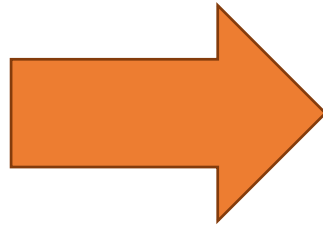


Pavement Management Systems

Adriana Vargas, PhD

The Problem

- Limited funds
- Increasing demands
- Aging infrastructure



- Network deterioration
- User discomfort
- Backlog

Pavement Management

- Pavements need to be managed, not just maintained

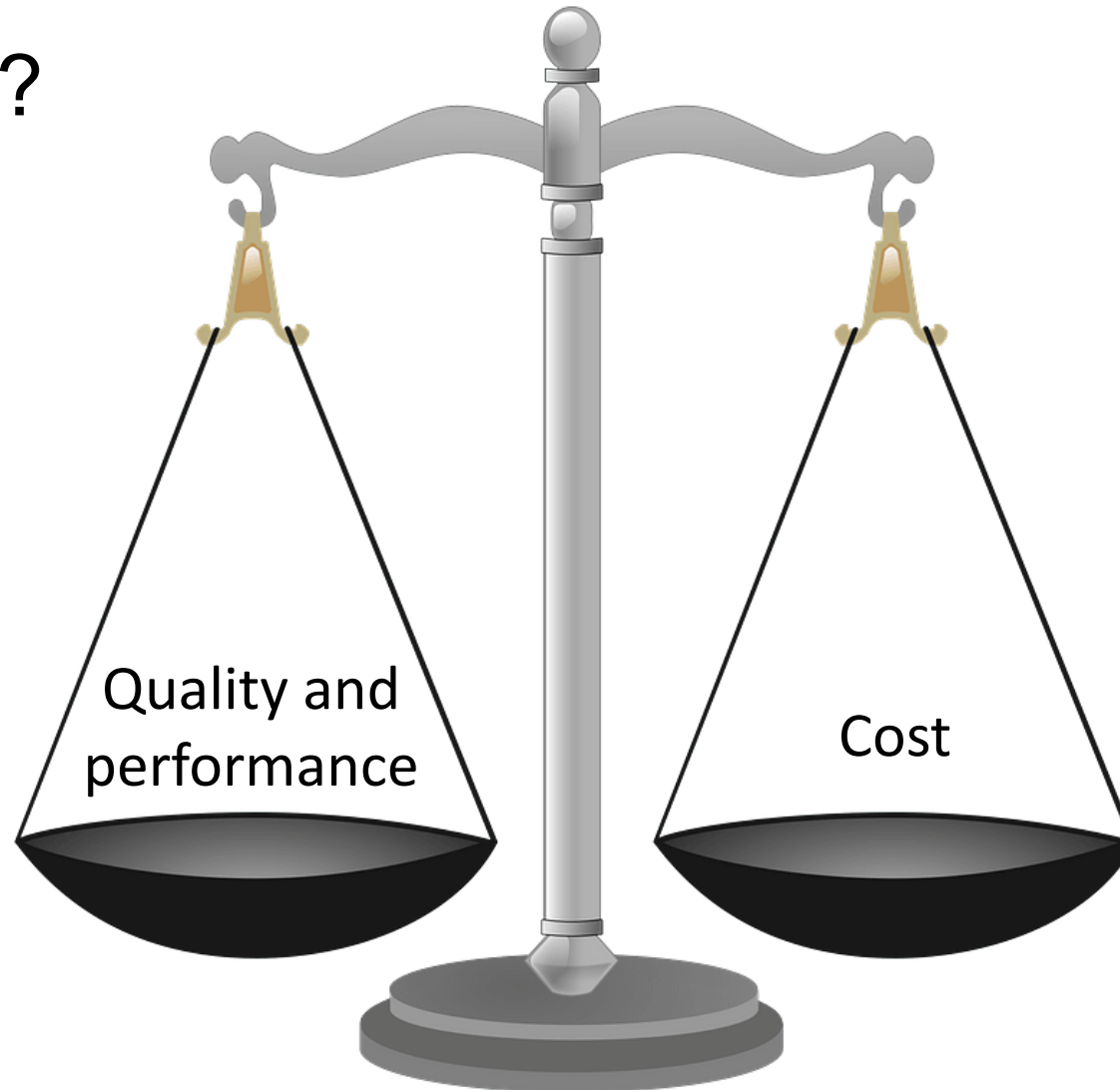
LIFE CYCLE COST

PRIORIZATION

OPTIMIZATION

Pavement Management

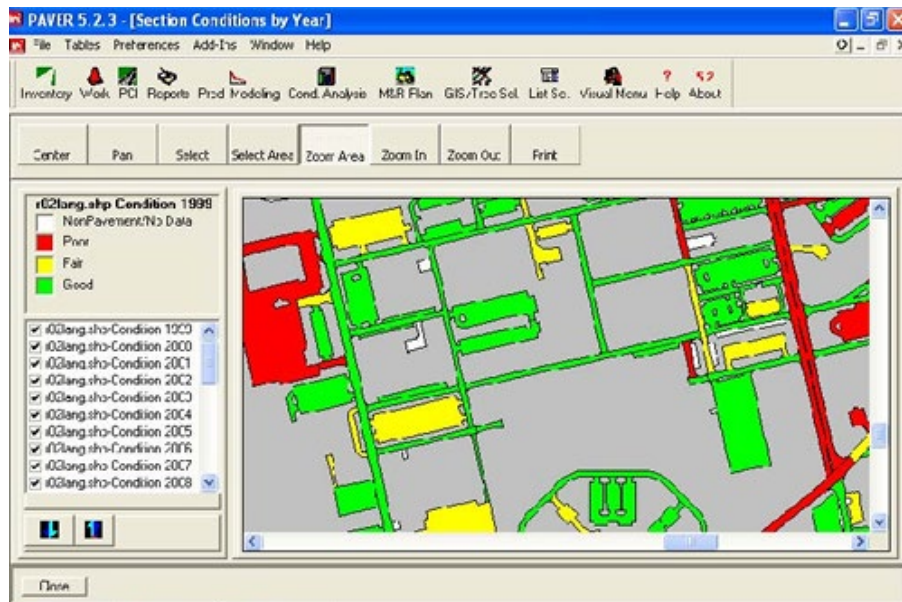
- What is it?



Pavement Management

- Pavement management is generally described, developed and used at two levels:

NETWORK LEVEL






PROJECT LEVEL



Pavement Management

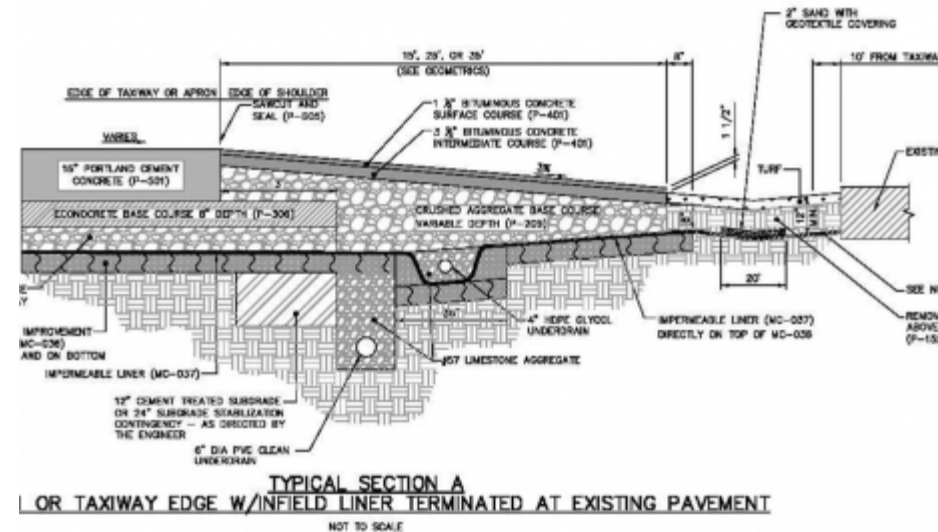
NETWORK LEVEL

- Select the right pavement at the right time

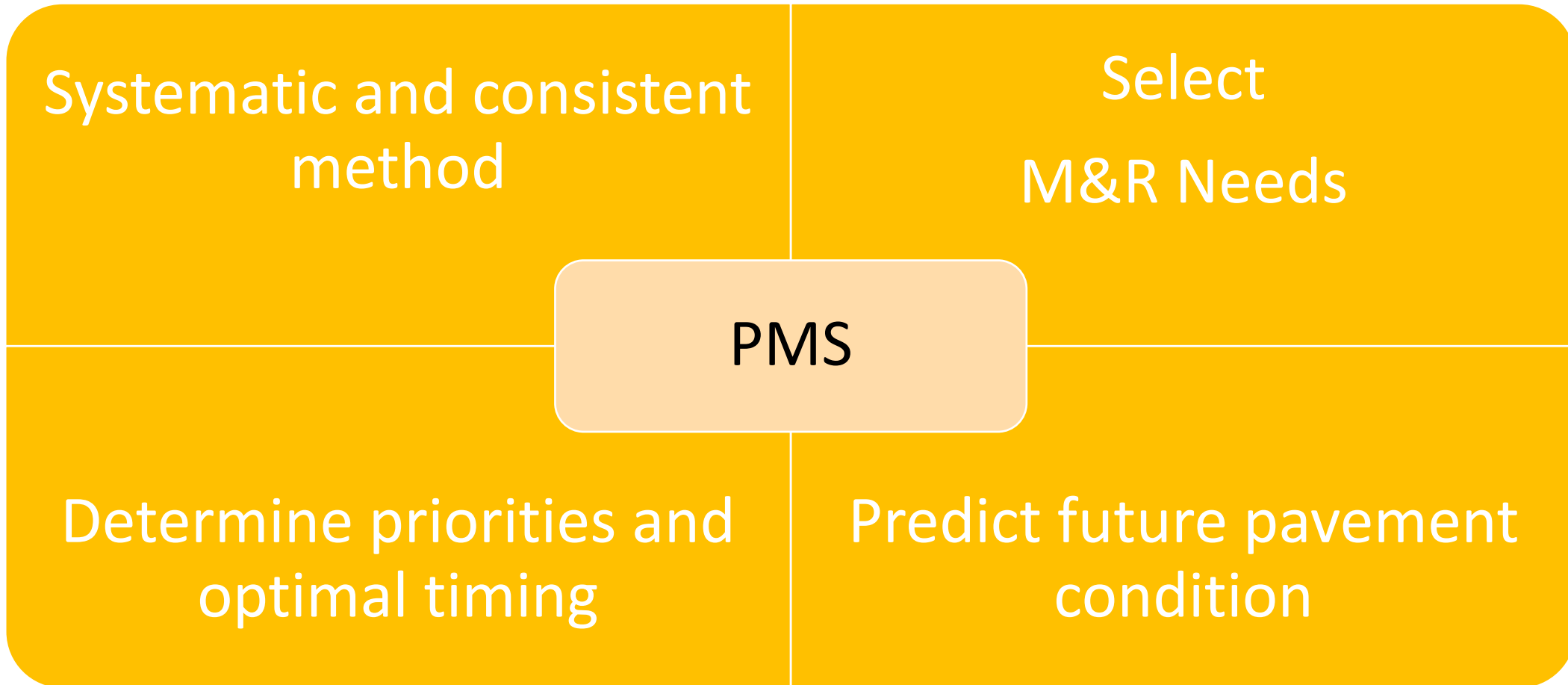
PCI	PCI	REPRESENTATIVE PAVEMENT SURFACE	REPAIR ALTERNATIVE
86 - 100	90		Pavements with PCIs above 85 will benefit from routine maintenance actions, such as periodic crack sealing, periodic joint resealing, or patching.
56-85	65		Pavements with a PCI of 56 (65 for PCC pavements) to 85 may require pavement preservation, such as a surface treatment, thin overlay, or PCC joint resealing.
0 - 55	25		Pavement allowed to deteriorate below a PCI of 55 (65 for PCC) will require costly reconstruction to restore it to operational condition.

PROJECT LEVEL

- Design and implement the right treatment

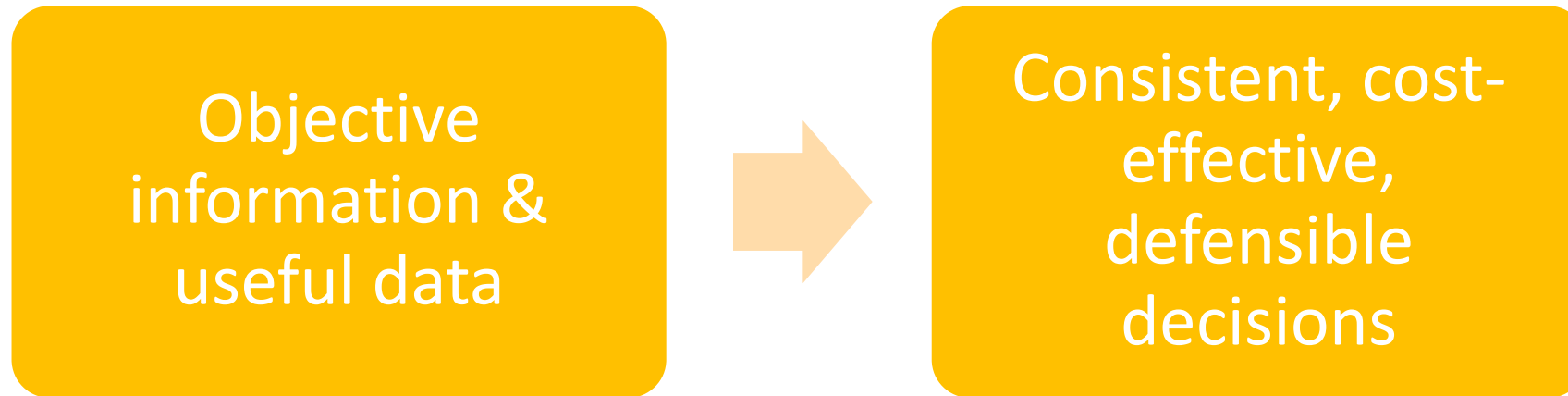


Pavement Management System



Pavement Management System

- Provides basis for an informed decision



- PMS does NOT make decisions, managers do
- PMS ≠ software

Major Components



Data Collection

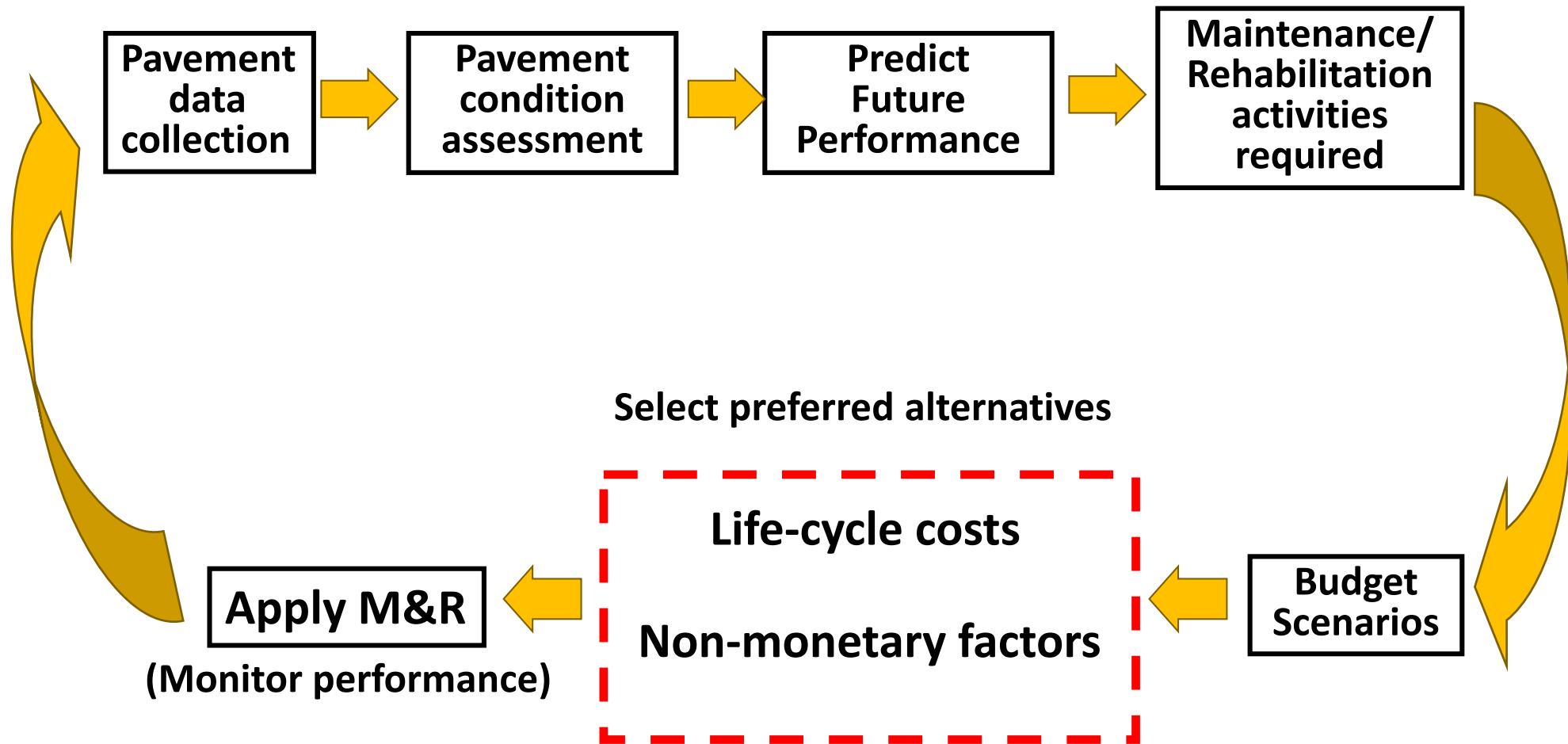


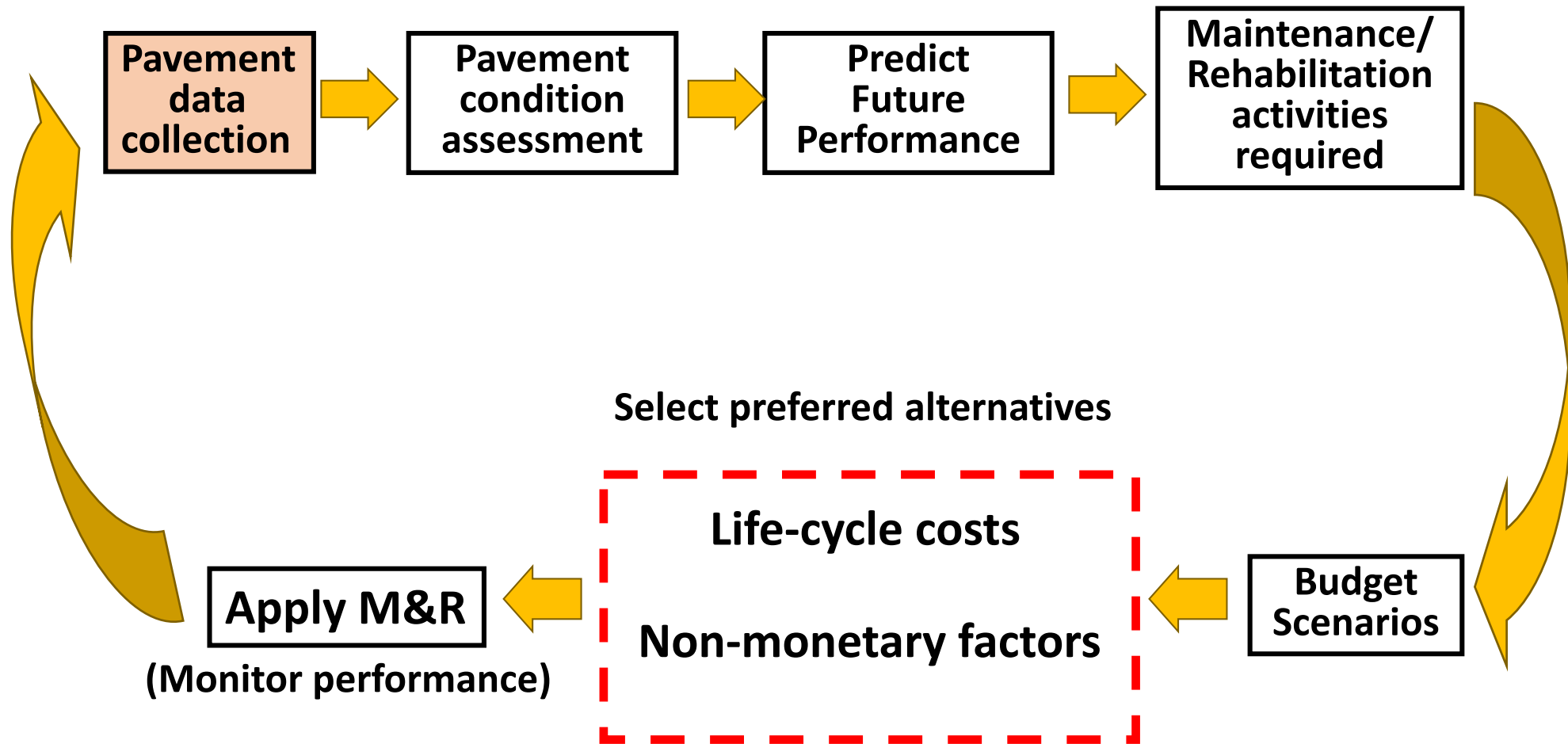
Time / Traffic

Analysis



Data Management & Update





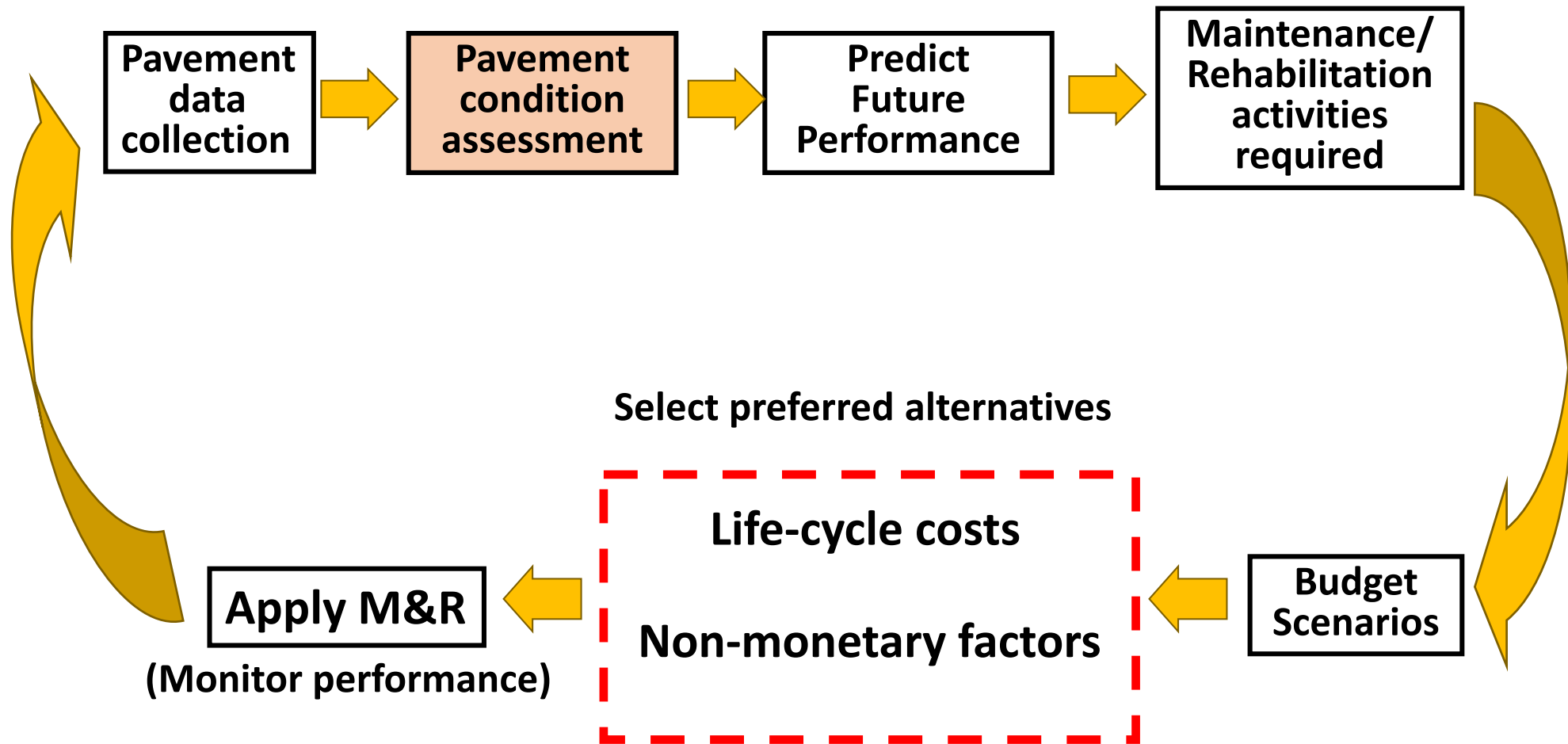
Data Collection

- INVENTORY – what do I have?

Need data on any feature that influences:

- Cost to Replace or Maintain
- Maintenance or Rehab Treatment Options
- Influences Management Decisions
- Service Life

- Quantity
- Location
- Geometry
- Materials
- Traffic
- History
- Costs
- Etc.

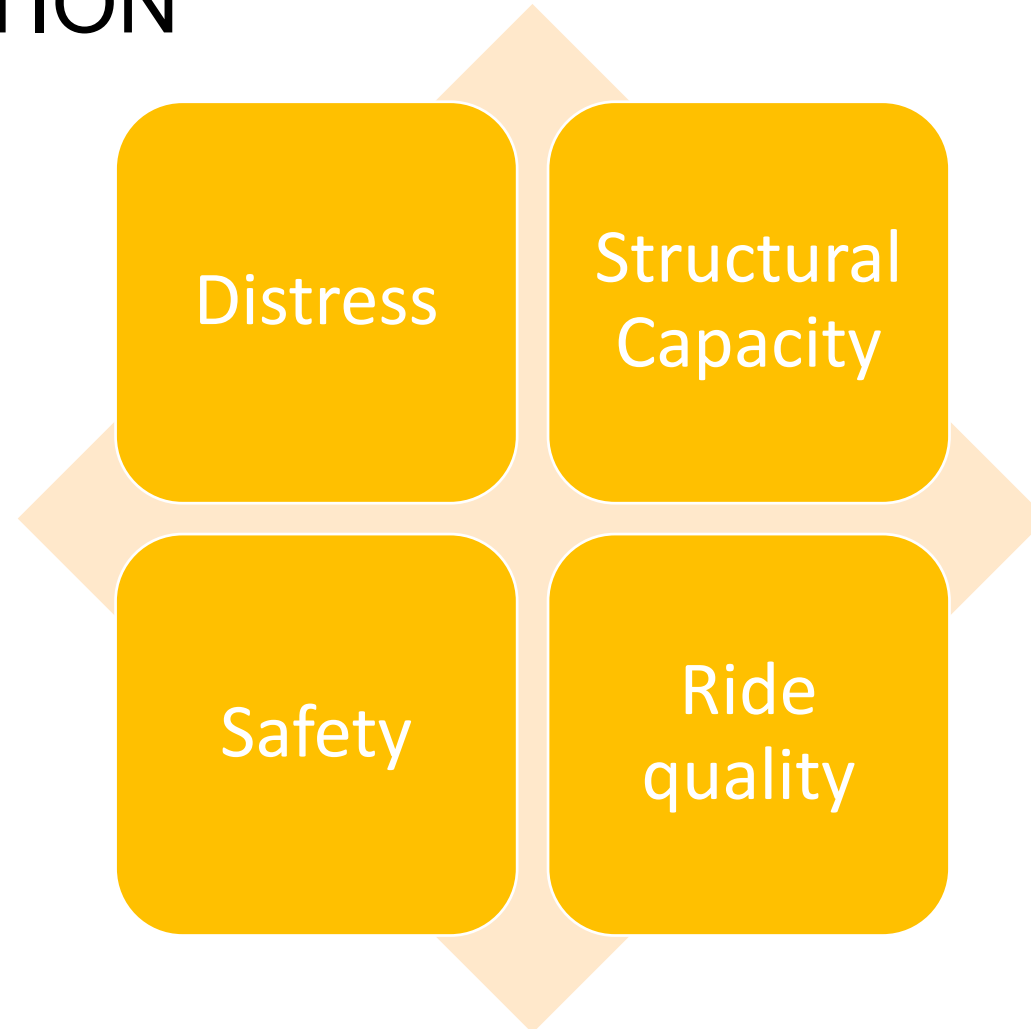


Data Collection

- **CONDITION** – What shape is it in?
 - Current condition
 - Rate of deterioration
 - Future condition and M&R needs
 - Future costs of repairs

Data Collection

- **CONDITION**



Data collection is expensive, collect only what you need!

Data Collection

- Distress Surveys
 - Evaluate the “health” of the pavement
 - Determine type, severity and extent of surface distress
 - Often used to calculate a pavement condition index
 - Help identify type and timing of treatment

Data Collection

- Distress Surveys
 - Manual
 - Walking and/or windshield
 - Automated
 - Pavement condition survey vehicles



Data Collection

- Distress Surveys

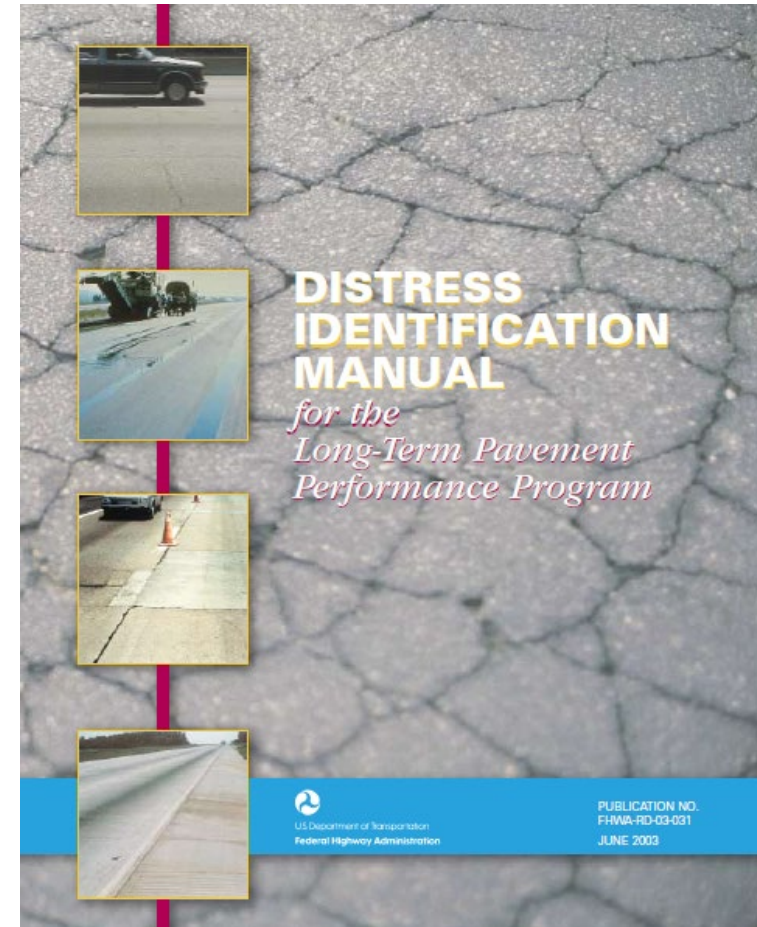


Designation: D6433 – 11

Standard Practice for Roads and Parking Lots Pavement Condition Index Surveys¹

This standard is issued under the fixed designation D6433; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

- Several protocols available, distress definitions and severity levels may vary



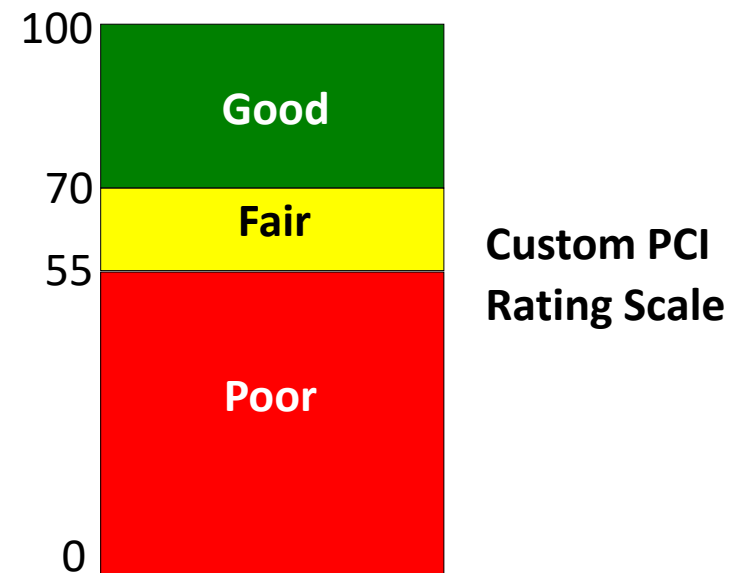
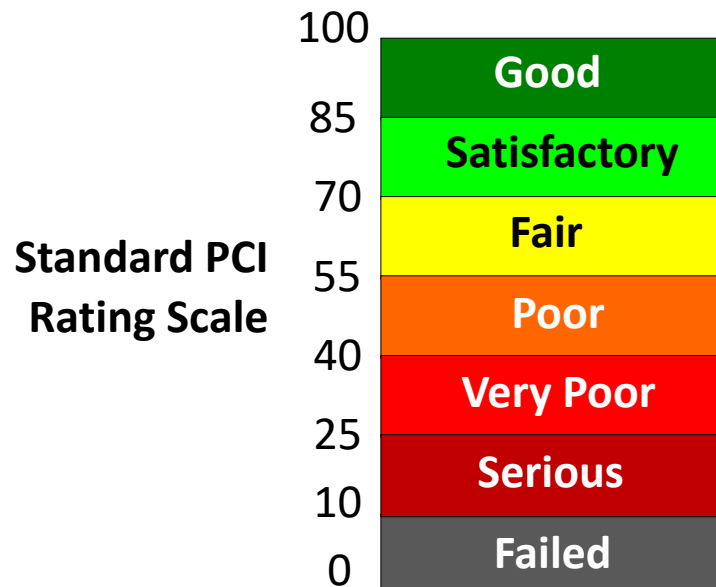
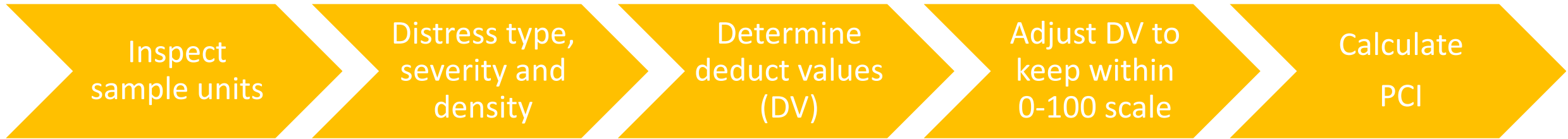
Data Collection

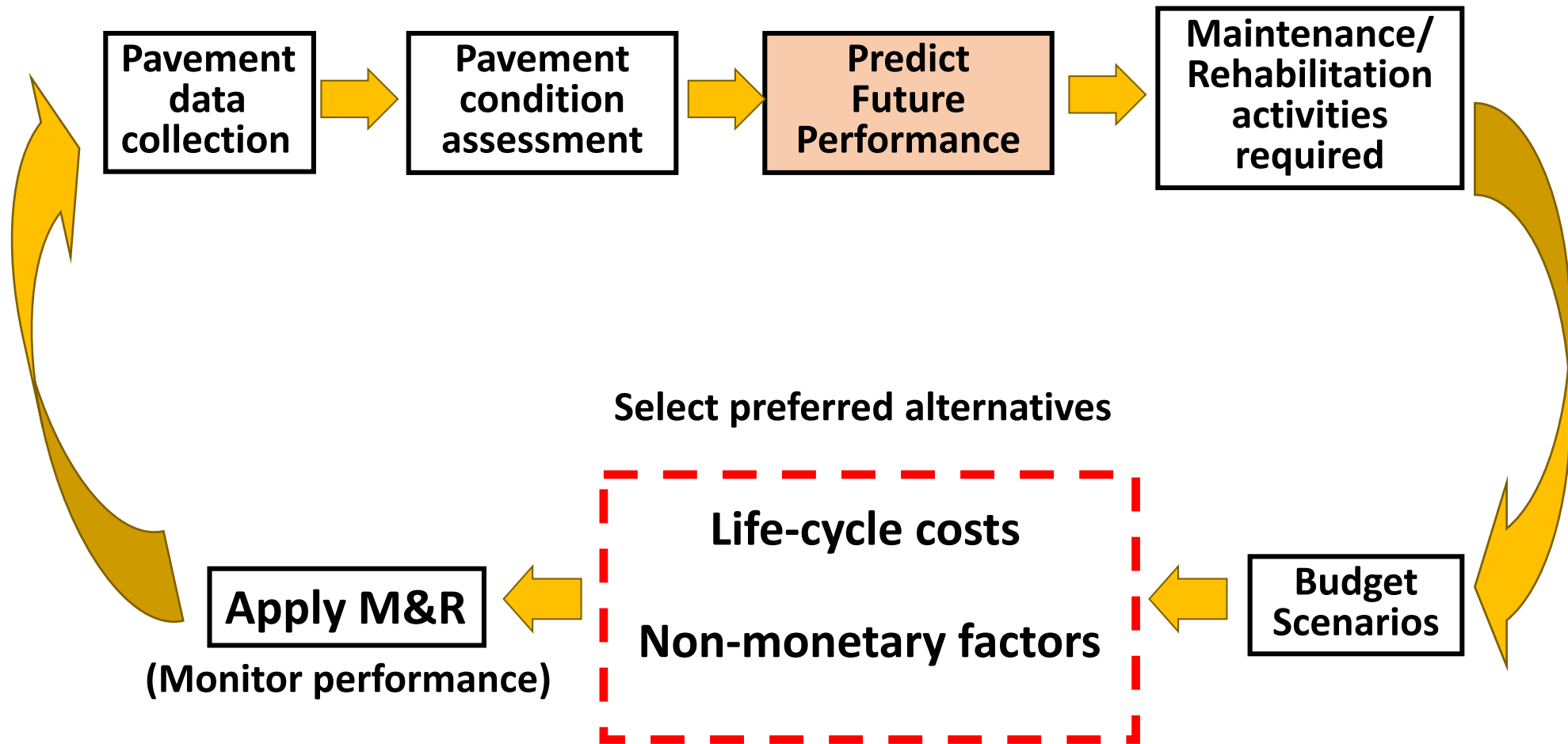
- Distress Surveys
 - ASTM D6433 for asphalt pavements (roads and parking lots)

Cracking	Surface Defects	Surface Deformation	Other
<ul style="list-style-type: none">• Fatigue• Block• Edge• Joint reflection• Longitudinal and transverse• Slippage	<ul style="list-style-type: none">• Bleeding• Polished aggregate• Raveling• Weathering	<ul style="list-style-type: none">• Bumps and sags• Corrugation• Depression• Rutting• Shoving• Swell	<ul style="list-style-type: none">• Lane/shoulder drop-off• Patching• Potholes• Railroad crossing

Data Collection

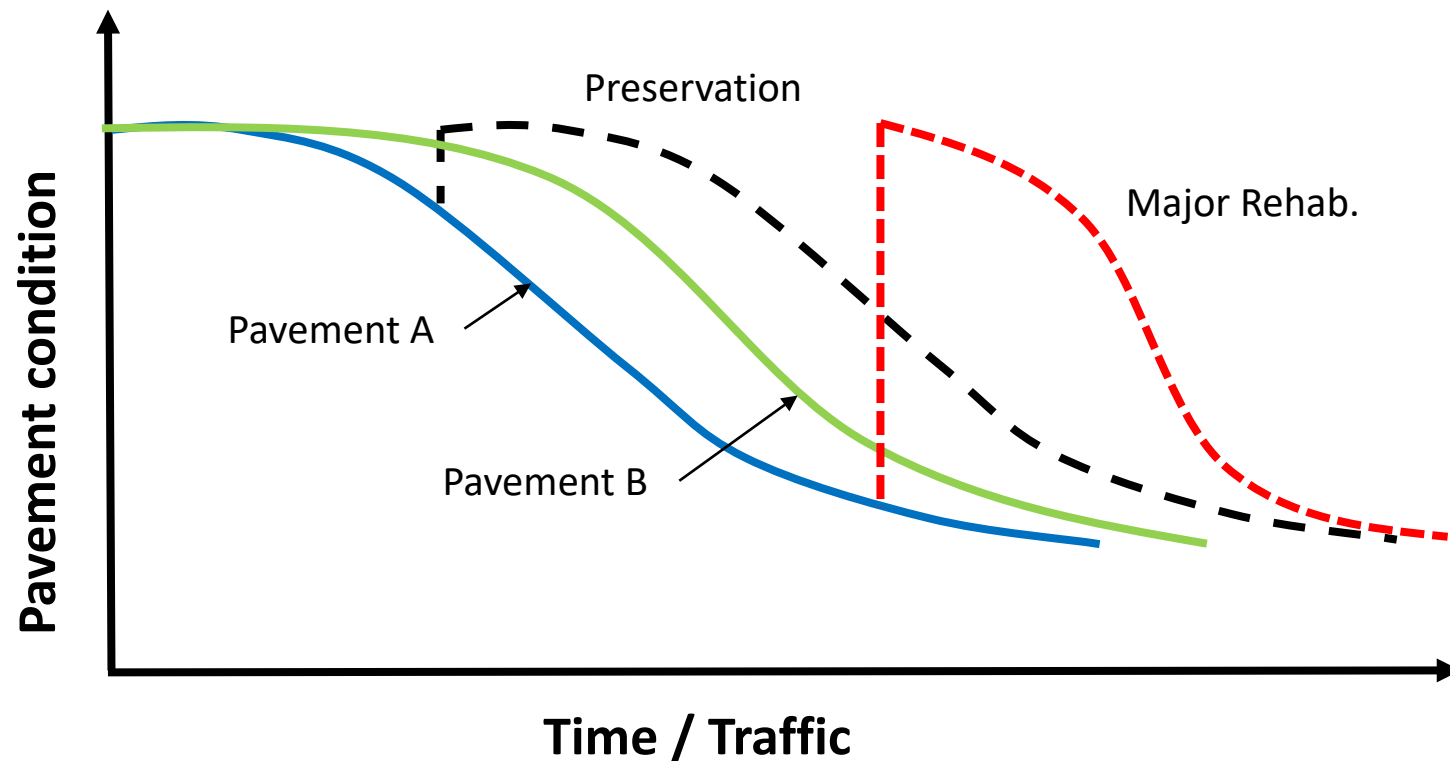
- Distress Surveys
 - Pavement Condition Index (PCI)



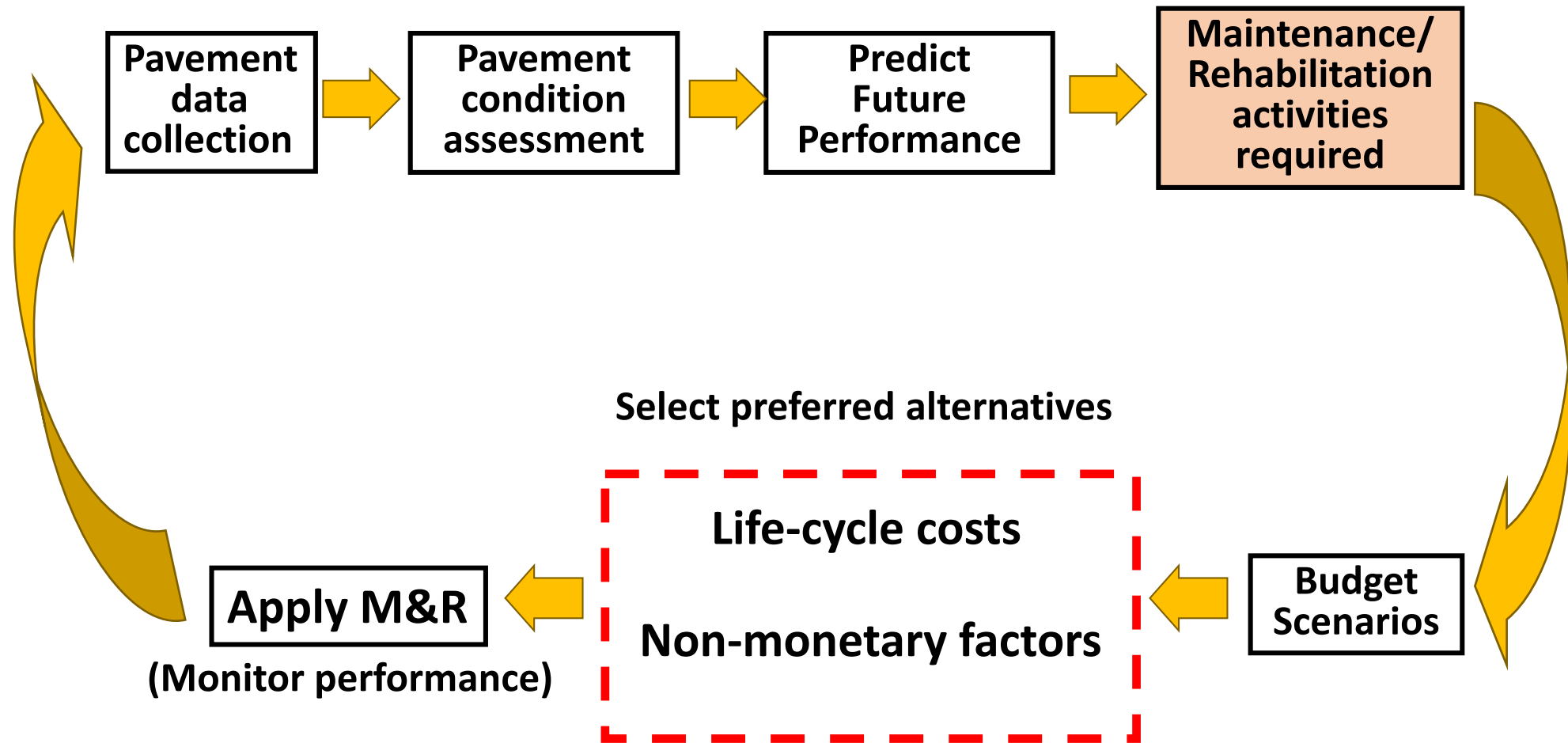


Analysis

- PERFORMANCE MODELING – What shape will it be in?

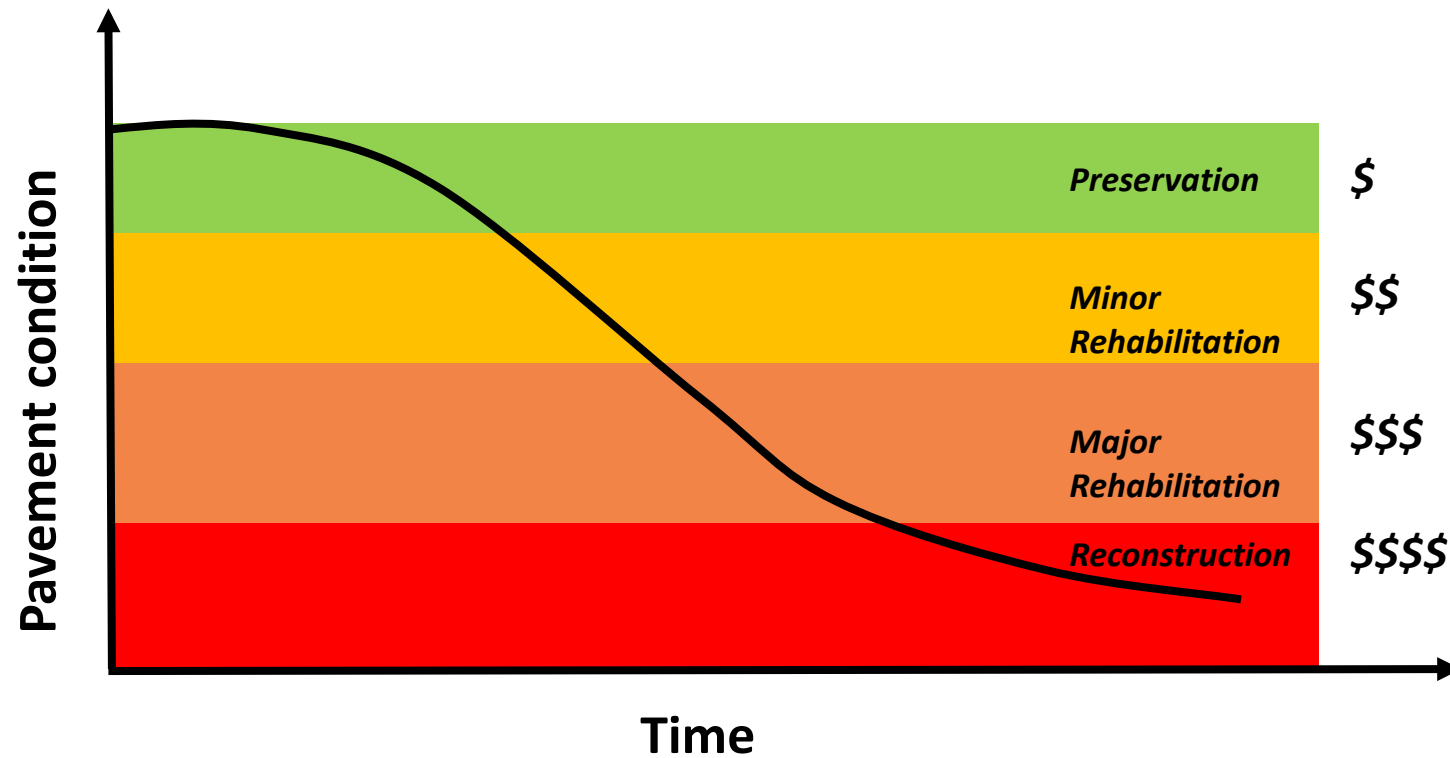


- Predict future condition
- Assess impact of treatments



Analysis

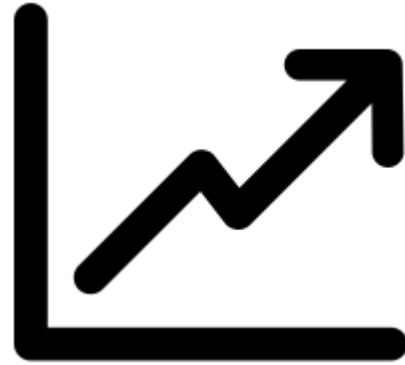
- Why is prediction important?
 - Plan ahead



Pavement Preservation



Planned
work



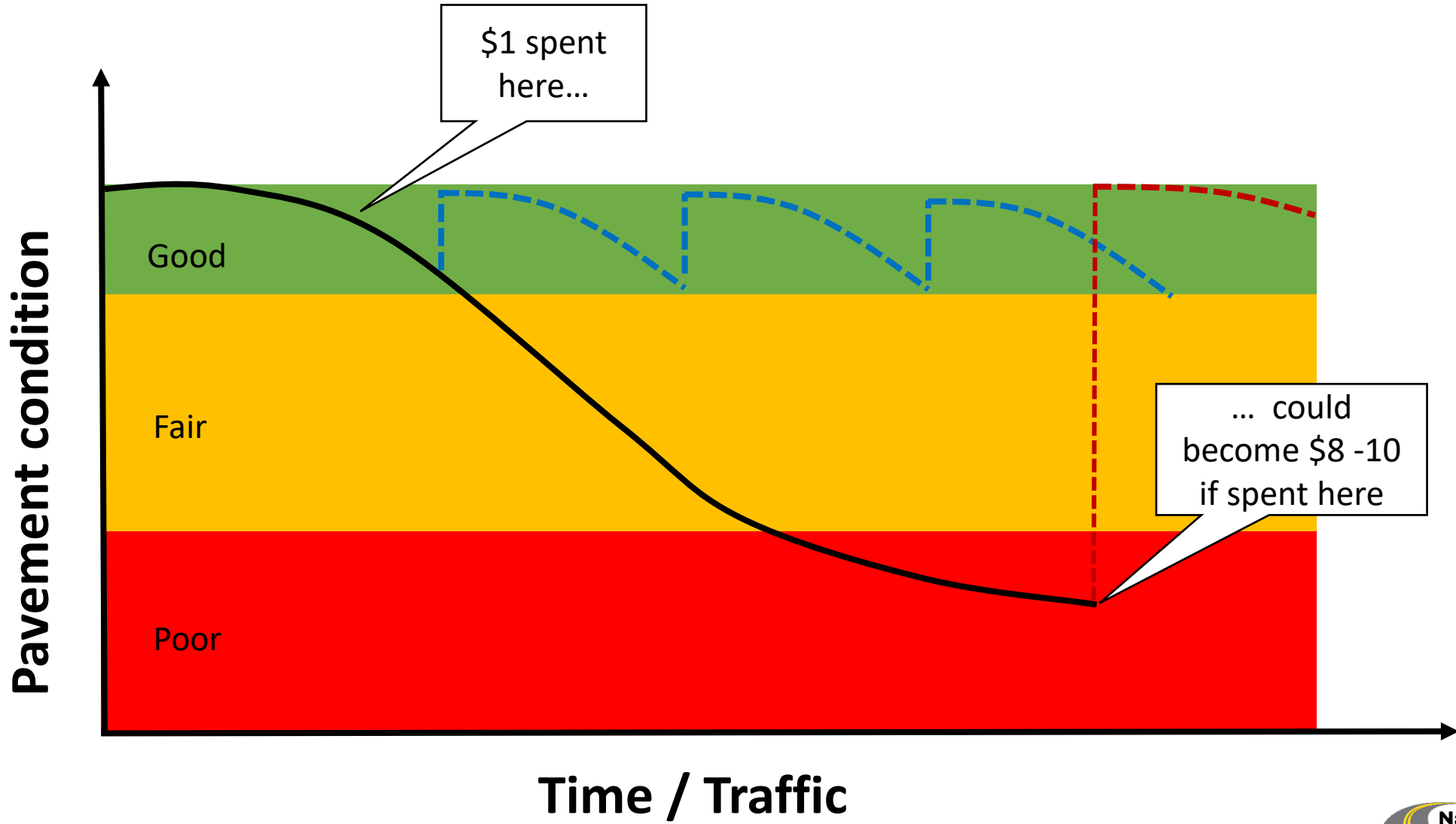
Improve or
maintain
condition



Does not add
structural
capacity

Pavement Preservation

- **KEEP GOOD PAVEMENTS GOOD**
- Extend pavement life
 - Prevent water infiltration
 - Slow aging
- Improve safety
- Maintain/restore ride quality
- Correct minor distresses



Many options under preservation



Appropriate Treatment Selection

Distress	Crack Seal	Fog Seal	Chip Seal	Scrub Seal	Slurry Seal	Micro Surfacing	Cape Seal	Thin Overlay
Cracking (minor)	✓	✓	✓	✓	✓	✓	✓	✓
Cracking (mod.)	✓			✓				
Weathering		✓	✓	✓	✓	✓	✓	✓
Raveling		✓	✓	✓	✓	✓	✓	✓
Rutting						✓		✓
Ride Quality						✓		✓
Loss of Friction			✓	✓	✓	✓	✓	✓

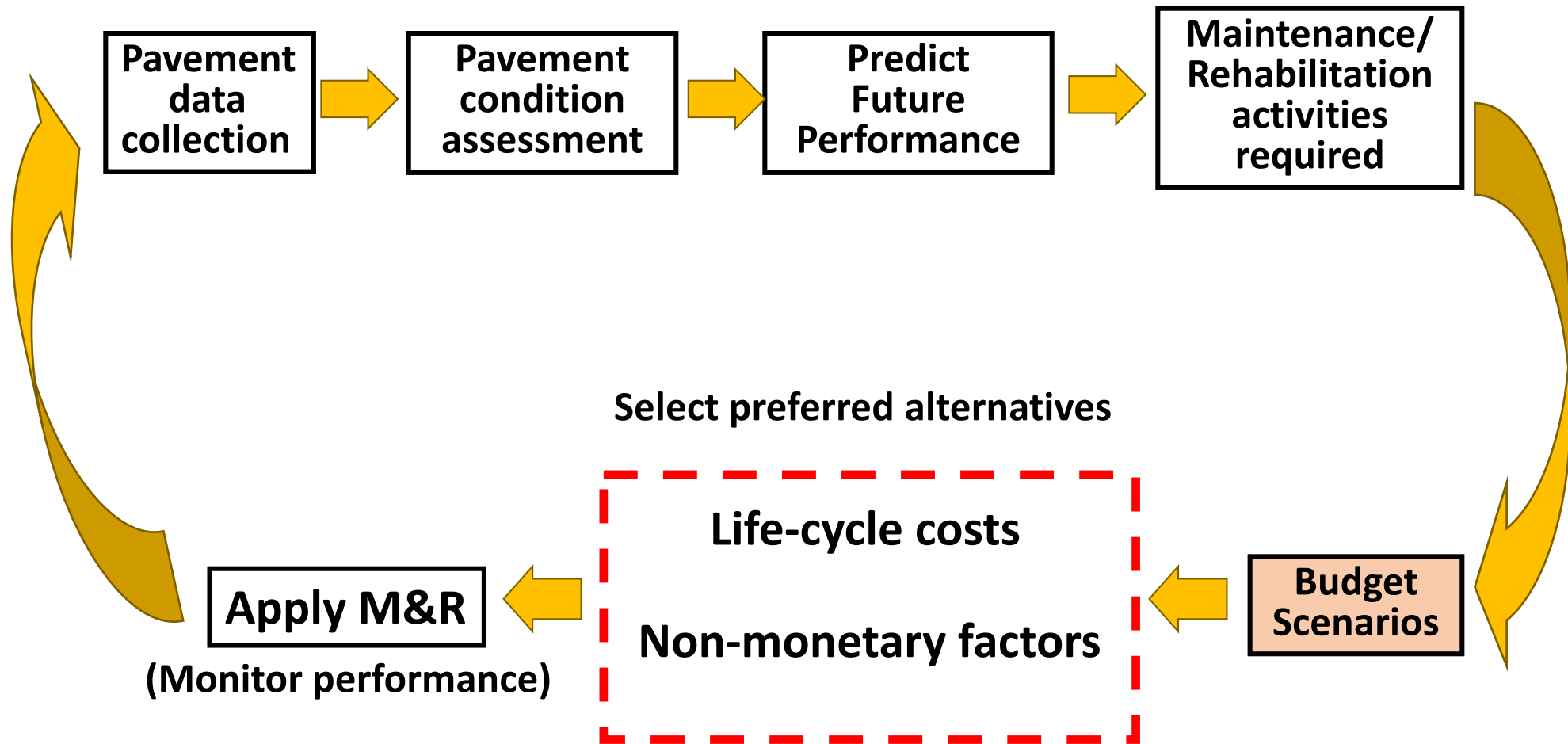
Big Difference!



Isolated
potholes/patches can
be repaired and then
treated with
preservation

Frequent
potholes/patches
require actions
beyond pavement
preservation





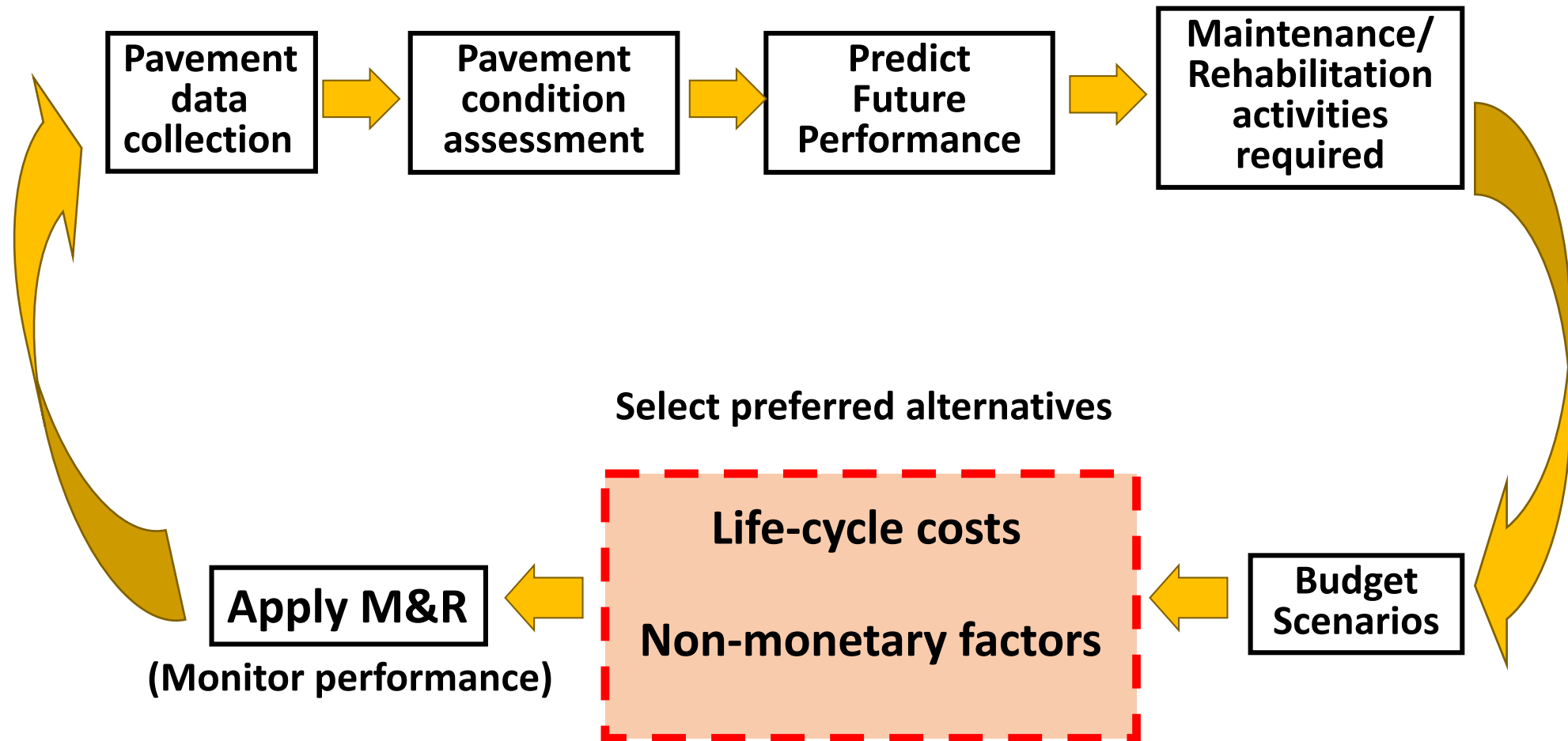
Analysis

- BUDGET ANALYSIS – How much will it cost?
- Establish network strategies and work planning
 - Quantify cost and benefit of work
- What-if scenarios
 - Determine consequences

Analysis

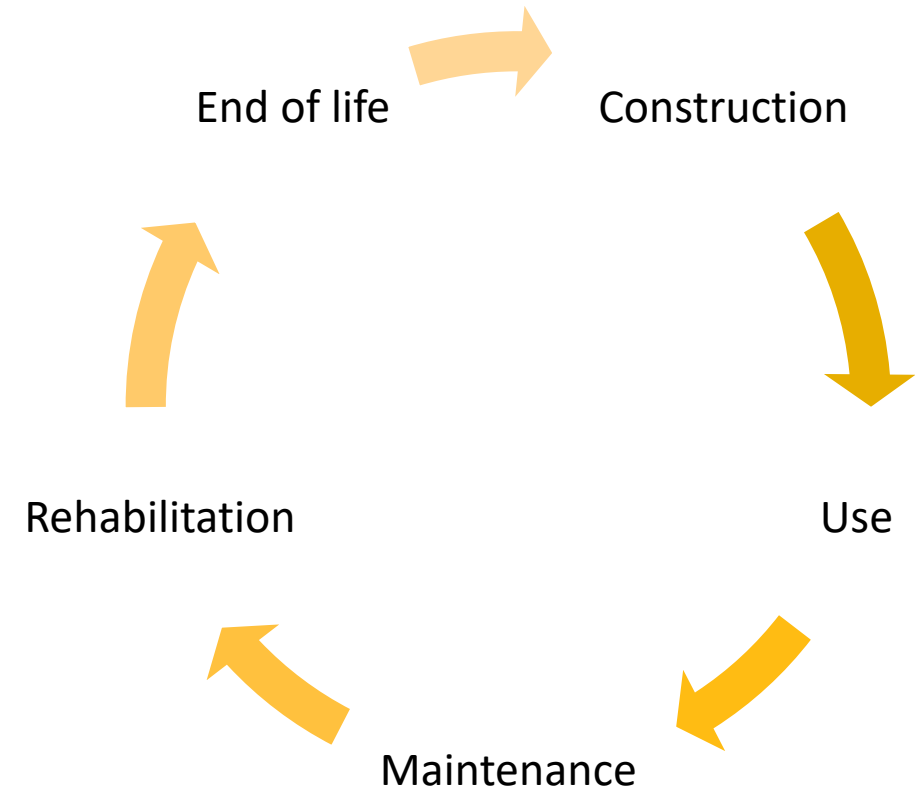
- Needs often exceed budget
- Priority programming
 - Select candidates for M&R projects
 - Select within M&R alternatives
 - Select timing of M&R projects
- Select most cost-effective option





Analysis

- Life Cycle Cost Analysis (LCCA)
 - Selection of feasible M&R alternatives based on pavement evaluation
 - Once list is developed, use LCCA to select most cost-effective solution

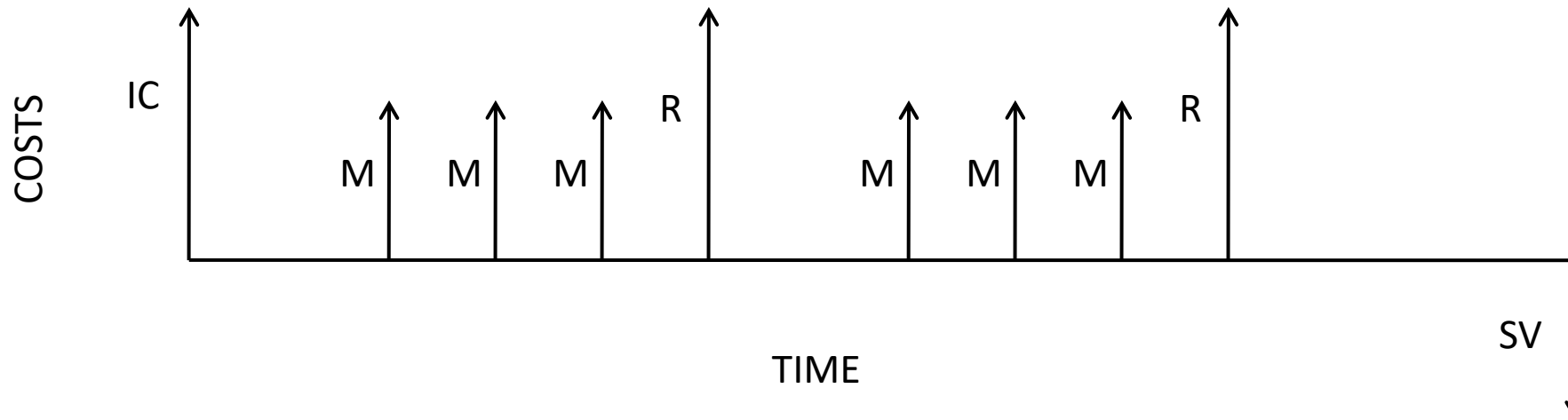


Analysis

- Life Cycle Cost Analysis (LCCA)
- Uses Net Present Value (NPV) to compare costs over lifespans of competing alternatives
- Initial construction + discounted future costs of maintenance, rehabilitation and salvage value

Analysis

- Life Cycle Cost Analysis (LCCA)



IC: Initial cost

M: Routine or preventive maintenance cost

R: Rehabilitation cost

SV: Salvage value (value of the structure at the end of the analysis period)

Analysis

- Life Cycle Cost Analysis (LCCA)

Discount Rate

- Value of money over time
- ~ interest – inflation

Analysis Period

- Reflect long-term cost differences
- Incorporate at least one rehabilitation

Costs

- Initial, future
- Agency, user

Estimated Life of Treatment

- Time each treatment will last before reaching a trigger value

Analysis

- Life Cycle Cost Analysis (LCCA)

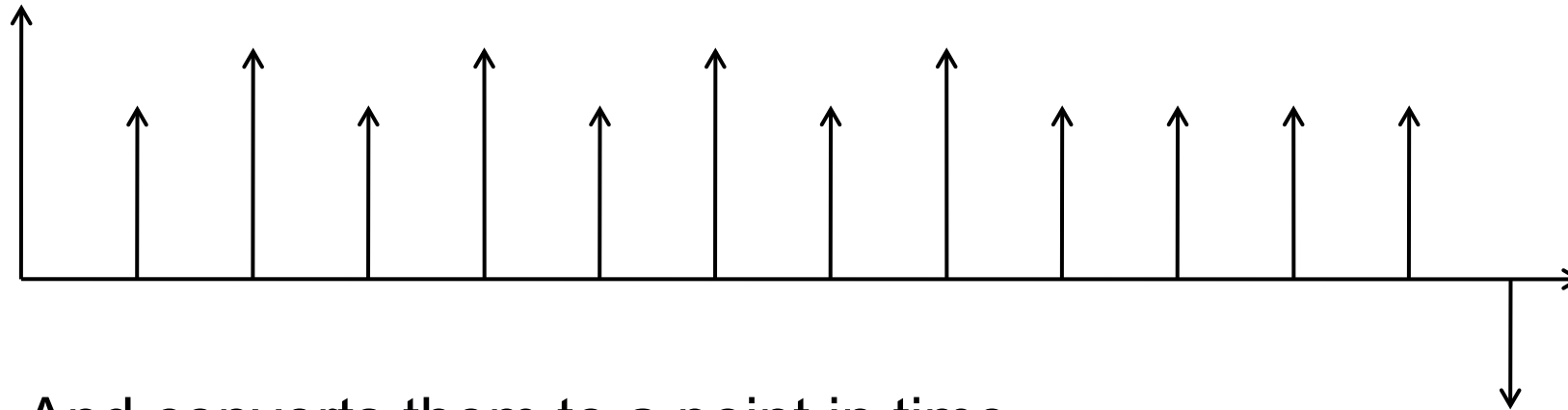
- Net Present Value (NPV)

$$NPV = IC + \sum_{k=1}^N F_k \frac{1}{(1+i)^{n_k}} - SV \frac{1}{(1+i)^{n_e}}$$

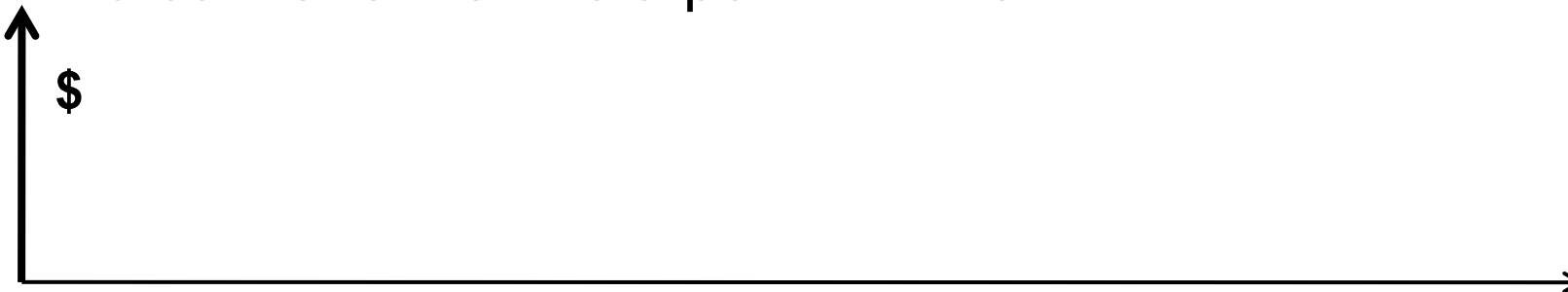
- IC: Initial cost of construction
- N: Number of future expenditures in the analysis period
- n_k : Number of years since initial construction for the kth expenditure
- n_e : Analysis period

Analysis

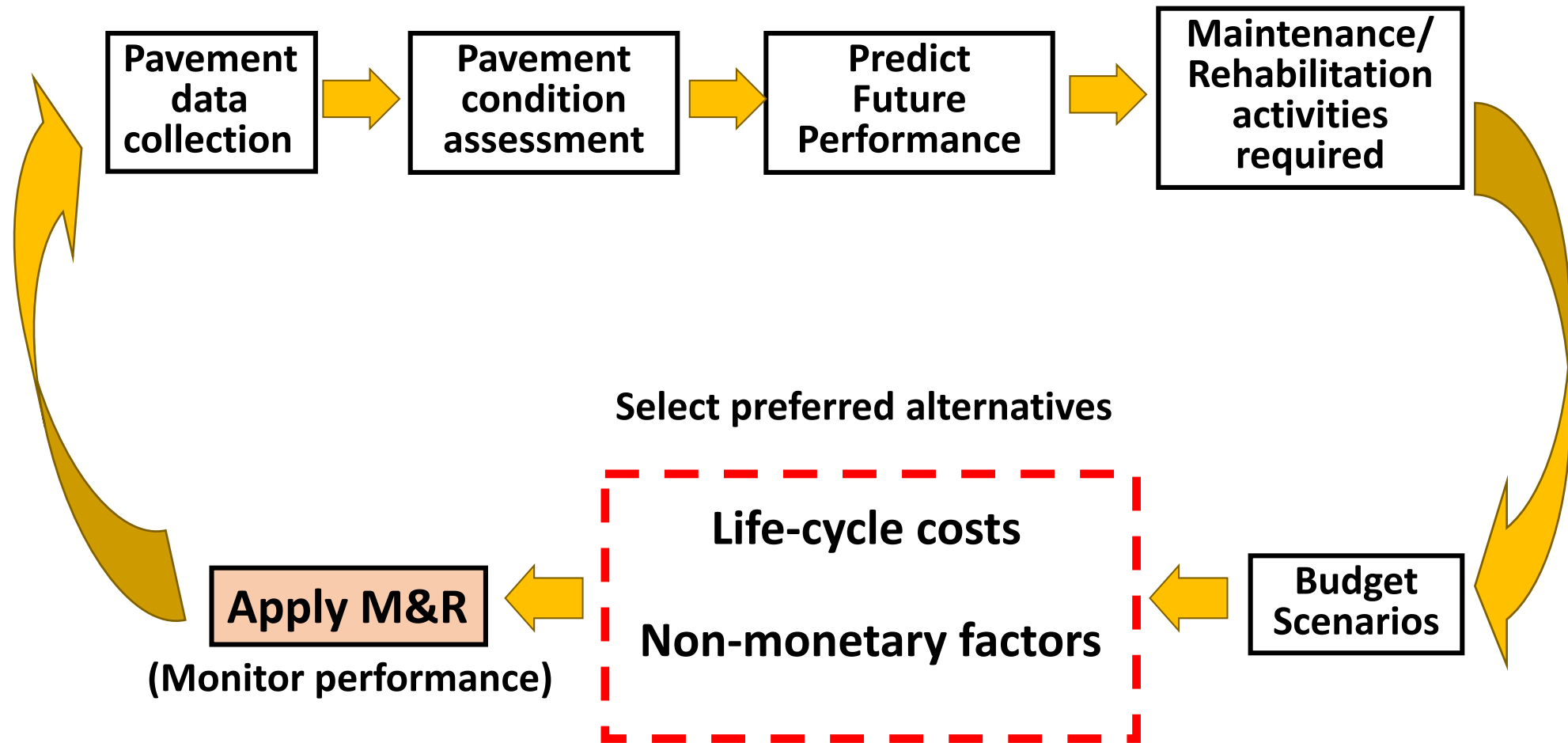
Takes a series of expenditures:



And converts them to a point in time



** Comparisons require similar analysis periods*



Data Management & Update

- **FEEDBACK** – Is it what I expected?
- Monitor distresses and performance
 - Evaluate consequences of decisions
 - Improve PMS based on data collected
- Keep accurate records

In Summary...

- PMS are **tools** for decision making
- A consistent system leads to cost-effectiveness
- Data needs
 - Inventory
 - Condition
 - Analysis
- Continuous feedback is key for success

Thank you!
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