



***Q4 What Are My “Minimum
Life-Cycle Cost” CIP And
O&M Strategies”?***

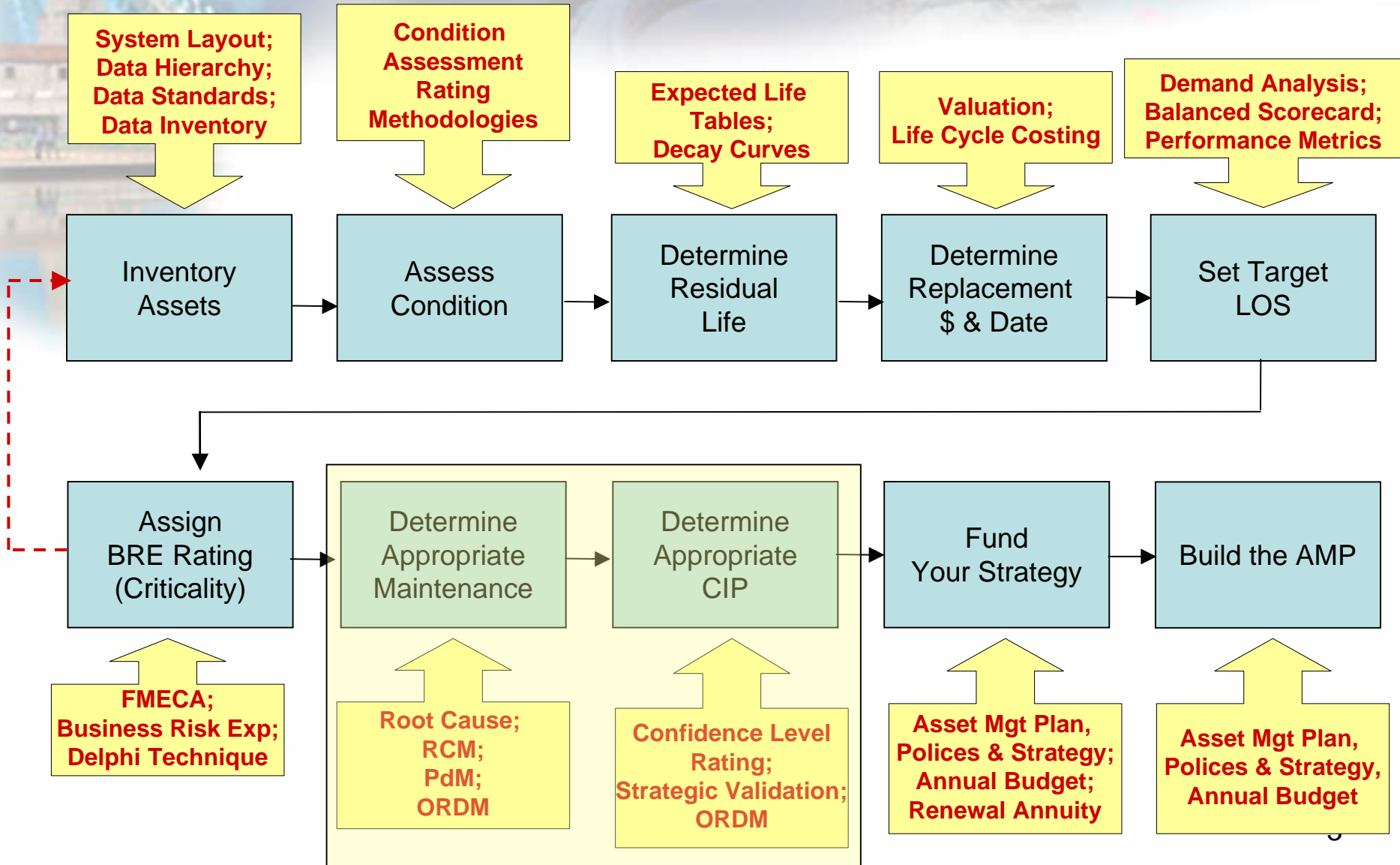
AMPLE

Asset Management Program
Learning Environment

Recapping Our Progress

- *We have our asset register ...*
- *We have assessed condition...*
- *We understand residual life and the approximate probability of failure...(estimated)*
- *We understand criticality and have a rating for the Business Risk Exposure (BRE)...*
- *Now we need to predict the future costs of the facility...*
- *What do we need to spend to meet our LOS performance?*

Core AAM Program Process Tools



AAM Focuses on Three Fundamental Management Decisions:

- What are my work crews doing, where are they doing it – *and why?*
- What CIP projects should be done and when?
- When to repair, when to refurbish and when to replace?

These decisions typically account for *at least 80%* of a Utility's annual expenditures!

The Asset Decision Framework

The Big Picture

- “Whole portfolio” perspective
 - Trends
 - “Macro forces”
- Policy framework
- Budget arena

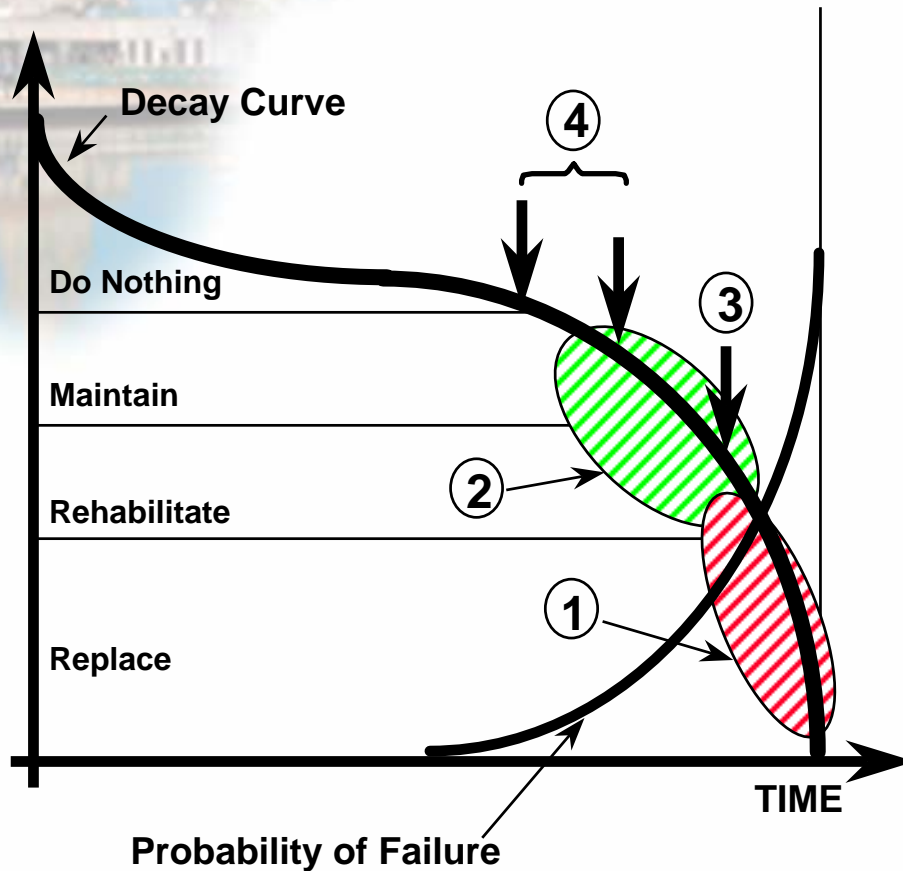
The Micro View

- Event-based
- Specific asset focus
- Case-by-case decision points

Repair? Renew? Replace? Augment?

Determining Lowest-Cost Action

CONDITION

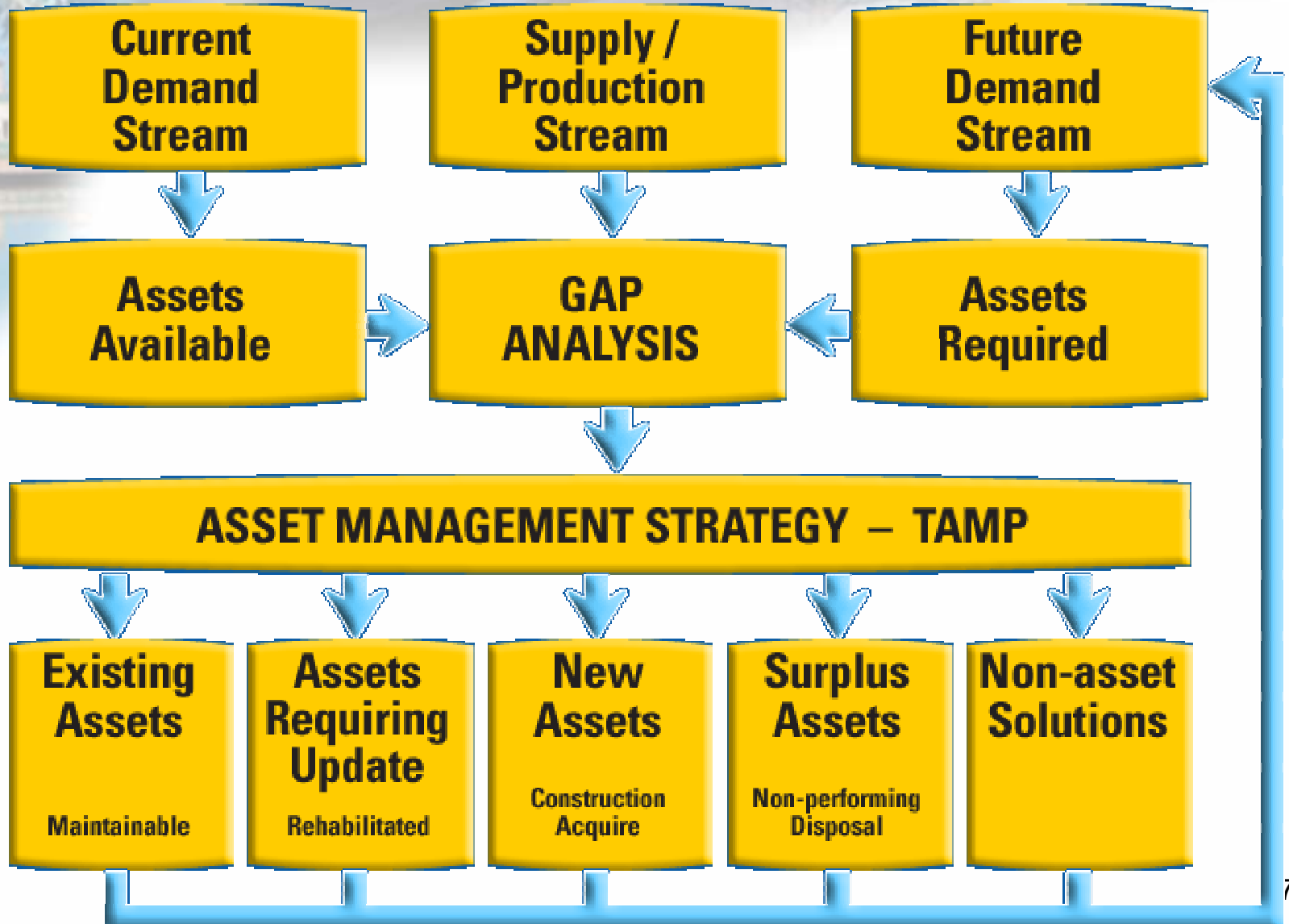


Benefit Based Priorities

Priority order

- 1 Assets with a high probability or history of failure (reliability).
- 2 Assets with a high business risk cost (consequence).
- 3 Assets where rehabilitation intervention is beneficial.
- 4 Assets where more appropriate maintenance is beneficial (eg. with high unplanned maintenance).

Infrastructure Assets – Strategic Planning



So, What do we mean by "...minimum life cycle cost strategies?"

- The fundamental asset management options available to the management team include:
 - Do nothing ("Zero-based" strategy)
 - Status quo
 - Repair
 - "Run-to-failure"
 - Preventive-based
 - Condition (predictive)-based
 - Refurbish/Rehabilitate
 - Replace
 - Decommission/non-asset-based
- Which *strategy* for each asset?
- **Combinations over life cycle**

What Do We Mean By "Alternative Treatment Options?"

Maintenance Options

Maint Option 1

Maint Option 2

Maint Option 3

Refurbish Options

Renewal Option 1

Renewal Option 2

Renewal Option 3

Replacement Options

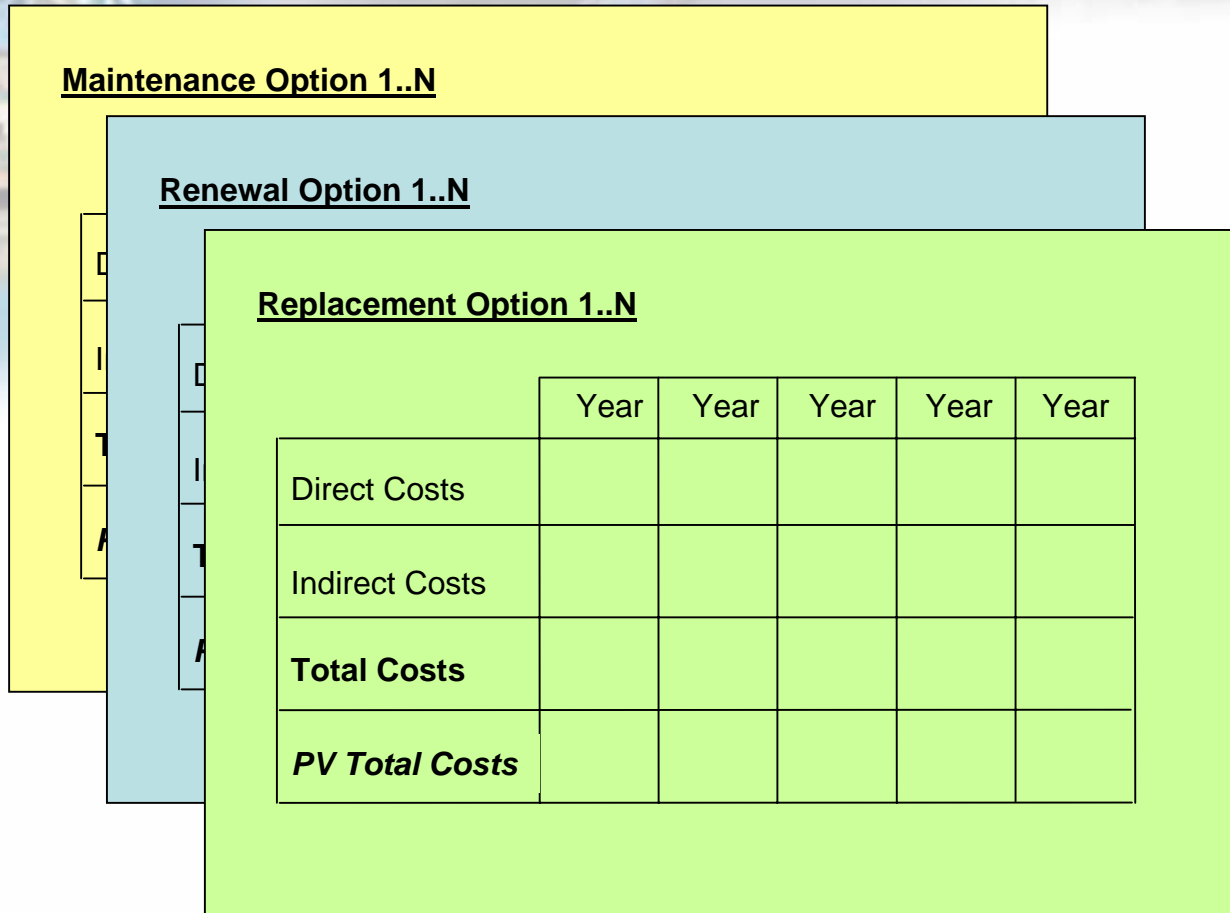
Replace Option 1

Replace Option 2

Non-Asset Options

Non-Asset Option 1

Our “Decision Rule”



“Search for the Alternative Treatment with the lowest ***average annual PV.***”

Putting it all together – “ORDM”

- “ORDM” – Optimal Renewal/Replacement Decision-making
- Treatment (management) options:
 - Continued maintenance
 - Renewal
 - Replacement
 - Non-asset solutions
- Decision rule: seek “treatment” option with lowest cost (“lowest present value of average annual economic costs”)

Articulating "Costs"*

- **Direct Costs to the Government Organization**
 - Repair and return to service costs
 - Service outage mitigation costs
 - Utility emergency response costs
 - Public safety costs
 - Admin & legal costs of damage settlements
 - (Lost product costs)
- **Direct Customer Costs**
 - Property damage costs (including restoration of business)
 - Service outage costs
 - Service outage mitigation and substitution costs
 - Access impairment and travel delay costs
 - Health damages
- **Community Costs**
 - Health/safety/welfare
 - Disease and illness mitigation
 - Emotional strain/welfare
 - Environmental impact
 - Pollution, erosion, sedimentation
 - Destruction of/damage to habitat
 - "Attractability" (tourist, economic)

Optimal Renewal Decision Making — Options

Non-Asset Solutions

- Policy strategies
- Processes / guidelines
- Human resources management issues (Productivity)
- Financial management strategies
- Information system strategies
- Customer strategies
- Private sector involvement

Improve Service Potential

- Optimise existing assets
- Manage asset stocks
- Refurbish assets
- Measure performance
- Dispose of non-performing assets
- Improve maintenance response / quality

Maintain Service Potential

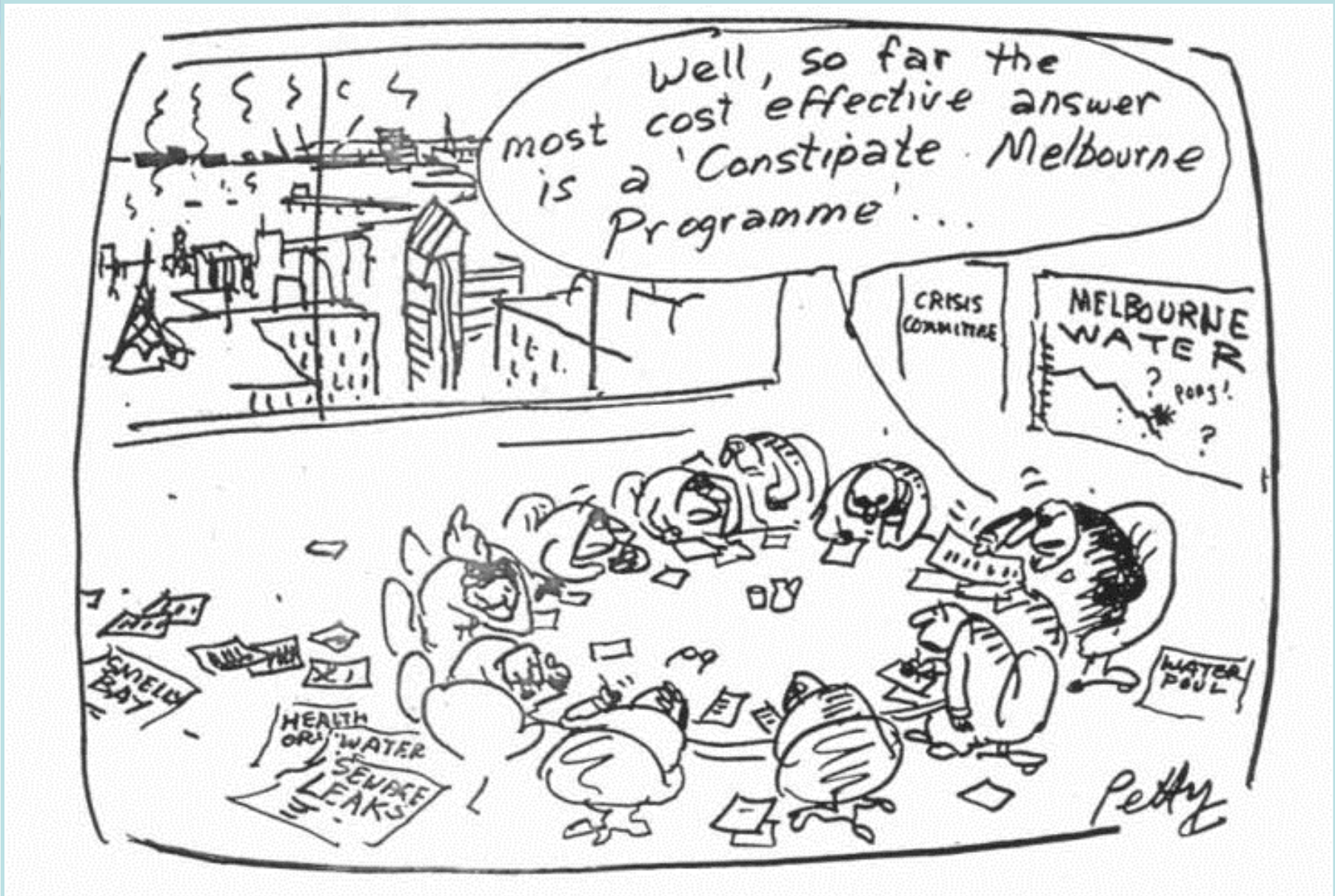
- Preserve asset
- Manage maintenance
- Maintain heritage value
- Assess condition
- Assess functionality
- Manage facility
- Optimise renewal

Augment Service Potential

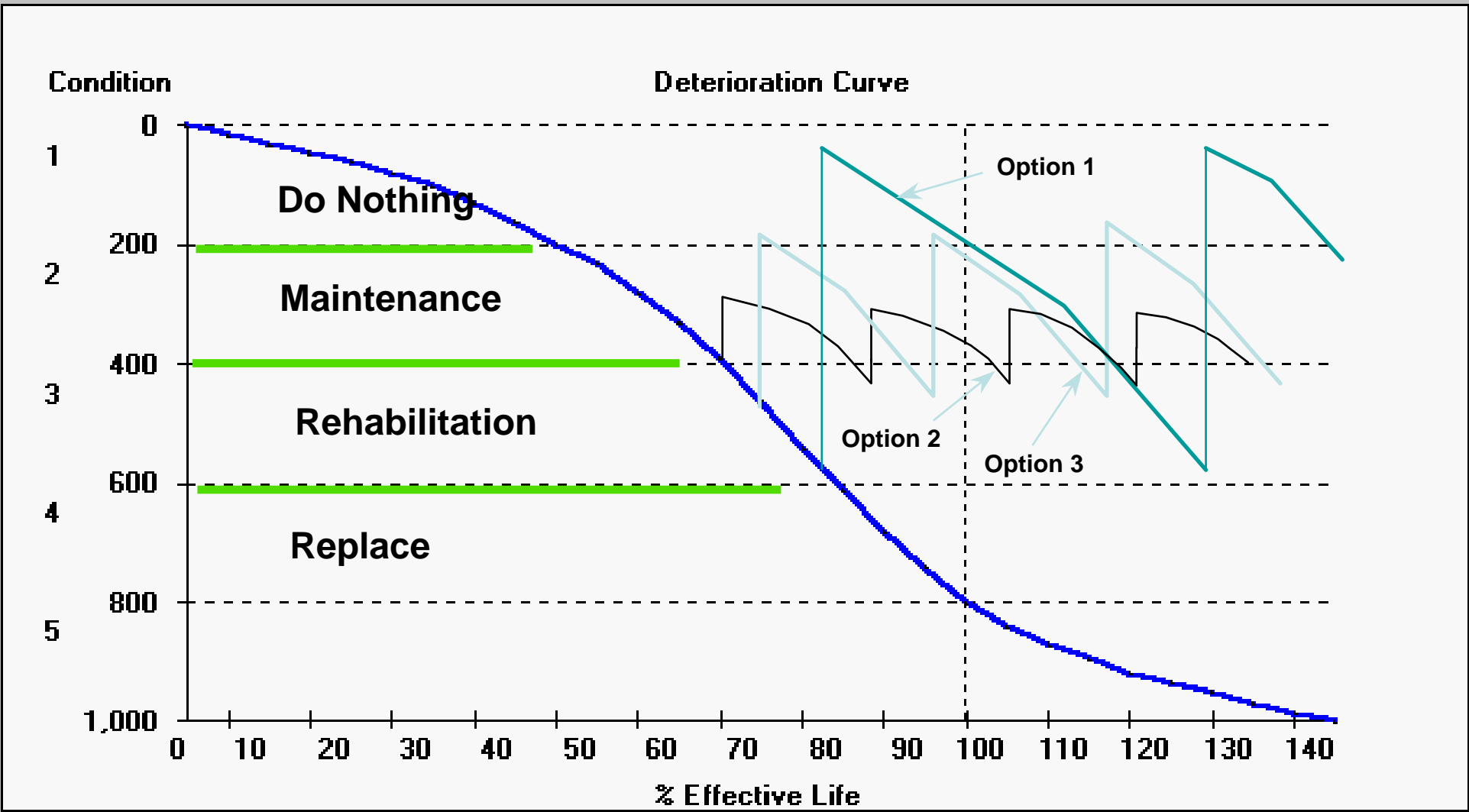
- Create new asset(s)
- Manage asset acquisition
- Share assets / resources
- Lease assets
- Purchase assets
- Augment existing assets

Review (Monitor) Asset Stock Performance

NON-ASSET OPTIONS...



Main

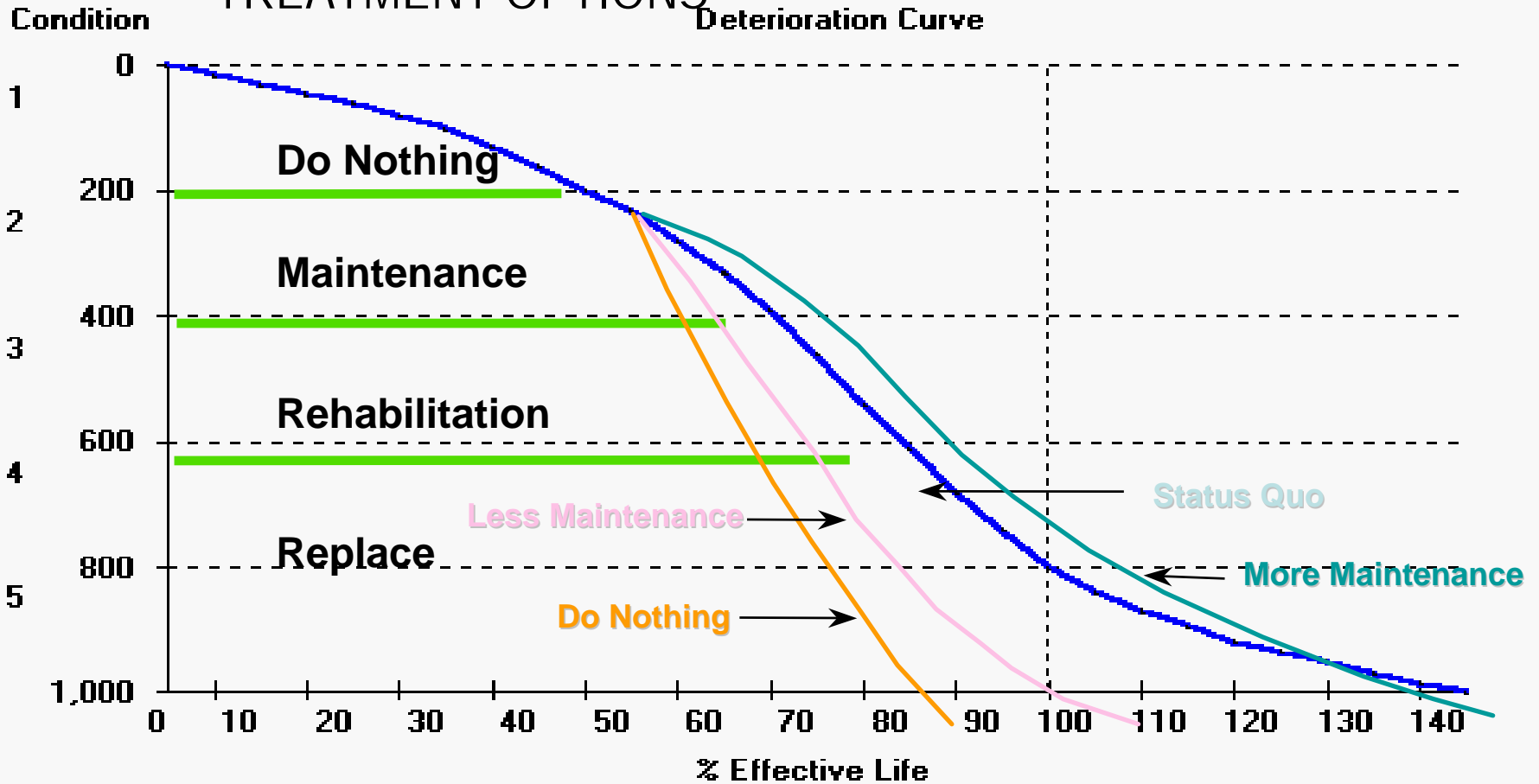


Overlay Prob. of Failure Curve

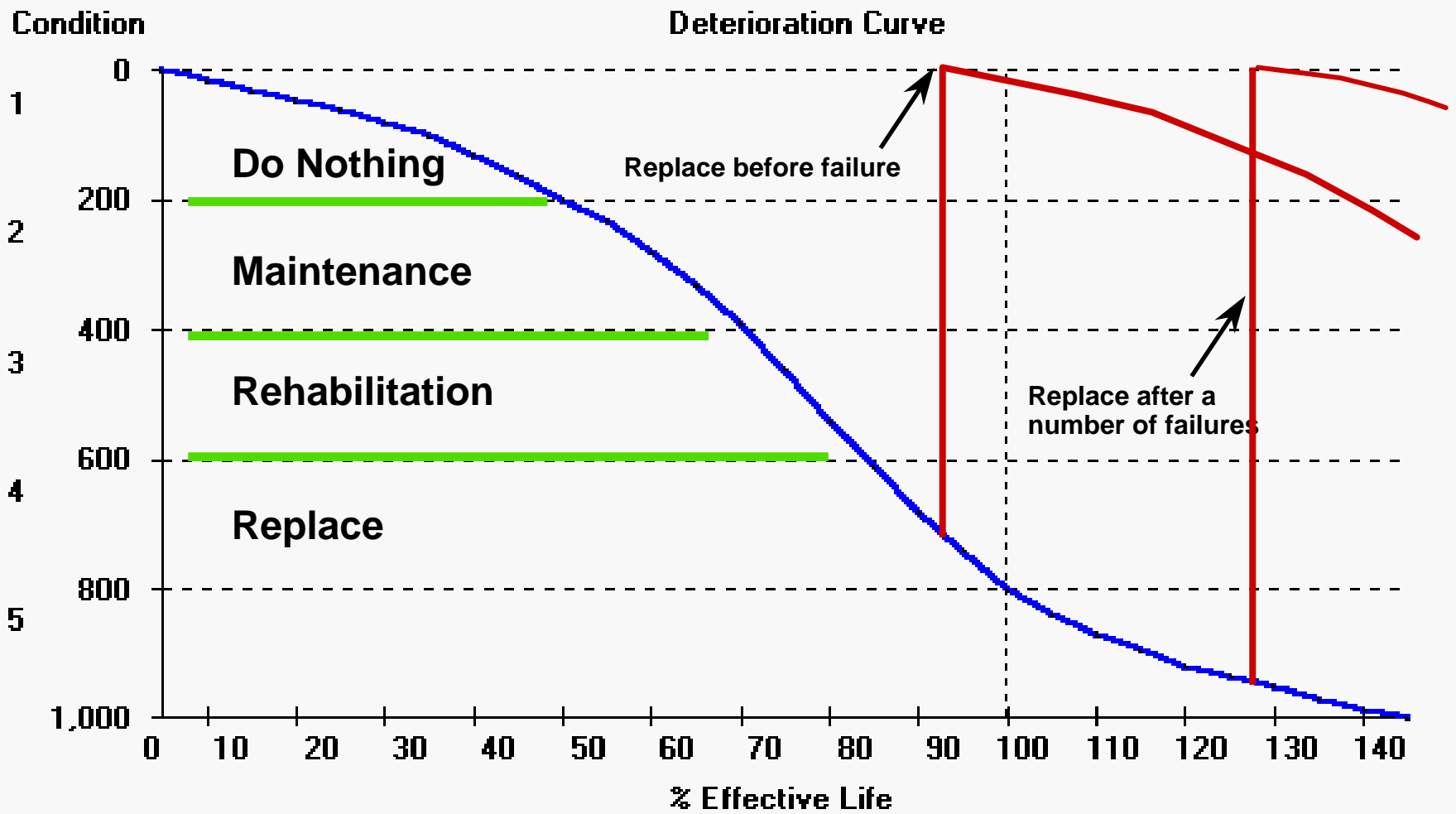


Main

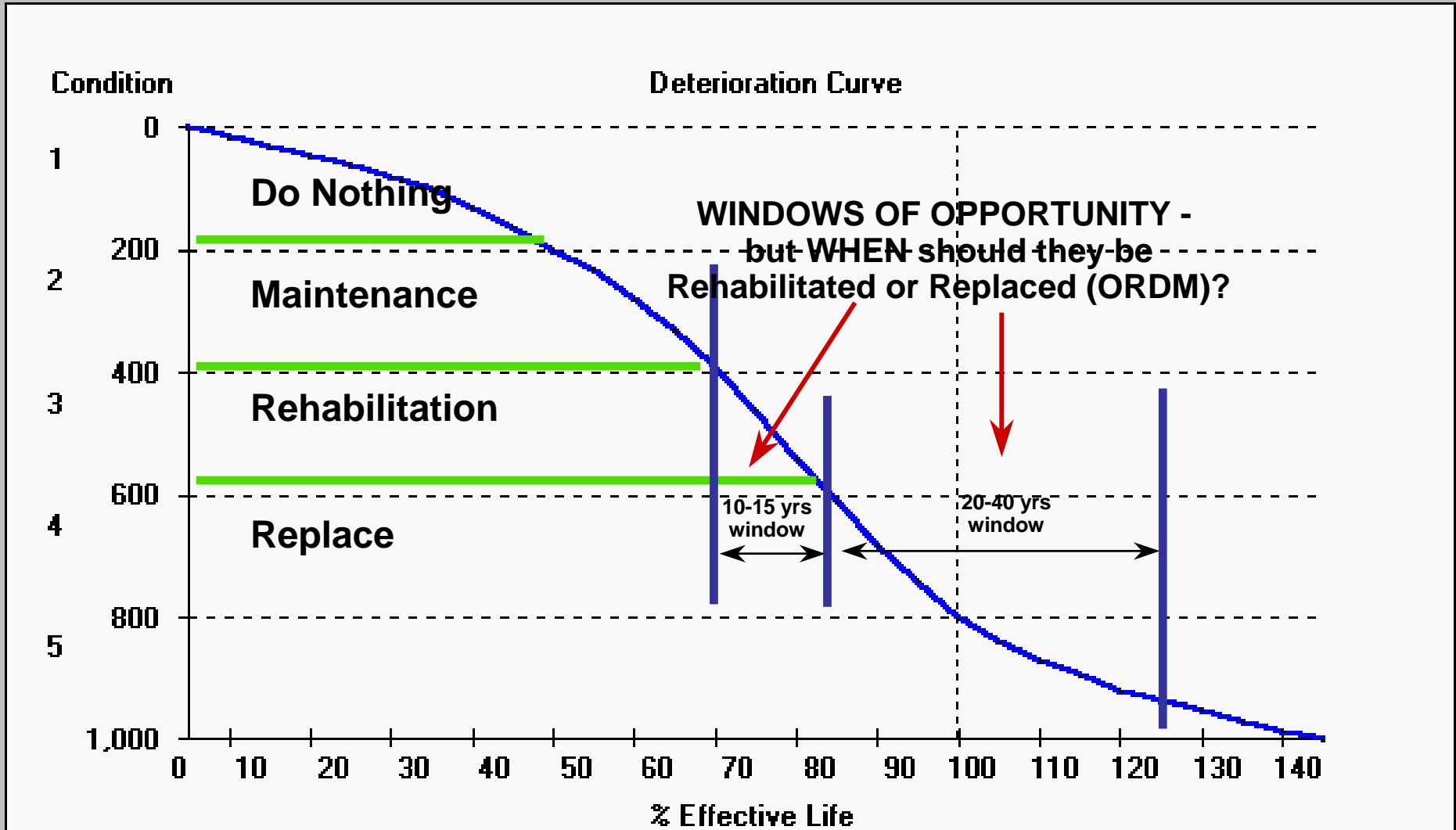
TREATMENT OPTIONS



Overlay Prob. of Failure Curve

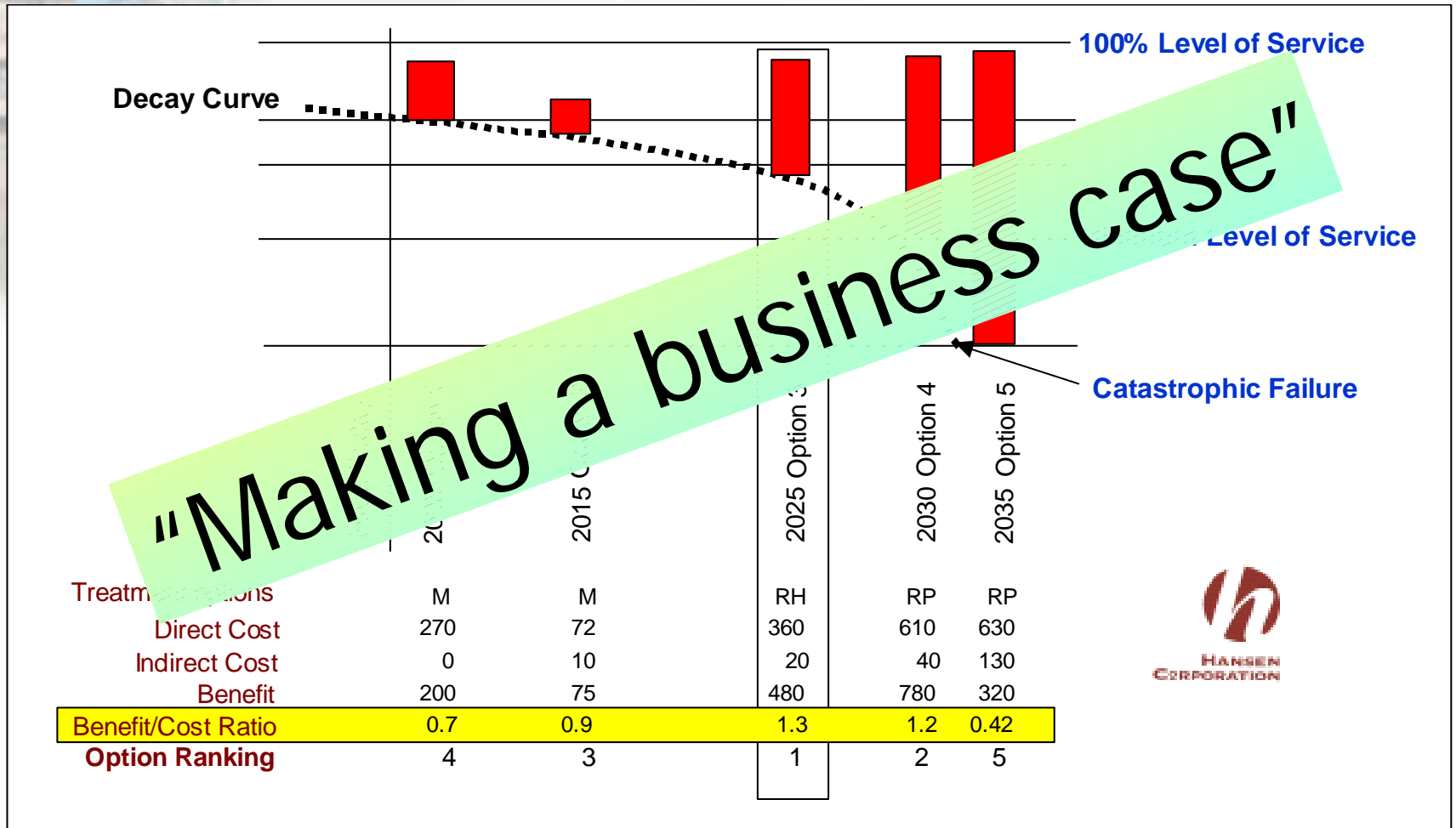


Overlay Prob. of Failure Curve



Overlay Prob. of Failure Curve

Optimal Replacement Decision Theory



Importance Of The Work Order

WORK ORDER

ASSET DETAILS

- **TYPE**
- **CATEGORY**
- **SIZE**
- **CONDITION**
- **PERFORMANCE HISTORY**

ASSET LINKED COSTS ALLOW SIGNIFICANT ANALYSIS:

1. **What type of sewer suffers the greatest number of blockages caused by tree roots?**
2. **How many failures are experienced by water mains of different ages in different ground conditions?**

Importance Of The Work Order

WORK ORDER

- ESTIMATED BILL OF QUANTITIES
- ACTUAL
 - LABOR
 - PLANT
 - MATERIALS
- PROCEDURE FOLLOWED
- FAILURE MODE NOTED
- PRIMARY CAUSE OF FAILURE
- MEMOS
- IMPACT ON CUSTOMERS
- UNPRODUCTIVE TIME
- OTHER ISSUES

TYPE
P.M.
U.M.

TELLS US PLANNED (PM) OR UNPLANNED (UM) MAINTENANCE COSTS

MONITORS PERFORMANCE REPORTS ON **COST OVERRUNS**

TELL US ACTUAL DIRECT COSTS OF ACTIVITY

TELL US THE ACTIVITY USED NECESSARY FOR **ACTIVITY ANALYSIS**

USEFUL IN **FAILURE MODE ANALYSIS**

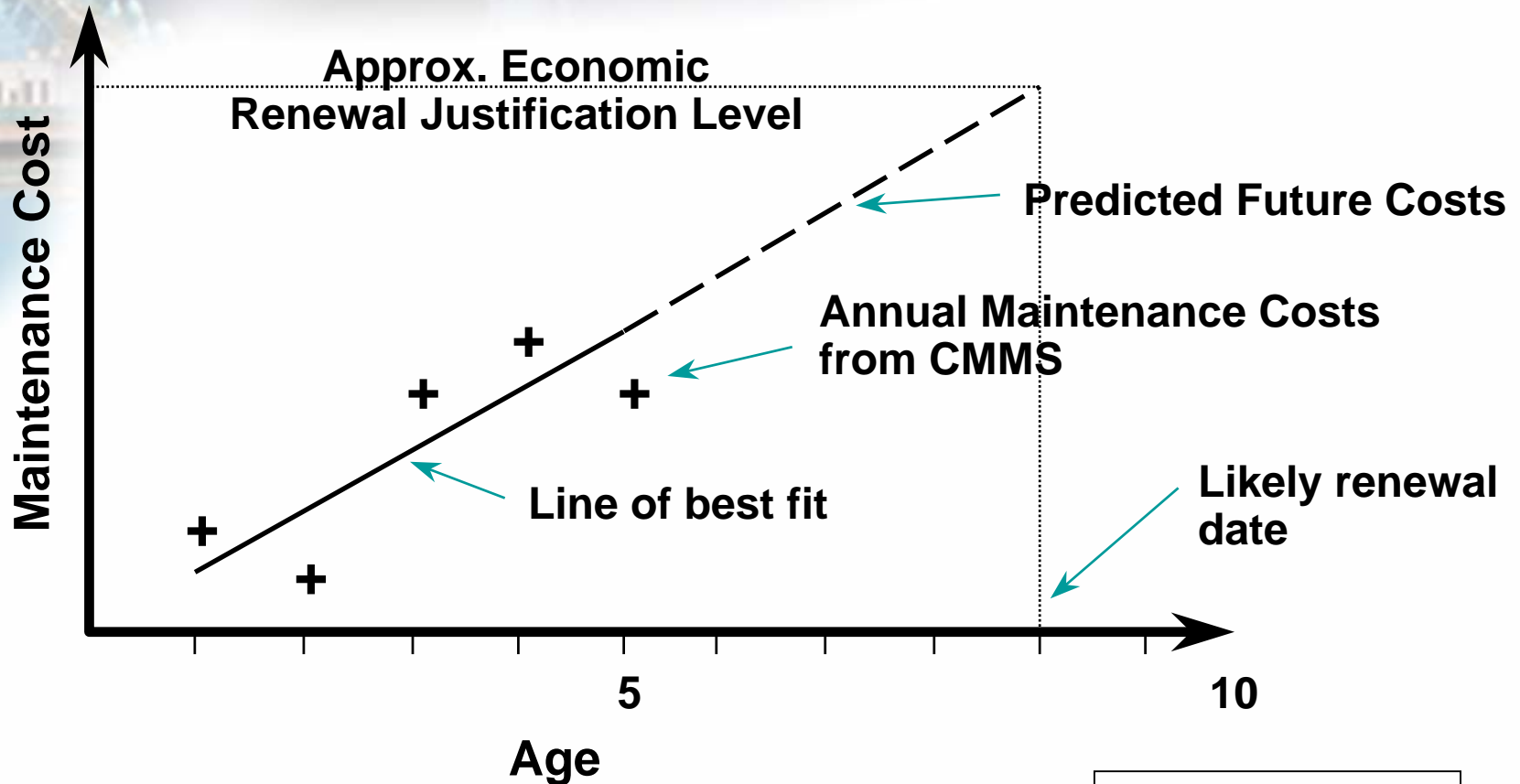
NECESSARY FOR **CAUSAL ANALYSIS**

INDIRECT COSTS ON BUSINESS IMPACT ON CUSTOMERS **EFFECTS ANALYSIS**

CAUSE OF COST OVERRUNS OR **POTENTIAL COST REDUCTIONS**

DATA FEEDBACK ALLOWS SIGNIFICANT ANALYSIS

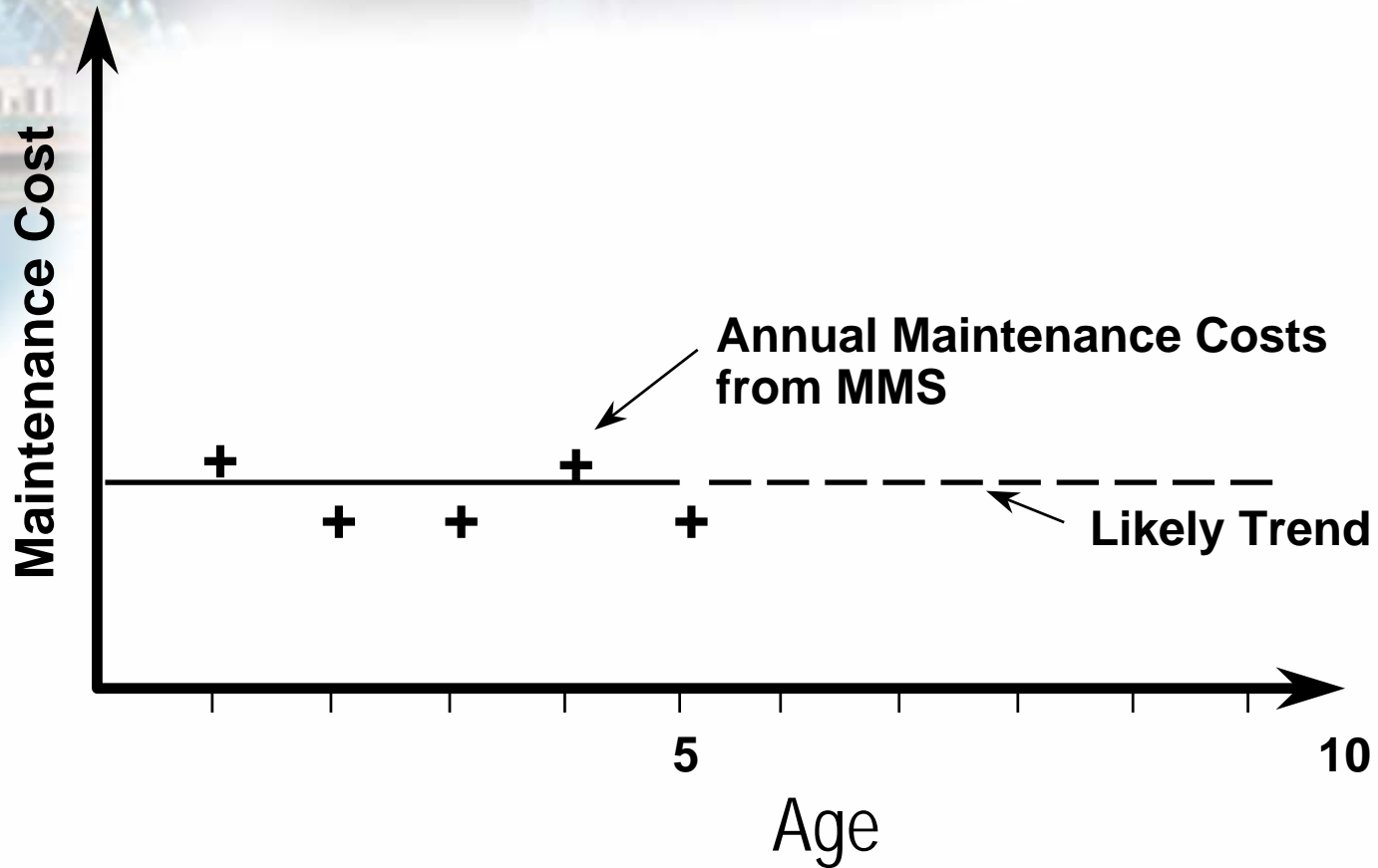
Predicting Maintenance Costs



**Increasing Costs Scenario
(Bath tub tail curve)**

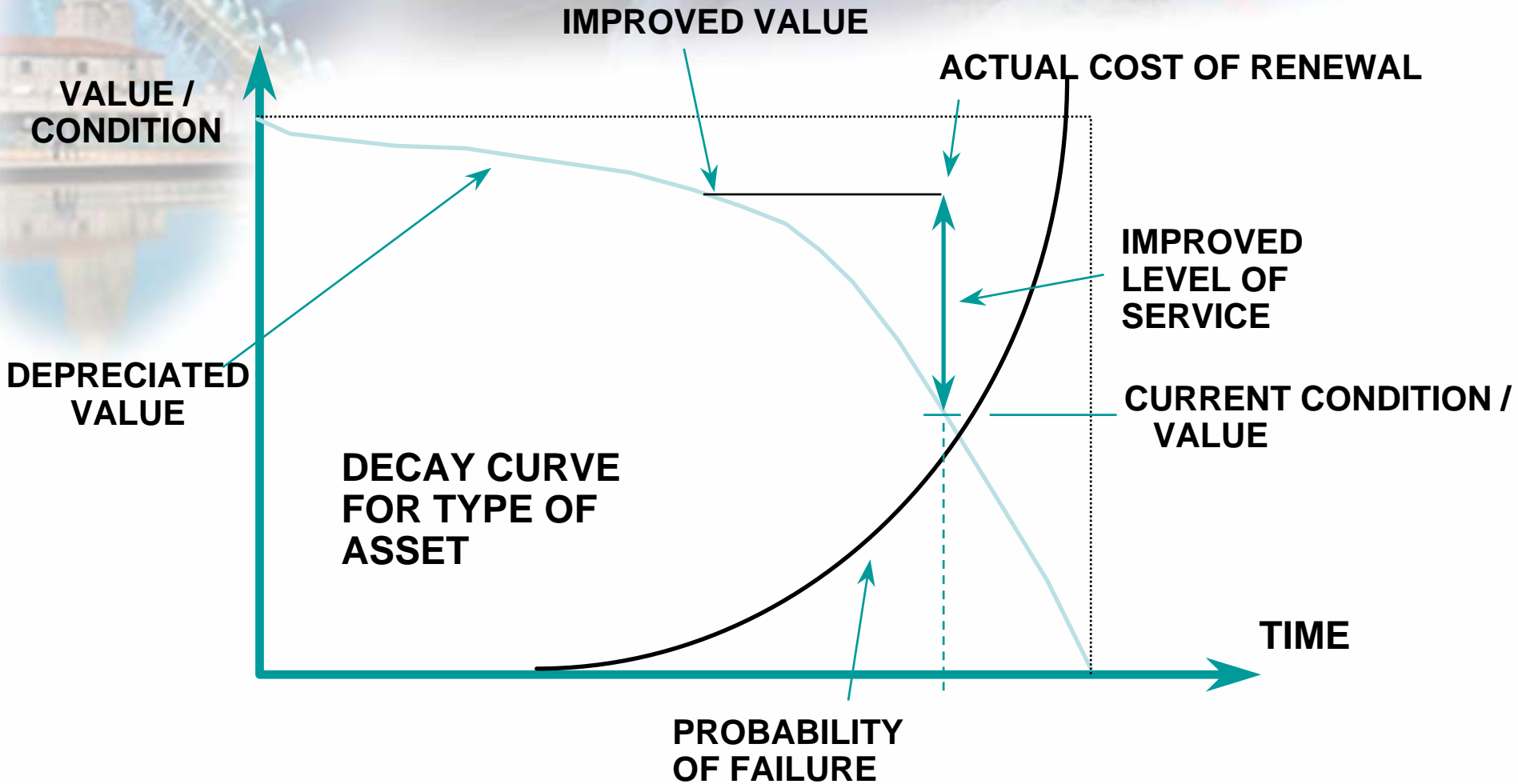
CMMS – Computer-based Maintenance Management System

Predicting Maintenance Costs



**Stable Maintenance Scenario
(Bottom of bath tub curve)**

Linking Condition & Probability Of Failure

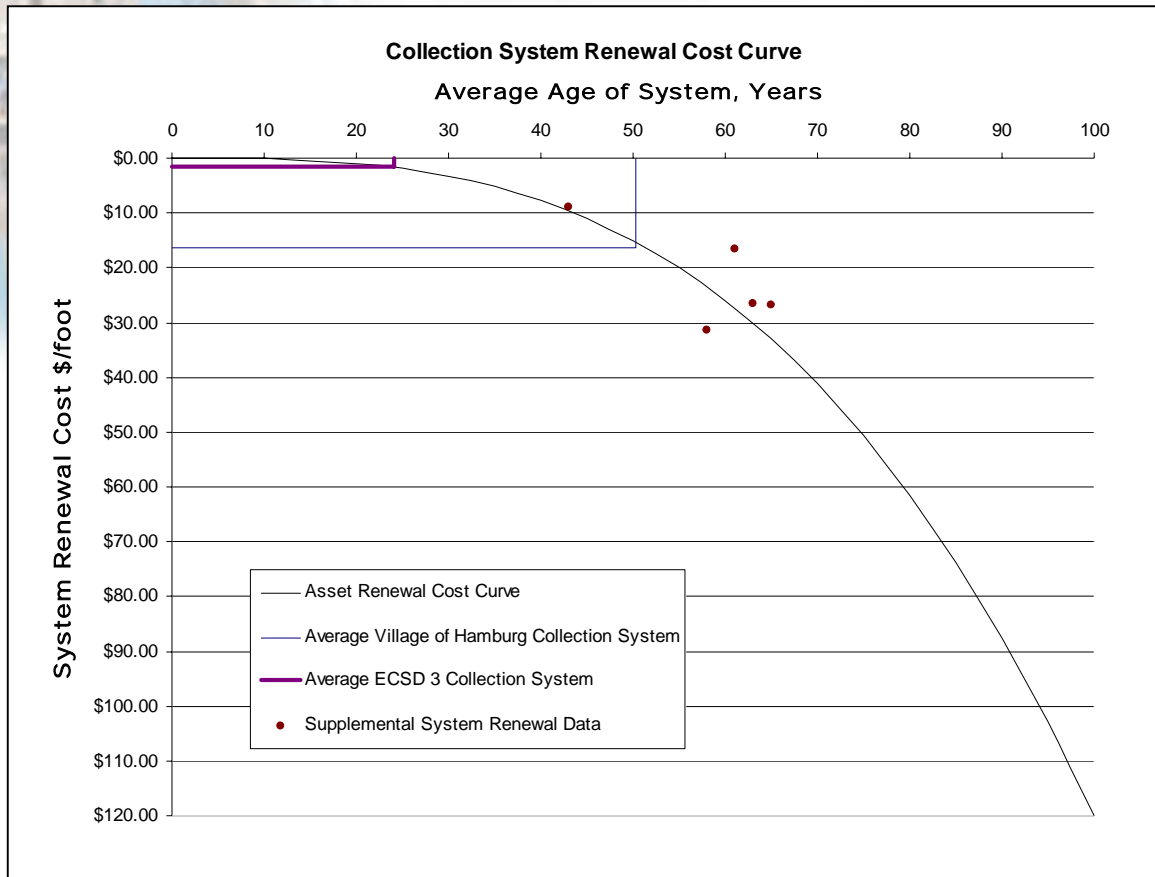


Linking Condition & Probability Of Failure

<i>Effective Lives (Years)</i>		Condition Rating / Residual Life				
Asset Type	Effective Lives	1	2	3	4	5
Civil	75	75	60	45	30	15
Pressure Pipework	60	60	48	36	24	12
Sewers	100	100	80	60	40	20
Pumps	40	40	32	24	16	8
Motors	35	35	28	21	14	7
Electrical	30	30	24	18	12	6
Controls	25	25	20	15	10	5
Building Assets	60	60	48	36	24	12

As condition deteriorates, residual life falls (not necessarily linear)

Linking Condition, Age & Probability Of Failure



$$\text{Condition Decay} = (\text{LTD}/\text{EL})^N$$

Where:

LTD = Life to Date

EL = Effective Life

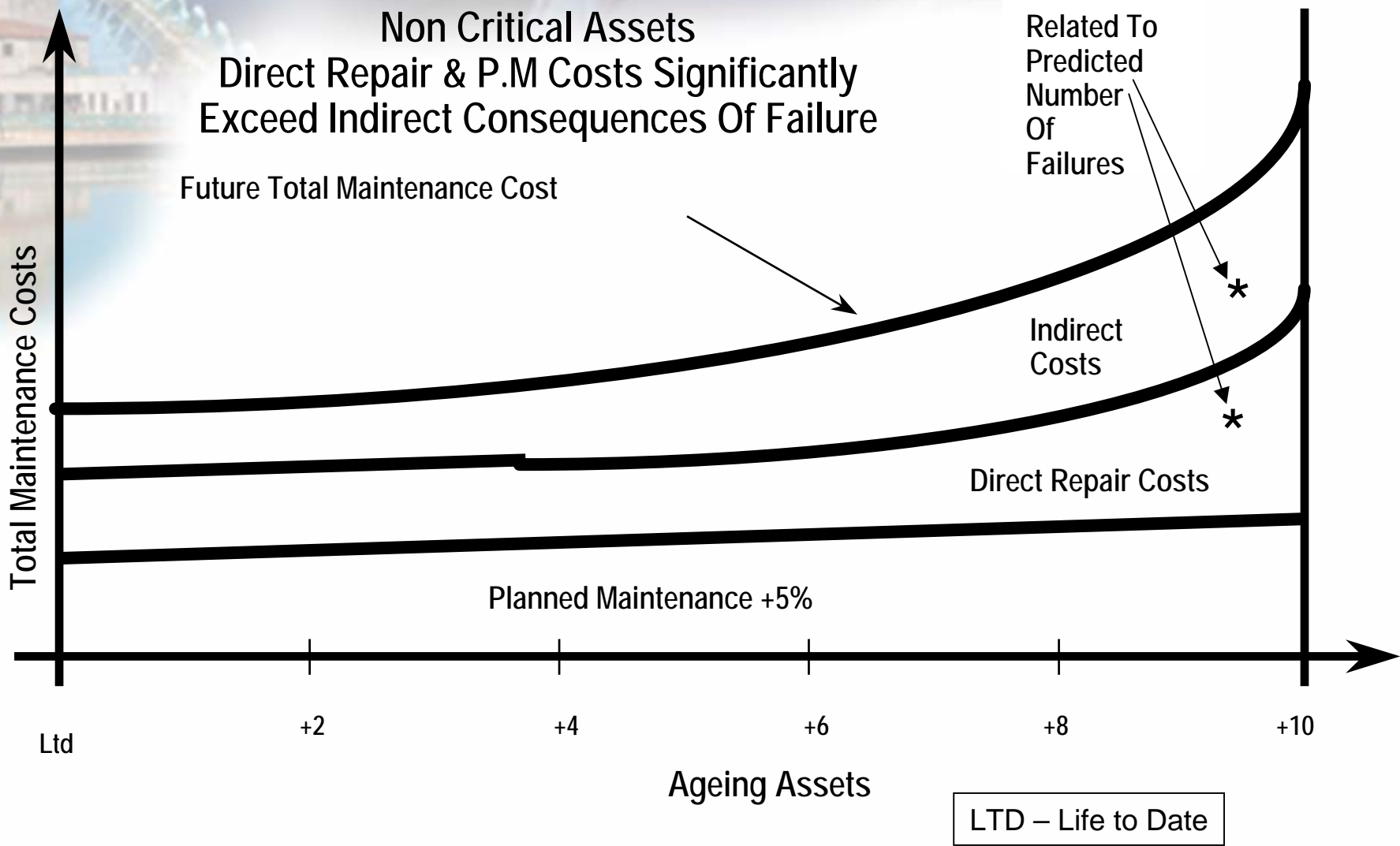
And N =:

Major linear assets = 4

Architectural passive assets = 3

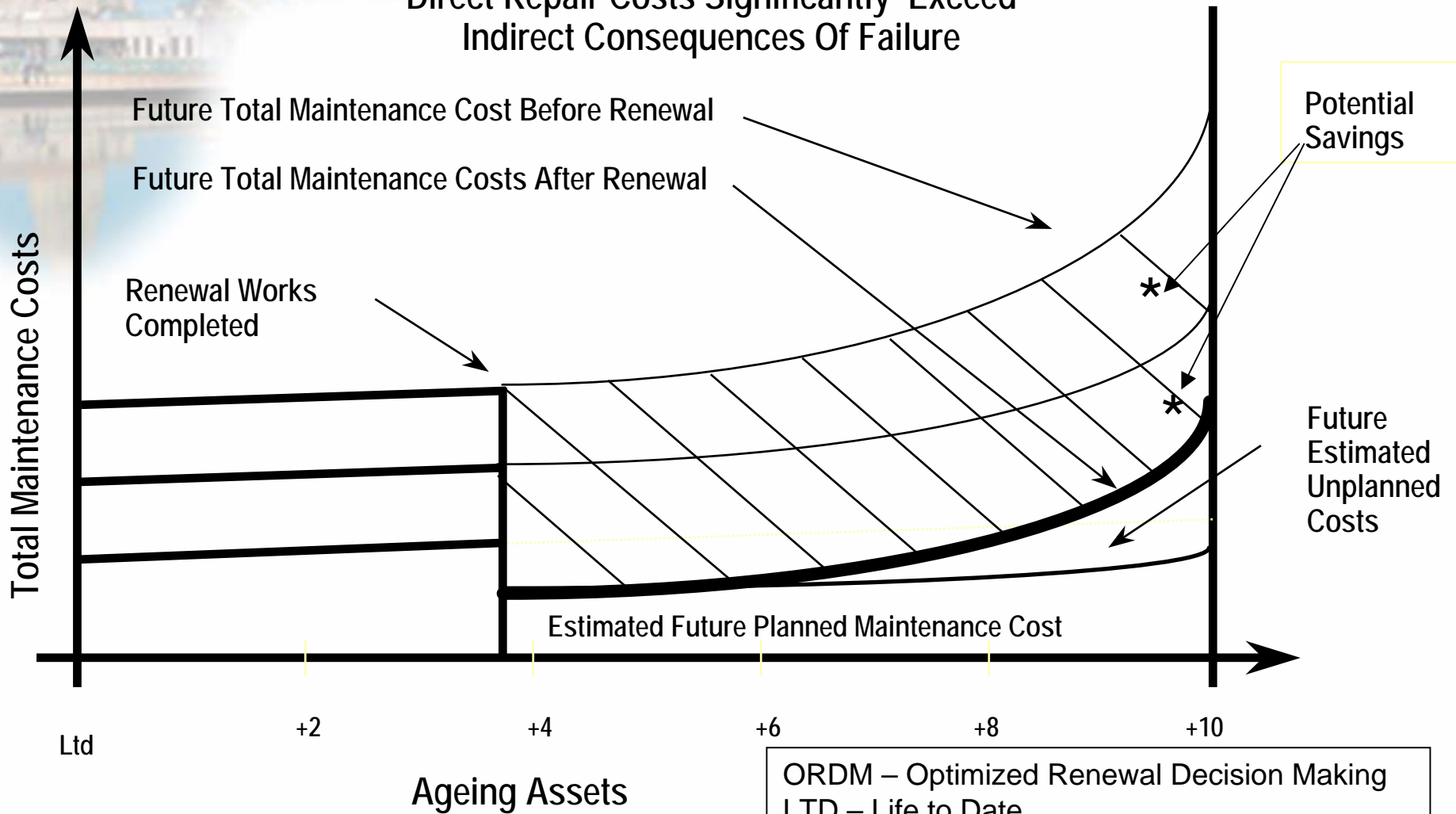
Mech/elec/dynamic assets = 4

ORDM - Future Costs

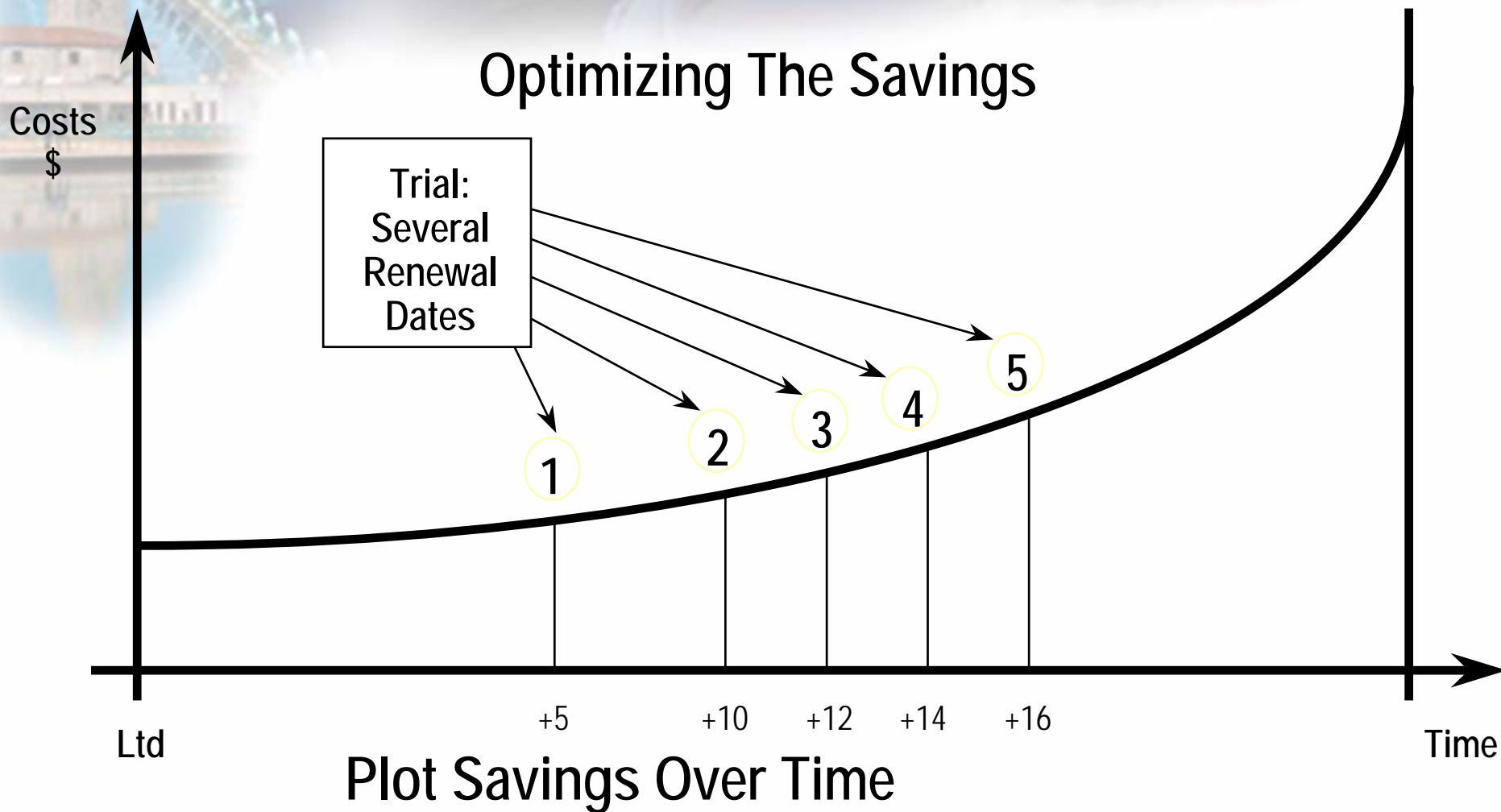


ORDM - Future Costs

Non-Critical Assets
Direct Repair Costs Significantly Exceed
Indirect Consequences Of Failure



ORDM - Timing The Renewal



ORDM – Optimized Renewal Decision Making
LTD – Life to Date

OCSD Hierarchy – Plant Assets

Microsoft Access - [frm_ASSETS : Form]

File Edit View Insert Format Records Tools Window Help

Select Asset Type

- 1 COLLECTION (Areas 50-59)
- 1 MISC (Non-Plant) (Area 90)
- 1 NOT USED - INTERPLANT (Areas 30-33)
- 1 NOT USED - MISC (P1/P2) (Area 39)
- 1 PLANT 1 (Areas 10-19)
- 1 PLANT 2 (Areas 20-29)
 - 2 20_PLANT #2 PRELIMINARY TREATMENT
 - 2 21_PLANT #2 PRIMARY TREATMENT
 - 2 22_PLANT #2 SECONDARY TREATMENT
 - 3 22A_GENERAL
 - 4 22A-NONE
 - 5 22A-201_EXHAUST FAN, JB-1 METER PIT
 - 5 22A-202_MODEM, POWER BLDG A PLC
 - 5 22A-203_POWER SUPPLY, 24VDC LOOP, POWER BLDG A
 - POWER SUPPLY
 - 6 22A2Y203_POWER-SUPPLY, 24VDC LOOP, PLC IN POWER BLDG A
 - 113010_POWER-SUPPLY, DC
 - 5 22A-204_POWER SUPPLY, FIBER OPTIC MODEM, POWER BLDG A
 - 5 22A-250_JB-1 GATE AND CONTROLS (OLD), SECONDARY TREATMENT
 - 5 22A-251_JB-1 GATE AND CONTROLS (NEW), SECONDARY TREATMENT
 - 5 22A-252_SAMPLER, JB-1 EFFLUENT JUNCTION BOX
 - 5 22A-260_JB-8 GATE AND CONTROLS, SECONDARY TREATMENT
 - 5 22A-262_SAMPLER, JB-4 JUNCTION BOX, SECONDARY TREATMENT
 - 5 22A-263_PH ANALYZER, JB-4, PRIMARY EFFL PS JUNCTION BOX
 - 3 22B_PRIMARY EFFLUENT PUMP STATION
 - 3 22C_EAST AERATION FACILITIES E-H
 - 3 22D_WEST AERATION FACILITIES A-D
 - 3 22E_MICRO-FILTRATION FACILITIES
 - 3 22F_EAST SECONDARY CLARIFIERS G-L
 - 3 22G_WEST SECONDARY CLARIFIERS A-F
 - 3 22I_SLUDGE THICKENER FACILITY
 - 2 23_PLANT #2 OXYGEN GENERATION FACILITY
 - 2 24_PLANT #2 EFFLUENT DISPOSAL
 - 2 25_PLANT #2 SOLIDS HANDLING
 - 2 26_PLANT #2 CENTRAL GENERATION
 - 2 27_PLANT #2 UTILITY UNITS
 - 2 28_PLANT #2 ELECTRICAL DISTRIBUTION
 - 2 29_PLANT #2 MISCELLANEOUS BUILDINGS & GROUNDS

ASSET DETAILS

Sub Type DFT

Unique ID 113010

Type PWR

POWER SUPPLY

Sub Type

LEVEL of SERVICE

Size 120

Size Unit VOLTS

Capacity

Cap. Unit

Performance

ASSET REHABILITATION

Last Rehab

Rehab Con

Eff Life 100%

Min Cost 100%

Diff Factor 1

ASSET REPLACEMENT

Install Date

Condition

Empty

Max Pot Life 50 years

Unit Rate \$1

Diff Factor 1

RISK

PoF

CoF

Form View

Asset Type Selection

Asset Type Selection

Select All Unselect All Apply Cancel

TYPE	TYPE DESCRIPTION	SUBTYPE	SUBTYPE DESCRIPTION	
<input checked="" type="checkbox"/>	AC	AIR CONDITIONING	DFT	DEFAULT SUB-TYPE
<input checked="" type="checkbox"/>	AHU	AIR HANDLER UNIT	DFT	DEFAULT SUB-TYPE
<input checked="" type="checkbox"/>	ALRM	ALARMS, AUDIO-VISUAL AND SOFTWARE	DFT	DEFAULT SUB-TYPE
<input checked="" type="checkbox"/>	ANA	ANALYZER	DFT	DEFAULT SUB-TYPE
<input checked="" type="checkbox"/>	APR	ASPIRATOR	DFT	DEFAULT SUB-TYPE
<input checked="" type="checkbox"/>	ATMZ	ATOMIZER	DFT	DEFAULT SUB-TYPE
<input checked="" type="checkbox"/>	BAT	BATTERIES	DFT	DEFAULT SUB-TYPE
<input checked="" type="checkbox"/>	BIC	BICYCLE	DFT	DEFAULT SUB-TYPE
<input checked="" type="checkbox"/>	BKR	BREAKER	DFT	DEFAULT SUB-TYPE
<input checked="" type="checkbox"/>	BLR	BOILER	DFT	DEFAULT SUB-TYPE
<input checked="" type="checkbox"/>	BLTP	BELTPRESS	DFT	DEFAULT SUB-TYPE
<input checked="" type="checkbox"/>	BLWR	BLOWER	DFT	DEFAULT SUB-TYPE
<input checked="" type="checkbox"/>	BRSC	BARSCREEN	DFT	DEFAULT SUB-TYPE
<input checked="" type="checkbox"/>	CAL	CALIBRATOR	DFT	DEFAULT SUB-TYPE
<input checked="" type="checkbox"/>	CAP	CAPACITORS	DFT	DEFAULT SUB-TYPE
<input checked="" type="checkbox"/>	CAR	CARS	DFT	DEFAULT SUB-TYPE
<input checked="" type="checkbox"/>	CART	CART,ELECTRIC	DFT	DEFAULT SUB-TYPE
<input checked="" type="checkbox"/>	CEN	CENTRIFUGE	DFT	DEFAULT SUB-TYPE
<input checked="" type="checkbox"/>	CFR	CLASSIFIER	DFT	DEFAULT SUB-TYPE
<input checked="" type="checkbox"/>	CHIL	CHILLER	DFT	DEFAULT SUB-TYPE
<input checked="" type="checkbox"/>	CHR	CHARGER, BATTERY	DFT	DEFAULT SUB-TYPE
<input checked="" type="checkbox"/>	CLEAN	CLEANER ULTRASONIC	DFT	DEFAULT SUB-TYPE
<input checked="" type="checkbox"/>	CLR	COLLECTOR, CLARIFIER SWEEP UNIT	DFT	DEFAULT SUB-TYPE
<input checked="" type="checkbox"/>	CMP	COMPRESSOR	DFT	DEFAULT SUB-TYPE
<input checked="" type="checkbox"/>	CND	CONDENSER	DFT	DEFAULT SUB-TYPE
<input checked="" type="checkbox"/>	CNVR	CONVEYOR	DFT	DEFAULT SUB-TYPE
<input checked="" type="checkbox"/>	COMP	COMPUTER EQUIPMENT	DFT	DEFAULT SUB-TYPE
<input checked="" type="checkbox"/>	CON	CONTROLLER	DFT	DEFAULT SUB-TYPE
<input checked="" type="checkbox"/>	CRN	CRANES	DFT	DEFAULT SUB-TYPE
<input checked="" type="checkbox"/>	CTW	COOLING TOWER (AC)	DFT	DEFAULT SUB-TYPE
<input checked="" type="checkbox"/>	CTB	CLUB (12KV CONTROLS OR NO BREAKER INSTA	DFT	DEFAULT SUB-TYPE

Asset Type Model

Microsoft Access - [Asset Types]

File Edit View Insert Format Records Tools Window Help

ASSET TYPE ATTRIBUTES



TYPE: PREVIOUS | WLV | NEXT

Type Description: VALVE

No. of Sub-Types: 2 of 4

Sub-Type: PREVIOUS | LGE | NEXT

Sub-Type Description: Large Valve

CLOSE RESET

RESET ALL

REPLACEMENT

Value by Size:

Default Size:

Size Unit Code: INCH

Use Size Limit:

Size Limit Upper: 200

Size Limit Lower: 50

Use Length:

Use Depth:

Depth Min: 0

Depth Factor: 0

Max Potential Life: 60

Unit Cost: \$150.00 per INCH

Difficulty Factor: 2

Condition Curve: Decay (non-linear)

Condition Curve Factor: 1.5

MAINTENANCE

Include Main Costs?

Average Main Cost: 3.00%

Main Curve: Increase (non-linear)

Main Curve Factor: 2

REHABILITATION

Rehabilitate?

Effective Life %: 30%

Min Rehab Cost %: 30%

Difficulty Factor: 3.00

Cost Curve: Exp with Con

Cost Curve Factor: 1.50

Condition Curve: Decay (non-linear)

Condition Curve Factor: 1.50

OPERATIONS

Include Op Costs?

Average Op %: 1.00%

Op Curve: Increase (non-linear)

Op Curve Factor: 1.5

RISK and INTERVENTION

PoF Curve: Exp with Con

PoF Curve Factor: 1

Minimum PoF: 0.1

Maximum Risk: 95

Minimum Condition: 1

Asset Renewal Decision Model

