Joint Water Commission

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Balancing Approach to

SEISMIC MITIGATION

PNWS Spring Conference

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carollo
Engineers...Working Wonders With Water™

Project Team

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Key Objective of the Project

1. Assess reliability of the JWC Water Treatment Plant and Raw Water Pump Station.

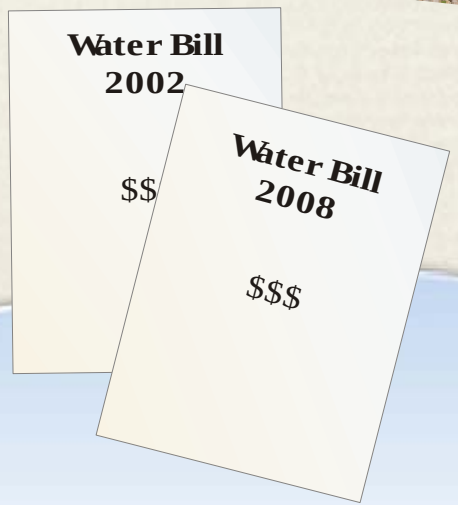
2. Develop recommendations to reduce vulnerability to seismic events.

The Approach to Seismic Mitigation Key

1. The “risk” message is sensitive

2. Risk Mitigation
   1. Acceptable Level
   2. Resource Allocation

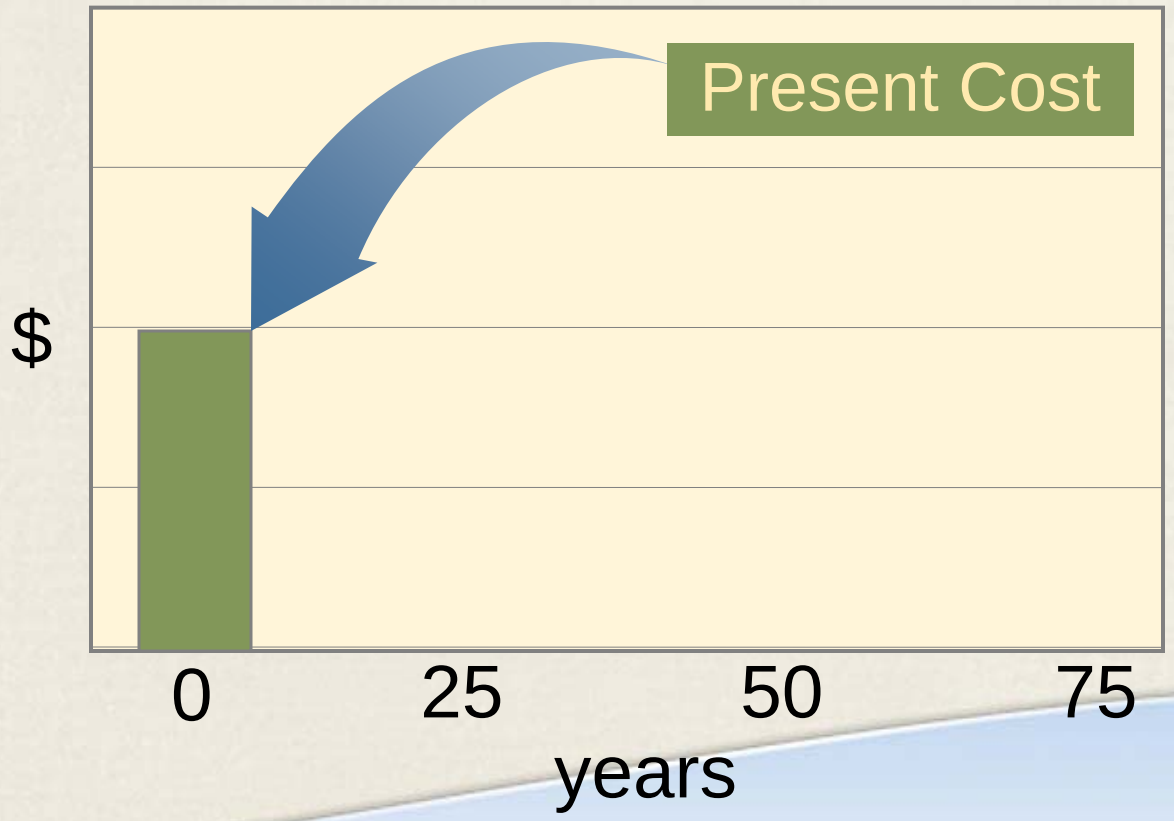
3. The plan may result in big $ costs



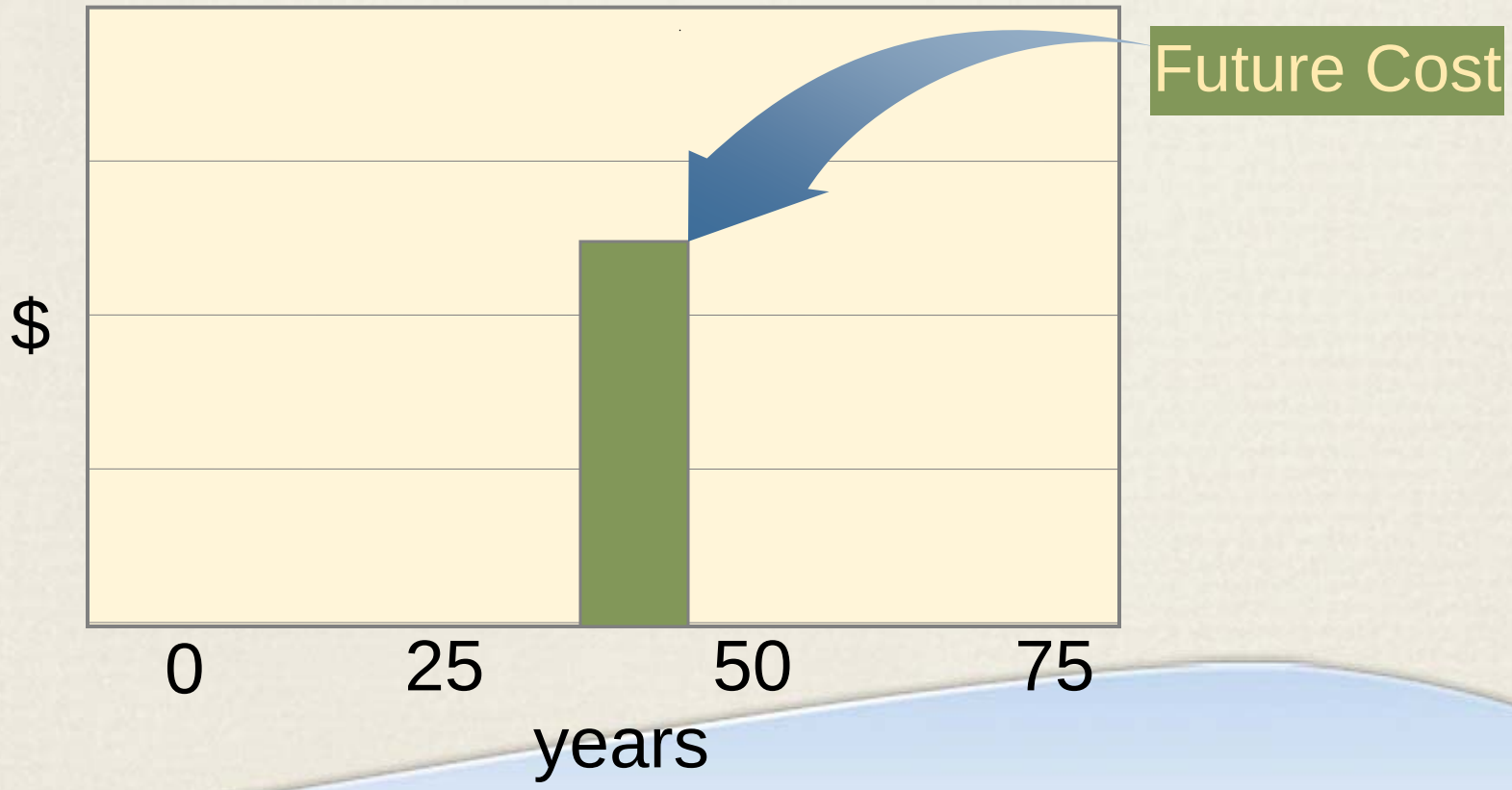
Balance Is Needed in Reducing the Vulnerability of the System

Achieve a balance between reduced risk and cost both near and long term

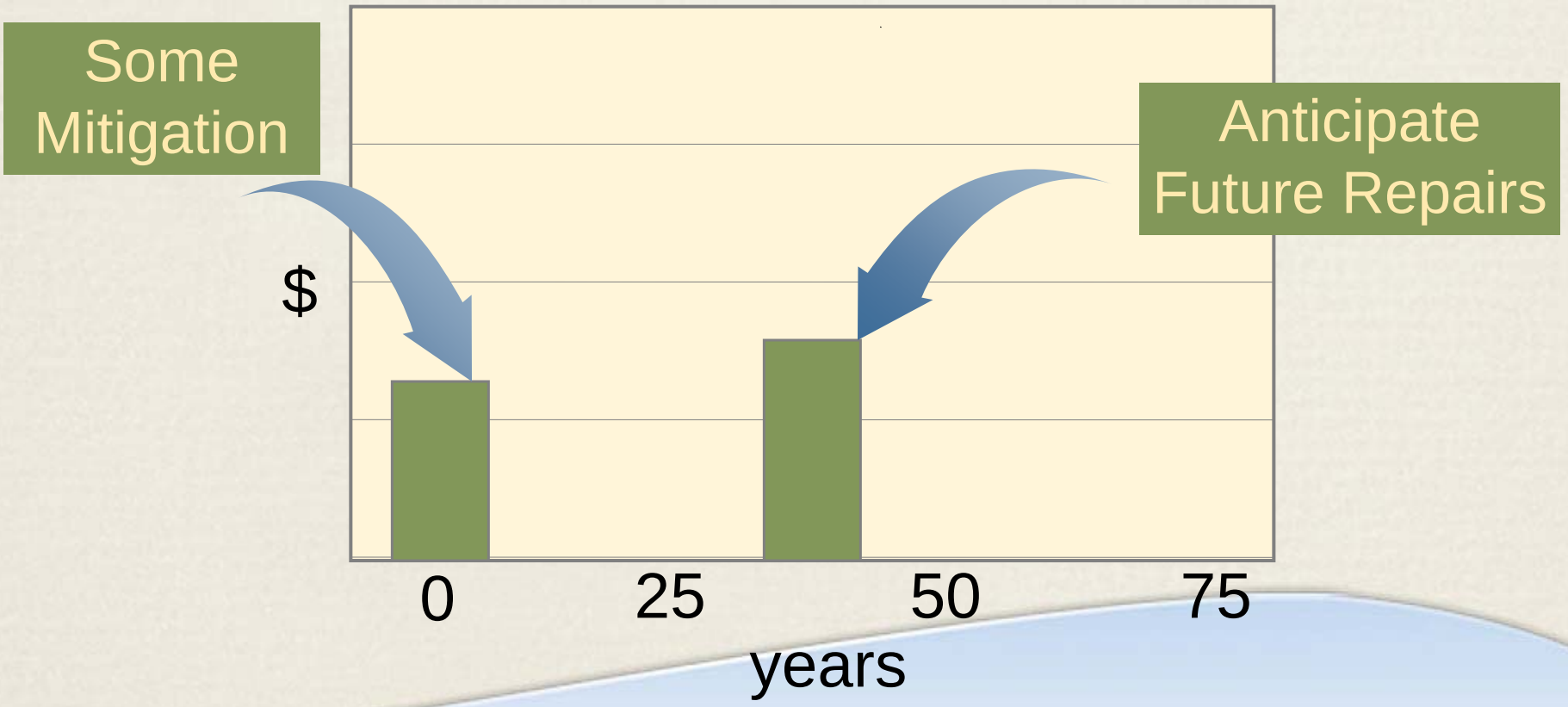
Near Term Mitigation Reduces Damage but Requires Resources



Repairs Following an Event Defer Cost but have Capacity Impacts.



A Combination of Mitigation and Repair Offers a Balanced Approach



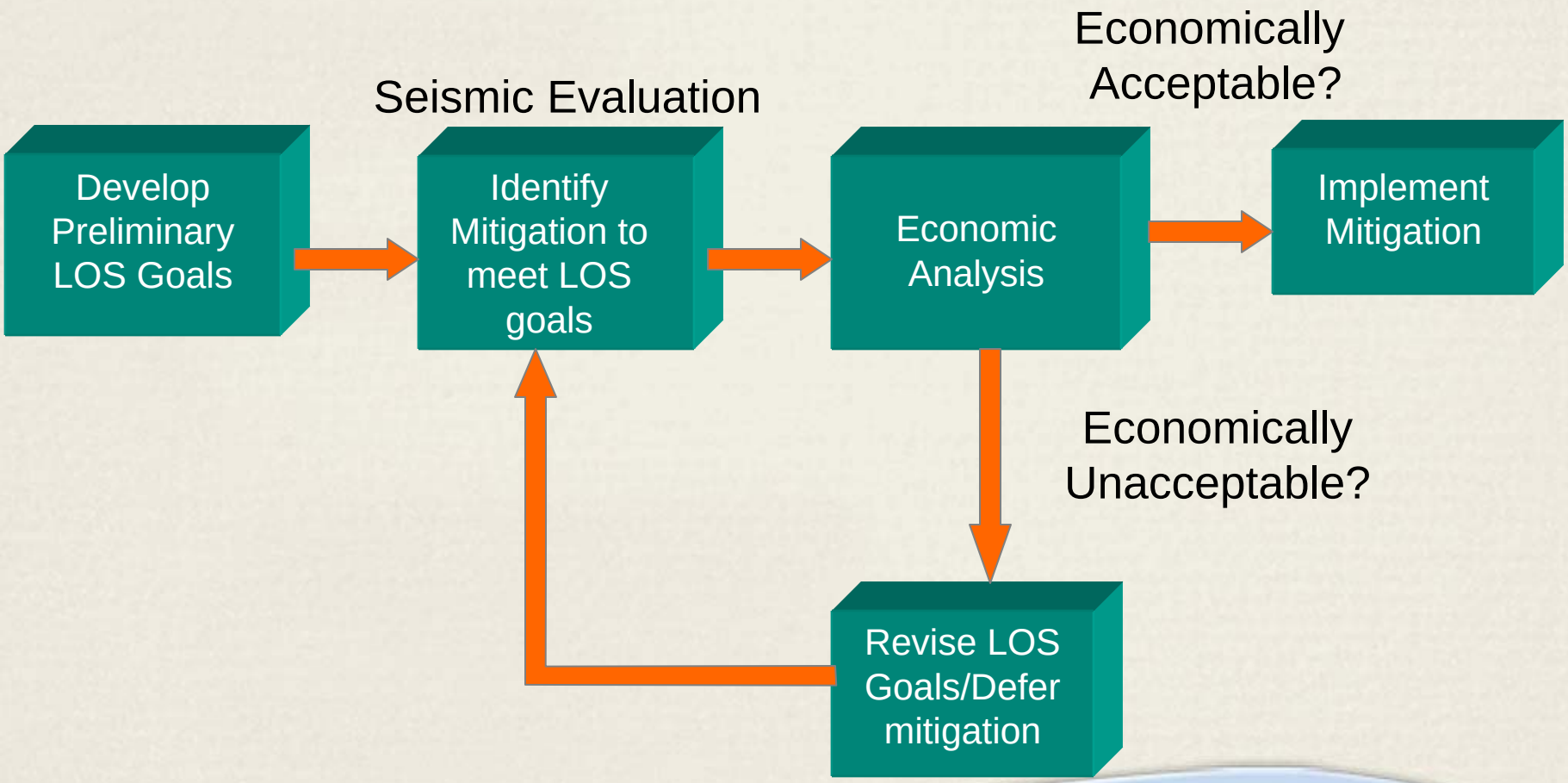
Level of Service Goals Provide Targets for Mitigation

1. Performance standards for service following an event
   a. Capacity
   b. Duration
   c. Quality

2. Policy Statement applicable to any stated event

3. Commission/Board level goal

Overview of Level of Service Approach



LOS Goals established for 3 seismic events

1. Small -72 yr event (50% in 50 yr)
2. Medium- 475 yr event (10% in 50 yr)
3. Large- 2475 yr event (2% in 50 yr)

Each Partner Has Different LOS Needs

a. Repair and restoration time
b. Partners storage volumes
c. Alternate supply sources
d. Fires following earthquakes
e. System control/emergency management of demand

2. LOS Goals Dependant on JWC <u>and</u> Partners systems

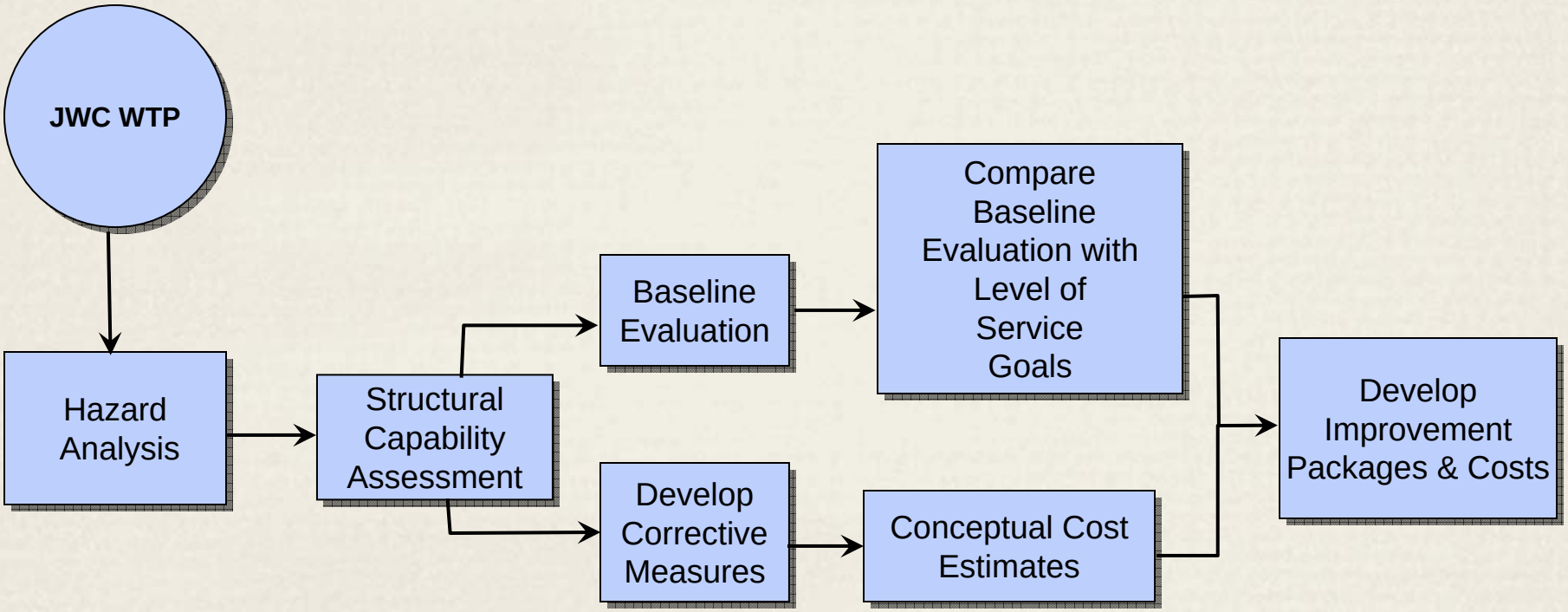
Partner Survey Sets Stage for LOS Workshop

1. Survey impact of reduced service to JWC Partners
2. LOS workshop
3. Preliminary LOS goals determined

JWC System
Preliminary LOS Goals

LOS Component	72 year event (50% in 50 year)	475 year event (10% in 50 year)	2475 year event (2% in 50 year)
Quantity	42 MGD (ADD)	28 MGD (Winter ADD)	½ WADD within 3 days WADD 7 – 14 days ADD 60 – 90 days
Restoration Time	Immediately following event.	Within 24 hrs	See above.
Water Quality	Potable	Potable	Potable

Seismic Evaluation Process



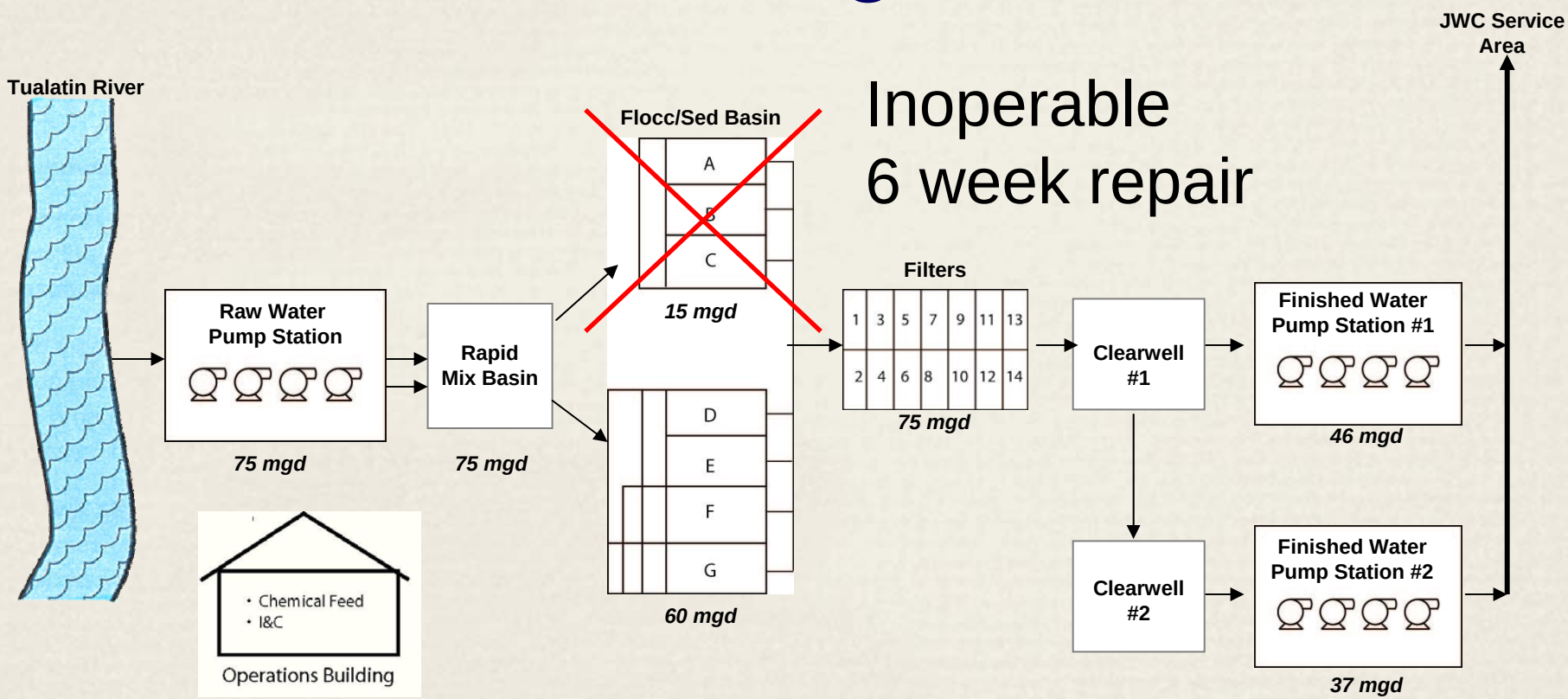
Hazard Analysis

1. Evaluated seismic events
   a. 72 yr event (50% in 50 yr) – M 5.7 crustal
   b. 475 yr event (10% in 50 yr) – M 8.6 subduction
   c. 2475 yr event (2% in 50 yr) – M 8.6 crustal

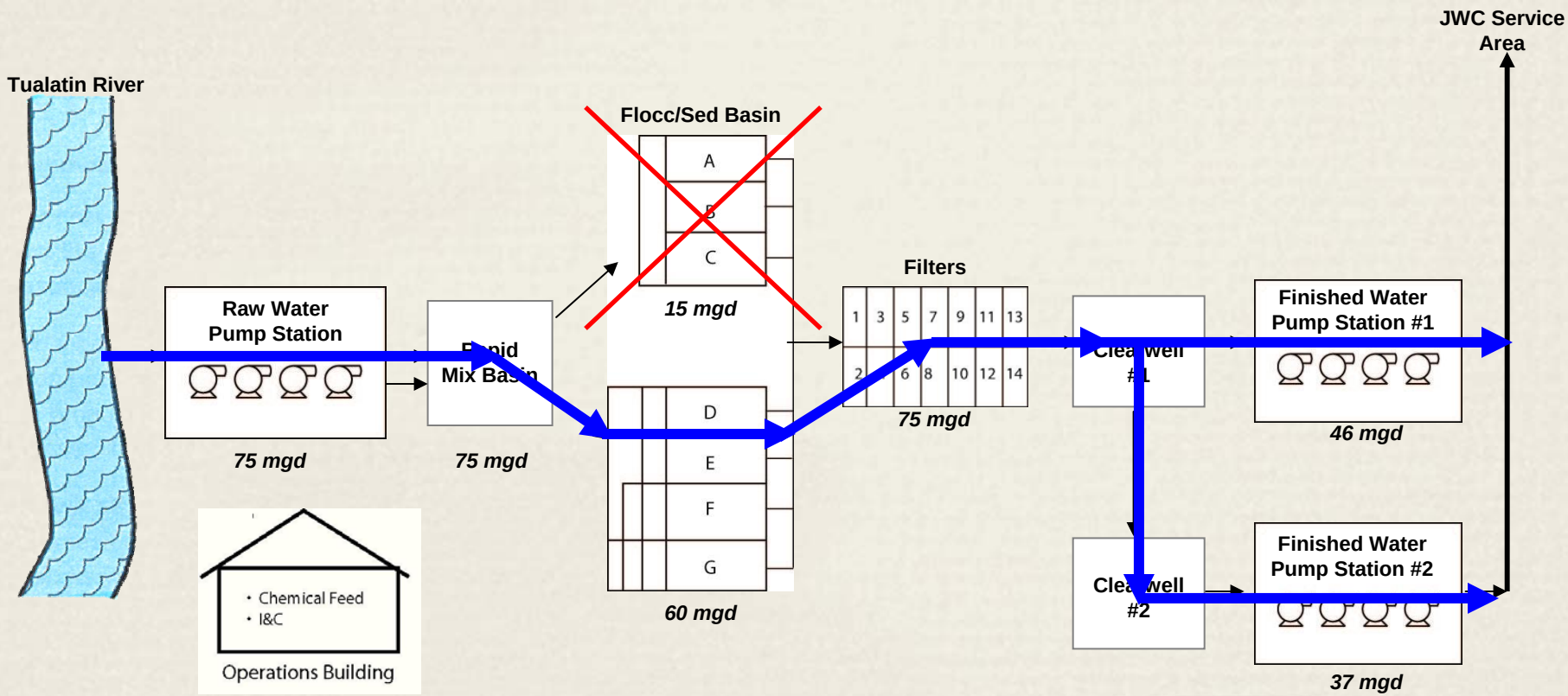
2. Identified seismic hazards
   a. Shaking
   b. Liquefaction
   c. Lateral Spreading

3. Liquefaction induced settlement
   a. 12” to 15” possible for 475-yr & 2475-yr

Structural Capability Assessment Determined Operability of Unit Processes Following Event

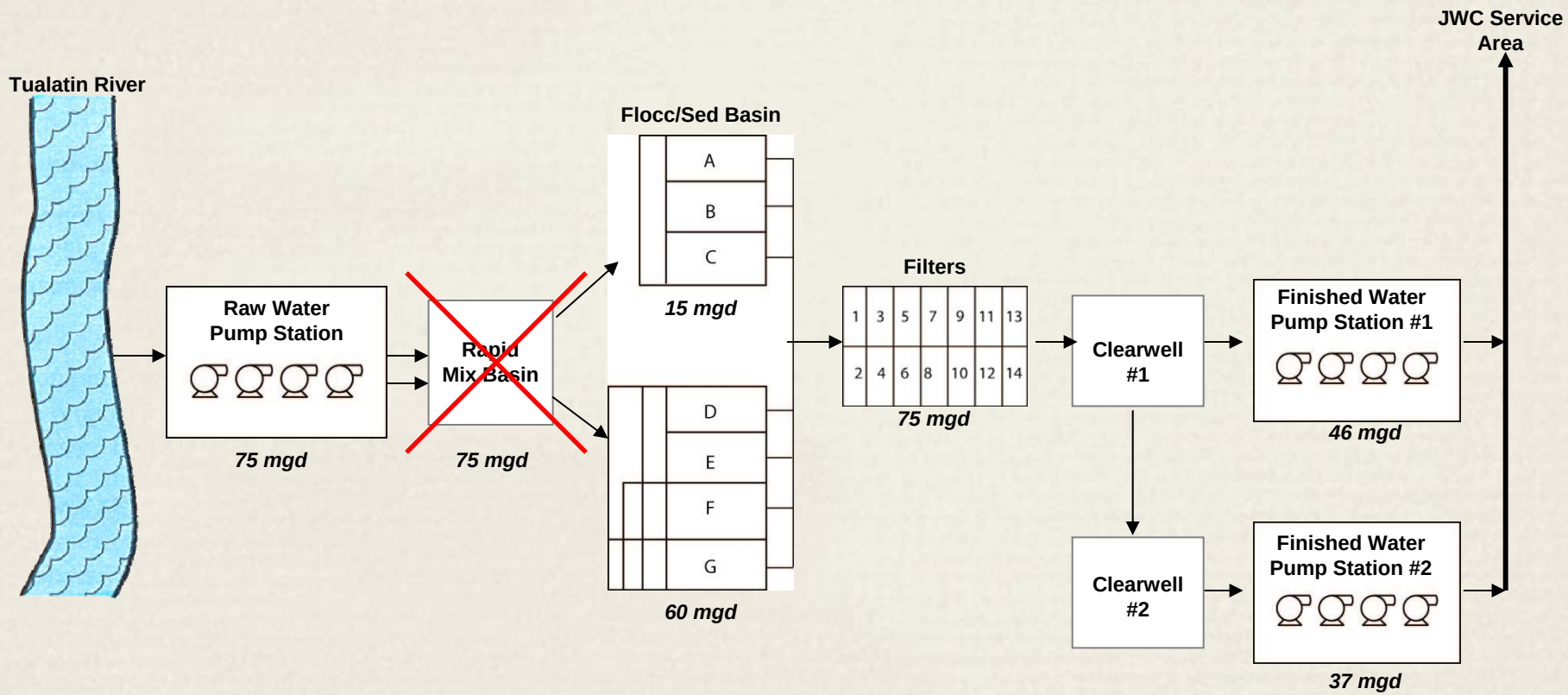


Impact of Damage State on LOS Drives Mitigation



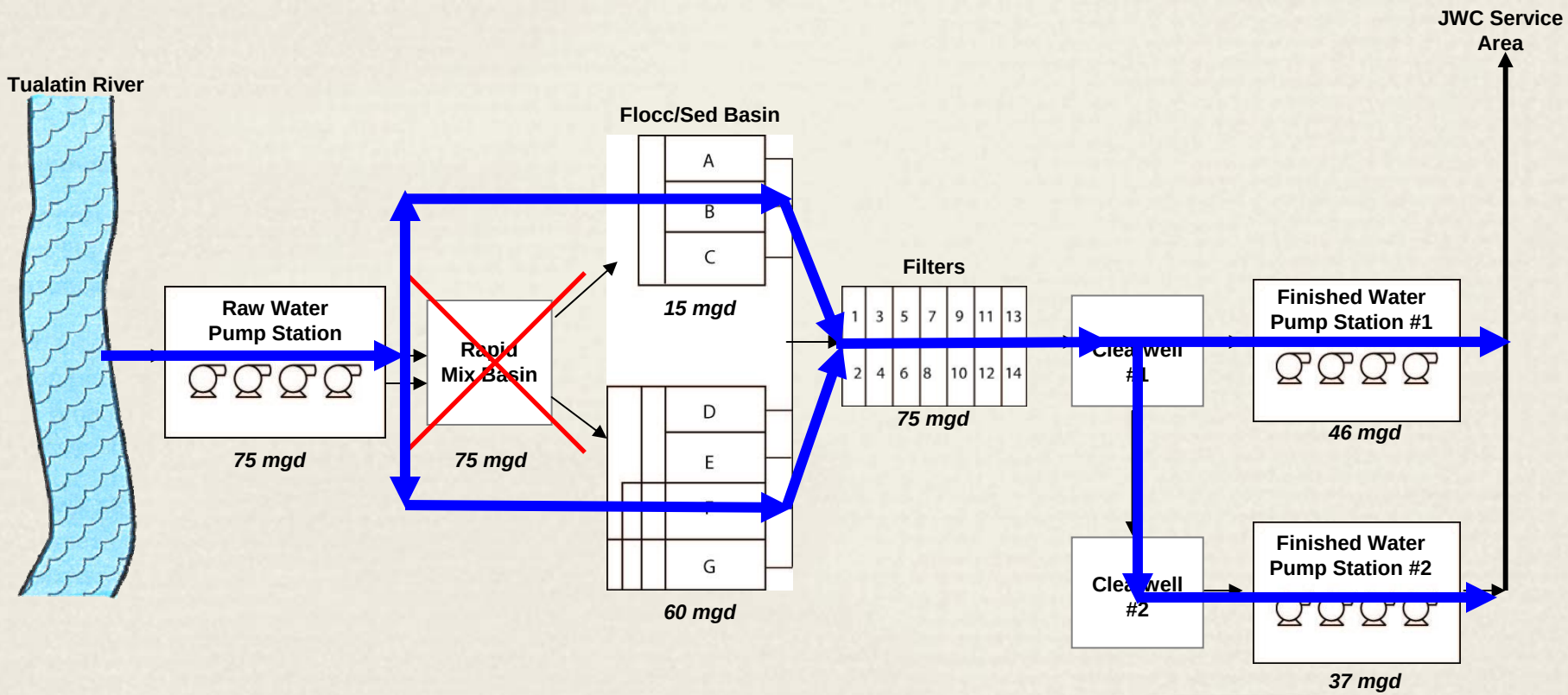
- Reduced Capacity – 60 MGD
- Reduction duration - 6 weeks

Loss of Non-Redundant Facilities Causes Plant Shutdown



- Plant shut down – 0 MGD
- Repair time – 8 weeks

Work Arounds Considered as Alternative to Mitigation



- Work around – 40 MGD
- Implementation time – 1 week

Performance Objectives

1. Life Safety
   a. Not intended to prevent damage to facilities
   b. Minimize threat to building occupants
   c. Prevent building collapse
   d. Not intended to keep plant operational

2. Immediate Occupancy
   a. Some damage to buildings
   b. Building can be occupied
   c. Basins/processes remain functional

Improvement Package Summary

Package	Event	Mitigation Cost
Package 1 0 MGD – Life Safety	475-yr	$2.8 M
Package 2a 46 MGD within 24 hrs	72-yr	$3.1 M
Package 2b 28 MGD Immediately 46 MGD within 24 hrs	72-yr	$6.1 M
Package 3 28 MGD Immediately 46 MGD within 24 hrs	475-yr	$23.8 M
Package 4 28 MGD Immediately 46 MGD within 24 hrs	2475-yr	$23.9 M

Probabilistic Risk Assessment

1. Determine benefit & cost of implementing each improvement package
2. Costs = Improvement package costs (PV)
3. Benefits = Future Avoided losses (PV)
4. Benefit/Cost = BC Ratio
   a. BC Ratio > 1 = Good
   b. BC Ratio < 1 = Not so good.
5. Total Combined Cost (Mitigation Cost + PV of Future Losses)

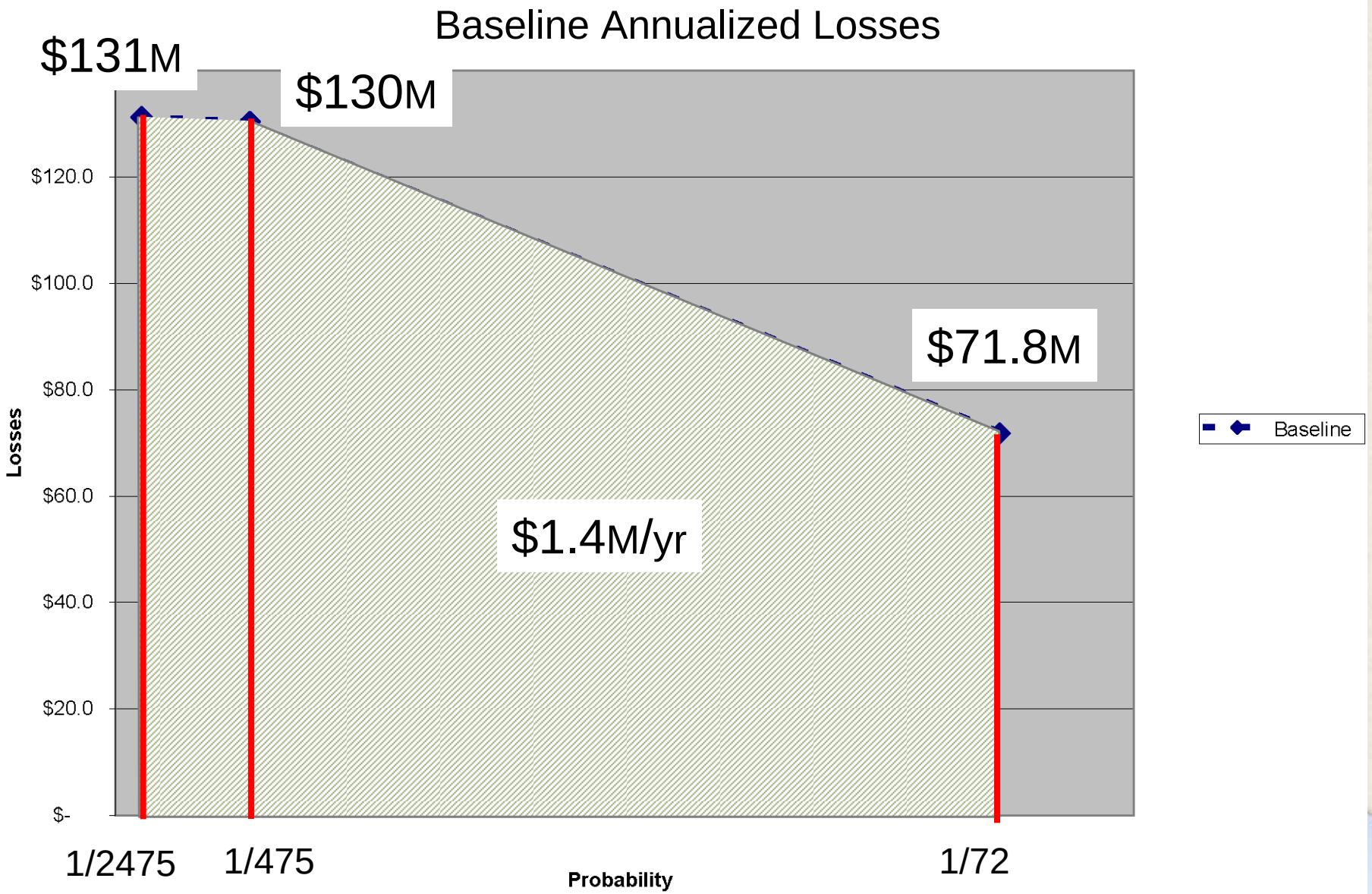
Avoided Loss Calculation

1. Losses are Future Costs
   a. Direct damage
   b. Water revenue loss
   c. Cost of replacement water (PWB, other?)
   d. Work around equipment rental

2. Future costs are annualized
   a. Annual probability applied to Future Costs
   b. Annualized risk related loss

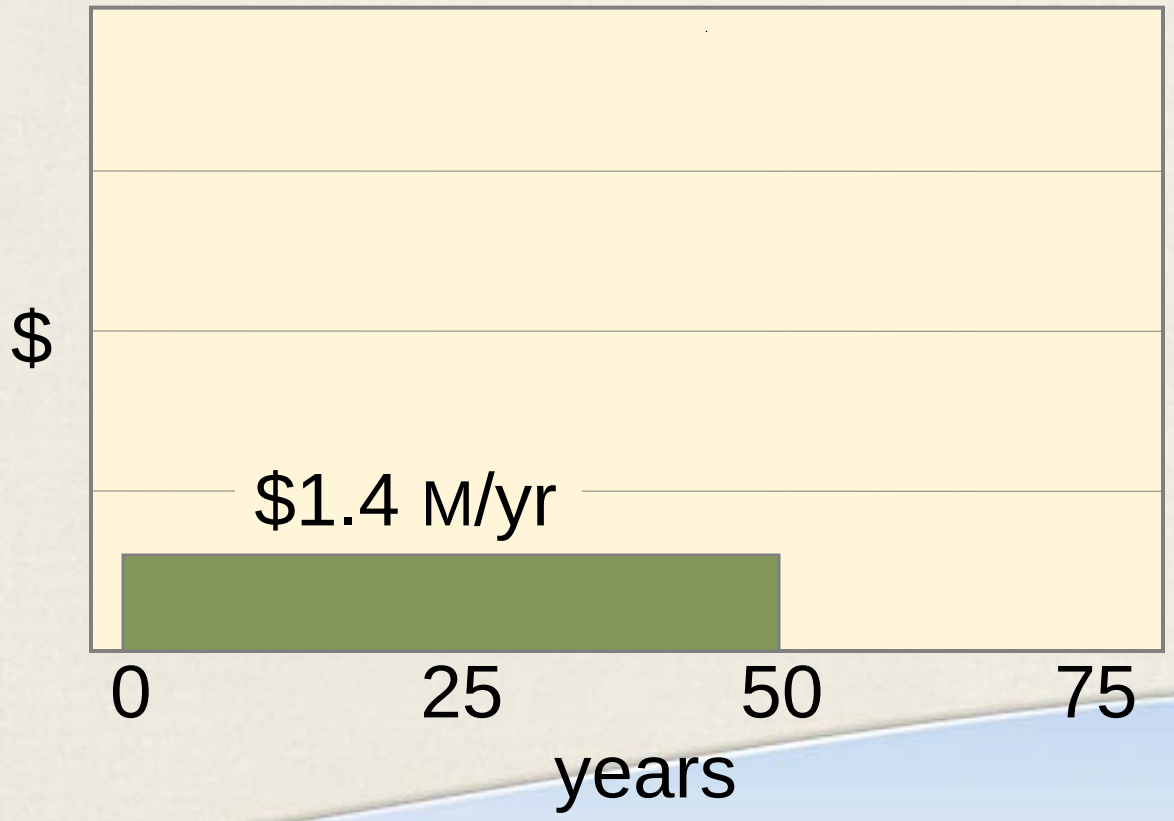
3. Present Value calculated

Annualized Costs - Baseline



Annualized Cost - Baseline

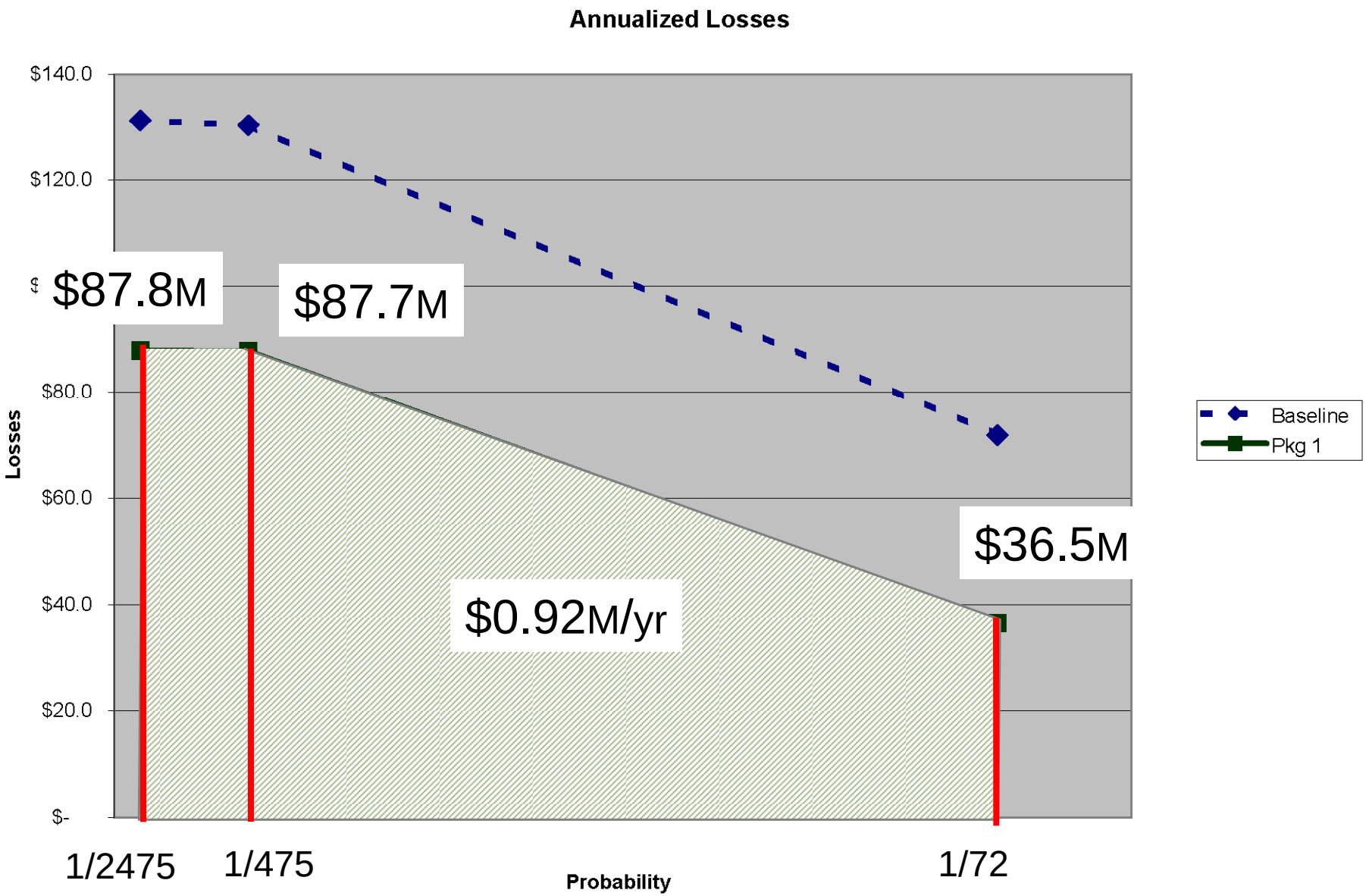
- Useful Service Life 50 yr
- 7% Annual percentage rate



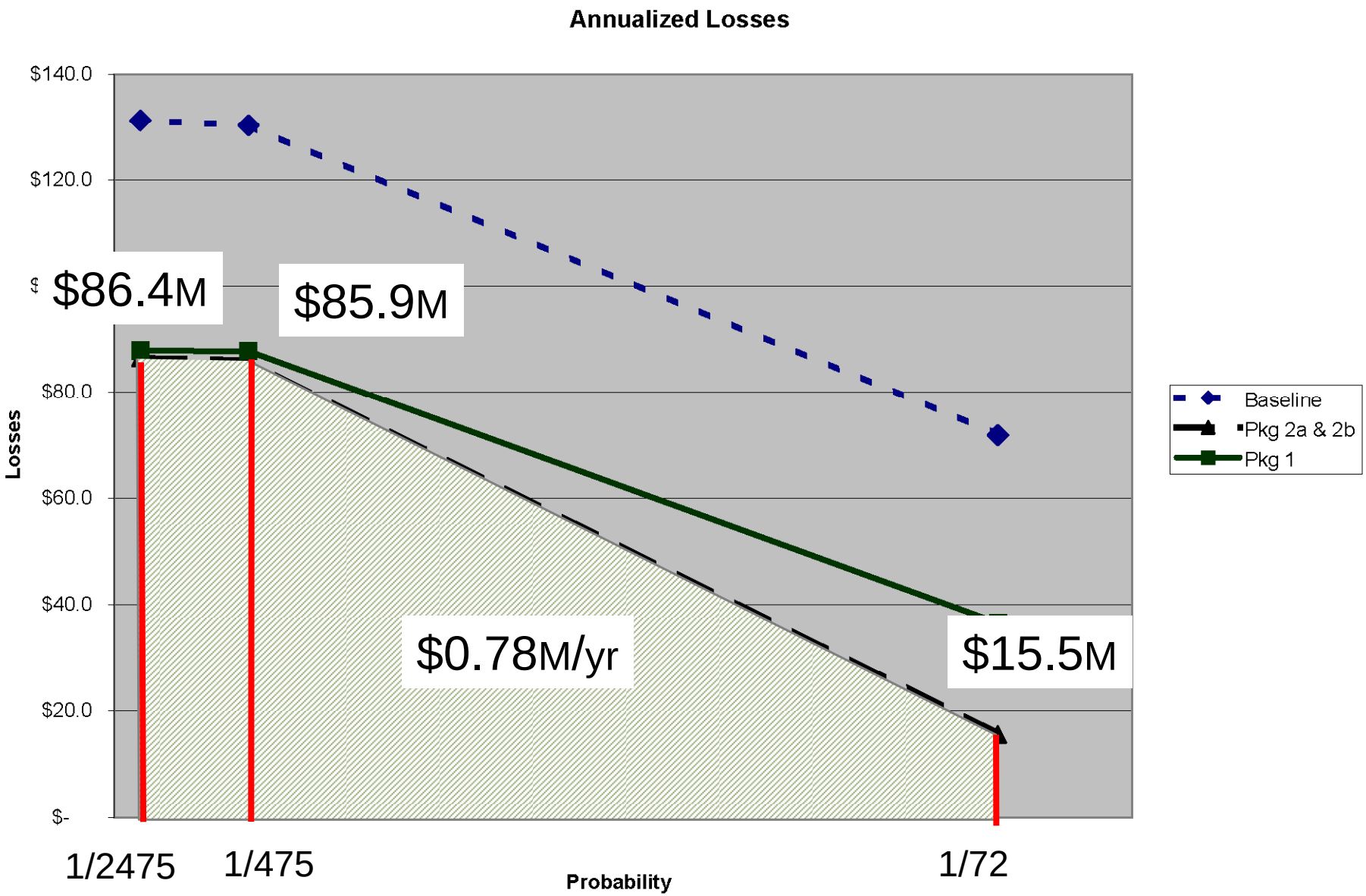
Present Value Annualized Losses

- Present value of 50 yr annuity
- 7% APR

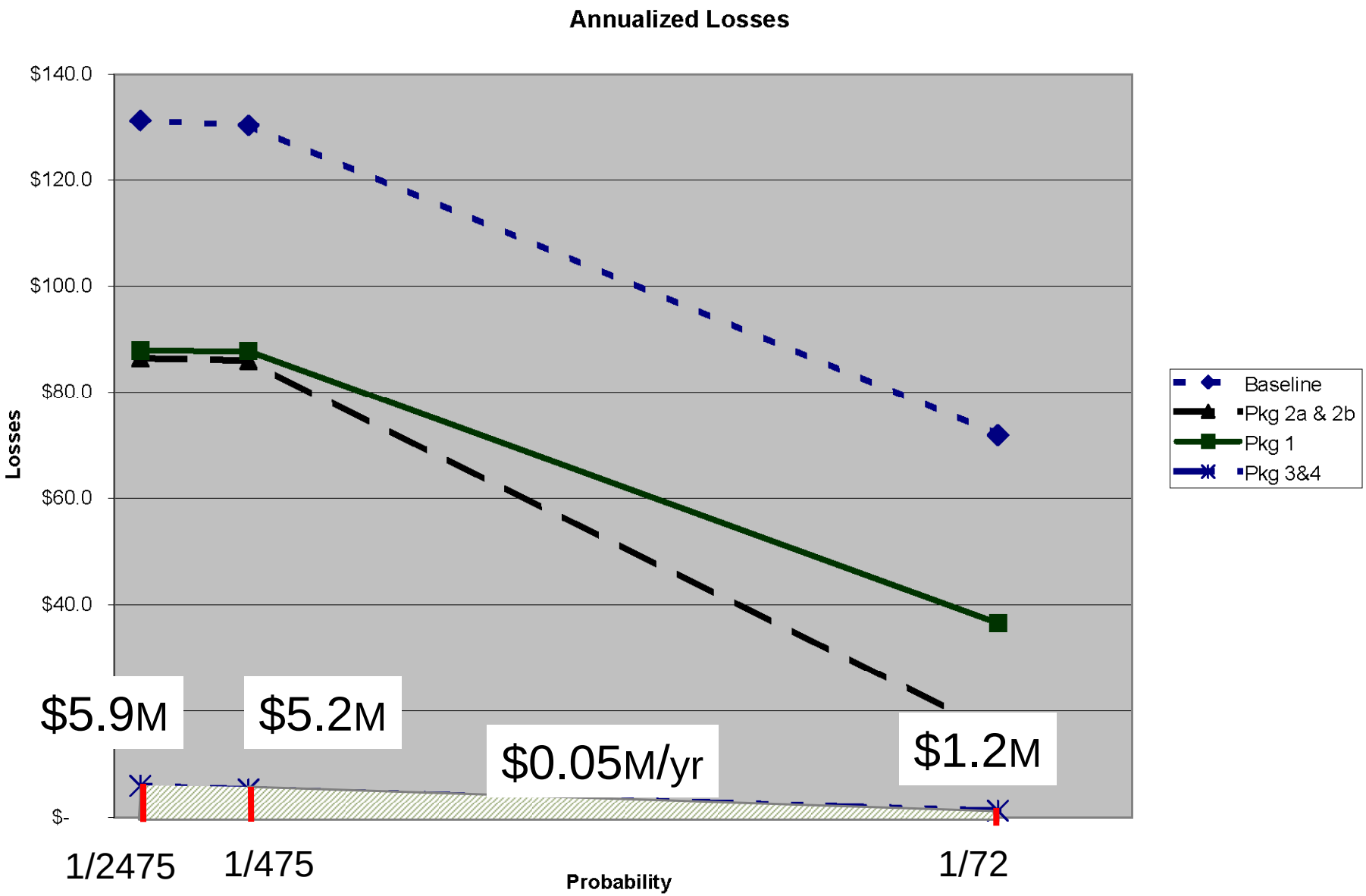
Annualized Costs – Package 1



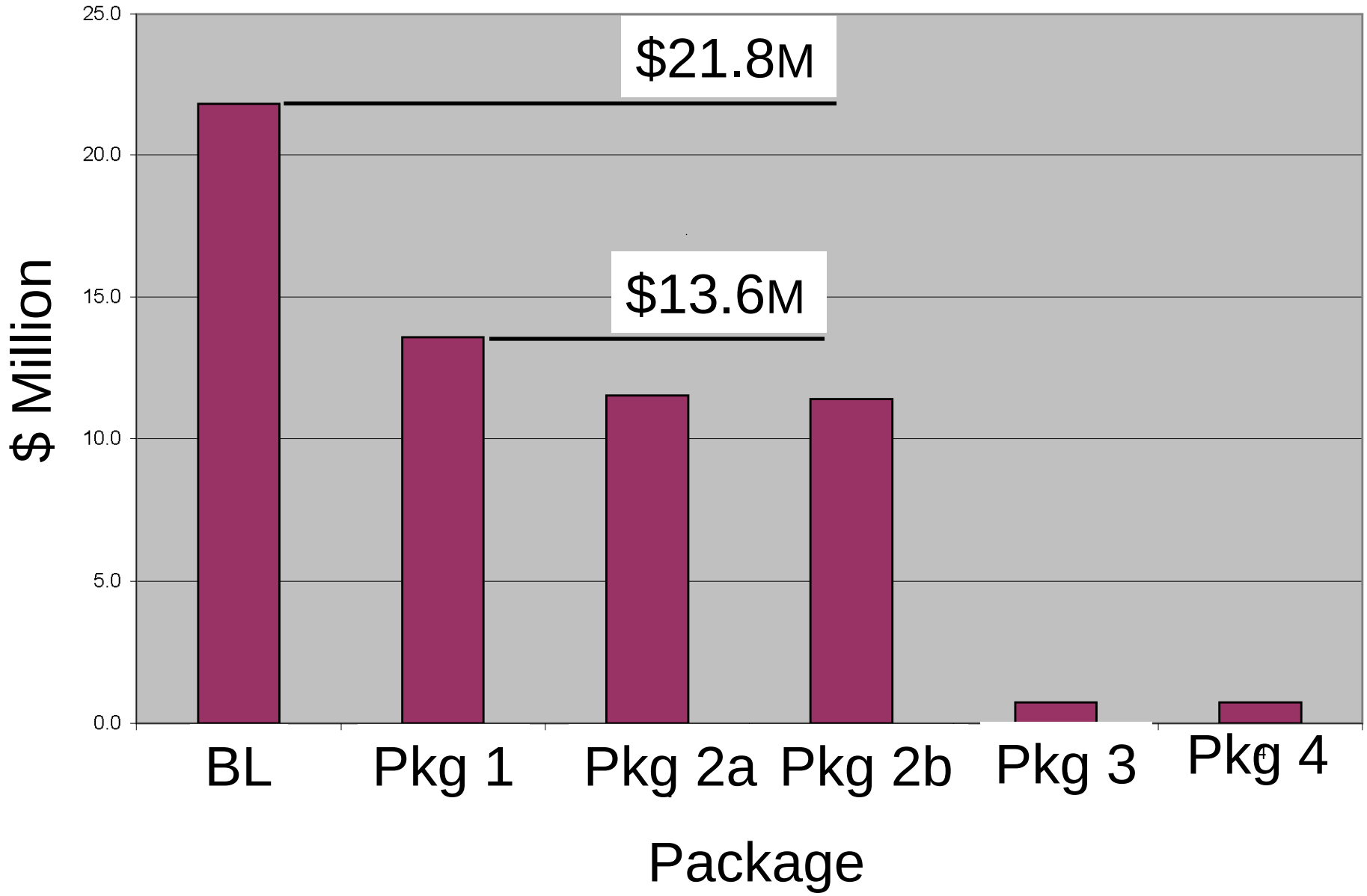
Annualized Costs – Pkg 2a & 2b



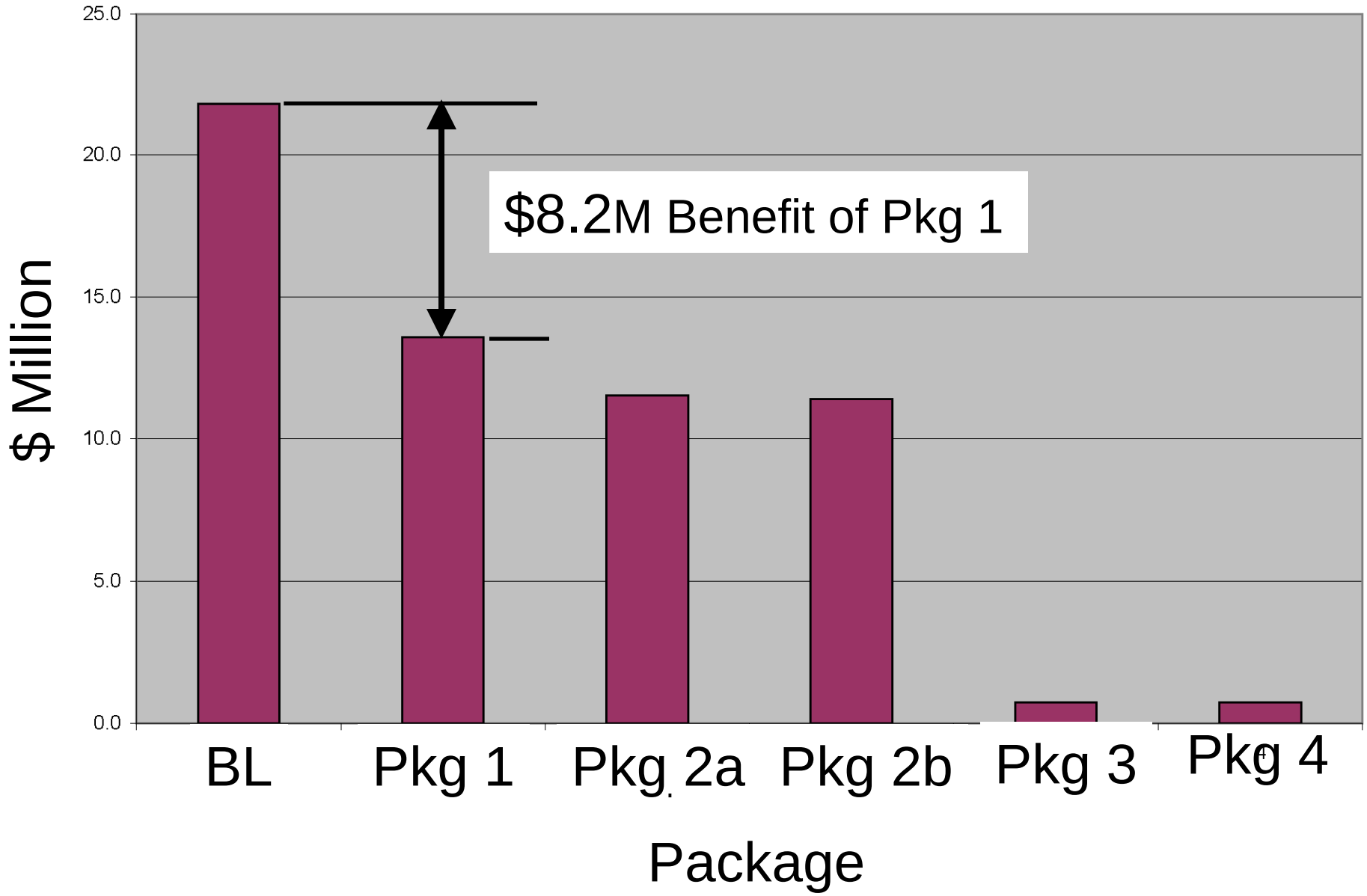
Annualized Costs – Package 3 & 4



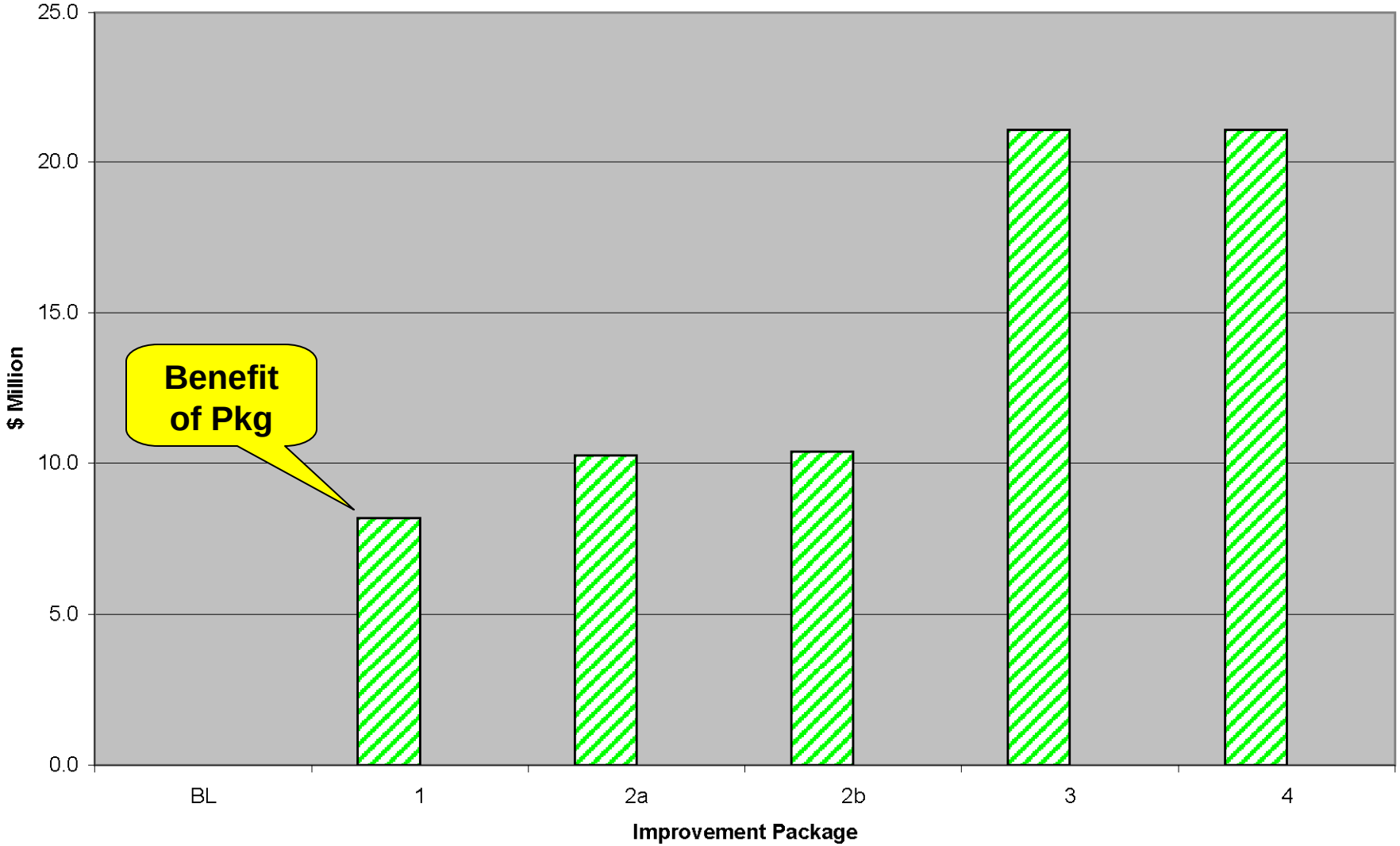
PV Annualized Losses Summary



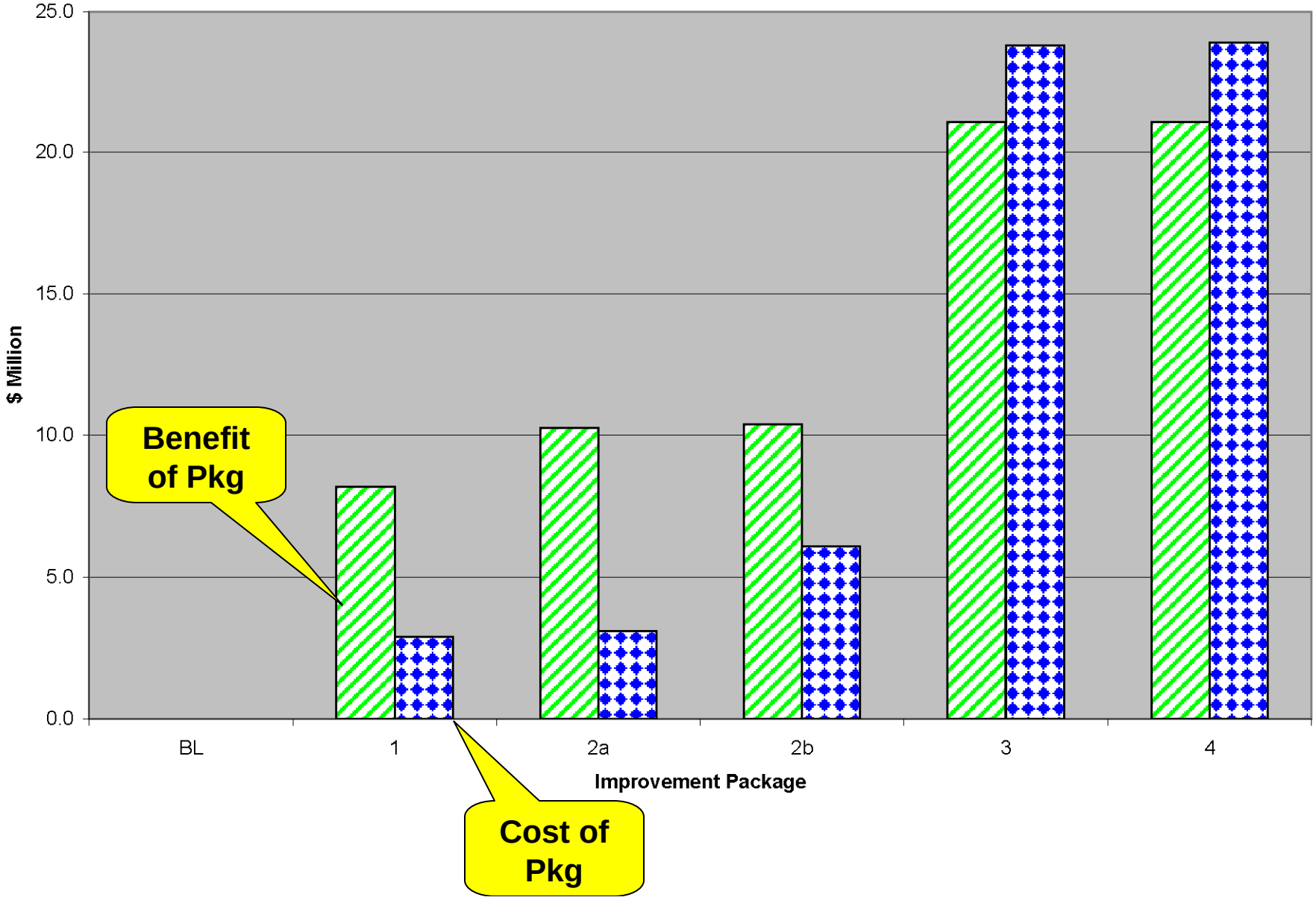
Net Benefit - Avoided Losses



Net Benefit


25.0
20.0
15.0
10.0
5.0
0.0
$ Million
Benefit of Pkg
BL
1
2a
2b
3
4
Improvement Package

Benefit / Cost Ratio



Benefit – Cost Summary

Package	PV Annualized Losses $M	Benefit (avoided losses) $M	Package Cost $M	Benefit / Cost
Baseline	$21.77	N/A	N/A	N/A
Package 1 475 yr – LS	$13.60	$8.17	$2.90	2.8
Package 2A 72-yr	$11.53	$10.24	$3.10	3.3
Package 2B 72-yr	$11.40	$10.37	$6.10	1.7
Package 3 475 yr	$0.74	$21.03	$23.8	0.9
Package 4 2475-yr	$0.74	$21.03	$23.90	0.9

Total Combined Cost

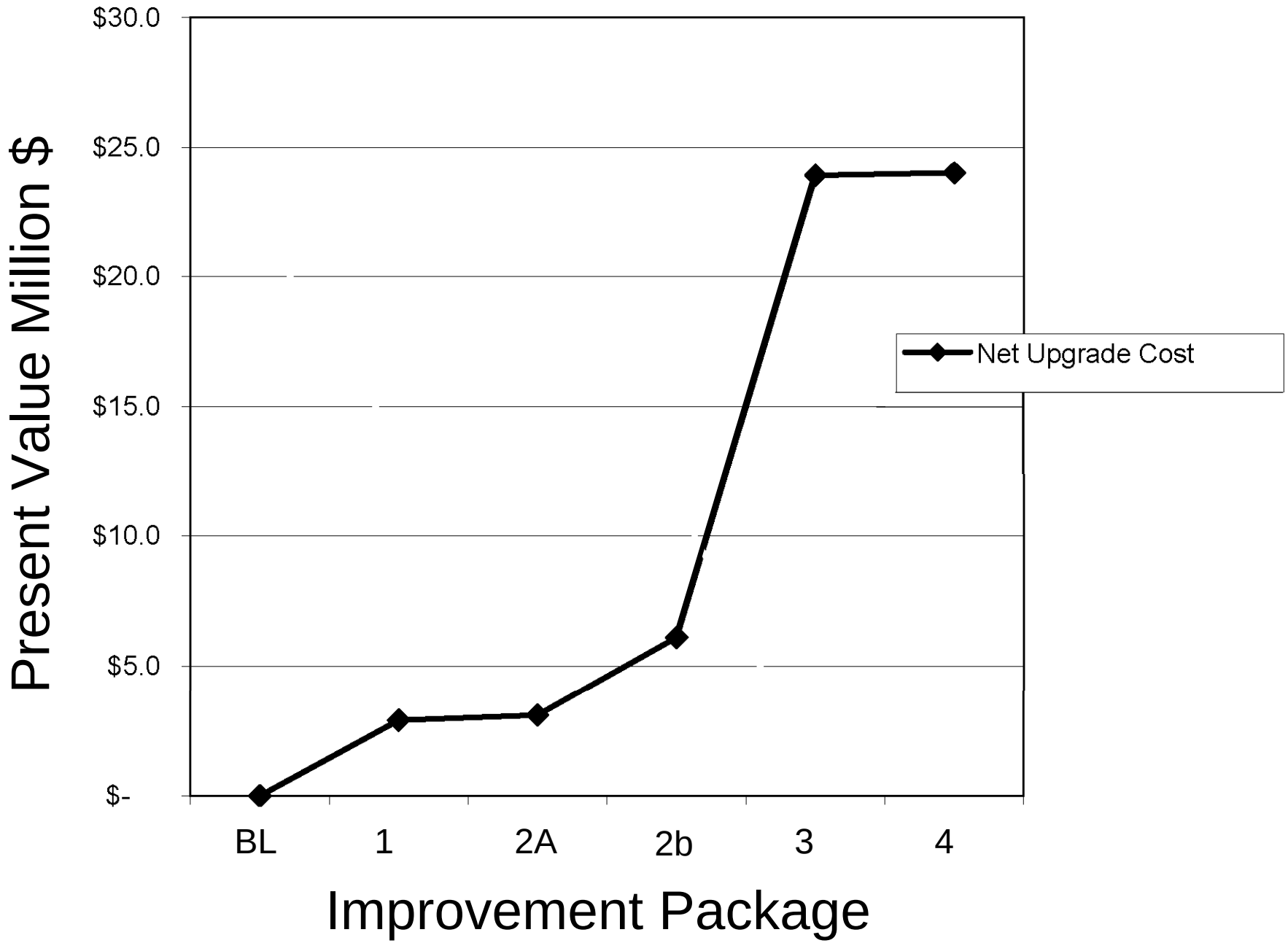
1. Cost of improvement package

2. Present value of annualized losses

3. Package 1 example

Mitigation Package Cost	$2.90M
PV annualized Losses	$13.6M
Total Combined Cost Pkg 1	$16.6M

Cumulative Cost Curves



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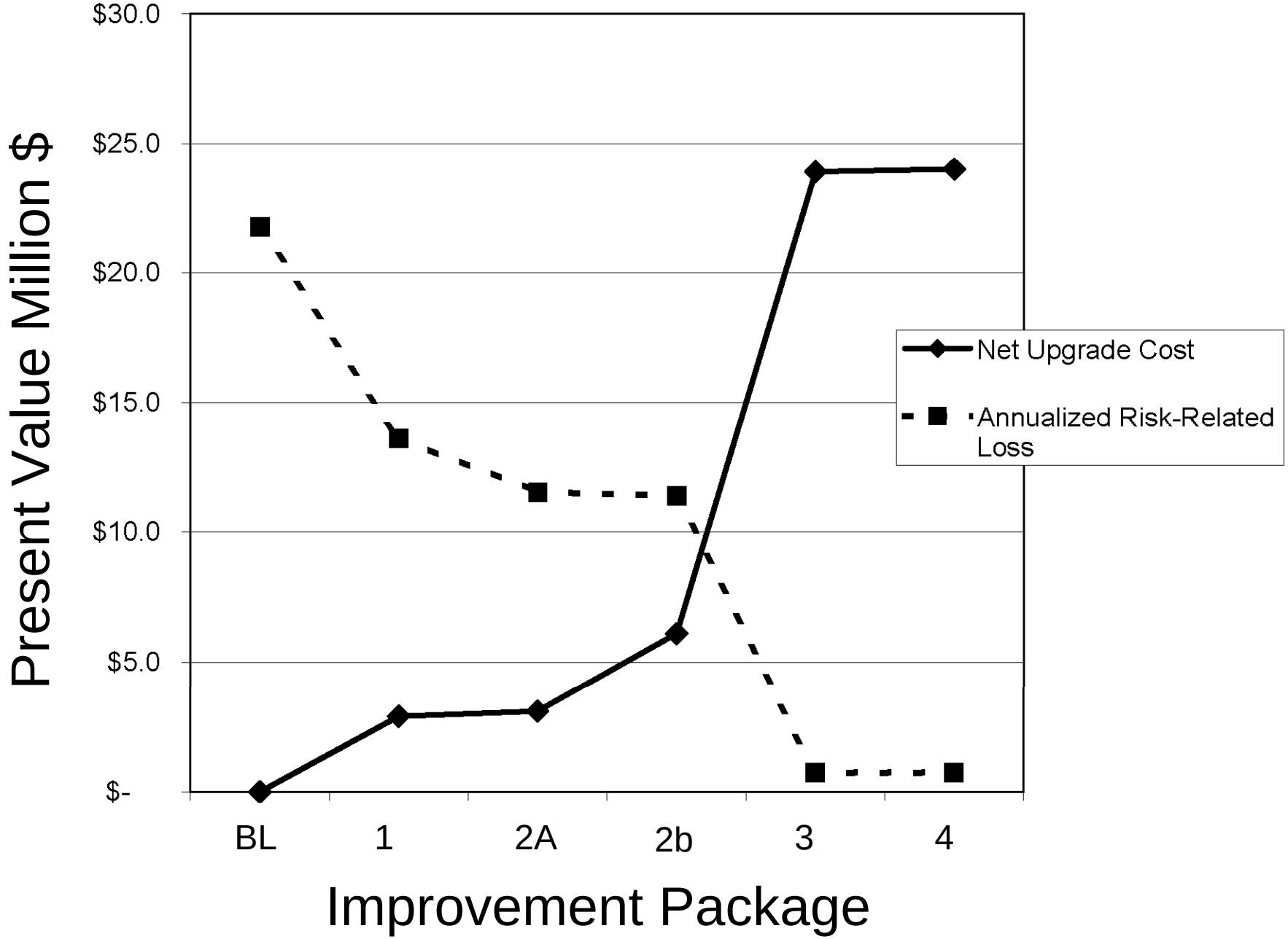

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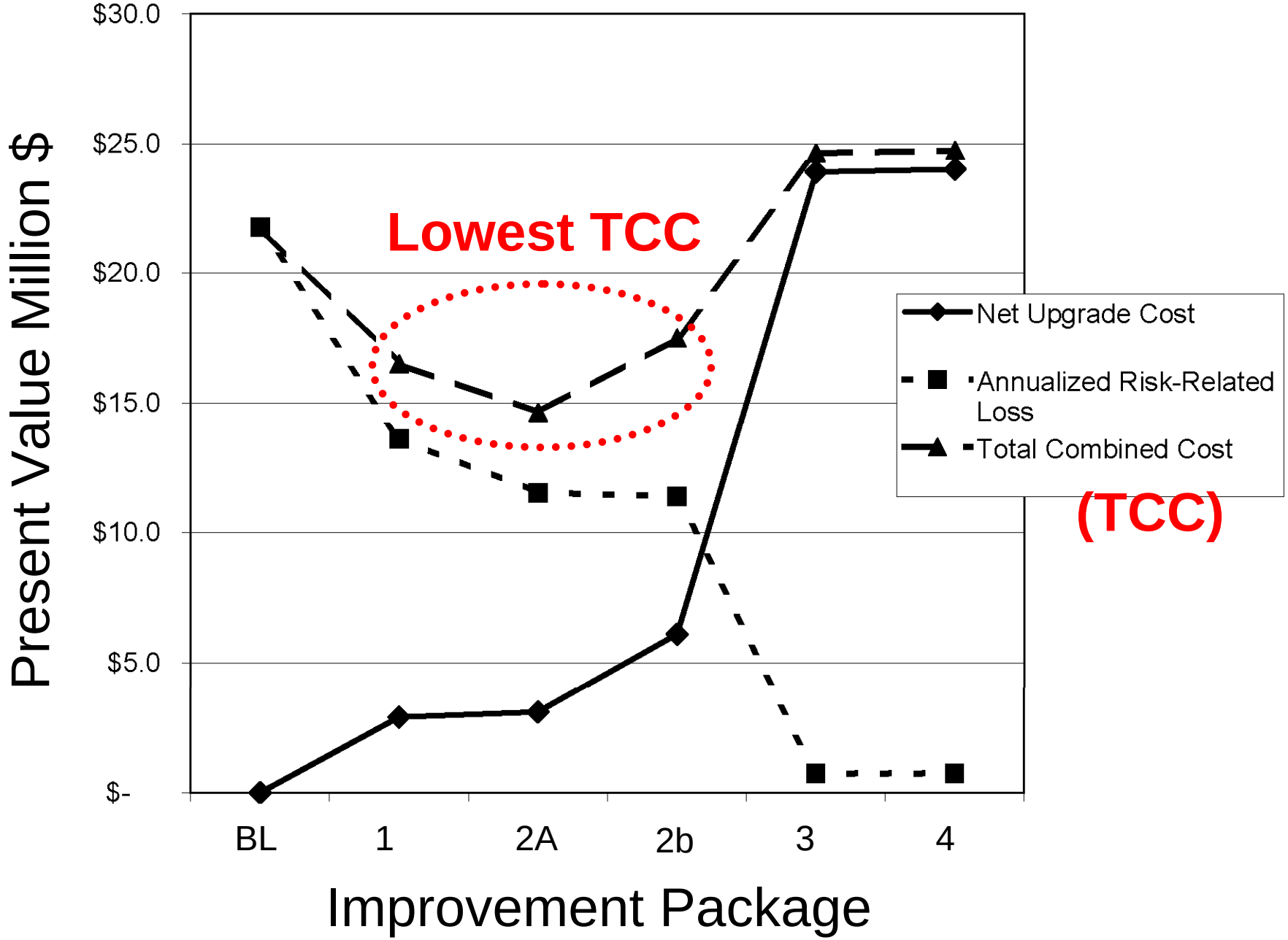

Recommended Package 2b Provides Benefits for Larger Events

LOS Component	72 year event (50% in 50 year)	475 year event (10% in 50 year)	2475 year event (2% in 50 year)
Preliminary Level of Service Goals	42 MGD (ADD) Immediate	28 MGD (WADD) Within 24 hrs	½ WADD within 3 days WADD 7 – 14 days ADD 60 – 90 days
Package 2b Actual LOS	28 MGD Immediately 46 MGD within 24 hrs	0 MGD for 14 days 5 MGD 2-6mo 40 MGD 6–12 mo	0 MGD for 14 days 5 MGD 2-6mo 40 MGD 6–12 mo

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