



Arizona State Retirement System

AUDIT OF JUNE 30, 2018 ACTUARIAL VALUATION

August 2019



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August 1, 2019

Board of Trustees
Arizona State Retirement System
3300 North Central Avenue, 14th Floor
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Dear Members of the Board:

We are pleased to present the results of this audit of the June 30, 2018 Actuarial Valuations for the Arizona State Retirement System (ASRS) Plan and Long Term Disability (LTD) Program. The purpose of this audit was to verify the calculations completed by Gabriel, Roeder, Smith & Company (GRS) and to offer comments on the methodology and the results of their actuarial valuations.

This review was conducted by Brad Ramirez, a Fellow of the Society of Actuaries, Member of the American Academy of Actuaries, and an Enrolled Actuary under ERISA, and John Monroe, an Associate of the Society of Actuaries, Member of the American Academy of Actuaries, and an Enrolled Actuary under ERISA. This review was conducted in accordance with the standards of practice prescribed by the Actuarial Standards Board.

The assistance of GRS and ASRS is gratefully acknowledged.

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

We appreciate the opportunity to serve as an independent actuarial advisor to ASRS's Board of Trustees, and we are available to answer any questions you may have on this report.

Sincerely,

A blue ink signature of Brad Ramirez, written in a cursive style.

Brad Ramirez, FSA, MAAA, FCA, EA
Vice President and Actuary

A blue ink signature of John Monroe, written in a cursive style.

John Monroe, ASA, MAAA, EA
Vice President and Actuary

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Summary of Findings and Recommendations

This report has been prepared by Segal Consulting (Segal) to present an audit of the June 30, 2018 Actuarial Valuations for the ASRS Plan and LTD Program performed by GRS for ASRS.

Summary of Results

This audit report includes an independent reproduction of the detailed valuation results that appear in the June 30, 2018 valuation reports prepared by GRS. This audit was based on actuarial reports, employee data and supplemental information provided by both ASRS and GRS.

We have performed this actuarial audit of ASRS's June 30, 2018 Actuarial Valuations to provide assurance to ASRS's Board of Trustees that the actuarial calculations are reasonable and that the actuarial process was conducted according to generally accepted actuarial principles and practices.

Our audit confirms that the results of the actuarial calculations as of June 30, 2018 are reasonable, and that those calculations are based on generally accepted actuarial principles and practices.

Our findings and recommendations are summarized as follows:

- Our first focus was on matching the core numbers on which the plans' ultimate costs depend: the Present Value of Future Benefits. The results of this analysis is shown below. We also focused on (i) the correct implementation of the actuarial assumptions as determined by the 2016 Actuarial Experience Study, (ii) the valuation of members hired after July 1, 2011 since important distinctions in plan provisions are applicable to these members and (iii) the determination of the contribution rate after reflecting the phase-in of the impact of the changes in actuarial assumptions from the 2016 experience study.
- Segal's *total Present Value of Future Benefits* for the combined 401(a) and 401(h) portions of the ASRS Plan as of June 30, 2018 is 99.7% of GRS's present value.
- Segal's *total Actuarial Accrued Liability* for the combined 401(a) and 401(h) portions of the ASRS Plan as of June 30, 2018 is 100.1% of GRS's liability.
- Segal's *employer and member contribution rate* for the combined 401(a) and 401(h) portions of the ASRS Plan before reflecting the phase-in of the impact of the assumption changes) as of June 30, 2018 is 98.8% of GRS's rate, resulting in a contribution rate that is 0.15% of pay less than GRS's rate.
 - After reflecting the phase-in, Segal's *employer and member contribution rate* is 97.5% of GRS's phased-in rate, resulting in a contribution rate that is 0.30% of pay less than GRS's rate.
- Our comparison of the demographics of the 2018 data provided by ASRS with the valuation data used by GRS for the June 30, 2018 actuarial valuations indicates that GRS made some

changes to the original data before the valuation was performed. These changes were based on discussions that GRS has with ASRS staff each year to ensure that all data elements are properly applied when measuring the liabilities. We have included a few comments in Section II under Step 1 regarding the data process. We understand that GRS has discussed these comments with ASRS staff to confirm the appropriate treatment of the data in the valuation.

- We reviewed the actuarial assumptions used in the valuation and believe that the assumptions are reasonable for use in the actuarial valuation and in compliance with the Actuarial Standards of Practice. This review is discussed in further detail in Section II under Step 5.
- For the investment rate of return assumption, GRS recommended a decrease from 8.00% to 7.50% in the last experience study. As an independent check, we applied two different models to review the 7.50% investment return assumption. Under one of the models, the 7.50% investment return assumption is reasonable and complies with the Actuarial Standards of Practice (ASOP). However, one of the models indicated that the investment return assumption may be on the high side based upon the underlying target asset allocation. We believe that a further reduction in the assumed real rate of return should be considered during the next experience study.
- GRS includes an explicit assumption for future Permanent Benefit Increases (PBIs) of 0.3% per year for eligible retirees and beneficiaries. This assumption was developed in the 2016 experience study using stochastic modeling based on the standard deviation of the target asset allocation using historical volatility. We strongly concur with GRS' introduction of this assumption as part of the 2016 experience study. In prior valuations, this provision was not valued in calculating the liabilities or the contributions.
 - Our modeling indicates that future PBIs could be larger than the current 0.3% assumption. However, we acknowledge that this assumption is significantly impacted by the expected return and standard deviation of the portfolio used in the modeling. In addition, the amounts of deferred investment gains and losses at the time the modeling is performed also have a significant impact on the results. We recommend that this assumption continue to be carefully monitored.
- We also have a few other comments regarding the valuation of PBIs that are shown under Step 5 in Section II. We recommend that GRS consider these issues when setting the assumption for future PBIs in the next experience study and valuing these increases in future actuarial valuations.
- The UAAL is funded as a level percentage of payroll using a “layered” approach. The amortization period for the 401(a) portion of the benefits is 30 years, with each year's changes amortized over a closed period. Based on this methodology, the UAAL for each new layer actually increases for 7 years. The UAAL also does not fall below the original amount until the 14th year, which is about half way into the amortization schedule. This effect of “negative amortization” is not uncommon in public pension plan funding. The stakeholders should be aware of the risks in this approach.
 - In recent years, a number of parties have issued papers with guidance on setting funding policies. These include the California Actuarial Advisory Panel (CAAP), Conference of Consulting Actuaries Public Plans Community (CCA) and the Government Finance

Officers Association (GFOA). A 30-year amortization is a non-recommended practice under both the CAAP and the CCA papers and falls outside the recommended range in the GFOA paper.

- We recommend that the UAAL amortization policy, particularly the UAAL amortization period, be reviewed with the ASRS Board. If the Board decides to transition to a shorter amortization period it could be done on a prospective basis. This would allow the current amortization layers to continue under their current schedules.
- The asset smoothing method used applies a 10-year smoothing for all investment gains/losses on a market value basis (as compared to the assumed return), with each annual gain or loss recognized over a 10-year period at the rate of 10% per year. However, offsetting unrecognized gains and losses are immediately recognized, with the shortest remaining bases recognized first and the net remaining bases continue to be recognized on their original timeframe. There is no corridor around the Market Value of Assets (MVA), so there is no restriction on how far the Actuarial Value of Assets (AVA) may vary from the MVA.
- This methodology will generally result in the AVA staying relatively close to the MVA, except in a period of sustained actuarial gains or losses, which is why we believe consideration should still be given to adding a “corridor” of at most 30%, where the AVA is limited to be within 70% and 130% of the MVA. The addition of a 30% corridor would also be consistent with the GFOA, CAAP and CCA papers described earlier regarding setting funding policies.
 - In addition, based on our experience, the immediate recognition of offsetting investment gains and losses is not a common practice for public sector retirement systems and should also be reviewed.
- The ASRS Board elected to phase-in the impact of new actuarial assumptions adopted for the June 30, 2017 valuation over a five-year period. The valuation report includes both the contribution rates before and after the phase-in. The phase-in of the contribution rate impact of assumptions is a common practice for public sector retirement systems. In addition, the impact of the assumption changes is being phased-in and there is no phasing in of the assumption change itself. We concur with this approach.
- However, it is our understanding that the current methodology is phasing in the impact of the assumption changes by first determining their impact on the contribution rate and then increasing the contribution rate calculated under the prior assumptions (both determined as of the time the experience study was adopted) by an equal amount each year over the period of time between experience studies (five years). This means that any impact on the contribution rate due to actuarial experience beginning with the first valuation under the new assumptions is not reflected, or more specifically is being deferred to some future year (presumably when the next experience study is performed).
 - The Board should consider an approach that reflects actuarial gains and losses in each year’s contribution rate instead of just reflecting the impact of the phase-in on the prior year contribution rate. A commonly used phase-in approach reduces the contribution rate (prior to phase-in) by the unrecognized portion of the phase-in at each valuation date. This approach allows for each year’s actuarial experience gains and losses to be treated equally and fully reflected in the contribution rate after phase-in.

- We also reviewed the GRS actuarial valuation reports in detail. We have confirmed that the GRS report contains required disclosures including those necessary to comply with Actuarial Standards of Practice (ASOP). In particular, the June 30, 2018 GRS valuation report already contains information that will be required to be disclosed starting with the June 30, 2019 actuarial valuation in regards to the new ASOP No. 51 regarding assessment of risk.
- Most of our comments on the content of the valuation reports were minor. We believe that the plan provisions described in the actuarial valuation report are overall consistent with governing law and employee handbooks. A list of suggested changes to the valuation report for GRS to consider can be found in Section II under Step 5.

Section I – Purpose and Scope

Purpose of the Actuarial Audit

Segal Consulting has performed an actuarial audit of the ASRS Plan and the ASRS LTD Program as of June 30, 2018 to provide assurance to ASRS's Board of Trustees that the actuarial calculations are reasonable and that the actuarial process was conducted according to generally accepted actuarial principles and practices.

Scope of the Actuarial Audit

The scope of the audit, as described in our Proposal Letter for Actuarial Audit Services, includes the following:

- Comparison of the plan provisions described in the actuarial valuation reports to governing law and employee handbooks for consistency
- Review of the actuarial assumptions to determine the reasonableness of assumptions and compliance with the Actuarial Standards of Practice
- Review of the actuarial funding policy to assess whether it is reasonable and appropriate
- Review of the actuarial valuation reports and provide recommendations for improvement, if applicable
- Comparison of the census data used by the actuary for the valuations to the census data provided by the System to assess whether the valuation census data is reasonable and consistent with the System data
- Review of detailed sample test life output, supplied by the System actuary, to determine if the calculations are accurate and reasonable
- Review of any unique aspects of the valuation process, as requested by the System
- A complete reconstruction of the valuation data file from the census data provided by the System
- A parallel valuation in which all of the plan liabilities are recalculated

Section II – Results

Results of the Actuarial Audit

Several steps are involved in conducting an actuarial audit of a retirement benefits program. Outlined below are the primary steps we took to comply with the scope of the audit services. Following each step is a description of our observations.

Step 1: Compare the demographics of the 2018 data provided by ASRS with the valuation data used by GRS for the June 30, 2018 Actuarial Valuations.

Results

Exhibit A provides a comparison of the number of participants, their average ages, average salaries (active members), average service (active members) and average benefits (pensioners). This exhibit indicates that GRS had to make some adjustments, estimations or corrections to the data received from ASRS. In general, the data received by GRS was not entirely “valuation ready.” Changes made to the data were based on discussions that GRS has with ASRS staff each year to ensure that all data elements are properly applied when measuring the liabilities. Overall, our comments below would not have a significant effect on the valuation results, but should be considered by GRS in the 2019 valuation.

Observations

1. There were approximately 1,000 records that were included on the “Critical Period Non Ret File.xlsx” file with a status of “Inactive”. They are all listed with a “drop date” that was after the date of the valuation (i.e., June 30, 2018). We were unable to locate these members in the valuation data files provided by GRS. If these are members that were due a refund of contributions, and the contribution refunds were not reflected in the financial statements as of June 30, 2018, then a liability for the value of their contributions should be included in the valuation. It is our understanding that GRS has had discussions with ASRS staff regarding the appropriate treatment of the data for these members and that these members are being accurately reflected in the valuation.
2. There were approximately 800 records that were included on the “ACTUAR_SUSPEND_FYE2018.xlsx” file that we were unable to locate in the valuation data files provided by GRS. It is our understanding that the members on this file are “members that were suspended and entitled to a continuing benefit”. We note that about 700 of these members were coded as deceased. It is our understanding that GRS has also had discussions with ASRS staff regarding the appropriate treatment of the data for these members and that these members are being accurately reflected in the valuation.
3. GRS provided us a document which detailed the methodology that they use to calculate a “smoothed salary”, which is then projected to calculate the valuation payroll. For the majority of members, they average the “annualized earnings” from the last two years and project forward with ½ year of the applicable salary scale.

- a. We were able to replicate this process and match the smoothed salary for the majority of members. However, we note that GRS is using the “Gross Salary” as reported by ASRS, without any adjustment to a full-time equivalent or annualized basis. While we believe this to be a reasonable method for the majority of active members, there are some members who, through this methodology, might still be valued with an artificially low salary. We recommend GRS review their procedure and determine whether the “Gross Salary” should first be adjusted to an annualized basis or certain other adjustments to the compensation data should be made.

Step 2: Develop a valuation program based on the relevant provisions of the Arizona Revised Statutes as summarized in the Summary Plan Descriptions, using the actuarial methods and assumptions outlined in the most recent valuation report, and further defined by GRS.

Observations

1. We modified our valuation software so that it more closely mimics the middle of the plan year timing of decrements used by GRS.
2. Our valuation program reflects all of the current actuarial assumptions that were adopted as part of the 2016 experience study.
3. Our valuation program also reflects the distinctions in plan provisions that apply to members hired on or after July 1, 2011. This includes the five-year period for determining average monthly compensation and the changes to retirement eligibility.

Step 3: Run the valuation program with specific individuals (test lives) who illustrate particular benefit provisions and compare results to GRS’s results.

Results

Exhibit B provides a comparison of Segal’s and GRS’s test life results for the present value of future benefits.

- *Present Value of Future Benefits (PVB)*: This liability represents the current value of the member’s projected benefits, recognizing the time value of money (discounted using the investment return assumption), the salary increase assumption and the probabilities of retirement, death, disability and turnover. This value is the cornerstone for the entire valuation as it represents the amount needed to provide all future expected benefit payouts for current members, based on the valuation assumptions.
 - The ratios of Segal’s results to GRS’s results, on a total present value of future benefits basis, range from 94% to 102% for the active test lives and 100% to 101% for the inactive and retired test lives.
 - We believe our results for these testlives are within an acceptable range of GRS’s results to provide assurance that the significant plan liabilities are properly valued.

Observations

1. Segal's valuation system generally assumes active members decrement (i.e., retire, terminate, etc.) at the beginning of each plan year (July 1). The GRS system, in contrast, assumes decrements occur in the middle of the year (January 1). As part of this audit for ASRS, we have changed our timing of the decrement to allow for the middle of the year timing for the decrements assumed by GRS. Either methodology is acceptable, with each actuarial firm establishing its own approach for the assumed timing of decrements.
2. Some differences in the results are expected due to differences between Segal and GRS's valuation systems. Differences could include such things as the rounding used in the calculations of ages or the assumed timing for salary increases or benefit payments. Various methodologies are acceptable, with each actuarial firm establishing its own approach. Given the differences in the valuation systems, we would not expect to match GRS's results exactly.
3. The actuarial assumptions adopted by the Board of Trustees in conjunction with the 2016 experience study were used to value the test lives.

Step 4: Run the valuation program with all participant data, compile results, and compare to GRS's results.

Results

Exhibit C provides a comparison by Plan of Segal's results and GRS's results including (i) the present value of future benefits, (ii) the actuarial accrued liability, (iii) the unfunded actuarial accrued liability (UAAL), (iv) the total (employer plus member) contribution rate, (v) the member contribution rate and (vi) the employer contribution rate.

- Arizona State Retirement System – Funding 401(a) Plan
 - In total, the present value of future benefits determined by Segal is 99.7% of the amount determined by GRS.
- Arizona State Retirement System – Funding 401(h) Plan
 - In total, the present value of future benefits determined by Segal is 99.5% of the amount determined by GRS.
- Arizona State Retirement System – Long Term Disability Program
 - In total, the present value of future benefits determined by Segal is 96.9% of the amount determined by GRS.
- The funding method adopted by ASRS, the Entry Age Actuarial Cost Method, separates the present value of future benefits for active members into two components, the actuarial accrued liability and the present value of future normal costs. Simply stated, the Entry Age Actuarial Cost Method determines a level cost as a percentage of pay for each year of service, called the normal cost. The actuarial accrued liability is the accumulated value of past normal costs (less any expected benefits, and assuming all actuarial assumptions were

exactly realized), while the present value of future normal costs represents the current value of future normal costs required to fully fund the member's projected benefits before the member is expected to retire.

- The method used to separate the present value of projected benefits into its two components can differ somewhat between valuation systems, even though the underlying funding method used in the systems is the same.
- The present value of future normal costs is allocated between member contributions and employer contributions. The Segal and GRS valuation systems have slight differences and we would expect minor discrepancies in this allocation.
- The accrued liability also depends in part on the valuation system's methodology for separating the present value of projected benefits into its two components – the actuarial accrued liability (AAL) and the present value of future normal costs. In total, the AAL determined by Segal for the combined 401(a) and 401(h) portions of the ASRS Plan is 100.1% of the amount determined by GRS. The unfunded actuarial accrued liability (UAAL) is simply the difference between the accrued liability and the actuarial value of assets. Therefore, differences in the accrued liabilities due to the variations in the valuation systems also impact the unfunded accrued liabilities.
- Segal's total (employer plus member) normal cost contribution rate for the combined 401(a) and 401(h) portions of the ASRS Plan as of June 30, 2018 is 97.8% of GRS's total normal cost rate.
- Segal's UAAL contribution rate for the combined 401(a) and 401(h) portions of the ASRS Plan as of June 30, 2018 is 100.3% of GRS's rate.
- Segal's member contribution rate for the combined 401(a) and 401(h) portions of the ASRS Plan before reflecting the phase-in of the impact of the assumption changes) as of June 30, 2018 is 98.8% of GRS's rate.
- Segal's employer contribution rate for the combined 401(a) and 401(h) portions of the ASRS Plan before reflecting the phase-in of the impact of the assumption changes as of June 30, 2018 is 98.8% of GRS's rate.
- Segal's member contribution rate for the combined 401(a) and 401(h) portions of the ASRS Plan after reflecting the phase-in of the impact of the assumption changes) as of June 30, 2018 is 97.5% of GRS's rate.
- Segal's employer contribution rate for the combined 401(a) and 401(h) portions of the ASRS Plan after reflecting the phase-in of the impact of the assumption changes as of June 30, 2018 is 97.5% of GRS's rate.

Observations

1. In determining the UAAL contribution rate, GRS uses a methodology that first projects the outstanding balances of the various UAAL layers to the next valuation date (i.e. one year in the future). Based on those projected outstanding balances and the remaining amortization periods as of that same date, they determine the UAAL amortization payments for each

layer. The total of these amortization payments is then converted to a percent of the expected payroll for the year that begins on the next valuation date. It is our understanding that the purpose of this methodology is to adjust for the one-year delay between the valuation date and the date that the contribution rates are implemented. We believe that the methodology they are applying is reasonable for this purpose.

2. There are some differences in the methodology used by Segal and GRS to phase-in the impact of the assumption changes from the 2016 experience study. This is discussed in further detail below under Step 5, where we comment on the methodologies used in the GRS valuation report.

Step 5: Evaluate the valuation results, assumptions and methodologies as presented in the GRS actuarial valuation reports.

Observations

We reviewed the actuarial assumptions used in the valuation and believe that the assumptions are reasonable for use in the actuarial valuation and in compliance with the Actuarial Standards of Practice. The focus of our comments regarding the actuarial assumptions is to comment on those items which, in our opinion, are subject to improvement, so as to contribute to the improvement of the experience study process.

Investment Return Assumption

- For the investment rate of return assumption, GRS recommended reducing the assumption from 8.00% to 7.50%, net of investment related expenses in the 2016 experience study.
- In their review of the investment return assumption, GRS used capital market assumptions from NEPC (the system's investment consultant), a survey of four investment consulting firms maintained by GRS and also a survey from Horizon Actuarial Services. GRS also used the target asset allocation from 2017.
- Models used by actuarial firms to develop a discount rate can be based on expected or mean arithmetic average returns, which correspond to an expected or mean level of future assets. In other words, if a retirement system uses the expected arithmetic average return as the discount rate in the funding valuation, that retirement system is expected to have no surplus or asset shortfall relative to its expected obligations assuming all actuarial assumptions are met in the future. Models can also be based on median geometric average returns and we believe that GRS is developing a discount rate using this approach, which correspond to a median level of future assets.
 - What is not commonly understood is that both of these approaches recognize that when returns are volatile, the compound or "geometric" historical returns will be less than the simple arithmetic average of the year-by-year historical returns. The difference is best understood by focusing on the assets that are expected to accumulate to fund the system's liabilities, rather than the average future investment returns. Because of the (small) possibility of very high returns, the expected value (probability-weighted outcome) of future assets is higher than the median value (50/50 chance) of future assets. This means, somewhat counter-intuitively, that "expecting" to have future assets that match your

future liabilities is not the same as there being a 50/50 chance of having future assets higher or lower than those liabilities.

- When setting the investment return assumption, we believe that both approaches are permitted under ASOP No. 27 “Selection of Economic Assumptions for Measuring Pension Obligations.”
- Most of the capital market assumptions used by GRS produced an expected compound geometric return in the range of 6.80% to 7.30%. The expected returns varied depending on the source of the capital market assumptions and the time horizon.
- As an independent check, Segal has applied a model based on arithmetic returns that we use for our public retirement systems to review the 7.50% investment return assumption. While, our model does not generally produce an absolute investment return recommendation, it is very useful for comparing the level of risk inherent in the investment return assumptions adopted by a given retirement system at different points in time or with other retirement systems that have previously been analyzed using that model.
 - This model is based on an average of a sample of arithmetic real rate of return assumptions provided to us by seven investment advisory firms retained by Segal’s public sector clients. We believe these averages are a reasonable consensus forecast of long-term future market returns in excess of inflation by asset class. Our model is based on the target asset allocation that was adopted in 2018 and is slightly different than the allocation used by GRS in their 2016 experience study.
 - Based on the application of our model, we believe that the level of risk implicit in the 7.50% investment return assumption, along with a 2.30% price inflation assumption, is higher when compared to recommendations we have made to other retirement systems. In particular, based on this model, the confidence level associated with meeting the 7.50% assumption is less than 50%. The assumed real rate of return of 5.20% is generally higher than that used by our other clients. We believe that a reduction in the assumed real rate of return should be considered during the next experience study, based upon the current target asset allocation.
- The model that we use includes a reduction for expected investment expenses. Those investment expenses are based on recent actual investment expenses and represent about 0.6% of assets. It is unclear whether the GRS model makes an adjustment for investment expenses, but we believe that they do not as there was no mention of those expenses in the development of the rate of return assumption.
 - This may be because the expected returns used are based on portfolio benchmark indices, which are expected to have minimal expenses. Or it may be because most of the investment expenses are associated with active portfolio management expenses. As allowed under ASOP No. 27, it can be assumed that additional returns (“alpha”) are earned to offset the active management expenses. We recommend that GRS consider clarifying their treatment of investment expenses in their recommended investment return assumption as part of the next experience study.
- In recent reviews of the investment return assumption that we performed for our clients, we have also applied an alternative model that is based on forward looking expected geometric returns. Under this model we have not reduced the investment return assumptions to

anticipate future investment expenses. We believe that this model is more consistent with the model used by GRS to develop their recommendations in the 2016 experience study.

- For comparison purposes, we evaluated the 7.50% assumption based on the expected geometric average return for the entire portfolio, gross of investment expenses. Note that this alternative model uses a different set of capital market assumptions based on a survey maintained by Horizon Actuarial Services. Under that model, over a 20-year period, there is a 53% likelihood that future average geometric returns will meet or exceed 7.50%.¹ Therefore, we believe that the current 7.50% investment return assumption is reasonable and complies with ASOP No. 27.

Mortality Assumption

- The non-disabled retiree mortality assumptions used by GRS are based on a mortality table constructed using actual ASRS experience. The table was developed on a benefit-weighted basis since benefit amounts are a significant predictor of life expectancy. Future mortality improvement is projected on a generational basis using the ultimate mortality improvement rates found in the MP projection scales. While we do not have the underlying data that was used to construct the table, we concur with GRS's description of the development of the mortality assumption and believe it is reasonable.
- The Retirement Plans Experience Committee (RPEC) of the Society of Actuaries has recently published the Pub-2010 Public Retirement Plans Mortality tables (Pub-2010). For the first time, the Pub-2010 mortality tables are based exclusively on public sector pension plan experience in the United States. Within the Pub-2010 family of mortality tables, there are separate tables by job categories of General, Safety and Teachers.
 - In the next experience study, we recommend that GRS consider whether to use these new mortality tables along with setting the mortality tables based on job class for members in the ASRS.
 - GRS should also consider using the latest MP projection scale without adjustment unless there is sufficient plan experience to justify an alternative assumption. We note that GRS included justification for using the ultimate mortality improvement rates in the previous experience study.

Assumption for Future Permanent Benefit Increases (PBIs)

- GRS includes an explicit assumption for future PBIs of 0.3% per year for eligible retirees and beneficiaries. This assumption was developed in the 2016 experience study using stochastic modeling based on the standard deviation of the target asset allocation using historical volatility. In the assumptions section of the actuarial valuation report GRS notes that "In an effort to support contribution stability, assumed PBIs are accumulated across successive valuations and reduced when actual PBIs are paid."

¹ We performed this stochastic simulation using the capital market assumptions included in the 2018 survey prepared by Horizon Actuarial Services. That simulation was performed using 10,000 trial outcomes of future market returns, using assumptions from 20-year arithmetic average returns, standard deviations and correlation matrix that were found in the 2018 survey that included responses from 34 investment advisors.

- We concur with the use of stochastic modeling to model the impact of this plan provision. We also concur with the inclusion of an explicit assumption for future PBI increases in the actuarial valuation. On page C-10 of the 2016 experience study, GRS includes a table that shows that the assumption for future PBI increases is dependent on whether the investment return assumption is 8.00%, 7.75% or 7.50%. This assumes that if there were three different asset allocations or sets of capital market assumptions that produce these expected investment returns, then the impacts on the assumed future PBIs will differ. We agree with GRS that different assumptions regarding future investment returns will result in different assumptions for future PBI increases.
- We performed our own stochastic modeling of future investment returns. Our modeling indicates that future PBIs could be larger than the current 0.3% assumption. However, we acknowledge that this assumption is significantly impacted by the expected return and standard deviation of the portfolio used in the modeling. In addition, the amounts of deferred investment gains and losses also have a significant impact on the results. When GRS performed this analysis back in 2017, there were significant amounts of deferred losses to recognize which would suppress future allocation of investment earnings to PBIs. There are now significant deferred gains for future recognition as of the June 30, 2018 valuation. All other things being equal, this increases the potential for future allocations of investment earnings to PBIs. We recommend that this assumption continue to be carefully monitored.
- The PBI assumption may warrant more frequent review since it depends on past investment experience (deferred gains or losses) as well as future expectations for asset returns and volatility. Most importantly, though, we strongly concur with GRS' introduction of this assumption as part of the 2016 experience study. In prior valuations, this provision was not valued in calculating the liabilities or the contributions.
- In applying this assumption, our understanding is that GRS applies a PBI of 0.3% per year starting with the July 1 following the valuation date (i.e., July 1, 2018 for the June 30, 2018 valuation). However, GRS should consider reflecting known information about future PBIs as of the valuation date.
 - For example, the actual PBIs as of July 1, 2018 (0%) and July 1, 2019 (0%) were already known based on the June 30, 2017 and June 30, 2018 valuations, respectively. It was also known in the June 30, 2018 valuation that an amount equal to \$62.6 million will be allocated to the July 1, 2020 PBI. GRS should consider including a liability equal to this amount in the June 30, 2018 valuation for the July 1, 2020 PBI. Future PBIs could then be projected after that date at 0.3% per year.

Other Assumptions

- GRS assumes that 60% of future retirees will elect to receive the post-retirement health insurance premium supplement and that 40% of those retirees will elect the dependent premium supplement. They also implicitly assume that all members over age 65 will have Medicare Part A and B. There was no data shown in the experience study to justify the use of these assumptions.
 - We recommend that GRS include at least some data in the next experience study to justify their assumptions.

- In addition, GRS should consider expanding the description of these assumptions to include that they are applied to members with a health flag but had no benefit amounts reported. GRS should also add their assumption regarding Medicare to their valuation report.
- There is an assumption for Optional Form Load of 0.174% that is added to 401(a) liabilities for non-retired members. In the valuation report, GRS mentions that this assumption is to account for the election of optional forms other than a single life annuity. In correspondence with GRS, they mentioned that the load was established as part of the 2012 experience study. The assumption was not studied in detail in the 2016 experience study. We recommend that GRS perform a more detailed analysis of this assumption in the next experience study and provide disclosure regarding exactly how it is calculated.
 - GRS provided us a file containing the full set of retirement rates used in their actuarial valuation. We note that some of the retirement rates reported in that file were not consistent with the proposed retirement rates shown on pages E-1 through E-3 of the 2016 experience study report. We recommend GRS review the assumptions that they are using to confirm they are consistent with their experience study.
 - When calculating the valuation payroll, GRS generally first projects the member's average salary over the last two years with one-half of a year's worth of the applicable salary scale (based on the member's years of service), and then projects that amount again with a full year's worth of the applicable salary scale.
 - We recommend that GRS consider providing disclosure regarding this process in the assumptions section along with a justification for why 1.5 years of salary scale is applied.
 - Furthermore, we note that the application of the one-half followed by the one year of salary scale was not consistent. For example, for a member with 12.2 years of service, we observed that one half of the **12** years of service salary scale (i.e., 3.30%) was applied, and then one year of the **11** years of service salary scale (i.e., 3.40%) was applied. We suggest GRS review this methodology to confirm that it was intentional to use two different salary scales and to also go backwards in applying their scales (i.e., using 12 years of service and then using 11 years of service).
 - GRS uses three distinct "pop-up" factors, which correlate with members with an optional joint and survivor form of benefit of either 50%, 66.67% or 100%. There was no mention of how these estimates were made (in the experience study or in the valuation). GRS should consider disclosing this in the assumptions section and reviewing these assumptions in the next experience study.
 - GRS uses three distinct estimations to calculate the unreduced benefit amounts, which correlate with members with a certain and life form of benefit with either a 5, 10 or 15 year certain period. There was no mention of how these estimates were made (in the experience study or in the valuation). GRS should consider disclosing this in the assumptions section and reviewing these assumptions in the next experience study.
 - GRS applies a three-year certain period when valuing single life annuities for current and future retirees. This assumption reflects anticipated potential payments for refunds of unused

member contributions. These could potentially be paid if a retired member dies before their accumulated benefit payments exceed their member contributions.

- The description of this assumption in the valuation report makes it sound like this assumption is only applied to inactive members that have terminated employment. Through correspondence with GRS, we understand that this assumption applies to all current and future retirees, and we recommend a note to clarify this assumption going forward.
 - In addition, GRS should review whether or not a three-year certain period is a long enough period since the ASRS member contribution accounts are relatively large and the implied certain period could be much higher for many members.
- GRS has an assumption that there is a three-year age difference between the member and their spouse, with husbands being older than their wives. GRS confirmed that they apply this three-year age difference for current actives when valuing the 401(h) liabilities, but they are not applying the age difference for current inactive members. We recommend that GRS be consistent with the application of this assumption and through our correspondence with GRS they indicated that they plan to update the methodology used for the inactive members in the next valuation.
- GRS should consider mentioning in the valuation report the Internal Revenue Code 401(a)(17) compensation limit currently in effect and the assumption that it will increase by 2.3% per year.

Plan Provisions

- We compared the plan provisions described in the actuarial valuation reports against those found in governing law and employee handbooks for consistency. Overall, we believe that the plan provisions are consistent with governing law and employee handbooks. Our comments are as follows:
- Some of the early retirement factors shown in the GRS valuation report are different from those shown in the Summary of Plan Description found on the ASRS website. For example, ages 58 through 61 for members with 19 years of service differ between the two documents. GRS should review and confirm whether the correct early retirement factors are used.
 - GRS confirmed that they value the benefits associated with the Optional Premium Benefit Program. However, there is no mention of it in the plan provisions. GRS should consider including a brief mention of this benefit in the plan provisions.

Funding Policy

- We reviewed the actuarial funding policy to assess whether it is reasonable and appropriate. The focus of our comments regarding the funding policy is to comment on those items which, in our opinion, are subject to improvement. Our comments are as follows:
- There was a recommendation in the prior actuarial audit completed in 2014 that the ASRS Board consider adopting a formal funding policy. In 2015 a formal funding policy was adopted. By developing a formal funding policy, ASRS has increased transparency

and enabled explicit consideration of each component of the policy. We have provided further comments below focusing on three aspects of the funding policy.

UAAL Amortization Policy

- The UAAL is funded as a level percentage of payroll using a “layered” approach. Under the layered approach each new amount of UAAL is amortized over a separate, fixed (i.e., closed or declining) period. The amortization period for each new layer is 30 years for the 401(a) portion and 15 years for the 401(h) portion and LTD. This approach has the advantage of identifying the source of each dollar of current UAAL, as well as when each portion of UAAL will be fully amortized. We concur with use of the layered approach.
- The vast majority of public plans use level percent of pay amortization where the payments increase each year in proportion to the assumed payroll growth assumption (currently 2.50% per year) for the entire active workforce. That means that the amortization payments start lower than the corresponding level dollar payments, but then increase until they are higher. We concur with the use of level percentage of pay amortization.
- The UAAL amortization periods for public plans typically range from 15 to 30 years. The amortization period should not be set so short that it creates too much volatility in the contributions yet it should not be so long that it constitutes a shift of cost to future funding sources. Balancing these two conflicting considerations is a key element of setting amortization periods. Another consideration (under level percent of pay amortization) is how much and in what circumstances negative amortization is an acceptable consequence of using longer amortization periods.
 - Negative amortization is when the UAAL increases during the early years of the amortization period even though contributions are being made to amortize the UAAL. This happens because with level percent of pay amortization, the lower early payments can actually be less than the interest on the outstanding balance of the UAAL. Under the current set of assumptions for ASRS, this happens whenever the amortization period is 24 years or longer. This means that the outstanding balance of the UAAL does not begin to decrease until the 8th year (i.e., when there are 23 years left in the amortization period). It also means that the outstanding balance will not fall below the original amount until the 14th year, which is about half way into the amortization schedule.
 - Item 1. on page 19 of the June 30, 2018 actuarial valuation for the 401(a) portion shows a UAAL from the previous year of \$15.4 billion. Item 7. shows an expected UAAL for the current year of \$15.8 billion. The difference between these two numbers is very roughly \$400 million and is the negative amortization that was experienced during the 2017/2018 plan year under the UAAL amortization policy.
 - An illustrative comparison of UAAL contributions under different amortization periods is provided in Attachment 1. Attachment 2 shows the outstanding UAAL balances under these same amortization periods using an original UAAL of \$1 billion as an example. While there is nothing inherently wrong with some amount of negative amortization for some period of time, the ASRS Board should be aware of its consequences, especially for level percent of pay amortization that is substantially longer than 20 years, such as the 30-year amortization period that is currently in place. Attachment 2 shows that the

example UAAL balance would increase for 7 years and it does not fall below the original \$1 billion balance until 14 years from the beginning of the amortization.

- Under the prior Governmental Accounting Standards Board (GASB) accounting standards, the maximum allowable amortization period was 30 years for financial reporting. The current GASB standards do not contain specific requirements for funding policy, other than requiring any actuarially determined contributions that the entity chooses to disclose be in accordance with the Actuarial Standards of Practice (which provide a considerable degree of latitude in recommending funding policies). Partly in response to the perceived gap in funding policy guidance, a number of parties have issued papers on this topic, including the selection of amortization periods, in recent years:
 - California Actuarial Advisory Panel (CAAP) – “Actuarial Funding Policies and Practices for Public Pension and OPEB Plans”
 - Conference of Consulting Actuaries Public Plans Community (CCA) – “Actuarial Funding Policies and Practices in Public Pension Plans”
 - Government Finance Officers Association (GFOA) – “Core Elements of a Funding Policy”
- The GFOA paper is the least specific, recommending an amortization period of no greater than 25 years, but ideally in the range of 15 to 20 years. The CAAP and CCA papers both contain detailed (and nearly identical) analysis of the amortization periods for different sources of UAAL, but in brief, their model practices include 15 to 20 years for gains and losses, 15 to 25 years for assumption changes, periods based on demographic matching for plan amendments, and 30 years for any surplus, if applicable. Note that a 30-year amortization period is a “non-recommended” practice under both the CAAP and the CCA papers.
- Based on the above, we recommend that the UAAL amortization policy (particularly the UAAL amortization period) be reviewed with the ASRS Board. If the Board decides to transition to a shorter amortization period it could be done on a prospective basis. This would allow the current amortization layers to continue under their current schedules.

Asset Smoothing Method

- The asset smoothing method used applies a 10-year smoothing for all investment gains/losses on a market value basis (as compared to the assumed return), with each annual gain or loss recognized over a 10-year period at the rate of 10% per year. However, offsetting unrecognized gains and losses are immediately recognized, with the shortest remaining bases recognized first and the net remaining bases continue to be recognized on their original timeframe.
- There is currently no “corridor” around the Market Value of Assets (MVA), so there is no restriction on how far the Actuarial Value of Assets (AVA) may vary from the MVA.
- An essential part of the public sector budgeting process is that material budget items, including pension contributions, should have a level cost pattern from year to year to the extent possible. Segal recognizes the importance of this requirement and assists clients in establishing reasonable methodologies for recognizing investment gains and losses and

limiting the potential volatility that may result in increased contributions due to investment results.

- The actuary's guide for determining the reasonableness of an asset smoothing method is ASOP No. 44. The following is an excerpt from this ASOP that establishes the qualities a reasonable asset smoothing method must exhibit.

From the Actuarial Standard of Practice (ASOP) No. 44:

3.3 Relationship to Market Value - *If the considerations in Section 3.2 have led the actuary to conclude that an asset valuation method other than market value may be appropriate, the actuary should select an asset valuation method that is designed to produce actuarial values of assets that bear a reasonable relationship to the corresponding market values. The qualities of such an asset valuation method include the following:*

- a. Given the inherent volatility in markets, the asset valuation method is likely to produce actuarial values of assets that are sometimes greater than and sometimes less than the corresponding market values.*
- b. The asset valuation method is likely to produce actuarial values of assets that, in the actuary's professional judgment, satisfy both of the following:*
 - 1. The asset values fall within a reasonable range around the corresponding market values. For example, there might be a corridor centered at market value, outside of which the actuarial value of assets may not fall, in order to assure that the difference from market value is not greater than the actuary deems reasonable.*
 - 2. Any differences between the actuarial value of assets and the market value are recognized within a reasonable period of time. For example, a formula addresses differences between the actuarial value of assets and the market value in a manner that, in the actuary's professional judgement, is rational, systematic, and produces an actuarial value of assets that is expected to converge toward market value at a pace that the actuary deems reasonable, assuming constant asset returns in future periods.*

In lieu of satisfying both (1) and (2) above, an asset valuation method could satisfy section 3.3(b) if, in the actuary's professional judgment, the asset valuation method either (i) produces values within a sufficiently narrow range around market value or (ii) recognizes differences from market value in a sufficiently short period.

- Two key principles arise from ASOP No. 44. First, an acceptable asset smoothing approach must create asset values that fall within a reasonable range around market value, and second, that gains and losses are recognized in a reasonable period of time. In lieu of satisfying both of these principles, a smoothing method could satisfy the requirements if, in the actuary's professional judgment, the range around market value is sufficiently narrow or the differences are recognized in a sufficiently short period.
 - We believe that, within the meaning of ASOP No. 44, 10 years may not be a sufficiently short period for the AVA to return to the MVA. This means the AVA must remain within a reasonable range of the MVA. Accordingly, for any of our clients using 10-year asset

smoothing we would recommend the use of a corridor of at most 30% around the MVA in the event there is a sustained period of either gains or losses. This would limit the AVA to be within 70% and 130% of the MVA. We believe this would comply with the ASOP in regards to producing a sufficiently narrow range around the MVA.

- Note that under the method used by ASRS offsetting unrecognized gains and losses are immediately recognized. This “enhancement” to the method was recommended by GRS as part of the 2016 experience study. Page C-22 of the GRS experience study contains the following text:
 - “This method has the benefit of ensuring that any individual gain or loss is recognized in a reasonable timeframe, while eliminating the artificial volatility that is introduced from the more traditional asset smoothing methods.”
 - This methodology will generally result in the AVA staying closer to the MVA, except in a period of sustained actuarial gains or losses, which is why we believe consideration should still be given to adding the corridor. The addition of a corridor would also be consistent with the GFOA and CCA papers described earlier regarding setting funding policies.
 - Since the shortest remaining unrecognized gain and loss bases are offset first, any unrecognized gains or losses will be recognized over a longer period. For example, in the June 30, 2018 valuation report, the only remaining unrecognized gains are to be recognized over 9 and 10 years. This illustrates how this method results in a slow recognition of any net unrecognized gains or losses as they are always spread over the long end of the 10 years.
 - Based on our experience, the immediate recognition of offsetting investment gains and losses in the asset smoothing method is not a common practice amongst public sector retirement systems. Furthermore, because the effective smoothing periods may remain close to 10 years, this method behaves like a “rolling” version of asset smoothing where, for example, investment losses are never fully recognized by the smoothing method but are continually deferred until they are explicitly offset by future investment gains.
 - We believe it may have made more sense to apply the offsetting after all of the deferrals for 2018 had been determined. Instead, GRS applied the offsetting before (i.e., they applied the offsetting to the 2017 deferral amounts for bases established before June 30, 2018), which then effectively changed the net deferral for the 2018 valuation. If GRS would have applied the offset after determination the net deferrals for 2018 would have been unchanged by the offsetting methodology.
- Based on the above, we recommend that the asset smoothing method be reviewed with the ASRS Board. The introduction of a corridor of at most 30% around the MVA should be considered along with additional review and reconsideration of the methodology that immediately recognizes offsetting investment gains and losses.

Phase-in of Impact of Changes in Actuarial Assumptions from 2016 Experience Study

- The ASRS Board elected to phase-in the impact of new actuarial assumptions adopted for the June 30, 2017 valuation over a five-year period. The valuation report includes both the contribution rates before and after the phase-in. The phase-in of the contribution rate impact of assumptions is a common practice for public sector retirement systems. Some systems

routinely phase-in such rate changes whenever assumptions are changed. Furthermore, recent guidance on funding policy from both the CAAP and the CCA views this as an acceptable practice as long as the phase-in period is no longer than the time until the next experience study, which we note is consistent with the current policy.

- In addition, the impact of the assumption changes is being phased-in and there is no phasing in of the assumption change itself. We concur with this approach.
- It is our understanding that GRS is phasing in the impact of the assumption changes by first determining their impact on the contribution rate and then increasing the contribution rate calculated under the prior assumptions (both determined as of the time the experience study was adopted) by an equal amount each year over the period of time between experience studies (five years).
 - The effect of this approach is that any impact on the contribution rate due to actuarial experience beginning with the first valuation under the new assumptions is not reflected, or more specifically is being deferred to some future year (presumably when the next experience study is performed), with the exception of the observation we note below.
 - Based on the projections shown on page 3 of the June 30, 2018 valuation, it appears that GRS may intend to eventually reflect favorable experience by setting the contribution rate equal to the lower of the phased rate and the calculated rate. This approach may therefore be asymmetrical in its treatment of actuarial gains and losses, as we did not observe the contribution increase as a result of the experience losses that occurred in the June 30, 2017 valuation. However, we note that there does not appear to be any explanation in the funding policy or valuation report as to exactly how the phase-in policy will work.
 - GRS should consider an approach that reflects both actuarial gains and losses in each year's contribution rate instead of just reflecting the impact of the phase-in on the prior year contribution rate. A commonly used phase-in approach reduces the contribution rate (prior to phase-in) by the unrecognized portion of the phase-in at each valuation date. This approach allows for each year's actuarial experience gains and losses to be treated equally and fully reflected in the contribution rate after phase-in.
- The contribution rate after phase-in determined by Segal as shown on the last page of Exhibit C reflects this approach. We have also recalculated the GRS contribution rate after phase-in using this approach and the resulting contribution total rate would be 11.79% of pay for both employer and member. These contribution rates are 0.15% of pay lower than the contribution rates after phase-in determined by GRS since they reflect the actuarial experience gain during 2018/2019. Segal's calculated employer and member contribution rates using our valuation software and reflecting this phase-in methodology would be approximately 0.30% of pay lower than the rates calculated by GRS.
- GRS should consider including more details and disclosure regarding how the phase-in is intended to work, especially in regards to how actuarial experience gains and losses are to be recognized on an annual basis, in the valuation report and also possibly in the funding policy.

Other Comments

- We reviewed the actuarial valuation reports in detail. We have confirmed that the GRS report contains required disclosures including those necessary to comply with Actuarial Standards of Practice (ASOP). In particular, the June 30, 2018 GRS valuation report already contains information that will be required to be disclosed starting with the June 30, 2019 actuarial valuation in regards to the new ASOP No. 51 regarding assessment of risk.
- Table 10 of the actuarial valuation report includes a schedule called the “Solvency Test”. This schedule is required to be included in the system’s Comprehensive Annual Financial Report (CAFR) each year. The name of this schedule has been changed recently and should be called “Schedule of Funded Liabilities by Type”. This is shown on page 36 of the GFOA checklist.

Section III – Exhibits

Exhibit A – Analysis of Participant Data Arizona State Retirement System June 30, 2018 Actuarial Valuations

Active Membership

	Count ²	Average Age ³	Average Service	Average Salary ⁴
ASRS Data	207,050	46.0	9.4	\$44,734
GRS Data	207,119	45.4	9.4	\$47,901
Ratio ASRS/GRS	1.00	1.01	1.00	0.93

Retired Membership

	Count ²	Average Age ³	Average Monthly Allowance
ASRS Data	153,908	71.9	\$1,703
GRS Data	146,956	71.1	\$1,678
Ratio ASRS/GRS	1.05	1.01	1.01

Inactive Membership

	Count ²	Average Age ³
ASRS Data	248,873	47.2
GRS Data	233,484	47.5
Ratio ASRS/GRS	1.07	0.99

² The counts shown for the ASRS data includes all members on the raw data files. The difference between the ASRS data and the GRS data represents the data clean up that GRS must perform (such as removing members who withdrew contributions, died during the year, or those that may have been reported on multiple files). In addition, the ASRS data counts for inactive membership also include approximately 3,400 members who are currently enrolled in the LTD Program, which are removed by GRS and valued separately.

³ The average age shown for the ASRS data is before any adjustment for members with missing dates of birth, whereas the average age shown for the GRS data includes an assumption for these members.

⁴ The average salary shown for the GRS data represents the projected valuation payroll. GRS generally calculates this salary by first developing a smoothed salary, and then projecting that salary forward. The average salary shown for ASRS represents the unaltered salary from the data files. As noted in Section II, GRS provided us the steps that they take in this calculation and we believe they are generally reasonable.

Exhibit B – Test Life Comparison
Arizona State Retirement System
June 30, 2018 Actuarial Valuations

Active Membership – 401(a)

	Active #1		Active #2		Active #3	
	GRS	Segal	GRS	Segal	GRS	Segal
PVB – Retirement	\$53,676	\$53,408	\$32,956	\$32,549	\$139,334	\$138,234
PVB – Termination	\$41,690	\$40,971	\$27,605	\$27,049	\$0	\$0
PVB – Death	\$3,141	\$3,306	\$1,041	\$1,100	\$3,367	\$3,470
PVB – Disability	\$3,060	\$3,157	\$1,463	\$1,907	\$4,669	\$4,653
Total PVB	\$101,568	\$100,841	\$63,066	\$62,606	\$147,370	\$146,356
Ratio Segal/GRS Total PVB		99.3%		99.3%		99.3%

	Active #4		Active #5		Active #6	
	GRS	Segal	GRS	Segal	GRS	Segal
PVB – Retirement	\$26,919	\$26,610	\$119,588	\$122,760	\$83,301	\$84,900
PVB – Termination	\$4,001	\$3,962	\$0	\$0	\$0	\$0
PVB – Death	\$835	\$864	\$3,399	\$2,945	\$1,917	\$1,944
PVB – Disability	\$1,241	\$1,241	\$764	\$709	\$1,093	\$954
Total PVB	\$32,997	\$32,677	\$123,751	\$126,414	\$86,312	\$87,799
Ratio Segal/GRS Total PVB		99.0%		102.2%		101.7%

Active Membership – 401(h)

	Active #1		Active #2		Active #3	
	GRS	Segal	GRS	Segal	GRS	Segal
Total PVB	\$1,564	\$1,563	\$684	\$679	\$7,637	\$7,637
Ratio Segal/GRS Total PVB		99.9%		99.4%		100.0%

	Active #4		Active #5		Active #6	
	GRS	Segal	GRS	Segal	GRS	Segal
Total PVB	\$3,994	\$3,986	\$6,706	\$6,722	\$5,757	\$5,434
Ratio Segal/GRS Total PVB		99.8%		100.2%		94.4%

Exhibit B – Test Life Comparison (continued)

Arizona State Retirement System June 30, 2018 Actuarial Valuations

Active Membership – Long Term Disability Program

	Active #1		Active #2		Active #3	
	GRS	Segal	GRS	Segal	GRS	Segal
Total PVB	\$1,413	\$1,359	\$810	\$805	\$1,596	\$1,542
Ratio Segal/GRS Total PVB		96.2%		99.4%		96.6%

Retired Membership – 401(a) and 401(h)

	Retiree #1		Retiree #2		Retiree #3	
	GRS	Segal	GRS	Segal	GRS	Segal
Benefit (w/ Assumed PBI)	\$19,383	\$19,383	\$1,854	\$1,854	\$3,243	\$3,243
PVB – 401(a)	\$224,947	\$225,018	\$21,888	\$21,894	\$38,737	\$38,765
PVB – 401(h)	\$9,596	\$9,596	\$0	\$0	\$0	\$0
Total PVB	\$234,543	\$234,614	\$21,888	\$21,894	\$38,737	\$38,765
Ratio Segal/GRS Total PVB		100.0%		100.0%		100.1%

	Retiree #4		Retiree #5		Beneficiary #1	
	GRS	Segal	GRS	Segal	GRS	Segal
Benefit (w/ Assumed PBI)	\$49,128	\$49,128	\$29,545	\$29,545	\$69,315	\$69,315
PVB – 401(a)	\$571,602	\$571,602	\$350,713	\$351,962	\$794,242	\$794,242
PVB – 401(h)	\$15,207	\$15,207	\$24,053	\$24,053	\$0	\$0
Total PVB	\$586,809	\$586,809	\$374,766	\$376,015	\$794,242	\$794,242
Ratio Segal/GRS Total PVB		100.0%		100.3%		100.0%

Exhibit B – Test Life Comparison (continued)

Arizona State Retirement System June 30, 2018 Actuarial Valuations

Retired Membership – 401(a) and 401(h) (continued)

	Beneficiary #2		Previously Disabled #1	
	GRS	Segal	GRS	Segal
Benefit (w/ Assumed PBI)	\$18,847	\$18,847	\$11,866	\$11,866
PVB – 401(a)	\$145,330	\$145,330	\$96,679	\$96,679
PVB – 401(h)	\$0	\$0	\$9,593	\$9,593
Total PVB	\$145,330	\$145,330	\$106,272	\$106,271
Ratio Segal/GRS Total PVB		100.0%		100.0%

Retired Membership – Long Term Disability Program

	LTD #1		LTD #2	
	GRS	Segal	GRS	Segal
LTD Gross Benefit	\$23,547	\$23,547	\$17,892	\$17,892
401(a) Deferred Benefit	\$19,653	\$19,653	\$15,997	\$15,997
PVB – LTD	\$72,671	\$72,339	\$53,666	\$53,757
PVB – 401(a)	\$107,556	\$109,023	\$102,464	\$103,282
PVB – 401(h)	\$25,898	\$25,898	\$13,021	\$13,021
Total PVB	\$206,125	\$207,260	\$169,151	\$170,060
Ratio Segal/GRS Total PVB		100.6%		100.5%

Exhibit B – Test Life Comparison (continued)

Arizona State Retirement System June 30, 2018 Actuarial Valuations

Inactive Membership

	Inactive #1		Inactive #2		Inactive #3	
	GRS	Segal	GRS	Segal	GRS	Segal
PVB – 401(a)	\$302,650	\$302,653	\$9,216	\$9,216	\$9,497	\$9,497
PVB – 401(h)	\$11,776	\$11,610	\$0	\$0	\$0	\$0
Total PVB	\$314,426	\$314,264	\$9,216	\$9,216	\$9,497	\$9,497
Ratio Segal/GRS Total PVB		99.9%		100.0%		100.0%

	Inactive #4		Inactive #5	
	GRS	Segal	GRS	Segal
PVB – 401(a)	\$5,528	\$5,531	\$7,971	\$7,972
PVB – 401(h)	\$536	\$555	\$0	\$0
Total PVB	\$6,064	\$6,085	\$7,971	\$7,972
Ratio Segal/GRS Total PVB		100.3%		100.0%

Exhibit C – Comparison of Results
Arizona State Retirement System
June 30, 2018 Actuarial Valuations

Present Value of Future Benefits (PVB) (\$ shown in thousands)

	401(a)		401(h)		Total	
	GRS	Segal	GRS	Segal	GRS	Segal
Active:						
Death	\$661,083	\$679,943	\$0	\$0	\$661,083	\$679,943
Withdrawal	\$2,574,668	\$2,573,923	\$11	\$13	\$2,574,679	\$2,573,936
Disability Deferred Retirement	\$635,668	\$622,228	\$33,381	\$32,781	\$669,049	\$655,009
Retirement	\$24,173,282	\$24,041,343	\$835,484	\$823,528	\$25,008,766	\$24,864,871
Active PVB	\$28,044,700	\$27,917,438	\$868,875	\$856,321	\$28,913,575	\$28,773,759
Inactive PVB	\$2,526,462	\$2,518,744	\$102,607	\$101,781	\$2,629,069	\$2,620,525
Retiree PVB⁵	\$30,602,702	\$30,581,804	\$914,372	\$917,997	\$31,517,074	\$31,499,801
Total PVB	\$61,173,864	\$61,017,986	\$1,885,854	\$1,876,099	\$63,059,718	\$62,894,085
Ratio Segal/GRS Total PVB		99.7%		99.5%		99.7%

	LTD	
	GRS	Segal
Active PVB	\$228,132	\$222,742
Current LTD PVB	\$187,100	\$179,460
Total PVB	\$415,232	\$402,201
Ratio Segal/GRS Total PVB		96.9%

⁵ Includes PVB for beneficiaries, formerly disabled, benefit increases for other-than-plan members and post-1981 System members.

Exhibit C – Comparison of Results (continued)
Arizona State Retirement System
June 30, 2018 Actuarial Valuations

Unfunded Actuarial Accrued Liability (UAAL) (\$ shown in thousands)

	401(a)		401(h)		Total	
	GRS	Segal	GRS	Segal	GRS	Segal
Actuarial Accrued Liability	\$52,546,438	\$52,600,566	\$1,630,300	\$1,636,265	\$54,176,738	\$54,236,831
Actuarial Value of Assets	\$36,984,395	\$36,984,395	\$1,608,500	\$1,608,500	\$38,592,895	\$38,592,895
UAAL	\$15,562,042	\$15,616,171	\$21,800	\$27,766	\$15,583,842	\$15,643,937
Funded Ratio	70.4%	70.3%	98.7%	98.3%	71.24%	71.16%
Ratio Segal/GRS						
Actuarial Accrued Liability		100.1%		100.4%		100.1%
Actuarial Value of Assets		100.0%		100.0%		100.0%
UAAL		100.3%		127.4%		100.4%

Contribution Rates – Before Phase In

	401(a)		401(h)		Total	
	GRS	Segal	GRS	Segal	GRS	Segal
Total Normal Cost Rate	14.41%	14.12%	0.50%	0.47%	14.91%	14.59%
UAAL Contribution Rate	10.30%	10.33%	0.05%	0.06%	10.35%	10.39%
Total Contribution Rate (Employer and Member)	24.71%	24.44%	0.55%	0.52%	25.26%	24.96%
Member Rate	12.63%	12.48%	0.00%	0.00%	12.63%	12.48%
Employer Rate	12.08%	11.96%	0.55%	0.52%	12.63%	12.48%
Ratio Segal/GRS						
Total Normal Cost Rate		98.0%		94.0%		97.8%
UAAL Contribution Rate		100.3%		109.9%⁶		100.3%
Total Contribution Rate		98.9%		94.5%		98.8%
Member Rate		98.8%		N/A		98.8%
Employer Rate		99.0%		94.5%		98.8%

⁶ Note this ratio of 110% is calculated using the unrounded values for the UAAL contribution rate.

Exhibit C – Comparison of Results (continued)
Arizona State Retirement System
June 30, 2018 Actuarial Valuations

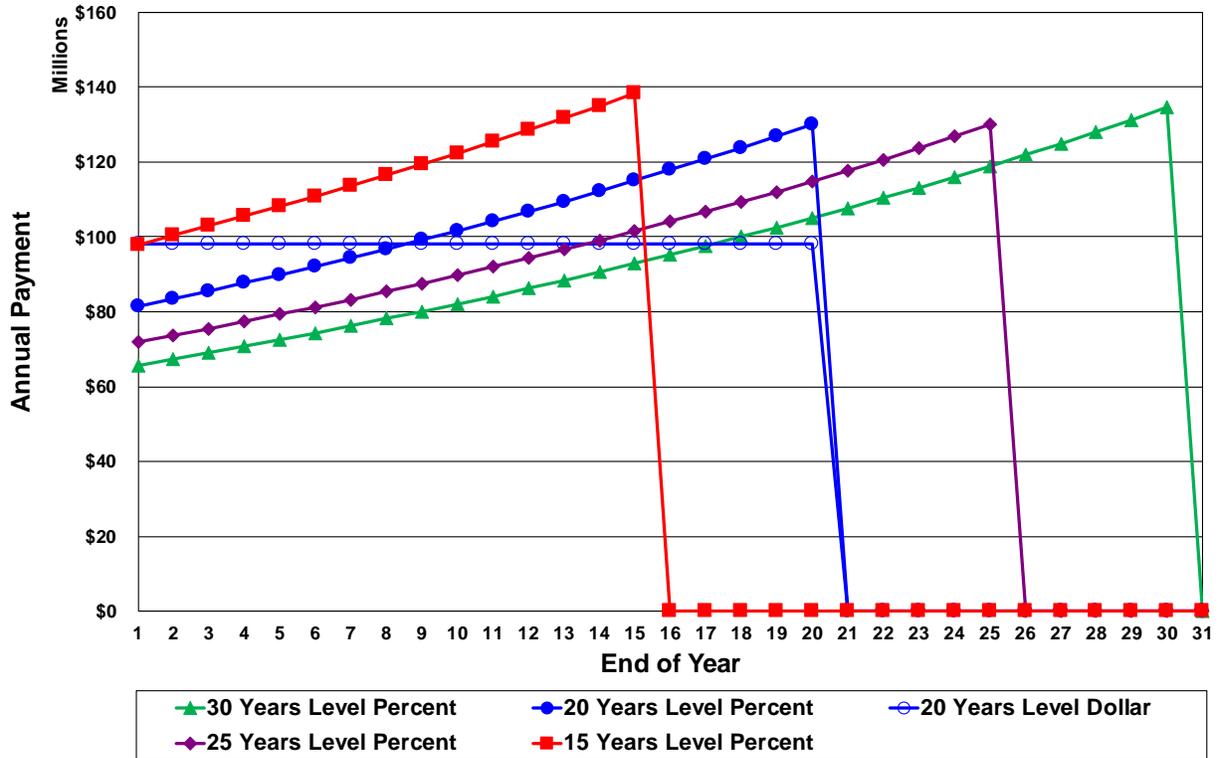
Contribution Rates – After Phase In⁷

	401(a)		401(h)		Total	
	GRS	Segal	GRS	Segal	GRS	Segal
Total Contribution Rate (Employer and Member)	23.39%	22.79%	0.49%	0.49%	23.88%	23.28%
Member Rate	11.94%	11.64%	0.00%	0.00%	11.94%	11.64%
Employer Rate	11.45%	11.15%	0.49%	0.49%	11.94%	11.64%
Ratio Segal/GRS						
Total Contribution Rate		97.4%		100.0%		97.5%
Member Rate		97.5%		N/A		97.5%
Employer Rate		97.4%		100.0%		97.5%

⁷ See page 21 for a discussion regarding the differences in the phase-in methodology used in the results shown for GRS and Segal.

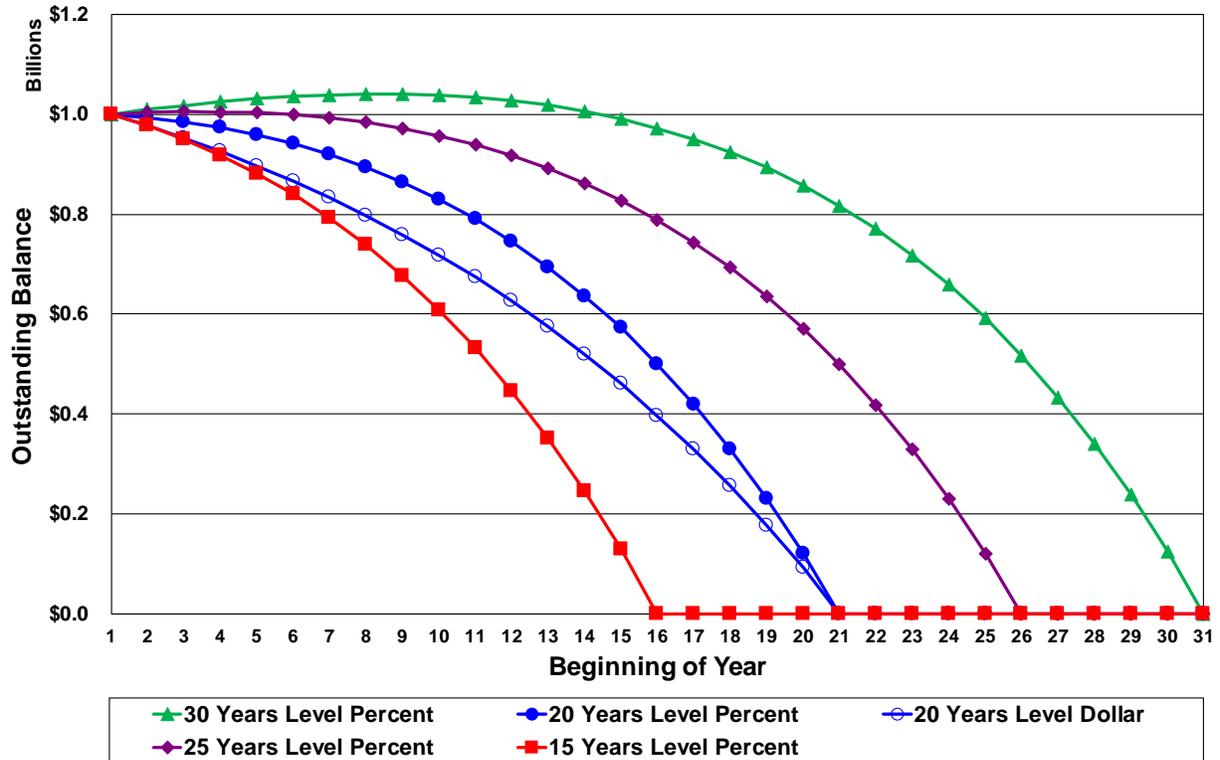
Attachment 1 – Annual Payments on UAAL

Annual Payments on \$1 Billion Initial UAAL Balance



Attachment 2 – Outstanding UAAL Balance

Outstanding UAAL Balance on \$1 Billion Initial UAAL



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