Liquidity Analysis

Pennsylvania Public School Employees' Retirement System (PSERS)
December 2022

Table of Contents

Empower Results®

Overview
Background

- PSERS' liquidity analysis is performed under the Current Long-Term Policy as well as contribution stress testing
  - Intended as a stress-testing model, incorporating the profile of the liabilities as well as expected future contributions
  - Uses different scenarios for economic environments and other relevant events
  - Shows how the portfolio's liquidity profile could evolve with a given investment strategy

- We categorized investments by liquidity into five buckets
  - ***Liquid (Risk-Reducing Assets):*** less than 3 months needed for return of capital (e.g., publicly traded securities)
  - ***Liquid (Return-Seeking Assets):*** less than 3 months needed for return of capital (e.g., publicly traded securities)
  - ***Quasi-Liquid:*** Typical lock-up of 3–12 months. Conservatively, we assumed a 1-year lock-up in most economic environments, 2 years in a Recession scenario, and 3 years in a Dark Skies scenario (e.g., many hedge funds, core real estate)
  - ***Illiquid: Potential lock-up of 5–10 years***, depending on economic environment (e.g., closed-end real estate)
  - ***Illiquid: Potential lock-up of 10+ years*** (e.g., typical private equity)

- This is intended to be a <u>conservative</u> approximation of the actual liquidity properties of the assets

- Not surprisingly, varying economic and contribution scenarios would lead PSERS' percentage allocation to alternative assets to differ from its targets due to liquidity differences in asset classes

Overview

Asset Allocation and Liquidity Category

Portfolio Studied	Current Long-Term Policy
Liquid (Risk-Reducing Assets + Financing)	
U.S. TIPS	10.0%
U.S. Core Fixed Income	4.0%
U.S. Long-Term Treasury	8.0%
Net Cash + Financing	-8.0%
Subtotal	*14.0%*
Liquid (Return-Seeking Assets)	
Public Equity	36.0%
Public Infrastructure	5.0%
REITs	4.0%
Commodities	2.5%
Gold	2.5%
High Yield Bonds	4.0%
Emerging Market Debt	2.0%
Subtotal	*56.0%*
Quasi-Liquid Assets	
Subtotal	*0.0%*
Illiquid 5-10 Years	
Private Real Estate	7.0%
Private Credit	6.0%
Subtotal	*13.0%*
Illiquid 10+ Years	
Private Equity	12.0%
Private Infrastructure	5.0%
Subtotal	*17.0%*
Total	**100.0%**
Total Illiquid and Quasi-Liquid Assets	**30.0%**

Empower Results®

Overview
Economic Scenarios

- **Base Case Scenario**
  - Markets perform consistent with our Capital Market Assumptions

- **Recession Scenario**
  - Somewhat pessimistic outlook for the markets
  - Return-seeking assets decline in the first two years with a modest rebound in later years

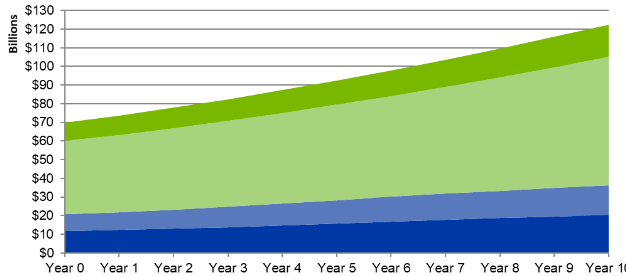
- **Dark Skies Scenario**
  - Very pessimistic outlook for markets
  - Return-seeking assets decline significantly
  - The value of public equities declines approximately 50% over three years, without an immediate rebound

Liquidity Analysis
Summary of Results | Current Policy

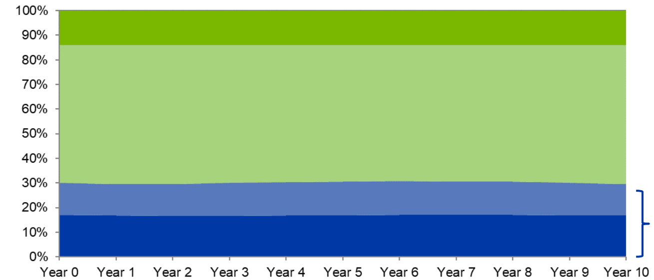
■ Illiquid: 10+ Years ■ Illiquid: 5-10 Years ■ Quasi-Liquid ■ Liquid (Return-Seeking Assets) ■ Liquid (Risk-Reducing Assets)

Base Case

Scenario: Base - PSERS (in Dollars)



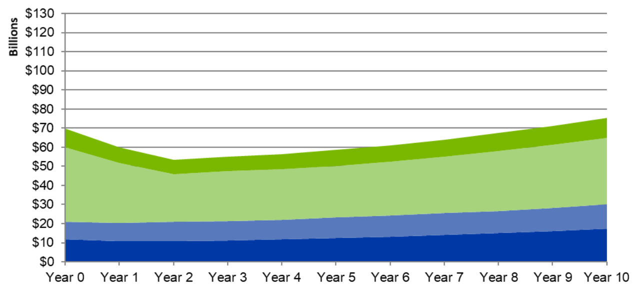
Scenario: Base - PSERS (in Percentages)



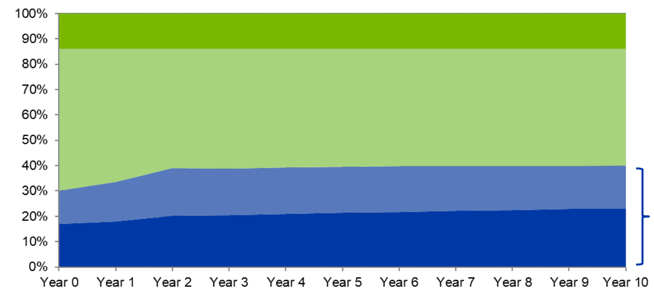
30% Illiquids

Recession

Scenario: Recession - PSERS (in Dollars)



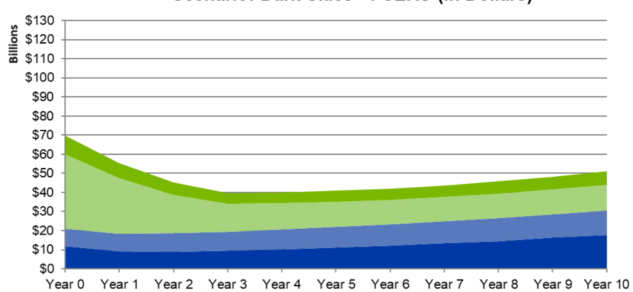
Scenario: Recession - PSERS (in Percentages)



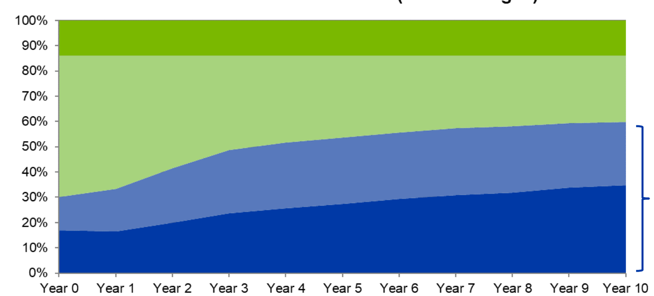
40% Illiquids

Dark Skies

Scenario: Dark Skies - PSERS (in Dollars)



Scenario: Dark Skies - PSERS (in Percentages)

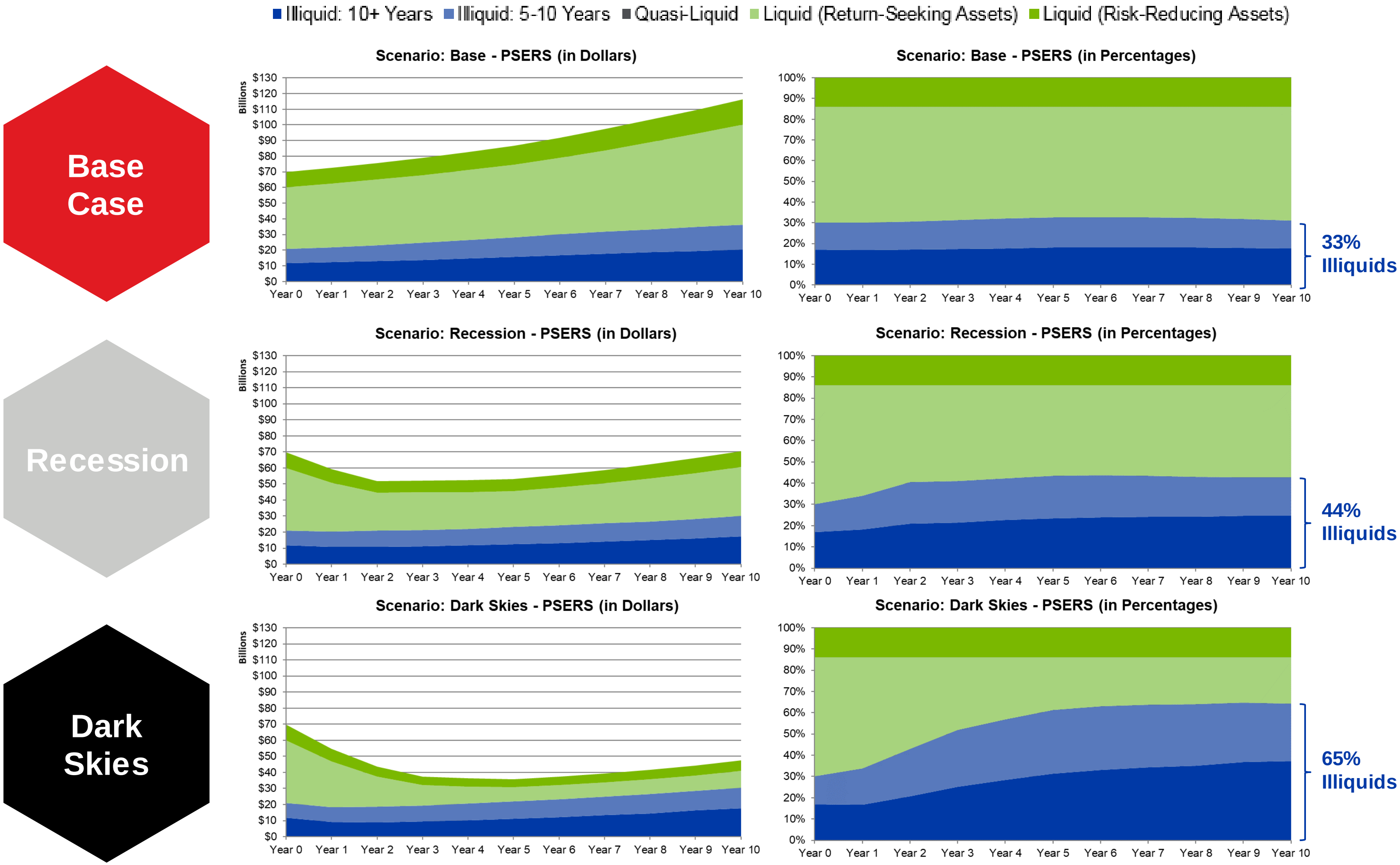


60% Illiquids

Note: Year 0 represents a starting point of June 30, 2022

Liquidity Analysis

Summary of Results | Current Policy (5 Years of 80% Employer Contributions)



Note: Year 0 represents a starting point of June 30, 2022

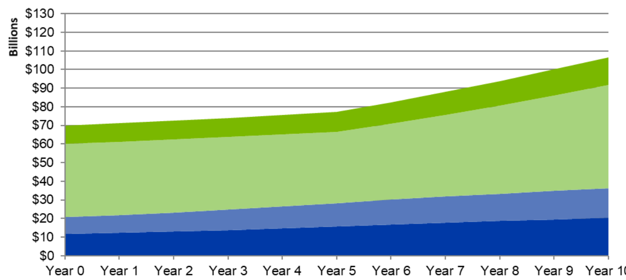
Liquidity Analysis

Summary of Results | Current Policy (5 Years of 50% Employer Contributions)

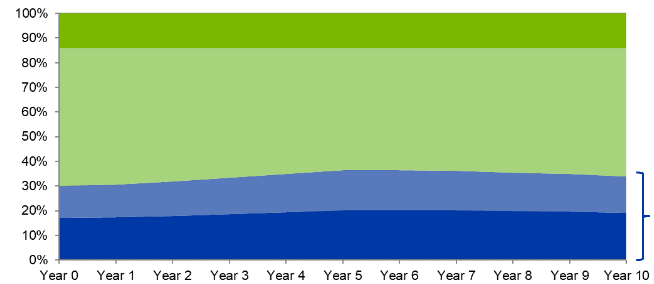
■ Illiquid: 10+ Years ■ Illiquid: 5-10 Years ■ Quasi-Liquid ■ Liquid (Return-Seeking Assets) ■ Liquid (Risk-Reducing Assets)

Base Case

Scenario: Base - PSERS (in Dollars)



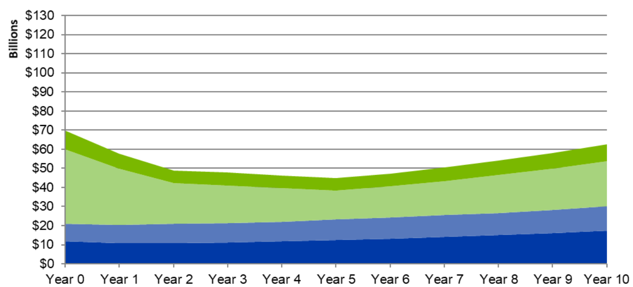
Scenario: Base - PSERS (in Percentages)



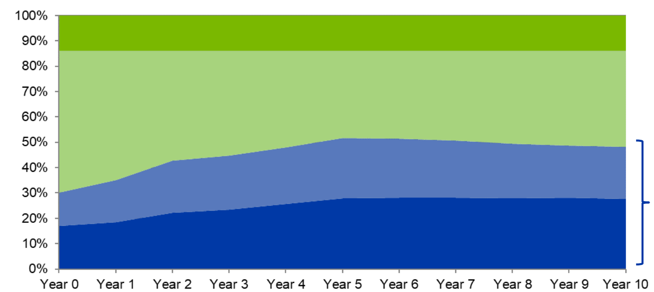
37% Illiquids

Recession

Scenario: Recession - PSERS (in Dollars)



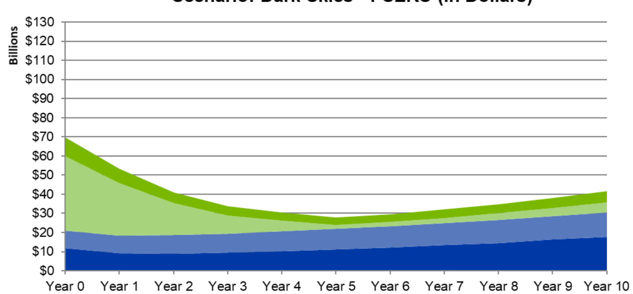
Scenario: Recession - PSERS (in Percentages)



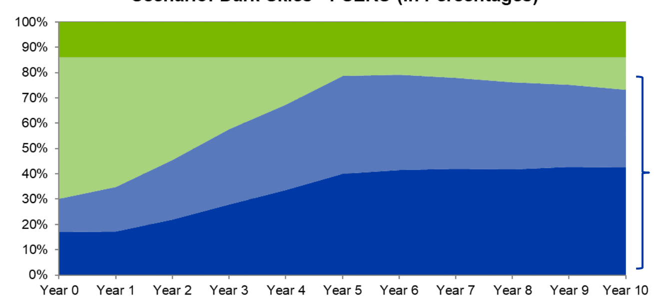
52% Illiquids

Dark Skies

Scenario: Dark Skies - PSERS (in Dollars)



Scenario: Dark Skies - PSERS (in Percentages)



79% Illiquids

Note: Year 0 represents a starting point of June 30, 2022

Conclusions

- **PSERS has sufficient liquidity in the modeled Base Case, Recession, and Dark Skies scenarios for the Current Long-Term Policy assuming full actuarial contributions are received**
  - In pessimistic Dark Skies scenarios, the asset allocation could drift far from its target allocation
    - Under these scenarios, PSERS may want to pare back future commitments to stay closer to the target allocations; in these cases, PSERS may be scaling back its alternative asset allocations at a time when the opportunity is greatest

- Lower contributions put more pressure on liquidity; in such scenarios, PSERS can look to manage the pace of future commitments

- This analysis is highly sensitive to the assumed contributions
  - If PSERS receives less contributions than assumed, especially in a Dark Skies environment, then the potential liquidity issue could be worse than projected here

Appendix

- Liquidity Analysis Detail

Background

Aon Investments' Approach to Analyzing Liquidity Risk from Alternatives

- Intended as a stress-testing model
- Develops multi-year projections of assets and spending needs
- Uses different scenarios for economic environments and other relevant events
- Shows how the portfolio's liquidity profile could evolve with a given investment strategy
- Incorporates the profile of the liabilities as well as expected future contributions

Background
Process Inputs and Outputs

Background

Modeling Parameters – Degrees of Illiquidity

- We categorized investments by liquidity into five buckets
  - **Liquid (Risk-Reducing Assets):** less than 3 months needed for return of capital (e.g., publicly traded securities)
  - **Liquid (Return-Seeking Assets):** less than 3 months needed for return of capital (e.g., publicly traded securities)
  - **Quasi-Liquid:** Typical lock-up of 3–12 months. Conservatively, we assumed a 1-year lock-up in most economic environments, 2 years in a Recession scenario, and 3 years in a Dark Skies scenario (e.g., many hedge funds, core real estate)
  - **Illiquid: Potential lock-up of 5–10 years**, depending on economic environment (e.g., closed-end real estate)
  - **Illiquid: Potential lock-up of 10+ years** (e.g., typical private equity)

- This is intended to be a <u>conservative</u> approximation of the actual liquidity properties of the assets

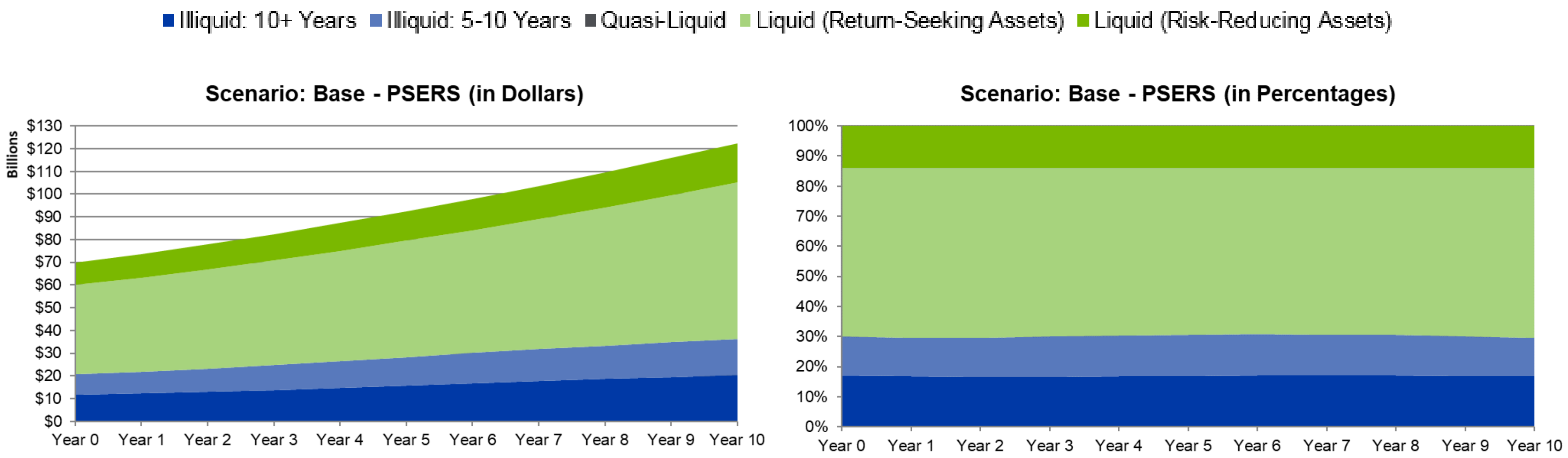
- We started with the target asset allocations, then see how the actual allocations would change in different economic scenarios, continuing new commitments to private assets, as expected.

- Assumptions
  - Asset-liability information based on projections provided by the plan actuary for the 2022 asset-liability analysis (based on the June 30, 2021 actuarial valuation report)
  - Starting asset value as of June 30, 2022
  - The plan's contribution policy is determined in accordance with the methodology used by the plan actuary
  - Assumes the portfolio starts at the target asset allocation levels for illiquid assets, maintaining close to the portfolio targets over the next 10 years

Liquidity Analysis: Base Case Economic Scenario

Current Policy

- The exhibit below shows the projected liquidity lock-up of the Current Policy allocation in the Base Case economic scenario, assuming commitments are continued as expected



Key Takeaway:

- Total illiquid assets are projected to stay near 30% of the Plan and can be maintained near the target with no cash flow problems

Note: Year 0 represents a starting point of June 30, 2022

Liquidity Analysis: Base Case Economic Scenario (continued)
Current Policy

- The exhibit below shows the projected liquidity lock-up of the Current Policy allocation in the Base Case economic scenario

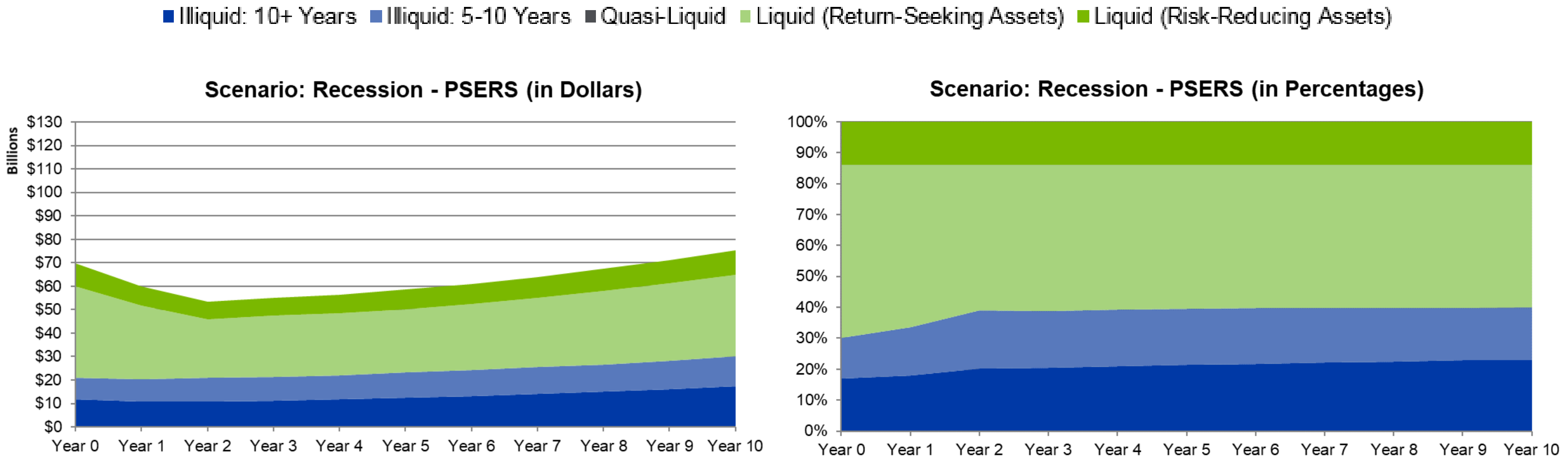
Asset Allocation	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Risk-Reducing Assets	14%	14%	14%	14%	14%	14%	14%	14%	14%	14%	14%
Liquid Return-Seeking	56	56	56	56	56	55	55	55	56	56	56
Total Liquid	**70%**	**70%**	**70%**	**70%**	**70%**	**69%**	**69%**	**69%**	**70%**	**70%**	**70%**
Quasi-Liquid	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Illiquid: 5-10 Year Lock-up	13	13	13	13	14	14	14	14	13	13	13
Illiquid: 10+ Year Lock-up	17	17	17	17	17	17	17	17	17	17	17
Total Quasi + Illiquid	**30%**	**30%**	**30%**	**30%**	**30%**	**31%**	**31%**	**31%**	**30%**	**30%**	**30%**

Note: Year 0 represents a starting point of June 30, 2022; Percentages may not sum to 100% due to rounding

Liquidity Analysis: Recession Economic Scenario

Current Policy

- The exhibit below shows the projected liquidity lock-up of the Current Policy allocation in the Recession economic scenario, assuming commitments are continued as expected



Key Takeaways:

- Commitments to illiquid alternatives are maintained at the steady state level, but recessionary markets cause the total portfolio to shrink
- Total illiquid assets are projected to reach as high as 40% of the Plan due to the shrinking market value of the total Plan in this scenario

Note: Year 0 represents a starting point of June 30, 2022

Liquidity Analysis: Recession Economic Scenario (continued)

Current Policy

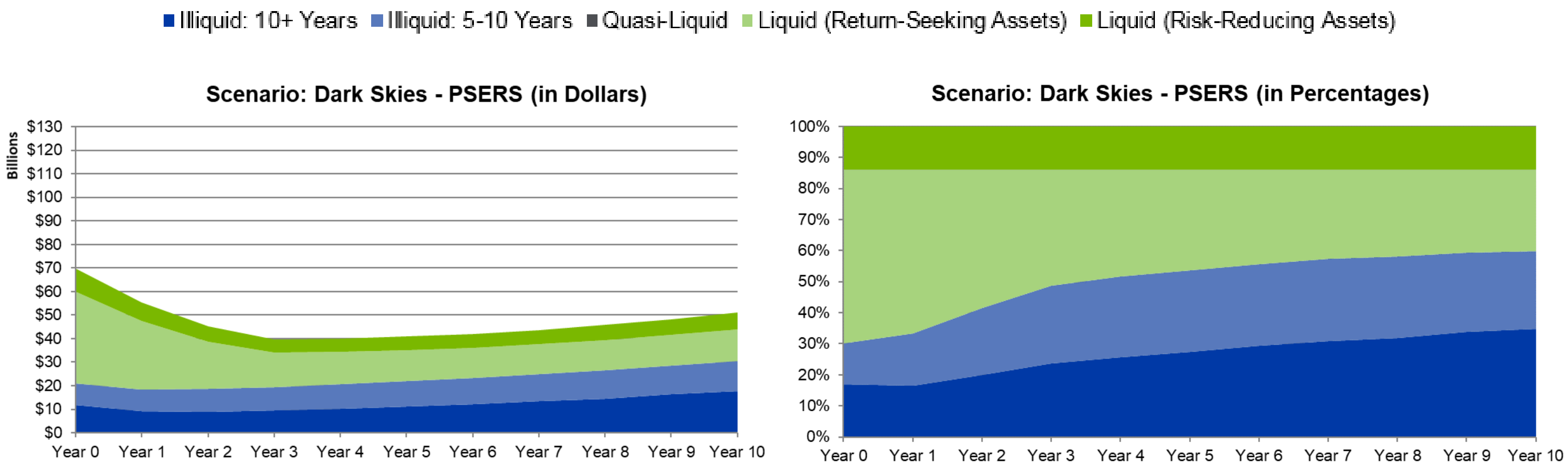
- The exhibit below shows the projected liquidity lock-up of the Current Policy allocation in the Recession economic scenario

Asset Allocation	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Risk-Reducing Assets	14%	14%	14%	14%	14%	14%	14%	14%	14%	14%	14%
Liquid Return-Seeking	56	52	47	47	47	46	46	46	46	46	46
Total Liquid	**70%**	**66%**	**61%**	**61%**	**61%**	**60%**	**60%**	**60%**	**60%**	**60%**	**60%**
Quasi-Liquid	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Illiquid: 5-10 Year Lock-up	13	16	19	19	18	18	18	18	17	17	17
Illiquid: 10+ Year Lock-up	17	18	20	20	21	21	22	22	22	23	23
Total Quasi + Illiquid	**30%**	**34%**	**39%**	**39%**	**39%**	**40%**	**40%**	**40%**	**40%**	**40%**	**40%**

Note: Year 0 represents a starting point of June 30, 2022; Percentages may not sum to 100% due to rounding

Liquidity Analysis: Dark Skies Economic Scenario
Current Policy

- The exhibit below shows the projected liquidity lock-up of the Current Policy allocation in the Dark Skies economic scenario, assuming commitments are continued as expected



Key Takeaways:

- Commitments to illiquid alternatives are maintained at the steady state level, but subpar markets cause the total portfolio to shrink
- Total illiquid assets are projected to reach as high as 60% of the Plan due to the shrinking market value of the total Plan in this scenario
- Under this scenario, PSERS may want to pare back future commitments to stay closer to the target allocations; in doing so, PSERS may be scaling back its alternative asset allocations at a time when the opportunity is greatest

Note: Year 0 represents a starting point of June 30, 2022

Liquidity Analysis: Dark Skies Economic Scenario (continued)

Current Policy

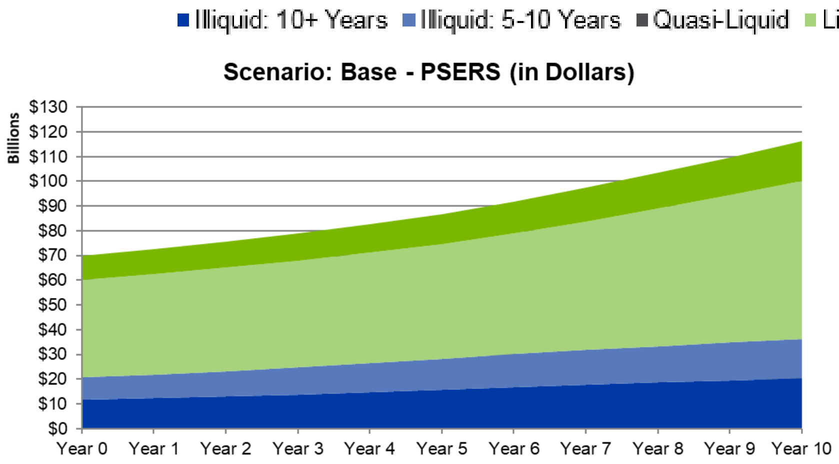
- The exhibit below shows the projected liquidity lock-up of the Current Policy allocation in the Dark Skies economic scenario

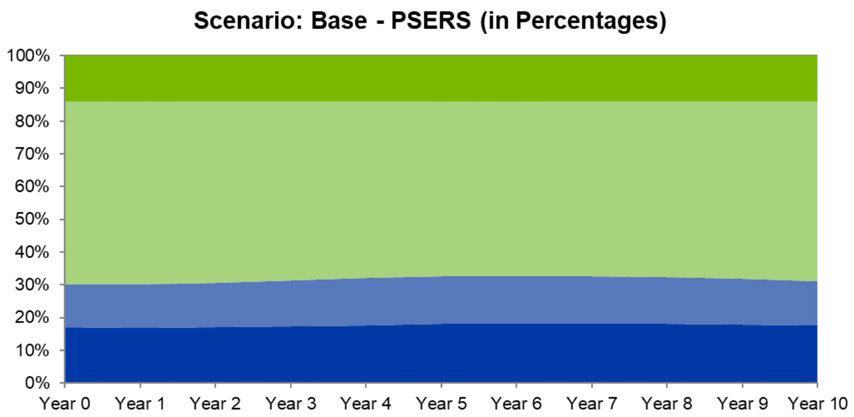
Asset Allocation	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Risk-Reducing Assets	14%	14%	14%	14%	14%	14%	14%	14%	14%	14%	14%
Liquid Return-Seeking	56	53	45	37	34	32	30	29	28	27	26
Total Liquid	**70%**	**67%**	**59%**	**51%**	**48%**	**46%**	**44%**	**43%**	**42%**	**41%**	**40%**
Quasi-Liquid	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Illiquid: 5-10 Year Lock-up	13	17	21	25	26	26	26	26	26	26	25
Illiquid: 10+ Year Lock-up	17	16	20	24	26	27	29	31	32	34	35
Total Quasi + Illiquid	**30%**	**33%**	**41%**	**49%**	**52%**	**54%**	**56%**	**57%**	**58%**	**59%**	**60%**

Note: Year 0 represents a starting point of June 30, 2022; Percentages may not sum to 100% due to rounding

Liquidity Analysis: Base Case Economic Scenario
Current Policy (5 Years of 80% Actuarial Contributions)

- The exhibit below shows the projected liquidity lock-up of the Current Policy allocation and 80% of the Actuarially Determined Employer Contribution in the Base Case economic scenario, assuming commitments are continued as expected





Key Takeaway:

- Total illiquid assets are projected to reach as high as 33% of the Plan in this scenario

Note: Year 0 represents a starting point of June 30, 2022

Liquidity Analysis: Base Case Economic Scenario (continued)

Current Policy (5 Years of 80% Actuarial Contributions)

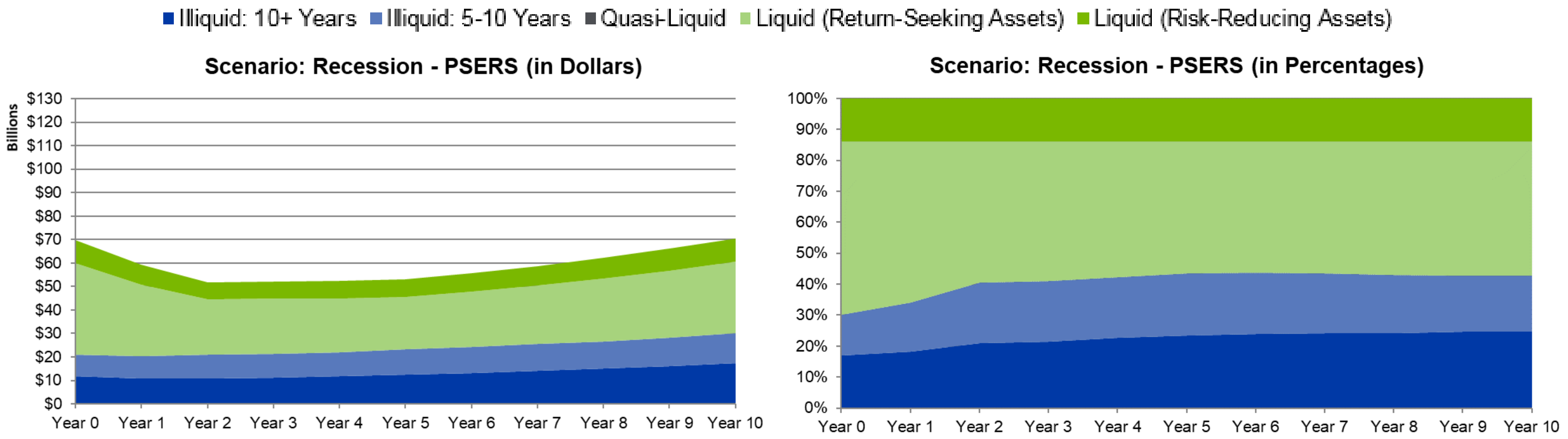
- The exhibit below shows the projected liquidity lock-up of the Current Policy allocation and 80% of the Actuarially Determined Employer Contribution in the Base Case economic scenario

Asset Allocation	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Risk-Reducing Assets	14%	14%	14%	14%	14%	14%	14%	14%	14%	14%	14%
Liquid Return-Seeking	56	56	56	55	54	53	53	53	54	54	55
Total Liquid	**70%**	**70%**	**70%**	**69%**	**68%**	**67%**	**67%**	**67%**	**68%**	**68%**	**69%**
Quasi-Liquid	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Illiquid: 5-10 Year Lock-up	13	13	13	14	14	15	15	14	14	14	14
Illiquid: 10+ Year Lock-up	17	17	17	17	18	18	18	18	18	18	18
Total Quasi + Illiquid	**30%**	**30%**	**30%**	**31%**	**32%**	**33%**	**33%**	**33%**	**32%**	**32%**	**31%**

Note: Year 0 represents a starting point of June 30, 2022; Percentages may not sum to 100% due to rounding

Liquidity Analysis: Recession Economic Scenario
Current Policy (5 Years of 80% Actuarial Contributions)

- The exhibit below shows the projected liquidity lock-up of the Current Policy allocation and 80% of the Actuarially Determined Employer Contribution in the Recession economic scenario, assuming commitments are continued as expected



Key Takeaways:

- Commitments to illiquid alternatives are maintained at the steady state level, but recessionary markets combined with lower contributions cause the total portfolio to shrink
- Total illiquid assets are projected to reach as high as 44% of the Plan due to the shrinking market value of the total Plan in this scenario

Note: Year 0 represents a starting point of June 30, 2022

Liquidity Analysis: Recession Economic Scenario (continued)

Current Policy (5 Years of 80% Actuarial Contributions)

- The exhibit below shows the projected liquidity lock-up of the Current Policy allocation and 80% of the Actuarially Determined Employer Contribution in the Recession economic scenario

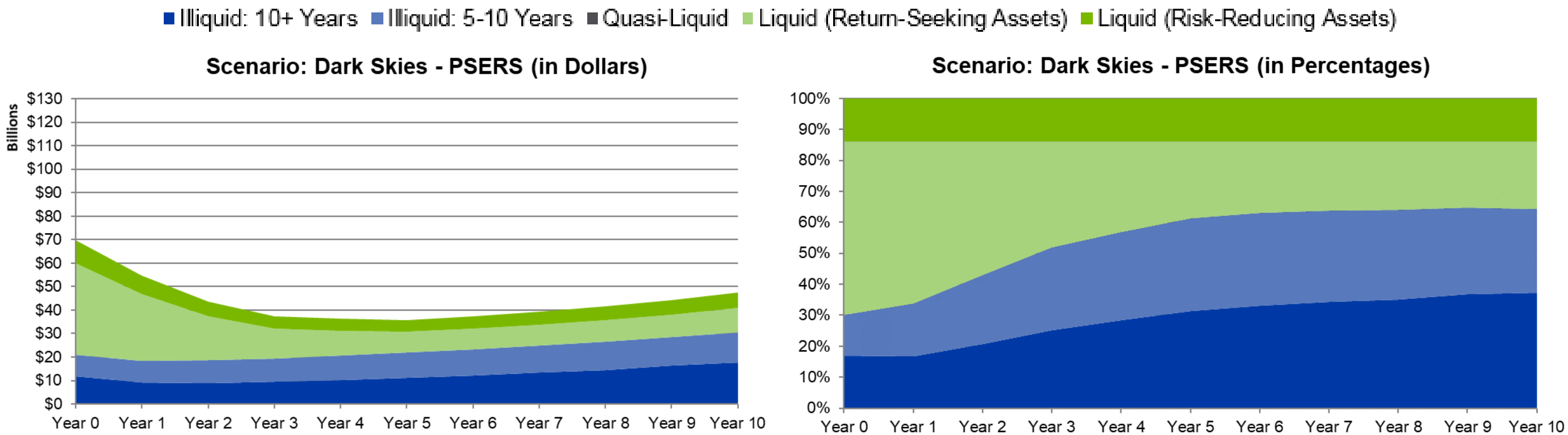
Asset Allocation	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Risk-Reducing Assets	14%	14%	14%	14%	14%	14%	14%	14%	14%	14%	14%
Liquid Return-Seeking	56	52	46	45	44	42	42	43	43	43	43
Total Liquid	**70%**	**66%**	**60%**	**59%**	**58%**	**56%**	**56%**	**57%**	**57%**	**57%**	**57%**
Quasi-Liquid	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Illiquid: 5-10 Year Lock-up	13	16	20	20	20	20	20	19	19	18	18
Illiquid: 10+ Year Lock-up	17	18	21	21	23	24	24	24	24	25	25
Total Quasi + Illiquid	**30%**	**34%**	**40%**	**41%**	**42%**	**44%**	**44%**	**43%**	**43%**	**43%**	**43%**

Note: Year 0 represents a starting point of June 30, 2022; Percentages may not sum to 100% due to rounding

Liquidity Analysis: Dark Skies Economic Scenario

Current Policy (5 Years of 80% Actuarial Contributions)

- The exhibit below shows the projected liquidity lock-up of the Current Policy allocation and 80% of the Actuarially Determined Employer Contribution in the Dark Skies economic scenario, assuming commitments are continued as expected



Key Takeaways:

- Commitments to illiquid alternatives are maintained at the steady state level, but subpar markets combined with lower contributions cause the total portfolio to shrink
- Total illiquid assets are projected to reach as high as 65 of the Plan due to the shrinking market value of the total Plan in this scenario
- Under this scenario, PSERS may want to pare back future commitments to stay closer to the target allocations; in doing so, PSERS may be scaling back its alternative asset allocations at a time when the opportunity is greatest

Note: Year 0 represents a starting point of June 30, 2022

Liquidity Analysis: Dark Skies Economic Scenario (continued)
Current Policy (5 Years of 80% Actuarial Contributions)

- The exhibit below shows the projected liquidity lock-up of the Current Policy allocation and 80% of the Actuarially Determined Employer Contribution in the Dark Skies economic scenario

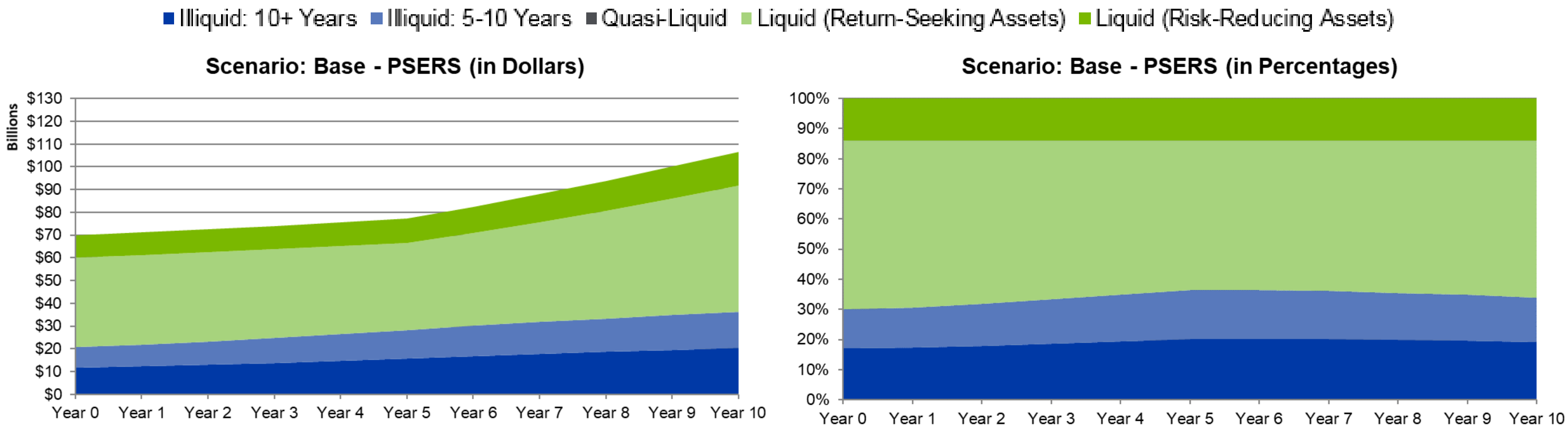
Asset Allocation	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Risk-Reducing Assets	14%	14%	14%	14%	14%	14%	14%	14%	14%	14%	14%
Liquid Return-Seeking	56	52	43	34	29	25	23	22	22	21	22
Total Liquid	**70%**	**66%**	**57%**	**48%**	**43%**	**39%**	**37%**	**36%**	**36%**	**35%**	**36%**
Quasi-Liquid	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Illiquid: 5-10 Year Lock-up	13	17	22	27	29	30	30	29	29	28	27
Illiquid: 10+ Year Lock-up	17	17	21	25	28	31	33	34	35	37	37
Total Quasi + Illiquid	**30%**	**34%**	**43%**	**52%**	**57%**	**61%**	**63%**	**64%**	**64%**	**65%**	**64%**

Note: Year 0 represents a starting point of June 30, 2022; Percentages may not sum to 100% due to rounding

Liquidity Analysis: Base Case Economic Scenario

Current Policy (5 Years of 50% Actuarial Contributions)

- The exhibit below shows the projected liquidity lock-up of the Current Policy allocation and 50% of the Actuarially Determined Employer Contribution in the Base Case economic scenario, assuming commitments are continued as expected



Key Takeaway:

- Total illiquid assets are projected to reach as high as 37% of the Plan in this scenario

Note: Year 0 represents a starting point of June 30, 2022

Liquidity Analysis: Base Case Economic Scenario (continued)

Current Policy (5 Years of 50% Actuarial Contributions)

- The exhibit below shows the projected liquidity lock-up of the Current Policy allocation and 50% of the Actuarially Determined Employer Contribution in the Base Case economic scenario

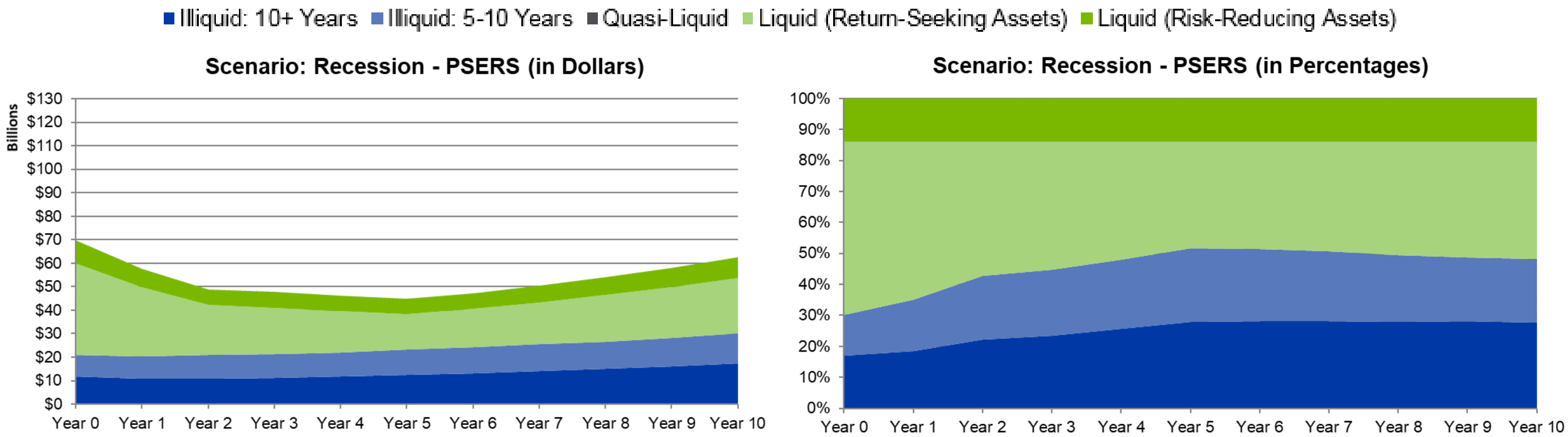
Asset Allocation	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Risk-Reducing Assets	14%	14%	14%	14%	14%	14%	14%	14%	14%	14%	14%
Liquid Return-Seeking	56	55	54	53	51	49	50	50	50	51	52
Total Liquid	**70%**	**69%**	**68%**	**67%**	**65%**	**63%**	**64%**	**64%**	**64%**	**65%**	**66%**
Quasi-Liquid	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Illiquid: 5-10 Year Lock-up	13	13	14	15	16	16	16	16	16	15	15
Illiquid: 10+ Year Lock-up	17	17	18	19	19	20	20	20	20	20	19
Total Quasi + Illiquid	**30%**	**31%**	**32%**	**33%**	**35%**	**37%**	**36%**	**36%**	**36%**	**35%**	**34%**

Note: Year 0 represents a starting point of June 30, 2022; Percentages may not sum to 100% due to rounding

Liquidity Analysis: Recession Economic Scenario

Current Policy (5 Years of 50% Actuarial Contributions)

- The exhibit below shows the projected liquidity lock-up of the Current Policy allocation and 50% of the Actuarially Determined Employer Contribution in the Recession economic scenario, assuming commitments are continued as expected



Key Takeaways:

- Commitments to illiquid alternatives are maintained at the steady state level, but recessionary markets combined with lower contributions cause the total portfolio to shrink
- Total illiquid assets are projected to reach as high as 52% of the Plan due to the shrinking market value of the total Plan in this scenario
- Under this scenario, PSERS may want to pare back future commitments to stay closer to the target allocations; in doing so, PSERS may be scaling back its alternative asset allocations at a time when the opportunity is greatest

Note: Year 0 represents a starting point of June 30, 2022

Liquidity Analysis: Recession Economic Scenario (continued)

Current Policy (5 Years of 50% Actuarial Contributions)

- The exhibit below shows the projected liquidity lock-up of the Current Policy allocation and 50% of the Actuarially Determined Employer Contribution in the Recession economic scenario

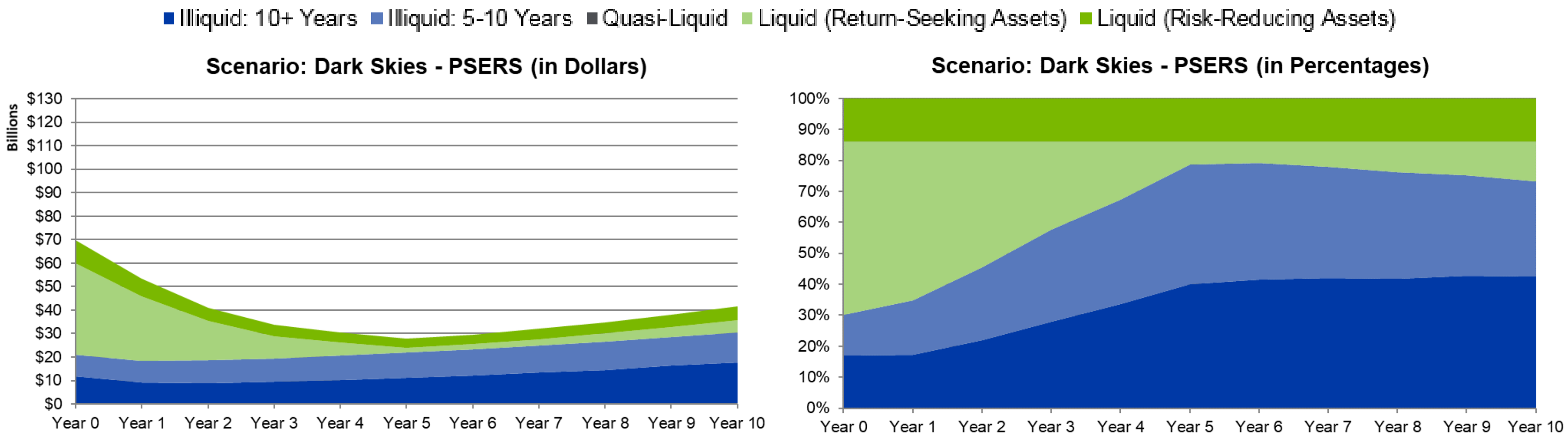
Asset Allocation	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Risk-Reducing Assets	14%	14%	14%	14%	14%	14%	14%	14%	14%	14%	14%
Liquid Return-Seeking	56	51	43	41	38	34	35	35	36	37	38
Total Liquid	**70%**	**65%**	**57%**	**55%**	**52%**	**48%**	**49%**	**49%**	**50%**	**51%**	**52%**
Quasi-Liquid	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Illiquid: 5-10 Year Lock-up	13	16	21	21	22	24	23	23	22	21	20
Illiquid: 10+ Year Lock-up	17	19	22	23	26	28	28	28	28	28	28
Total Quasi + Illiquid	**30%**	**35%**	**43%**	**45%**	**48%**	**52%**	**51%**	**51%**	**50%**	**49%**	**48%**

Note: Year 0 represents a starting point of June 30, 2022; Percentages may not sum to 100% due to rounding

Liquidity Analysis: Dark Skies Economic Scenario

Current Policy (5 Years of 50% Actuarial Contributions)

- The exhibit below shows the projected liquidity lock-up of the Current Policy allocation and 50% of the Actuarially Determined Employer Contribution in the Dark Skies economic scenario, assuming commitments are continued as expected



Key Takeaways:

- Commitments to illiquid alternatives are maintained at the steady state level, but subpar markets combined with lower contributions cause the total portfolio to shrink
- Total illiquid assets are projected to reach as high as 79% of the Plan due to the shrinking market value of the total Plan in this scenario
- Under this scenario, PSERS may want to pare back future commitments to stay closer to the target allocations; in doing so, PSERS may be scaling back its alternative asset allocations at a time when the opportunity is greatest

Note: Year 0 represents a starting point of June 30, 2022

Liquidity Analysis: Dark Skies Economic Scenario (continued)

Current Policy (5 Years of 50% Actuarial Contributions)

- The exhibit below shows the projected liquidity lock-up of the Current Policy allocation and 50% of the Actuarially Determined Employer Contribution in the Dark Skies economic scenario

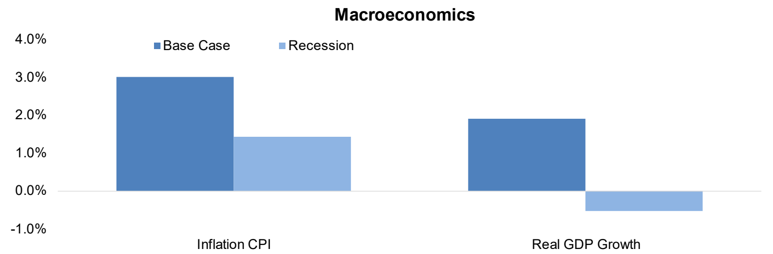
Asset Allocation	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Risk-Reducing Assets	14%	14%	14%	14%	14%	14%	14%	14%	14%	14%	14%
Liquid Return-Seeking	56	51	40	28	19	7	7	8	10	11	13
Total Liquid	**70%**	**65%**	**54%**	**42%**	**33%**	**21%**	**21%**	**22%**	**24%**	**25%**	**27%**
Quasi-Liquid	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Illiquid: 5-10 Year Lock-up	13	18	24	30	34	38	38	36	34	33	31
Illiquid: 10+ Year Lock-up	17	17	22	28	34	40	41	42	42	43	43
Total Quasi + Illiquid	**30%**	**35%**	**46%**	**58%**	**67%**	**79%**	**79%**	**78%**	**76%**	**75%**	**73%**

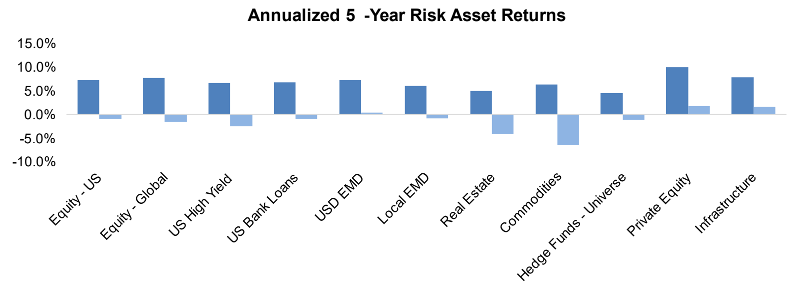
Note: Year 0 represents a starting point of June 30, 2022; Percentages may not sum to 100% due to rounding

Recession Scenario
Description

The US economy slips into recession in 2022/23

- Global growth is much weaker than the base case. Concerns that inflation will remain high for longer lead to central banks rapidly tightening monetary policies.
- Tightening financial conditions, combined with spill over effects from geopolitical volatility and reduced consumer and business spending, as real incomes are squeezed by high inflation, lead to a deep recession in the US in 2022/23.
- The economic slowdown leads to developed economies implementing modest fiscal stimulus measures and monetary policy becomes more accommodative. Policy actions are only partially effective as they are tackling the demand side of the equation.
- Inflation is lower than the base case. However, inflation starts to rise in later years as the post-recession recovery gets underway.
- Treasury yields fall while TIPS yields remain at low levels as the US enters recession. Yields rise in later years as a recovery gets underway. Corporate spreads rise significantly due to the poor economic situation and increased risks of downgrades or defaults.
- Most risk assets make losses in the first two years but rebound in later years as the economy recovers.





Returns from 30 June 2022
Source: Aon
The opinions referenced are as of the date of publication and are subject to change due to changes in the market or economic conditions and may not necessarily come to pass. Information contained herein is for informational purposes only and should not be considered investment advice.

Recession Scenario

Data Table

RECESSION SCENARIO

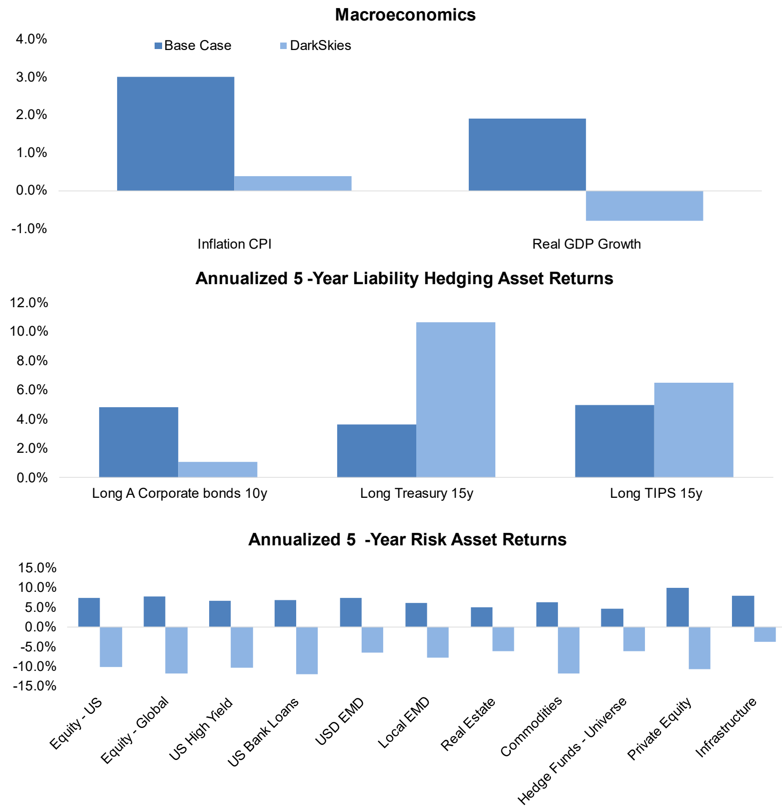
	Year 0	1	2	3	4	5	6	7	8	9	10
Yields (BOY)											
Treasury yield 5y	3.0%	0.8%	0.6%	1.3%	1.6%	1.9%	1.9%	2.0%	2.1%	2.2%	2.4%
Long Treasury yield 15y	3.2%	1.0%	0.9%	1.8%	2.1%	2.4%	2.5%	2.6%	2.7%	2.8%	2.8%
TIPS yield 5y	0.6%	-1.0%	-1.1%	-0.6%	-0.5%	-0.3%	-0.3%	-0.2%	0.0%	0.2%	0.5%
Long TIPS yield 15y	1.0%	-0.7%	-0.8%	-0.2%	0.0%	0.1%	0.3%	0.4%	0.5%	0.7%	0.8%
Breakeven price inflation 15y	2.2%	1.7%	1.7%	2.0%	2.1%	2.2%	2.2%	2.2%	2.2%	2.1%	2.0%
A Corporate bond yield 5y	4.5%	5.0%	5.5%	5.5%	5.1%	5.1%	4.9%	4.7%	4.5%	4.4%	4.4%
Long A Corporate bond yield 10y	4.6%	4.5%	4.8%	5.2%	5.0%	4.9%	4.9%	5.0%	5.0%	5.1%	5.1%
A Corporate spread 5y	1.5%	4.3%	4.9%	4.2%	3.6%	3.2%	3.0%	2.7%	2.5%	2.2%	2.0%
Long A Corporate spread 10y	1.4%	3.6%	4.1%	3.7%	3.2%	3.0%	2.8%	2.6%	2.4%	2.3%	2.1%
Expected nominal return on assets											
Equity - US		-17.2%	-9.1%	11.5%	6.6%	6.6%	6.7%	6.7%	6.8%	6.9%	6.9%
Equity - Global		-19.6%	-10.5%	12.5%	7.0%	7.0%	7.0%	7.1%	7.2%	7.2%	7.3%
A Corporate bonds 5y		2.1%	1.4%	3.3%	5.4%	4.2%	4.8%	4.7%	4.5%	4.3%	4.2%
Long A Corporate bonds 10y		3.7%	-1.1%	-1.7%	5.6%	3.2%	3.5%	3.9%	4.1%	4.6%	4.8%
Treasury 5y		13.1%	1.7%	-1.6%	0.5%	0.9%	2.1%	2.1%	2.0%	2.0%	1.9%
Long Treasury 15y		40.3%	3.9%	-10.5%	-0.3%	-0.5%	1.8%	2.0%	2.2%	2.3%	2.1%
TIPS 5y		9.9%	1.0%	-1.7%	0.1%	0.4%	1.0%	1.1%	1.1%	1.2%	1.4%
Long TIPS 15y		32.4%	2.6%	-7.6%	0.0%	0.0%	0.8%	0.9%	1.0%	0.9%	1.1%
US High Yield		-15.3%	-11.8%	7.2%	5.4%	4.0%	5.4%	5.4%	5.3%	5.4%	5.3%
Bank Loans		-10.2%	-7.1%	6.3%	3.7%	3.6%	3.9%	4.2%	4.5%	4.7%	4.9%
USD Emerging Market Debt		-11.2%	-6.9%	9.2%	6.4%	6.2%	6.7%	6.7%	6.7%	6.7%	6.7%
Local Emerging Market Debt		-12.4%	-8.1%	8.0%	5.3%	5.0%	5.5%	5.5%	5.5%	5.5%	5.5%
Real Estate		-13.2%	-8.1%	-3.0%	0.5%	4.4%	4.4%	4.5%	4.6%	4.6%	4.7%
Commodities		-26.0%	-20.1%	8.9%	5.5%	5.5%	5.6%	5.6%	5.7%	5.8%	5.9%
Hedge Funds - FoHF - Universe		-13.4%	-8.2%	7.4%	6.2%	4.4%	4.5%	4.5%	4.5%	4.5%	4.5%
Private Equity		-19.8%	-9.9%	14.7%	9.2%	9.2%	9.2%	9.3%	9.4%	9.5%	9.5%
Infrastructure - US		-4.9%	-0.6%	2.9%	3.7%	7.3%	7.4%	7.4%	7.5%	7.5%	7.5%
Cash		2.8%	0.3%	0.4%	0.8%	1.1%	1.2%	1.4%	1.6%	1.7%	1.8%
CPI		2.4%	1.5%	0.8%	1.1%	1.4%	1.5%	1.6%	1.7%	1.8%	1.9%

Scenario information as of June 30, 2022

Dark Skies Scenario
Description

A deep recession followed by a longer period of stagnant growth

- A worsening Russia-Ukraine war, which expands beyond Ukraine's borders, and a renewed flare up of the pandemic, disrupts to the global economy, as additional restrictions are required over the next few years. China experiences a sharp deterioration in economic growth, due to stricter Covid restrictions and structural issues.
- Worsening geopolitical instability and central banks' aggressive monetary tightening has a severe impact on world economic growth. Economic weakness in developed and emerging market economies and severe levels of financial distress (due to high debt levels and political crisis) lead to a global recession followed by stagnation.
- Inflation falls sharply in late 2022 and sluggish growth over the following years means that inflation stays low.
- Treasury yields fall and remain at low levels as the US enters recession. Corporate spreads rise significantly due to the poor economic situation and increased risks of downgrades or defaults.
- Risk assets make losses in the first few years. There is no pronounced bounce in growth and the economic situation remains poor for a long time, which weighs on returns in later years.



Returns from 30 June 2022
Source: Aon
The opinions referenced are as of the date of publication and are subject to change due to changes in the market or economic conditions and may not necessarily come to pass. Information contained herein is for informational purposes only and should not be considered investment advice.

Dark Skies Scenario
Data Table

DARK SKIES SCENARIO

	Year 0	1	2	3	4	5	6	7	8	9	10
Yields (BOY)											
Treasury yield 5y	3.0%	0.2%	-0.6%	-0.7%	-0.7%	-0.5%	-0.2%	0.0%	0.3%	0.6%	0.9%
Long Treasury yield 15y	3.2%	0.4%	-0.1%	-0.2%	-0.1%	0.0%	0.3%	0.6%	0.9%	1.2%	1.4%
TIPS yield 5y	0.6%	-1.1%	-1.7%	-1.9%	-1.8%	-1.7%	-1.5%	-1.3%	-1.1%	-0.8%	-0.4%
Long TIPS yield 15y	1.0%	-1.1%	-1.5%	-1.6%	-1.5%	-1.4%	-1.2%	-0.9%	-0.7%	-0.4%	-0.2%
Breakeven price inflation 15y	2.2%	1.5%	1.4%	1.4%	1.4%	1.4%	1.5%	1.6%	1.6%	1.6%	1.6%
A Corporate bond yield 5y	4.5%	5.8%	5.6%	5.2%	4.6%	4.3%	4.2%	4.1%	4.1%	4.0%	4.0%
Long A Corporate bond yield 10y	4.6%	4.9%	4.8%	4.5%	4.1%	3.9%	4.0%	4.1%	4.2%	4.3%	4.4%
A Corporate spread 5y	1.5%	5.6%	6.2%	5.9%	5.2%	4.8%	4.4%	4.1%	3.8%	3.4%	3.1%
Long A Corporate spread 10y	1.4%	4.6%	5.0%	4.8%	4.4%	4.0%	3.8%	3.6%	3.3%	3.1%	2.9%
Expected nominal return on assets											
Equity - US		-26.2%	-18.6%	-9.8%	3.7%	3.7%	4.0%	4.4%	4.7%	5.1%	5.5%
Equity - Global		-29.5%	-21.0%	-11.1%	3.7%	3.7%	4.1%	4.5%	4.9%	5.3%	5.7%
A Corporate bonds 5y		-1.9%	1.7%	1.5%	2.2%	0.9%	0.3%	0.8%	1.2%	1.6%	1.9%
Long A Corporate bonds 10y		-1.0%	0.4%	1.8%	3.1%	1.1%	-0.4%	0.2%	0.7%	1.3%	1.8%
Treasury 5y		15.5%	3.6%	-0.4%	-1.0%	-1.4%	-1.8%	-1.5%	-1.2%	-1.0%	-0.7%
Long Treasury 15y		52.5%	8.9%	1.7%	-0.3%	-1.5%	-3.2%	-2.8%	-2.5%	-2.1%	-2.0%
TIPS 5y		8.8%	1.2%	-1.3%	-2.0%	-2.1%	-2.0%	-1.7%	-1.4%	-1.1%	-0.7%
Long TIPS 15y		37.0%	4.8%	-0.1%	-2.1%	-2.4%	-3.6%	-3.2%	-3.0%	-2.7%	-2.4%
US High Yield		-19.6%	-15.2%	-11.2%	-1.6%	-2.9%	-3.1%	-2.1%	-1.1%	-0.2%	0.6%
Bank Loans		-23.3%	-19.9%	-12.5%	-0.8%	-1.1%	-0.5%	0.2%	0.9%	1.6%	2.2%
USD Emerging Market Debt		-17.2%	-12.4%	-6.9%	2.9%	2.4%	2.4%	2.9%	3.4%	3.8%	4.3%
Local Emerging Market Debt		-18.4%	-13.6%	-8.0%	1.8%	1.2%	1.2%	1.7%	2.2%	2.7%	3.1%
Real Estate		-14.9%	-10.5%	-4.9%	-0.6%	1.5%	1.9%	2.2%	2.6%	2.9%	3.2%
Commodities		-33.1%	-25.1%	-1.6%	4.1%	4.1%	4.3%	4.5%	4.7%	5.0%	5.2%
Hedge Funds - FoHF - Universe		-16.3%	-11.1%	-5.5%	1.5%	1.5%	1.8%	2.1%	2.4%	2.7%	3.0%
Private Equity		-30.6%	-21.4%	-10.5%	5.6%	5.6%	6.0%	6.5%	6.9%	7.3%	7.8%
Infrastructure - US		-11.8%	-7.5%	-3.7%	1.3%	3.9%	4.3%	4.7%	5.0%	5.4%	5.8%
Cash		2.8%	-0.1%	-0.5%	-0.6%	-0.5%	-0.3%	-0.1%	0.2%	0.4%	0.7%
CPI		1.0%	-0.2%	0.2%	0.4%	0.6%	0.8%	0.9%	1.1%	1.3%	1.5%

Scenario information as of June 30, 2022

Appendix

- Actuarial Assumptions and Methods

Empower Results®

Actuarial Assumptions and Methods

- Actuarial projections were provided by the plan actuary as of the most recent valuation date (June 30, 2021) with key assumptions noted below:
  - Assumed Investment Return: 7.00%
  - Average Salary Increase: 4.50%
  - Payroll Growth: 3.25%
  - Inflation: 2.50%

- Additional actuarial assumptions:
  - Actuarial Value of Assets: smooth gains/losses relative to expected valuation rate of interest over 10 years and shall be no less than 70% and no greater than 130% of the market value of assets
  - Projection assumptions from the plan actuary
    - The active workforce size is assumed to remain constant over the projection period;
    - Future new employees have similar characteristics (age/gender/salary) to new employees for the period July 1, 2018 through June 30, 2021
      - Among new school employees hired on or after July 1, 2021, 98% will become Class T-G members, 1% will elect Class T-H membership, and 1% will elect Class DC participation.

Actuarial Assumptions and Methods (continued)

- Additional actuarial assumptions (continued):
  - Projection assumptions from the plan actuary (continued)
    - The projection reflects the ACT 5 risk-sharing provisions for TE/TF/TG/TH members. We caution that while the System assets and projected unfunded accrued liability amortization schedules reflect the under/over contribution from the basic member rate resulting from the assumed asset returns, the corresponding System accrued liabilities do not reflect the increase in the affected members contribution rates. Changes in the member rate influence the System's total liabilities due to incidence of return of contributions for non-vested members, Option 4 lump sum withdrawals, etc.
  - All other assumptions as documented in the Actuarial Valuation Report as of June 30, 2021

- Actuarially-Determined Contribution Calculation = Normal Cost plus a level percent amortization of the unfunded liability with layered 24 year, closed periods, and a 3.25% salary scale
  - Amortization bases developed are projected to continue until either their individual expiry or the plan reaches 100% funded on an actuarial value of assets basis at which point any remaining balance is fully recognized

- Other assumptions
  - Asset figures reflect performance for the period July 1, 2021 – June 30, 2022 resulting in a market asset value of $69.748.1 billion as of June 30, 2022
  - Employee contributions are limited to the actuarially-determined contribution
  - The health care premium assistance assets and liabilities have been excluded from this analysis
  - The rate collar provision of Act 120 was not considered in this analysis as it has been deemed to no longer be effective
  - "Shared Risk" provisions of Act 120 have not been considered in this analysis

Appendix

- Capital Market Assumptions

Capital Market Assumption Methodology

- The Aon Asset Model and Economic Scenario Generator (ESG) creates 5,000 simulations of key economic variables and total returns.
- We believe the model is complete and consistent. All the major markets and asset classes are modeled within a consistent framework allowing for the interactions between them to be properly taken into account.
- It is arbitrage free and captures the fact that extreme market events do occur more frequently than would be predicted by simpler statistical models.
- The ESG models the full yield curve as this allows for accurate treatment of liabilities and realistic modeling of the future distribution of interest rates and inflation. This allows us to assess the sensitivities of assets and liabilities to changes in interest and inflation rates.
- The model is calibrated to Aon's globally-consistent Capital Market assumptions every quarter.
- Nominal and real government interest rates are projected using an extended two factor Black-Karasinki model and a 2 factor Vasicek model respectively. The models are mean reverting starting with current yield curves and reverting towards our long-term fair values over the very long-term.
- Credit spreads are modeled stochastically using a Markov based model to determine the probabilities of transition between various credit rating and default, and a stochastic parameter reflecting the level of risk aversion in the market.
- Return seeking assets (including equities) are modeled using an individual asset class model with its own returns and volatilities but no correlations to other asset classes, and exposure to 6 other economic models to gain the correct correlation structures between returns for each asset class.

Aon Investments' Capital Market Assumptions

As of June 30, 2022 (30 Years)

		Expected Real Return[1]	Expected Nominal Return[1]	Expected Nominal Volatility
	Equity			
1	Large Cap U.S. Equity	4.8%	7.3%	17.5%
2	Small Cap U.S. Equity	5.3%	7.8%	23.5%
3	International Equity (Developed) - Hedged	5.2%	7.7%	18.5%
4	International Equity (Developed) - Unhedged	5.1%	7.6%	21.0%
5	Emerging Markets Equity	5.7%	8.2%	24.5%
	Fixed Income			
6	TIPS	1.0%	3.4%	3.5%
7	Core Fixed Income	1.3%	3.7%	4.5%
8	Long Duration Bonds – Gov't	1.1%	3.5%	9.0%
9	High Yield Bonds	3.3%	5.8%	10.5%
10	Emerging Market Bonds, Hard	3.3%	5.8%	11.5%
	Alternatives			
11	REITs	3.9%	6.4%	19.0%
12	Non-Core Real Estate	4.2%	6.7%	25.5%
13	Commodities	3.5%	6.0%	17.0%
14	Private Equity	8.0%	10.6%	26.5%
15	Infrastructure - Private	5.2%	7.7%	15.0%
16	Infrastructure - Public	4.9%	7.4%	17.5%
17	Gold	0.8%	3.2%	19.5%
18	Private Debt	4.6%	7.1%	17.5%
	Inflation			
19	Inflation	0.0%	2.4%	2.0%

Notes:

[1] Expected returns based on Aon Investments Q3 2022 30-year Capital Market Assumptions assuming the detailed portfolios found in the Appendix. All expected returns are geometric (long-term compounded; rounded to the nearest decimal) and net of investment fees. Expected returns presented are models and do not represent the returns of an actual client account. Not a guarantee of future results. See Appendix for the Capital Market Assumptions.

[2] Private Equity assumptions developed as follows: 72% Buyouts, 13% Venture Capital, 15% Distressed Debt

Aon Investments’ Capital Market Assumptions

As of June 30, 2022

	Nominal Correlations	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1	Large Cap U.S. Equity	**1.00**	0.93	0.87	0.81	0.73	-0.02	0.02	-0.13	0.62	0.45	0.65	0.45	0.46	0.92	0.34	0.90	0.01	0.38	0.07
2	Small Cap U.S. Equity	0.93	**1.00**	0.81	0.75	0.68	-0.03	0.02	-0.13	0.58	0.43	0.61	0.43	0.41	0.87	0.34	0.85	0.01	0.36	0.07
3	International Equity (Developed) – Hdg	0.87	0.81	**1.00**	0.89	0.74	-0.01	0.03	-0.14	0.59	0.43	0.59	0.48	0.32	0.80	0.35	0.82	0.01	0.37	0.07
4	International Equity (Developed) – Unhdg	0.81	0.75	0.89	**1.00**	0.76	-0.02	0.01	-0.13	0.61	0.45	0.54	0.44	0.49	0.75	0.31	0.84	0.02	0.38	0.10
5	Emerging Markets Equity	0.73	0.68	0.74	0.76	**1.00**	-0.02	0.03	-0.13	0.68	0.49	0.50	0.41	0.35	0.68	0.29	0.75	0.01	0.40	0.07
6	TIPS	-0.02	-0.03	-0.01	-0.02	-0.02	**1.00**	0.50	0.41	0.08	0.14	0.00	0.02	0.16	-0.03	0.03	0.01	0.05	-0.12	0.39
7	Core Fixed Income	0.02	0.02	0.03	0.01	0.03	0.50	**1.00**	0.72	0.29	0.47	0.02	0.04	0.03	0.02	0.05	0.03	0.00	0.07	-0.02
8	Long Duration Bonds – Gov’t	-0.13	-0.13	-0.14	-0.13	-0.13	0.41	0.72	**1.00**	-0.15	0.10	-0.09	-0.07	-0.05	-0.13	-0.05	-0.13	-0.02	-0.25	-0.17
9	High Yield Bonds	0.62	0.58	0.59	0.61	0.68	0.08	0.29	-0.15	**1.00**	0.76	0.41	0.33	0.39	0.59	0.26	0.63	0.02	0.68	0.17
10	Emerging Market Bonds, Hard	0.45	0.43	0.43	0.45	0.49	0.14	0.47	0.10	0.76	**1.00**	0.30	0.24	0.25	0.43	0.18	0.45	0.01	0.45	0.05
11	REITs	0.65	0.61	0.59	0.54	0.50	0.00	0.02	-0.09	0.41	0.30	**1.00**	0.47	0.28	0.60	0.24	0.68	0.01	0.25	0.05
12	Non-Core Real Estate	0.45	0.43	0.48	0.44	0.41	0.02	0.04	-0.07	0.33	0.24	0.47	**1.00**	0.16	0.42	0.22	0.46	0.02	0.19	0.07
13	Commodities	0.46	0.41	0.32	0.49	0.35	0.16	0.03	-0.05	0.39	0.25	0.28	0.16	**1.00**	0.43	0.09	0.56	0.04	0.18	0.39
14	Private Equity	0.92	0.87	0.80	0.75	0.68	-0.03	0.02	-0.13	0.59	0.43	0.60	0.42	0.43	**1.00**	0.32	0.83	0.01	0.37	0.06
15	Infrastructure - Private	0.34	0.34	0.35	0.31	0.29	0.03	0.05	-0.05	0.26	0.18	0.24	0.22	0.09	0.32	**1.00**	0.32	0.01	0.15	0.06
16	Infrastructure - Public	0.90	0.85	0.82	0.84	0.75	0.01	0.03	-0.13	0.63	0.45	0.68	0.46	0.56	0.83	0.32	**1.00**	0.02	0.37	0.13
17	Gold	0.01	0.01	0.01	0.02	0.01	0.05	0.00	-0.02	0.02	0.01	0.01	0.02	0.04	0.01	0.01	0.02	**1.00**	0.00	0.12
18	Private Debt	0.38	0.36	0.37	0.38	0.40	-0.12	0.07	-0.25	0.68	0.45	0.25	0.19	0.18	0.37	0.15	0.37	0.00	**1.00**	0.01
19	Inflation	0.07	0.07	0.07	0.10	0.07	0.39	-0.02	-0.17	0.17	0.05	0.05	0.07	0.39	0.06	0.06	0.13	0.12	0.01	**1.00**

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Appendix

- About This Material

About This Material

This material includes a summary of calculations and consulting related to the finances of Pennsylvania Public School Employees' Retirement System (PSERS). The following variables have been addressed:

- Contributions, Liquidity, Net Outflow

This analysis is intended to assist the Investment Committee with a review of the associated issues and options, and its use may not be appropriate for other purposes. This analysis has been prepared solely for the benefit of the Investment Committee. Any further dissemination of this report is not allowed without the written consent of Aon Investments USA Inc.

Our calculations were generally based on the methodologies identified in the actuary's valuation report for PSERS. We believe the methodology used in these calculations conforms to the applicable standards identified in the report.

Models are used to develop alternative scenarios based on the underlying valuation model and project financial results under those scenarios. The models were developed by experts outside and within Aon. Where outside models were used, the models were reviewed by experts within Aon. The models were selected as appropriate for these projections by the undersigned.

Experience different than anticipated could have a material impact on the ultimate costs of the benefits. In addition, changes in plan provisions or applicable laws could have a significant impact on cost. Actual experience may differ from our modeling assumptions.

Our calculations were based on data provided by the plan actuary. The actuarial assumptions and methods and plan provisions reflected in these projections are the same as those used for the June 30, 2021 actuarial valuation for PSERS as noted in the actuarial reports, except where noted in this report. Unless specifically noted, our calculations do not reflect any other changes or events after June 30, 2021. Reflecting events after June 30, 2021 would impact the results of the projection.

In conducting these projections, we have relied on plan design, demographic and financial information provided by other parties, including the plan's actuary and plan sponsor. While we cannot verify the accuracy of all of the information, the supplied information was reviewed for consistency and reasonableness. As a result of this review, we have no reason to doubt the substantial accuracy or completeness of the information and believe that it has produced appropriate results.

These projections have been conducted in accordance with generally accepted actuarial principles and practices, including applicable Actuarial Standards of Practice as issued by the Actuarial Standards Board. The undersigned actuary is familiar with the near-term and long-term aspects of pension valuations and meet the Qualification Standards of the American Academy of Actuaries necessary to render the actuarial opinions contained herein. All sections of this report are considered an integral part of the actuarial opinions.

To our knowledge, no colleague of Aon Investments USA Inc. providing services to PSERS has any direct financial interest or indirect material interest in PSERS. Thus, we believe there is no relationship existing that might affect our capacity to prepare and certify this report for PSERS.

Aon Investments USA Inc.

Phil Kivarkis FSA, CFA

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