Pavement Asset Management Decision Support Tools: Ohio Department of Transportation Case Study

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Introduction

❑ Aging pavement network and tight budget at most highway agencies

❑ Demonstrated optimal use of M&R dollars has become necessary amid calls for transparency and accountability

❑ Ohio DOT has developed decision support tools for pavement asset management through research projects

❑ Expanding from pavement to bridges and other assets

❑ Pilot for web access of information and tools

Dashboard Condition Reporting

PCR Mileage Report

System = All Systems / Priority = P / District = All Districts / County = All Counties / Route = All Routes / PavementType = All Types / Year = 2006 - 2011
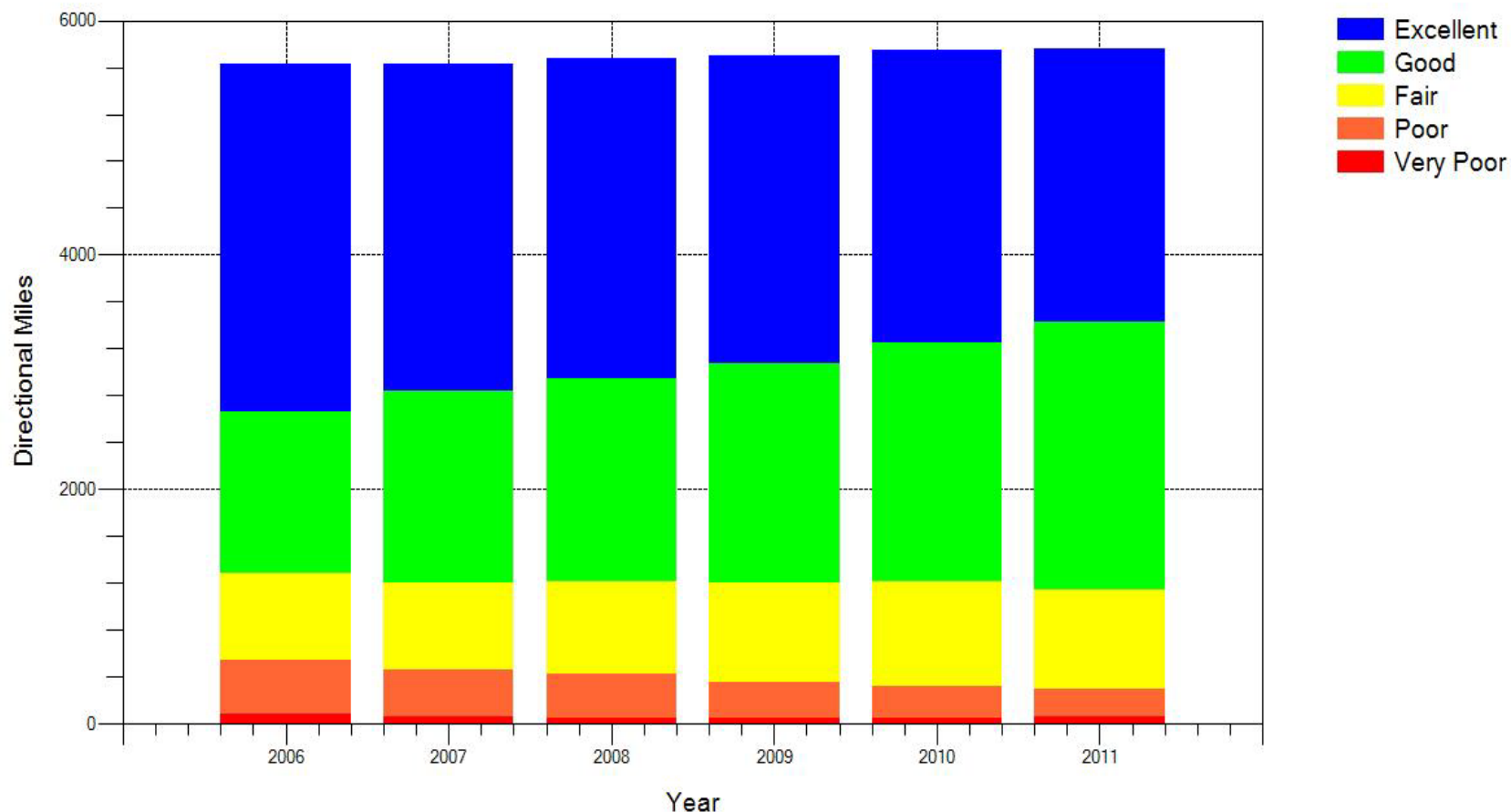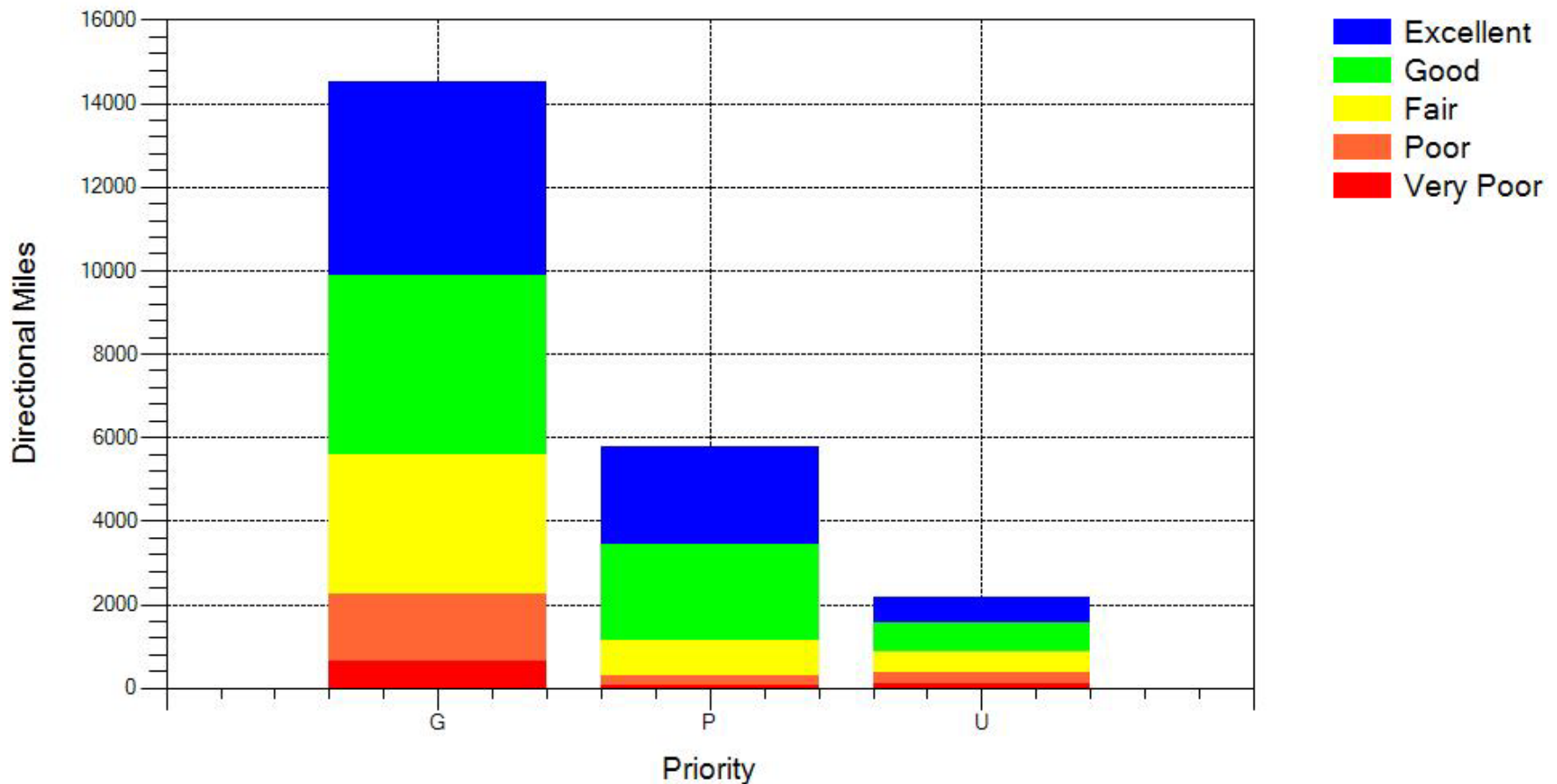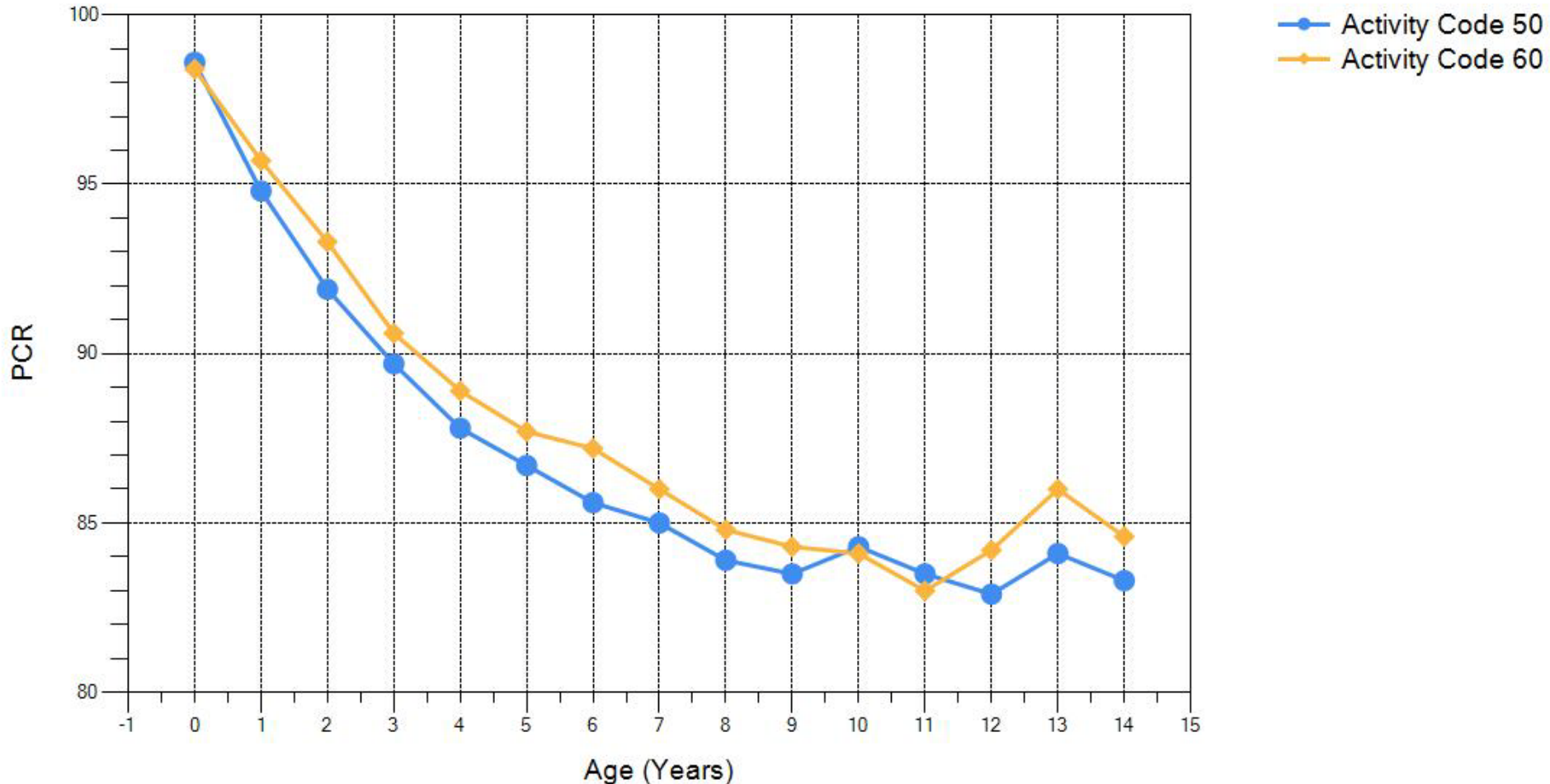
Condition of Different Systems

PCR Mileage Report

System = All Systems / Priority = All / District = All Districts / County = All Counties / Route = All Routes / PavementType = All Types / Year = 2011 - 2011
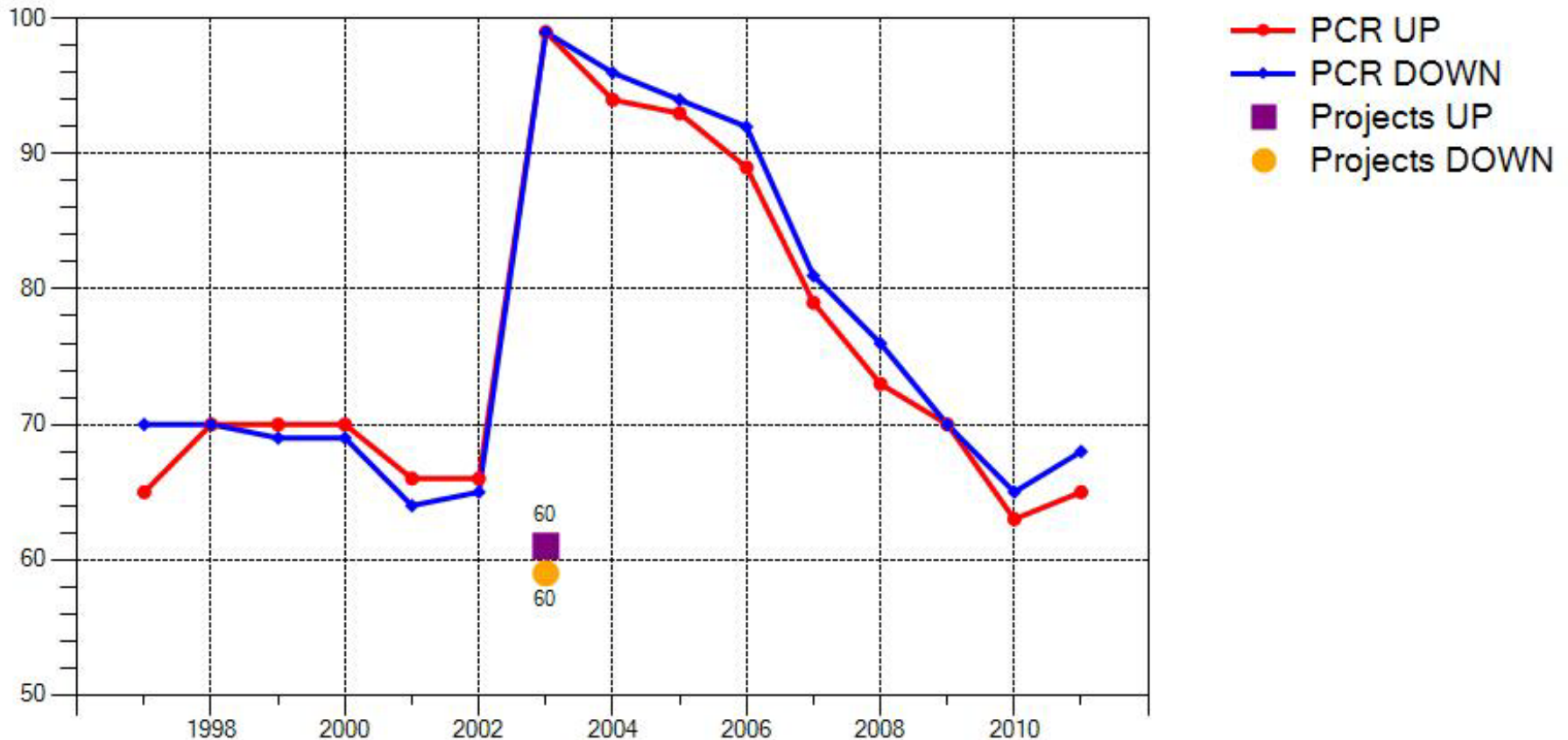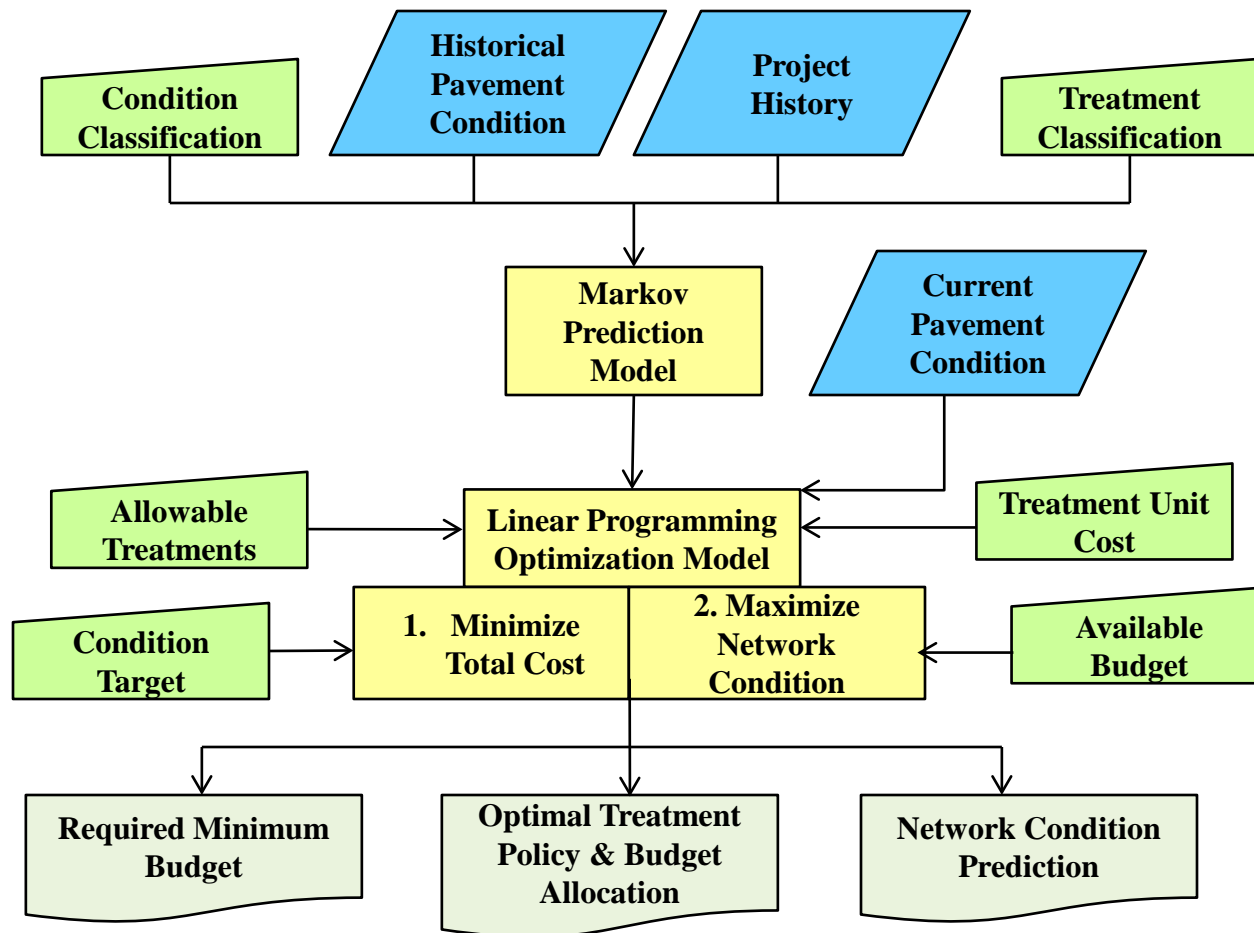
Average Treatment Performance

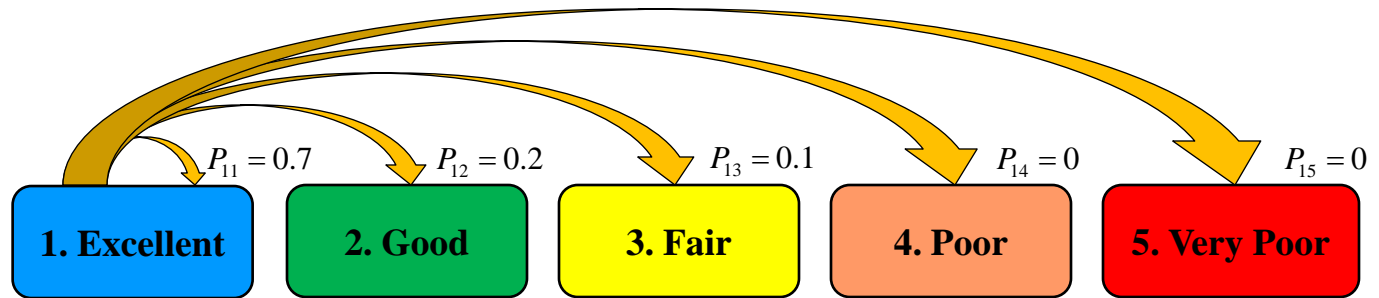LUC 075R PCR(Manual Log) vs Year (2- 2.05)

Network Level Optimization

- ❏ Supports high level asset management decisions

- ❏ Estimate the minimum budget required to achieve a desired condition level

- ❏ Maximize the benefits for a given amount of budget

- ❏ Determine treatment policy and budget allocation

Network Level Optimization

Markov Prediction Model

$P_{11} = 0.7$ $P_{12} = 0.2$ $P_{13} = 0.1$ $P_{14} = 0$ $P_{15} = 0$

1. Excellent   **2. Good**   **3. Fair**   **4. Poor**   **5. Very Poor**

Markov Transition Probability Matrix:

$$P = \begin{bmatrix} p_{11} & p_{12} & p_{13} & p_{14} & p_{15} \\ p_{21} & p_{22} & p_{23} & p_{24} & p_{25} \\ p_{31} & p_{32} & p_{33} & p_{34} & p_{35} \\ p_{41} & p_{42} & p_{43} & p_{44} & p_{45} \\ p_{51} & p_{52} & p_{53} & p_{54} & p_{55} \end{bmatrix}$$

Markov Prediction Model

❑ System priority: General and Priority

❑ Pavement type: Concrete, Flexible and Composite

❑ Repair treatment: Preventive Maintenance, Thin Overlay, Minor Rehab and Major Rehab

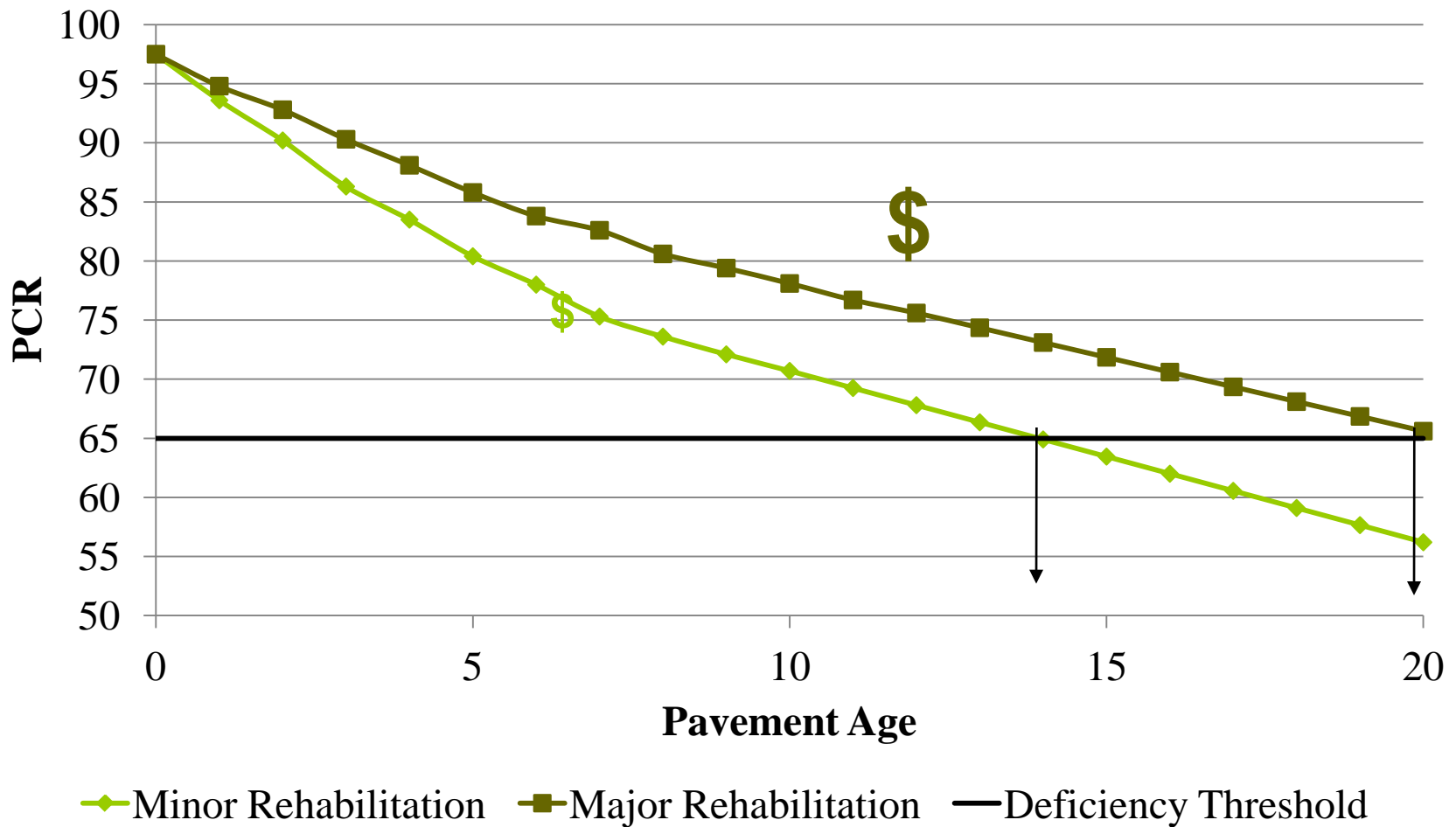$$2 \times 3 \times 4 = 24$$ **pavement groups are formed**

Treatment Matrix

	Excellent	Good	Fair	Poor	Very Poor
Excellent	1	0	0	0	0
Good	1	0	0	0	0
Fair	1	0	0	0	0
Poor	1	0	0	0	0
Very Poor	1	0	0	0	0

Do Nothing Matrix

	Excellent	Good	Fair	Poor	Very Poor
Excellent	0.82	0.18	0	0	0
Good	0	0.73	0.27	0	0
Fair	0	0	0.69	0.31	0
Poor	0	0	0	0.58	0.42
Very Poor	0	0	0	0	1

Performance vs. Treatment Cost

Pavement Condition Deterioration Trend

Determination of Treatment Policy

Current Network Condition

Predicted Performance

Condition Target

Treatment Options & Cost

Optimization

Optimal Treatment Policy

Condition	Recommended Treatment				
	Do Nothing	PM	Thin Overlay	Minor	Major
Excellent	100%	0%	0%	0%	0%
Good	100%	0%	0%	0%	0%
Fair	31%	69%	0%	0%	0%
Poor	0%	0%	0%	100%	0%
Very Poor	0%	0%	0%	0%	100%

$ Required Network Budget
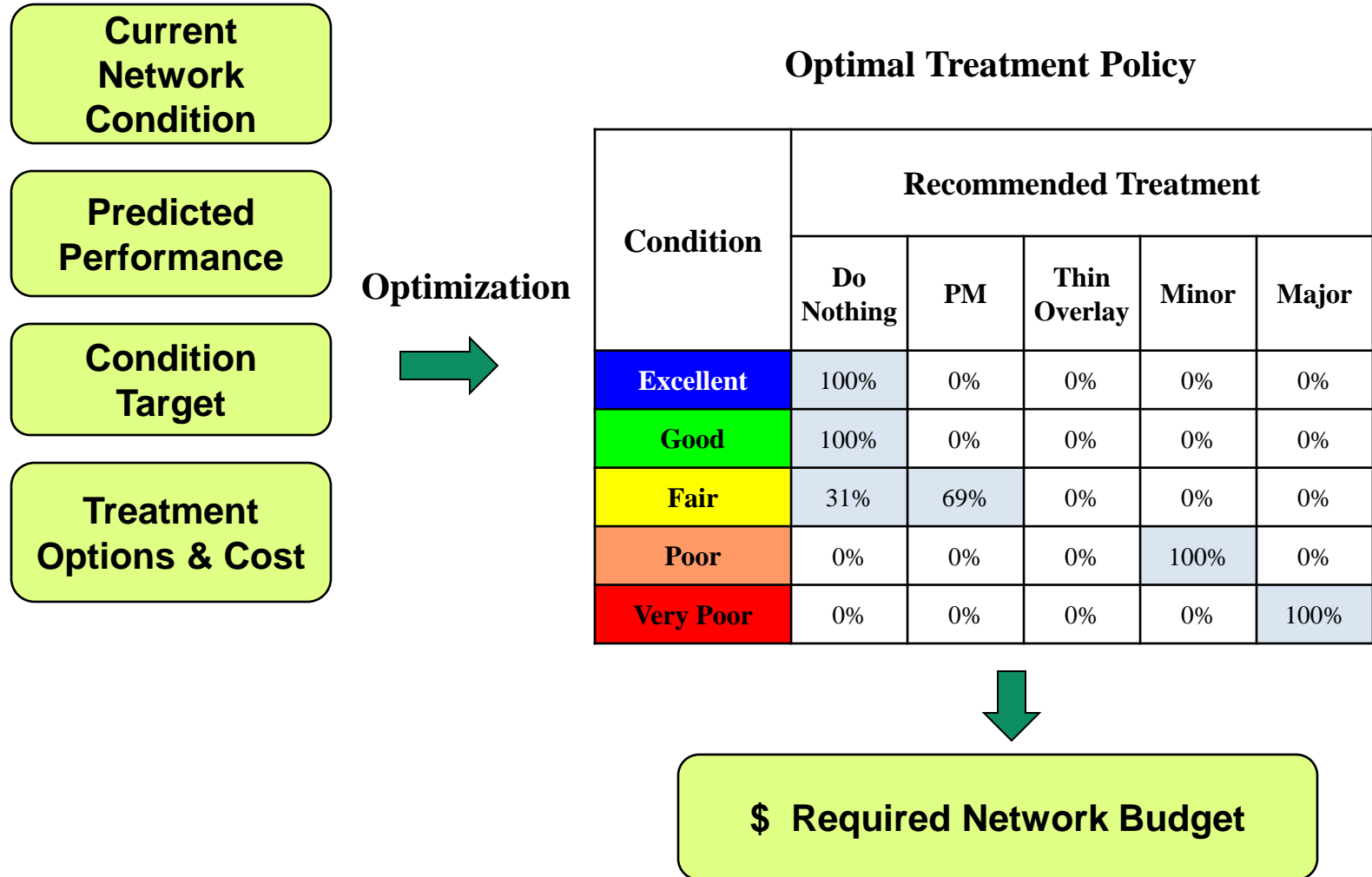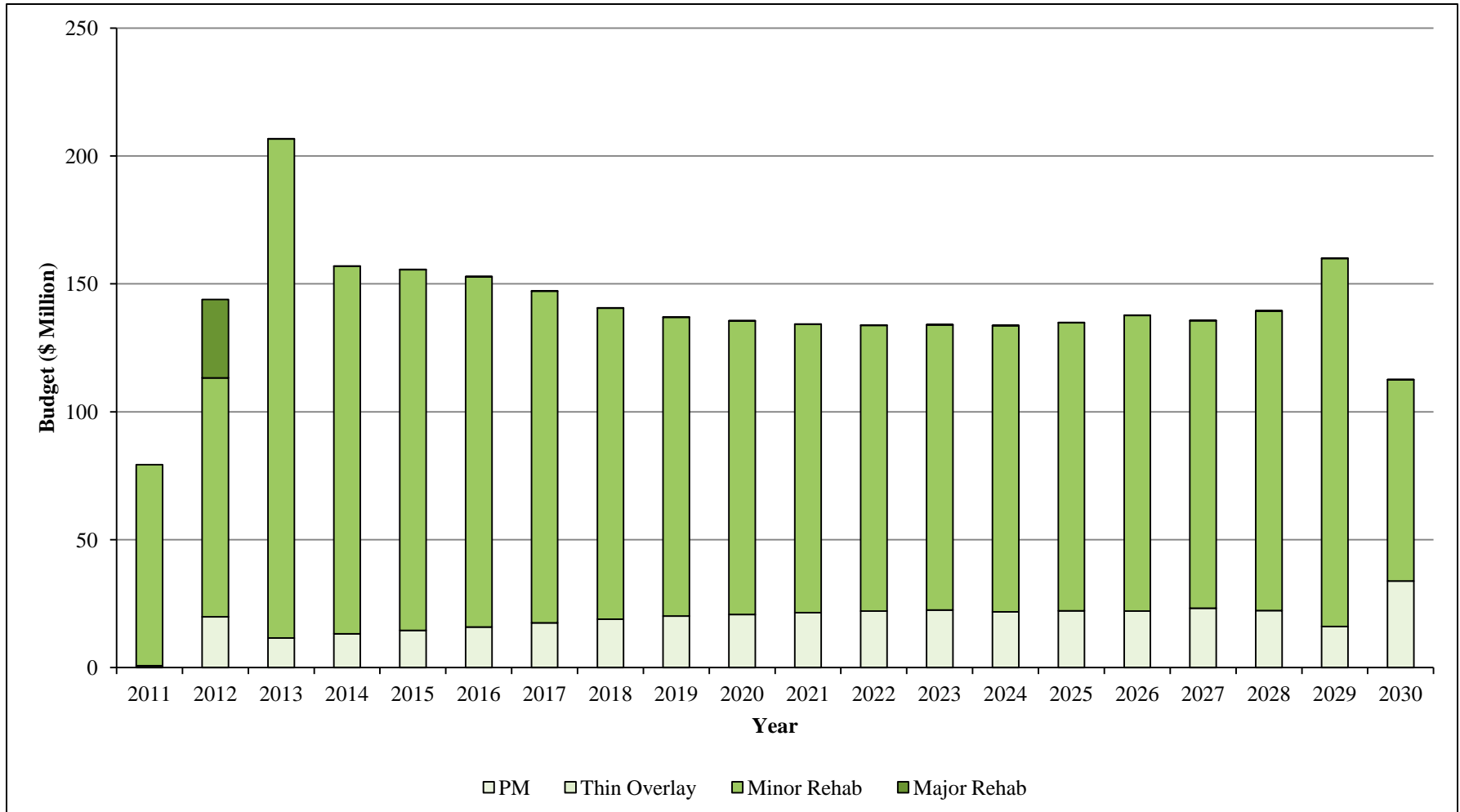
Minimum Budget Required to Achieve a Condition Level
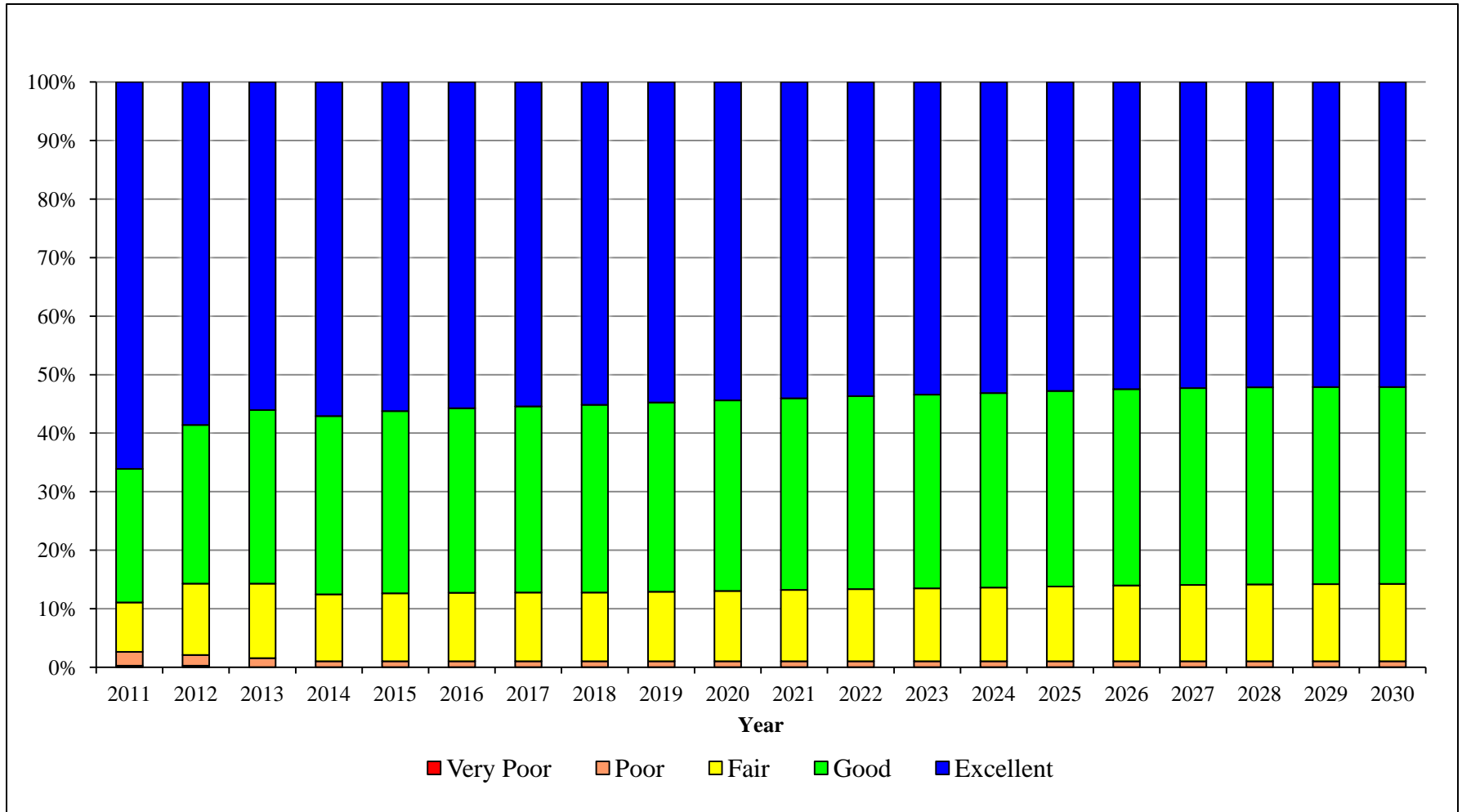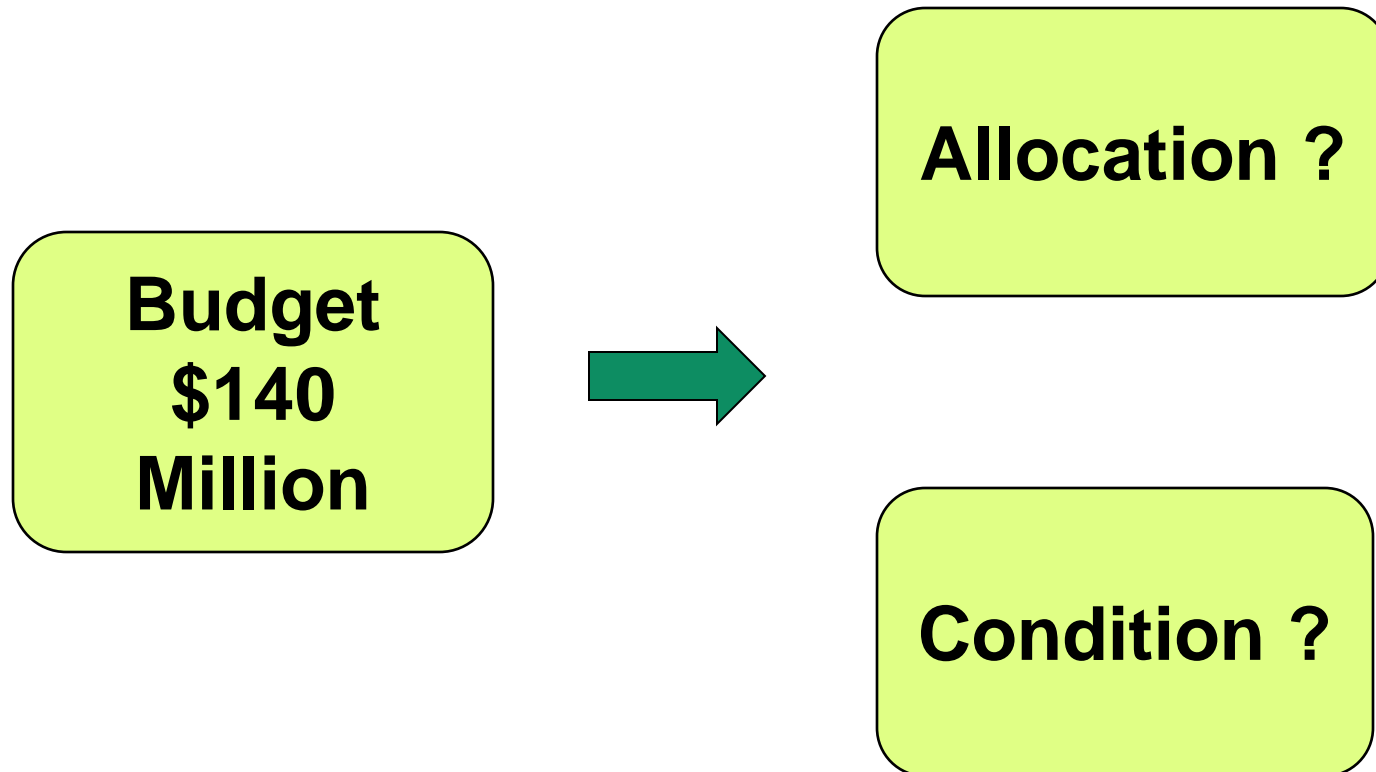

Condition Target
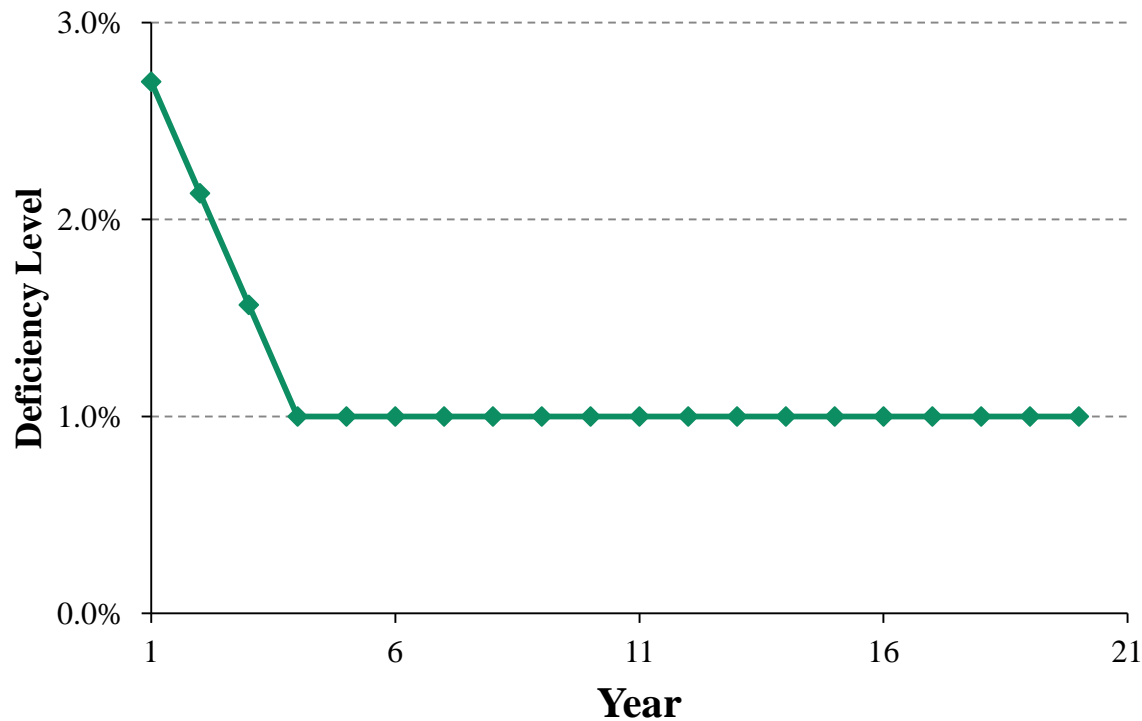
$ Budget ?

Recommended Treatment Budget and Allocation

Corresponding Pavement Condition Distribution

Budget Allocation among Treatments to Achieve the Best Condition Level

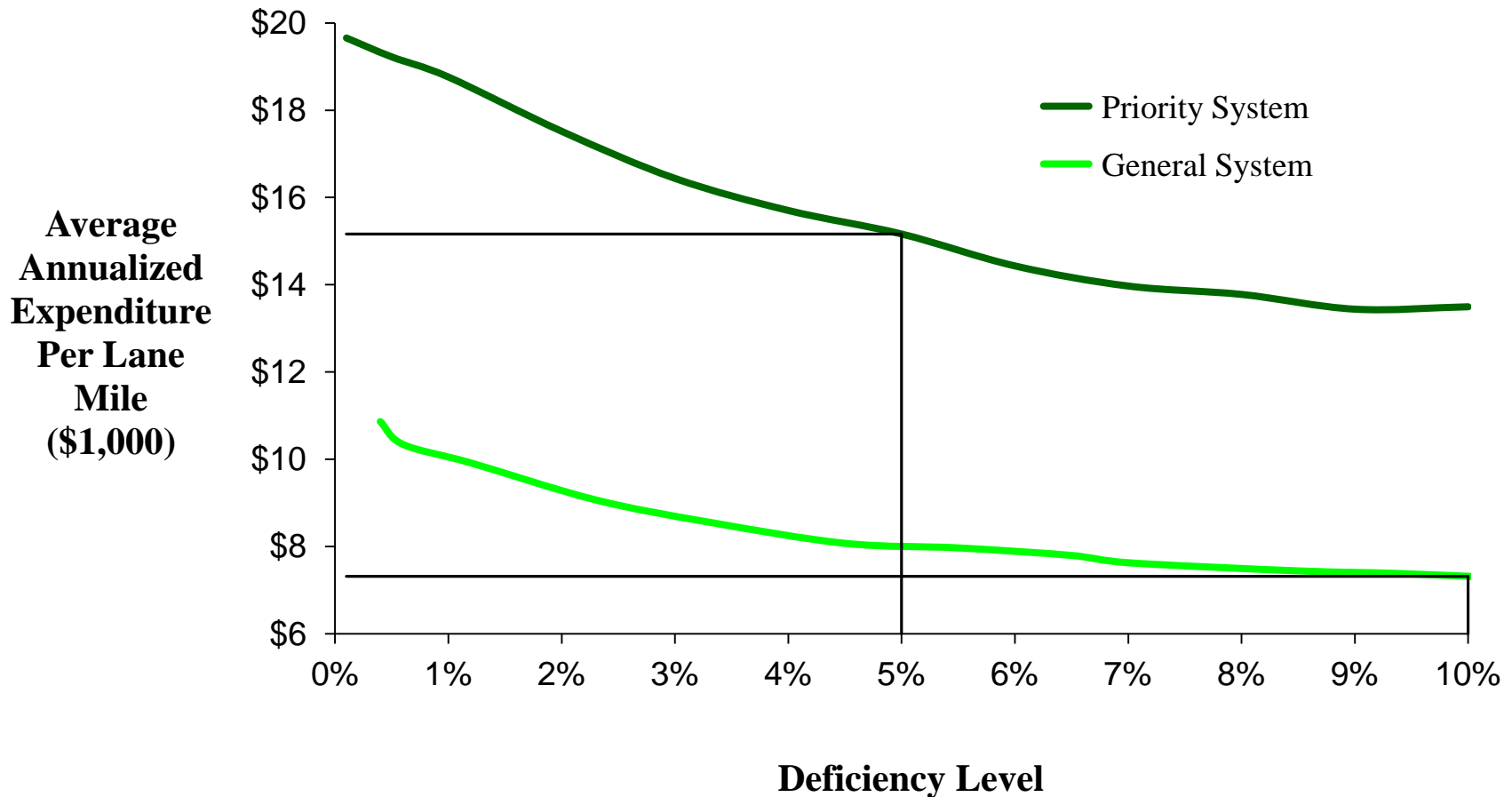**Budget $140 Million**

→

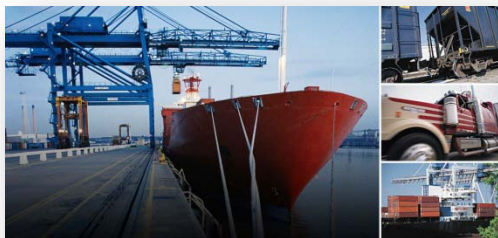**Allocation ?**

Condition ?

Use of Network Optimization

Network optimization can be used as a decision making tool to answer "**what-if**" questions regarding:

❑ Impact of different condition targets

❑ Impact of different funding levels

❑ Impact of different budget allocation

❑ Impact of different repair treatment policy

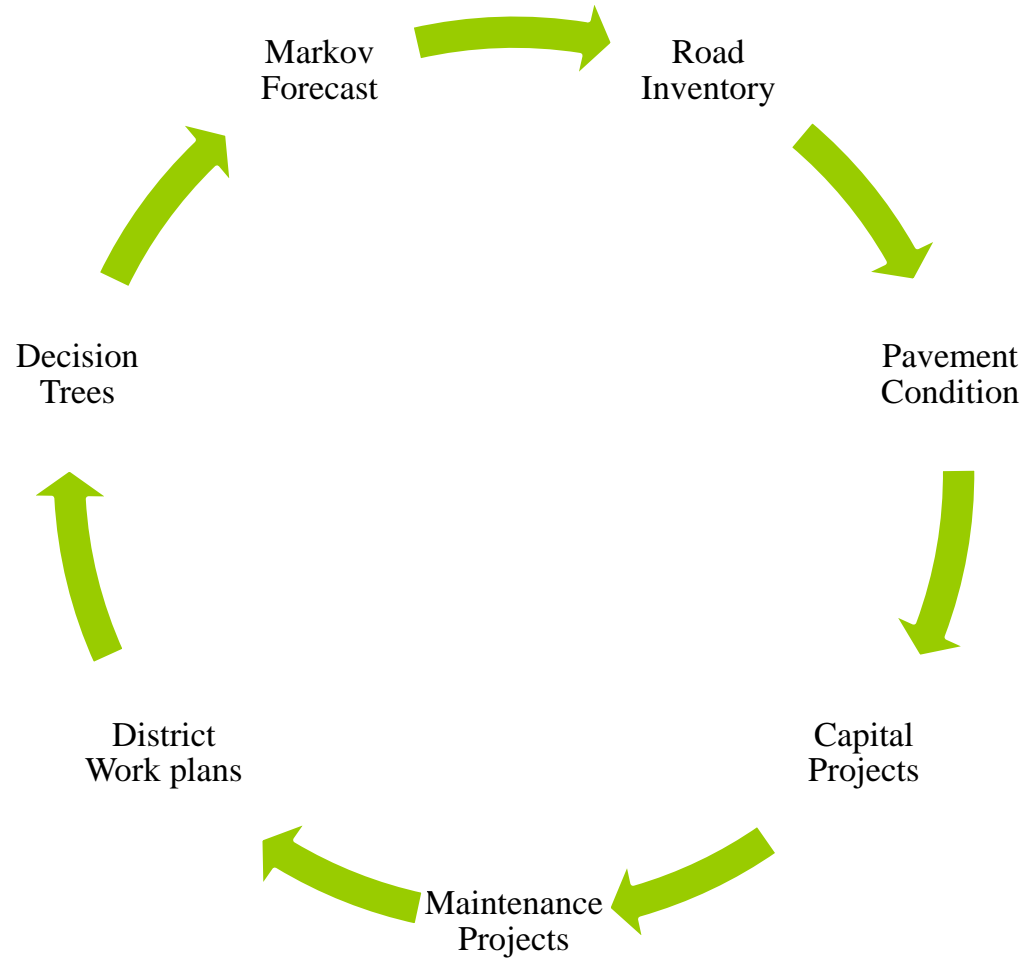# Deficiency Level Versus Average Annualized Expenditure

Ohio's Assets

- Pavement
- River Ports
- Pedestrian Facilities
- Parks
- Bike Facilities
- Transit Lines
- Rail Lines
- Bridges

Pavement Management Development

PMS
PCR
Roughness
Skid
Coring
Analysis
(PMS Software)

Analyze Data
List Projects/
Treatments
Budget Allocation
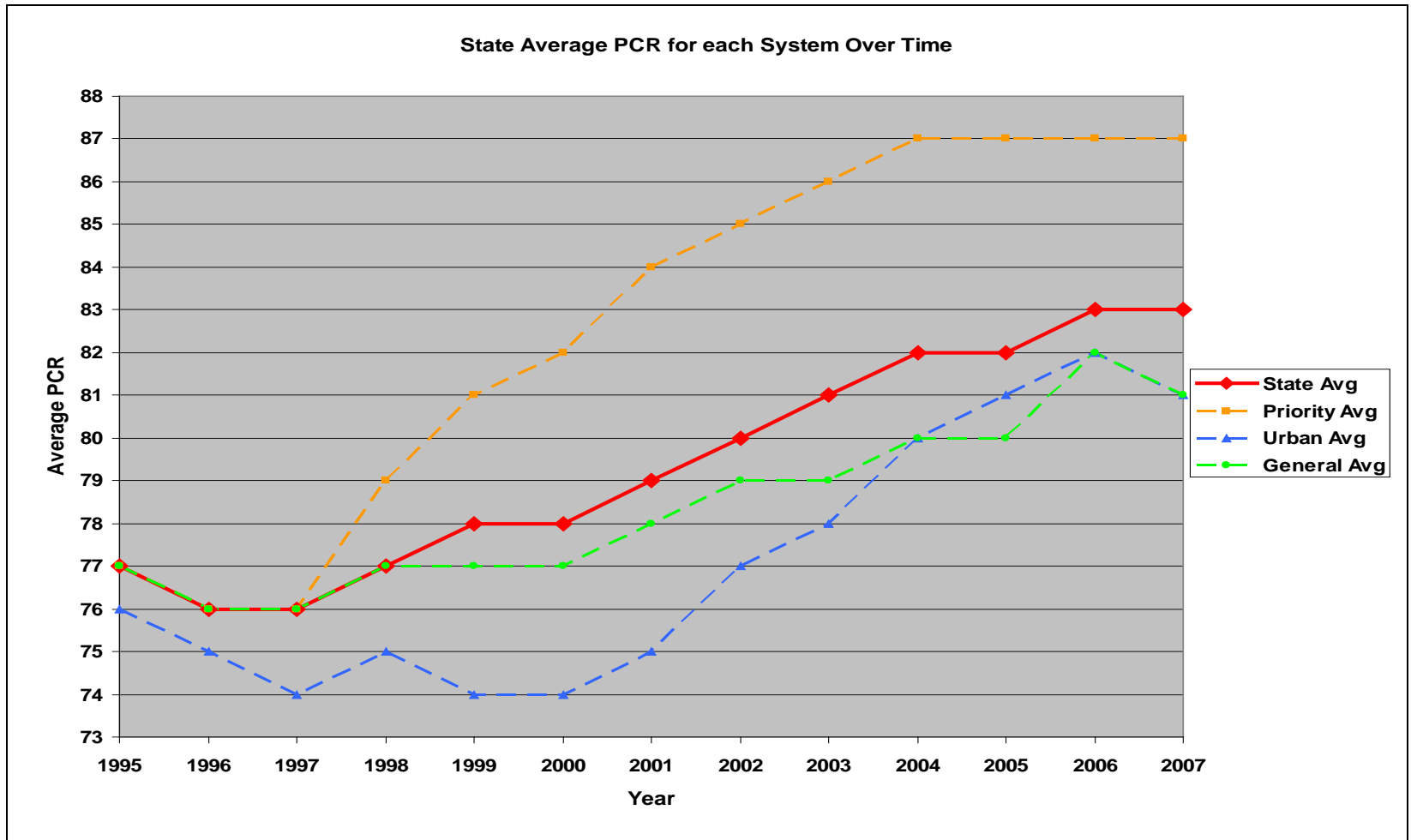(PMS Software)

District
Analysis
Scoping
Muliti Year
Program
(PMS Software)

DoIT Support

1. DoIT will transfer Pavement Databases needed for analysis into Sybase.
DoIT Support
2. DoIT will provide GQL access to those basic databases on the PMS model.
3. Pavement Engineering will provide DoIT with the pavement management logic needed for programming analysis tools.
4. Pavement Engineering and DoIT will develop an update plan for all pavement databases.

BTRS
(RI, .01, Log file, etc.)
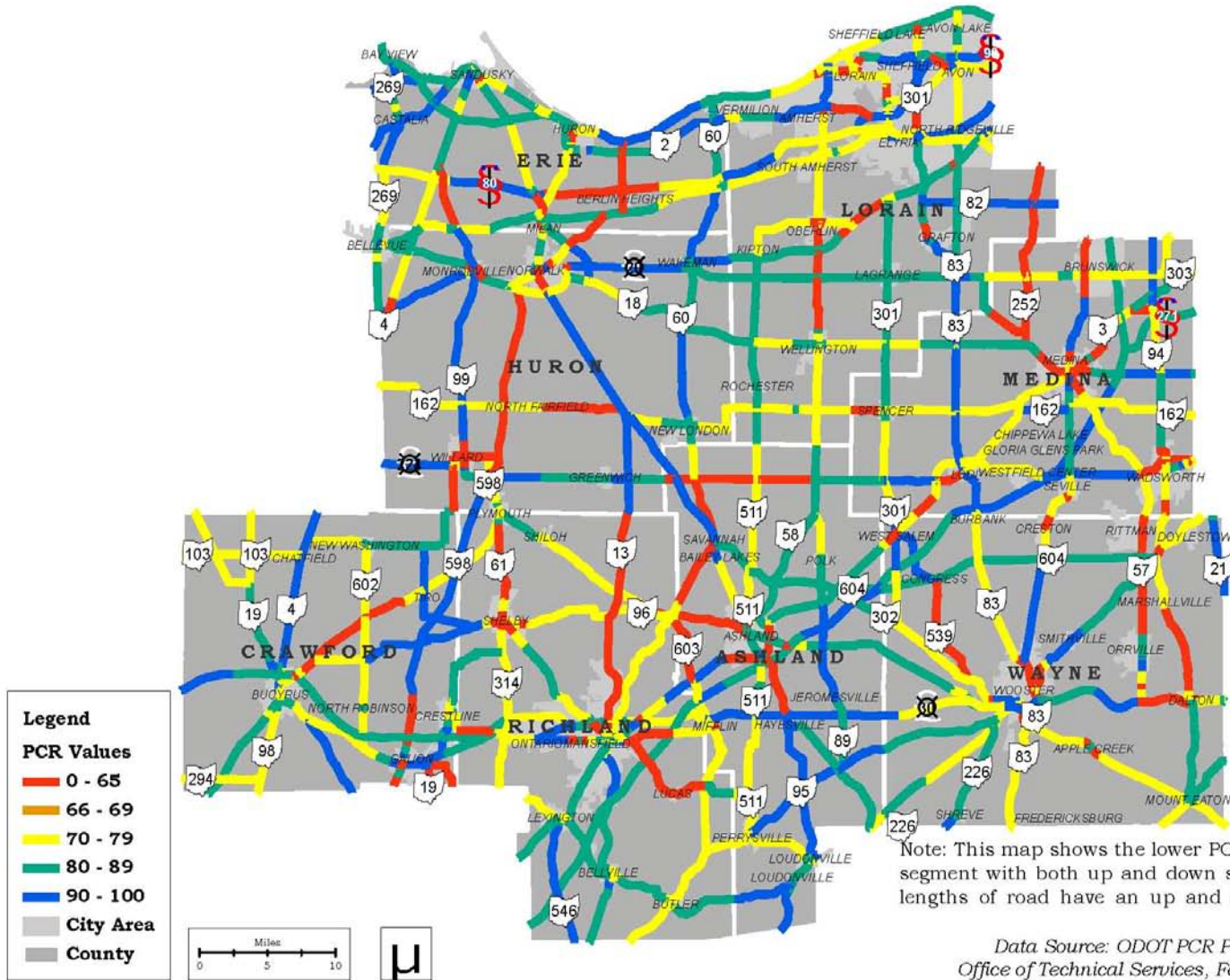
Feedback

Ellis Project Tracking

TMS

DoIT Extraction

DoIT Extraction

Pavement History Database

CMS

21

Systems Conditions

State Average PCR for each System Over Time
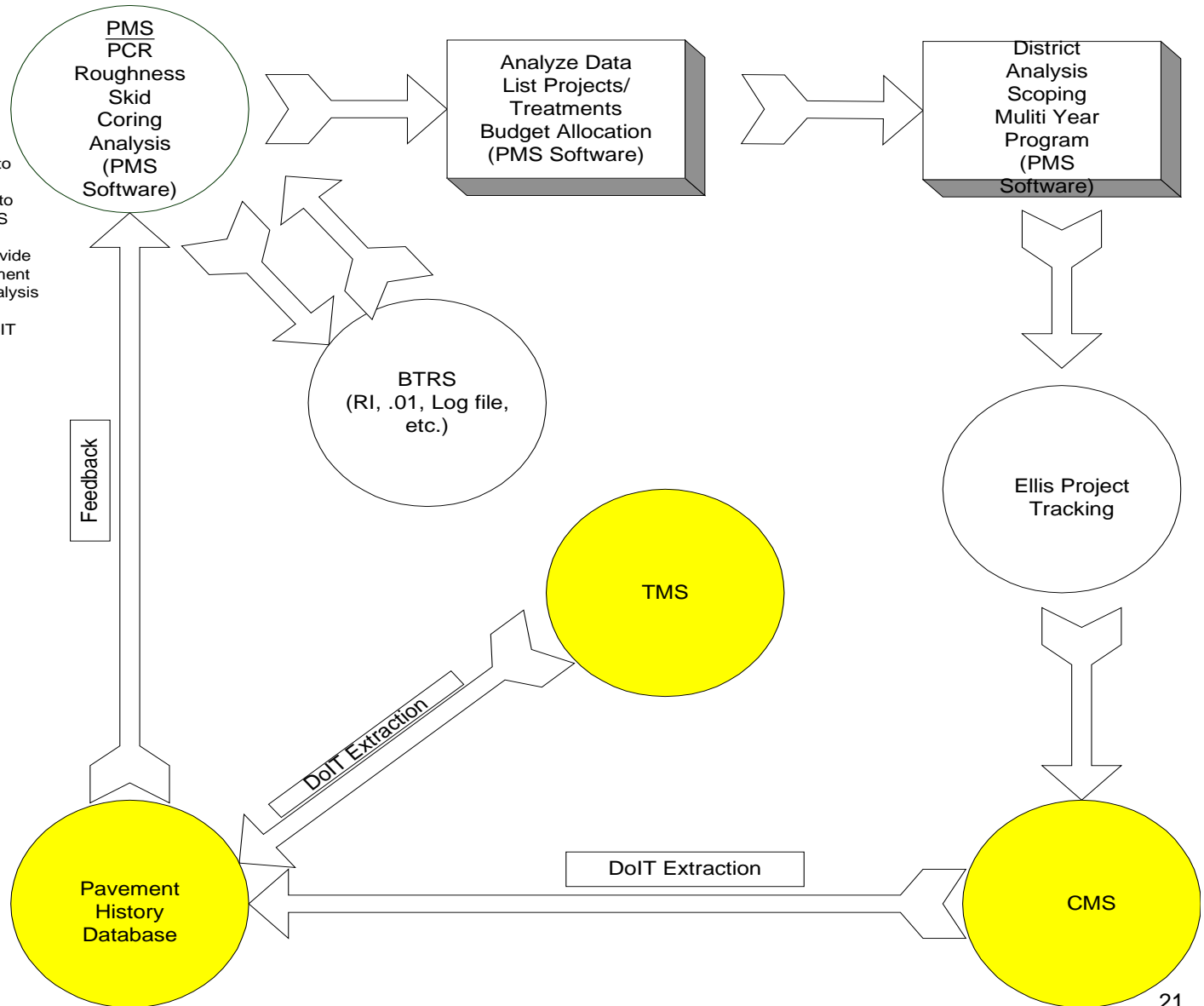
Integrated Decision Support

District	1	2	3	4	5	6	7	8	9	10	11	12
PCR Prior	78.3	69	60.6	61.4	63.3	70.7	72.3	68	68.5	63.5	63.1	60
CRD Prior	9.44	16.41	21.78	21.42	20.34	16.32	14.79	16.33	17.08	19.89	20.41	21.98
STRD Prior	10.09	15.25	20.69	19.93	20.02	14.65	13.78	15.9	15.75	19.04	19.03	21.11
Raveling	3.09	3.52	4.04	4.68	4.29	3.31	3.3	3.52	3.68	4.07	4.24	4.7
Bleeding	0.96	0.26	0.13	0.13	0.19	0.25	0.5	0.49	0.43	0.16	0.11	0.11
Patching	0.75	1.63	2.39	1.89	1.45	1.26	0.84	1.86	1.65	2	1.97	2.5
Debonding	0.09	0.31	0.85	0.69	0.72	0.22	0.1	0.22	0.15	0.42	0.59	1.02
Crack Sealing Defic.	3.61	4.72	4.8	4.79	4.46	4.44	4.09	4.8	4.62	4.78	4.74	4.34
Rutting	3.56	3.96	5.02	4.54	4.17	3.29	3.9	4.5	3.46	4.04	3.86	5.01
Settlements	0.02	0.08	0.07	0.06	0.58	0	0.01	0.12	0.27	0.92	0.75	0.01
Corrugations	0	0	0.01	0.01	0.06	0	0	0.02	0.03	0.02	0.02	0.04
Wheel Track Cracking	1.45	2.11	4.93	5.53	5.61	2.76	2.09	2.61	4.59	5.89	6.18	4.51
Block and Transverse Cracking	2.86	5.98	7.38	6.33	7.06	5.62	5.3	6.13	5.43	6.36	6.38	7.06
Longitudinal Cracking	2.33	3.76	3.03	3.03	2.52	2.93	3.04	3.3	2.09	1.85	1.71	3.71
Edge Cracking	1.12	1.62	3.26	3.27	2.31	2.01	1.43	1.13	1.89	2.53	2.79	2.85
Random Cracking	1.59	2.67	2.03	1.87	2.19	2.19	2.02	2.57	2.12	2.3	1.95	2.55
Thermal cracking	0.38	0.5	1.5	1.79	1.03	1.01	1.08	0.79	1.17	1.24	1.64	1.65
Thickness Added	1.63	2.1	2.12	1.92	2.14	1.71	2.12	2.43	1.89	2.02	1.69	2.73
Thickness Removed	1.37	1.98	1.76	1.49	1.62	1.43	1.14	1.61	1.58	1.93	1.57	1.99
Age at Repair	8.1	11.9	9.2	10.4	8.7	8.1	9.5	11	10.8	9.7	9.1	10.6
Age at Next Repair	9	10.8	10	11.7	9.9	9.3	9.8	11.1	12.5	11.5	9.8	11

ODOT: District 3
Pavement Condition Ratings, 2011

Legend

PCR Values
- 0 - 65
- 66 - 69
- 70 - 79
- 80 - 89
- 90 - 100
- City Area
- County

Note: This map shows the lower PCR value of a road segment with both up and down segments. Not all lengths of road have an up and a down segment.

Data Source: ODOT PCR PMS Table
Office of Technical Services, February 2012

Remaining Life

System = All Systems / Priority = All / District = 3 / County = All Counties / Route = All Routes / PavementType = All Types / Rem Life From = 2010

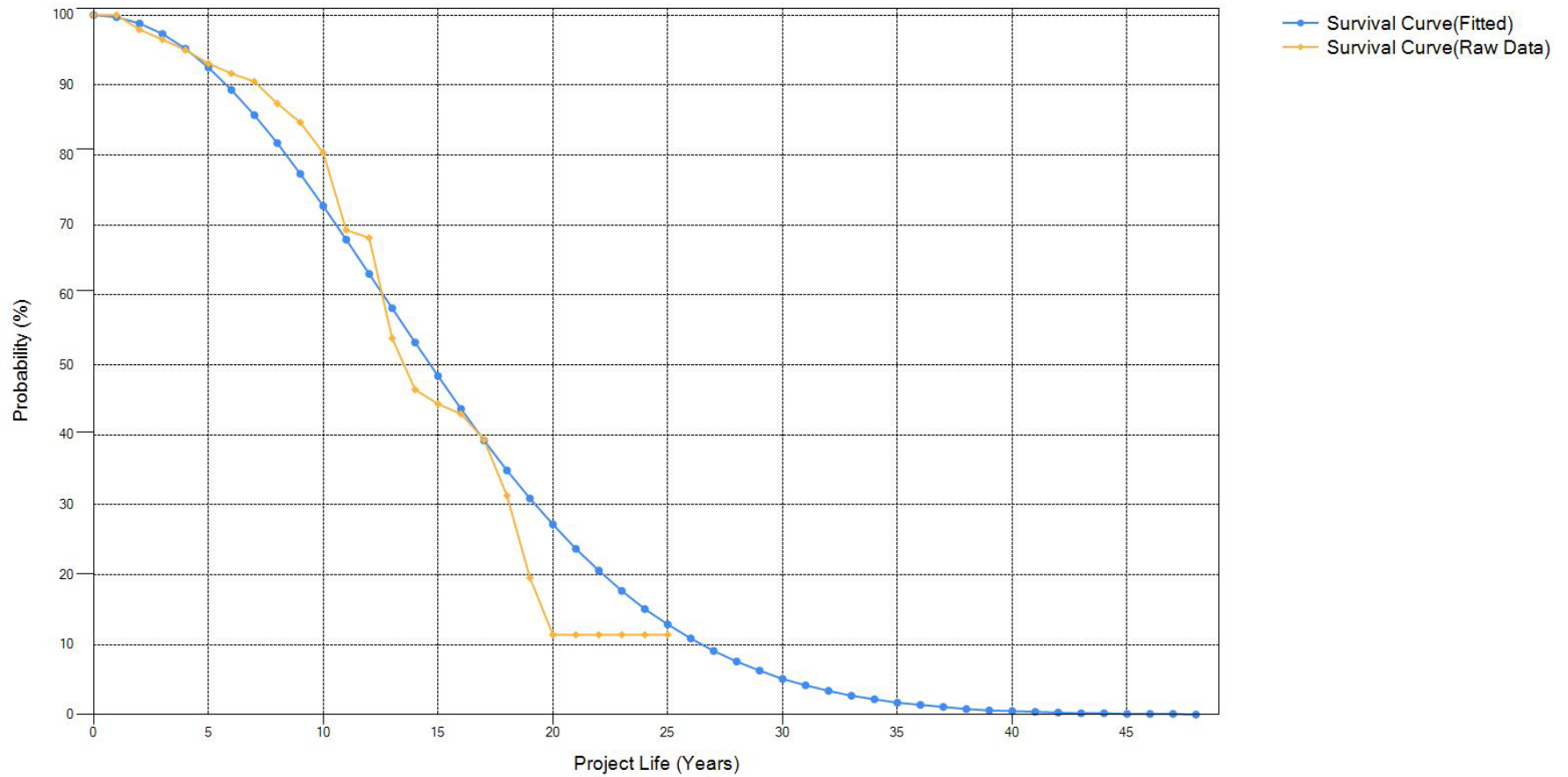PCR Threshold - Priority = 65 / Urban = 60 / General = 60
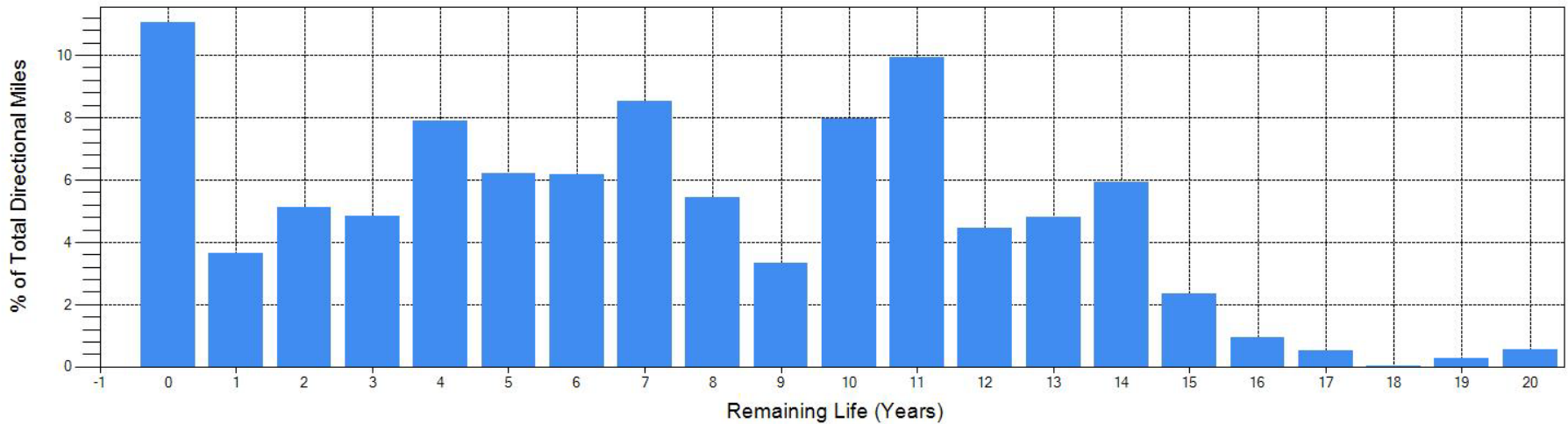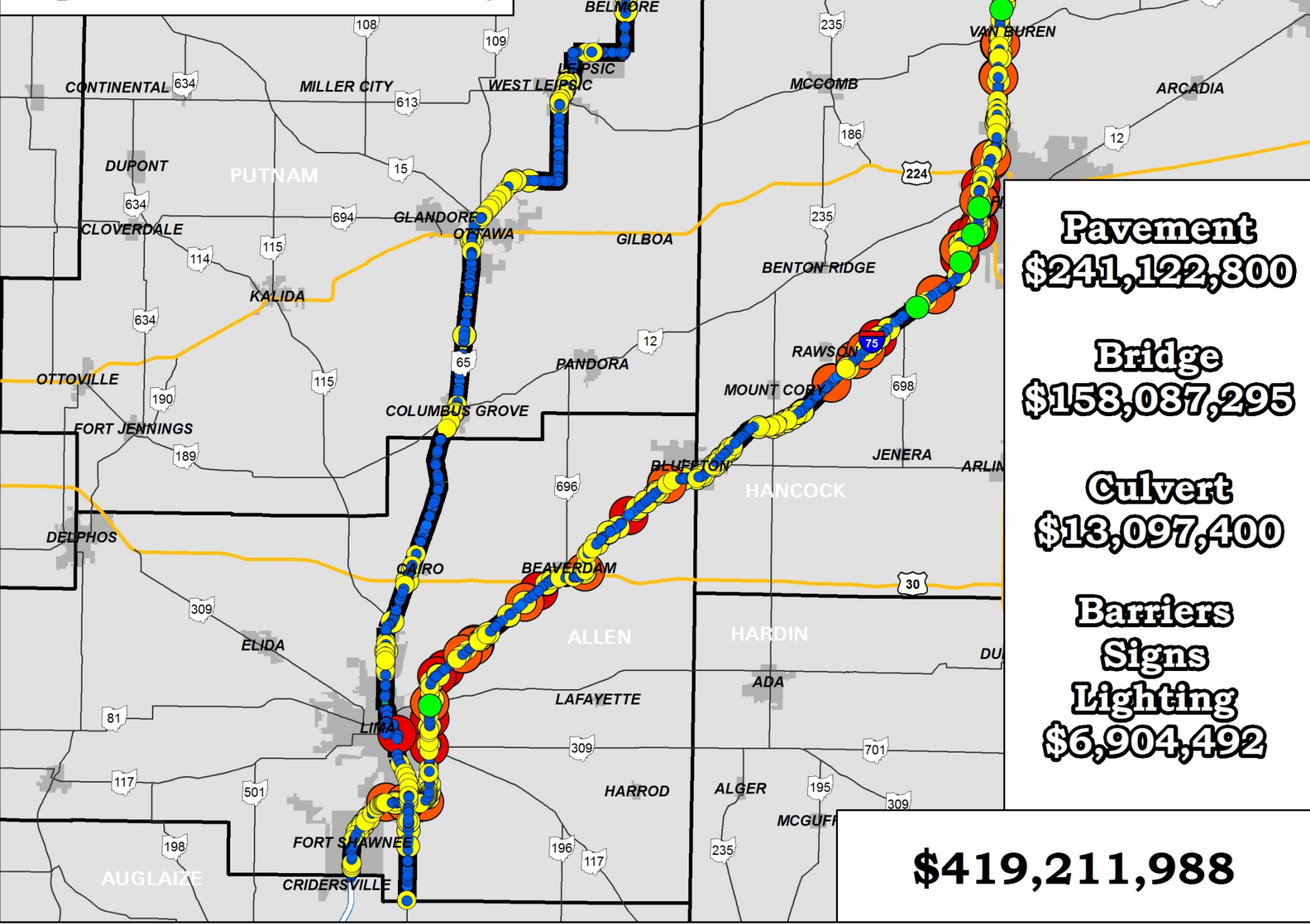
Survival Curve

Survival Curve

System = All Systems / Priority = All / District = All Districts / County = All Counties / PavementType = 3-Asphalt / Year = 1982 - 2011
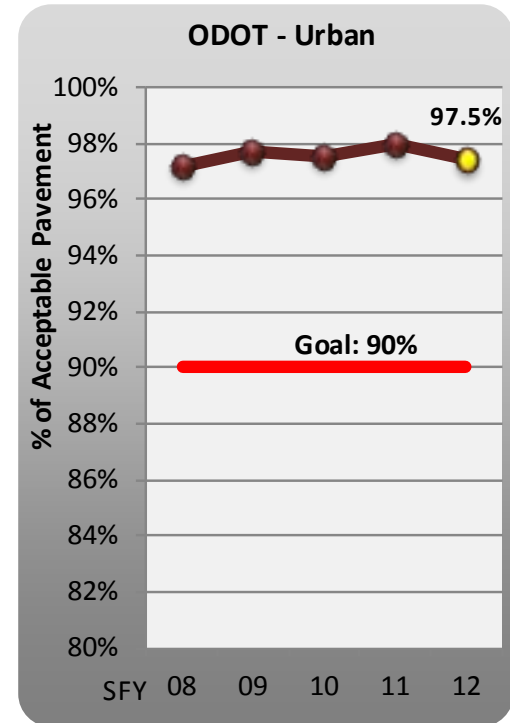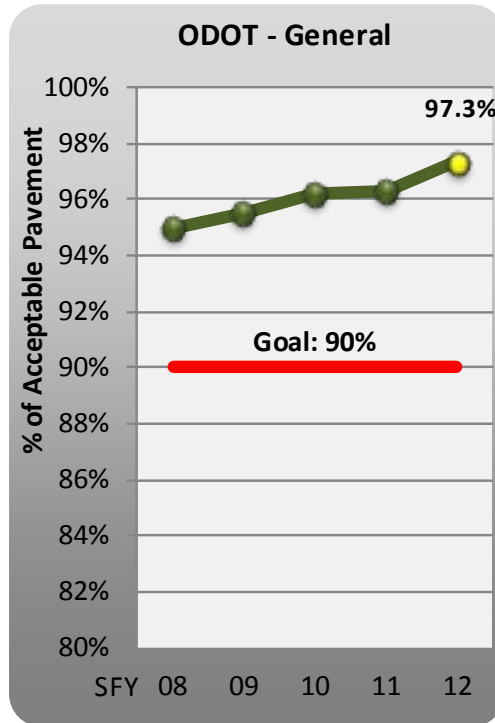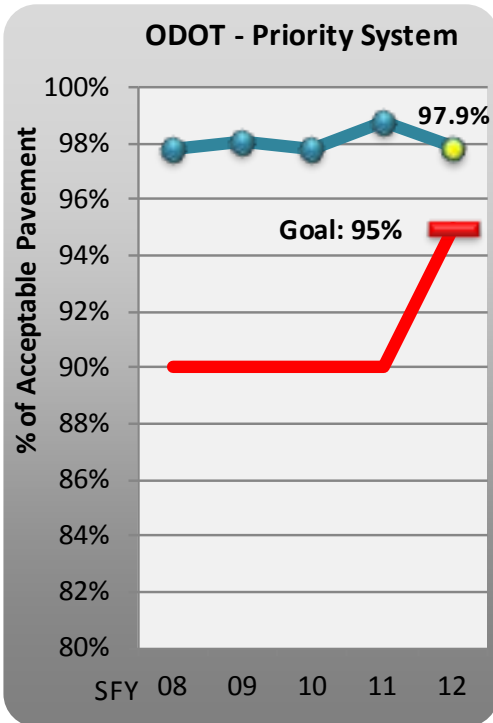
Legend:
- Survival Curve(Fitted)
- Survival Curve(Raw Data)

X-axis: Project Life (Years)
Y-axis: Probability (%)

Replacement Cost Summary

**Pavement
$241,122,800**

**Bridge
$158,087,295**

**Culvert
$13,097,400**

**Barriers
Signs
Lighting
$6,904,492**

$419,211,988

Pavement Summary

Where are we going?

- Currently Implementing a Commercial Pavement Management System (Deighton System)
- Currently developing an integrated asset management system prototype through the University of Toledo
- Currently Implementing Web-GIS application for displaying, distributing, and analyzing pavement and other assets
- Currently developing the framework for asset management database (consolidated database, COD)

- Performance Based Management
- Return on Investment Management
- Integrated System Support Tools
- World Class Transportation System

Thank You!