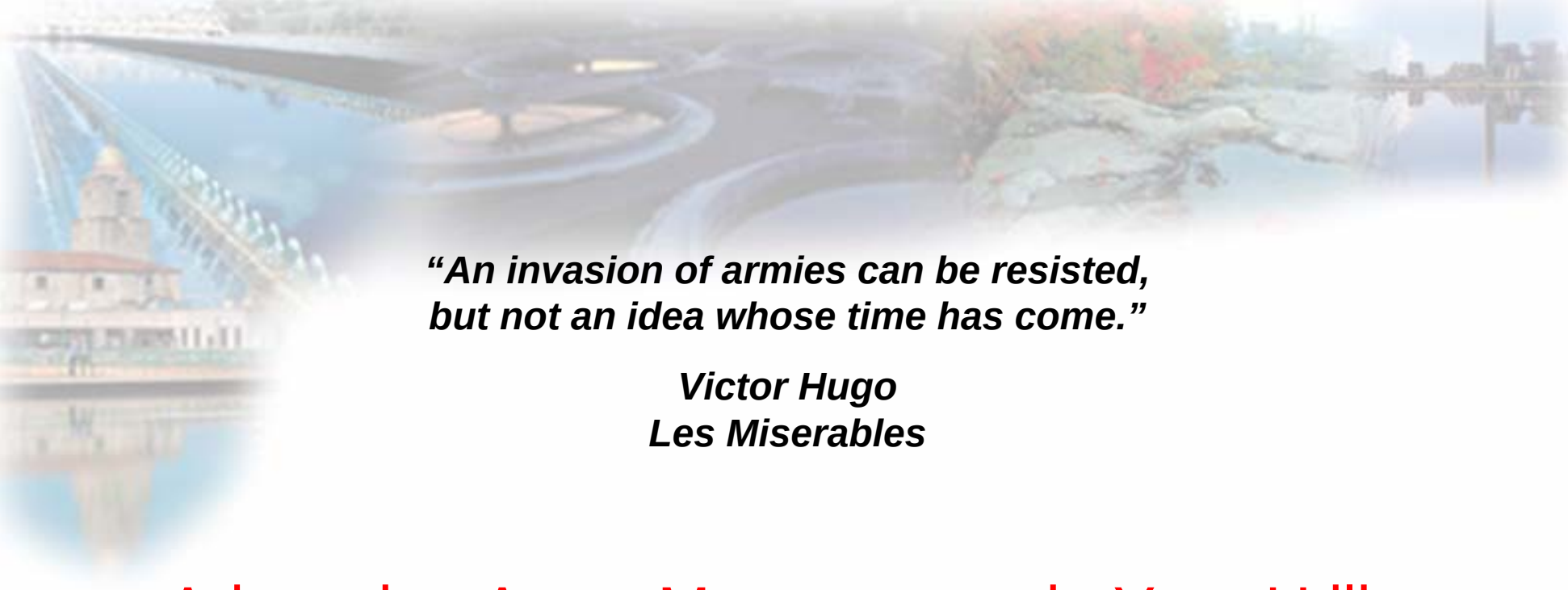

"An invasion of armies can be resisted,
but not an idea whose time has come."

Victor Hugo
Les Miserables

Advancing Asset Management in Your Utility: A "Hands-on" Approach

Our Hosts & Sponsors

- USEPA – Office of Wastewater Management
- New Jersey Water Environment Association (NJWEA)

Context of Workshop

- US utilities face major challenges to renew an aging infrastructure while simultaneously addressing growth and security needs.
- New revenues – federal or local – will be increasingly difficult to come by.
- A large part of meeting the challenge must come from better techniques for managing our assets.
- New concepts, new techniques and new technologies have been aggressively deployed in our private sector and in other countries.
- These techniques - this emerging paradigm - can change the way we manage our utilities. But how to proceed?

Focus of Workshop

This workshop examines:

- What is (advanced) asset management?
- Why should we be interested?
- What are the core practices?
- How are they applied? What do they “feel” like?
- How to deploy?

*Our focus is on the **management** of assets*

AGENDA

Day 1

- *Welcome, Introductions & Housekeeping Details*
- *Background And Context*
- *Overview Of Fundamental Concepts & Core Practices*
- *The "Storyline": Tom's Really Bad Day*
- *Core Question 1: What Is The Current State Of My Assets?*
- *Core Question 2: What Is My Required "Sustainable" Level Of Service?*
- *Core Question 3: Which Assets Are Critical To Sustained Performance?*
- *Core Question 4: What Are My Minimum "Life-cycle-cost" CIP and O&M Strategies?*
- *Discussion/Q & A; Review of Self-audit*

Day 2

- ***Summary of Day 1; Outline of Day 2***
- ***Core Question 4: Continuation of Day 1***
- ***Core Question 5: Given The Above, What Is My Best Long-term Funding Strategy?***
- ***Case Study 1: Deploying An AAM Program***
- ***Case Study 2: Meeting The IT Challenge – Toward An Enterprise Asset Management System (EAMS)***
- ***Summary, Addressing Your Questions, Comments, Self-audit***

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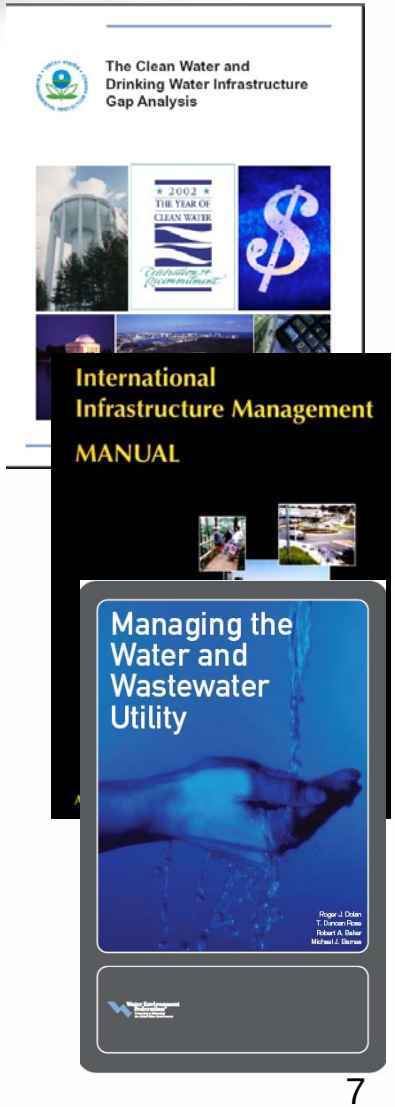
- *Core Question 4: What Are My Best Minimum Life-cycle-cost CIP and O&M Strategies?*
- *Discussion; Q&A*

Our Presenters

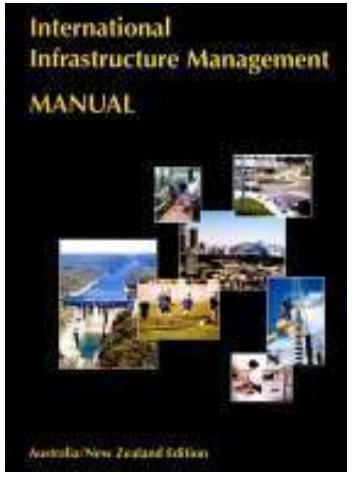
Mr. Steve Allbee - *USEPA Project Director, Gap Analysis; primary author, USEPA's The Clean Water and Drinking Water Infrastructure Gap Analysis; 25 years EPA - development of financing programs; BA, MA, MPA.*

Mr. Don Vincent – *Principal Consultant, Service Line Leader – Asset Management, GHD Melbourne, Aus; 25 years infrastructure management experience; former Engineering and Operations Manager for water and sewerage authorities; BCE; NPER3*

Mr. Duncan Rose - *Technical Director, PAMC; Former city/county manager; co-author of WEF's Managing the Water/Wastewater Utility; 30 years state & local management; Adjunct Faculty, Florida State University, Askew School of Public Policy and Administration; BA, MSP, MAPA.*



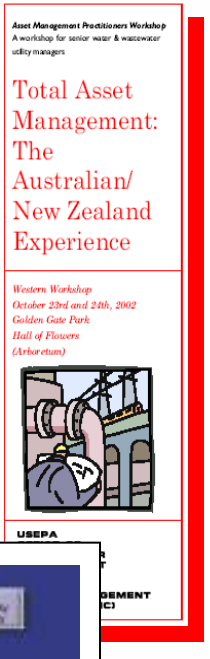
Content Developers:
Parsons/GHD Asset Management Center



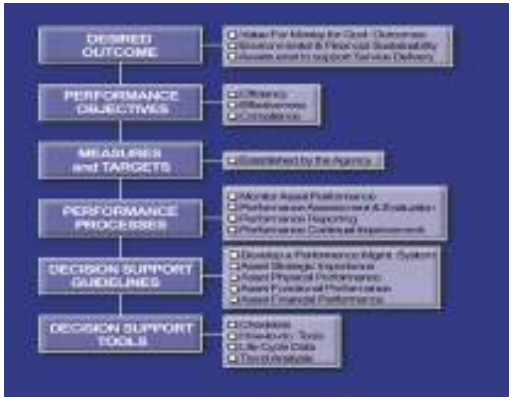
World's Best Practices

Providing *value added advanced asset management services* to the wastewater industry through:

- Identifying, evaluating and cataloging AAM "Best Practices"
- Development and refinement of Best Practice applications, tools and techniques
- Knowledge transfer
  - AM University
  - Seminars, workshops, training sessions, "brown-bag" lunches
  - Side-by-side coaching and Mentoring
  - Knowledge management systems
- Consulting services




"Side-by-side" Mentoring



Knowledge Management

AGENDA

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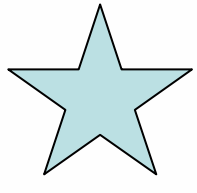

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Storyline:

Tom's Very Bad Day –
A Step-By-Step Approach To Applying Advanced Asset Management To A Utility Environment

Prologue

It's twilight. Night is coming on fast. A light rain is falling; the temperature is in the 40's. Tom is standing in the mud in an over-grown field looking at his Jones Street lift station. Raw sewage is flowing out of the pump station and across the street. An old pick-up truck has slid in the flowing sewage, swerved off the road and has hit the power pole up at the corner. The power is out. The police have been called and are starting to direct traffic. Tom is expecting a reporter to show up at any moment with a camera crew. Small electric generators are adding their whine to the din as temporary lighting is being hooked up.

His emergency response crews are standing about with glum faces. The crew is waiting for an electrician who knows how to connect a large generator up to the pump station's motor control center. The generator has not yet arrived. While they wait, they would like to connect their small gas powered pumps up to the force main to divert the sewage from the storm drain, but the piping connections can not be found and the right fittings are not in inventory back at the warehouse. June, the Field Super, calls Red, the local plumbing supply store owner, and asks the owner to open his store to furnish the fittings.

Meanwhile the size of the violation builds as the sewage flows into the storm drain and from there into the river. Tom winces as he notes to himself that the river is the sole water supply for Anders, a small downstream community. To make matters worse, Tom just got a radio call advising him that AgriCrop, an up-stream local industry – the major employer in the area – has just reported wastewater backups.

This, unfortunately, is the fourth major failure of a pump station in 18 months. Each of the other three failures resulted from equipment failures – an electrical problem in a control panel in one case, and a variable speed drive failure in another. The third failure resulted from the rupture of a section of the force main from a 50 year old pump station. Each of these failures resulted in significant wastewater spills into storm drains that connect to the river. Two also caused wastewater backups into businesses and homes – both of which made the six o'clock news!

Tom has been a City employee for 16 years. He joined the City as a Supervisor, was promoted to Plant Manager after 5 years, and has been the

Storyline

Bottom Line: Emergent Industry Profile

- Increasing aggregate demand – water and wastewater
- Diminishing available water resources
- Leveling of “production efficiencies”
- Increasing output restrictions
- Aging infrastructure

➢ ***Result: Increasingly expensive treatment options***

- Aging customer base – more and more on fixed income
- Diminishing technical labor pool running larger and more sophisticated plants and facilities
- Outflow of knowledge with retiring labor base
- Increasing resistance to rate increases

↘ ***Result: Increasingly complex management environment***

The Changing Business Environment

- Demands to do more with what we have got.
- Need to better focus our capital & recurrent budgets
- Move from reactive based activities to a greater planned and predictive work environment.
- Transitioning from being really good at building assets to being really good at extending asset life and achieving acceptable reliability.
- Optimizing maintenance, non-asset solutions
- Developing accurate long term funding models

The Consequences of Asset Failures Can Be Severe

All Assets Deteriorate and Eventually Fail…

. . . Unless they are properly maintained and renewed or replaced

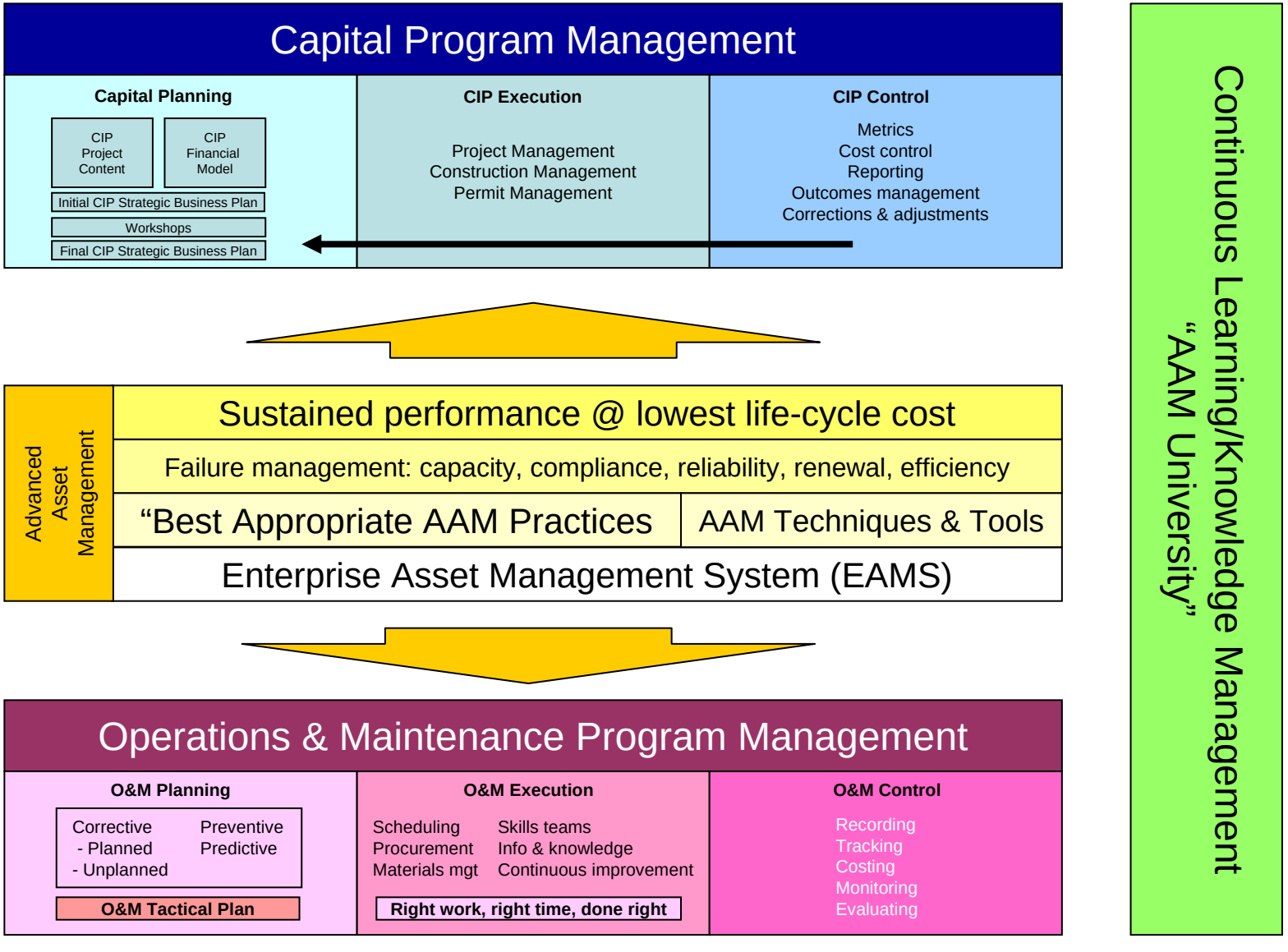
Sediment build-up increasingly restricts flow

Cleaning & relining adds 50 years life

Advanced Asset Management helps make…

better acquisition, operations, maintenance, and renewal and replacement DECISIONS

Parsons/GHD AAM Model



The AAM "Paradigm"

- **The capacity to produce output of value to a customer is directly related to *sustained performance of the system of capital assets*.**
- ***Failures* in the asset base directly affect system performance.**
- ***Sustained system performance is the result of successfully managing failure within the asset base.***
- **The management of failure in the asset base is highly *constrained by cost*; that is, customers are not typically willing to pay for zero likelihood of failure.**
- ***Different assets have different likelihood of failure* as determined largely by materials used, operating environment, usage and maintenance.**
- ***Failures vary substantially in consequence to the organization*, that is, in terms of the production of valued output to the customer.**
- **Investment in capital (acquisition, operation, maintenance and renewal), then, should be directed by the *likelihood of failure and its consequence* to the customer and regulator.**

The Nine Fundamental "Building Blocks" of AAM

1. Definition
2. The asset life-cycle
3. How assets fail
4. Risk-consequence
5. Cost/valuation
6. Asset demand
7. Level of service
8. Business risk
9. Confidence in decision-making

Our Definition of AAM

Advanced Asset Management ("AAM") is

- **a management paradigm and a body of m… practices**
- **that is applied to the entire p… infrastructure assets and at all levels o… nization**
- **that seeks to mini… total cost of acquiring, operating, m… and renewing the assets**
- **with… onment of limited resources**

… ntinuously delivering the service levels …stomers desire and regulators require.

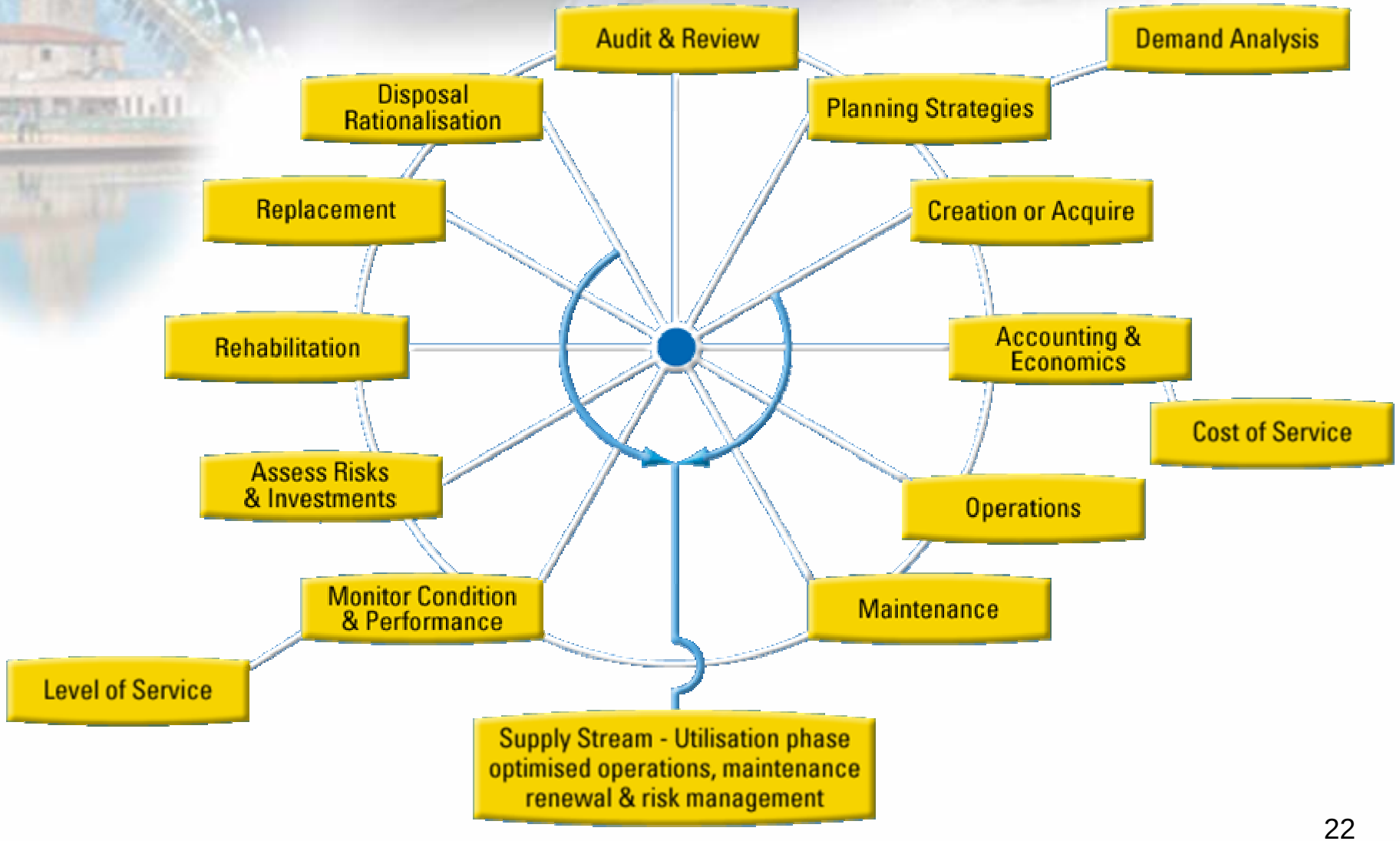
Lowest-cost sustainable performance

These Workshops Focus on Three Fundamental Management Decisions:

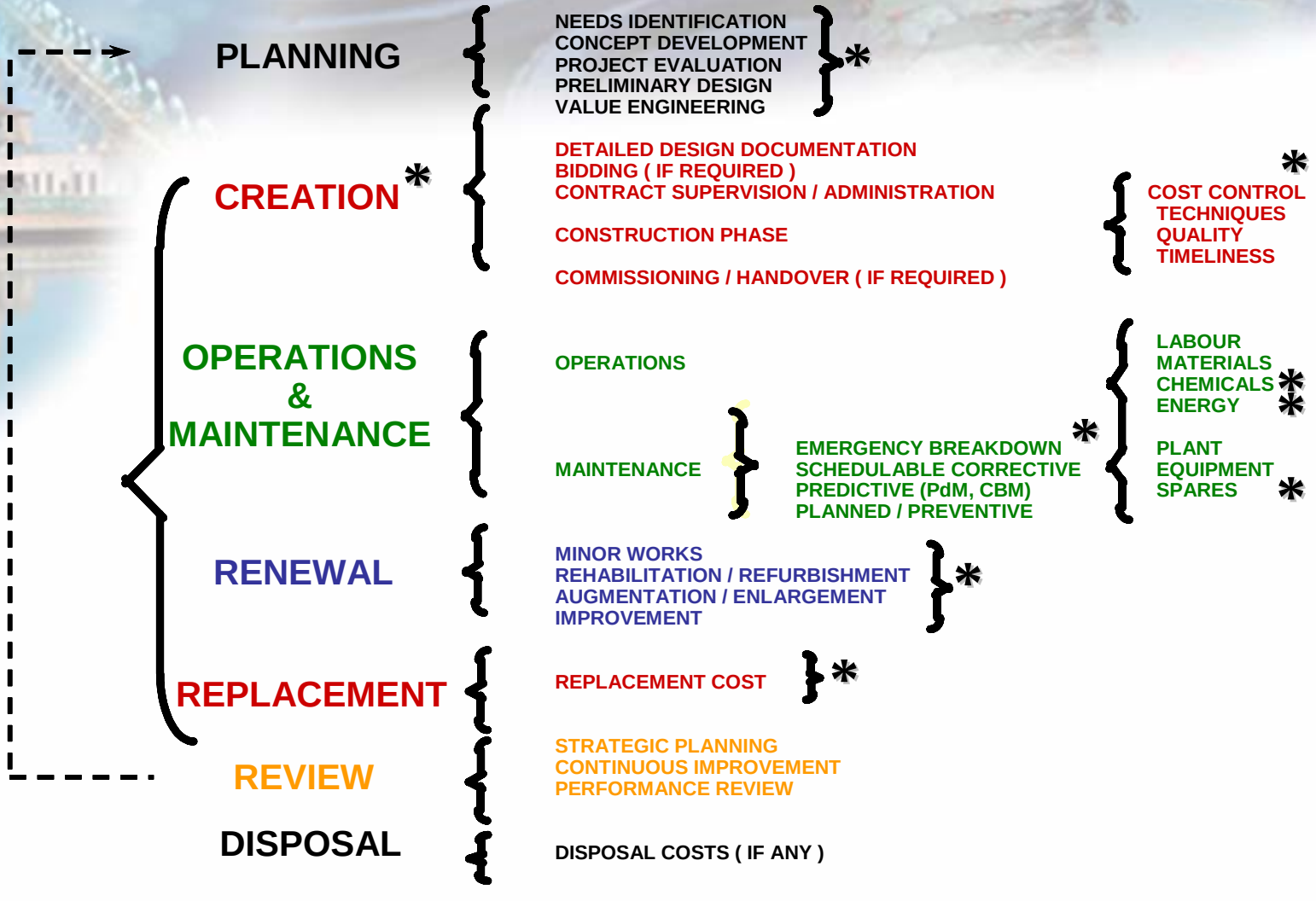
- What are my work crews doing and where are they doing it?
- What CIP projects should be done and when?
- When to repair, when to renew and when to replace?

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

Life Cycle AM Quality Processes

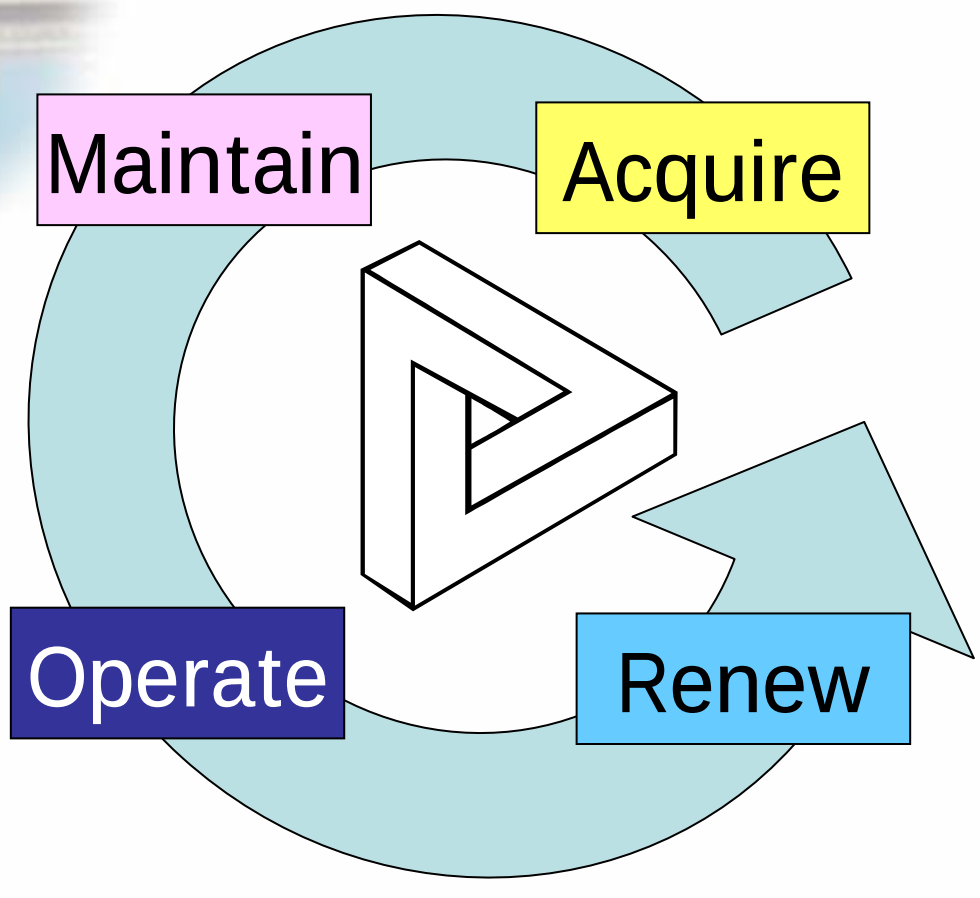


Life Cycle Cost Reduction Targets



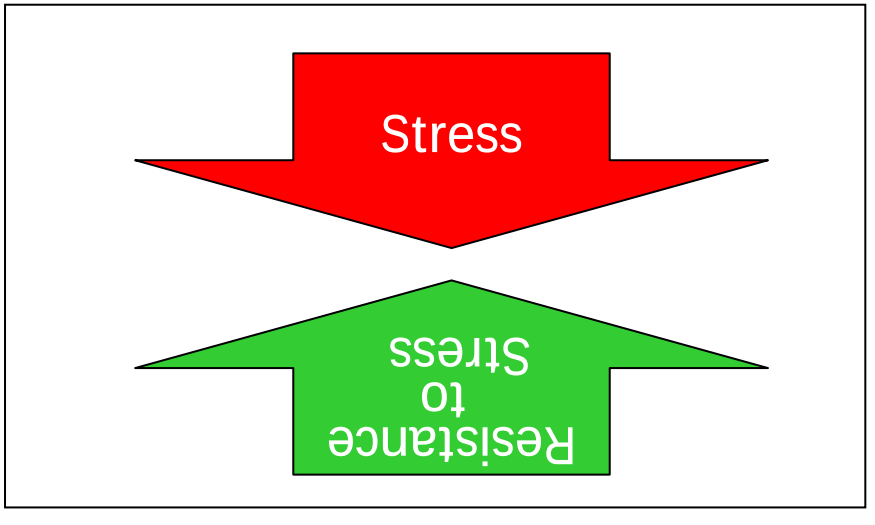
* **AREAS OF GREATEST POTENTIAL SAVINGS**
(May warrant spending more on operations but reducing capital outlay)

Total Cost of Ownership
- “A Dollar Spent is A Dollar Spent”



Key to Sustainability – Understanding How Our Assets Fail

The yin-yang of asset failure



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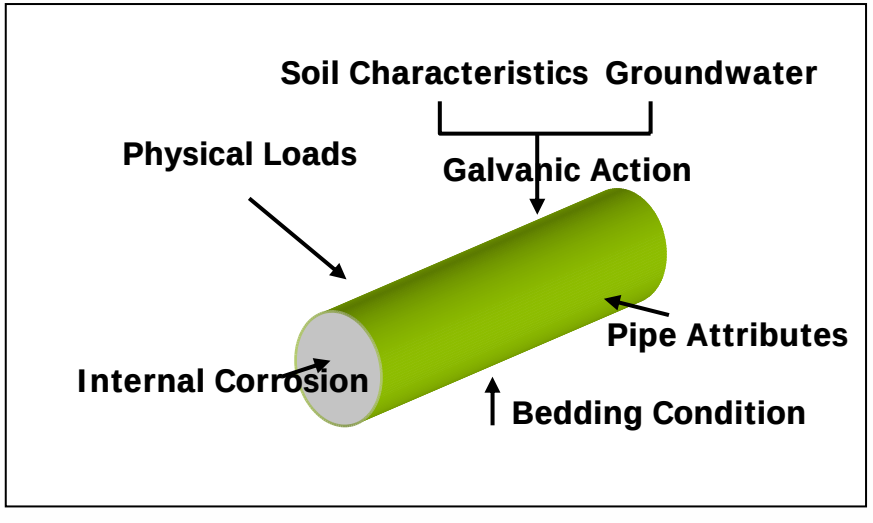

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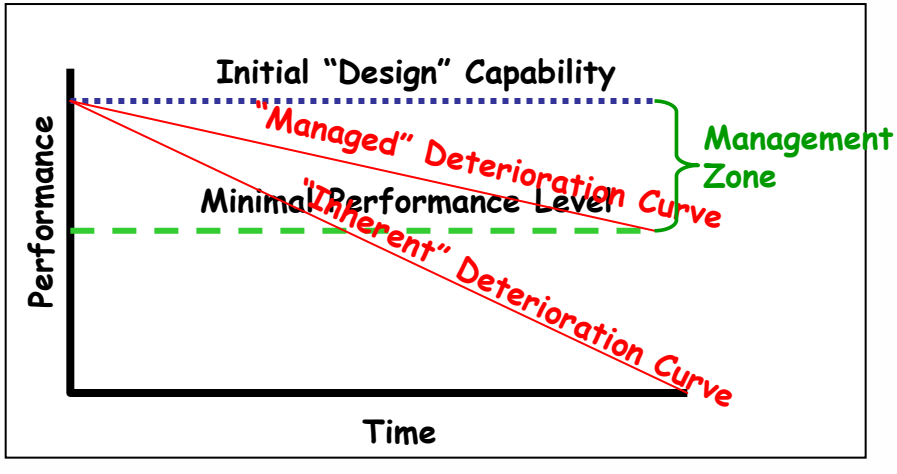
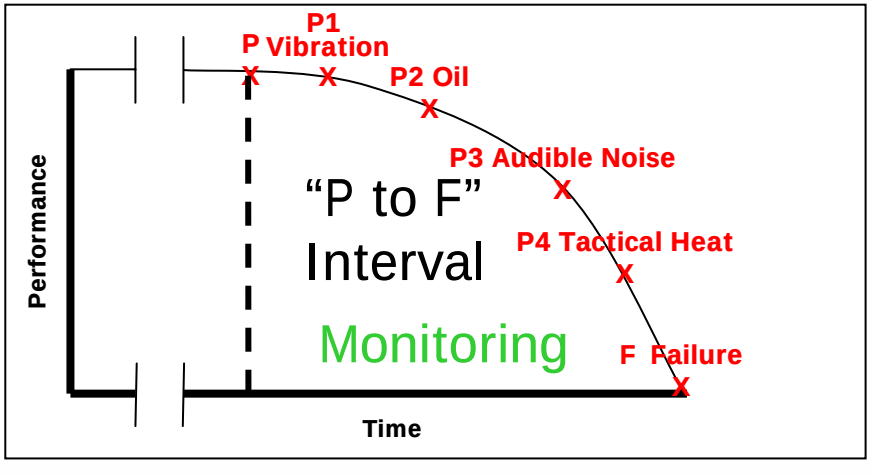


"Failure is defined as the inability of any asset to do what its users want it to do."

John Moubray

Key to Sustainability – Understanding How Our Assets Fail

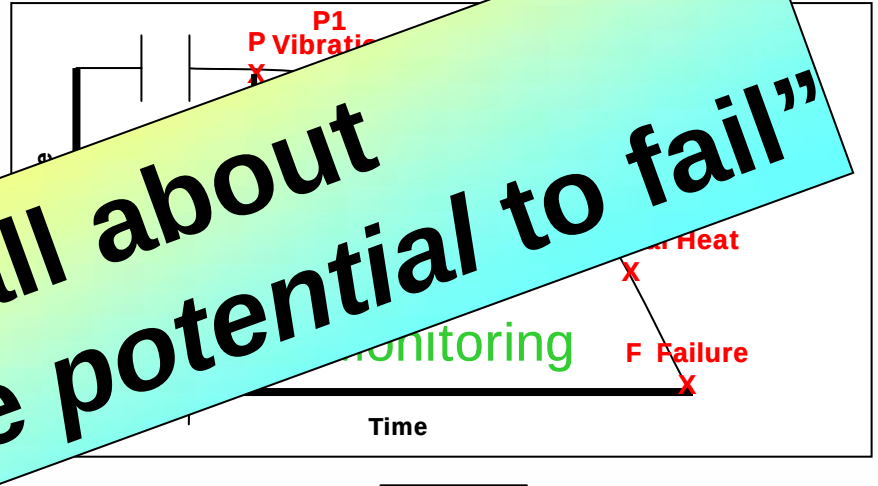
The yin-yang of asset failure



Key to Sustainability – Understanding How Our Assets Fail

Findings:

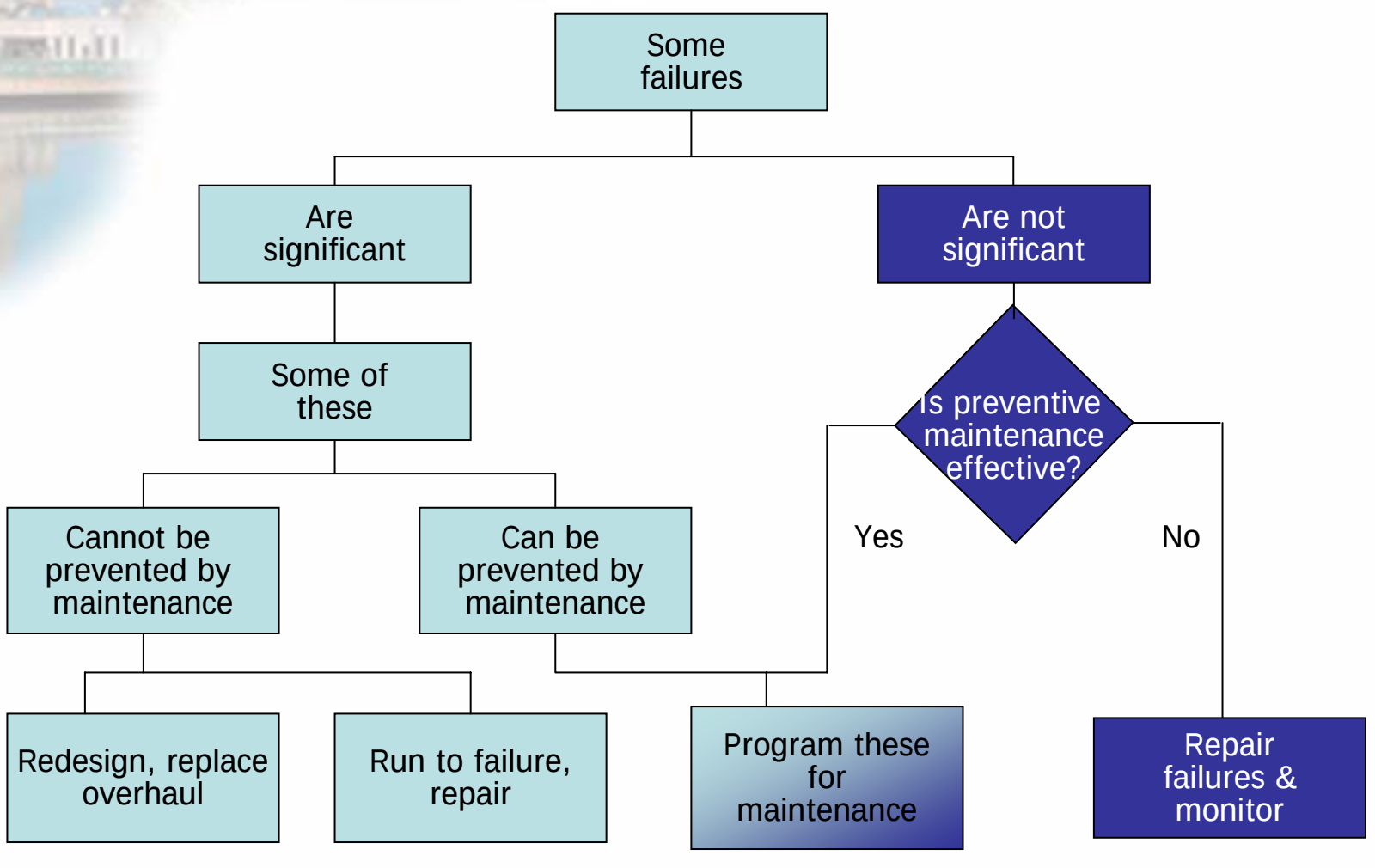
- Only a moderate relationship between *preventive* maintena… an… …e is …*irected!*



AM is all about "managing the potential to fail"

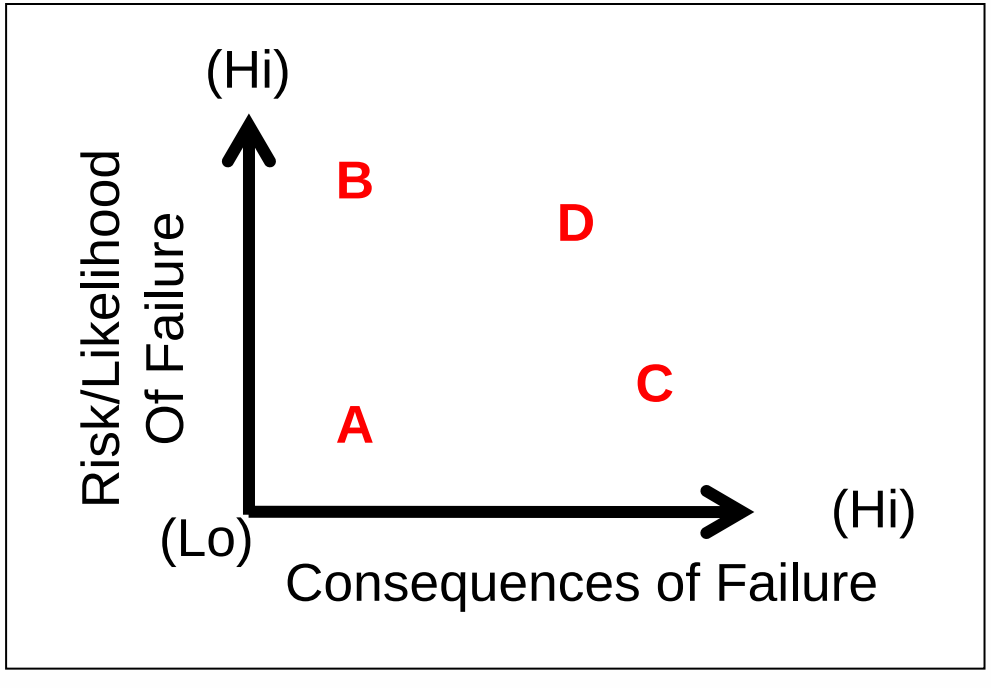
"Failure Mode" Analysis, Condition-based Monitoring, Predictive Maintenance & "Reliability Centered Maintenance"

Failure-mode Based Management Logic

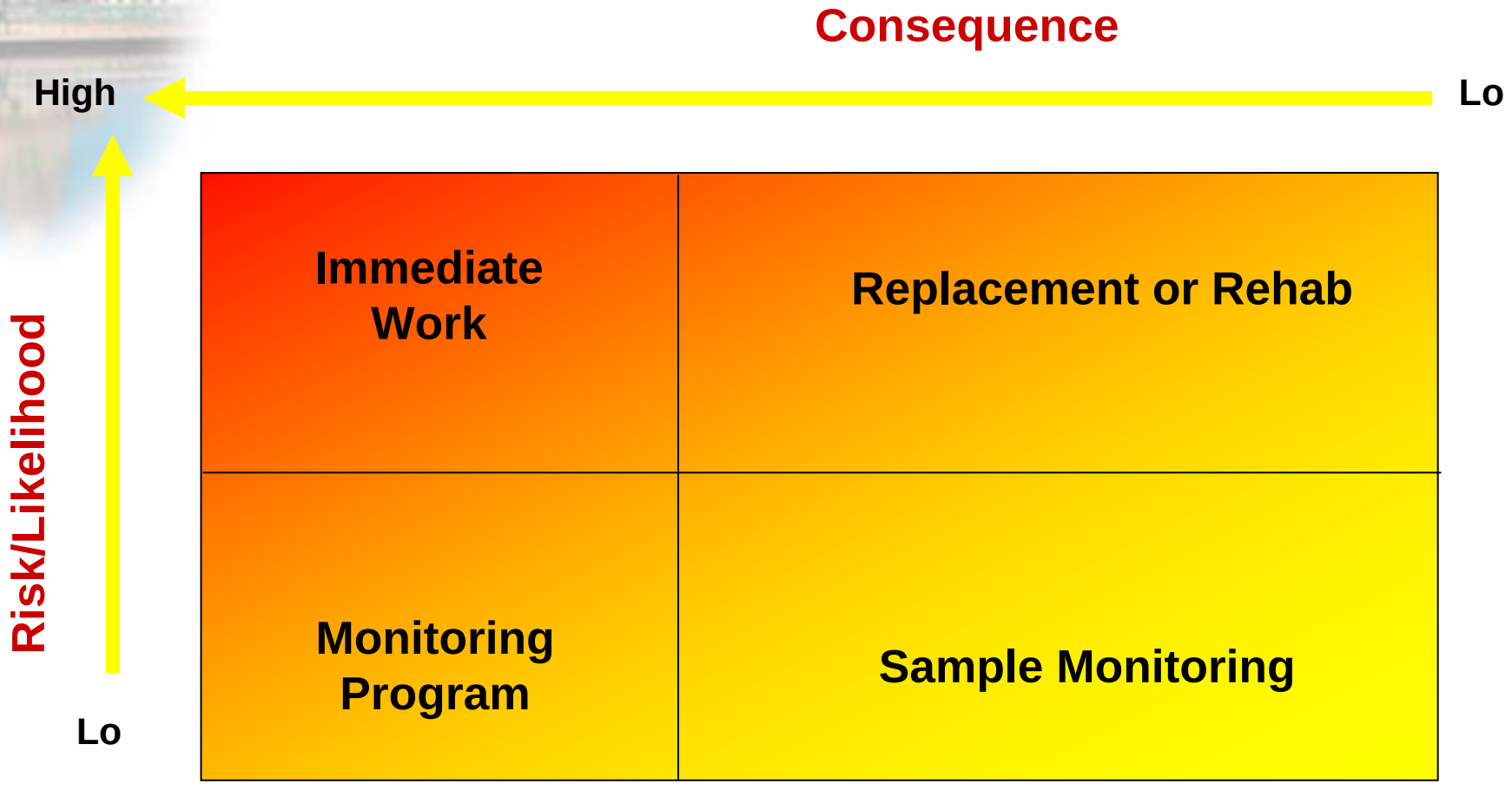


Determining "Significant" Failures: The Risk – Consequence Trade-off

- What is the likelihood of failure ? (risk)
- What is the cost of failure? (consequence)



Failure Risk/Consequence Drives Work Program



The AAM Toolbag – What It All Boils Down To

- Defined asset performance targets tied to service level
- Risk/consequence analysis
  - "Failure mode" or "root cause" anal
  - Effects analysis
  - Consequenc
- Action -making
- Li ling (decay curves)
- Life cycle costing (cost curves)
- Business risk evaluation
- Optimal renewal decision-making
- Renewal annuity funding

"Making a business case"

Strategic vs Tactical Levels

Strategic Level

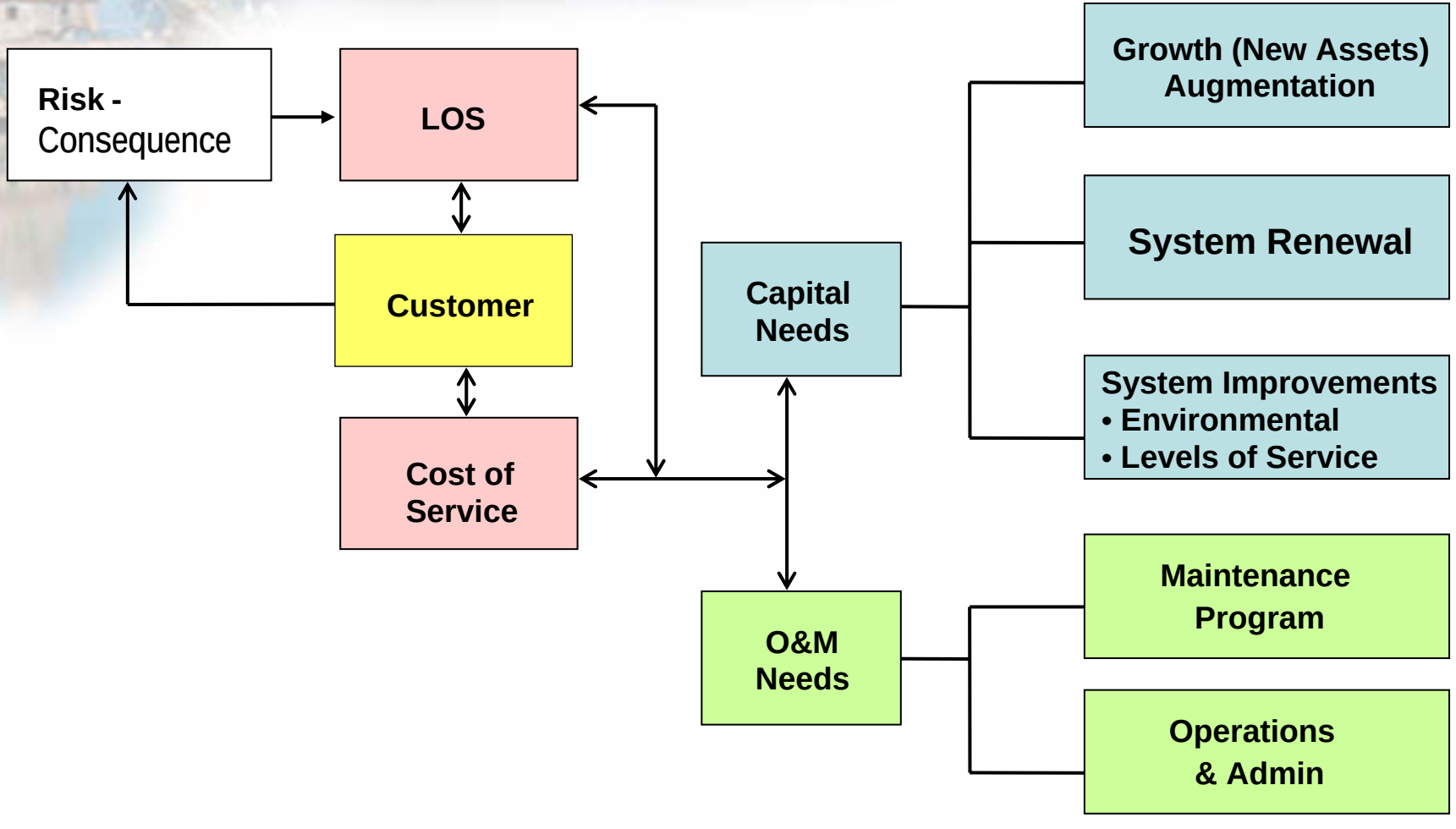
- Big picture view
- Longer time frame
- Aggregated data

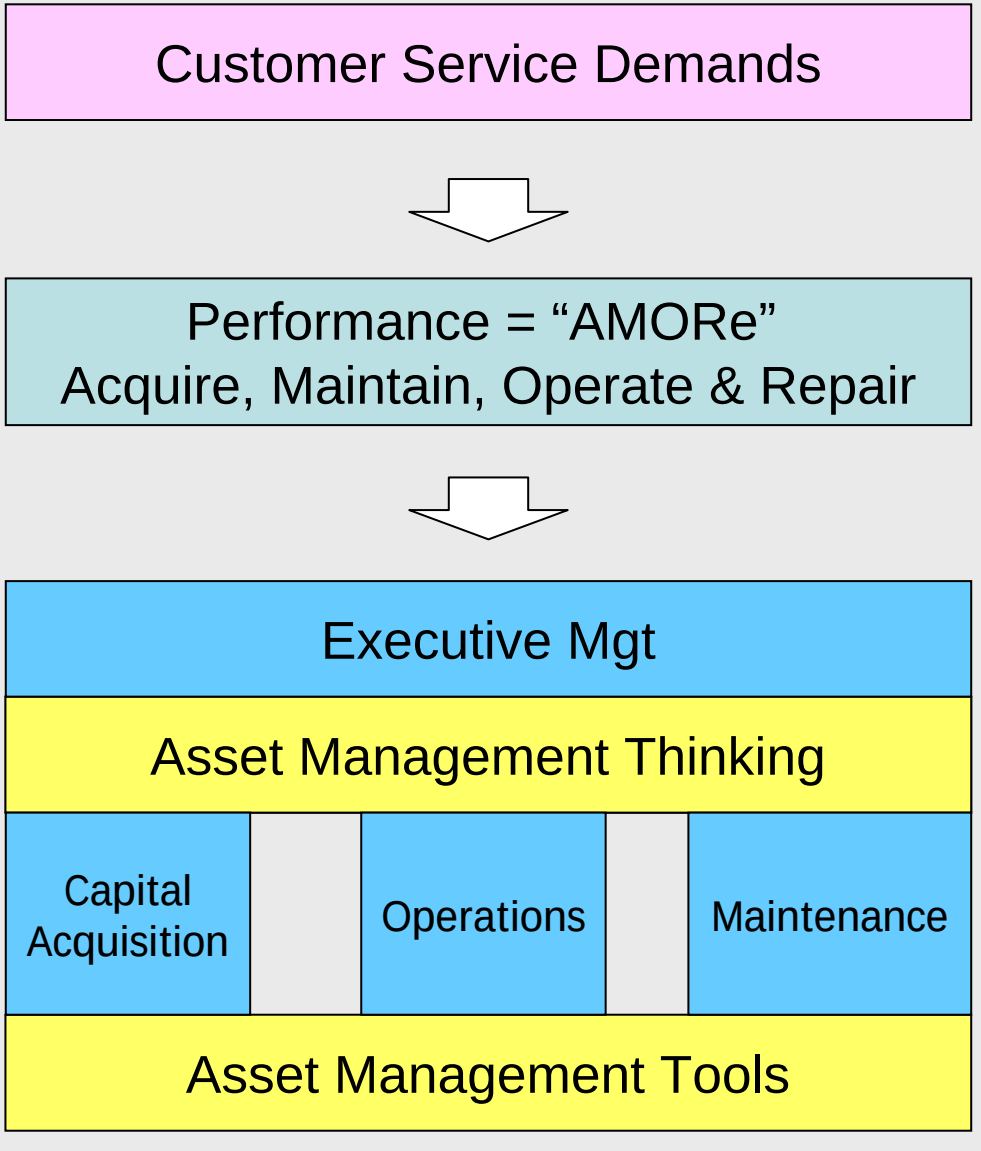
- Asset Management Plans
- LOS
- CapEx & OpEx Budgets
- Renewal annuities
- Treatment options
- Optimal renewal/replacement policies
  - Decay curves
  - Life cycle costs
- Asset Ops/Maintenance plans
  - Failure analysis
  - Asset functionality statements
  - Condition-based monitoring
- Condition assessment
- Asset registry

Tactical Level

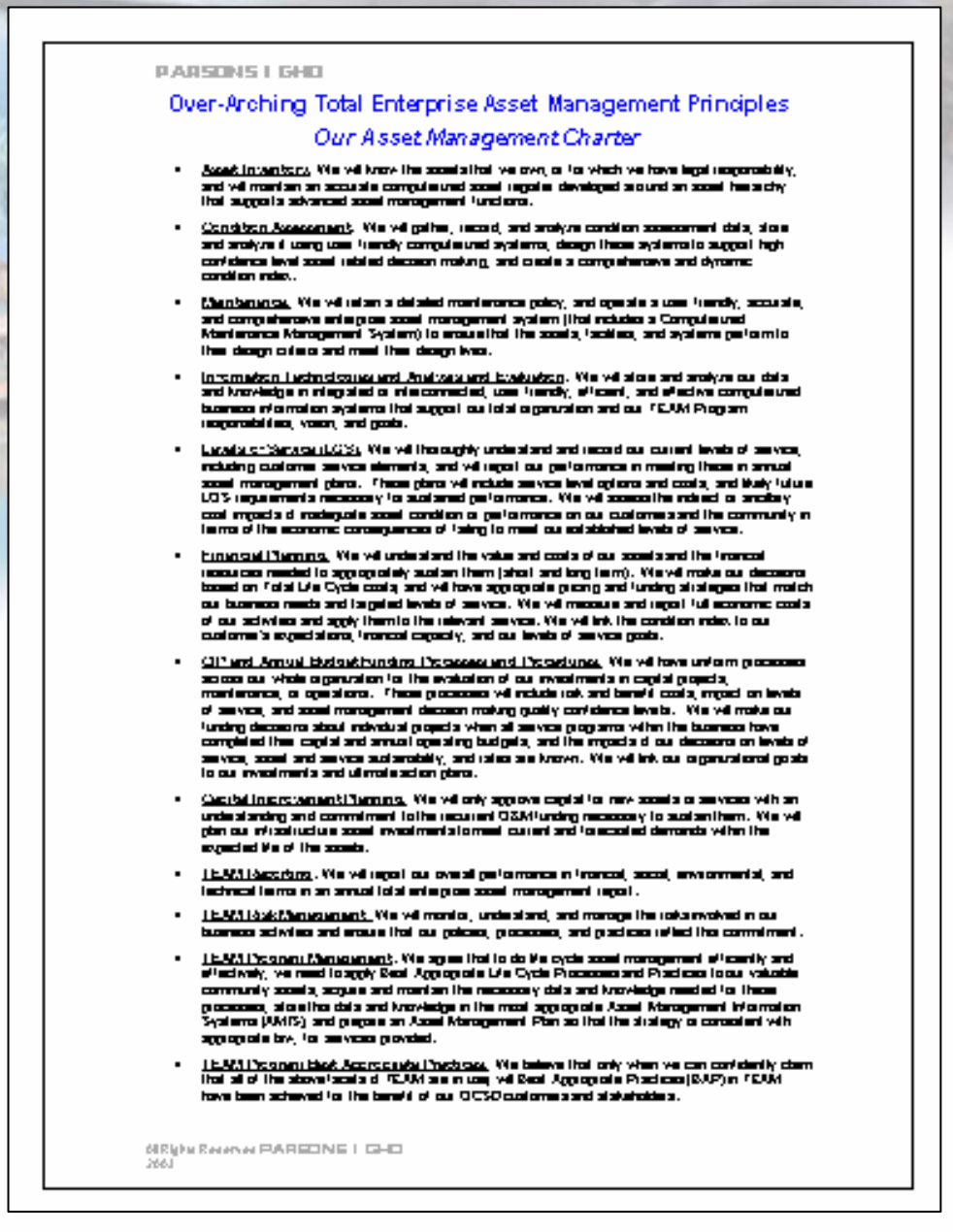
- Operations view
- Day to day perspective
- Detailed asset unit (MMI) view

The Big Picture





AM Oriented Structure



PARSONS | GHD

Over-Arching Total Enterprise Asset Management Principles

Our Asset Management Charter

- Asset Inventory. We will know the assets that we own, or for which we have legal responsibility, and will maintain an accurate computerised asset register developed around an asset hierarchy that supports advanced asset management functions.
- Condition Assessment. We will gather, record, and analyse condition assessment data, store and analyse it using user friendly computerised systems, design these systems to support high confidence level asset related decision making, and create a comprehensive and dynamic condition index..
- Maintenance. We will retain a detailed maintenance policy, and operate a user friendly, accurate, and comprehensive enterprise asset management system (that includes a Computerised Maintenance Management System) to ensure that the assets, facilities, and systems perform to their design criteria and meet their design lives.
- Information Technology and Analysis and Evaluation. We will store and analyse our data and knowledge in integrated or interconnected, user friendly, efficient, and effective computerised business information systems that support our total organisation and our TEAM Program responsibilities, vision, and goals.
- Levels of Service (LOS). We will thoroughly understand and record our current levels of service, including customer service elements, and will report our performance in meeting these in annual asset management plans. These plans will include service level options and costs, and likely future LOS requirements necessary to sustained performance. We will assess the indirect or ancillary cost impacts of inadequate asset condition or performance on our customers and the community in terms of the economic consequences of failing to meet our established levels of service.
- Financial Planning. We will understand the value and costs of our assets and the financial resources needed to appropriately sustain them (short and long term). We will make our decisions based on Total Life Cycle costs, and will have appropriate pricing and funding strategies that match our business needs and targeted levels of service. We will measure and report full economic costs of our activities and apply them to the relevant service. We will link the condition index to our customer's expectations, financial capacity, and our levels of service goals.
- CIP and Annual Budget Funding Processes and Procedures. We will have uniform processes across our whole organisation for the evaluation of our investments in capital projects, maintenance, or operations. These processes will include risk and benefit costs, impact on levels of service, and asset management decision making quality confidence levels. We will make our funding decisions about individual projects when all service programs within the business have completed their capital and annual operating budgets, and the impacts of our decisions on levels of service, asset and service sustainability, and risks are known. We will link our organisational goals to our investments and all rationalisation plans.
- Capital Improvement Planning. We will only approve capital for new assets or services with an understanding and commitment to the recurrent O&M funding necessary to sustain them. We will plan our infrastructure asset investments to meet current and foreseeable demands within the expected life of the assets.
- TEAM Reporting. We will report our overall performance in financial, asset, environmental, and technical terms in an annual total enterprise asset management report.
- TEAM Risk Management. We will monitor, understand, and manage the risks involved in our business activities and ensure that our policies, processes, and practices reflect this commitment.
- TEAM Program Management. We agree that to do life cycle asset management efficiently and effectively, we need to apply Best Appropriate Life Cycle Processes and Practices to our valuable community assets, acquire and maintain the necessary data and knowledge needed for these processes, store the data and knowledge in the most appropriate Asset Management Information Systems (AMIS) and prepare an Asset Management Plan so that the strategy is consistent with appropriate brw. for services provided.
- TEAM Program Best Appropriate Practices. We believe that only when we can confidently claim that all of the above listed of TEAM are in use will Best Appropriate Practices (BAP) in TEAM have been achieved for the benefit of our OCSO customers and stakeholders.

The AM "Charter"

The AM Charter

- **Asset Inventory.** We will know the assets that we own, or for which we have legal responsibility, and will maintain an accurate computerized asset register developed around an asset hierarchy that supports advanced asset management functions.

The AM Charter

- **Condition Assessment.** We will gather, record, and analyze condition assessment data; store and analyze it using user friendly computerized systems; design these systems to support high confidence level asset related decision making; and create a comprehensive and dynamic condition index.

The AM Charter

- **Maintenance.** We will retain a detailed maintenance policy, and operate a user friendly, accurate, and comprehensive enterprise asset management system (that includes a Computerized Maintenance Management System) to ensure that the assets, facilities, and systems perform to their design criteria and meet their design lives.

The AM Charter

- **Information Technologies and Analysis and Evaluation**. We will store and analyze our data and knowledge in integrated or interconnected, user friendly, efficient, and effective computerized business information systems that support our total organization and our TEAM Program responsibilities, vision, and goals.

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- **Levels of Service (LOS).** We will thoroughly understand and record our current levels of service, including customer service elements, and will report our performance in meeting these in annual asset management plans. These plans will include service level options and costs, and likely future LOS requirements necessary for sustained performance. We will assess the indirect or ancillary cost impacts of inadequate asset condition or performance on our customers and the community in terms of the economic consequences of failing to meet our established levels of service.

The AM Charter

- **Financial Planning.** We will understand the value and costs of our assets and the financial resources needed to appropriately sustain them (short and long term). We will make our decisions based on Total Life Cycle costs, and will have appropriate pricing and funding strategies that match our business needs and targeted levels of service. We will measure and report full economic costs of our activities and apply them to the relevant service. We will link the condition index to our customer's expectations, financial capacity, and our levels of service goals.

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- **CIP and Annual Budget Funding Processes and Procedures.** We will have uniform processes across our whole organization for the evaluation of our investments in capital projects, maintenance, or operations. These processes will include risk and benefit costs, impact on levels of service, and asset management decision making quality confidence levels. We will make our funding decisions about individual projects when the impacts of our decisions on levels of service, asset and service sustainability, and rates are known. We will link our organizational goals to our investments and ultimate action plans.

The AM Charter

- **<u>Capital Improvement Planning.</u>** We will only approve capital for new assets or services with an understanding and commitment to the recurrent O&M funding necessary to sustain them at lowest projected life-cycle cost. We will plan our infrastructure asset investments to meet current and forecasted demands within the expected life of the assets.

The AM Charter

- **<u>TEAM Reporting</u>**. We will report our overall performance in financial, social, environmental, and technical terms in an annual total enterprise asset management report.

TEAM – Total Enterprise Asset Management

The AM Charter

- **<u>TEAM Risk Management.</u>** We will monitor, understand, and manage the risks involved in our business activities and ensure that our policies, processes, and practices reflect this commitment.

TEAM – Total Enterprise Asset Management

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TEAM – Total Enterprise Asset Management

The AM Charter

- **<u>TEAM Program Best Appropriate Practices.</u>** We believe that only when we can confidently claim that all of the above facets of TEAM are in use, will Best Appropriate Practices (BAP) in TEAM have been achieved for the benefit of our customers, regulators and stakeholders.

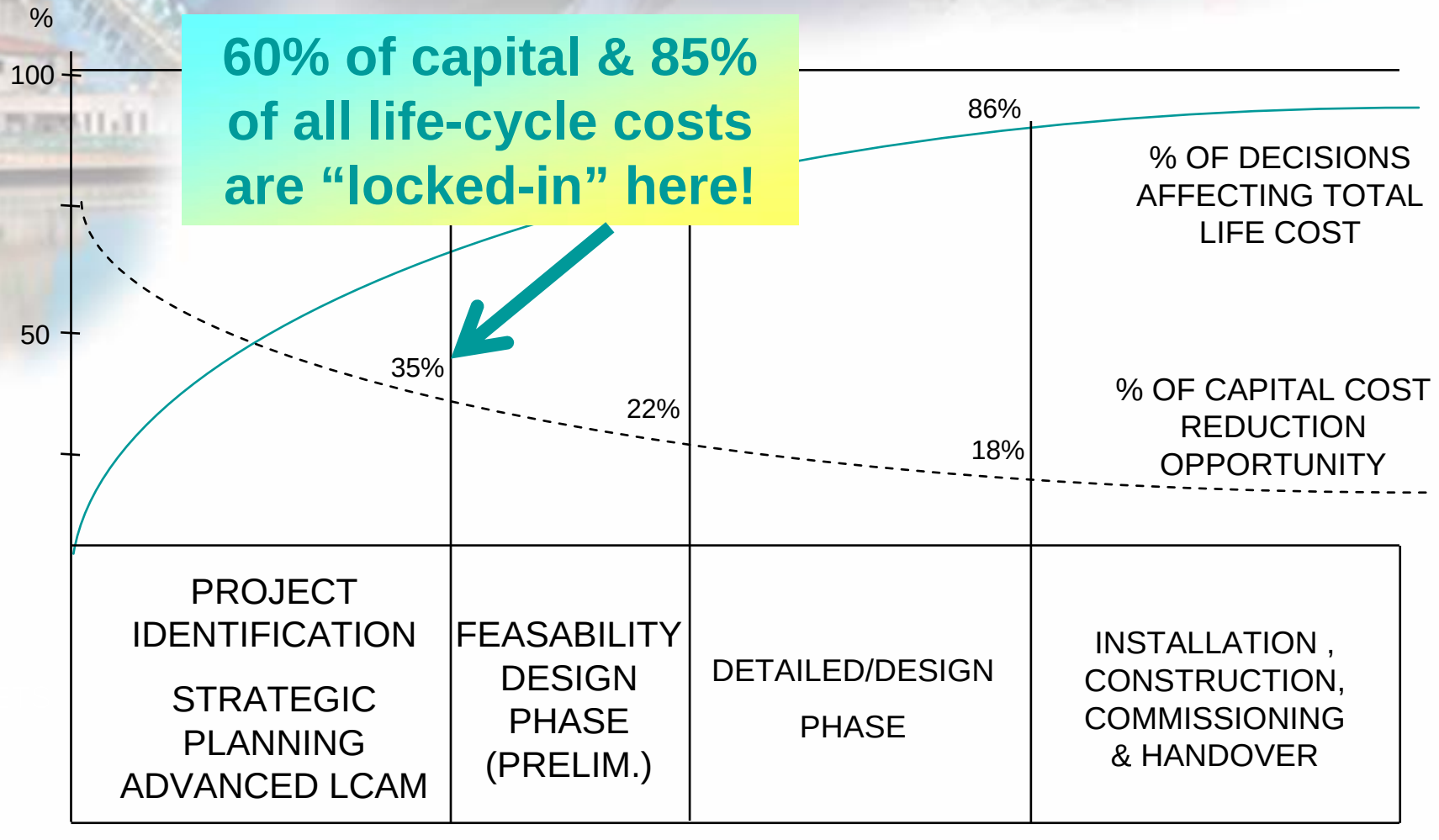
TEAM – Total Enterprise Asset Management

Better Decisions Produce Real Savings

Assessment of Australia's advanced asset managements practices suggests:

20% to 30% Life Cycle Cost Savings for US Wastewater Utilities

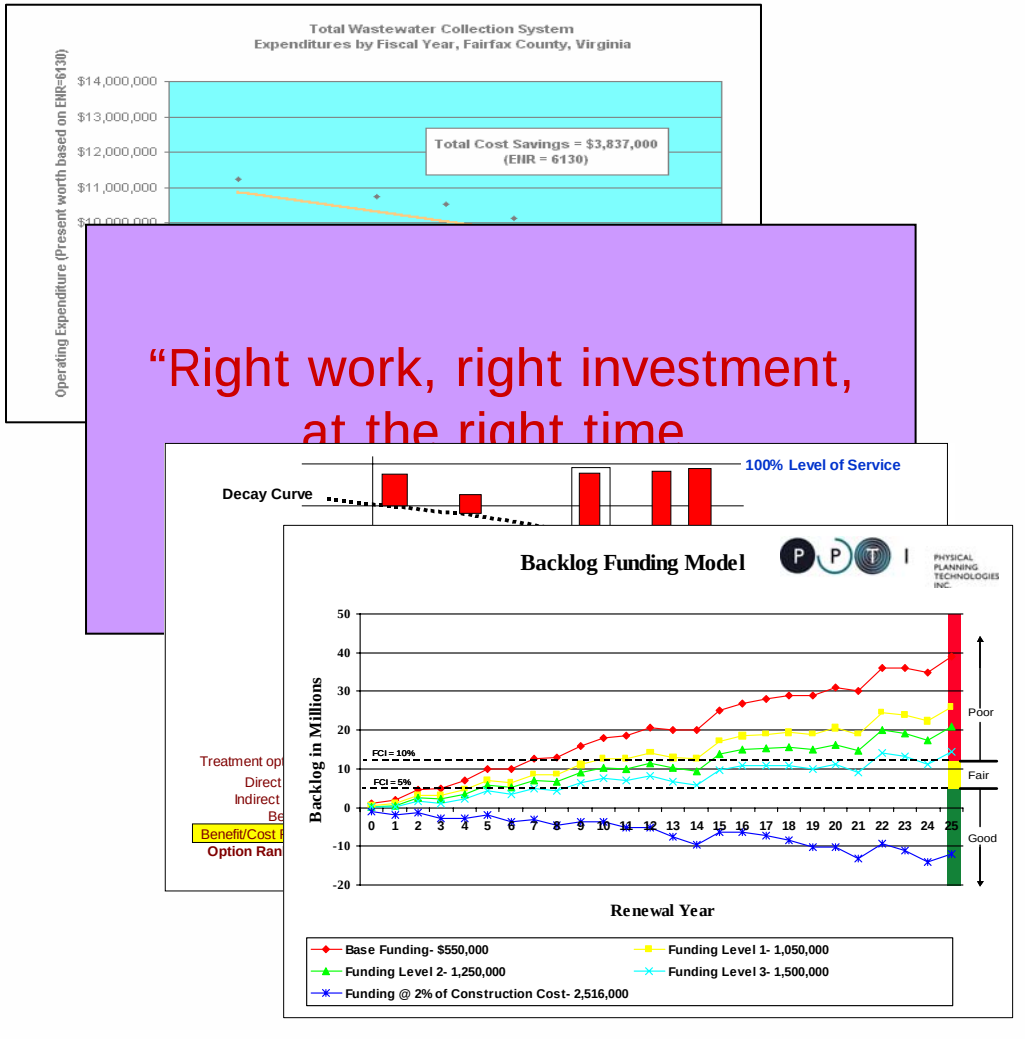
Why is AAM So Important ?



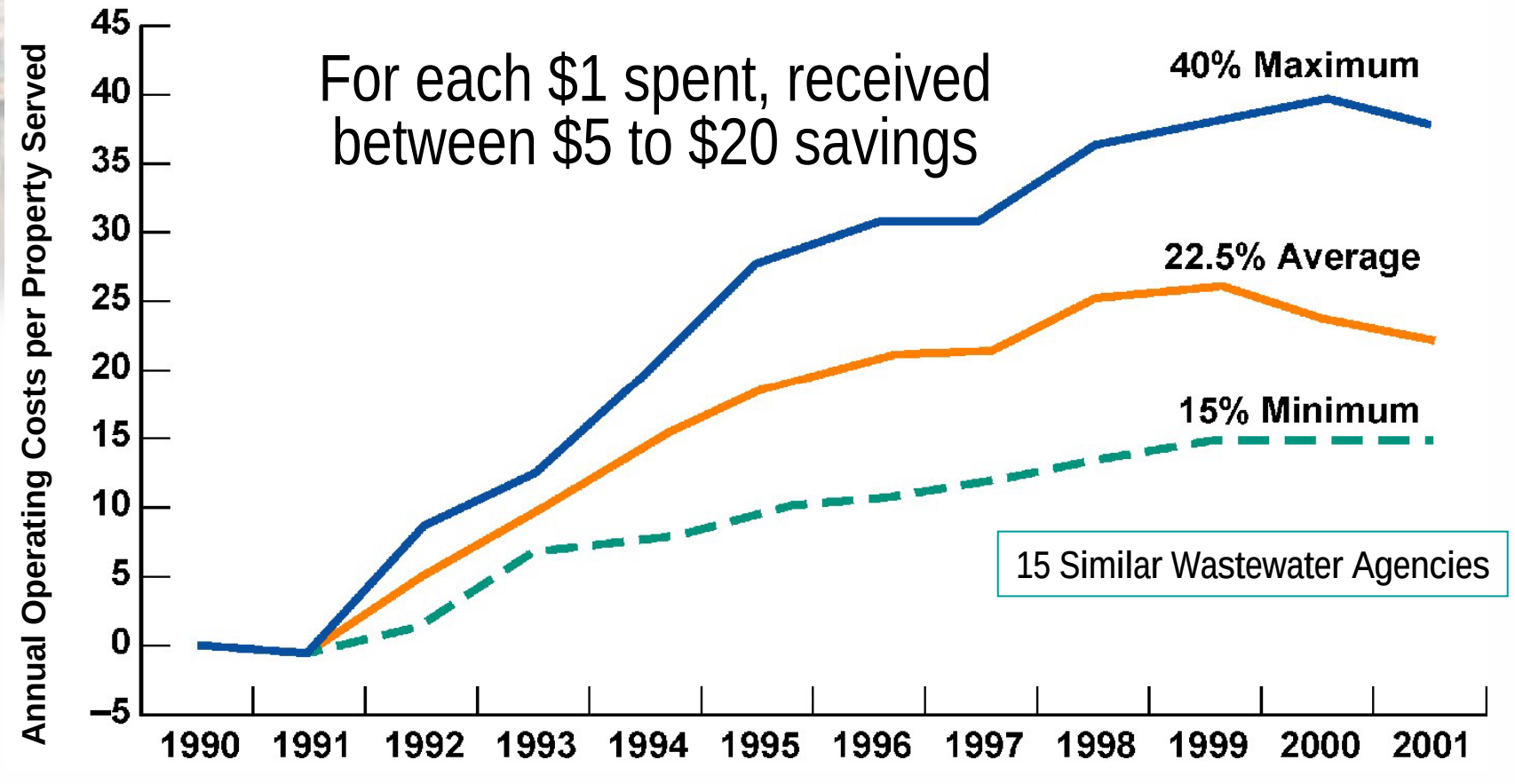
Life Cycle Cost Reduction Opportunities ..

AAM Payoffs

- Real reduced costs; redirected resources
- Best "value per dollar spent"
- Confidence in decision making

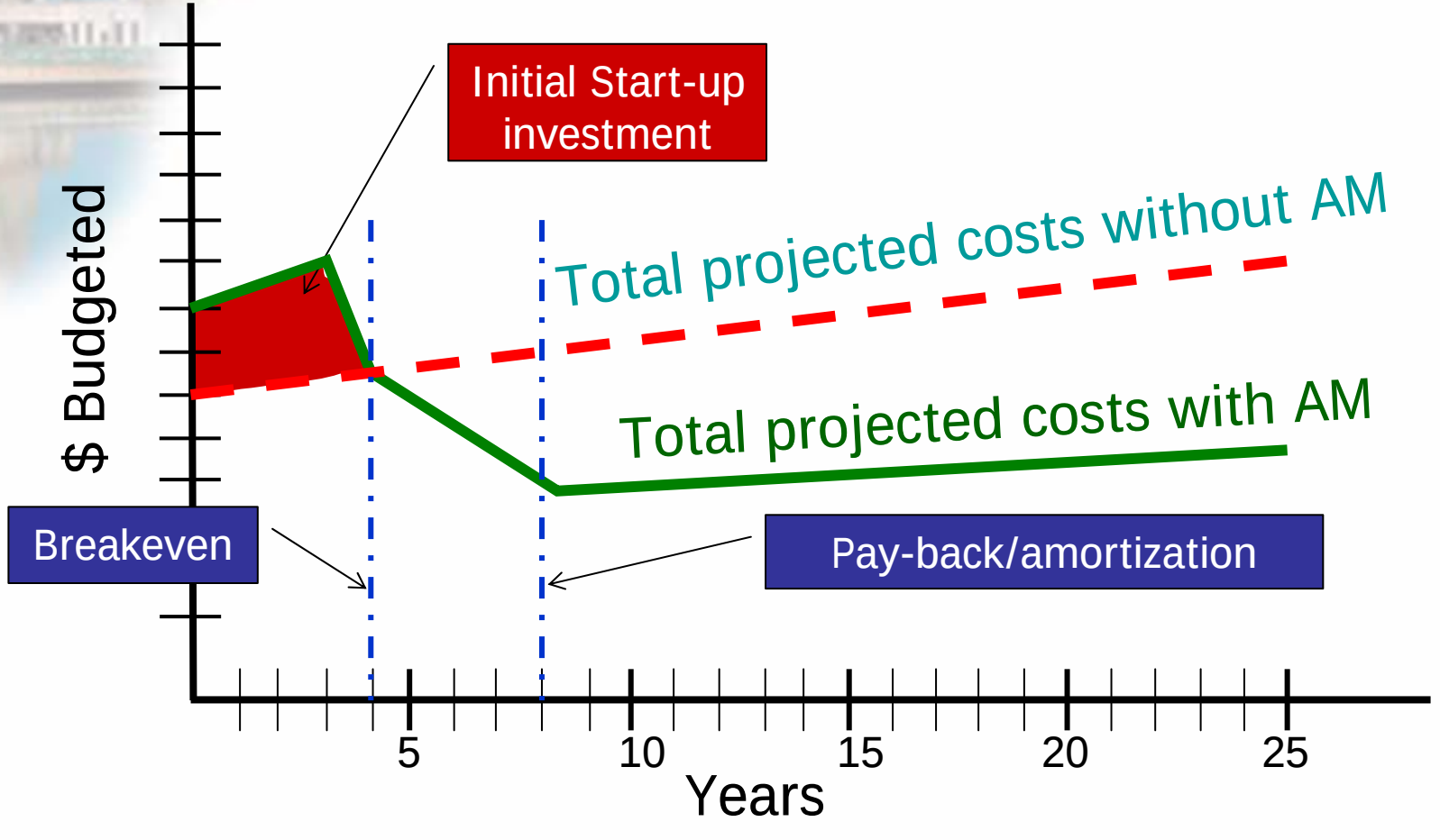


Range of Actual Australian Savings



Source: David Evans - Hunter Water Australia

Typical AM Investment Curve

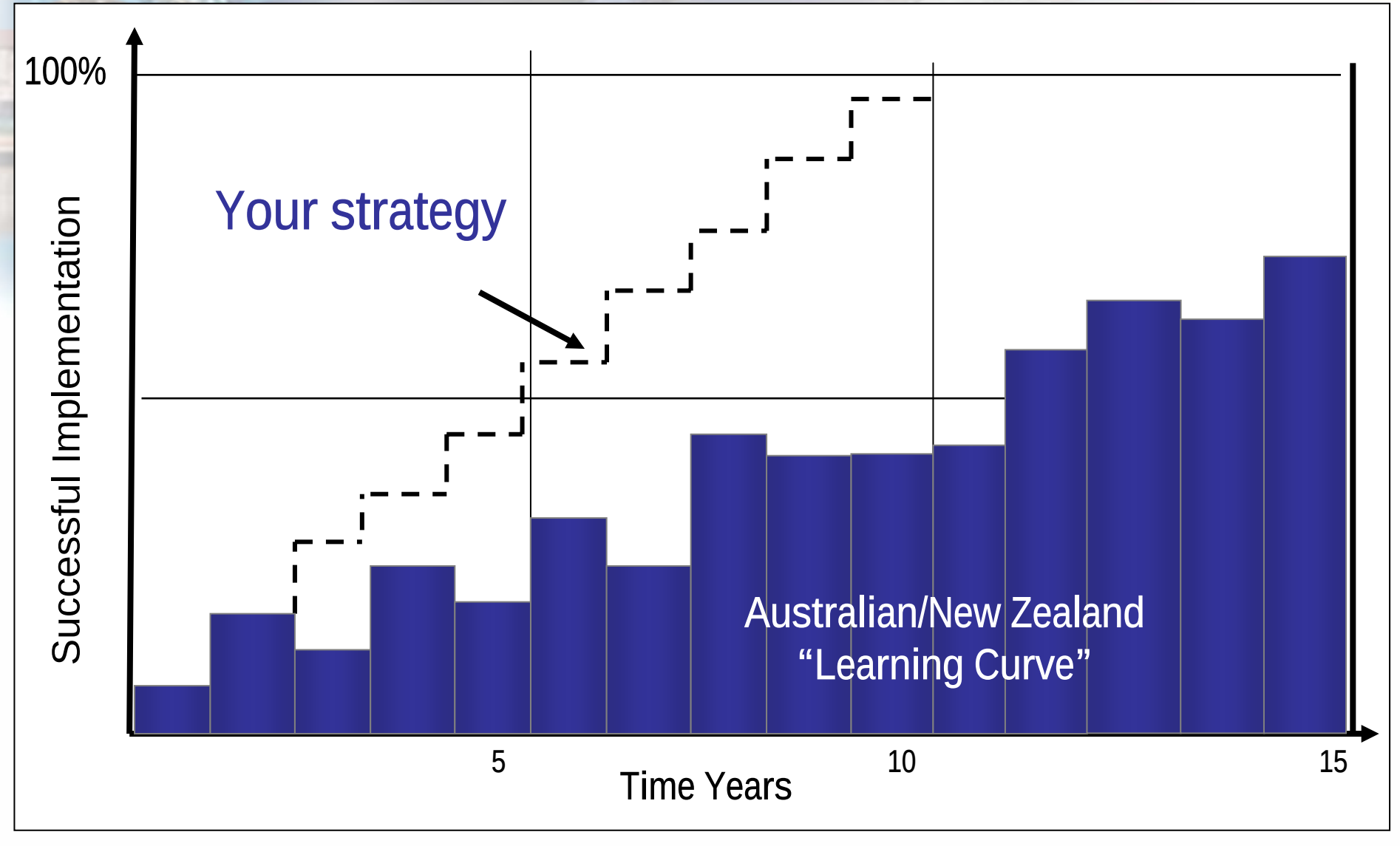


Realistic Expectations

- Will take several years of detailed, “nitty-gritty” work to fully deploy
- Will eventually require “buy-in”/commitment of the whole organization
- Requires “upfront” investment to get started, with “hidden” return for several years

The Key Role of Knowledge Management

We Benefit From Other's Learning Curve



The Five Core AM Questions

Core Questions
1. What is the current state of my assets? • What do I own? • Where is it? • What condition is it in? • What is its remaining useful life? • What is its economic value?
2. What is my required sustained Level Of Service?
3. Given my system, which assets are critical to sustained performance? • How does it fail? How can it fail? • What is the likelihood of failure? • What does it cost to repair? • What are the consequences of failure?
4. What are my best "minimum life-cycle-cost CIP and O&M strategies? • What alternative treatment options exist? • Which are most feasible?
5. Given the above, what is my best long-term funding strategy?

The Five Core Questions of Advanced Asset Management
And
Associated Techniques and Output

Core Questions	Associated Techniques/Output
1. What is the current state of my assets? • What do I own? • Where is it? • What condition is it in? • What is its remaining useful life? • What is its economic value?	• Asset registry/inventory • Data standards, asset hierarchy • System maps • Delphi approach to locating other sources of data • Process diagrams • "Handover" procedures • Condition analysis • Condition rating • Valuation techniques • Optimized renewal / replacement cost tables
2. What is my required sustained Level Of Service?	• Customer demand analysis • Regulatory requirements analysis • Level of service statements; LOS "roll-up" hierarchy • "Balanced scorecard" • Asset functionality statements • AM Charter
3. Which of my assets are critical to sustained performance? • How do my assets fail? How can they fail? • What is the likelihood of failure? • What does it cost to repair? • What are the consequences of failure?	• Failure analysis ("root cause" analysis; failure mode, effects and criticality analysis; reliability-centered analysis) • Risk/consequence analysis • Asset list by criticality code • Failure codes • Probability of failure • Business risk exposure • Asset functionality statements • Asset "decay curves" • Asset-unit level management plans and guidelines • Asset knowledge
4. What are my best minimum life-cycle - cost CIP and O&M strategies? • What alternative treatment options exist? • Which are most feasible?	• Optimal renewal decision-making • Life-cycle costing • CIP development and validation • Condition-based monitoring plans and deployment • Failure response plans • Capital "cost compression" strategies • Operating "cost compression" strategies
6. Given the above, what is my best long-term funding strategy?	• Over-arching financial impact analysis • Optimized financial strategy • Total Asset Management Plan • Telling the story with confidence
Deployment of AAM	• Best practices/best appropriate practices • Gap analysis and visioning • Enterprise asset management system (EAMS) • Change management • Side-by-side mentoring • AM University • Knowledge management system

Core Questions & Associated Techniques

AGENDA

Day 1

- *Welcome, Introductions & Housekeeping Details*
- *Background And Context*
- *Overview Of Fundamental Concepts & Core Practices*
- *The "Storyline": Tom's Really Bad Day*
- *Core Question 1: What Is The Current State Of My **Assets**?*
- *Lunch*
- *Core Question 2: What Is My Required "Sustainable" Level Of Service?*
- *Core Question 3: Which Assets Are Critical To Sustained Performance?*
- *Core Question 4: What Are My Best Minimum Life-cycle-cost CIP and O&M Strategies?*
- *Discussion; Q&A*

Storyline:

Tom's Very Bad Day –
A Step-By-Step Approach To Applying Advanced Asset Management To A Utility Environment

Prologue

It's twilight. Night is coming on fast. A light rain is falling; the temperature is in the 40's. Tom is standing in the mud in an over-grown field looking at his Jones Street lift station. Raw sewage is flowing out of the pump station and across the street. An old pick-up truck has slid in the flowing sewage, swerved off the road and has hit the power pole up at the corner. The power is out. The police have been called and are starting to direct traffic. Tom is expecting a reporter to show up at any moment with a camera crew. Small electric generators are adding their whine to the din as temporary lighting is being hooked up.

His emergency response crews are standing about with glum faces. The crew is waiting for an electrician who knows how to connect a large generator up to the pump station's motor control center. The generator has not yet arrived. While they wait, they would like to connect their small gas powered pumps up to the force main to divert the sewage from the storm drain, but the piping connections can not be found and the right fittings are not in inventory back at the warehouse. June, the Field Super, calls Red, the local plumbing supply store owner, and asks the owner to open his store to furnish the fittings.

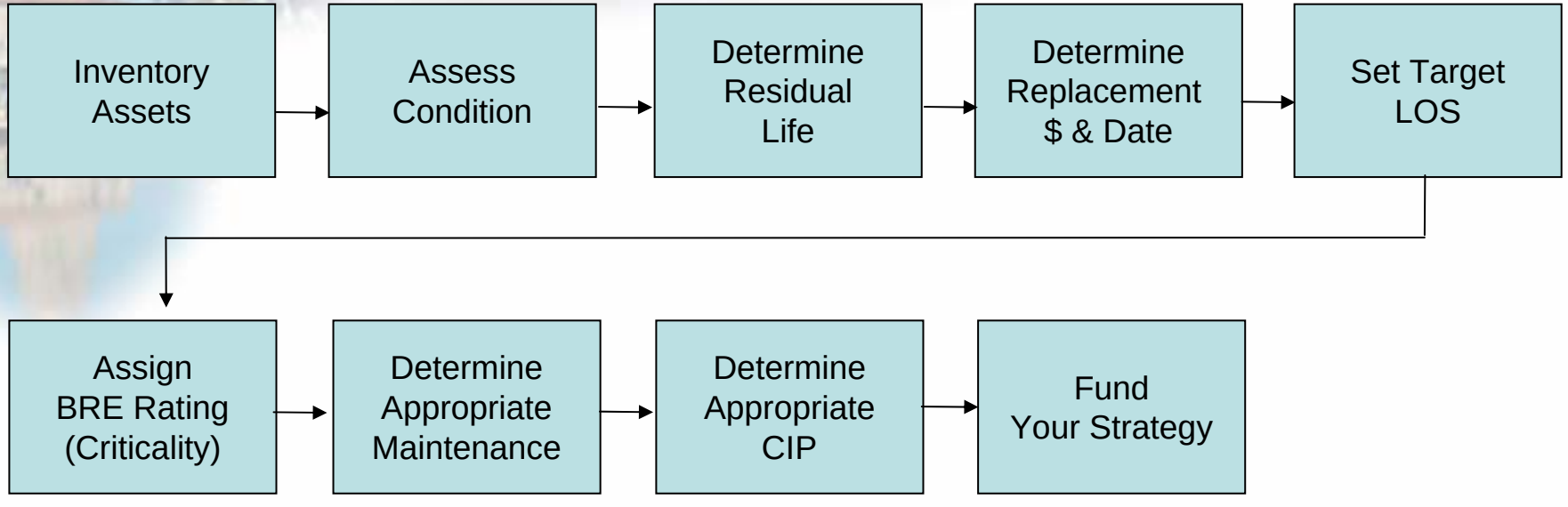
Meanwhile the size of the violation builds as the sewage flows into the storm drain and from there into the river. Tom winces as he notes to himself that the river is the sole water supply for Anders, a small downstream community. To make matters worse, Tom just got a radio call advising him that AgriCrop, an up-stream local industry – the major employer in the area – has just reported wastewater backups.

This, unfortunately, is the fourth major failure of a pump station in 18 months. Each of the other three failures resulted from equipment failures – an electrical problem in a control panel in one case, and a variable speed drive failure in another. The third failure resulted from the rupture of a section of the force main from a 50 year old pump station. Each of these failures resulted in significant wastewater spills into storm drains that connect to the river. Two also caused wastewater backups into businesses and homes – both of which made the six o'clock news!

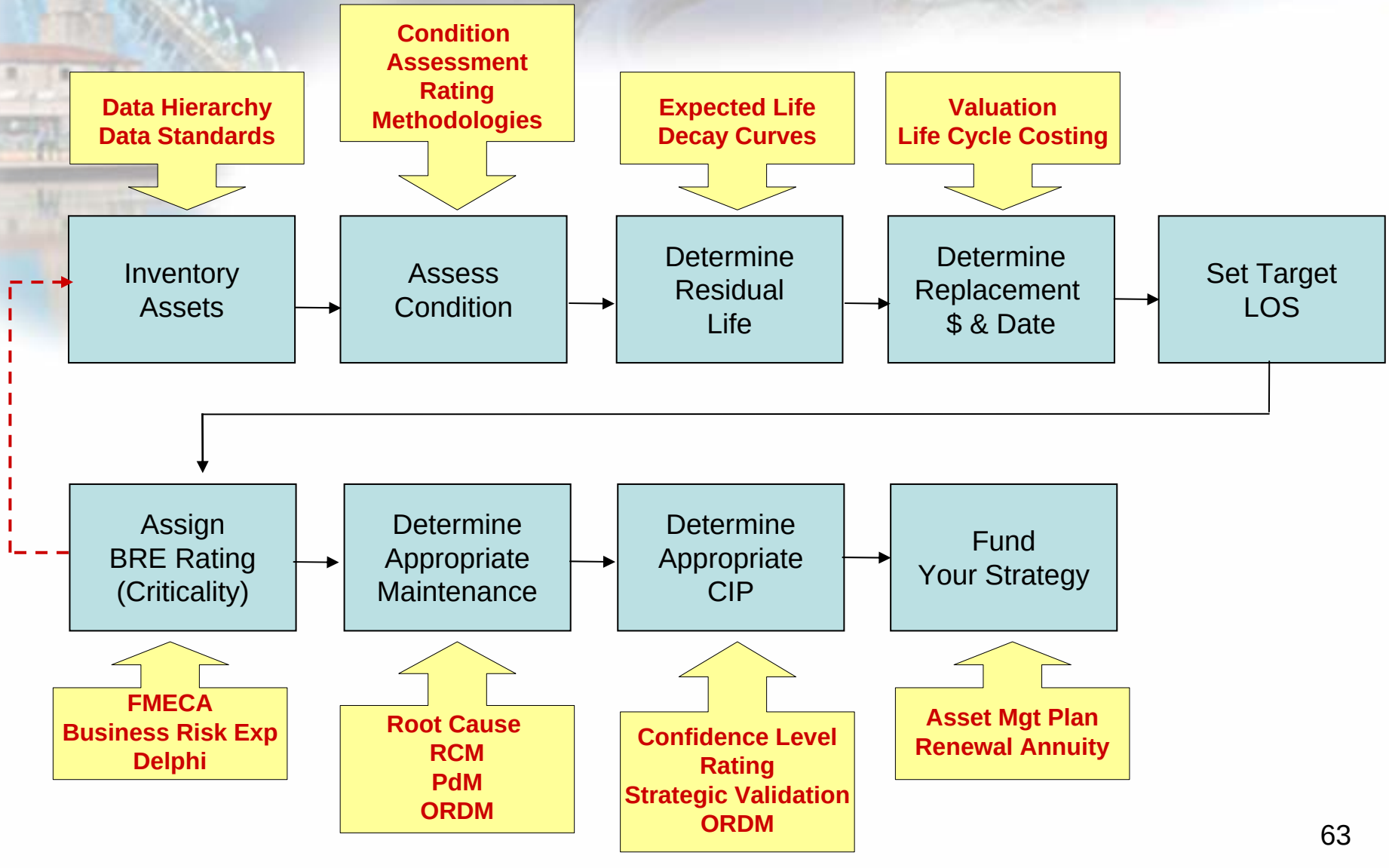
Tom has been a City employee for 16 years. He joined the City as a Supervisor, was promoted to Plant Manager after 5 years, and has been the

Storyline

AAM Program Process



Core AAM Program Process Tools



AGENDA

Day 1

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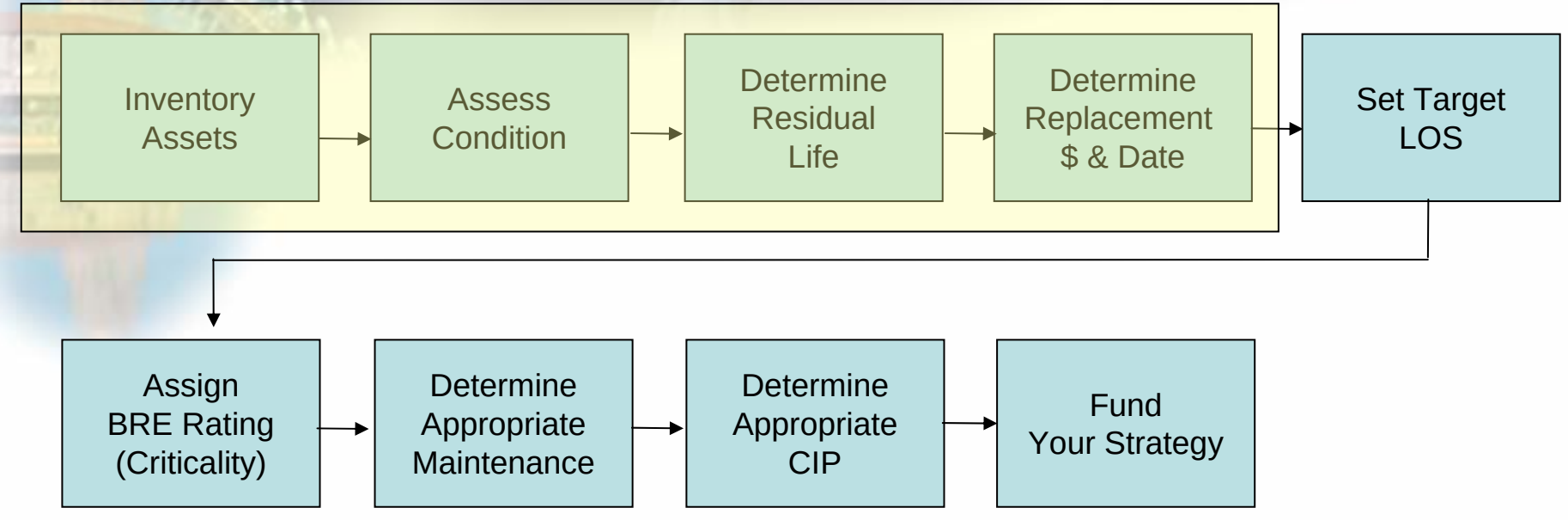
AAM Program Process



Q1: What is the State of My Assets?

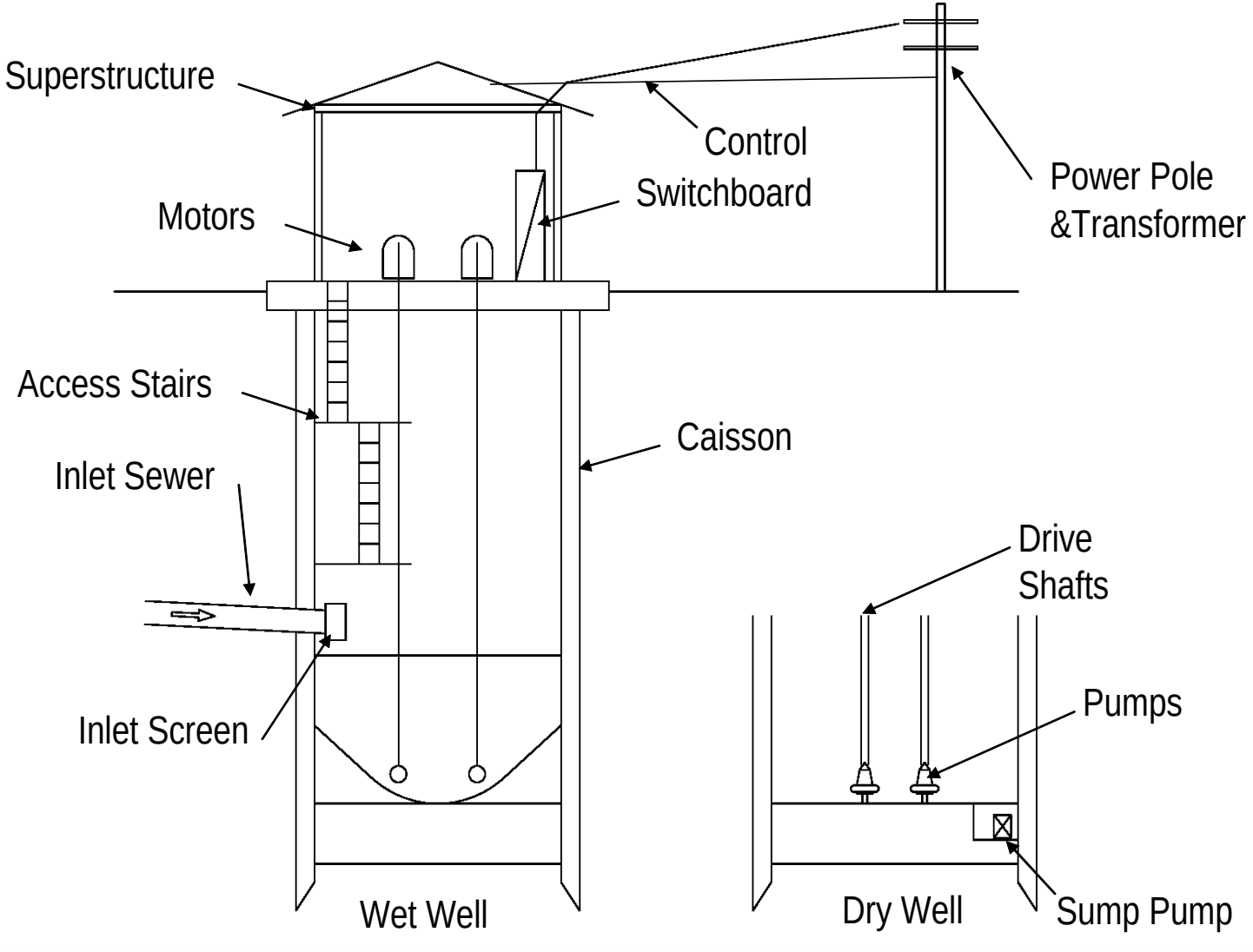
Q1a: What do I own and where is it?

Setting the Scene

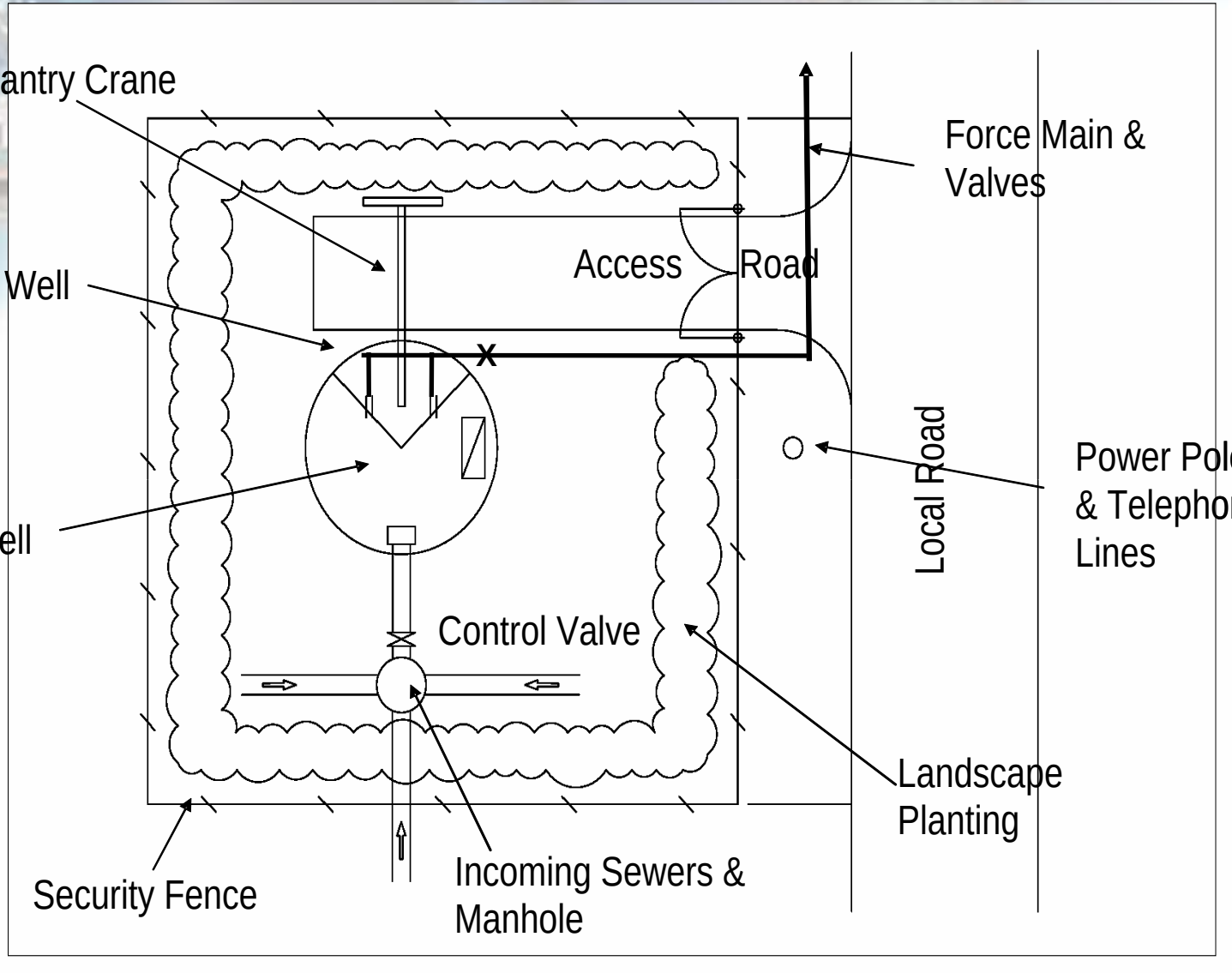
First some background ….

- *Four major failures over the last 18 months*
- *Electrical switchboard & control panel*
- *Pump Motor*
- *Force main failure*
- *Inlet Sewer blockage*
- *Now the power pole …*
- *What does the station look like… ??*

The Pump Station



The Layout View



Question No. 1A

What do we own and where is it ?

- *To fully understand what we own we need an asset register.*
- *To know where it is we need good plans.*

A Vision of “Best Appropriate Practice” Asset Registers

- We know what we own or have responsibility or legal liability for.
- We have recorded these assets in a register down to a “maintenance managed item (MMI)”.
- We can roll up results in costs and levels of service (performance) .

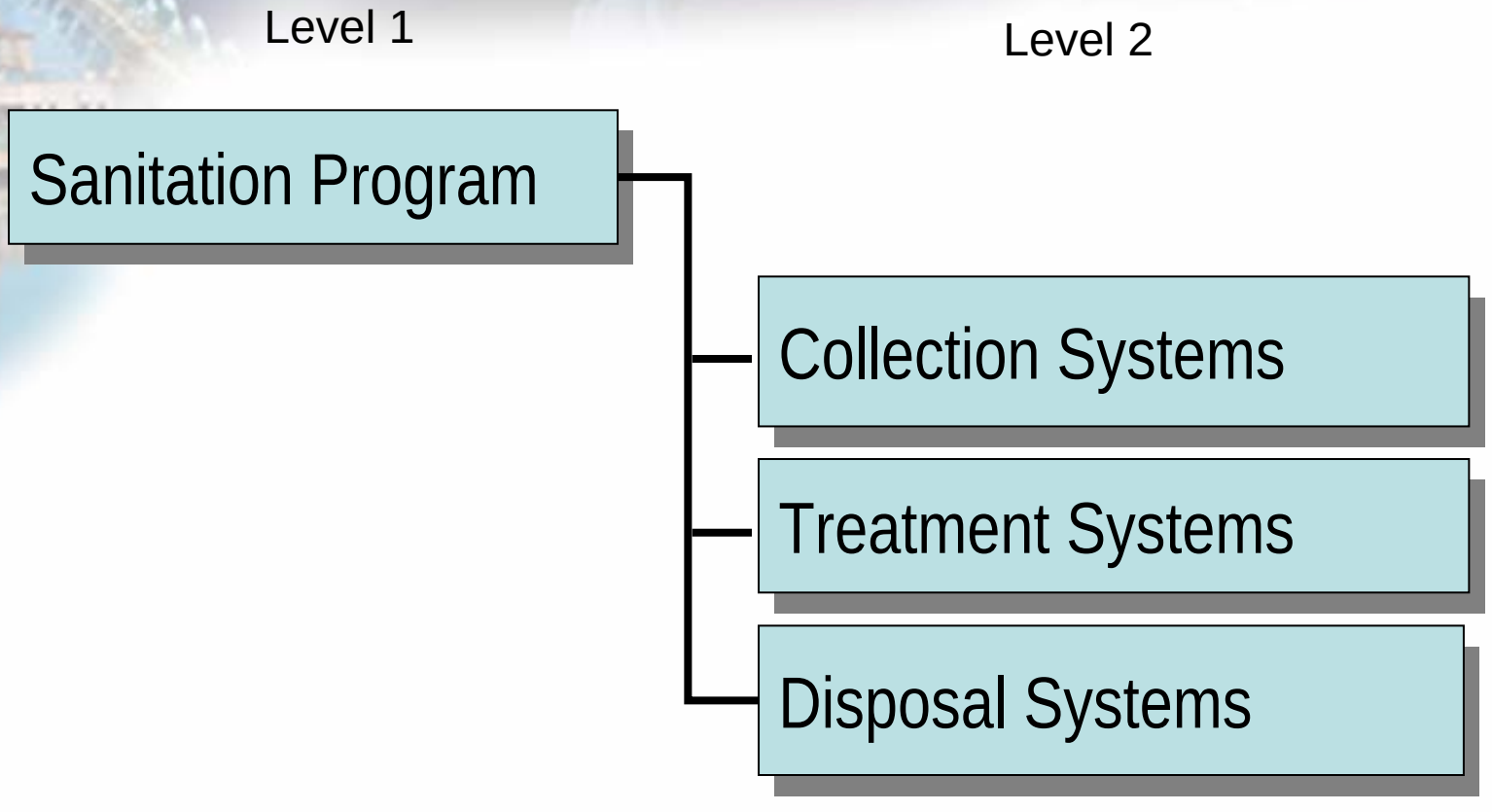
Sources of Data

- As-built plans
- Design plans
- Manufacturers Manuals
- Bid documents
- Schedules of quantities
- Staff - current
  - previous

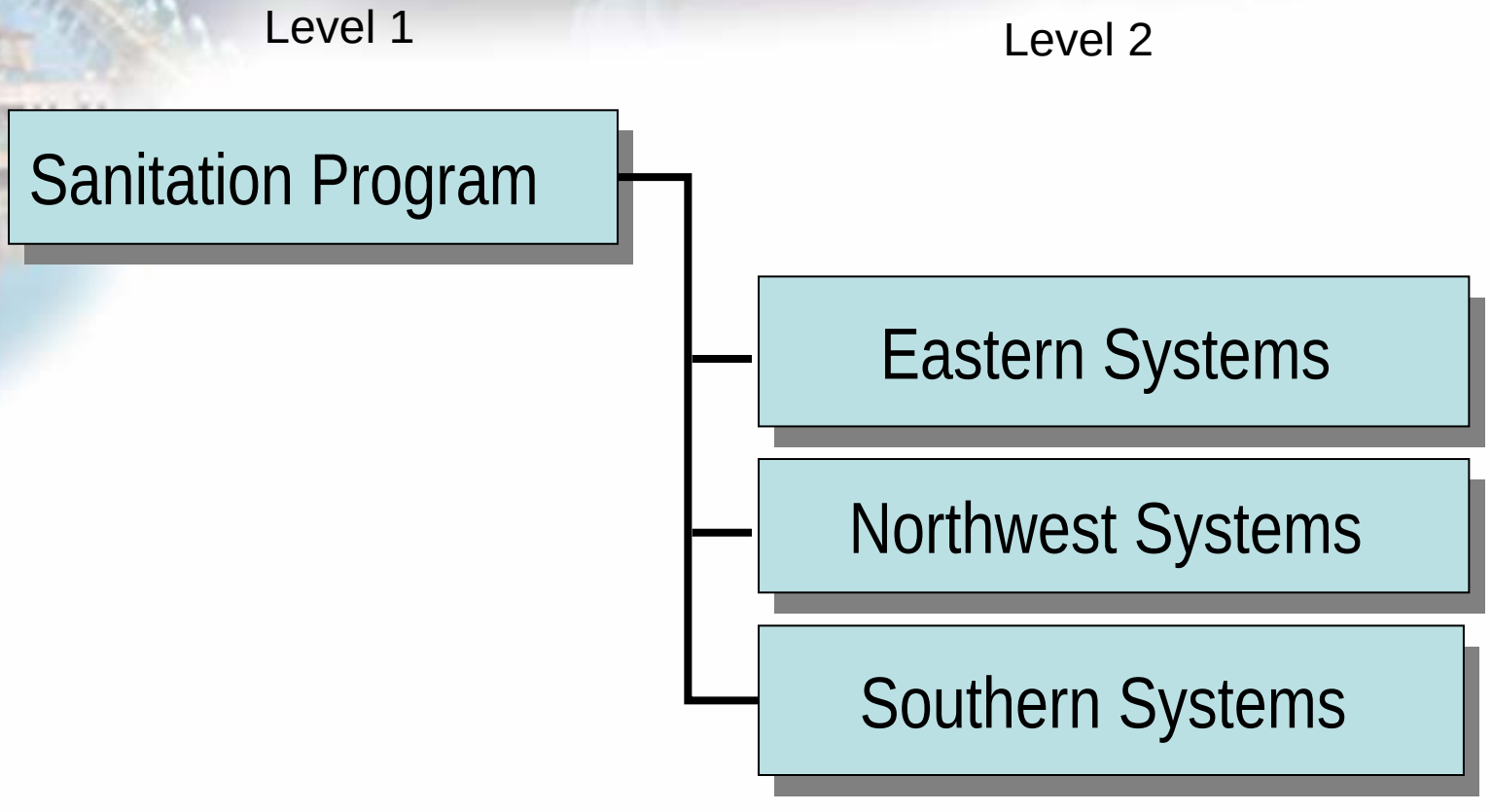
Types of Asset Registers

- Hierarchical – Parent child
- Category based
- Process loops
- Spatial Relationships – GPS generated
- Business unit responsibilities
- Service Provision

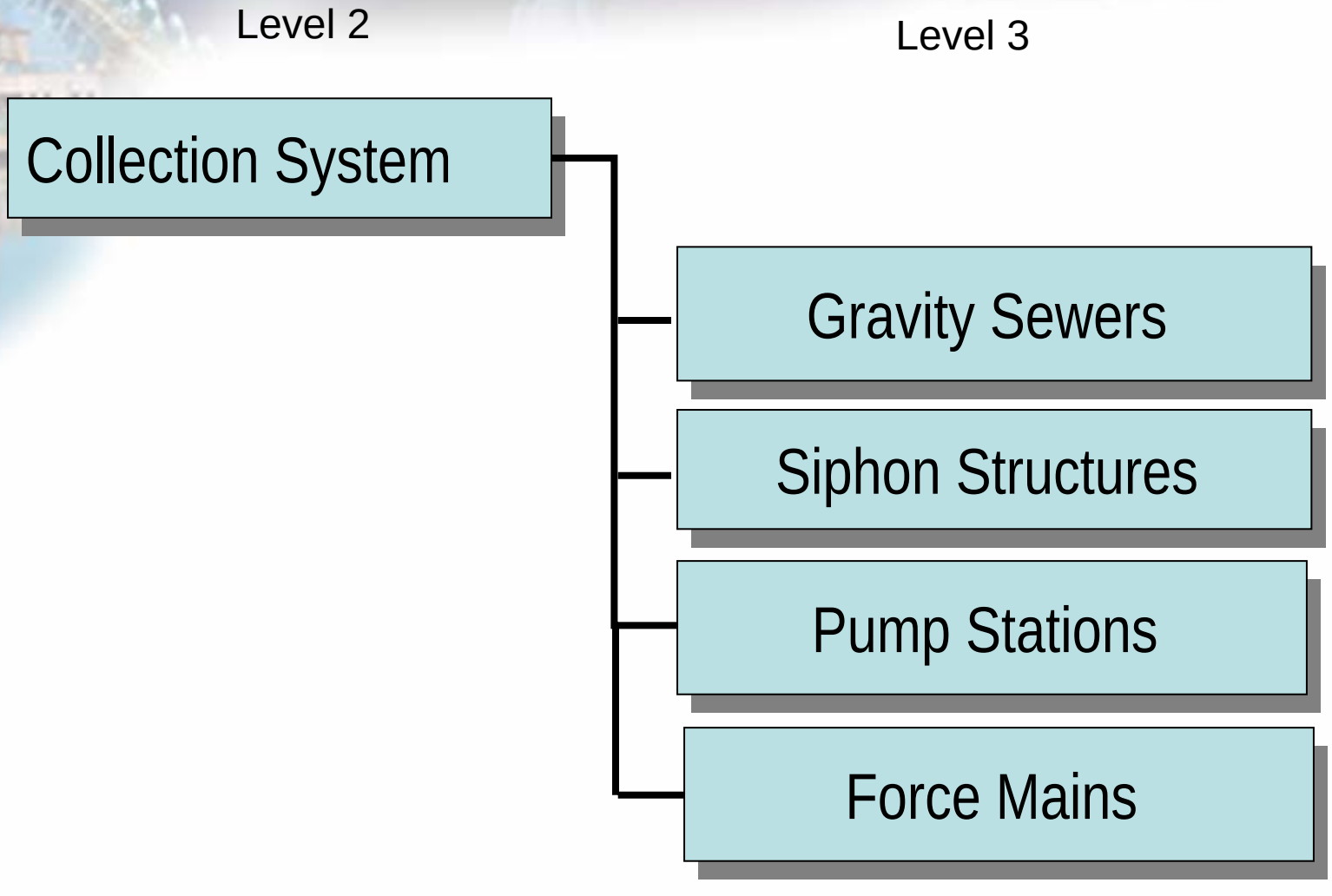
Hierarchical Structures



Hierarchical Structures



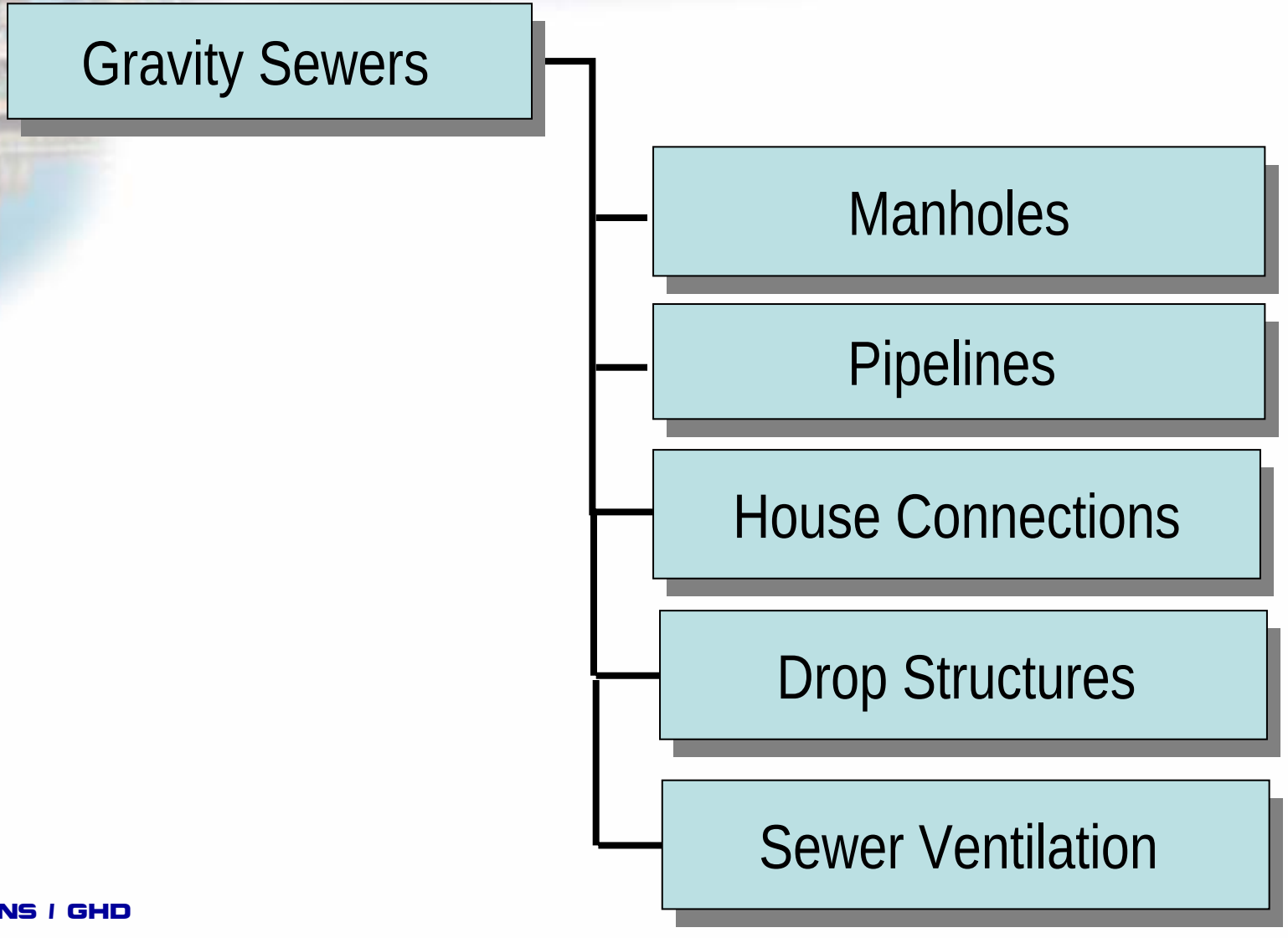
Hierarchical Structures



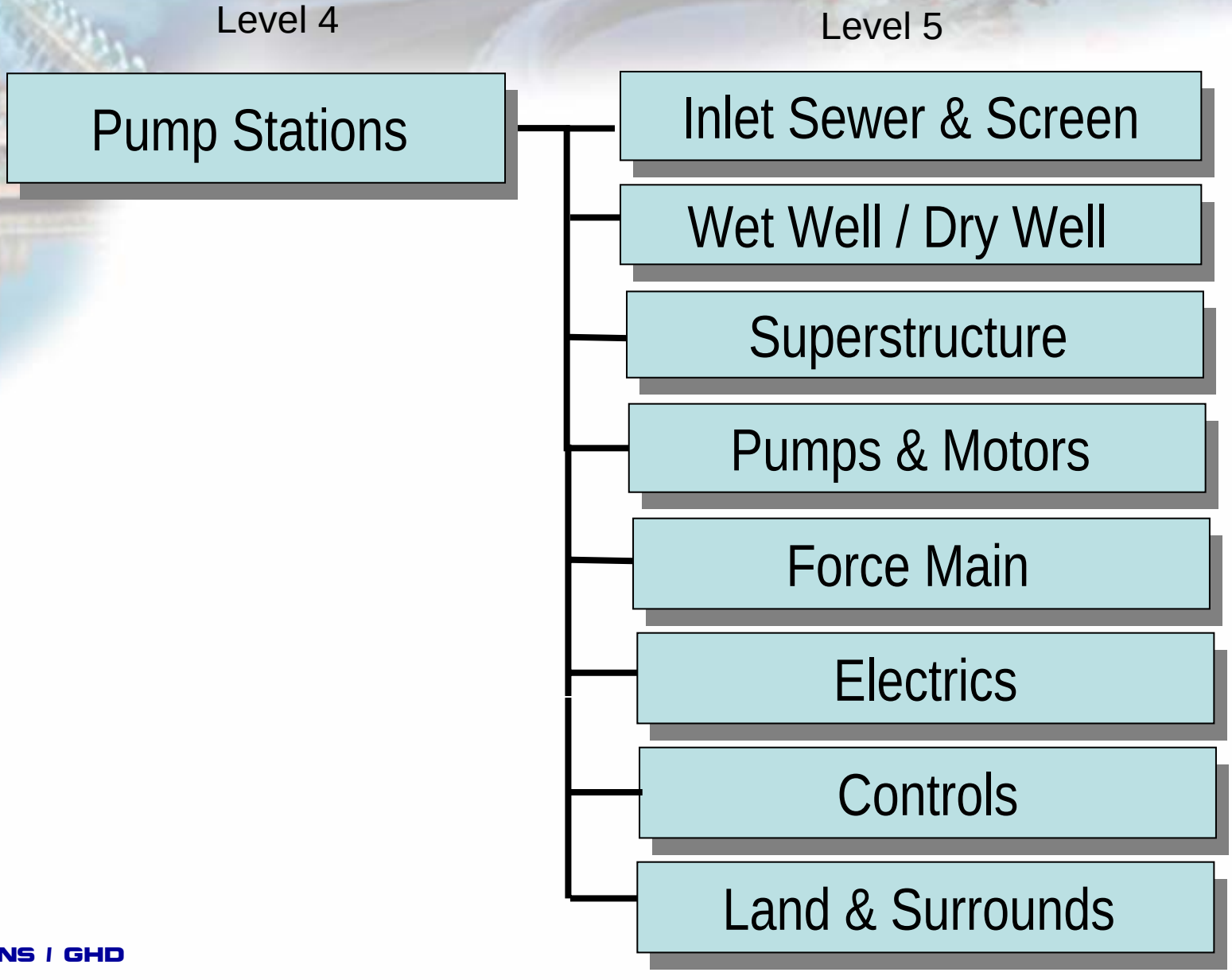
Hierarchical Structures

Level 3

Level 4



Hierarchical Structures



Types of Asset Data

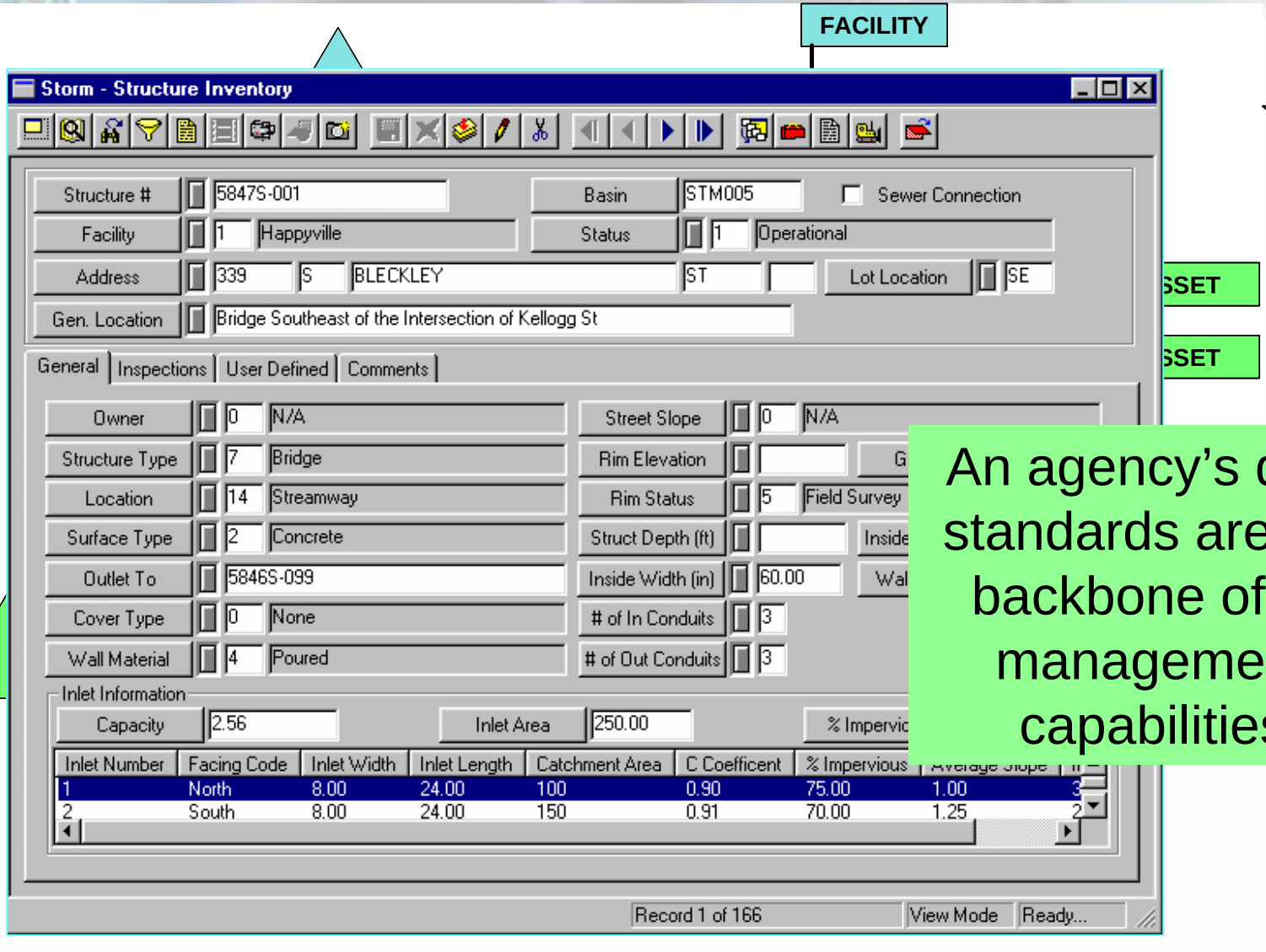
- ⇨ Basic attributes
- ⇨ Location / spatial (plans)
- ⇨ Feature details / attribute
- ⇨ Manufacture type data
- ⇨ Maintenance & operations
- ⇨ Resource allocation / spares
- ⇨ Risk assessments
- ⇨ Life cycle cost / ORDM

Primary Data

Secondary Data

Tertiary Data

Data Standards and the Asset Hierarchy

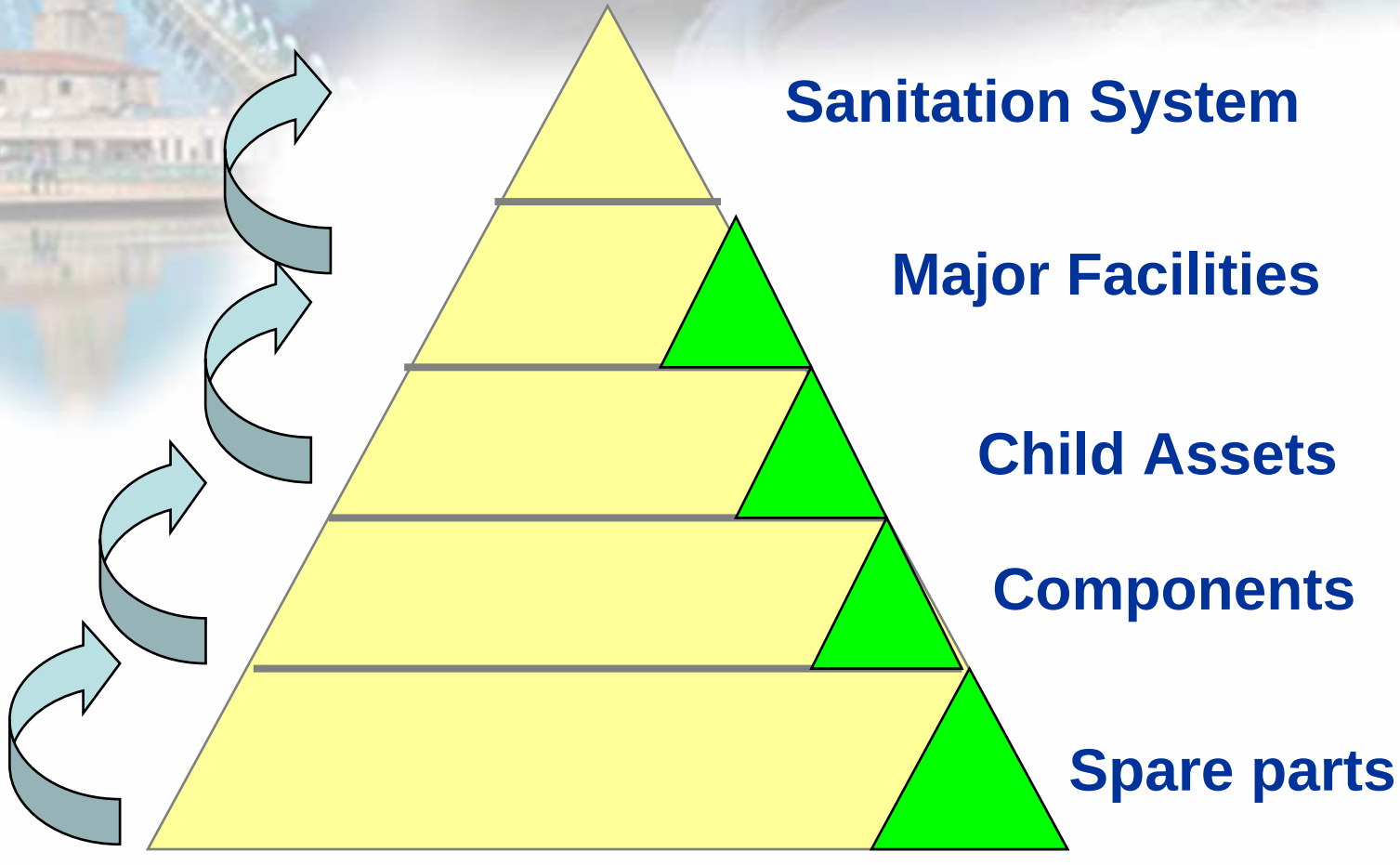


SSET

SSET

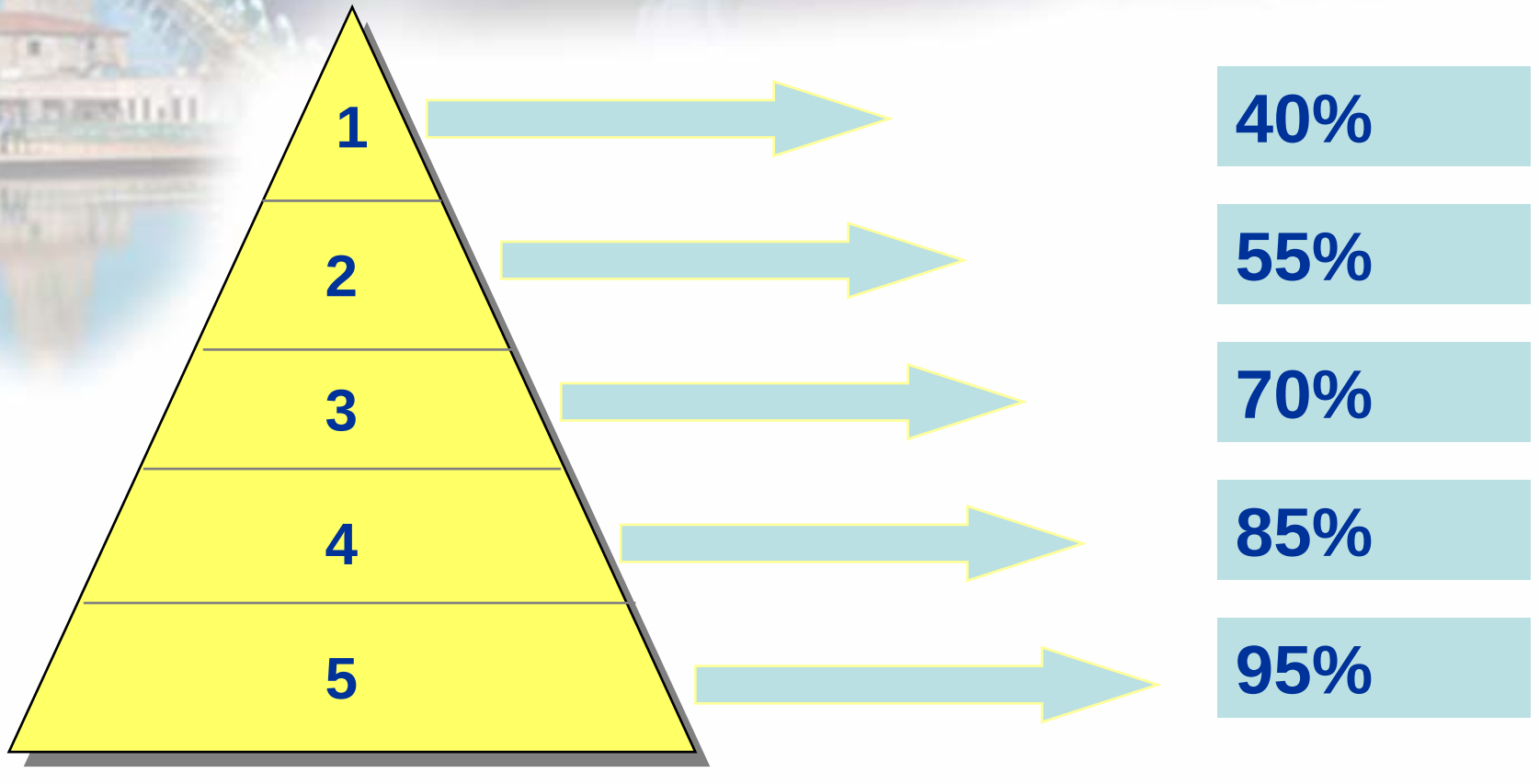
An agency's data standards are the backbone of its management capabilities

Rolling up with Confidence



Confidence at the asset level is required to roll it up with confidence.

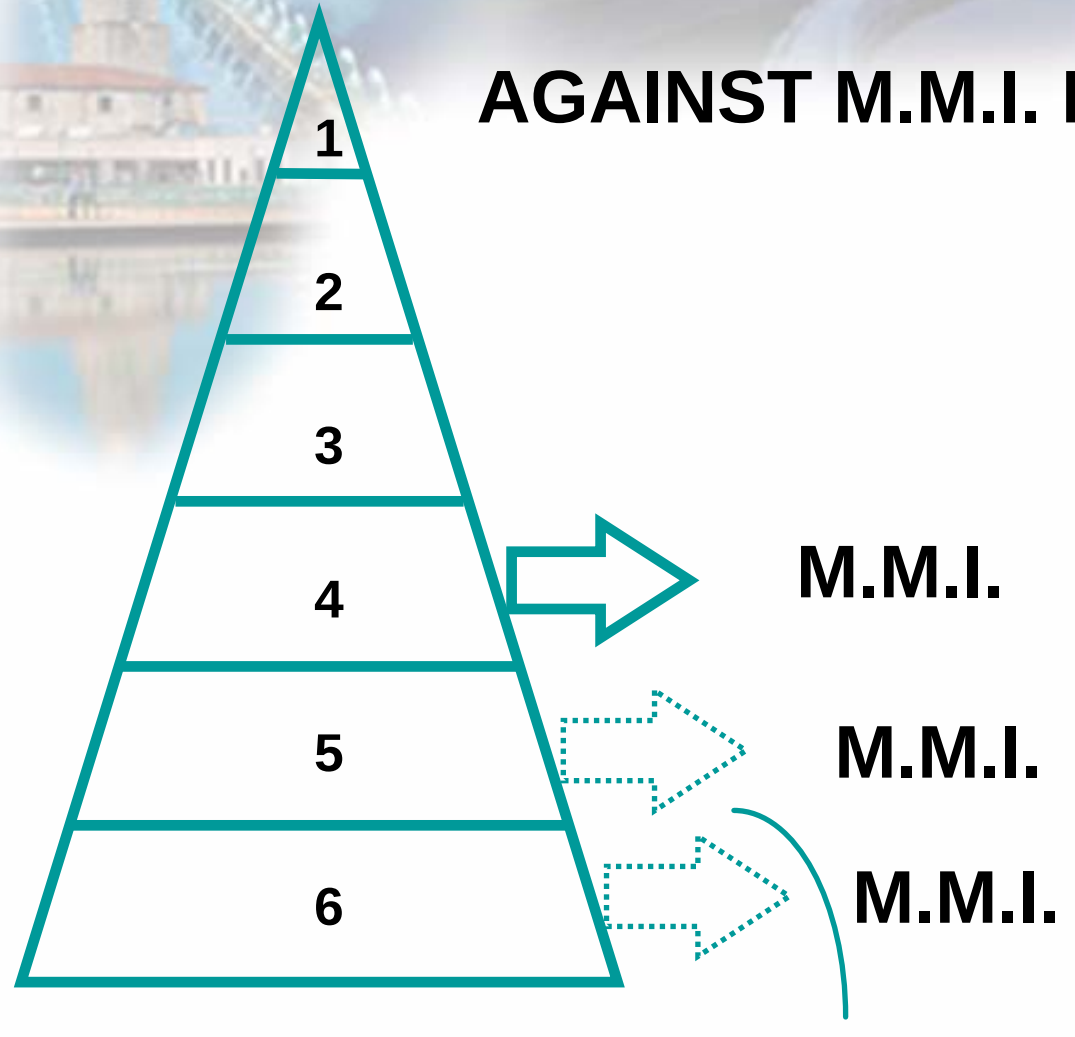
Data – Confidence Levels



Data Hierarchy

Asset Cost Records

AGAINST M.M.I. LEVEL



MAINTENANCE DATA

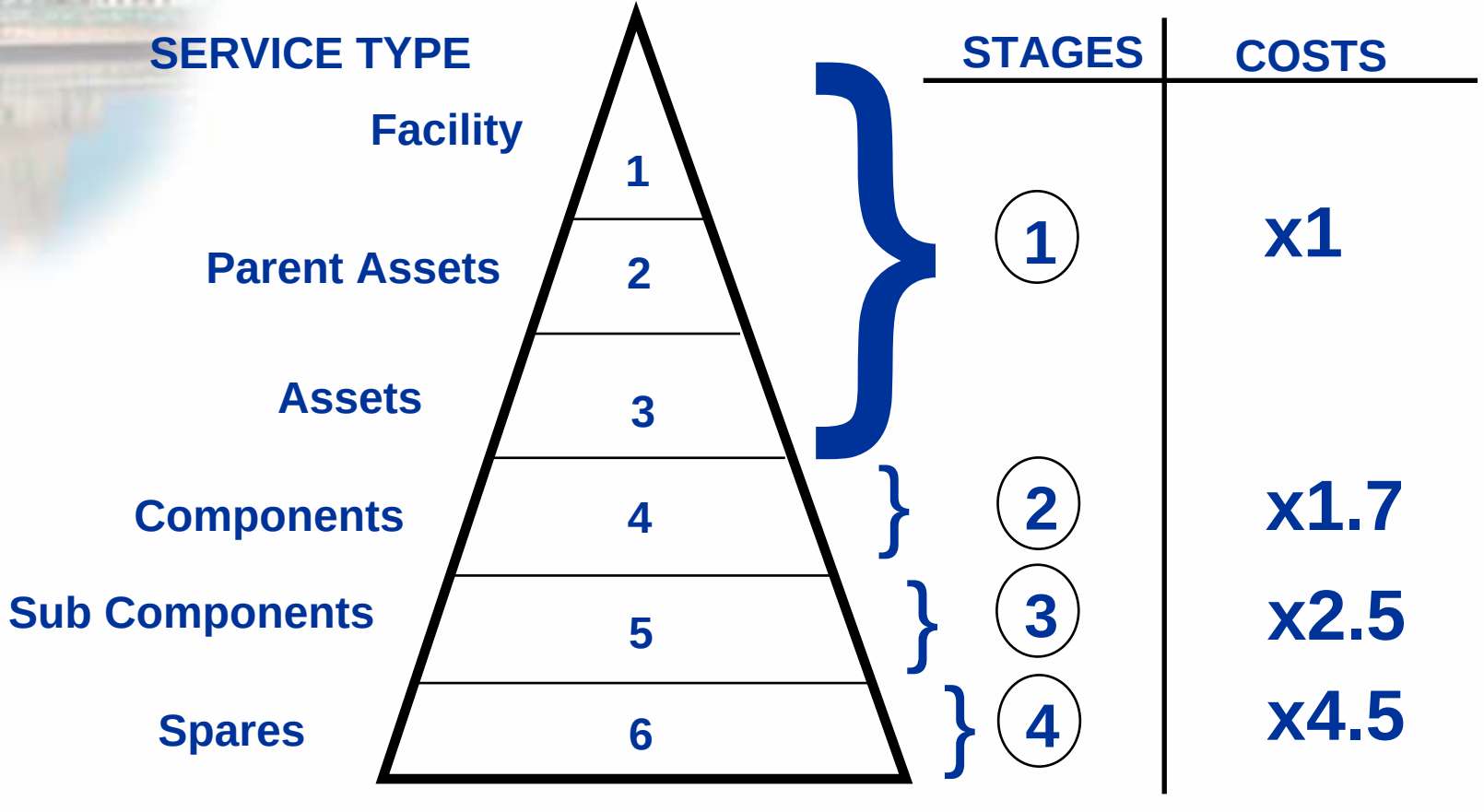
- **Planned or unplanned**
  - **+ labor**
  - **+ materials / spares**
  - **+ plant**
- **Indirect impact on customers**
- **Failure codes**
- **Activity codes**

HIERARCHY

WHAT LEVEL IS WARRANTED?

AM Data levels – Costs .

Levels of Hierarchy - Staging



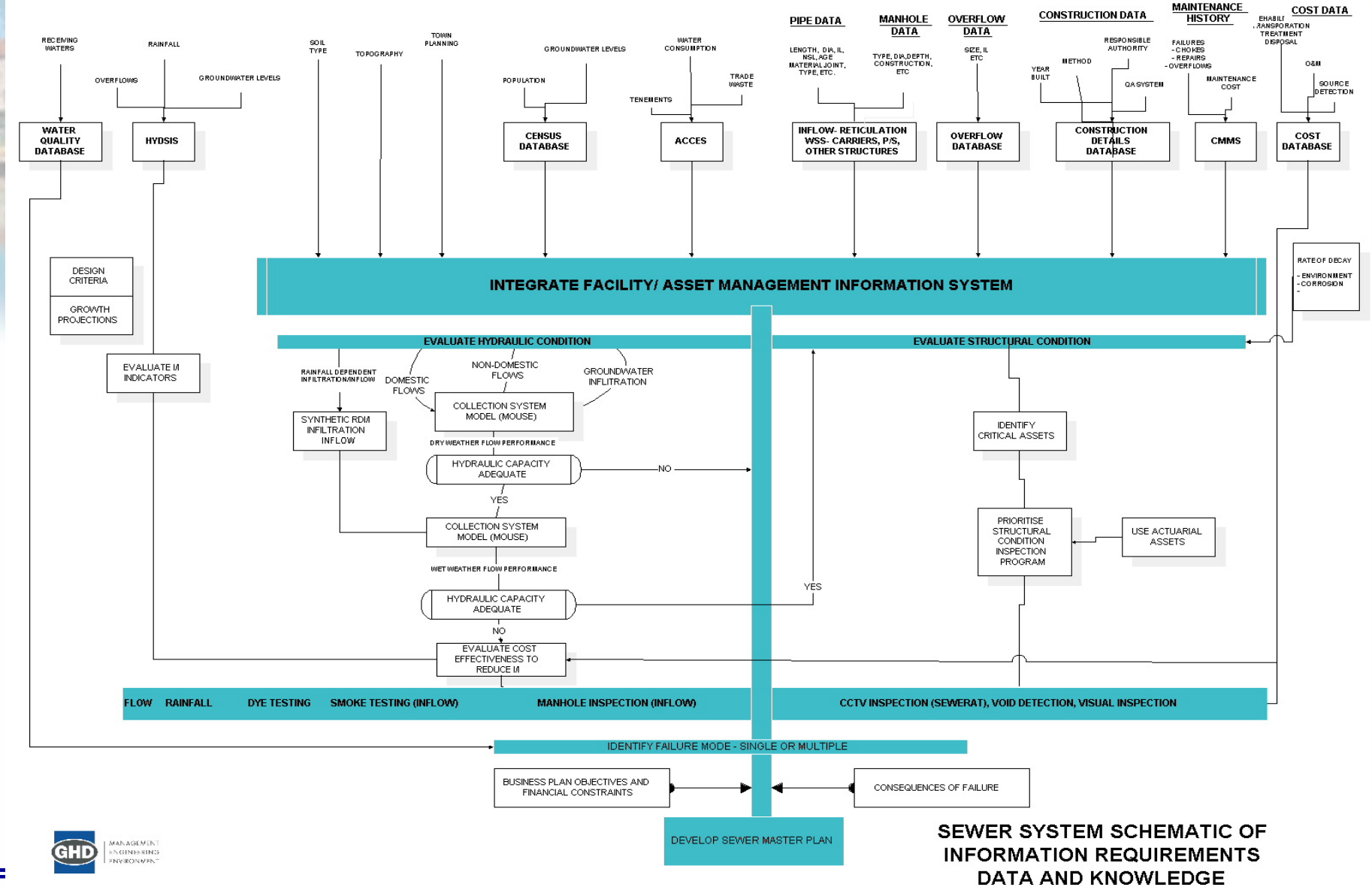
Maintenance Managed Items

ASSET TYPE	SUGGESTED REGISTER BREAK UP
PIPE ELEMENTS - Manholes - Pipelines - House Connections	 Individual manholes Pipelines between manholes House connections per pipeline
PUMP STATIONS	Split into pump well structure, inlet screens and valves, pumps, controls, electrics, rising main, valves, superstructure, ladders and landings
MAJOR FACILITIES	Split into individual assets Then split into individual components • Civil elements • Mechanical elements • Electrical elements • Other items

Key Data & Knowledge Activities

- Data collection
- Logging data into EAMS
- Manipulation of the data
- Interpretation of results
- Recording of decision
- Issue of new instructions/strategy

Dataflow Diagrams



SEWER SYSTEM SCHEMATIC OF INFORMATION REQUIREMENTS DATA AND KNOWLEDGE

GHD MANAGEMENT ENGINEERING ENVIRONMENT

Data Responsibilities – Pump Station?

Who has responsibilities in your Agency?

⇨ Asset Details	Operations
⇨ Condition Assessment	Maintenance
⇨ Asset Values	Engineering
⇨ Residual Physical Lives	Engineering
⇨ Probability of Failure	Maintenance
⇨ Consequence of Failure	Engineering
⇨ Business Risk Exposure	Engineering
⇨ Optimal Renewal Strategy	Maint/Engineering

Principle Data Responsibilities

Primary Data	AMSC	OPS	MAINT	ENG
Asset Categories	1			
Asset Hierarchy	1			
Asset Attributes				1
GIS Entries		1		
Autocad drawings				1
Detailed Attributes				1

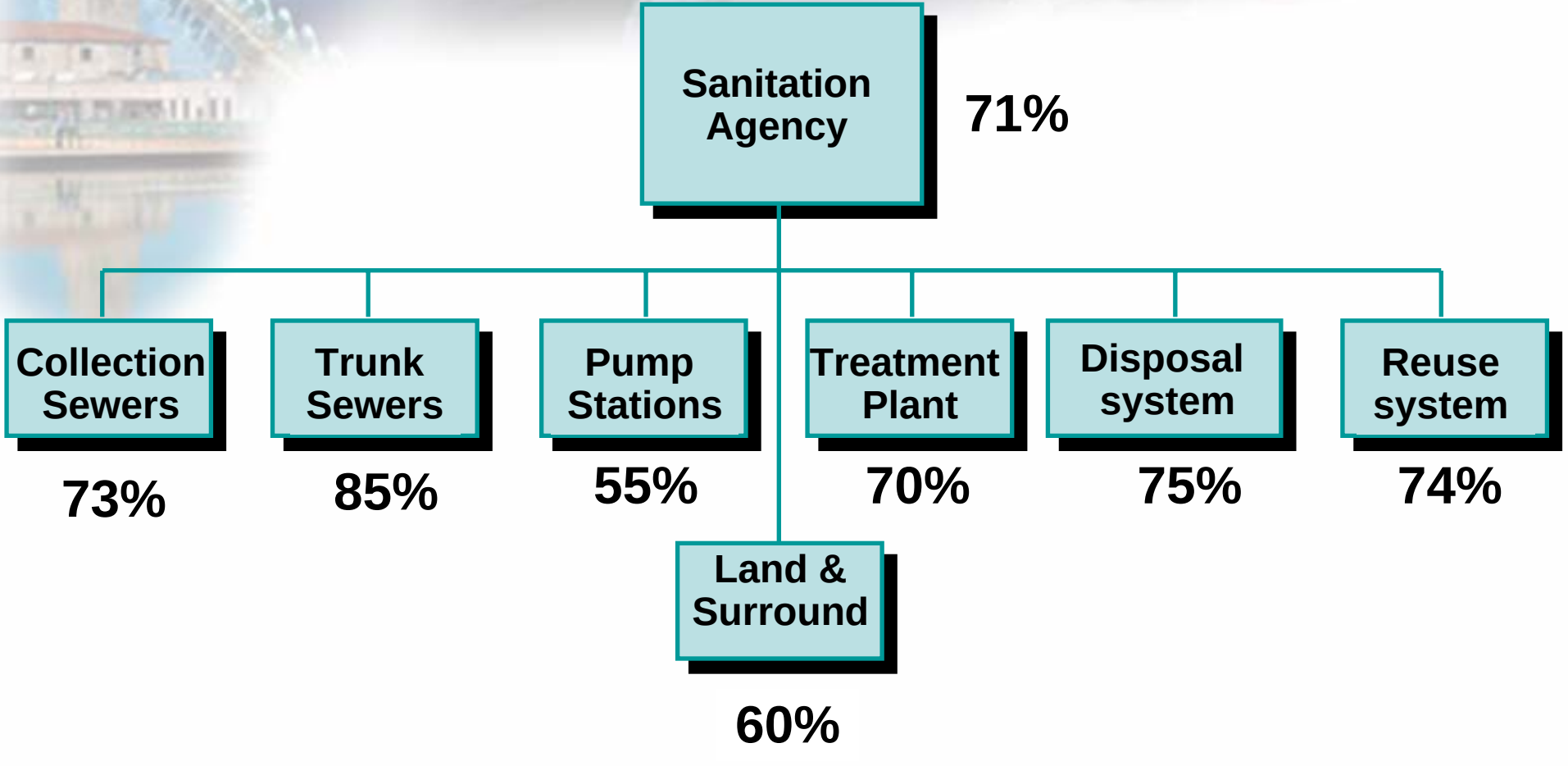
Principle Data Responsibilities

Secondary Data	AMSC	OPS	MAINT	ENG
Detailed Attributes		1		1
Condition Assessments			1	
Performance data		1		
Probability of failure		1	1	
Maintenance Data PM			1	
Maintenance Data CM			1	
Failure Mgt data (plans)			1	
Works/Resource Mgt Data			1	

Principle Data Responsibilities

Tertiary Data	AMSC	OPS	MAINT	ENG	FIN
Consequence of failure				1	
Cost Histories		1	1		
Intervention Strategies				1	
ORDM data				1	
L.C.C.A data				1	
Capex Validation				1	
Optimised Strategies					
Overall Costs					

Ensuring Business Uniformity



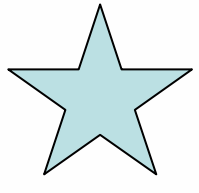
RATING THE INDIVIDUAL DEMANDS FOR RESOURCES BY USING CONFIDENCE LEVELS

Exercise Number 1a

Help Tom develop his first asset register for the pump station ..

Using the data provided :

- Prologue
- Layout Plans
- The Excel spreadsheet giving to you earlier..



Answers to Exercise Number 1a & 1b

Roger and the team will show you what answers they developed …

Ask questions , challenge their assumptions

Tell us why you did what you did…

Key Lessons Learned

- How to construct your asset register
- Always include all assets
- Decide on a data standard
- Choose an initial MMI
- Start your condition assessment process based on criticality

Q1: What is the State of My Assets?

Q1b: What condition is it in and what is its remaining physical life?

How do we assess condition ?

Why should we assess performance ?

What are the four major failure modes ?

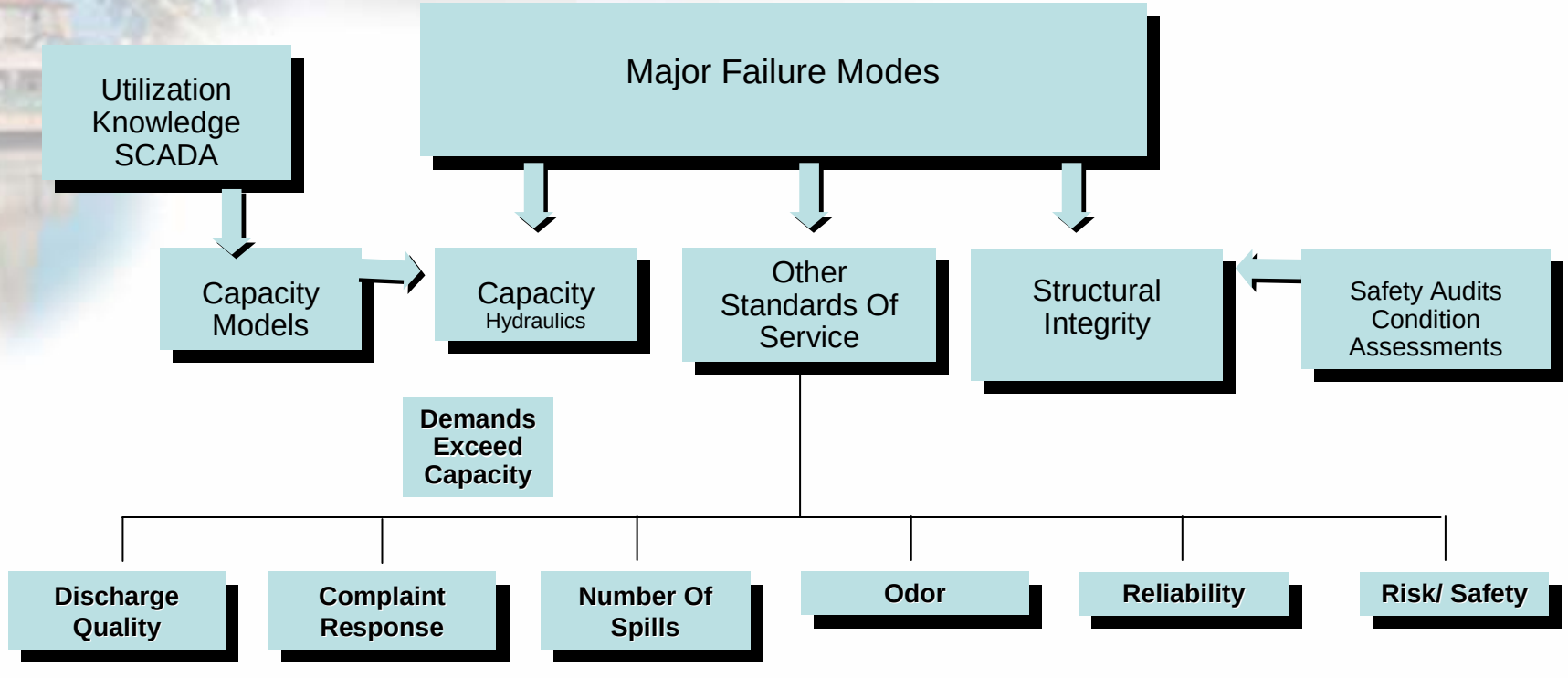
Capacity / Availability

Structural Integrity

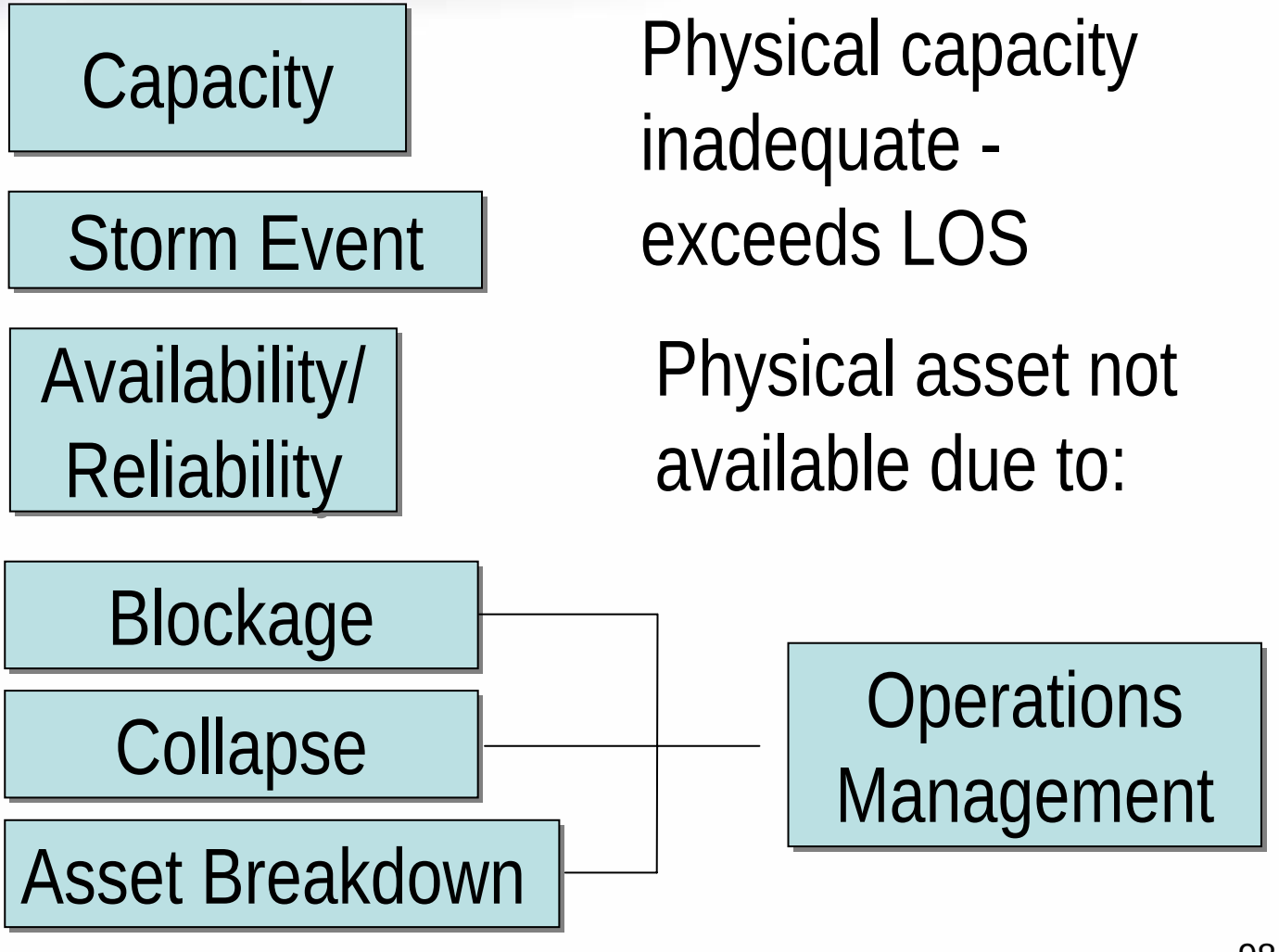
Reliability – level of service

Affordability – cost of service

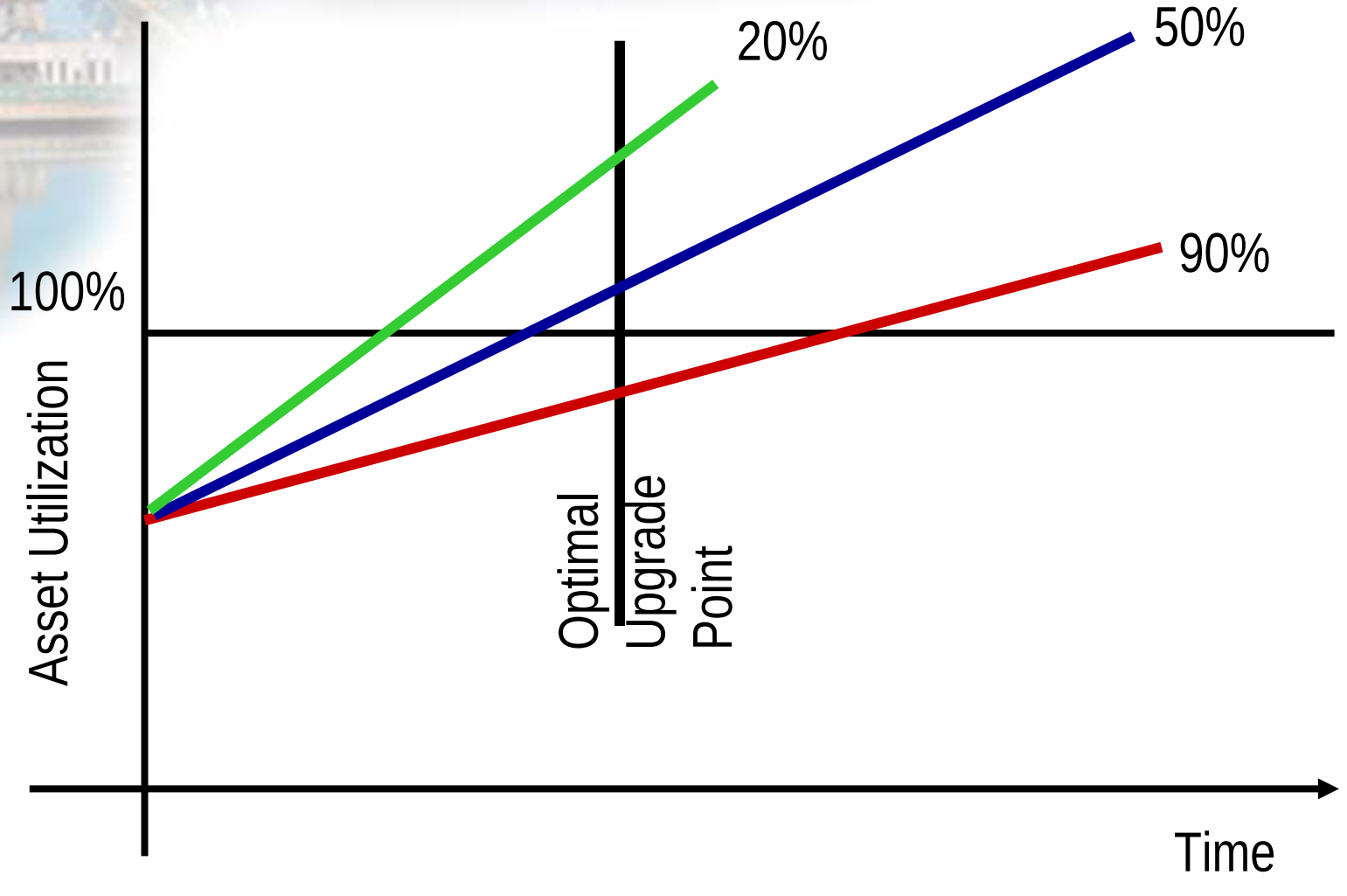
Sewer Assets – Failure Modes



CMOM – Failure Modes



Augmentation Triggers



BAP Condition / Performance Assessment

- We thoroughly understand and have recorded the current levels of service in terms of quantity and quality of service including :
  - Condition
  - Function / size /type (fit for use)
  - Regulatory requirements
  - Reliability
  - Repair response times
- We report this performance against our required levels of service annually …

BAP Condition / Performance Assessment

- We monitor condition, performance and cost to enable us to predict the failure mode by which the asset will fail to (or cause to) deliver the service level required from the asset.

Typical Condition Assessment Techniques

1. Visual inspection
2. Non-destructive testing
3. Wear products/contaminants testing
4. Vibration analysis
5. Performance analysis
6. Current & temperature analysis

Condition Rating Example

Condition Assessment

Condition Rating	Description	Maintenance Level	Degree of Replacement
0	NEW	Normal	0%
1	PERFECT/EXCELLENT CONDITION	Normal	0%
2	MINOR DEFECTS ONLY	Minor	5%
3	BACKLOG MAINTENANCE REQUIRED	Significant	10-20%
4	REQUIRES MAJOR RENEWAL	Renew	20-40%
5	ASSET ALMOST UNSERVICEABLE	Replace	>50%

Condition Assessment

Intermediate Method

4.1
4.3
4.5
4.7
4.9
5.0
5.1
5.2
5.3
5.4
5.5
5.6
5.7
5.8
5.9

Develop Method
Related To
Distress
Of Assets

Condition Assessment

Sophisticated methods

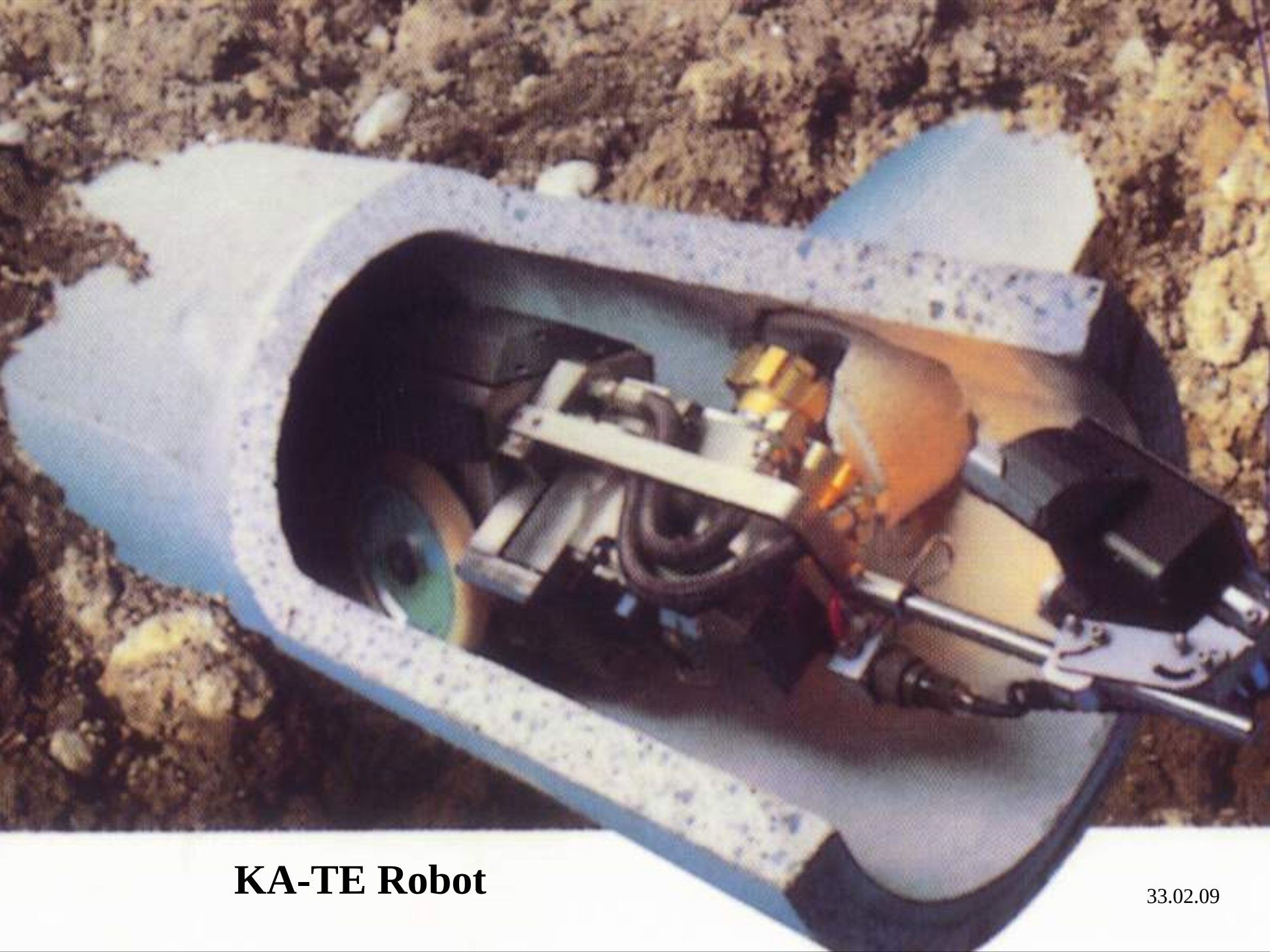
Assess condition of each distress mode and apply a weighting factor to each to produce both element condition and overall condition

For example: a sewer score 1 to 5 for:
Cracking longitudinal, joint displacement ,
Circumferential cracks, alignment, etc.

Condition Monitoring Systems / Asset Groups	Vibration	Temperature	Oil Usage/Level/Contaminants	Efficiency Change (Head Loss)	Infra Red Thermography GP Radar	Hours Run	Power Usage Monitoring	Concrete Decomposition Testing & Core Sampling	X-Ray	Remote Control Television Inspection	Pressure Testing	Smoke Testing	Capacity Modelling (for failure)	Leak Testing (PIZZ)	Intelligent Pigs	Protection (Paint) Thickness	Manual Inspection (Operators)	Alarms/Auto Shutdowns Shut Down Telemetry Protection	Life Expectancy Review	Visual Assessments	Laser Profiling / Roughness Meters	Pavement Strength Testers	Skid Resistance Testers
DYNAMIC ASSETS																							
Mechanical plant	✓	✓	✓	✓	✓	✓	✗	✗	✓	✓	✓	✗	✓	✓	✗	✗	✓	✓	✓	✓	✗	✗	✗
Electrical plant	✗	✓	✓	✗	✓	✓	✓	✗	✗	✗	✗	✗	✓	✓	✗	✗	✓	✓	✓	✗	✗	✗	✗
Instruments	✗	✓	✗	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓	✓	✓	✗	✗	✗	✗
Control systems (Electronic)	✗	✓	✗	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓	✓	✓	✗	✗	✗	✗
PASSIVE ASSETS																							
Roads	✗	✗	✗	✗	✓	✗	✗	✗	✗	✗	✗	✗	✓	✗	✗	✗	✓	✗	✓	✓	✓	✓	✓
Reservoirs / dams	✗	✗	✗	✗	✓	✗	✗	✓	✗	✗	✗	✗	✓	✓	✗	✗	✓	✗	✓	✓	✗	✗	✗
Structures	✗	✗	✗	✗	✓	✗	✗	✓	✗	✗	✗	✗	✗	✗	✗	✓	✓	✗	✓	✓	✗	✗	✗
concrete	✗	✗	✗	✗	✗	✗	✗	✓	✗	✗	✗	✗	✗	✗	✗	✗	✓	✗	✓	✓	✗	✗	✗
earthern	✗	✗	✗	✗	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓	✓	✗	✗	✗
Buildings	✗	✗	✗	✗	✗	✗	✓	✓	✓	✗	✗	✗	✓	✗	✗	✓	✓	✗	✓	✓	✓	✗	✗
Pipelines																							
gravity conduits	✗	✗	✗	✓	✓	✗	✗	✓	✓	✓	✗	✓	✓	✓	✓	✗	✓	✗	✓	✓	✗	✗	✗
pressure conduits	✗	✗	✗	✓	✓	✓	✗	✓	✓	✓	✓	✗	✓	✓	✓	✗	✓	✓	✓	✓	✗	✗	✗
ELECTRICAL NETWORKS																							
Poles	✗	✗	✗	✗	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓	✗	✓	✓	✗	✗	✗
Wires	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓	✗	✗	✗	✓	✓	✓	✓	✗	✗	✗

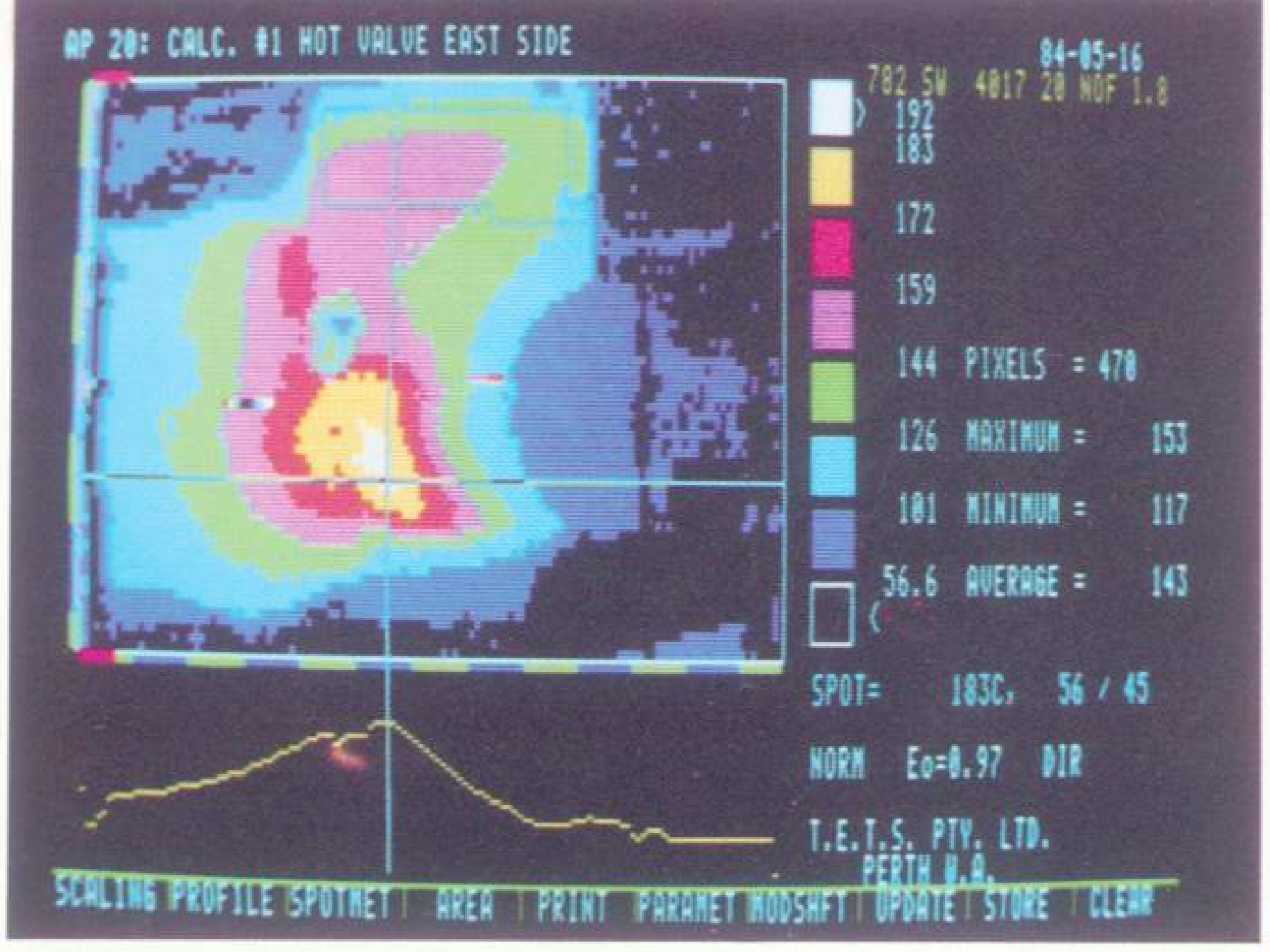
✗ Denotes Not Applicable

✓ Denotes Applicable

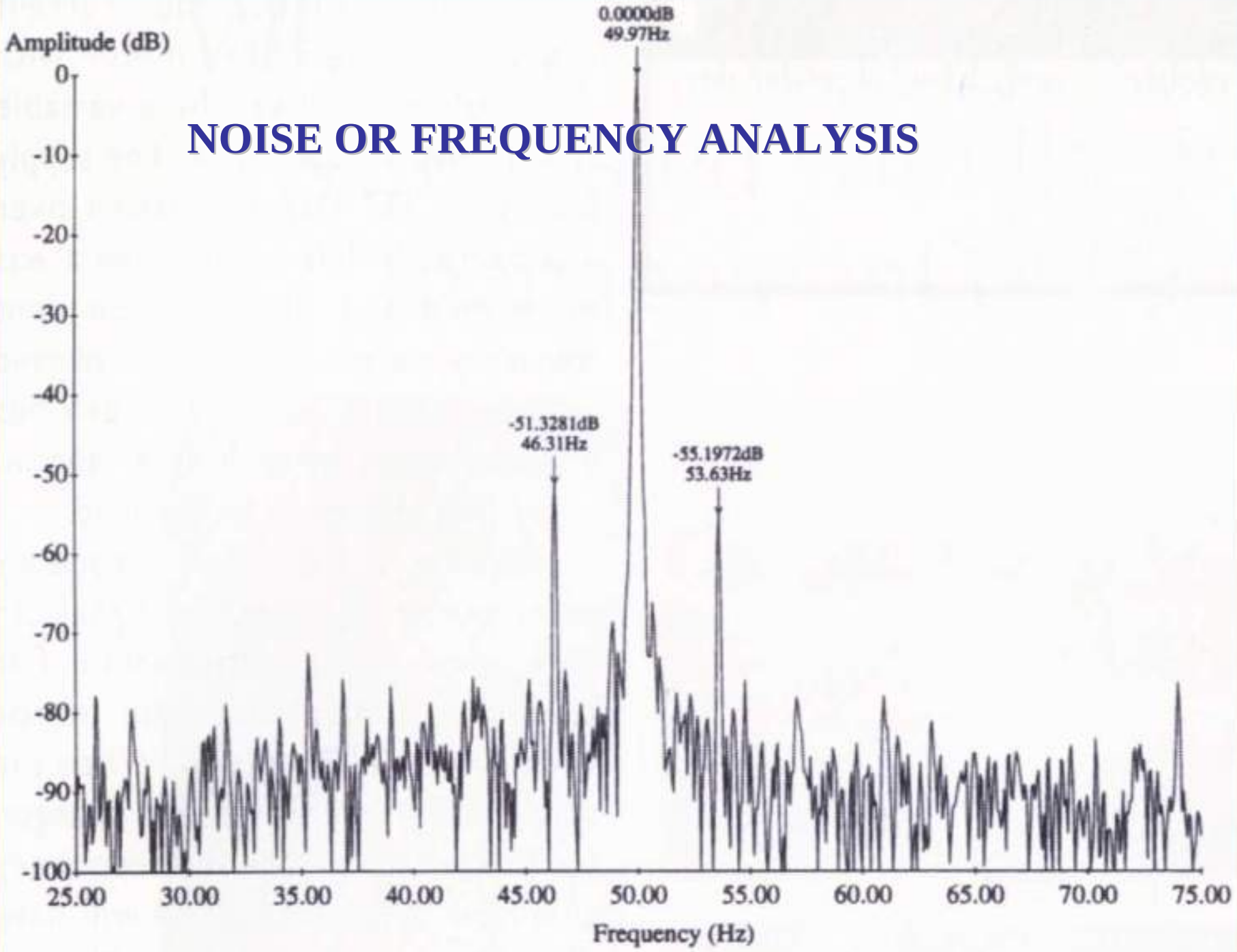


KA-TE Robot

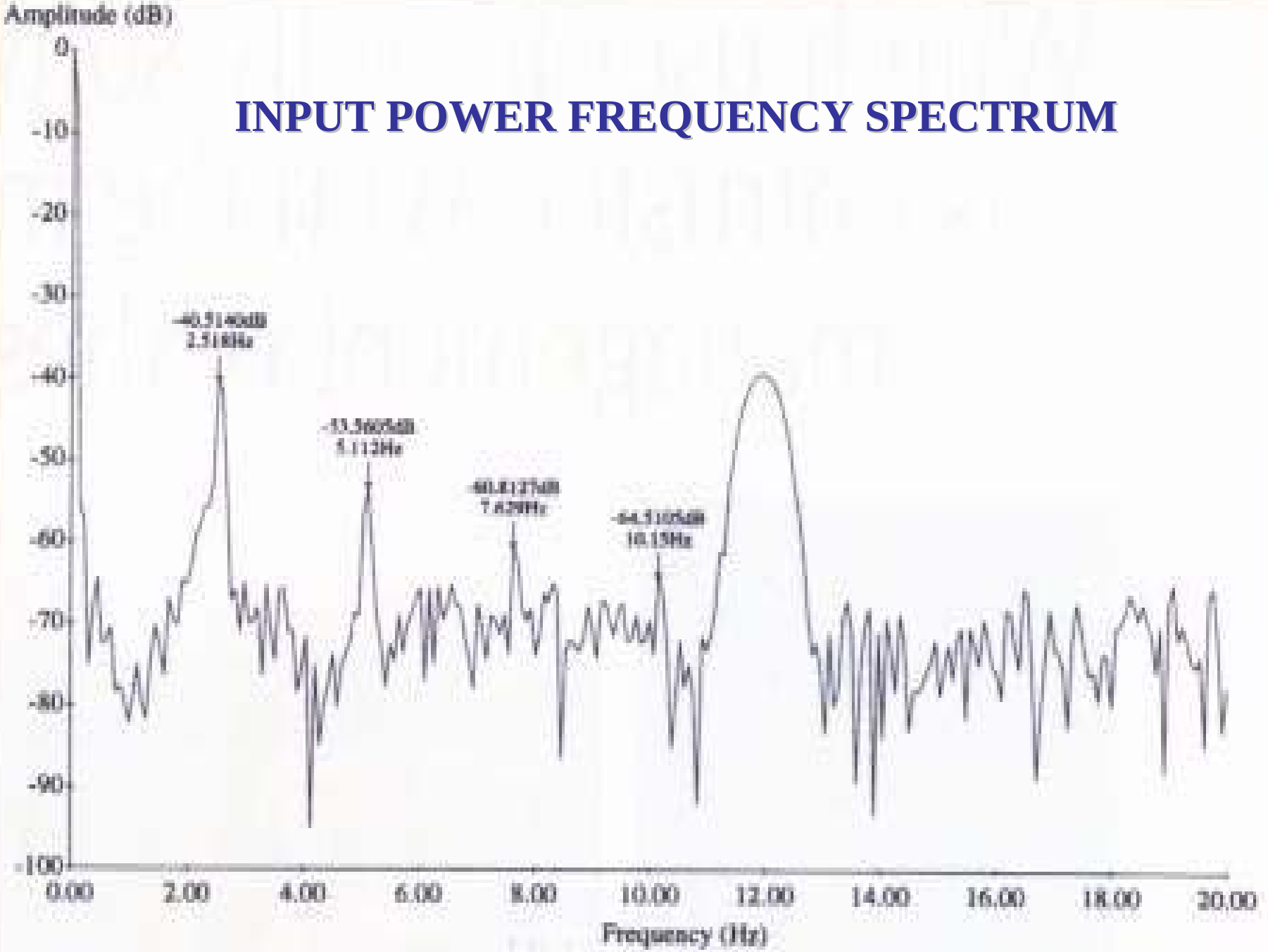
33.02.09


AP 20: CALC. #1 HOT VALUE EAST SIDE
84-05-16
782 SW 4017 20 NOF 1.8
192
183
172
159
144 PIXELS = 470
126 MAXIMUM = 153
101 MINIMUM = 117
56.6 AVERAGE = 143
SPOT= 183C, 56 / 45
NORM Eo=0.97 DIR
T.E.T.S. PTY. LTD.
PERTH W.A.
SCALING PROFILE SPOTMET AREA PRINT PARAMET MODSHFT UPDATE STORE CLEAR

NOISE OR FREQUENCY ANALYSIS



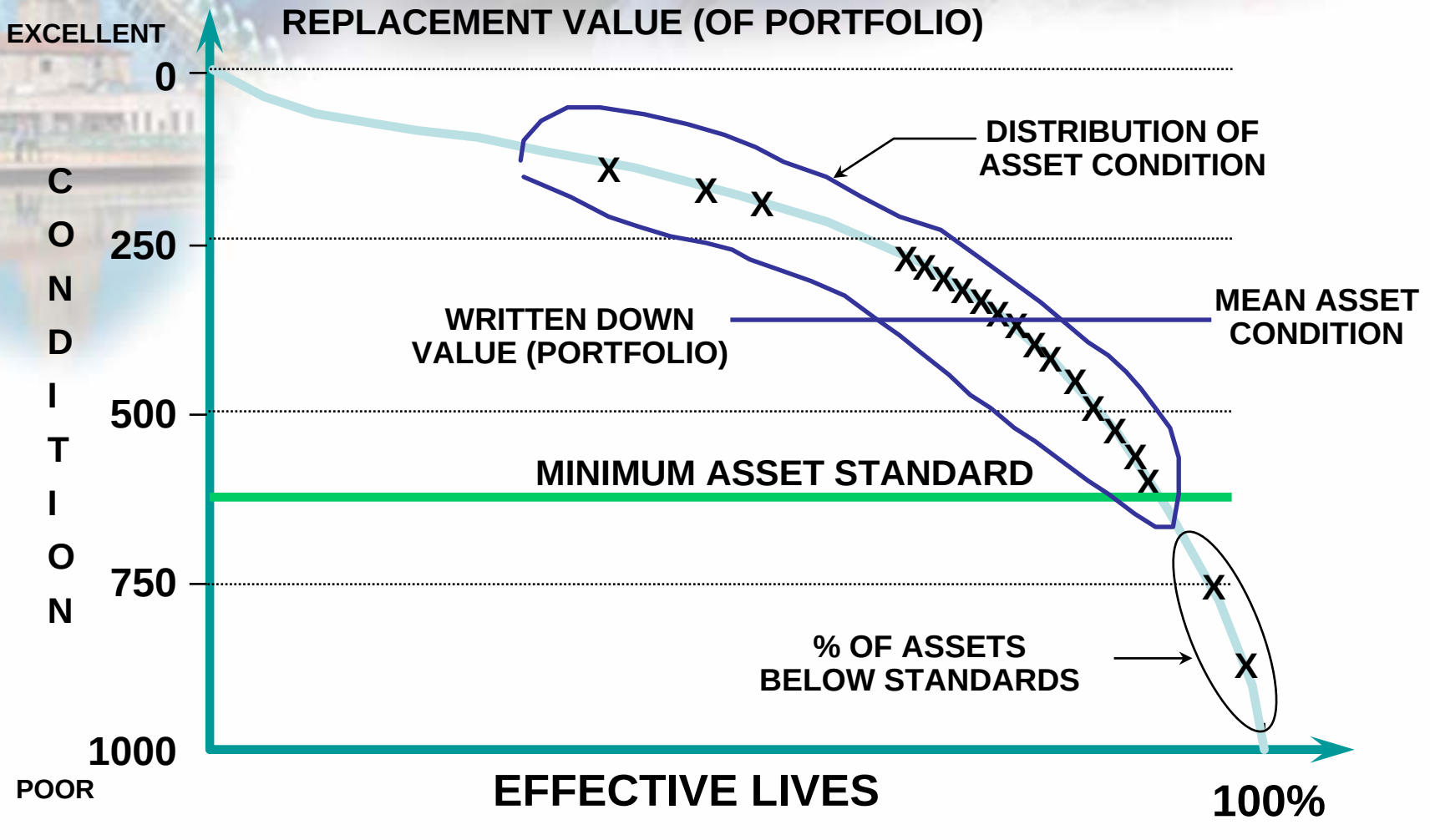
INPUT POWER FREQUENCY SPECTRUM

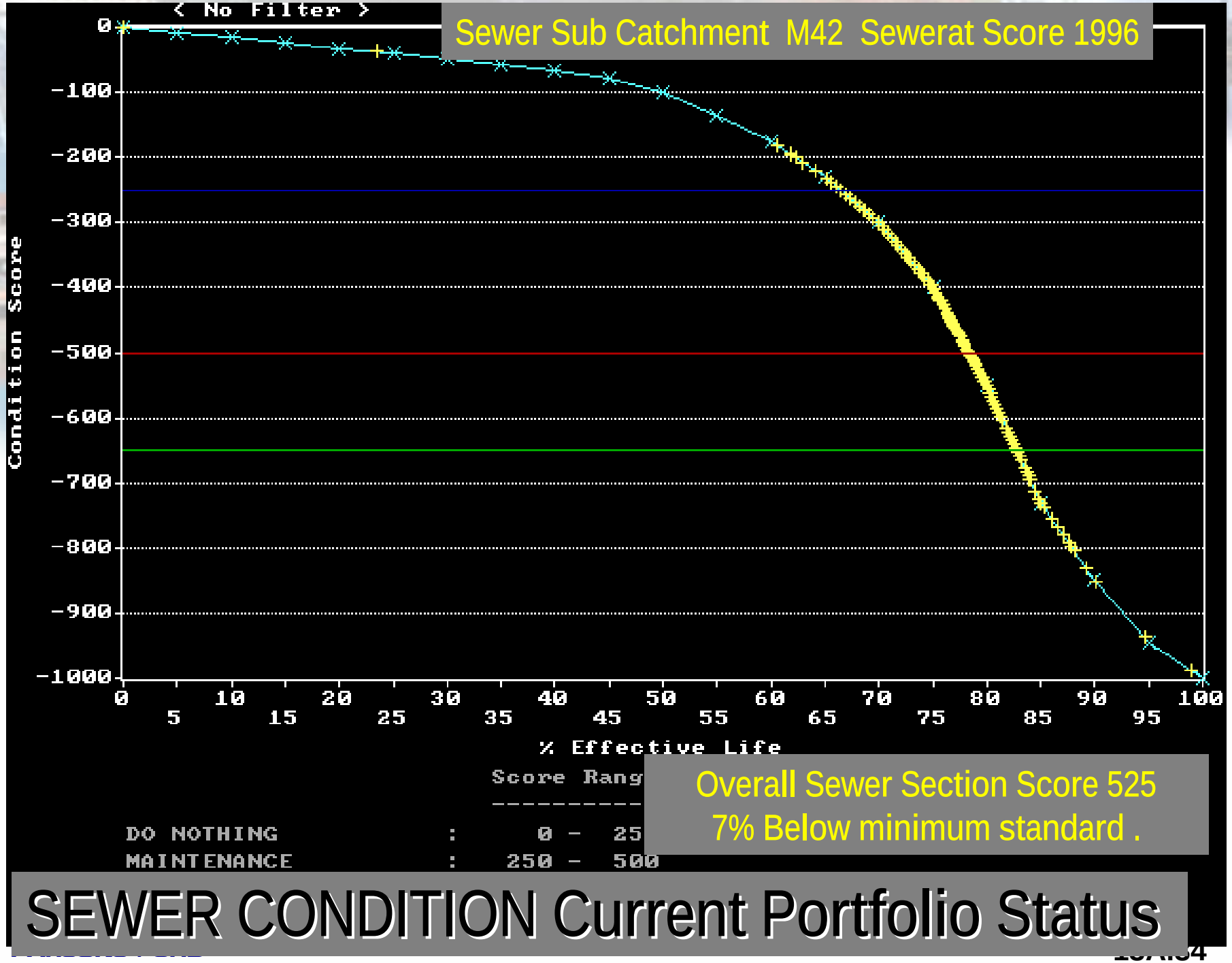


SHOCK PULSE ANALYSIS

PARSONS / GHD

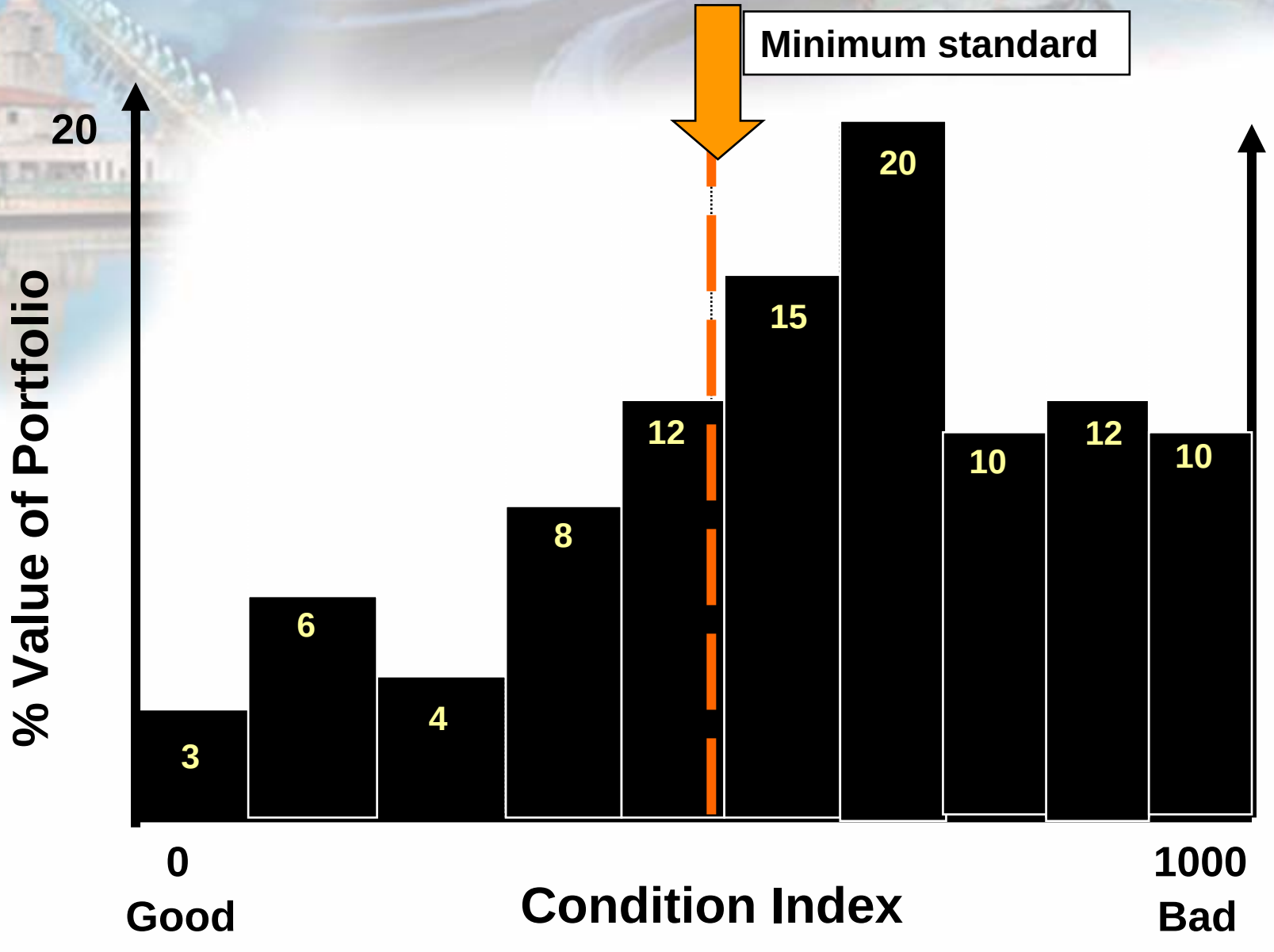
Reporting on Asset Portfolios





SEWER CONDITION Current Portfolio Status

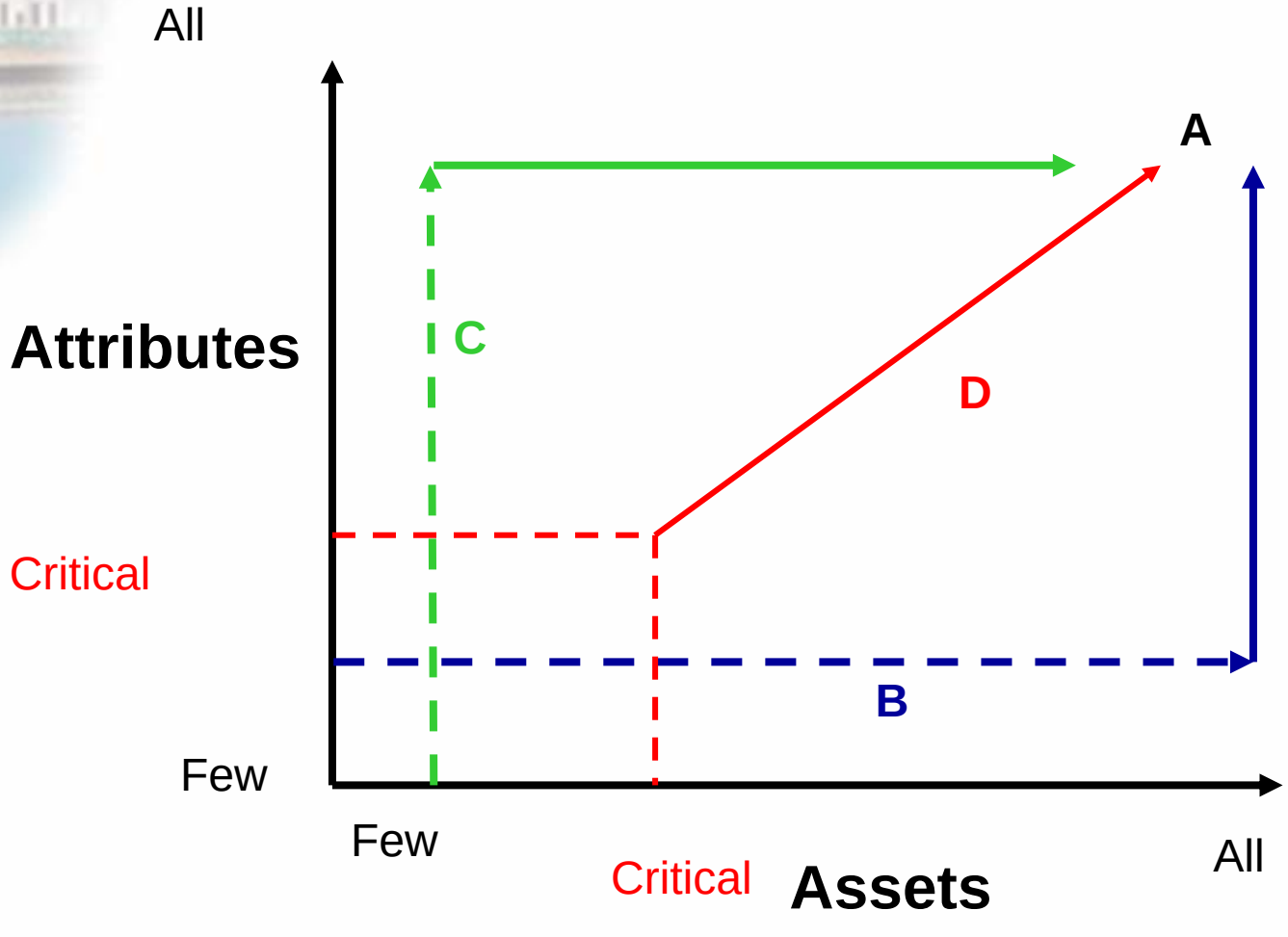
Portfolio Condition



Expanding This To The Whole Asset System Cost Effectively

- We cannot afford to understand the condition of all our assets!
- Do we really need to understand this ?
- Yes , we need to be confident in what we tell our Board and stakeholders .
- Can’t we do it smarter ?
- Yes we can …

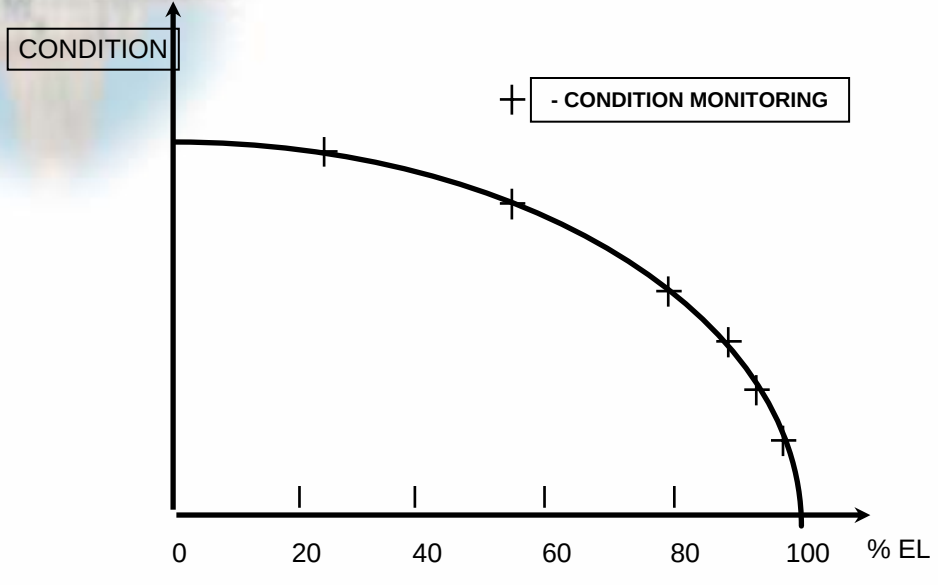
Data Collection Strategies



Actuarial / Risk Based CAP

- Understand causes of decay
- Understand risk (criticality) of assets
- Determine risk drivers
- Rank assets against drivers
- Use actuarial sampling techniques to determine sample needed to derive necessary confidence level
- Complete sample till confidence level is confirmed

Level 2 – Benefits Based

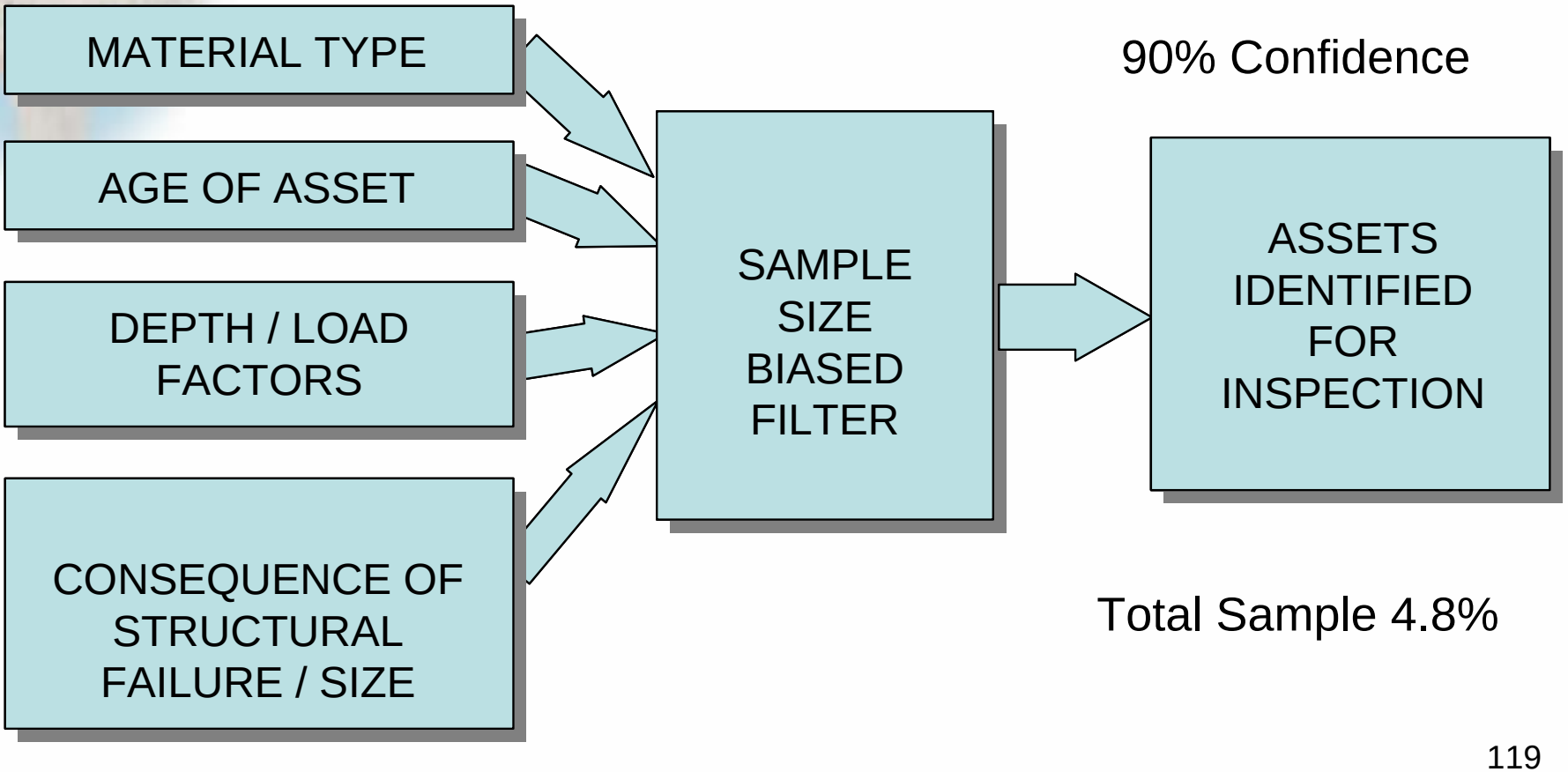


EFFECTIVE LIFE	NUMBER OF INSEPECTIONS	
	STATUS QUO	BENEFITS BASED
30	7	4
40	10	5
50	12	6
75	18	10
100	25	14

Level 3 Actuarial Sampling

Key Variables (4 No.):

Sewer asset profile consists of 20,000 pipelines (manhole lengths)



Actual Savings Achieved

OPTION	COSTS / SAVINGS ACHIEVED
1. ORIGINAL PRACTICE	$ 4.48 Million
2. BENEFITS BASED	$ 2.45 Million
3. ACTUARIALLY BASED	$ 0.74 Million

Exercise Number 1a Cont.

Develop a register that you think is needed to manage the pump station …

Set the level of the maintenance managed item MMI to the level of hierarchy that you think is needed.

Exercise Number 1 b

Help Tom develop an understanding of the physical condition of the assets and components in the pump station :

- use your asset register
- rate their condition using the assessment table shown on sheet A …
- The spreadsheet will then calculate the residual life and the % asset consumed…

Take Home Messages

- If you understand the asset condition you can understand how long they will last, but
- We also need to know their performance & cost.
- We need real data to do that …
- But what performance is required ?
- We can't set an economic life until we know this …
- So "how should we set the level of service?"

Q1: What is the State of My Assets?

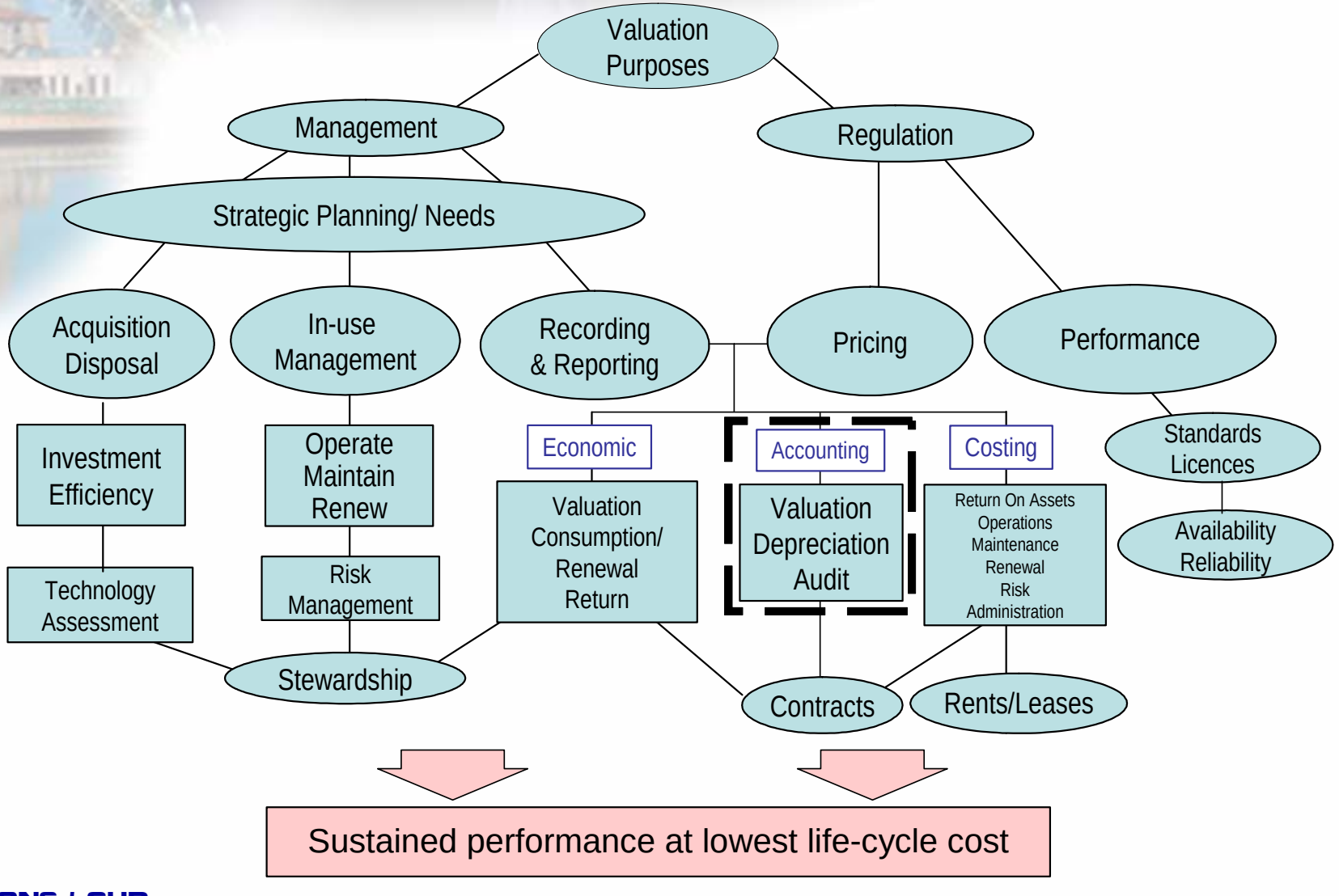
Q1c: What is the value of my assets?

Reasons for Valuing Assets

- Financial reporting/auditing
- Measuring loss of service potential (de / depreciation)
- Pricing/funding
- Determination of equit
- Risk managemen ance)
- Sale and p akeovers/mergers
- AM d aking – especially renewals
- B rking

Measuring "Sustained Stewardship"

Valuation Purposes & Uses

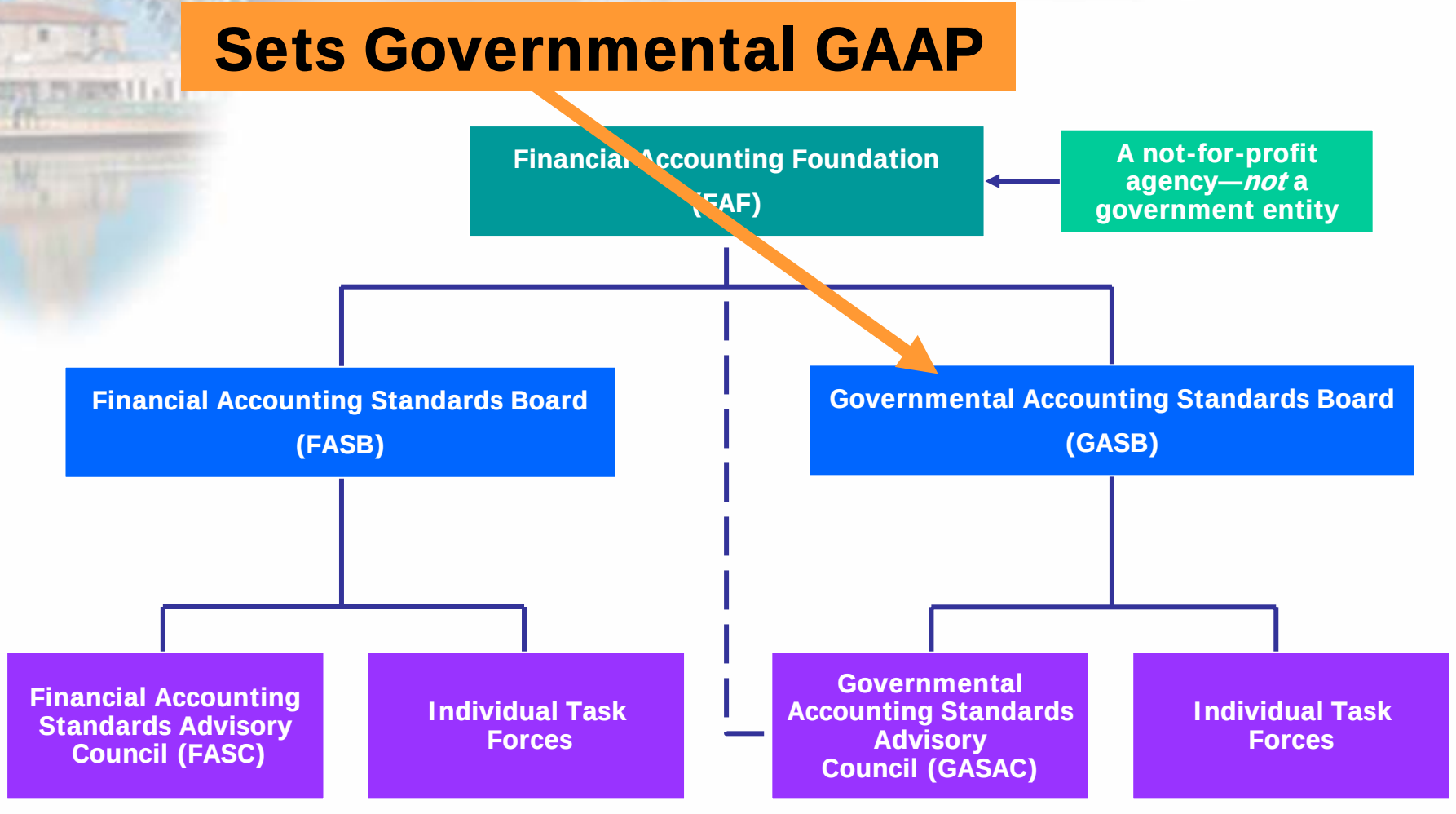


Valuation Approaches

- Comparable Sales / Market Selling Price
- Earnings based / Cash Income NPV
- Asset Value
  - Historic cost
  - Renewal cost
  - Reproduction cost
  - Deprival cost
  - Depreciated Replacement Cost (DRC)
  - Optimized Depreciated Replacement Cost (ORDC)

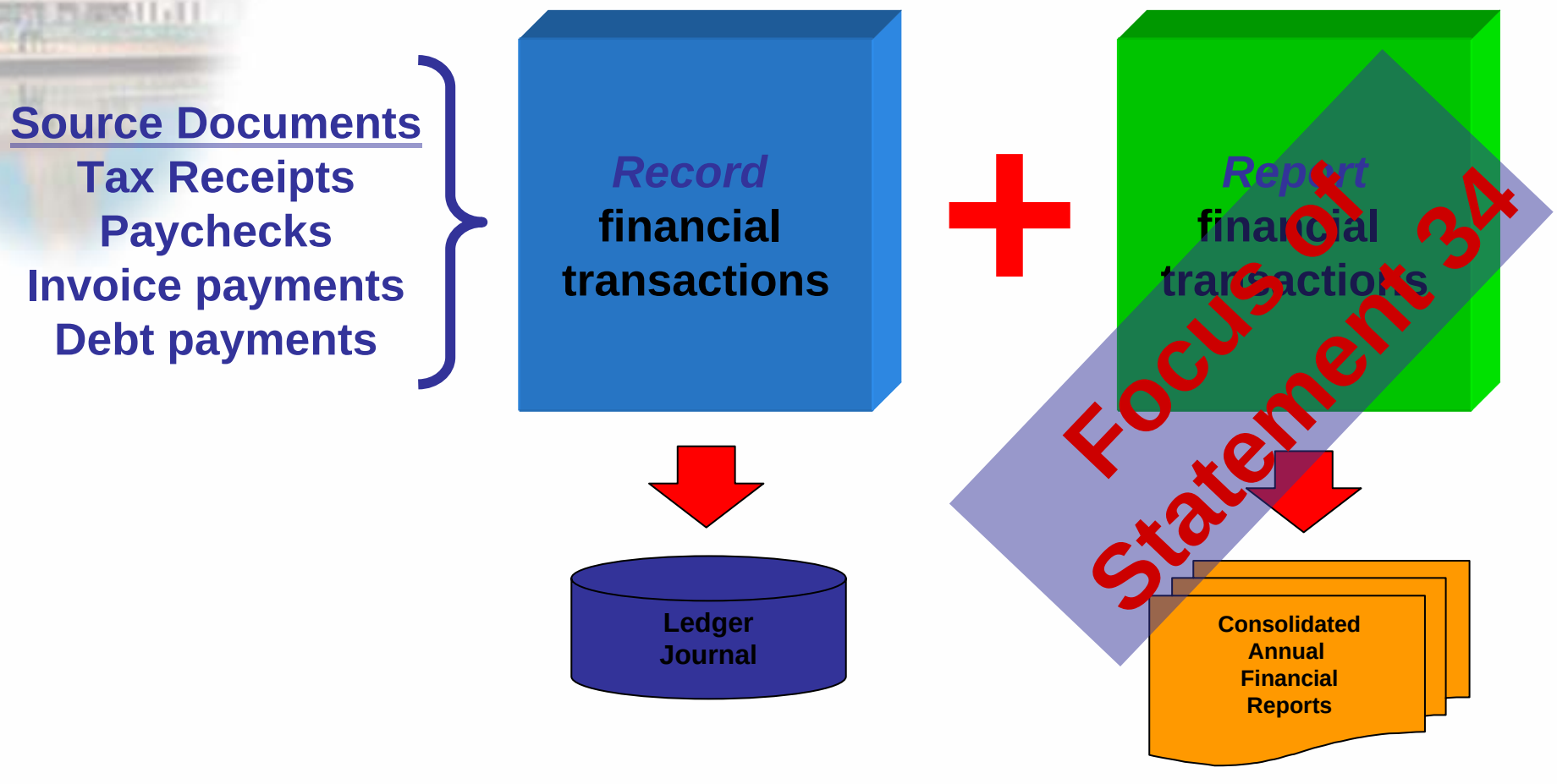
The heartbreak of valuation

GASB - How GAAP is Set



What GAAP Is All About

Practices And Procedures By Which Governments:



Reporting of Capital Assets

- One of the main goals of the new reporting model is to provide information about the "full cost" of providing government services.
- Cost of services must include the consumption of capital resources used to provide those services.
- Two techniques for estimating those "consumption of capital" costs are available:
  - Depreciation
  - "Modified" (preservation) method

Why Two Methods of Valuation?
Finite-lived versus Indefinite-lived Capital Assets:

"Consumable" Assets:

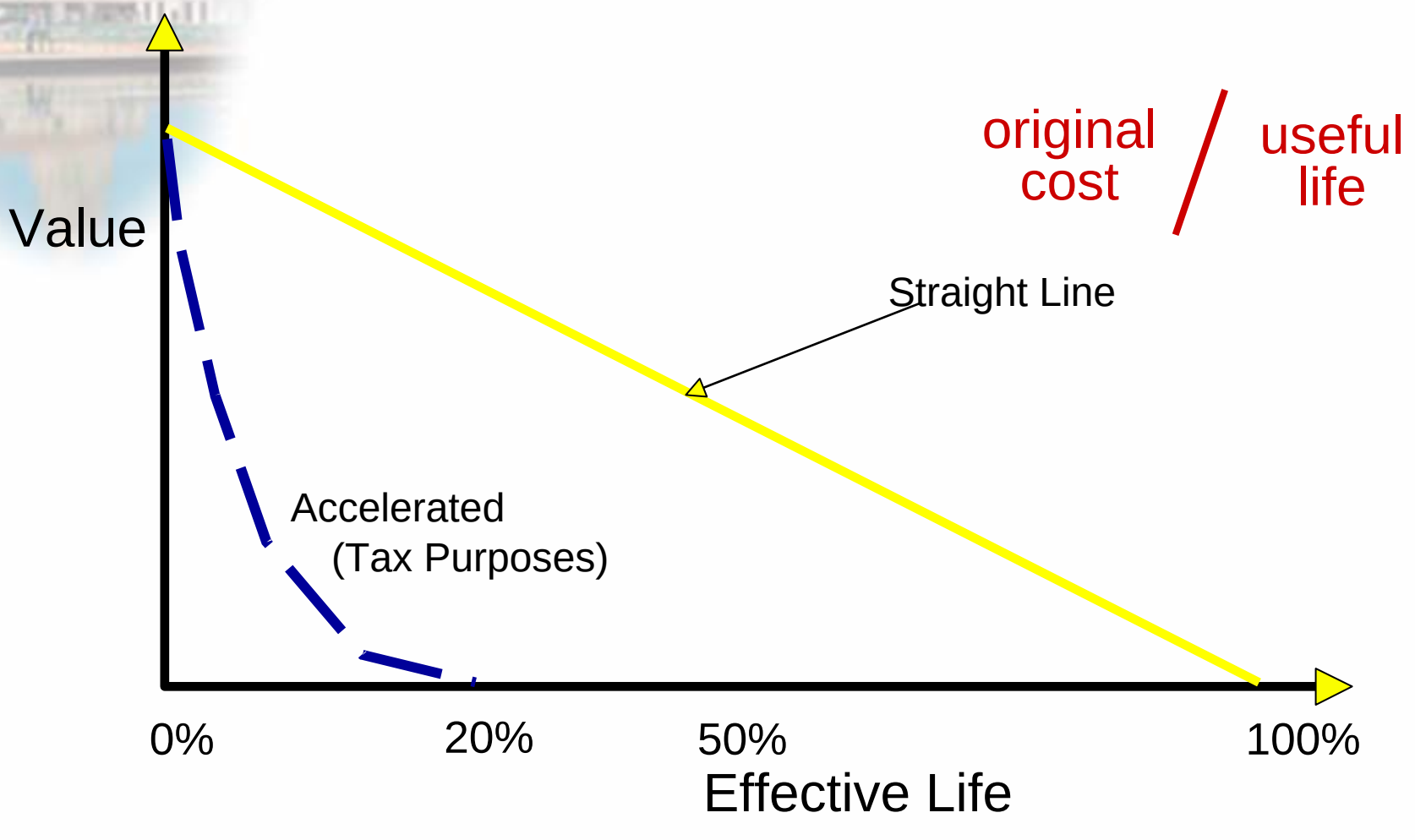
- Vehicles
- Equipment
- Metal Building
- Signs
- Furniture and Fixtures

"Preservable" Assets:

- Roads
- Bridges
- Stormwater Systems
- Water/Sewer
  - Collection systems
  - Distribution systems
  - Treatment Plants

Basic Depreciation Method

- Straight line depreciation
  - easy to apply but rarely a true reflection of decay



Traditional Depreciation

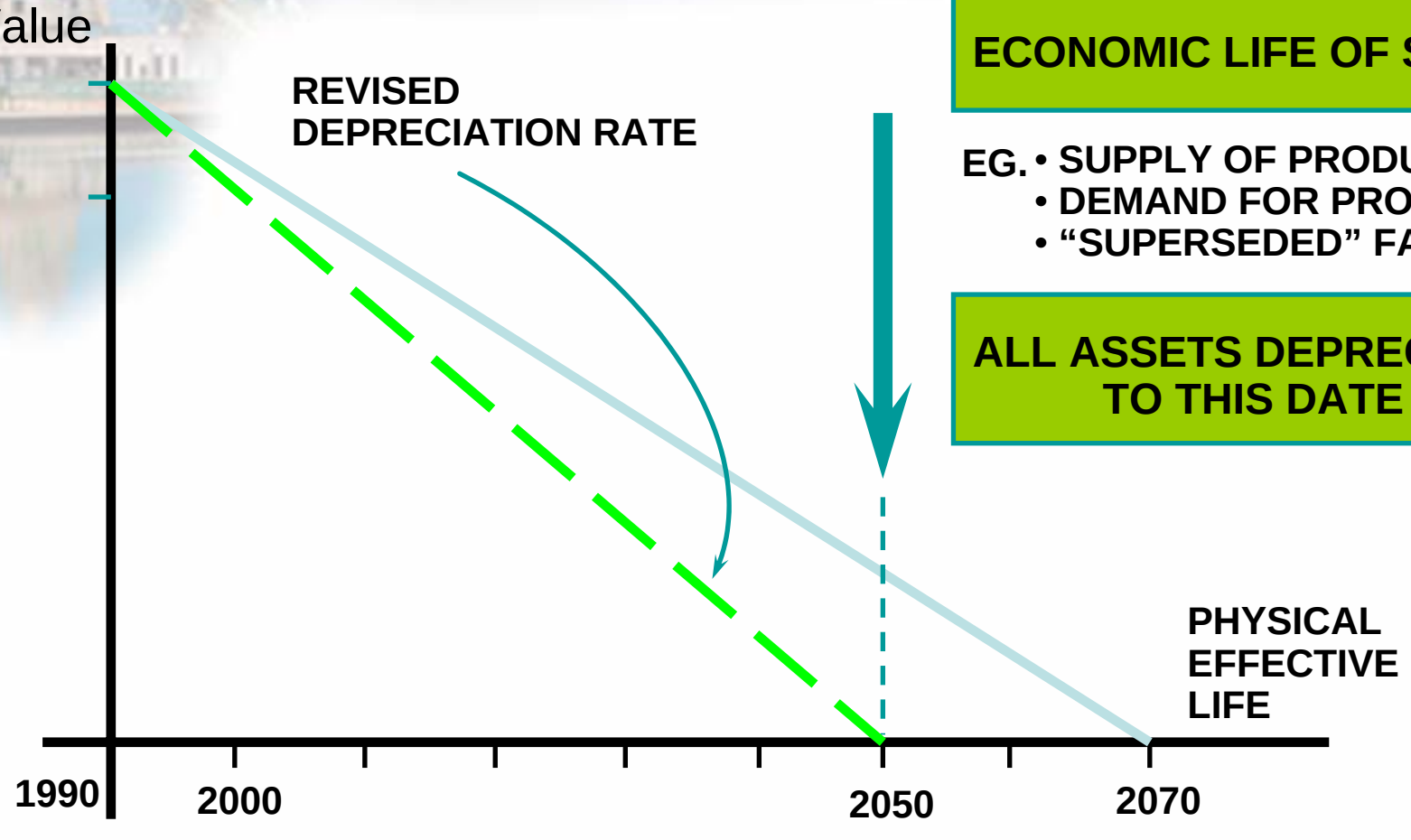
Perceived advantages of traditional depreciation

- ✓ Authoritative under Generally Accepted Accounting Principles
- ✓ Easy to calculate
- ✓ More certainty from valuation perspective (source documents)

Perceived disadvantages of traditional depreciation

- X Backward looking, allocation of past costs
- X Conveys a precision that doesn't reflect reality
- X Perceived as remote from decisions on managing assets
- X Emphasis on an individual asset, not the network

System Or Facility Lives



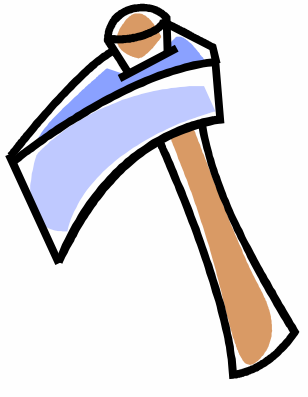
ECONOMIC LIFE OF SYSTEM

EG.
- SUPPLY OF PRODUCT
- DEMAND FOR PRODUCT
- "SUPERSEDED" FACILITY

ALL ASSETS DEPRECIATE TO THIS DATE

Characteristics of Infrastructure Assets

- Don’t actually (physically) depreciate on a straight line basis - that is, loss of service potential is not evenly distributed across time
- Large networks are made up of components that are replaced, but network service potential remains constant
- Are maintained in perpetuity (Grandfather’s axe)



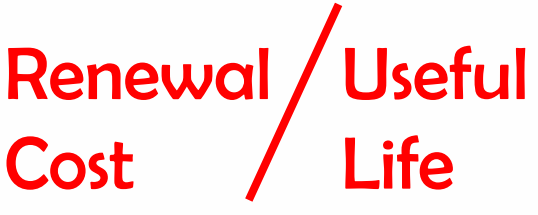
Alternative Valuation Methods

- "Modified (Preservation) Method
  - Based on *historic* cost
  - Historic cost is not reduced if the condition of the asset is preserved
  - Requires setting a measurable condition or performance standard (level of service)
  - Requires condition to be measured and disclosed at least every three years

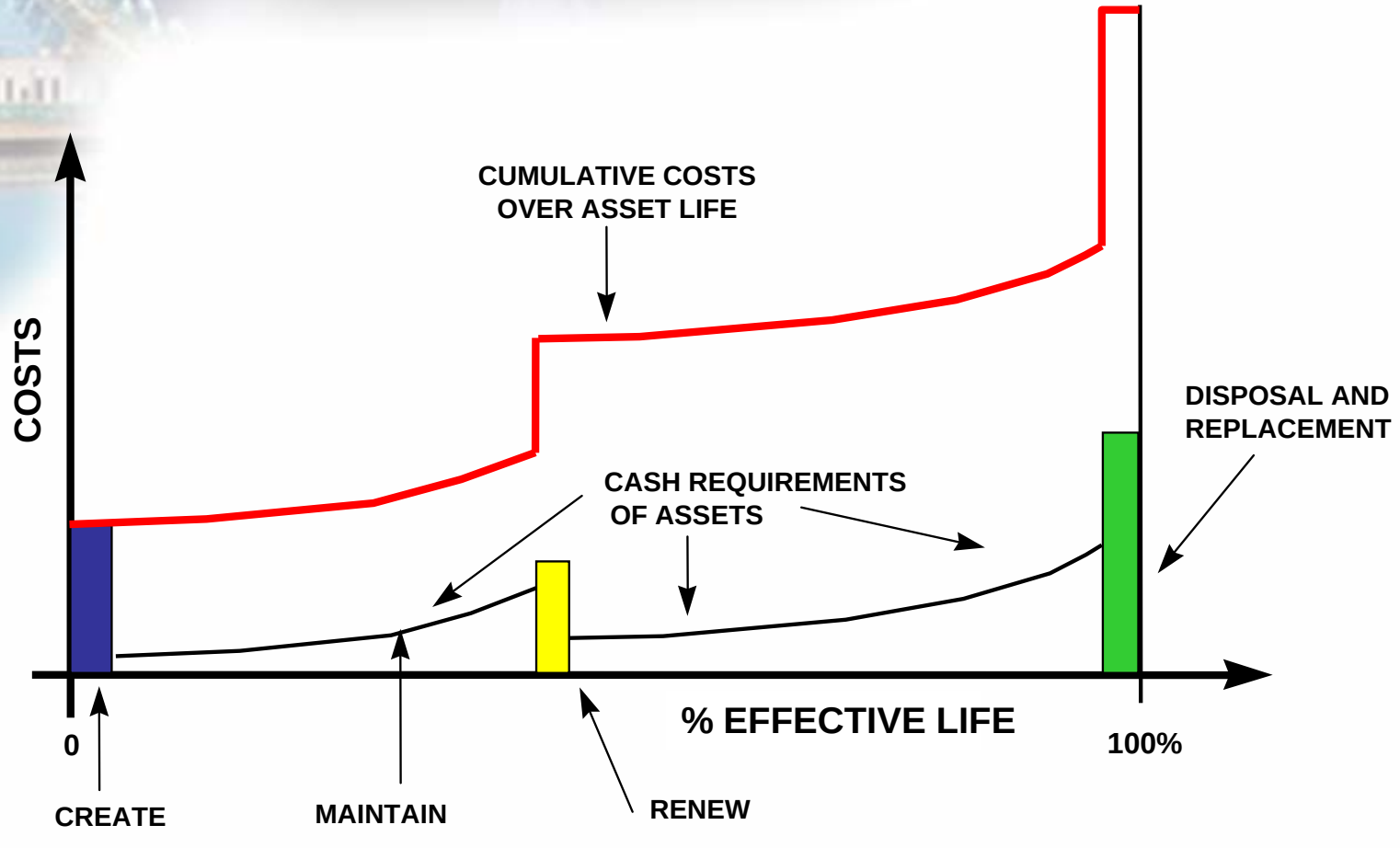
Historic cost (renewal costs are expensed each year)

Alternative Valuation Methods

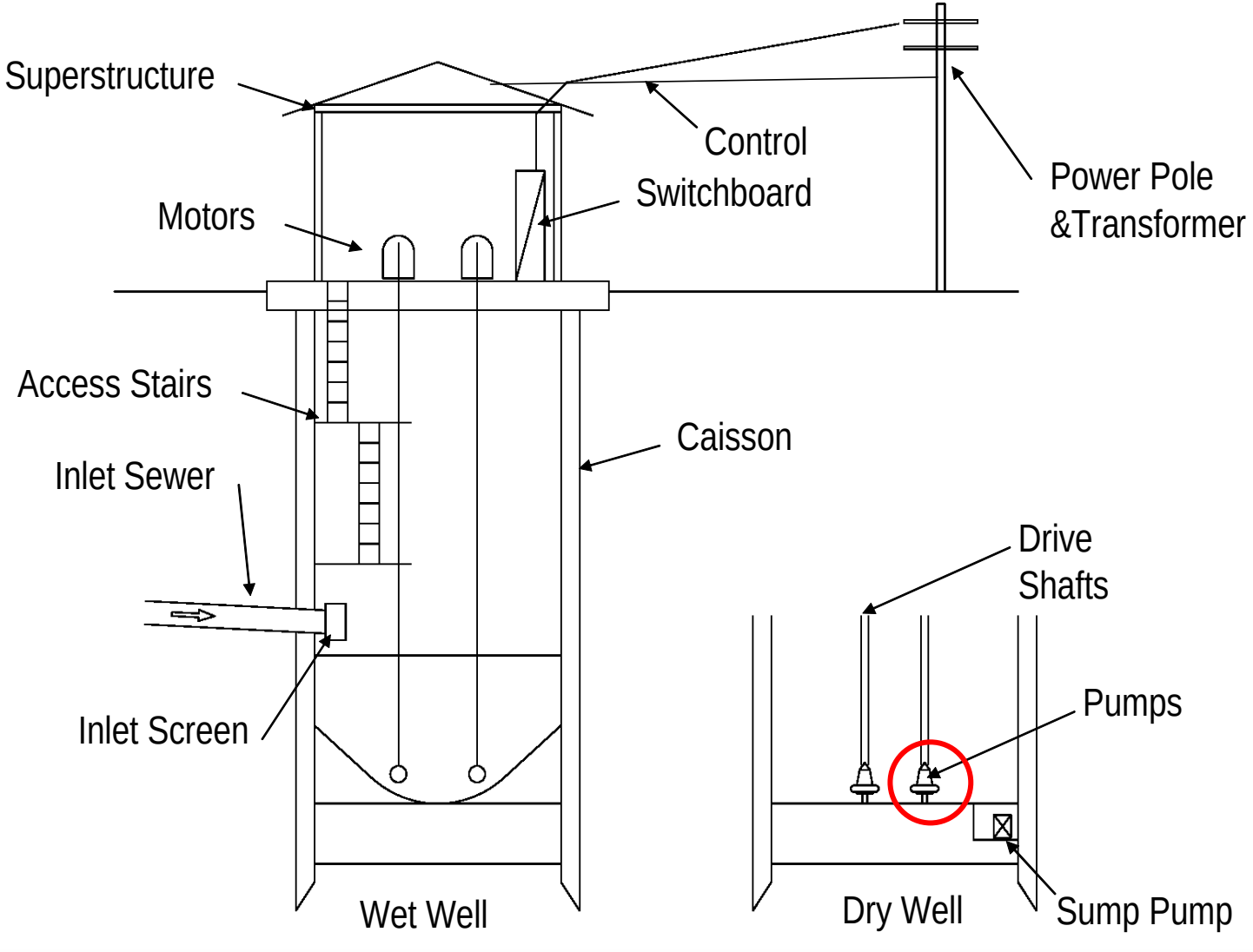
- Condition based depreciation (CBD)
  - Based on forecast *renewals*.
  - Uses condition based data to identify optimal life *extension* strategy
  - Deals at *component or asset* level
  - Requires accurate condition rating system
  - Looks to intermediate time range rather than longest life-cycle
  - Not recognized by GAAP in US



The Nature of Life-Cycle Costs



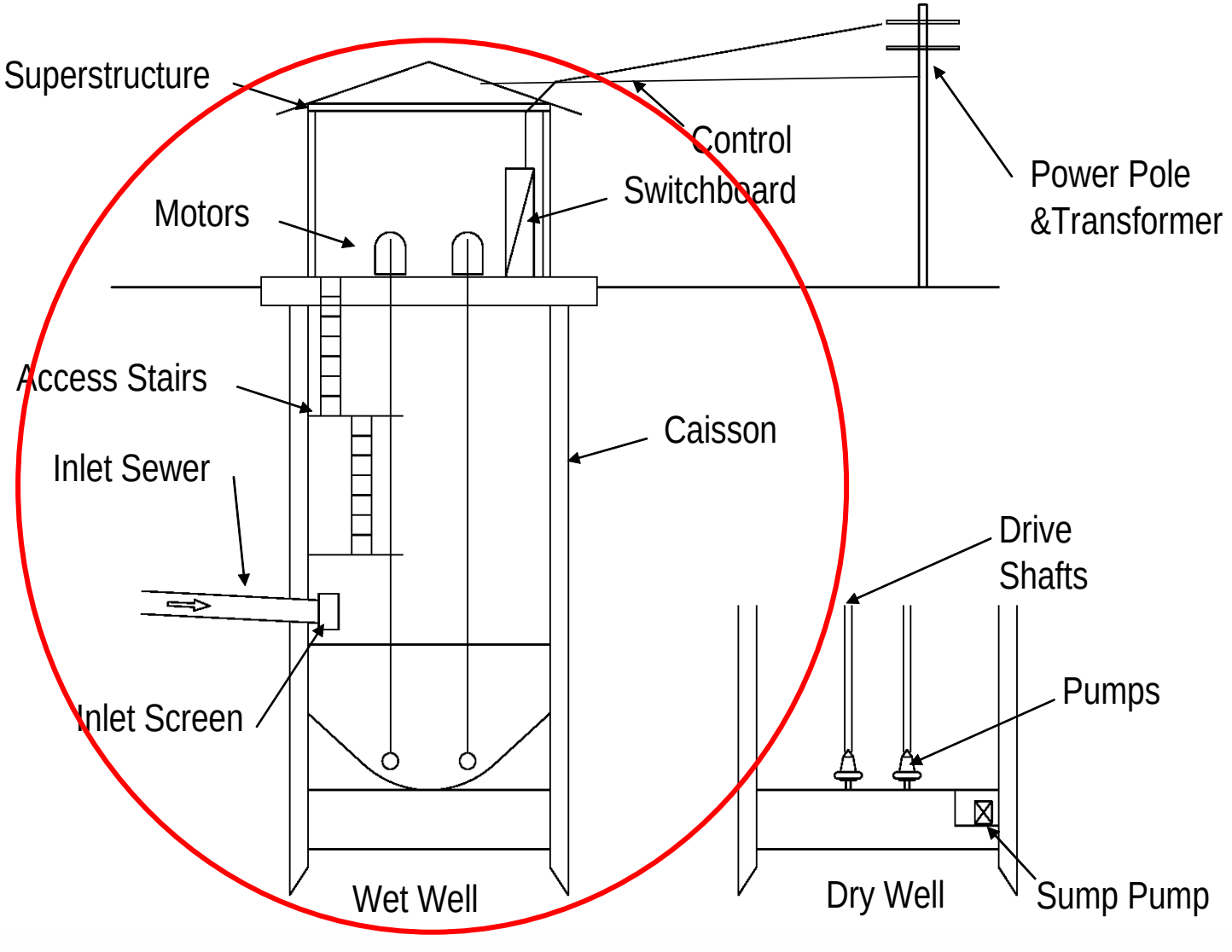
The Pump Station



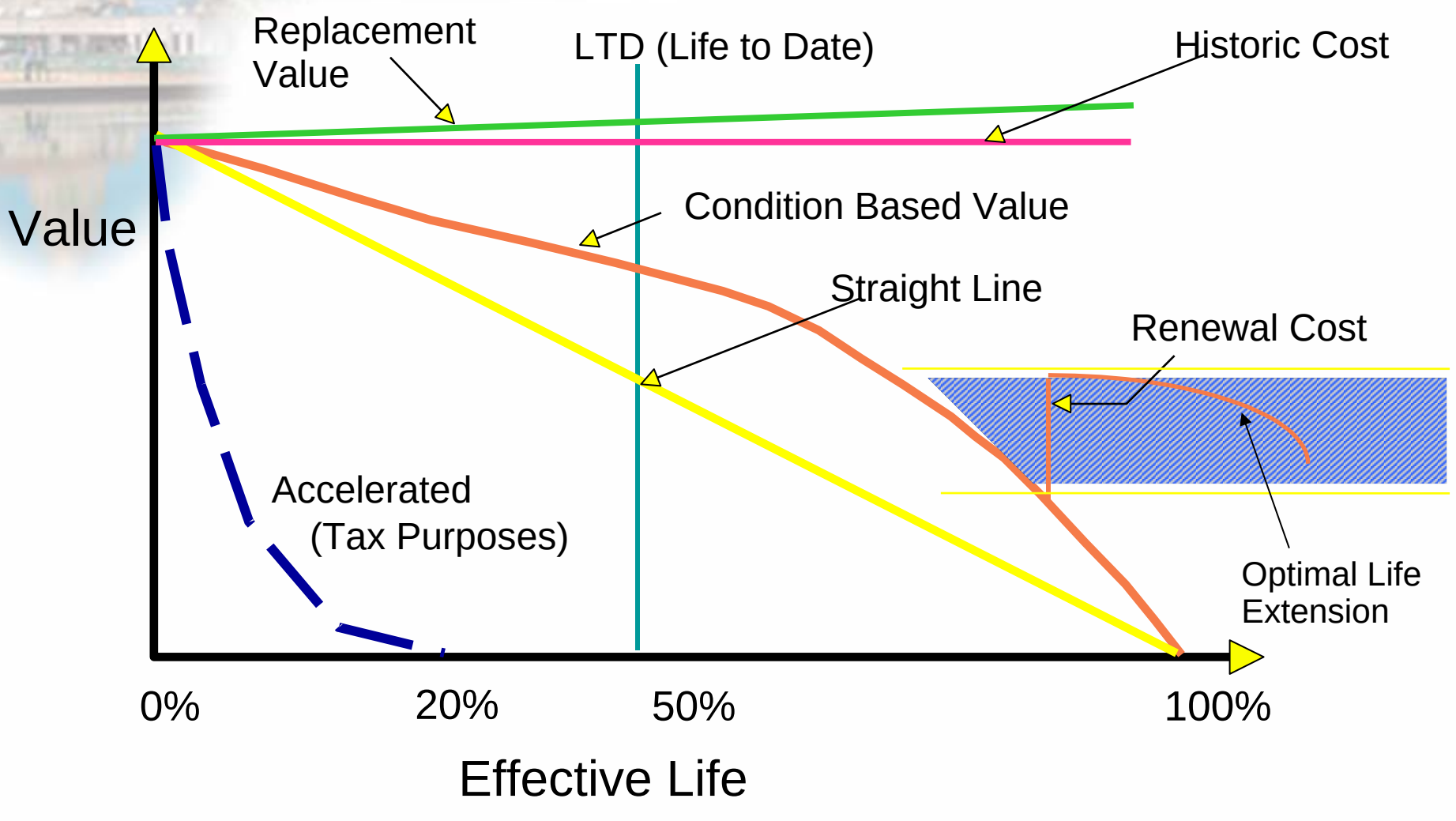
Alternative Valuation Methods

- Depreciated replacement cost (DRC)
  - Uses estimated *replacement* cost rather than renewal or original cost
  - Optimized replacement identifies optimal solution costs rather than straight replacement cost
  - Deals at *asset, facility or system* level
  - Looks to long term life-cycle (e.g.,100 years)
  - Not recognized by GAAP in US

The Pump Station



Depreciation – What Method?



Replacement/Renewal Accounting

Perceived advantages of Replacement/Renewal Accounting

- ✓ Closely aligned to management of the asset (ie consistent with how the network is operated)
- ✓ Forward looking; put the emphasis on what needs to be done to keep the network up to scratch
- ✓ Discloses “”deferred”” maintenance

Perceived disadvantages of Replacement/Renewal Accounting

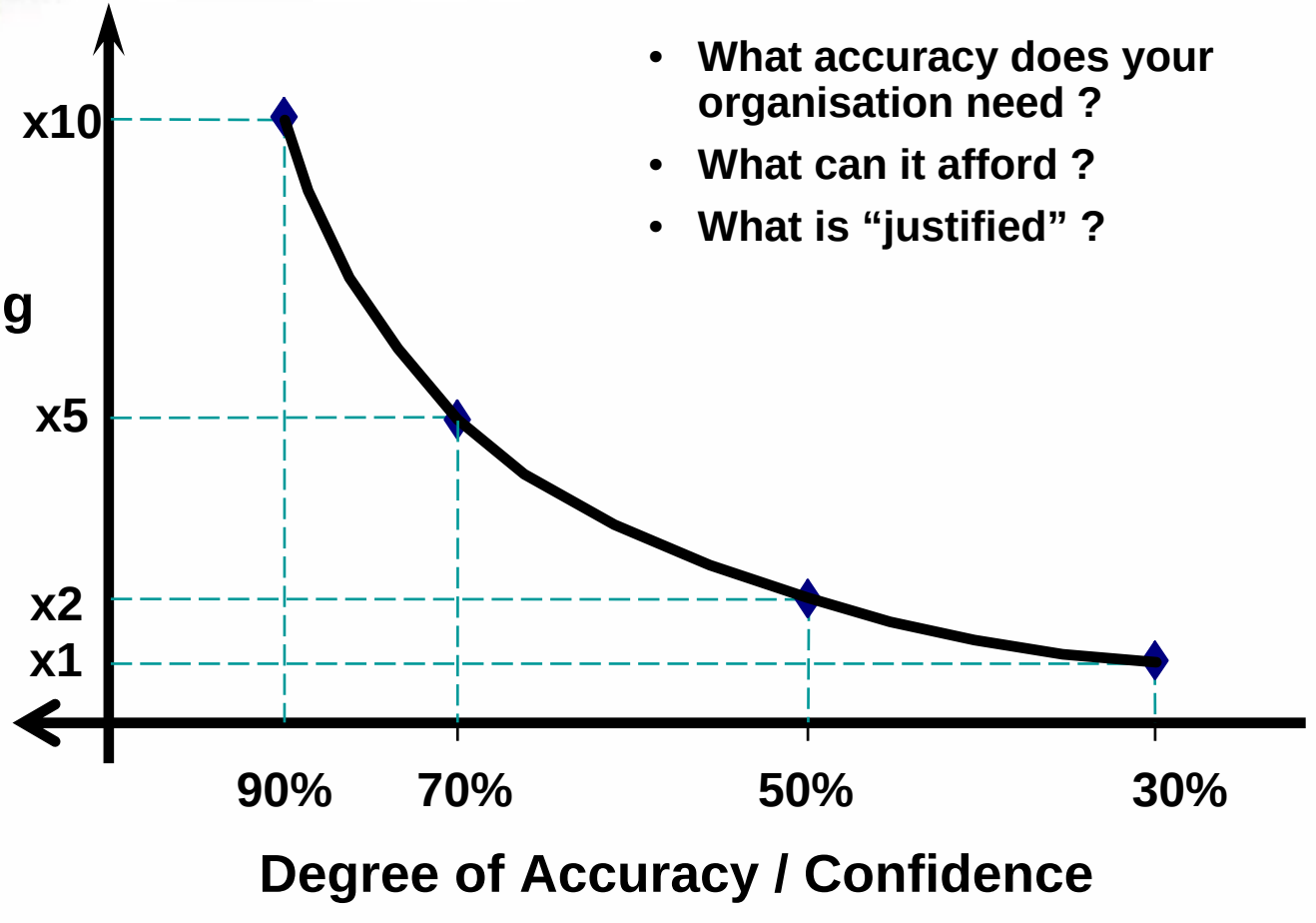
- X Doesn’t have authoritative GAAP support
- X No “source document” as definitive documentation of “value”
- X Hard to apportion between true renewals and augmentation - expenditures which increase capacity or service potential of the network
- X Can any network be in a ‘steady state’?
- X Variability in level of renewals (when does renewal become replacement?)
- X It’s hard to do

Valuation Parameters

- Historic cost
- Asset age
- Condition
- Remaining useful (economic) life
- Replacement cost
- Deterioration profile
- Assessment of optimization (utilization/capacity)

Increasing accuracy

Cost Versus Accuracy

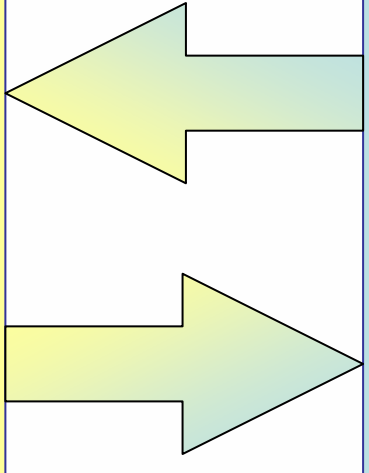


- What accuracy does your organisation need ?
- What can it afford ?
- What is “justified” ?

Which Valuation Technique?

Financial Accounting

- Used for GASB reporting purposes
- Choice of:
  - Historic depreciation
  - Modified or "preservation" approach



Managerial Accounting

- For renewal and replacement analysis
- For long-term funding strategies including rate setting
- Choice of:
  - Condition-based renewal
  - Depreciated replacement

Valuation Exercise 1C

What is the “value” of my pump station?

AGENDA

Day 1

- *Welcome, Introductions & Housekeeping Details*
- *Background And Context*
- *Overview Of Fundamental Concepts & Core Practices*
- *The "Storyline": Tom's Really Bad Day*
- *Core Question 1: What Is The Current State Of My **Assets**?*
- *Lunch*
- *Core Question 2: What Is My Required "Sustainable" Level Of Service?*
- *Core Question 3: Which Assets Are Critical To Sustained Performance?*
- *Core Question 4: What Are My Best Minimum Life-cycle-cost CIP and O&M Strategies?*
- *Discussion; Q&A*

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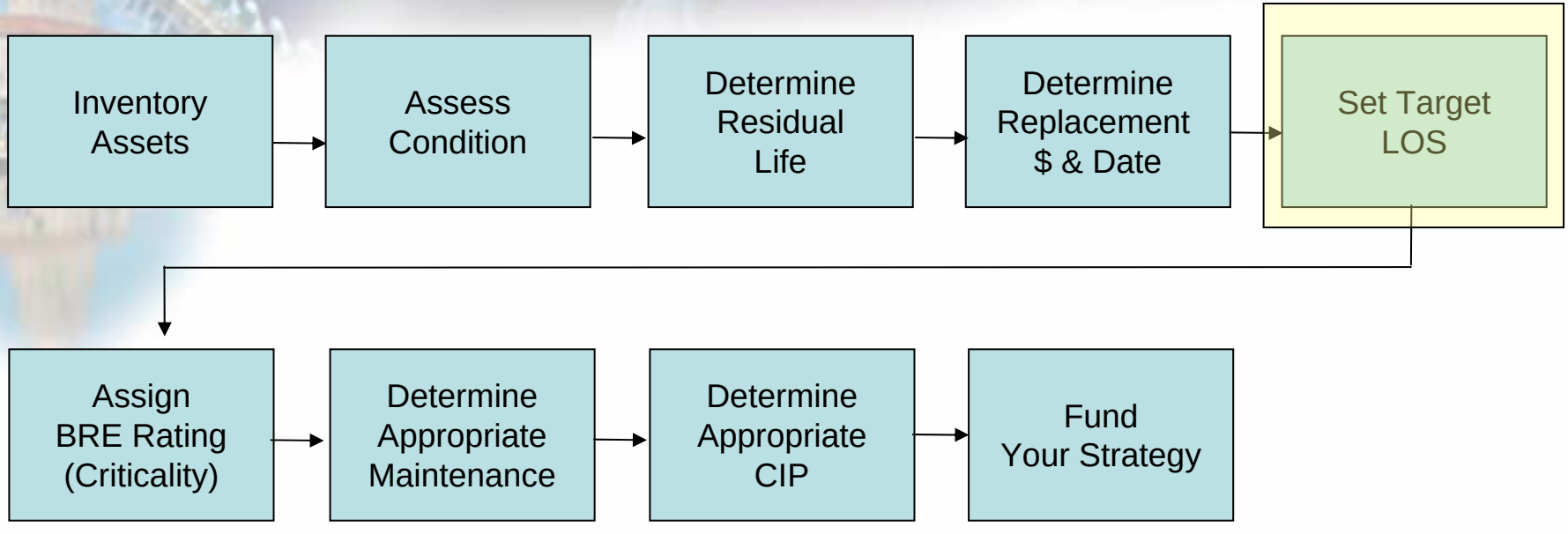
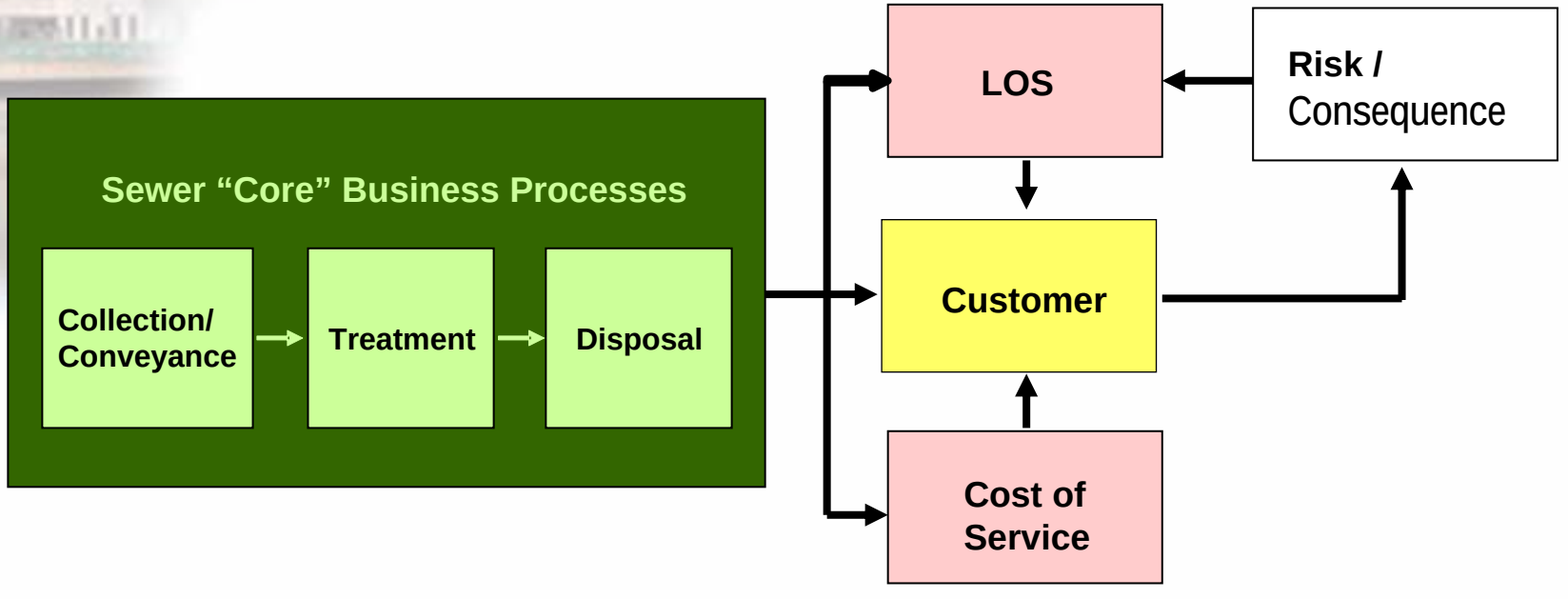
AAM Program Process



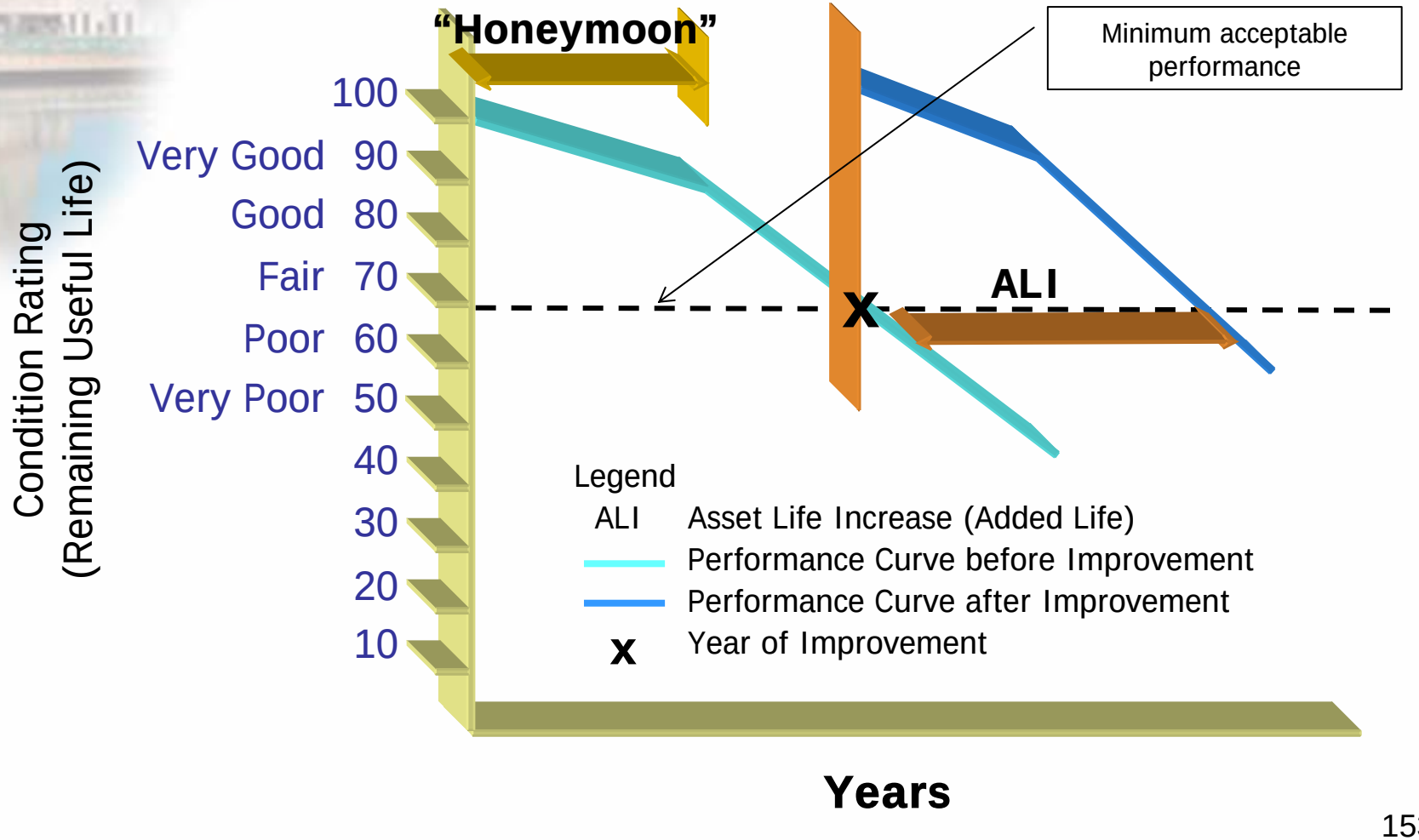
“Levels of Service”

- Good output-oriented management is driven by a defined standard or level of service.
- Where that LOS is:
  - Driven by customers/user demand
  - As determined by the appropriate legislative body in a political arena
- LOS can be defined as:
  - Characteristics or attributes of a service that describe its required level of performance;
  - These characteristics typically describe “how much”, “of what nature” and “how frequently” about the service.

LOS's Strategic Position



Defining Asset Performance



Performance-based Asset Management

Performance = Adequacy
Reliability
Efficiency

Service = customer *perception* of performance

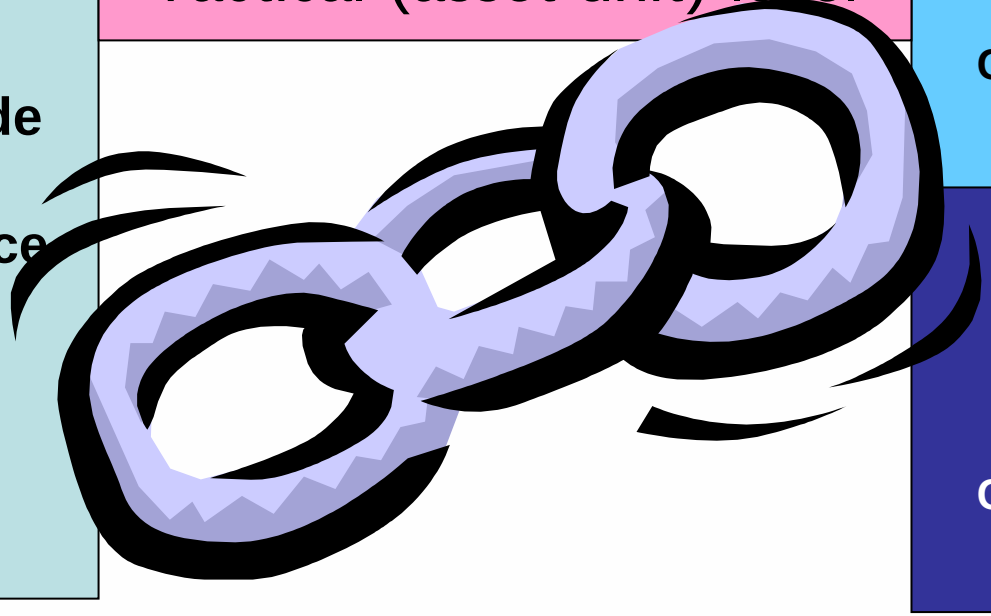
Nature of LOS

- LOS occurs at multiple levels
  - Agency-wide
  - Groups or systems of assets (collection system, treatment plants)
  - Assets (individual pump stations, digesters, clarifiers)
  - Key asset components (pumps, motors, etc.)
- LOS targets are established to “roll up” to meet higher level targets
- There are internal and external LOS targets
  - External LOS targets are typically strategic or “KPI” outcomes:
    - Driven by customers/user demand
    - Confirmed or determined by the appropriate legislative body in a political arena
  - Internal LOS targets are typically tactical in nature and are set at the asset level

Alignment of O&M and Capital Tactics with Organizational Strategies

Agency-wide Asset Performance Targets

LOS Performance Targets:
Strategic (customer) level
Tactical (asset unit) level



O&M

Plan → Sched
↓ ↑
Control Eval ← Execute

Capital

Plan → Sched
↓ ↑
Control Eval ← Execute

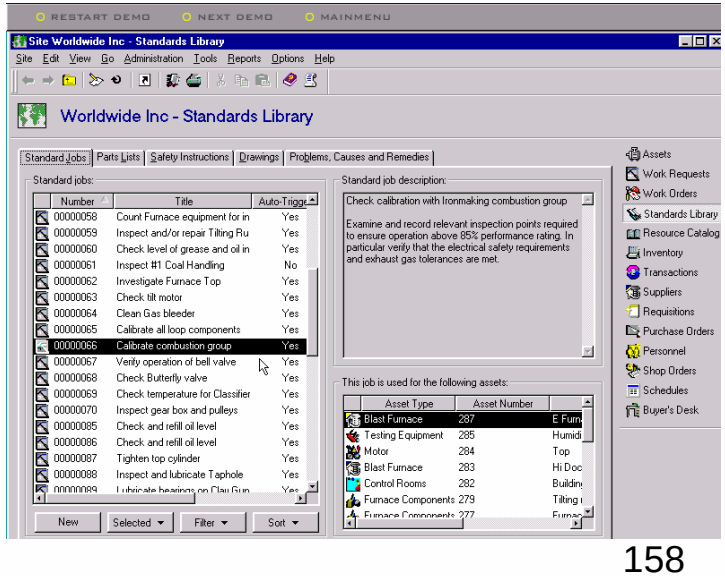
Key Management Questions
The "Balanced Scorecard"

SUGGESTED LOS/PERFORMANCE MEASUREMENT STRUCTURE	
KEY DELIVERY CRITERIA	PERFORMANCE MEASURES
The criteria or indicator against which the asset manager and customer will judge the level of service	The specific measures used to determine actual performance of the service delivered through the assets
Financial Performance	Total Proportion of Income from Charges (%) (Usage/Access/Other)
	Proportion of Income from Charges (%)(Usage/Access/Other/Trade Waste)
	Actual Total Capital Expenditure Over Time
	Actual Capital Expenditure by Type
	Renewals Expenditure as a Proportion of Current Replacement Cost of Assets
	Revenue per Property/Connection
	Revenue per Million Gallons per Day
	Economic Real Rate of Return
	Financial Ratios
	Asset-based Financial Ratios – Return on Assets, Return on Earnings
	Profit / Loss
	Written Down Current Cost of Fixed Assets
	Change in Revenue (% previous year)
Responsiveness	Time to Respond to Customer Contacts (Written & Verbal)
	Restoration of Service within X hours (unplanned (%))
Legislative Requirements	Water Quality Compliance (%) (Bacteriological/Physical/ Chemical/Standard)
	BOD – Compliance (%)
	Suspended Solids – Compliance (%)
	Nutrients – Compliance (%)
	Wastewater Treatment Plants Compliance with Permits at all Times
System Efficiency	Total Operating Costs Per Million Gallons Treated
	Energy Consumption As % of Operating Expenditures
	Wastewater System Infiltration per 1000 feet Pipeline (gallons/day/1000 ft)
Cost Effectiveness	Percentage Change In Customer Average Annual Bill
	Operating Cost per Property/Connection Served
Reliability	Interruption Frequency per 1000 Properties/Connections (unplanned)
	Average Duration of Interruptions (hours per interruption-unplanned)
	Average Outage Time (minutes/property –unplanned)
	Sewer Main Blockages and Collapses
	Sewer Main Blockages and Collapses Repaired < 5hours (%)
	Sanitary Sewer Overflows (SSO per 1000 ft of pipeline)
Customer Satisfaction	Odor Complaints per 1000 Connections
	Customer Interruption Frequency (%)
Quantity	Connected Populations and Connections
	Wastewater Collected (million gallons per day)
	Wastewater Collected per Property (gpd per connection)
	Volume of Infiltration Collected per Property (gpd per connection)
	Proportion of Wastewater Treatment Levels (Primary/Secondary/Tertiary)
	Peak Wet Weather Flow
	Average Dry Weather Flow
	Average Daily Flow
	Proportion Wastewater Reused
	Proportion of Wastewater Biosolids Reused
	Fixed Assets – Physical Quantities
Utilization	Utilization – Ratio of Peak Day to Average Day Flow
	Utilization – Ratio of Peak Day to Peak System Capacity
	Utilization – Ratio of Average Dry Weather to Average Dry Flow
Organizational Learning	Progress Toward Defined Objectives On Gap Chart

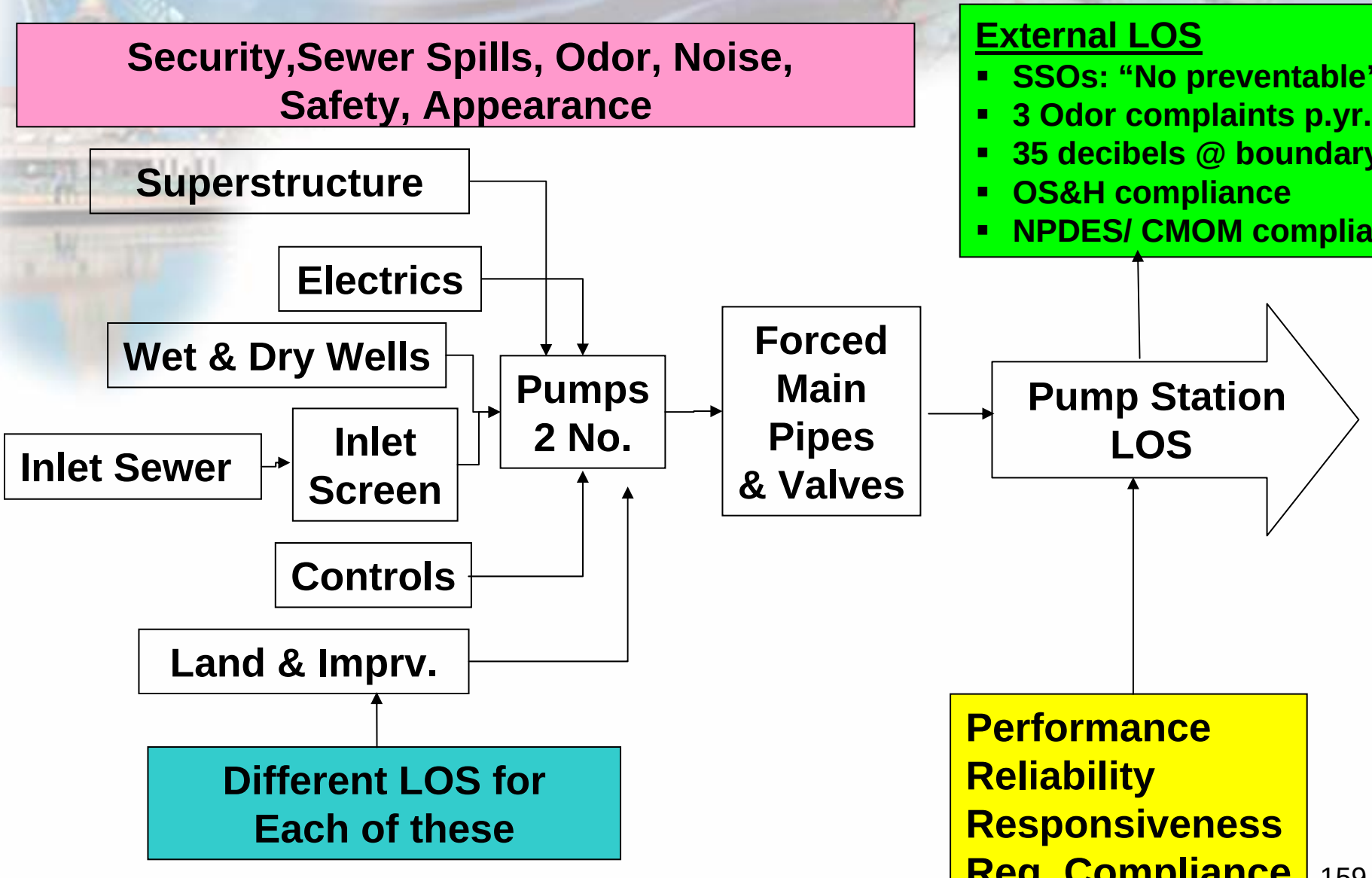
Content of LOS – What do we measure?

Develop content:

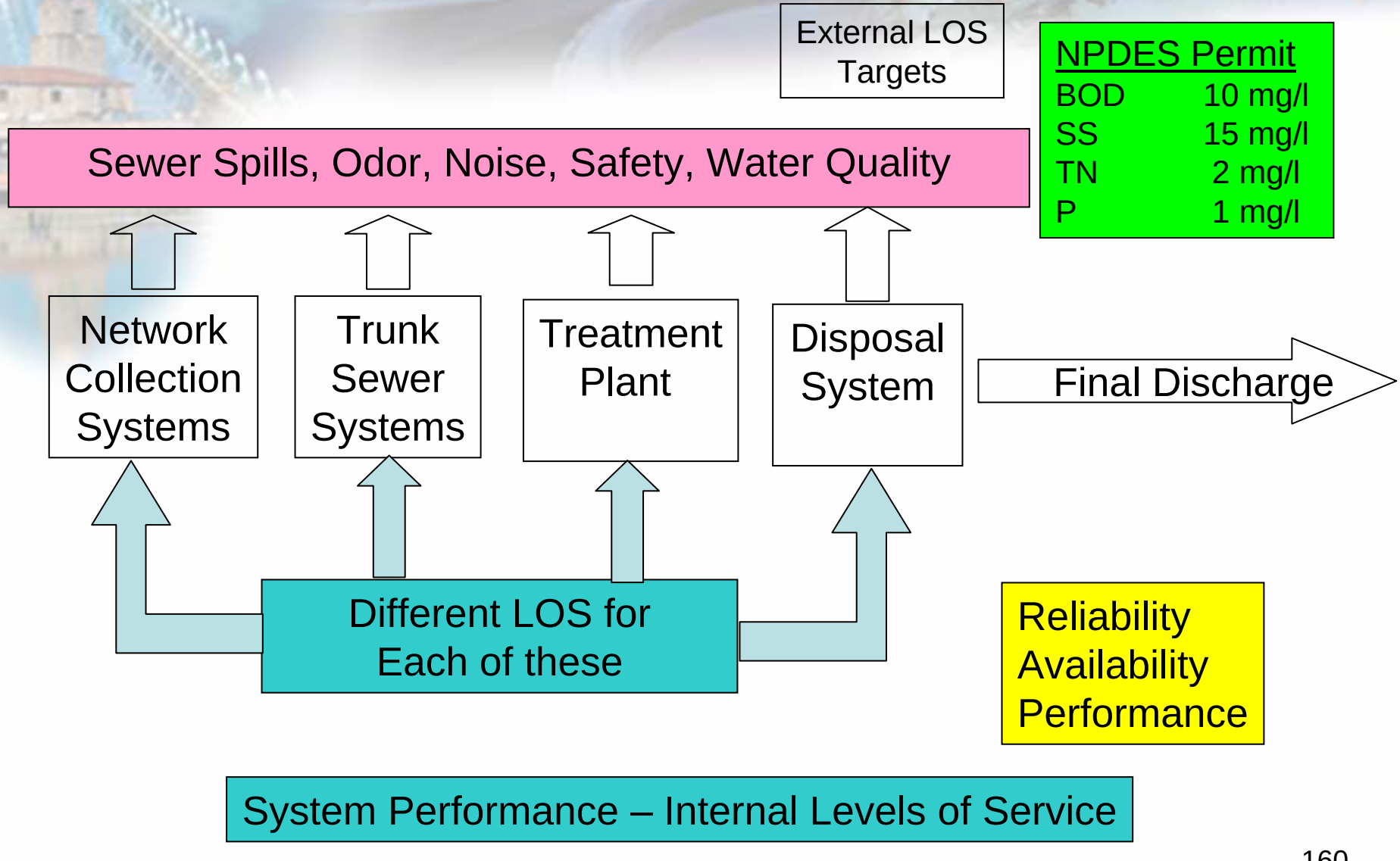
- Select starting framework
- Build metrics

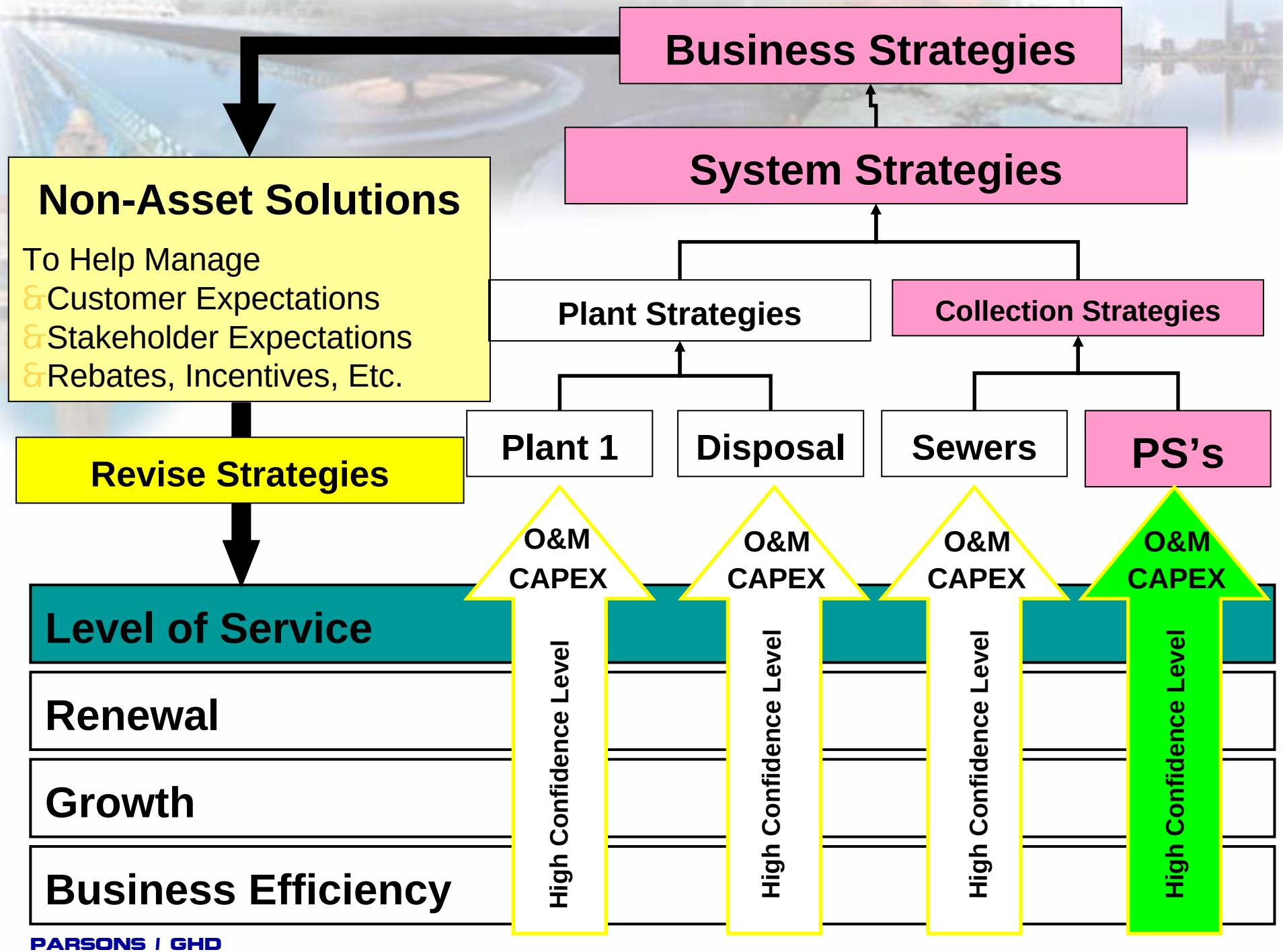


Minor P.S. LOS Requirements



System Performance Requirements




Business Strategies
System Strategies
Non-Asset Solutions
To Help Manage
&Customer Expectations
&Stakeholder Expectations
&Rebates, Incentives, Etc.
Plant Strategies
Collection Strategies
Revise Strategies
Plant 1
Disposal
Sewers
PS's
O&M
CAPEX
O&M
CAPEX
O&M
CAPEX
O&M
CAPEX
High Confidence Level
High Confidence Level
High Confidence Level
High Confidence Level
Level of Service
Renewal
Growth
Business Efficiency

LOS Exercise

Help Tom develop the LOS targets for his "problem" pump station.

Pump Station LOS

Performance	Measure	Current	Target
Odor	*Complaints/yr*	***0.5***	***1***
Spills	*#/yr*	***2***	***0***
	Gals/spill	***56,000***	***2,000***
Pumping	*% influent*	***99.68%***	***100%***
Reliability			
Scada	*Outages/yr*	***7***	***2***
	Duration, hrs	***72+***	***8***
Power	*Outages/yr*	***1***	***1***
	Duration, hrs	***7***	***2.5***

Pump Station LOS

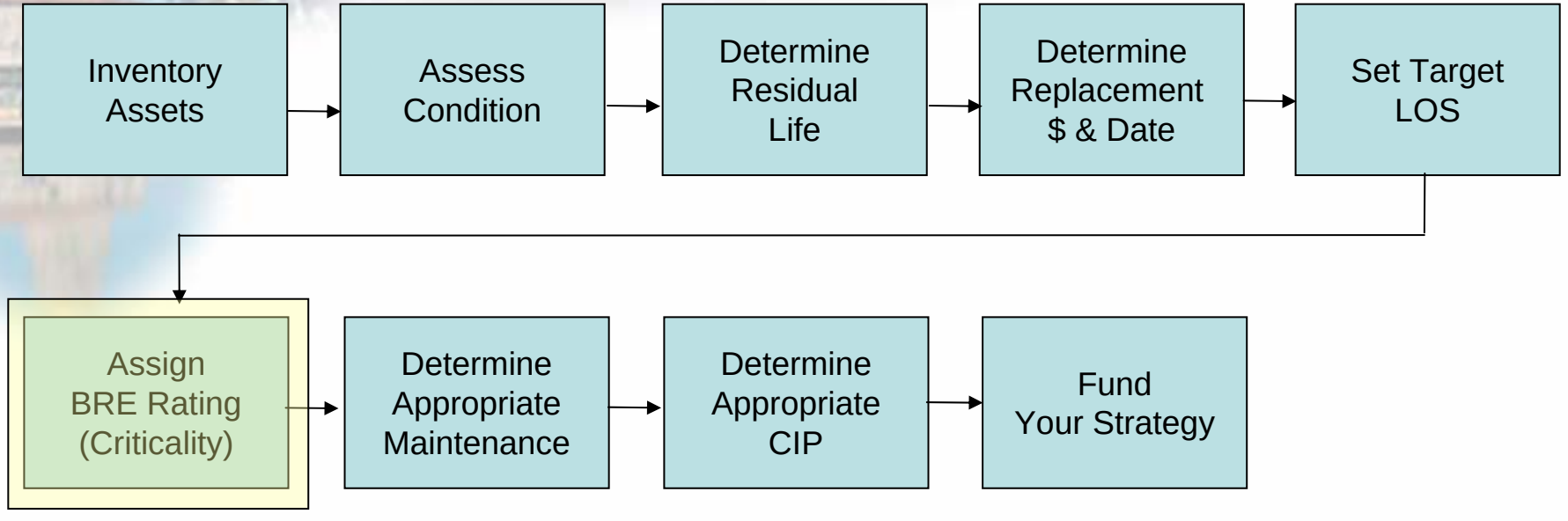
Reliability	Measure	Current	Target
Pumps	*% reserve capacity, Peak Q*	*30%*	***30%***
	% redundancy @ peak Q	*0%*	***50%***
Power	*2nd source, hrs*	*7*	***2.5***
Regulatory			
Spill reporting	*verbal, hrs*	*N/A*	***24***
	Report, days	*21*	***10***
	Impact Notice, hrs	*N/A*	***8***
	Response plan trng, hrs/yr	*0*	***8***

AGENDA

Day 1

- *Welcome, Introductions & Housekeeping Details*
- *Background And Context*
- *Overview Of Fundamental Concepts & Core Practices*
- *The "Storyline": Tom's Really Bad Day*
- *Core Question 1: What Is The Current State Of My **Assets**?*
- *Lunch*
- *Core Question 2: What Is My Required "Sustainable" Level Of Service?*
- *Core Question 3: Which Assets Are Critical To Sustained Performance?*
- *Core Question 4: What Are My Best Minimum Life-cycle-cost CIP and O&M Strategies?*
- *Discussion; Q&A*

AAM Program Process

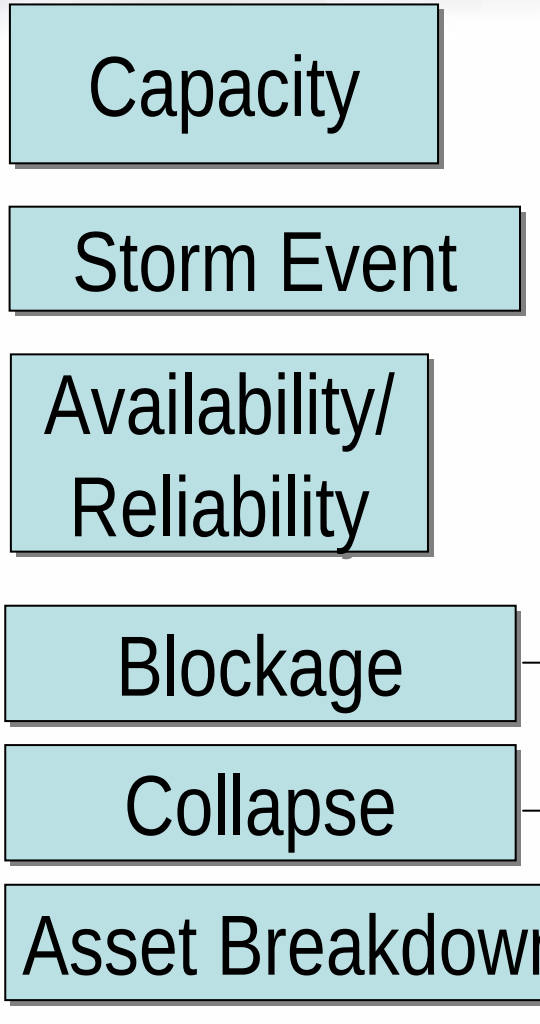


Q3: Which assets are critical to our sustainable performance – service delivery ?

To better understand where Tom and his team should focus his efforts and scarce resources…we need to work out what is critical and what is not ..

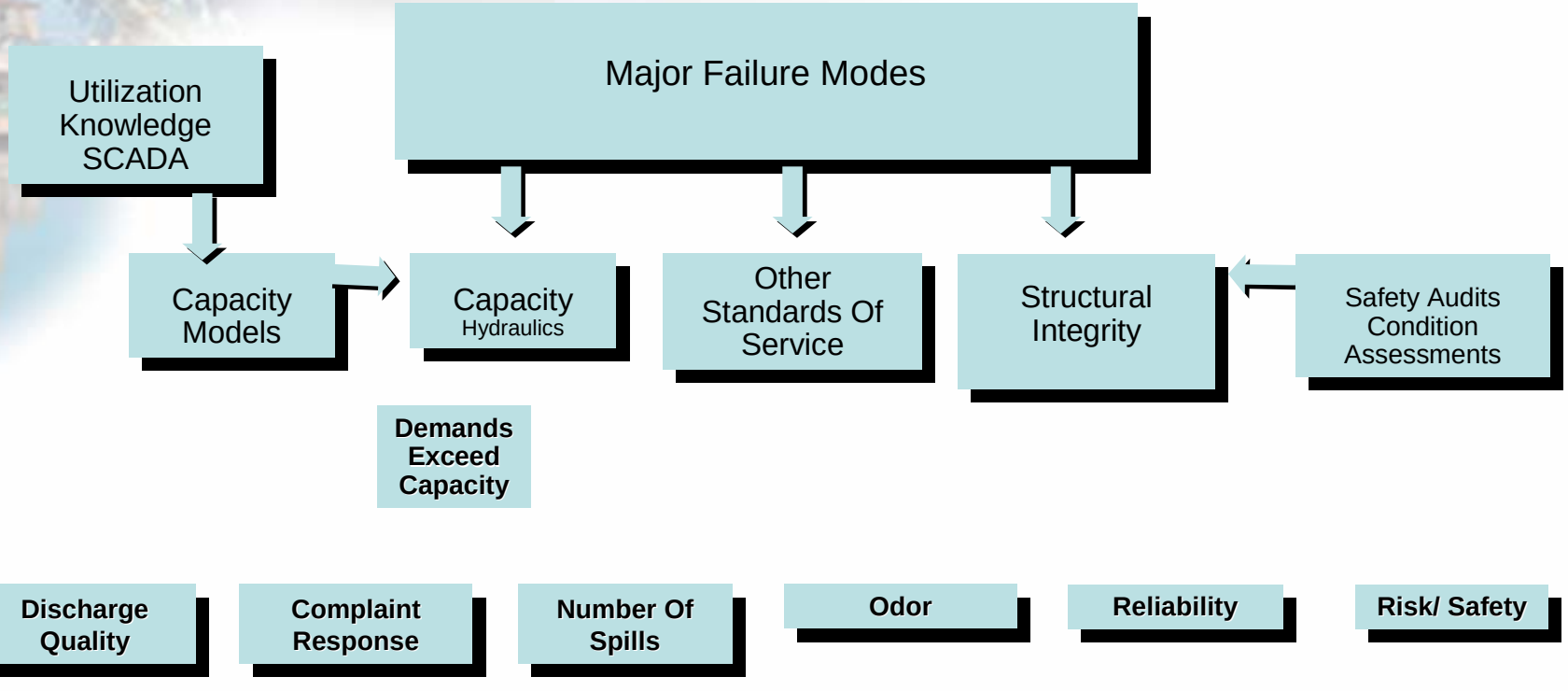
Don

CMOM – Failure Modes



- Physical capacity inadequate
  - exceeds LOS
- Physical asset not available due to:

Sewer Assets – Strategic Planning



Definition of Risk

Risk is the consequence of uncertainty

Variables:

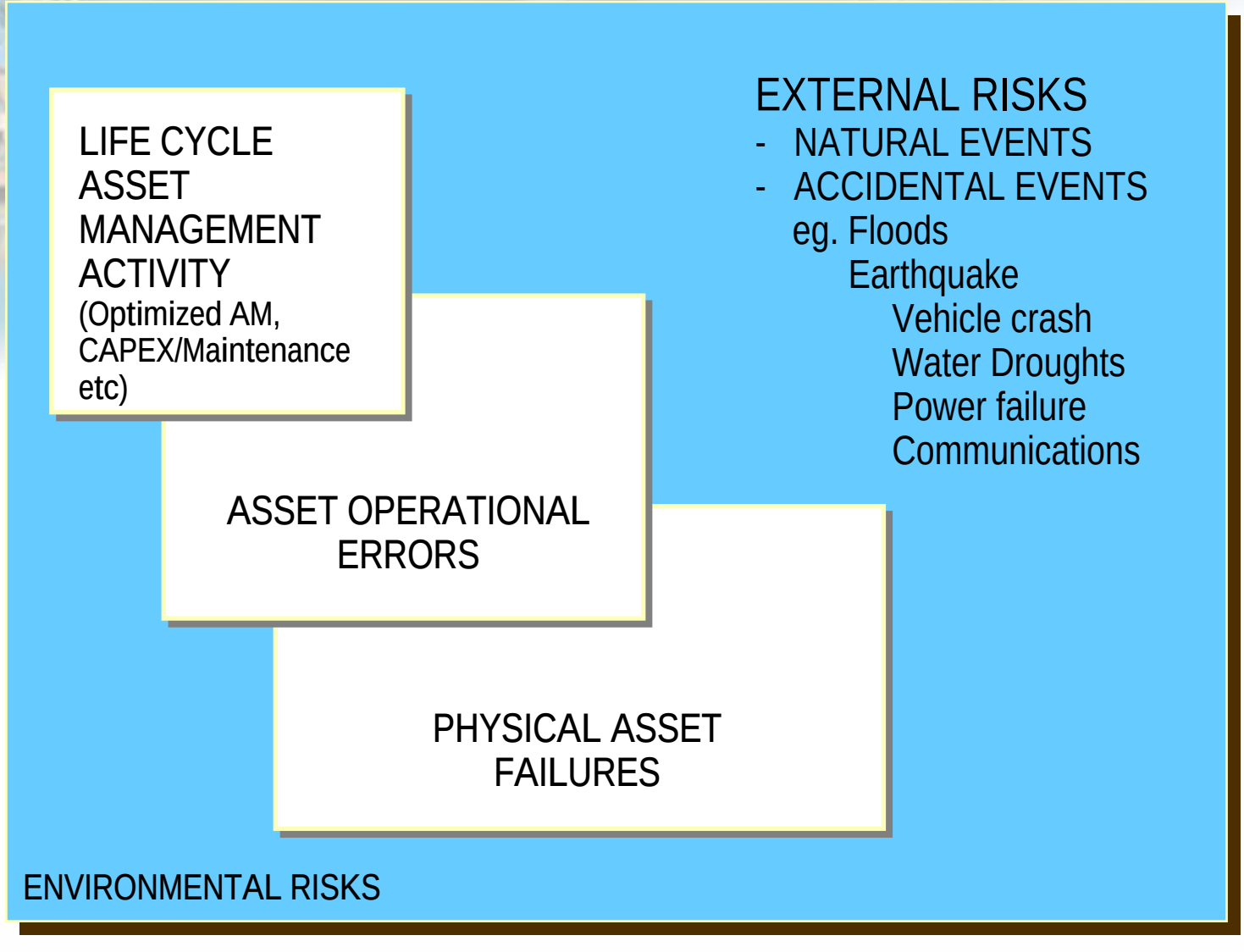
The impact of the event (CoF)

The likelihood of the event (PoF)

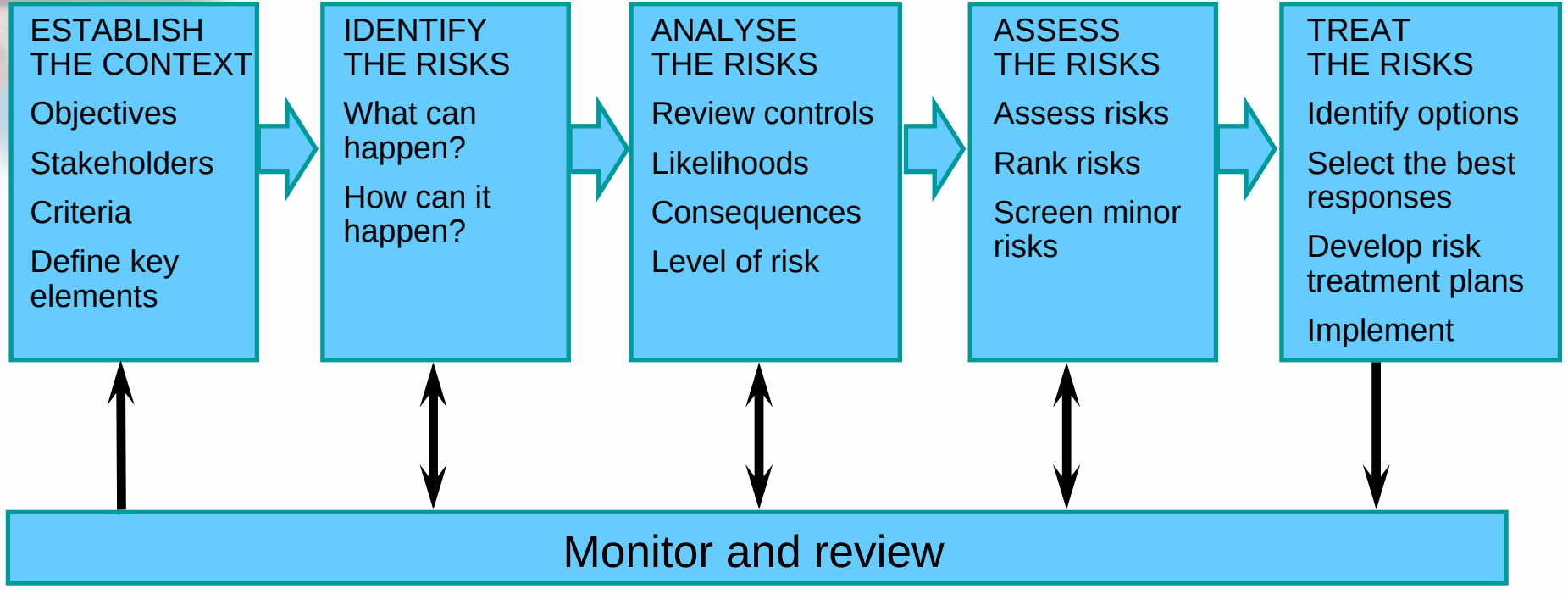
Key Business Risk Areas

1. Critical assets with high probability of failure
2. Assets with high consequence of failure
3. High cost maintenance activities
4. Low return (benefit) capital improvement programs

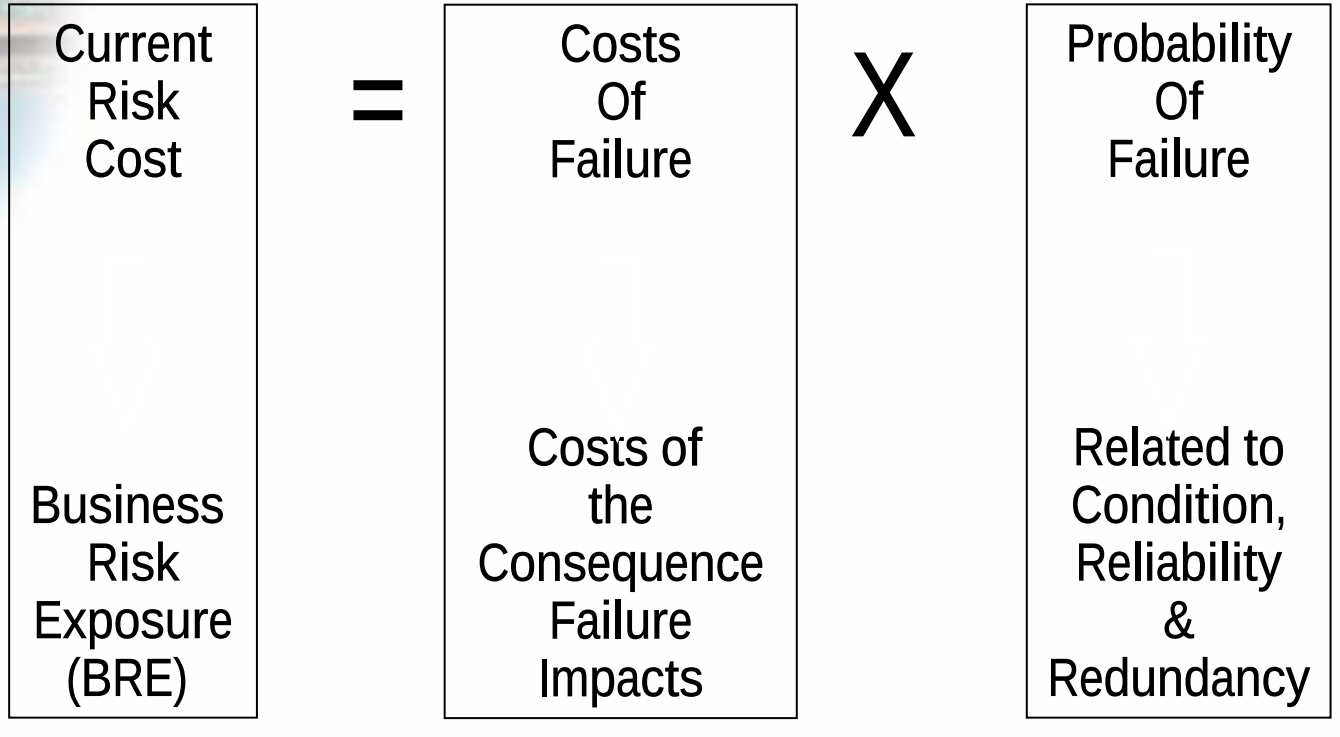
Business Risks Of Assets



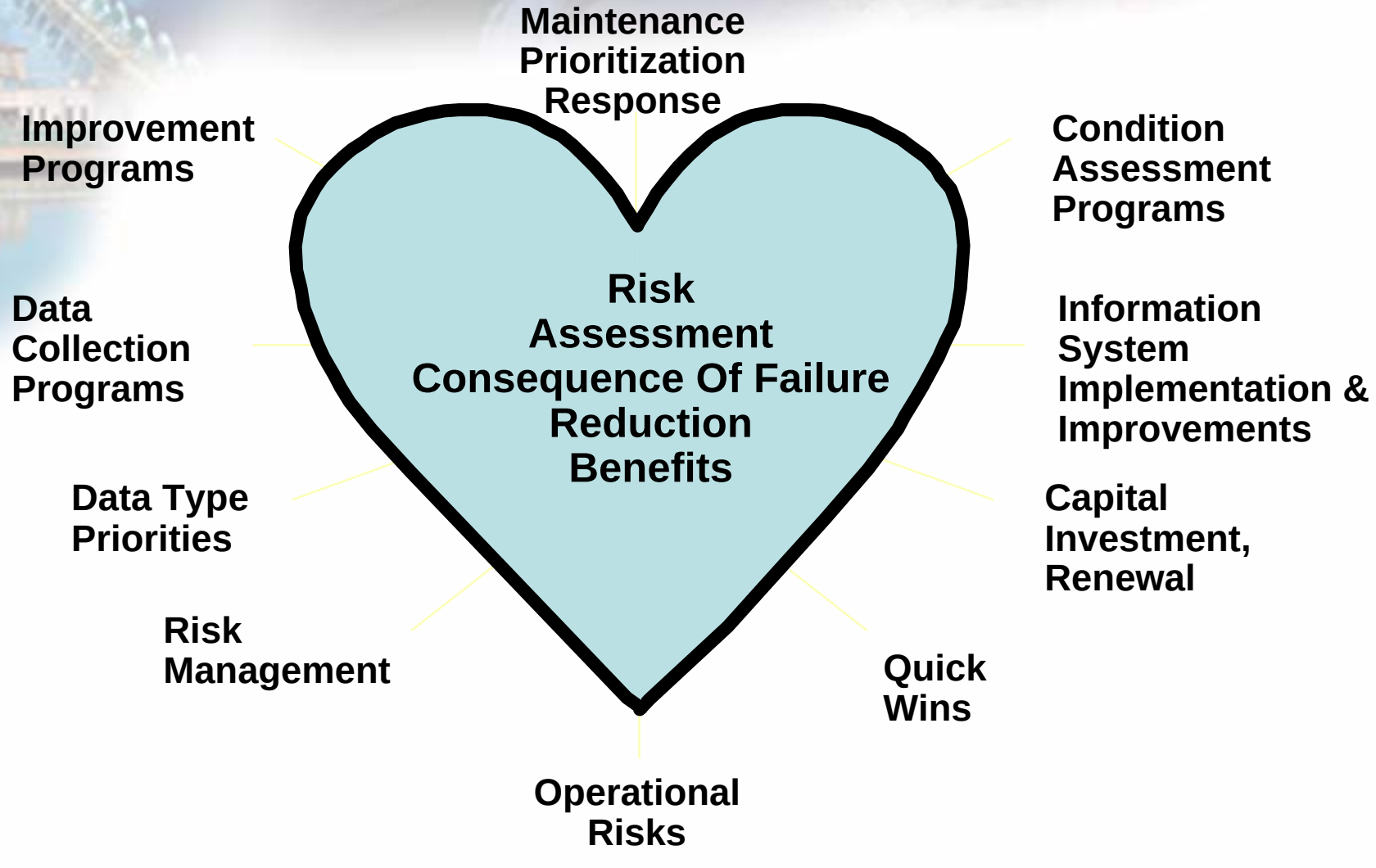
The Risk Management Process



Risk (Criticality) Assessment

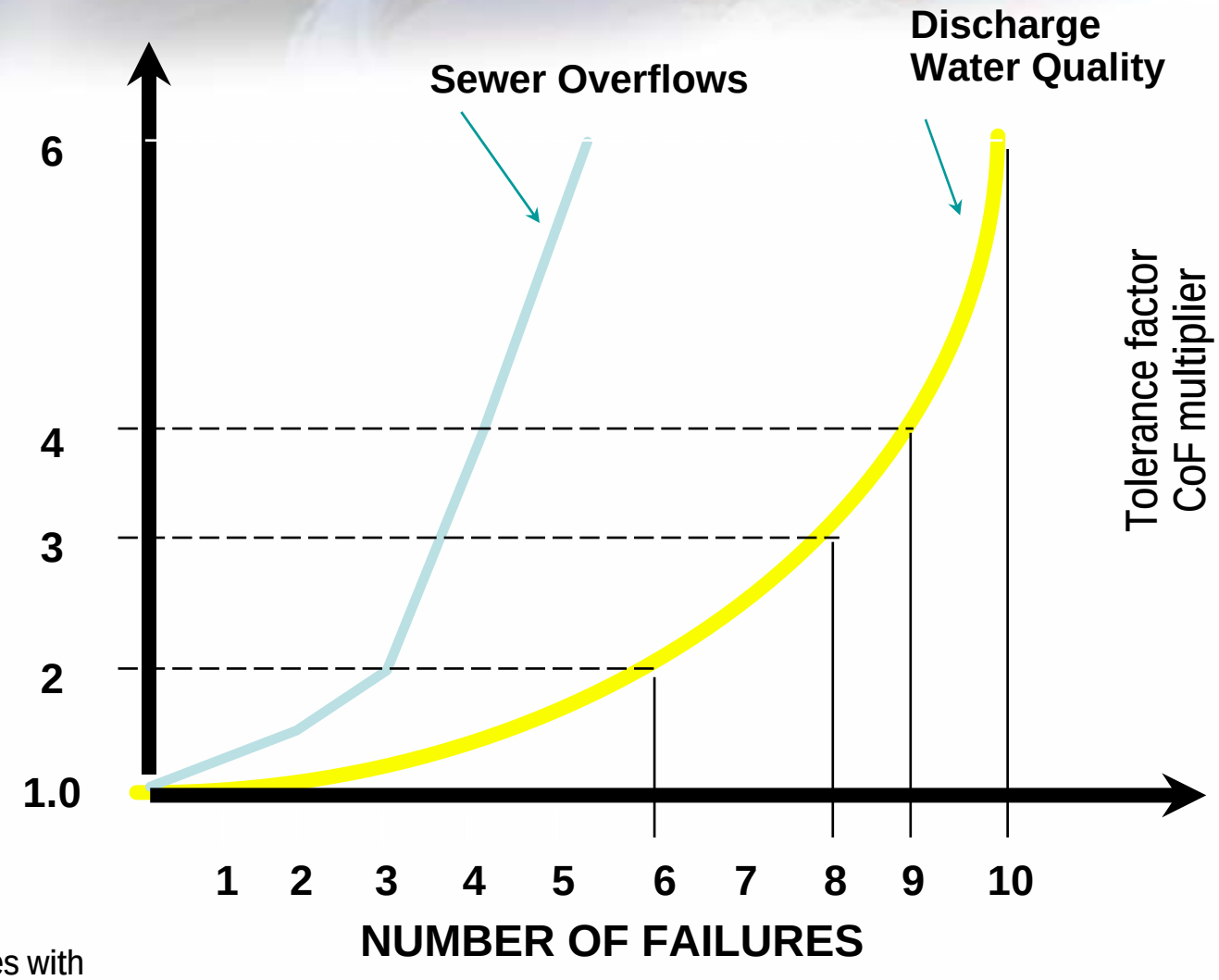


Risk - The Heart Of A.A.M.



Customer tolerance of failure

We Need To Understand Point At Which Customer Would Change Suppliers

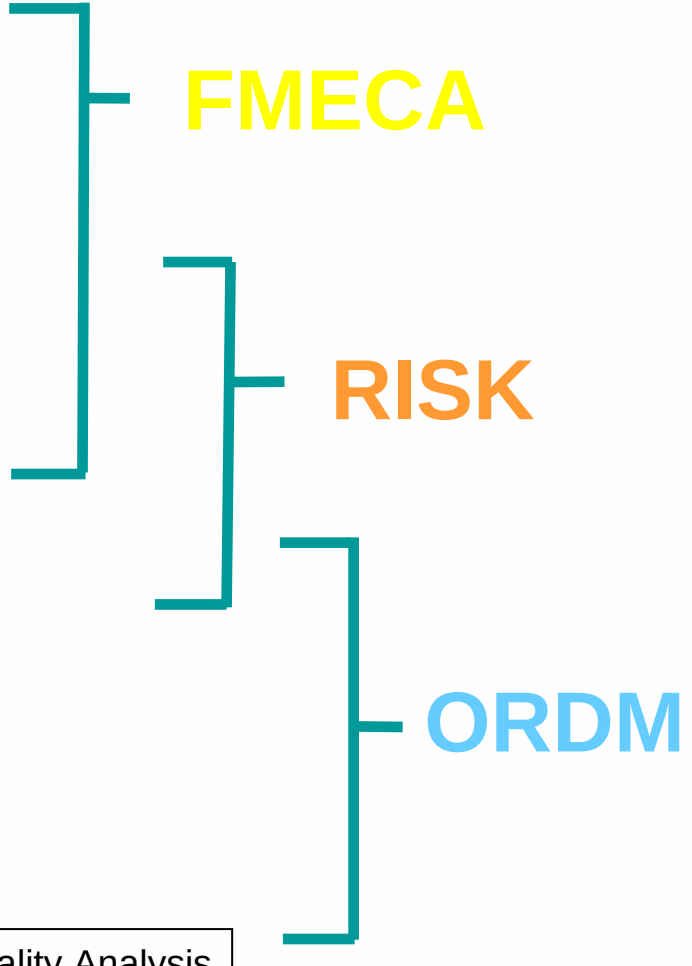


Premise
Customer tolerance reduces with repeated failures (example only)

CoF– Consequence of Failure

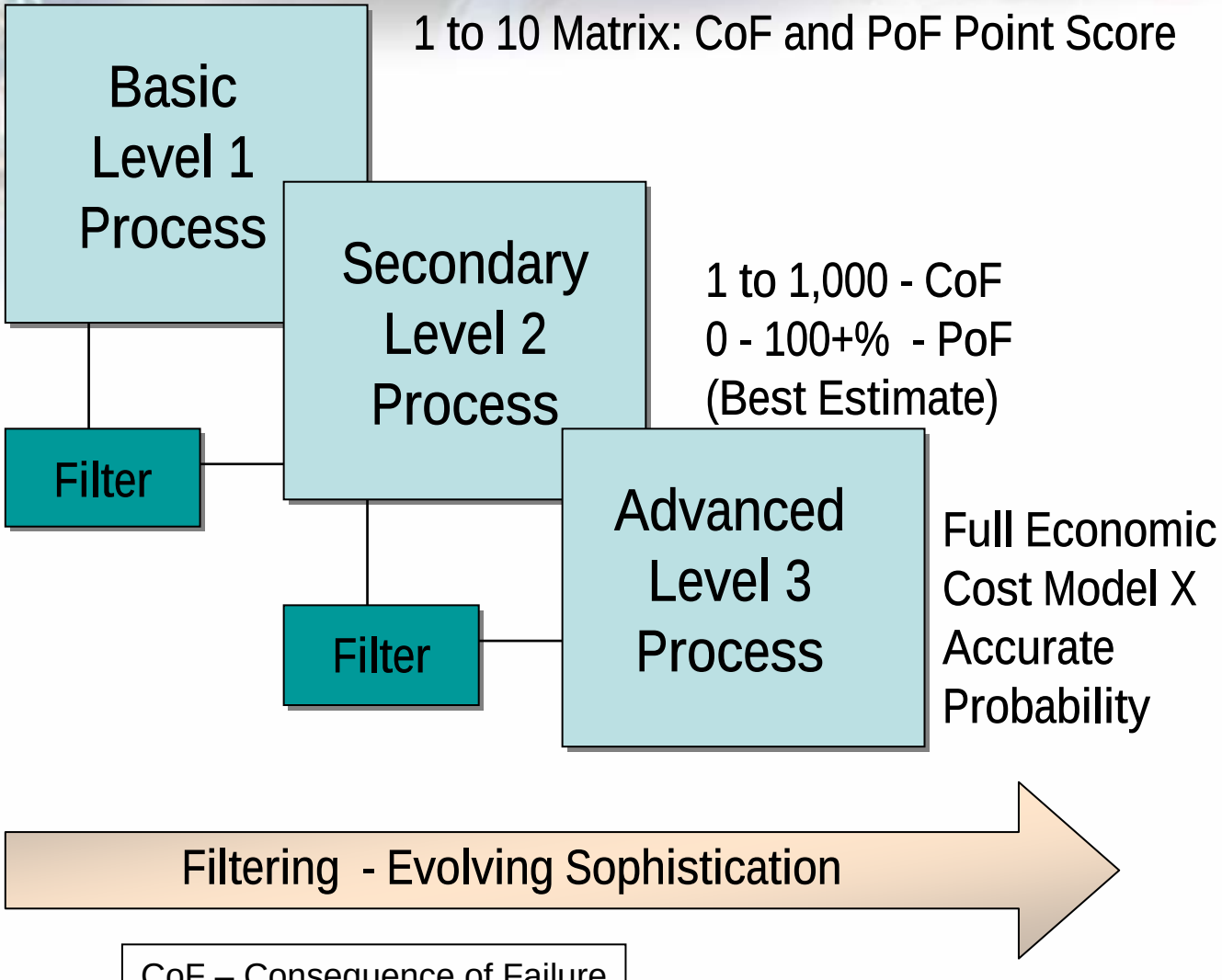
Risk - Inputs / Relationships

- Cause of failure
- Mode of failure
- Consequence of failure
- Probability of failure
- Risk cost exposure
- Risk cost reduction options
- Economic evaluation of options



FMECA – Failure Mode, Effects & Criticality Analysis
ORDM – Optimal Renewal Decision Making

The Evolving BRE Methodology



CoF – Consequence of Failure
PoF – Potential of Failure

Stage one - simple

1. Use your existing valuation or technical asset register. (Break up large assets to better reflect the key components).
2. Show each asset as a percentage of asset life (eg. 60%).
3. Use this percentage as the “probability of failure” (P.O.F.).
4. Allocate consequence of failure ratings (criticality) of asset on a simple 1 - 10 basis.

Stage One - Simple

5 Apply this to all assets that are over 60% through their effective life.

6 Multiply the “probability” & “consequence” and develop a “risk ranking” of assets from highest down.

7 Decide on an “acceptable” risk level and review condition (& consequence) of these assets and;

- Revise residual lives (if necessary)

- Identify assets for further investigation (renewal).

Stage One - Simple

EXAMPLE: Not all sewers are the same..

Risk Rating = Probability X Consequence

ASSET No.	PROBAB.	CONSEQ.	RISK RATING
1	.60	4	2.4
2	.70	2	1.4
3	.40	5	2.0
4	.85	8	6.8 *
5	.75	9	6.8 *
6	.10	10	1.0

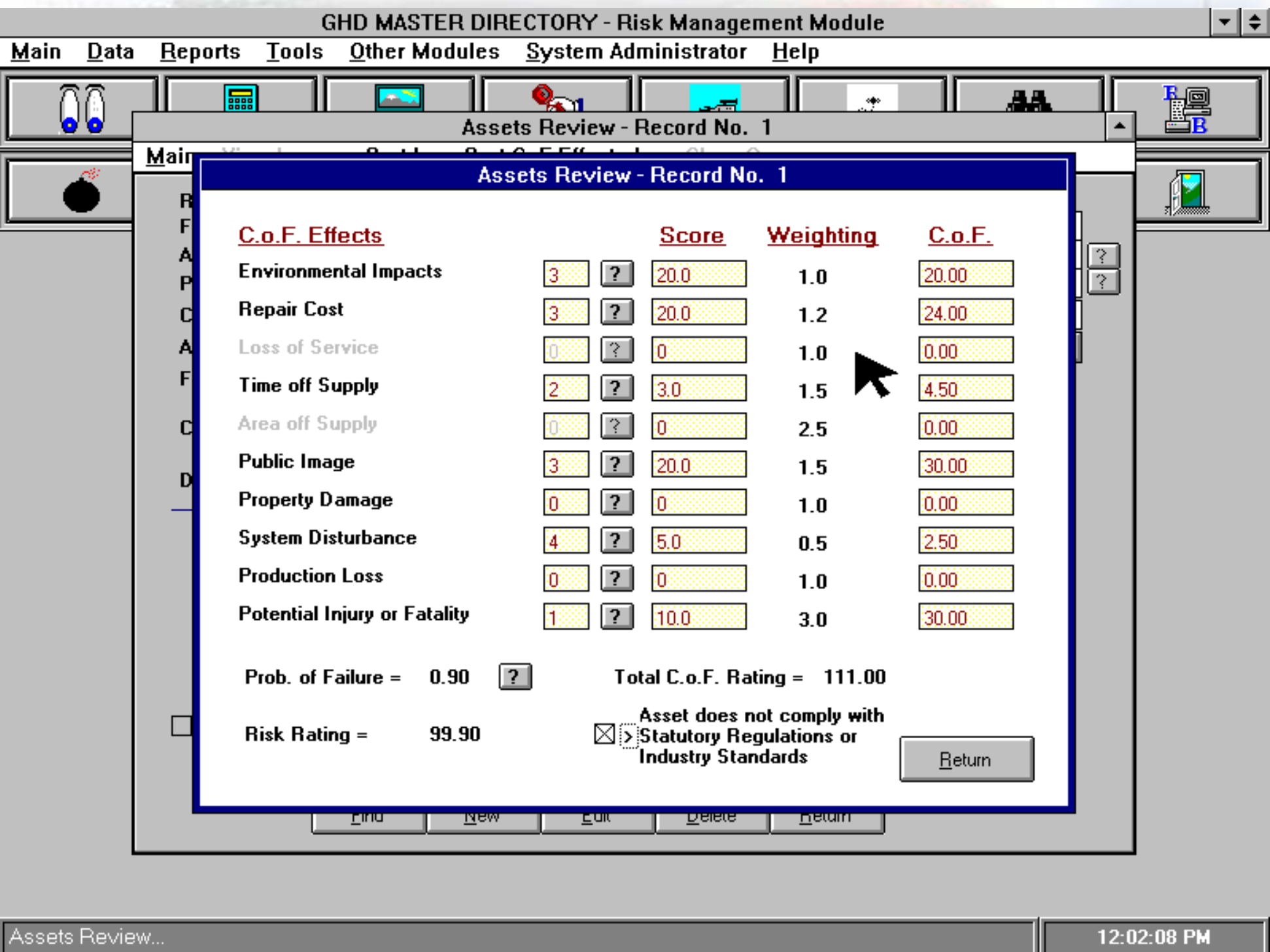
*** THESE REQUIRE FURTHER INVESTIGATION**

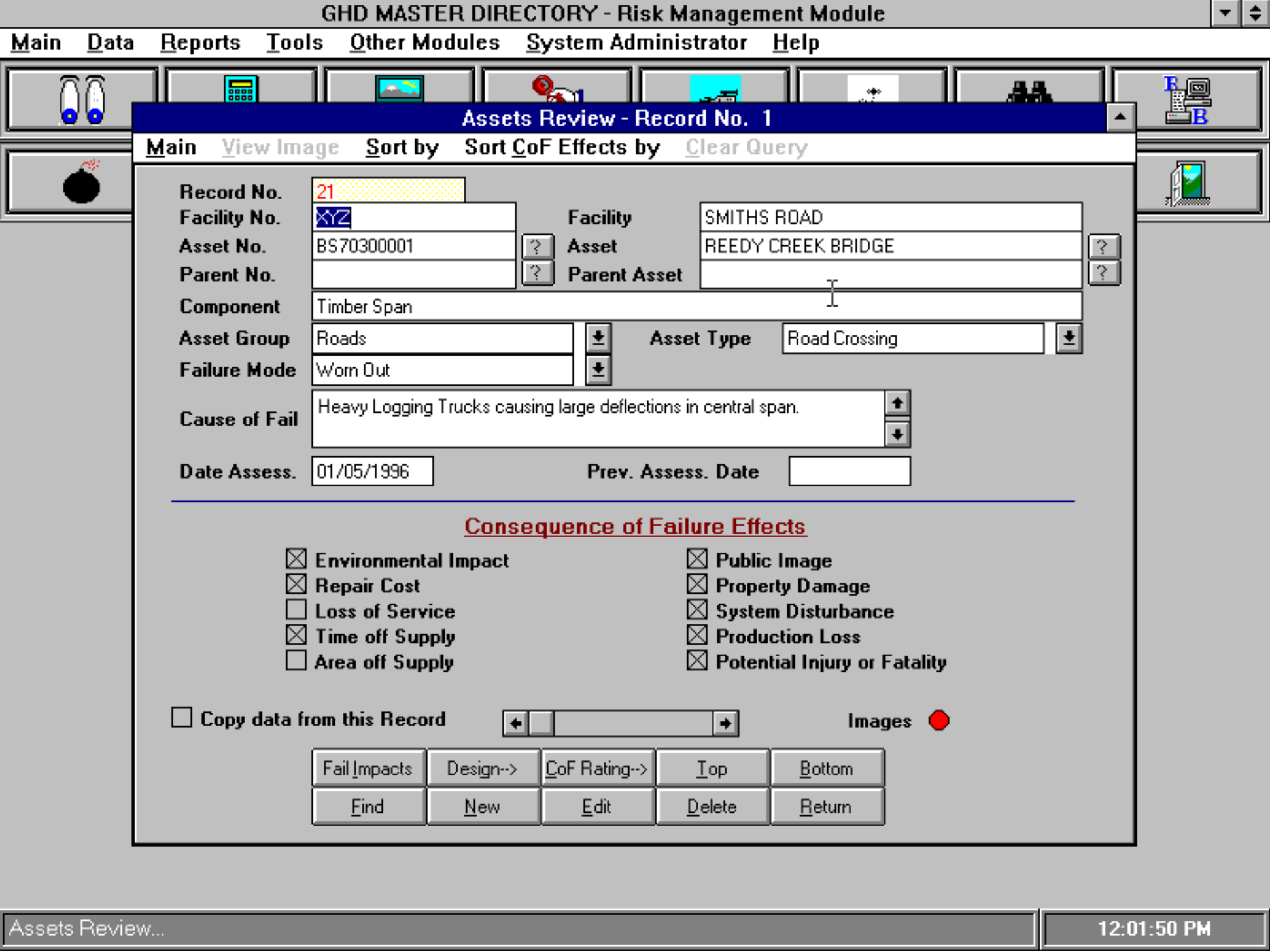
Stage Two – Intermediate

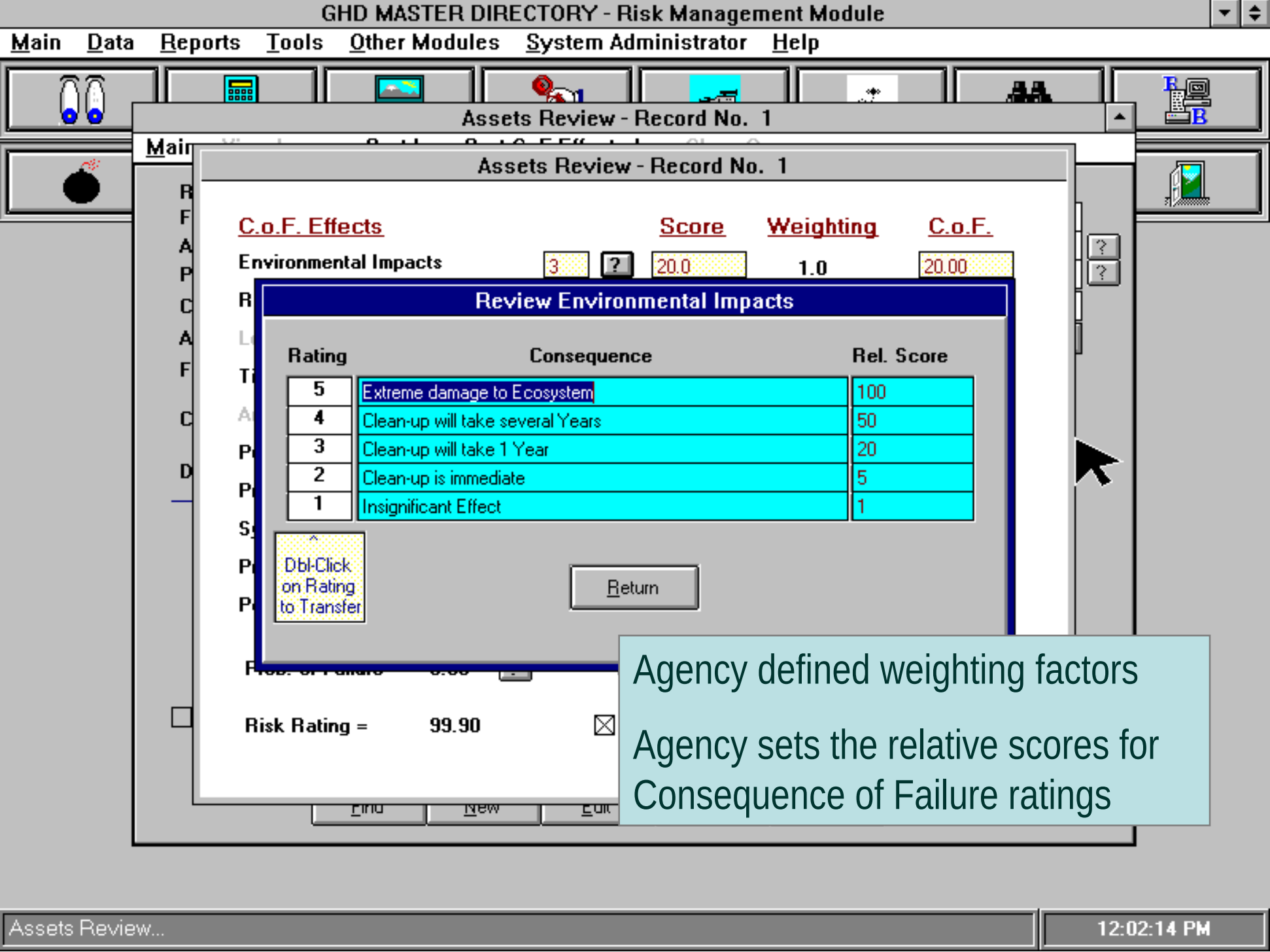
Multiple Elements

ENHANCED FMECA ANALYSIS TECHNIQUES

ELEMENT	RATING	WEIGHTING	MAX. SCORE
Safety	1 - 5	10	50
Environment	1 - 5	6	30
Functionality	1 - 5	5	25
Cost	1 - 5	8	40
			145


GHD MASTER DIRECTORY - Risk Management Module
Main Data Reports Tools Other Modules System Administrator Help
Assets Review - Record No. 1
Assets Review - Record No. 1
C.o.F. Effects
Score
Weighting
C.o.F.
Environmental Impacts 3 ? 20.0 1.0 20.00
Repair Cost 3 ? 20.0 1.2 24.00
Loss of Service 0 ? 0 1.0 0.00
Time off Supply 2 ? 3.0 1.5 4.50
Area off Supply 0 ? 0 2.5 0.00
Public Image 3 ? 20.0 1.5 30.00
Property Damage 0 ? 0 1.0 0.00
System Disturbance 4 ? 5.0 0.5 2.50
Production Loss 0 ? 0 1.0 0.00
Potential Injury or Fatality 1 ? 10.0 3.0 30.00
Prob. of Failure = 0.90 ?
Total C.o.F. Rating = 111.00
Risk Rating = 99.90
Asset does not comply with Statutory Regulations or Industry Standards
Return
Find New Edit Delete Return
Assets Review...
12:02:08 PM


GHD MASTER DIRECTORY - Risk Management Module
Main Data Reports Tools Other Modules System Administrator Help
Assets Review - Record No. 1
Main View Image Sort by Sort CoF Effects by Clear Query
Record No. 21
Facility No. XYZ
Facility SMITHS ROAD
Asset No. BS70300001
Asset REEDY CREEK BRIDGE
Parent No.
Parent Asset
Component Timber Span
Asset Group Roads
Asset Type Road Crossing
Failure Mode Worn Out
Cause of Fail Heavy Logging Trucks causing large deflections in central span.
Date Assess. 01/05/1996
Prev. Assess. Date
Consequence of Failure Effects
Environmental Impact
Repair Cost
Loss of Service
Time off Supply
Area off Supply
Public Image
Property Damage
System Disturbance
Production Loss
Potential Injury or Fatality
Copy data from this Record
Images
Fail Impacts
Design-->
CoF Rating-->
Top
Bottom
Find
New
Edit
Delete
Return
Assets Review...
12:01:50 PM


GHD MASTER DIRECTORY - Risk Management Module
Main Data Reports Tools Other Modules System Administrator Help
Assets Review - Record No. 1
Assets Review - Record No. 1
C.o.F. Effects
Score
Weighting
C.o.F.
Environmental Impacts
3
20.0
1.0
20.00
Review Environmental Impacts
Rating
Consequence
Rel. Score
5
Extreme damage to Ecosystem
100
4
Clean-up will take several Years
50
3
Clean-up will take 1 Year
20
2
Clean-up is immediate
5
1
Insignificant Effect
1
Dbl-Click on Rating to Transfer
Return
Risk Rating =
99.90
Agency defined weighting factors
Agency sets the relative scores for Consequence of Failure ratings
Assets Review...
12:02:14 PM

Some Failures Will Happen

Educate Our Customers To Expect Acceptable Or Unavoidable Failures

Probability of Failure (PoF)

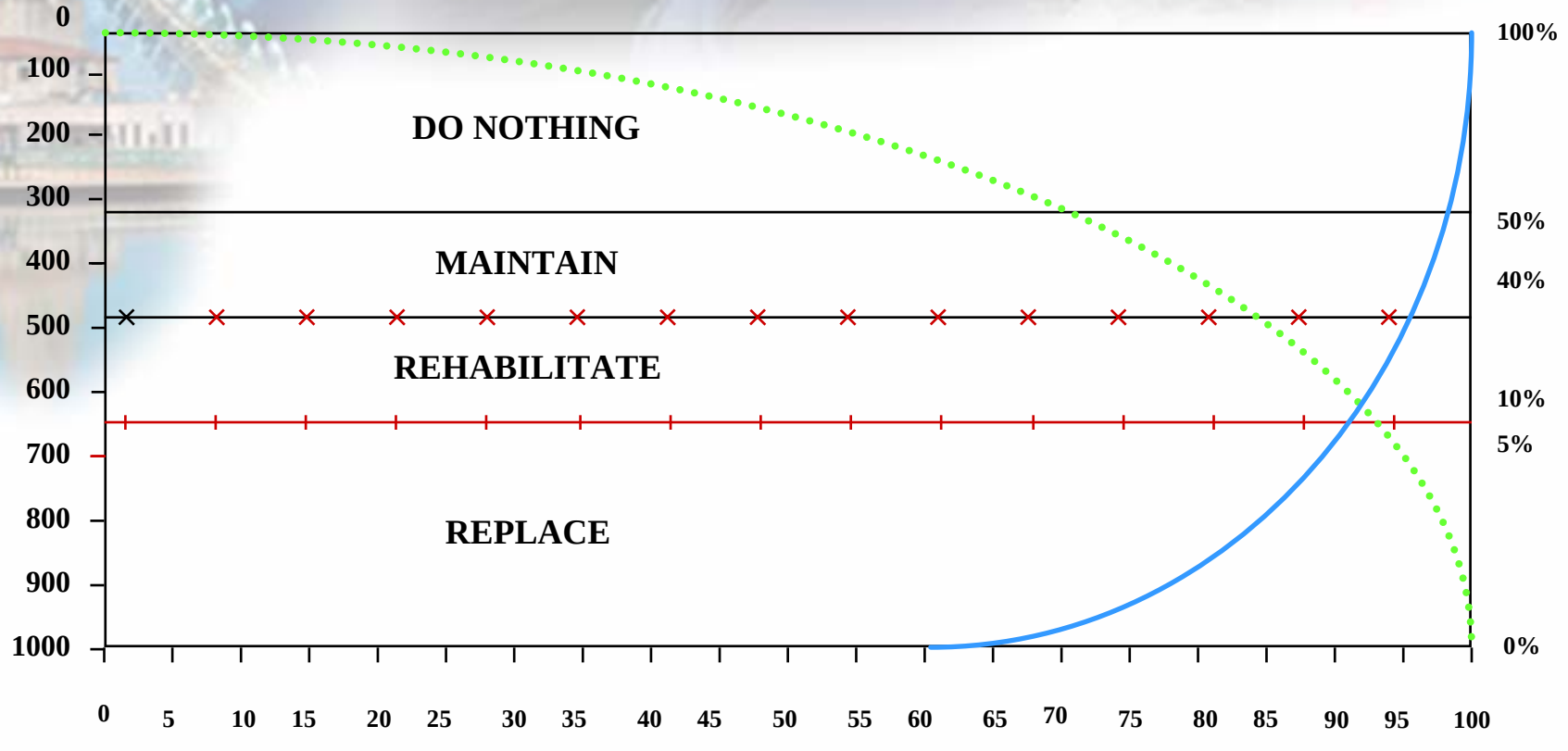
- The PoF is directly related to the “mode of failure” (MoF)
- We cannot be absolutely sure of the PoF.
- Sometimes we have good data, sometimes we do not.
- We can estimate a range of failure - how early (pessimistic) and how late (optimistic).

What are the Sources of PoF?

- CMMS – “Mean Time Between Failure” (MTBF)
- Vendor / industry information
- Other failure records (hard copies)
- Our “Brilliant Memories” (Staff)
- Our SCADA System (if we have one and it records this asset).

PoF – Potential of Failure

Decay Curve Probability Of Failure



Do Nothing 0-300

Maintenance 300-450

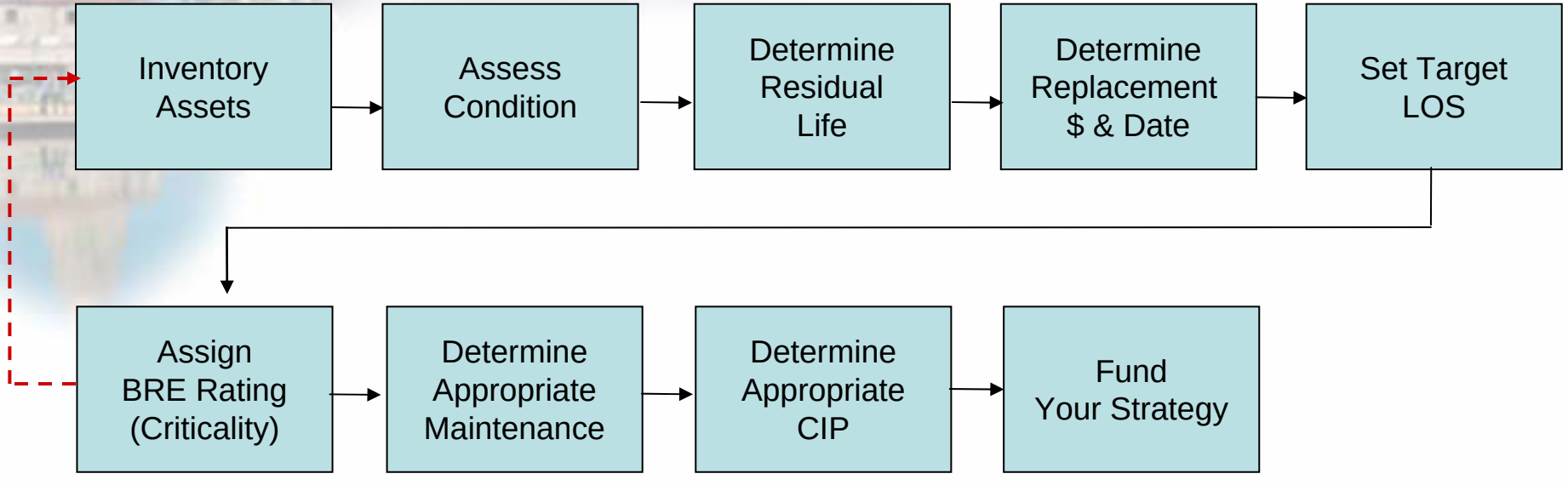
Rehabilitation 450-700

Replace 700-1000

Condition Decay Curve

Probability Curve

AAM Program Process - Modified



Exercise Number 4

Help Tom develop an understanding of the criticality (BRE) of the components of the pump station ..

Using the data provided, determine :

- The consequence of failure using the 1 to 10 score card shown in sheet C of the exercise spreadsheet ...
- Apply these to all the components you have in your asset register

Exercise Number 4

- The probability of failure will be calculated by the spreadsheet using the residual life (but in future you need to use real data)
- Have a look at the BREs. Are they what you expected ?
- What is the total BRE for the pump station?

BRE – Business Risk Exposure

Sheet C on the exercise spreadsheet

Effective Lives (Years)

Asset Type	Effective Lives
Civil	75
Pressure Pipework	60
Sewers	100
Pumps	40
Motors	35
Electrical	30
Controls	25
Building Assets	60

Sheet B on the exercise spreadsheet

Effective Lives (Years)		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

This is calculated – you only have to rate condition

Sheet D on the exercise spreadsheet

Probability of Failure

% of Effective Life Consumed	PoF Rating
0%	**1**
10%	**2**
20%	**3**
30%	**4**
40%	**5**
50%	**6**
60%	**7**
70%	**8**
80%	**9**
90%	**10**

Don't Forget Redundancy??

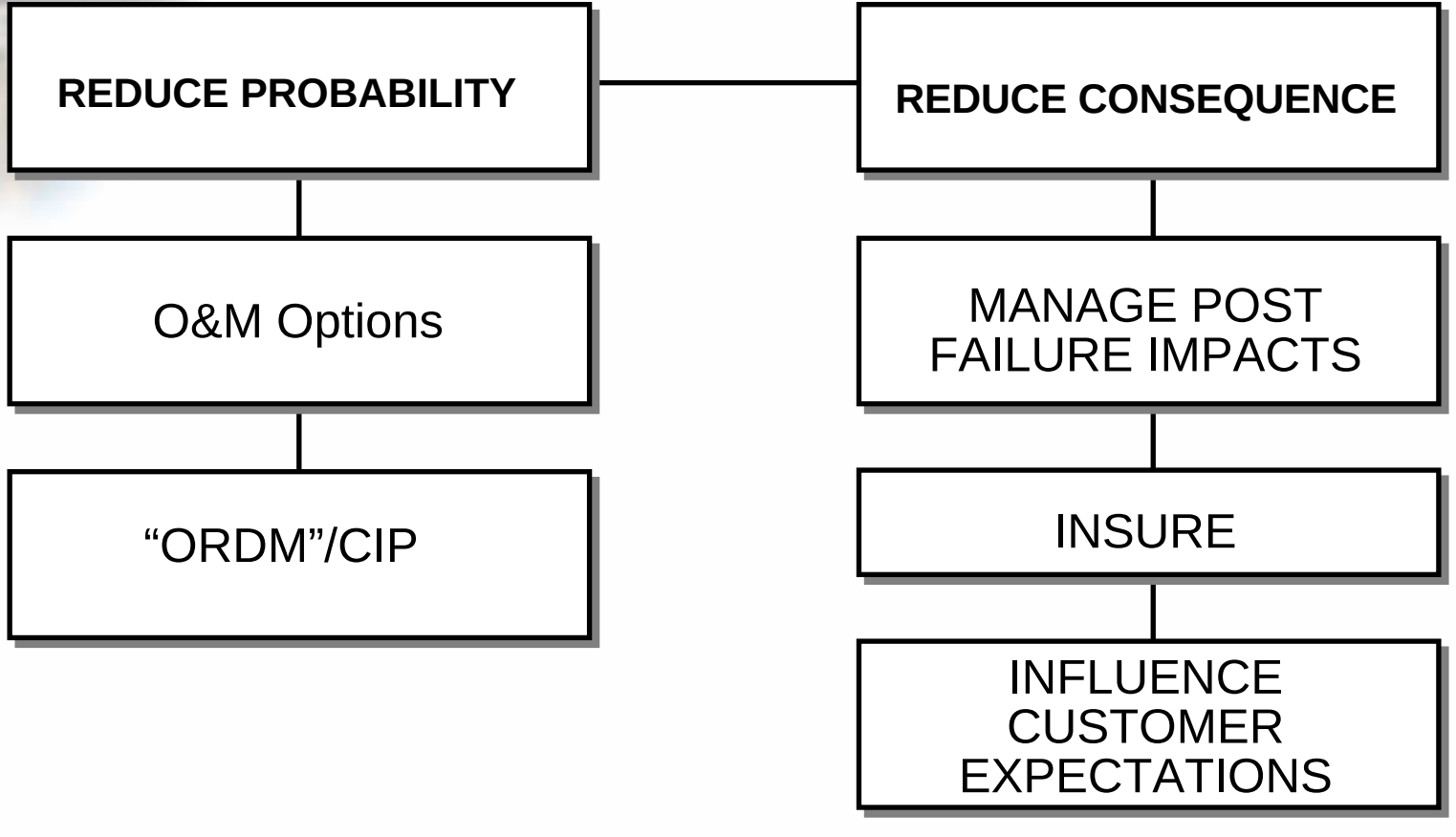
Level of Redundancy	Reduce PoF by:
50% Backup	50%
100% Backup	90%
200% Secondary Backup	98%

This is calculated – you only have to rate condition

Risk - Reduction Options

REDUCE CAUSE OF FAILURE
ASSET - NON ASSET

Treatment Options



Answers to Exercise Number 4

Roger and the team will show you what answers they developed …

Ask questions , challenge their assumptions..

Tell us why you did what you did…right & wrong ….

What could be improved?

Key Lessons Learned

- ⇨ BRE is the heart of all good Advanced AM.
- ⇨ It helps us make better decisions by far …
- ⇨ BRE comes in different levels of sophistication.
- ⇨ You can start very easily – as shown.
- ⇨ PoF data is hard to get and it is individual asset related.
- ⇨ So start completing your work orders now.

BRE – Business Risk Exposure
PoF – Potential of Failure

Take home messages

- Get ‘cracking’ ….(aussie for started)
- Develop a simple 1 to 10 criticality for all assets under your control …
- Encourage others to do it …but
- Don’t try and change the world overnight…
- Change your world …

AGENDA

Day 1

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- *Background And Context*
- *Overview Of Fundamental Concepts & Core Practices*
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- *Core Question 1: What Is The Current State Of My **Assets**?*
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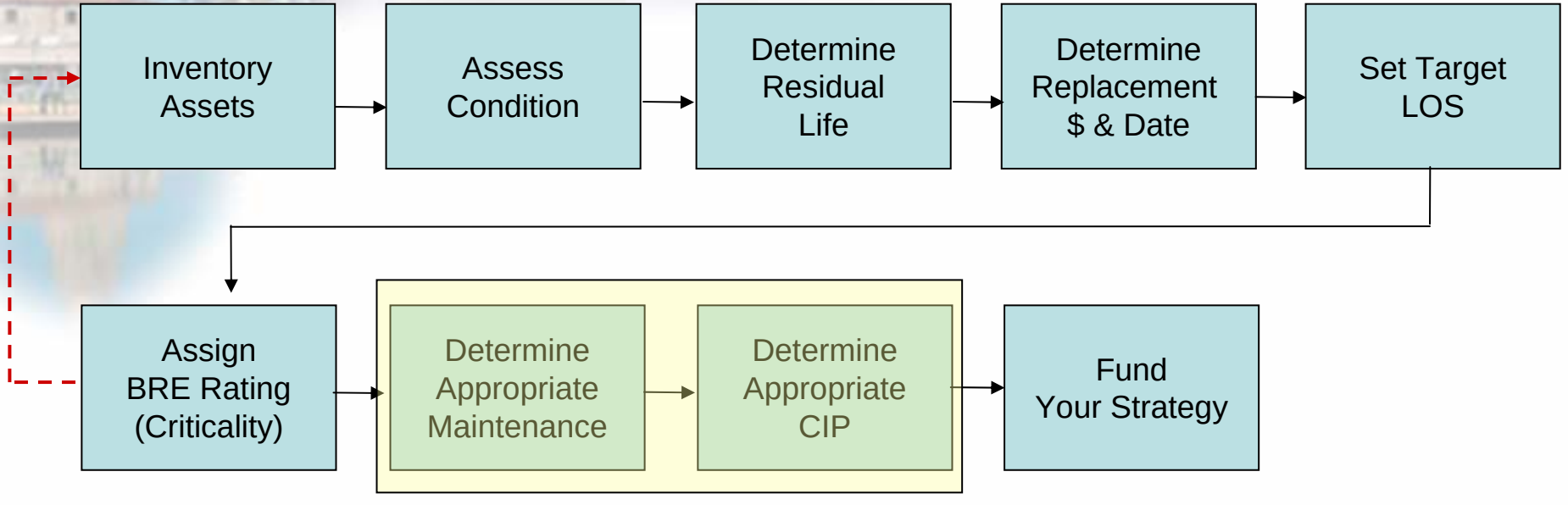
AAM Program Process



Question No. 4

Q4: “What are my best minimum life cycle cost strategies?”

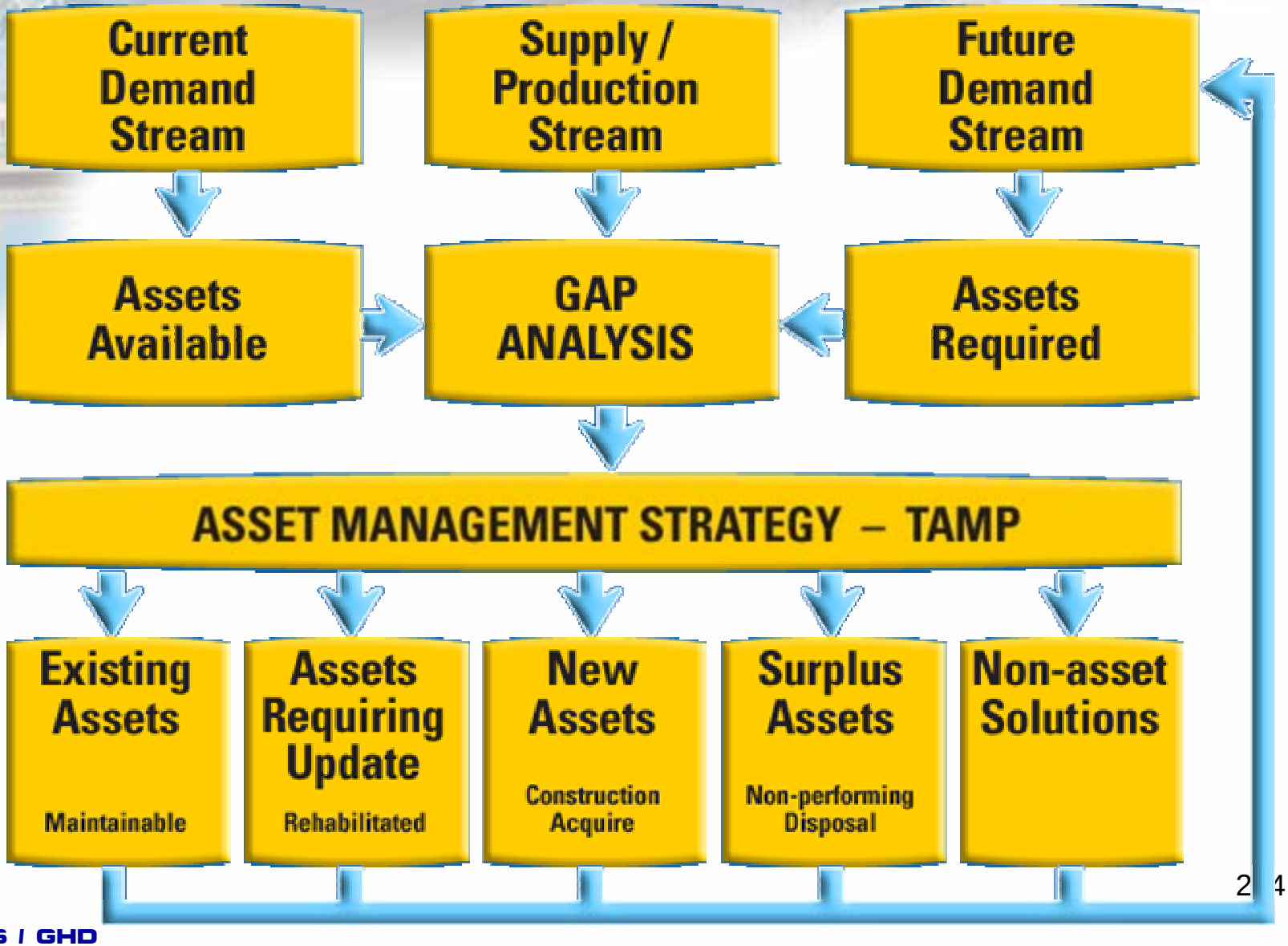
- *Understanding our target levels of service (LOS)*
- *Predicting decay in condition or performance against that LOS*
- *Understanding our future costs*
- *Capital and O&M*
- *Optimized Renewal Decision Making (ORDM)*

Roger

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?*

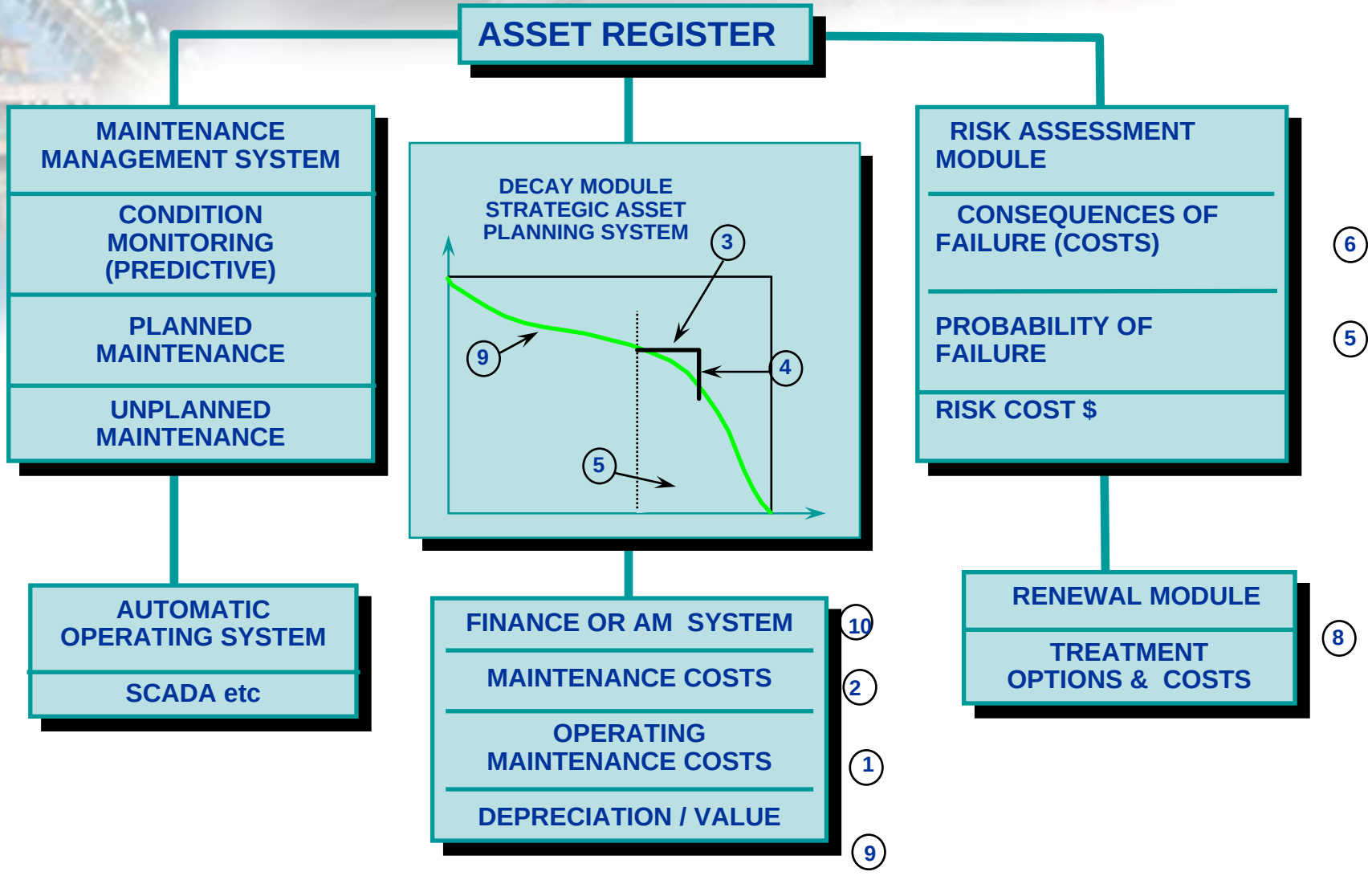
Infrastructure Assets — Strategic Planning



Objectives of This Session

- Understand the process of “optimized renewal decision making” (ORDM)
- Its relationship to life cycle asset management
- The inputs required and
- The outputs necessary for inclusion in asset management plans (AMPs)

Renewals – Sources of Data



Inputs – Sources of Data

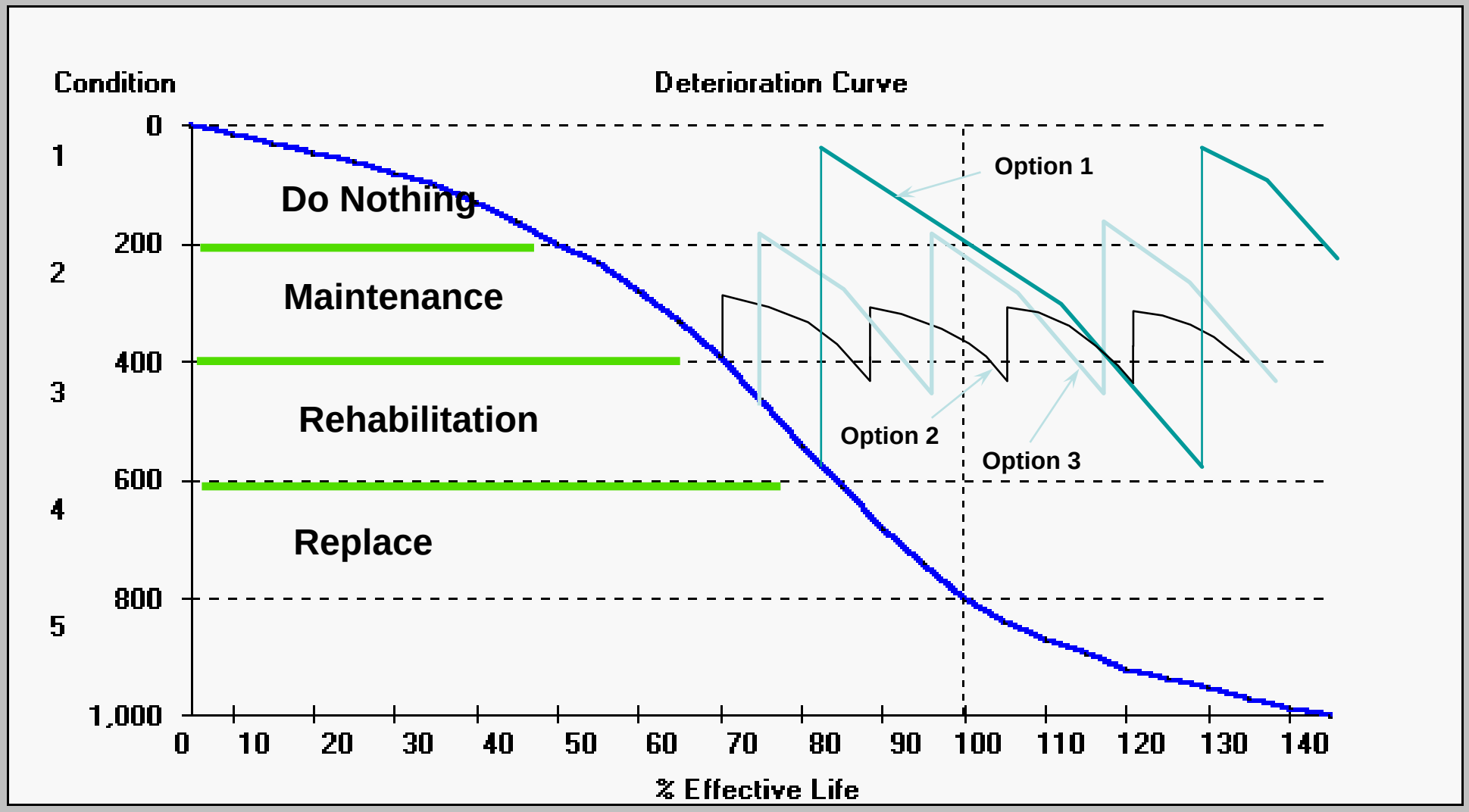
STRATEGIES & BENEFITS		DERIVED FROM
(i)	REDUCED OPERATING COSTS	(1) OPERATIONS / FINANCE
(ii)	REDUCED MAINTENANCE COSTS	(2) MAINTENANCE / FINANCE
(iii)	LIFE EXTENSION OR INCREASED VALUE OF ASSET	(3) DECAY MODEL
(iv)	IMPROVED LEVEL OF SERVICE	(4) DECAY MODEL
(v)	INCREASED PRODUCTION OR INCOME, REDUCED PRODUCT LOSS	INDIVIDUAL ASSESSMENT
(vi)	REDUCED RISK COST (Before and after Failure) - DIRECT - INDIRECT	(5) PROBABILITY OF FAILURE (6) CONSEQUENTIAL COSTS (Before and After)
(vii)	TOTAL BENEFITS (Per Option)	(11) ADDITION OF ABOVE
(viii)	COSTS	(8) $
(ix)	BENEFIT / COST RATIO (Initial Filter)	(11) $ / (8) $

Optimal Renewal Decision Making — Options

NON-ASSET OPTIONS...

Sewarmain Decay Curve

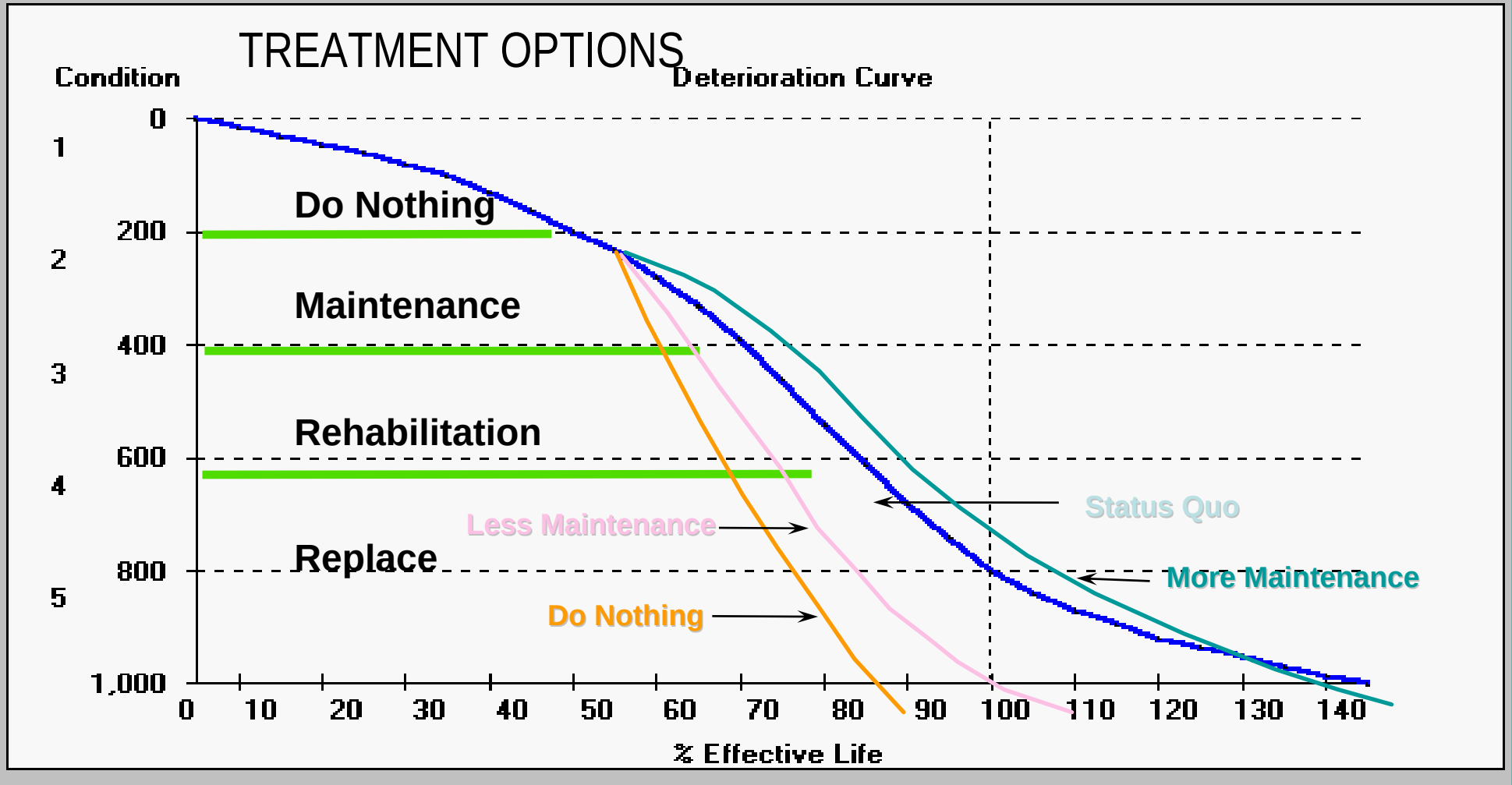
Main



Overlay Prob. of Failure Curve

Sewarmain Decay Curve

Main

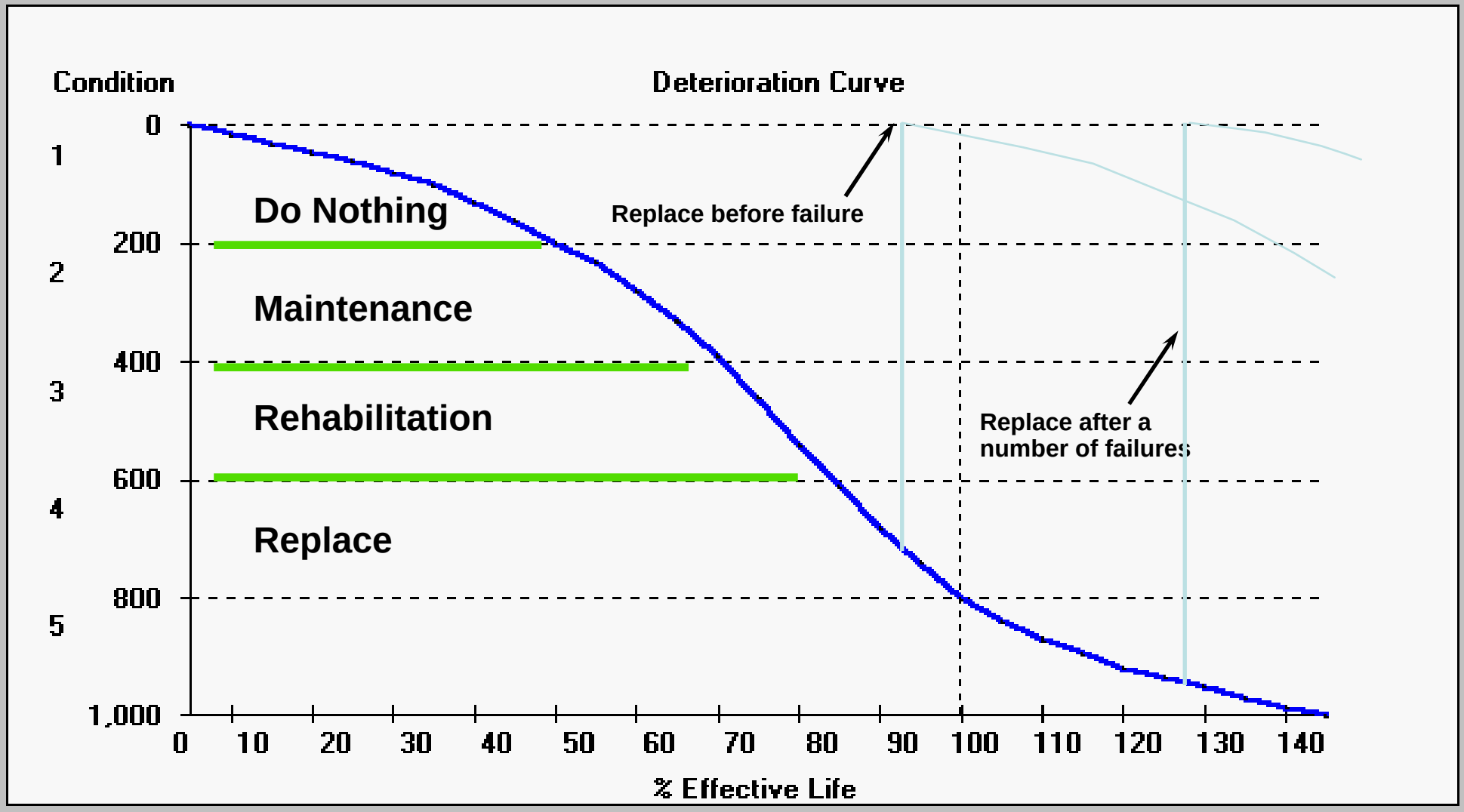


Overlay Prob. of Failure Curve

PARSONS / GHD

Sewarmain Decay Curve

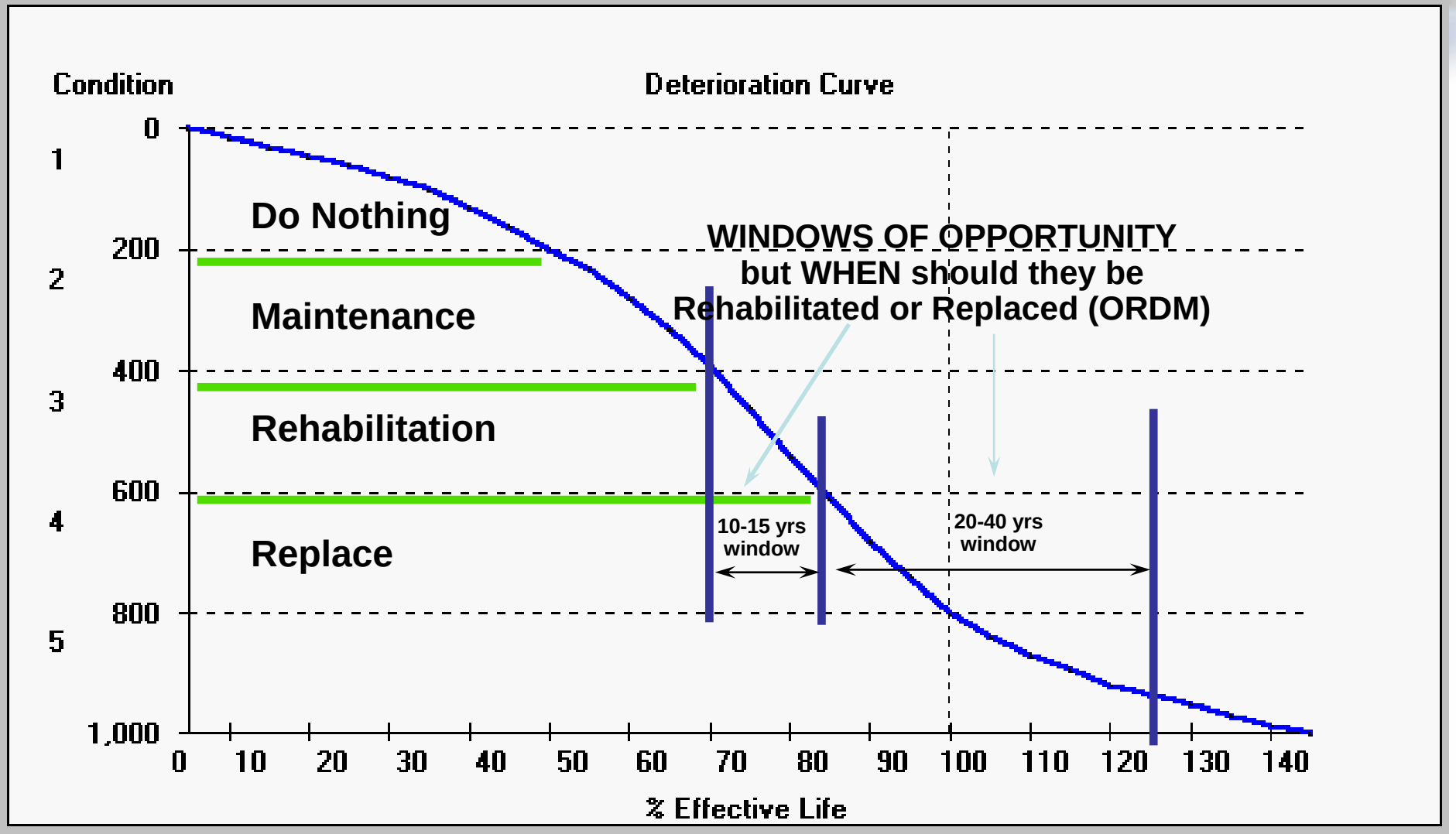
Main



Overlay Prob. of Failure Curve

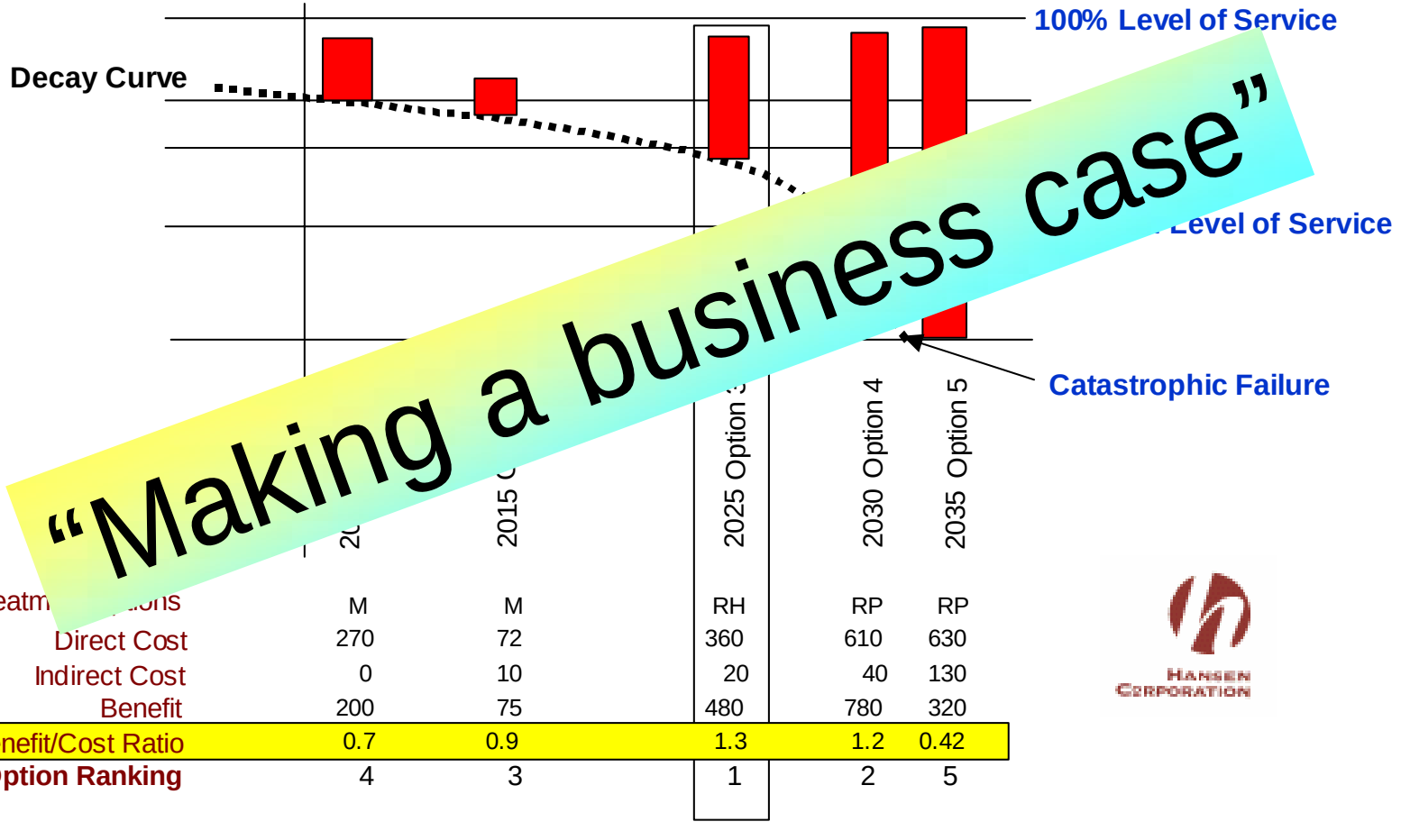
Sewarmain Decay Curve

Main



Overlay Prob. of Failure Curve

Optimal Replacement Decision Theory



"Making a business case"

Treatm…ions	M	M	RH	RP	RP
Direct Cost	270	72	360	610	630
Indirect Cost	0	10	20	40	130
Benefit	200	75	480	780	320
Benefit/Cost Ratio	0.7	0.9	1.3	1.2	0.42
Option Ranking	4	3	1	2	5

HANSEN CORPORATION

Importance Of The Work Order

WORK ORDER

ASSET DETAILS

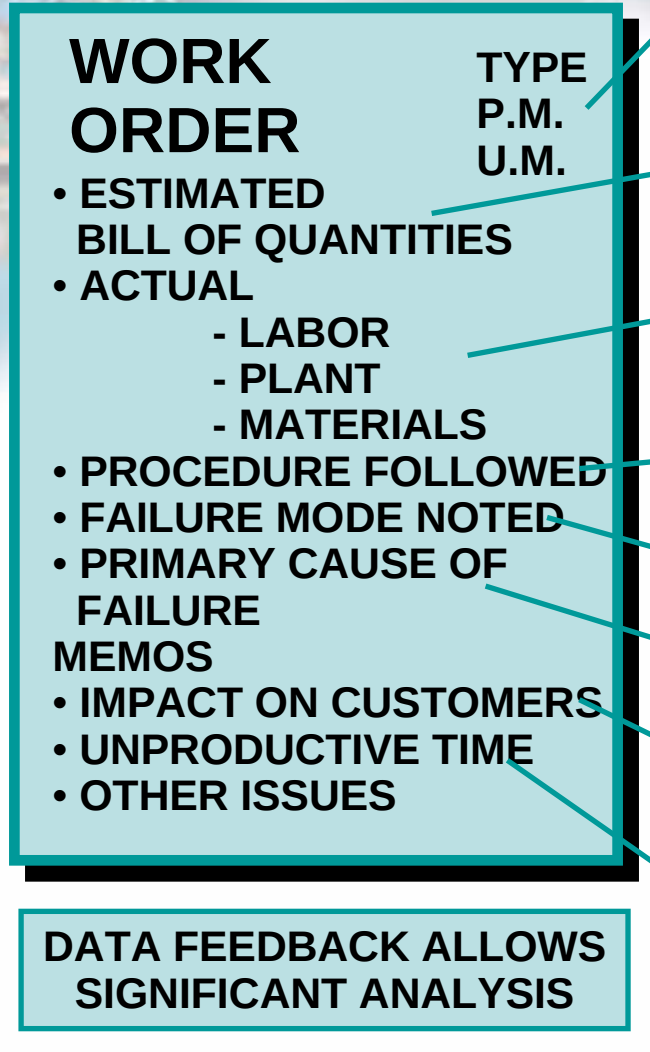
- TYPE
- CATEGORY
- SIZE
- CONDITION
- PERFORMANCE HISTORY

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



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

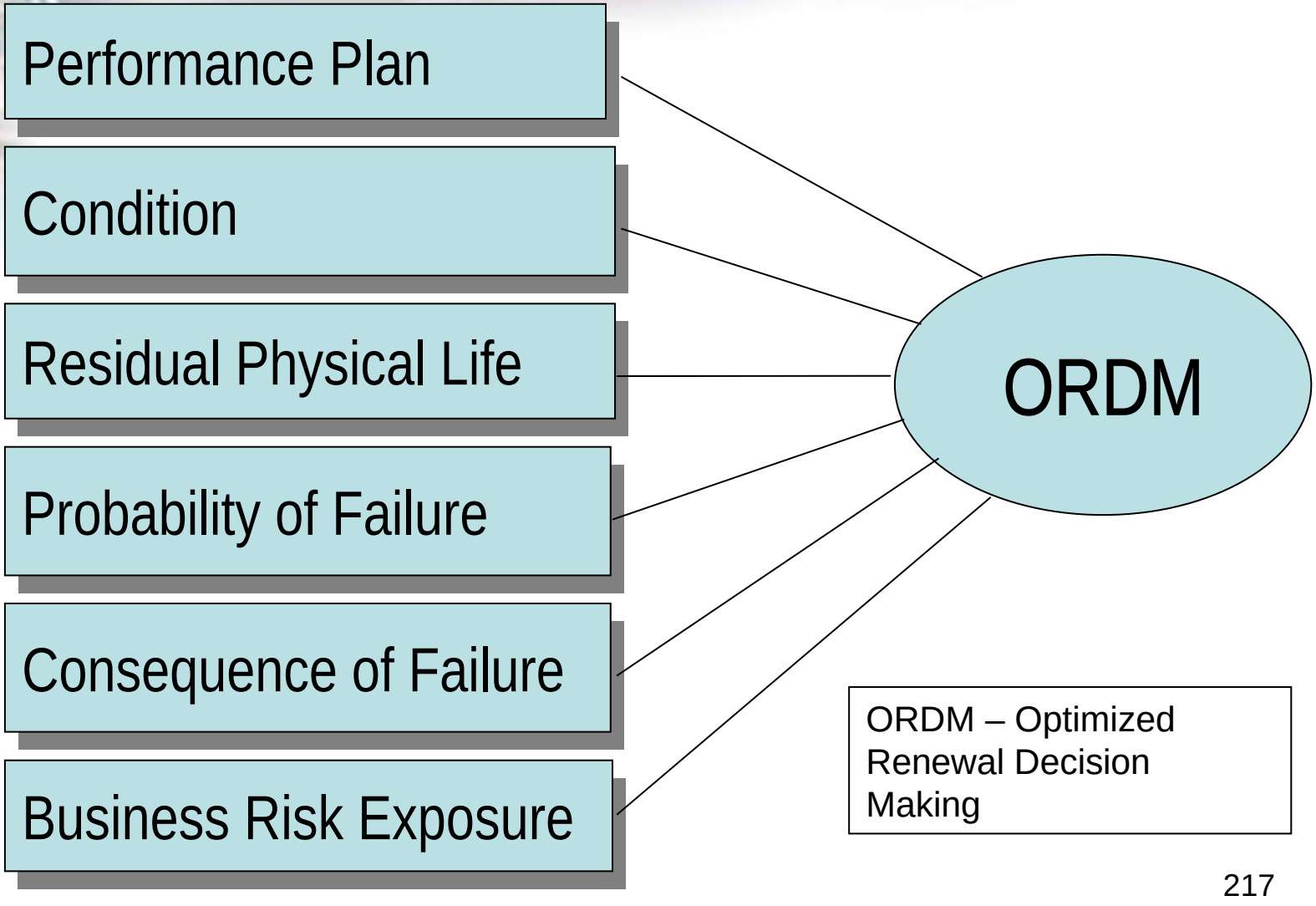
NECESSARY FOR CAUSAL ANALYSIS

INDIRECT COSTS ON BUSINESS IMPACT ON CUSTOMERS EFFECTS ANALYSIS

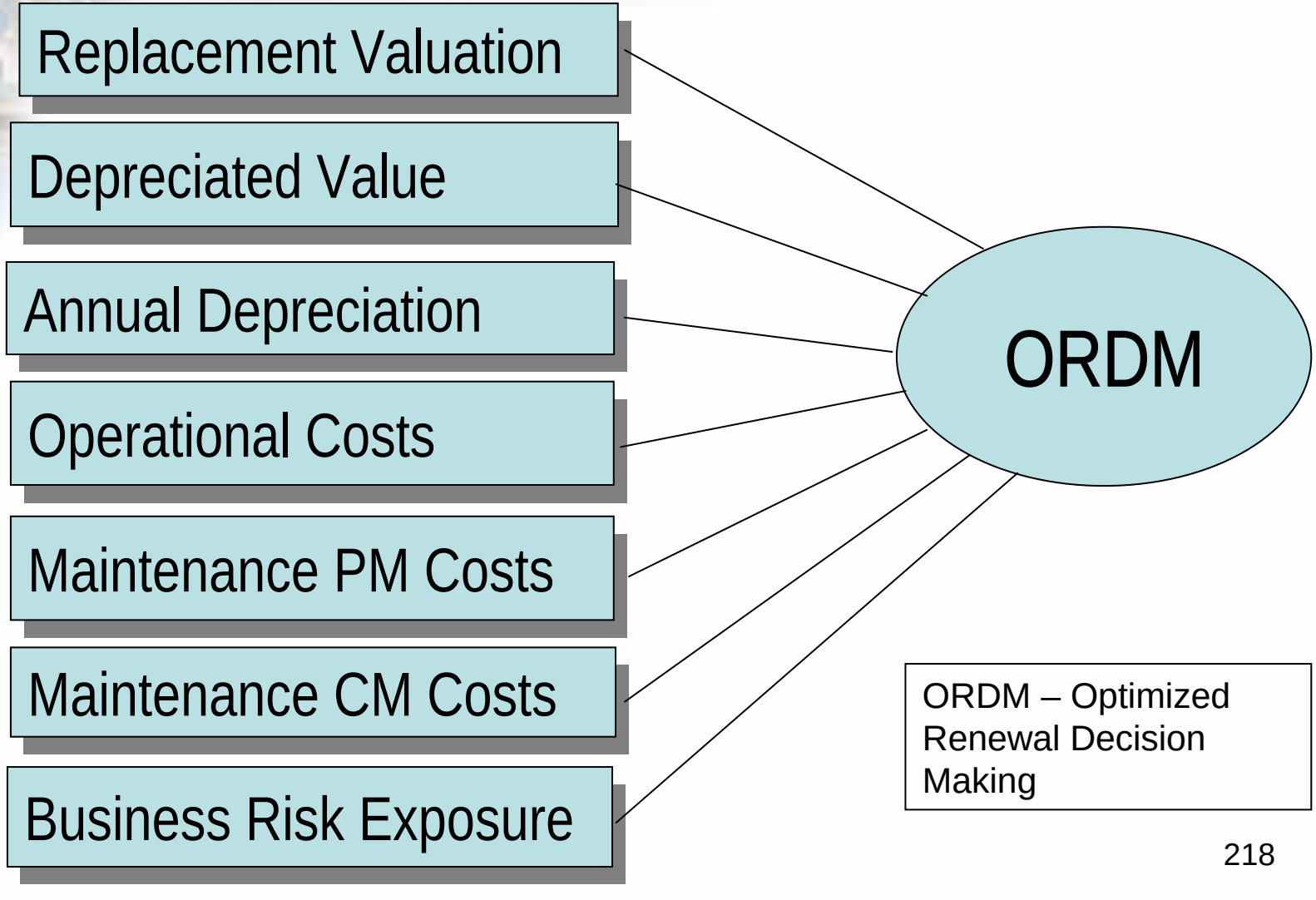
CAUSE OF COST OVERRUNS OR POTENTIAL COST REDUCTIONS

DATA FEEDBACK ALLOWS SIGNIFICANT ANALYSIS

ORDM Decisions – Data Flows

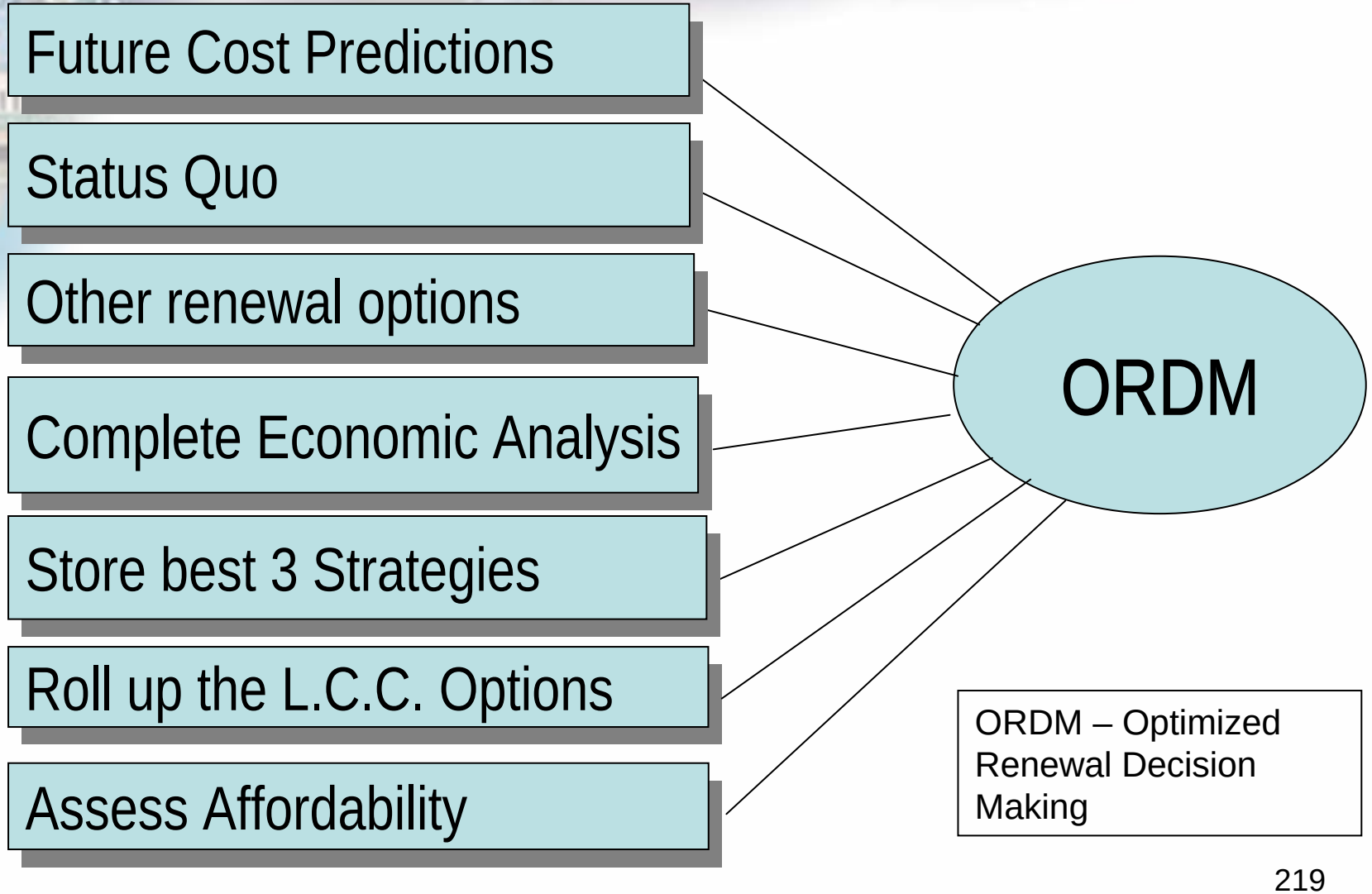


ORDM - Cost Flows

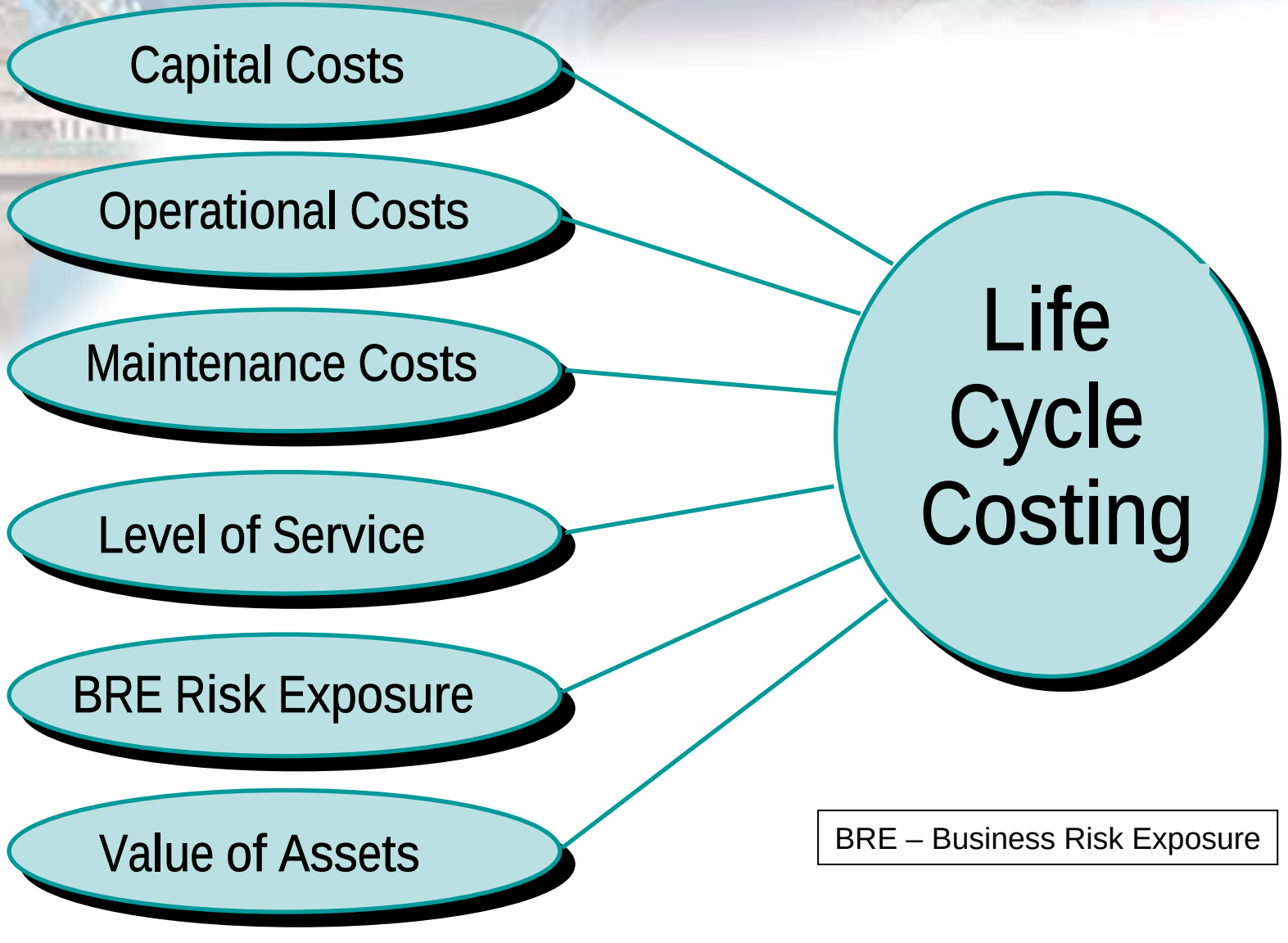


ORDM – Optimized Renewal Decision Making

ORDM – Economic Analysis

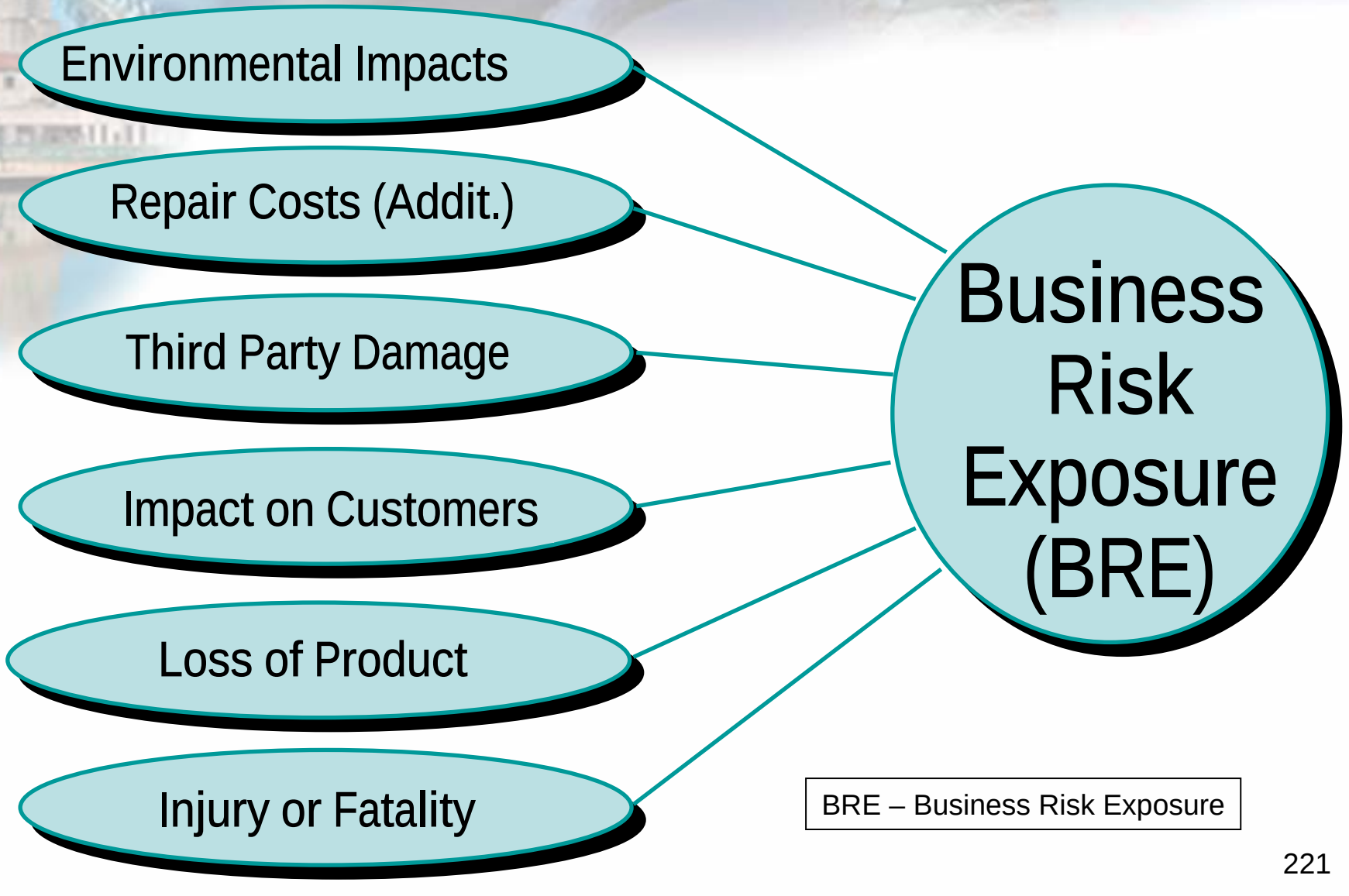


Life Cycle Cost Analysis



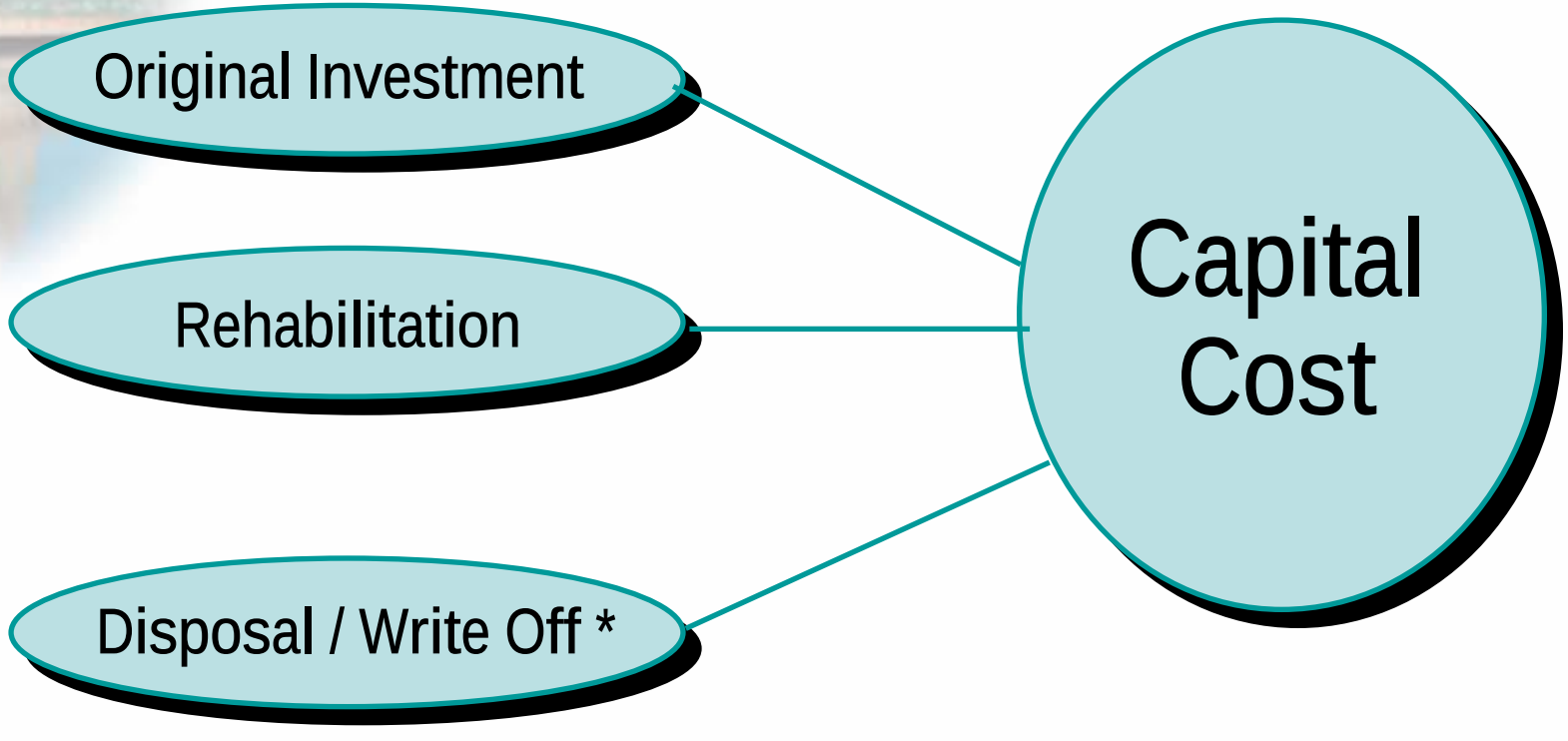
BRE – Business Risk Exposure

Life Cycle Cost Analysis



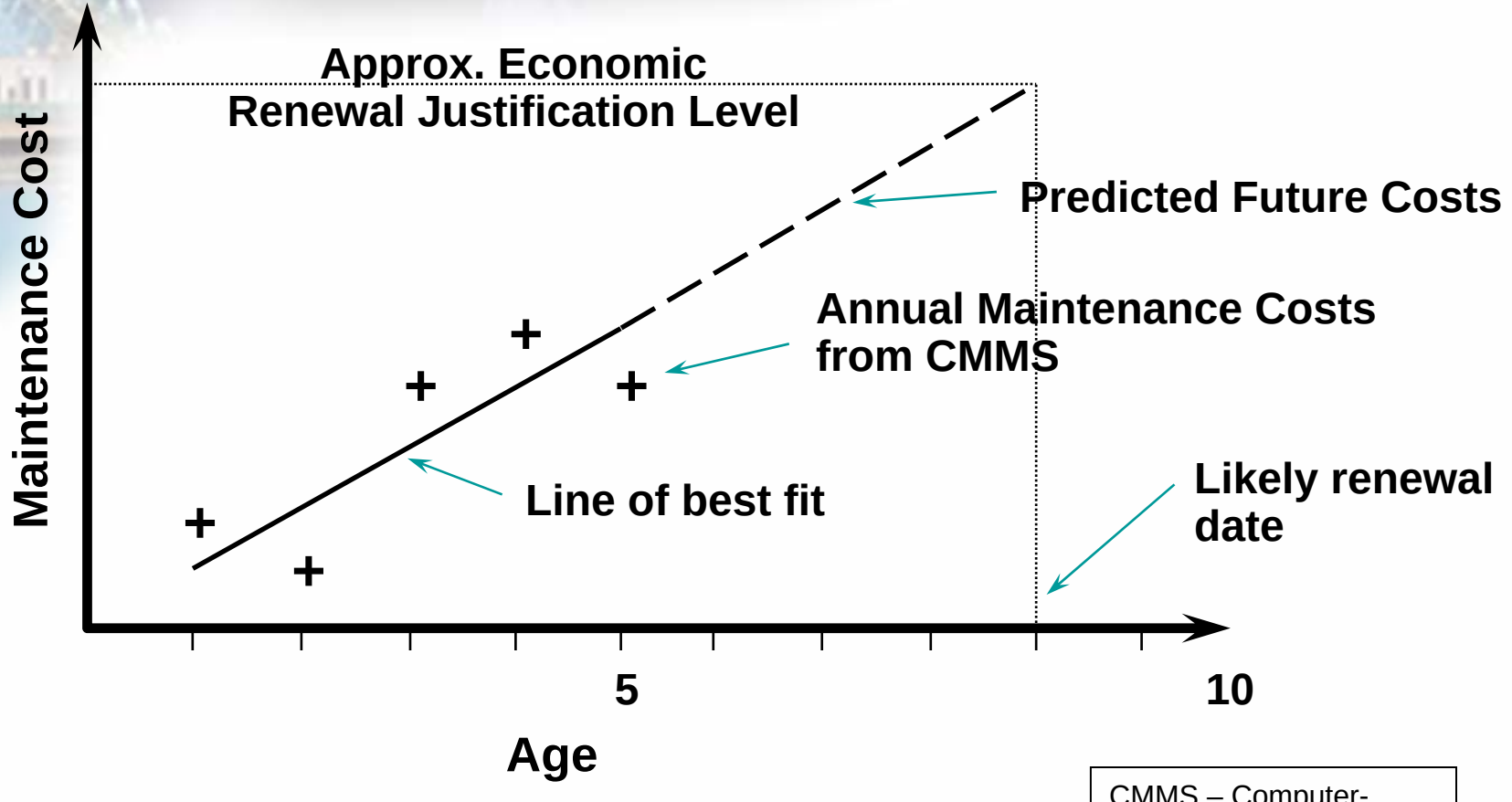
BRE – Business Risk Exposure

Life Cycle Cost Analysis



* must include write-off of residual value

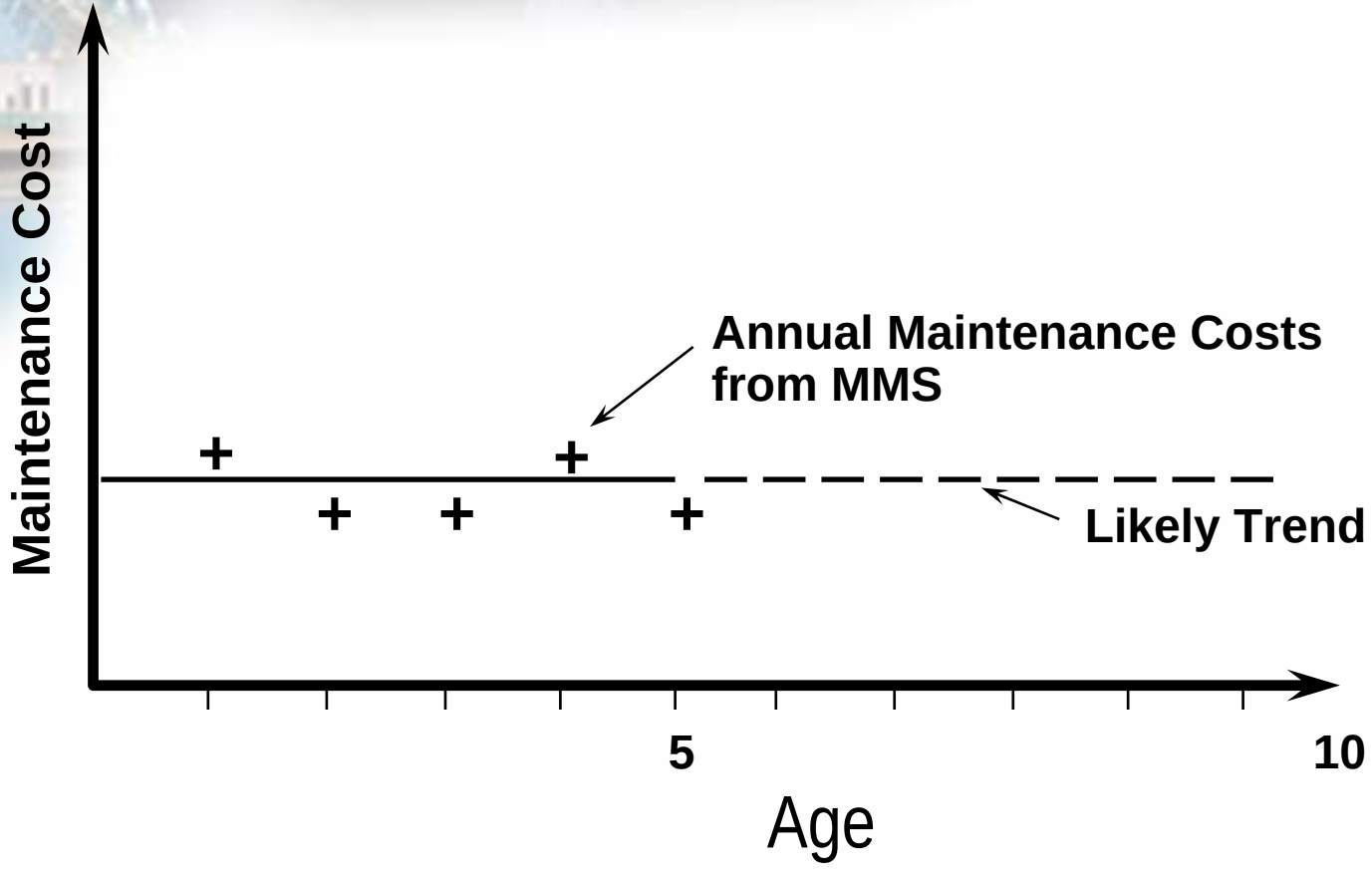
Predicting Maintenance Costs



Increasing Costs Scenario
(Bath tub tail curve)

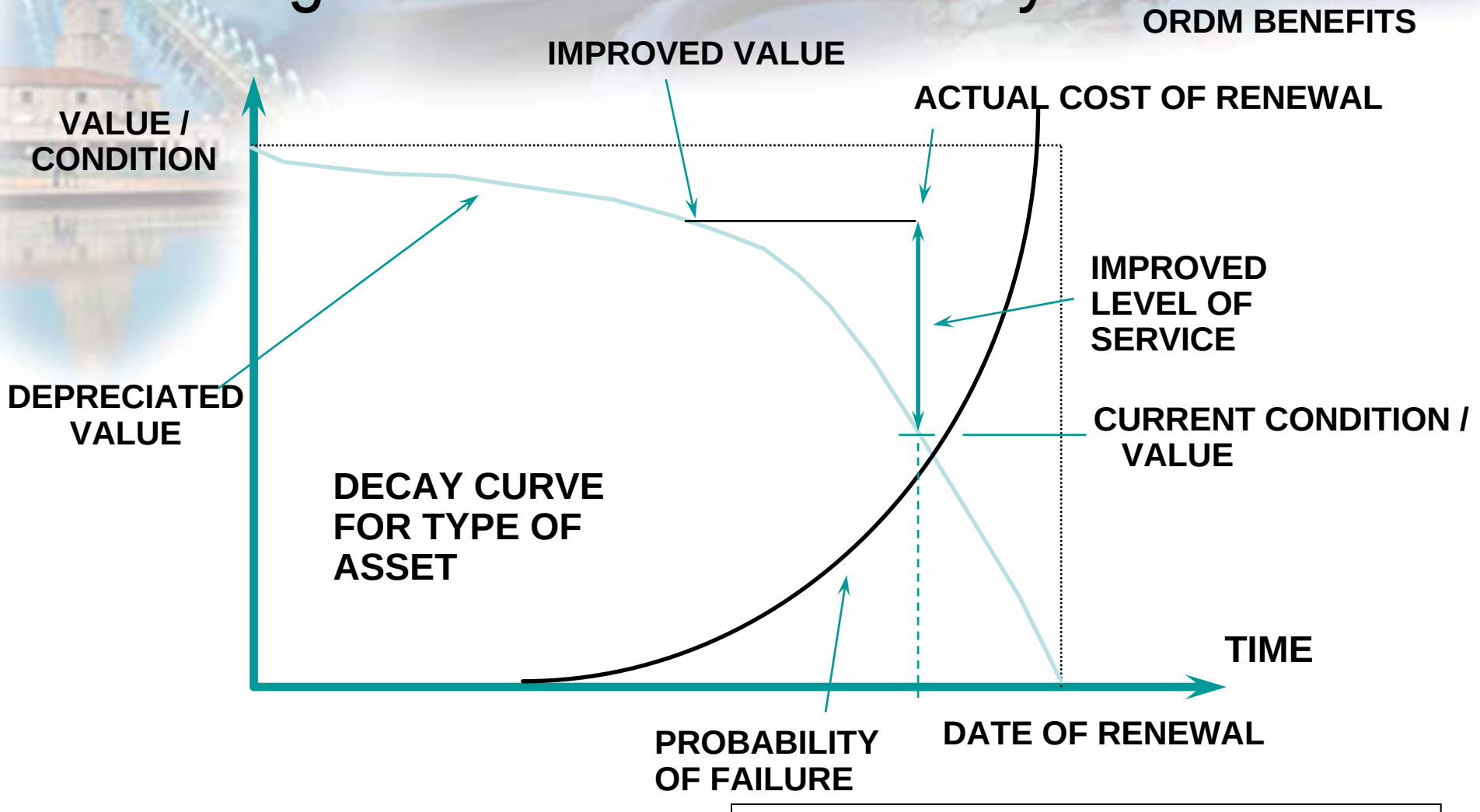
CMMS – Computer-based Maintenance Management System

Predicting Maintenance Costs



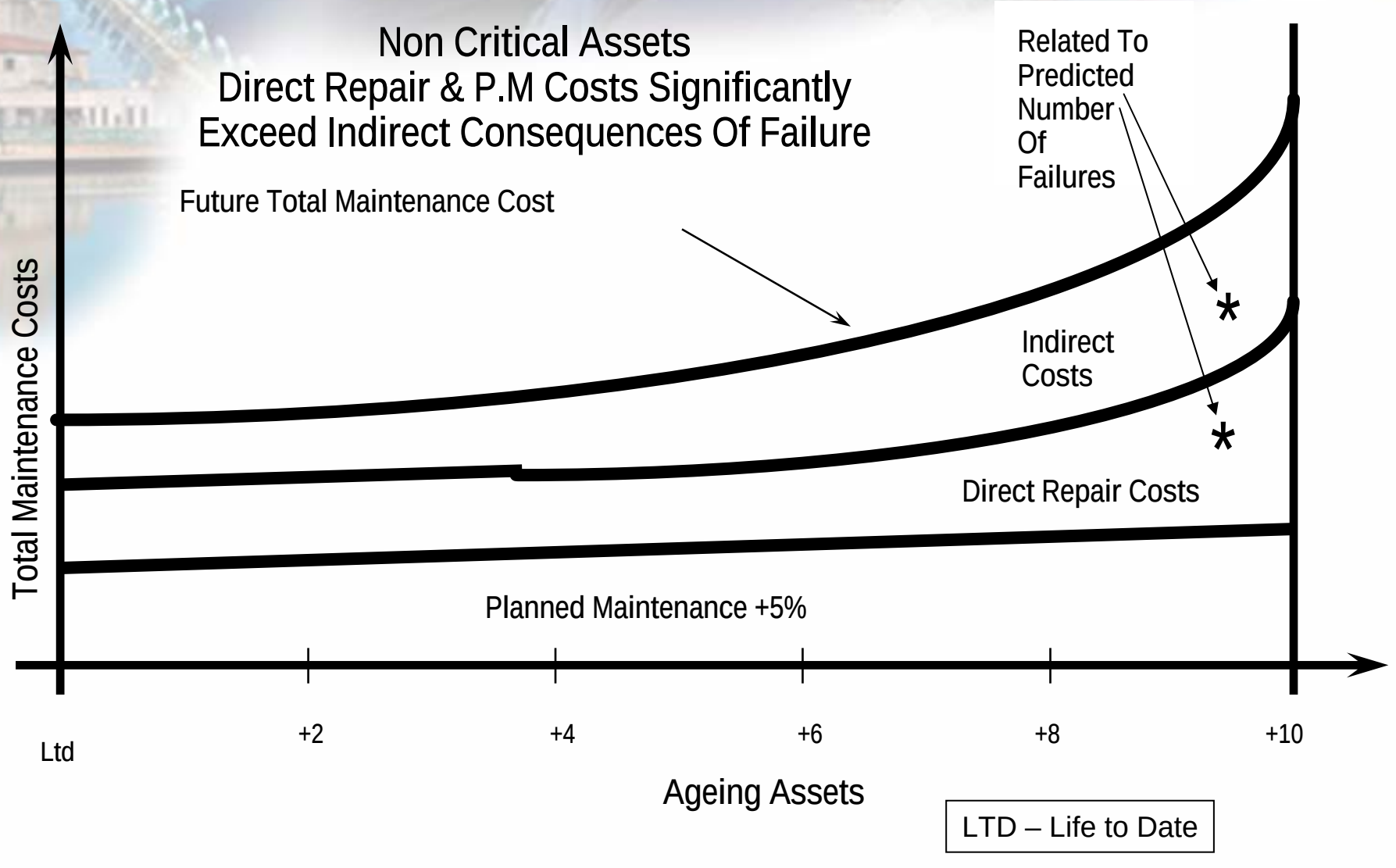
Stable Maintenance Scenario
(Bottom of bath tub curve)

Linking Condition & Probability Of Failure



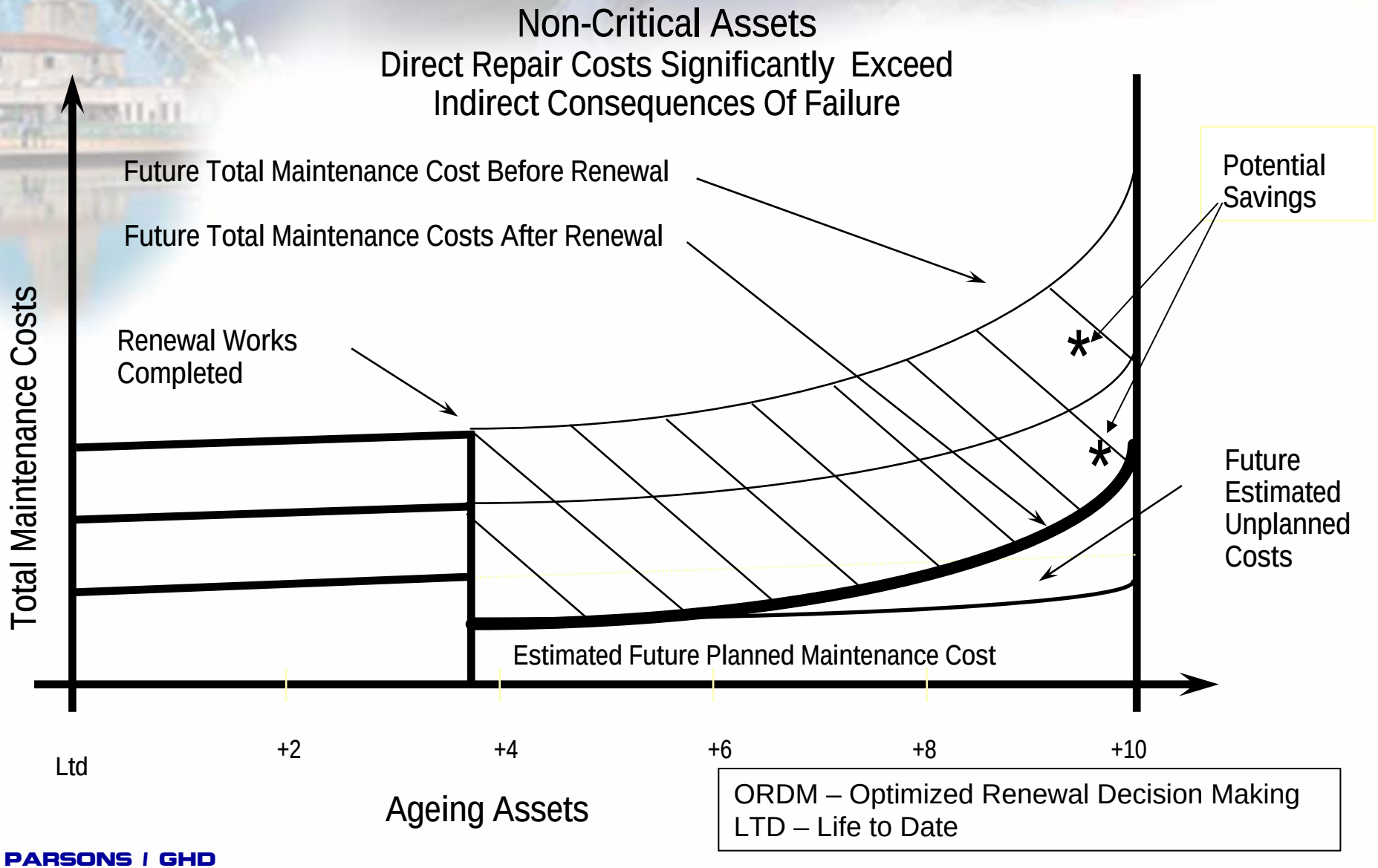
ORDM – Optimized Renewal Decision Making

ORDM - Future Costs



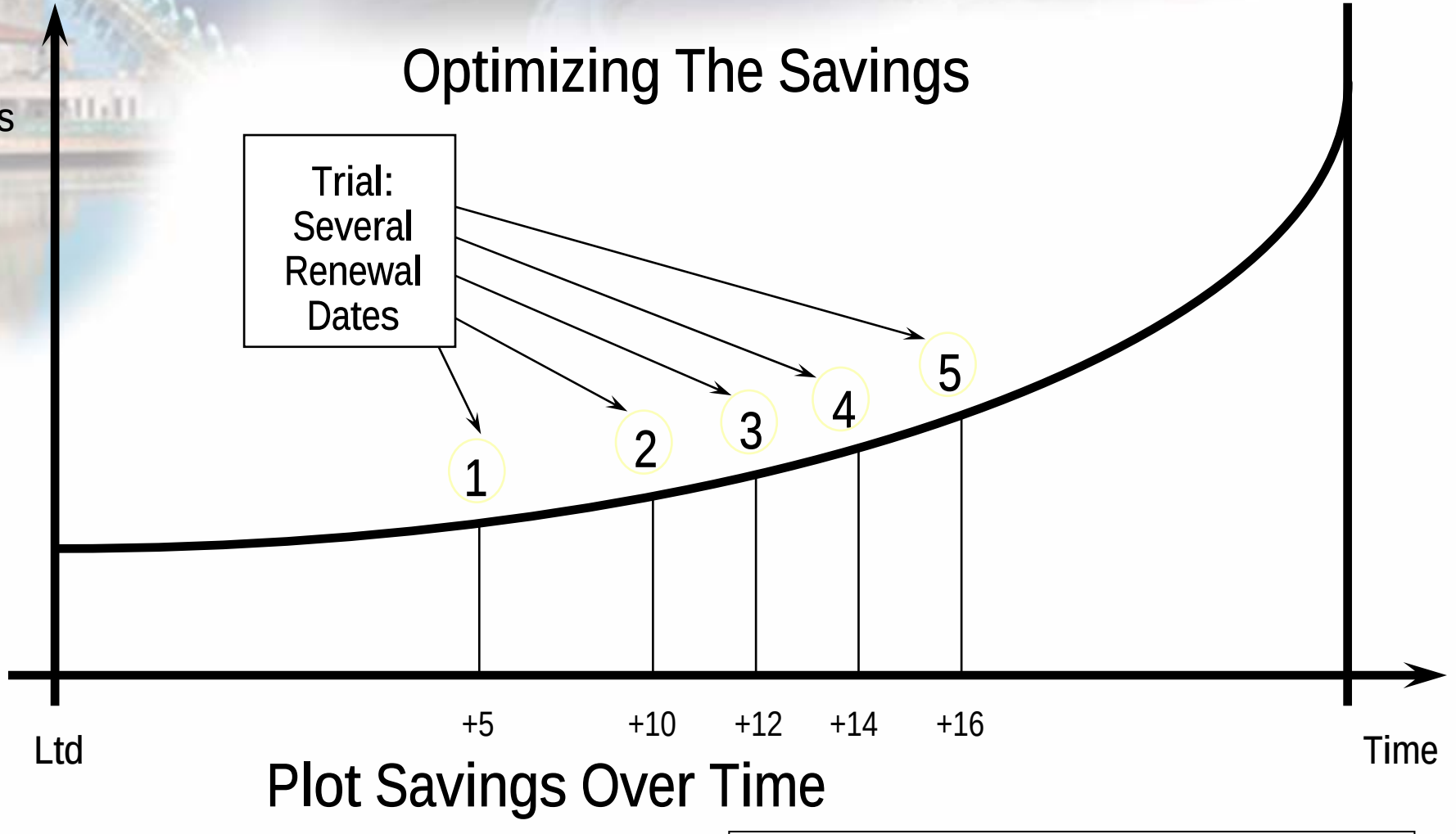
LTD – Life to Date

ORDM - Future Costs



ORDM – Optimized Renewal Decision Making
LTD – Life to Date

ORDM - Timing The Renewal



ORDM – Optimized Renewal Decision Making
LTD – Life to Date

Exercise Number 5
30 minutes

Help Tom develop an understanding of the future costs of the pump station ..

Using the data provided, :

- Assess the future maintenance impacts in column S and apply the change you expect..using % shown in column S
- If you believe they will rise, then reassess the residual physical life and give the component a new residual economic life…in column T of the spread sheet

Exercise Number 5 Cont.

Using the data provided, :

- Adopt a renewal strategy based on your best judgment using sheet F on the spreadsheet.
- Estimate the cost of this renewal strategy based on your best estimate …(in dollars)
- The spreadsheet will calculate the date required using the shortest of the physical or economic lives ..

Exercise Number 5 Cont.

- Then, have a look at the graph on the second sheet, “Renewal Profile”, to see how much your program will require
- How much Tom will need to convince the Finance manager & Board to fund

Answers to Exercise Number 5
15 minutes

Roger and the team will show you what answers they developed …

Ask questions , challenge their assumptions..

Tell us why you did what you did…right & wrong ….

What could be improved?

Key Lessons Learned

- ⇨ There are lots of ways to renew (extend the economic life) of an asset
- ⇨ We need to think differently …outside our normal box - our normal culture
- ⇨ We need good technical and cost data to understand the best time to renew
- ⇨ To get the required confidence level
- ⇨ Our CMMS and Work Orders are the heart of any good data flow

CMMS – Computer-based Maintenance Management System

Take home messages

- Get ‘cracking’ ….(aussie for started)
- Develop a simple approach like this example and get started
- You don’t have to be perfect to be much better …(process – data comes later ..)
- We must realize that capital is not free and that sometimes more maintenance will be cheaper .. Encourage others to do it …but
- Don’t try and change the world over night…
- Change your world …

AGENDA

Day 1

- *Welcome, Introductions & Housekeeping Details*
- *Background And Context*
- *Overview Of Fundamental Concepts & Core Practices*
- *The "Storyline": Tom's Really Bad Day*
- *Core Question 1: What Is The Current State Of My **Assets**?*
- *Lunch*
- *Core Question 2: What Is My Required "Sustainable" Level Of Service?*
- *Core Question 3: Which Assets Are Critical To Sustained Performance?*
- *Core Question 4: What Are My Best Minimum Life-cycle-cost CIP and O&M Strategies?*
- *Discussion; Q&A*