Pavement Management 101 Workshop

NWPMA 2022 Meeting

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Pavement Management System or PMS Software

- Decision Support Tool
  - Stores Data
  - Provides Information
  - Prepares Reports & Graphs
- Help Make Cost-effective Decisions
  - Primarily Network-level
  - Existing Pavement System

Introductions

- Please introduce yourself
  - Name, Agency, Role
- What topics interest you?

- **What is the benefit of pavement management to your agency?**

Agenda for the Day

- 8:00-8:45 am Introduction
- 8:45-9:00 am Inventory
- 9:00-10 am Condition Assessment
  - Break (10 am)
- 10:10-12:00 pm Determination of Needed Work & Funds
  - Lunch Break (12 noon – 1 pm)
- 1:00-2:15 pm Identification of Candidate Projects
  - Break (2:15 pm)
- 2:25-4:00 pm Determination of Funding Alternatives
- 4:00-4:25 pm Feedback & Upkeep
- 4:25-4:30 pm Evaluation (Adjourn at 4:30)

Participant Guidelines

- Stay engaged
- Use your resources
- Step out if using your phone
- Follow emergency procedures

In Concept PMS Includes

- Planning
- Programming
- Analysis
- Design
- Construction
- Research

As Implemented, PMS Addresses

- Programmed (Preventive) Maintenance
- Rehabilitation
- Reconstruction

Of Existing Pavements

PMS Management Levels

- Network - Planning & Programming for Entire Set of Pavements Managed
- Project Selection - Programming a Subset
- Project - Designing a Specific Section

Purpose of Network-Level

- Related to the Budget Process
- Identify Maintenance and Rehabilitation Needs
- Show Impact of Funding Options
- Communicate With Funding Authorities

- **What types of reporting do you currently do for stakeholders?**

Purpose of Project-Selection-Level

- Refine Alternative Treatments
- Select Sections for Funding

Input from Network-level

Purpose of Project-Level

- Develop Cost-effective Strategy For:
  - Original Construction
  - Maintenance
  - Rehabilitation
  - Reconstruction

Input from Project Selection-level

- Within Imposed Constraints

Network-Level

- PMS Software Used to Develop Recommendations
- Staff Use These to Prepare Recommendations to Senior Management & Funding Authorities
- Decisions About Funding Levels, Allocation, and Policies

Project-Selection Level

- More Staff Intensive
- PMS Software helps….
  - Finalize Candidate Project List
  - Add & Remove Projects
  - Consider Constraints
  - Adjust Limits
  - Adjust Dates
  - Adjust Cost Estimates

Project-Level

- Completed by Engineering or Public Works
  - Use Available Design Procedures
  - Consider Life Cycle Costs and Impacts
  - Adjust for Constraints
  - Within Available Funds

Network-Level Activities

- **Inventory**
- Condition Assessment
- Determination of Needed Work & Funds
- Identification of Candidate Projects
- Determination of Impacts of Funding Alternatives
- Feedback & Upkeep

Inventory

- What agency is responsible for
  - What it “owns”
- Where it is located
  - Location referencing
  - How is it connected to other sections
  - Political subdivision in which it is located
- Importance of section
  - Functional classification
  - User-defined characteristics

Question

- **What information needs to be viewable regarding pavement sections?**

Basic Information for Each Section

- Name
- Begin - End
- Surface Type
- Construction Date (Last Surface)
- Importance (Functional Class)
- Area (Length & Width)

Other Information and Sort Codes

- ADT
- Traffic Index
- Area ID
- Funding Code
- General Code
- More

Work History

- Work completed
  - Construction
  - Rehabilitation
  - Maintenance
- Dates of completed work

More Detailed Data

- Often needed at:
  - Project Selection
  - Project Design

Network-Level Activities

- Inventory
- **Condition Assessment**
- Determination of Needed Work & Funds
- Identification of Candidate Projects
- Determination of Impacts of Funding Alternatives
- Feedback & Upkeep

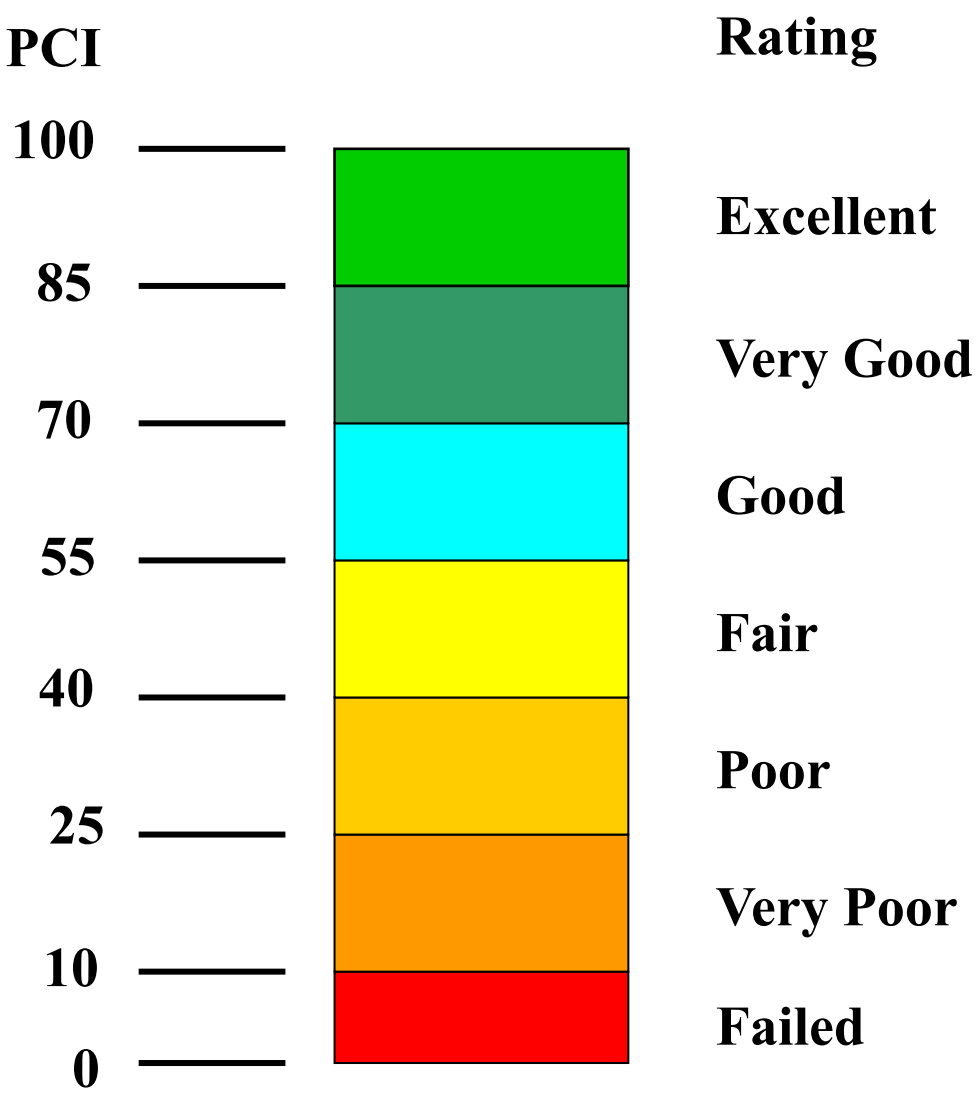
Condition Assessment

- Health of individual segments
  - Engineering
  - Functional
  - Safety
  - Noise generated by traffic
- Collectively define health of network

What is PCI?

- Pavement Condition Index basic measure of condition

- Method to uniformly characterize condition of paved surface
  - Along road/street
  - Over time
  - Among raters


PCI
Rating
100
85
70
55
40
25
10
0
Excellent
Very Good
Good
Fair
Poor
Very Poor
Failed

PCI Values

- Based on Distress Surveys
  - Type - What Is Wrong?
  - Severity - How Bad Is It?
  - Density - How Much Present?

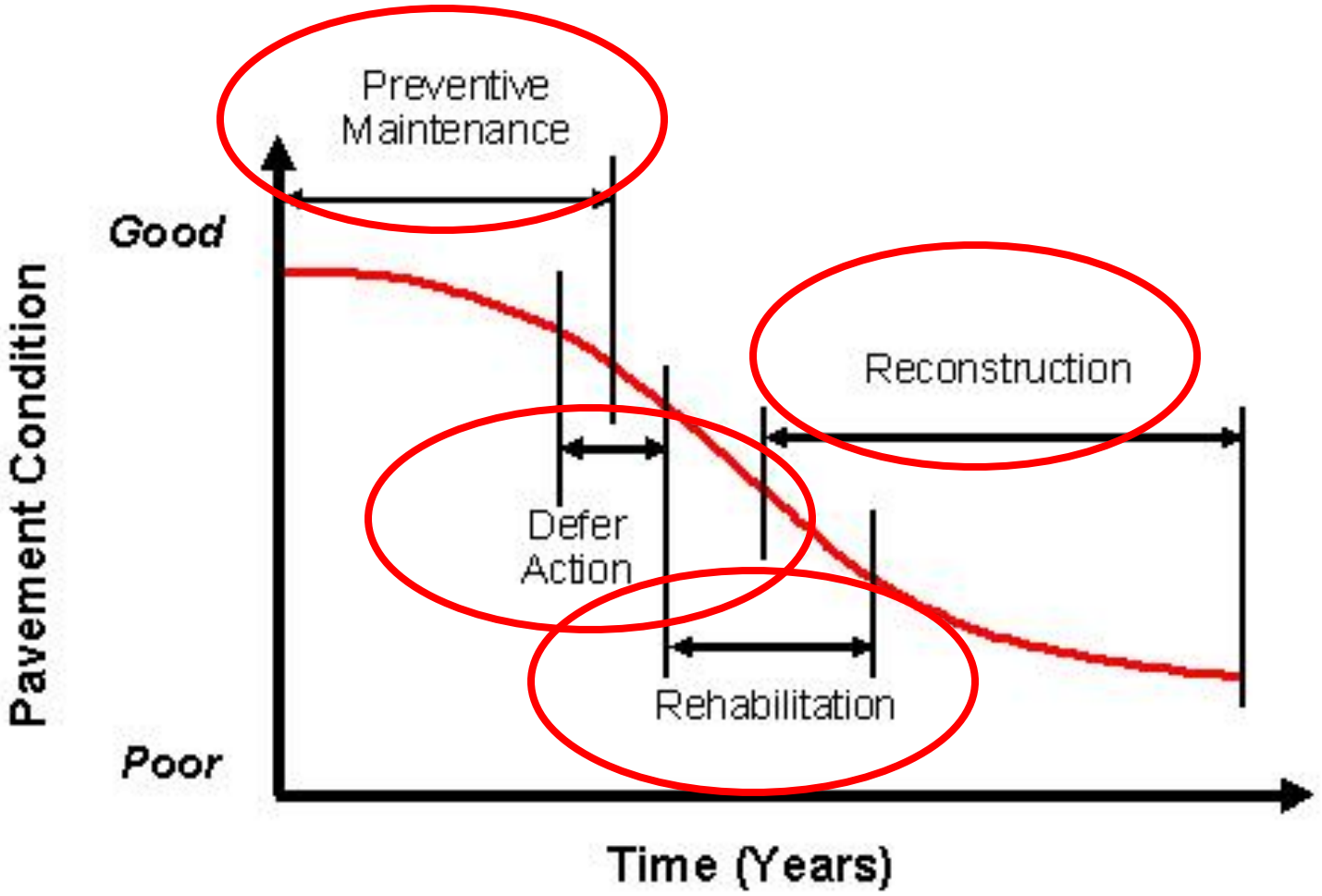
PCI Values Used

- To identify level of work needed
- Amount of funding needed
- Project future condition

Importance of PCI

- PCI values are:
  - Basis of most management recommendations
- Incorrect PCI values will cause the PMS to
  - Give incorrect recommendations

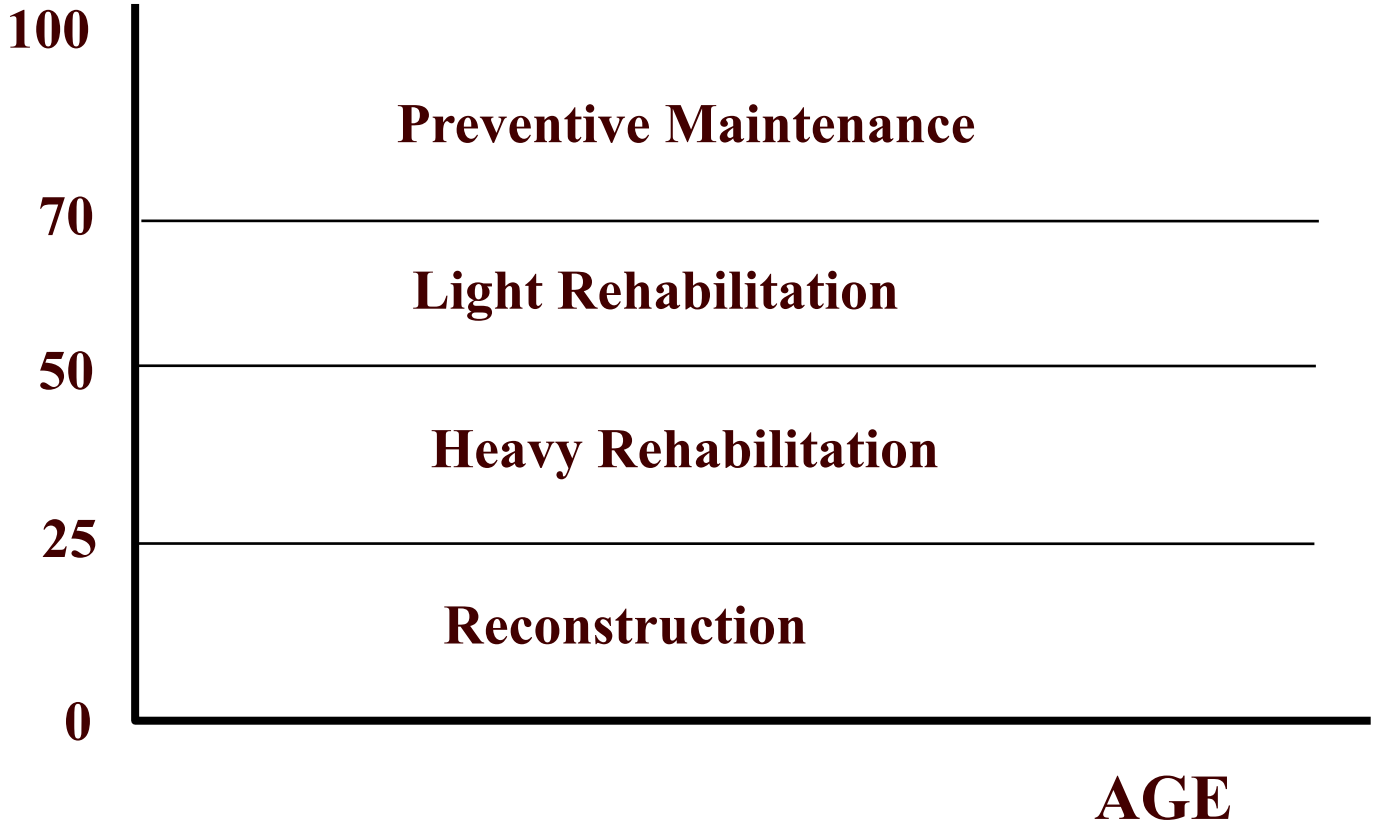
Network-Level Treatment Selection Normally Based on Pavement Condition



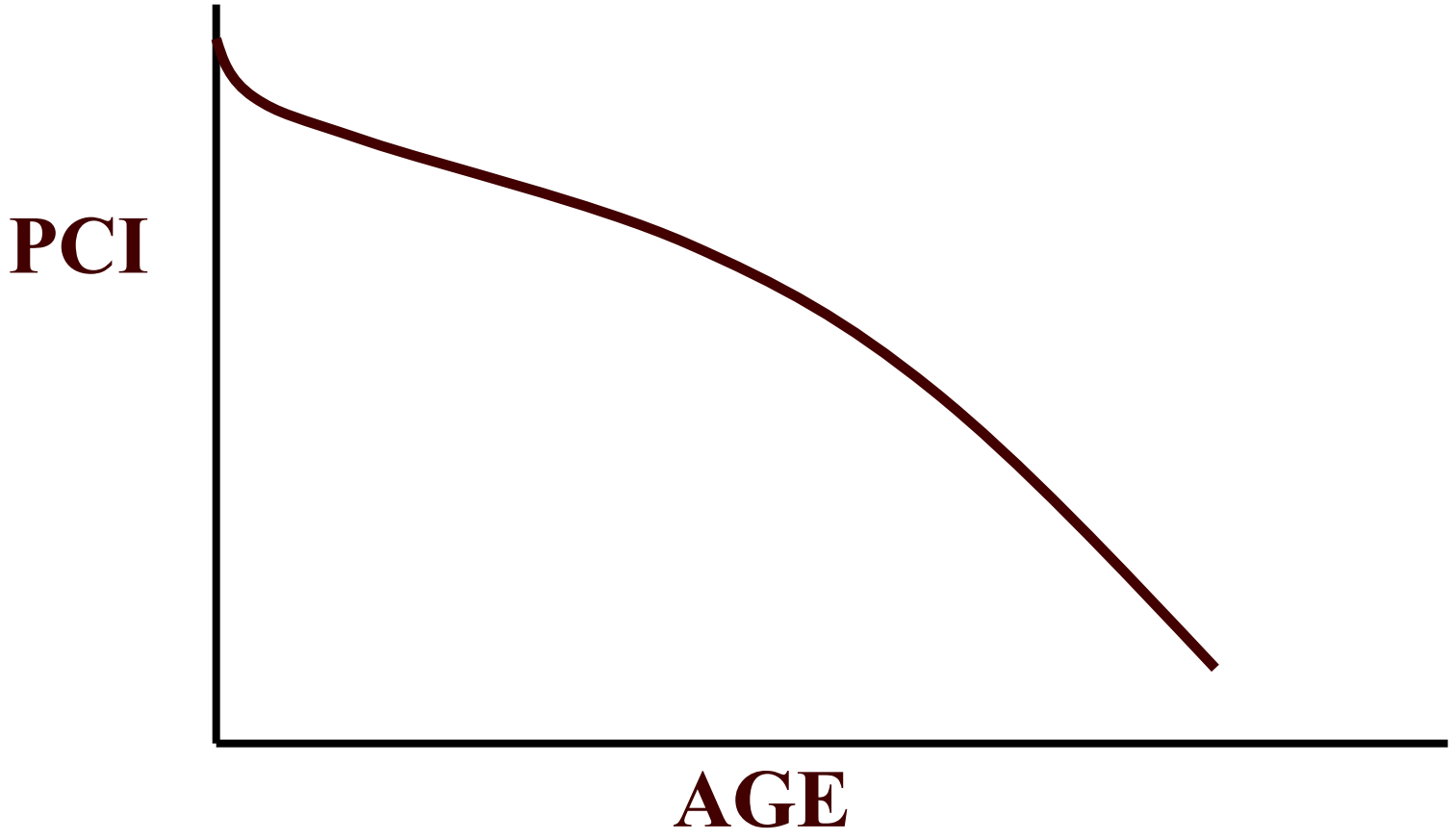
PCI Values Used

- To identify level of work needed
- Amount of funding needed
- Project future condition

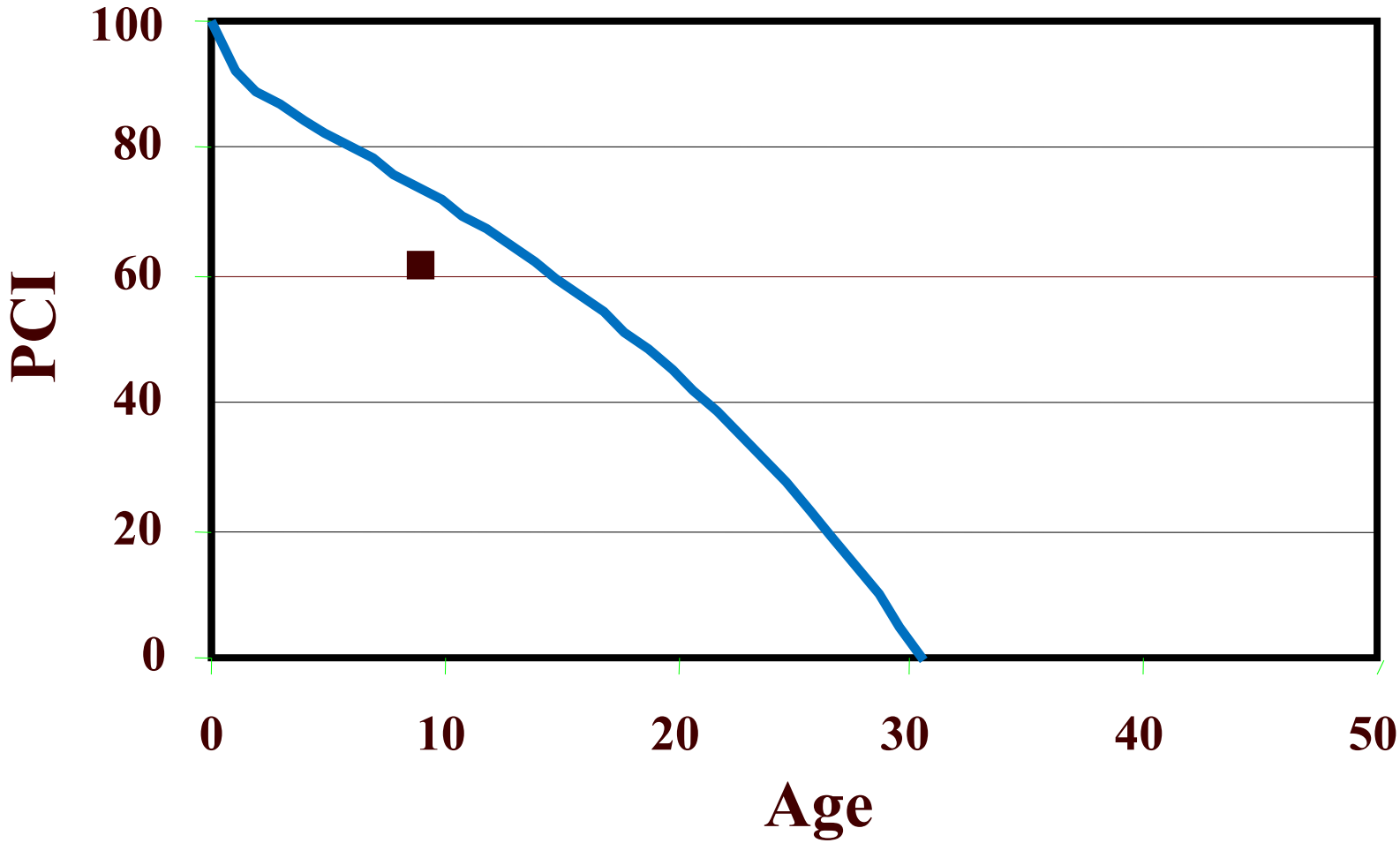
PCI Values Affect Recommended Treatment



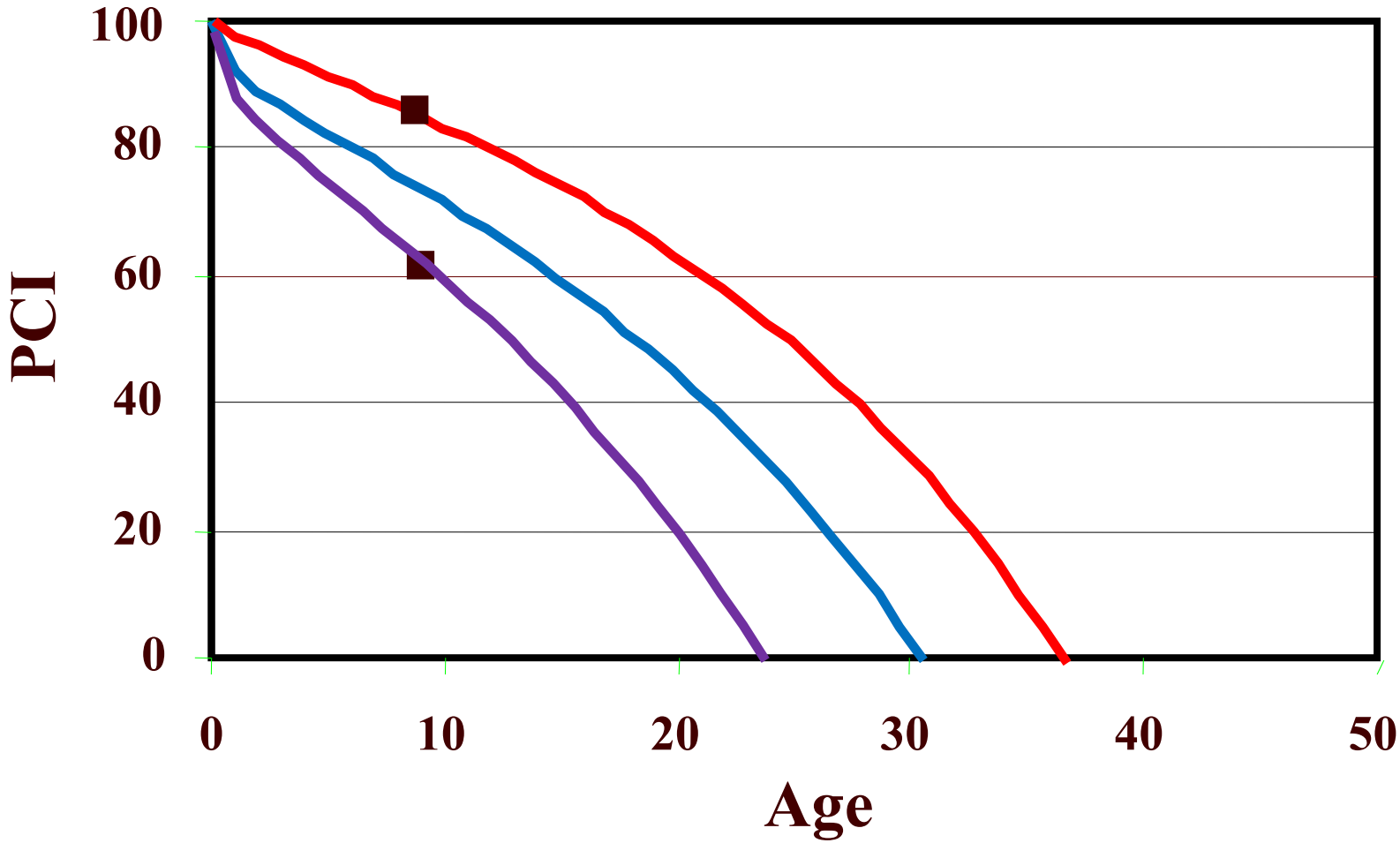
Projecting Condition - Family Curve



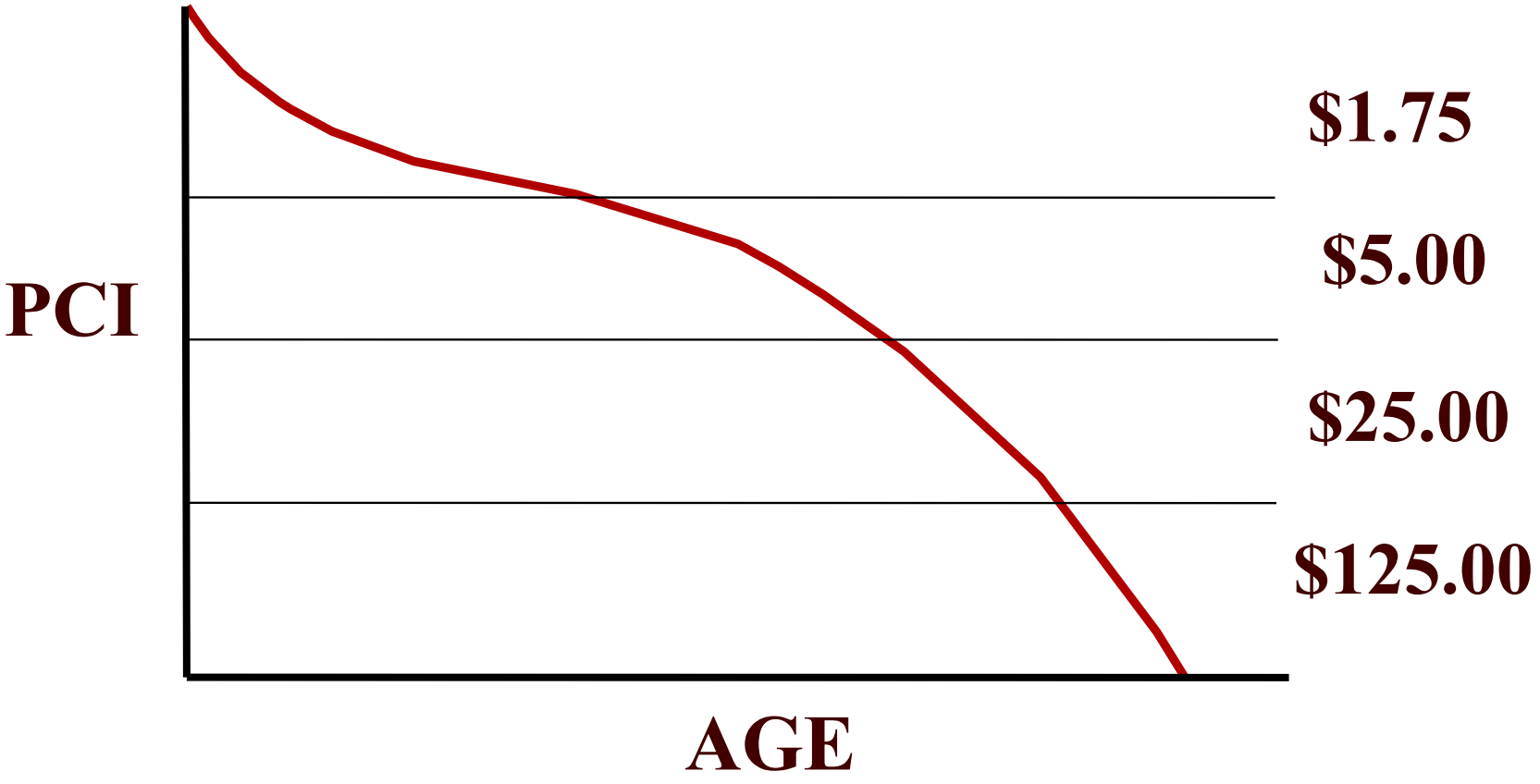
Projected PCI Adjusted for Observed PCI



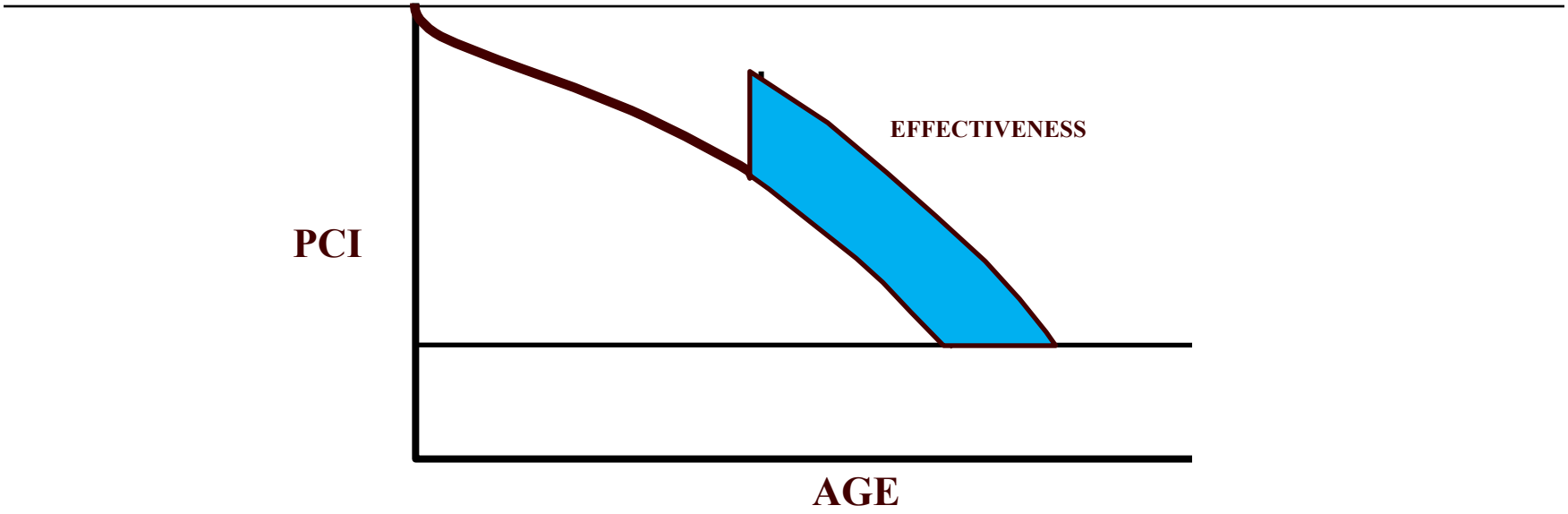
Projected PCI Adjusted for Observed PCI



Projected PCI Affect $'s



Prioritization Based on Projected PCI



$$\text{Cost-Effectiveness Ratio} = \frac{\text{Effectiveness}}{\text{Cost}}$$

PCI Values

- Drive most recommendations from PMS
- Incorrect values produce incorrect recommendations

Staged Data

- Network-level – distress on every section
- Project-Selection – more distress, maybe deflection, maybe roughness (seat-o-meter?)
- Project-level – detailed materials and structural data for major rehabilitation/ reconstruction

Collecting Condition Data

- Manual (still used extensively)
  - ASTM D6433
  - Windshield/PASER
- Automated (a few specific types)
- Semi-automated (collected by machines, interpreted by people)
- Artificial Intelligence (developing field)

Collection Methodologies

- Affect:
  - Accuracy ↑
  - Precision ↑
  - Resolution ↑
  - Cost ↑

Group Activity

What are the advantages and disadvantages of data collection types i.e., windshield, walking ASTM, automated survey?

Automated Collection of Distress

- Improve safety of personnel
- Decrease traffic interruptions
- Funds to contract but limited staff
- Will not collect “same” data

- Don’t switch back and forth between manual and automated

Manual Collection of Distress

- Requires commitment of trained personnel
- Develops expertise within agency
- Can improve understanding of pavement performance
- Can help develop confidence in PMS
- Can help develop communication with agency

Quality Data

- Develop quality control & quality assurance plans for data
- Define what is required
  - Type of data
  - Accuracy
  - Precision
  - Resolution

Quality Control in Agency Collection

- With more than one team
  - Change rating team members regularly
    - Don't let divergence develop
  - Have teams rerate sections rated by other teams (5%)
  - Check inspected values against projected values
    - Field check those that differ significantly

Contracting for Distress Data Collection

Define distress ID methodology to be used and precision and accuracy needed

Require Data Quality Control Plan

Establish Data Quality Assurance Plan

MTC has plans that agencies can end can use in developing their contract plans at: http://www.mtcpms.org/support/consultants.html

MTC Data Quality Management Plan

- Includes Pre-qualification & Rater Certification for distress identification using the MTC distress definitions
- Pre-qualification - Ensures that contracting agencies are capable of collecting distress data that is reasonably close to what would be collected by an "expert" rater
- Rater Certification Program - Under the P-TAP, even if a firm has pre-qualified, all of the firm's raters must

Data Quality Control Plan

- Each firm required to provide Quality Control Plan that includes
  - Qualifications of each rater
  - Description of their data verification processes including what checks will be made and actions to be taken when issues arise

MTC Data Quality Acceptance Plan

Administer Rater Certification Program
Pre-qualification of the contractor does not ensure that all raters are capable of rating with the desired level of accuracy

Conduct Audits of Contractors' Quality Control Plans

MTC reviews quality control plans and approves prior to commencement of work

CSUC conducts audits of the QCP results to ensure that the data collection contractors are meeting the requirements established in their plans

Verify Data Collected by Contractors

CSUC conducts full audits of the data collected from selected projects when issues are encountered

CSUC spot checks data collected by contractors from selected projects

Consulting Partners

- These consultants are licensed to use StreetSaver®
  - *https://www.streetsaver.com/support/partners/consultant*
- MTC Data Quality Management Plan
  - *https://www.streetsaver.com/academy/mtc-data-quality-management-plan*

Network-Level Activities

- Inventory
- Condition Assessment
- **Determination of Needed Work & Funds**
- Identification of Candidate Projects
- Determination of Impacts of Funding Alternatives
- Feedback & Upkeep

Needs Analysis

- Determines
  - What segments (or group of segments) need work
    - All segments needing work to provide selected level-of-service
  - Cost to complete work
    - That is needed without regard to funds available
  - During designated analysis period

Needs Analysis

Projects PCI to 1st analysis year

Identifies treatments based on ***decision trees***

Makes adjustments if treatment identified

Projects PCI to 2nd analysis year

Repeats until analysis years completed

No constraints on funds

Decision Support Systems

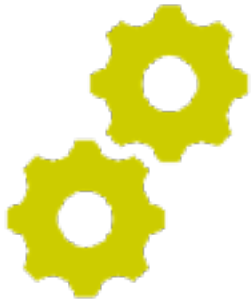
- Computerized decision support systems
- Decision support tools used by agency personnel to
  - Provide quantified information to support cost-effective decisions
- ***Key elements*** include *models that connect funding to levels of service provided over time*

Future Needs and Actions

- Require projecting condition into future
  - Project for individual segments with curves adjusted for individual segment performance
    - Modified deterministic
  - Family curves for each FC-ST combination
    - New ones being developed

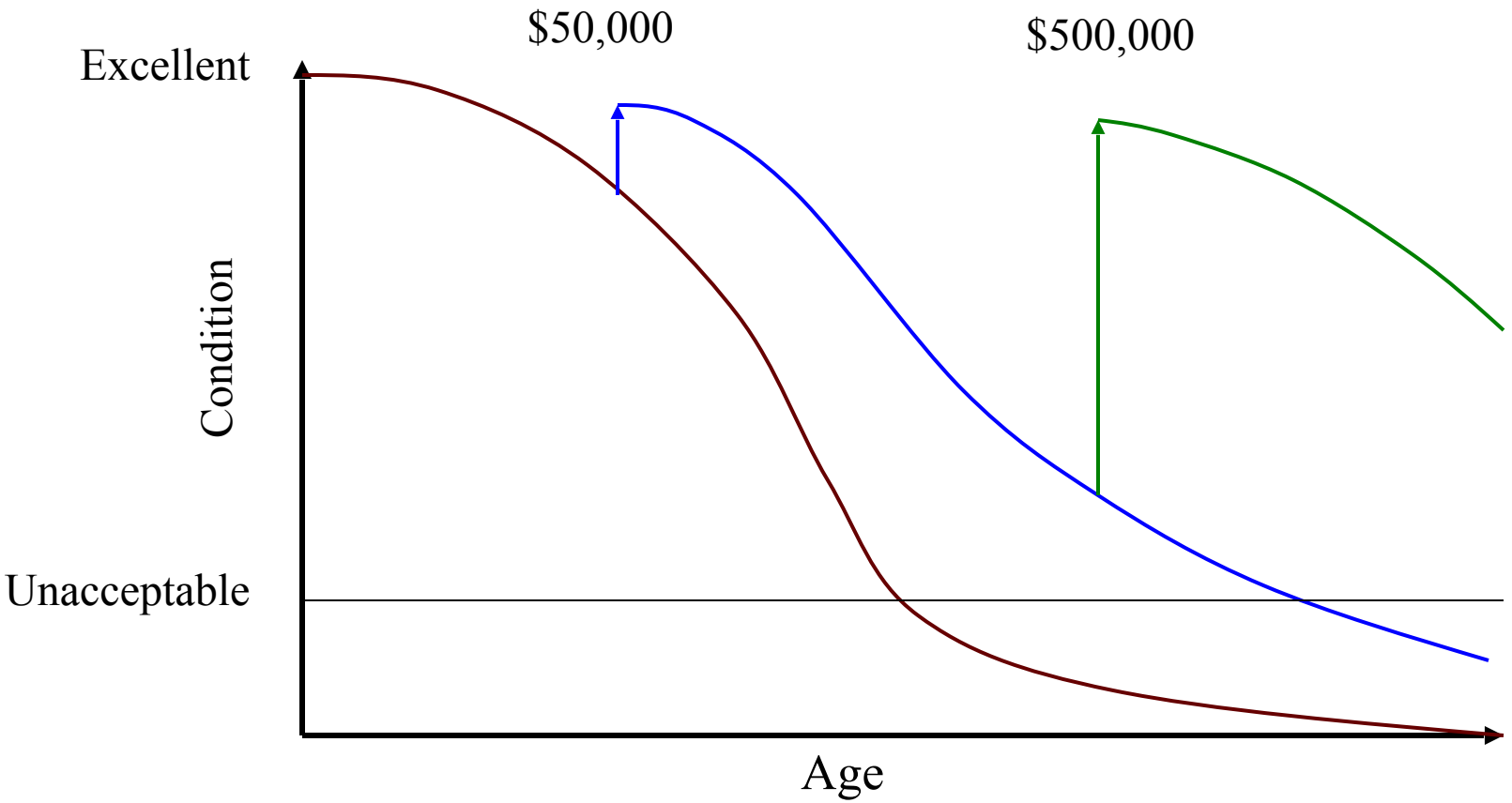
Model

Theoretical construct representing processes by a set of variables and a set of logical and/or quantitative relationships between them



Simplified framework designed to illustrate complex processes

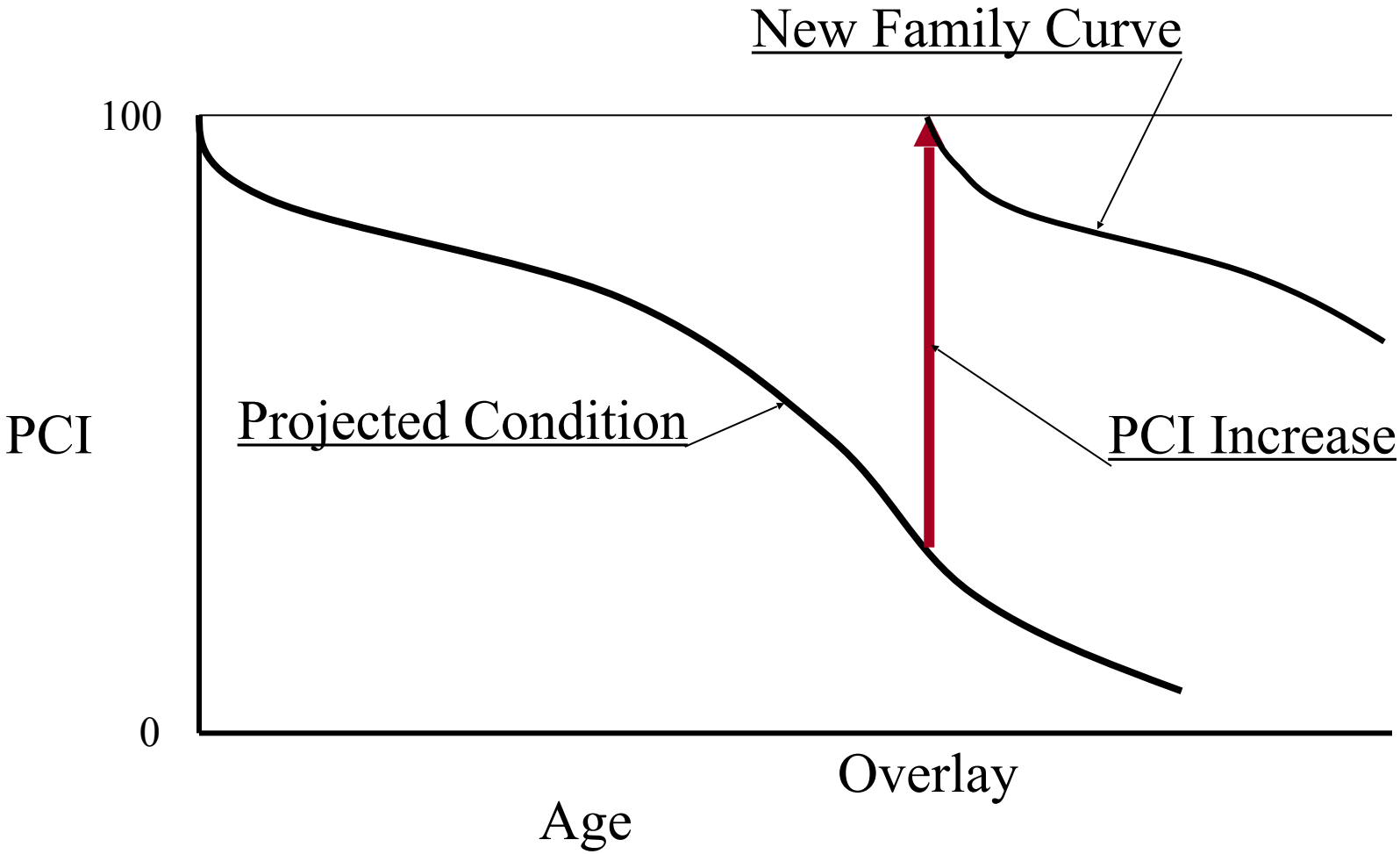
Condition vs Expenditure Model



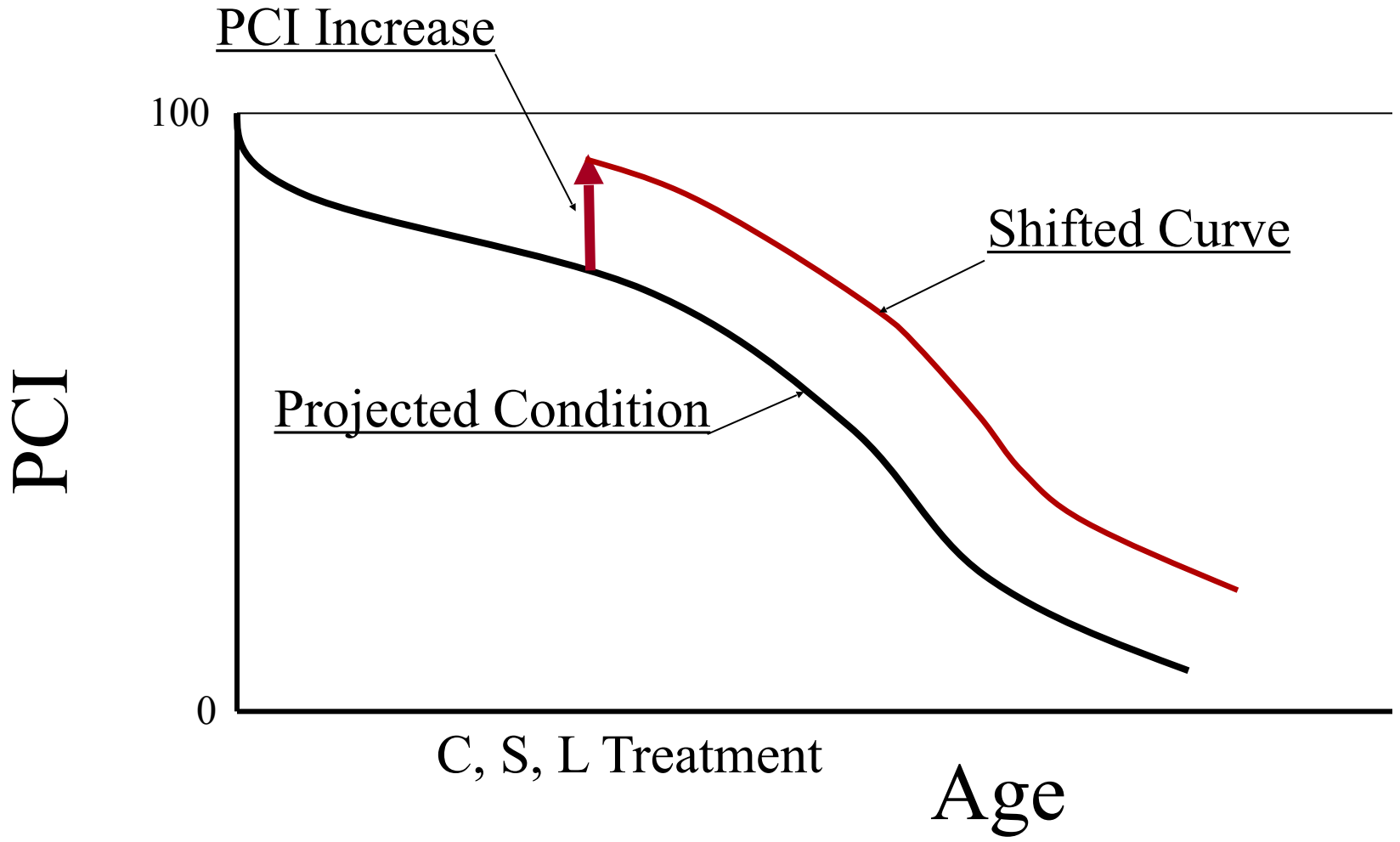
Changes Due to Actions

- How treatments change:
  - Condition
  - Future life
  - Treatment alternatives
  - Construction dates
  - Surface types?

Overlay & Reconstruction (O & R)



Surface Seal, Crack Seal, Localized (S, C, & L)



Assignment Procedure

- Connects inventory & condition data to treatment levels & costs
- PMS uses decision trees
  - Treatment cost category
  - Assigned by type facility
  - In one of several condition categories
  - (Family analysis)
- Impacts treatment approach
  - Preservation
  - Worst first

Treatment Assignment Used in

Inventory

Condition Assessment

Determination of Needed Work & Funds

Identification of Candidate Projects

Determination of Impacts of Funding Alternatives

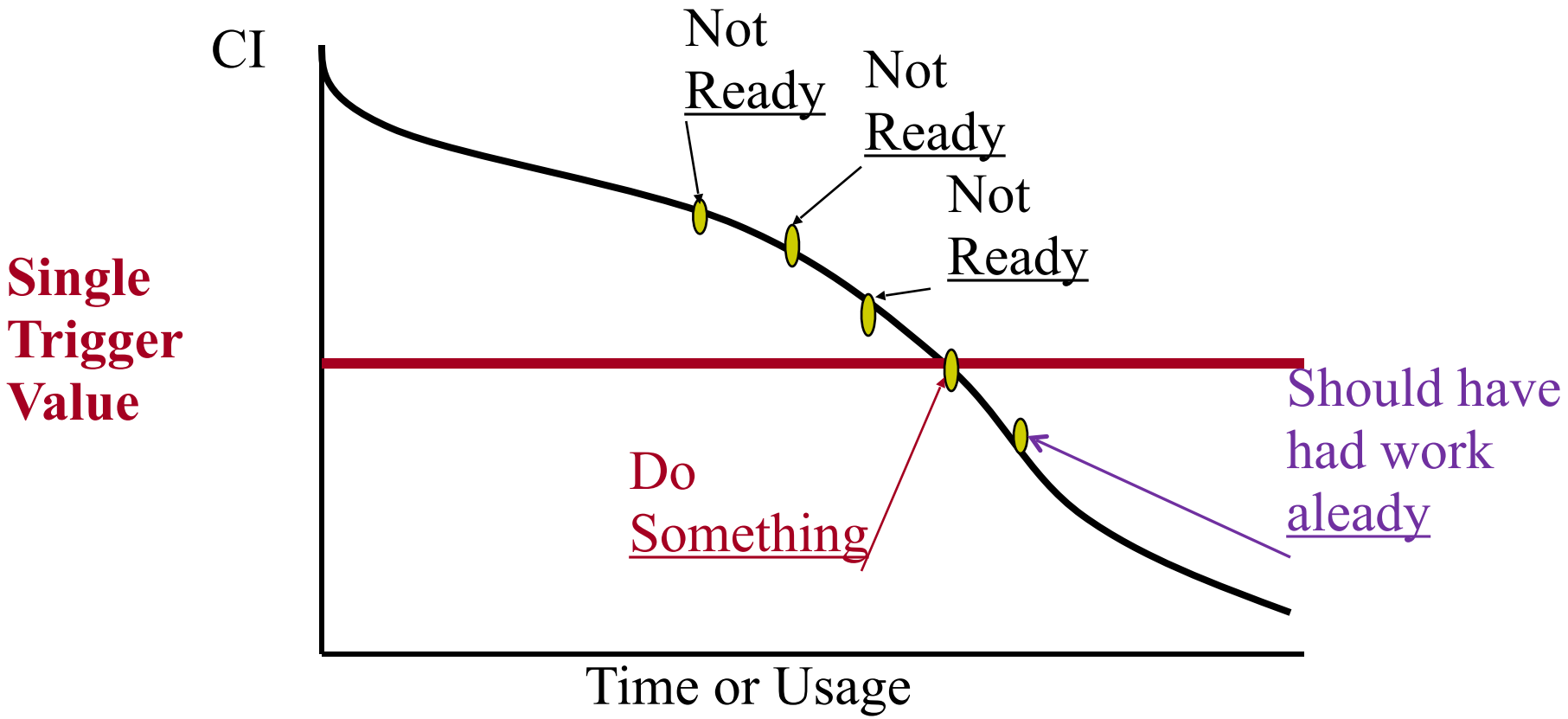
Feedback

Network-Level Methods

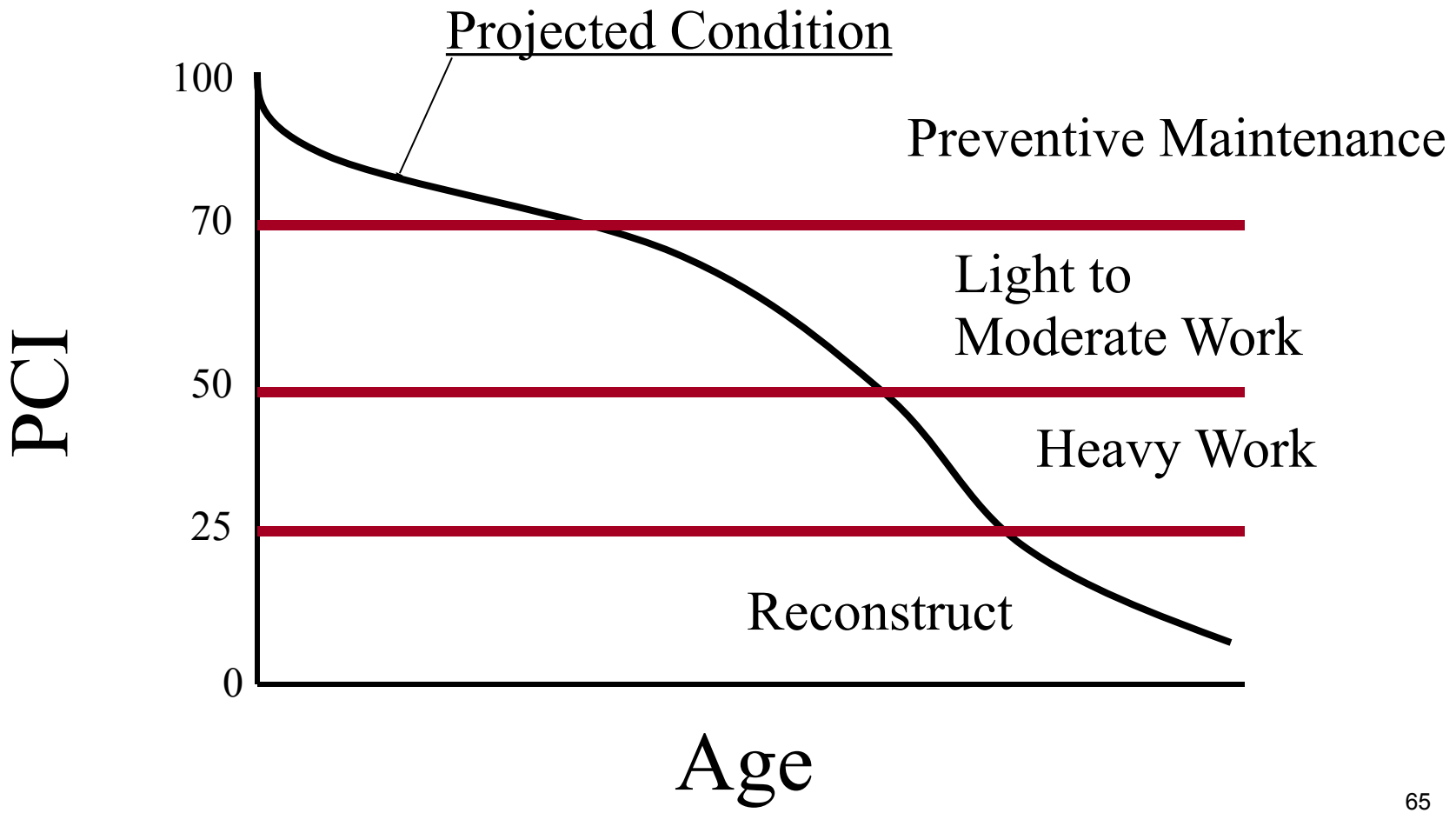
- Identify intervention (Treatment) levels
  - Combine with projected condition for each segment
- Use “Trigger Values”
  - To trigger a treatment

- **What project triggers are used for different treatments?**

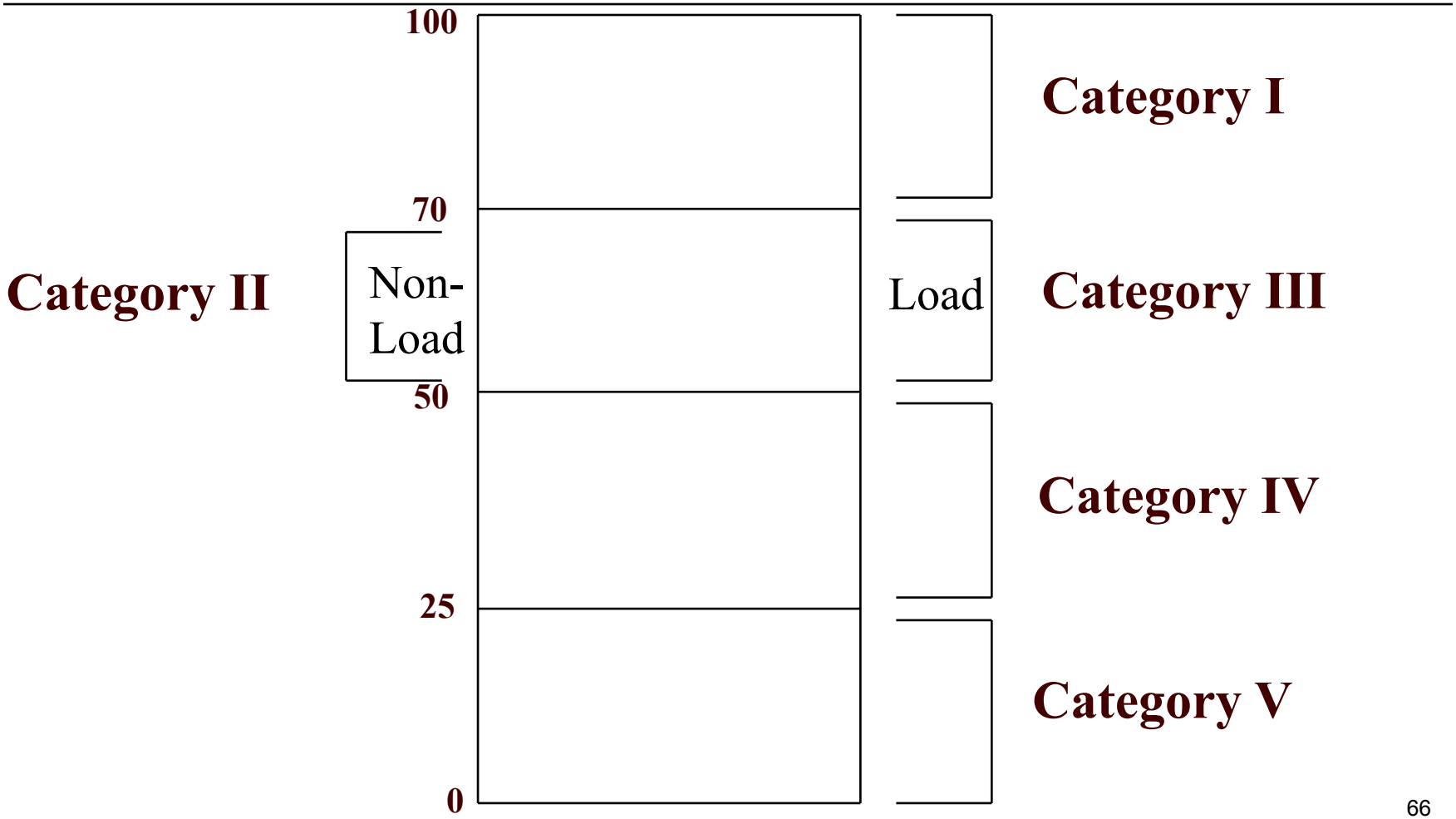
Condition at Time to Intervene Often Reflected in "Trigger Values"



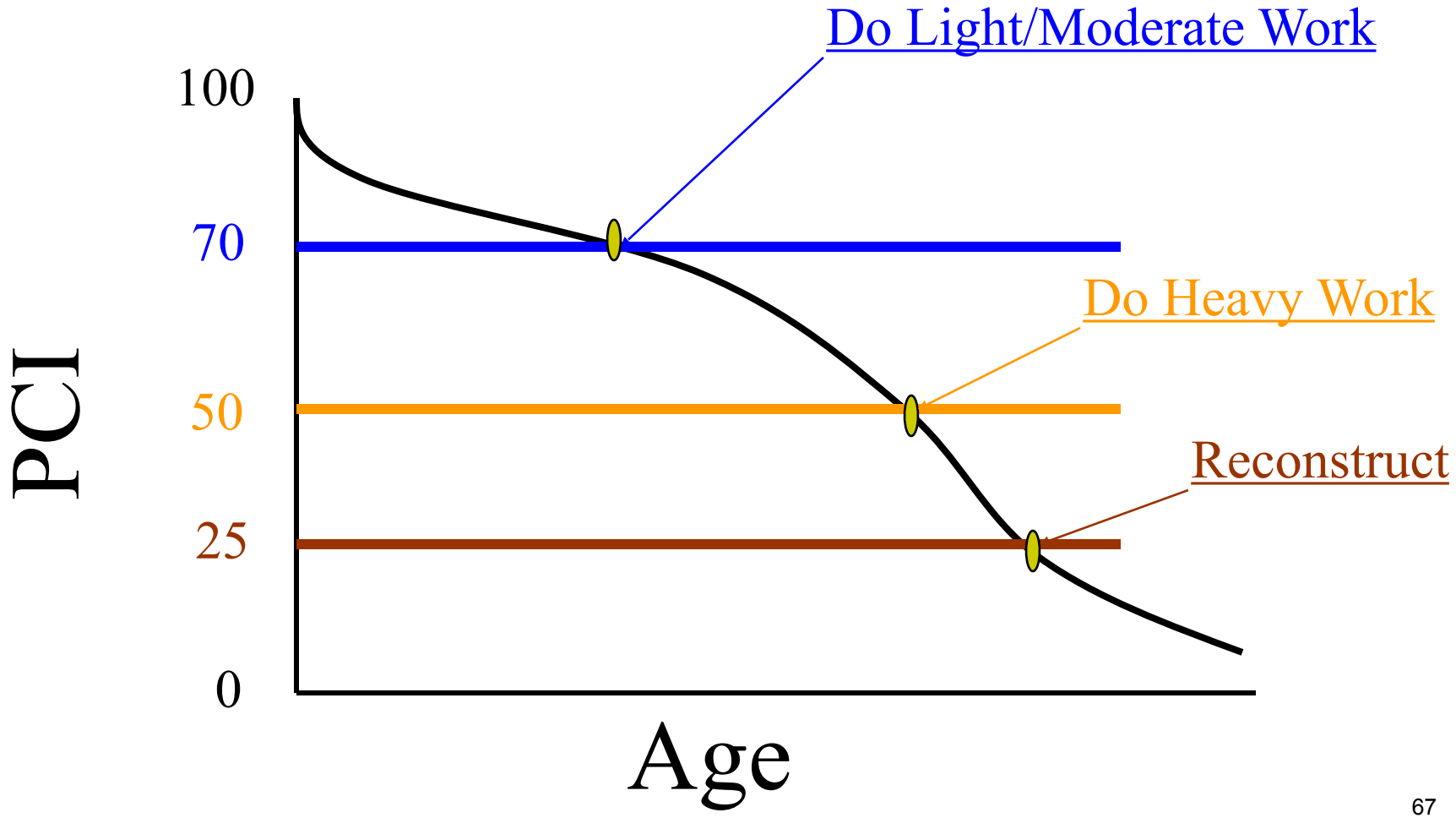
PMS Treatment Levels



PMS Condition Categories

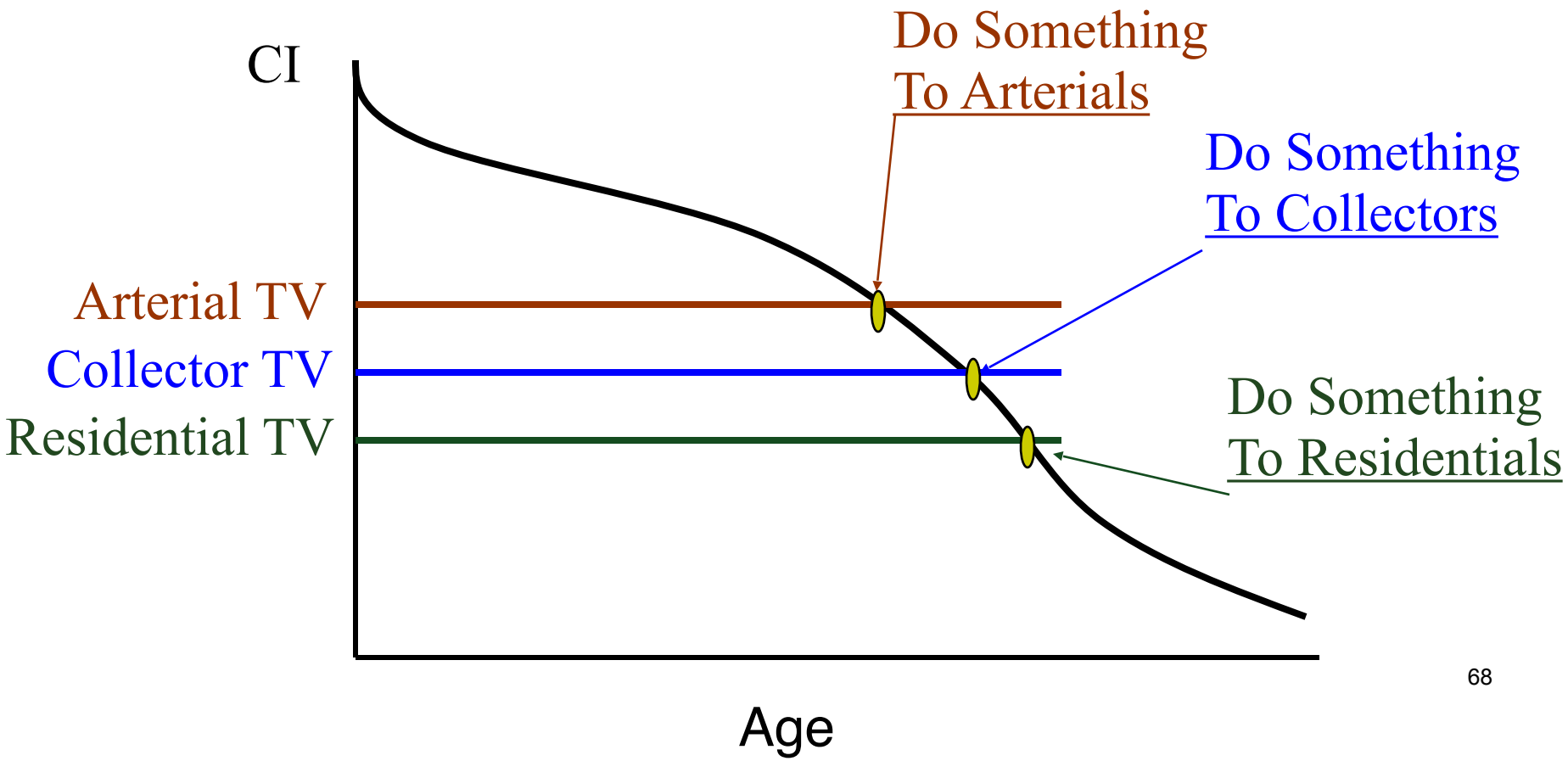


Default Trigger Values

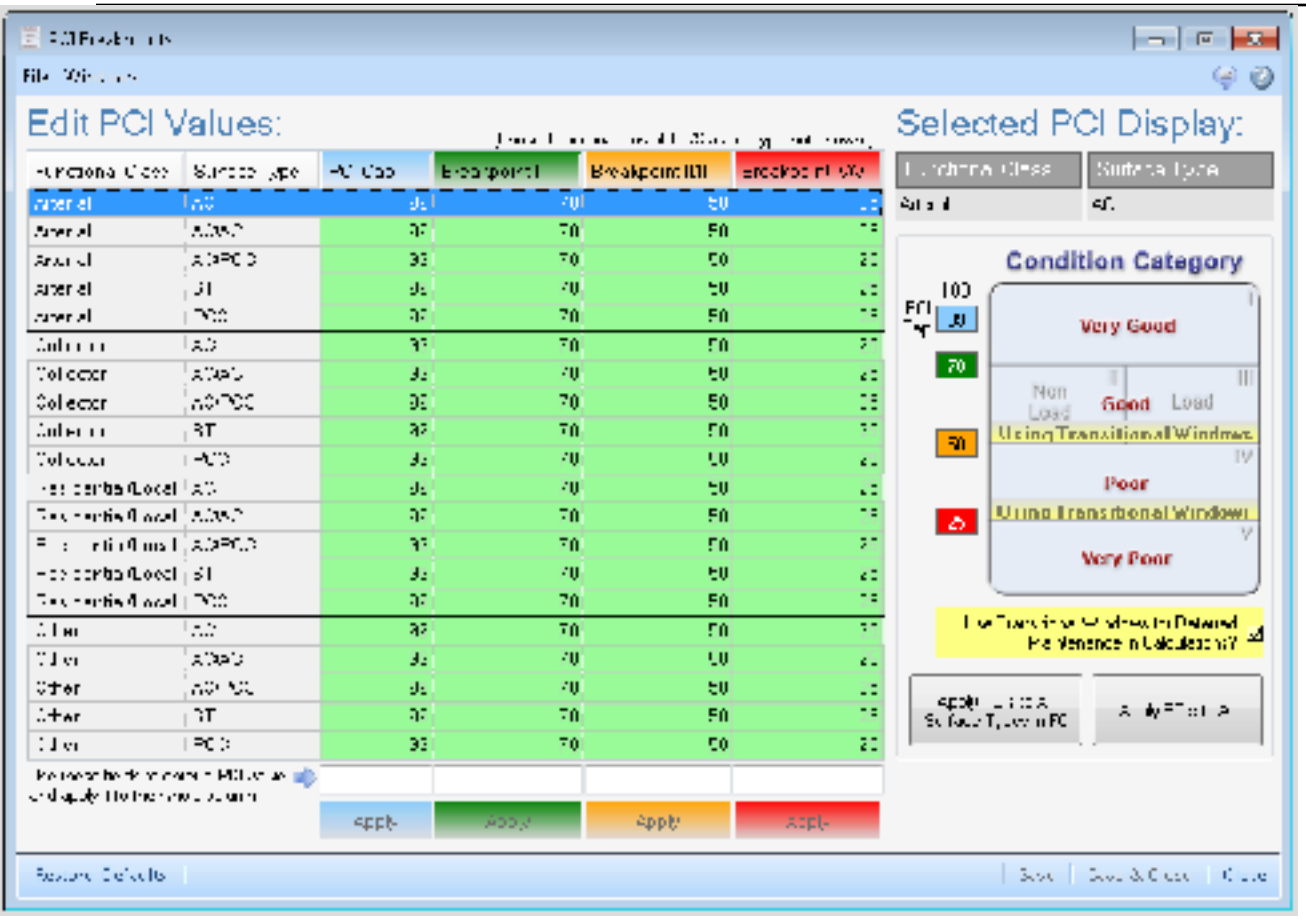


Adjust Levels For Importance/Usage

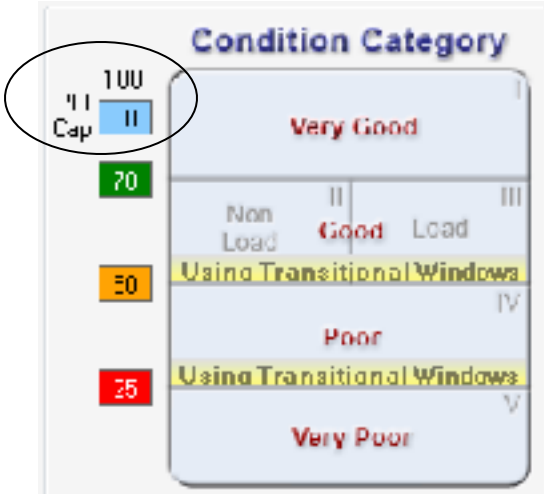
Moderate Level Trigger Value (TV)



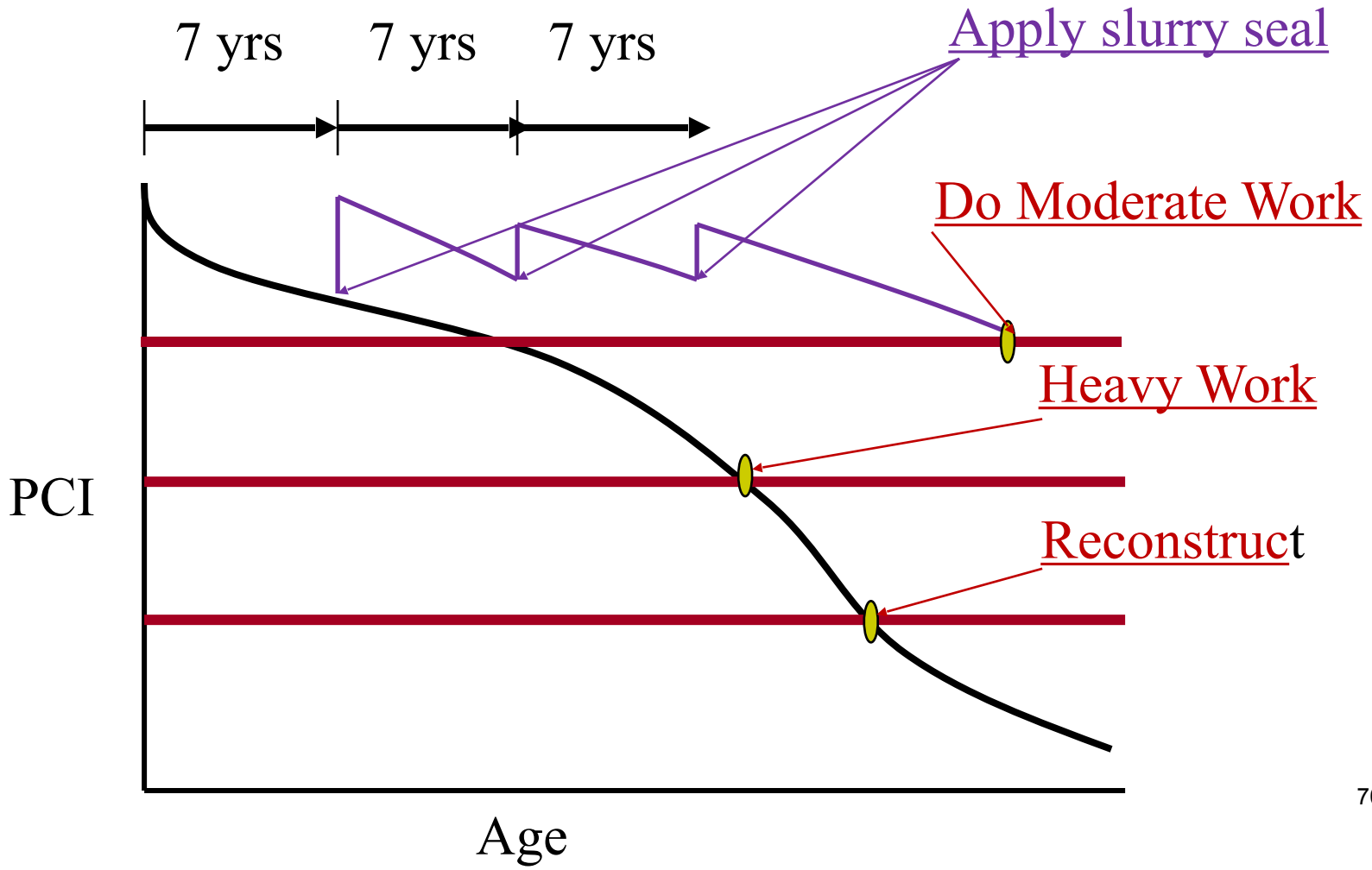
Set/Change in Table Maintenance



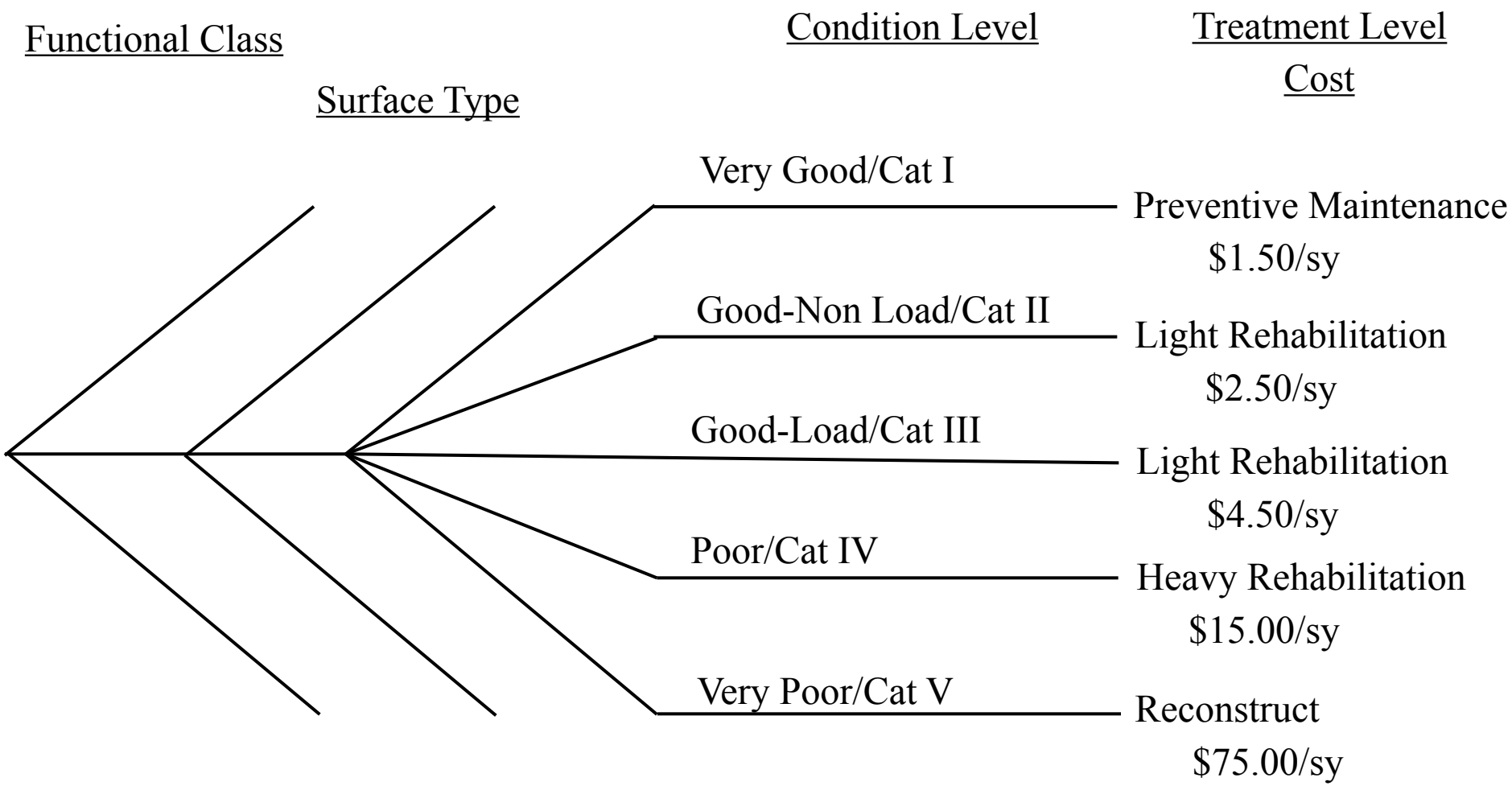
No treatment will be applied if PCI is greater than PCI Cap



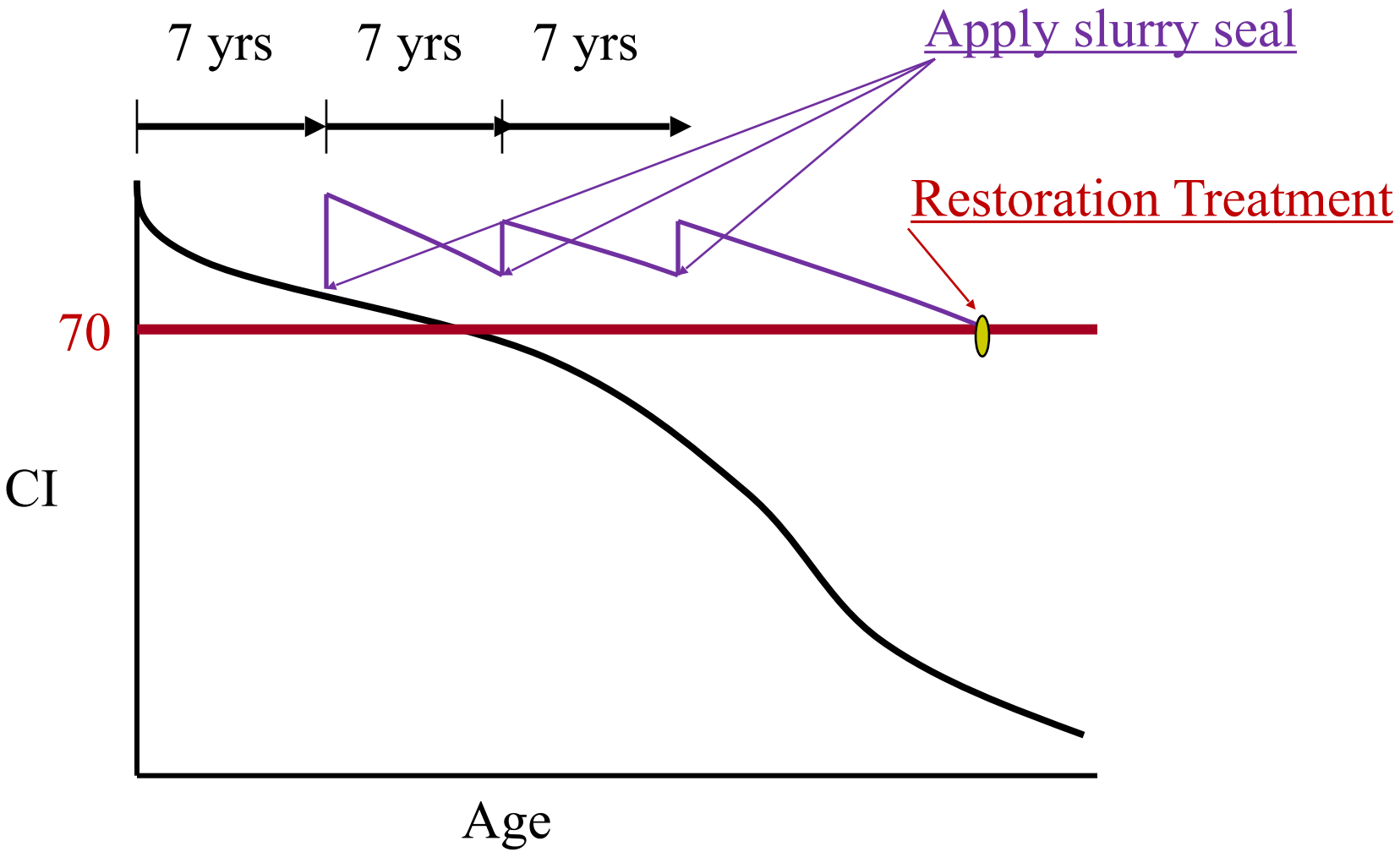
One of These for Every FC-ST Combination



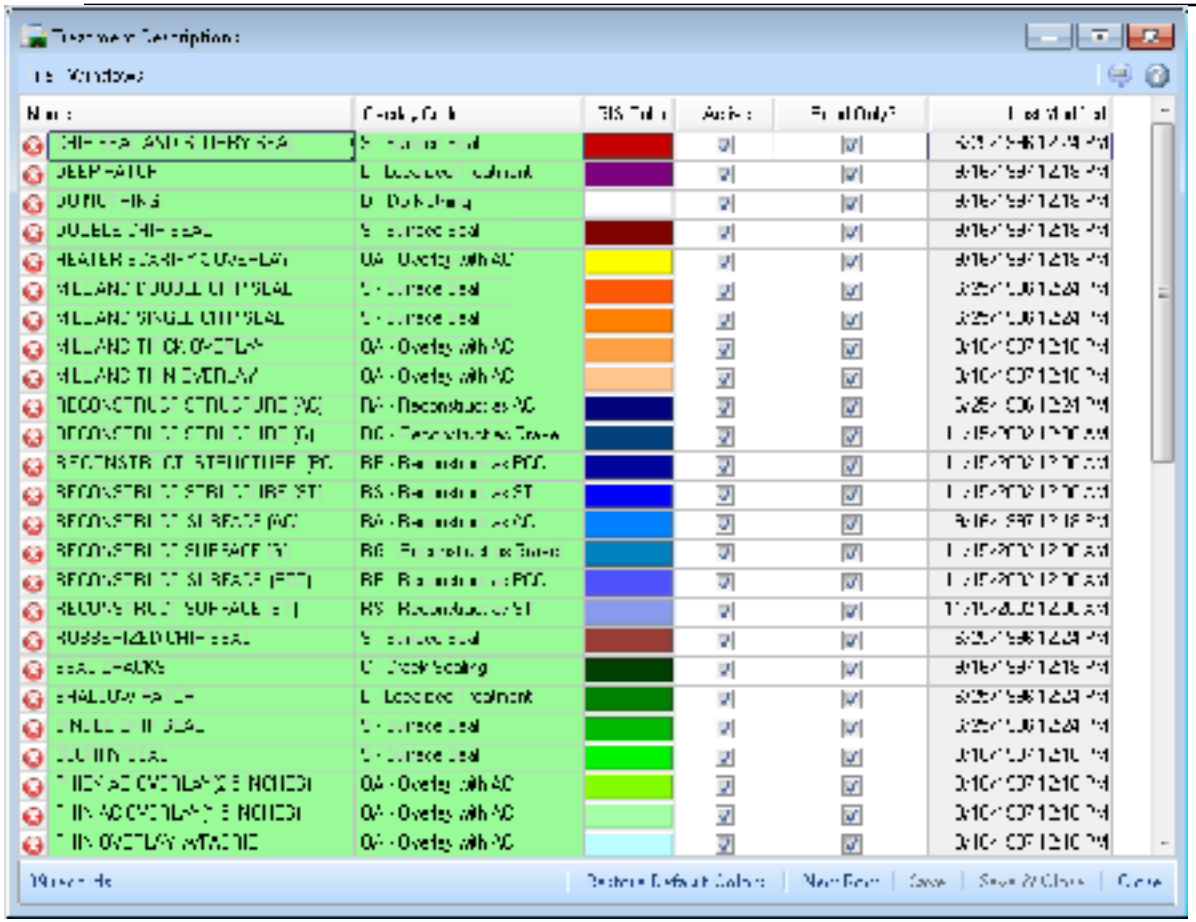
PMS Decision Trees

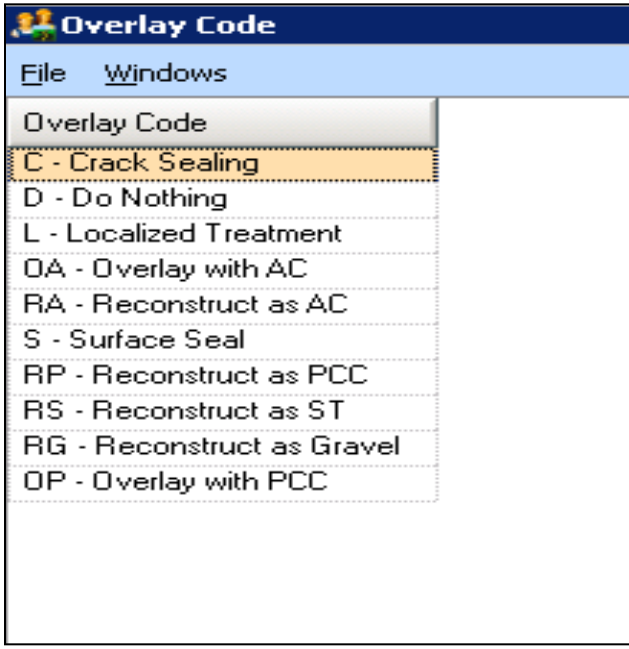


Preventive Maintenance - Time Driven



Can Only Select Established Treatments





Restoration Treatment

- When maximum number of seals reached
  - No further seals
  - Programmed for restoration treatment when PCI reaches Cat II/ III trigger value
- Based on issues of instability created by several sequential seals
- Normally includes a mill & overlay

Rehabilitation Treatment

- Identified for application when PCI projected to reach one of the Cat II through III trigger values
- Can still be a seal – normally with significant surface repair prior to treatment
- Localized & Do-Nothing can be used

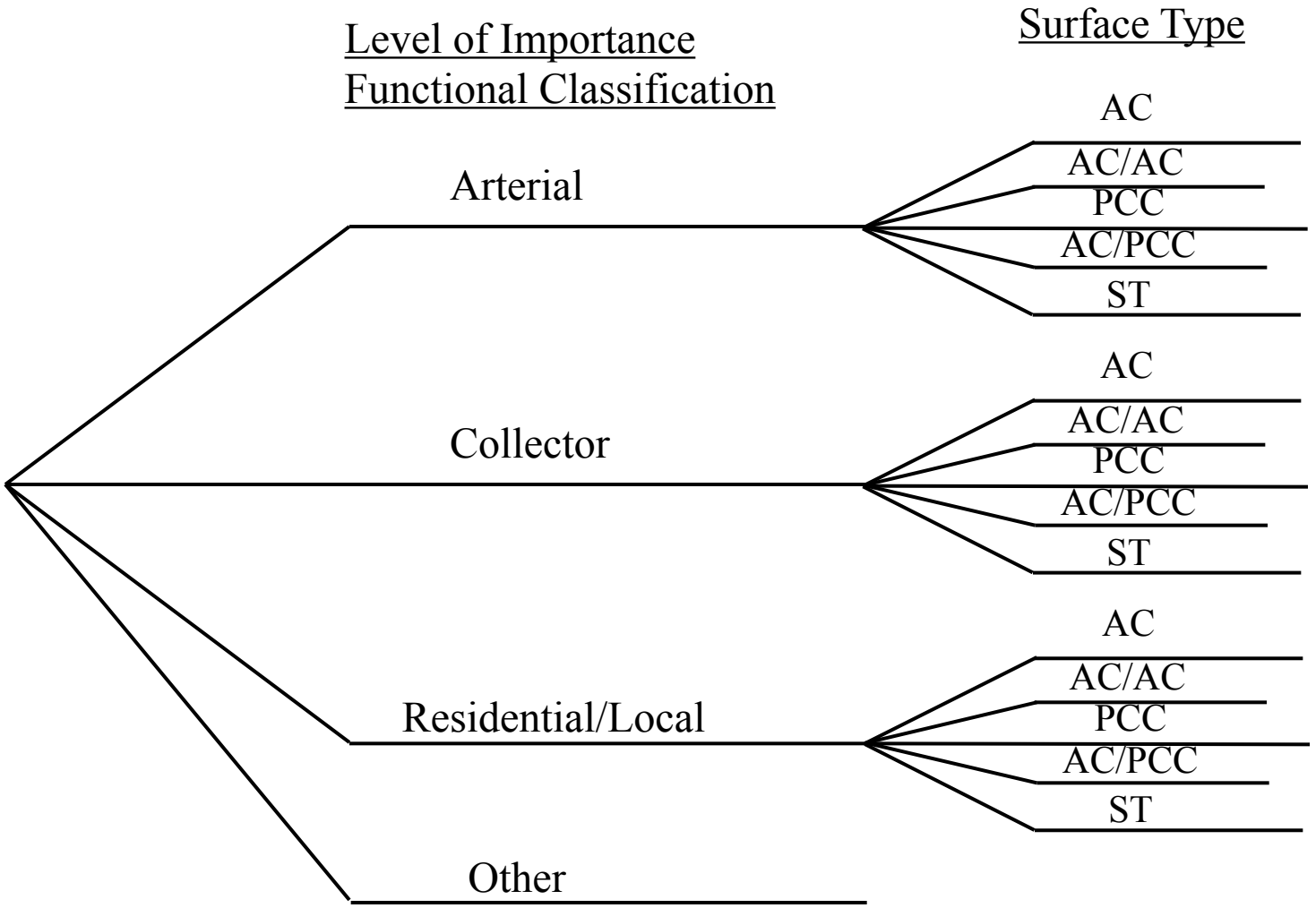
Decision Tree Approach

- Connects selected information to a treatment
- Network-level planning treatment
  - Assigned each section needing work
  - During analysis period (5 to 30 yrs)
  - Costs connected to treatments

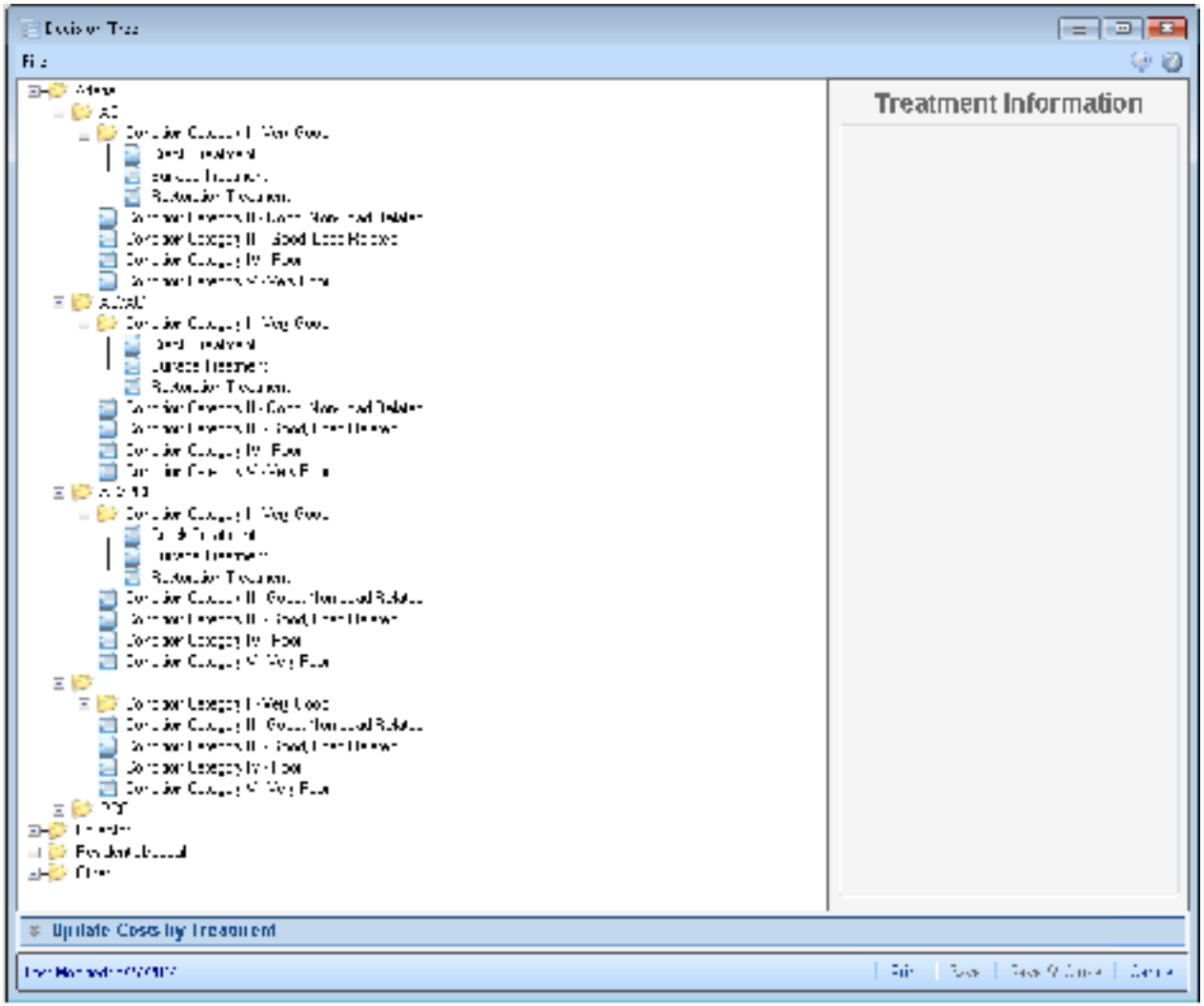
Factors Considered in PMS

- Condition
  - Projected PCI
  - Cause of damage
- Functional classification
  - Usage
  - Construction
- Surface type
  - Construction

PMS Decision Trees



Typical PMS Databases Have Default Decision Trees

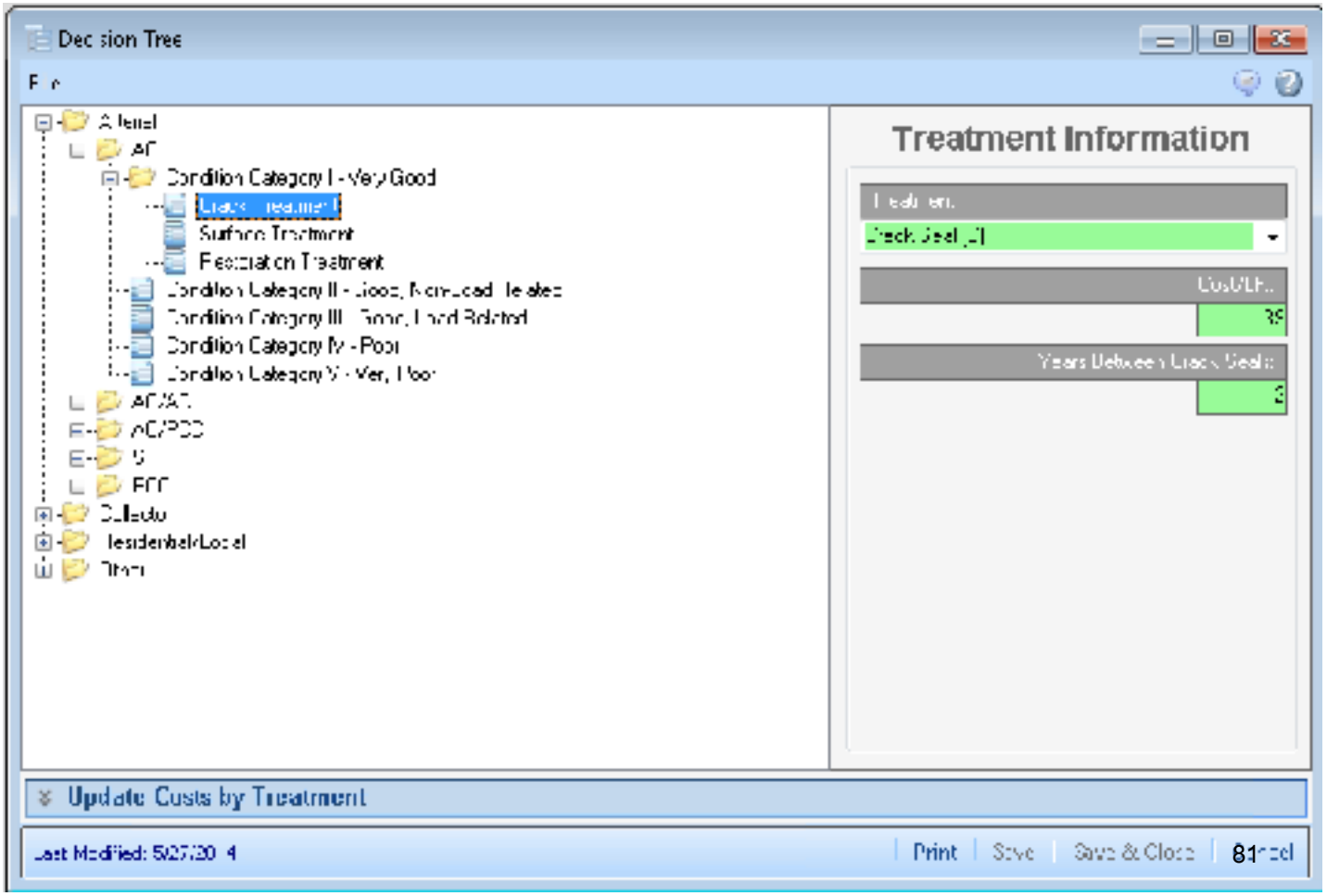


Treatments and Unit Costs

- Default – User modifiable
- Agencies need to modify to reflect their:
  - Treatments
  - Unit costs
- Cost will affect the calculated needs

Seven Treatments for Each FC/ST Combination

- 3 PM
- 4 Rehab



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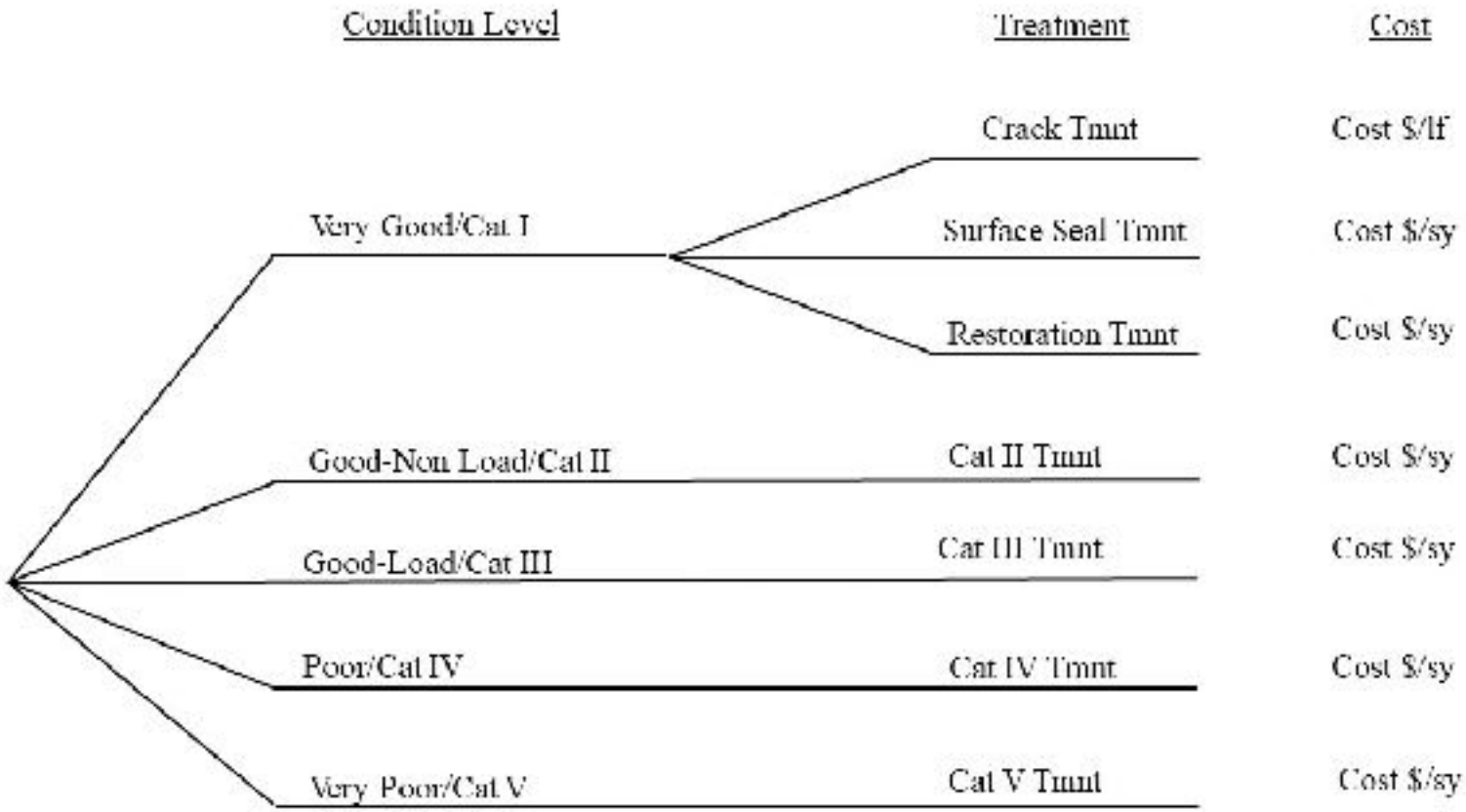
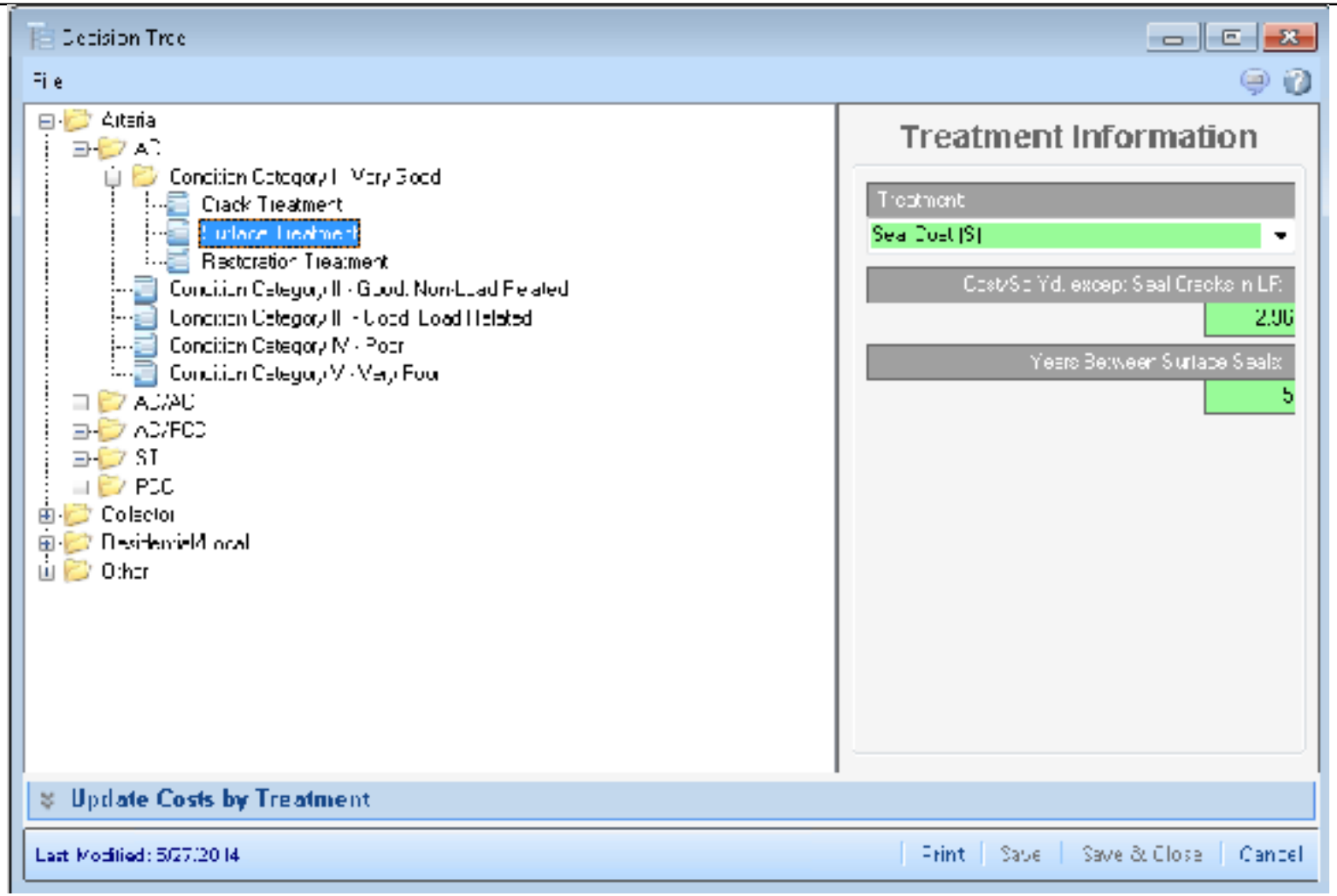


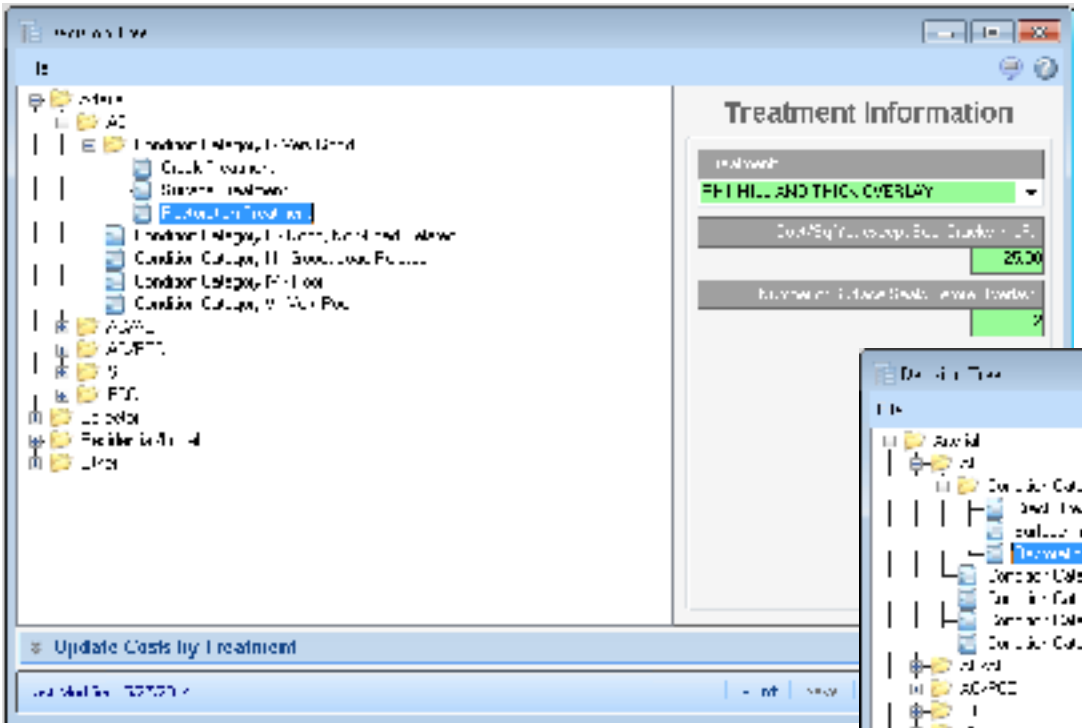
All Seals Require Time Between Seals

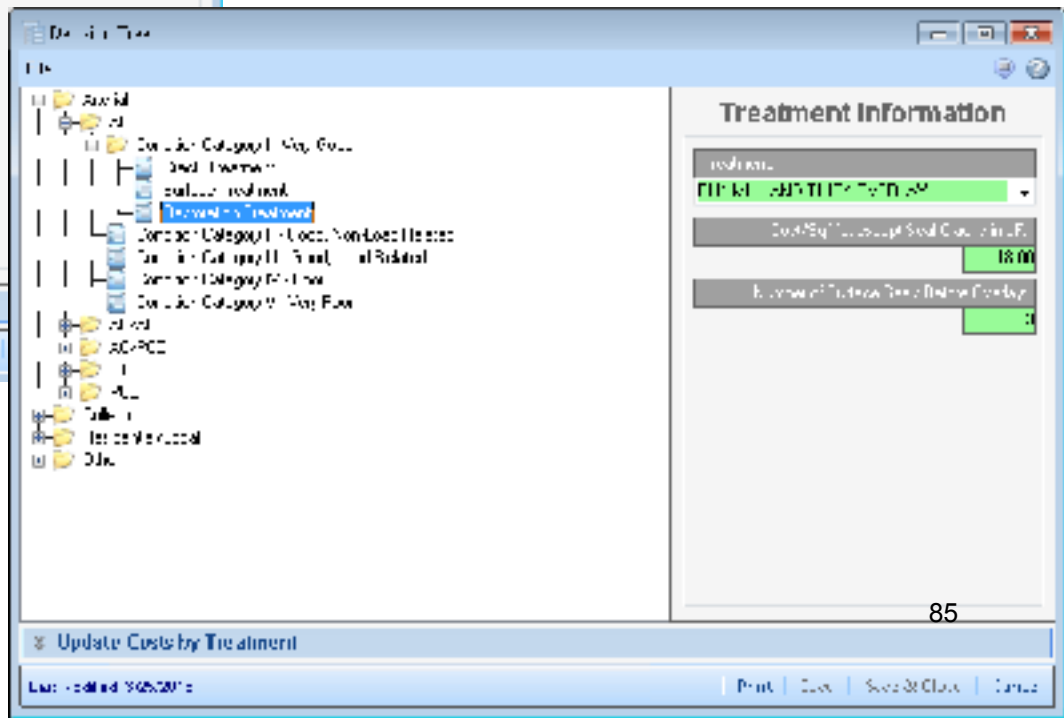


Maximum Number of Surface Seals

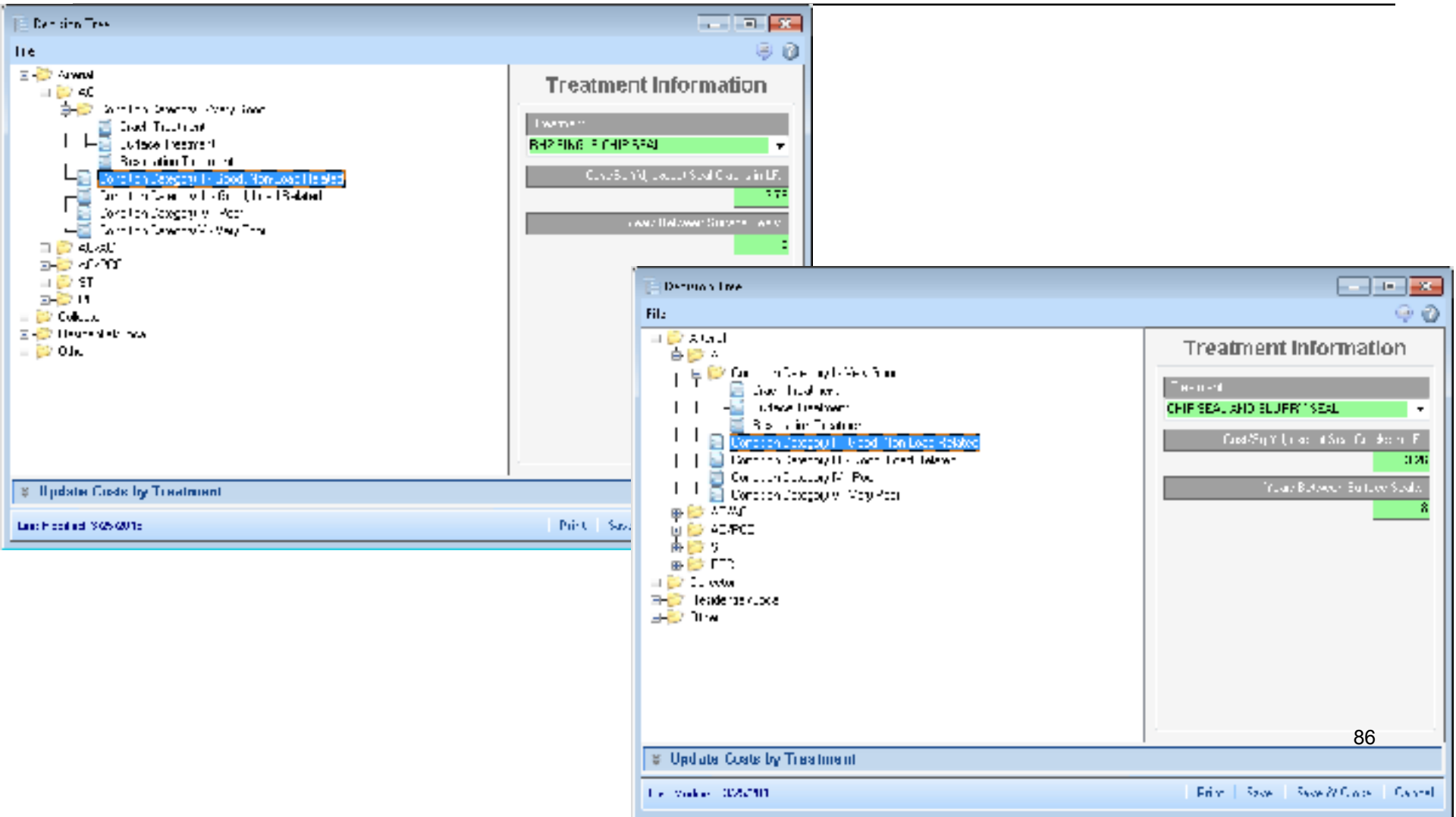
- Can set maximum number of surface Seals (AC, AC/AC, AC/PCC)
- Once maximum reached, no additional surface seals applied
  - Restoration treatment applied when PCI reaches 70
  - Rehab - next rehab treatment that is not a surface seal

Restoration Treatments Require Maximum Number of Seals

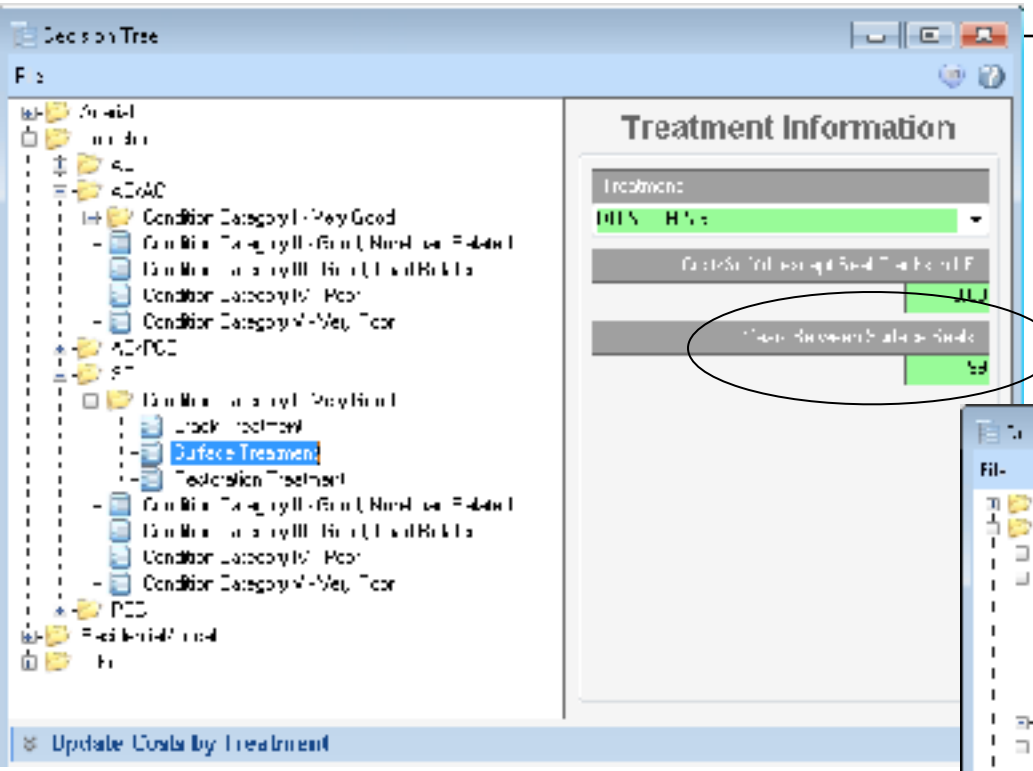


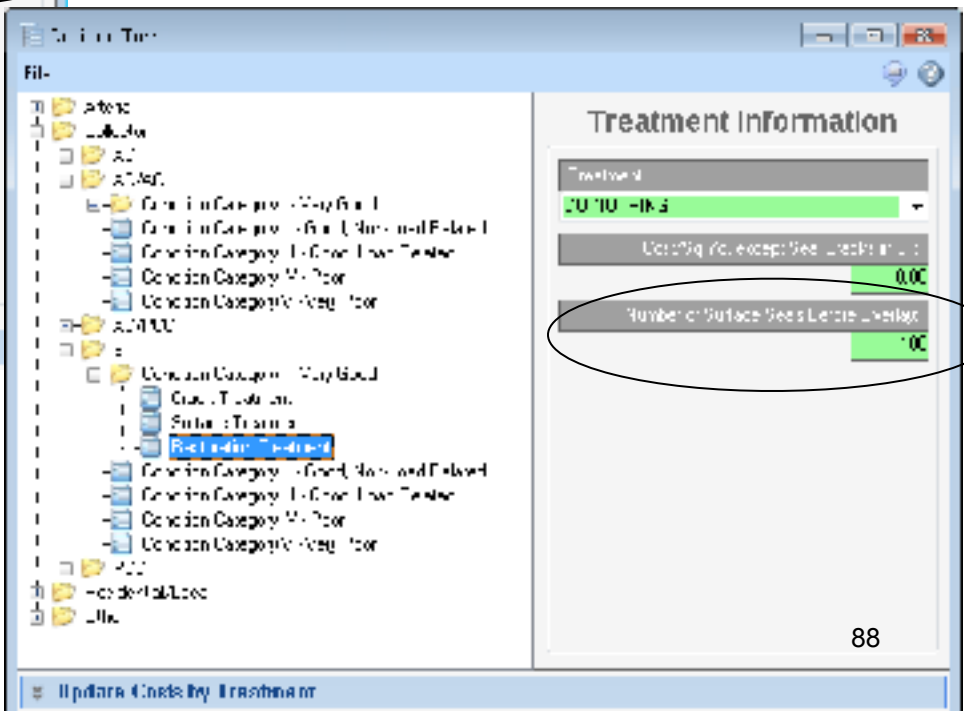


Seals Can be Applied as Rehabilitation

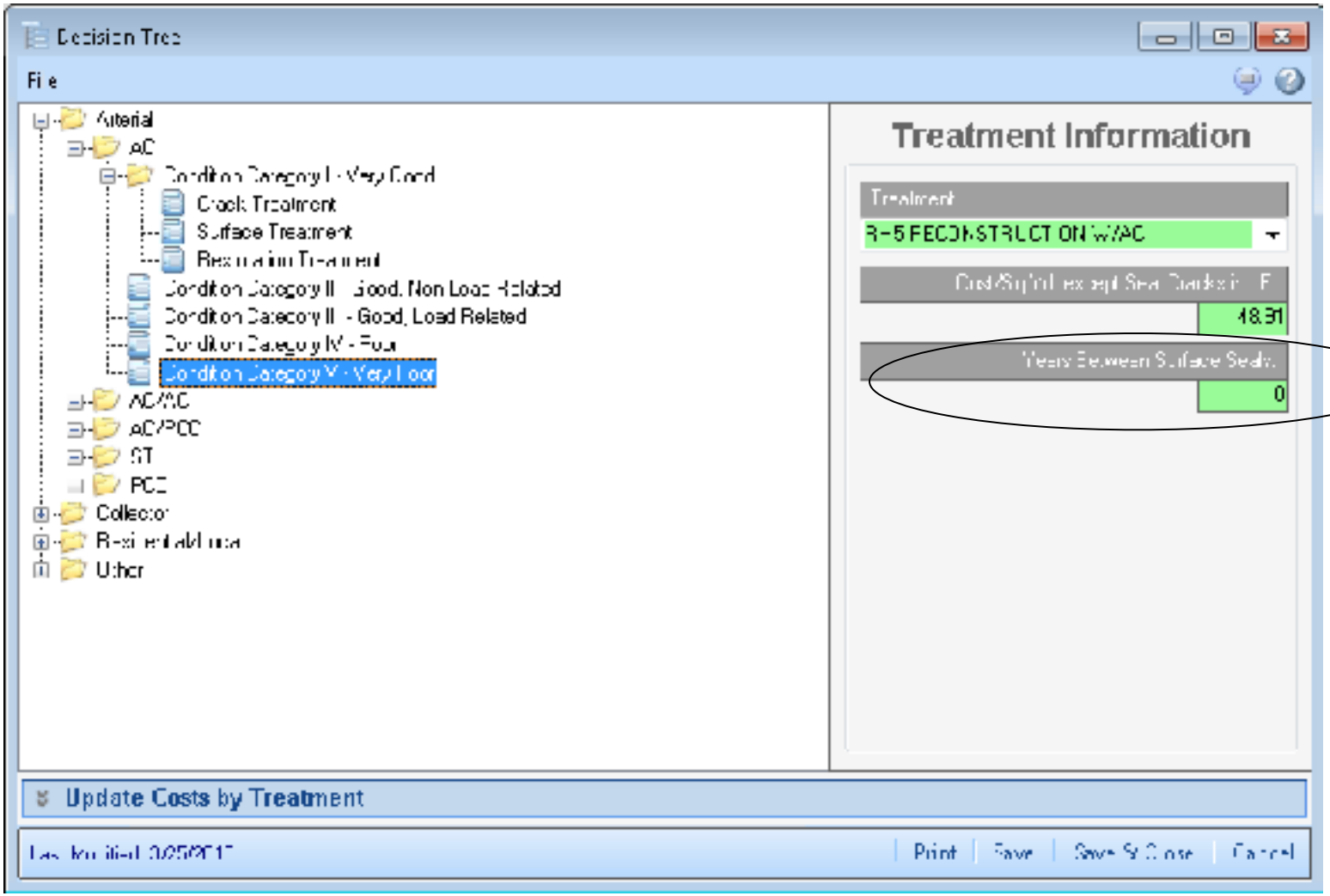


Years between seals = 99
Maximum numbers of seals = 100





Non-seals Do Not Have Years Between Treatments



Report Lists Current Treatments

[illegible]

Decision Tree

Printed: [illegible]

Functional Class	Surface	Condition Category	Treatment Type	Treatment	Cost/Sq Yd, except Seal Cracks in LF	Yrs Between Crack Seals	Yrs Between Surface Seals	# of Surface Seals before Overlay
[illegible]	AC	1 - Very Good	Crack Treatment	Crack Seal (Y)	$1.90	2		
			Surface Treatment	Seal Coat (S)	[illegible]		5	
			Restoration Treatment	RH1 MILL AND THICK OVERLAY	$18.00			9
		2 - Good Non-Load Related		RH2 SINGLE CHIP SEAL	[illegible]		5	
		3 - Good Load Related		[illegible]	[illegible]			
		4 - Fair		[illegible]	[illegible]			
		5 - Very Poor		RH5 RECONSTRUCTION (AC)	$48.9[illegible]			
	[illegible]	1 - Very Good	Crack Treatment	[illegible]	[illegible]	2		
			Surface Treatment	Seal Coat (S)	[illegible]		5	
			[illegible]	[illegible]	[illegible]			[illegible]
		[illegible]		[illegible]	[illegible]		[illegible]	
		[illegible] Good Load Related		RH3 HEATER SCARIFY OVERLAY	[illegible]			
		[illegible]		[illegible]	[illegible]			
		5 - Very Poor		RH5 RECONSTRUCTION (AC)	$48.9[illegible]			
	[illegible]	[illegible] Very Good	[illegible]	[illegible]	[illegible]	[illegible]		
			[illegible]	[illegible]	[illegible]		[illegible]	
			Restoration Treatment	RH1 MILL AND THICK OVERLAY	[illegible]			2
		[illegible]		[illegible]	[illegible]		[illegible]	
		[illegible] Good Load Related		RH3 HEATER SCARIFY OVERLAY	[illegible]			
		[illegible] Poor		[illegible]	[illegible]			
		[illegible]		[illegible]	[illegible]			
	[illegible]	1 - Very Good	Crack Treatment	[illegible]	[illegible]	5		
			[illegible]	[illegible]	[illegible]		[illegible]	
			Restoration Treatment	DO NOTHING	[illegible]			100
		2 - Good Non-Load Related		DO NOTHING	[illegible]			
		3 - Good Load Related		[illegible]	[illegible]			
		4 - Fair		[illegible]	[illegible]			
		[illegible]		[illegible]	[illegible]			

Decision Tree

[illegible]

[illegible]

Functional Class	Surface	Condition Category	Treatment Type	Treatment	Cost/Sq Yd, except Seal Cracks in LF	Yrs Between Crack Seals	Yrs Between Surface Seals	[illegible] Overlay
Arterial	ST	Very Good	Crack Treatment	Crack Seal (C)	$[illegible]	2		
			Surface Treatment	DO NOTHING	$[illegible]		[illegible]	
			Restoration Treatment	DO NOTHING	$0.00			100
		Good/Non Load Related		[illegible]	$[illegible]			
		[illegible]		[illegible]	$4.[illegible]			
		[illegible] - Poor		RES SINGLE CHIP SEAL	$7.00			
		V - Very Poor		RES THICK AC OVERLAY (2.5 IN)	$[illegible]			

Treatment Assignment

- Reflects how the agency plans to manage their network
- If PM and light treatments are not included
  - Only major rehabilitation and reconstruction will be assigned
- Selecting PM and light treatments allows a preservation approach

Selecting Appropriate Treatments

- Treatment applied
- Treatment cost
- Treatment timing for seals
  - Surface seals
  - Crack seals

Pay Me Now or Pay Me Later

Pay Me Now

- 3 Seal Coats at $ 0.70 /sy - 24 yrs
- 1 Overlay at $ 3.50 /sy - 8 yrs
- 2 Seal Coats at $ 0.70 /sy - 16 yrs

- Total $7.00 /sy for 56 yrs

Pay Me Later

- 2 Remove & Replace at $ 14.00 /sy
  - 54 yrs
- Total $28.00 /sy for 54 yrs

Compare

- Pay Me Now
  - Total $7.00 /sy for 56 yrs
- Pay Me Later
  - Total $28.00 /sy for 54 yrs
- Which Gave Better Service?

Treatment Assignment

- Agency policy must be established
- Can use different decision trees/matrices to show impacts of applying different treatment approaches

Pavement Preservation Strategies

- Apply:
  - The right treatment
  - To the right pavement
  - At the right time
- Focuses on preventive maintenance
  - Dedicate funds to preventive maintenance

Worst First

- Many agencies have backlog of sections that need major rehabilitation of reconstruction
- One approach - fix those in worst condition first
- To address backlog, best approach is:
  - Retain good roads
  - While repairing some percent of poor roads each year

Good Roads Cost Less than Bad Roads

- It costs the maintaining agencies less to have good roads than bad roads - Over the long term. If….
  - Reasonable level of service provided
  - Pavements will respond to preventive maintenance, e.g. they must be structurally adequate
- Pavement preservation approach provides best roads for the least cost

To Address Backlog

- Agencies must retain good roads
- While repairing poor roads

Back to Network-Level Questions

- Funds needed – long-term
  - To provide selected level-of-service
  - Impact of spending less or more
  - Impact of spending differently
- Funds set – short-term
  - Which segments give best potential return on funds
  - Impact of repairing different segments
  - Impact of applying different treatments
  - Impact of applying treatments at different times

Treatment vs Treatment Category

- At network level
  - Treatment category rather than actual treatment
  - Cost estimating treatment
- Level of funding more important than actual treatment
  - Treatment refined in project selection-level
  - Treatment selected in project-level
- Treatment Name needed to develop costs

Needs Analysis Results

- List of sections needing work
- Approximate funds needed
- Based on agency goals
- Over an analysis period

Network-Level Activities

- Inventory
- Condition Assessment
- Determination of Needed Work & Funds
- **Identification of Candidate Projects**
- Determination of Impacts of Funding Alternatives
- Feedback & Upkeep

Identification of Candidate Projects

- Prioritization/Optimization
- Identifies segments for repair
  - Best candidates to give
  - Highest return for
  - Available funds
- Various ranking and optimization procedures used
  - Some allow analysis of benefits

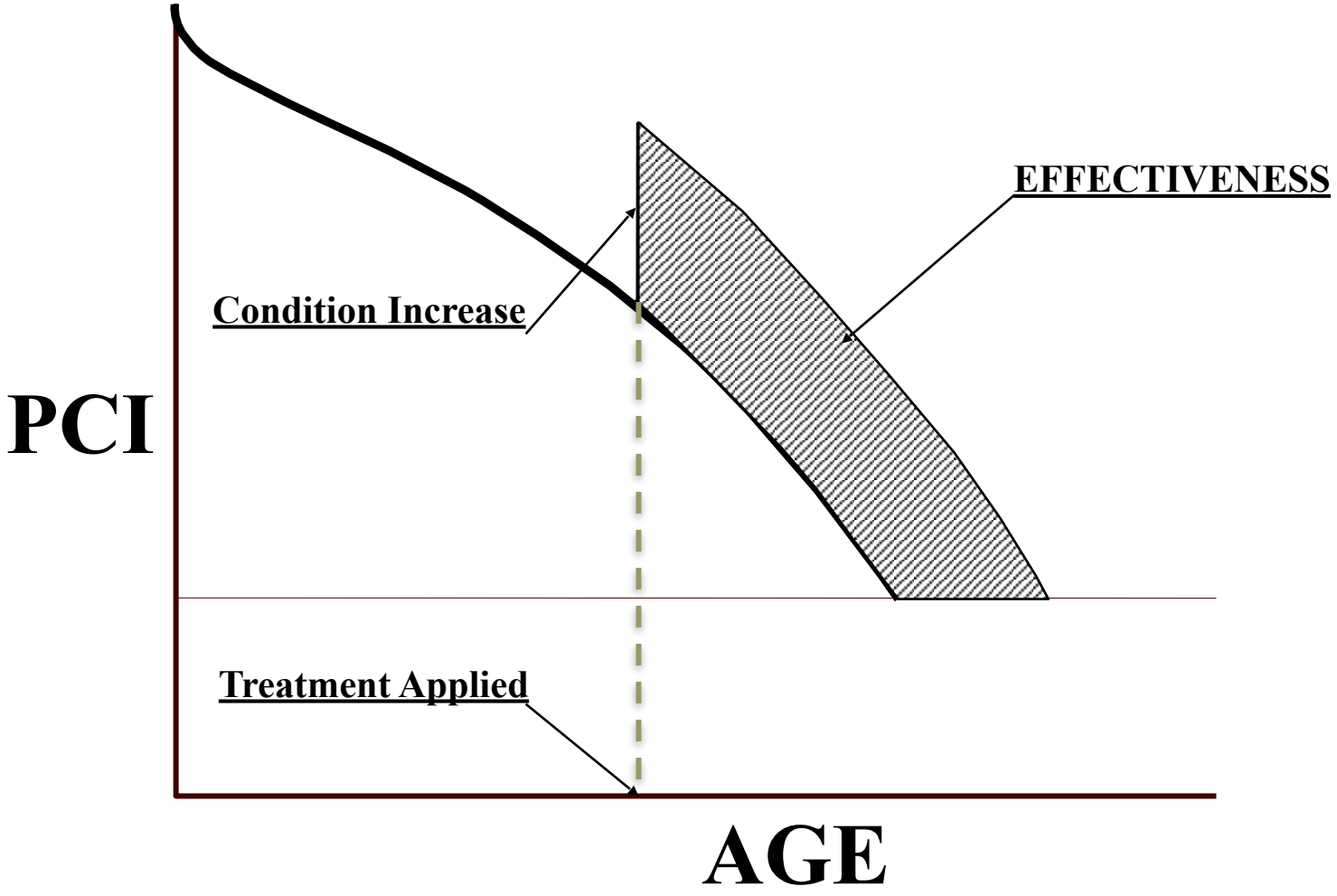
Basic Approaches

- Minimize funds needed to provide desired service
- Maximize return on set funding levels

Cost-Benefit Analysis

- Often uses reduction in
  - Costs incurred by public as the benefit of the treatment
- Primary issue
  - How to calculate dollar value of work to public or "benefit to society"

Cost Effectiveness



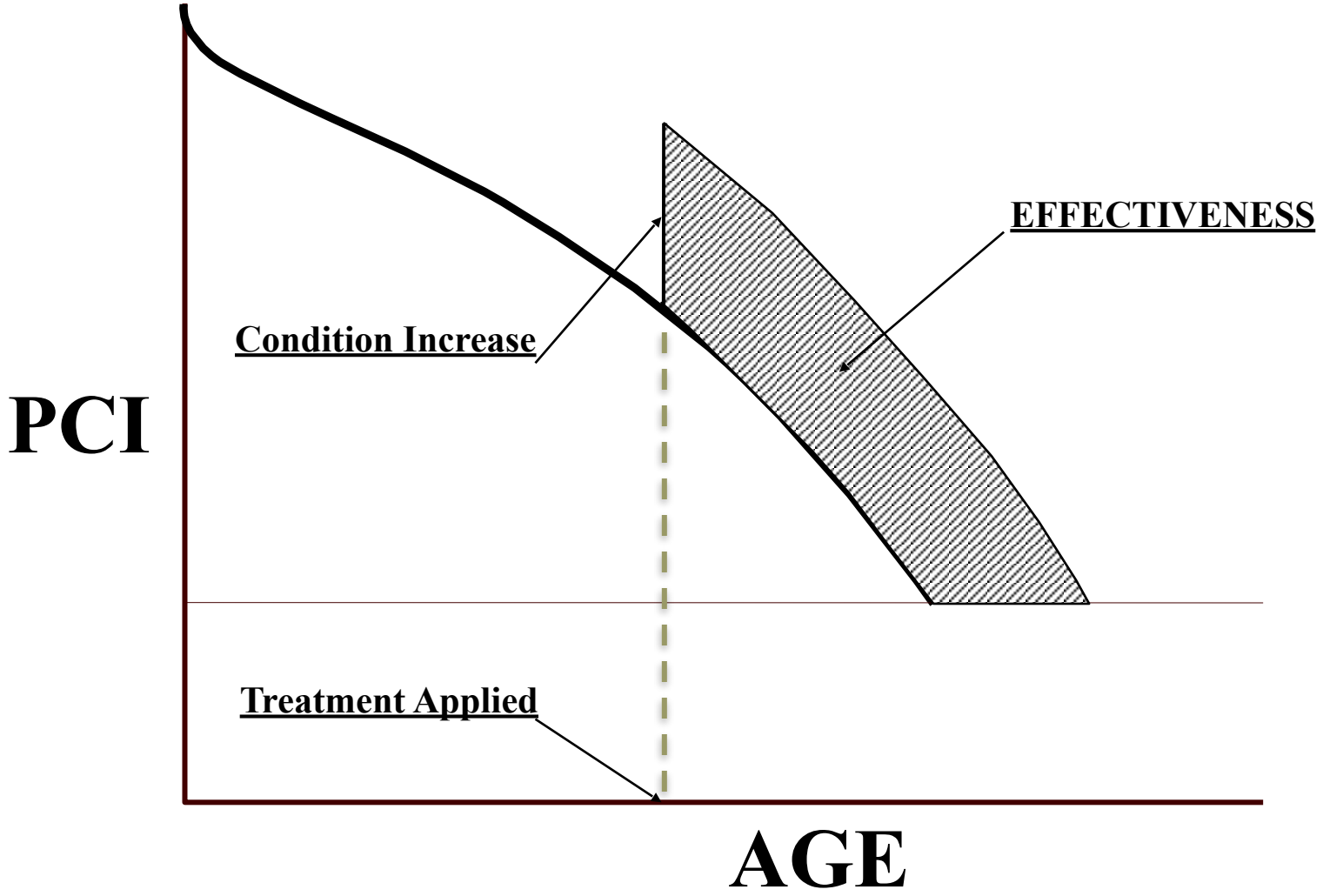
Cost-Effectiveness

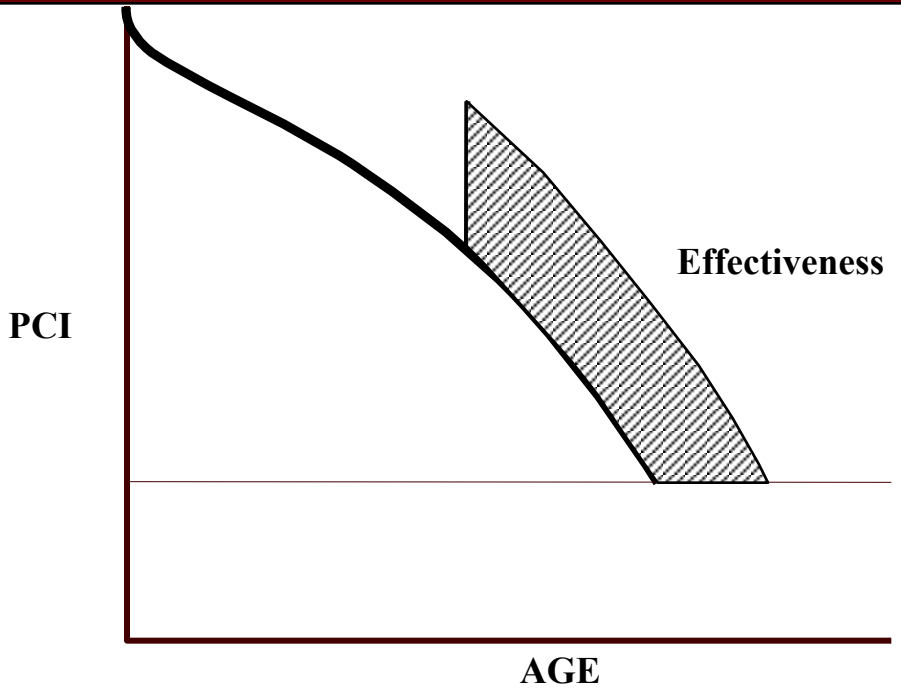
- Sections
  - That will be in the best condition for the longest time for least cost
  - Give best return on funds and
  - Should be repaired first

Cost-Effectiveness Analysis

- Used to prioritize pavement sections
  - From highest to lowest
  - Weighted effectiveness-cost ratio

Better Condition Over Longer Time Gives Better Return on Funds Invested





Cost

$$\text{Cost-Effectiveness Ratio} = \frac{\text{Effectiveness}}{\text{Cost}}$$

Factors for Consideration

- Which pavements last the longest?
- Which treatments cost the least to build?
- Must weight for usage

Weighted Cost Effectiveness Ratio

$$WER = \frac{(AREA/YR)\ WF}{EUAC/SY}$$

where

WER = weighted effectiveness ratio
AREA = area under PCI curve
YR = years affected
WF = weighting factor for usage
EUAC = equivalent uniform annual cost
SY =square yards in management section

Target Driven Scenarios

Set Conditions and Minimize Costs

Set Targets (Goals)

- Targets (goals) set by agency
  - Condition (PCI)
  - Remaining life
  - % In very good condition
  - % In poor & very poor condition
- One or more of these can be set
- Can be set for network or sub-groupings of network

Multiple Decision Criteria Optimization

- Near optimal algorithm
- Select sections based on Cost-Effectiveness until target(s) reached
- Calculates funds needed to reach the targets and provides list of candidate sections

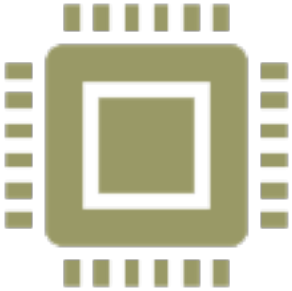
Goal of the Method

Minimize the overall treatment costs needed to achieve target objectives

Maximize the overall treatment effectiveness

Uses existing cost-effectiveness concepts

Near “Optimal” Solving Technique



Developed based on optimization using a multi-objective model with an integer programming solving technique

Solved using the “dynamic bubble up” (DBU) methodology

Analysis Process

- Calculate current values for target objectives
- Identify treatment needs for each section in group being analyzed
- Calculate WER for each section in group being analyzed that needs treatment
- Rank those sections from highest to lowest WER
- Calculate minimum funds needed to reach set target objectives using DBU methodology
- Repeated for each year of analysis period

Dynamic Bubble Up - DBU

- Iterative calculation based on established incremental cost-benefit (effectiveness) analysis methodology
- Done for each target objective in analysis of group being analyzed
- Each analysis is tested and adjusted among groups to get “near optimal” solution

Target-Driven Results

- Funds needed to achieve targets
- Iterative use allows analysis of different targets
- Helps establish agency goals over the long-term
- Provides lists of segments that would need work to achieve the goals

Standard Scenario Prioritization Process

- Fix Funds & Maximize Benefit
- User sets :
  - Available funds
  - Amount PM
  - Increase factor (inflation of funds)
- Go thru calculation process

Analysis Process

- Weighted effectiveness ratio (WER) calculated for each section needing work in 1st year
- Rehab separated into one group, PM into another
- All those needing rehab ranked from highest to lowest
- Sections selected until funds exhausted

Analysis Process (cont'd)

- Those not selected are assessed stop-gap maintenance funds
- Assumes they will require additional maintenance funds that would not have been needed had they been repaired at the appropriate time
- Stop-gap can be subtracted from PM if desired

Analysis Process (cont'd)

- All those needing PM ranked from highest to lowest
- Sections selected until funds exhausted
- Remaining funds are considered excess funds

Analysis Process (cont'd)

- Condition projected forward one year
  - With treatment if selected
  - Without treatment if not selected
- Process repeated for each analysis year
  - Sections can have multiple treatments in analysis period

What are Stop-Gap Factors

- Unit costs for estimating:
  - Emergency or routine maintenance needed
  - Because needed work not funded
- Extra maintenance funding needed

Prioritization Results

- Ranked listings of candidates for funding that maximize “effectiveness” for funds invested for both Rehab & PM
- Changes in network if this selection process occurs

Troubleshooting: Large Amount of Excess $'s

- Check allocation to PM vs Rehab
- Large amounts of excess funds often means too much allocated to PM
  - Adjust amount allocated
  - Can be done by year in $'s or % total $'s
- Change allocation & rerun analysis

Results from Both Approaches

- Used in the impact analysis
- Provide information to present to funding authorities and upper management

Reports Are Provided

- Ranked sections selected
- Ranked sections not selected
- Condition with and without treatment
- Cost summaries
- Can be exported to spreadsheets & other formats

Which Should You Use

- Probably both
- Target driven to determine funds needed
  - Long-term investment analysis
- Standard scenarios after budget has been set
  - Short-term to identify candidate segments to be considered in project-selection analysis

Run Series of Long-term Scenarios

- Establish best treatment approach that will be supported by funding authorities
- Develop funding plan to provide, or reach, the level-of-service to be provided to citizens and driving/riding public
- Funding levels for next few years are established

Investment Analysis

- Target Driven – Long-term (30 years)
  - This can take some time to run
- Provide funding authorities information to help set agency goals
  - With current condition, what funds are needed to reach some set goals?
  - What goals are achievable over different analysis periods?

Run Series of Short-Term Scenarios

- Funds available have been established
- Identify how to get best return on funds allocated
  - Which sections to fund first

When Budget is Established

- Seldom does it match what had been established as needed in target driving analysis
- What are the impacts of the budget?
- Which sections are the “best candidates” for work?
- Run standard scenarios

Will They Give the Same Answer

- Probably Not!
- They are working at the problem from two different directions
  - Maximize benefit vs minimize cost
- They are NOT using the same parameters
- They are based on same cost-effectiveness concept

Prioritization

- Provides a list of candidate sections that can be funded with available funds
- Cannot give the best treatment for each section - only provides a treatment or cost category

Network-level Only a Step in Process

- Network-level
  - Recommended budget planning treatment for a group of sections for available funds based on long-term goals
- Project selection-level
  - Better definition of segments, treatments, costs, & constraints based on available funds in near term
- Project-level
  - Used to define best treatment & final cost estimate for each selected section within constraints

Network-Level Activities

- Inventory
- Condition Assessment
- Determination of Needed Work & Funds
- Identification of Candidate Projects
- **Determination of Impacts of Funding Alternatives**
- Feedback & Upkeep

Group Activity

How do you use pavement management to communicate needs for your agency?

Impact Analysis

- Develop information to communicate impacts of infrastructure funding and policies with
  - Senior management/funding authorities
  - Elected officials
  - Primary constituents
- Not generally a different set of decision support tools
  - Extracting information in terms of report, graphs, etc.

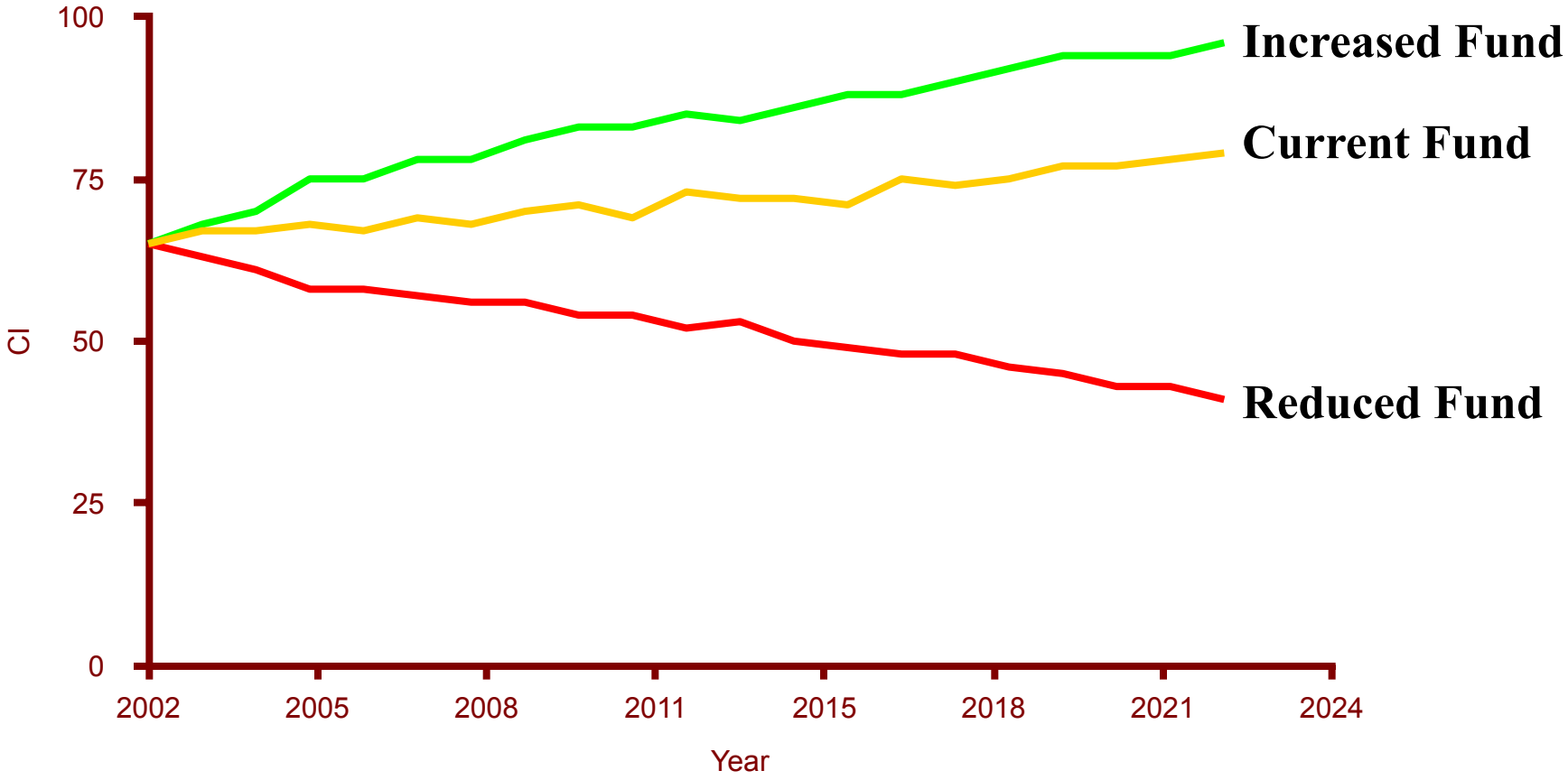
Funding Decisions

- Funding decisions controlled by non-engineers (politicians)
- Public works spends (cost-effectively)
- Public works staff must explain effects of funding recommendations
- Impact analysis is the connection of PMS to the budget process

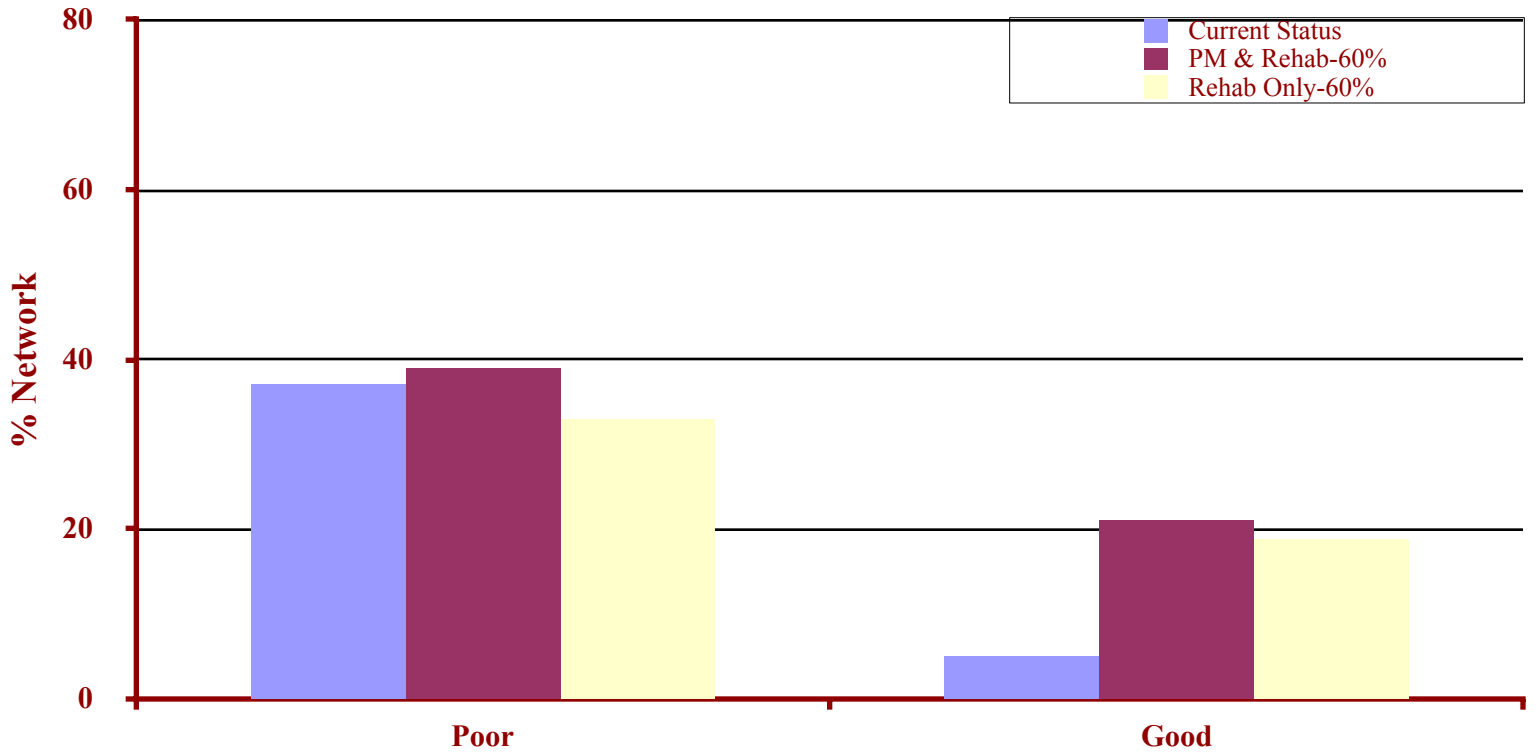
Impact of Funding Decisions

- Future facility/network condition
- Future fund needs
- Segments with deferred needs
- Segments with stop-gap treatments
- Remaining life of segments & system
- User costs
- Other impacts

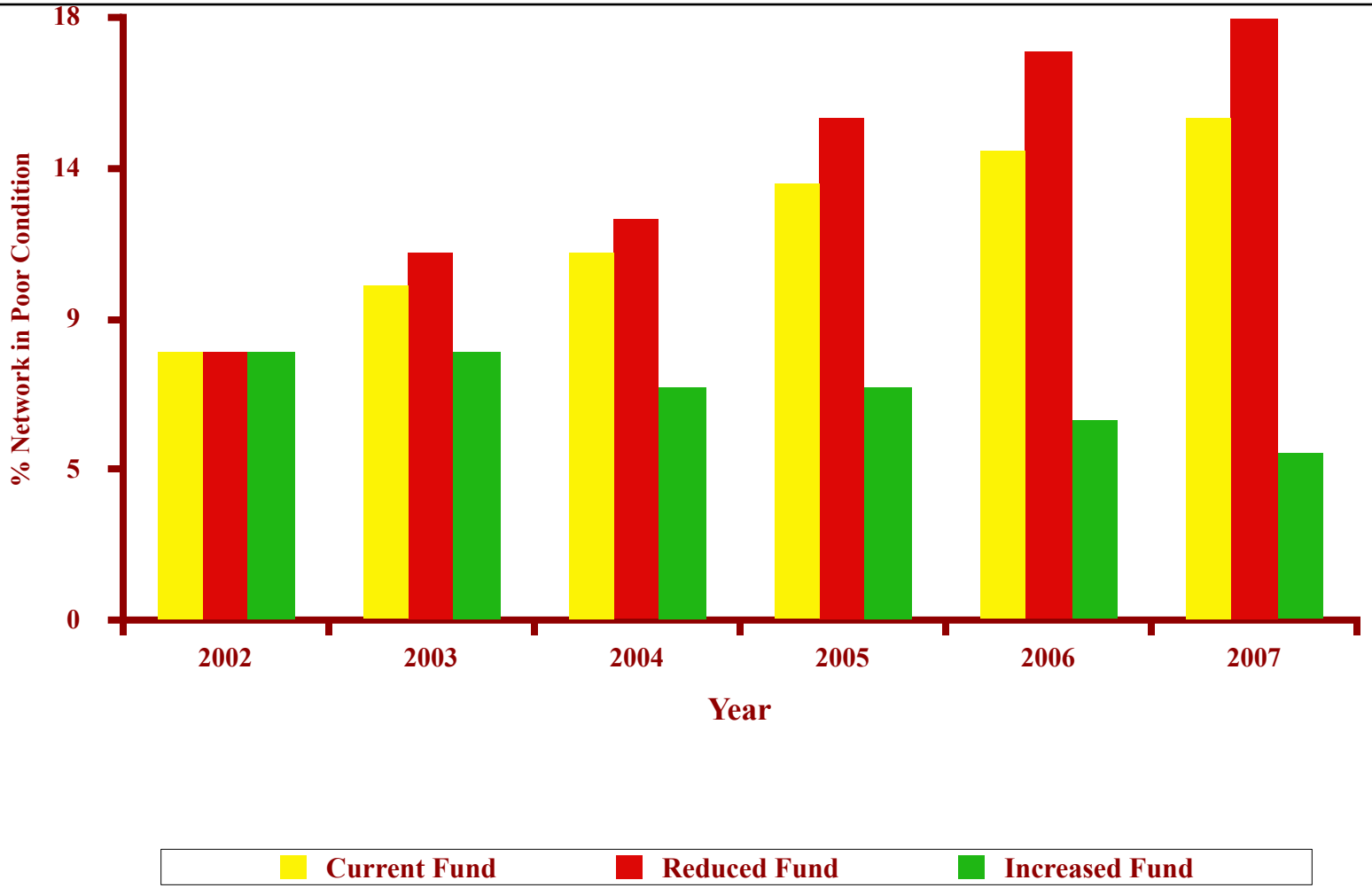
Projected Condition



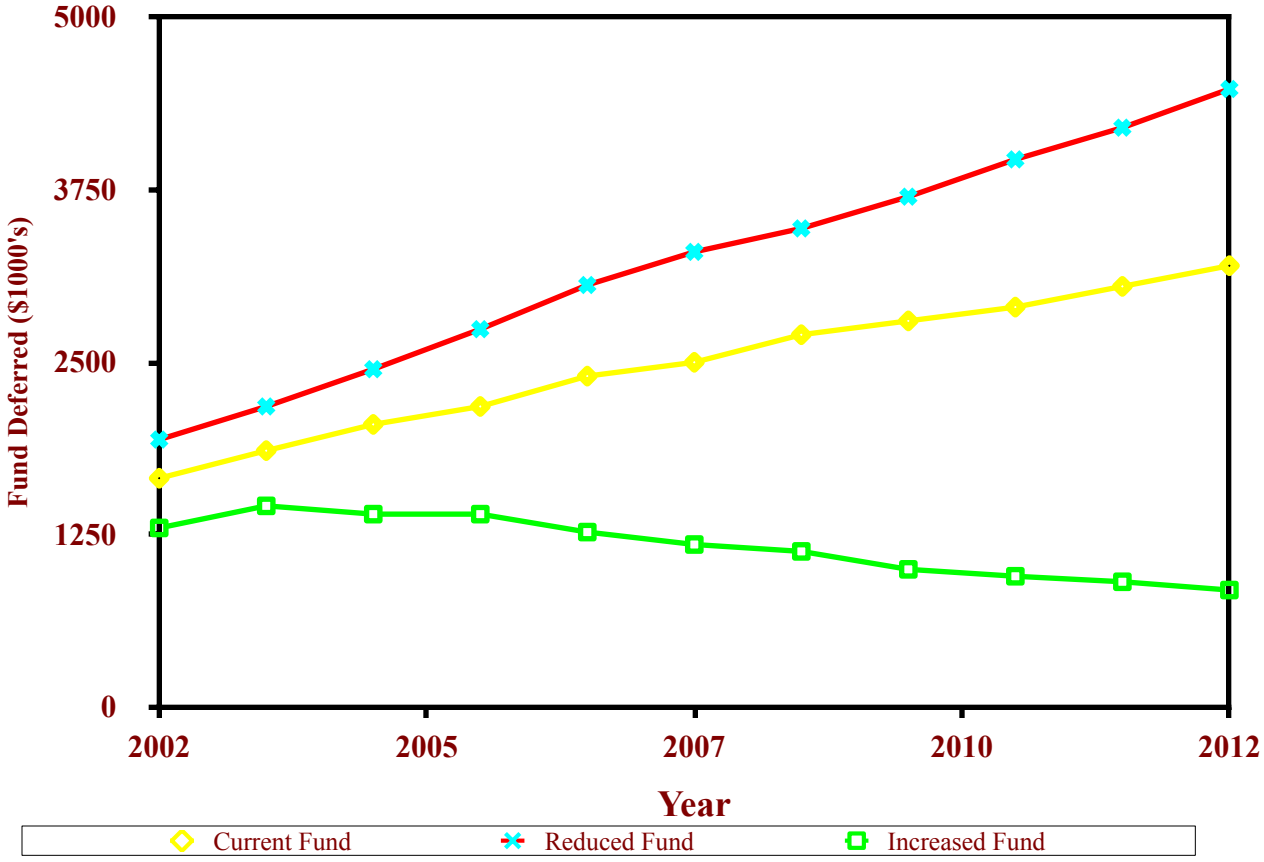
Impact of PM on Average CI



Poor Condition Category

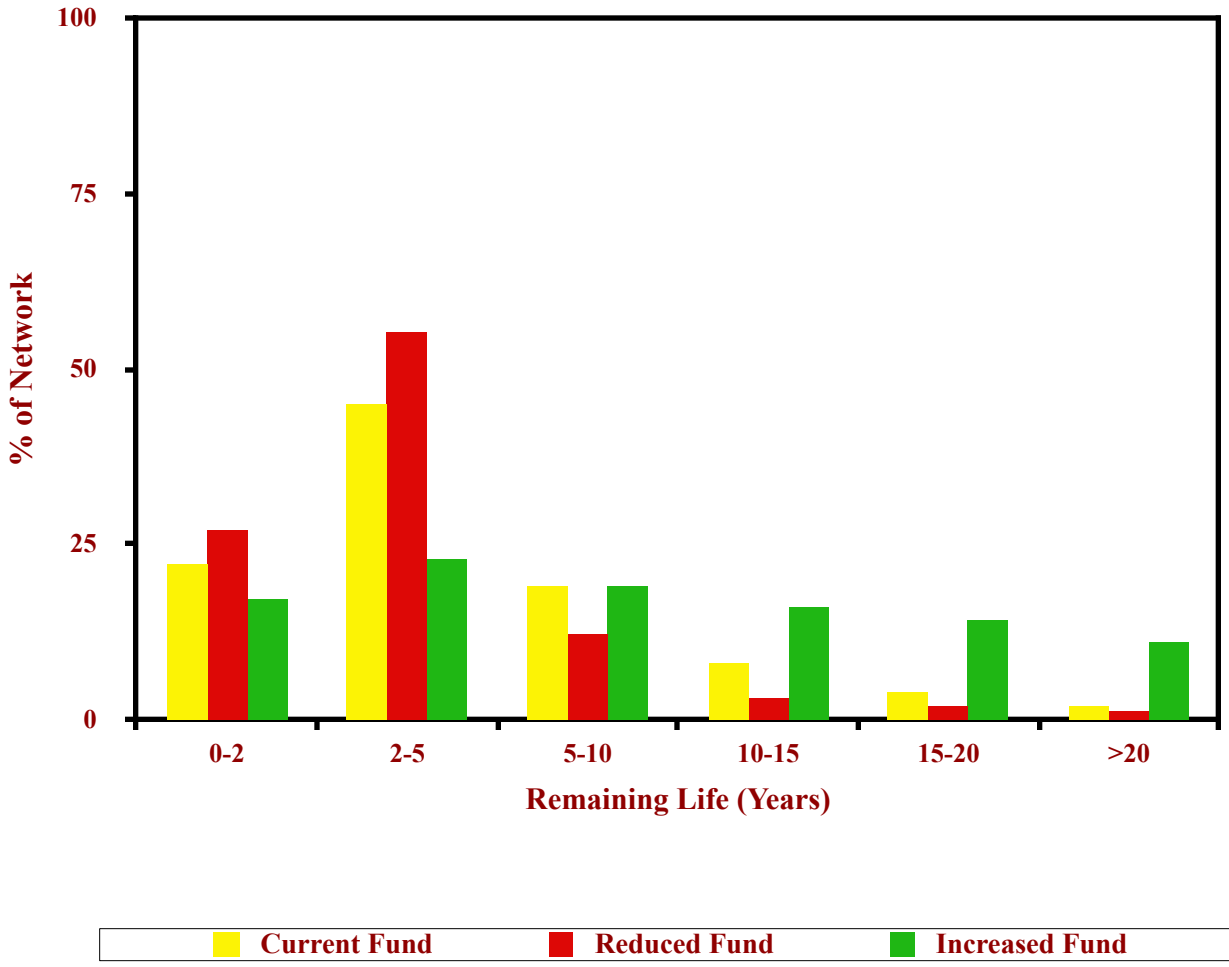


Deferred Fund Needs



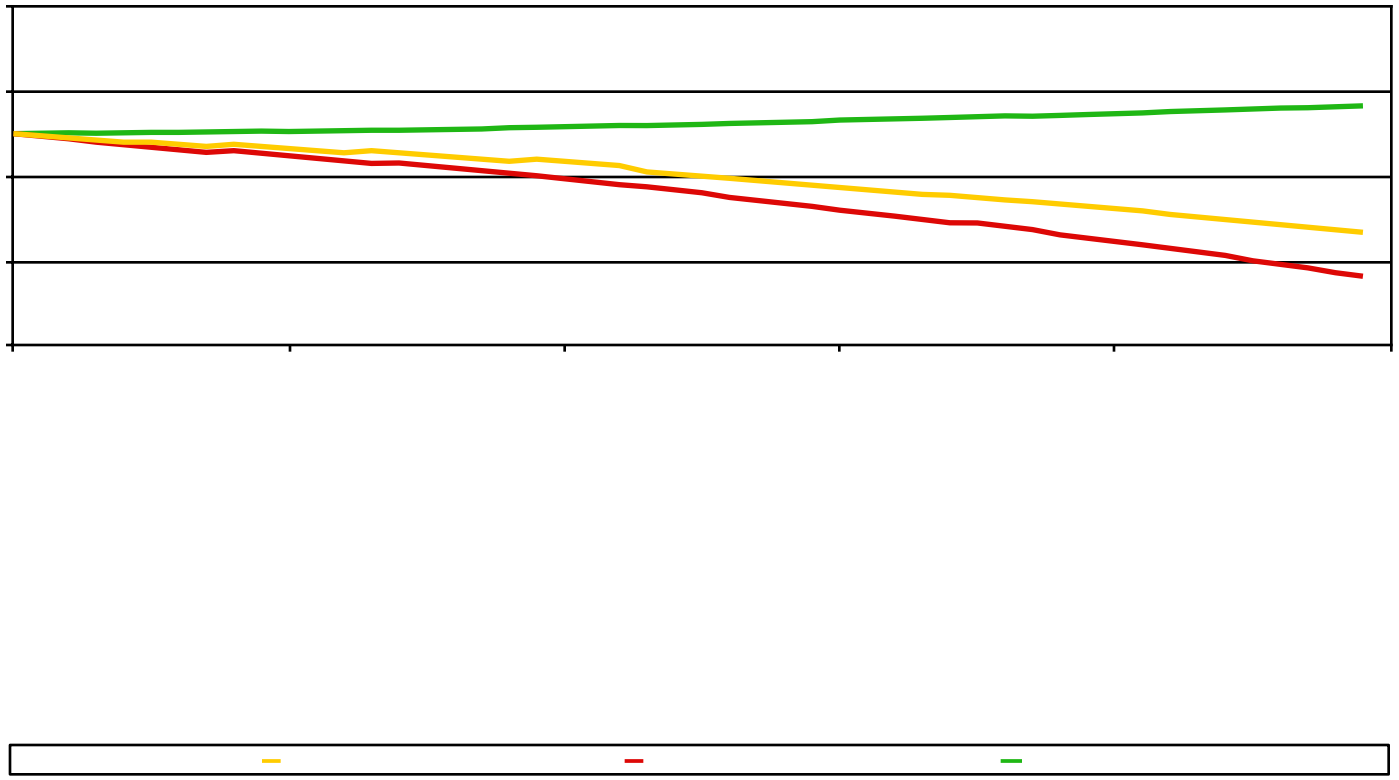
Remaining Life Definition

Large Amount of Short Remaining Life



Asset Value Calculation

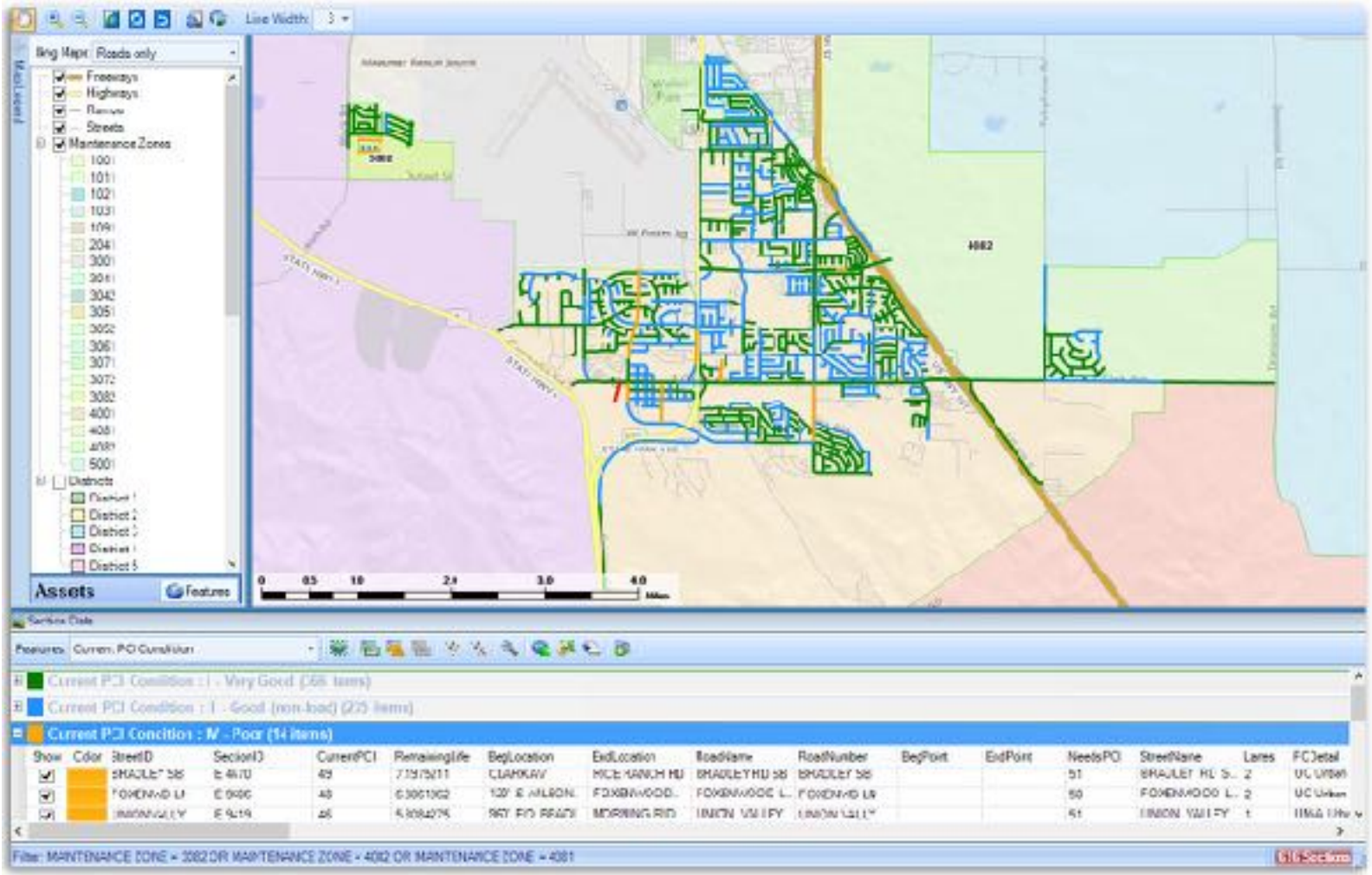
Projected Change in Asset Value



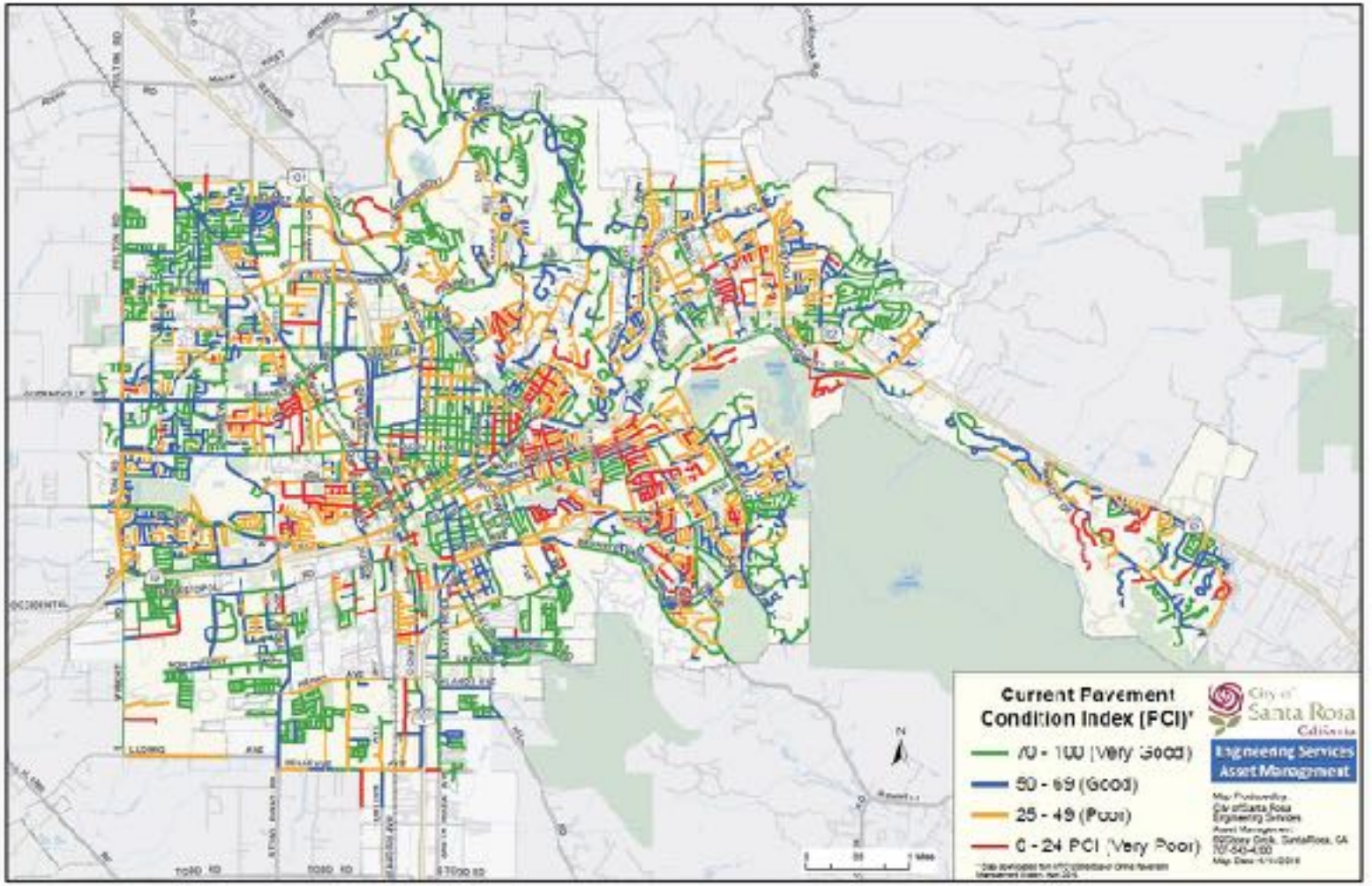
GIS

- Typical PMS has GIS or export data to in-house GIS
- Produce map-based reports to communicate with
  - Agency personnel
  - Funding authorities
  - Citizens

GIS Based Reports



Street Condition Map



Funding Decisions

- Funding decisions controlled by non-engineers (politicians)
- Public works spends (cost-effectively)
- Public works staff must explain effects of funding recommendations
- Impact analysis is the connection of PMS to the budget process

Network Level Analysis

- Budget has been established and it does not match what had been established in target driving analysis?
- What are the impacts of the budget?
- Which sections are the “best candidates” for work?
- Run standard scenarios

Caution

- Network-level
  - Recommended Budget Planning Treatment
- Project Selection-level
  - Better Definition of Treatment, Costs, & Constraints
- Project-level
  - Used to Define Best Treatment & Final Cost Estimate

Results of Network-Level

- Maintenance and Rehabilitation Needs
  - List of Sections
  - Planning Treatment
  - Average Costs
- Prioritized Listing of Candidate Projects
- Impact of Funding Options

Project Selection-level Analysis

- Select sections for near term work from candidate sections identified network-level analysis
- Small percent of network
  - PM
  - Rehab/reconstruct

Project Selection-level Analysis

- Develop more specific treatment and improved cost estimate for sections to be funded in near term
- Consider constraints & cost elements not included in network-level analysis
- May require more data and more analysis
  - Deflection testing/structural evaluation
  - Need to address roughness

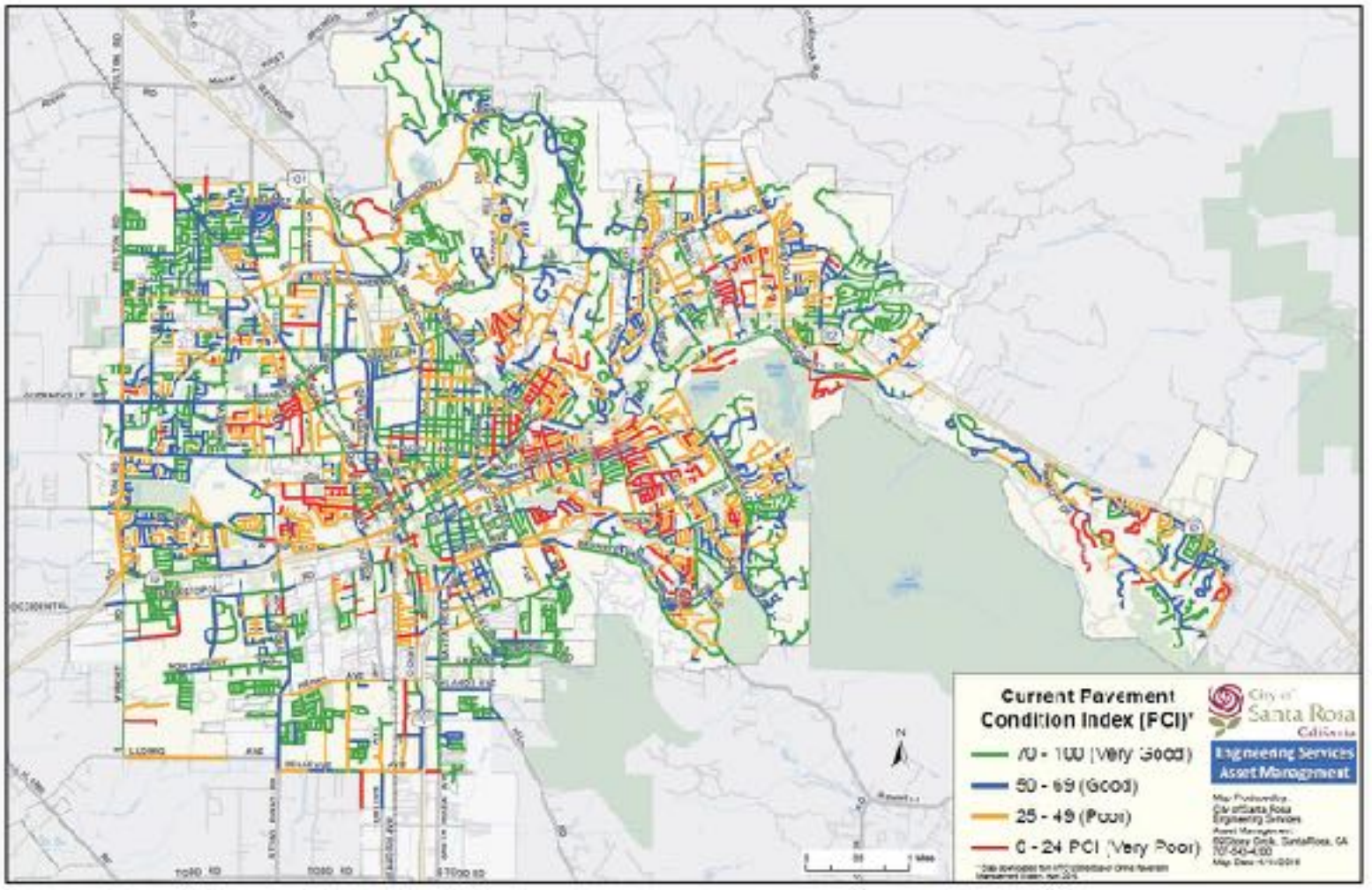
Project-Selection Level

- Software used to evaluate results
  - Most work requires staff input
  - Finalize candidate project list
    - Add & Remove projects
    - Combine projects
  - Consider constraints - other work
  - Change dates
  - Adjust limits of projects
  - Revise cost estimates

Contract package

- Set same date and treatment to a group of sections needing similar treatment over some period of time (slurry seal program)
- User must know sections
  - Set sections, treatment type and date
- Sections 001, 006, and 011

Street Condition Map



Construction package

- Set same, or similar, treatment to a group of adjacent sections
- User must know sections
  - Set sections, treatment type and date
- Sections 004, 048, & 060

Treatment over multiple years

- Large segment of street, or group of streets, will have worked sequenced over a number of years
- User must know sections
  - Set sections, treatment type and date
- Sections 028-04, 033-05, & 038-06

Conflict analysis

- Avoid treatment until after utility work completed
- User must know conflicts
  - 1. Designate date after which work is allowed
    - or
  - 2. Set treatment type and date
- Section 009 – No work until 2008

Delay work

- The section needs reconstruction, but work will be delayed until some future date (parabolic section)
- User must know sections and dates
  - 1. Designate date after which work is allowed, or
  - 2. Set treatment type and date
- Section 023 – Delay work until after 2010

Required Section

- Improve street because of agency commitment
- User must know section
  - Set treatment type and date
- Section 026 – Thick overlay 2007

Changed Treatments

- Treatments for individual sections may be designated and better defined
  - Are structural improvements needed
  - Does roughness need to be addressed
  - Will roadway noise be a consideration
  - Does treatment need to be adjusted because of adjacent section treatment needs

Rerun Short-term Scenario Analysis

- Sections identified in project-selection are identified for treatment at the time, with the treatment, and with the cost identified in project selection.
- Those sections can then be placed back into the regular assignment process.
- Those not established in project-selection are funded through the regular analysis process if the funds area adequate to address them

Caution

- This analysis will not complete designs

User Responsible

- Must have completed appropriate
  - Data collection
  - Analysis
- Must have appropriate costs
- Must make decisions about adjustments

Results of Project Selection-Level

- Prioritized Listing of Candidate Projects
- Adjusted for User Selected Sections
  - Constraints Considered
  - Construction Packages
  - Contract Packages
  - Refined & Alternative Treatments
  - Adjusted Treatment Times
  - Improved Estimates

Project-Level

- Start with project selection level list
- Develop cost-effective strategy for:
  - Original construction
    - Maintenance
    - Rehabilitation
    - Reconstruction
  - Within imposed constraints

Complete Project Level Analysis

- With level and causes of damage known
- Final selection of feasible treatments (Evaluation of more complete information)
- Preliminary design
- Life cycle cost analysis
- Final design
- Construction

Structurally Adequate

- Coring
- Deflection testing
- Structural analysis
  - With and without removing localized damage

Distress Collection

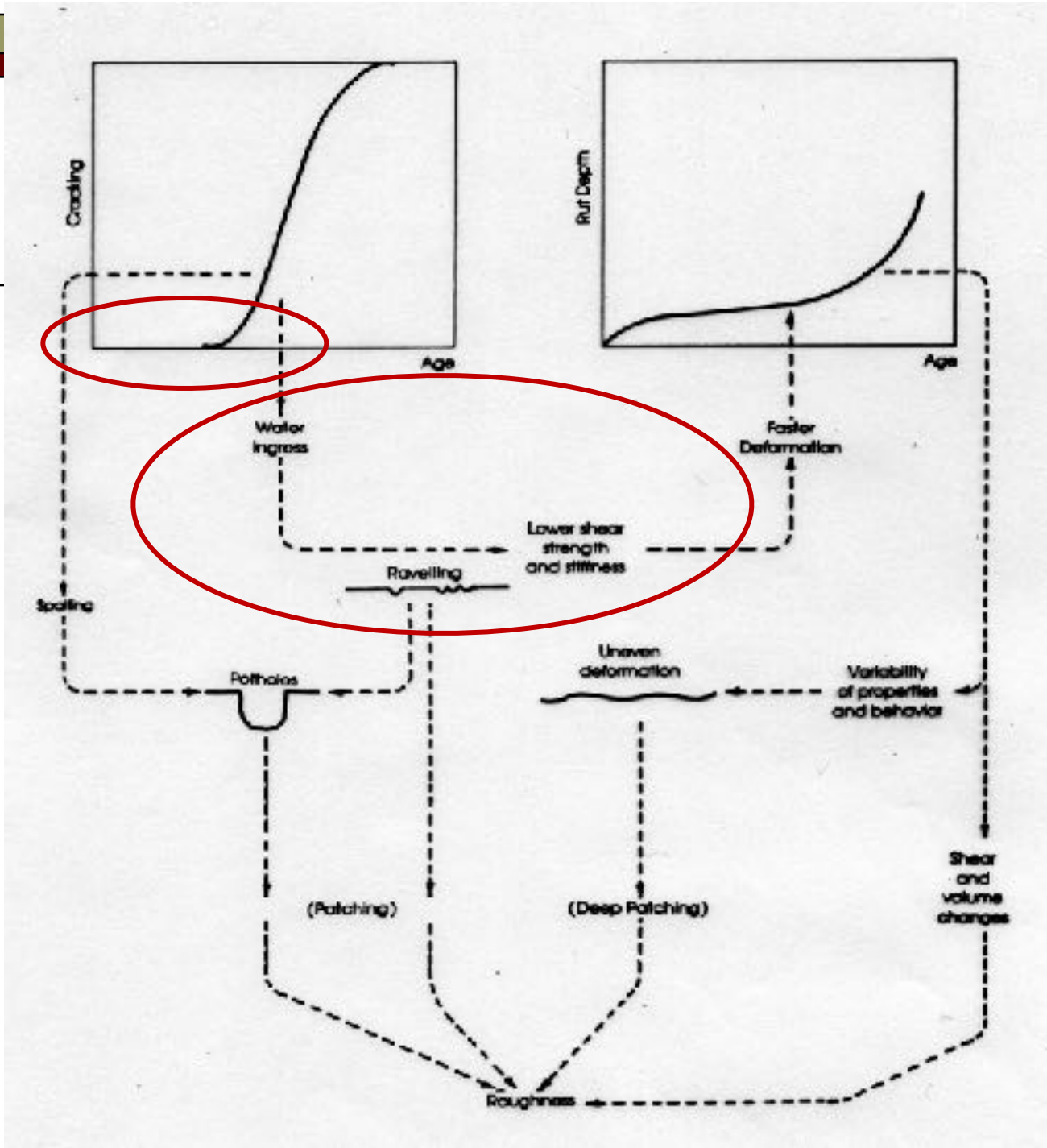
- May need distress on entire section
  - Should I do localized with a seal coat/localized with thin overlay

Preventive Maintenance

Prevent development of extensive distress

Primarily addresses environmental caused deterioration

Preserves existing structure so that it can resist traffic loadings



PM Analysis

- Often completed by Public Works Personnel
- Generally, not much structural or other analysis unless conditions warrant it

Pavements Must be Designed

- Pavements not structurally adequate to support traffic loads will fail no matter the preventive maintenance applied
- Many existing local pavements not designed
- Many agencies have a large backlog of more extensive/expensive work

Project-Level Analysis

- Used to determine the best treatment and to develop final cost estimates for each individual segment
- Requires more detailed data and more extensive analysis
- Some help from software
  - Run Analysis with Selected Projects

Structurally Inadequate?

- Overlay or other strengthening approach required
  - More later
- Reconstruction - remove & replace
  - Use new design procedure
- Overlay - add additional surface layer
  - Use overlay design procedure
  - Use in-place material property values for layers left in place

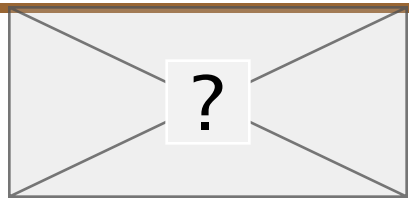
Typical Flexible Pavement Layers

AC

Base

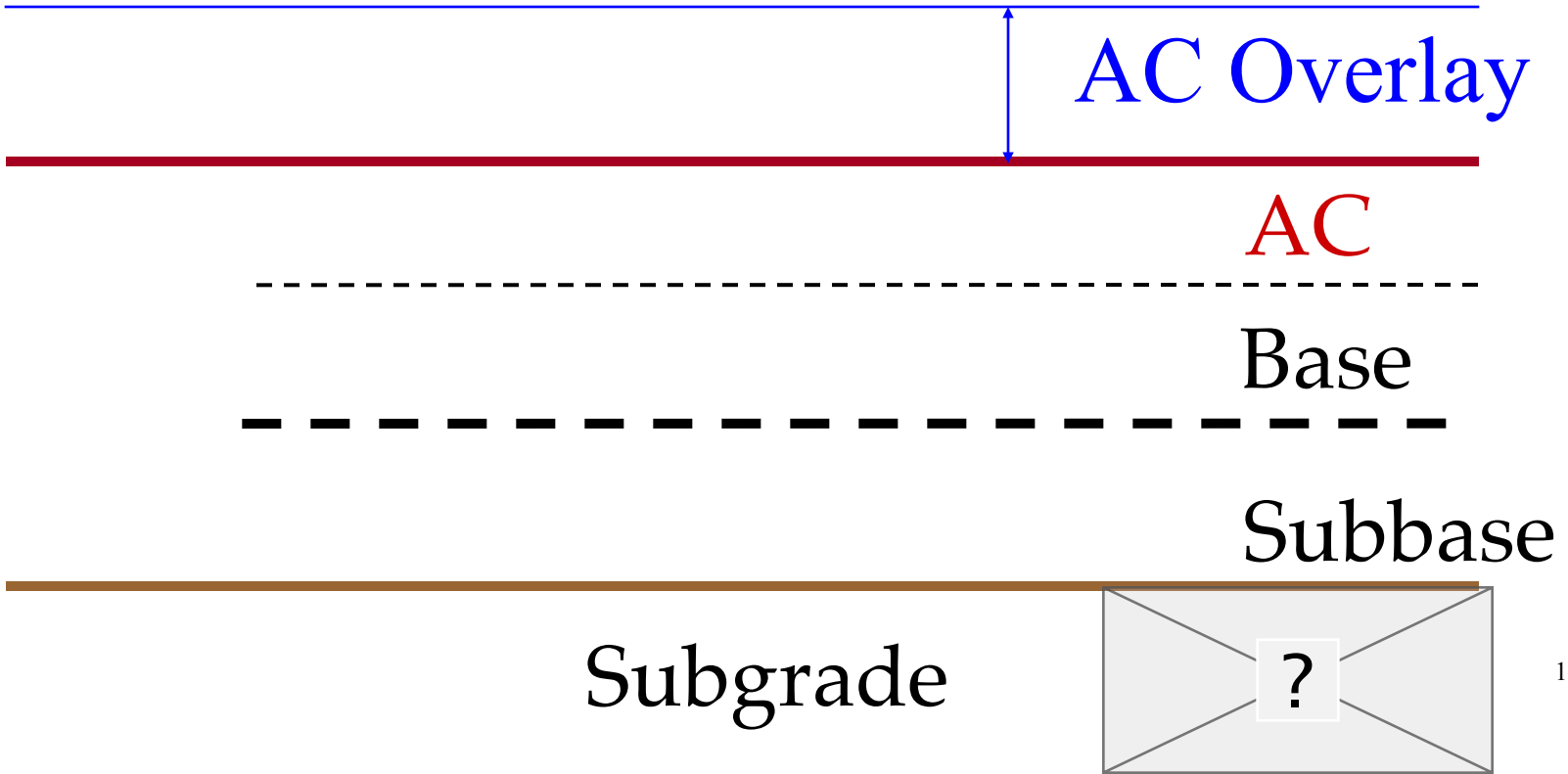
Subbase

Subgrade



Overlay

Add Layer Above
Existing Pavement Layers



Properties

- Typical characteristics
  - Dense graded HMA
  - Rubberized Hot Mix Asphalt (RHMA)
  - Applied to flexible or rigid surface
  - 0.1 to 0.75 ft (25 to 225 mm) thickness
- Options
  - Mill and Fill
  - Interlayers (SAMI, Fabrics, etc.)

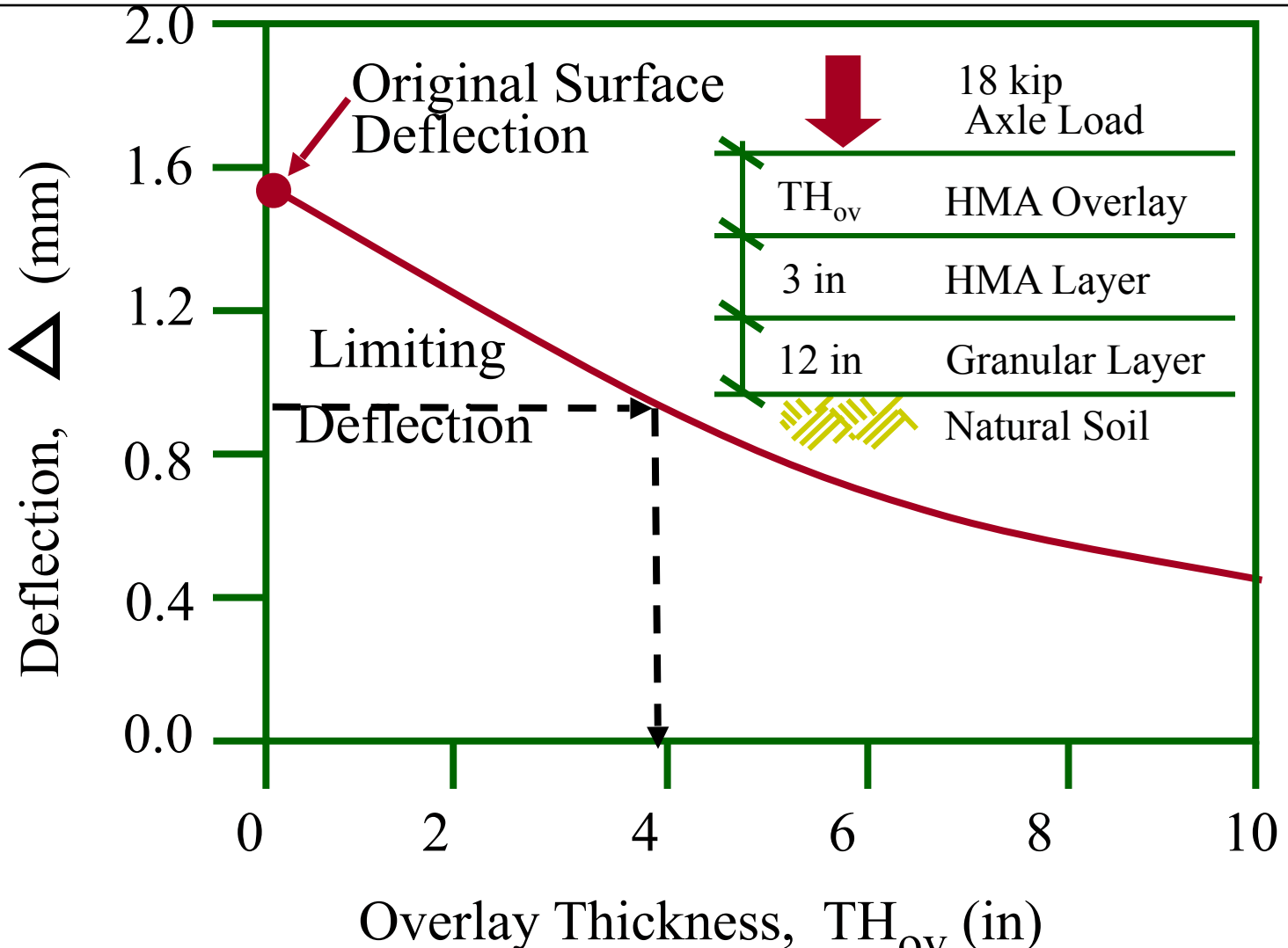
Purpose and Applications

- Improve
  - Structural capacities (structural overlay)
  - Functional characteristics (non-structural overlay)
- Select approach based on pavement conditions at time of overlay

Deflection Approach to Overlay Design

- Determine deflection needed to carry current and future traffic (Limiting Deflection)
- Determine current deflection
- Find added asphalt thickness required to reduce deflection to Limiting Deflection

CALTRANS Deflection Approach



Design Approach

- Follow local design method
  - WSDOT Pavement Policy – Sep 2018
  - ODOT Pavement Design Guide
  - ITD Roadway Design Manual
  - NTD Road Design Guide
- Most rehabilitation/reconstruction designed by:
  - Agency engineers
  - Consulting engineers under contract

Selecting Appropriate Treatments

- Engineering knowledge & Engineering economics
- Life Cycle Cost Analysis (LCCA)
  - Uses economic principles to compare investment in competing treatments & strategies
  - Among candidate treatments for a specific segment type
  - Determine which is generally most cost effective
- Based on historical data for similar work

Project-Level Results

- Cost-effective design for:
  - Original construction
  - Maintenance (PM & Preservation)
  - Rehabilitation
  - Reconstruction
- Within imposed constraints
- For each selected section

Following Design

- Construction
  - Monitoring and reporting
  - Recording work and important information from construction
- Performance
  - Monitoring

Network-Level Activities

- Inventory
- Condition Assessment
- Determination of Needed Work & Funds
- Identification of Candidate Projects
- Determination of Impacts of Funding Alternatives
- **Upkeep & Feedback**

Upkeep

- Update inventory data based on work completed
- Periodically re-inspect pavements

- **How often do you think distress survey should be done?**

Feedback System

- Accuracy of past estimates
  - Treatments applied
  - Cost of treatments applied
- Improve future estimates based on observed performance
  - Improve condition projections

Update For Work Completed

- Computer does not know work completed until data entered
- Will recommend work on wrong projects unless data updated

Update Condition Information

- State or GASB requirements
- Inspect arterials/collectors once every 2 years?

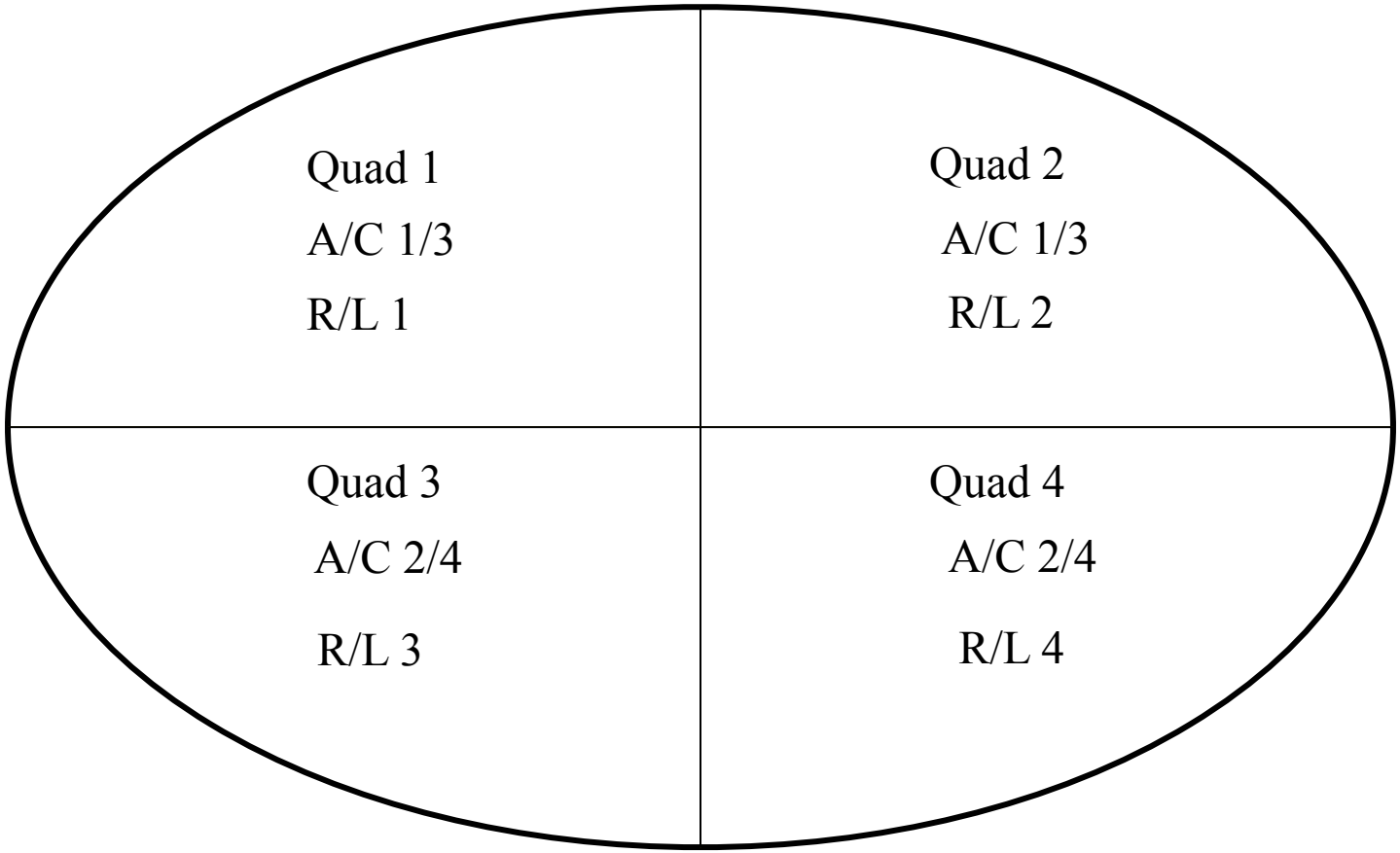
How to Select Sections for Reinspection

- Rate of deterioration
- Sections in designated area
- Consider not Inspecting those with Recent (less than 1 year old) Surface Seals

Distributed Inspection

- Year 1
  - Inspect all arterial & collector sections in north half
  - Inspect all residential/local & others in north-east quadrant
- Year 2
  - Inspect all arterial & collector sections in south half
  - Inspect all residential/local & others in south-east quadrant
- Year 3
  - Inspect all arterial & collector sections in north half
  - Inspect all residential/local & others in north-west quadrant
- Year 4
  - Inspect all arterial & collector sections in south half
  - Inspect all residential/local & others in south-west quadrant

Reinspection by Quadrant



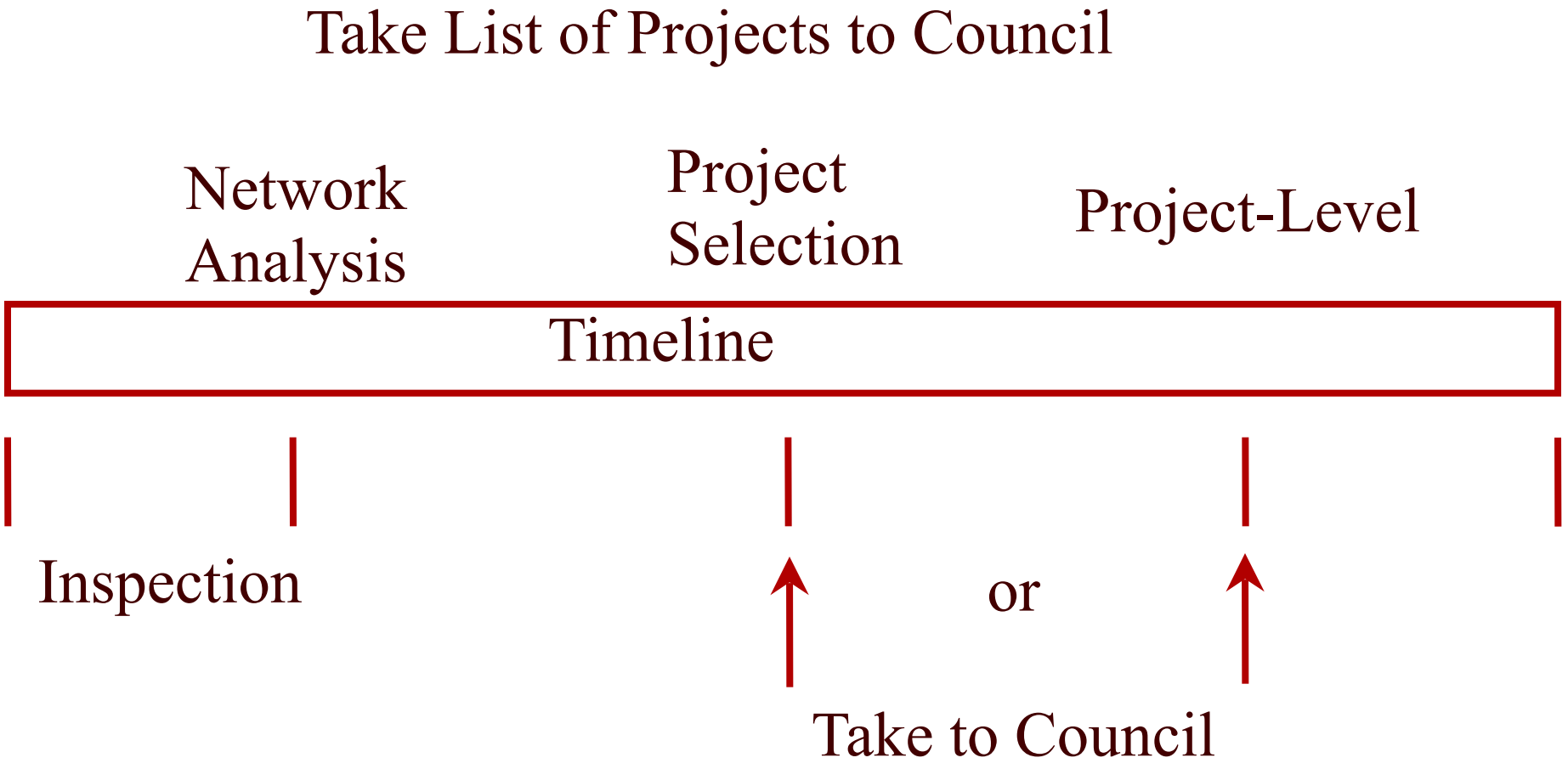
Concentrated Inspection

- Year 1
  - Inspect all arterial & collector sections
  - Inspect all residential/local & others in north half
- Year 3
  - Inspect all arterial & collector sections
  - Inspect all residential/local & others in south half

Training

- For all affected by PMS
  - At several levels
  - Upper management
- PMS training for
  - Basic concepts
  - Distress
  - Software use
  - Analysis

Timing of Analysis Actions



Questions?

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