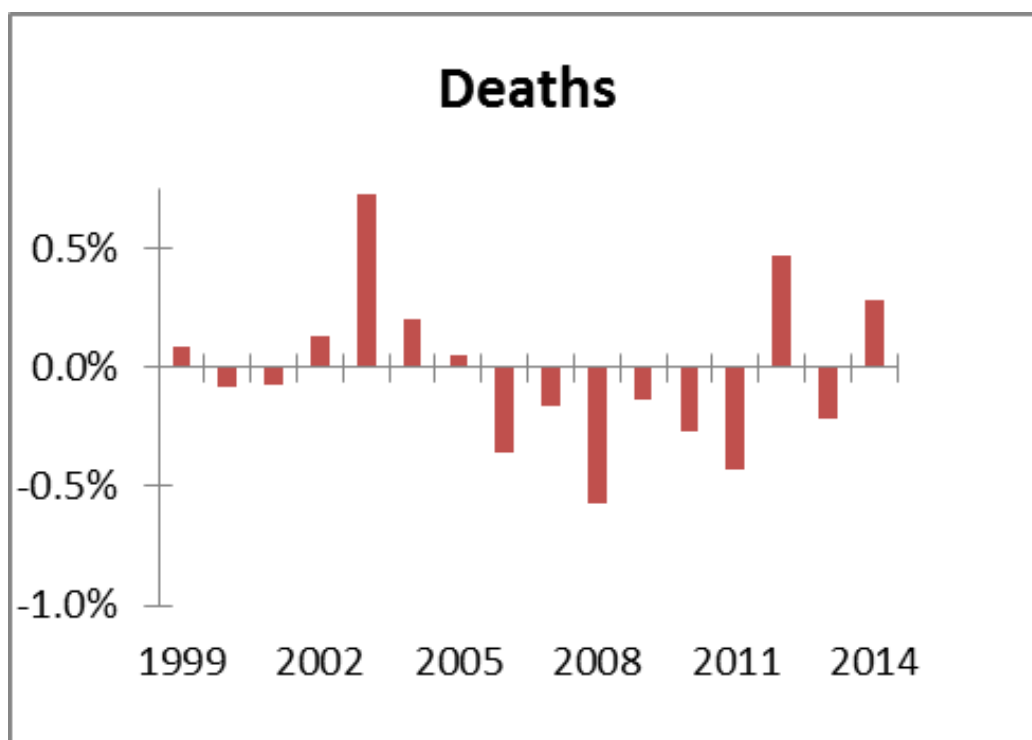
Appendix D: Historical Gains/Losses Judicial Division

The following charts summarize the historical actuarial gains and losses. They are PTA calculations based on the 1999-2014 PERA Annual Actuarial Valuation reports. The annual gain or loss due to Retirements, Disabilities, Deaths, Turnover, New Members, and Pay Increases as a percentage of the AAL is illustrated below:

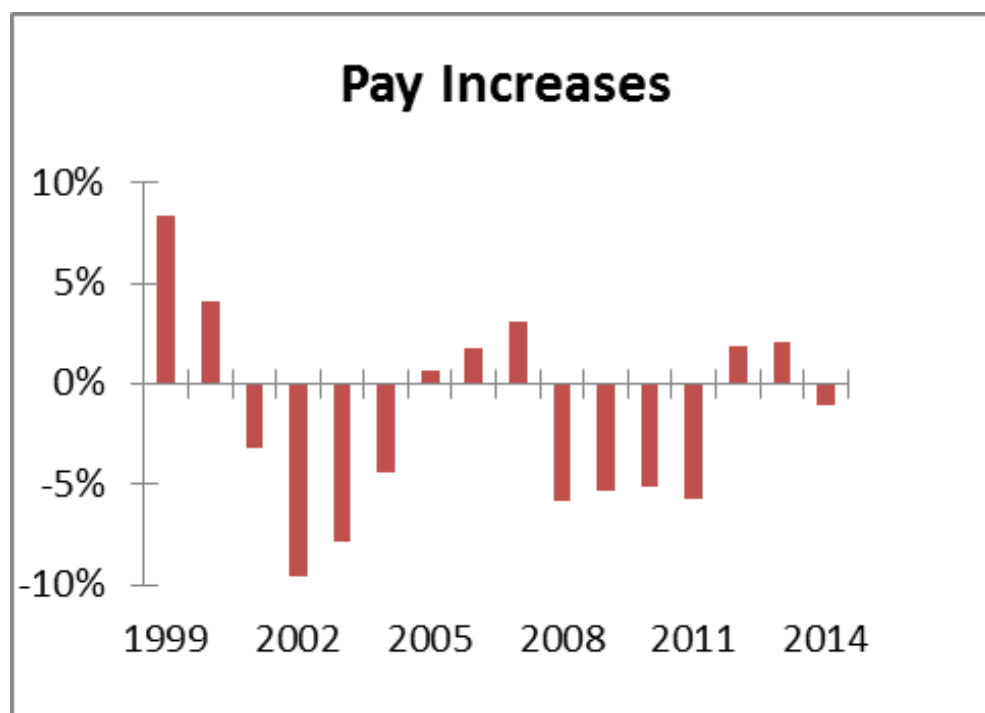
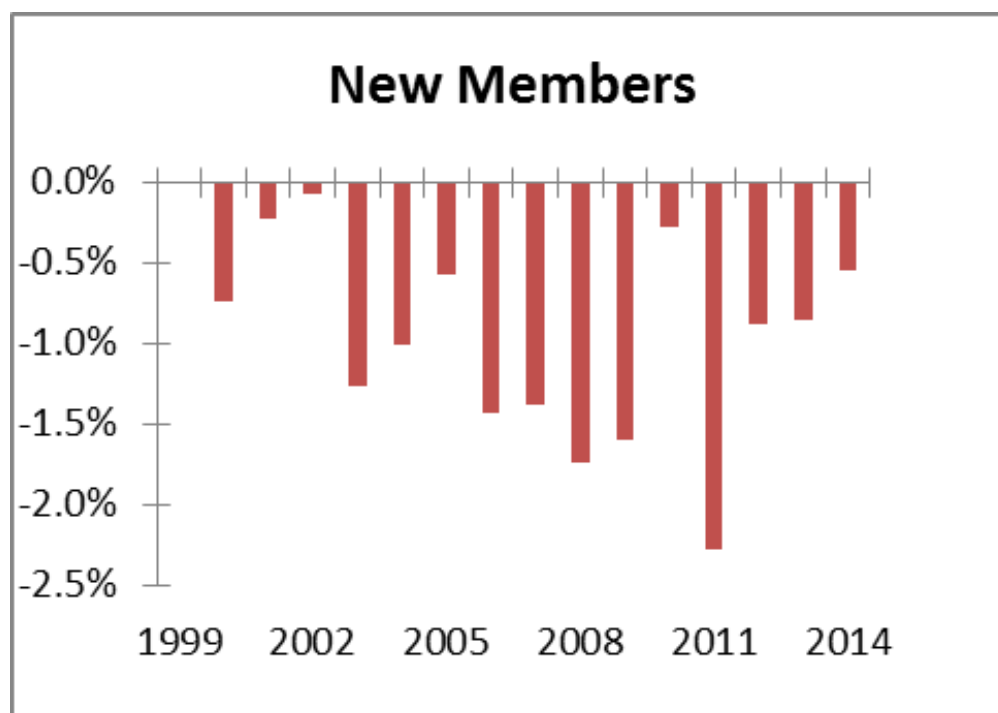
**Actuarial Gains and (Losses) as a Percentage of Actuarial Accrued Liability
1999 – 2014 Judicial Division**



Actuarial Gains and (Losses) as a Percentage of Actuarial Accrued Liability
1999 – 2014 Judicial Division
(cont'd)



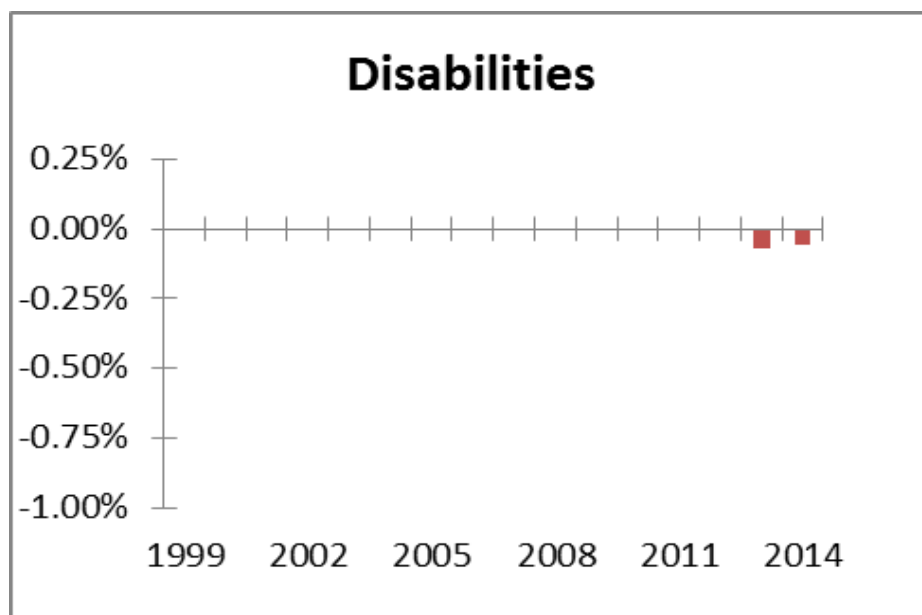
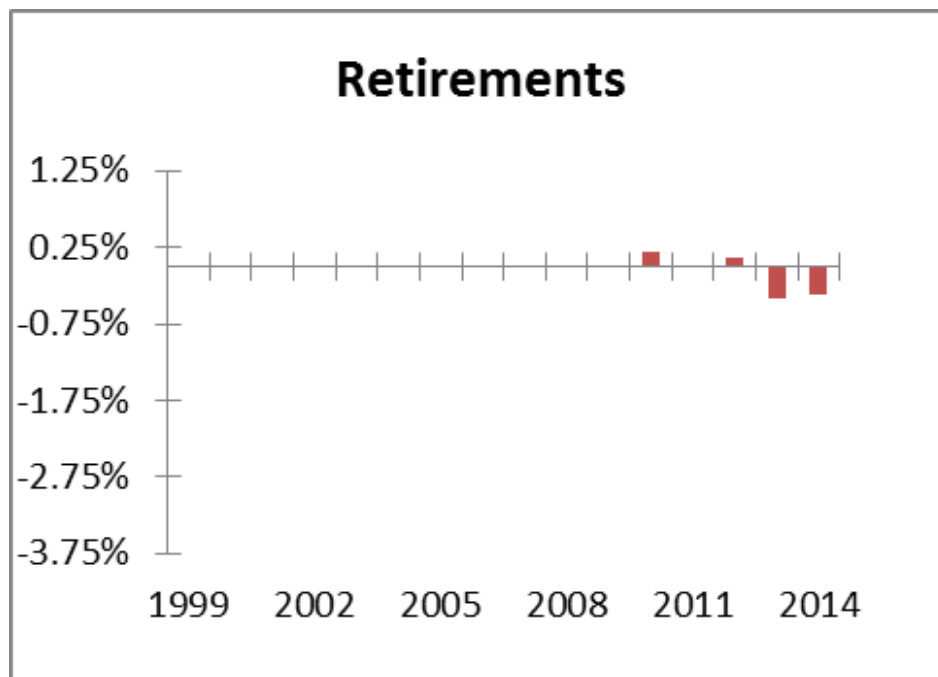
Actuarial Gains and (Losses) as a Percentage of Actuarial Accrued Liability
1999 – 2014 Judicial Division
(cont'd)



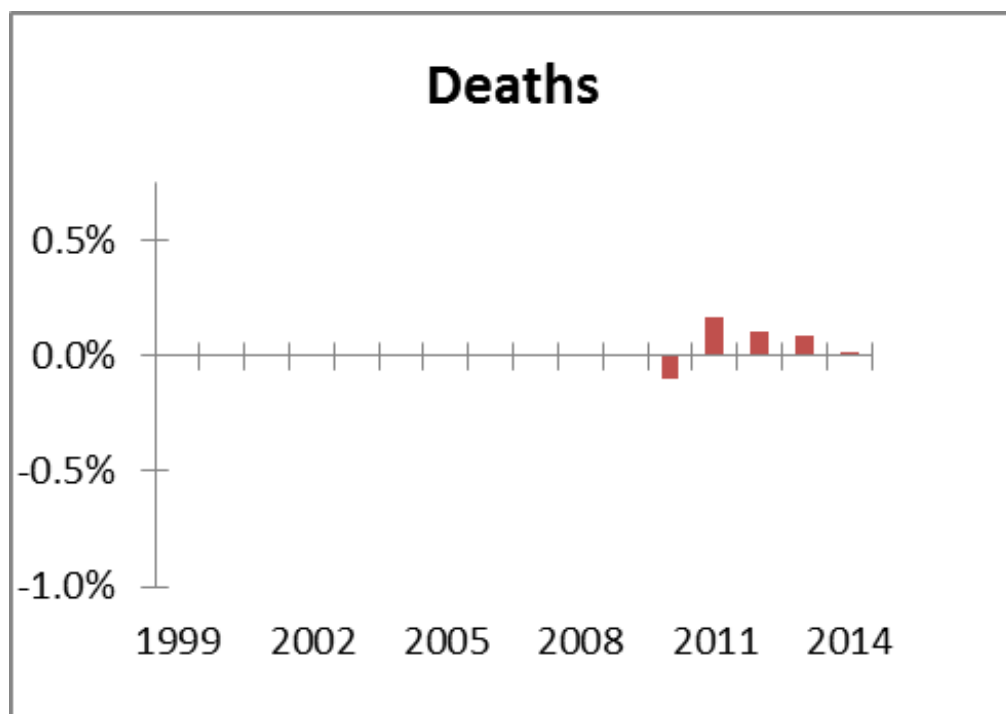
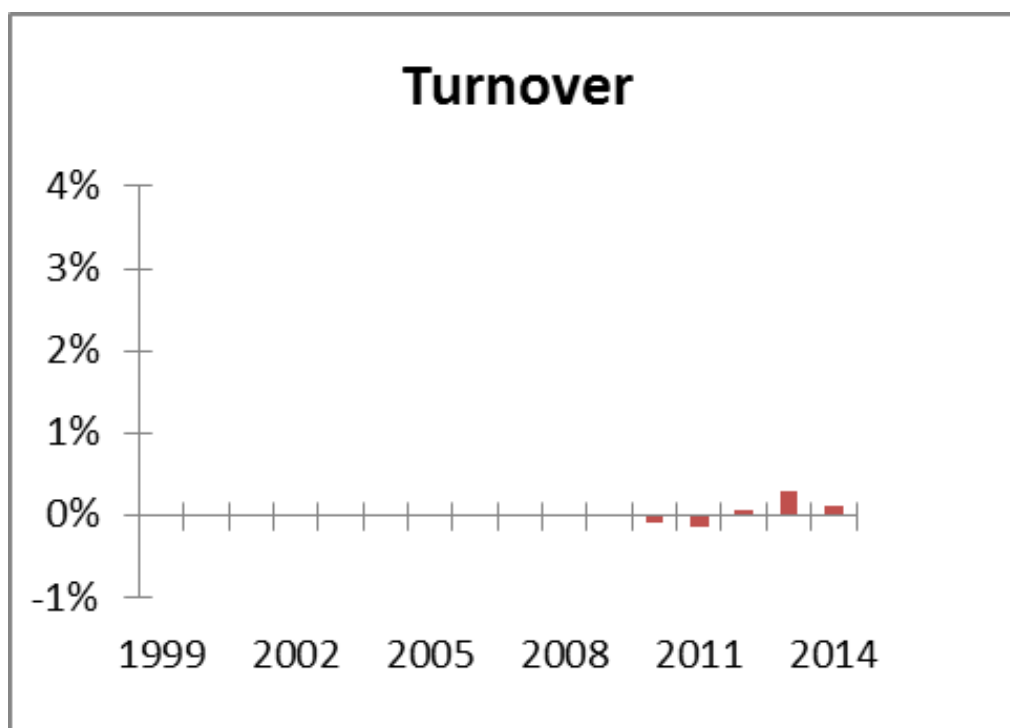
Appendix E: Historical Gains/Losses Denver Public Schools Division

The following charts summarize the historical actuarial gains and losses. They are PTA calculations based on the 1999-2014 PERA Annual Actuarial Valuation reports. The annual gain or loss due to Retirements, Disabilities, Deaths, Turnover, New Members, and Pay Increases as a percentage of the AAL is illustrated below:

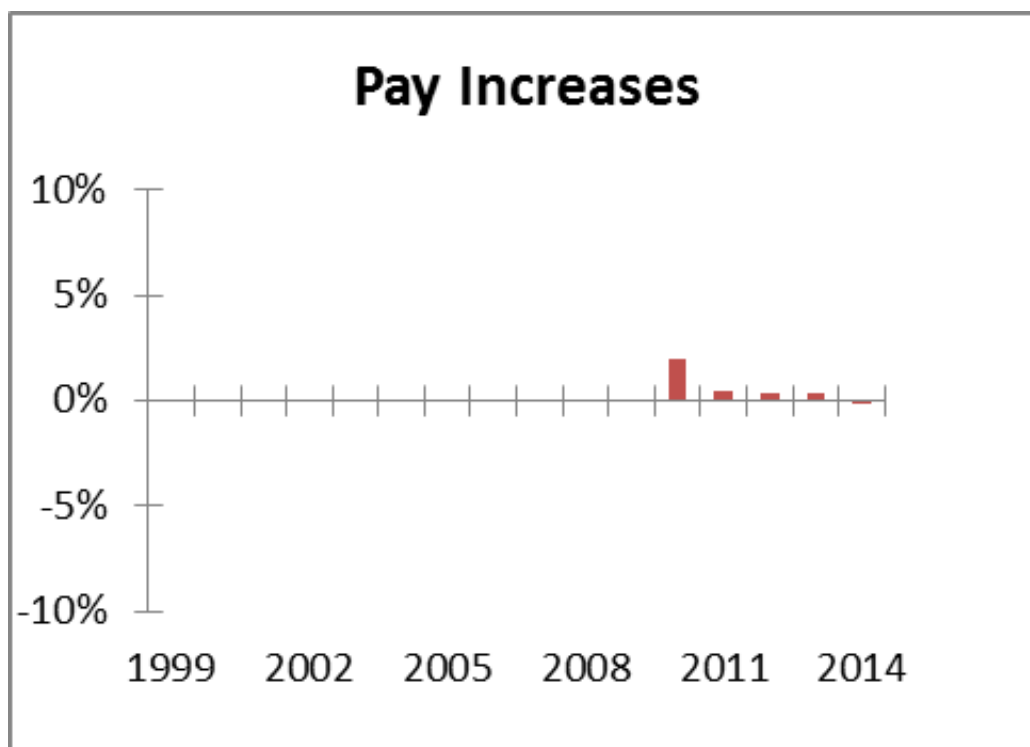
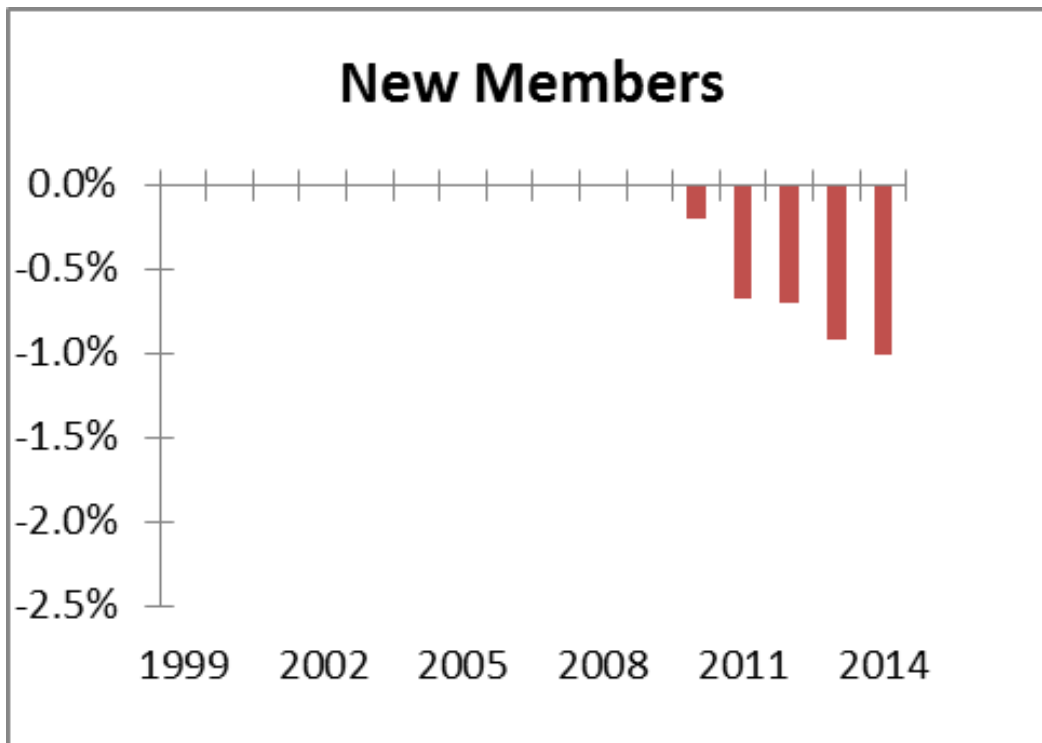
**Actuarial Gains and (Losses) as a Percentage of Actuarial Accrued Liability
1999 – 2014 Denver Public Schools Divisions**



Actuarial Gains and (Losses) as a Percentage of Actuarial Accrued Liability
1999 – 2014 Denver Public Schools Divisions
(cont'd)



Actuarial Gains and (Losses) as a Percentage of Actuarial Accrued Liability
1999 – 2014 Denver Public Schools Divisions
(cont'd)



Appendix F: Statistical Techniques

Independent Random Variables and Dependent Variables

The future funding position depends on many uncertain future events. Because of the uncertainty, it is appropriate to analyze these possible future outcomes using the discipline of probability and statistics. While this study focuses primarily on investment return, other future events are uncertain and can be analyzed statistically. These include:

- Future growth in number of individuals entering PERA
- Salary increases
- Mortality experience
- Other actuarial gains and losses

The outcomes of these as well as the investment returns are considered *independent random variables*. That is, their outcomes are essentially independent of each other and independent of the funding position of PERA. The outcome, such as the date that PERA becomes fully funded is considered a *dependent variable*. In other words, we do not know today when PERA would become fully funded. It is *dependent* on a number of variables such as investment return, population growth, salary increases, mortality experience, and other actuarial gains and losses. It is also dependent on whether contributions are made in the manner proscribed and whether the benefit formula changes, but this study assumes that these will occur as under current law.

We have several *independent random variables* which, in large part, determine the outcome of the *dependent variable*, which (for purposes of this study) is the date that a 100% funded position is achieved. We believe that the full funding date (which can also be thought of as the amortization period) is the single best indicator, for Colorado, of the long term sustainability and health of PERA.

Since we have *independent random variables*, it can be appropriate to analyze them statistically as long as they follow a statistically measurable pattern. This does not mean that we can predict what they might be in any particular year, but rather that we can analyze their likelihood. For example, as discussed in Section 8.2, since 1980, PERA annual investment returns have ranged from a positive return of 31% to a negative return (loss) of 26%. The PERA actuary has used this past return history as well as other economic data as a guide for expectations for future returns and concluded that a reasonable assumption for mean future return is 7.5%. The auditing actuary has concurred that this is a reasonable assumption. We also find this to be reasonable and appropriate.

Standard Deviation

While PERA and their actuaries have built their actuarial projection valuation model on earning *exactly* 7.5% each and every future year, our task is to analyze what possible other outcome might occur. To do that, the first step is to measure the variance in the annual returns, and use that for further analysis of possible deviation of future returns. There is a precise mathematical formula for *variance*, and it's more commonly used sibling *standard deviation* or (σ). The PERA annual σ since 1980 has been about 11% and about 13% since 1999. The PERA advisors also implied an expected annual σ of about 13% in their analysis of future investment returns. This is consistent with expectations by other financial and investment firms. Our analysis developed an annual σ of 13.2%. This is also consistent with expectations by other financial and investment firms.

One feature of knowing the standard deviation is that statistical methods such as the *z-test* and *central limit theorem* can be used to determine the likelihood of certain events occurring. For example:

- There is a 68% likelihood that an event will fall within one standard deviation of the mean:
 - There is about a 34% chance that 1-year's return will fall between 7.5% and 20.7% (7.5% + 13.2%)
 - There is about a 34% chance that 1-year's return will fall between -5.7% and +7.5%
 - There is about a 16% chance that 1-year's return will exceed 20.7%
 - There is about a 16% chance that 1-year's return will be worse than -5.7%
- We can also calculate percentile likelihoods if we know the mean and σ :
 - There is a 10% probability that a 1-year return will be below -9.3%
 - There is a 10% probability that a 1-year return will be above +24.3%
 - There is a 25% probability that a 1-year return will be below -1.4%
 - There is a 25% probability that a 1-year return will be above +16.4%
- Given that the standard deviation for 1-year investment returns is 13.2%, we can calculate multiple year standard deviations:
 - The σ for 5-year returns is 5.9%
 - The σ for 10-year returns is 4.2%
 - The σ for 30-year returns is 2.4%
 - The σ for 40-year returns is 2.1%

Incorporating the statistics above results in the following table of likelihoods:

PERA Hybrid Defined Benefit Plan
Statistical Distribution of Investment Returns

Likelihood	One Year	Five Years	Forty Years
Standard Deviation (σ)	13.2%	5.9%	2.1%
10 th percentile worst case	-9.3%	0.0%	4.8%
25 th percentile bad case	-1.4%	3.5%	6.1%
Mean expected return	7.5%	7.5%	7.5%
75 th percentile good case	16.4%	11.5%	8.9%
90 th percentile best case	24.3%	15.0%	10.2%

Source: Pension Trustee Advisors

Standard Deviation Examples over Non-Annual Time Periods

While 1 year returns might have a fairly high variance (σ of 13.2%), over a longer period of time, we would expect less variance. Over a 5 year period, we would expect average annual returns to be less volatile. Think about throwing one die. We have outcomes ranging from one to six, each equally likely. While the average expected outcome from one die is 3.5, the standard deviation is 2. (about one-third of the time you'd get 2 or 3, one-third you'd get 4 or 5). But if you throw two dice and average the counts, you'd still have an expected outcome of 3.5 (remember that seven is the average of the sum of the two dice), but the standard deviation falls to 1.4. About two-thirds of the rolls would be 5,6,7,8, or 9 (averages between 2.5 and 4.5). Two years of investment return is like throwing two dice. Throw 40 dice and the average counts are even more condensed.

As another simplified example, let's assume that the expected annual return in the stock market, as measured by the Dow Jones Industrial Average (DJIA), is 10%. With 252 trading days in the year, we would expect the DJIA to increase by about \$7 each day. But we know from following the daily news that most daily returns are dramatically higher or lower than this. Stanford economists calculated that the standard deviation for monthly DJIA return was about 5.5%, with a mean expected return of 0.6%. (*The Dow Jones Industrial Average: The Impact of Fixing Its Flaws*, John B. Shoven and Clemens Sialm, Stanford University, 2000). Using this, we can calculate a daily standard deviation of about \$45. This means that in about 1/3 of the days, the market goes up by less than \$52, in about 1/3 it is fairly flat or goes down by less than \$38. In one-sixth it goes up by more than \$52, and in one-sixth it falls by more than \$38.

Deterministic versus stochastic modelling

In our analysis, we assumed that each year's investment return was identical and equal to the average return being studied. For example, to measure whether the plan would become fully funded in 40 years under the 75th percentile best case, we assumed that each year's return would be 8.9% (see table above). This is what is known as a deterministic approach. This approach is taken because it is somewhat simpler and much easier to understand and explain. We find that it is accurate enough for these uncertain purposes. Once the decision-makers are comfortable with the concepts, future studies might consider utilizing a more robust stochastic approach.

Under a stochastic approach, the same statistics are used, but a simulation of a range of possible returns is constructed. Based on the 1-year standard deviation and mean, a string of 50 annual returns is generated. Then based on a single string of returns, all dependent variables are calculated (asset values, funded levels, etc.). This is what's known as a single pass. Then a large number of passes (typically one thousand) are generated to look at many potential outcomes. Then percentiles are determined based on the thousand outcomes.

While stochastic results are more complex and difficult to represent, explain, and understand, they are more accurate and represent the real world randomness. While it may have been worthwhile to use a stochastic approach, it was beyond the scope of the analysis. We find that the more simplified deterministic approach is completely valid and an excellent tool to help decision-makers understand the risks and varying possible outcomes.

Multivariate Analysis

The discussion above has focused on the most significant independent random variable – investment return. As set forth in the body of this report, the analysis has also developed standard deviations for population growth, payroll growth, and other actuarial gains and losses. But each variable has been analyzed primarily on its own. For example, there was a 48% chance, based on 40-year investment return volatility, that the State Division would not be 100% funded by 2055 (falling from light green signal to yellow signal light). There is also an 11% chance that, based on reduced population growth, of not meeting that 2055 target, a 14% chance that based on increased salary growth and 14% chance based on other actuarial losses of the same outcome.

The combined likelihood of this based on all four independent random variables is not merely the sum of the independent likelihoods (48%+11%+14%+14%=87%). There is a statistical tool known as multivariate distribution analysis which allows measurement of this combined deviation. In order to calculate this, we need to look at the impact on full funding date of a one-standard-deviation of each independent variable. We find that long-term experience which deviates from that expected has the following impact on full funding date:

Change in Funding Period for State Division

Variable	Change in Funding Period due to one standard deviation event	Share of total
Investment Return	21.1 years	93.4%
Salary Growth	4.5 years	4.2%
Investment Return	2.7 years	1.5%
Investment Return	2.0 years	0.9%
Total	21.8 years	100.0%

Source: Pension Trustee Advisors

From this information, it is possible to construct an all-encompassing likelihood signal light based on these four variables. The results are shown in the following chart from Chapter Nine, Signal Light for Assessing PERA, Section 9.6:

Long-Term Signal Light for State Division

(Based on Investment Return, Salary Growth, Population Growth and Other Actuarial Experience)

Status	Definition	Possible outcomes to get to this status	Likelihood	
Dark Green	100% funded by 2041 (30 years from 2011)	Earn 8.6% or more or other highly favorable experience	34%	51%
Green	100% funded by 2045 (30 years from 2015)	Earn 8.2% to 8.6% or other favorable experience	5%	
Light Green	100% funded by 2055 (40 years from 2015)	Earn 7.4% to 8.2% with other average experience	13%	
Yellow	100% funded by 2065, and never as low as 20% funded	Earn 7.3% to 7.4% or other unfavorable experience	2%	22%
Orange	Solvent, and only gets as low as 20% funded	Earn 6.1% to 7.3% or other unfavorable experience	20%	
Red	Insolvent or technically insolvent after 2035	Earn 3.1% to 6.1% or other unfavorable experience	19%	27%
Dark Red	Insolvent by 2035 (within 20 years)	Earn less than 3.1% or other unfavorable experience	8%	

Source: Pension Trustee Advisors. Numbers may not add due to rounding

By comparing this all-encompassing signal light table with the investment-only signal light table below, we can see that incorporating the other variables has a very modest impact in our analysis in the long run. For example, looking at only investment outcomes, there is a 25% chance of being in the red zones, based on long run returns averaging 5.9% or less. But if we also consider unfavorable other actuarial experience, the probability of ending in the red zones rises to 27%. This difference is well within the margin of error, and means that most of our attention should be focused on investment return.

Long-Term Signal Lights for State Division
(Based on Investment Return Only)

Status	Definition	Possible outcomes to get to this status	Likelihood	
Dark Green	100% funded by 2041 (30 years from 2011)	Earn 8.6% or more	33%	51%
Green	100% funded by 2045 (30 years from 2015)	Earn 8.2% to 8.6%	5%	
Light Green	100% funded by 2055 (40 years from 2015)	Earn 7.4% to 8.2%	14%	
Yellow	100% funded by 2065, and never as low as 20% funded	Earn 7.3% to 7.4%	3%	21%
Orange	Solvent, and only gets as low as 20% funded	Earn 6.1% to 7.3%	18%	
Red	Insolvent or technically insolvent after 2035	Earn 3.1% to 6.1%	22%	28%
Dark Red	Insolvent by 2035 (within 20 years)	Earn less than 3.1%	6%	

Source: Pension Trustee Advisors. Numbers may not add due to rounding

The following table shows that there is not much difference in the likelihoods based on investment return only versus all four variables:

Long-Term Signal Lights for State Division
(Based on Investment Return and All Other Variables)

Status	Definition	Possible outcomes to get to this status	Likelihood – Investments Only		Likelihood – All Variables	
Dark Green	100% funded by 2041 (30 years from 2011)	Earn 8.6% or more	33%	51%	34%	51%
Green	100% funded by 2045 (30 years from 2015)	Earn 8.2% to 8.6%	5%		5%	
Light Green	100% funded by 2055 (40 years from 2015)	Earn 7.4% to 8.2%	14%		13%	
Yellow	100% funded by 2065, and never as low as 20% funded	Earn 7.3% to 7.4%	3%	21%	2%	22%
Orange	Solvent, and only gets as low as 20% funded	Earn 6.1% to 7.3%	18%		20%	
Red	Insolvent or technically insolvent after 2035	Earn 3.1% to 6.1%	22%	28%	19%	27%
Dark Red	Insolvent by 2035 (within 20 years)	Earn less than 3.1%	6%		8%	

Source: Pension Trustee Advisors. Numbers may not add due to rounding.

Appendix G: PERA Funding Policy



COLORADO PERA DEFINED BENEFIT PENSION PLAN FUNDING POLICY

ADOPTED MARCH 20, 2015



CONTENTS

- I. Introduction..... 1
- II. Background 1
- III. Funding Goals 2
- IV. Annual Actuarial Metrics 3
- V. Funding Valuation Elements..... 3
- VI. Governance Policy/Processes 5
- VII. Glossary of Funding
Policy Terms..... 5



I. INTRODUCTION

The Colorado Public Employees' Retirement Association (PERA) maintains five pre-funded, hybrid defined benefit pension plans (i.e., State, School, Local Government, Judicial, and Denver Public Schools). Each defined benefit pension plan is funded through PERA-affiliated employer contributions, employee contributions, and the investment earnings resulting from those contributions. The fixed contribution rate at which each division's employers contribute is determined by the Colorado General Assembly and defined within the statutes governing PERA.

The purposes of this funding policy are to state the overall funding goals and annual actuarial metrics and to guide the PERA Board of Trustees (Board) when considering whether to pursue or support proposed contribution and benefit legislation. Finally, the policy will include a brief list of governance responsibilities regarding the commissioning, collection, and review of actuarial information, as described in the Board's *Governance Manual*.

PERA also maintains two pre-funded retiree health care subsidy plans, classified as other postemployment benefit (OPEB) plans. The funding policy regarding the retiree health care subsidy plans will be revised and updated after the completion and release of the anticipated GASB Financial and Accounting Standards applicable to OPEB. Until that time, the current funding policy will remain in force with regard to the health care subsidy plans administered by PERA.

It is the intention of the Board that this funding policy be considered a working document, reviewed periodically and, as necessary, altered in the future through formal action of the Board. The final page of this document contains the review and revision/adoption history pertaining to the funding policy of the PERA defined benefit pension plans.

II. BACKGROUND

In response to the unfavorable investment market of 2008, and in addition to the funding policy adopted in November 2007, the Board set the following guiding principles in 2009 in the development of a comprehensive package to maintain long-term sustainability:

- » Shared responsibility among members, retirees, and employers;
- » Intergenerational equity;
- » Preservation of the defined benefit plan;
- » Preservation of portability through the maintenance of existing benefit structures for the different divisions; and
- » Development of recommendations that would have little-to-no short-term impact on member behavior.

In 2009 and 2010, these guiding principles benefited the Board and all the stakeholders associated with the pension plan as solutions to the immediate funding situation were explored. The Board constructed a series of plan provision changes, enlisting the philosophy of the guiding principles—under the umbrella of shared responsibility—and communicated their recommendations to the General Assembly. Senate Bill 10-001 was the culmination of all the provisional and contribution changes that were to set PERA's course toward sustainability. Senate Bill 10-001 also contained the following funding and annual increase requirements, which now are embedded in Colorado Statute and will be implemented regardless of the Board's pension funding policy:

- » Per C.R.S. § 24-51-411(8), and § 24-51-411(9), the AED and the SAED are adjusted based on the year-end actuarial funded ratio within a particular division;
 - If a division trust fund's actuarial funded ratio;
 - Reaches 103 percent, a decrease in the AED and SAED is mandated, and,
 - Subsequently falls below 90 percent, an increase is mandated.

- For the Local Government and Judicial Divisions, if the actuarial funded ratio reaches 90 percent and subsequently falls below 90 percent, an increase in the AED and SAED is mandated.
 - Increases in AED and SAED cannot exceed the statutory maximum allowable limitation.
- » Per C.R.S. § 24-51-1009.5, if the combined pension divisions' trust fund actuarial funded ratio;
- Reaches 103 percent, the upper limit of the annual increase shall be increased by one-quarter of one percent, and,
 - Subsequently falls below 90 percent, the upper limit of the annual increase shall be decreased by one-quarter of one percent.

These statutory elements, in addition to the current schedule of employer contribution rates, assist in the ongoing balance of shared responsibility. It is not the intention of this Board, through the development of this funding policy, to undermine or circumvent the work accomplished by Senate Bill 10-001, but rather to ensure continued fiduciary commitment through sound governance practices and recognition of these statutory funding policies.

III. FUNDING GOALS

- » Preservation of the **defined benefit plan structure** of providing lifetime benefits to the employees of PERA-affiliated employers, reflecting the fact that PERA members are not covered under Social Security.
- » Demonstration of **transparency and accountability** through the continued maintenance of a defined benefit pension plan funding policy for the stakeholders of PERA.
- » **Achievement of a combined divisions' trust fund actuarial funded ratio greater than or equal to 110 percent.** Once the 110 percent combined funded ratio is achieved, following (1) the complete discontinuance of AED and SAED contributions, **and** (2) the restoration of the annual increase to pre-2010 levels pursuant to C.R.S. § 24-51-1009.5, the Board will consider and/or support the following actions, as ordered, as long as the funded ratio, either combined or

individual by division, does not fall below 100 percent after consideration of the proposed change:

- Examination and possible action of de-risking the entire plan, including all divisions
- Reduction in the base contribution rate(s)
- Adoption of a benefit enhancement, beyond restoration of the annual increase as described above.

If the 110 percent funded ratio benchmark is attained through the assistance of certain funding arrangements where assets, outside of statutory contributions, are added to the plan, and results in additional tax-payer obligation, the payment method and duration of this debt should be considered prior to any supportive action taken regarding benefit enhancements.

- » Dedication to the balance between:
- **Contribution rate stability**—keeping contributions relatively stable over time, and
 - **Intergenerational equity**—allocating costs over the employees' period of active service.
- » Dedication to the systematic **reduction of the unfunded actuarial accrued liabilities (UAAL)**, subject to the required action by the state legislature as described in C.R.S. § 24-51-411(8), § 24-51-411(9), and § 24-51-1009.5, and as briefly summarized above in Section II.
- » Recognition that within a multiple-employer cost-sharing defined benefit plan there are **beneficial elements of pooled risk**, both in the accrual of plan liabilities, recognizing actuarial gains and loss by division, rather than by employer; and in the accumulation of plan assets through the engagement of an appropriate level of asset risk management.

IV. ANNUAL ACTUARIAL METRICS

Below is a list of actuarial metrics to be assessed on an **annual basis as of the actuarial valuation date**. The Board recognizes that a single year's results may not be indicative of long-term trends and projected results.

FUNDED RATIOS

- » Calculate and review by division:
 - The actuarial funded ratio based on the actuarial value of plan assets divided by the defined benefit pension plan's actuarial accrued liability (AAL), and
 - The market value funded ratio based on the market value of plan assets divided by the defined benefit pension plan's AAL.

FUNDING PERIOD

- » To be determined for each division with respect to the division's contribution rates. A funding period is the amortization period required to pay off that division's UAAL considering the resources available. Funding periods for each division will be determined in the annual actuarial valuation in relationship to both
 - Statutory contribution rates, and
 - Actuarially determined contribution (ADC) rates.

CONTRIBUTION RATE COMPARISON

- » Calculate and review by division.

ACTUARIAL PROJECTIONS

- » Perform and review, by division,
 - Actuarial projections considering appropriate benefit provisions, salary and demographic data, actuarial assumptions, membership growth, and statutory contribution rates in order to determine the sustainability of each division under their benefit provisions and statutory contribution rate structure.
 - Projection modeling that allows for the testing of projection results under various economic and demographic stress conditions.

V. FUNDING VALUATION ELEMENTS

Annually, the Board's actuary will perform an actuarial valuation for funding purposes, and calculate ADC rates against which to compare contribution rates mandated under State statute. The ADC will be the sum of a payment based on normal cost and a payment on the UAAL. The normal cost and the amount of payment on the UAAL are determined by the following three major components of a funding valuation:

ACTUARIAL COST METHOD

This component determines the attribution method upon which the cost/liability of the retirement benefits are allocated to a given period, defining the normal cost or annual accrual rate associated with the projected benefits.

- » The Entry Age Normal Cost Method (EAN), as is used for PERA's annual actuarial valuation purposes, is to be used for the determination of the normal cost rate and the actuarial accrued liability for purposes of calculating the ADC.
- » Under this method, normal cost is calculated using benefits based on projected service and salary at retirement and is allocated over an individual's career as a level percent of payroll. Because EAN normal cost rates are level for each participant, the normal cost pattern for the entire plan under EAN is more stable in the face of demographic shifts in the workforce. It is this normal cost stability that makes the EAN method the preferred funding method for the majority of public defined benefit pension plans.

ASSET VALUATION METHOD

This component dictates the method by which the asset value, used in the determination of the UAAL, is determined, which could be a market value or a smoothed actuarial value of trust assets.

- » Because investment markets are volatile and defined benefit pension plans typically have long investment horizons, application of an asset-smoothing technique can be an effective tool to manage contribution volatility and provide a more consistent measure of pension plan funding over time. Asset-smoothing methods reduce the effect of short-term market volatility on contributions, while still tracking the overall

movement of the market value of plan assets, by recognizing the effects of investment gains and losses over a period of years.

- » The asset valuation method to be used shall be a four-year *smoothed* market value of assets. The difference between actual market value investment returns and the expected actuarial investment returns is recognized equally over a four-year period.

AMORTIZATION METHOD

This component prescribes, in terms of duration and pattern, the systematic manner in which the difference between the actuarial accrued liability and the actuarial value of assets is reduced.

- » Once established for any component of the UAAL, the amortization period for that component will be closed and will decrease by one year annually.
- » The amortization payment will be determined on a level percentage of pay basis.
- » The length of the amortization periods will be as follows:
 - Existing UAAL on December 31, 2014—30 years.
 - Any increase (or decrease) in the UAAL existing as of December 31, 2014—remaining period of the initial 30-year period from the date of the valuation.
 - Annual future actuarial experience gains and losses—30 years from the date of the valuation.
 - Future assumption changes—30 years from the date of the valuation.
 - Future benefit enhancements/reductions—the number of years, as determined by the Board, to represent the anticipated duration of payment of the enhancement or, if a reduction, duration of the benefit to the plan. This determination will be based on the nature of the benefit change and the demographics of the membership group affected by the change, not to exceed 25 years from the date of the valuation.
- » If any future annual actuarial valuation indicates a division has a negative UAAL, the ADC shall be set equal to the Normal Cost until such time as the funded ratio equals or exceeds 120 percent. At that time, the ADC shall be equal to the Normal Cost less an amount equal to 15 year amortization of the portion of the negative UAAL above the 120 percent funded ratio.

- » The target amortization period noted above regarding new UAAL will be applied for funding benchmark and RSI reporting purposes. Alternative ADCs, will be determined by division, by applying the layered amortization methodology as described above, using a 25-year closed period, a 20-year closed period, and a 15-year closed period, in lieu of the 30-year period, for amortization of new UAAL. These comparatives are to appear in the *Comprehensive Annual Financial Report (CAFR)* as a demonstration of the transparency and accountability funding goal delineated in Section III of this document.

In conjunction with the three major components discussed above, a number of actuarial assumptions are used to develop the annual actuarial metrics, as well as the ADC rates, and are described in detail in the annual actuarial valuation report. The actuarial assumptions are derived and proposed by the Board's actuary and adopted by the PERA Board of Trustees in conformity with the *Actuarial Standards of Practice* issued by the Actuarial Standards Board. The assumptions represent the Board's best estimate of anticipated experience under the benefit provisions of PERA and are intended to be long-term in nature. In the development of actuarial assumptions, the Board considers not only past experience but also trends, external economic forces, and future demographic and economic expectations.

ACTUARIAL ASSUMPTIONS

Actuarial assumptions are generally grouped into two major categories:

- » **Demographic assumptions**, which include rates of termination, retirement, disability, mortality, etc., and
- » **Economic assumptions**, which include investment return, salary increase, payroll growth, and inflation, etc.

Actuarial assumptions do not impact the total cost of the plan (benefit payments and expenses), but rather the timing of prescribed contributions. To the extent that actuarial experience deviates from the assumptions, and actual contributions deviate from projected, experience gains and losses will occur. These gains (or losses) then serve to reduce (or increase) the projected future contributions necessary to achieve or sustain a certain actuarial standard. It is in this vein that the ADC rates may

help indicate if the statutory contribution rates are adequate to meet the future cost requirements of the plan, although the ADC calculated in valuation results has limitations due to changing costs over time. In Colorado PERA's situation, until future scheduled contribution increases are fully realized, the results of the actuarial projections will be the best indication of the adequacy of the statutorily prescribed contribution schedule.

VI. GOVERNANCE POLICY/PROCESSES

As delineated in the PERA *Governance Manual*, below is a list of specific actuarial and/or funding-related studies, the frequency at which they should be commissioned/requested by the Board, and additional responsibilities relating to the studies:

ACTUARIAL VALUATION

Perform Annually

The Board is responsible for reviewing PERA's annual actuarial valuation report; and submitting a summary report to the Legislative Audit Committee and the Joint Budget Committee of the General Assembly, together with any recommendations concerning such liabilities that have accrued. In addition, the Board, in consultation with the pension actuary, will provide recommendations to the Colorado General Assembly regarding any necessary adjustments to the statutory employer and member contribution rates.

EXPERIENCE ANALYSIS

Perform Periodically, Historically Performed Approximately Every Four Years

The Board is responsible for ensuring that an experience analysis is performed as prescribed, for reviewing the results of that study, and for approving the actuarial assumptions and methodologies to be used for all actuarial purposes relating to the defined benefit pension plans.

ACTUARIAL AUDIT

Perform Every Five Years, or The Appointment of a New Actuarial Firm Will Satisfy Requirement

The Board is responsible for ensuring that an actuarial audit is performed as prescribed and for reviewing the results of that audit.

ASSET LIABILITY STUDY

Perform at Least Every Three To Five Years, or More Frequently If Necessary

The Board is responsible for ensuring that a study of the relationship between the defined benefit trust assets and liabilities is performed as prescribed and for reviewing the results of that study.

REVIEW OF THE DEFINED BENEFIT PENSION PLAN FUNDING POLICY

Perform Periodically

The Board is responsible for the periodic review of the defined benefit pension plan funding policy, as is deemed necessary.

VII. GLOSSARY OF FUNDING POLICY TERMS

ACTUARIAL ACCRUED LIABILITY (AAL)

The AAL is the value at a particular point in time of all past normal costs. This is the amount of assets the plan would have today if the current plan provisions, actuarial assumptions, and participant data had always been in effect, contributions equal to the normal cost had been made, and all actuarial assumptions had been met. For each of the PERA defined benefit plans, the AAL includes the balance in the affiliated annual increase reserve.

ACTUARIAL COST METHOD

The actuarial cost method allocates a portion of the total cost (present value of benefits) to each year of service, both past service and future service.

ANNUAL INCREASE RESERVE (AIR)

As of January 1, 2007, an AIR was created for each division trust fund for the purpose of funding annual increases for PERA benefit structure members hired on or after January 1, 2007. A portion of the employer contribution, equal to one percent of the salaries of affected members, is accumulated in the AIR to be paid out in annual increases each July 1, to the extent affordable. Although invested with the affiliated division assets, the reserve balances are accounted for separately.

ASSET VALUES

For each of the PERA defined benefit plans, the actuarial and market asset values include the balance in the affiliated AIR.

ACTUARIAL VALUE OF ASSETS (AVA)

The AVA is the market value of assets less the deferred investment gains or losses not yet recognized by the asset smoothing method.

MARKET VALUE OF ASSETS (MVA)

The MVA is the fair value of assets of the plan as reported in the plan's audited financial statements.

ENTRY AGE NORMAL ACTUARIAL COST METHOD (EAN)

The EAN actuarial cost method is a funding method that calculates the normal cost as a level percentage of pay or level dollar amount over the working lifetime of the plan's members.

FUNDED RATIO

The funded ratio is the ratio of the plan assets to the plan's actuarial accrued liabilities.

ACTUARIAL VALUE FUNDED RATIO

The ratio of the AVA to the AAL.

MARKET VALUE FUNDED RATIO

The ratio of the MVA to the AAL.

NORMAL COST

The normal cost is the cost allocated under the actuarial cost method to each year of active member service.

PRESENT VALUE OF BENEFITS (PVB) OR TOTAL COST

The PVB is the value at a particular point in time of all projected future benefit payments for current plan members, plus the balance in the affiliated AIR. The future benefit payments and the value of those payments are determined using actuarial assumptions regarding future events. Examples of these assumptions are estimates of retirement and termination patterns, salary increases, investment returns, etc.

SURPLUS

A surplus refers to the positive difference, if any, between the AVA and the AAL.

UNFUNDED ACTUARIAL ACCRUED LIABILITY (UAAL)

The UAAL is the portion of the AAL that is not currently covered by the AVA. It is the positive difference between the AAL and the AVA.

VALUATION DATE

The valuation date is the annual date upon which an actuarial valuation is performed; meaning that the trust assets and liabilities of the plan are valued as of that date. PERA's annual valuation date is December 31st.

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Adopted: March 20, 2015

Appendix H: Signal Light Methodology

The following example contrasts the typical static actuarial valuation results with the dynamic model suggested in this report.

Static Actuarial Valuation Methodology

Imagine you are driving from Denver to Durango at 9:00 AM. Your GPS suggests you will arrive 6 hours later at 3:00 PM. This is based on no stops and a standard driving speed. Each time you check the GPS as you're driving, it will continue to assume no stops and the same standard speed. The baseline is that you would be in Fairplay by 10:30, then another 4.5 hours to get to Durango by 3:00. If you made good time and arrived in Fairplay ten minutes early, the GPS would show 2:50 arrival. Or maybe a Highway Patrol Officer caught you speeding and you were stopped for an extra fifteen minutes. In that case the Fairplay GPS would show 3:15 arrival.

The static actuarial valuation model is like the GPS. It considers only past variations but not future ones.

Dynamic Actuarial Model

Our projections are real life and consider the future as well as the past. Maybe you will drive faster or slower than expected, or maybe you will stop for a picnic that will change your arrival time. This methodology allows consideration of all the variables that will impact your expected arrival time and assign probabilities to those events. For example, if you arrived in Fairplay 10 minutes early, our model shows a range of possibilities including the chances you will continue to arrive 10 minutes early in Durango, even earlier, or later.

Signal Light Tables

The signal light works like the dynamic actuarial model and addresses the critical question of when policymakers should be concerned because it considers future variability and the most likely outcomes.