

Pavement Management Systems



PMS

**PAVEMENT MANAGEMENT SYSTEMS
OVERVIEW**

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PMS CONCEPTS

DISCUSSION TOPICS

- ✓ DEFINITION OF PM AND PMS
- ✓ PMS SUBSYSTEMS
- ✓ NETWORK & PROJECT LEVEL PMS
- ✓ PAVEMENT EVALUATION
- ✓ PERFORMANCE AND ECONOMIC ANALYSES
- ✓ DATA BASES/DATA MANAGEMENT

Pavement Engineering

Pavement Materials	Classification, quality assurance testing (specifications), material design
Pavement Design	Design of Structural layers for New Pavements and Pavement Rehabilitation Assess in-situ pavement material properties and layer thickness
Pavement Construction	Construction practices of New Pavements and Pavement Rehabilitation including specification development and quality assurance
Pavement Management	Monitoring Post-construction condition, timing preventive maintenance and rehabilitation treatments, and economic analysis of alternatives
Pavement Research	Research to improve all of the above



PAVEMENT MANAGEMENT SYSTEM Overview

DEFINITIONS

PAVEMENT MANAGEMENT

"Pavement Management is a program for improving the quality and performance of pavements and minimizing costs through good management practices"

DEFINITIONS

PAVEMENT MANAGEMENT SYSTEMS

"A Pavement Management System is a set of defined procedures for collecting, analyzing, maintaining, and reporting pavement data, to assist the decision makers in finding optimum strategies for maintaining pavements in serviceable condition over a given period of time for the least cost."



PAVEMENT MANAGEMENT SYSTEM

Overview

A Pavement Management System (PMS) is designed to provide objective information and useful data for analysis so that road managers can make more consistent, cost-effective, and defensible decisions related to the preservation of a pavement network.

While a PMS cannot make final decisions, it can provide the basis for an informed understanding of the possible consequences of alternative decisions.

A PMS does NOT make decisions, Managers DO!

PMS LEVELS

NETWORK

BIRD'S EYE VIEW OF NETWORK PAVEMENTS AS A WHOLE.

- **STATEWIDE PAVEMENT CONDITION SUMMARY**
- **BUDGET ESTIMATE**
- **PERFORMANCE PREDICTION**

PROJECT

ASSIST DESIGNERS IN CONSTRUCTING, MAINTAINING, OR REHABILITATING A SECTION OF ROADWAY.

- **PREVENTIVE MAINTENANCE**
- **RESURFACING OR RECONSTRUCTION**
- **TREATMENTS OPTIONS ALONG THE PROJECT**

PMS SUBSYSTEMS

-PMS DATA

- ***Inventory***
- ***Condition - Pavement Evaluation***
- ***History – Initial, PM, RM, Rehab, Reconstruction***
- ***Traffic***
- ***Costs***

-MODELING - ANALYSIS

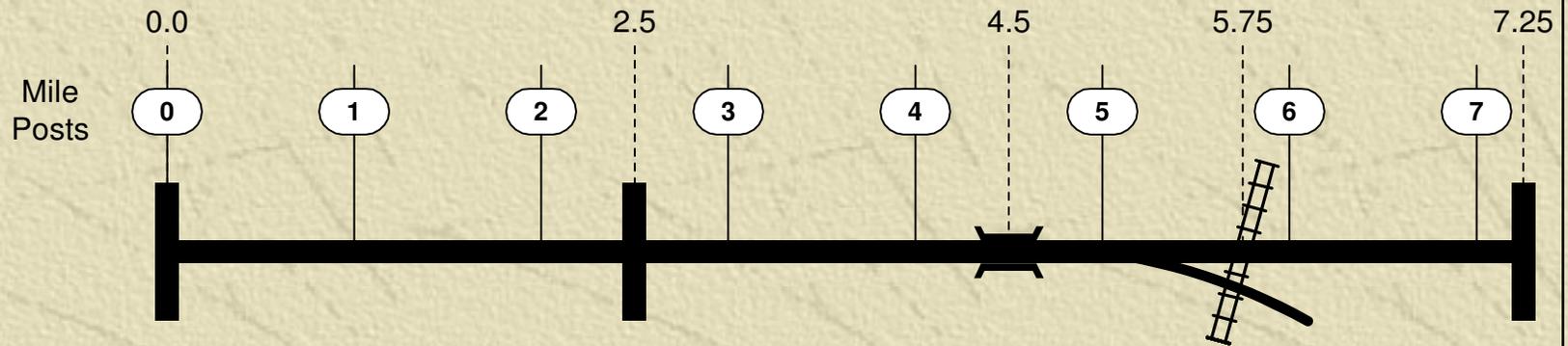
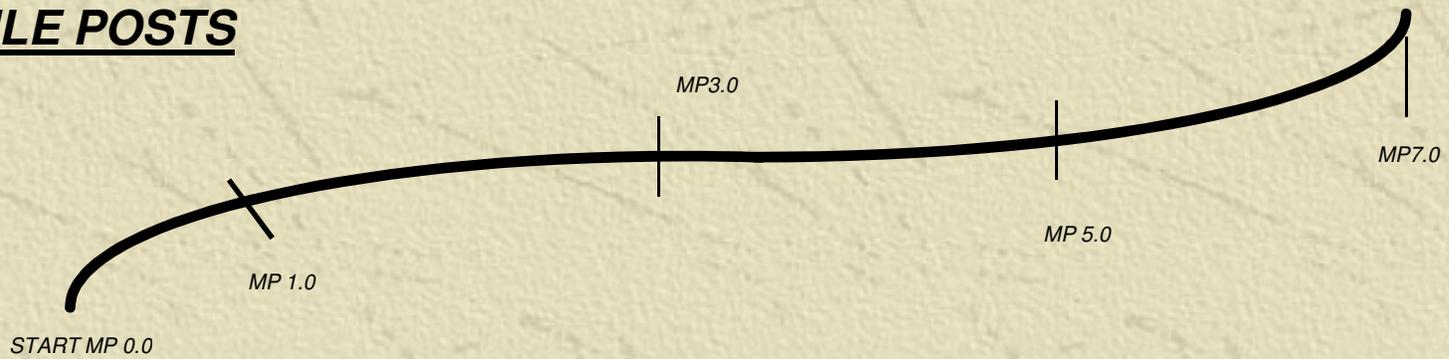
- ***Serviceability Rating***
- ***Performance Predictions***
- ***Economic Analyses-Budgeting / Programming***

-DATA MANAGEMENT

- ***Relational Databases***
- ***Report Generation***

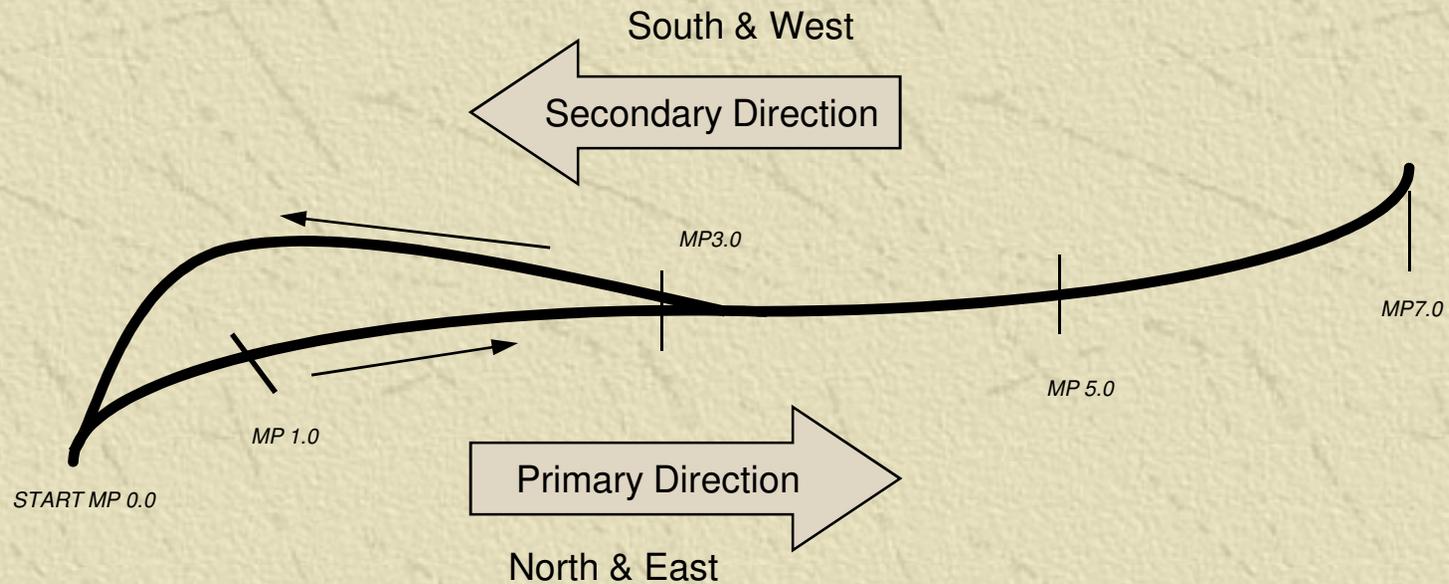
REFERENCE SYSTEMS

MILE POSTS



REFERENCE SYSTEMS

MILE POSTS



Length of Route in Primary Direction may be different than that in the Secondary Direction.



DATA COLLECTION

PMS DATA COLLECTION

DATA TYPES

- ***INVENTORY,***
- ***PAVEMENT CONDITION***
- ***TRAFFIC/LOADS,***
- ***COSTS - Construction, PM, RM, Rehab, Reconstruction***
- ***HISTORY – Initial Const, PM, RM, Rehab, Reconstruction***
(Last Treatment)



Example Inventory Data

- **Route Number**
- **Route Type (Interstate, US, NJ)**
- **Functional Class**
- **Length**
- **Divided/Undivided Route Section**
- **Pavement Type**
- **Number of Lanes and Widths**
- **Shoulder Type and Width**
- **County**
- **Legislative District**

PMS DATA COLLECTION

PAVEMENT CONDITION EVALUATION

- **PAVEMENT ROUGHNESS or RIDE QUALITY**
- **SURFACE DISTRESS**
- **RUTTING**
- **SKID RESISTANCE**
- **STRUCTURAL CAPACITY**



Need for Annual Condition Surveys

Ride Quality, Surface Distress, Rutting, Friction

- **Evaluating current condition of pavement**
- **Determining rates of deterioration**
- **Project future conditions to determine current and future maintenance & rehabilitation needs**
- **Determining future cost of repairs**

Pavement Condition Survey Equipment

Profiler

roughness, distress,
rutting, **noise**,
pavement cracking



**Structural
Capacity**

Skid Trailer

**Pavement
friction**



FWD



GPR

**Layer
Thickness**



Equipment Demo

Last Day

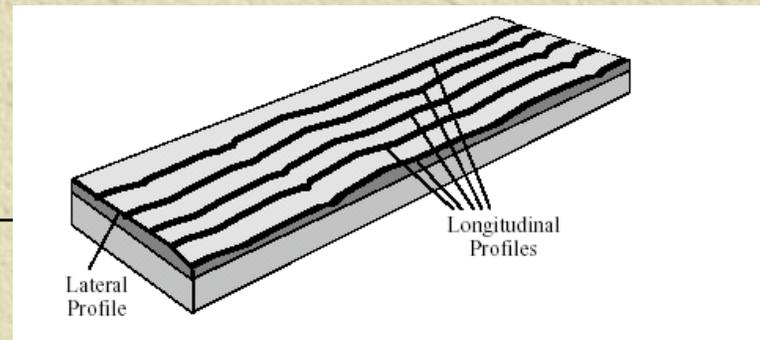
PAVEMENT CONDITION EVALUATION

ROAD ROUGHNESS

"ROAD ROUGHNESS IS THE IRREGULARITIES IN THE PAVEMENT SURFACE AFFECTING USER COMFORT AND SAFETY"

DUE TO VARIATIONS IN HORIZONTAL, VERTICAL, AND TRANSVERSE PROFILES

RIDE QUALITY - USER PERCEPTION OF PAVEMENT ROUGHNESS



PAVEMENT CONDITION EVALUATION

SURFACE DISTRESS

DESCRIPTION

TYPE OF DISTRESS (Cracking, Patching, Rutting)

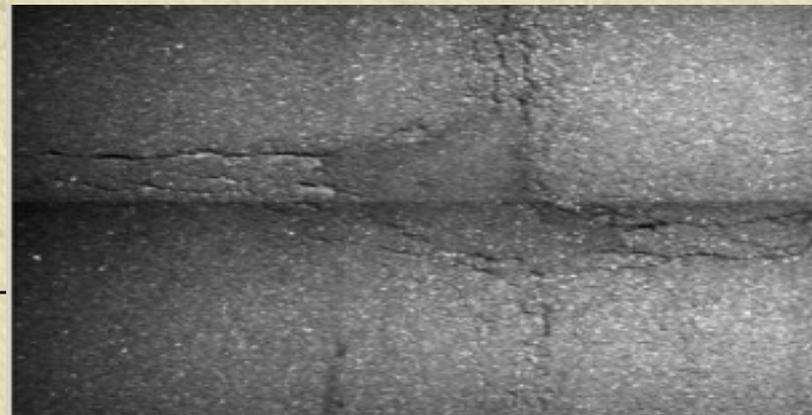
SEVERITY (Crack Width, Condition Assessment)

EXTENT (Percentage of the Pavement Length)

DATA COLLECTION

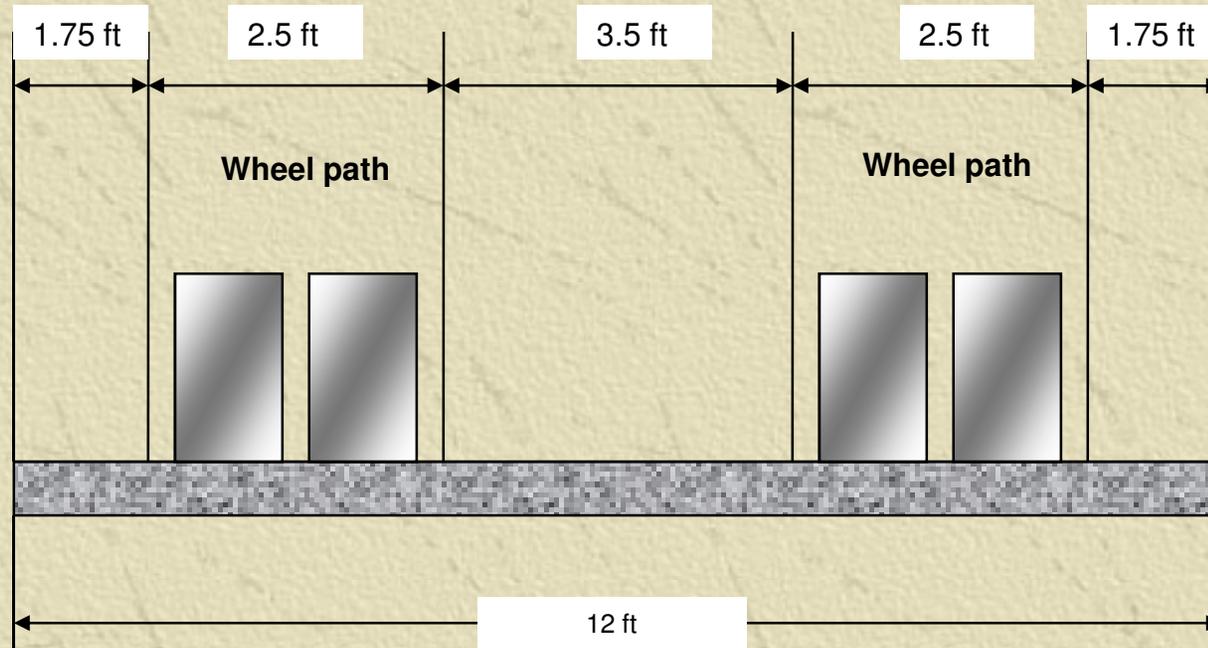
CONTINUOUS - WINDSHIELD SURVEY

(COMPUTER RATER KEYBOARD, and VIDEO)



PAVEMENT CONDITION EVALUATION

SURFACE DISTRESS



LOAD ASSOCIATED vs. Non-LOAD ASSOCIATED LOCATION

Network Level PMS "Slow" lane in each direction – 4600 directional miles

PAVEMENT CONDITION EVALUATION

SURFACE DISTRESS

BITUMINOUS/COMPOSITE PAVEMENTS

NDI

CRACKING

MULTIPLE

LOGITUDINAL

TRANSVERSE

MISCELLANEOUS

SHOULDER CONDITION

PATCH CONDITION

LDI

CRACKING

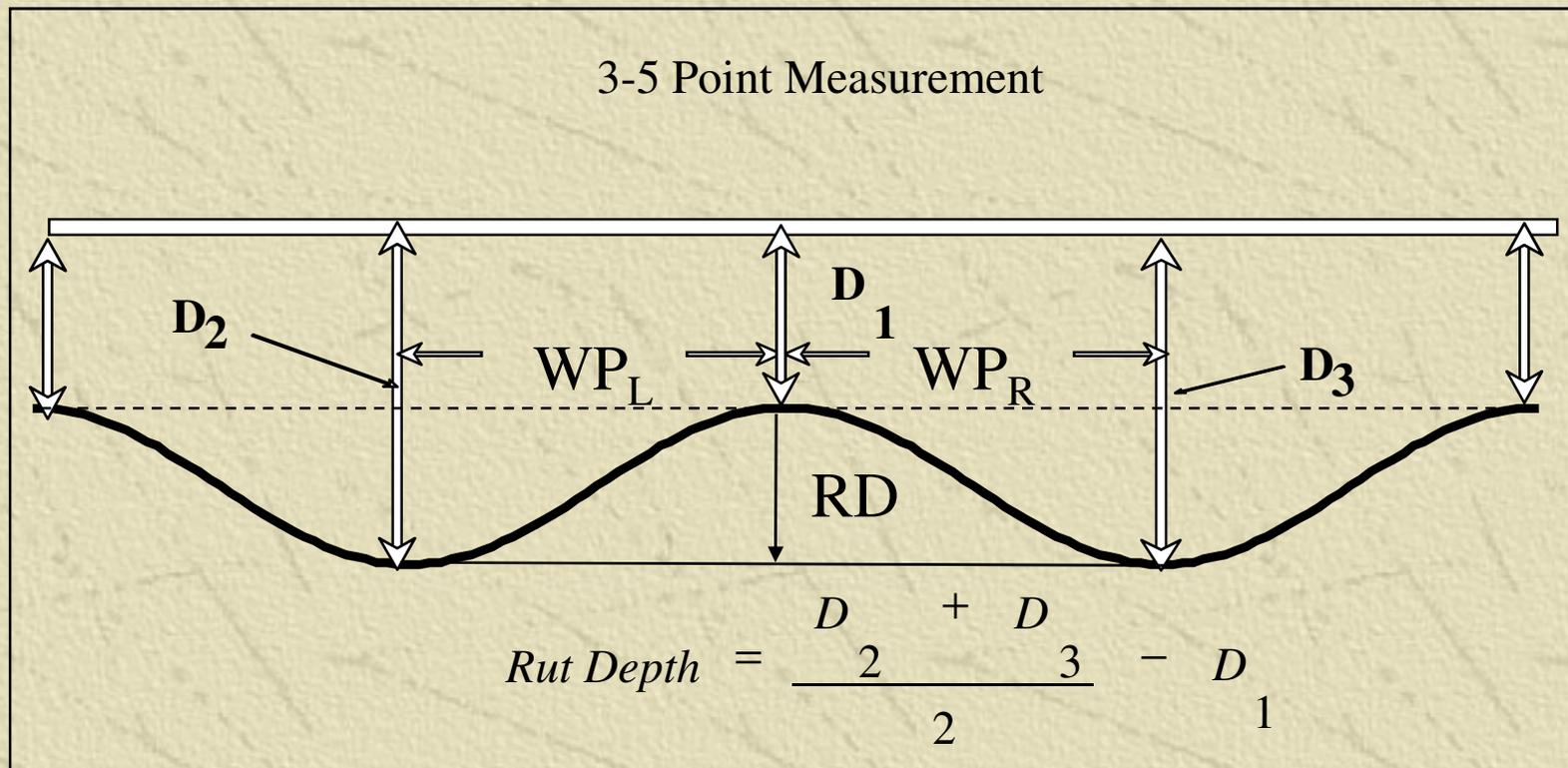
MULTIPLE

SURFACE DEFORMATION

RUTTING

Observation of condition in the other lanes

RUT DEPTH MEASUREMENT



PAVEMENT CONDITION EVALUATION

SURFACE DISTRESS CONCRETE PAVEMENTS

CRACKING

JOINT DEFECTS

JOINT SEAL DAMAGE

JOINT CONDITION

MISCELLANEOUS

PATCH CONDITION

PAVEMENT CONDITION EVALUATION

SKID RESISTANCE SAFETY

DESCRIPTION

**ASSESSMENT OF THE COEFFICIENT OF FRICTION
OF THE PAVEMENT SURFACE (BASED ON SPEED)**

DATA COLLECTION

**CONTINUOUS - ASTM E274 (LOCK WHEEL) SKID
TRAILER**



PAVEMENT CONDITION EVALUATION

STRUCTURAL LOAD CAPACITY

Project Level PMS

DESCRIPTION

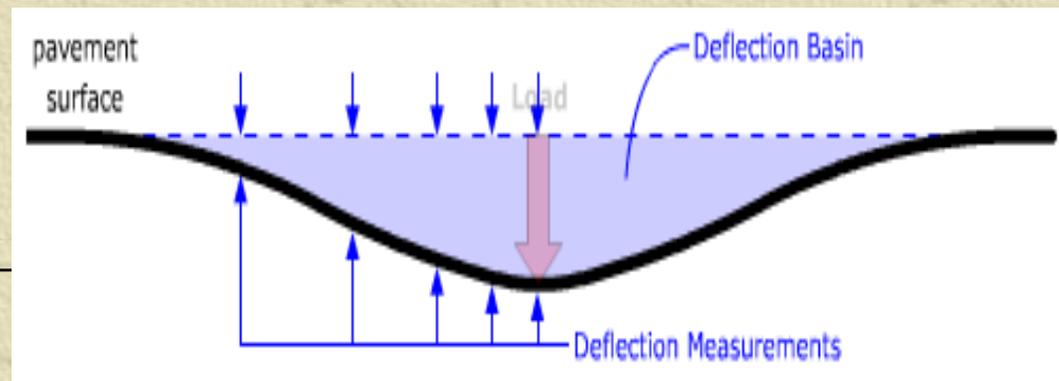
ASSESSMENT OF THE LOAD CARRYING CAPACITY OF THE PAVEMENT STRUCTURE

DATA COLLECTION

DESTRUCTIVE - CORING/BORINGS/LAB TESTS

NON-DESTRUCTIVE TEST –

- **FALLING WEIGHT DEFLECTOMETER (FWD)**
- **CONCRETE JOINT LOAD TRANSFER EFFICIENCY**
- **GROUND PENETRATING RADAR**





QUESTIONS ?



PMS

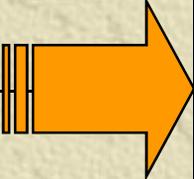
**Performance
Analyses**

Condition Surveys

Ride Quality, Surface Distress, Rutting

Pavement Indices

Pavement Wheel Path Profile	Ride Quality Index IRI
Pavement Surface Distresses	Surface Distress Index
Rutting	Average Pavement Rut Depth
Structural Capacity Deflections	Structural Capacity Index

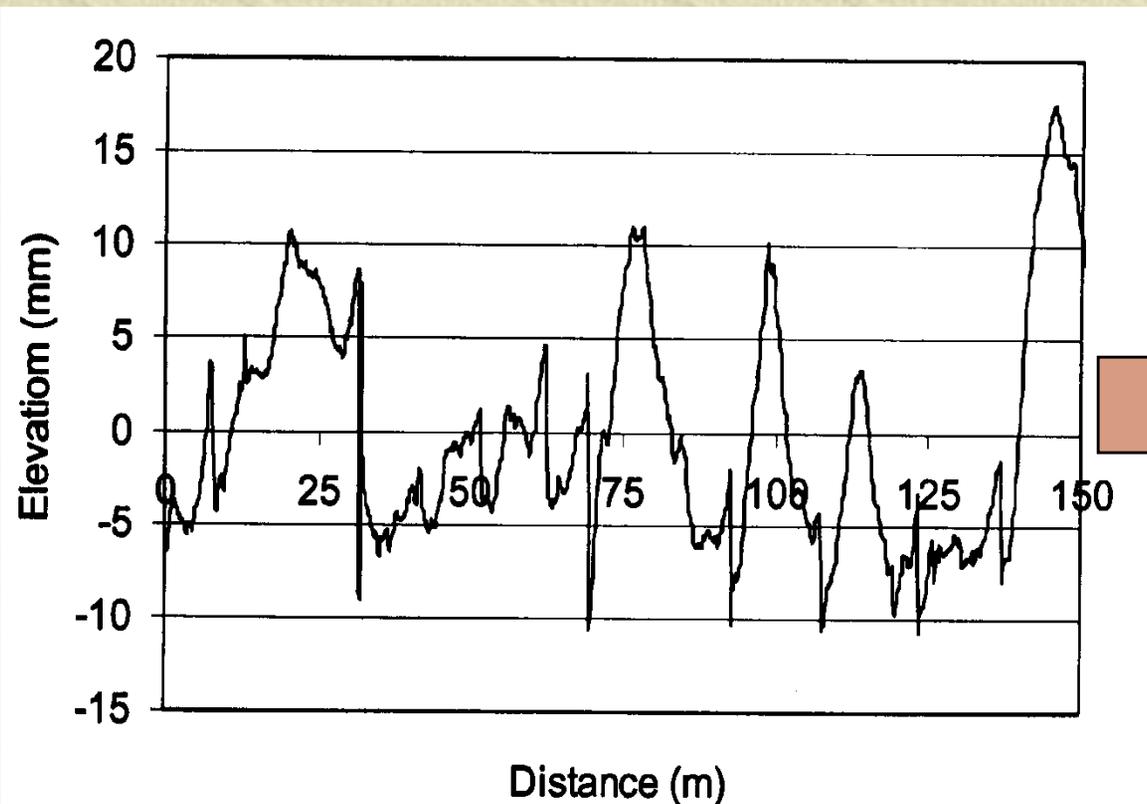


Converts collected data to single value

Need for Condition Surveys

Ride Quality Index

- Measure Pavement Wheel Path Profile(s) to assess Pavement Ride Quality
- Convert Pavement Wheel Path Profile (L&R) to Pavement Ride Quality Indices (IRI)



0.1 mile

IRI

Pavement Distress Survey

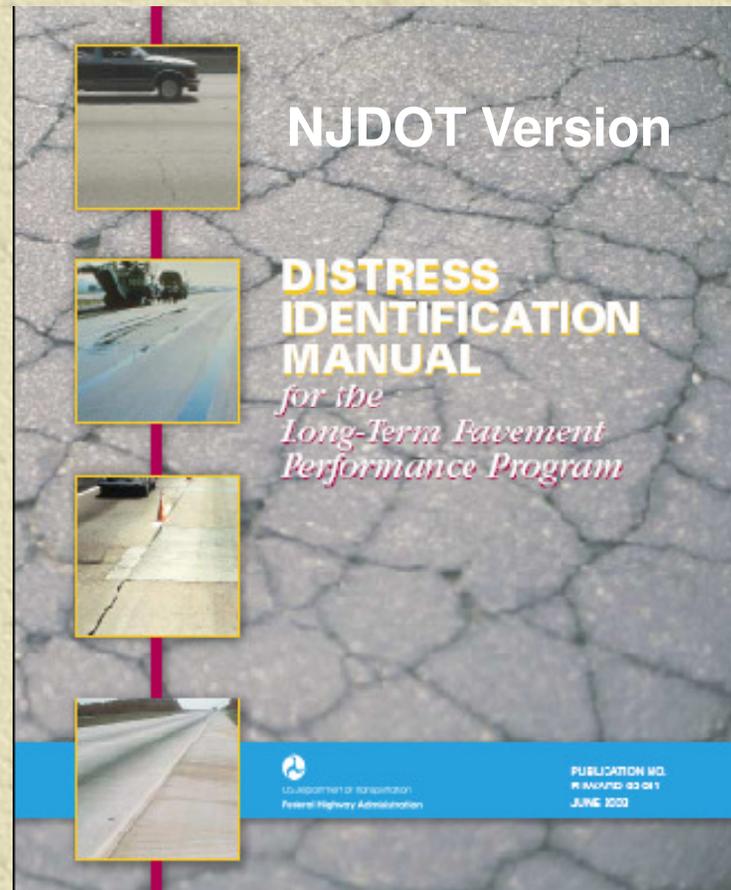
- **Type of distress (Cracking, Patching, etc)**
- **Severity (width of cracks, condition of the patch, etc.)**



- **Extent - Quantity of distress present on the pavement (percentage of length)**

Distress Identification Manual for the Long-Term Pavement Performance Program

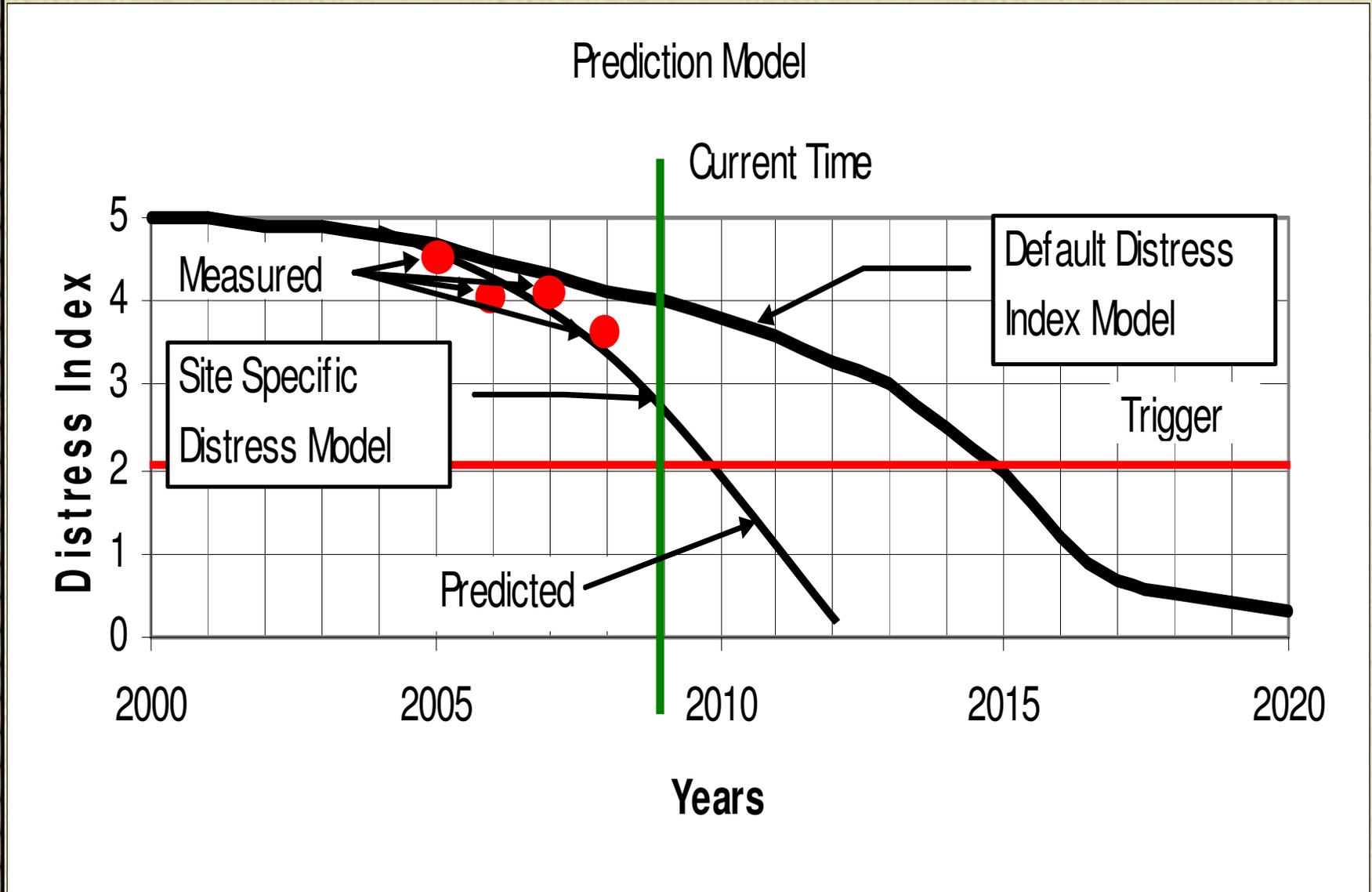
<http://www.tfhrc.gov/pavement/ltpm/reports/03031/index.htm>





Pavement Models

Pavement Performance Example





PMS

Economics

Analyses

Reporting

ANALYSES

ECONOMIC ANALYSES

Multi-Year Prioritization (MYP)

A method of allocating limited resources in an efficient and cost-effective way over a multi-year period (2-10 year's needs), through an evaluation of long-term impacts.

A PMS process or tool used to objectively identify the best combination of projects over a multi-year program.

ANALYSES

ECONOMIC ANALYSES

Multi-Year Prioritization (MYP)

Prioritization techniques use mathematical modeling tools to achieve the best combination of projects over the specified analysis period:

- Pavement performance Models predict future condition and suggest timing of needed rehab
- Projects are identified with need for PM, Minor Rehab, Major Rehab or Reconstruction
- The most effective timing for the applying the appropriate treatment are identified

ANALYSES

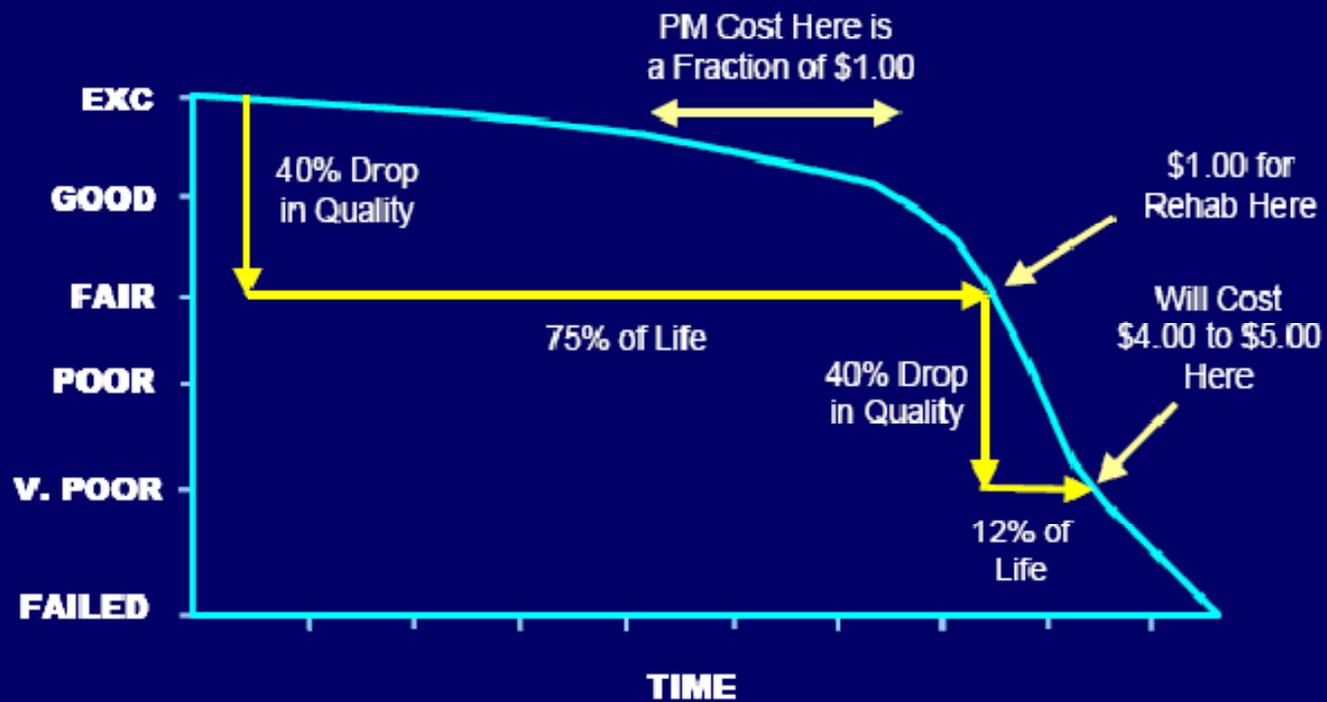
ECONOMIC ANALYSES

Benefits Provided By MYP

- Forecast future conditions
- Analyze timing options
- Evaluate effectiveness of alternative strategy
- Perform economic analyses
- Use of objective measures for prioritizing needs
- Project future budgets
- Predict the impact of each combination of projects on the network over the given analysis period

Effect of Treatment Timing on Costs

Typical Variation of Pavement Condition as a Function of Time



You never have enough fish!



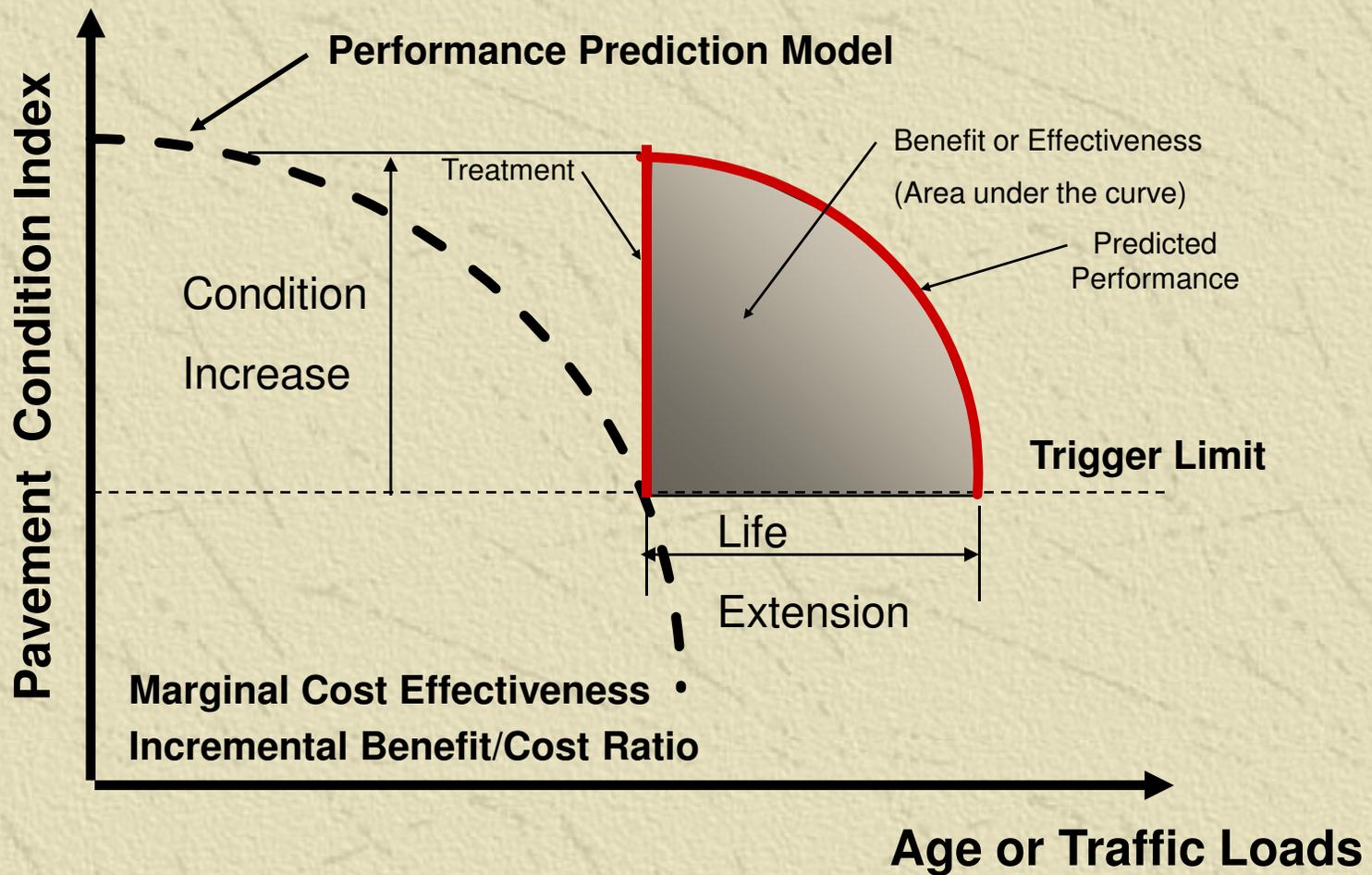


Homogeneous Analysis Sections

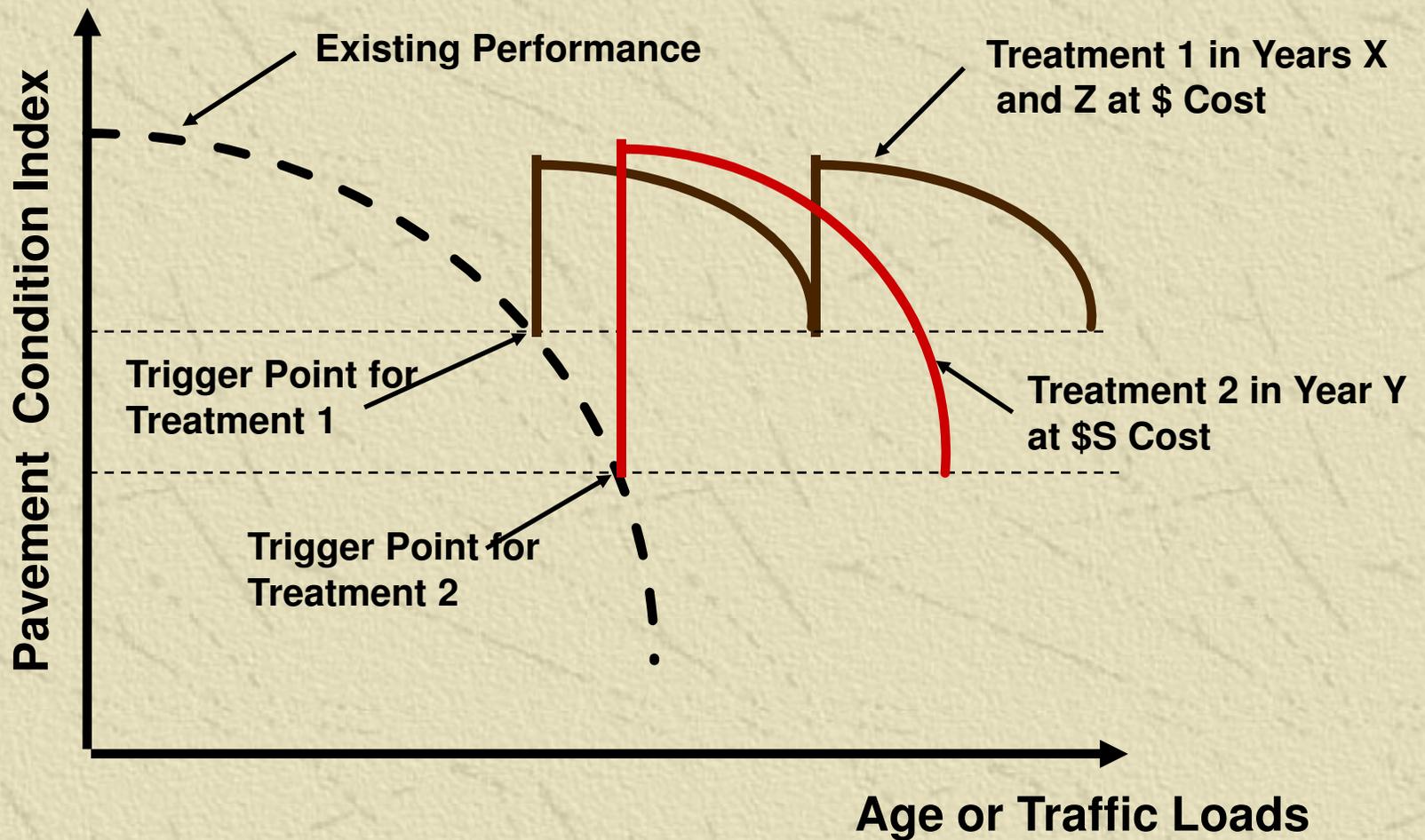
- Change in pavement type
- Change in pavement structure
- Change in traffic Volume
- Political boundaries
- **Change in pavement condition (Dynamic)**
- Construction Project limits

**Decide the overall condition, timing, costs,
and treatment type**

Treatment Options in MYP



Treatment Options in MYP



ANALYSES

ECONOMIC ANALYSES

Decision Benefits Provided By MYP

Provide answers for the questions:

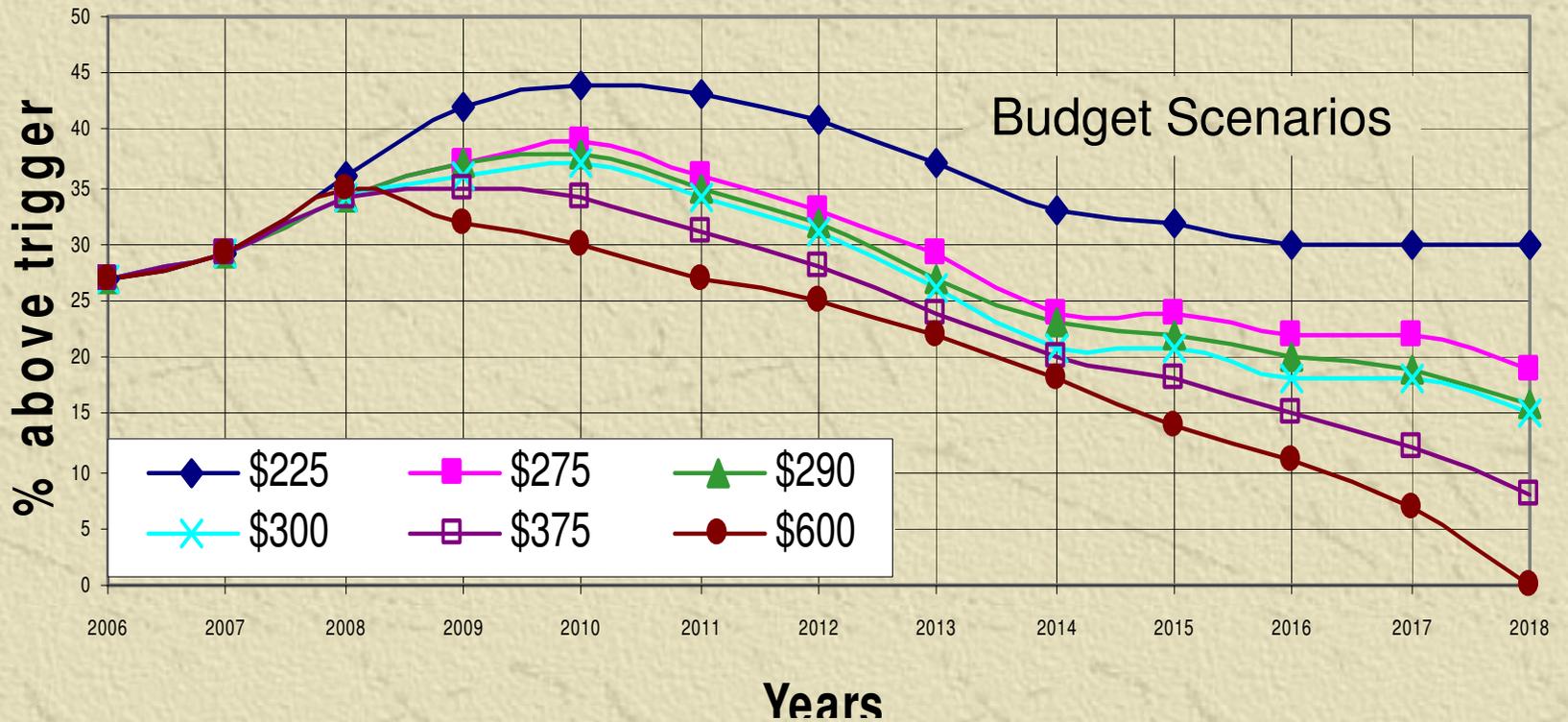
1. What condition will be reached for a given level of funding?
2. What budget is needed to reach or maintained a given level of condition?

Example Network Performance

Illustrates Policy Decisions

What are the average projected IRI for the given Budget Levels?

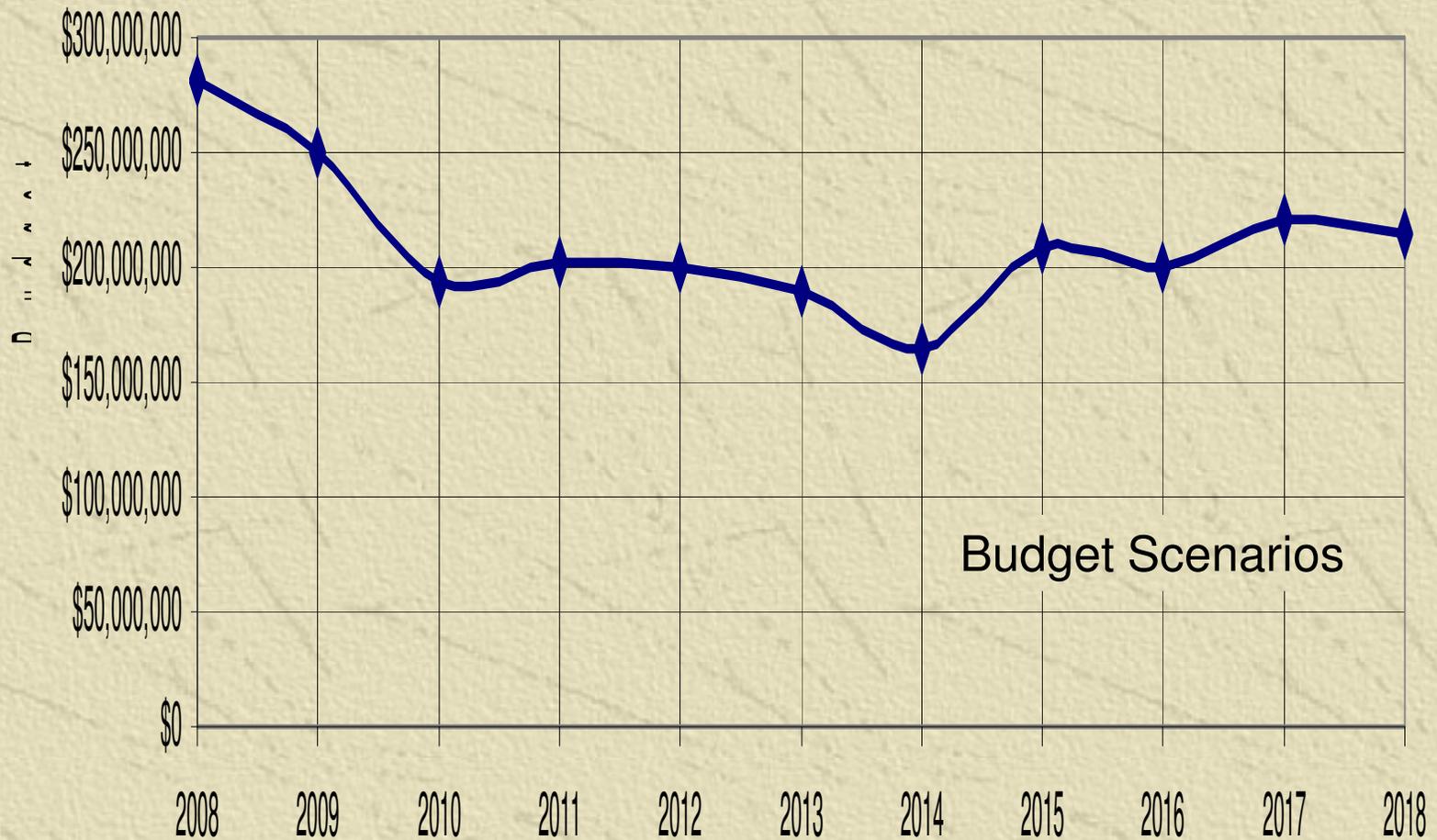
IRI % above trigger



Example Network Performance

Illustrates Policy Decisions

What will it cost to maintain the current IRI?



Pavement Strategy Development

Pavement Strategy

- ✦ **Plan of action**
- ✦ **Comprised of the application of one or more maintenance or rehabilitation techniques**
- ✦ **Designed to improve or maintain the condition of a pavement segment above some predetermined minimum requirement**



Requirements for Developing a Strategy

- **List of strategy guidelines and treatment options**
- **Treatment Costs**
- **Pavement performance models for treatment**

Options in Strategy Development

- **Project Selection/Treatment Selection - simultaneous or not**
- **Single treatments or multiple treatments**



Single Treatment Strategy

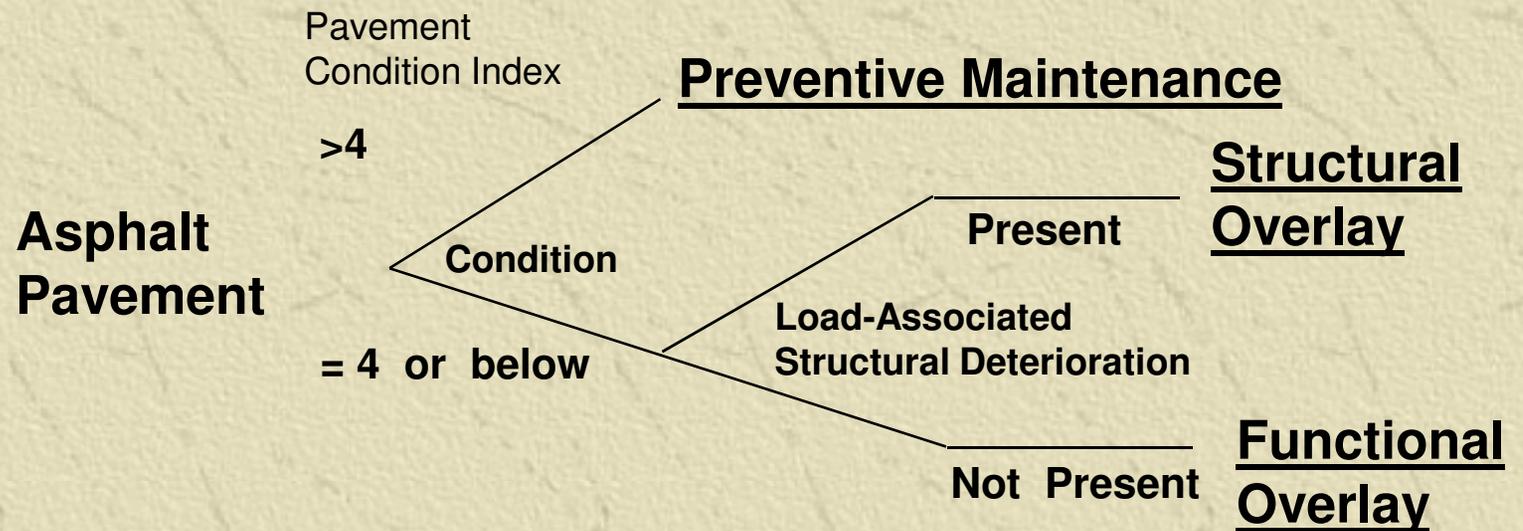
- **Most common approach**
- **Several feasible alternatives may be identified for each section**
- **Each treatment considered independently**
- **Most cost-effective treatment generally selected**

Multiple Treatment Strategy

- **Combination of treatments considered for each section**
- **Effectiveness of all treatments is representative of effectiveness of entire strategy**
- **Subsequent treatments affect selection of strategy**
- **Repeated treatments**

Treatment Selection

Decision Trees



PMS DATABASES

**COMPUTERIZED DATABASE
MANAGEMENT SYSTEMS (DBMS)**

INTEGRATED RELATIONAL DATABASES

PMS COORDINATED DATABASES

COMPUTERIZED DATABASE MANAGEMENT SYSTEMS (DBMS)

INTEGRATED RELATIONAL DATABASES

- **INVENTORY - RT NUMBER, FUNCTIONAL CLASS,**
- **PAVEMENT TYPE, etc.**
- **CONDITION - RIDE QUALITY, DISTRESS, FRICTION,**
- **DEFLECTION**
- **COSTS**
- **HISTORY**
- **TRAFFIC / LOADS**

PAVEMENT HISTORY

Initial Construction Data

Date, Cost, Material, Structure, etc.

Preventive Maintenance

Date, Treatment, Cost, Material, Structure, etc.

Rehabilitation

Date, Treatment, Cost, Material, Structure, etc.

Reconstruction

Date, Treatment, Cost, Material, Structure, etc.

COSTS

AGENCY COSTS

- ***P&E***
- ***DESIGN***
- ***CONSTRUCTION***
- ***PREVENTIVE AND ROUTINE MAINTENANCE***
- ***REHABILITATION / RESURFACING / RECONSTRUCTION***
- ***SALVAGE***

PMS DATABASES

DATABASE PRODUCTS/REPORTS

DEFICIENCY REPORTS –

SECTIONS WITH UNACCEPTABLE RQ OR DISTRESS

PERFORMANCE HISTORIES

DISPLAY GIVEN CONDITION PARAMETER OVER TIME OR LOADS

CONSTRUCTION, MAINTENANCE, REHAB HISTORIES

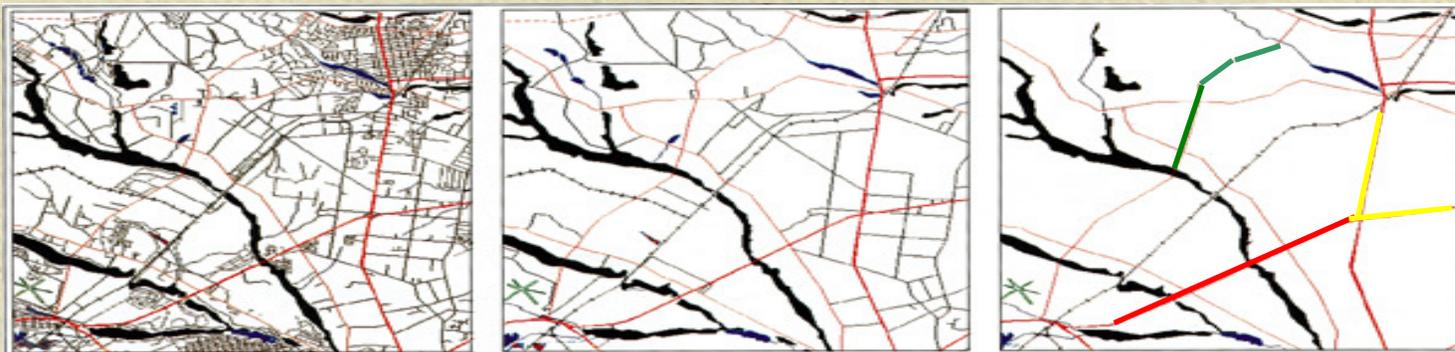
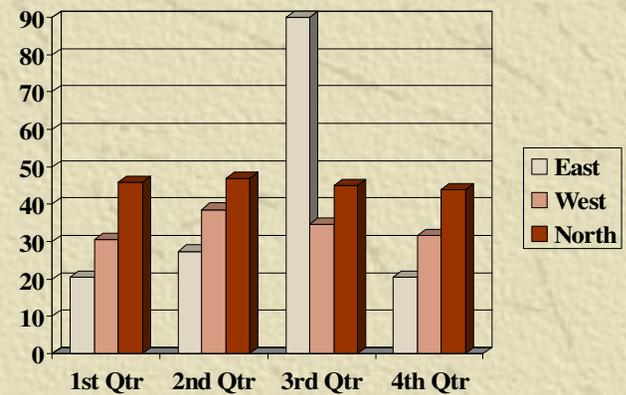
LIST OF BUDGET NEEDS - STATE, MPO, COUNTY, TOLL AUTHORITIES

PMS DATABASES

DATABASE PRODUCTS/REPORTS

[TABULAR, BUSINESS GRAPHICS, GIS MAP, Video]

Section	Year	Cost
32	2006	\$100,000
47	2008	\$237,999



Data Storage



1 Terabyte = 1,024 Gigabytes



That's All Folks

QUESTIONS ?



THANK YOU