The Metropolitan *Water Reclamation District* of Greater Chicago

WELCOME

TO THE JUNE EDITION

OF THE 2014

M&R SEMINAR SERIES

BEFORE WE BEGIN

- PLEASE SILENCE CELL PHONES & SMART PHONES
- QUESTION AND ANSWER SESSION WILL FOLLOW PRESENTATION
- PLEASE FILL EVALUATION FORM
- SEMINAR SLIDES WILL BE POSTED ON MWRD WEBSITE (www.MWRD.org: Home Page ? Reports ? M&R Data and Reports ? M&R Seminar Series ? 2014 Seminar Series)
- STREAM VIDEO WILL BE AVAILABLE ON MWRD WEBSITE (www.MWRD.org: Home Page ? MWRDGC RSS Feeds)

Tim Skeel

Current: **(retiree) Principal Economist, City of Seattle, Washington**

Experience: - Over 30 years in applied economics including capital asset management, triple bottom line evaluation, life cycle cost analysis, benefit/cost analysis, risk assessment, integrated resource planning, supply and demand forecasting, utility rates, finance and value engineering.

- With Seattle Public Utilities and Seattle Department of Transportation), conducting project business cases, developing economic decision models, conducting risk assessments, creating asset management plans for optimal maintenance, repair and renewal strategies, educating staff on asset management principles, and managing its formal Value Management Program.
- Worked as a consultant for CH2M Hill,
- Taught Economics courses at North Seattle Community College and at the University of Washington.
- worked as an economist for the Montana Department of Natural Resources.

Education: BA from the University of Montana
Master from the University of Washington
Ph.D. Candidate, the University of Washington

Seattle Public Utilities

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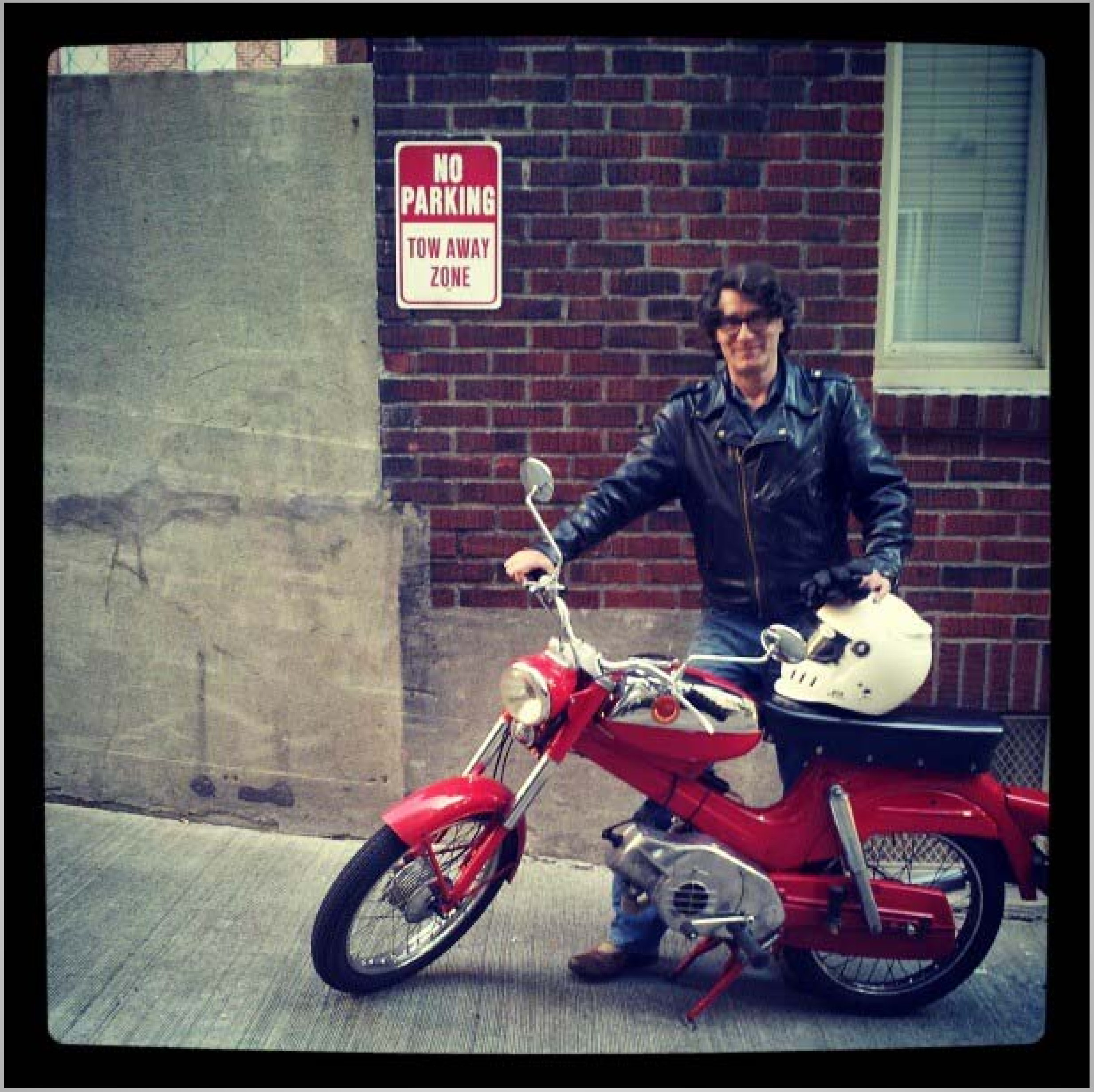

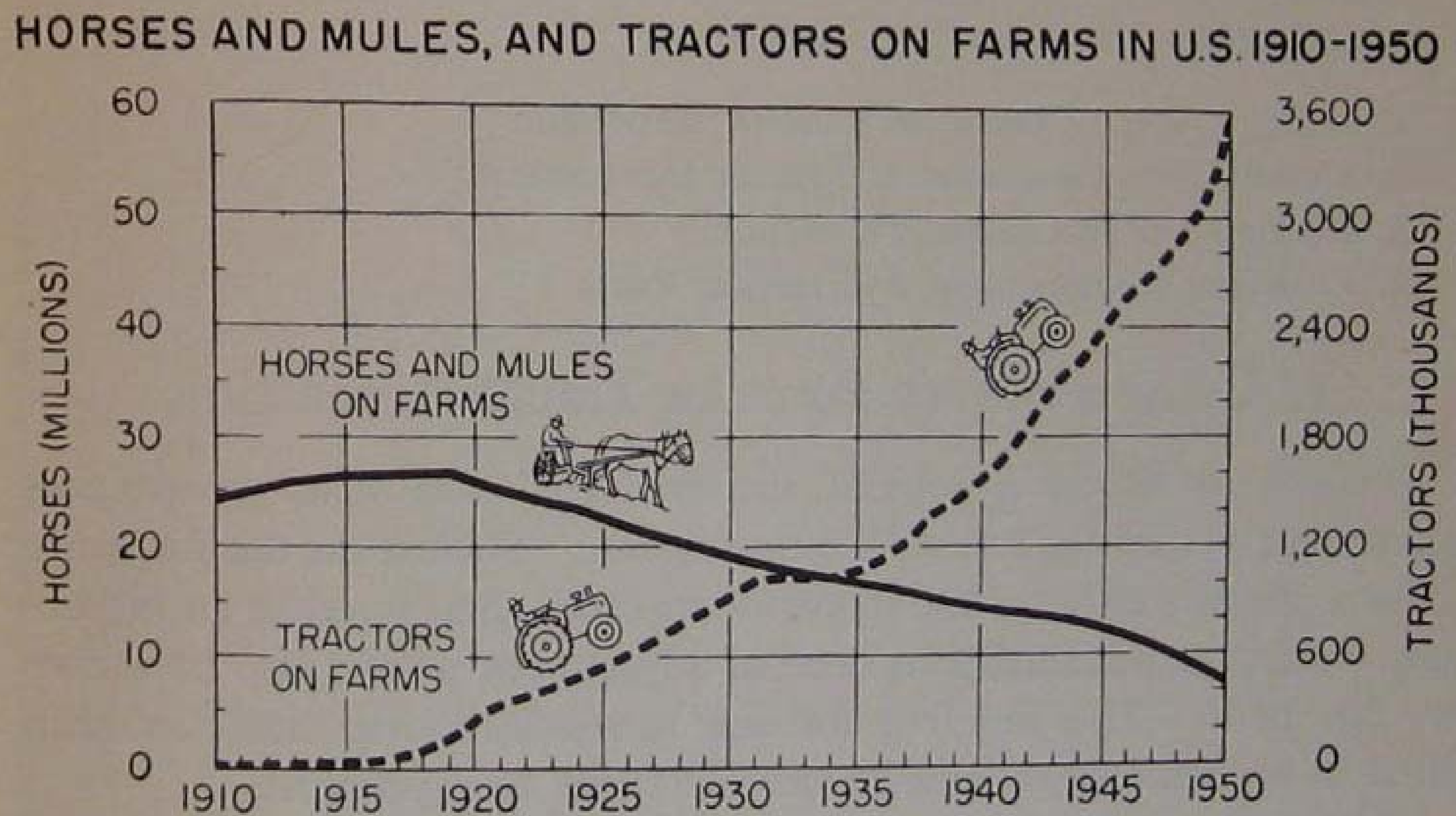

FIG. 34. The trend toward farm mechanization is indicated by the rapid increase in the number of tractors on the farm and the steady decline in the number of horses and mules used for farm power.

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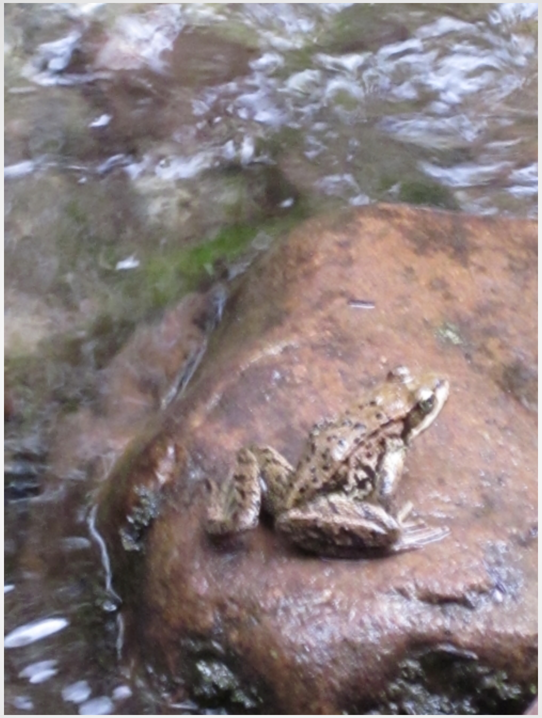

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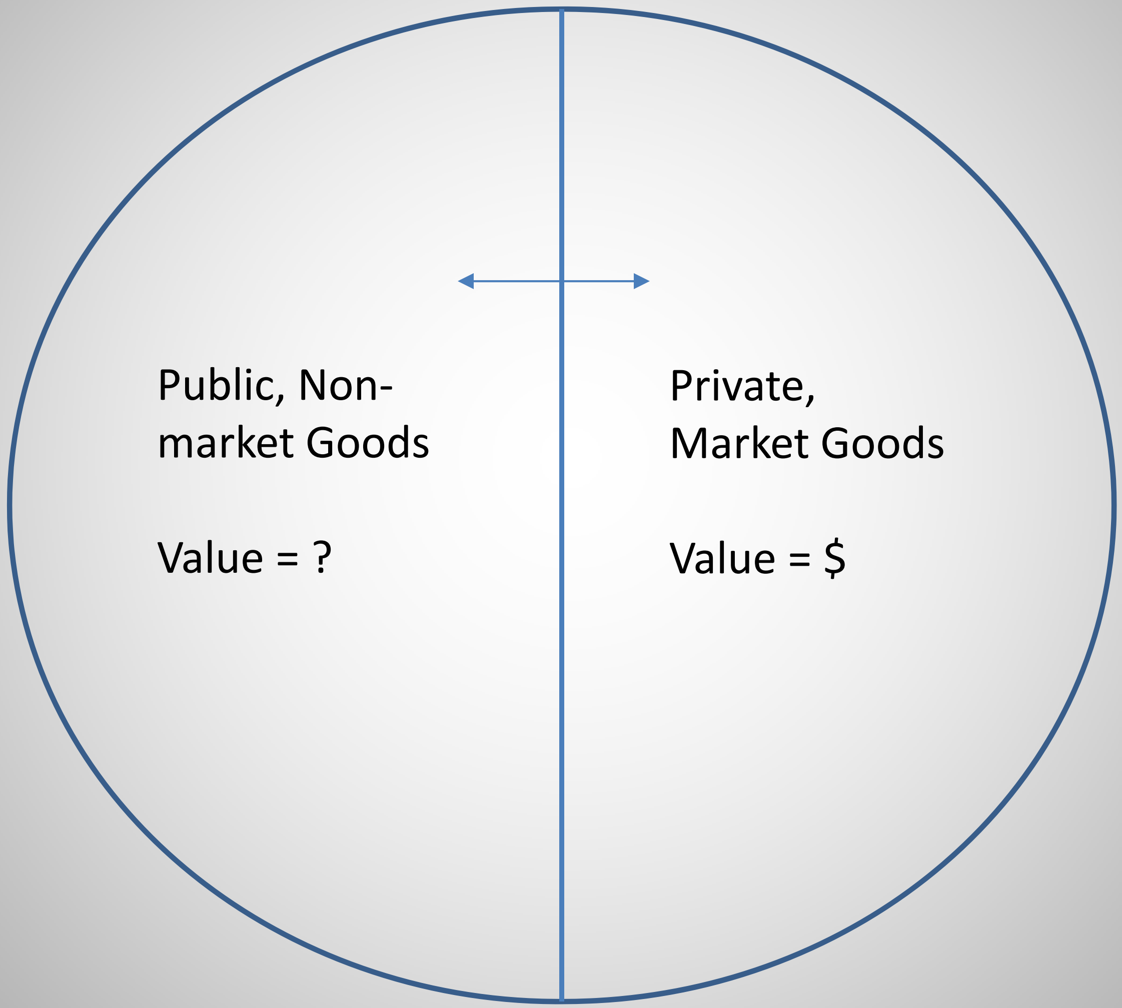
- Universe of Value



- How can you deliver the best value for money to customers and the community?
- Well, first, make the right capital investments at the right time. Minimize life cycle cost by implementing cradle-to-grave asset strategies that balance renewal and rehab against preventive and corrective maintenance. Optimize risk exposure by understanding the likelihood and consequences of failure, and employing the most cost-effective risk mitigation measures. Ensure that expenditures are made efficiently and effectively. Understand the full financial, social and environmental impacts on the community.
- Optimizing expenditures and providing best value for money means you need to analyze cost and performance data, you need to know the value customers put on your services, and you need appropriate analytical tools and models. You need an effective decision management structure to turn the analysis, evaluation and resulting optimal strategies into efficient projects and programs. It's not rocket science, but, you could call it asset management science.
- A decision management structure incorporating business case analysis is a powerful tool in delivering the best value for money to customers and the community. Business case analysis and review of expenditure decisions has saved Seattle Public Utilities' customers millions of dollars in capital and O&M expenses while providing them with equal or better service.
- This talk will provide an overview of the business case tools, analysis and decision making structures that help SPU to provide the most value for money to its customers and community, including the triple bottom line of financial, social and environmental impacts.

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Benefit/Cost Analysis: Theory and Practice at a Public Utility

Tim Skeel, Principal Economist, Asset Management and Economic Services, Seattle Public Utilities

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What is Benefit/Cost Analysis and Why do We Do It?

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We consume a lot of scarce resources to deliver utility services to the community.

We should strive to maximize the net benefits to society in our use of resources.

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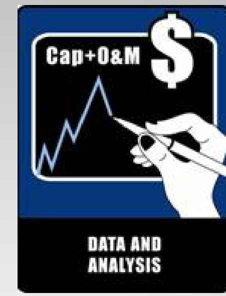
Guiding Light:

Focus on Long-Run Value and Life-cycle Cost

…

to the Customer and the Community



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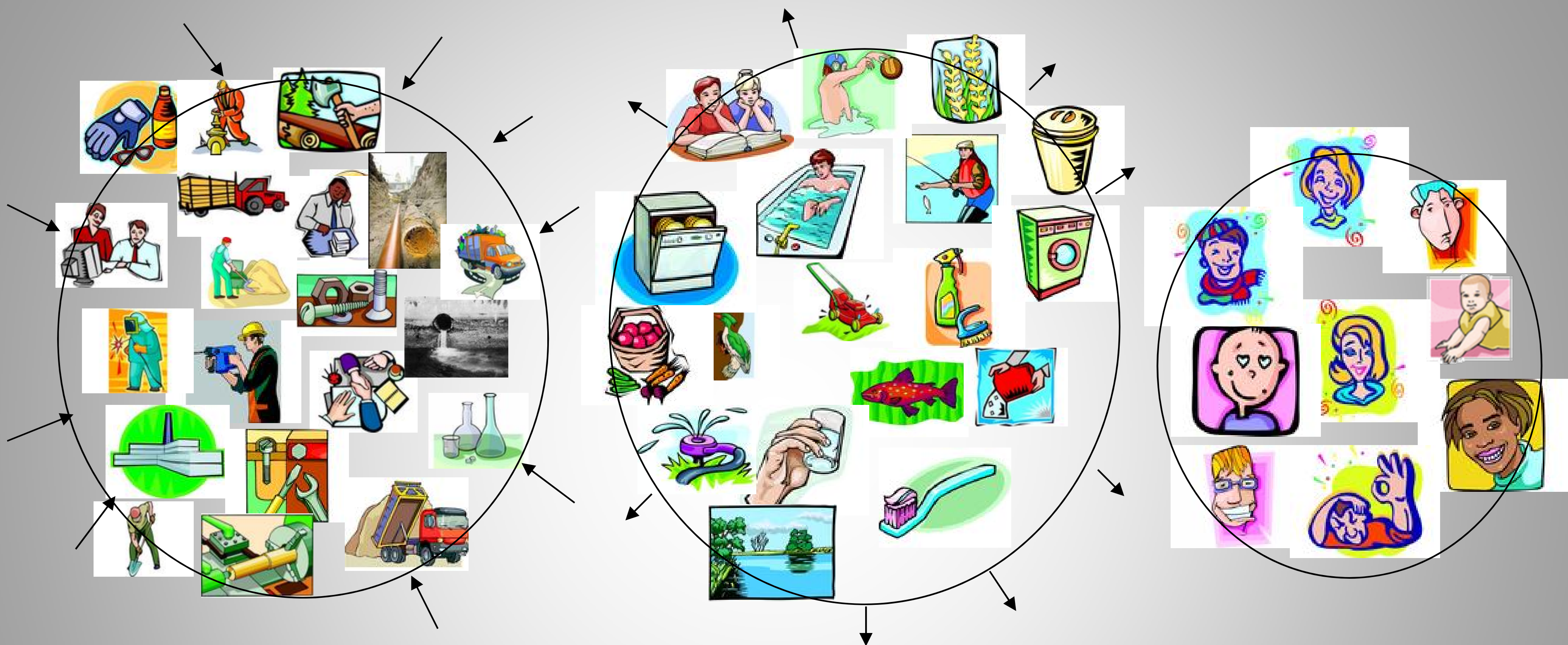
The Essential Mission of Public Agency



Scarce community resources → Valuable community services → Community well-being

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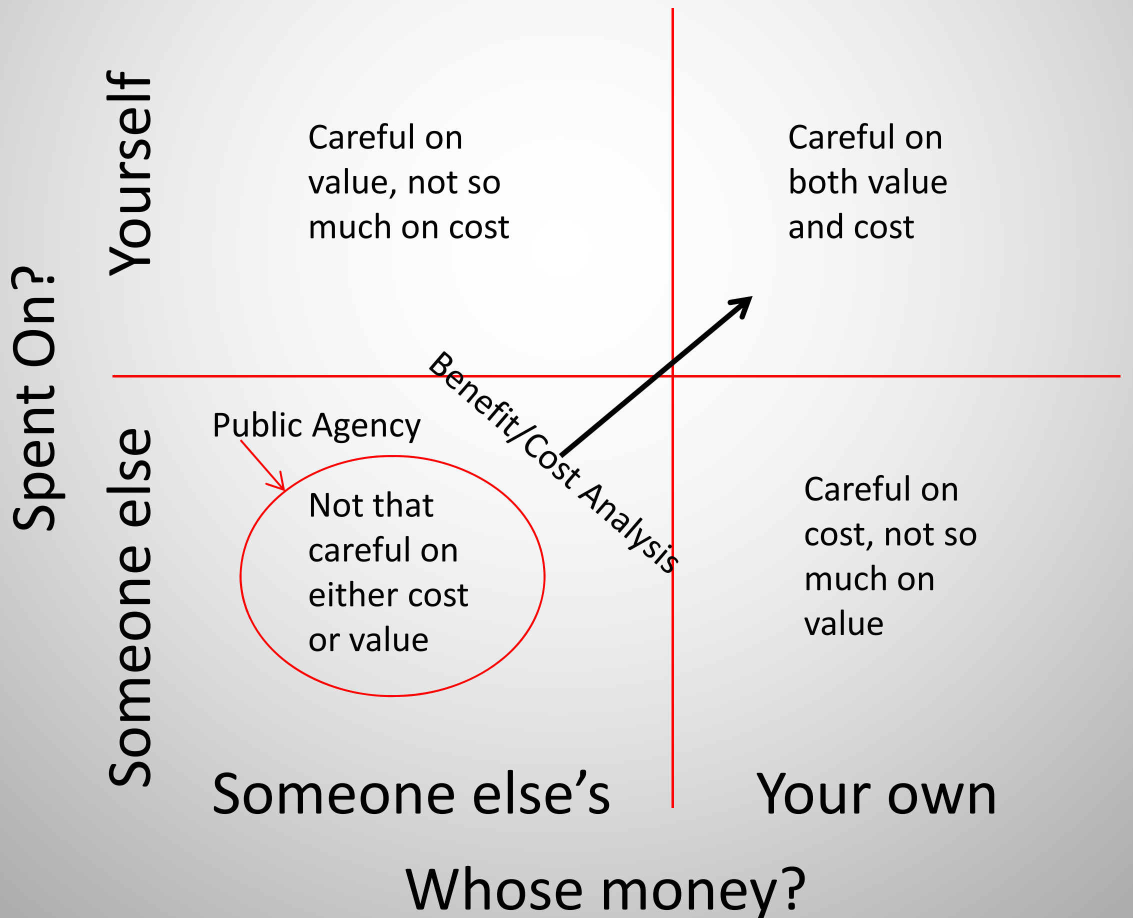
Lack of Incentives in Public Agencies: 4 ways to spend $



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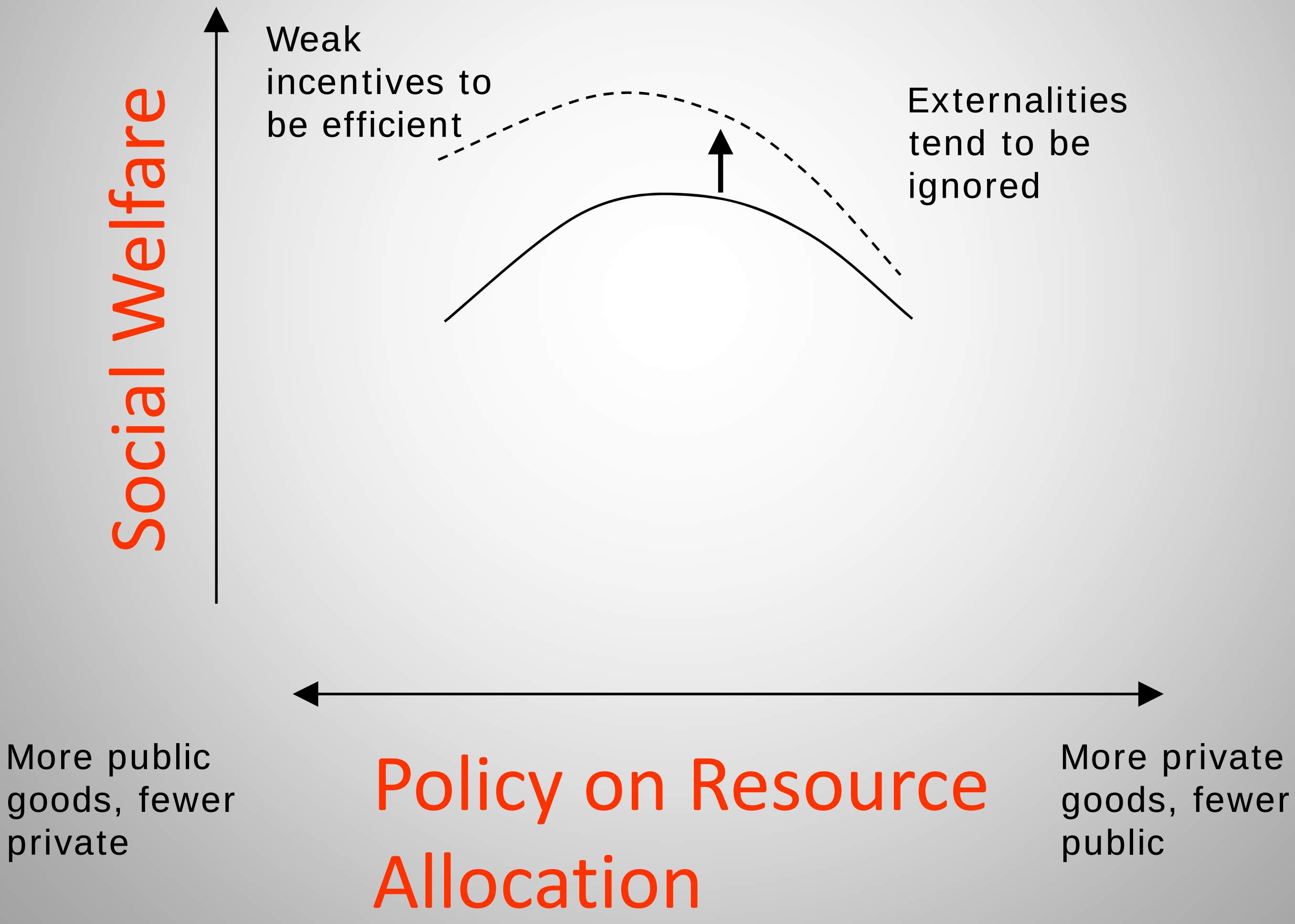
Why B/C Analysis on Public Expenditure?



Benefit/Cost Analyses demonstrate greatest net value to the community to:

- 1) maintain or improve utility service, and/or
- 2) reduce long-run life-cycle cost
- 3) reduce financial/social/environmental risk
- 4) meet regulatory requirements
- 5) improve social/environmental outcomes

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Benefit/Cost Analysis Guides Decisions

Transparent, objective, decisions based on sound data and analysis to return the best value to the community.

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Value of B/C Analysis

- Improve Expenditure Decisions – Better Net Value for the Community
- Provide Transparent Documentation of Decisions
- Make Decisions Corporate – Risk and Accountability becomes Executives’

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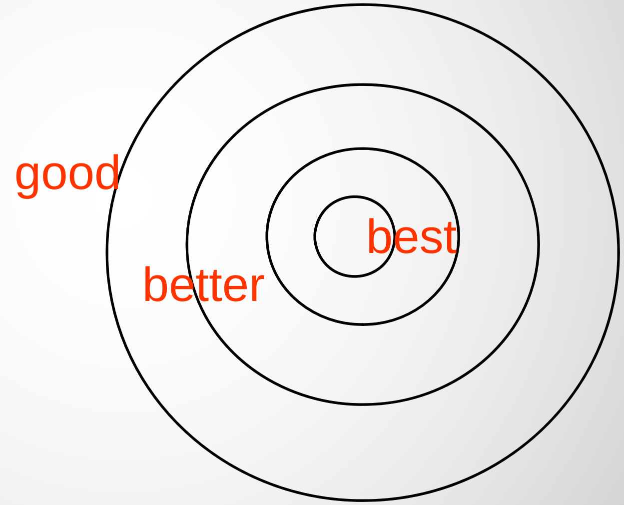
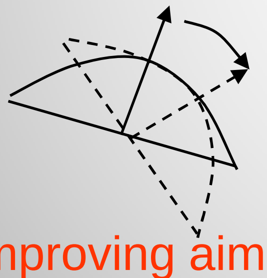
Benefit/Cost Analysis: What and Why

Value for cost target





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Best Value to Society/Community

"Full" benefit and cost accounting –

- Market Values: $, labor, capital, energy, materials, inputs, land (market priced)
- Social: service, aesthetics, time, convenience, health, recreation (no market price)
- Environmental: habitat, ecosystem services, green space, air and water quality (no market price)

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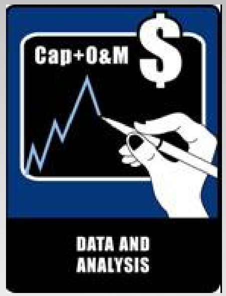

Guiding Light:

Focus on Long-Run Value and Life-cycle Cost

…

to the Customer and the Community

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What Are the Issues with Benefit/Cost Analysis?

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Methodologies

- Valuing public goods and externalities
- Indirect market and non-market valuation
  - Travel cost, revealed preference, hedonic estimation, willingness to pay, contingent valuation, etc.
- Reasonable person test

Two Approaches

- Valuing triple bottom line

  Indirect market and non-market valuation techniques, willingness-to-pay, set of agreed values

- Application of "reasonable person test"

  Shortcut to direct valuation, executive judgement

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Guide for TBL Valuation

- When available, use agreed values for non-market (social and environmental) benefits and costs, otherwise:
- When justified, use agreed non-market valuation techniques to estimate value, otherwise:
- Use “reasonable person test” to determine “break-even” value of non-market benefits or costs

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Risk Cost

- Risk Cost = % Likelihood times
  $ Consequence
- 10% Chance of Failure x $10,000 Cost of Failure = $1,000 Risk Cost of Failure
- Actuarial value – expected long run average cost of failure

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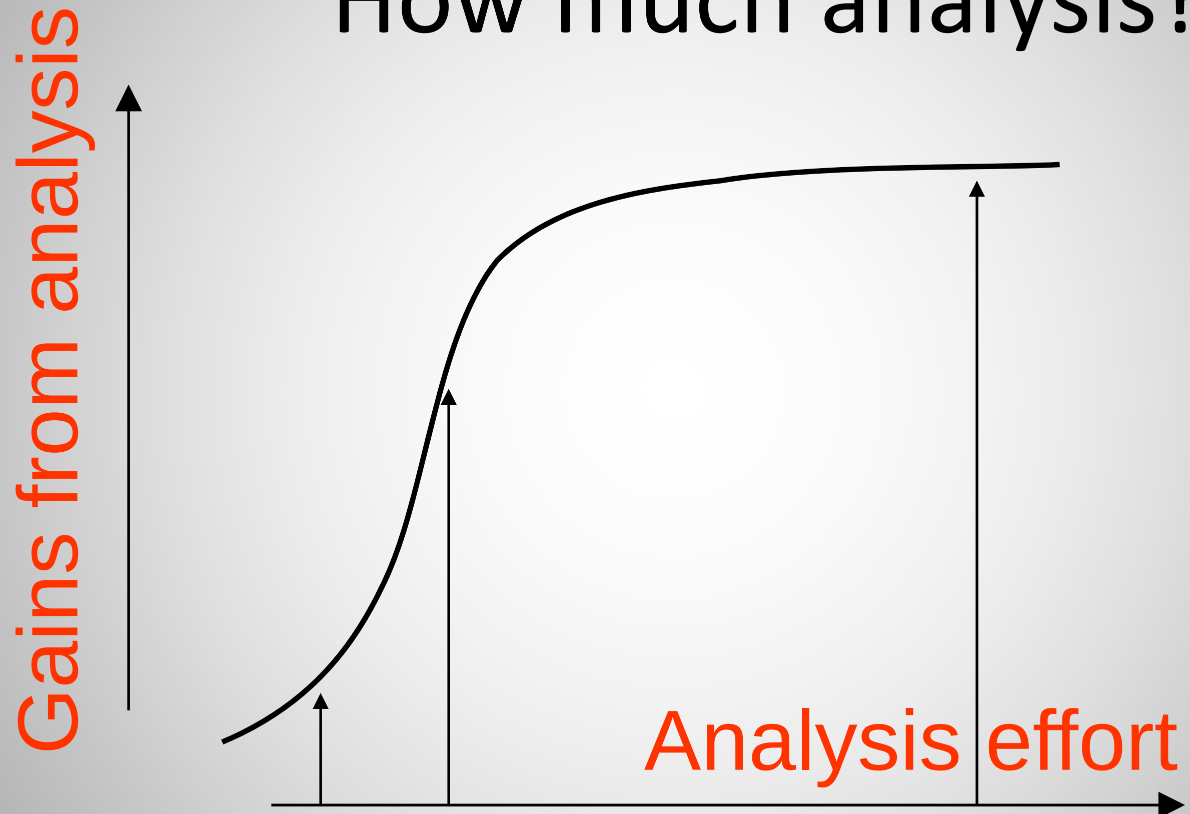
Elements for Success

How much analysis?



Personal decision w/in organizational norms - BAU

Answer a few key questions about $ value and $ cost

Peer-reviewed $ WTP study on color of recycling can

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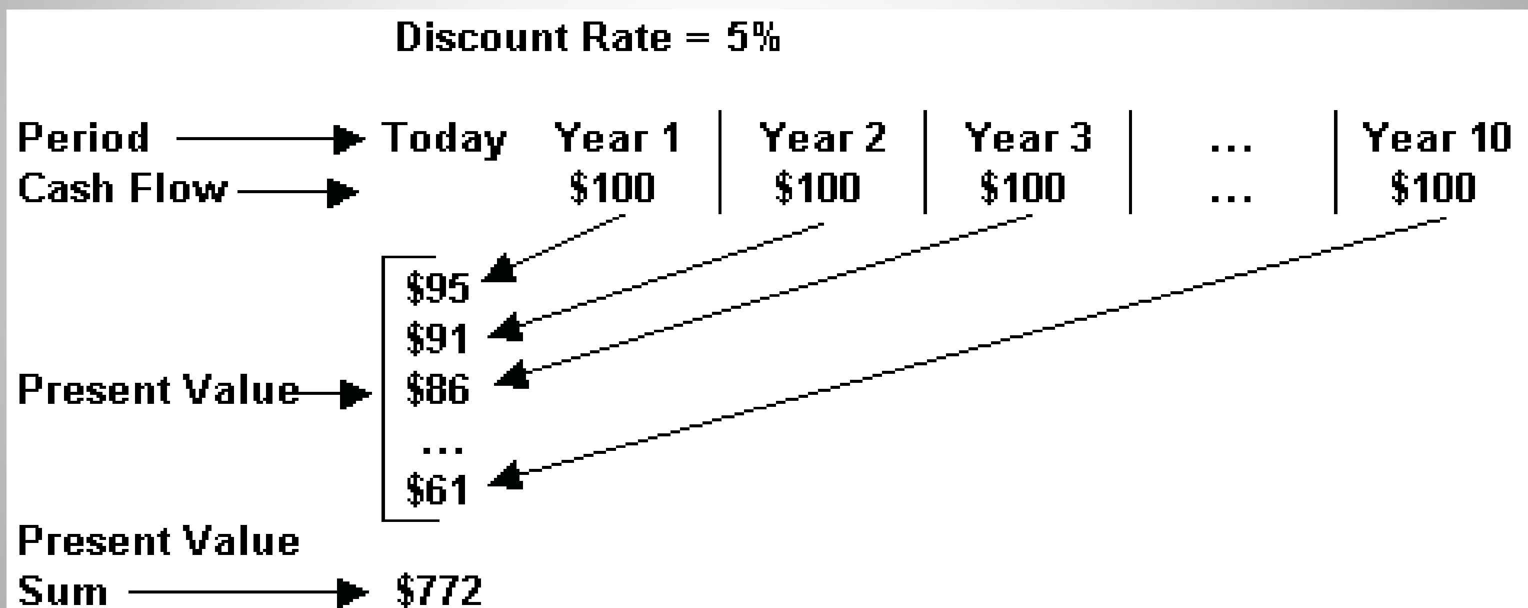
Discounting to Present Value

Present Value of Cash Flow From Year 1 to Year 10 =



The “Miracle of Compound Interest” in Reverse!

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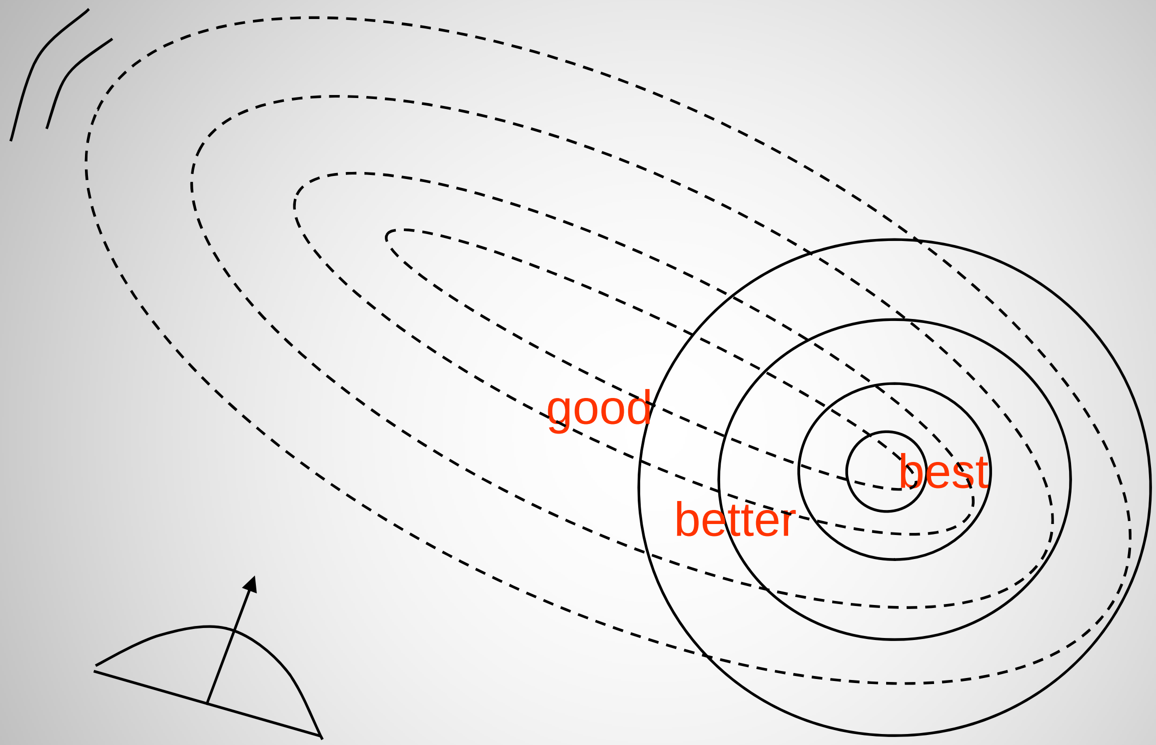

Fitting the target to the arrow – NOT!

Why B/C Analysis on Public Expenditure?

Other reasons:

- CYA – re-direct accountability
- Sales job
- Process is our product
- Another hoop to jump through
- Economists like to do analyses

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Other Issues

- Cost shifting

  Traffic costs, cleaning grease traps, maintaining pressure pumps, legal liability,

- Benefits beyond core business

  Aesthetics, open space, safety, security, protection of private property, habitat

- Who counts, who pays

  Region, ratepayers, citizens, direct beneficiaries

Defining the Base Case

- Each business case should clearly define what will be used as the "Base Case". This could vary across analysis so key here is to explain exactly what is meant for that particular business case.
- Economic analysis of the options should "always" be done relative to the base case.
- The costs and the benefits will therefore be changes in costs and changes in benefits from the base case.

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Some barriers to effective B/C Analysis

Conflict of interest: Vested interests put in charge of analyses

Decision makers personal B/C at odds with social B/C analysis

Analysts with skills not suited to B/C analysis

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What is Triple Bottom Line?

Financial

- ✓ *Costs: (capital) design, materials, construction, permitting, disposal, operation and maintenance*
- ✓ *Benefits: capital and O&M cost reductions (over base case)*

Social

- ✓ *Costs: traffic disruption, lost aesthetics, outages*
- ✓ *Benefits: improved aesthetics, recreation, convenience, safety*

Environmental

- ✓ *Costs: negative impacts on air, water, habitat, etc.*
- ✓ *Benefits: improved water quality, wildlife and fish species enhancement, ecosystem services*

"Willingness to Pay" Surveys
Example 1

SPU Recently Asked it's Customers:

"How Much More Would You be Willing to Pay to Ensure that All Customers Receive an Acceptable Level of Sewer Backup Service?"

"Willingness to Pay" Surveys Example 1 (Cont'd)

Study Design:

- **Conjoint Analysis** (i.e. Compelling Survey Respondents to make Tradeoffs Between Alternative Service Levels at Differing Costs)
- Detailed Phone Survey of **354 SPU Customers**
- **Statistically Acceptable Sample Was Achieved** Across Gender, Geography, Own vs. Rent, Household Size, Race, and Income

"Willingness to Pay" Surveys Example 1 (Cont'd)

What Our Customers Said:

- Forty-Two% of Those Sampled were Unwilling to Pay any Additional Monthly Expense
- However…75% of Those Willing to Incur Added Expenses Agreed to Pay an Additional 5% Per Year for the Next 20 Years
- The Median (Consultant Recommended) Amount of All Respondents was to Pay an Additional $0.35 per Month to Achieve a Minimum Sewer Backup Level of Service

Stated Willingness to Pay

	All Respondents N =354		Respondents Willing to Pay N=206	
	%	$	%	$
Mean (Average)	2.39	0.84	4.11	1.44
Median	1.00	0.35	4.00	1.40

"Willingness to Pay" Surveys Example 1 (Cont'd)

We Also Calculated the Cost to Meet These Alternative Service Level Options:

Service Level Options Customers in all areas of the City should be served so that on average they do not experience a sewer backup due to a problem with an SPU sewer more frequently than:	**Maximum Cost Above Do-Nothing Alternative**
Once in 2 years	$23.9 million
Once in 5 years	$36.9 million
Once in 10 years	$46.8 million
Once in 20 years	$59.1 million

The Service Level Most Closely Resembling That Chosen by Customers in our Survey (1.0% or $0.35 Additional Cost Per Month) Equated to a **5-year Level of City-Wide Sewer Backup Service** When Converted from CIP to an Average Monthly Sewer Rate

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"Willingness to Pay" Surveys
Example 2

SPU Recently Asked it's Customers:

"We Have Estimated that Your Bill Will Increase by $4.62 per Month for the Next Five Years to Pay for Combined Sewer Overflow Projects to Meet Regulations. How Supportive are You of This?"

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"Willingness to Pay" Surveys Example 2 (Cont'd)

Study Design:

- **Simple Question and Answer** with Respondents Typically Responding on a 1 (Low) to 7 (High) Scale in Regards to System Knowledge and Willingness to Pay.
- Detailed Phone Survey of **402 SPU Customers** was Performed
- **Statistically Acceptable Sample Was Achieved** Across Gender, Geography, Own vs. Rent, Household Size, Race, and Income

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"Willingness to Pay" Surveys Example 2 (Cont'd)

What Our Customers Said:

- There was a Fairly Low Degree of Knowledge about SPU's CSO Program (24%)
- Those Who Knew of CSOs Mostly Became Aware via Reading Local Newspaper Articles
- When Informed of the Problem, 68% Felt "Supportive" or "Very Supportive" of SPU's Efforts to Reduce CSOs
- When Informed of the Cost ($4.62 Extra Per Month) Only 49% Felt "Supportive" or "Very Supportive"

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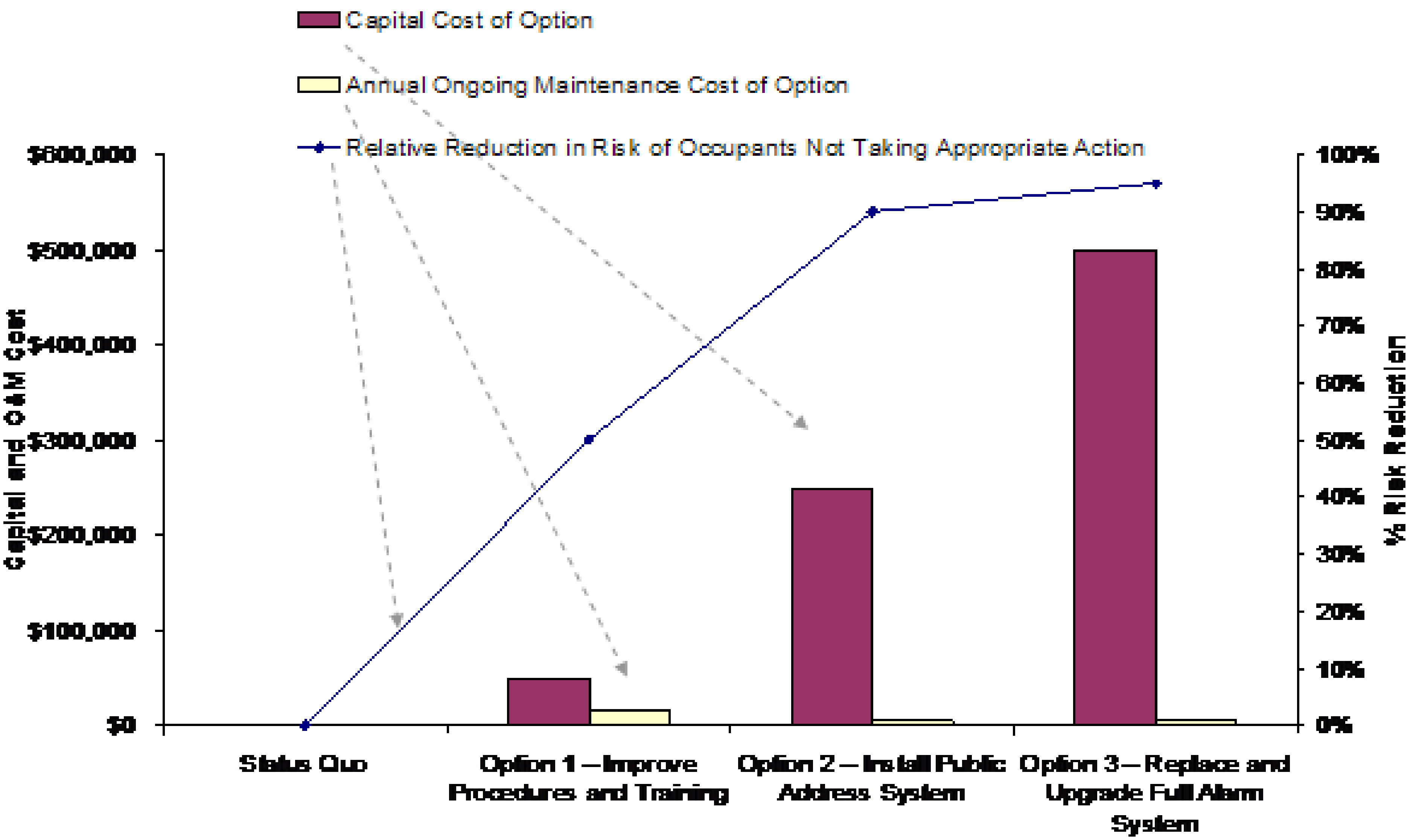
U-bridge Watermain Break

Time	Cost	% of Total
Drivers	$ 440,000	47%
Transit	$ 130,000	14%
Walkers, Bicyclists	$ 32,000	3%
Blocked access to houseboats	$ 800	<1%
SPU Response		
Contracted Repairs	$ 200,000	21%
Other Response Costs	$117,000	12%
Other		
Water Service Outage	$ 2,000	<1%
Lost Water	$ 300	<1%
Other Property Damage (cars)	$ 4,000	<1%
Environmental Costs	$ 5,000	<1%
Lost Business	$ 10,000	1%
Total	$ 940,000	

Option Cost and Risk Reduction



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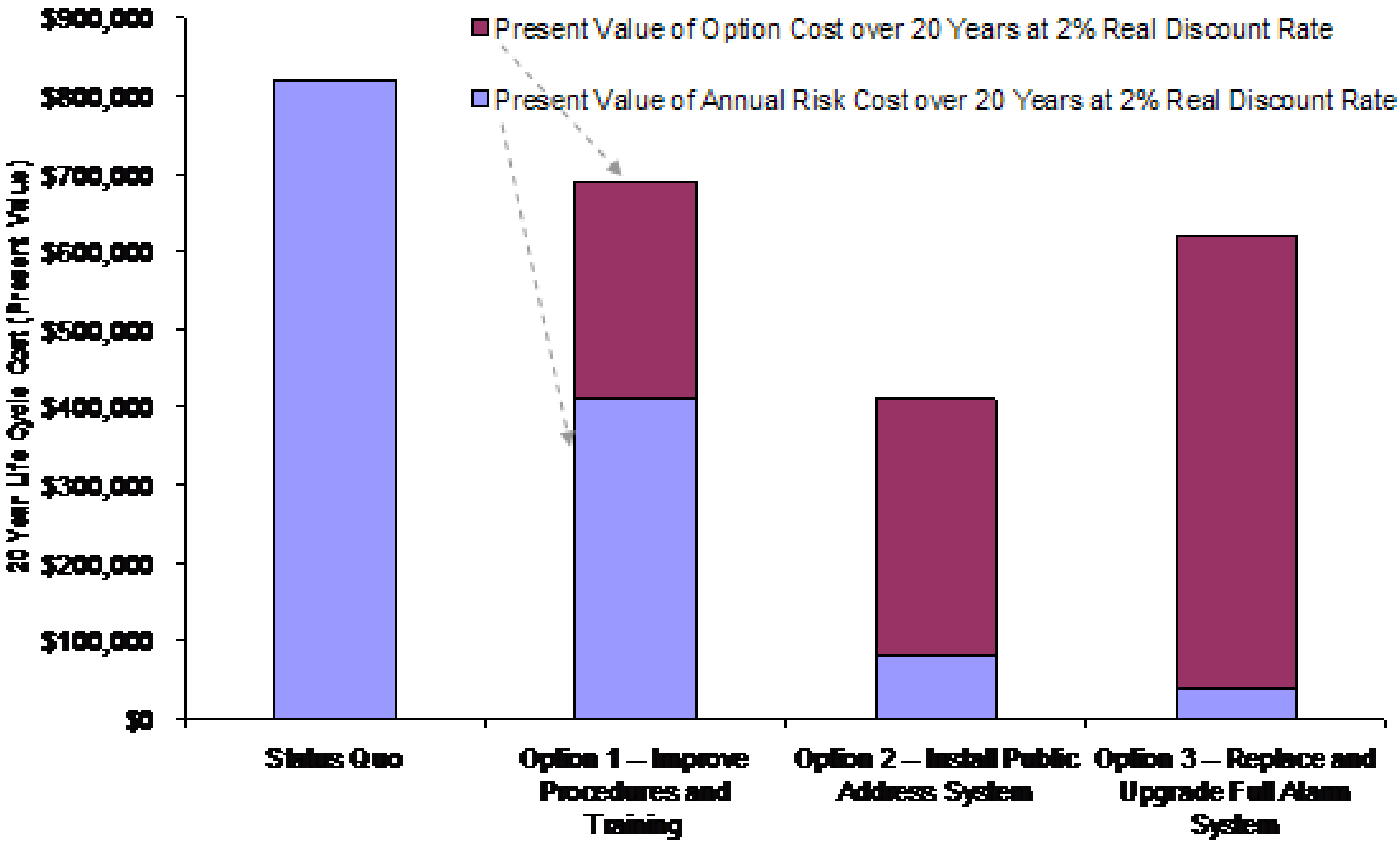
Life Cycle Cost Including Risk Cost, Capital and O&M (20 Year Present Value)



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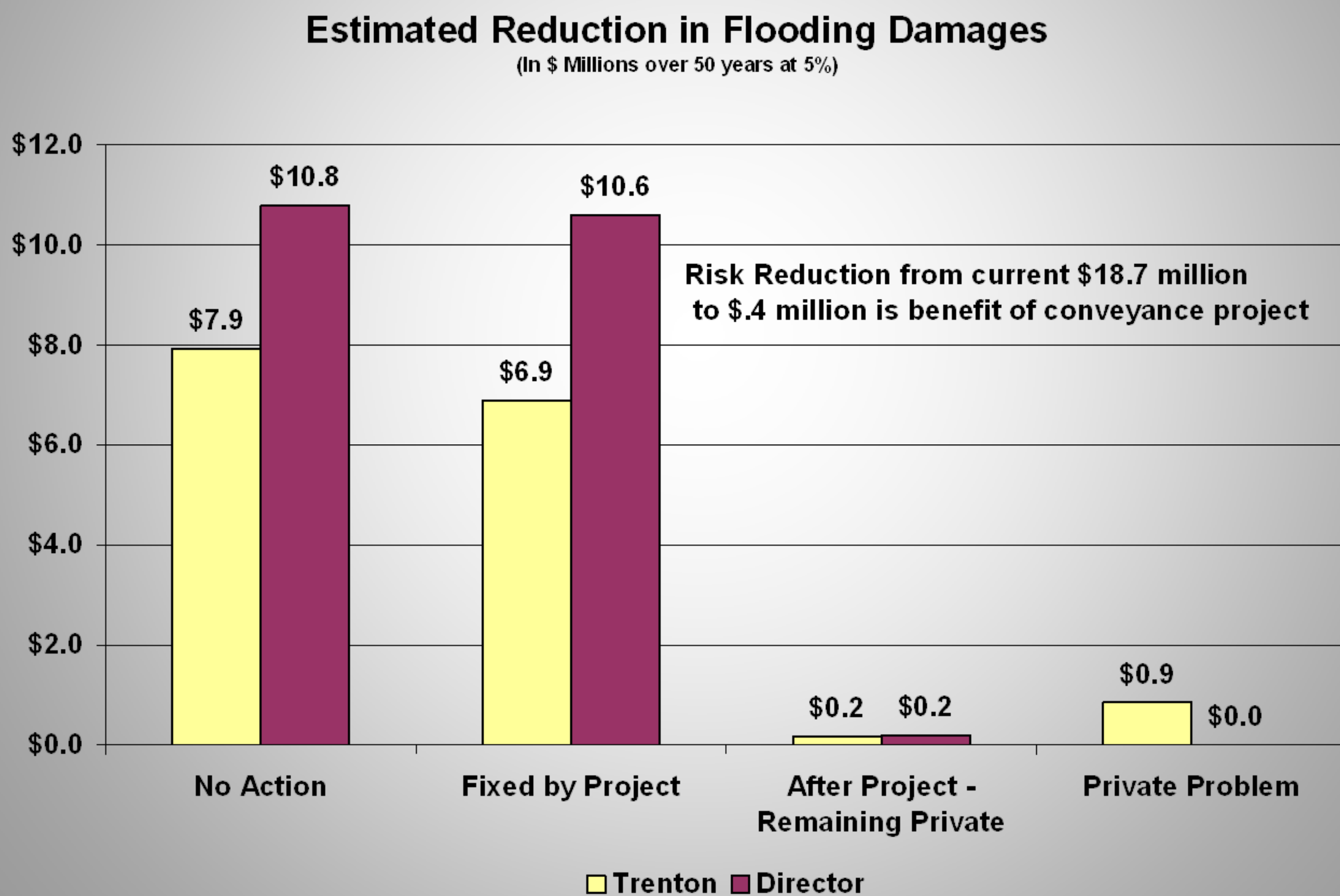
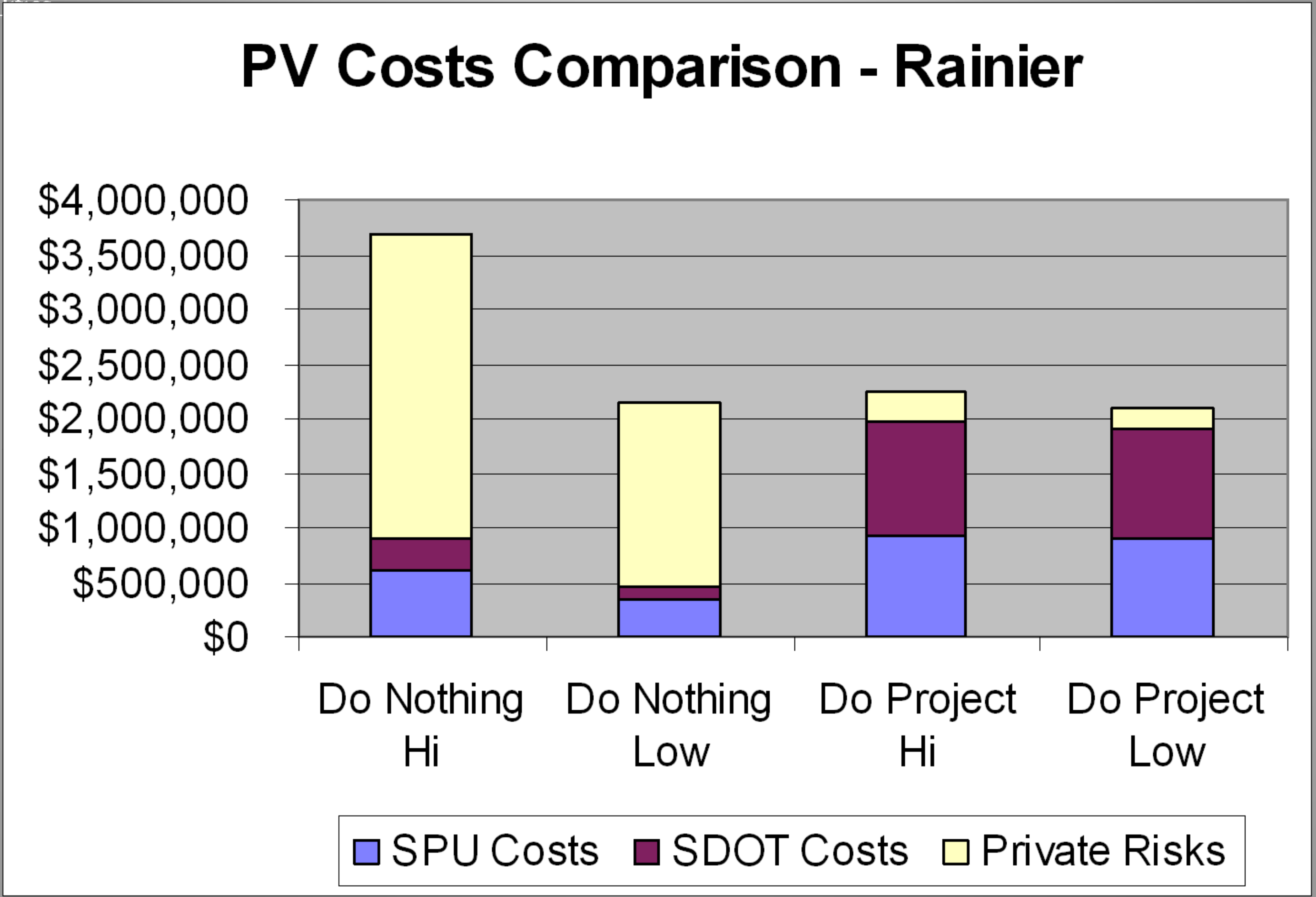
1 of 3 Charts: Flood Reduction

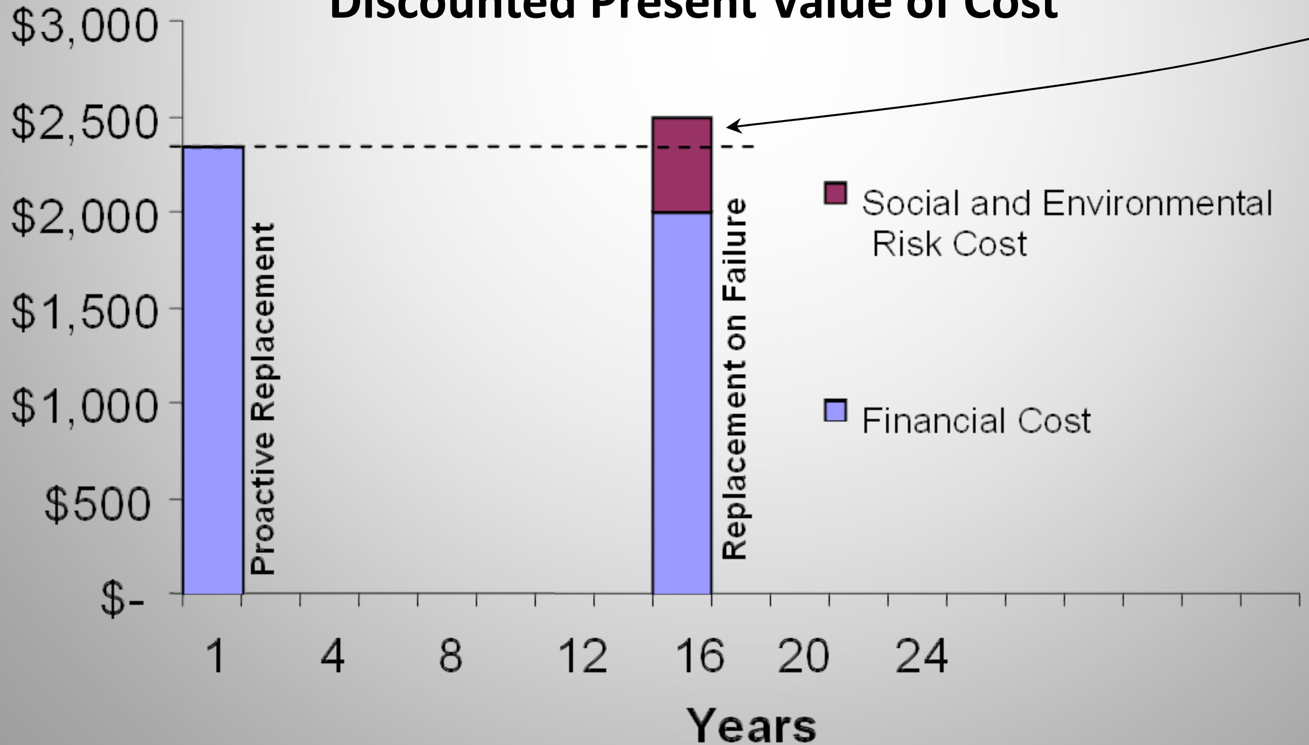



PV Costs Comparison - Rainier
$4,000,000
$3,500,000
$3,000,000
$2,500,000
$2,000,000
$1,500,000
$1,000,000
$500,000
$0
Do Nothing Hi
Do Nothing Low
Do Project Hi
Do Project Low
SPU Costs
SDOT Costs
Private Risks

Triple Bottom Line Justifies Early Replacement of Plastic Service Pipes

Risk Category	Probability	Consequence	Risk Cost
Service Interruption	10%	1 hr x 10 cust x $100/hr/cust	$100
Property Use Impact	1%	$2,000	$20
Surface Water Discharge	0.1%	$1,000	$1
Traffic Delay	10%	1 hr x 400 cars/hr x $5/car	$200
Total			**$321**

Discounted Present Value of Cost



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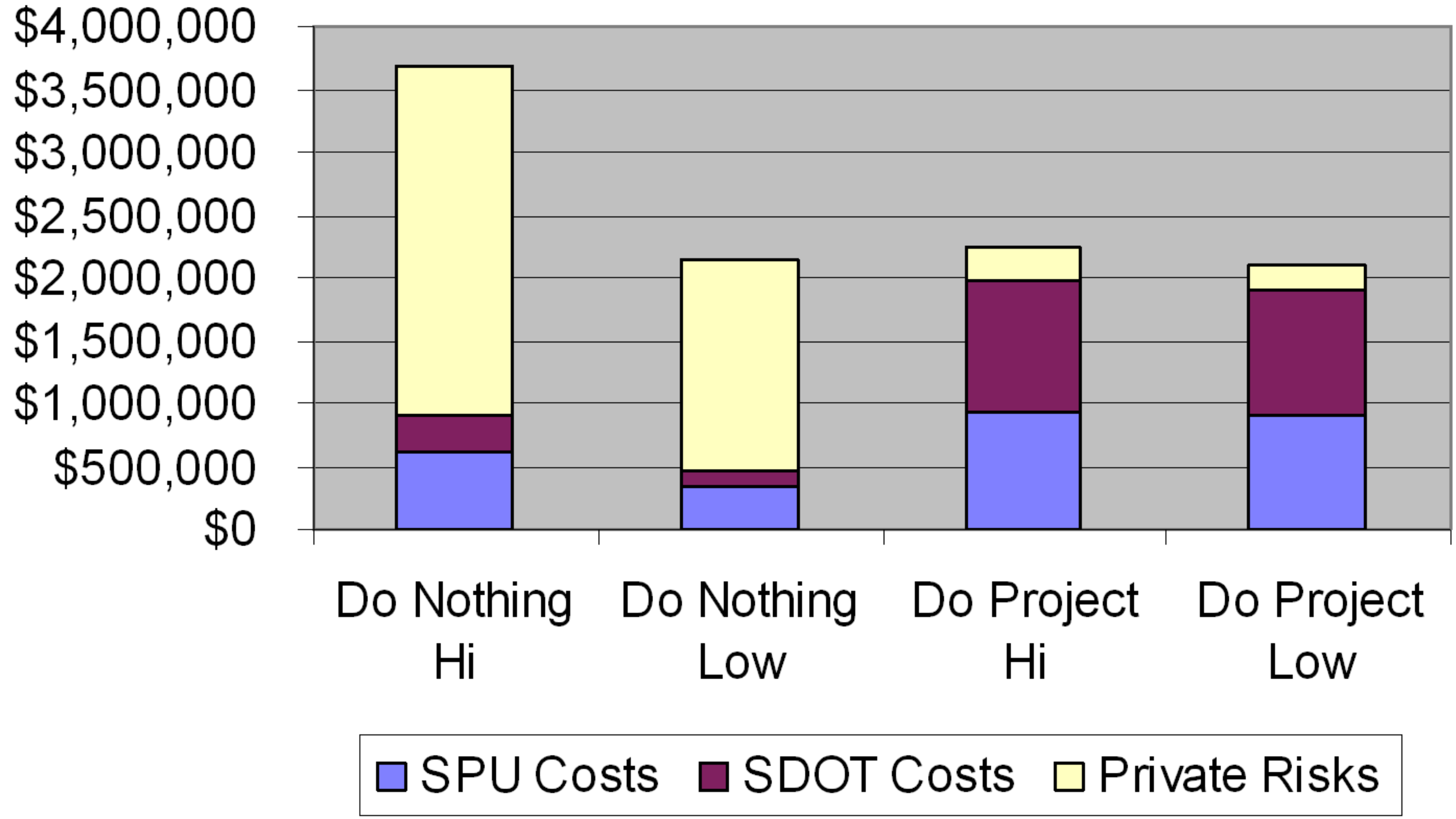
PV Costs Comparison - Rainier



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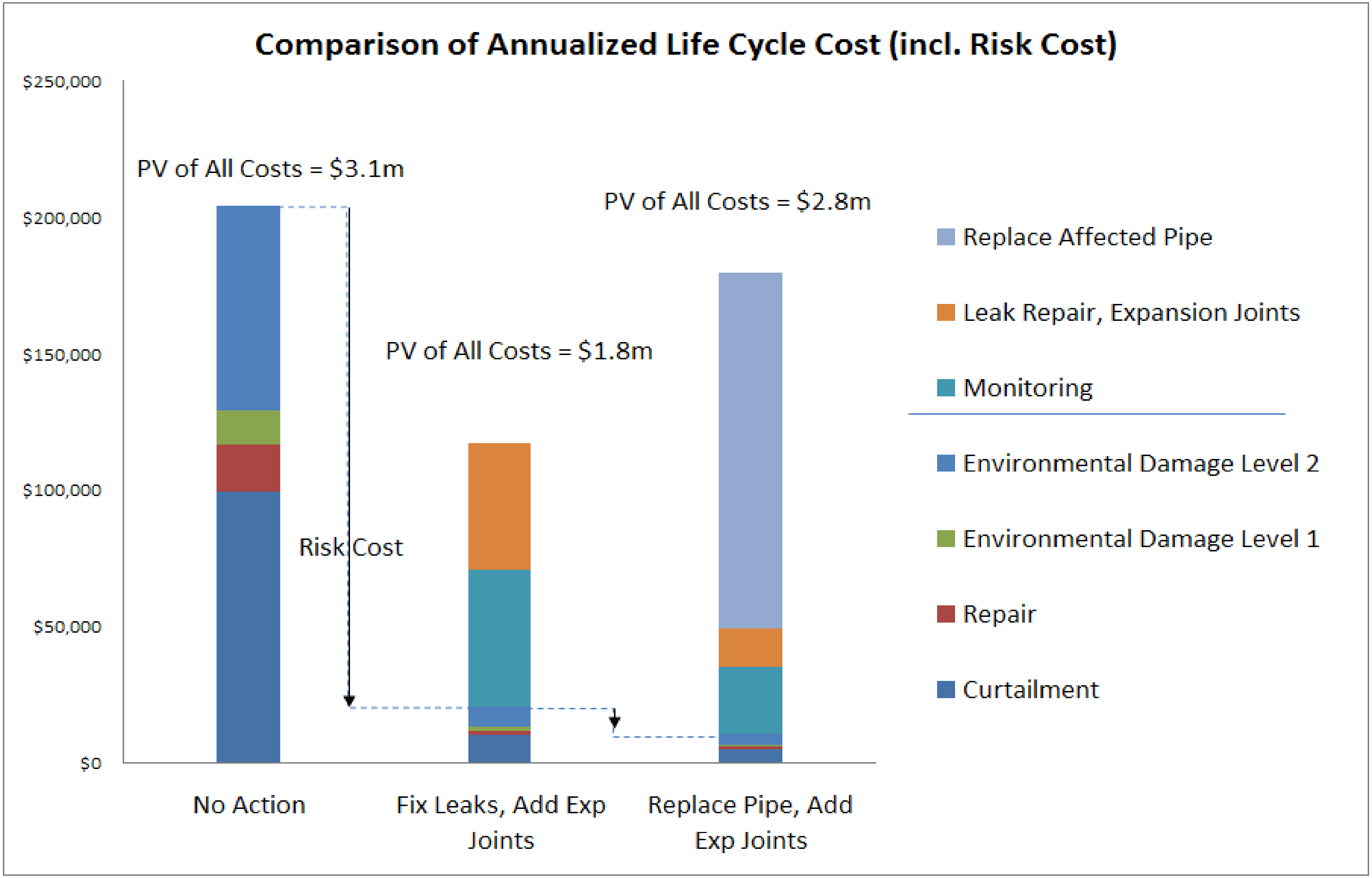

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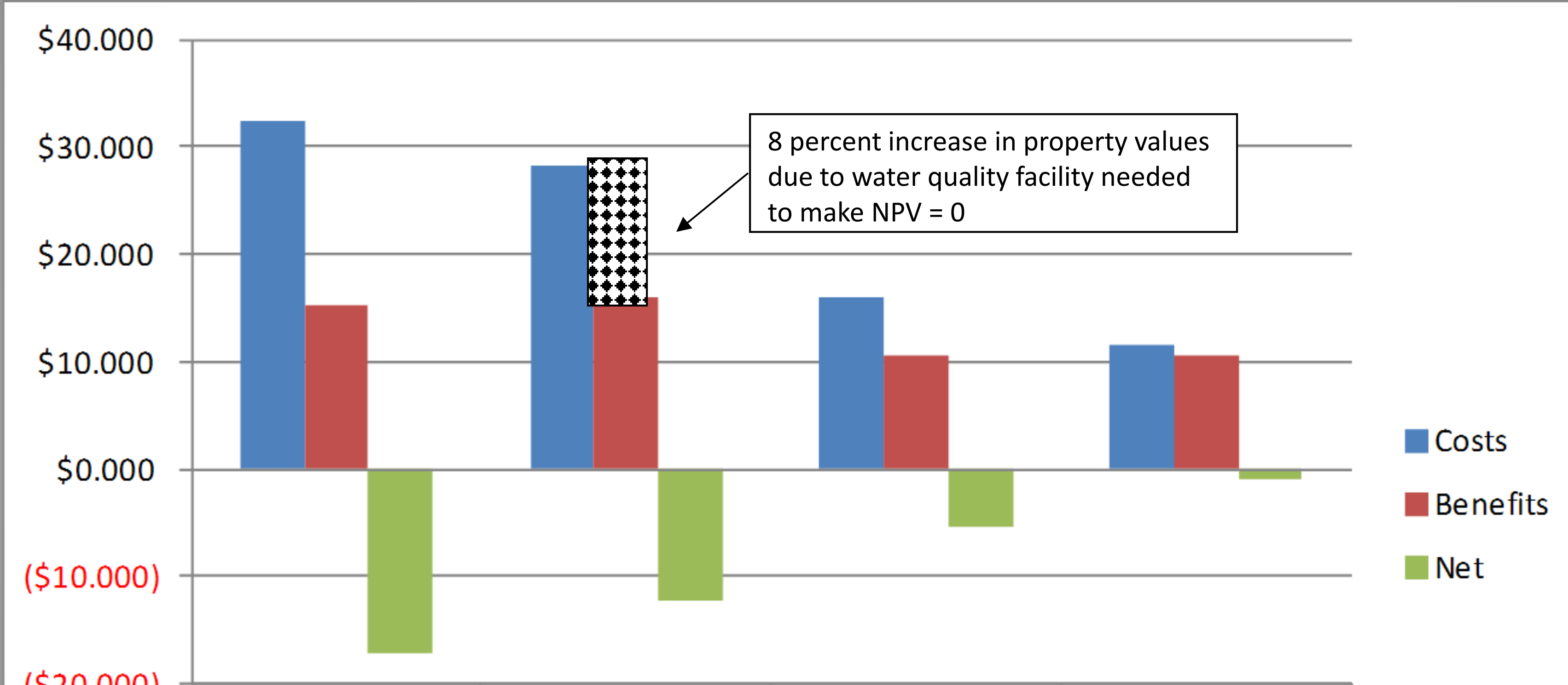
Economic Analysis - NPV

Figure 6.3: Net present value of South Park Water Quality Facility, excluding pump station costs, millions of dollars.



	2. Stormfilter with increased maintenance	4a. CESF with pressure sand, Single level	7. Delay WQ Fac ility	8. Delay Both
Costs	$32.500	$28.300	$15.900	$11.600
Benefits	$15.300	$16.100	$10.600	$10.600
Net	($17.100)	($12.200)	($5.300)	($1.000)

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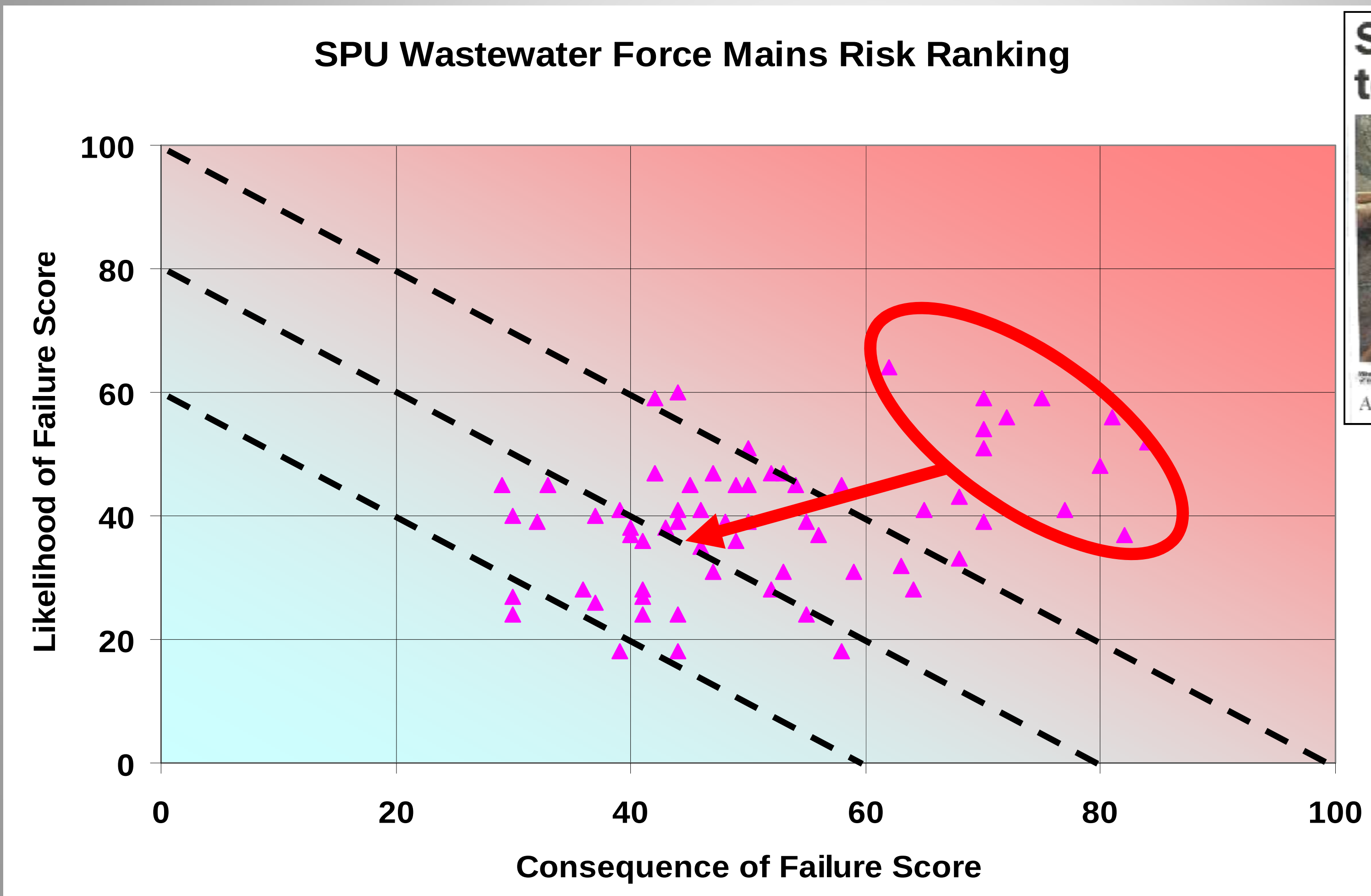
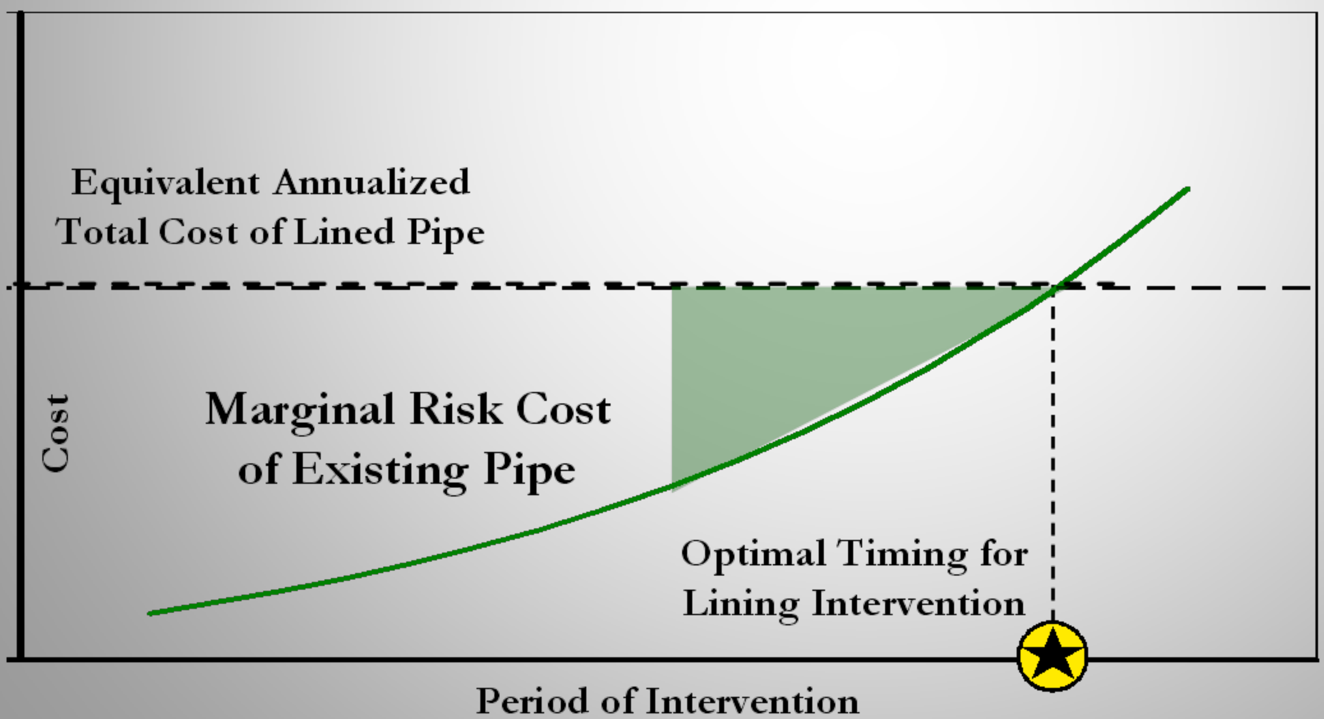
Evaluating Risk Improves Performance and Reduces Life Cycle Cost



Benefit of Optimal Intervention

1) **Old practice based on service life of 100 years; actual economic life averaged 150 years.**
2) **Cost of intervening too early = green area.**
3) **Typical PV of savings due to optimal timing = $17 million per pipe.**



Water Service Pipes Program

	2007 Units	&	Spending
Reactive Failure Renewals	570		$4,772,000
Proactive Renewals	320		$936,000

More of this now = Less of this in future

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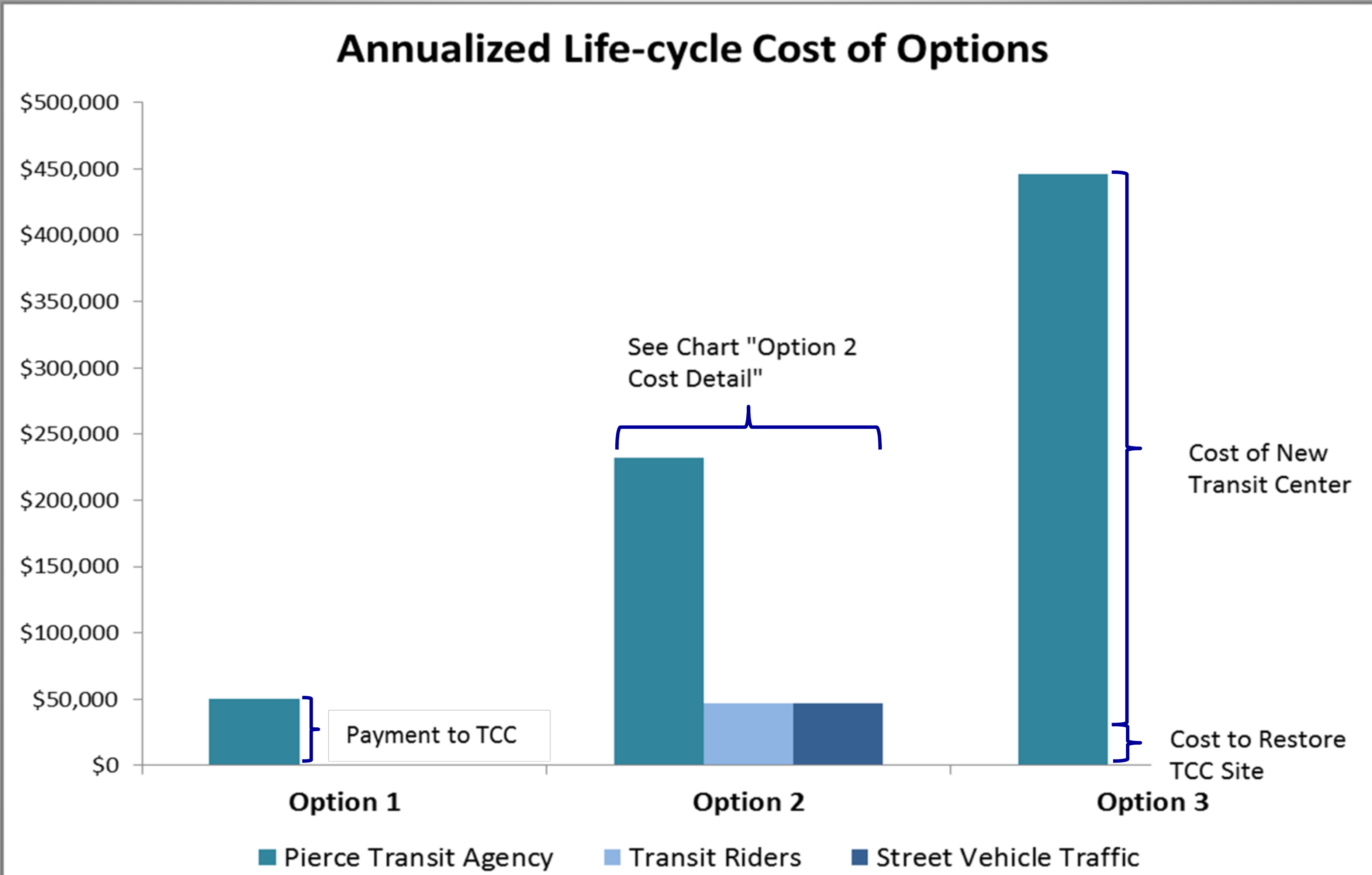
Comparing Option Costs



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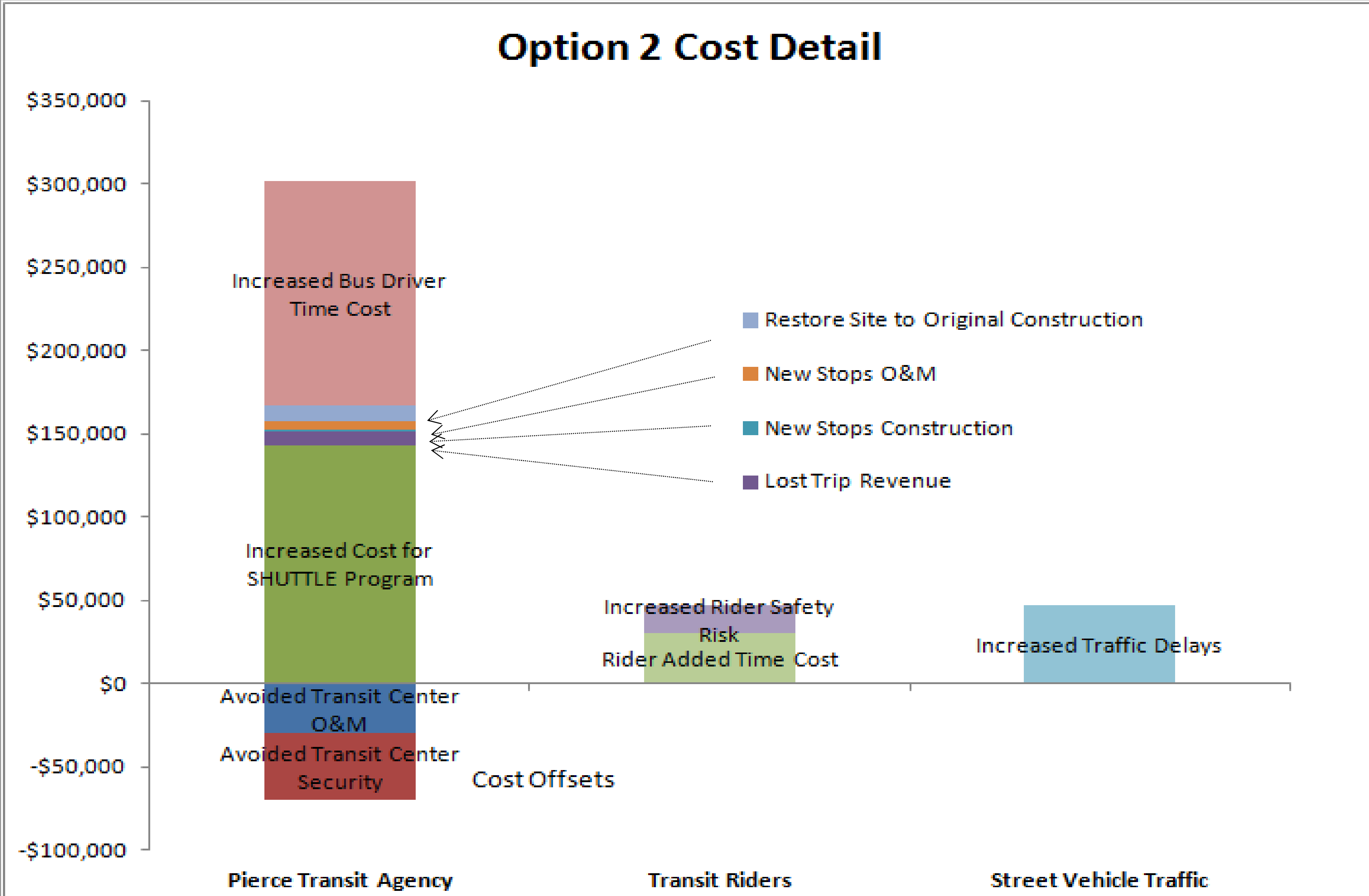
Option 2 Details



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Watershed Bridges

Steps	Traditional Approach	BCE Approach
1. Problem Statement	*Failing bridges need to be replaced*	*Access to sections of watershed threatened by failing bridges*
2. Options Analysis	*None*	*None, some or all bridges replaced; various designs*
3. Economic Analysis	*None*	*Compare TBL value and cost of options over full life cycle*
4. Recommendation	*Replace all failing bridges with concrete design appropriate for major urban arterial at a cost of $7-8 million*	*Best value is replace highest value bridges with steel design appropriate for limited mountain road use at a cost of $2-3 million; decommission low valued bridges*

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Maple Leaf Tank

Steps	Traditional Approach	BCE Approach
1. Problem Statement	*Tank needs to be upgraded to meet SPU seismic design standards; also, neighborhood receives low pressure*	*Neighborhood is exposed to risk cost due to seismic vulnerability of existing tank; minimum pressure service levels in neighborhood are being met, but lower than system average*
2. Options Analysis	*None*	*Tank, pipeline, pump, storage and operational solutions*
3. Economic Analysis	*None*	*Compare TBL value and cost of options over full life cycle*
4. Recommendation	*Replace tank with higher elevation tank meeting current seismic design standards at a cost of $7 million*	*Best value is connect neighborhood distribution network to higher head transmission line in vicinity and eliminated tank from service at a cost under $100K*

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Elmore Trestle

- 75 year old 30" clay sewer main
- On wooden trestle crossing ravine
- Conveys collected waste water from 2,000 customers to treatment interceptor line
- Trestle shows signs of structural weakness
- Pipe has some dripping leaks from joints

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Elmore Trestle

Steps	Traditional Approach	BCE Approach
1. Problem Statement	*Old, leaking sewer line on failing trestle needs to be replaced*	?
2. Options Analysis	*None*	?
3. Economic Analysis	*None*	?
4. Recommendation	*Replace sewer line in new alignment around ravine through neighborhood streets at a cost of $3 million*	?

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Elmore Trestle

Option	Present Value of Cost @ 5% Discount Rate*
1. Do Nothing	$1,531,000
2. Re-align in 35th Ave. W.	$1,900,000
3. Re-route to 36th Ave. W.	$3,000,000
4. Reline pipe and Rebuild Trestle with wood timbers	$584,000
5. Reline pipe and Rebuild Trestle with reinforced recycled plastic timbers	$776,000

*Includes risk cost of failure and periodic rehabilitation over 100 years

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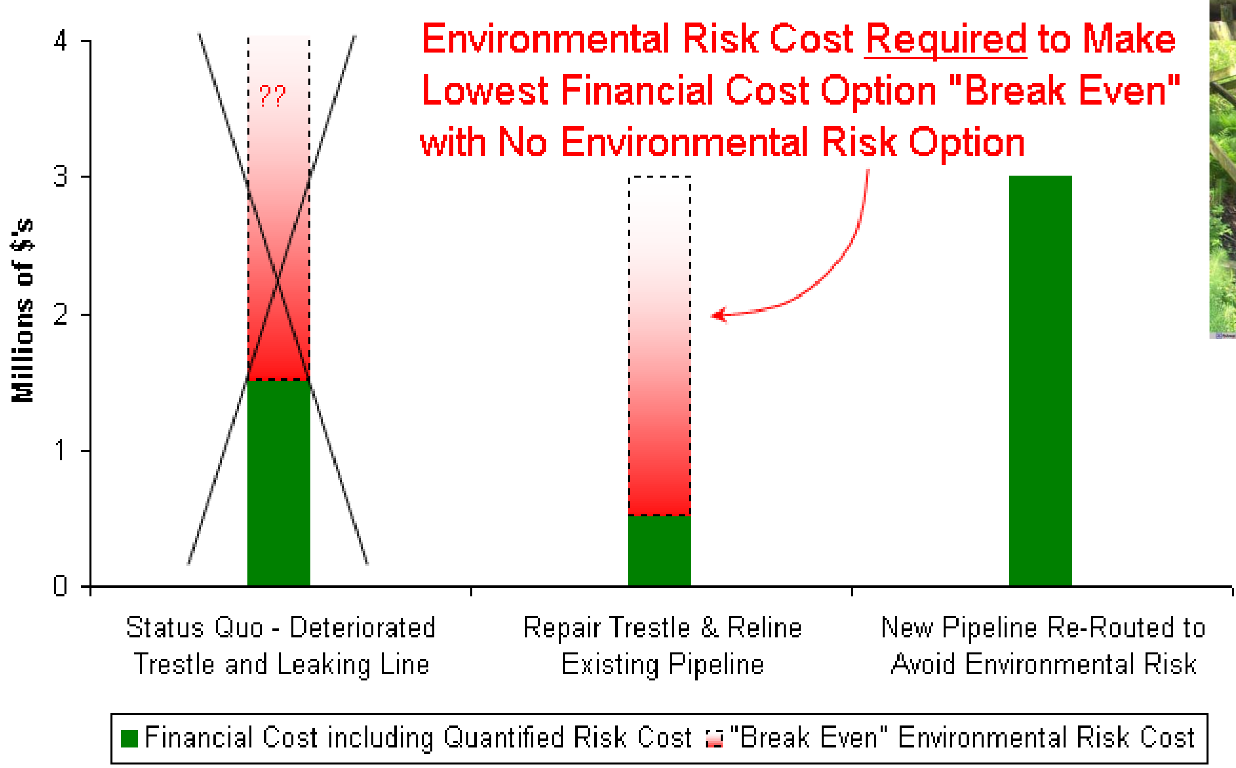
Triple Bottom Line “Reasonable Person” Test Helps Choose Best Value Option



Likelihood		Environmental Consequence		Environmental Risk Cost
100%	X	$2,500,000	=	$2,500,000

Likelihood and consequence required to "break even" with no risk option judged unreasonably high.

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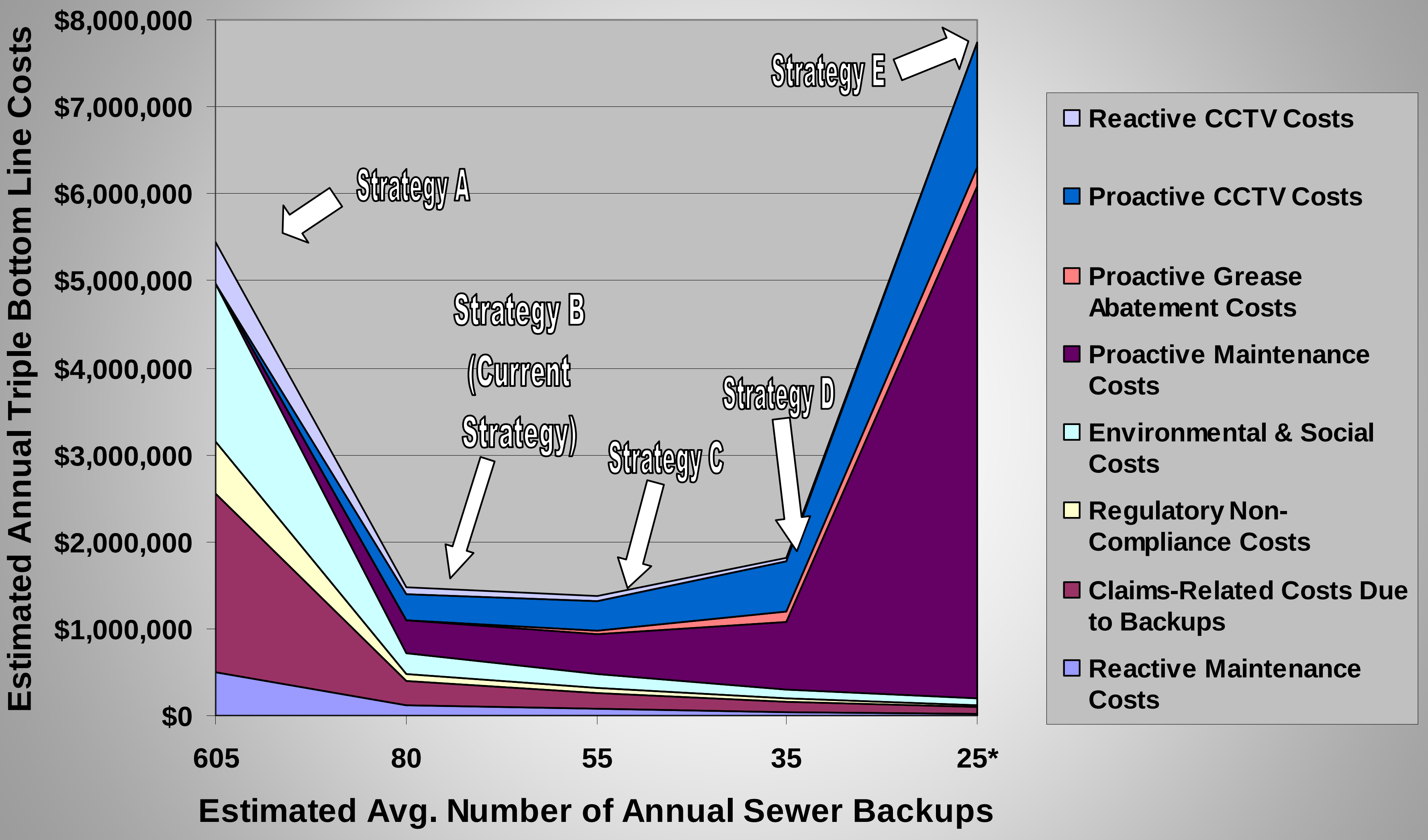

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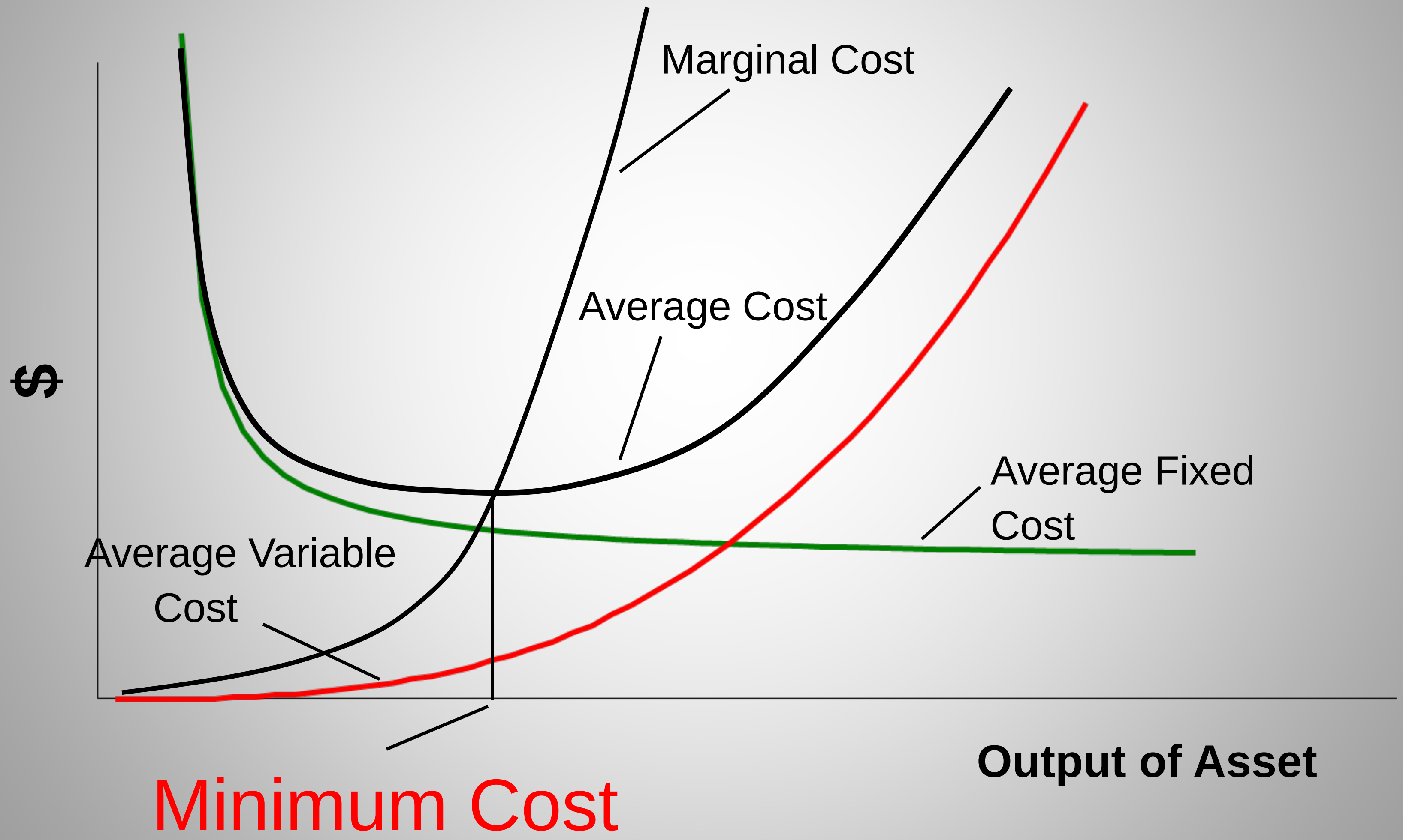
Economic Principles



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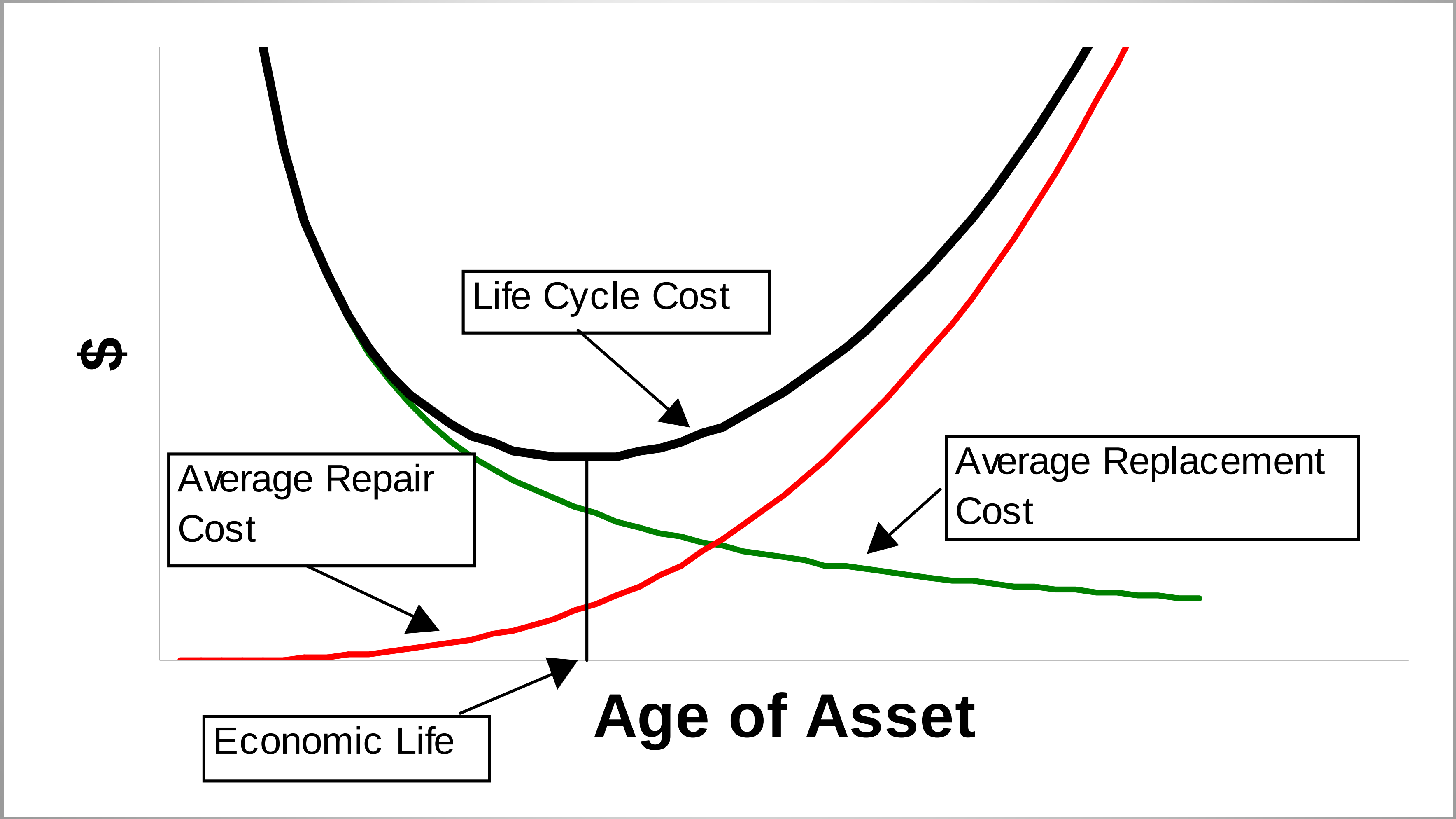
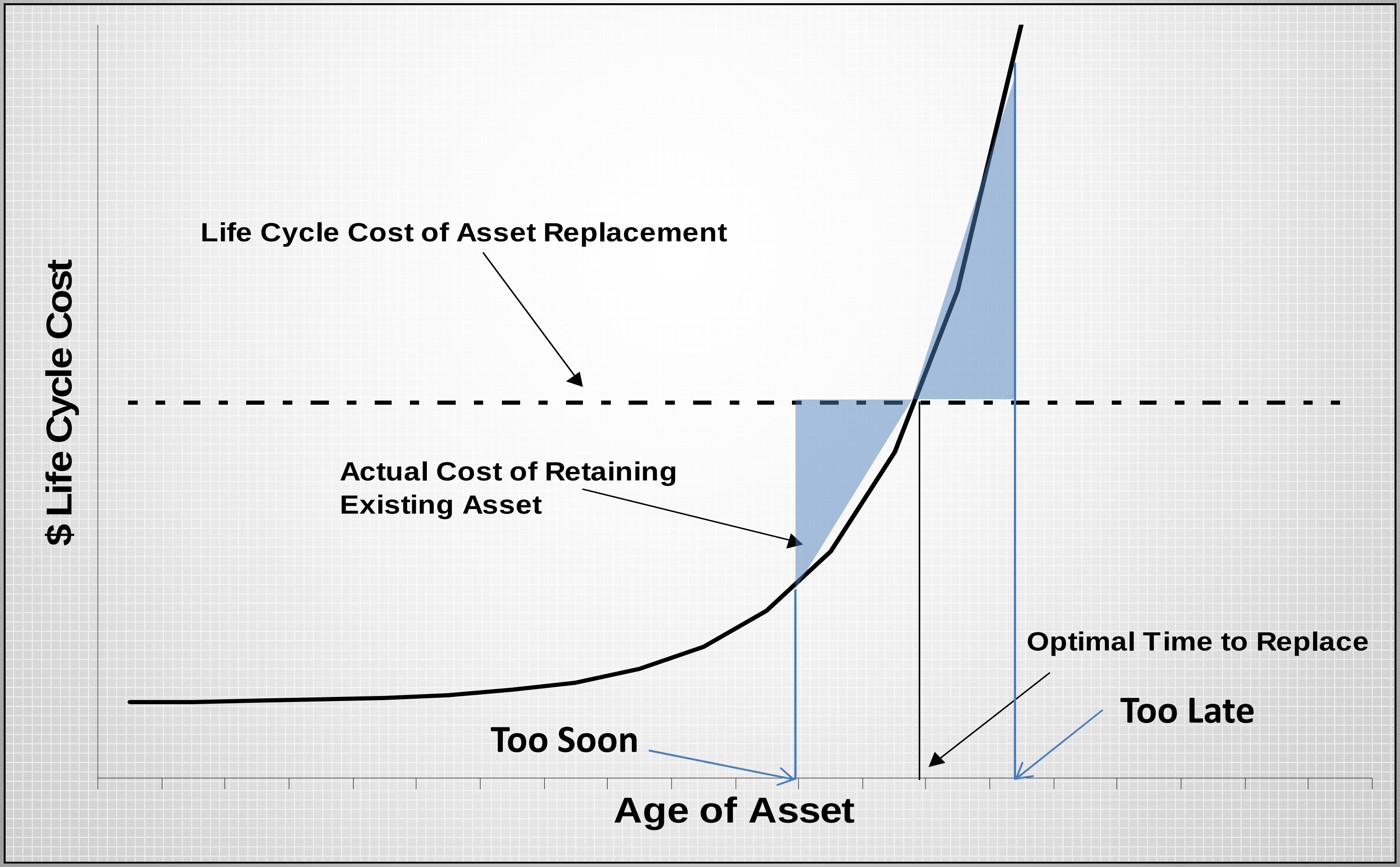
Replace Assets at end of Economic Life – Minimum Average Life Cycle Cost



Economic Life Models: Optimal Asset Replacement

Replace when retention exceeds cost of replacement



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Pipe Replacement Model

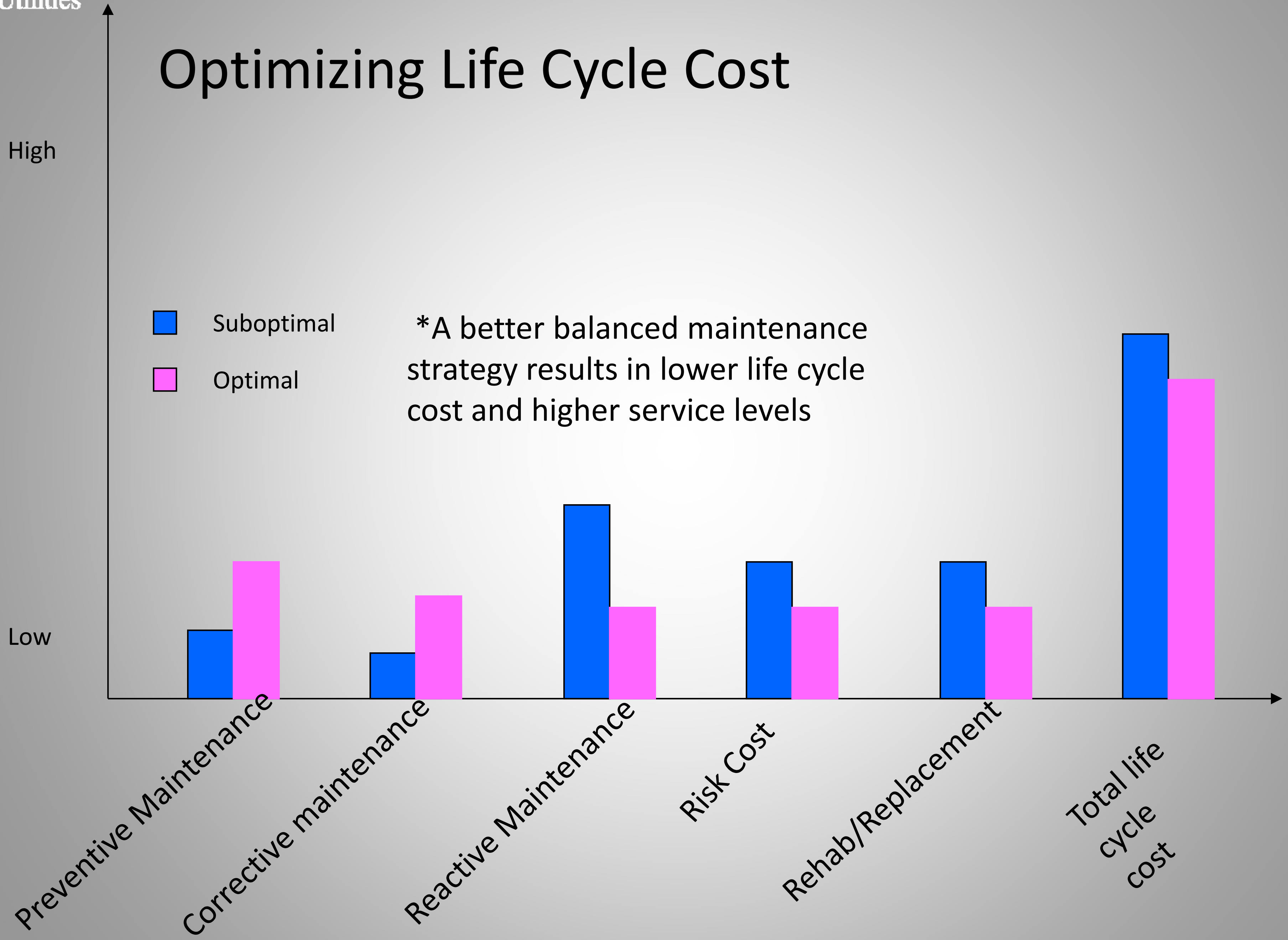
Scenario: **W Cremona St: 8th Ave W to 7th Ave W**
(model modification, 10% contingency, 8" DI replacement option)

INPUTS

Option	*Data Class*	*Input Variables*	*Input Values*
Leak Repair	Pipe	Pipe Length Miles	0.063
Leak Repair	Pipe	Leaks per Mile per Year in Year 1	25.4
Leak Repair	Pipe	Pipe Age	76.0
Leak Repair	Construction	Leak Repair Hours	5
Leak Repair	Construction	Persons per Repair	3
Leak Repair	Construction	Cost per Person per Hour	$ 50
Leak Repair	Construction	Equipment Pieces per Repair	3
Leak Repair	Construction	Cost per Equipment Piece per Hour	$ 75
Leak Repair	Construction	Material Cost	$ 625
Leak Repair	Construction	Total Cost per Leak	$ 2,500
Leak Repair	Service	Hours Service Interruption per Leak	3
Leak Repair	Service	Customers Impacted per Leak	48
Leak Repair	Service	% Leak Repairs w/ Water Shutoff	50%
Leak Repair	Service	Cost per Customer per Hour	$ 5
Leak Repair	Traffic	Hours Traffic Interruption	5
Leak Repair	Traffic	Traffic Flow Cars per Hour	40
Leak Repair	Traffic	Cost per Car	$ 2
Leak Repair	Lost Water	Hours of Water Loss per Leak	168
Leak Repair	Lost Water	Gallons Lost per Hour	25
Leak Repair	Lost Water	Cost per Gallon Lost	$ 0.002
Leak Repair	Damage	Number of Damage Claims per Leak	0.167
Leak Repair	Damage	Settlement Cost per Claim	$ 2,000
Leak Repair	Fire Risk	Customers Impacted Fire Flow	0
Leak Repair	Fire Risk	Property Value per Customer	$ 500,000
Leak Repair	Fire Risk	Probability each Year Fire w/ Inadequate Fire Flow	0.00001

OUTPUTS	
Net Present Value of Replacement @ 3%	$130,533
Net Present Value of Replacement @ 5%	$64,874
Net Present Value of Replacement @ 7%	$16,597
Total Leaks per Year in Year 1	1.60
Total Leaks per Year in Year 20	4.89
Construction % of Leak Repair Option Cost	52%
Service % of Leak Repair Option Cost	7%
Traffic % of Leak Repair Option Cost	8%
Lost Water % of Leak Repair Option Cost	0%
Damage % of Leak Repair Option Cost	7%

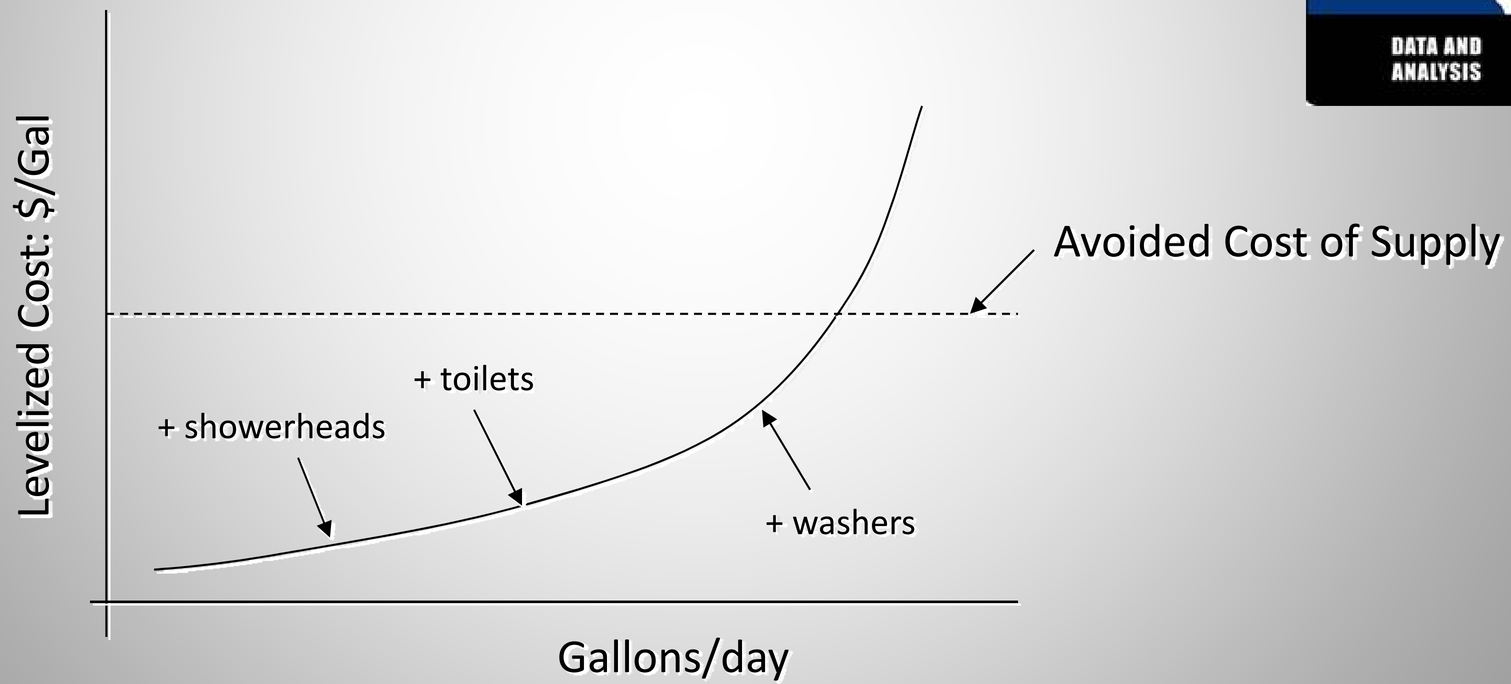
Optimizing Life Cycle Cost



Multiple Options and Complex Systems

Optimizing Value over Cost

Complete a *Demand Management Potential Assessment*



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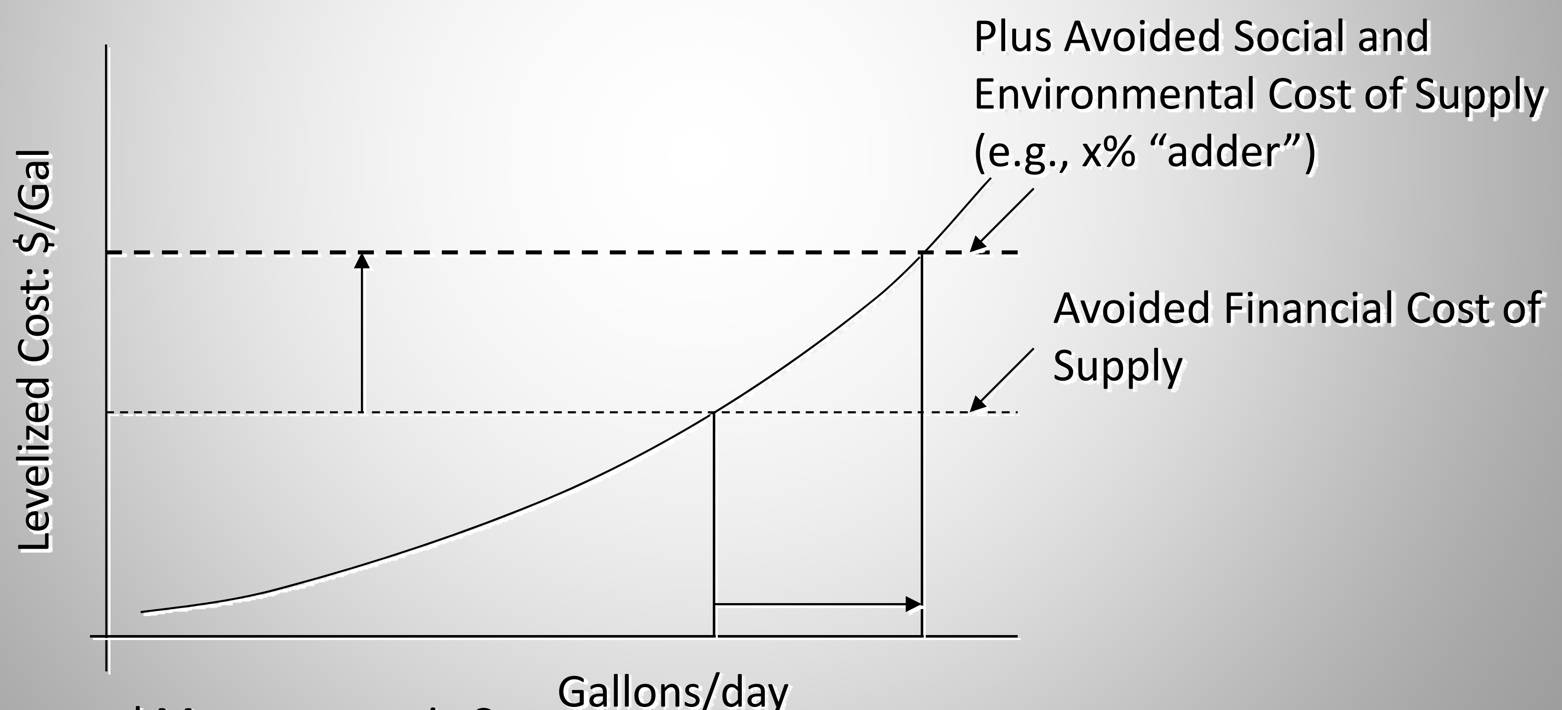
Multiple Options and Complex Systems

Optimizing Value over Cost

Including Triple Bottom Line in Costs



Further Demand Management is Cost Effective

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Optimizing Cost and Service Level