Public Employees' Retirement Association of Colorado

Actuarial Audit of December 31, 2021, Actuarial Valuations

State Division Trust Fund
School Division Trust Fund
Local Government Division Trust Fund
Judicial Division Trust Fund
Denver Public Schools Division Trust Fund
Health Care Trust Fund
Denver Public Schools Health Care Trust Fund

October 2022

110 West Berry Street
Suite 1300
Fort Wayne, IN 46802

October 14, 2022

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

Re: Actuarial Audit Report for December 31, 2021, Valuations

Dear Trustees:

Buck Global, LLC (Buck) has been retained to complete an actuarial audit of the December 31, 2021, actuarial valuations of the five Division Trust Funds and two Health Care Trust Funds of the Public Employees' Retirement Association of Colorado (PERA), as performed by Segal, the retained actuarial service provider for the PERA Board of Trustees. We would like to thank both PERA's professional staff and Segal's professional staff for their assistance and cooperation during this actuarial audit.

This report includes our findings and recommendations with respect to our actuarial audit. The Table of Contents, which immediately follows, outlines the material contained in the report. The service performed in our actuarial audit included the following:

- Review of all actuarial methods and economic and demographic actuarial assumptions currently used within the funding actuarial valuations;
- Review of any additional assumptions and new entrant profile data sets currently used in the annual funding actuarial projections;
- Replication of the most recent funding actuarial valuation census data and results as of December 31, 2021, performed on a "closed group" basis; including, but not limited to:
    - Review of the 2021 census data (both raw PERA-provided and final edited data used by the Board's actuary) for reasonability and continuity;
    - Replication of the development of the Actuarial Value of Assets;
    - Replication of the Present Value of Future Benefits and Actuarial Accrued Liability;
    - Replication of Normal Costs and Actuarially Determined Contributions; and
    - Replication of the results of the Automatic Adjustment Provision assessment.
- Replication of the most recent funding actuarial projections, based on the December 31, 2021, funding actuarial valuation results, performed on an "open group" basis; and
- Review of recent actuarial communications (most recent actuarial valuation and experience analysis reports).

The primary purpose of this report is to present the results of our actuarial audit. The report was prepared for the PERA Board of Trustees and professional staff of PERA for their use in evaluating the preparation of actuarial valuation reports and experience reviews prepared by Segal. Use of the report for any other purposes or by anyone other than PERA staff or the PERA Board of Trustees may not be appropriate and may result in mistaken conclusions because of failure to understand applicable assumptions, methods, or inapplicability of the report for that purpose. Because of the risk of misinterpretation of actuarial results, you should ask us to review any statement you wish to make on the results contained in this report. Buck will not accept any liability for any such statement made without prior review by Buck.

As discussed in the report, we believe the actuarial methods and assumptions used are reasonable for the purpose of the measurements in the report and the valuation reports comply with Actuarial Standards of Practice unless otherwise noted. We have summarized findings and recommendations that Segal and the Board of Trustees should consider for future actuarial valuations.

The results of this report are based upon participant data, financial data, Colorado statutes governing PERA and PERA administrative rules provided by PERA professional staff, as well as December 31, 2021, actuarial valuation reports and 2020 experience review reports prepared by Segal. In addition, we also relied upon verbal and written communications from PERA and Segal professional staff. Buck reviewed the final edited data used for the valuation for reasonableness and consistency with raw data provided by PERA for the valuation. The accuracy of the results presented in this report is dependent on the accuracy of the data and information provided.

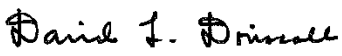
Future actuarial measurements may differ significantly from current measurements due to plan experience differing from that anticipated by the economic and demographic assumptions, changes expected as part of the natural operation of the methodology used for these measurements, and changes in plan provisions, applicable law, or regulations. An analysis of the potential range of such future differences is beyond the scope of this actuarial audit.

Actuarial Standard of Practice No. 56 (ASOP 56) provides guidance to actuaries when performing actuarial services with respect to designing, developing, selecting, modifying, using, reviewing, or evaluating models. Buck used third-party software in the performance of replicating actuarial valuations and projections. The model is intended to calculate the liabilities associated with the provisions of the plans using data and assumptions as of the measurement date specified in this report. The output from the third-party vendor software is used as input to internally developed models that apply applicable funding rules to the liabilities derived and other inputs, such as plan assets and contributions, to generate many of the exhibits found in this report. Buck has an extensive review process whereby the results of the liability calculations are checked using detailed sample output. Other outputs and the internal models are similarly reviewed in detail and at a high level for accuracy and reasonability. Buck also reviews the third-party model when significant changes are made to the software. The review is performed by experts within the company who are familiar with applicable funding rules as well as the manner in which the model generates its output. If significant changes are made to the internal models, extra checking and review are completed. Significant changes to the internal models that are applicable to multiple clients are generally developed, checked, and reviewed by multiple experts within the company who are familiar with the details of the required changes.

This report was prepared under the supervision of David L. Driscoll, a Fellow of the Society of Actuaries, Member of the American Academy of Actuaries and Enrolled Actuary, Michael. A. Ribble, a Fellow of the Society of Actuaries, Member of the American Academy of Actuaries and Enrolled Actuary, and Kevin Penderghest, an Associate of the Society of Actuaries and Member of the American Academy of Actuaries.

David Driscoll and Michael Ribble meet the Qualification Standards of the American Academy of Actuaries in the retirement practice area, and Kevin Penderghest meets the Qualification Standards of the American Academy of Actuaries in the health practice area. Together, we meet the Qualification Standards of the American Academy of Actuaries to render the actuarial opinions contained in this report. This report has been prepared in accordance with all applicable Actuarial Standards of Practice, and we are available to answer questions about it.

Respectfully submitted,



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Schedules

The Board of Trustees
October 14, 2022

Section I – Executive Summary

Introduction

This report summarizes our review of the results of the December 31, 2021, actuarial valuations of the five pension plans (collectively, the "Division Trust Funds") and two retiree health care subsidy plans (collectively, the "Health Care Trust Funds") as follows:

- Division Trust Funds
  - State Division Trust Fund
  - School Division Trust Fund
  - Local Government Division Trust Fund
  - Judicial Division Trust Fund
  - Denver Public Schools Division Trust Fund
- Health Care Trust Funds
  - Health Care Trust Fund
  - Denver Public Schools Health Care Trust Fund

The scope of this actuarial audit includes:

- Review of all actuarial methods and economic and demographic actuarial assumptions currently used within the funding actuarial valuations;
- Review of any additional assumptions and new entrant profile data sets currently used in the annual funding actuarial projections;
- Replication of the most recent funding actuarial valuation census data and results as of December 31, 2021, performed on a "closed group" basis; including, but not limited to:
  - Review of the 2021 census data, for reasonability and continuity regarding raw PERA-provided census data and the final edited data used by the Board's actuary;
  - Replication of the Actuarial Value of Assets;
  - Replication of the Present Value of Future Benefits and Actuarial Accrued Liability;
  - Replication of Normal Costs and Actuarially Determined Contributions;
  - Replication of the results of the Automatic Adjustment Provision assessment.
- Replication of the most recent funding actuarial projections, based on the December 31, 2021, funding actuarial valuation results, performed on an "open group" basis;
- Review of recent actuarial communications (most recent actuarial valuation and experience analysis reports).

Summary of Findings

Based on our review of the census data, experience study documents, liability replication, review of individual sample life calculations, and the actuarial valuation reports, we believe the December 31, 2021, actuarial valuations for Division Trust Funds and Health Care Trust Funds are reasonable, based on appropriate assumptions and methods, and the reports generally comply with the Actuarial Standards of Practice (ASOPs).

Division Trust Funds

The following is a summary of our key findings from the actuarial audit. Please refer to applicable sections of this report to review our findings in more detail.

- In our opinion, the methodology used to assess the reasonability of the economic assumptions complies with the guidance provided in ASOP 27, and the assumptions are reasonable.
- Based on our analysis, we believe the assumed long-term rate of investment return, in the actuary's professional judgment, is reasonable for the purpose of the measurement.
- In our opinion, the methodologies used to recommend demographic assumptions (e.g., future rates of mortality, mortality improvement, retirement, and termination of employment) comply with the guidance provided in ASOP 35, and the conclusions drawn concerning these assumptions were appropriate based on the information provided in the experience study.
- In our opinion, the actuarial methods used in the valuation, including the actuarial cost method, asset valuation method, amortization of unfunded actuarial accrued liability, administrative expense assumption, and active member growth assumption comply with applicable actuarial standards of practice and are reasonable for the purposes of the measurements.
- In our opinion, we believe the final valuation data used by the retained actuary is reasonable and valid for use in the December 31, 2021, valuations. The final data was consistent with the counts included in the report.
- We found that we were able to match to the market value of assets, cash flows and final actuarial value of assets for all five Division Trust Funds and both Health Care Trust Funds. In addition, we agree that the current asset valuation method satisfies ASOP 44.
- In our opinion, the methodologies used to recommend assumptions for future rates of active population growth comply with ASOP 27. The conclusions drawn for this assumption based on the experience study were appropriate.
- We were able to replicate Segal's 40-year actuarial projections for the Division Trust Funds within a reasonable tolerance. We were able to match the time to achieve full funding for all five divisions. In addition, the trend of the funded ratio over time was consistent between the projections modeled by us and Segal.
- In our review of actuarial communications, we found that key assumptions were properly summarized. We also made several recommendations for more accurate and transparent disclosure of certain assumptions.

- Our review has indicated that the actuarial process followed by Colorado PERA is thorough, complete, and complies with applicable Actuarial Standards of Practice (ASOPs) and U.S. Qualification Standards (USQ) of the American Academy of Actuaries (AAA).

Health Care Trust Funds

The following is a summary of our key findings from the actuarial audit. Please refer to applicable sections of this report to review our findings in more detail. We believe the report was prepared in accordance with ASOP 6, which governs the measurement of retiree group benefits obligations.

- Overall, we believe the data, methods, and assumptions used in the valuation of the Health Care Trust Funds (HCTF) are reasonable and appropriate, and in compliance with relevant Actuarial Standards of Practice. The report does not comment on the Actuarial Standard of Practice No. 6 Practice Note released in March 2021, which expands benefits that do not need to be age-adjusted to include Medicare Advantage, MA-PD, and stand-alone Medicare prescription drug plans.
- Our replication of results was within our tolerance level for present value of future benefits, actuarial accrued liability, and normal cost. We were not able to match as closely by benefit, due to the retirement decrement being applied at beginning-of-year, which is inconsistent with both how other decrements are applied for the HCTF valuations, as well as how decrements are applied for the pension valuation. One coding error was discussed with Segal, which had minimal impact on results.
- We were able to replicate the calculation of actuarial value of assets and actuarially determined contribution. Our replication of the funding projections yielded a match within 1 year for the calculation of when each Trust would be fully funded.
- Overall, we believe the Experience Study performed in 2020 was reasonable, but disclosure of the exposures included in the observation period for each assumption would assist in assessment of the actuary’s recommendations.

Summary of Replication Results

The table below shows a high-level summary of liabilities for each Division and Health Care Trust Fund, with additional detail shown in Schedule A of this report. As seen in the table, our replication of results was well within our tolerance level, and we were able to replicate Segal's calculations of liabilities within an acceptable range.

Summary of Liabilities by Division Trust Fund
$ Millions

	State	School	Local Government	Judicial	Denver Public Schools
Actuarial Accrued Liability					
Segal	$27,159.8	$46,336.8	$5,745.0	$488.0	$4,637.9
Buck	$26,838.9	$45,828.9	$5,683.6	$487.8	$4,560.7
% Difference to Segal	*(1.2%)*	*(1.1%)*	*(1.1%)*	*(0.0%)*	*(1.7%)*
Present Value of Future Benefits					
Segal	$30,096.5	$52,746.8	$6,424.6	$570.3	$5,581.0
Buck	$29,969.9	$52,473.5	$6,419.7	$571.2	$5,546.2
% Difference to Segal	*(0.4%)*	*(0.5%)*	*(0.1%)*	*0.2%*	*(0.6%)*

Summary of Liabilities by Health Care Trust Fund
$ Millions

	HCTF	DPS HCTF
Actuarial Accrued Liability		
Segal	$1,345.5	$62.1
Buck	$1,334.2	$61.4
% Difference to Segal	*(0.8%)*	*(1.1%)*
Present Value of Future Benefits		
Segal	$1,457.7	$70.6
Buck	$1,450.8	$70.1
% Difference to Segal	*(0.5%)*	*(0.7%)*

The tables below show a high-level summary of normal cost for each Division and Health Care Trust Fund, with additional detail shown in Schedule B of this report. As seen in the table, our replication of results was well within our tolerance level, and we were able to replicate normal costs consistently with Segal.

Summary of Normal Cost by Division Trust Fund
% of Pay

	State	School	Local Government	Judicial	Denver Public Schools
Total Normal Cost as a % of Pay					
Segal	12.76%	14.57%	12.71%	17.15%	13.32%
Buck	12.88%	14.46%	12.91%	16.84%	13.27%
Difference to Segal	*0.12%*	*(0.11%)*	*0.20%*	*(0.31%)*	*(0.05%)*

Summary of Normal Cost by Health Care Trust Fund
% of Pay

	HCTF	DPS HCTF
Total Normal Cost as a % of Pay		
Segal	0.18%	0.14%
Buck	0.17%	0.13%
Difference to Segal	*(0.01%)*	*(0.01%)*

For all Division Trust Funds and Health Care Trust Funds, our calculation of the actuarially determined contribution rates, as a percentage of pay, differed by less than 0.7% from Segal's calculations. In addition, we were able to match the effective amortization periods for each division within two years.

A high-level summary of our replication is shown below, with additional detail shown in Schedule C of this report.

Actuarially Determined Contribution by Division Trust Fund
% of Pay

	State	School	Local Government	Judicial	Denver Public Schools
Segal	20.71%	21.13%	9.20%	13.83%	6.77%
Buck	20.25%	20.50%	8.93%	13.49%	6.24%
Difference to Segal	(0.46%)	(0.63%)	(0.27%)	(0.34%)	(0.53%)

Effective Amortization Period by Division Trust Fund

	State	School	Local Government	Judicial	Denver Public Schools
Segal	23 years	26 years	12 years	7 years	9 years
Buck	23 years	24 years	11 years	6 years	9 years
Difference to Segal	0 years	(2) years	(1) year	(1) year	0 years

Actuarially Determined Contribution by Health Care Trust Fund
% of Pay

	HCTF	DPS HCTF
Segal	0.73%	0.24%
Buck	0.71%	0.23%
Difference to Segal	(0.02%)	(0.01%)

Effective Amortization Period by Health Care Trust Fund

	HCTF	DPS HCTF
Segal	13 years	2 years
Buck	13 years	2 years
Difference to Segal	0 years	0 years

We were also able to imitate the ratio of the blended total contribution rate and the blended total required contribution. We arrived at a ratio of 99.97% compared to 98.21% for Segal. This means that under our calculation, we would also arrive at the same conclusion as Segal that the AAP assessment performed as of December 31, 2021 does not indicate the need to make automatic changes to member and employer contribution rates, the annual increase cap, and the direct distribution from the State.

We were able to replicate Segal's 40-year actuarial projections for the Division Trust Funds and Health Care Trust Funds within a reasonable tolerance. In general, we were able to match the time to achieve full funding within 1 year for all five Division Trust Funds and both Health Care Trust Funds. In addition, the trend of the funded ratio over time was consistent between the projections modeled by us and Segal.

Projected Years Until 100% Funded Based on 40-Year Projection			
Division Trust Fund	Segal	Buck	Difference to Segal
State Division	16 years	16 years	0 years
School Division	16 years	16 years	0 years
Local Government Division	2 years	2 years	0 years
Judicial Division	3 years	3 years	0 years
DPS Division	2 years	2 years	0 years

Projected Years Until 100% Funded Based on 40-Year Projection			
Health Care Trust Fund	Segal	Buck	Difference to Segal
HCTF	12 years	13 years	1 year
DPS HCTF	1 year	1 year	0 years

Detailed information showing a comparison of our projection results to Segal's projection results are shown in Schedule D of this report.

Summary of Recommendations – Division Trust Funds

The following is a summary of our key recommendations from the actuarial audit. Please refer to applicable sections of this report to review our recommendations in more detail.

- We recommend the assumed long-term rate of investment return assumption continue to be monitored given the current economic environment and our analysis indicating the current assumption of 7.25% is near the top of the range that we would consider to be reasonable.
- We recommend continued monitoring of the unfunded accrued liability of each Division Trust Fund, the pattern of amortization payments and whether the expected amortization payments are expected to fully amortize the unfunded actuarial accrued liabilities within a reasonable period and in accordance with policy objectives.
- We have the following recommendations with respect to our review of the census data used for the valuation:
    - We recommend all survivors in the valuations be tracked separately as beneficiaries.

  - We recommend that the valuation report include summaries of retirees, beneficiaries, and disabled census data and liability information separately rather than solely in the aggregate.
  - We recommend that the valuation report provide a more detailed summary for terminated vested and non-vested members.
- We recommend adding a description for post-termination death benefits prior to retirement to the plan provisions section of the report.
- We recommend review of the valuation for post-termination death benefits for active and deferred vested members to ensure it is valued in accordance with plan provisions.
- When recommending assumptions with respect to rates of termination of employment, we recommend giving more weight to recent experience in future experience studies, especially for larger divisions with more credibility in number of data observations.
- We recommend careful review of the observations to ensure proper categorization of reduced or unreduced retirement during the next experience study. For example, careful review of age rounding methodology may result in more observed unreduced retirements.
- We recommend that future experience studies review and describe the methodology of developing new entrant profiles for projections.
- We recommend future valuation reports provide demographic summaries of the new entrant profiles used in the open group projections.
- We recommend an additional statement in the valuation report that the actuaries who have performed the valuations meet the Qualification Standards “to render the statements of actuarial opinion presented in the report”.
- We recommend an additional statement that the actuaries are available to answer questions about the information contained in the report.
- ASOP 51, applicable when measuring pension obligations and determining pension contributions, requires a statement regarding the range of future actuarial measurements, which may differ from measurements presented in the report. While Segal made note of this and listed examples of factors that could cause future actuarial measurements to differ, we recommend that language be added to the Division Trust Fund report stating that the analysis of the potential range of future differences is beyond the scope of the valuation.

Summary of Recommendations – Health Care Trust Funds

The following is a summary of our key recommendations from the actuarial audit. Please refer to applicable sections of this report to review our recommendations in more detail.

- During the data preparation process, investigate records listed in the source data but also as Defined Contribution participants. 75 were excluded as of the last valuation, but it may be appropriate to include these individuals as they may be eligible for benefits from prior employment.
- Per the ASOP 6 Practice Note, remove aging from the valuation of MA-PD benefits, or provide justification why aging is still included.
- Document the justification for valuing only the employer subsidy for pre-Medicare benefits.
- Adjust the application of the retirement decrement to middle-of-year, which is consistent with other decrements' timing for the HCTF valuations as well as decrement timing for the pension valuations.
- Update coding to reflect the revised assumption regarding the percentage of disabled participants hired before April 1, 1986, assumed to qualify for premium-free Medicare Part A.
- Update the new entrant profiles used to be consistent with those used for the pension plans.
- Revisit participation assumptions for the MA-PD plans given the reduction in premiums under the new carrier.

Section II - Review of Actuarial Assumptions and Methods

We have reviewed the actuarial methods and economic and demographic actuarial assumptions used in Segal's December 31, 2021, actuarial valuations for the Division Trust Funds and the Health Care Trust Funds. To assist in our review of the assumptions and methods, we relied upon information in the actuarial experience reviews covering the period January 1, 2016, through December 31, 2019, as reported by Segal in October 2020 for the Division Trust Funds and November 2020 for the Health Care Trust Funds. The valuation reports indicate that these experience reviews formed the basis for the actuarial assumptions and methods used in these valuations. In addition, the valuation reports indicate that the Board reaffirmed the current 7.25% assumed long-term rate of investment return at the November 15, 2019, Board meeting based on the results of the 2019 Asset Liability Study. Finally, the valuation reports indicate that the Board adopted the current pension policy effective November 16, 2018, and the current OPEB funding policy effective January 19, 2018.

We also note that Actuarial Standards of Practice (ASOPs) provide guidance to actuaries when performing actuarial services. ASOP No. 27 discusses the selection of economic assumptions for the measurement of pension obligations. Similarly, ASOP No. 35 discusses the selection of demographic and other non-economic assumptions for the measurement of pension obligations and ASOP No. 4, section 3.13 discusses the selection of an actuarial cost method. In our opinion, the assumptions used in the December 31, 2021, actuarial valuations for the Division Trust Funds and the Health Care Trust Funds are reasonable, and the methodology used to select these assumptions is appropriate and consistent with the guidance provided in ASOP 27 and ASOP 35. In addition, the actuarial methods used for these funding valuations are reasonable and comply with the guidance provided in ASOP 4.

Division Trust Funds

Review of Economic Assumptions

As noted above, ASOP 27 provides guidance in the selection of economic assumptions for the measurement of pension obligations, primarily investment return, discount rate, post-retirement benefit increases, inflation, and compensation increases. ASOP 27 states that when selecting economic assumptions, the actuary should (1) identify components, if any, of the assumption, (2) evaluate relevant data, (3) take into account factors specific to the measurement, (4) take into account other general considerations, when applicable and (5) select a reasonable assumption. The actuary should also review the set of economic assumptions for consistency and adjust as necessary.

We have reviewed the economic assumptions used in the December 31, 2021, valuation for the Division Trust Funds. We have also reviewed the 2020 experience study prepared by Segal with assumption recommendations adopted by the Board, and in the case of the assumed long-term rate of return later reaffirmed by the Board based on the results of the 2019 Asset Liability Study.

The key valuation assumptions include the following:

- Assumed long-term rate of investment return: 7.25%, net of investment expenses
- Price inflation: 2.30%
- Payroll growth: 3.00% (including inflation of 2.30% and real wage inflation (or "productivity") of 0.70%)
- Salary increases assumption varies by division; full description can be found in both the December 31, 2021 valuation report for the Division Trust Funds and the 2020 experience study
- Post-Retirement Benefit Increases

We reviewed the manner in which economic assumptions were assessed in the 2020 experience study, specifically to ensure that the methods used were thorough and geared toward the development of recommended assumptions that were appropriate for the purpose of the measurements in which they would be used. We also reviewed the study to make sure the conclusions drawn based on the study were appropriate based on the information provided. We did not perform an audit of the analysis of plan experience.

Assumed Long-Term Rate of Investment Return

In order to review the assumed long-term rate of investment return assumption for the Division Trust Funds, Segal reviewed the historical investment returns of the funds over the past 5, 10, 15, 20, and 30 years, and compared the current assumption to the composite 20-year return based on the target allocation of the funds and the 20-year Capital Market Assumptions provided in the Horizon Survey of Capital Market Assumptions (2020 edition). Segal also cited a study of PERA's investments conducted by Aon in September 2019, which determined that the 7.25% investment return assumption was achievable.

In addition, we have reviewed the assumed long-term rate of investment return of 7.25%, net of investment expenses, using economic information and tools provided by Buck's Financial Risk Management (FRM) practice as well as the 2021 policy benchmark weight and long-term asset allocation target of the Funds effective January 1, 2020. A spreadsheet tool created by the FRM team converts averages, standard deviations, and correlations from Buck's Capital Markets Assumptions (CMA) that are used for stochastic forecasting into approximate percentile ranges for the arithmetic and geometric average returns. It is intended to suggest possible reasonable ranges for the assumed long-term rate of investment return without attempting to predict or select a specific best estimate rate of return. It takes into account the duration (horizon) of investment and the target allocation of assets in the portfolio to various asset classes. Based on our analysis, the percentiles generated by the tool described above indicate that the 7.25% assumption is near the top of the range that we would consider to be reasonable.

Price inflation

In reviewing the price inflation assumption for the Division Trust Funds, Segal examined 5, 10, 20, and 30-year average annual changes in the National Consumer Price Index for all urban consumers (CPI-U) as of December 31. Segal also cited 10-year and 20-year averages from respondents in the 2020 edition of the Survey of Capital Market Assumptions from Horizon. To review future inflation expectations, Segal also examined US Treasury Bond Yields, the Consumer Price Index for Urban Wage Earners and Clerical Workers (CPI-W) and the Philadelphia Federal Reserve Bank Survey of Professional Forecasters.

In our analysis of reasonability of the assumed long-term rate of investment return using economic information and tools from Buck's FRM practice, we also reviewed the long-term inflation expectation. The tools from the FRM specifically generate 10-year, 20-year, and 30-year (arithmetic) inflation expectations. We found that the price inflation assumption of 2.30% appears reasonable based on our analysis.

Payroll Growth

In reviewing the payroll growth assumption for the Division Trust Funds, Segal examined two key components of the assumption: inflation and real wage inflation (also referred to as productivity). Segal reviewed data published by the Social Security Administration and compared general wage growth to price inflation. Segal also summarized the historical payroll and active population growth of the Division Trust Funds.

Salary Scale

In reviewing the salary scale assumption for the Division Trust Funds, Segal examined the assumption of individuals' salary changes over the long term for each division as the sum of four components: inflation, productivity, merit, and seniority increases. Findings from the payroll growth review were used to assess inflation and productivity. Merit and seniority increases were assessed by using recent experience for each division. Segal indicated review of all divisions by both age and years since date of hire. Segal proposed salary increase rates are based on age for all divisions except Judicial, which are based on years since date of hire.

Findings – Economic Assumptions

- In our opinion, the methodology used to assess the reasonability of the assumed long-term rate of investment return complies with the guidance provided in ASOP 27.
- Based on our analysis, including review of consistency with other assumptions used in the valuation and the percentiles generated by Buck's FRM spreadsheet tool described above, we believe the assumed long-term rate of investment return, in the actuary's professional judgment, is reasonable for the purpose of the measurement.

- In our opinion, the methodologies used to develop recommended assumptions for price inflation, payroll growth and salary scale comply with the guidance provided in ASOP 27. The conclusions drawn for these assumptions in the experience study were appropriate based on the information provided.

General Commentary – Economic Assumptions

The economic assumptions used in the December 31, 2021, valuations do not appear to have been selected by Segal but rather were adopted by the Board based on recommendations from Segal. The assumed long-term rate of investment return assumption was adopted by the Board on November 18, 2016, as part of the 2016 experience study process, including the October 28, 2016, Assumptions Workshop. The assumption was also later reaffirmed by the Board based on the results of the 2019 Asset Liability Study and supported by Segal in the 2020 experience study. Other economic assumptions, including the underlying price, wage inflation, and merit and seniority increases were adopted by the Board on November 20, 2020, as part of the 2020 experience study process.

We should note that Section 4.2 of ASOP 27 covers disclosures about assumptions that have not been selected by the actuary and indicates that the actuary's report should identify the following, if applicable:

a. any such assumption that significantly conflicts with what, in the actuary's professional judgment, is reasonable for the purpose of the measurement (section 3.14); or

b. any such assumption that the actuary is unable to assess for reasonableness for the purpose of the measurement (section 3.14).

While ASOP 27 does not directly require the actuary to state an opinion, silence on the matter of the reasonableness of the assumptions implies that the actuary finds them reasonable. While Segal supports the economic assumptions selected by the Board in the 2020 experience study report, we recommend that future actuarial valuation reports include a statement supporting the continued belief in the reasonableness of the assumptions as of the valuation date.

Recommendations – Economic Assumptions

- We recommend the assumed long-term rate of investment return assumption continue to be monitored as our results indicate the current assumption of 7.25% is near the top of the range that we would consider to be reasonable.
- We recommend that Segal comment on the reasonability of the long-term rate of return assumption in future actuarial valuation reports.
- We note the executive summary of the 2020 experience study report indicates that the assumed investment rate of return is net of investment expenses. However, we recommend future experience studies clarify this point more prevalently in the investment rate of return section of the report.

- We note that the experience study did not include review or discussion of the assumption to be used for future post-retirement benefit increases. Further, we note that, for applicable members, this assumption changed from 1.25% per year in the December 31, 2020, valuation, to 1.00% per year in the December 31, 2021, valuation. We understand that this change in assumptions coincides with changes to provisions initiated by the Automatic Adjustment Provision as part of the funding policy. In fact, it appears that any liability decreases attributable to the decrease to the AI cap and coinciding assumption changes are bundled together in various parts of the report (e.g., reconciliation of ADC rates and UAAL amortization schedules). While we agree with this approach, we have the following recommendations:
    - Future experience studies should address the post-retirement benefit increase assumption if only to recommend and document that the long-term postretirement increase assumption be set equal to the current AI cap, where applicable.
    - Include a description of the change in assumption for future post-retirement benefit increases in the actuarial valuation report, when applicable, even if such assumption change is made in parallel with the Automatic Adjustment Provision impact on the AI cap.

Review of Demographic Assumptions

As noted above, ASOP 35 provides guidance in the selection of demographic and other noneconomic assumptions for pension obligations, most notably assumptions with respect to assumed future rates of mortality and mortality improvement, retirement, and termination of employment. ASOP 35 states that when selecting demographic assumptions, the actuary should select each assumption based on the universe of available tables considering such factors as (1) the purpose and nature of the measurement, (2) plan design features or changes in plan design, (3) appropriate experience from the specific plan, and (4) relevant factors known to the actuary that may affect future experience. Plan experience may be useful in forming a judgement, but the actuary should not give undue weight to experience that is not sufficiently credible nor to experience that may not be relevant to future expectations.

We have reviewed the demographic assumptions used in the December 31, 2021, valuation for the Division Trust Funds. We have also reviewed the 2020 experience study prepared by Segal with assumption recommendations adopted by the Board. The demographic assumptions reviewed included rates of mortality and mortality improvement, rates of termination, rates of retirement, and other demographic assumptions.

We reviewed how the demographic assumptions were assessed in the 2020 experience study, specifically to ensure that the methods used were thorough and appropriate to the measurements. We also reviewed the study to make sure the conclusions drawn based on the study were appropriate based on the information provided. We did not perform an audit of the analysis of plan experience.

Rates of Mortality and Mortality Improvement

To review the mortality assumption for the Division Trust Funds, Segal first reviewed tables of four types of members in each division: healthy post-retirement mortality, disabled mortality, beneficiary

mortality and pre-retirement mortality. Segal used a benefit-weighted approach to review mortality experience, i.e., the calculated probability of death was weighted by the amount of each annuitant's benefit. In addition, Segal included adjustments for PERA-specific experience and applied either full or partial credibility, depending on the numbers of deaths observed within the group analyzed.

Retirement Rates

In assessing the retirement assumption for the Division Trust Funds, Segal used a benefit-weighted basis to and analyze experience for three groups: those eligible for a reduced benefit, those eligible for an unreduced benefit in the first year only, and those eligible for an unreduced benefit in all other years.

Termination Rates

In reviewing the termination assumption for the Division Trust Funds, Segal examined experience by age, service, and division. Segal proposed "select and ultimate" termination rates for all groups other than State Troopers, the Judicial Division, and the DPS Benefit Structure. All select termination rates are unisex and apply to applicable members until five years after hire date. All other rates proposed are ultimate rates and vary based on age. The proposed ultimate rates also varied by gender except for State Troopers and the Judicial Division. As in the case of mortality and retirement rates, experience was reviewed on a benefit-weighted basis. Finally, with the exception of the DPS Division (PERA Benefit Structure), proposed rates of termination were the result of the weighted average of two-thirds of the existing assumed rates (i.e., those established on the basis of previous experience studies) and one-third of rates based on recent experience (i.e., the period under examination for the 2020 experience study).

Other Demographic Assumptions

Other demographic assumptions reviewed in the 2020 experience study for Division Trust Funds included refund of contributions, disability retirement and spouse information. Disability retirement was reviewed by age. Very little data was available to assess refund of contribution experience for the Judicial Division and State Troopers. Consequently, Segal recommended no change to the prior assumptions. In addition, Segal indicated there was limited data available for the examination of marital status and spouse information but stated that current assumptions are reasonable and consistent with those used by other comparable plans.

Findings – Demographic Assumptions

In our opinion, the methodologies used to recommend assumptions for future rates of mortality, mortality improvement, retirement and termination of employment comply with the guidance contained in ASOP 35.

Recommendations – Mortality Assumptions

- When commenting on the recommended mortality table and improvements, the recommendation by Segal was to update the mortality improvement scale to Scale MP-2019 released by the Society of Actuaries in October 2019. The experience study provided no comment as to whether the mortality improvement scale would be updated in subsequent valuations based on future updates from the Society of Actuaries. We have no issue with keeping the mortality improvement scale the same until the next experience study. However, we recommend providing clarity in the next experience study as to whether the mortality improvement scale is to be updated each year. Based on the December 31, 2021, valuation it appears the intent is that Scale MP-2019 will be used in each valuation until a new table is recommended, likely as part of the next experience study.

Recommendations – Retirement Rates

- When reviewing the experience as shown in the report, we note that the reduced retirement rates assumed at age 59 are relatively high and are higher than rates shown at the same age for unreduced retirement. This may be caused by some observations during the experience study being categorized as reduced retirements instead of unreduced retirements. In our experience, we have observed age and service rounding issues result in mapping members into the wrong retirement eligibility group. We recommend careful review of the observations to ensure proper categorization of reduced or unreduced retirement during the next experience study. Assuming more members retire with eligibility for a reduced benefit when actual experience results in a higher number of members retiring with eligibility for an unreduced benefit would result in actuarial losses in future valuations.
- With regard to how these assumed retirement rates are presented in the valuation report, we note that for all divisions, the December 31, 2021, valuation report states that Deferred Vested (DV) members are assumed to retire at age 62 with a pension benefit, and the 2020 experience study report states that DV members are assumed to retire at age 62 with an unreduced pension benefit. We recommend Segal clarify that DV members are assumed to retire as soon as they are eligible for an unreduced pension benefit (whether that is upon attainment of age 62, 65 or some date in between).

Recommendations – Termination Rates

- As noted above, Segal proposed rates of termination by weighting two-thirds based on the current assumption (i.e., previous experience studies) and one-third based on recent experience (i.e., the period under examination for the 2020 experience study). We recommend giving more weight to recent experience in future experience studies, especially for larger divisions with relatively greater credibility. Assuming more members terminate employment prior to retirement eligibility when actual experience suggests that a higher number of members actually reach retirement eligibility would likely result in actuarial losses in future valuations.

Recommendations – Other Demographic Assumptions

For the Denver Public Schools (DPS) Division, both the experience study and valuation report state that the marital assumption is “80% for members of the DPS Division Trust Fund”. It is unclear whether this applies to members of the DPS by division, or by the DPS benefit structure. We recommend Segal clarify that the assumption applies to members with the DPS benefit structure.

Review of Actuarial Methods

We have also reviewed the actuarial methods used in the December 31, 2021, valuation for the Division Trust Funds. As noted above, ASOP 4 provides guidance in the selection of an actuarial cost method. ASOP 44 provides guidance regarding the selection of an asset valuation method and appropriate disclosures regarding the method.

In the 2020 experience study for Division Trust Funds, Segal reviewed the actuarial cost method, asset valuation method, amortization of unfunded actuarial accrued liability, administrative expense assumption, and active member growth assumption.

Actuarial cost methods are used to allocate the total present value of future benefits to past, current, and future service. The value of past service is used to determine the actuarial accrued liability and the cost of benefit accruing during the upcoming year determines the normal cost. The entry age normal cost method used by PERA tends to result in a normal cost that stays level as a percent of pay over a member’s career. As Segal stated, for this reason the entry age normal cost method is the most widely utilized method for U.S. public sector retirement systems.

Asset valuation methods smooth or average the market value returns over time to alleviate contribution volatility that results from market returns. PERA currently uses a smoothed market value method where asset returns that differ from the expected return on market value of assets are reflected over a four-year period. The asset valuation method does not restrict the actuarial value of assets to a “corridor” (i.e., to differ from the market value of assets by not more than a certain percentage).

Amortization methods determine the payment schedule for reducing the unfunded actuarial accrued liability (UAAL or the difference between the actuarial accrued liability and actuarial value of assets). For purposes of determining the actuarially determined contribution rates, the amortization method for PERA is as follows:

- Amortization payment is determined based on a level percentage of pay basis. This means that future amortization payments are assumed to grow at the same rate as future payroll growth, or 3% per year. When payroll does not grow at that rate, the payoff of the UAAL will not be paid off as assumed.

- Amortization periods are closed, meaning that the amortization period of each amortization base will decrease by one year in each subsequent valuation until reaching zero years.
- Amortization periods are multi-layered, meaning that actuarial gains and losses and other changes that impact the UAAL in a subsequent valuation will be amortized over a new time period.
- The length of the amortization periods varies by source of the change in UAAL. As of December 31, 2021, the legacy UAAL as of December 31, 2017, and any subsequent balances due to contribution deficiencies/(surpluses) resulting from the funding policy have 26 years of amortization remaining. Actuarial experience gains and losses and the impacts of any assumption changes are to be amortized over 30 years. The amortization periods for the impacts of benefit enhancements or reductions are amortized over periods determined on the basis of the nature of the benefit changes and the demographics of the groups impacted by the changes, but in any case will not exceed 25 years.
- The funding policy also provides contingent amortization procedures if a division has a negative UAAL and further adjustments occur if the AAP resulting ratio equals or exceeds 120%.

Findings - Actuarial Methods

In our opinion, the actuarial methods used in the valuation including the actuarial cost method, asset valuation method, amortization of unfunded actuarial accrued liability, administrative expense assumption, and active member growth assumption comply with applicable actuarial standards of practice and are reasonable for the measurement.

Commentary and Recommendations – Actuarial Methods

- The asset smoothing method used for both the pension and OPEB plans involves deferred recognition of investment gains and losses but does not incorporate a corridor or any other mechanism whereby the “smoothed” value would be constrained from deviation to an excessive degree from market value. In the experience study reports, Segal argues (correctly) that constraining differences of the smoothed value from market value is not necessary if the smoothing method “recognizes differences from market value in a sufficiently short period,” and that four years is a defensibly short period. We would suggest that this claim (which we think is valid) be made in the assumptions and methods sections of the valuation reports.
- For information on our review of the actuarial value of assets, please refer to Section V - Review of Actuarial Valuation Results.
- The amortization periods used to calculate the contribution rates against which the fixed contribution rates are compared to determine their adequacy do not exceed any limits codified an any actuarial standard of practice. The Conference of Consulting Actuaries’ Public Plans Community (CCA PPC) published a white paper entitled “Actuarial Funding Policies and Practices for Public Policies and Practices.” The CCA white paper is intended to provide model practices for

applying a Level Cost Allocation Model (LCAM) not general best practices for funding public pension plans. Further, the CCA white paper states, *"Some pension plans have contributions rates that are set on a fixed basis, rather than being regularly reset to a specific, actuarially determined rate. The CCA PPC believes that such plans should develop an actuarially determined contribution rate for comparison to the fixed rate. However, this white paper does not address procedures for evaluating that comparison, or for determining whether the fixed rate is sufficient or when and how the fixed rate should be changed."*

- We understand that the current amortization periods were selected to assist in comparing and monitoring the effectiveness of PERA's funding policy, including the Automatic Adjustment Provision. We do note that the amortization periods for the Division Trust Fund valuations exceed those found in the "LCAM Model Practices" for amortization periods, as set forth in the CCA white paper. The LCAM is a defensible and "well established actuarial practice" that Colorado PERA may want to use to determine the adequacy of fixed contribution rates. Having said that, the CCA white paper includes a footnote that states, "*Some commentators have interpreted 'model practices' as synonymous with 'best practices.' That is not the intent of this categorization of practices. Given their circumstances retirement boards may find that other practices, particularly those categorized and acceptable or acceptable with conditions, are considered both appropriate and reasonably consistent with the policy objectives stated herein."*
- Focusing on the broader amortization method utilized in the Division Trust Fund valuations to calculate the Actuarially Determined Contribution (ADC), we note the following:
    - The combination of the 30-year amortization period for most bases and the 3% assumed payroll growth assumption results in a negative amortization pattern. A negative amortization pattern means that for the first several years of the amortization period, the amortization payment drawing down the outstanding balance on the unfunded actuarial accrued liability does not exceed the interest on the unfunded actuarial accrued liability. Essentially, the unfunded actuarial accrued liability continues to grow for the first few years of the amortization period.
    - Longer amortization patterns exceed the average future service of active and therefore spreads the cost longer than while in active service. In order to balance intergenerational equity with volatility management, an amortization period closer to the average future service of active members should be considered.
    - We recommend reviewing the amount and duration of negative amortization occurring in each division and considering whether such pattern aligns with Colorado PERA's funding policy objectives.
    - We note that the most recently updated version of ASOP 4, *Measuring Pension Obligations and Determining Pension Plan Costs or Contributions*, will be effective for actuarial reports issued on or after February 15, 2023 that also have a measurement date on or after February 15, 2023. Specifically, the soon-to-be effective ASOP 4 addresses amortization methods, adds requirements with regard to disclosure of amortization methods and indicates factors the actuary should in consider in selecting a method, which include, amongst other items the

anticipated pattern of the payments, including the length of time until the payments exceed interest on the outstanding balance. The actuary will also need to assess whether the unfunded actuarial accrued liability is expected to be fully amortized and will need to select a method that will fully amortize the unfunded actuarial accrued liability within a reasonable time period or reduce the unfunded actuarial accrued liability by a reasonable amount within a sufficiently short period. The revised standard will also require the actuary to make a statement regarding whether the actuarial accrued liability is not expected to be fully amortized.

Health Care Trust Funds

The valuation of the HCTF plans relies on a number of assumptions used by the pension plans, including rates of retirement, termination, disability, mortality, and salary scale. The HCTF valuations use the headcount-weighted versions of the base mortality tables used for the pension valuations, which we believe is appropriate. In addition, the actuarial cost method, asset valuation method, and amortization method were selected to be consistent with the pension plans. Below is a summary of our review of assumptions specific to the HCTF valuations.

Per Capita Cost Assumptions

Based on our review of the valuation report, we assume that only the PERA/DPS subsidies are valued for pre-Medicare medical and prescription drug benefits and most Medicare medical and prescription drug benefits. For enrollees who are age sixty-five or older and who are either not eligible for premium-free Medicare Part A or where the selected plan premium is lower than the service-based subsidy, per capita health care costs of the Medicare plans are adjusted to reflect expected health care cost changes related to age. These costs are based on 2022 MA-PD premiums.

Findings – Per capita cost assumptions

For pre-Medicare benefits, we believe the approach described above is reasonable, as any costs beyond the PERA/DPS subsidies to purchase coverage will be paid by retirees. In addition, it is our understanding that the premium is set to include the entire cost of coverage, such that no implicit subsidy exists. There is no documentation in the report providing justification for this methodology. We recommend documenting the justification for no age-related implicit subsidy for pre-Medicare coverage in future reports.

Similarly, valuing only the PERA/DPS subsidies for most Medicare participants is reasonable as any costs beyond the PERA/DPS subsidies to purchase coverage will be paid by retirees.

For enrollees who are age sixty-five or older and who are either not eligible for premium-free Medicare Part A or where the selected plan premium is lower than the service-based subsidy, we believe using 2022 premiums as a basis for these costs is appropriate. The Actuarial Standard of Practice (ASOP) No. 6 Practice Note released in March 2021 expands benefits that do not need to be

age-adjusted according to Section 3.7.7 (c) to include Medicare Advantage, MA-PD, and stand-alone Medicare prescription drug plans. Risk adjusted federal subsidies received under these plans are intended to eliminate any difference in costs due to age, gender, or health status. Currently aging is still reflected for MA-PD benefits, but the report does not include justification for this assumption or any discussion of this Note. We believe it is appropriate to either remove aging from the cost assumption for the MA-PD plans or provide documentation explaining why it is appropriate for aging to still be reflected.

Health Care Cost Trend

Based on our review of the valuation report, health care cost trend rates for the Medicare plans are based on published annual health care inflation surveys in conjunction with actual plan experience (if credible), building block models and industry methods developed by health plan actuaries and administrators. Increase rates for Medicare Part A premiums are based on projected trends for the Federal Hospital Insurance Trust Fund (Medicare Part A premiums) provided by the Centers for Medicare & Medicaid Services.

Findings – Health Care Cost Trend

The sources cited by the actuary for the trend assumptions are appropriate. Based on Buck's review of similar source information to recommend trend assumptions for similar plans, we believe the assumptions used are reasonable.

Non-Economic Assumptions

Non-economic assumptions specific to the HCTF valuations are primarily based on historical experience from 2016 through 2019. These include assumptions related to participation, coverage of dependents, Medicare eligibility, plan election, and commencement of benefits for inactive members. Participation rates for future retirees vary by age at retirement. Changes to assumptions were generally selected by beginning with the midpoint of the current assumption and the assumption indicated by the experience reviewed, with adjustments made for credibility of the experience. While the midpoint approach is reasonable, we recommend for future studies to include the number of exposures included in the experience for each assumption analyzed. A higher number of exposures for a particular assumption would support a recommendation aligned with recent experience, while a lower number would support a recommendation closer to the current assumption. Disclosing the exposure information would help assess the reasonability of the actuary's recommendations.

Findings – Non-Economic Assumptions

The overall methodology of selecting non-economic assumptions is reasonable. Please note the following recommendations:

- Upon review of sample lives provided by Segal for the pension and HCTF valuations, Buck observed significant differences between the present value of future salary amounts for the same

records between the pension and HCTF valuations. Since eligibility for benefits and assumptions regarding decrements and salary growth are consistent between the pension and HCTF plans (except for the use of headcount-weighted vs. amount-weighted mortality tables), we would expect these values to be consistent. Buck reached out to Segal regarding this discrepancy, and Segal confirmed that all decrements were being applied at middle-of-year for the HCTF valuation, except for the retirement assumption, which is applied at beginning-of-year. This is inconsistent with how pension decrements are applied, which are all applied at middle-of-year (except for when 100% retirement is assumed, which uses beginning-of-year timing). Buck does not believe decrements should be applied differently for pension and HCTF benefits and did not identify any provisions of the plan or characteristics of the population that would indicate assuming beginning of year retirement is appropriate. We recommend updating this assumption to be consistent with the valuation of the pension plans.

- The report documents separate assumptions for the commencement of benefits for active participants expected to terminate at a future date and current inactive members. Buck reached out to Segal to confirm that separate assumptions are used, and Segal confirmed that the assumptions listed for active participants are used for current inactive members. We recommend clarifying that the assumption used for active participants is also used for current inactive members in the report and remove the language regarding the assumption for current inactive participants since this is not used in the valuation.
- Participation rates have decreased overall based on the data provided in the most recent experience study. Given the subsidy provided is not expected to increase over time, while premiums are expected to increase with healthcare cost trend, this decrease is reasonable and expected to continue over time. Given this, we recommend analyzing the number of participants who drop coverage after initially electing and implementing a persistency assumption if the experience supports this to reflect expected lower participation over time.
- Subsidies for the retiree health plan are based on years of service completed, which indicates participation is correlated to years of service. We recommend considering basing participation on years of service instead of the current assumptions which only consider age at retirement.
- Segal notes in their 2020 experience study that plan election assumptions should be reviewed annually given evolving health care market forces that cause volatility year to year. We also recommend that participation assumptions be reviewed annually for this reason. In particular, Medicare Advantage premiums decreased significantly in 2022 in conjunction with the change in plan carrier and cost sharing provisions. This decrease in premiums will likely impact participation in the plans for future retirees as the employer subsidy will now cover a larger percentage of the plan premium. We recommend an increased initial participation assumption be considered given the magnitude of the change.
- The percentage of disabled participants hired before April 1, 1986, assumed to qualify for premium-free Medicare Part A was increased from 90% to 95%. The 2020 experience study indicates the last 4 years of experience is consistent with the initial assumption (90% vs 91%). We recommend clarifying why this assumption was changed based on the experience presented.

Section III - Review of Census Data

As part of our actuarial audit, we received several sets of census data files for both the Division Trust Funds and the Health Care Trust Funds. We received preliminary census data ("raw data"), including active members, inactive members, retirees, and beneficiaries as of December 31, 2021, as originally provided by Colorado PERA to the retained actuary Segal for the actuarial valuations. We also received correspondence between Segal and Colorado PERA regarding any questions about the preliminary data. Additionally, we received final census data ("final edited data"), including active members, inactive members, retirees, and beneficiaries as of both December 31, 2020, and December 31, 2021, as used by Segal for the actuarial valuations. We also received data field descriptions and summaries for both the raw data from Colorado PERA and the final edited data from Segal detailing the significance of the data fields provided.

We used this data, along with the census summaries included in the valuation reports, to review the valuation data process. Specifically, for active members, we reviewed number counts and average pay, age, and service amounts. For inactive members, we reviewed number counts, and for retirees and beneficiaries, we reviewed number counts and average annual benefit amounts to ensure the appropriate final census was used in the calculation of the liabilities. For all members, we reviewed counts by division and by benefit structure, where applicable. We also compared the preliminary census from Colorado PERA to the final census from Segal to ensure missing members and/or information was addressed.

In addition to reviewing the data for reasonability, we reviewed the data summaries and statistics shown in the final valuation report to make sure that sufficient information was provided to inform the review of the report by a third party.

We have some recommendations regarding the census data and demographic information shown in the valuation report.

Findings – Census Data

In our opinion, we believe the final valuation data used by the retained actuary is reasonable and valid for use in the December 31, 2021, valuations. The final data was consistent with the counts included in the report.

Recommendations – Census Data

Division Trust Funds

In the final census data used by Segal to perform the final December 31, 2021, for all divisions, many survivors are tracked under a retiree record with a separate field identifying that the original retiree had deceased. However, not all survivors and beneficiaries are tracked in this manner.

- We recommend all survivors should be tracked as beneficiaries rather than retirees in their own record for internal consistency.

We also recommend some additional data disclosures:

- We recommend that the valuation report include summaries of retirees, beneficiaries, and disabled census data information separately rather than solely in the aggregate.
- We recommend that the valuation report provide a more detailed summary for terminated vested members, specifically showing average benefits at unreduced retirement age and the average age of terminated vested members as of the valuation date.
- We recommend that the valuation report provide a more detailed summary for inactive non-vested members, specifically showing the total balance of contributions due.
- The average expected remaining service life for Local Government Division State Troopers in the valuation report was reported as 8.22 years. Based on Buck's review of the final edited census data and calculation of liabilities, the average expected remaining service life was much higher at 15.63 years. Segal noted assumptions for Local Non-Troopers were applied to the 29 members of the Local Troopers group. We recommend Segal apply the correct assumptions for these members in future valuations. We anticipate the adjustment would not have a material impact on the results of the valuation.

The following comments only apply to internal data fields received from Segal as part of the actuarial audit. While the recommendations could certainly aid in future actuarial audits, Segal might find that some of the recommendations improve efficiency or reduce the risk of future errors.

- The "Entry Age" field was provided by Segal but is not used to value Entry Age Normal (EAN) liabilities. Benefit service is used to determine the funding span for EAN liabilities.
- Deferred vested accrual amounts ("Acru1" field) were provided by Segal but are not used to determine liabilities. In addition, amounts in the field were calculated inconsistently with the valuation of final benefits. Accrued benefits for deferred vested members were calculated based on the final average salary ("HAS") and benefit service ("Esvc") fields. We recommend that the "Acru1" field either be updated to make it consistent with the valuation of benefits in the plan's liabilities or be omitted from the data to avoid confusion.
- We recommend that pop-up annuity amounts be provided explicitly in a separate data field. Pop-up benefit amounts were not provided in the data received from Segal. Calculations were required across multiple data fields from the original client data to obtain these amounts, which compromises transparency when reviewing the data and opens the possibility for errors.
- The description of the "DCBAL1" field containing the balance of contributions under the Defined Contribution (DC) plan was unclear as to whether it included employer contributions. We recommend updating data field descriptions to clarify that employer contributions are excluded from the DC balance field.
- Active participant data was originally provided by Segal without the historical pay information, used to determine the Actuarial Accrued Liability. We recommend including historical pay information used to calculate plan liabilities in the data.

- We recommend that Segal review and update their data field descriptions to incorporate additional clarity for the fields provided. In particular, the “CERT1” field for certain periods was provided in years, not months. Also, the “ATE111” data field for January 1, 2011, retirement eligibility has a default value of blank that was not consistent with the participant tiers. Lastly, the description of the “Sal01” field for current-year salary should clearly state whether it contains prior earnings for the year ending December 31, 2021, or a salary rate in effect as of January 1, 2022.

Health Care Trust Funds

- Our review of the census data used for the HCTF valuations confirmed that the same active and terminated vested data was used for the pension and HCTF valuations.
- We performed a comparison of the source and final retiree data for the HCTF valuations. Overall, these files are consistent, but Buck noted the following:
    - 75 records in the source data were not included in the final data. These individuals were reported in the Defined Contribution (DC) census; Segal has confirmed that these records were intentionally excluded since they were DC participants. We recommend for future valuations that records like this be questioned as they could be eligible for OPEB benefits from prior employment, and later re-hired as a DC participant.
    - Fewer than 10 other records were either identified as participants receiving benefits in the source data but excluded from the final data or identified as non-participants in the source data but included in the final data. While it was not clear why these data adjustments were made, the adjustments do not have a material impact on the results of the valuation.
- The final data was consistent with the counts included in the report. We would recommend some additional data disclosures that would help compare census information between valuations:
    - Average age and service for the active population, including an age/service scatter (in 5-year increments).
    - Active counts by division
    - Average age and service for deferred vested participants.
    - Inactive counts by age (in 5-year increments)
- In addition, retiree data is reported as “under age 65” vs “age 65 and older” on page 57, while actives are summarized by “Eligible for Medicare” on pages 16 and 17 with the footnote “State and Local Government Division employees hired (or rehired) after March 31, 1986, are subject to mandatory Medicare coverage.” This is misleading, because the active eligible for Medicare count is the number over age 65, regardless of whether they were hired before or after March 31, 1986.

Section IV – Review of Actuarial Liabilities

The steps followed in our replication of actuarial liabilities are described below.

We requested a copy of the final December 31, 2021, valuation report for the five Division Trust Funds and two Health Care Trust Funds of Colorado PERA, and completed the following steps:

1. We requested:
   a) The complete decrement tables used by Segal to prepare the valuation
   b) The final participant data used in generating the valuation report
   c) The key actuarial results presented in each valuation report (Normal Cost, Actuarial Accrued Liability, Present Value of Future Benefits, etc.) both in the aggregate as well as with specific subtotals of liabilities, including liability by benefit type for active members and liabilities by status.
   d) Sample participant liabilities for different members in different divisions and across different statuses
   e) Sample individual benefit calculations to ensure benefits are calculated consistently with plan administration

2. Colorado PERA also provided:
   a) Colorado PERA Law including legislation enacted in 2021
   b) Colorado PERA Rules effective January 1, 2022
   c) Enacted legislation passed during 2022 that impacted the funds
   d) PERA Administrative Rules as of January 1, 2021

3. Using the information provided in the valuation report and in 1(a) and 1(b) above, we produced a valuation for the plan using ProVal®, a commercially available valuation system used worldwide by actuaries and investment professionals. We refined our understanding of the provisions based on information provided in item (2) above and the summary of the plan provisions stated in Colorado PERA's 2021 Annual Comprehensive Financial Report. We independently generated the key actuarial results for comparison to results published in the actuarial valuation report.

4. In the reconciliation process, using the data provided in 1(b) above and the output from ProVal®, we compared the key results in total for the present value of future benefits, actuarial accrued liability, and normal cost. We also compared each of these values by status and by benefit type. We then used the sample participant liabilities to continue our refinements. Throughout this process, we communicated our progress and discussed issues with our replication with Colorado PERA and Segal through conference calls and emails. As needed, we requested additional sample lives to help resolve differences.

5. In matching to liability calculations, we generally aim to arrive at aggregate results that fall within a 5% tolerance level. Although we may initially fall within 5% of the liability calculations in the aggregate, we also compare subtotals by status as well as by benefit type. The reason we review calculations in total as well as by different subtotals is that aggregate valuation results that differ by less than 5% in total may camouflage systematic errors with respect to particular types of participants. Comparing results by benefit type, by status and by individual sample participant calculations helps us to detect any discrepancies and ensure that differences in aggregate that fall within the tolerance indeed indicate we are valuing liabilities appropriately.

Note that in the following tables of this section numbers may not sum due to rounding. We have shown the “Difference to Segal” as the excess/(deficiency) of the Buck value over/(under) the Segal value. We have shown “% Difference to Segal” as the percentage excess/(deficiency) of the Buck value over/(under) the Segal value.

Division Trust Funds

The table below shows a high-level summary of liabilities by status for each division. As seen in the table, our replication of results was well within our tolerance level, and we were able to replicate liabilities consistently with Segal. The tables in Schedule A of this report also provide a more detailed comparison of each plan’s liabilities by status and by benefit type.

Liabilities by Status and Division Trust Fund
$ Millions

	State	School	Local Government	Judicial	Denver Public Schools
Segal					
Active Members - Actuarial Accrued Liability					
Active	$8,080.6	$16,573.0	$1,766.9	$156.3	$1,716.3
Active Members - Present Value of Future Benefits					
Active	$11,017.3	$22,983.0	$2,446.5	$238.6	$2,659.5
Inactive					
Terminative Vested	$641.5	$1,071.3	$244.7	$4.3	$121.2
Terminated Non-Vested	193.1	304.6	59.3	0.2	51.8
Subtotal	$834.6	$1,375.9	$304.0	$4.5	$173.0
Members in Receipt of Payments					
Retirees	$17,283.6	$27,571.3	$3,471.3	$315.5	$2,648.8
Disableds	747.7	623.1	161.5	8.3	77.0
Beneficiaries	213.3	193.4	41.4	3.4	22.8
Subtotal	$18,244.6	$28,387.8	$3,674.2	$327.2	$2,748.6
Actuarial Accrued Liability	$27,159.8	$46,336.8	$5,745.0	$488.0	$4,637.9
Present Value of Future Benefits	$30,096.5	$52,746.8	$6,424.6	$570.3	$5,581.0
Buck					
Active Members - Actuarial Accrued Liability					
Active	$7,919.0	$16,309.7	$1,734.0	$155.6	$1,664.7
% Difference to Segal	*(2.0%)*	*(1.6%)*	*(1.9%)*	*(0.5%)*	*(3.0%)*
Active Members - Present Value of Future Benefits					
Active	$11,050.0	$22,954.2	$2,470.0	$239.0	$2,650.3
% Difference to Segal	*0.3%*	*(0.1%)*	*1.0%*	*0.2%*	*(0.3%)*
Inactive					
Terminative Vested	$646.1	$1,078.0	$246.3	$4.3	$121.1
Terminated Non-Vested	193.1	304.6	59.3	0.2	51.8
Subtotal	$839.2	$1,382.6	$305.6	$4.5	$172.9
% Difference to Segal	*0.6%*	*0.5%*	*0.5%*	*0.3%*	*(0.0%)*
Members in Receipt of Payments					
Retirees	$17,120.2	$27,321.5	$3,441.2	$316.0	$2,625.7
Disableds	747.6	622.5	161.5	8.3	76.9
Beneficiaries	212.8	192.6	41.3	3.4	20.4
Subtotal	$18,080.6	$28,136.6	$3,644.0	$327.7	$2,723.0
% Difference to Segal	*(0.9%)*	*(0.9%)*	*(0.8%)*	*0.2%*	*(0.9%)*
Actuarial Accrued Liability	$26,838.9	$45,828.9	$5,683.6	$487.8	$4,560.7
% Difference to Segal	*(1.2%)*	*(1.1%)*	*(1.1%)*	*(0.0%)*	*(1.7%)*
Present Value of Future Benefits	$29,969.9	$52,473.5	$6,419.7	$571.2	$5,546.2
% Difference to Segal	*(0.4%)*	*(0.5%)*	*(0.1%)*	*0.2%*	*(0.6%)*

As shown in the tables above, when grouping present value of future benefits by status, Buck's calculations are within 1% across each division and status. This liability measurement gives us confidence that we have benefits and assumptions coded very consistently with Segal. For actuarial

accrued liability, the discrepancy is slightly larger, up to a maximum of 1.7% for DPS when comparing total actuarial accrued liability and up to maximum of 3.0% for DPS when only comparing actuarial accrued liability for active members. The actuarial accrued liability is calculated using the entry age normal cost method, which spreads the normal cost as a level percentage of payroll over the funding span for each active member. There are inherent differences in the details of how this spread is accomplished from valuation system to valuation system and actuary to actuary. Therefore, it is normal and expected to see a larger difference in the accrued liabilities and normal cost as compared to the present value of future benefits. Although the discrepancy is larger on this measurement, these differences are still within the 5% tolerance.

In addition to reviewing liability measurements, we also replicated the calculation of the normal cost rates used in the calculation of the actuarially determined contribution.

Normal Cost by Division Trust Fund
% of Pay

	State	School	Local Government	Judicial	Denver Public Schools
Segal					
Normal Cost as a % of Pay					
Total Normal Cost as a % of Pay	12.76%	14.57%	12.71%	17.15%	13.32%
Less Member Contribution Rate	(11.08%)	(11.00%)	(9.01%)	(11.00%)	(11.00%)
Employer Normal Cost Rate	1.68%	3.57%	3.70%	6.15%	2.32%
Buck					
Normal Cost as a % of Pay					
Total Normal Cost as a % of Pay	12.88%	14.46%	12.91%	16.84%	13.27%
Less Member Contribution Rate	(11.08%)	(11.00%)	(9.01%)	(11.00%)	(11.00%)
Employer Normal Cost Rate	1.80%	3.46%	3.90%	5.84%	2.27%
Difference to Segal					
Normal Cost as a % of Pay					
Total Normal Cost as a % of Pay	0.12%	(0.11%)	0.20%	(0.31%)	(0.05%)
Less Member Contribution Rate	0.00%	0.00%	0.00%	0.00%	0.00%
Employer Normal Cost Rate	0.12%	(0.11%)	0.20%	(0.31%)	(0.05%)

Total Normal Cost reflects administrative expenses load.

As shown in the table above, normal cost rates were matched fairly closely. When comparing to dollar amounts of normal cost in total for each division, the normal cost was within 2% of Segal's values. Additional details showing dollar amounts by division as well as by benefit are shown in Schedule B of this report.

Upon finalizing our replication and reviewing our understanding of the manner in which Segal measures liabilities, we arrived at a few recommendations regarding the calculation and reporting of liabilities.

Recommendations – Actuarial Liabilities for Division Trust Funds

- We first note that the plan provision section in the December 31, 2021, valuation does not include a description for post-termination death benefits prior to retirement. We recommend such a description be added to the valuation report.

- In addition, this is how post-termination death benefits are valued for active and deferred vested members:

    a. Survivors of active members who are not in DPS with the DPS benefit structure with 10 years of service or less receive 25% of Highest Average Salary.

    b. Survivors of active members who are not in DPS with the DPS benefit structure with more than 10 years of service receive the greater of 25% of Highest Average Salary or the value of the accrued benefit as a 100% joint and survivor annuity.

    c. Survivors of deferred members who are not in DPS with the DPS benefit structure the death benefit is the greater of the accrued benefit as a 100% joint and survivor annuity or the return of contributions.

    d. Survivors of both active and deferred vested members in DPS with the DPS benefit structure receive a return of contributions.

    e. Recommendation: Based on the descriptions above, active and deferred vested members are valued differently. We recommend the two be valued consistently and in accordance with the provisions of the plan.

Health Care Trust Funds

The table below shows a high-level summary of liabilities by status for each Health Care Trust Fund. As seen in the table, our replication of results was within our tolerance level, and we were able to replicate liabilities consistently with Segal. The tables in Schedule A of this report also provide a more detailed comparison of each plan's liabilities by status and by benefit type.

Liabilities by Status and Health Care Trust Fund
$ Millions

	HCTF	DPS HCTF
Segal		
Active Members - Actuarial Accrued Liability		
Active	$372.4	$21.4
Present Value of Future Benefits		
Active	$484.7	$30.0
Terminative Vested	$37.6	$2.0
Retirees and Survivors in Receipt of Benefits	$935.4	$38.7
Actuarial Accrued Liability	$1,345.5	$62.1
Present Value of Future Benefits	$1,457.7	$70.6
Buck		
Active Members - Actuarial Accrued Liability		
Active	$366.9	$20.7
% Difference to Segal	*(1.5%)*	*(3.3%)*
Present Value of Future Benefits		
Active	$483.4	$29.4
% Difference to Segal	*(0.3%)*	*(2.0%)*
Terminated Vested	$36.0	$1.9
% Difference to Segal	*(4.3%)*	*(5.0%)*
Retirees and Survivors in Receipt of Benefits	$931.4	$38.8
% Difference to Segal	*(0.4%)*	*0.3%*
Actuarial Accrued Liability	$1,334.2	$61.4
% Difference to Segal	*(0.8%)*	*(1.1%)*
Present Value of Future Benefits	$1,450.8	$70.1
% Difference to Segal	*(0.5%)*	*(0.7%)*

As shown in the table above, when grouping present value of future benefits and actuarial accrued liability by trust and status, Buck's calculations are within the 5% tolerance across each trust and

status. As shown in Schedule A, liabilities by decrement do not match as closely, which can be explained by Segal's use of beginning of year retirement decrements as described in Section II.

Buck performed additional calculations based on sample lives provided by Segal to confirm that adjusting for this difference in decrement timing would result in a closer match by decrement. These calculations along with the results above give us confidence that we have benefits and assumptions coded very consistently with Segal.

Consistent with the pension plans, we also replicated the calculation of the normal cost rates used in the calculation of the actuarially determined contribution.

Normal Cost by Health Care Trust Fund
% of Pay

	HCTF	DPS HCTF
Segal		
Normal Cost as a % of Pay		
Total Normal Cost as a % of Pay	0.18%	0.14%
Less Member Contribution Rate	0.00%	0.00%
Employer Normal Cost Rate	0.18%	0.14%
Buck		
Normal Cost as a % of Pay		
Total Normal Cost as a % of Pay	0.17%	0.13%
Less Member Contribution Rate	0.00%	0.00%
Employer Normal Cost Rate	0.17%	0.13%
Difference to Segal		
Normal Cost as a % of Pay		
Total Normal Cost as a % of Pay	(0.01%)	(0.01%)
Less Member Contribution Rate	0.00%	0.00%
Employer Normal Cost Rate	(0.01%)	(0.01%)

As shown in the table above, normal cost rates were matched closely. Expressed in dollars, our normal cost amounts were within 5% of Segal's values. Note that the normal cost calculations are also impacted by the decrement timing discrepancy described above.

Recommendations – Actuarial Liabilities for Health Care Trust Funds

Upon finalizing our replication and reviewing our understanding of how Segal measures liabilities, we arrived at some recommendations concerning their calculation and description in the report.

- All decrements are being applied at middle-of-year for the HCTF valuations, except for the retirement assumption, which is applied at beginning-of-year. This is inconsistent with how pension decrements are applied, which are all applied at middle-of-year (except for when 100% retirement is assumed, which uses beginning-of-year timing). Buck does not believe decrements should be applied differently for pension and HCTF benefits and did not identify any provisions of the plan or characteristics of the population that would indicate assuming beginning of year retirement is appropriate. We recommend updating this assumption to be consistent with the valuation of the pension plans.
- During our review and subsequent discussions with Segal, we discovered that the percentage of disabled participants hired before April 1, 1986, assumed to qualify for premium-free Medicare Part A being valued was 90% instead of 95% as documented in the valuation report. This assumption was updated from 90% to 95% based on the 2020 experience study. This should be corrected for future valuations, but the impact on liabilities is minimal.

Section V – Review of Actuarial Valuation Results

Schedule C summarizes the results for the five Division Trust Funds and two Health Care Trust Funds of Colorado PERA.

In our parallel valuation and review, we compared present values of future benefits, actuarial accrued liabilities, and total normal costs for each Division and Health Care Trust Fund. We also replicated the calculation of the actuarial value of assets.

Actuarial Value of Assets

Actuarial Standard of Practice No. 44 (ASOP 44) guides the actuary in selecting or recommending an asset valuation method and determining the appropriate disclosures regarding the asset method, in particular the reasonability of the asset smoothing method. Specifically, the actuarial value of assets should (a) produce values which are sometimes above and sometimes below the market value; (b) fall within a reasonable range of the corresponding market values; and (c) recognize differences between the market value and the actuarial value within a reasonable period of time.

The current actuarial value of assets method smooths asset gains and losses over a four-year period without a corridor around the market value.

To facilitate our replication of the calculation of the actuarial value of assets, Colorado PERA provided financial statements and accompanying financial information as of December 31, 2020, and December 31, 2021. We first matched to the reconciliation of the market value of assets from December 31, 2020, to December 31, 2021. Using our independent market value reconciliation, we then determined the expected return based on descriptions from the valuation report and the gains and losses on assets to smooth into the final actuarial value of assets over a four-year period.

Findings – Actuarial Value of Assets

We found that we were able to match to the market value of assets, cash flows and final actuarial value of assets for all five Division Trust Funds and both Health Care Trust Funds. In addition, we agree that the current asset valuation method satisfies ASOP 44.

Key Valuation Results

We used key valuation results to compute and compare the actuarially determined contributions as well as the effective amortization periods based on statutory and related employer contribution rates to the values shown in the actuarial valuations of the five Division Trust Funds and two Health Care Trust Funds.

We also imitated the calculation of the ratio of the blended total contribution rate and the blended total required contribution. This ratio, when less than 98% or greater than 120%, triggers automatic

changes to member and employer contribution rates, the annual increase cap, and the direct distribution from the State under certain circumstances.

Findings – Key Valuation Results

For all Division Trust Funds and Health Care Trust Funds, our calculation of the actuarially determined contribution rates, as a percentage of pay, differed by less than 0.7% from Segal's calculations. In addition, we were able to match the effective amortization periods for each division within two years.

A high-level summary of our replication is shown below, with additional detail shown in Schedule C of this report.

Note that in the following tables of this section numbers may not sum due to rounding. We have shown the "Difference to Segal" as the excess/(deficiency) of the Buck value over/(under) the Segal value. We have shown "% Difference to Segal" as the percentage excess/(deficiency) of the Buck value over/(under) the Segal value.

Actuarially Determined Contribution by Division Trust Fund
% of Pay

	State	School	Local Government	Judicial	Denver Public Schools
Segal	20.71%	21.13%	9.20%	13.83%	6.77%
Buck	20.25%	20.50%	8.93%	13.49%	6.24%
Difference to Segal	(0.46%)	(0.63%)	(0.27%)	(0.34%)	(0.53%)

Effective Amortization Period by Division Trust Fund

	State	School	Local Government	Judicial	Denver Public Schools
Segal	23 years	26 years	12 years	7 years	9 years
Buck	23 years	24 years	11 years	6 years	9 years
Difference to Segal	0 years	(2) years	(1) year	(1) year	0 years

Actuarially Determined Contribution by Health Care Trust Fund
% of Pay

	HCTF	DPS HCTF
Segal	0.73%	0.24%
Buck	0.71%	0.23%
Difference to Segal	(0.02%)	(0.01%)

Effective Amortization Period by Health Care Trust Fund

	HCTF	DPS HCTF
Segal	13 years	2 years
Buck	13 years	2 years
Difference to Segal	0 years	0 years

We were also able to imitate the ratio of the blended total contribution rate and the blended total required contribution. We arrived at a ratio of 99.97% compared to 98.21% for Segal. This means that under our calculation, we would also arrive at the same conclusion as Segal that the AAP assessment performed as of December 31, 2021 does not indicate the need to make automatic changes to member and employer contribution rates, the annual increase cap, and the direct distribution from the State.

Section VI – Review of Actuarial Projections

In addition to our review of the key results of the actuarial valuations for the five Division Trust Funds and two Health Care Trust Funds of Colorado PERA, we also reviewed 40-year projection information. We reviewed the additional assumptions and new entrant profile data sets used in the actuarial projections included in the valuation reports.

Projection Assumptions

New Entrant Growth

For each of the five Division Trust Funds, a 40-year deterministic forecast of valuation results was performed on an open-group basis. Assumptions and methods to project liabilities and assets matched those disclosed in the December 31, 2021, valuation. The active population for School, Local Government, and Denver Public Schools Divisions was assumed to grow at 1.0% per year. The active population for State and Judicial Divisions was assumed to grow at 0.25% per year. Projected payroll for new entrants was assumed to grow at 3.0% per year.

In the 2020 experience study, Segal reviewed the active member growth assumption. They reviewed the annual active member growth over a 10-year period for each of the five Division Trust Funds. In addition, Segal reviewed the data included in the “Colorado Department of Affairs State Demography Office – Dashboard.”

New Entrants

New entrant profile data for the pension plans is based on new hires over the last five years, according to the description provided in the December 31, 2021, valuation report. However, in the Summary Review of December 31, 2021, Actuarial Valuation Results for the Division Trust Funds and Health Care Funds presentation from Segal presented on June 17, 2022, the presentation states that the new entrant profiles have the same demographic mix as new hires over the last three years. Regardless, we reviewed the new entrant profile for reasonability and completeness.

Separate profiles were developed for members of the State and Local Government Divisions (both State Troopers and other than State Troopers), and members of the School, Judicial, and DPS Divisions. A demographic summary is shown in Schedule D of this report.

Findings – Projection Assumptions

In our opinion, the methodologies used to recommend assumptions for future rates of active population growth comply with the guidance provided in ASOP 35. The conclusions drawn for this assumption based on the experience study was appropriate.

Recommendations – Projection Assumptions – Division Trust Funds

We have no recommended updates to the new entrant profile data used in the actuarial projection for the five Division Trust Funds and believe the profile data to be reasonable. We have two recommendations for the valuation report:

- We recommend that in future experience studies Segal describe the methodology of developing the new entrant profile and provide demographic summaries in the study.
- We recommend Segal clarify the period that was used to determine new entrant demographics.

Projection Results - Division Trust Funds

We performed the 40-year deterministic forecast of valuation results using assumptions from the December 31, 2021, valuation and new entrant information provided by Segal. The forecast assumes that Colorado PERA continues its present funding policy as described in the December 31, 2021, actuarial valuation. Specifically, for each of the five divisions the plan sponsor contributes the statutory rate as a percentage of pay, the Amortization Equalization Disbursement, the Supplemental Amortization Equalization Disbursement, and the amount attributable to the DC supplement, offset by amounts directed to the Health Care Trust Funds, the Annual Increase Reserve (AIR), and the PCOP offset (where applicable).

We were able to replicate Segal's 40-year actuarial projections for the Division Trust Funds within a reasonable tolerance. We were able to match the time to achieve full funding for all five divisions. In addition, the trend of the funded ratio over time was consistent between the projections modeled by us and Segal.

Detailed information showing a comparison of our projection results to Segal's projection results are shown in Schedule D of this report.

Projected Years Until 100% Funded Based on 40-Year Projection

Division Trust Fund	Segal	Buck	Difference to Segal
State Division	16 years	16 years	0 years
School Division	16 years	16 years	0 years
Local Government Division	2 years	2 years	0 years
Judicial Division	3 years	3 years	0 years
DPS Division	2 years	2 years	0 years

Projection Results - Health Care Trust Funds

For the HCTF valuations, Segal shared that no new entrant profiles were used. For PERA HCTF, all 2020 hires were used, while for DPS HCTF all those hired between 2016 – 2020 were used. In addition, service is set to zero.

We recommend that new entrant profiles that are consistent with the pension projections be used for the HCTF projections. In addition, given the pandemic and resulting shutdown that began in 2020, it is reasonable to consider that 2020 hiring experience may be different from future years.

We were able to replicate Segal's actuarial projections for the Health Care Trust Funds within a reasonable tolerance. We matched the time to achieve full funding exactly for the DPS HCTF, and within 1 year for the HCTF.

Projected Years Until 100% Funded Based on 40-Year Projection			
Health Care Trust Fund	**Segal**	**Buck**	**Difference to Segal**
HCTF	12 years	13 years	1 year
DPS HCTF	1 year	1 year	0 years

Recommendations – Projection Assumptions – Health Care Trust Funds

In addition to the recommendations above regarding the new entrant profile for these plans, we recommend including additional documentation when presenting this information; in particular, including the projected benefit payments and administrative fees used.

Section VII – Review of Actuarial Communications

First, we would like to note that our review has indicated that the actuarial process followed by Segal is thorough, complete and complies with applicable Actuarial Standards of Practice. In this section, we will recommend some updates and refinements to the actuarial communications issued by Segal.

Actuarial Assumptions Section – Valuation Report Recommendations

We recommend the following updates to the assumptions section of the Division Trust Funds valuation report:

- We recommend the assumptions section be updated to state that the credibility-weighted Pub-2010 Contingent Annuitant mortality tables are also applied prior to the original retiree's death.
- We recommend the assumptions section state the disability decrement rates continue after retirement eligibility.
- We recommend the assumption section be updated to reflect that the 80% married assumption for DPS is applied only to those members in the DPS Division with the DPS Benefit Structure. Currently, the valuation report states that it is applied to all members in the DPS Division.
- We recommend the assumptions section clarify the assumed retirement ages used to value the deferred vested participants.
- We recommend the assumption section state that the 0.4% administrative expense is based on a percentage of payroll.
- We recommend the assumptions section state the assumed frequencies of optional payment forms.
- The assumptions section should state that decrements are applied at middle of year.
- We recommend the assumptions section state the assumptions or methods used for missing or incomplete data.

We recommend the following updates to the assumptions section of the Health Care Trust Funds valuation report:

- We recommend the HCTF valuation report should document the rationale for not valuing any implicit subsidy for pre-Medicare benefits.
- We recommend the HCTF valuation report should clarify that the assumption that survivors of current retirees under the PERA benefit structure with a Joint and Survivor pension will continue to receive the explicit subsidy upon the retiree's death applies to all DPS participants with any PERA service, regardless of the plan of benefits under which they are valued.

- The HCTF valuation report states that 95% of disabled participants are assumed to qualify for premium-free Medicare Part A. We recommend that the documentation should be clarified to indicate that this applies only to those hired before April 1, 1986, and that 100% hired after that date are assumed to qualify for premium-free Medicare Part A.

Actuarial Standards of Practice and Qualification Standards

Our review has indicated that the actuarial process followed by Colorado PERA is thorough, complete, and complies with applicable Actuarial Standards of Practice (ASOPs) and U.S. Qualification Standards (USQ) of the American Academy of Actuaries (AAA). We have the following recommendations with regard to the ASOPs and USQs:

1. From both the pension and OPEB valuation reports, acknowledgements of the USQ of the AAA are phrased as follows:
    a. Pension: “The undersigned are independent actuaries. All are Fellows of the Society of Actuaries, Enrolled Actuaries, and Members of the American Academy of Actuaries, and are experienced in performing valuations for large public retirement systems. All meet the Qualification Standards of the American Academy of Actuaries.”
    b. OPEB: “The undersigned are independent actuaries. All are Fellows or Associates of the Society of Actuaries and Members of the American Academy of Actuaries, and are experienced in performing valuations for large public retirement systems. All meet the Qualification Standards of the American Academy of Actuaries.”
2. We recommend that the above statements be amended as follows:
    a. Include a statement that the actuaries who have performed the valuations meet the Qualification Standards “to render the statements of actuarial opinion presented in the report” in order to match the prototype statement in the current edition of the Qualification Standards and to be consistent with how these standards are referenced in the experience study; and
    b. Include a statement that the actuaries are available to answer questions about the information contained in the report. This will more fully comply with the guidance provided in Section 3.1.4 of ASOP 41, which states: “Unless the actuary judges it inappropriate, the actuary issuing an actuarial communication should also indicate the extent to which the actuary is available to provide supplementary information and explanation.”
3. ASOP 51, applicable when measuring pension obligations and determining pension contributions, requires a statement regarding the range of future actuarial measurements, which may differ from measurements presented in the report. While Segal made note of this and listed examples of factors that could cause future actuarial measurements to differ, we recommend that language be added to the Division Trust Fund report stating that the analysis of the potential range of future differences is beyond the scope of the valuation.
4. The HCTF valuation report should document consideration of the ASOP 6 Practice Note concerning aging of Medicare Advantage plans, and the rationale for not complying with the recommended approach.

Additional Communications Recommendations

- The asset smoothing method used for both the pension and OPEB plans involves deferred recognition of investment gains and losses but does not incorporate a corridor nor any other mechanism whereby the "smoothed" value would be constrained from deviation to an excessive degree from market value. In the experience study reports, Segal states that constraining differences of the smoothed value from market value is not necessary if the smoothing method "recognizes differences from market value in a sufficiently short period," and that four years is a defensibly short period. We recommend this claim also be made in the assumptions and methods sections of the valuation reports.
- The experience study reports develop different credibility adjustments for the base mortality tables for post-retirement mortality at ages below 80 and for ages 80 and above. We recommend the reports indicate what the rationale is for partitioning experience at the age of 80.
- We recommend making the differences in the "amortization periods" (specifically, the effective amortization period and the equivalent single amortization period) referenced in the report clearly distinguished and defined in the report, as well as making clear their uses and calculation methods for the benefit of the reader.
- We recommend under Section 4, rather than using exhibits for the Actuarial Assumptions and Actuarial Cost Methods and the Summary of Plan Provisions, instead giving each its own Section given the volume information contained in each and the similarity in the two exhibits.

Typographical Errors and Clean-Up

Finally, we call attention to a handful of typographical errors and that could be clarified in the December 31, 2021, valuation reports issued by Segal:

- On page 85 of the pension valuation report, the Judicial projected payroll is shown as $28,238,682. This value should be $58,238,682.
- For the Judicial Division for the Unfunded Actuarial Accrued Liability Amortization Schedule, the December 31, 2019, balance of (143,776) is reported as a contribution deficiency. This should be reported as a contribution surplus.
- For the Local Government Division for the Unfunded Actuarial Accrued Liability Amortization Schedule, the December 31, 2019, balance of (6,326,553) is reported as a contribution deficiency. This should be reported as a contribution surplus.
- We recommend plan provisions state that the benefit payment forms under the PERA Benefit Structure include a residual refund of member contributions, consistent with the description of benefit payment forms under the DPS Benefit Structure.
- We recommend the summary of the plan provisions in the valuation report address how compensation and 415 benefit limits are applied.

- The funding policy definitions under the definition of the Actuarial Accrued Liability (AAL) and Asset Values state that such amounts include the balance in the affiliated annual increase reserve. This appears to be incorrect for these definitions shown throughout the report.
- In the Reduced Service Retirement Benefit section of the DPS Benefit Structure assumptions:
    - For those hired prior to July 1, 2005, the reduction amount for those over age 55 with 15 years of service should read as over age 55 with 15-25 years of service.
    - For those hired prior to July 1, 2005, the reduction amount from ages 50-55 with 25-30 years of service should show the lesser of 4% for each year of service below 30 years and 4% for each year below age 55 (rather than age 50).
    - For those hired on or after July 1, 2005, but before January 1, 2010, the reduction amount for those over age 55 with 15 years of service should read over age 55 with 15-25 years of service.
    - For those hired on or after July 1, 2005, but before January 1, 2010, the reduction amount from ages 50-55 with 25-30 years of service should show the lesser of 6% for each year of service below 30 years and 6% for each year below age 55 (rather than age 50).
- For the HCTF valuation report, we recommend documenting retirement eligibility provisions.

Schedule A – Comparison of Actuarial Liabilities

State Division Trust Fund Liabilities by Status and Benefit Type *$ Millions*	Segal	Buck	% Difference to Segal
Active Members - Actuarial Accrued Liability			
Retirement	$7,518.4	$7,441.8	(1.0%)
Disability	106.1	101.3	(4.5%)
Death	106.6	98.9	(7.2%)
Withdrawal	349.4	276.9	(20.7%)
Total	$8,080.6	$7,919.0	(2.0%)
Active Members - Present Value of Future Benefits			
Retirement	$9,439.2	$9,491.9	0.6%
Disability	185.9	186.8	0.5%
Death	165.0	159.5	(3.4%)
Withdrawal	1,227.2	1,211.8	(1.2%)
Total	$11,017.3	$11,050.0	0.3%
Inactive Members			
Terminated Vested	$641.5	$646.1	0.7%
Terminated Non-Vested	193.1	193.1	0.0%
Total	$834.6	$839.2	0.6%
Members in Receipt of Payments			
Retirees	$17,283.6	$17,120.2	(0.9%)
Disableds	747.7	747.6	(0.0%)
Beneficiaries	213.3	212.8	(0.2%)
Total	$18,244.6	$18,080.6	(0.9%)
Totals			
Actuarial Accrued Liability	$27,159.8	$26,838.9	(1.2%)
Present Value of Future Benefits	$30,096.5	$29,969.9	(0.4%)

Schedule A – Comparison of Actuarial Liabilities

School Division Trust Fund Liabilities by Status and Benefit Type *$ Millions*	Segal	Buck	% Difference to Segal
Active Members - Actuarial Accrued Liability			
Retirement	$15,615.3	$15,486.4	(0.8%)
Disability	128.2	123.9	(3.3%)
Death	148.9	140.2	(5.8%)
Withdrawal	680.6	559.1	(17.9%)
Total	$16,573.0	$16,309.7	(1.6%)
Active Members - Present Value of Future Benefits			
Retirement	$20,202.0	$20,210.7	0.0%
Disability	226.6	225.1	(0.6%)
Death	238.7	230.4	(3.5%)
Withdrawal	2,315.8	2,288.0	(1.2%)
Total	$22,983.0	$22,954.2	(0.1%)
Inactive Members			
Terminated Vested	$1,071.3	$1,078.0	0.6%
Terminated Non-Vested	304.6	304.6	0.0%
Total	$1,375.9	$1,382.6	0.5%
Members in Receipt of Payments			
Retirees	$27,571.3	$27,321.5	(0.9%)
Disableds	623.1	622.5	(0.1%)
Beneficiaries	193.4	192.6	(0.4%)
Total	$28,387.8	$28,136.6	(0.9%)
Totals			
Actuarial Accrued Liability	$46,336.8	$45,828.9	(1.1%)
Present Value of Future Benefits	$52,746.8	$52,473.5	(0.5%)

Schedule A – Comparison of Actuarial Liabilities

Local Government Division Trust Fund Liabilities by Status and Benefit Type *$ Millions*	Segal	Buck	% Difference to Segal
Active Members - Actuarial Accrued Liability			
Retirement	$1,643.4	$1,628.8	(0.9%)
Disability	23.4	22.3	(4.5%)
Death	25.3	23.2	(8.5%)
Withdrawal	74.8	59.7	(20.2%)
Total	$1,766.9	$1,734.0	(1.9%)
Active Members - Present Value of Future Benefits			
Retirement	$2,096.2	$2,122.4	1.2%
Disability	40.7	41.3	1.5%
Death	40.1	38.7	(3.6%)
Withdrawal	269.5	267.7	(0.7%)
Total	$2,446.5	$2,470.0	1.0%
Inactive Members			
Terminated Vested	$244.7	$246.3	0.7%
Terminated Non-Vested	59.3	59.3	0.0%
Total	$304.0	$305.6	0.5%
Members in Receipt of Payments			
Retirees	$3,471.3	$3,441.2	(0.9%)
Disableds	161.5	161.5	(0.0%)
Beneficiaries	41.4	41.3	(0.1%)
Total	$3,674.2	$3,644.0	(0.8%)
Totals			
Actuarial Accrued Liability	$5,745.0	$5,683.6	(1.1%)
Present Value of Future Benefits	$6,424.6	$6,419.7	(0.1%)

Schedule A – Comparison of Actuarial Liabilities

Judicial Division Trust Fund Liabilities by Status and Benefit Type *$ Millions*	Segal	Buck	% Difference to Segal
Active Members - Actuarial Accrued Liability			
Retirement	$150.9	$150.7	(0.2%)
Disability	1.5	1.3	(17.8%)
Death	2.8	2.7	(4.1%)
Withdrawal	1.0	0.9	(10.5%)
Total	$156.3	$155.6	(0.5%)
Active Members - Present Value of Future Benefits			
Retirement	$223.3	$223.9	0.3%
Disability	3.6	3.6	0.8%
Death	5.1	5.0	(3.0%)
Withdrawal	6.6	6.5	(1.7%)
Total	$238.6	$239.0	0.2%
Inactive Members			
Terminated Vested	$4.3	$4.3	0.3%
Terminated Non-Vested	0.2	0.2	0.0%
Total	$4.5	$4.5	0.3%
Members in Receipt of Payments			
Retirees	$315.5	$316.0	0.2%
Disableds	8.3	8.3	0.0%
Beneficiaries	3.4	3.4	0.0%
Total	$327.2	$327.7	0.2%
Totals			
Actuarial Accrued Liability	$488.0	$487.8	(0.0%)
Present Value of Future Benefits	$570.3	$571.2	0.2%

Schedule A – Comparison of Actuarial Liabilities

Denver Public Schools Division Trust Fund Liabilities by Status and Benefit Type *$ Millions*	Segal	Buck	% Difference to Segal
Active Members - Actuarial Accrued Liability			
Retirement	$1,529.2	$1,516.6	(0.8%)
Disability	16.9	16.0	(5.3%)
Death	16.0	14.8	(7.5%)
Withdrawal	154.2	117.4	(23.9%)
Total	$1,716.3	$1,664.7	(3.0%)
Active Members - Present Value of Future Benefits			
Retirement	$2,151.2	$2,153.9	0.1%
Disability	31.8	31.1	(2.0%)
Death	28.6	26.8	(6.1%)
Withdrawal	448.0	438.4	(2.1%)
Total	$2,659.5	$2,650.3	(0.3%)
Inactive Members			
Terminated Vested	$121.2	$121.1	(0.0%)
Terminated Non-Vested	51.8	51.8	0.0%
Total	$173.0	$172.9	(0.0%)
Members in Receipt of Payments			
Retirees	$2,648.8	$2,625.7	(0.9%)
Disableds	77.0	76.9	(0.0%)
Beneficiaries	22.8	20.4	(10.8%)
Total	$2,748.6	$2,723.0	(0.9%)
Totals			
Actuarial Accrued Liability	$4,637.9	$4,560.7	(1.7%)
Present Value of Future Benefits	$5,581.0	$5,546.2	(0.6%)

Schedule A – Comparison of Actuarial Liabilities

Health Care Trust Fund Liabilities by Status and Benefit Type *$ Millions*	Segal	Buck	% Difference to Segal
Active Members - Actuarial Accrued Liability			
Retirement	$353.5	$347.9	(1.6%)
Disability	3.6	4.0	11.1%
Death	2.5	2.4	(4.0%)
Withdrawal	12.9	12.6	(2.3%)
Total	$372.4	$366.9	(1.5%)
Active Members - Present Value of Future Benefits			
Retirement	$446.8	$441.7	(1.1%)
Disability	6.0	6.7	11.7%
Death	3.7	4.0	8.1%
Withdrawal	28.1	31.0	10.3%
Total	$484.7	$483.4	(0.3%)
Terminated Vested Members	$37.6	$36.0	(4.3%)
Retirees and Survivors in Receipt of Benefit	$935.4	$931.4	(0.4%)
Totals			
Actuarial Accrued Liability	$1,345.5	$1,334.2	(0.8%)
Present Value of Future Benefits	$1,457.7	$1,450.8	(0.5%)

Schedule A – Comparison of Actuarial Liabilities

DPS Health Care Trust Fund Liabilities by Status and Benefit Type *$ Millions*	Segal	Buck	% Difference to Segal
Active Members - Actuarial Accrued Liability			
Retirement	$19.9	$19.2	(3.5%)
Disability	0.2	0.2	0.0%
Death	0.1	0.1	0.0%
Withdrawal	1.2	1.2	0.0%
Total	$21.4	$20.7	(3.3%)
Active Members - Present Value of Future Benefits			
Retirement	$26.6	$25.7	(3.4%)
Disability	0.4	0.4	0.0%
Death	0.2	0.2	0.0%
Withdrawal	2.8	3.1	10.7%
Total	$30.0	$29.4	(2.0%)
Terminated Vested Members	$2.0	$1.9	(5.0%)
Retirees and Survivors in Receipt of Benefit	$38.7	$38.8	0.3%
Totals			
Actuarial Accrued Liability	$62.1	$61.4	(1.1%)
Present Value of Future Benefits	$70.6	$70.1	(0.7%)

Schedule B – Comparison of Normal Cost

State Division Trust Fund			
Normal Cost by Benefit Type *$ Millions*	**Segal**	**Buck**	**% Difference to Segal**
Normal Cost			
Retirement	$262.4	$269.5	2.7%
Disability	10.2	10.5	3.1%
Death	8.1	8.0	(1.7%)
Withdrawal	120.3	117.0	(2.7%)
Normal Cost	$401.0	$405.0	1.0%
Administrative Expenses	$13.0	$13.0	0.0%
Total Normal Cost	$414.0	$418.0	1.0%
% of Pay	**Segal**	**Buck**	**Difference to Segal**
Normal Cost as a % of Pay			
Total Normal Cost as a % of Pay	12.76%	12.88%	0.12%
Less Member Contribution Rate	(11.08%)	(11.08%)	0.00%
Employer Normal Cost Rate	1.68%	1.80%	0.12%
Payroll	$3,244.1	$3,244.4	$0.3

Schedule B – Comparison of Normal Cost

School Division Trust Fund			
Normal Cost by Benefit Type *$ Millions*	**Segal**	**Buck**	**% Difference to Segal**
Normal Cost			
Retirement	$585.3	$584.1	(0.2%)
Disability	12.2	12.1	(0.5%)
Death	11.7	11.1	(4.6%)
Withdrawal	207.1	202.6	(2.2%)
Normal Cost	$816.3	$810.0	(0.8%)
Administrative Expenses	$23.0	$23.0	0.0%
Total Normal Cost	$839.3	$833.0	(0.8%)
% of Pay	**Segal**	**Buck**	**Difference to Segal**
Normal Cost as a % of Pay			
Total Normal Cost as a % of Pay	14.57%	14.46%	(0.11%)
Less Member Contribution Rate	(11.00%)	(11.00%)	0.00%
Employer Normal Cost Rate	3.57%	3.46%	(0.11%)
Payroll	$5,759.7	$5,761.0	$1.3

Schedule B – Comparison of Normal Cost

Local Government Division Trust Fund			
Normal Cost by Benefit Type *$ Millions*	**Segal**	**Buck**	**% Difference to Segal**
Normal Cost			
Retirement	$62.3	$64.9	4.0%
Disability	2.3	2.4	4.3%
Death	2.1	2.0	(1.4%)
Withdrawal	27.0	26.0	(3.9%)
Normal Cost	$93.7	$95.2	1.6%
Administrative Expenses	$3.0	$3.0	0.0%
Total Normal Cost	$96.7	$98.2	1.6%
% of Pay	**Segal**	**Buck**	**Difference to Segal**
Normal Cost as a % of Pay			
Total Normal Cost as a % of Pay	12.71%	12.91%	0.20%
Less Member Contribution Rate	(9.01%)	(9.01%)	0.00%
Employer Normal Cost Rate	3.70%	3.90%	0.20%
Payroll	$761.0	$761.0	$0.0

Schedule B – Comparison of Normal Cost

Judicial Division Trust Fund			
Normal Cost by Benefit Type *$ Millions*	**Segal**	**Buck**	**% Difference to Segal**
Normal Cost			
Retirement	$8.6	$8.5	(1.9%)
Disability	0.2	0.3	15.2%
Death	0.3	0.3	(6.1%)
Withdrawal	0.6	0.6	(3.9%)
Normal Cost	$9.8	$9.6	(1.8%)
Administrative Expenses	$0.2	$0.2	0.0%
Total Normal Cost	$10.0	$9.8	(2.0%)
% of Pay	**Segal**	**Buck**	**Difference to Segal**
Normal Cost as a % of Pay			
Total Normal Cost as a % of Pay	17.15%	16.84%	(0.31%)
Less Member Contribution Rate	(11.00%)	(11.00%)	(0.00%)
Employer Normal Cost Rate	6.15%	5.84%	(0.31%)
Payroll	$58.2	$58.3	$0.1

Schedule B – Comparison of Normal Cost

Denver Public Schools Division Trust Fund **Normal Cost by Benefit Type** *$ Millions*	Segal	Buck	% Difference to Segal
Normal Cost			
Retirement	$76.6	$75.3	(1.6%)
Disability	1.8	1.8	(2.2%)
Death	1.6	1.4	(10.6%)
Withdrawal	33.2	34.3	3.0%
Normal Cost	$113.2	$112.7	(0.4%)
Administrative Expenses	$3.5	$3.5	0.0%
Total Normal Cost	$116.7	$116.2	(0.4%)
% of Pay	**Segal**	**Buck**	**Difference to Segal**
Normal Cost as a % of Pay			
Total Normal Cost as a % of Pay	13.32%	13.27%	(0.05%)
Less Member Contribution Rate	(11.00%)	(11.00%)	0.00%
Employer Normal Cost Rate	2.32%	2.27%	(0.05%)
Payroll	$875.7	$875.7	$0.0

Schedule C – Comparison of Key Actuarial Valuation Results

State Division Trust Fund Actuarially Determined Contribution *% of Pay and $ Millions*	Segal	Buck	Difference to Segal
Total Normal Cost as a % of Pay	12.76%	12.88%	0.12%
Less Member Contribution Rate	(11.08%)	(11.08%)	0.00%
Employer Normal Cost Rate	1.68%	1.80%	0.12%
Unfunded Actuarial Accrued Liability Rate	19.03%	18.45%	(0.58%)
Actuarially Determined Contribution Rate	20.71%	20.25%	(0.46%)
Effective Amortization Period	23 years	23 years	0 years
Payroll	$3,244.1	$3,244.4	$0.3

Schedule C – Comparison of Key Actuarial Valuation Results

School Division Trust Fund Actuarially Determined Contribution *% of Pay and $ Millions*	Segal	Buck	Difference to Segal
Total Normal Cost as a % of Pay	14.57%	14.46%	(0.11%)
Less Member Contribution Rate	(11.00%)	(11.00%)	0.00%
Employer Normal Cost Rate	3.57%	3.46%	(0.11%)
Unfunded Actuarial Accrued Liability Rate	17.56%	17.04%	(0.52%)
Actuarially Determined Contribution Rate	21.13%	20.50%	(0.63%)
Effective Amortization Period	26 years	24 years	(2) years
Payroll	$5,759.7	$5,761.0	$1.3

Schedule C – Comparison of Key Actuarial Valuation Results

Local Government Division Trust Fund **Actuarially Determined Contribution** *% of Pay and $ Millions*	Segal	Buck	Difference to Segal
Total Normal Cost as a % of Pay	12.71%	12.91%	0.20%
Less Member Contribution Rate	(9.01%)	(9.01%)	0.00%
Employer Normal Cost Rate	3.70%	3.90%	0.20%
Unfunded Actuarial Accrued Liability Rate	5.50%	5.03%	(0.47%)
Actuarially Determined Contribution Rate	9.20%	8.93%	(0.27%)
Effective Amortization Period	12 years	11 years	(1) year
Payroll	$761.0	$761.0	$0.0

Schedule C – Comparison of Key Actuarial Valuation Results

Judicial Division Trust Fund **Actuarially Determined Contribution** *% of Pay and $ Millions*	Segal	Buck	Difference to Segal
Total Normal Cost as a % of Pay	17.15%	16.84%	(0.31%)
Less Member Contribution Rate	(11.00%)	(11.00%)	(0.00%)
Employer Normal Cost Rate	6.15%	5.84%	(0.31%)
Unfunded Actuarial Accrued Liability Rate	7.68%	7.65%	(0.03%)
Actuarially Determined Contribution Rate	13.83%	13.49%	(0.34%)
Effective Amortization Period	7 years	6 years	(1) year
Payroll	$58.2	$58.3	$0.1

Schedule C – Comparison of Key Actuarial Valuation Results

Denver Public Schools Division Trust Fund **Actuarially Determined Contribution** *% of Pay and $ Millions*	Segal	Buck	Difference to Segal
Total Normal Cost as a % of Pay	13.32%	13.27%	(0.05%)
Less Member Contribution Rate	(11.00%)	(11.00%)	0.00%
Employer Normal Cost Rate	2.32%	2.27%	(0.05%)
Unfunded Actuarial Accrued Liability Rate	4.45%	3.96%	(0.49%)
Actuarially Determined Contribution Rate	6.77%	6.24%	(0.53%)
Effective Amortization Period	9 years	9 years	0 years
Payroll	$875.7	$875.7	$0.0

Schedule C – Comparison of Key Actuarial Valuation Results

Health Care Trust Fund			
Actuarially Determined Contribution *% of Pay and $ Millions*	**Segal**	**Buck**	**Difference to Segal**
Total Normal Cost as a % of Pay	0.18%	0.17%	(0.01%)
Less Member Contribution Rate	0.00%	0.00%	0.00%
Employer Normal Cost Rate	0.18%	0.17%	(0.01%)
Unfunded Actuarial Accrued Liability Rate	0.55%	0.54%	(0.01%)
Actuarially Determined Contribution Rate	0.73%	0.71%	(0.02%)
Effective Amortization Period	13 years	13 years	0 years
Payroll	$9,823.0	$9,824.3	$1.3

Schedule C – Comparison of Key Actuarial Valuation Results

DPS Health Care Trust Fund			
Actuarially Determined Contribution *% of Pay and $ Millions*	**Segal**	**Buck**	**Difference to Segal**
Total Normal Cost as a % of Pay	0.14%	0.13%	(0.01%)
Less Member Contribution Rate	0.00%	0.00%	0.00%
Employer Normal Cost Rate	0.14%	0.13%	(0.01%)
Unfunded Actuarial Accrued Liability Rate	0.10%	0.09%	(0.01%)
Actuarially Determined Contribution Rate	0.24%	0.23%	(0.01%)
Effective Amortization Period	2 years	2 years	0 years
Payroll	$875.7	$875.7	$0.0

Schedule C – Comparison of Key Actuarial Valuation Results

Automatic Adjustment Provisions (AAP)
Ratio of Blended Total Contribution Rate to Blended Total Required Contribution for 2023 Plan Year

	State	School	Local Government	Judicial	Denver Public Schools	Total Weighted Average
Segal						
Unfunded Actuarial Accrued Liability	9,780,329,667	16,083,611,995	654,444,885	68,781,194	608,779,266	27,195,947,007
Member Contribution Rate	11.08%	11.00%	9.01%	11.00%	11.00%	10.98%
Employer Contribution Rate	19.99%	19.80%	13.06%	23.33%	9.00%	19.47%
Actuarially Determined Employer Contribution Rate	20.71%	21.13%	9.20%	13.83%	6.77%	20.35%
Direct Distribution Rate						0.32%
Blended Total Contribution Rate						30.77%
Blended Total Required Contribution						31.33%
Ratio of Blended Total Contribution Rate to Blended Total Required Contribution						**98.21%**
Buck						
Unfunded Actuarial Accrued Liability	9,459,408,396	15,575,746,114	593,040,904	68,567,535	531,590,580	26,228,353,529
Member Contribution Rate	11.08%	11.00%	9.01%	11.00%	11.00%	10.98%
Employer Contribution Rate	19.99%	19.80%	13.06%	23.33%	9.00%	19.51%
Actuarially Determined Employer Contribution Rate	20.25%	20.50%	8.93%	13.49%	6.24%	19.84%
Direct Distribution Rate						0.32%
Blended Total Contribution Rate						30.81%
Blended Total Required Contribution						30.82%
Ratio of Blended Total Contribution Rate to Blended Total Required Contribution						**99.97%**
Difference to Segal						*1.76%*

Schedule D – Comparison of Actuarial Projections

New entrant demographics

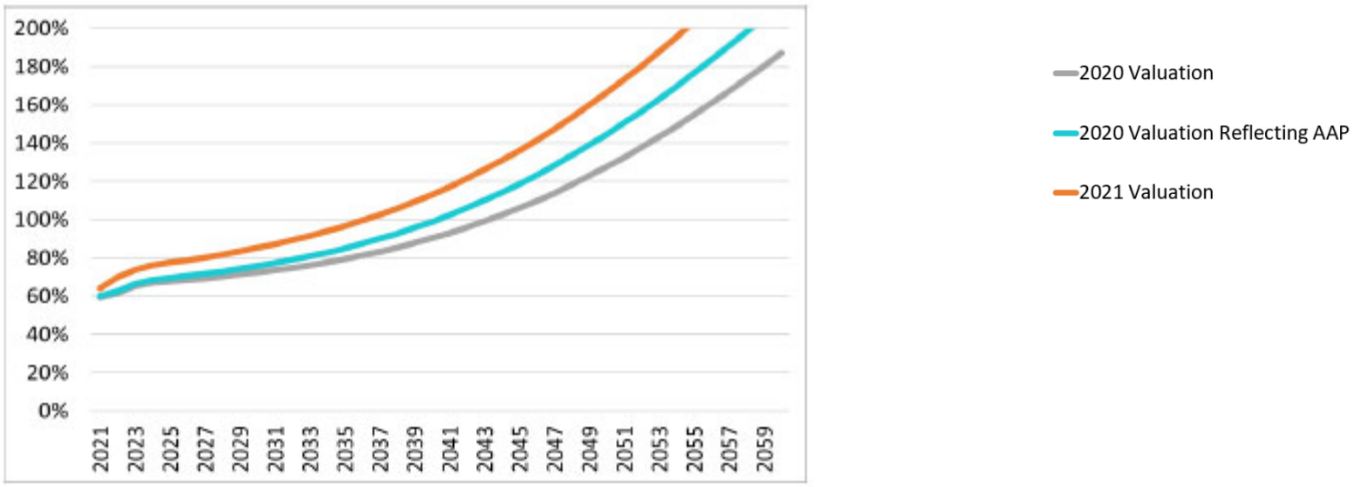
Summary of Segal's New Entrant Profile Demographics	State Division			Local Government Division			
	Other Than State Troopers	State Troopers	School Division	Other Than State Troopers	State Troopers	Judicial Division	Denver Public Schools Division
Count	12	11	12	12	11	8	12
Percent Male	46%	71%	34%	51%	71%	46%	34%
Average Age	36.20	31.03	37.37	37.44	31.03	45.95	32.86
Average Entry Service	0.50	0.50	0.38	0.50	0.50	0.62	0.38
Average Entry Salary*	43,989	60,695	28,005	40,489	60,695	153,312	38,827
Minimum Weight	1.14%	0.13%	1.59%	1.43%	0.13%	1.75%	0.65%
Maximum Weight	20.19%	33.67%	20.10%	15.27%	33.67%	24.56%	29.28%

**Average Entry Salary increases by 3.00% in each projected year.*

Schedule D – Comparison of Actuarial Projections

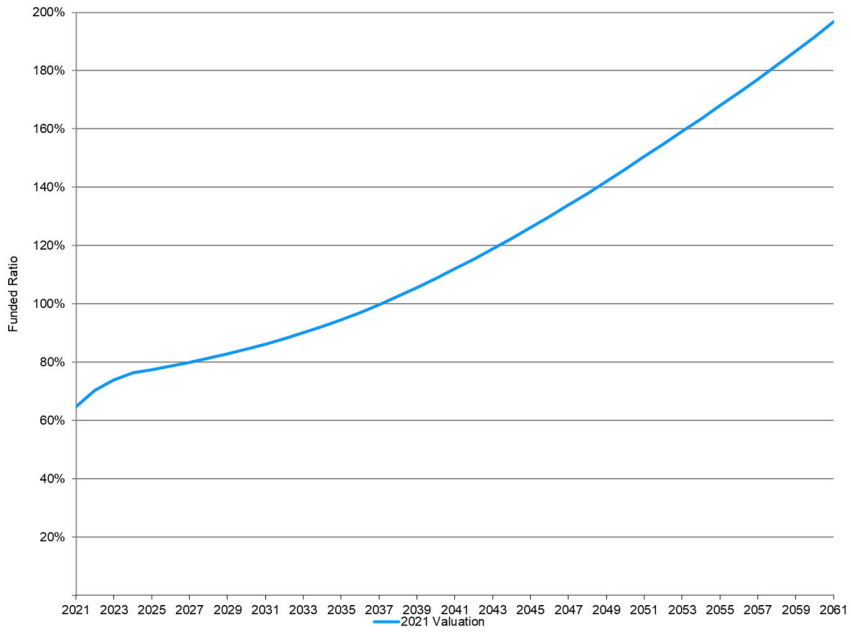
Funded Ratio – State Division

Segal



The State Division achieves 100% funding as of 12/31/2037, which is 16 years from the valuation date.

Buck

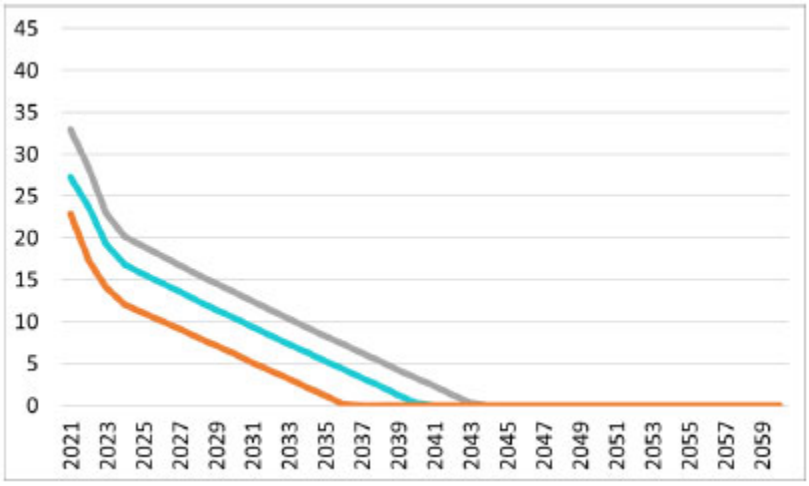


The State Division achieves 100% funding as of 12/31/2037, which is 16 years from the valuation date.

Schedule D – Comparison of Actuarial Projections

Estimated Number of Years until 100% Funded – State Division

Segal



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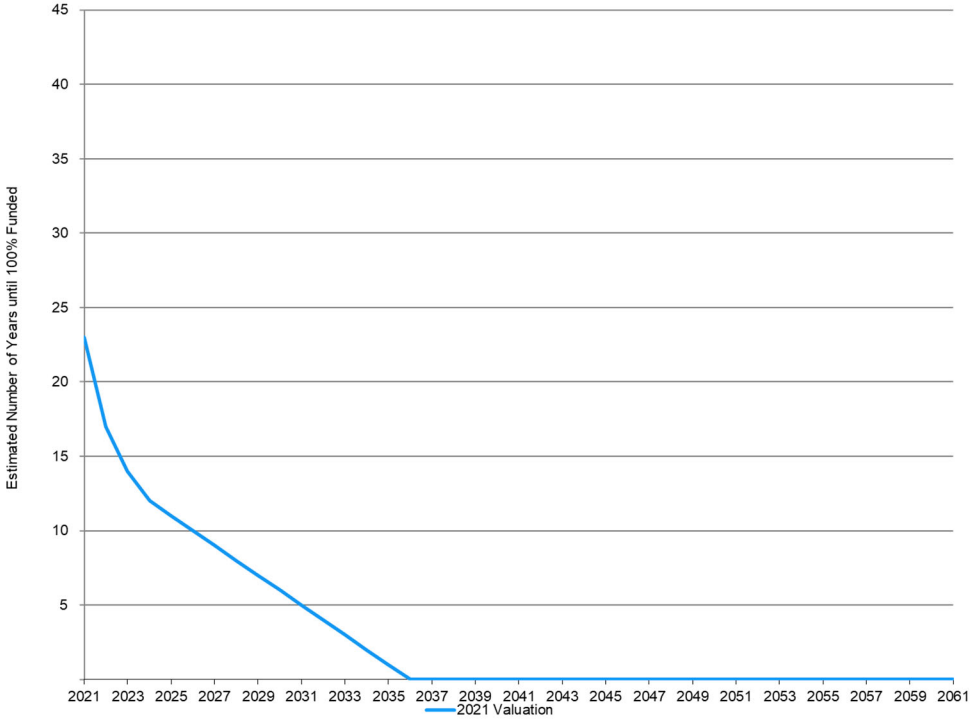
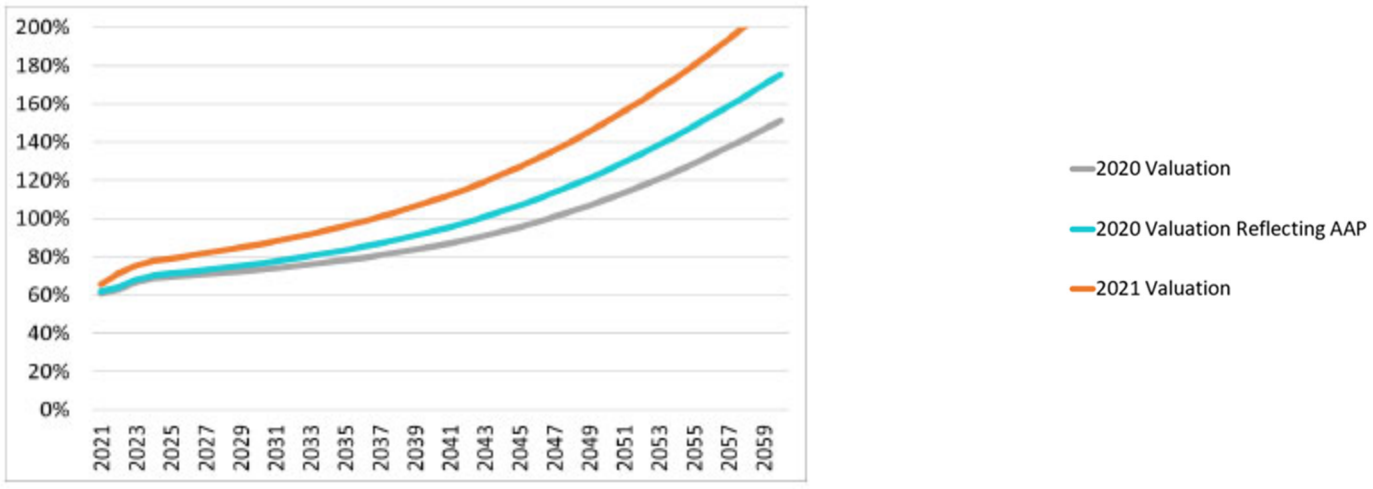


Schedule D – Comparison of Actuarial Projections

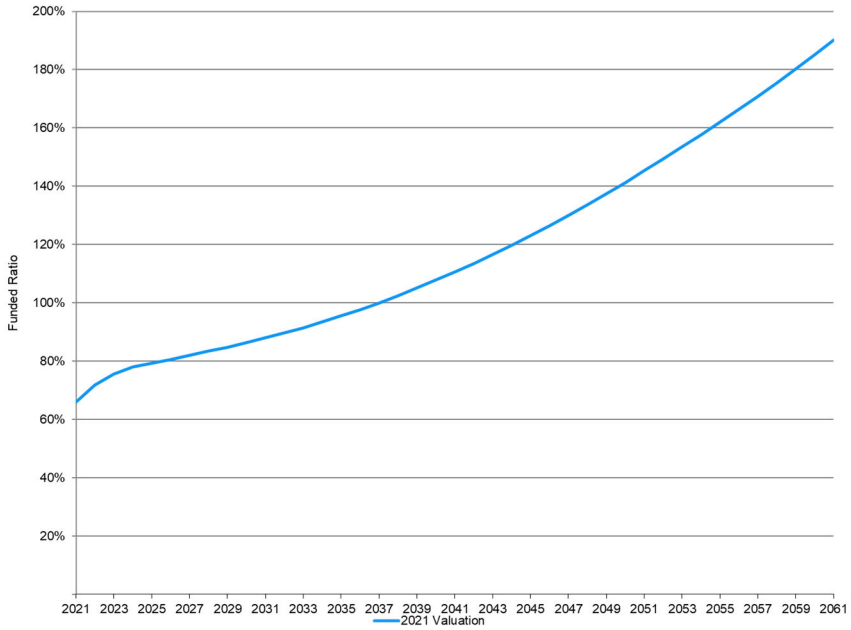
Funded Ratio – School Division

Segal



The School Division achieves 100% funding as of 12/31/2037, which is 16 years from the valuation date.

Buck

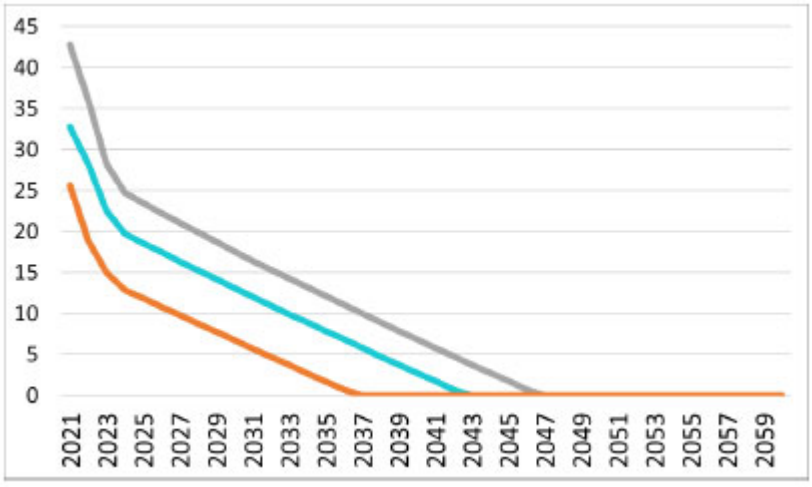


The School Division achieves 100% funding as of 12/31/2037, which is 16 years from the valuation date.

Schedule D – Comparison of Actuarial Projections

Estimated Number of Years until 100% Funded – School Division

Segal



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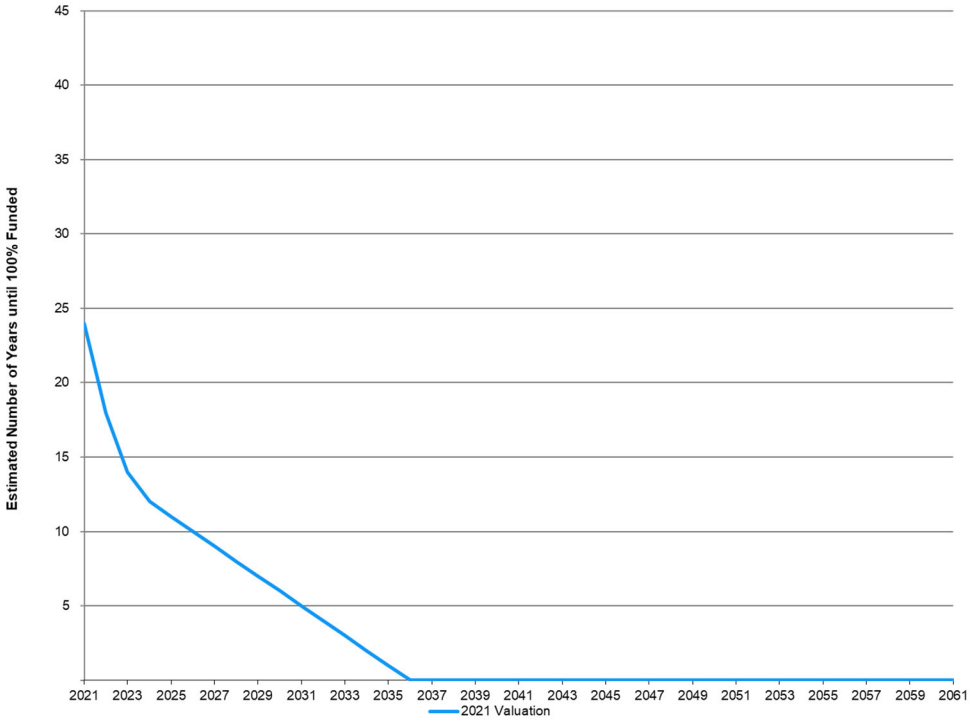
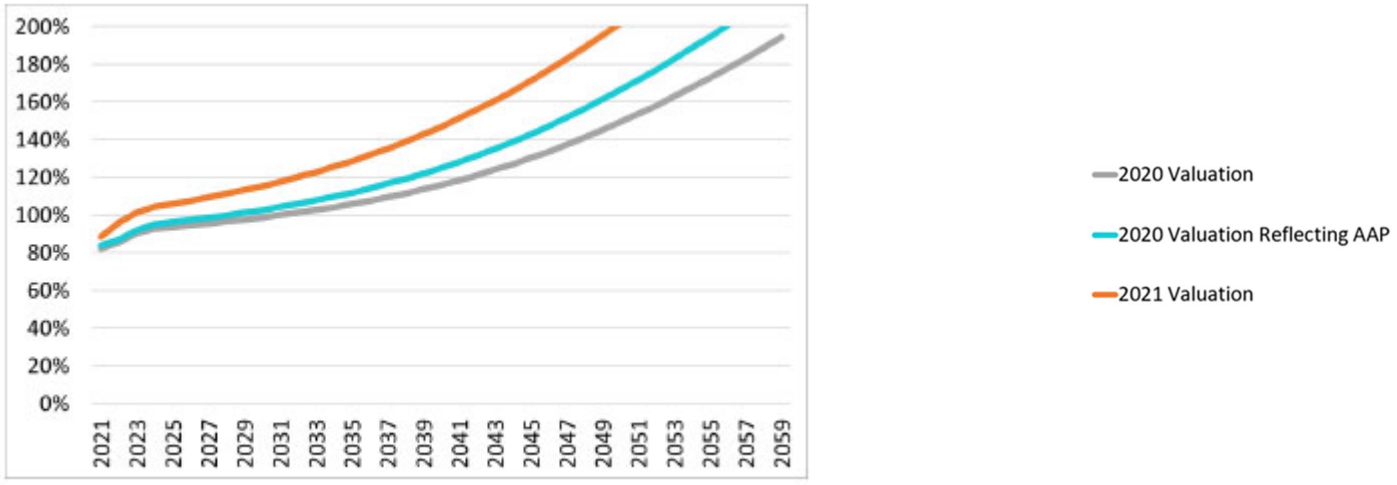


Schedule D – Comparison of Actuarial Projections

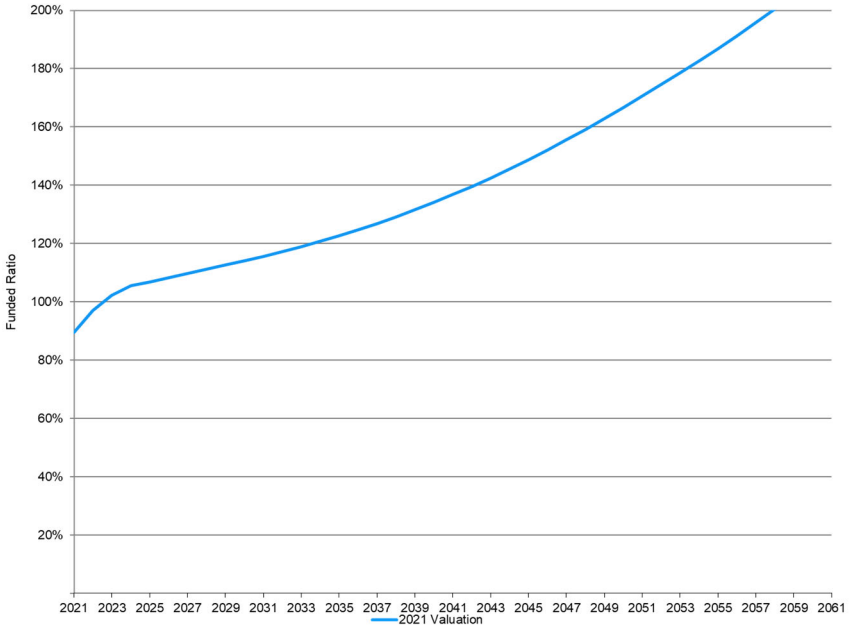
Funded Ratio – Local Government Division

Segal



The Local Government Division achieves 100% funding as of 12/31/2023, which is 2 years from the valuation date.

Buck

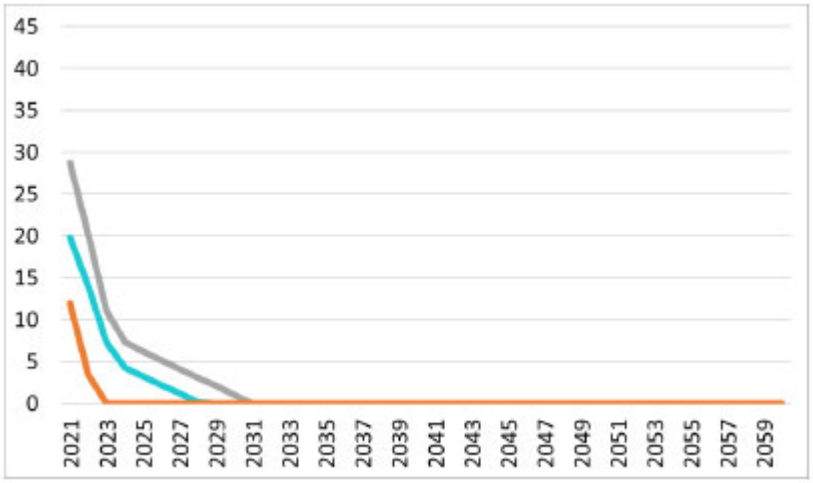


The Local Government Division achieves 100% funding as of 12/31/2023, which is 2 years from the valuation date.

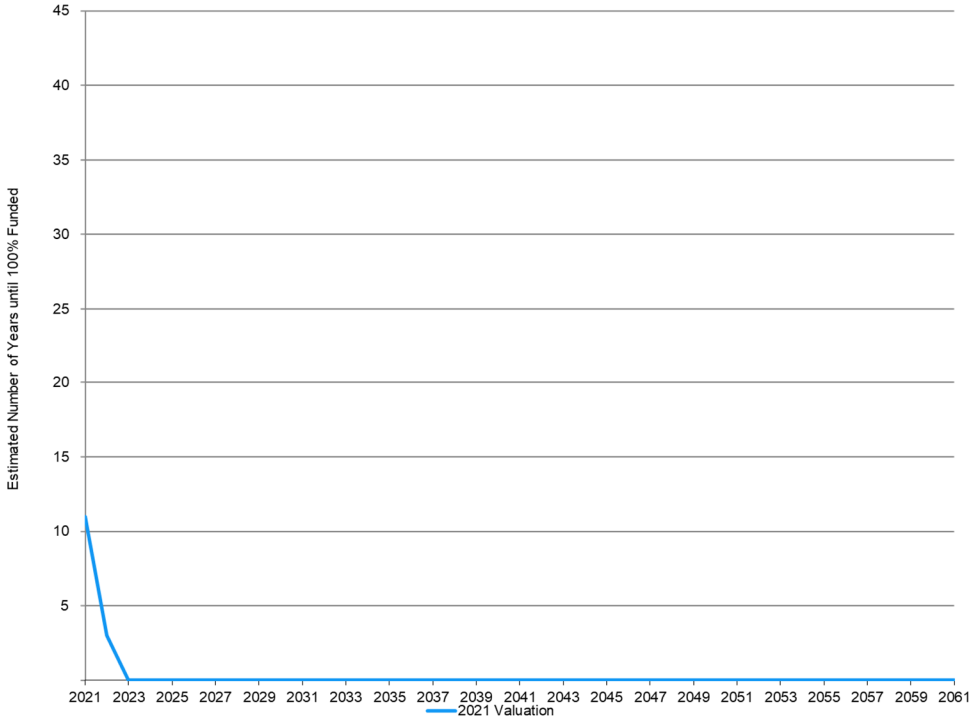
Schedule D – Comparison of Actuarial Projections

Estimated Number of Years until 100% Funded – Local Government Division

Segal



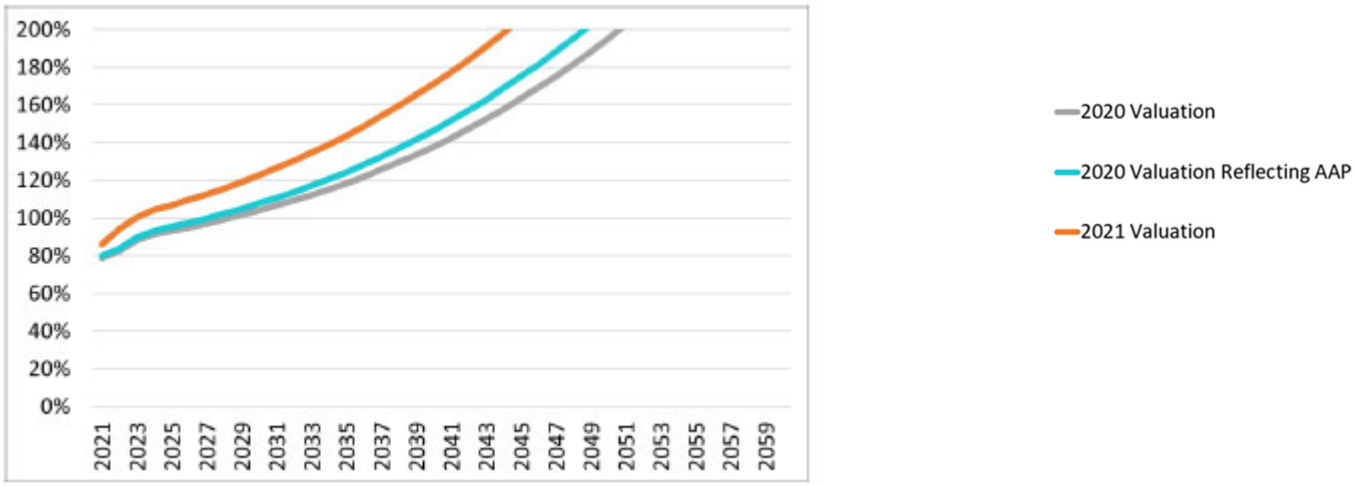
Buck



Schedule D – Comparison of Actuarial Projections

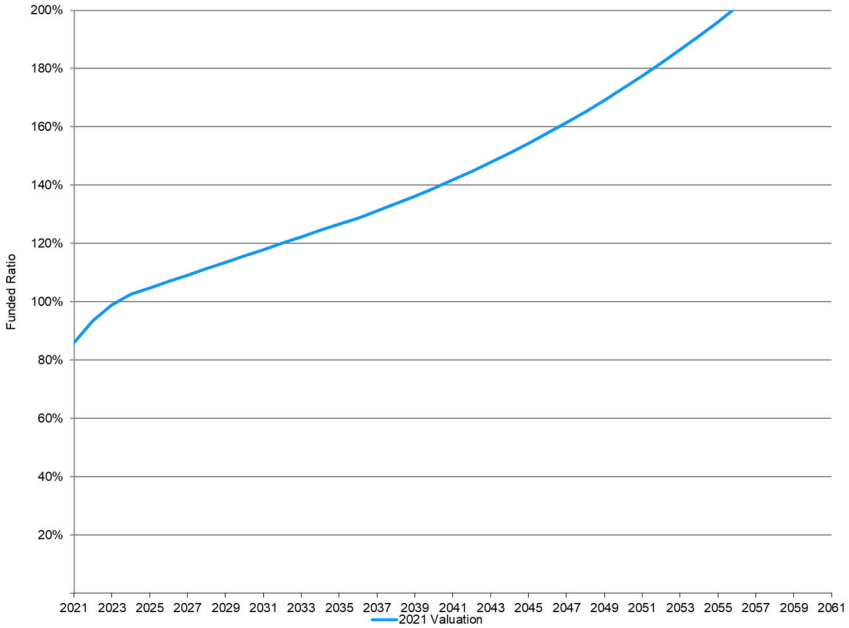
Funded Ratio – Judicial Division

Segal



The Judicial Division achieves 100% funding as of 12/31/2024, which is 3 years from the valuation date.

Buck

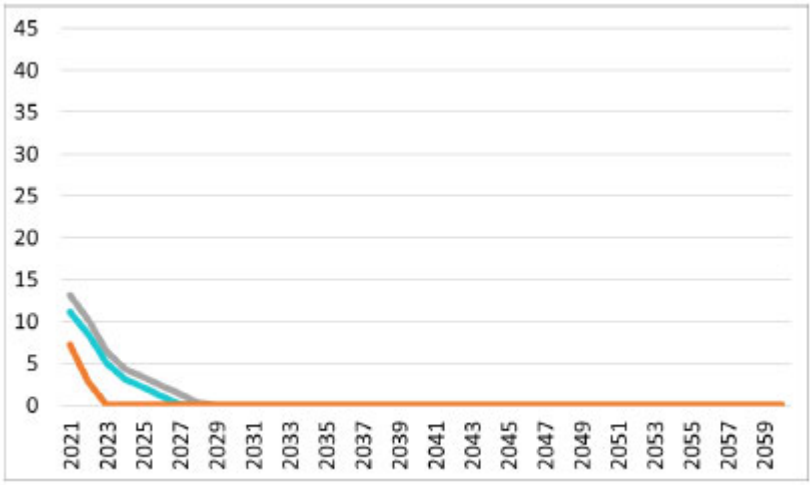


The Judicial Division achieves 100% funding as of 12/31/2024, which is 3 years from the valuation date.

Schedule D – Comparison of Actuarial Projections

Estimated Number of Years until 100% Funded – Judicial Division

Segal



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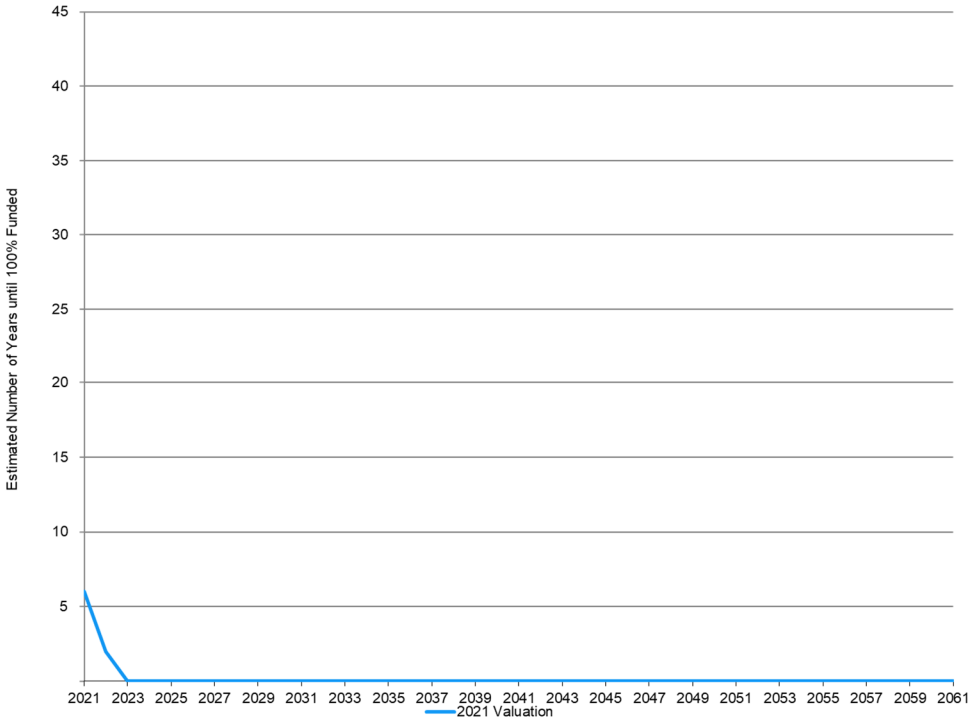
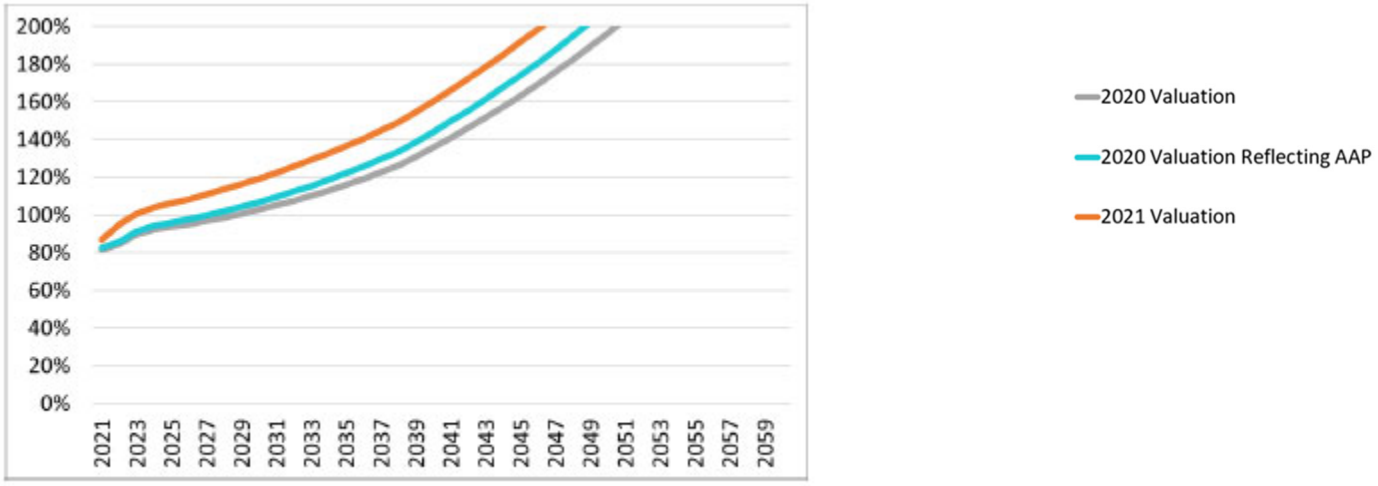


Schedule D – Comparison of Actuarial Projections

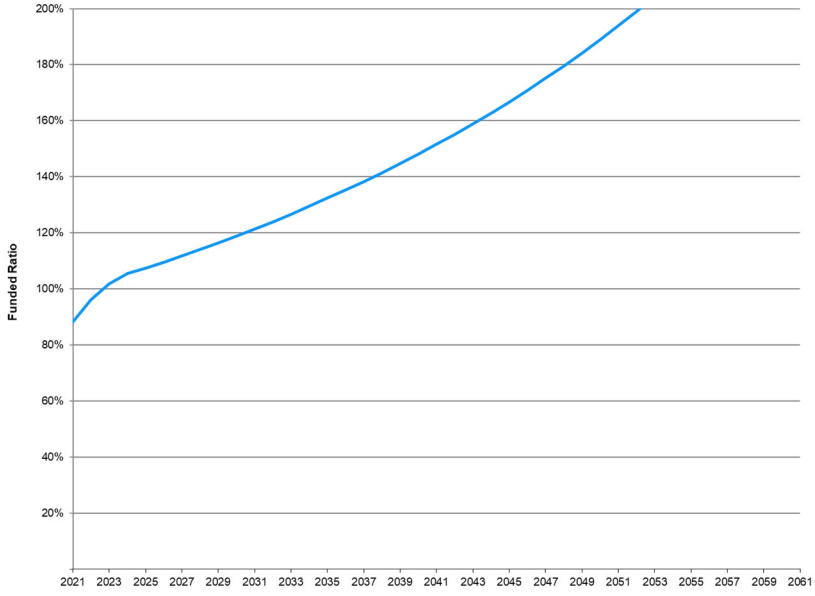
Funded Ratio – Denver Public Schools Division

Segal



The Denver Public Schools Division achieves 100% funding as of 12/31/2023, which is 2 years from the valuation date.

Buck

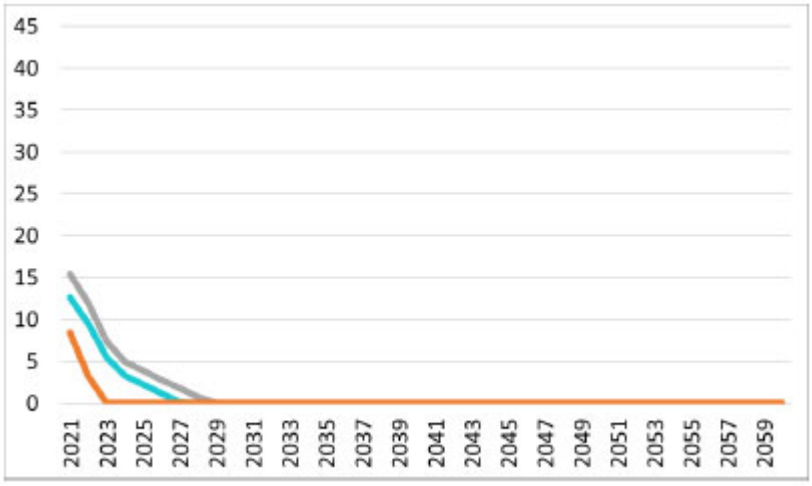


The Denver Public Schools Division achieves 100% funding as of 12/31/2023, which is 2 years from the valuation date.

Schedule D – Comparison of Actuarial Projections

Estimated Number of Years until 100% Funded – Denver Public Schools Division

Segal



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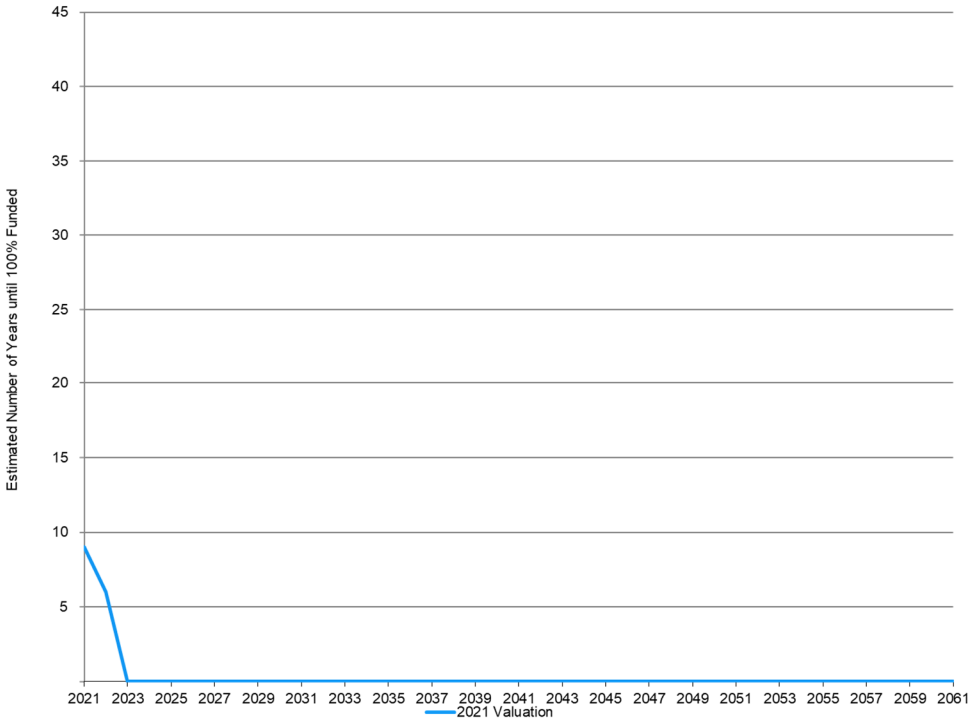
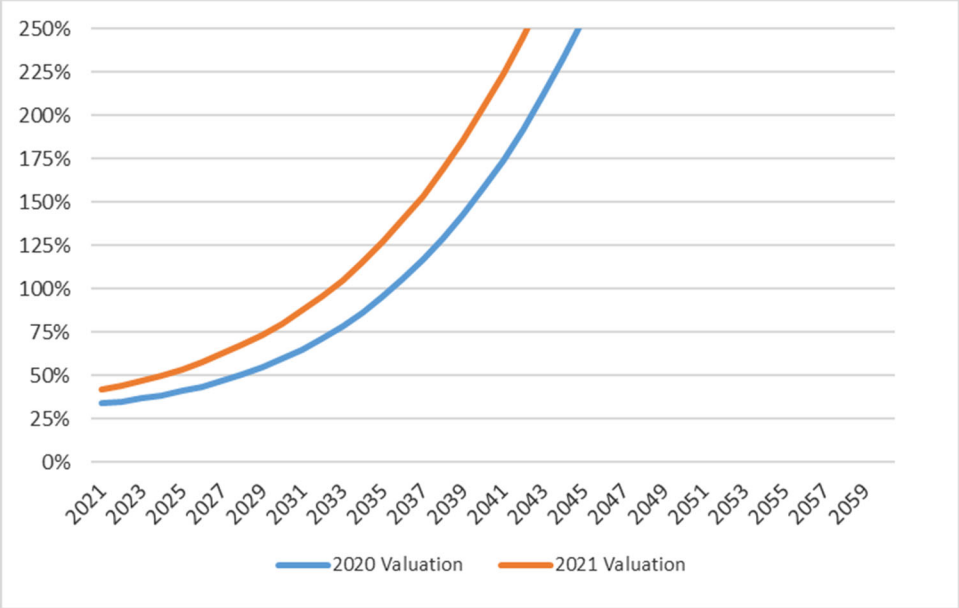


Schedule D – Comparison of Actuarial Projections

Funded Ratio – Health Care Trust Fund

Segal



The Health Care Trust Fund achieves 100% funding as of 12/31/2033, which is 12 years from the valuation date.

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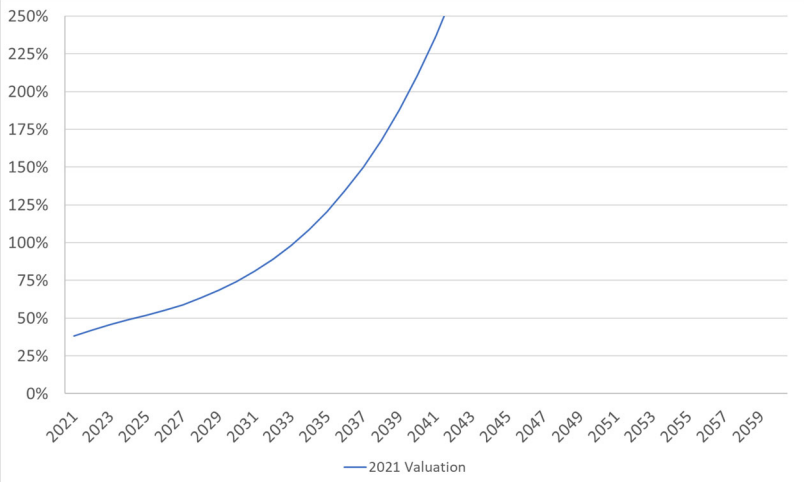
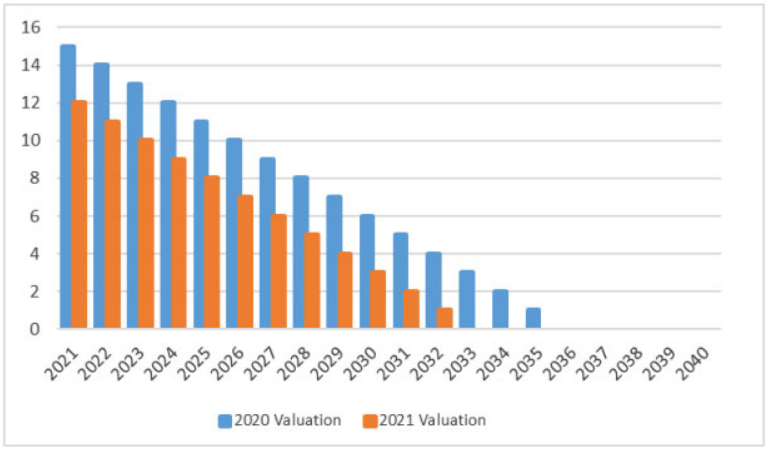


The Health Care Trust Fund achieves 100% funding as of 12/31/2034, which is 13 years from the valuation date.

Schedule D – Comparison of Actuarial Projections

Estimated Number of Years until 100% Funded – Health Care Trust Fund

Segal



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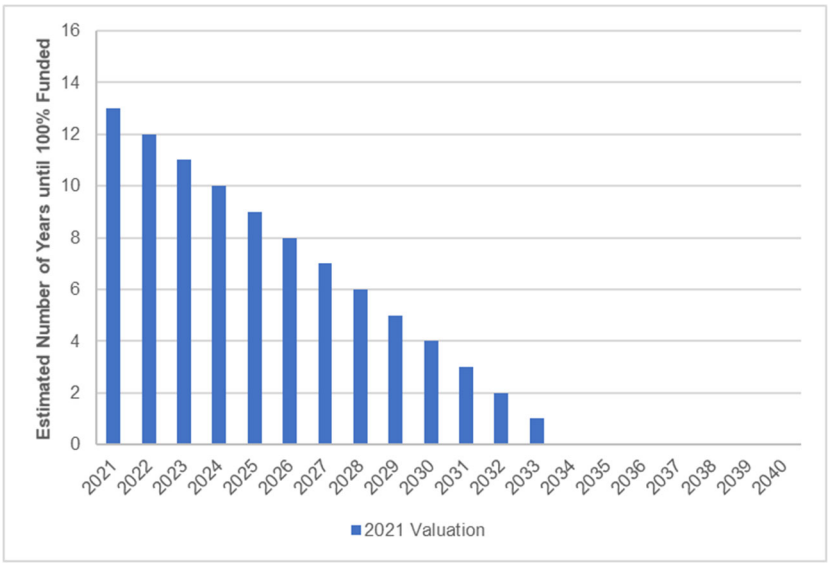
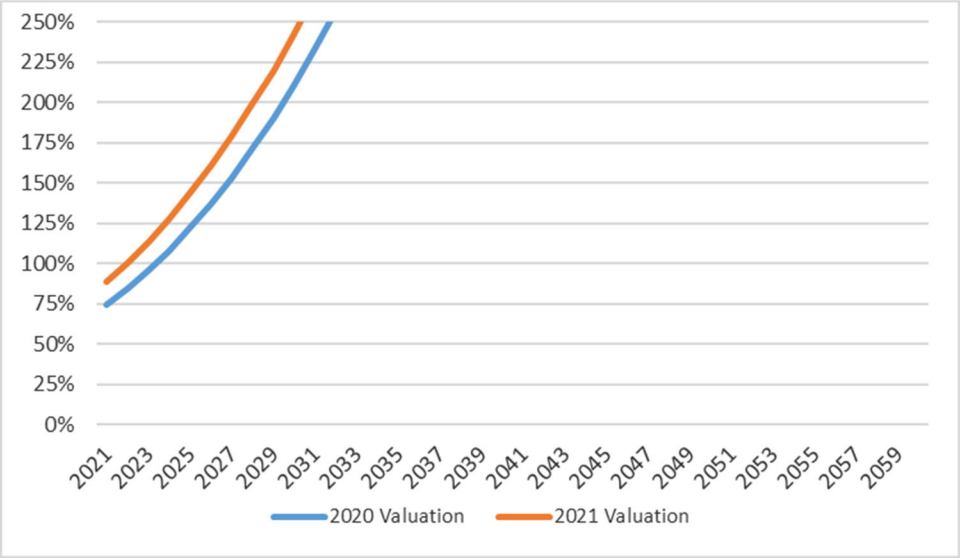


Schedule D – Comparison of Actuarial Projections

Funded Ratio – Denver Public Schools Health Care Trust Fund

Segal



The Denver Public Schools Health Care Trust Fund achieves 100% funding as of 12/31/2022, which is 1 year from the valuation date.

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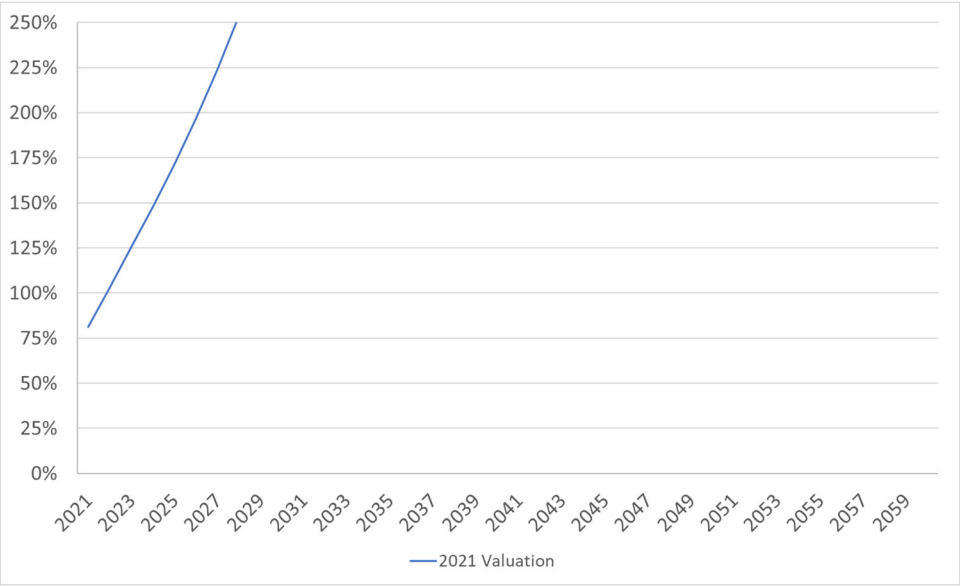
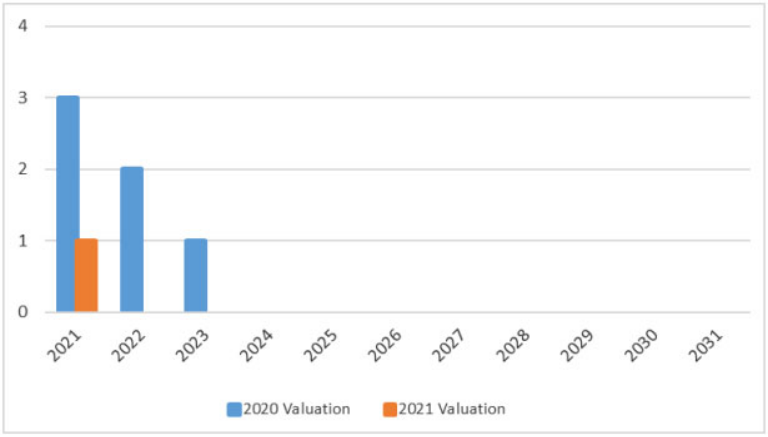


The Denver Public Schools Health Care Trust Fund achieves 100% funding as of 12/31/2022, which is 1 year from the valuation date.

Schedule D – Comparison of Actuarial Projections

Estimated Number of Years until 100% Funded – Health Care Trust Fund

Segal



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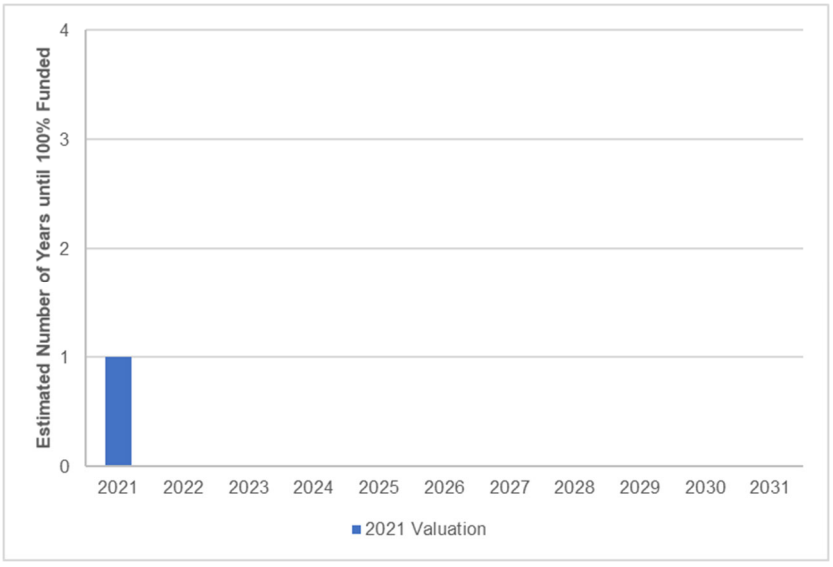

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