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**State of Colorado  
Public Employees' Retirement Association**

Actuarial Audit of December 31, 2013 Actuarial Valuation

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January 9, 2015

The Board of Trustees  
Public Employees' Retirement Association  
1301 Pennsylvania Street  
Denver, CO 80203-2386

Re: Actuarial Audit Report

Dear Members of the Board,

The enclosed report presents the findings and comments resulting from a detailed review of the December 31, 2013 Actuarial Valuation performed by Cavanaugh Macdonald Consulting LLC for the Public Employees' Retirement Association (PERA). An overview of our major findings is included in the Executive Summary section of the report. More detailed commentary on our review process is included in the latter sections.

All calculations for the Milliman replication valuation are based on Colorado Revised Statutes and the actuarial methods and assumptions shown in Schedules D and E of the December 31, 2013 Actuarial Valuation. As discussed in our report, we believe the package of actuarial assumptions and methods is reasonable (taking into account the experience of PERA and reasonable expectations). Nevertheless, the emerging costs will vary from those presented in this report to the extent that actual experience differs from that projected by the actuarial assumptions. Future actuarial measurements may differ significantly from the current measurements presented in this report due to factors such as the following:

- Plan experience differing from the actuarial assumptions,
- Future changes in the actuarial assumptions,
- Increases or decreases expected as part of the natural operation of the methodology used for these measurements (such as potential additional contribution requirements due to changes in the plan's funded status), and
- Changes in the plan provisions or accounting standards.

Due to the scope of this assignment, we did not perform an analysis of the potential range of such measurements.

In preparing this report, we relied, without audit, on information (some oral and some in writing) supplied by PERA and Cavanaugh Macdonald's staff. This information includes, but is not limited to, statutory provisions, employee data, and financial information. In our examination of these data, we have found them to be reasonably consistent. Since the audit results are dependent on the integrity of the data supplied, the results can be expected to differ if the underlying data is incomplete or missing. It should be noted that if any data or other information is inaccurate or incomplete, our calculations may need to be revised.

This work product was prepared solely for Colorado PERA for the purposes described herein and may not be appropriate to use for other purposes. Milliman does not intend to benefit and assumes no duty or liability to other parties who receive this work. Milliman recommends that third parties be aided by their own actuary or other qualified professional when reviewing the Milliman work product.

On the basis of the foregoing, we hereby certify that, to the best of our knowledge and belief, this report is complete and accurate and has been prepared in accordance with generally recognized and accepted actuarial principles and practices which are consistent with the Actuarial Standards of Practice promulgated by the Actuarial Standards Board and the applicable Guides to Professional Conduct, amplifying Opinions, and supporting Recommendations of the American Academy of Actuaries.

Milliman's work product was prepared exclusively for the Public Employees' Retirement Association for a specific and limited purpose. It is a complex, technical analysis that assumes a high level of knowledge concerning the operations of PERA, and uses PERA's census data, which Milliman has not audited. It is not for the use or benefit of any third party for any purpose. Any third party recipient of Milliman's work product who desires professional guidance should not rely upon Milliman's work product, but should engage qualified professionals for advice appropriate to its own specific needs.

The consultants who worked on this assignment are pension actuaries. Milliman's advice is not intended to be a substitute for qualified legal or accounting counsel.

The signing actuaries are independent of the plan sponsor. We are not aware of any relationship that would impair the objectivity of our work.

We would like to express our appreciation to PERA's staff and Cavanaugh Macdonald's staff for their assistance in supplying the data and information on which this report is based.

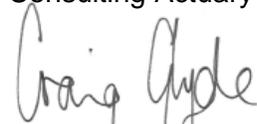
We are members of the American Academy of Actuaries and meet the Qualification Standards of the American Academy of Actuaries to render the actuarial opinion contained herein.

We respectfully submit the following report, and we look forward to discussing it with you.

Sincerely,

Handwritten signature of Mark C. Olleman in black ink.

Mark C. Olleman, FSA, EA, MAAA  
Consulting Actuary

Handwritten signature of Craig Glyde in black ink.

Craig Glyde, ASA, EA, MAAA  
Consulting Actuary

MCO/NJC/CJG/DRW/nlo

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Daniel R. Wade, FSA, EA, MAAA  
Consulting Actuary

**Public Employees' Retirement Association  
Actuarial Audit of the 2013 Actuarial Valuation**

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# Colorado Public Employees' Retirement Association Actuarial Audit of the 2013 Actuarial Valuation

## Section 1 Summary of the Findings

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### Purpose and Scope of the Actuarial Audit

This actuarial audit reviews the December 31, 2013 Actuarial Valuation performed by Cavanaugh Macdonald. The purpose of this audit is to verify that the results of the valuation are accurate and that the assumptions the valuation is based upon are reasonable. The following tasks were performed in this audit:

- Evaluation of the data used in the valuation
- Evaluation of the method used to determine the actuarial valuation of assets
- Full independent replication of the key valuation results
- Evaluation of the reasonableness of the assumptions used in the valuation
- Analysis of valuation results and reconciliation of material differences (if any)
- Analysis of the written work product

### Audit Conclusion

#### Overall

Based upon our replication of the December 31, 2013 Actuarial Valuation, we were able to match the total valuation liabilities and normal costs closely. It should be noted that these results are based on the same methods used in the valuation. As detailed in this report, we have recommended some changes to these methods. A list of all of our recommendations is included at the end of this section, with additional detail in subsequent sections of the report.

The table on the following page displays a comparison of the Actuarial Accrued Liabilities (AAL). The middle columns show the values calculated in the valuation (Cavanaugh Macdonald) and those calculated in our replication valuation (Milliman).

There will always be differences in the calculated liabilities when different software is used by different actuaries. The purpose of a replication audit is not to provide a different set of numbers, but to provide assurance that the liabilities and normal costs calculated in the valuation provide a reasonable estimate. As previously noted, our overall match on the liabilities and normal costs is close in relative terms. Therefore, we believe the valuation results are reasonable based on the assumptions and methods used.

**Overall  
(continued)**

(in \$Millions)	Cavanaugh Macdonald	Milliman	CM / M Ratio
<b>Actuarial Accrued Liability</b>			
State	\$ 22,844	\$ 23,033	99.2%
School	35,437	35,742	99.1%
Local Gov.	4,502	4,511	99.8%
Judicial	352	350	100.6%
DPS	3,786	3,762	100.6%
PERA HCTF	1,557	1,548	100.6%
DPS HCTF	77	77	100.0%

**Statement of Key Findings**

**Membership Data**

We performed tests on both the raw data supplied by PERA and the processed data used by Cavanaugh Macdonald in the December 31, 2013 Actuarial Valuation. We found that the data used by Cavanaugh Macdonald was consistent with the data supplied by PERA. We have one recommended change in the determination of the compensation used in the first year to be consistent with the assumptions.

Based on this review, we feel the individual member data used in the actuarial valuation is appropriate and complete. A summary for all divisions in aggregate is shown in the chart below:

All Divisions in Aggregate	Cavanaugh Macdonald	Milliman	CM/M Ratio
<b>Active Members</b>			
Count	200,183	200,202	100.0%
Average Annual Compensation	\$ 37,617	\$ 37,767	99.6%
<b>Retirees &amp; Survivors</b>			
Count	104,021	103,836	100.2%
Average Annual Benefit	\$ 36,328	\$ 36,393	99.8%

The membership data is discussed in more detail in Section 2 of this report.

**Actuarial Value of Assets**

We have reviewed the calculations for the actuarial value of assets used for each plan in the December 31, 2013 valuation. We found the calculations to be accurate and the methodology to be appropriate and in compliance with Actuarial Standard of Practice No. 44 (“Selection and Use of Asset Valuation Methods for Pension Valuations”). The actuarial value of assets is discussed in more detail in Section 3 of this report.

## Actuarial Liabilities

We independently calculated the present value of future benefits and the entry age normal costs for PERA. We found that the significant benefit provisions were generally accounted for in an accurate manner and the actuarial assumptions are being applied correctly. We identified a few differences; however, our total liabilities still matched closely to those calculated by Cavanaugh Macdonald.

The total liabilities in the following chart are represented by the Present Value of All Future Benefits, which equals the expected value of all benefits earned to date and those expected to be earned in the future for all current PERA members. A summary of the results for each system is shown in the chart below. Further breakdowns are shown in Section 4 and Appendix A.

(in \$Millions)	Cavanaugh Macdonald	Milliman	CM / M Ratio
<b>Present Value of All Future Benefits</b>			
State	\$ 24,726	\$ 24,945	99.1%
School	39,201	39,631	98.9%
Local Gov.	4,879	4,915	99.3%
Judicial	404	399	101.3%
DPS	4,378	4,359	100.4%
PERA HCTF	1,645	1,633	100.7%
DPS HCTF	85	86	98.8%

Note that there will always be differences in the calculated liabilities when different software is used by different actuaries; however, the results should not deviate significantly without explanation. Although our overall match on the valuation liabilities was close, there were a few areas that we did not match as closely as we would expect.

We identified the factors that we believe are causing these differences. The only one of these factors with any materiality to the overall valuation results is the valuation of future service retirement benefits for active members. Our understanding is that although our calculations are projecting similar benefit amounts to Cavanaugh Macdonald, in some cases their valuation system is calculating a value for these benefits that is about 2% lower than the value we calculated. In total, these differences amounted to less than 1% of the total liabilities.

**Actuarial Liabilities  
(continued)**

We have two technical changes that we recommend be implemented in the calculation of the normal cost rate. The goal of the entry age normal cost method is that the expected value of future normal cost contributions be equal to the value of expected future benefits when a member enters the plan, if all assumptions are met. Under the current method, this equation does not hold; that is, the expected value of the normal cost contributions is insufficient to fund the expected value of the benefits, if all assumptions are met. Making the recommended changes would make the current method consistent with the intent of the entry age normal cost method.

For purposes of our replication valuation, we used the normal cost method that was used in the valuation. The actuarial liabilities and normal cost method are discussed in more detail in Section 4 of this report.

**Funding**

Based on the valuation calculations, methods and assumptions, we believe the employer contribution rates and amortization periods for each division are accurately calculated.

The following table shows a comparison of our independent calculations (based on the replication valuation results) of the amortization periods to pay off the Unfunded Actuarial Accrued Liability (UAAL), as shown in the valuation. It should be noted that these calculations do not reflect the declining normal cost rate due to lower cost benefits for new hires, which should ultimately result in shorter amortization periods than those shown below, if all assumptions are met.

We have one recommended change to the method Cavanaugh Macdonald uses in the amortization calculation that would be more technically precise. We recommend that the payroll used in the amortization calculation be assumed to increase at the beginning of year for consistency with the liability calculations.

	Cavanaugh Macdonald	Milliman	CM - M Difference
<b><i>Amortization Period with Future Increases to AED &amp; SAED</i></b>			
State	44 years	49 years	-5 years
Schools	44 years	49 years	-5 years
Local Government	37 years	43 years	-6 years
Judicial	Infinite	Infinite	Infinite
Denver Public Schools	Infinite	Infinite	Infinite
PERA HCTF	40 years	38 years	2 years
DPS HCTF	19 years	20 years	-1 years

## Funding (continued)

The growing consensus in the public plan community is that amortizing a plan's UAAL over a period longer than 30 years is no longer a prudent level of financing, and the periods viewed as acceptable are growing shorter. Additionally, Colorado state law says: "A maximum amortization period of thirty years shall be deemed actuarially sound."

Each PERA division is funded with contribution rates that are specified in statute. PERA's rates were most recently amended by Senate Bill 10-001, which was signed by the governor in March of 2010. This legislation provided for graded increases in the state and employer contribution rates and reduced benefit levels. This legislation, combined with strong asset returns in recent years, has made significant progress toward what, in our opinion, should be the goal of an amortization period of less than 30 years, with the long-term objective of 100% funding.

Two additional aspects of PERA's funding should be noted:

1. Recent changes in benefit levels are projected to result in a lower cost as a percentage of payroll in the future as new entrants are hired at the lower benefit levels. This aspect is not reflected in the amortization periods reported in the valuation. Cavanaugh Macdonald prepares separate projections incorporating the impact of the declining normal cost rate as part of their valuation presentation. As expected, the periods forecast to fund the UAAL are shorter in these projections. For example, both the State and Schools divisions have forecasted periods of about 35 years in the projections, compared to the 44 years in the valuation calculation. We have not completed a full replication of these projections as it is outside the scope of this audit, although the overall differences appear to be reasonable. It should be noted that the projections assume an increase in active membership every year and reflect the expected future recognition of asset gains that are currently deferred by the asset valuation method. Neither of these assumptions is reflected in the amortization periods reported in the valuation.
2. Because PERA is funded by statutory contribution rates, changes in assumptions and experience different than assumed will cause changes in the amortization period. This is in contrast to plans where the amortization period is fixed and these types of changes cause the contribution rates to vary each year. For example, PERA recently adopted a more conservative (i.e., higher probability of attaining) investment return assumption, which resulted in a longer amortization period.

PERA's funding is discussed in more detail in Section 5 of this report.

## **Actuarial Assumptions (Economic)**

We reviewed the key economic assumptions used in the valuation and found them to be reasonable. The economic assumptions used were adopted at the November 15, 2013 Board meeting, based on analysis presented at the Actuarial Assumptions Workshop that took place earlier that month.

We have the following comments regarding the economic assumptions:

- Our analysis shows the 7.50% investment return assumption was reasonable for use in the December 31, 2013 valuation. In comparison to other statewide systems, it is below the median of 7.75%.
- The inflation assumption of 2.80% is reasonable, as is the real wage growth assumption of 1.10% for productivity. The general salary increase assumption of 3.90% is the sum of these two assumptions.

A revision to the actuarial standard of practice relating to setting economic assumptions has been recently adopted. Since this new standard is not effective until after the December 31, 2013 valuation, our analysis is limited to the standard that was applicable at that time. It should be noted that the revised standard has a more restrictive definition of what is reasonable; therefore, it is possible that assumptions that were in the best estimate range under the old standard may not be considered reasonable under the new standard. Based on the analysis presented at the November, 2013 Actuarial Assumptions Workshop, we believe that the current package of economic assumptions would have satisfied the new actuarial standard, if the new standard had applied to the December 31, 2013 valuation. The economic assumptions are discussed in more detail in Section 6 of this report.

## **Actuarial Assumptions (Demographic)**

We reviewed the analysis and recommendations for the Experience Investigation for the Four-Year Period Ending December 31, 2011. Based on this review, we believe the demographic assumptions used in the valuation are generally reasonable. We have suggested some items for consideration with the next experience investigation. The demographic assumptions are discussed in more detail in Section 7 of this report.

## **Review of Reports**

We found Cavanaugh Macdonald's reports to be generally clear and complete given the volume of numbers required in an actuarial report. We felt that the amount of disclosure included in the report was commensurate with the complexity of PERA. We have recommended some changes for more complete disclosure, in particular, a clearer description of how the normal cost rate is calculated. See Section 8 for further discussion.

## Recommendations and Other Considerations

We are not recommending any changes to the current actuarial valuation or experience study reports. We have provided some recommendations to consider in the future, as listed below and discussed in further detail in the body of this report.

### Recommended Changes to the December 31, 2013 Valuation

None.

### Recommended Changes for Future Valuations and Experience Investigations

We recommend the following changes for the next valuation or experience investigation. The recommendations are listed in rough descending order of potential magnitude.

- **Normal Cost Method.** Revise the cost method to reflect that normal cost contributions are received evenly throughout the year (not at the beginning of the year) and remove the negative AAL adjustment. [Section 4, pp. 19-20]
- **Compensation Used in Amortization Calculation.** Revise amortization calculation to reflect that compensation increases are expected to occur only at the beginning of the year. [Section 5, p. 22]
- **Value of Service Retirement Benefits for Active Members.** Adjust calculations to more accurately reflect the expected value of the service retirement benefit. [Section 4, p. 17]
- **First Year Compensation Data.** Include the merit salary increase in the compensation data for the first year. [Section 2, p. 12]
- **Liabilities for Current Survivors.** Value full survivor benefit without any reduction for possible remarriage. [Section 4, p. 17]
- **Refund of Disability Retirements.** Review current assumption that 35% of future disability retirements will take a refund and forfeit their annuity benefit. [Section 7, p. 41]
- **Employer Match on Separation Benefit.** Reflect the match on the return of contribution benefit for all years of contributions for which the member is eligible. [Section 4, p. 17]
- **Future Survivor Benefit Eligibility.** Reflect one year of service eligibility for survivor annuity benefit. [Section 4, p. 17]
- **Valuation Report.** Include additional disclosure in the valuation report. [Section 8, p. 44]

**Consideration for Future Valuations and  
Experience Studies**

We suggest the following items for consideration for future valuations and experience investigations:

- **Increased Margin for Mortality Assumption.** Consider incorporating a larger margin in the mortality assumption to reflect expectations of increases in future life expectancies. [Section 7, pp. 40-41]
- **Timing of Annual Increase for Active Members.** Consider reflecting actual retirement pattern in assumed timing of delay in commencement of annual increases. [Section 7, p. 43]

# Colorado Public Employees' Retirement Association Actuarial Audit of the 2013 Actuarial Valuation

## Section 2 Membership Data

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### Audit Conclusion



We performed tests on both the raw data supplied by PERA and the processed data used by Cavanaugh Macdonald in the December 31, 2013 Actuarial Valuation. We found that the data used by Cavanaugh Macdonald was consistent with the data supplied by PERA.

We have one recommended change in the determination of the compensation used in the first year to be consistent with the assumptions.

Based on this review, we feel the individual member data used in both projects is appropriate and complete.

### Comments

Overall, the data process appears to be thorough and accurate. We would add the following comments:

- **Raw Data:** PERA provided us with the same files that were given to Cavanaugh Macdonald for use in the actuarial valuation.

**Completeness:** The data contained all the necessary fields to perform the actuarial valuation.

**Quality:** Although we did not audit the data at the source, we performed some independent checks to confirm the overall reasonableness of the data. We compared the total retiree and beneficiary benefit amounts with the actual benefit payments made, as reported in the financial statements.

We also compared the total active member compensation on the PERA data with the estimated active payroll for 2013. To get the estimated payroll for each plan, the actual employer contribution amounts in the financial statements were divided by the applicable contribution rates for the prior year for each plan. Based on this analysis, we found the compensation data to be reasonable.

## Comments (continued)

- Parallel Data Processing: We performed independent edits on the raw data provided by PERA and then compared our results with the valuation data used by Cavanaugh Macdonald, as summarized in the valuation report. We found our results to be consistent.

Our results do not match exactly. This is understandable, as some adjustments were made, such as annualizing salaries for those with less than one year of service during the valuation period. Overall, each key data component matched well within an acceptable level and we believe the individual member data used by Cavanaugh Macdonald was appropriate for valuation purposes.

A summary of the data for each plan is shown in Exhibit 2-1. In all cases, the summarized totals for our edited data matched those for Cavanaugh Macdonald's valuation data closely. The "Milliman" rows reflect the PERA data after adjustments by Milliman. The "Cavanaugh Macdonald" rows reflect the actual data used in Cavanaugh Macdonald's valuation.

**Exhibit 2-1  
Member Statistics as of December 31, 2013**

	State	School	Local Government	Judicial	Denver Public Schools
<b><u>Active Members</u></b>					
<b>Cavanaugh Macdonald</b>					
Count	55,354	117,727	11,954	332	14,816
Compensation (\$millions)	\$ 2,475.0	\$ 3,938.6	\$ 529.0	\$ 39.9	\$ 547.7
<b>Milliman</b>					
Count	55,360	117,735	11,958	332	14,817
Compensation (\$millions)	\$ 2,481.5	\$ 3,957.8	\$ 528.6	\$ 40.3	\$ 552.8
<b>Ratio (Cavanaugh Macdonald / Milliman)</b>					
Count	100.0%	100.0%	100.0%	100.0%	100.0%
Compensation	99.7%	99.5%	100.1%	99.0%	99.1%
<b><u>Retirees and Survivors</u></b>					
<b>Cavanaugh Macdonald</b>					
Service Retirement	30,515	51,665	5,287	290	6,060
Disability Retirement	3,455	3,076	704	19	349
Survivors	1,011	1,245	176	14	155
<b>Milliman</b>					
Service Retirement	30,465	51,611	5,272	290	6,049
Disability Retirement	3,432	3,043	696	19	346
Survivors	1,019	1,248	178	14	154
<b>Ratio (Cavanaugh Macdonald / Milliman)</b>					
Service Retirement	100.2%	100.1%	100.3%	100.0%	100.2%
Disability Retirement	100.7%	101.1%	101.1%	100.0%	100.9%
Survivors	99.2%	99.8%	98.9%	100.0%	100.6%
<b><u>Terminated Vested and Inactive Members</u></b>					
<b>Cavanaugh Macdonald</b>					
Terminated Vested Members	5,340	12,854	2,868	6	759
Inactive Members	63,759	96,832	20,286	5	5,501
<b>Milliman</b>					
Terminated Vested Members	5,332	12,847	2,865	6	759
Inactive Members	63,761	96,845	20,286	5	5,504
<b>Ratio (Cavanaugh Macdonald / Milliman)</b>					
Terminated Vested Members	100.2%	100.1%	100.1%	100.0%	100.0%
Inactive Members	100.0%	100.0%	100.0%	100.0%	99.9%

**Comments  
(continued)**

The valuation assumption is that members receive compensations increases due to both wage inflation (3.90%) and merit increases (varies by age). The compensation used in the valuation in the year following the valuation date is the prior year compensation increased by wage inflation, but not merit. We recommend that the merit salary increase be included in the compensation used in the first year following the valuation date.

Note that given the current low salary increase environment that exists for most public employees, there may be an argument for a lower increase in the first year. However, if this is the intended approach, the first year payroll increase used in the amortization would need to be reduced for consistency.

# Colorado Public Employees' Retirement Association Actuarial Audit of the 2013 Actuarial Valuation

## Section 3 Actuarial Value of Assets

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### Audit Conclusion



We have reviewed the calculations for the actuarial value of assets used for each plan in the December 31, 2013 valuation. We found the calculations to be accurate and the methodology to be appropriate and in compliance with Actuarial Standard of Practice (ASOP) No. 44 ("Selection and Use of Asset Valuation Methods for Pension Valuations").

### Comments

We reviewed the calculations of the actuarial value of assets and found them to be accurate. Our calculations matched the values calculated by Cavanaugh Macdonald.

The method used to determine the actuarial value of assets smoothes investment gains and losses first by calculating the expected return based on the previous year's actuarial value. The expected return on an actuarial basis is then compared to the actual returns, and 25% of the difference is recognized for each of the next four years. The recognition of 25% of the difference from the previous three years is combined with the expected actuarial value to calculate the actuarial value.

The values are adjusted to exclude the Annual Increase Reserve (AIR) and associated cash flow, so the market values do not exactly match those shown in PERA's financial statements. This approach is consistent with the liability calculations where the postretirement benefit increases for members of the PERA benefit structure hired on or after January 1, 2007 (2010 for PERA structure members of DPS) are excluded. We agree this adjustment is appropriate.

We believe the current approach is reasonable and complies with ASOP No. 44 (Selection and Use of Asset Valuation Methods for Pension Valuations).

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# Colorado Public Employees' Retirement Association Actuarial Audit of the 2013 Actuarial Valuation

## Section 4 Actuarial Liabilities

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### Audit Conclusion



We independently calculated the present value of future benefits and future salaries and the entry age normal costs for PERA. We found that the significant benefit provisions were generally accounted for in an accurate manner and the actuarial assumptions are being applied correctly. We identified a few differences; however, our total liabilities still matched closely to those calculated by Cavanaugh Macdonald.

Note that there will always be differences in the calculated liabilities when different software is used by different actuaries; however, the results should not deviate significantly without explanation. Although our overall match on the valuation liabilities was close, there were a few areas that we did not match as closely as we would expect.

We identified the factors that we believe are causing these differences. The only one of these factors with any materiality to the overall valuation results is the valuation of future service retirement benefits for active members. Our understanding is that although our calculations are projecting similar benefit amounts to Cavanaugh Macdonald, in some cases their valuation system is calculating a value for these benefits that is about 2% lower than the value we calculated.

We have two technical changes that we recommend be implemented in the calculation of the normal cost rate. The goal of the entry age normal cost method is that the expected value of future normal cost contributions be equal to the value of expected future benefits when a member enters the plan, if all assumptions are met. Under the current method, this equation does not hold; that is, the expected value of the normal cost contributions is insufficient to fund the expected value of the benefits, if all assumptions are met. Making the recommended changes would make the current method consistent with the intent of the entry age normal cost method.

For purposes of our replication valuation, we used the normal cost method that was used in the valuation.

### Comments

We incorporated the following information into our valuation system:

- **Data** – We used the valuation data provided by Cavanaugh Macdonald. As discussed in Section 2, we confirmed that this data was consistent with the valuation data supplied by PERA.

**Comments  
(continued)**

- **Assumptions and Methods** – We used the assumptions and methods recommended by Cavanaugh Macdonald for the December 31, 2013 Actuarial Valuation. This was supplemented by discussions between Cavanaugh Macdonald and Milliman on the technical application of these methods.
- **Benefit Provisions** – We obtained this information from the Colorado Revised Statutes and various member handbooks.

We then performed an independent valuation as of December 31, 2013. Based on this valuation, we completed a detailed comparison of the Present Value of Future Benefits (PVFB) computed in our independent valuation and the amounts calculated by Cavanaugh Macdonald. Exhibit 4-1 shows a summary of this analysis broken down by benefit type. Note that this exhibit shows all divisions in aggregate. We also performed similar analysis by division. This is shown in Appendix A.

Exhibit 4-2 shows a summary of this analysis broken down by division. As can be seen in the chart, the overall difference in PVFB between the valuation and our replication valuation is less than 2%. There were differences for a few of the benefit types for active member liabilities and the liabilities for current survivors that were outside what we would usually expect. We identified several factors that we believe are the main reason for these differences which are discussed later.

**Exhibit 4-1  
Present Value of Future Benefits by Benefit Type**

(in \$Millions)	Cavanaugh Macdonald	Milliman	CM / M Ratio
<b>Present Value All Future Benefits</b>			
<b>Active members</b>			
Retirement	\$ 26,044.4	\$ 26,561.6	98.1%
Separation	3,097.4	3,351.9	92.4%
Death	248.6	257.9	96.4%
Disability	313.5	307.7	101.9%
<b>Total Actives</b>	<b>\$ 29,703.9</b>	<b>\$ 30,479.1</b>	<b>97.5%</b>
<b>Inactive Members</b>	<b>\$ 1,632.2</b>	<b>\$ 1,652.6</b>	<b>98.8%</b>
<b>Retirees and Survivors</b>			
Retired members	\$ 43,601.6	\$ 43,398.9	100.5%
Survivors	380.5	438.0	86.9%
<b>Total In Payment</b>	<b>\$ 43,982.1</b>	<b>\$ 43,836.9</b>	<b>100.3%</b>
<b>Total for All Members</b>	<b>\$ 75,318.2</b>	<b>\$ 75,968.6</b>	<b>99.1%</b>

## Comments (continued)

Although our overall match on the PVFB was fairly close, there were a few areas that we did not match as closely as we would expect. We identified the following reasons for these differences. In total, these differences were less than 1% of the total liabilities.

- **Value of Active Service Retirement Benefits** – Our calculations were slightly higher on the value of future service retirement benefits for active members. Our understanding is that although we are projecting similar benefit amounts to Cavanaugh Macdonald, in some cases their valuation system is calculating a value for these benefits that is about 2% lower than the value we calculated. The impact of this was less than 1% of the total liabilities.
- **Employer Match on Member Accounts** – In cases where the employer match on employee contributions applies, the valuation calculations are not applying the match to the first five years of contributions, even when the member has more than five years of service. This is not consistent with the provisions of the plan. The impact of this was less than 0.2% of the total liabilities.
- **Future Survivor Benefit Eligibility** – The requirement to receive a survivor annuity is one year of service. The valuation calculations are assuming the threshold is five years. The impact of this was less than 0.01% of the total liabilities.
- **Current Survivor Liability** – The valuation applies a 15% reduction to account for survivor benefits being terminated upon remarriage. Our understanding is this only applies to remarriages prior to July 1, 1997. The impact of this was less than 0.1% of the total liabilities.

We recommend Cavanaugh Macdonald address these issues in the next valuation.

The valuation does not reflect the annual increase for those members and retirees only eligible for the annual increase payable from the Annual Increase Reserve (AIR). The AIR is analyzed in a separate valuation. Since the AIR is also excluded from the Actuarial Value of Assets, we believe this is an appropriate method.

**Exhibit 4-2**  
**Present Value of Future Benefits by Division**

(in \$Millions)	Cavanaugh Macdonald	Milliman	CM / M Ratio
<b>Present Value All Future Benefits</b>			
<b>State Division</b>			
Active Members	\$ 9,430.0	\$ 9,672.3	97.5%
Inactive Members	15,296.4	15,272.3	100.2%
Total	\$ 24,726.4	\$ 24,944.6	99.1%
<b>School Division</b>			
Active Members	\$ 15,899.1	\$ 16,338.1	97.3%
Inactive Members	23,301.6	23,292.9	100.0%
Total	\$ 39,200.7	\$ 39,631.0	98.9%
<b>Local Government Division</b>			
Active Members	\$ 1,887.9	\$ 1,945.1	97.1%
Inactive Members	2,991.2	2,970.3	100.7%
Total	\$ 4,879.1	\$ 4,915.4	99.3%
<b>Judicial Division</b>			
Active Members	\$ 195.6	\$ 190.5	102.7%
Inactive Members	208.2	208.9	99.7%
Total	\$ 403.8	\$ 399.4	101.1%
<b>Denver Public Schools Division</b>			
Active Members	\$ 1,706.0	\$ 1,753.9	97.3%
Inactive Members	2,672.3	2,605.3	102.6%
Total	\$ 4,378.3	\$ 4,359.2	100.4%
<b>PERA Health Care Trust Fund</b>			
Active Members	\$ 552.7	\$ 544.7	101.5%
Inactive Members	1,092.5	1,088.7	100.3%
Total	\$ 1,645.2	\$ 1,633.4	100.7%
<b>DPS Health Care Trust Fund</b>			
Active Members	\$ 32.6	\$ 34.5	94.5%
Inactive Members	52.1	51.1	102.0%
Total	\$ 84.7	\$ 85.6	98.9%

**Comments  
(continued)**

Lastly, we looked at the normal cost rates. Note that these are the total value including the 0.35% of payroll administrative expense load, and prior to reduction for the member contribution.

**Exhibit 4-3  
Total Normal Cost Rates by Division**

	Cavanaugh Macdonald	Milliman	CM/M Ratio
<b>Total Normal Cost Rate</b>			
State	10.30%	10.66%	96.6%
Schools	11.65%	12.01%	97.0%
Local Government	9.90%	10.48%	94.5%
Judicial	17.30%	17.03%	101.6%
Denver Public Schools	12.42%	12.37%	100.4%
PERA HCTF	0.22%	0.21%	104.8%
DPS HCTF	0.24%	0.27%	88.9%

**Entry Age Normal  
Cost Method**

As previously mentioned, we have two technical changes that we recommend be implemented in the calculation of the normal cost rate. Making the recommended changes would make the cost method consistent with the intent of the entry age normal cost method. That is, the expected value of future normal cost contributions would be equal to the value of expected future benefits when a member enters the plan, if all assumptions are met. The current method results in the expected value of the normal cost contributions being insufficient to fund the expected value of the benefits, if all assumptions are met.

- Timing of Compensation** – The current method assumes that all compensation is paid in full on the first day of each year in the determination of the normal cost rate. In practice, normal cost contributions are collected on compensation that is paid throughout the year. Also, members who terminate employment during the year do not receive a full year of compensation, as compared to the assumption which is full payment of compensation for the year. The timing of the compensation should be consistent with the timing of the normal cost contributions.

**Entry Age Normal  
Cost Method  
(continued)**

- **Negative AAL Adjustment** – Due to the way the AAL accrues under the entry age normal cost method, it is possible to have a negative AAL value for the separation benefit for active members. A negative AAL can occur for an individual, because normal costs accrue over the lifetime of a member, but separation benefits are assumed to cease at retirement eligibility. Therefore, a person eligible for retirement will have a zero present value of benefits for the separation benefit, but a non-zero value for the value of future normal costs. The overall value of the AAL should still be positive in all cases. This is a natural product of the entry age normal cost method, and we believe it is theoretically correct.

Cavanaugh Macdonald has made an adjustment to the AAL value for the separation benefit to ensure that it is always positive. This eliminates the negative AAL associated with the separation benefit, but it causes the basic equation (value of benefits at entry age = value of normal costs) to be out of balance. We recommend that this adjustment be removed.

# Colorado Public Employees' Retirement Association Actuarial Audit of the 2013 Actuarial Valuation

## Section 5 Funding

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### Audit Conclusion



Based on the valuation calculations, methods and assumptions, we believe the employer contribution rates and amortization periods for each division are accurately calculated.

The growing consensus in the public plan community is that amortizing a plan's Unfunded Actuarial Accrued Liability (UAAL) over a period longer than 30 years is no longer a prudent level of financing, and the periods viewed as acceptable are growing shorter. Additionally, Colorado state law says: "A maximum amortization period of thirty years shall be deemed actuarially sound."

Each PERA division is funded with contribution rates that are specified in statute. PERA's rates were most recently amended by Senate Bill 10-001, which was signed by the governor in March of 2010. This legislation provided for graded increases in the state and employer contribution rates and reduced benefit levels. This legislation, combined with strong asset returns in recent years, has made significant progress toward what, in our opinion, should be the goal of an amortization period of less than 30 years, with the long-term objective of 100% funding.

It should be noted that the valuation does not reflect the expected decline in future normal costs due to reduced benefit levels for new entrants. If the impact of the declining normal costs were reflected in the valuation, the required contribution rates would be less and the amortization periods would be shorter than those reported in the valuation. The impact of this is reflected in projections that Cavanaugh Macdonald provides separately to the Board.

### Comments

We have one recommended change to the method Cavanaugh Macdonald uses in the amortization calculation that would be more technically precise. We recommend that the payroll used in the amortization calculation be assumed to increase at the beginning of year for consistency with the liability calculations.

The following table shows a comparison of the total required contribution rates assuming 30-year amortization of the UAAL. Note that the total required contribution rate differs from the total employer contribution rate shown in the valuation report in that it also includes the member, Amortization Equalization Disbursement (AED) and Supplemental Amortization Equalization Disbursement (SAED) contribution rates.

**Comments  
(continued)**

The Milliman column represents the total calculated contribution rate using the valuation amortization methods and the liabilities and normal cost rates calculated by Milliman as described in Section 4. We used the actuarial value of assets from the valuation, since it was identical to our calculation. The differences in the Milliman calculations and the valuation calculations are due to the differences in liabilities and normal cost rates discussed in the previous section. The Milliman calculations use the same methods used in the valuation. As previously noted, we are recommending a change to the normal cost method.

	<b>Cavanaugh Macdonald</b>	<b>Milliman</b>	<b>CM/M Ratio</b>
<b><i>Total Required Contribution (30-Year Amortization)</i></b>			
State	30.40%	31.15%	97.6%
Schools	29.94%	30.70%	97.5%
Local Government	21.62%	22.29%	97.0%
Judicial	29.45%	28.92%	101.8%
Denver Public Schools	19.06%	18.79%	101.4%
PERA HCTF	1.15%	1.13%	101.8%
DPS HCTF	0.81%	0.84%	96.4%

Since the employer contribution rates are set in statute and not based on the actuarial calculation, additional calculations are done to determine the projected period needed to amortize the UAAL based on the current employer rate. This calculation is done reflecting both the current and ultimate AED and SAED.

We verified the amortization periods based on the valuation results were accurate based on the valuation results and methods.

**Comments  
(continued)**

We also determined the amortization periods for each division based on the results of our replication valuation. The following is a summary of those results reflecting future increases in the AED and SAED. The differences in the Milliman calculations and the valuation calculations are due to the differences in liabilities and normal cost rates discussed in the previous section.

	Cavanaugh Macdonald	Milliman	CM - M Difference
<b><i>Amortization Period with Future Increases to AED &amp; SAED</i></b>			
State	44 years	49 years	-5 years
Schools	44 years	49 years	-5 years
Local Government	37 years	43 years	-6 years
Judicial	Infinite	Infinite	Infinite
Denver Public Schools	Infinite	Infinite	Infinite
PERA HCTF	40 years	38 years	2 years
DPS HCTF	19 years	20 years	-1 years

**Contribution  
Adequacy**

In the past the Government Accounting Standards Board (GASB) Statements No. 25 and 27 provided general guidelines on the appropriate annual pension cost for financial reporting purposes. GASB statements No. 25 and No. 27 set a maximum amortization period for the Unfunded Actuarial Accrued Liability (UAAL) of 30 years. The recently issued GASB statements No. 67 and 68 do not provide guidance on acceptable limits for amortization periods.

In 2013 the Government Finance Officers Association (GFOA) issued a Best Practice note on the “Core Elements of a Pension Funding Policy.” The GFOA paper says every government employer that offers defined benefit pensions should obtain an Actuarially Determined Contribution (ADC) and should make a commitment to fund the full amount of the ADC each period. The GFOA goes on to state that the amortization of the UAAL in the ADC should be closed, should never exceed 25 years, and should ideally fall in the 15-20 year range.

In October, 2014 the Conference of Consulting Actuaries Public Plans Community (CCA PPC) issued a white paper on “Actuarial Funding Policies and Practices for Public Pension Plans.” The CCA PPC paper also recommends amortization periods in the range of 15 to 25 years. Note that the CCA PPC paper specifically states that it does not address Systems like Colorado PERA which have contributions set on a fixed basis. The CCA PPC intends to prepare a separate white paper to address these plans.

## Contribution Adequacy (continued)

The growing consensus in the public plan community is that amortizing a plan's UAAL over a period longer than 30 years is no longer a prudent level of financing, and the periods viewed as acceptable are growing shorter. Additionally, Colorado state law says: "A maximum amortization period of thirty years shall be deemed actuarially sound."

Each PERA division is funded with contribution rates that are specified in statute. PERA's rates were most recently amended by Senate Bill 10-001, which was signed by the governor in March of 2010. This legislation provided for graded increases in the state and employer contribution rates and reduced benefit levels. This legislation, combined with strong asset returns in recent years, has made significant progress toward what, in our opinion, should be the goal of an amortization period of less than 30 years, with the long-term objective of 100% funding.

Two additional aspects of PERA's funding should be noted:

1. Recent changes in benefit levels are projected to result in a lower cost as a percentage of payroll in the future as new entrants are hired at the lower benefit levels. This aspect is not reflected in the amortization periods reported in the valuation. Cavanaugh Macdonald prepares separate projections incorporating the impact of the declining normal cost rate as part of their valuation presentation. As expected, the periods forecast to fund the UAAL are shorter in these projections. For example, both the State and Schools divisions have forecasted periods of about 35 years in the projections, compared to the 44 years in the valuation calculation. We have not completed a full replication of these projections as it is outside the scope of this audit, although the overall differences appear to be reasonable. It should be noted that the projections assume an increase in active membership every year and reflect the expected future recognition of asset gains that are currently deferred by the asset valuation method. Neither of these assumptions is reflected amortization period reported in the valuation.
2. Because PERA is funded by statutory contribution rates, changes in assumptions and experience different than assumed will cause changes in the amortization period. This is in contrast to plans where the amortization period is fixed and these types of changes cause the contribution rates to vary each year. For example, PERA recently adopted a more conservative (i.e., higher probability of attaining) investment return assumption, which resulted in a longer amortization period.

## Comments on the UAAL Amortization

We have the following additional comments on the UAAL amortization calculation:

### 1. Compensation Used in Amortization

Member compensation in the first year following the valuation date is assumed to increase by a full year's wage inflation at the beginning the year. In the amortization calculation, this compensation amount is assumed to increase the first year and each succeeding year by a full year's wage inflation at the middle of the year. This results in the first year payroll used in the amortization to be equal to the prior year's payroll increased by 1.5 years of wage inflation. We recommend that the amortization calculation be revised to reflect compensation increases at the beginning of the year, consistent with the assumption used in the calculation of the liabilities.

### 2. Contribution Lag

The December 31, 2013 valuation calculated the Annual Required contribution rates based on an effective date of January 1, 2015. Cavanaugh Macdonald does not account for this one-year lag in the potential implementation of the contribution rates. That is, they are making all calculations as if the calculated contribution rate was effective immediately. In our valuation work, we generally make an adjustment to account for this lag in contributions; however, based on our experience, both approaches are common among actuaries working with public sector retirement systems. We feel Cavanaugh MacDonald's approach is reasonable; however, we would note that there is an inconsistency in their method, as they recognize the AED and SAED contribution rates that are effective January 1, 2015, but all other calculations assume the contributions are effective January 1, 2014. The same approach is used in the calculated amortization period.

### 3. Declining Normal Cost Rate

The amortization period and the Annual Required Contribution rate calculations are based on a fixed normal cost rate. New entrants in the future will tend to have lower normal cost rates, which should result in a declining aggregate normal cost rate in the future. This declining normal cost rate is not reflected in the amortization calculations. From our experience, this approach is typical for public sector retirement systems, and we agree it is appropriate. Cavanaugh Macdonald prepares separate projections incorporating the impact of the declining nature of the normal cost rate as part of their valuation presentation. Reflecting the declining normal cost rates results in lower amortization periods in the projections than shown in the valuation.

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## Colorado Public Employees' Retirement Association Actuarial Audit of the 2013 Actuarial Valuation

### Section 6 Actuarial Assumptions (Economic)

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#### Audit Conclusion



We reviewed the key economic assumptions used in the valuation and found them to be reasonable. The economic assumptions used were adopted at the November 15, 2013 Board meeting, based on analysis presented at the Actuarial Assumptions Workshop that took place earlier that month.

We have the following comments regarding the economic assumptions:

- Our analysis shows the 7.50% investment return assumption was reasonable for use in the December 31, 2013 valuation. In comparison to other statewide systems, it is below the median of 7.75%.
- The inflation assumption of 2.8% is reasonable, as is the real wage growth assumption of 1.10% for productivity. The general salary increase assumption of 3.90% is the sum of these two assumptions.

A revision to the actuarial standard of practice relating to setting economic assumptions has been recently adopted. Since this new standard is not effective until after the December 31, 2013 valuation, our analysis is limited to the version of the standard that was applicable at that time. It should be noted that the revised standard has a more restrictive definition of what is reasonable; therefore, it is possible that assumptions that were in the best estimate range under the old standard may not be considered reasonable under the new standard. Based on the analysis presented at the November, 2013 Actuarial Assumptions Workshop, we believe that the current package of economic assumptions would have satisfied the new actuarial standard, if the new standard had applied to the December 31, 2013 valuation.

## Background

This section provides an analysis of the economic assumptions used in the valuation. We have done an analysis similar to what the retained actuary does; however, in an actuarial audit, the purpose is not to come up with a separate recommended set of assumptions, but to use the analysis to confirm that the current package of assumptions is (or is not) reasonable. Therefore, this analysis should be viewed in that light. As previously noted, we find that the package of economic assumptions is reasonable.

The PERA Board has devoted a significant amount of time to the review of the economic assumptions. In each of the last three years, the Board has held an actuarial workshop focusing on assumptions, primarily economic. Following the November, 2013 workshop, the Board adopted the 2.80% inflation and 7.50% investment return assumptions. The investment return assumption adopted was more conservative (i.e., higher probability of attaining) than the 8.00% recommended by Cavanaugh Macdonald.

## Comments

The purpose of the actuarial valuation is to analyze the resources needed to meet the current and future obligations of the system. To provide a reasonable estimate of the long-term funded status of the system, the actuarial valuation must be based on methods and assumptions that will estimate the future obligations of the system in a reasonable manner.

An actuarial valuation uses various methods and two different types of assumptions: economic and demographic. Economic assumptions are related to the general economy and its long-term impact on the system, or to the operation of the system itself. Demographic assumptions are based on the emergence of the specific experience of the system's members.

## Actuarial Standard of Practice No. 27: Selection of Economic Assumptions

The Actuarial Standards Board has adopted Actuarial Standard of Practice (ASOP) No. 27, *Selection of Economic Assumptions for Measuring Pension Obligations*. This standard provides guidance to actuaries giving advice on selecting economic assumptions for measuring obligations under defined benefit plans, such as PERA.

As no one knows with precision what the future holds, the best an actuary can do is to use professional judgment to estimate possible future economic outcomes. These estimates are based on a mixture of past experience, future expectations, and professional judgment. The actuary should consider a number of factors, including the purpose and nature of the measurement, and appropriate recent and long-term historical economic data. The Standard explicitly advises the actuary not to give undue weight to recent experience.

**Actuarial Standard  
of Practice No. 27:  
Selection of  
Economic  
Assumptions  
(continued)**

Recognizing that there is not one “right answer,” the Standard applicable at the valuation date calls for the actuary to develop a best-estimate range for each economic assumption, and then recommend a specific point within that range. Each economic assumption should individually satisfy the Standard.

After completing the selection process, the actuary should review the set of economic assumptions for consistency. For example, this suggests the actuary should use the same inflation component in each of the economic assumptions selected.

An actuary’s best-estimate range with respect to a particular measurement of pension obligations may change from time to time due to changing conditions or emerging plan experiences. Even if assumptions are not changed, we believe that the actuary should be satisfied that each of the economic assumptions selected for a particular measurement complies with Actuarial Standard of Practice No. 27, unless that assumption has been prescribed by someone with the authority to do so.

**Economic  
Assumptions**

Based on the information and economic environment present as of the date of valuation, we believe the economic assumptions used in the December 31, 2013 Actuarial Valuation are reasonable. In our opinion, the price inflation, wage inflation, and the investment return recommendations were reasonable and in line with what we have been recommending to our other clients. The current economic assumptions are as follows:

Assumption	Rate
Price Inflation	2.80%
Real Wage Growth or Productivity	<u>1.10%</u>
Total Wage Growth	3.90%
Membership Growth	0.00%
Total Investment Return	7.50%

The liabilities and normal cost are directly impacted by these important assumptions. The most critical assumption in determining the present value of benefits is the total investment return assumption.

In our opinion, the current package of economic assumptions is reasonable. The following portion of this report discusses four of the key economic assumptions (price inflation, wage inflation, investment return, and membership growth).

## Price Inflation

**Use in the Valuation:** Inflation, as referred to here, means price inflation. The inflation assumption has an indirect impact on the results of the actuarial valuation through the development of the assumptions for investment returns, general wage increases, payroll increase, and the cost-of-living adjustments for retirees and survivors.

**Historical Perspective:** The data for inflation shown below is based on the national Consumer Price Index, US City Average, All Urban Consumers (CPI-U) as published by the Bureau of Labor Statistics. These statistics are nationwide averages, and do not reflect the history of Colorado. However, we believe that future long-term inflation in this state will track that of the nation as a whole.

There are numerous ways to review historical data, with significantly differing results.

The table below shows the compounded annual inflation rate for the last five 10-year periods, and for the 75-year period ended in December 2013, the final calendar year prior to the selection of assumptions.

Decade	CPI Increase
2004-2013	2.4%
1994-2003	2.4%
1984-1993	3.7%
1974-1983	8.2%
1964-1973	4.1%
<b>Prior 75 Years</b>	
1939-2013	3.8%

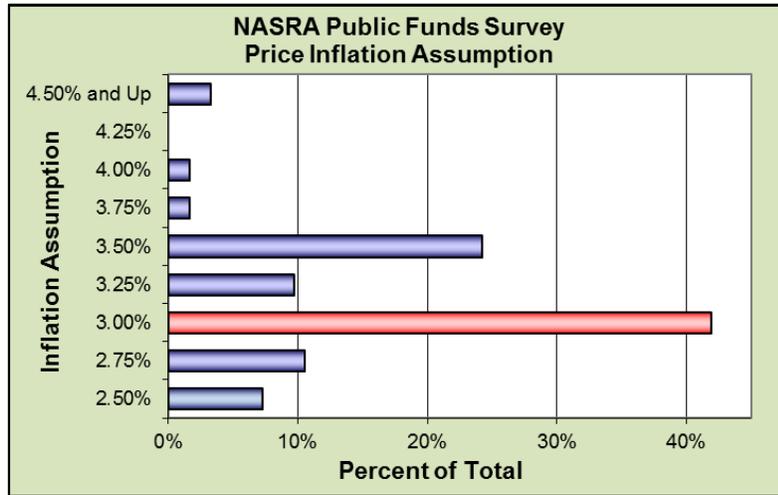
**Forecasts of Inflation:** Since the U.S. Treasury started issuing inflation-indexed bonds (TIPS), it is possible to determine the approximate rate of future inflation anticipated by the financial markets over a given period by comparing the yields on inflation indexed bonds with traditional fixed government bonds. As of the end of 2013, market prices suggested investors expected inflation to be about 2.3% over the next thirty years. As of December 2014, this measure has decreased to about 2.0%.

Although most investment consultants and economists forecast lower inflation compared to what is used in the valuation, they are generally looking at a shorter time horizon than is appropriate for a pension valuation. To consider a longer time frame, we looked at the expected increase in the CPI by the Office of the Chief Actuary for the Social Security Administration. In the 2014 Trustees Report, the projected average annual increase in the CPI over the next 75 years under the intermediate cost assumptions was 2.70%. The low-cost, high-cost range was stated as 2.00% to 3.40%.

**Price Inflation  
(continued)**

**Peer System Comparison:** Although assumptions should not be set based on what other systems are doing, it is informative to see how PERA compares.

According to the 2013 *Public Fund Survey* (a survey of approximately 100 statewide systems), the average inflation assumption for statewide systems has been steadily declining. As of the most recent study, the average rate is 3.17%, the median was 3.00%, and 3.00% was the most common. PERA’s assumption of 2.80% is slightly below this. The following chart shows the distribution.



**Reasonable (Best Estimate) Range:** We believe that a range for inflation between 2.00% and 3.50% is reasonable for an actuarial valuation of a retirement system. The current assumption falls well within that range.

Consumer Price Inflation	
Current Assumption	2.80%
Best-Estimate Range	2.00% - 3.50%

## Investment Return

**Use in the Valuation:** The investment return assumption is one of the primary determinants in the calculation of the expected cost of the benefits of PERA, providing a discount of the estimated future benefit payments to reflect the time value of money. This assumption has a direct impact on the calculations of actuarial accrued liabilities, normal cost, and member and employer contribution rates.

The discount rate is the rate used to discount projected future benefit payments into a single actuarial net present value. The traditional actuarial approach used in the public sector sets the discount rate equal to the expected investment return. Under current standards set by the GASB, the terms “discount rate” and “investment return assumption” are used interchangeably and that rate “should be based on an estimated long-term investment yield on the investments that are expected to be used to finance the payment of benefits, with consideration given to the nature and mix of current and expected plan investments.”<sup>1</sup>

It should be noted that GASB has recently revised the accounting and financial reporting for pension plans. While GASB has made many fundamental changes, the discount rate will still be based on the “long-term expected rate of return,” provided that the plan is not expected to be depleted of assets. Further, GASB’s provisions only apply to financial reporting and are not intended to impact a system’s funding. Analysis of the discount rate for purposes of financial reporting for pension plans is outside of the scope of our engagement.

The current net investment return assumption is 7.50%.

**Method to Determine Best-Estimate Range for Investment Return:** The following chart sets out the target asset allocation as of December 31, 2013.

Asset Class	Target Asset Allocation
Global Equity	56%
Fixed Income	25%
Alternative Investments	7%
Real Estate	7%
Opportunity Fund	5%
Total	100%

<sup>1</sup> Governmental Accounting Standards Board (GASB) Statement No. 27, paragraph 10.c, and GASB Statement No. 45, paragraph 13.c.

**Investment Return  
(continued)**

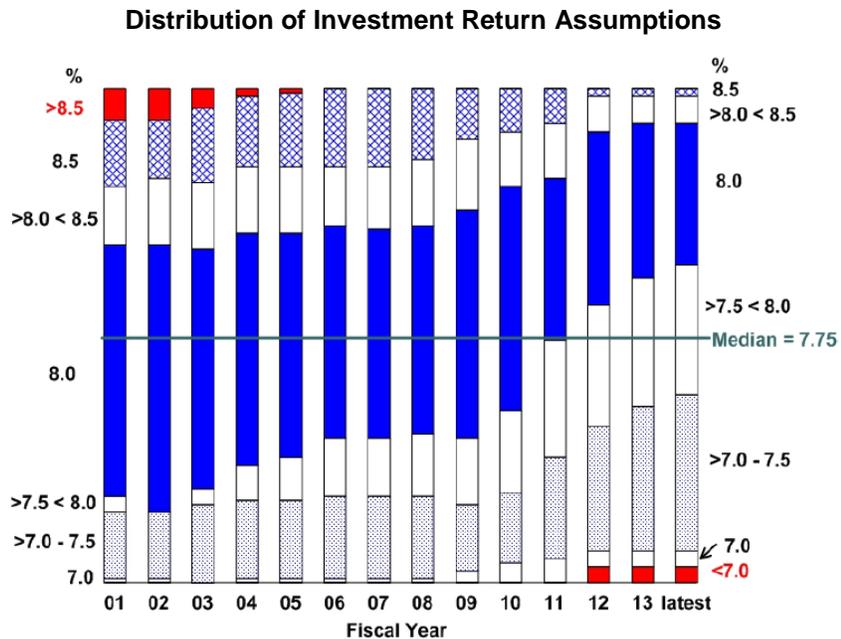
We used a model to project future returns based on Milliman’s capital market assumptions as of December 31, 2013, the target asset allocation, and assumed annual rebalancing. Based on Milliman’s capital market assumptions, PERA’s allocation, and a 30-year time horizon we calculated 25<sup>th</sup> and 75<sup>th</sup> percentile returns of 5.5% and 8.6%, respectively, and a 50<sup>th</sup> percentile return of 7.1%. It should be noted that the valuation inflation assumption of 2.80% is higher than the 2.50% used in Milliman’s model. All calculated averages are median geometric means averages, rather than arithmetic means.

The 25<sup>th</sup> and 75<sup>th</sup> percentiles of 5.5% and 8.6% become our best-estimate range because 50% of the outcomes are expected to fall within this range and it is the narrowest symmetric range with 50% of the probable outcomes.

Therefore, we can say that based on our model the 30-year average annual investment return is just as likely to be within the range from 5.5% to 8.6% as not.

**Peer System  
Comparison**

According to the *Public Fund Survey*, the average investment return assumption for statewide systems has been slowly declining. As of the most recent study, the median assumption is 7.75%. The following chart illustrates the decline in investment return assumptions since the inception of the *Survey* in FY 2001.



Source: Compiled by NASRA based on Public Fund Survey, Oct. 2014

## Peer System Comparison (continued)

**Conclusion:** We find the 7.50% investment return assumption was reasonable for use in the 2013 valuation.

It should be noted that there are recent revisions to Actuarial Standard of Practice No. 27 (ASOP No. 27) that will be effective for the December 31, 2014 valuation and later. These revisions will impact how an actuary determines a reasonable assumption. In particular, the current standard allows for the selection of an assumption that falls within the best-estimate range, whereas the new standard considers an assumption to be reasonable only if it has no significant bias (i.e., it is neither significantly optimistic nor pessimistic). The standard does allow for a provision for adverse deviation. Ultimately, we believe that an assumption that was on the high end of the best-estimate range under the current standard may not be reasonable under the new standard. This could impact the selection of the economic assumptions and should be considered by Cavanaugh Macdonald and PERA at the time of the 2014 Actuarial Valuation.

## Wage Inflation

**Use in the Valuation:** Estimates of future salaries are based on two types of assumptions. Rates of increase in the general wage level of the membership are directly related to inflation, while individual salary increases due to promotion and longevity (also referred to as the merit scale) occur even in the absence of inflation. This section will address the wage inflation assumption (price inflation plus increases related to productivity and competitive wage pressures). The merit scale is discussed in the following section of this report (demographic assumptions).

The current real wage inflation assumption is 1.10% above the price inflation rate, or 3.90% per year. Note that the 3.90% includes increases in wages due to productivity and competitive wage pressures as discussed below.

**Wage Inflation  
(continued)**

**Historical Perspective:** We have used statistics from the Social Security Administration on the National Average Wage back to 1951. For years prior to 1951, we studied the Total Private Nonagricultural Wages as published in *Historical Statistics of the U.S., Colonial Times to 1970*.

There are numerous ways to review this data. For consistency with our observations of other indices, the table below shows the compounded annual rates of real wage inflation for various 10-year periods, and for the 75-year period ended in 2013.

Decade	Wage Growth	CPI Increase	Real Wage Inflation
2004-2013	2.9%	2.4%	0.5%
1994-2003	3.9%	2.4%	1.5%
1984-1993	4.3%	3.7%	0.6%
1974-1983	7.2%	8.2%	-1.0%
1964-1973	5.6%	4.1%	1.5%
<b>Prior 75 Years</b>			
1939-2013	5.2%	3.8%	1.4%

The excess of wage inflation over price inflation represents the increase in the standard of living, also called the real wage inflation rate.

**Forecasts for Future Wage Inflation:** Real wage inflation has been projected by the Office of the Chief Actuary of the Social Security Administration. In the 2014 Trustees Report, the long-term annual increase in the National Average Wage is estimated to be 1.1% higher than the Social Security intermediate inflation assumption of 2.7% per year. The range of the assumed real wage inflation in the 2014 Trustees Report was from 0.5% to 1.8% per year.

**Best-Estimate Range:** We believe that a range between 0.00% and 1.25% is reasonable for the actuarial valuation. We believe that the current estimate of 1.10% is a reasonable estimate. Note that over the last 50 years, real wage inflation has averaged 0.60% per year.

Real Wage Inflation	
Current Assumption	1.10%
Reasonable Range	0.00% - 1.25%

**Growth in System Membership**

The UAAL is amortized as a level percentage of payroll in determining contribution rates as a percentage of pay. The current payroll increase assumption is equal to the wage inflation assumption of 3.90% and assumes no future growth in system active membership. This is consistent with our general recommendation and the approach used by most public sector retirement systems.

**Economic Assumptions Specific to the Health Care Trust Funds**

The HCTF valuations included medical trend rates to project future medical costs. Based on our experience with other health care funds, we believe these rates are reasonable.

# Colorado Public Employees' Retirement Association Actuarial Audit of the 2013 Actuarial Valuation

## Section 7 Actuarial Assumptions (Demographic)

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### Audit Conclusion



We reviewed the analysis and recommendations for the Experience Investigation for the Four-Year Period Ending December 31, 2011. Based on this review, we believe the demographic assumptions used in the valuation are generally reasonable. We have recommended some items for consideration with the next experience investigation.

### Comments

Studies of demographic experience involve a detailed comparison of actual and expected experience. If the actual experience differs significantly from the overall expected results, or if the actual pattern does not follow the expected pattern, new assumptions are considered. Recommended revisions normally are not an exact representation of the experience during the observation period. Judgment is required to project future experience from past trends and current evidence, including a determination of the amount of weight to assign to the most recent experience.

### Actuarial Standard of Practice No. 35: Selection of Demographic Assumptions

Actuarial Standard of Practice No. 35 (ASOP 35) governs the selection of demographic and other noneconomic assumptions for measuring pension obligations. ASOP 35 states that the actuary should use professional judgment to estimate possible future outcomes based on past experience and future expectations, and select assumptions based upon application of that professional judgment. The actuary should select reasonable demographic assumptions in light of the particular characteristics of the defined benefit plan that is the subject of the measurement. A reasonable assumption is one that is expected to appropriately model the contingency being measured and is not anticipated to produce significant cumulative actuarial gains or losses over the measurement period.

### Actual-to-Expected Ratio

In performing an Experience Study, an actuary will compare the actual results of the study with those the assumptions would have projected. This comparison is called the "Actual-to-Expected" (A/E) ratio. If, for example, the A/E ratio for service retirement is 120%, this would indicate that the actual number of service retirements exceeded the number expected by the assumptions by 20%.

## Postretirement Mortality

We reviewed the section of the Experience Investigation regarding postretirement mortality. Based on the results reported, we believe that the current assumptions for mortality are reasonable.

The overall A/E ratio (based on the proposed assumptions) during the period was approximately 109% for all members (male and female and service retirement and disability combined). Therefore, there were more deaths than the proposed assumptions would have projected (i.e., retirees were not living as long as the assumptions projected). This is a positive result from the perspective of funding a pension plan and provides some margin for future increases in life expectancies.

It is generally accepted that life expectancies will continue to increase, and it is prudent to have a “margin” in the rates used (i.e., predict fewer deaths in the future than actually occurred in the past). The 9% margin is in line with what we have seen with other public retirement systems.

Although we believe the postretirement mortality assumption is reasonable, we have several suggestions to be considered with the next experience investigation. As with any assumption, the level of significance should be weighed against the additional complexity.

- **Differences by Benefit Amount:** Our analysis of public retirement systems has typically shown that retirees with above-average benefit amounts tend to live longer than those with below-average benefit amounts. This means that if the assumptions are accurately predicting the number of deaths, they may still be overstating the release of liability expected when retirees die, which is what impacts the valuation. Therefore, a greater margin may be appropriate to account for this.
- **Differences by Division:** The same postretirement mortality assumptions are used for each division. Life expectancies may vary somewhat by occupation. For example, our experience has been that teachers have longer life expectancies than other public employees.
- **Differences by Age Group:** Almost the entire margin that exists is due to deaths at age 90 and above, where there is less liability. In the key age groups 65 through 80, the A/E ratio is 96%.
- **Projected Increases in Life Expectancies:** A recent study by the Society of Actuaries is projecting more rapid increases in life expectancies than previously projected.

## Postretirement Mortality (continued)

- **Generational Mortality:** As an alternative to including a margin, the actuary could project future mortality improvements directly through the use of a generational table, which uses higher life expectancies for people born in later years, although we believe the “static” approach currently being used is appropriate if there is sufficient margin. Additionally, for some systems, like PERA, the factors used in the determination of optional forms of payment are required by law to use the valuation mortality tables. Adopting generational mortality could cause an administrative burden, in that new factors would need to be adopted every year.

## Merit and Longevity Salary Increases

Cavanaugh Macdonald studied the individual salary increases due to promotion and longevity – the merit component of salaries. These increases are in addition to the assumed increases due to general wage inflation (price inflation plus productivity and competitive wage pressure increases) discussed in the previous section. We believe the current assumption is reasonable.

We looked at the magnitude of the observed increases and Cavanaugh Macdonald’s recommended salary scale (no change from the prior version). We have the following comments:

- The rates of merit increase are in line with what we have observed in other systems.
- The observed merit increases trailed the increases projected by the assumption. However, the previous investigation showed actual increases that were greater than the assumption. Accordingly, Cavanaugh Macdonald recommended no change. We find this approach acceptable.
- The merit assumption varies by age. We have found in other systems that there is a closer correlation between merit salary increases and years of service than there is with age. However, we believe that the current approach of using age will still yield reasonable results.

In total, we believe that the recommended assumptions for merit increases are reasonable and consistent with the data from the prior two studies.

## Rates of Service Retirement

We reviewed the rates of service retirement. The current assumption varies by employee class, age, service, and gender. We agree that these factors are the most significant in projecting retirement rates.

Higher retirement rates are assumed for those members eligible for unreduced service retirement than members eligible for reduced service retirement. This is consistent with what we have observed in other retirement systems.

The rates of service retirement recommended by Cavanaugh Macdonald appear reasonable based on the observed data.

## Rates of Disability

Actual disabilities were significantly less than assumptions projected during the study period. Cavanaugh Macdonald recommended lowering the assumptions to partially reflect this experience. We believe this was reasonable.

The valuation has an additional assumption for disability retirement. Specifically, it is assumed that 35% of members who become disabled elect to take a refund of their contributions and forfeit their monthly benefit. This assumption is contrary to what we have observed in other retirement systems and we strongly recommend that it be reviewed with the next experience investigation.

## Rates of Separation (Withdrawal of Contributions and Vested Separation)

We reviewed the rates of separation. The current assumption varies by division, age, gender, and length of service (up to five years). We agree that these factors are the most significant in projecting separation rates, although we have observed a stronger correlation with service than age for all levels of service, not just the first five years. The proposed rates are aligned with actual experience, as reported in the experience investigation report. We believe that assumptions are reasonable.

## Probability of Refund

An assumption is included for the probability a member elects a refund upon separation. The current assumption is that 35% of all vested members who terminate prior to retirement will elect a refund of contributions.

The proposed rates are aligned with actual experience, as reported in the experience investigation report. Although, we believe that assumption is reasonable for use in the valuation, we would recommend consideration be given to incorporating additional factors in this assumption. In particular, factoring in age or service in the probability of refund might provide a more accurate predictor of future refunds. For example, we have found in other systems that individuals who terminate close to retirement eligibility are less likely to elect a refund than those who would have to wait a significant amount of time before becoming eligible for a benefit.

## Assumptions Specific to the Health Care Trust Funds

**Age-Specific Claims Costs:** Cavanaugh Macdonald does not vary medical costs by age or sex in its calculations. This methodology may need to change for valuing those who are not eligible for premium-free benefits under Medicare Part A.

Actuarial Standard of Practice No. 6 (ASOP 6) governs the measurement of these types of benefit obligations. A new standard was issued in May 2014 and it will be effective for any actuarial work product with a measurement date on or after March 31, 2015.

According to the new standard, “the actuary should reflect the full age-specific cost, including the implicit subsidy, regardless of the size of the group being valued.” Under the new standard, this is the case for nearly all pooled health plans, including community rated plans. Note that we do believe that Cavanaugh Macdonald’s approach was acceptable under the standard effective at the date of the most recent actuarial valuation.

This change in ASOP 6 should not impact the service-based premium subsidy, as there are no additional costs to the system for that subsidy as the member ages.

## Other Assumptions

We reviewed the calculations and recommendations for the following assumptions and found them to be reasonable. We provide additional commentary for some of the items.

**Spouse Age Difference:** Males are assumed to be two years older than their spouse. This appears reasonable based on the data provided in the investigation of experience.

**Probability of Marriage:** 100% of employees are assumed to be married (80% DPS division). Although the actual percent will be less, particularly for non-DPS divisions, we believe this is a reasonable assumption to account for children who may be eligible for future death benefits, since members are not assumed to have children in the valuation calculations. This is an approximation that we typically use.

**Retirement Age for Deferred Members:** The assumed retirement age for current and future members varies by benefit structure, division and service. The assumed ages take into account that the value of the benefit will vary depending on these factors and will likely influence when deferred members retire.

**Timing of Annual Increase:** For members who are currently active or in deferred status, the assumption is that their annual increase will commence eighteen months after retirement, if eligible for the annual increase with no additional deferral. In practice, there is about a 15-month delay for this group on average, since a significant portion of members retire in June. Consideration could be given to reflecting the shorter delay in the valuation.

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# Colorado Public Employees' Retirement Association Actuarial Audit of the 2013 Actuarial Valuation

## Section 8 Review of Valuation and Experience Investigation Reports

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### Audit Conclusion



We found Cavanaugh Macdonald's reports to be generally clear and complete given the volume of numbers required in an actuarial report. We felt that the amount of disclosure included in the report was commensurate with the complexity of PERA. We have recommended some changes for more complete disclosure, in particular, a clearer description of how the normal cost rate is calculated.

### Comments Regarding Cavanaugh Macdonald's Reports

In our opinion, Cavanaugh Macdonald's valuation report satisfies Actuarial Standard of Practice No. 41 dealing with actuarial communications.

We offer the following comments on the valuation and investigation reports:

- Clarification should be added to item 3 of Schedule E (Actuarial Cost Method) in the valuation report, as we do not believe it accurately represents how the cost method is being applied in the valuation.
- Clarification should be added to the merit salary assumption in Schedule D of the valuation report that it does not apply in the valuation year.
- The assumption that 35% of future disabled retirements elected a refund of contributions should be disclosed in Schedule D.
- We note that the proposed male mortality rates for disabled retirees shown on page 89 of Cavanaugh Macdonald's experience investigation report do not match the rates from the mortality table used in the valuation. It appears they are off by 10 years (i.e., age 70 is showing the age 60 rate). It appears that Cavanaugh Macdonald is applying the rates from the table in the valuation, not the rates shown in the report, which we believe is appropriate.
- The addition of a membership reconciliation chart to summarize changes in the member population between successive valuation dates could be helpful to the reader.

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**Colorado Public Employees' Retirement Association  
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**Appendix A Present Value of Future Benefits by Benefit Type**

**State**

(in \$Millions)	Cavanaugh Macdonald	Milliman	CM / M Ratio
<b>Present Value All Future Benefits</b>			
<b>Active members</b>			
Retirement	\$8,262.5	\$8,426.7	98.1%
Separation	950.0	1,026.8	92.5%
Death	92.3	96.1	96.0%
Disability	<u>125.2</u>	<u>122.7</u>	102.0%
<b>Total Actives</b>	<b>\$9,430.0</b>	<b>\$9,672.3</b>	<b>97.5%</b>
<b>Inactive members, not in payment</b>	<b>\$498.1</b>	<b>\$502.2</b>	<b>99.2%</b>
<b>Retired members, and survivors of deceased members</b>			
Retired members	\$14,632.8	\$14,579.2	100.4%
Survivors	<u>\$165.5</u>	<u>\$190.9</u>	86.7%
<b>Total retired members</b>	<b>\$14,798.3</b>	<b>\$14,770.1</b>	<b>100.2%</b>
<b>Total for all members</b>	<b>\$24,726.4</b>	<b>\$24,944.6</b>	<b>99.1%</b>

**School**

(in \$Millions)	Cavanaugh Macdonald	Milliman	CM / M Ratio
<b>Present Value All Future Benefits</b>			
<b>Active members</b>			
Retirement	\$13,966.2	\$14,233.2	98.1%
Separation	1,686.4	1,855.8	90.9%
Death	116.8	122.2	95.6%
Disability	<u>129.7</u>	<u>126.9</u>	102.2%
<b>Total Actives</b>	<b>\$15,899.1</b>	<b>\$16,338.1</b>	<b>97.3%</b>
<b>Inactive members, not in payment</b>	<b>\$758.4</b>	<b>\$765.3</b>	<b>99.1%</b>
<b>Retired members, and survivors of deceased members</b>			
Retired members	\$22,390.3	\$22,350.7	100.2%
Survivors	<u>\$152.9</u>	<u>\$176.9</u>	86.4%
<b>Total retired members</b>	<b>\$22,543.2</b>	<b>\$22,527.6</b>	<b>100.1%</b>
<b>Total for all members</b>	<b>\$39,200.7</b>	<b>\$39,631.0</b>	<b>98.9%</b>

Local Government

(in \$Millions)	Cavanaugh Macdonald	Milliman	CM / M Ratio
<b>Present Value All Future Benefits</b>			
<b>Active members</b>			
Retirement	\$1,632.2	\$1,666.3	98.0%
Separation	218.7	241.4	90.6%
Death	19.3	20.1	96.0%
Disability	<u>17.7</u>	<u>17.3</u>	102.3%
<b>Total Actives</b>	<b>\$1,887.9</b>	<b>\$1,945.1</b>	<b>97.1%</b>
<b>Inactive members, not in payment</b>	<b>\$282.8</b>	<b>\$282.8</b>	<b>100.0%</b>
<b>Retired members, and survivors of deceased members</b>			
Retired members	\$2,678.6	\$2,650.4	101.1%
Survivors	<u>\$29.8</u>	<u>\$34.1</u>	87.4%
<b>Total retired members</b>	<b>\$2,708.4</b>	<b>\$2,684.5</b>	<b>100.9%</b>
<b>Total for all members</b>	<b>\$4,879.1</b>	<b>\$4,912.4</b>	<b>99.3%</b>

Judicial

(in \$Millions)	Cavanaugh Macdonald	Milliman	CM / M Ratio
<b>Present Value All Future Benefits</b>			
<b>Active members</b>			
Retirement	\$182.9	\$178.3	102.6%
Separation	5.8	5.7	101.8%
Death	3.7	3.6	102.8%
Disability	<u>3.2</u>	<u>2.9</u>	110.3%
<b>Total Actives</b>	<b>\$195.6</b>	<b>\$190.5</b>	<b>102.7%</b>
<b>Inactive members, not in payment</b>	<b>\$1.6</b>	<b>\$1.6</b>	<b>100.0%</b>
<b>Retired members, and survivors of deceased members</b>			
Retired members	\$203.6	\$203.8	99.9%
Survivors	<u>\$3.0</u>	<u>\$3.5</u>	85.7%
<b>Total retired members</b>	<b>\$206.6</b>	<b>\$207.3</b>	<b>99.7%</b>
<b>Total for all members</b>	<b>\$403.8</b>	<b>\$399.4</b>	<b>101.1%</b>

## Denver Public Schools

(in \$Millions)	Cavanaugh Macdonald	Milliman	CM / M Ratio
<b>Present Value All Future Benefits</b>			
<b>Active members</b>			
Retirement	\$1,470.8	\$1,529.7	96.1%
Separation	200.0	185.8	107.6%
Death	14.6	14.1	103.5%
Disability	<u>20.6</u>	<u>24.3</u>	84.8%
<b>Total Actives</b>	<b>\$1,706.0</b>	<b>\$1,753.9</b>	<b>97.3%</b>
<b>Inactive members, not in payment</b>	<b>\$61.4</b>	<b>\$66.9</b>	<b>91.8%</b>
<b>Retired members, and survivors of deceased members</b>			
Retired members	\$2,587.2	\$2,511.3	103.0%
Survivors	<u>\$23.7</u>	<u>\$27.1</u>	87.5%
<b>Total retired members</b>	<b>\$2,610.9</b>	<b>\$2,538.4</b>	<b>102.9%</b>
<b>Total for all members</b>	<b>\$4,378.3</b>	<b>\$4,359.2</b>	<b>100.4%</b>

## PERA Health Care Trust Fund

(in \$Millions)	Cavanaugh Macdonald	Milliman	CM / M Ratio
<b>Present Value All Future Benefits</b>			
<b>Active members</b>			
Retirement	\$500.1	\$495.7	100.9%
Separation	34.9	34.8	100.3%
Death	1.9	1.8	105.6%
Disability	<u>15.8</u>	<u>12.4</u>	127.4%
<b>Total Actives</b>	<b>\$552.7</b>	<b>\$544.7</b>	<b>101.5%</b>
<b>Inactive members, not in payment</b>	<b>\$29.4</b>	<b>\$30.3</b>	<b>97.0%</b>
<b>Retired members, and survivors of deceased members</b>			
Retired members	\$1,057.5	\$1,052.9	100.4%
Survivors	<u>\$5.6</u>	<u>\$5.5</u>	101.8%
<b>Total retired members</b>	<b>\$1,063.1</b>	<b>\$1,058.4</b>	<b>100.4%</b>
<b>Total for all members</b>	<b>\$1,645.2</b>	<b>\$1,633.4</b>	<b>100.7%</b>

DPS Health Care Trust Fund

(in \$Millions)	Cavanaugh Macdonald	Milliman	CM / M Ratio
<b>Present Value All Future Benefits</b>			
<b>Active members</b>			
Retirement	\$29.7	\$31.7	93.7%
Separation	1.6	1.6	100.0%
Death	0.0	0.0	100.0%
Disability	<u>1.3</u>	<u>1.2</u>	108.3%
<b>Total Actives</b>	<b>\$32.6</b>	<b>\$34.5</b>	<b>94.5%</b>
<b>Inactive members, not in payment</b>	<b>\$0.5</b>	<b>\$0.5</b>	<b>100.0%</b>
<b>Retired members, and survivors of deceased members</b>			
Retired members	\$51.6	\$50.6	102.0%
Survivors	<u>\$0.0</u>	<u>\$0.0</u>	100.0%
<b>Total retired members</b>	<b>\$51.6</b>	<b>\$50.6</b>	<b>102.0%</b>
<b>Total for all members</b>	<b>\$84.7</b>	<b>\$85.6</b>	<b>98.9%</b>