PRE-XVII CONGRESO ARGENTINO
de Vialidad y Tránsito
8º EXPOVIAL ARGENTINA

expo 2014 vial Argentina

3 AL 6 DE NOVIEMBRE 2014

HOTEL PANAMERICANO - Buenos Aires, Argentina

X CONGRESO INTERNACIONAL ITS

X SIMPOSIO DEL ASFALTO

II SEMINARIO INTERNACIONAL DE PAVIMENTOS DE HORMIGÓN

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Temática

1. Conceptos Fundamentales
2. Mantenimiento Preventivo versus Mantenimiento Diferido
3. Estado Situacional en los Estados Unidos
4. Pavimentos
5. Puentes
6. Reflexiones Finales

¿ Mantenimiento ?

mantenimiento s. m.

“1 Conservación de una cosa en buen estado o en una situación óptima para evitar su degradación”

Sinónimos

mantenimiento

sustantivo masculino

1 sustento, manjar*, alimento*.

2 sostenimiento, entretenimiento, conservación.

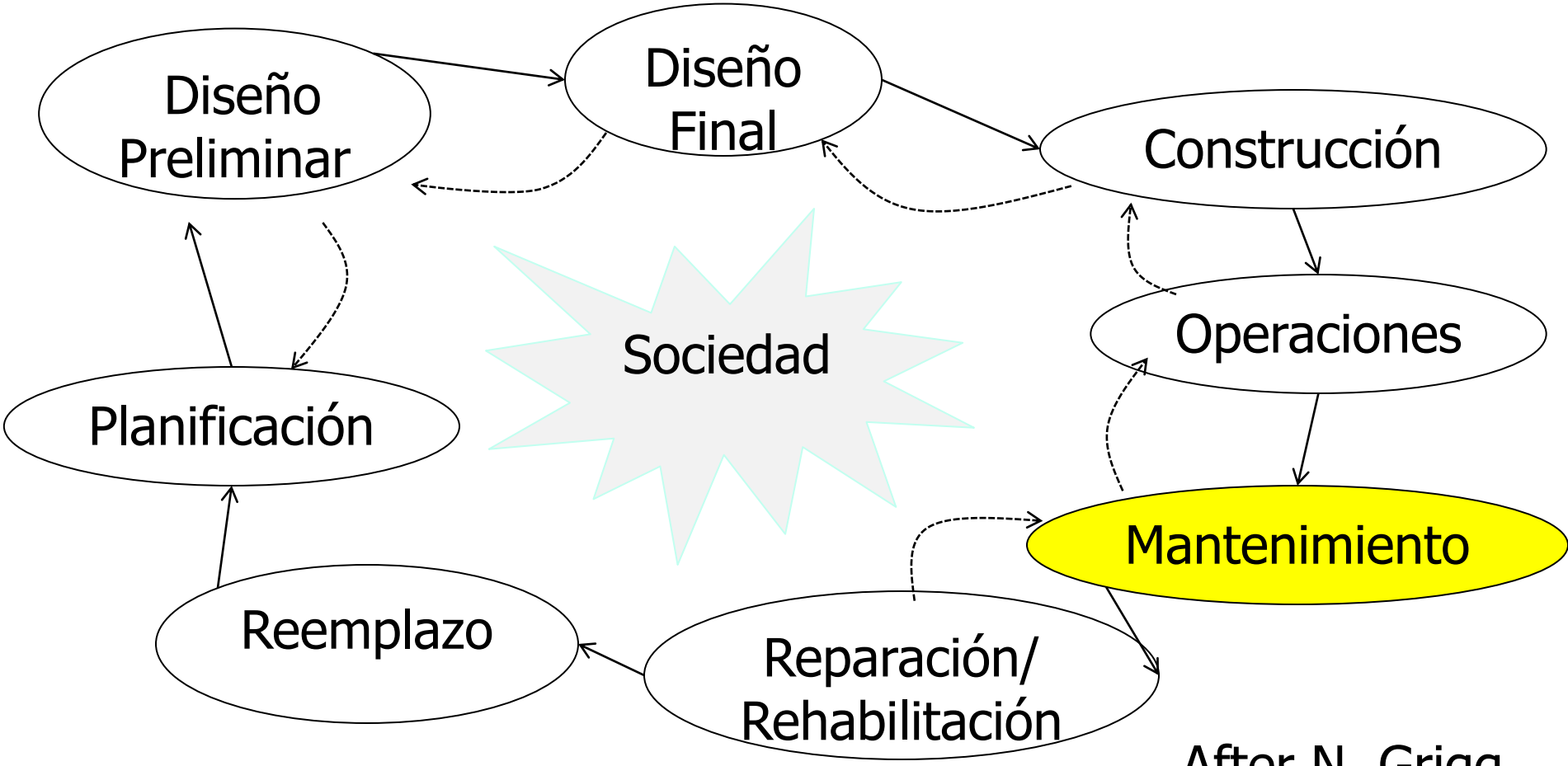
Diccionario Manual de Sinónimos y Antónimos de la Lengua Española Vox © 2007 Larousse Editorial, S.L.

Entonces …

En un sentido amplio el **mantenimiento o conservación vial** se define como el conjunto de operaciones e intervenciones necesarias para que la red vial pueda seguir funcionando adecuadamente.

Mantenimiento = Conservación

Gestión y Ciclo de Vida de la Infraestructura Vial

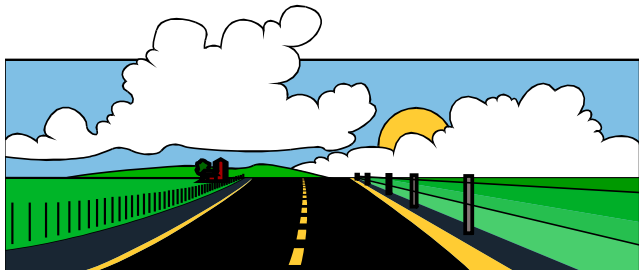


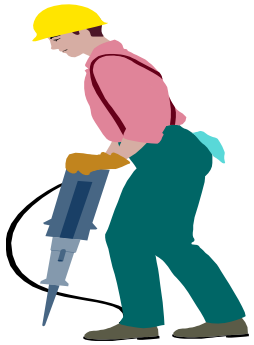
After N. Grigg

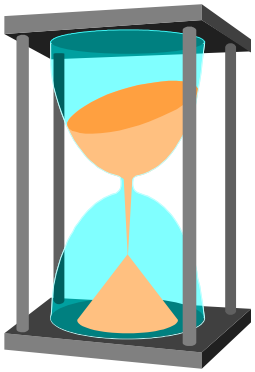

¿ Mantenimiento o
Rehabilitación ?

Filosofía del Mantenimiento Preventivo

Aplicar el tratamiento adecuado







. . Al pavimento correcto

. . . En el momento apropiado

¿Cuáles son los Objetivos del Mantenimiento Preventivo?

1. Preservar la Inversión

   (Aspectos Estructurales)

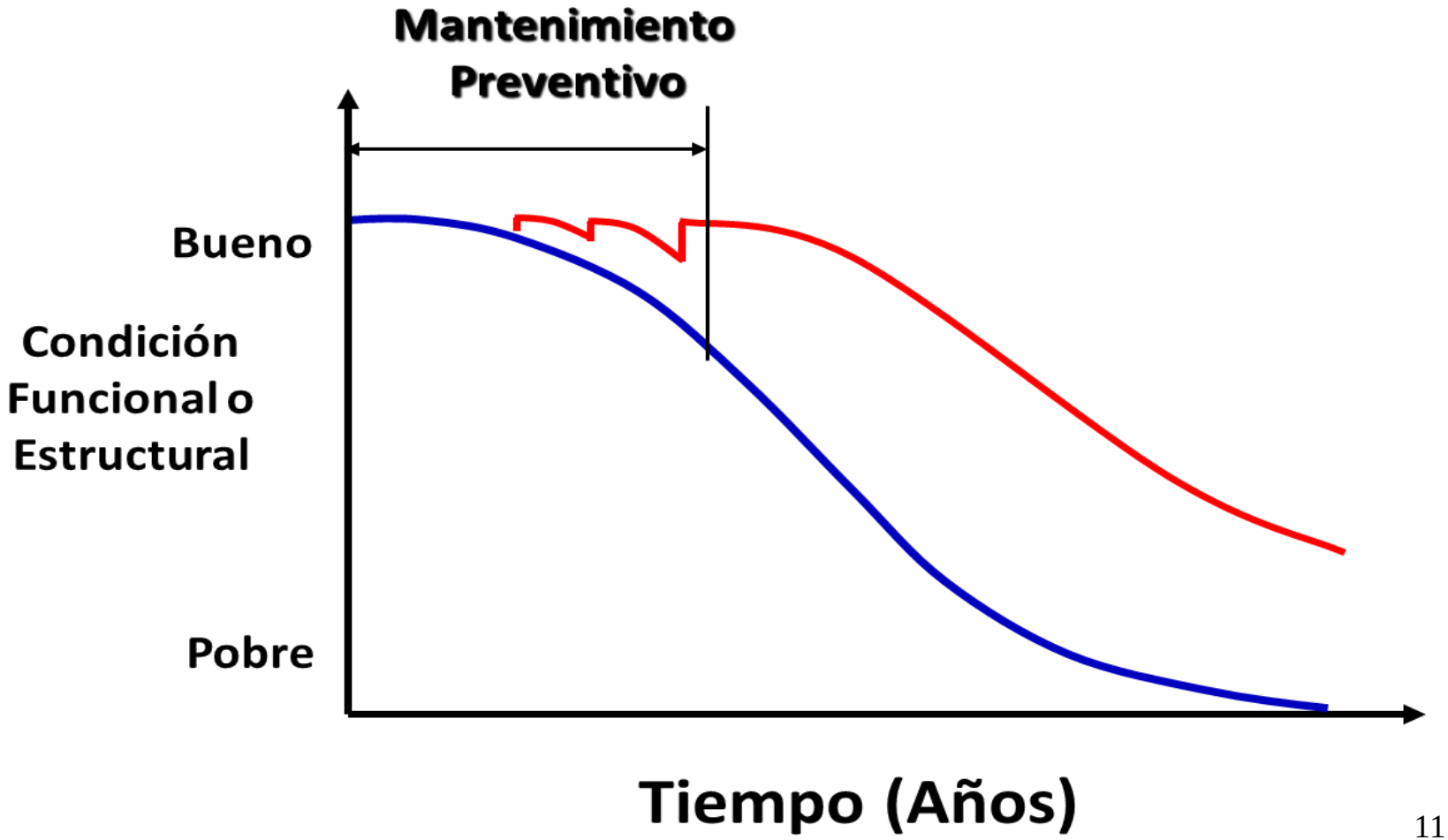
2. Mantener un Nivel de Servicio Alto

   (Aspectos Funcionales)


377


Marlboro

¿Cuándo Aplicar Mantenimiento Preventivo ?

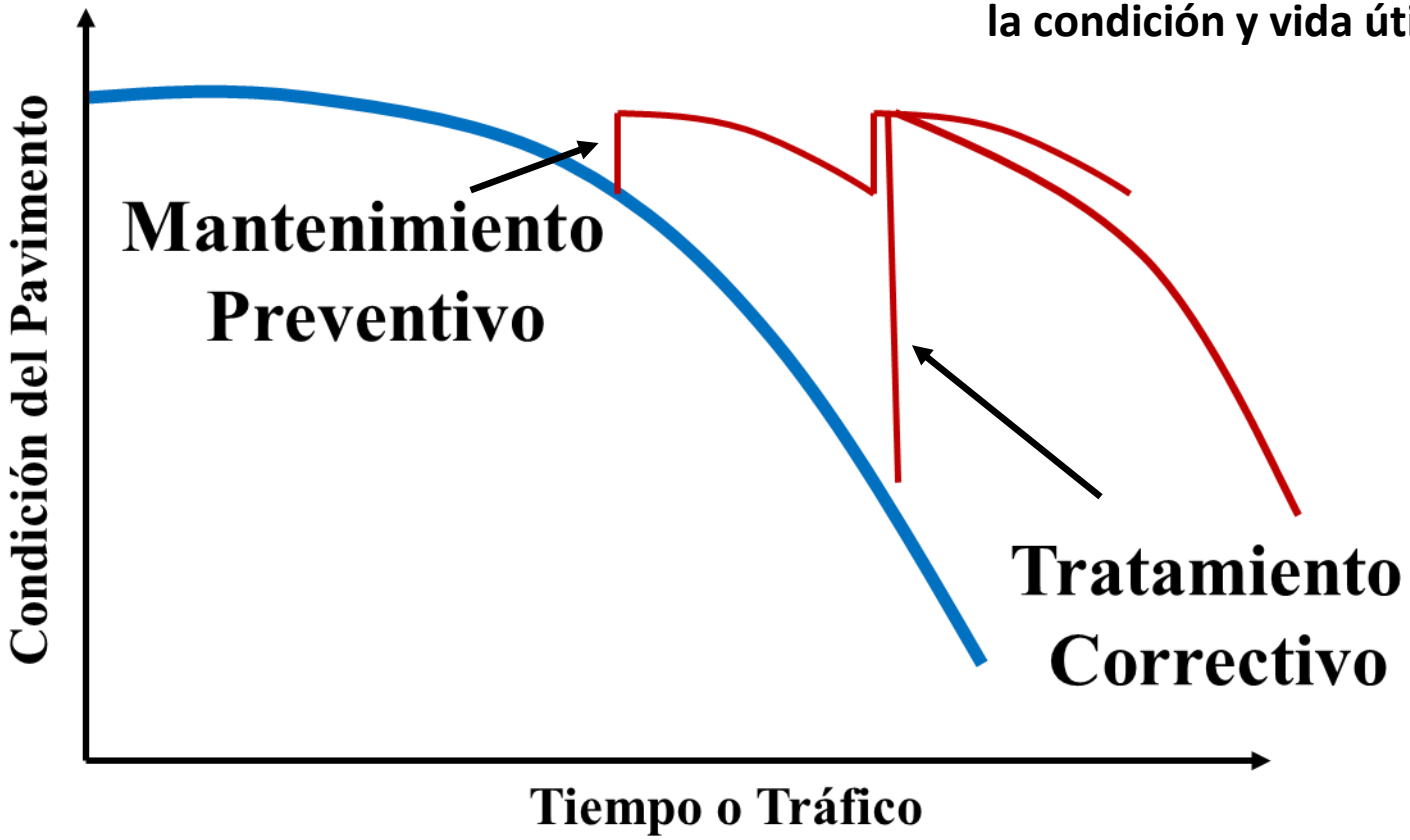


Mantenimiento Vial “Diferido”

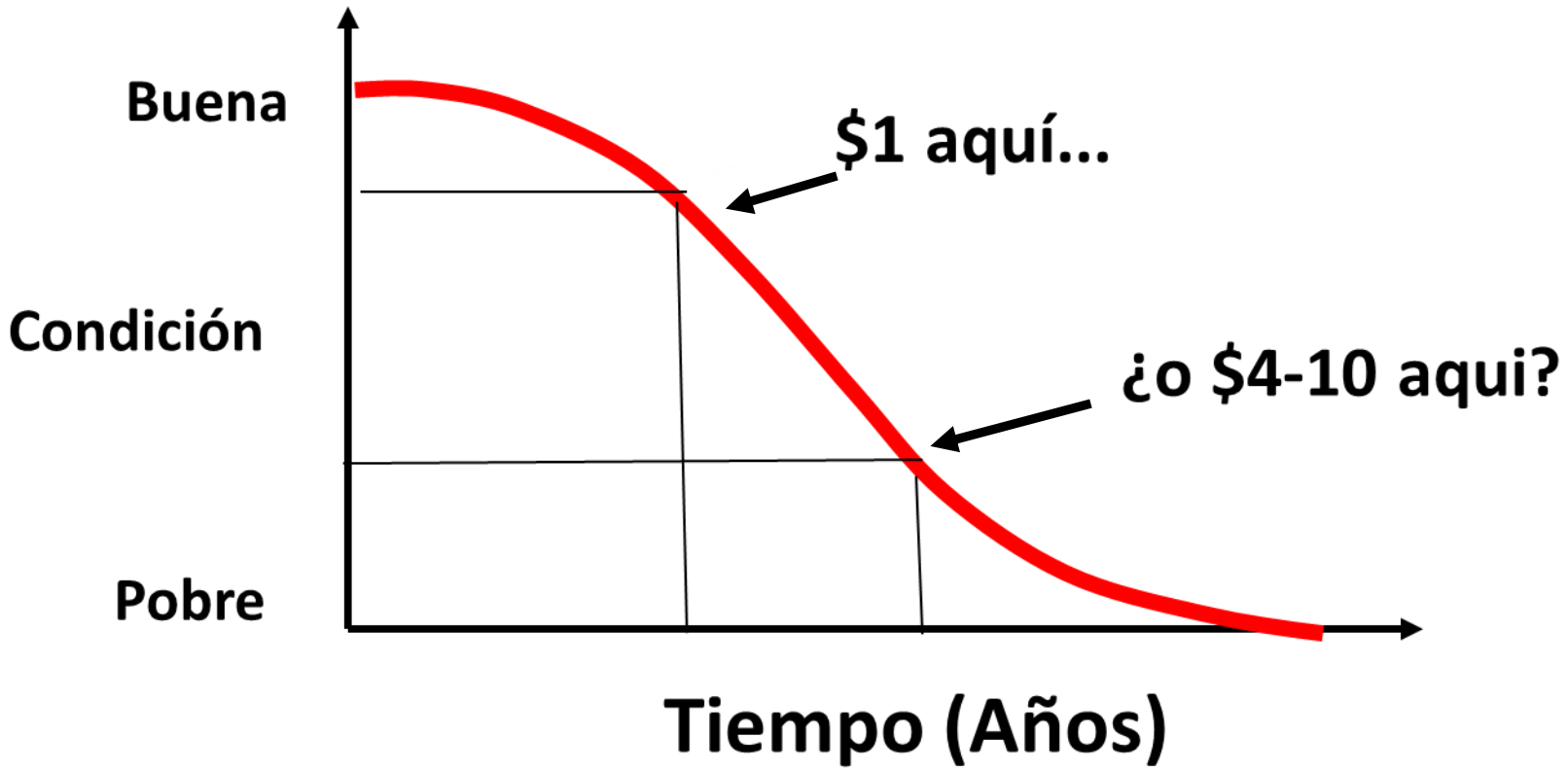
El mantenimiento diferido se refiere a intervenciones que se requieren realizar para conservar los diversos elementos que componen la red vial pero que han sido postpuestas en el programa de actividades de la agencia.

Mantenimiento Vial “Diferido”

Afecta negativamente la condición y vida útil



Mantenimiento Vial "Diferido"



Incrementa los costos de conservación al requerir intervenciones futuras más costosas (rehabilitación).


Korea, 1994


China, 1999


India, 2003


Portugal, 2001

… y en los U.S. ?

I-35W Mississippi River bridge

From Wikipedia, the free encyclopedia

Coordinates: 44°58′44″N 93°14′42″W

This article is about the bridge that collapsed in 2007. For the replacement bridge, see I-35W Saint Anthony Falls Bridge.

The **I-35W Mississippi River Bridge** (officially known as **Bridge 9340**) was an eight-lane, steel truss arch bridge that carried Interstate 35W across the Saint Anthony Falls of the Mississippi River in Minneapolis, Minnesota, United States. During the evening rush hour on August 1, 2007, it suddenly collapsed, killing 13 people and injuring 145. The bridge was Minnesota's fifth busiest,[4][5] carrying 140,000 vehicles daily.[3] The NTSB cited a design flaw as the likely cause of the collapse, noting that the gusset plates ripped like paper, and asserted that additional weight on the bridge at the time of the collapse contributed to the catastrophic failure.[6] Many families were affected.

Immediately after the collapse, help came from mutual aid in the seven county Minneapolis-Saint Paul metropolitan area and emergency response personnel, charities, and volunteers.[7][8][9] Within a few days of the collapse, the Minnesota Department of Transportation (Mn/DOT) planned a replacement bridge, the I-35W Saint Anthony Falls Bridge. Construction was completed rapidly, and it opened on September 18, 2008.[10][11]

I-35W Mississippi River Bridge

Bridge 9340 in May 2006

Official name	Bridge 9340
Carries	8 lanes of I-35W

STACY BENGS / THE MINNESOTA DAILY / AP

17 de Octubre del 2014

Friday, October 17, 2014 | TRAFFIC | 57°F

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Tuesday, May 28, 2013 - Page updated at 10:54 AM

Map: 'Structurally deficient' bridges in Washington state

The 2012 National Bridge Inventory shows 143 state-maintained bridges classified as "structurally deficient," which means that a bridge "requires repair or replacement of a certain component, such as cracked or spalled (damaged) concrete or the entire bridge itself," according to the Washington State Department of Transportation. Being structurally deficient does not imply that the bridge is in danger of collapse or unsafe for travel. The I-5 bridge that collapsed over the Skagit River was not classified as structurally deficient, though the span wasn't built to take a critical hit. Inspectors give bridges sufficiency ratings based on a 100-point scale that takes into account several factors, including structural adequacy, serviceability and how essential the bridge is for public use.

Recommend 356 people recommend this. Sign Up to see what your friends recommend.

In 2012, Washington had **143** **structurally deficient** bridges.

81 structurally deficient bridges were built **50 or more** years ago.

66 bridges have a sufficiency rating of **50 or below** out of a scale of 100.

20 bridges are also **fracture-critical**, meaning one failure could ruin an entire span.

12 fracture-critical bridges carry **10,000 or more vehicles** per day, on average.

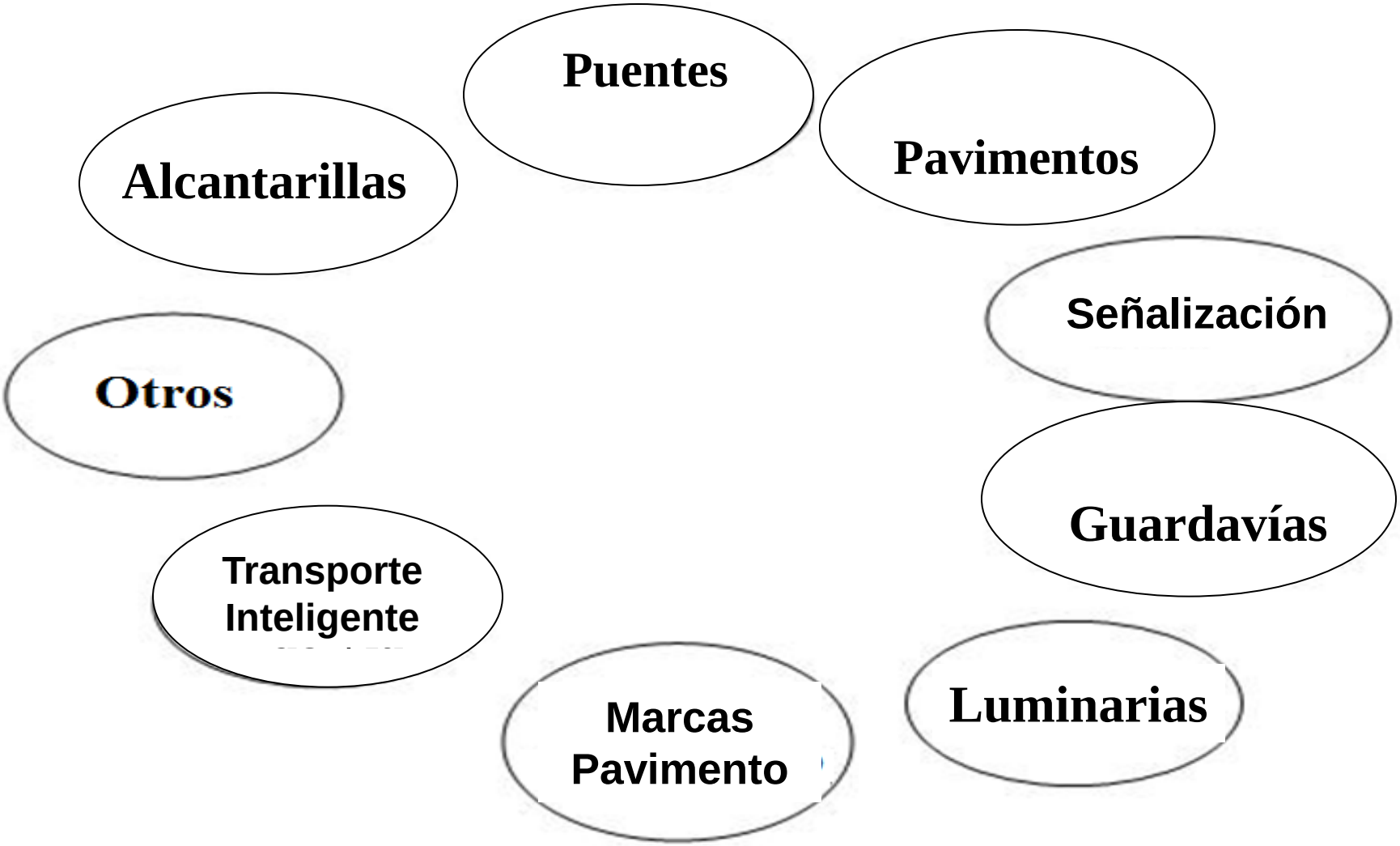
NCHRP 14-20A [Active]

Consequences of Delayed Maintenance of Highway Assets

Project Data	
Funds:	$450,000
Staff Responsibility:	Amir N. Hanna
Research Agency:	The University of Texas at El Paso
Principal Investigator:	Carlos M. Chang
Effective Date:	12/9/2013
Completion Date:	3/9/2016

BACKGROUND: Various maintenance treatments are employed by highway agencies to slow deterioration and bridges, and other physical assets. However, budget constraints and other factors have often led to delaying treatments. Such actions are expected to adversely influence the condition and performance and lead to a reduc and eventually to the need for costly rehabilitation or replacement.

Muchos Tipos de Elementos pueden ser Considerados



Causas del Mantenimiento Vial "Diferido"

1. Fondos insuficientes para atender las necesidades de mantenimiento a tiempo.

2. Otras prioridades de inversión o procesos administrativos complejos que resultan en políticas de mantenimiento restringidas.

3. Mayor interés en ver resultados a corto plazo que a largo plazo.

4. **Falta de métodos claros para cuantificar las consecuencias del mantenimiento vial diferido.**

Mantenimiento Vial y Desempeño

1. Condición actual de la red vial.

2. Influencia del tráfico y clima en el desempeño futuro de los elementos que componen la red vial durante la vida en servicio.

3. Extensión de la vida útil remanente debido a la implementación de un programa de mantenimiento vial efectivo y eficiente.

2013 REPORT CARD for America's INFRASTRUCTURE

March 2013

Forty-two percent of America's major
estimated $101 billion in wasted time
near term, and Federal, state, and loca
level of investment is insufficient and
performance in the long term. Currently, the Federal Highway Administration estimates that $170
billion in capital investment would be needed on an annual basis to significantly improve conditions
and performance.

Inversión anual actual

$ 91 Billones

Necesidad de inversión anual

$ 170 Billones

Over two hundred million trips are rgest
metropolitan regions. In total, one ficient,
while the average age of the natio way
Administration (FHWA) estimates 2028, we
would need to invest $20.5 billion annually, while only $12.8 billion is being spent currently. The

Inversión anual actual

$ 12.8 Billones

Necesidad de inversión anual

$ 20.5 Billones

2013 REPORT CARD FOR AMERICA'S INFRASTRUCTURE ASCE

Category	1988*	1998	2001	2005	2009	2013
Aviation	B-	C-	D	D+	D	D
Bridges	-	C-	C	C	C	C+
Dams	-	D	D	D+	D	D
Drinking Water	B-	D	D	D-	D-	D
Energy	-	-	D+	D	D+	D+
Hazardous Waste	D	D-	D+	D	D	D
Inland Waterways	B-	-	D+	D-	D-	D-
Levees	-	-	-	-	D-	D-
Public Parks and Recreation	-	-	-	C-	C-	C-
Rail	-	-	-	C-	C-	C+
Roads	C+	D-	D+	D	D-	D
Schools	D	F	D-	D	D	D
Solid Waste	C-	C-	C+	C+	C+	B-
Transit	C-	C-	C-	D+	D	D
Wastewater	C	D+	D	D-	D-	D
Ports	-	-	-	-	-	C
America's Infrastructure GPA	C	D	D+	D	D	D+
Cost to Improve	-	-	$1.3 trillion	$1.6 trillion	$2.2 trillion	$3.6 trillion

Problemas y Soluciones

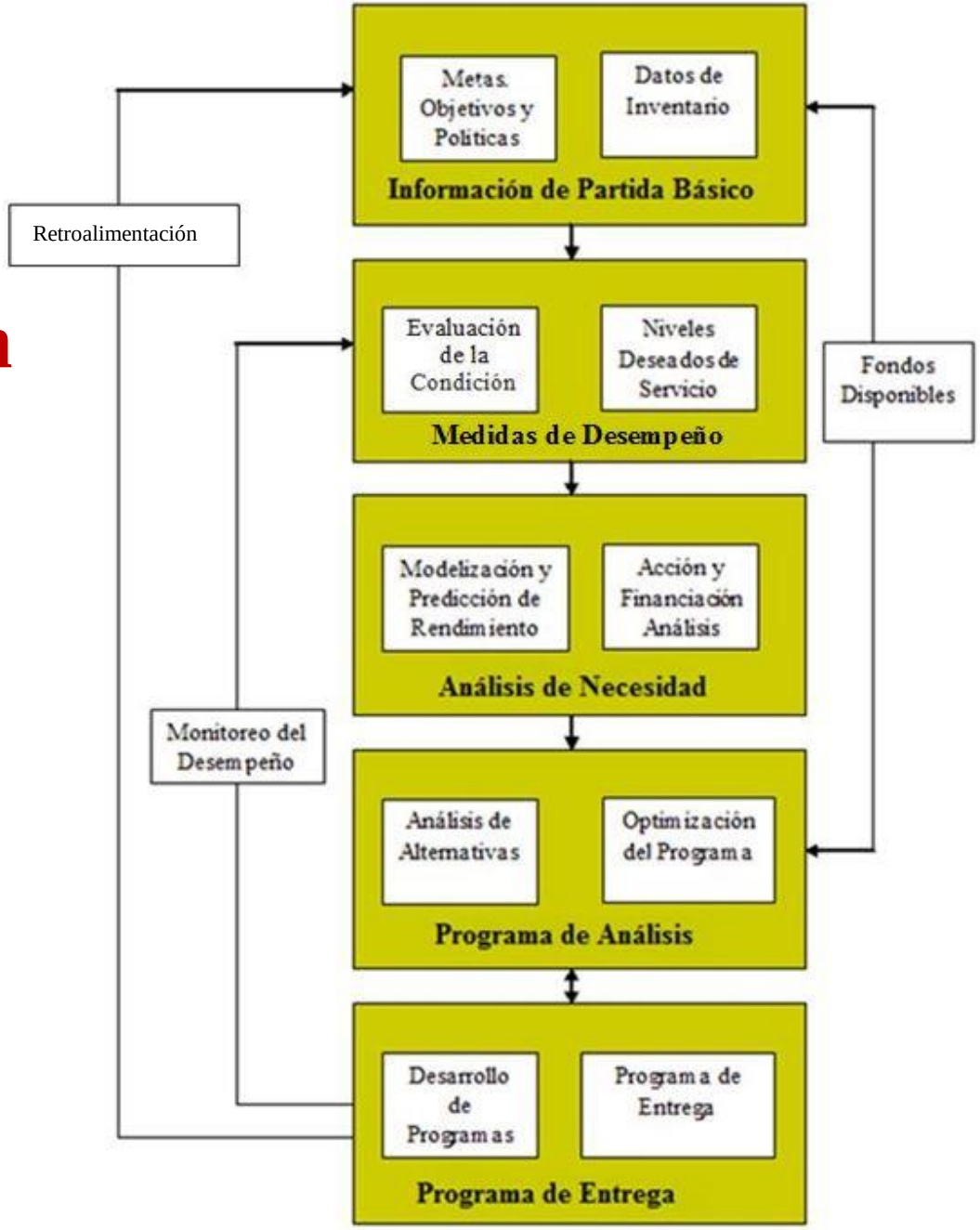
1. Las **políticas y prioridades** al formular los programas de mantenimiento varían significativamente de una agencia a otra.

2. El mantenimiento diferido es un **problema común.**

3. Utilizar **indices de desempeño** para evaluar y comunicar las consecuencias de las políticas de mantenimiento.

4. Implementar sistemas de gestión para administrar la información de la red vial y realizar análisis de escenarios para **cuantificar el impacto.**

Sistema de Gestión Infraestructura Vial




Pavimentos

Índices de Desempeño - Pavimentos

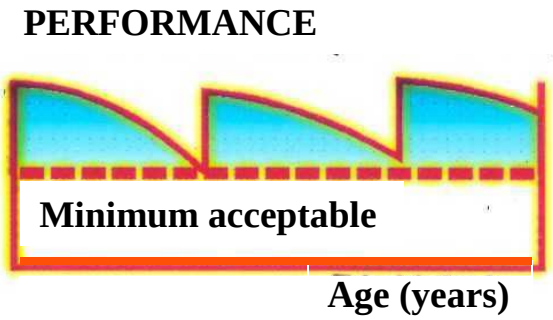
1. International Roughness Index (IRI)
2. Present Serviceability Index (PSI)
3. Present Serviceability Rating (PSR)
4. Skid Number (SN) or Friction Number (FN)
5. International Friction Index (IFI)
6. Pavement Condition Index (PCI)
7. Pavement Quality Index (PQI)
8. Ahuellamiento, Fisuramiento, Desniveles
9. Structural Strength Index (SSI)
10. Vida útil remanente

Objetivos de Desempeño - Pavimentos

1. Valor Máximo de IRI
2. Valor Mínimo de Condición del Pavimento
3. Valor Mínimo de Vida Util Remanente
4. Valor Mínimo de Resistencia a la Fricción
5. Porcentaje Mínimo de la Red Vial en Buena Condición
6. Porcentaje Máximo de la Red Vial en Buena Condición

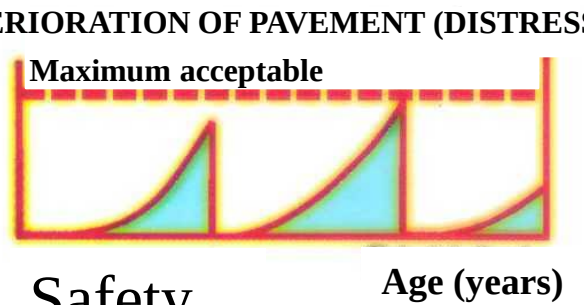
Main Parameters that make the Serviceability of a Pavement

Roughness level

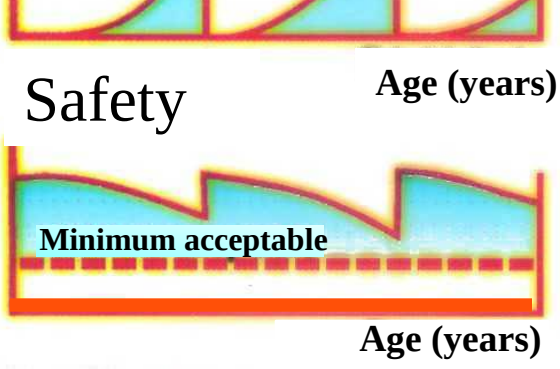


Level of Structural Capacity

Level of Distress



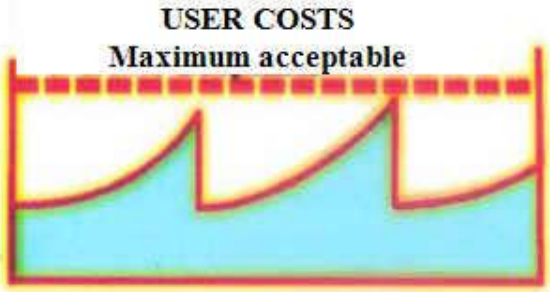
Skid Resistance Level



PARAMETERS USUALLY DETERMINED IN THE EVALUATION OF PAVEMENTS

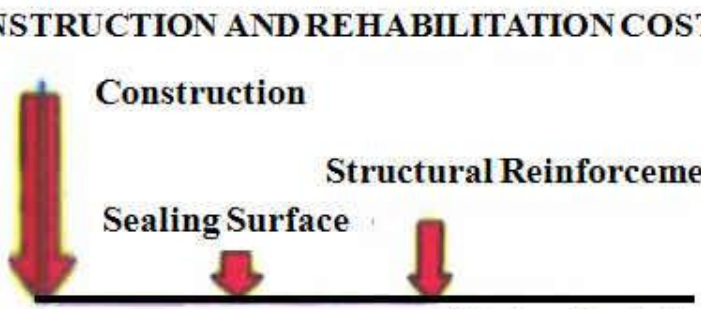
Maintenance Costs

User Costs



ADITIONAL PARAMETERS FOR USE IN ECONOMIC ANALYSIS

Construction and Rehabilitation costs



Geometric Characteristics

Categories f(IMD)

- **-Road width - Shoulder**
- **-Curve Radius, etc.**

Tipos de Mantenimiento de Pavimentos

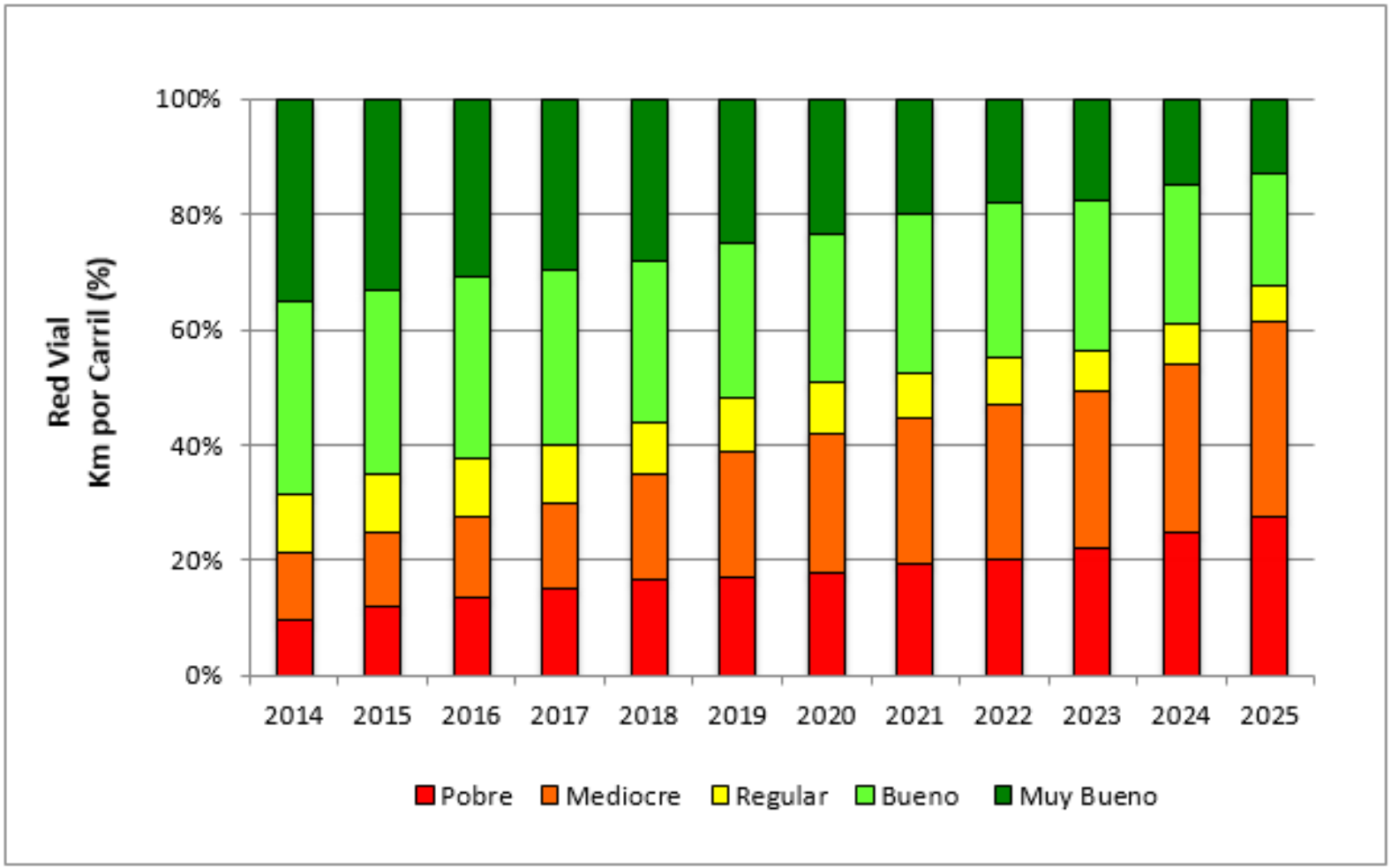
Mantenimiento Preventivo: Preservar y retardar el deterioro futuro, mantener la funcionalidad del sistema vial.

Mantenimiento Rutinario: Actividades que son realizadas rutinariamente para preservar la condición o restaurar un nivel de servicio adecuado.

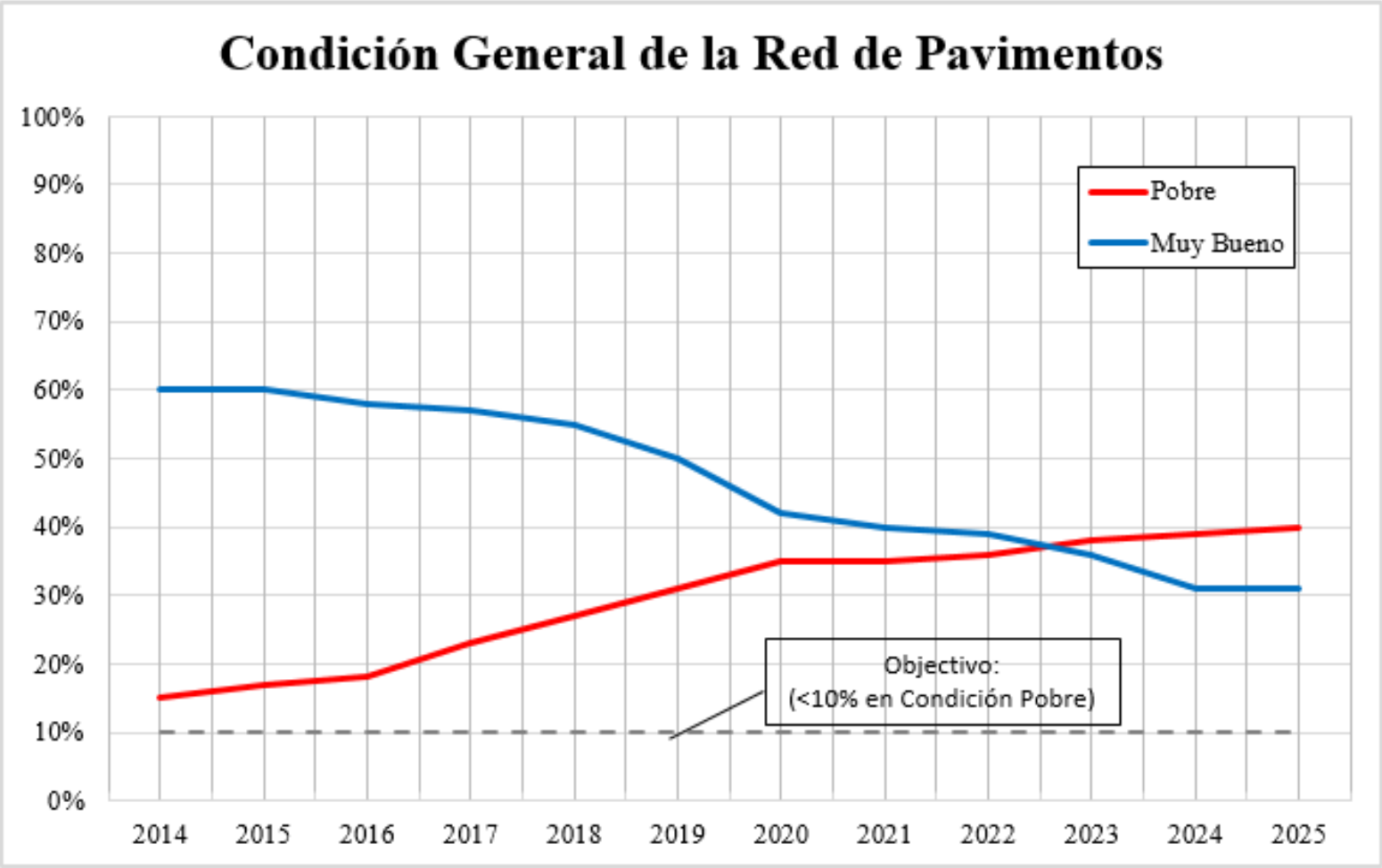
Bases de Datos y Herramientas de Análisis para Pavimentos

1. Highway Performance Monitoring System (HPMS)
2. Highway Economic Requirements System (HERS)
3. Long-Term Pavement Performance (LTPP)
4. Highway Development and Management (HDM-4)
5. **Pavement Health Track (PHT)**

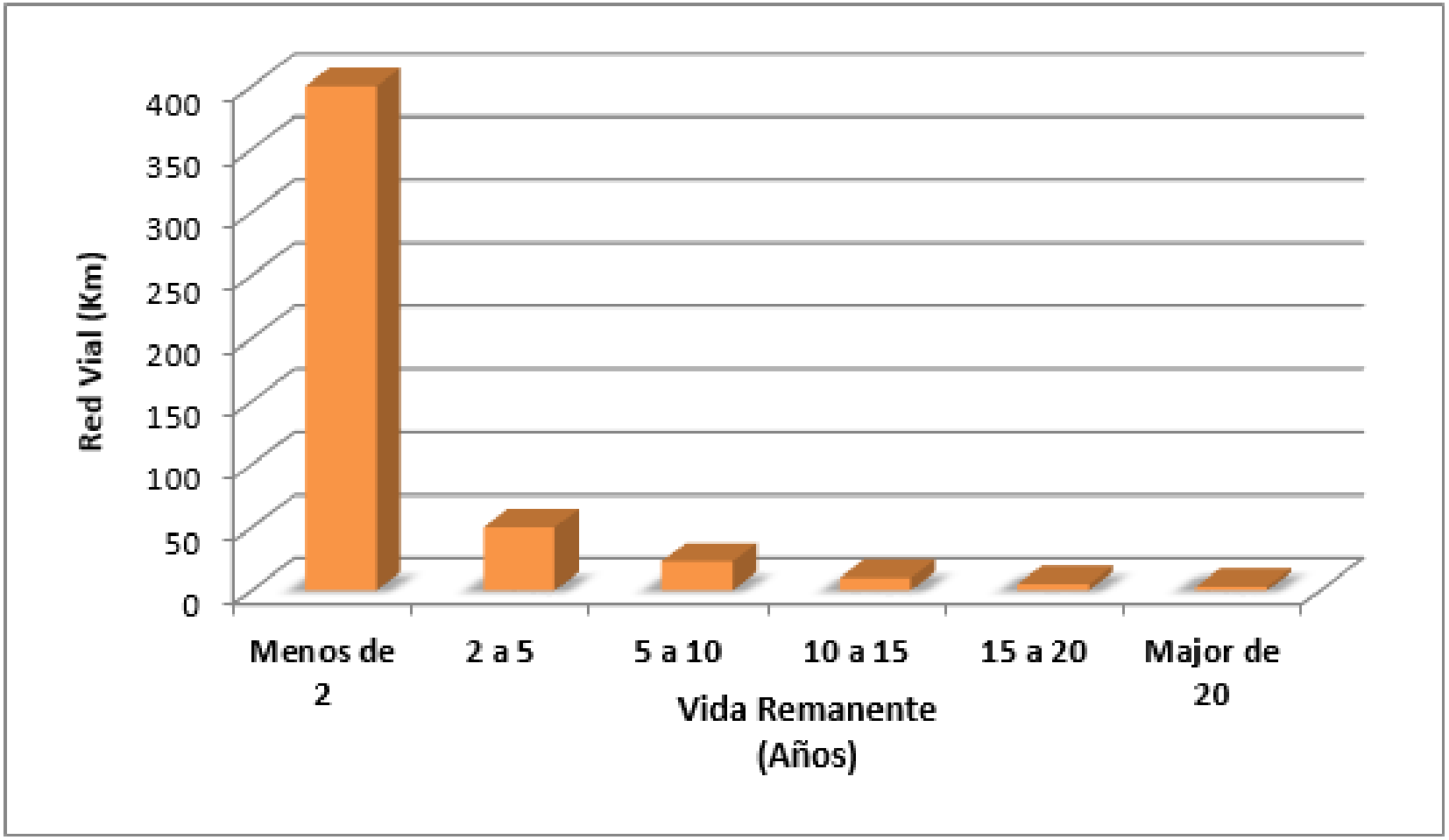
Escenario de Mantenimiento Diferido
Condición del Pavimento



Escenario de Mantenimiento Diferido
Condición del Pavimento



Escenario de Mantenimiento Diferido
Vida Útil Remanente

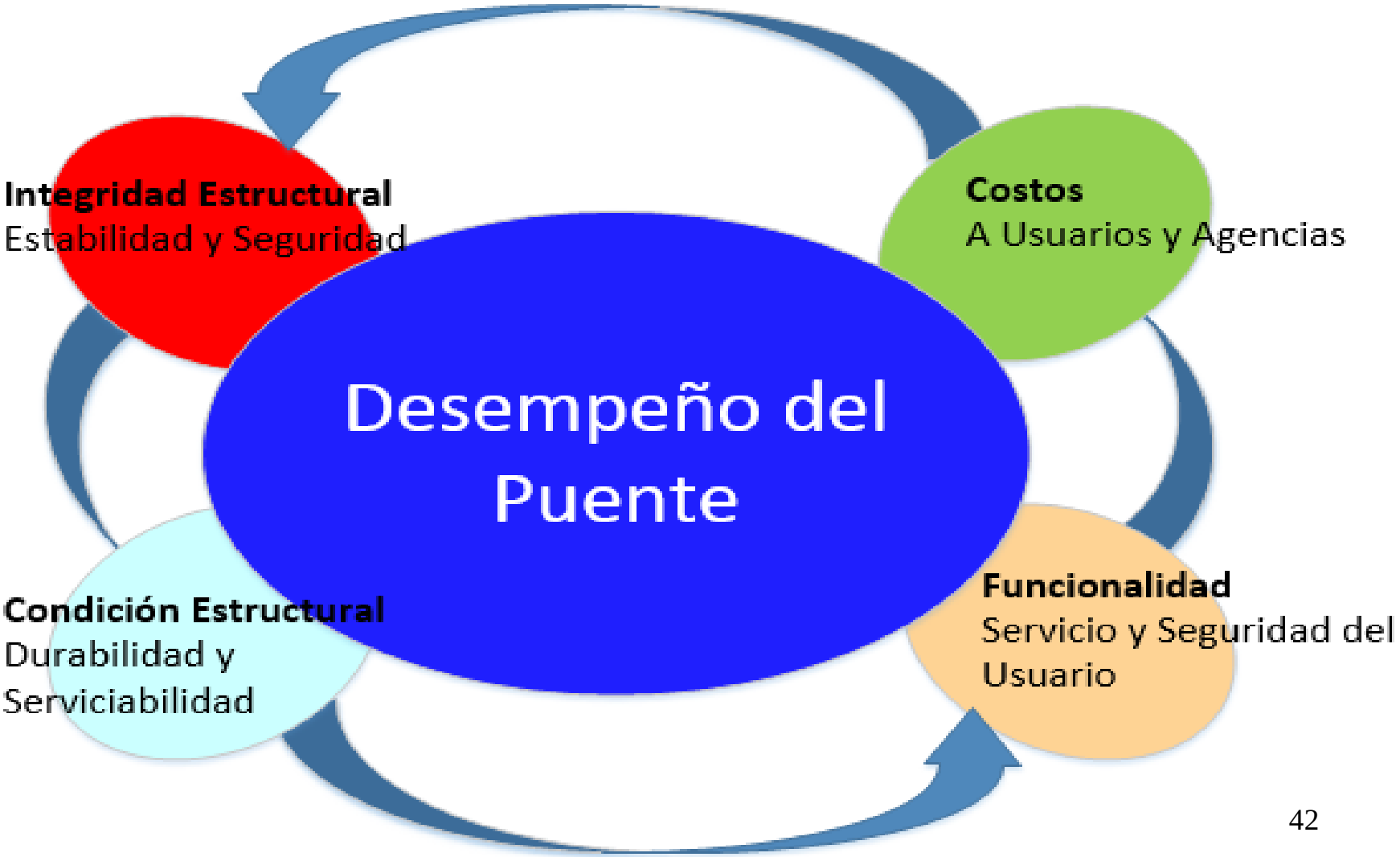


Escenario de Mantenimiento Diferido Valor de Recuperación y Sostenibilidad

	2000	2002	2004	2006	2008	2010	2012	2014	2016	2018	2019
Valor De la Red Vial	$3,500	$3,430	$3,328	$3,163	$3,069	$2,886	$2,605	$2,278	$2,056	$1,855	$1,762
ISP	1	0.98	0.96	0.94	0.92	0.91	0.89	0.87	0.85	0.84	0.83

Puentes

Gestión de Puentes y Desempeño



Objetivos del Mantenimiento de Puentes

1. Que sean seguros para los usuarios
2. Que no obstruyan el libre tráfico
3. Amistosos al medio ambiente
4. Nivel de riesgo aceptable en caso de eventos catastróficos
5. Presentar una apariencia estética
6. Minimizar el costo del ciclo de vida

U.S. Puentes por Edad

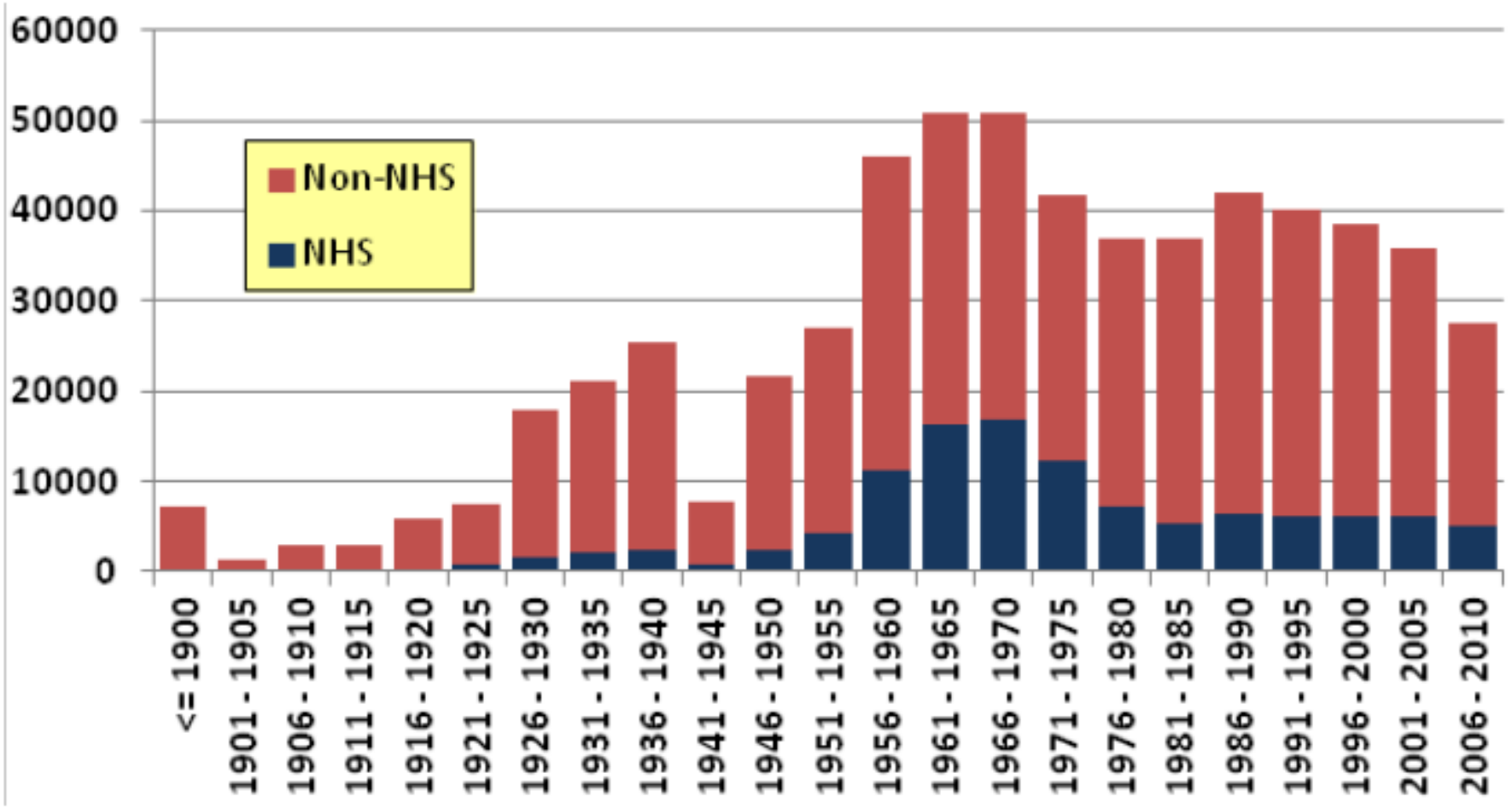


Figure 1. Graph. Age Distribution of All Bridges in the United States.[2]

Long-Term Bridge Performance Program

TECHBRIEF

Long-Term Bridge Performance High Priority Bridge Performance Issues

FHWA Publications No.: FHWA-HRT-14-043

FHWA Contact: Susan Lane, HRDI-60, (202) 493-3151, susan.lane@dot.gov

This document is a technical summary of the published Federal Highway Administration (FHWA) report *Long-Term Bridge Performance High Priority Bridge Performance Issues* (FHWA-HRT-14-052), available through the National Technical Information Service at www.ntis.gov.

NTIS Accession No. of the report covered in this TechBrief: PB2014-106340

1. Report No. FHWA-HRT-13-051	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle LTBP Bridge Performance Primer		5. Report Date December 2013
		6. Performing Organization Code:

Índices de Desempeño - Puentes

1. Bridge Health Index (BHI – 0 -100)
2. National Bridge Inventory (NBI)
   Estructuralmente Deficiente (SD)
   Funcionalmente Obsoleto (FO)
3. Sufficiency Ratio (SR)
4. Bridge Value Index (BVI)

NBI Items

Item #	Description	Item #	Description
1	State Code	55	Minimum Lateral Under clearance on Right
2	Highway Agency District	56	Minimum Lateral Under clearance on Left
3	County (Parish) Code	58	Deck Condition Rating
4	Place Code	59	Superstructure Condition Ratings
5	Inventory Route	60	Substructure Condition Ratings
6	Features Intersected	61	Channel and Channel Protection
7	Facility Carried by Structure	62	Culverts Condition Ratings
8	Structure Number	63	Method used to Determine Operating Rating
9	Location	64	Operating Rating
10	Inventory Route, Minimum Vertical Clearance	65	Method used to Determine Inventory Rating
11	Kilometer Point	66	Inventory Rating
12	Base highway Network	67	Structural Evaluation Appraisal Ratings
13	LRS Inventory Route, Subroute Number	68	Deck Geometry Appraisal Ratings
19	Bypass, Detour, Length	69	Under clearances, Vertical and Horizontal Appraisal Ratings
20	Toll	70	Bridge Posting
21	Maintenance Responsibility	71	Waterway Adequacy Appraisal Ratings
22	Owner	75	Type of Work
26	Functional Classification of Inventory Route	76	Length of Structure Improvement
27	Year Built	90	Inspection Date
28	Lanes On and Under the Structure	91	Designated Inspection Frequency
29	Average Daily Traffic	92	Critical Feature Inspection

NBI Rating – Condición del Puente

9: Excelente
8: Muy buena condición
7: Buena condición
6: Condición Satisfactoria
5: Condición Regular
4: Condición Mala
3: Condición Muy Mala
2: Condición Crítica
1: Condición de Falla Inminente
0: Condición de Falla

Bridge Health Index

$$HI = (\Sigma QCS_i \times WF_i)/(\Sigma TEQ \times We) \times 100\% \qquad \{Worst = 0\%, Best = 100\%\}$$

Figure 4. Equation. California Bridge Health Index.[4]

Where:

HI = Health index.

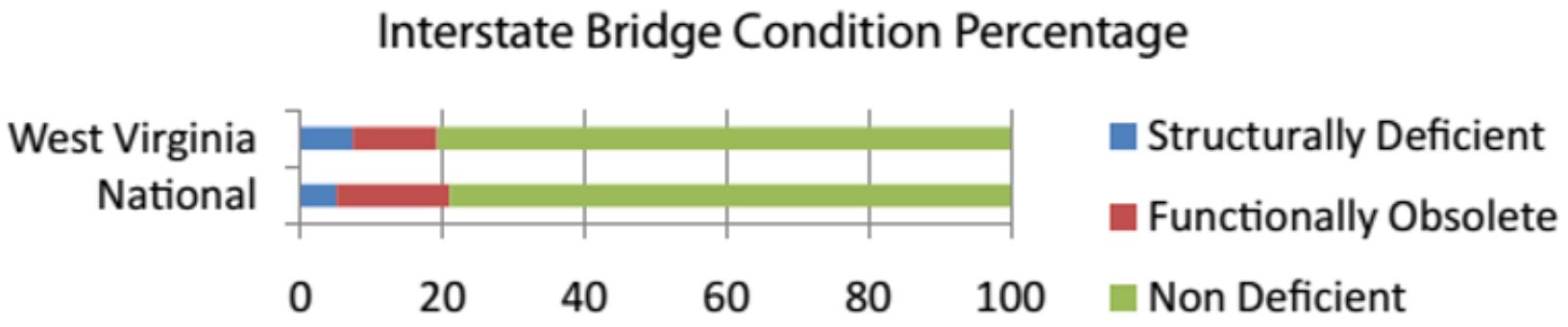
QCS_i = Quantity in condition state i.

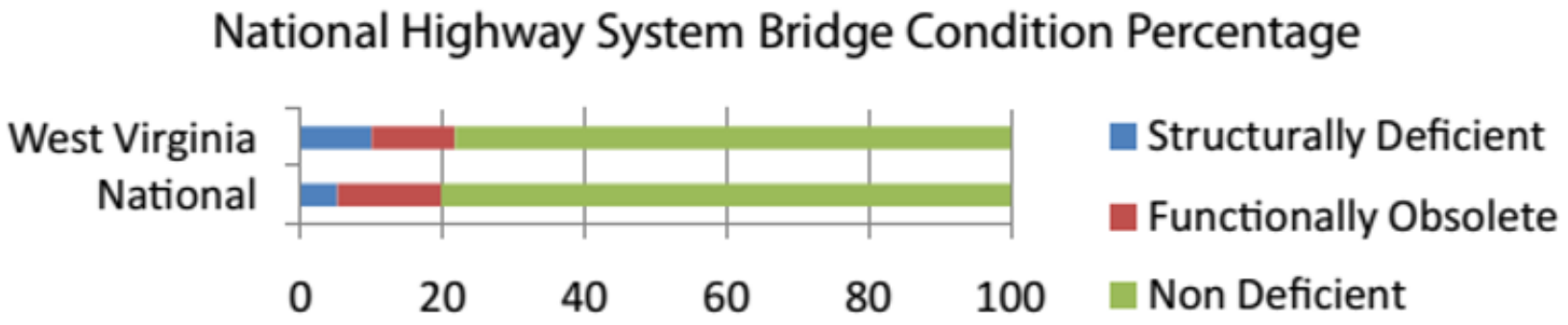
WF_i = Weighting factor for condition i.

TEQ = Total element value i.

We = Element indicator cost of other important indicator for each element.

Condición de los Puentes





Condición NBI

SD: Structural Deficiency - Estructuralmente deficiente si el tablero, superestructura, o subestructura tiene un evaluación de 4 o menos.

FO: Functional Obsolete - No es estructuralmente deficiente pero el diseño es obsoleto

SR: Sufficient Rating - FHWA Determina que puentes son elegibles para rehabilitación o reemplazo. Es función de integridad estructural, seguridad, serviciabilidad, funcionabilidad, nivel de importancia (100 a 0)

Sufficient Rating (SR)

SR is calculated using a complex formula wherein weighting factors are assigned to several bridge parameters and attributes in order to arrive at the numerical index for each bridge. The basic formula is shown in figure 3.

$$SR = S_1 + S_2 + S_3 - S_4$$

Figure 3. Equation. Federal SR.[1]

Where:

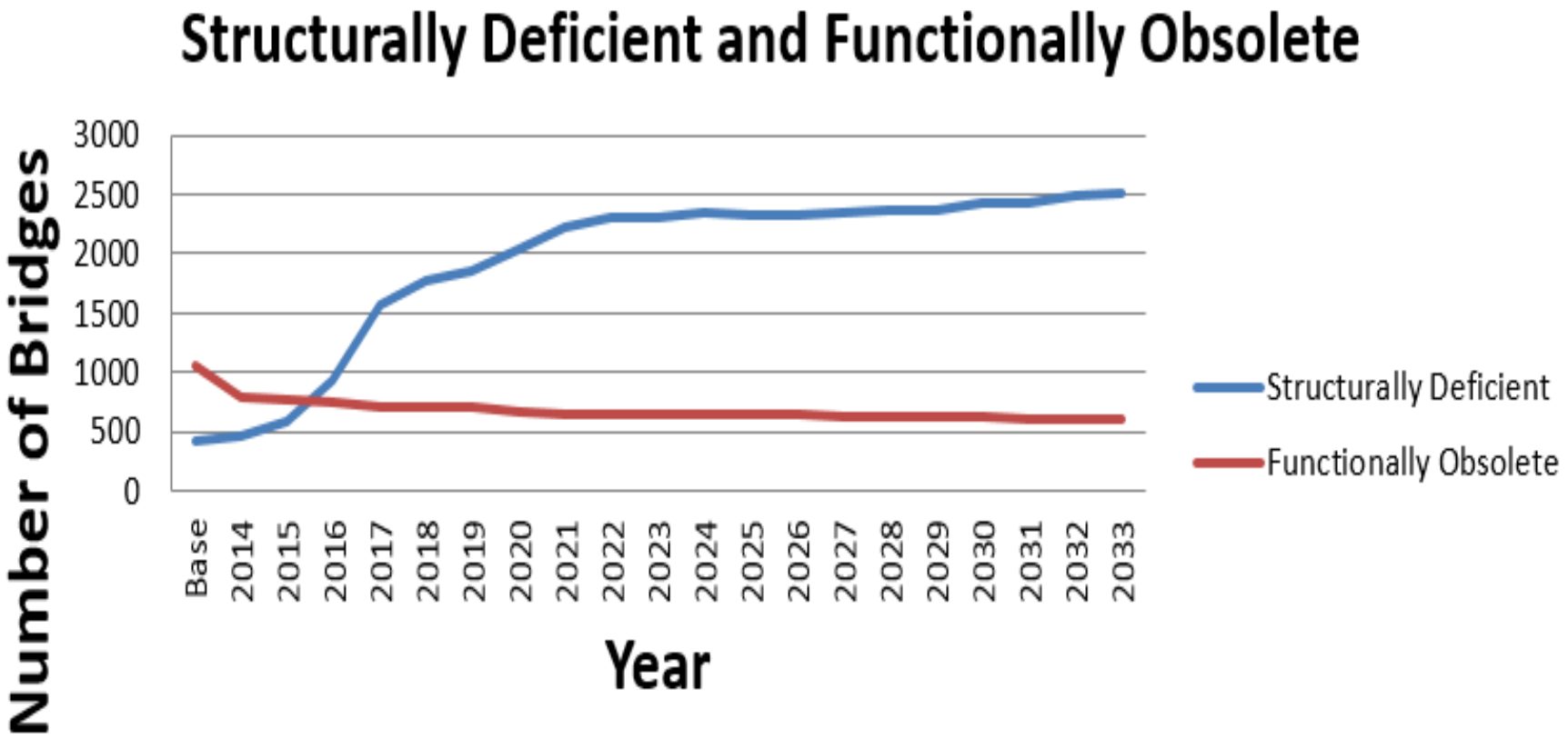
S_1 = Structural adequacy and safety (maximum value = 55 percent).

S_2 = Serviceability and functional obsolescence (maximum value = 30 percent).

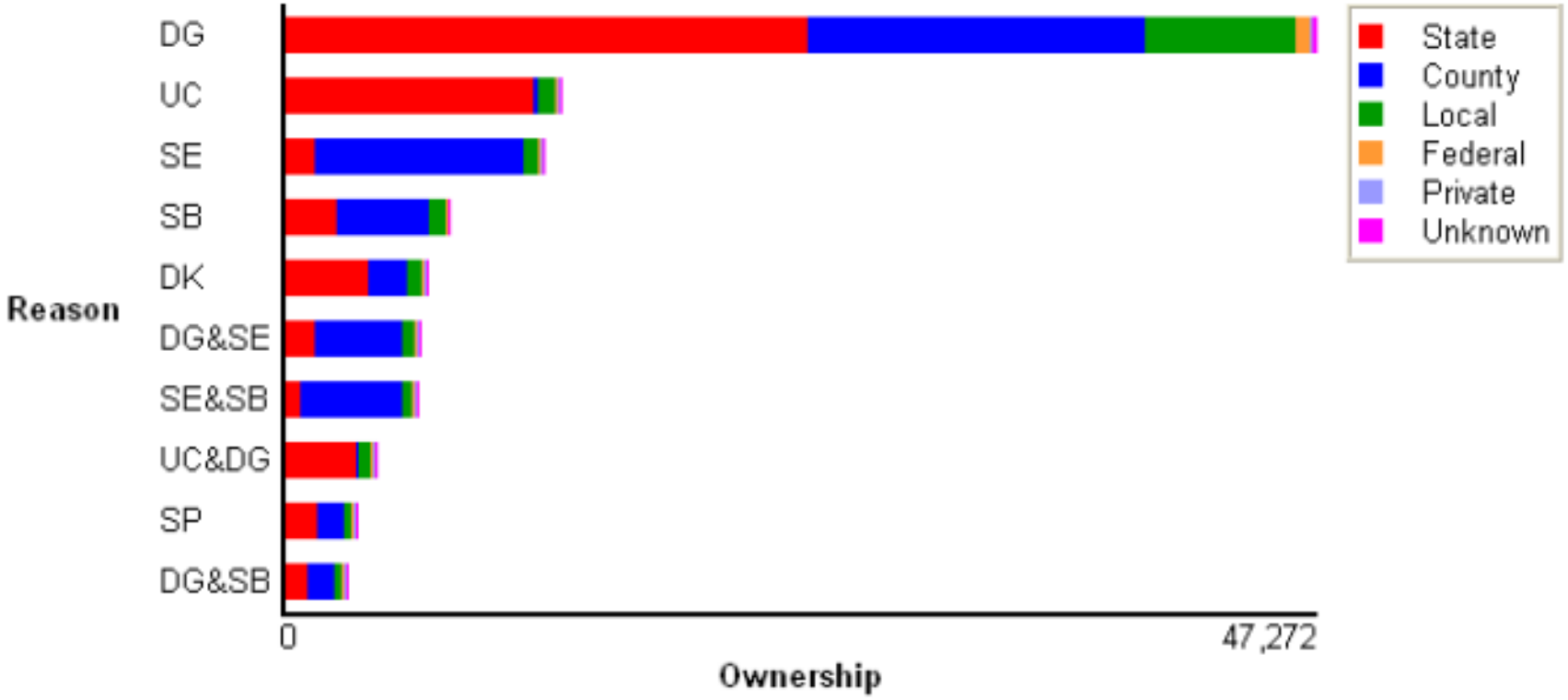
S_3 = Essentiality for public use (maximum value = 15 percent).

S_4 = Special reductions (maximum value = 6 percent).

Puentes con Deficiencia Estructural u Obsoletos Funcionalmente

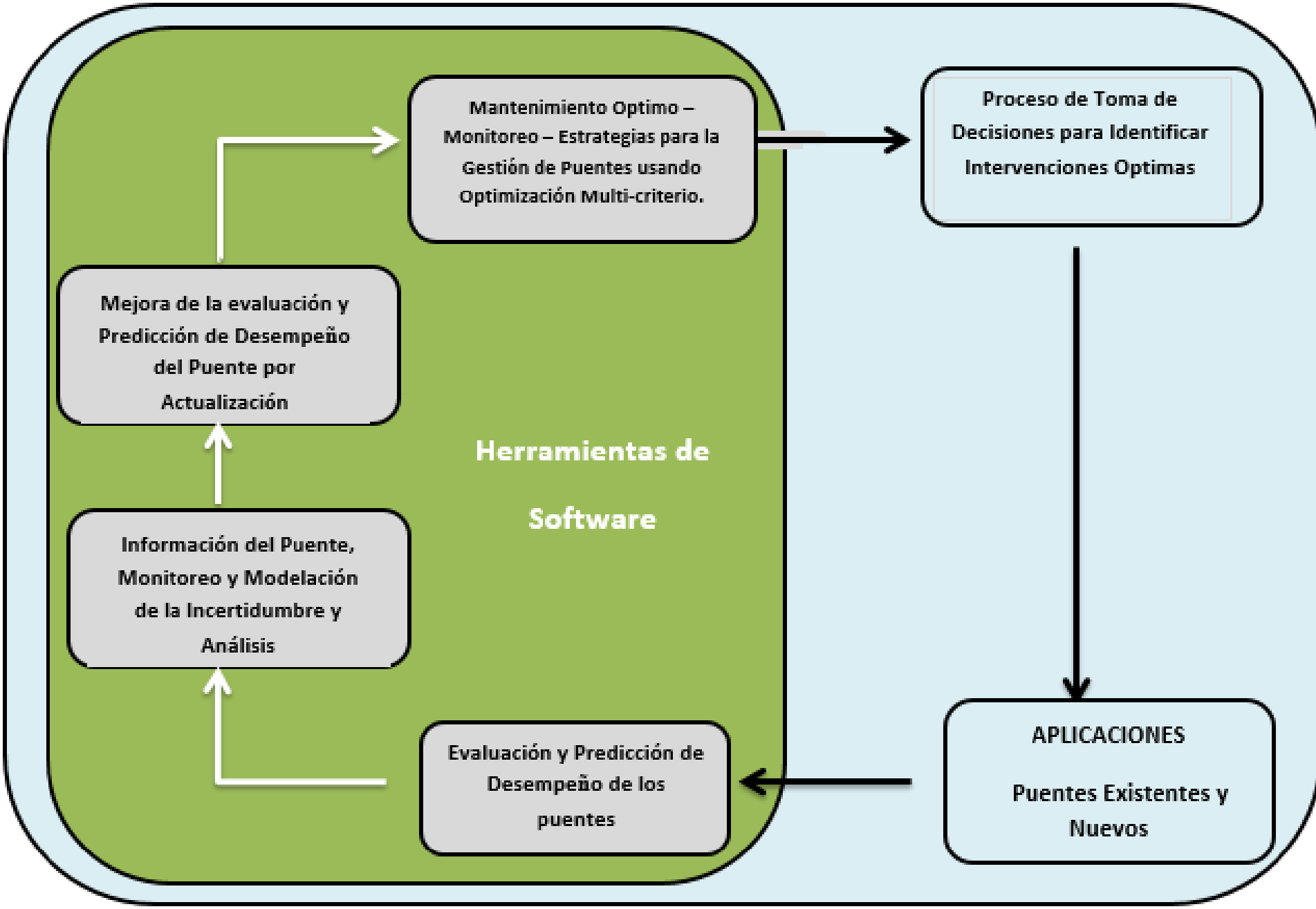


Analysis of the 2011 NBI data shows that the primary cause for a bridge to be flagged as SD or FO is related to deck geometry—a bridge is FO because the roadway width is considered too narrow for the traffic volumes currently using the bridge.[2] Figure 49 provides the top 10 reasons why a bridge is rated as deficient.



AL = Approach Alignment
DG = Deck Geometry
DK = Deck Condition Rating
SB = Substructure Condition Rating
SE = Structural Evaluation
SP = Superstructure Condition Rating
UC = Underclearance
WW = Waterway Adequacy

Figure 49. Graph. Reasons for Bridge Rating of SD or FO.[2]


Mantenimiento Optimo – Monitoreo – Estrategias para la Gestión de Puentes usando Optimización Multi-criterio.
Proceso de Toma de Decisiones para Identificar Intervenciones Optimas
Mejora de la evaluación y Predicción de Desempeño del Puente por Actualización
Herramientas de Software
Información del Puente, Monitoreo y Modelación de la Incertidumbre y Análisis
Evaluación y Predicción de Desempeño de los puentes
APLICACIONES
Puentes Existentes y Nuevos

Objetivos de Desempeño - Puentes

1. Especificar un valor mínimo de Bridge Health Index (BHI)
2. Porcentaje Mínimo de Puentes en Buena Condición
3. Porcentaje de Área de tablero de puentes clasificados como estructuralmente deficiente
4. Porcentaje de puentes clasificados como funcionalmente obsoletos.

Tipos de Mantenimiento de Puentes

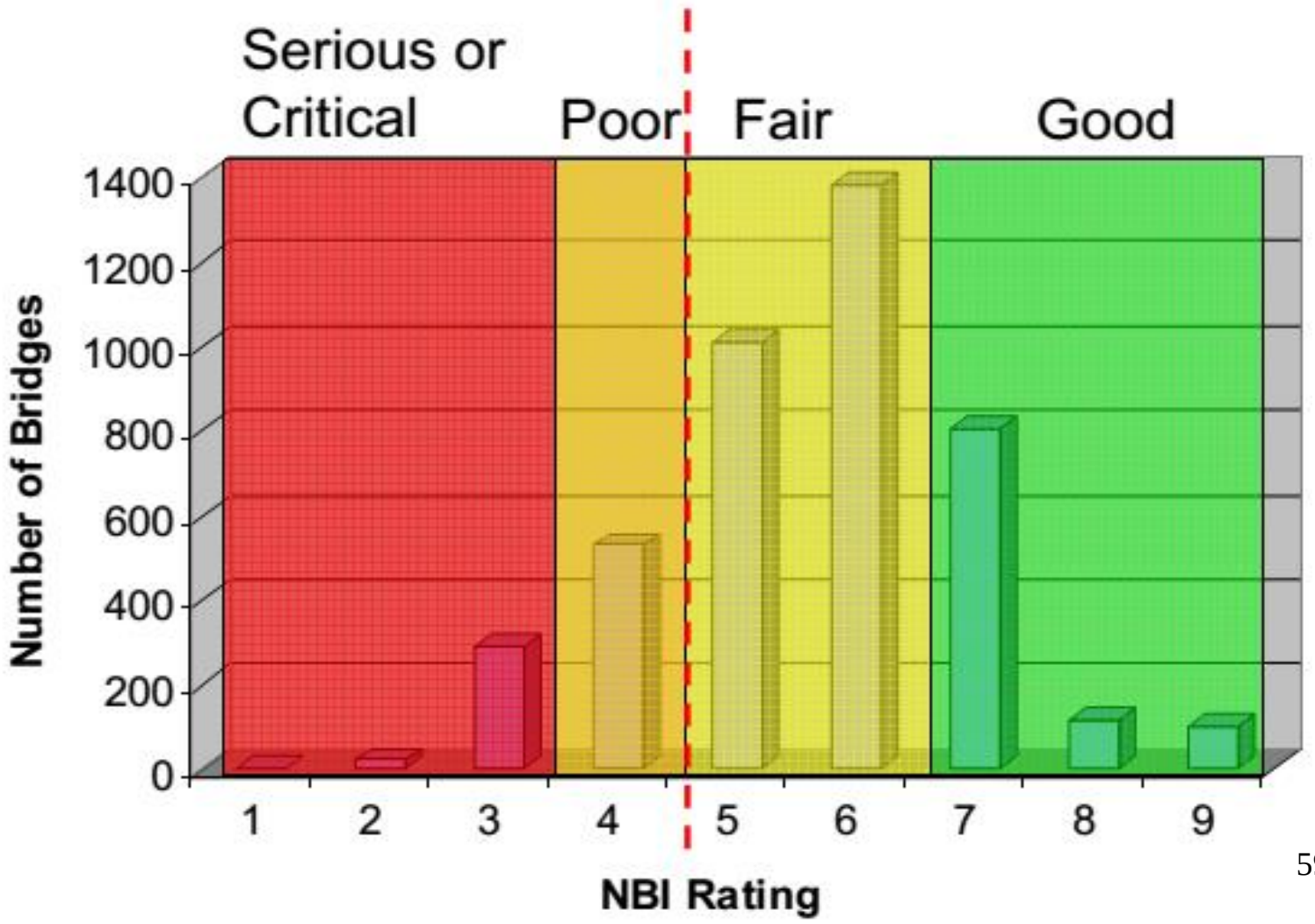
Mantenimiento Preventivo Cíclico : Actividades que son **realizadas en intervalos de tiempo predeterminados** para preservar los elementos del puente y retardar el deterioro.

Mantenimiento Basado en la Condición : Actividades necesarias de realizar que son **identificadas al evaluar la condición de los elementos** del puente mediante una inspección.

Bases de Datos y Herramientas de Análisis para Puentes

1. National Bridge Investment Analysis System (NBIAS)
2. AASHTOware Bridge Management (formerly Pontis)
3. Bridge Life-cycle Cost Analysis (BLCCA)
4. Project Level Analysis Tool (PLAT)
5. Long-Term Bridge Performance (LTBP)

Condición de los Puentes (NBI)



Transition Probabilities

Action 0 (do nothing)

CS	1	2	3	4	5
1	87.06	12.94			
2		93.30	6.70		
3			84.09	15.91	
4				84.09	15.91
5					79.37

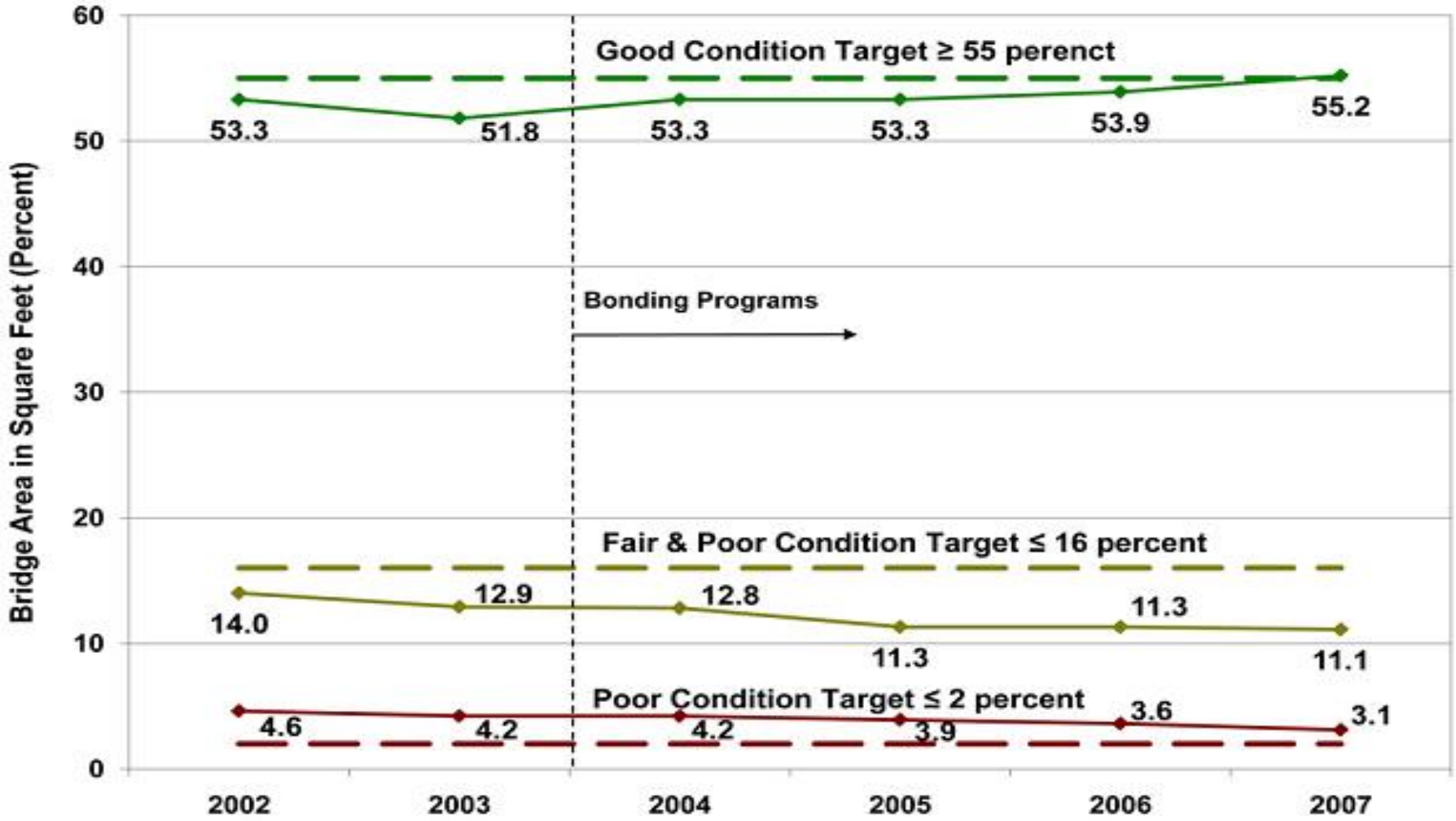
Failure Probability 20.63

Action 1

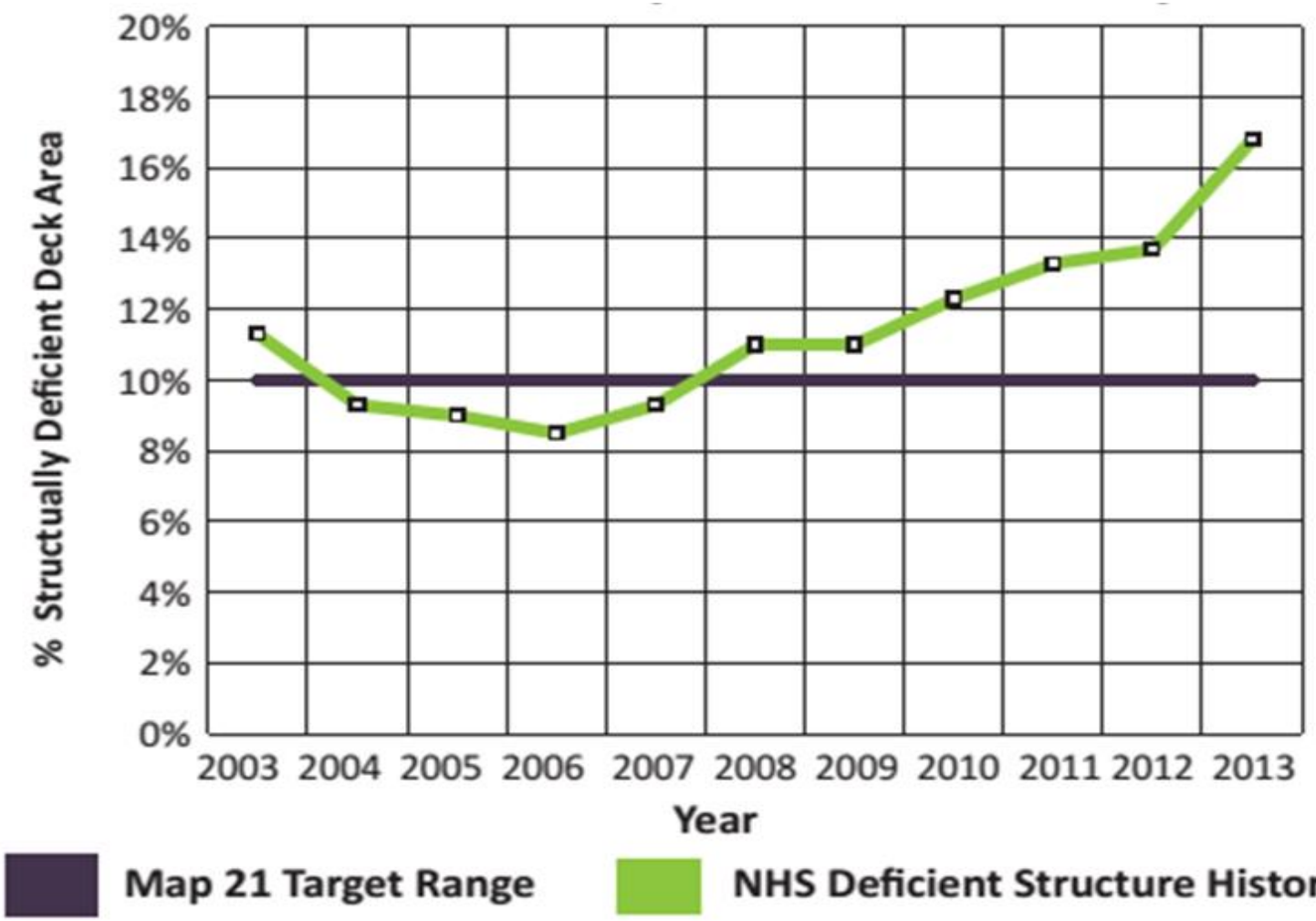
CS	1	2	3	4	5
1	97.03	2.97			
2	41.00	55.24	3.76		
3	29.50	10.50	55.77	4.23	
4	25.00	5.00	8.33	53.09	8.58
5	41.67	6.67	1.67	0.83	49.16

NBIAS use transition probability deterioration models in their analysis. Transition probability between condition states represent the probabilities of an element moving to (or staying in) various condition states when an intervention or action is taken. There are three possible actions: Do nothing (Action 0), Maintenance (Action 1) and Rehabilitation or Replace (Action 2). The condition states represent different levels of deterioration from the best condition (State 1) to the worst (State 5).

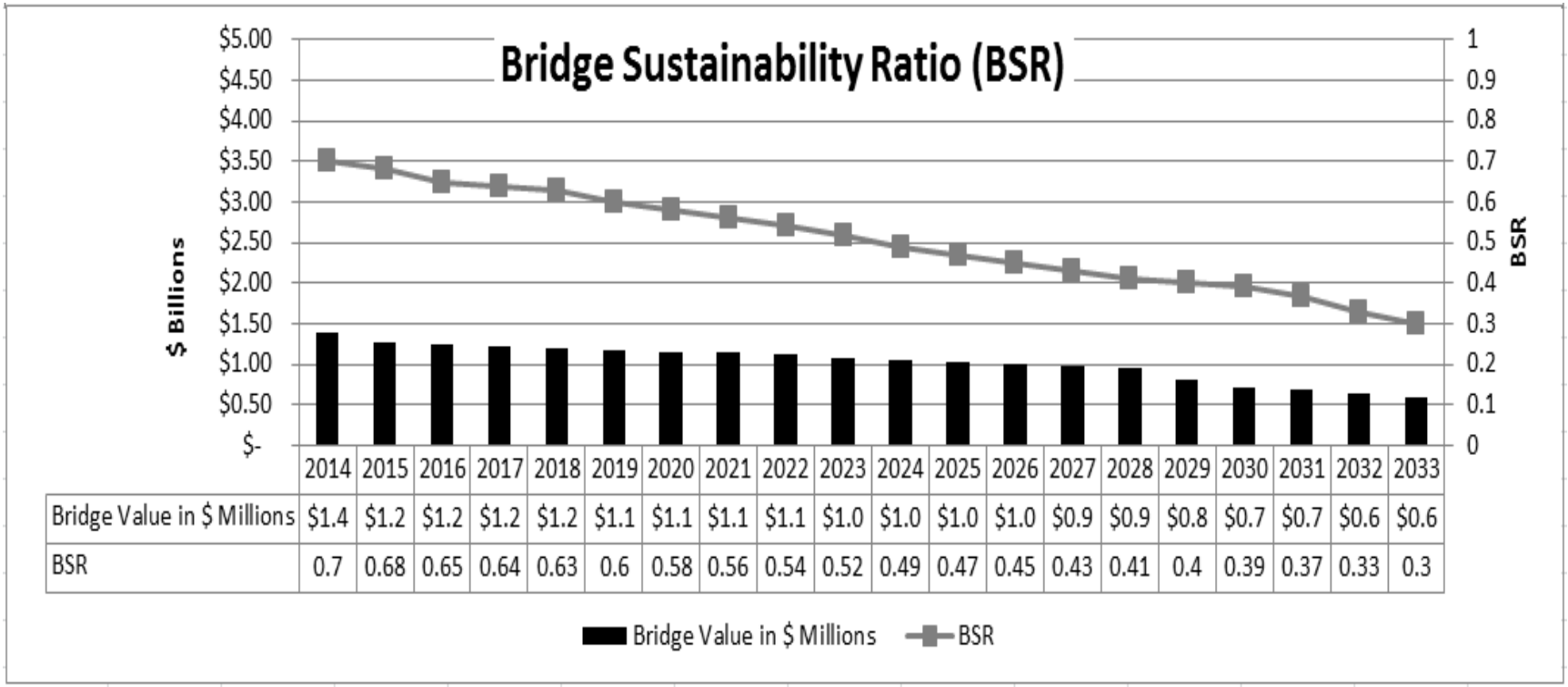
Escenario de Mantenimiento Diferido
Condición de los Puentes



Porcentaje del Área del Tablero con Deficiencia Estructural

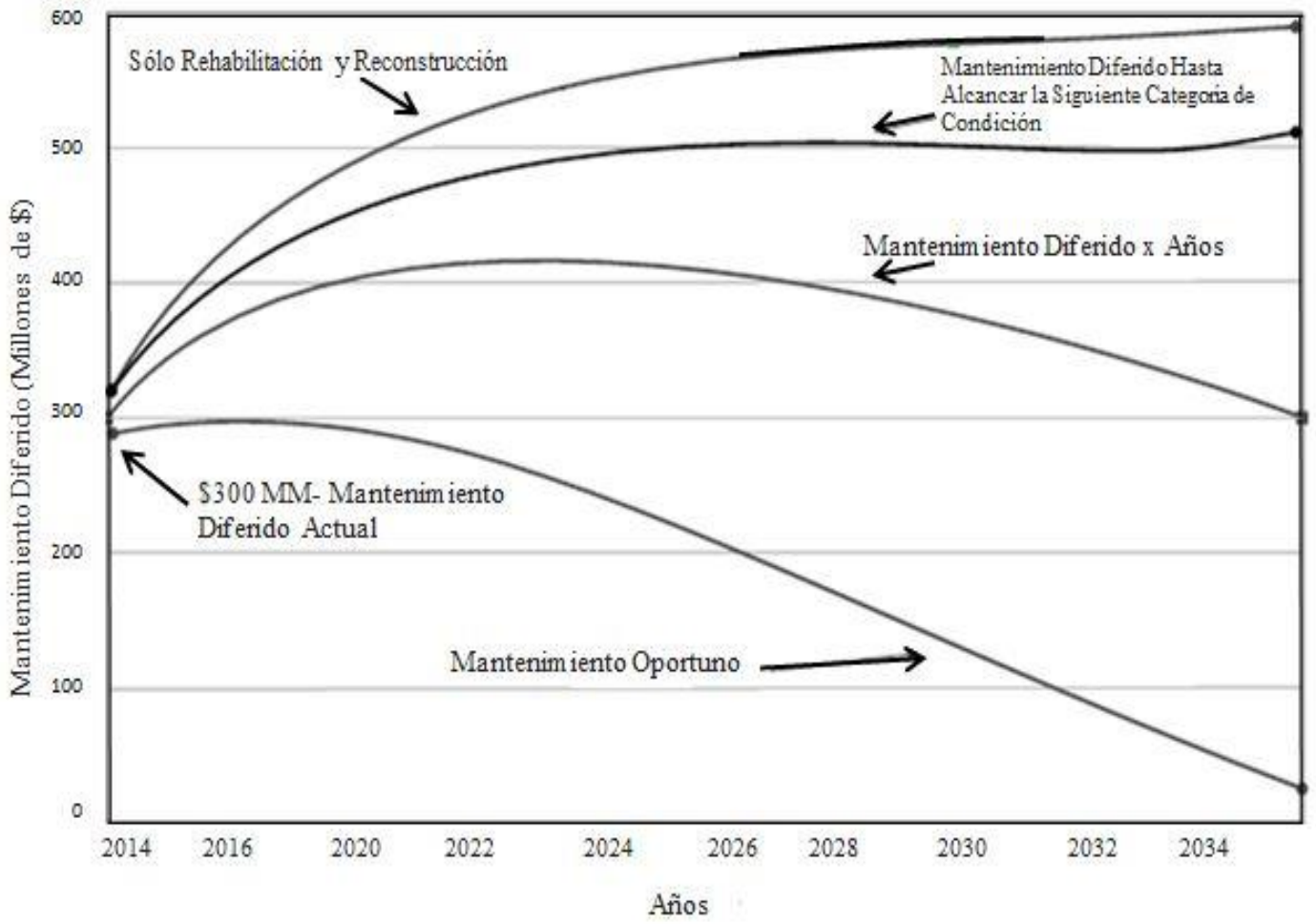


Fondos Requeridos vs. Presupuesto Asignado

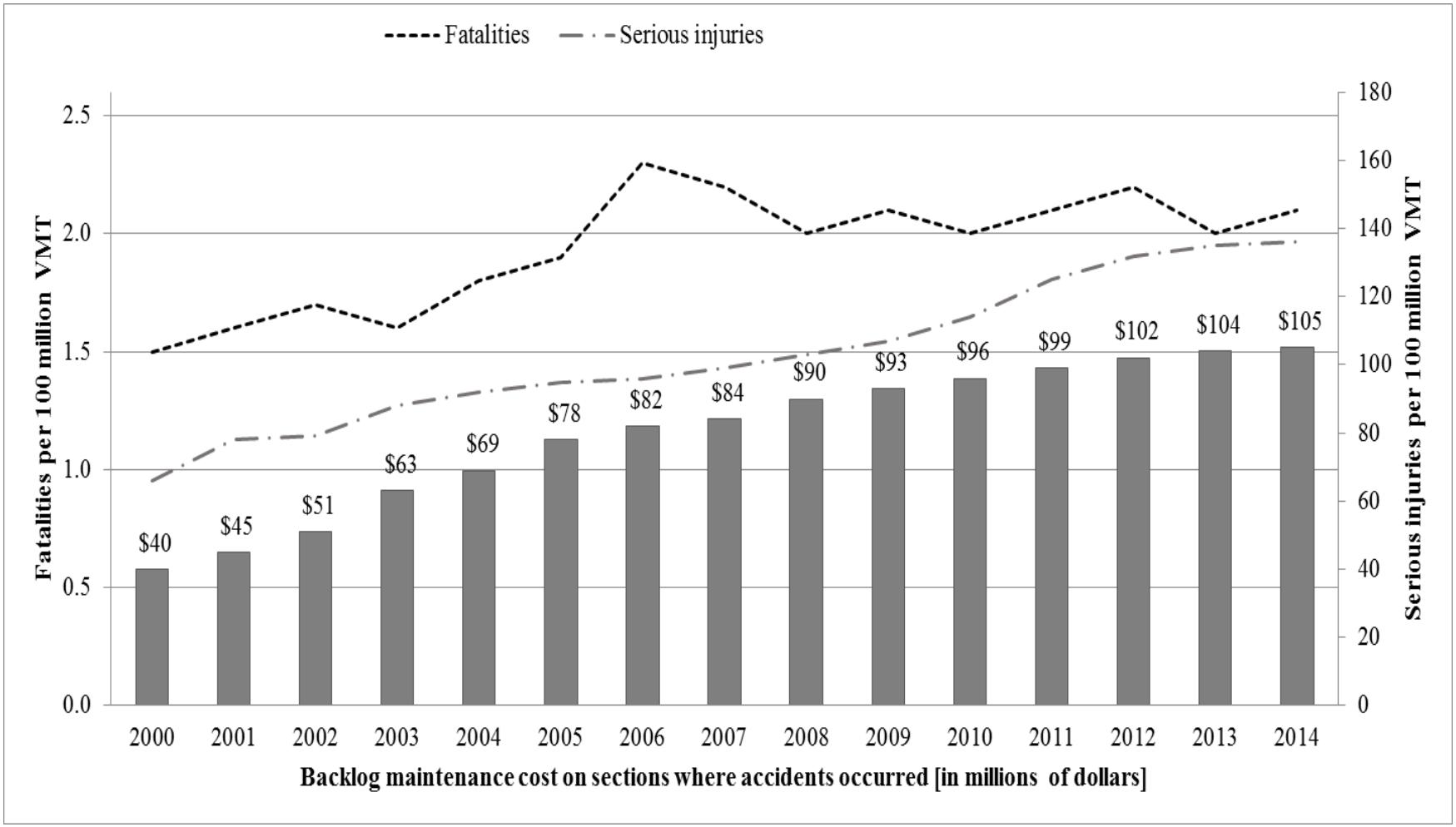


	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Bridge Value in $ Millions	$1.4	$1.2	$1.2	$1.2	$1.2	$1.1	$1.1	$1.1	$1.1	$1.0	$1.0	$1.0	$1.0	$0.9	$0.9	$0.8	$0.7	$0.7	$0.6	$0.6
BSR	0.7	0.68	0.65	0.64	0.63	0.6	0.58	0.56	0.54	0.52	0.49	0.47	0.45	0.43	0.41	0.4	0.39	0.37	0.33	0.3

Escenario de Mantenimiento Diferido
Costos Generados



Mantenimiento Diferido e Incremento de Accidentes



Reflexiones Finales

1. Una población en constante crecimiento implica una mayor necesidad por mantener la red vial en los niveles de servicio esperados por la sociedad.

2. El mantenimiento vial debe ser parte de una estrategia planificada para mantener o mejorar los niveles de servicio y retardar el deterioro futuro para preservar el capital invertido.

3. Contar con legislación que facilite la implementación de las políticas de mantenimiento, y mejorar la comunicación en todos los niveles involucrados en la toma de decisiones.

El Futuro depende de NOSOTROS

Si no ACTUAMOS hoy, sabemos las consecuencias

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