

Optimal Timing of Chip Seal

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Background: What is the Chip Seal?



Distributor



Chip Spreader



Roller

Background: Preventive Maintenance Treatments

Crack Sealing

Slurry Seal

Cape Seal

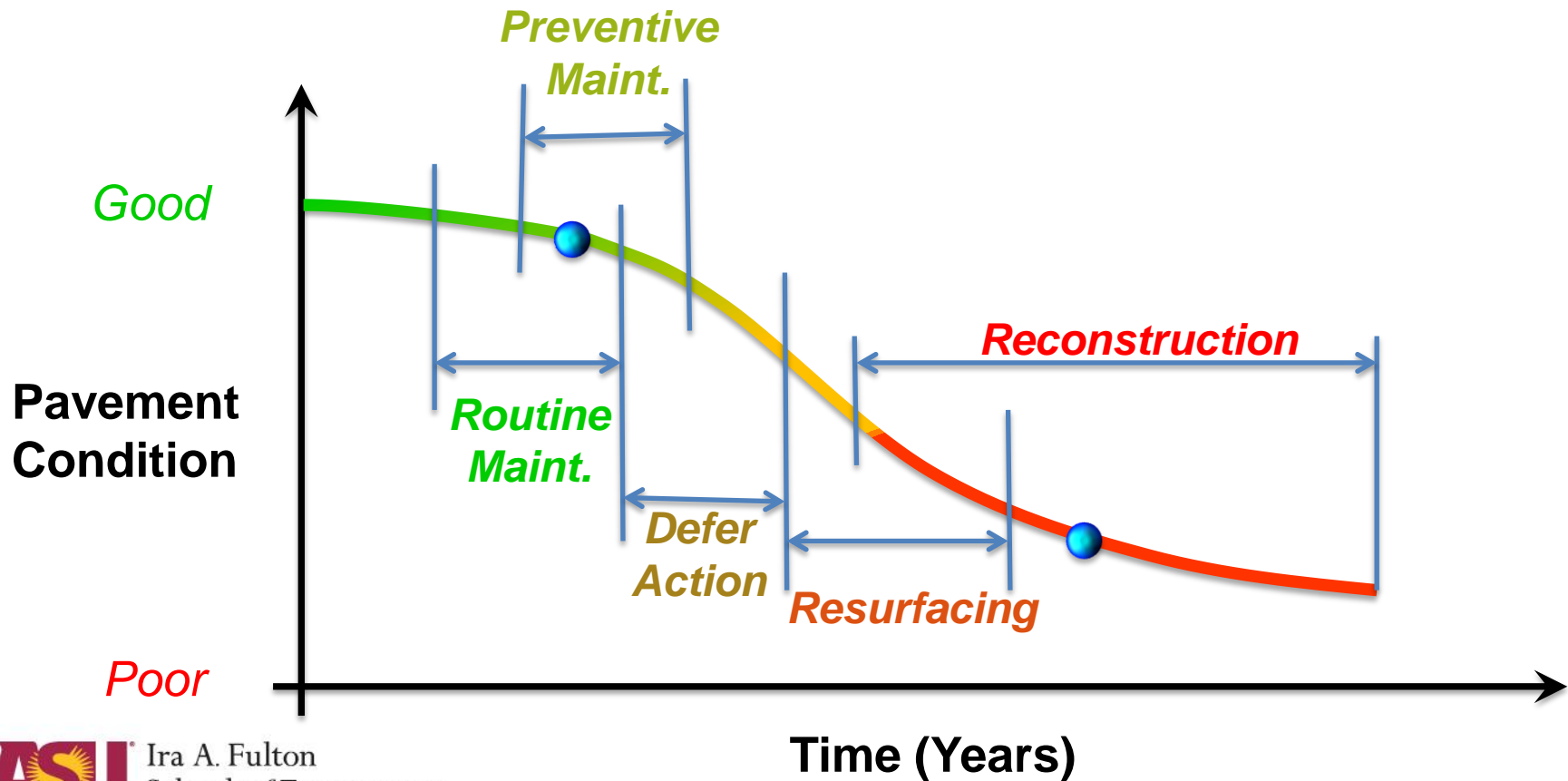
Thin Overlay

Fog Seal

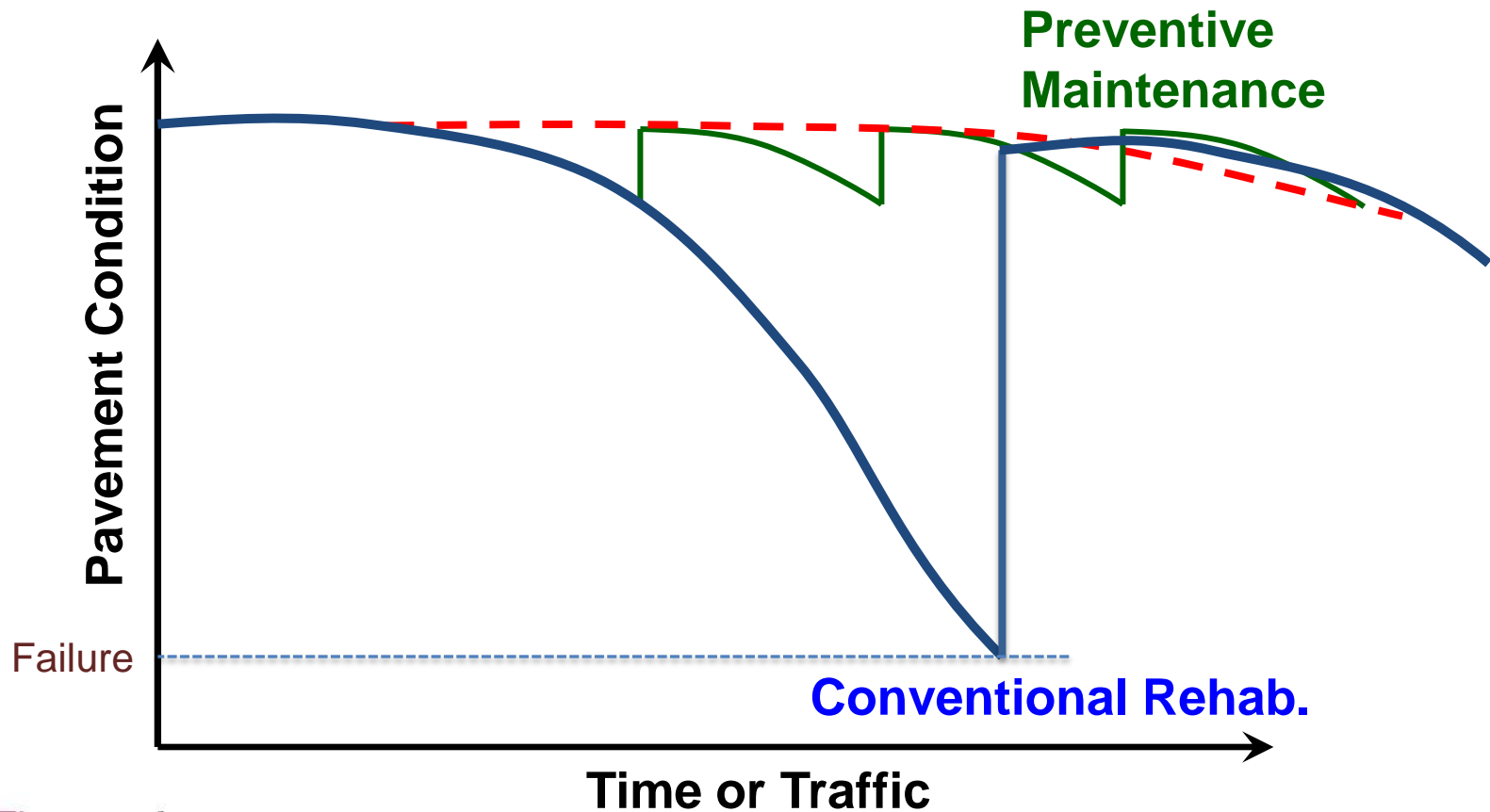
Chip Seal

Microsurfacing

Background: Pavement Performance and Rehabilitation



Background: Expected Benefits of Successive Preventive Maintenance



Problem Statement

- No formal guidelines that tie chip seal treatment timing to effectiveness.
- Use of empirical, experience-based approach in applying chip seal.

Objectives and Scope of Study

- Evaluate the effectiveness of single-application of chip seal using IRI data from LTPP Database at different times.
- Compare the performance of chip seal sections to flexible untreated (control) sections.
- Relate findings to climatic, and traffic conditions.

Information Extracted from LTPP Database

Information	Location in LTPP Database
State Code	Various Modules (Tables)
SHRP ID	Various Modules (Tables)
Climatic Region Classification	Administration Module (REGIONS)
Construction Year	Maintenance Module (EXPERIMENT_SECTION)
Rehabilitation/Maintenance History	Maintenance Module (EXPERIMENT_SECTION)
Roughness Data (IRI)	Monitoring Module (MON_PROFILE_MASTER)
Measured/Computed Traffic Data	Traffic Module (TRF_MON_EST_ESAL, TRF_ESAL_COMPUTED)

Extraction of LTPP Sections

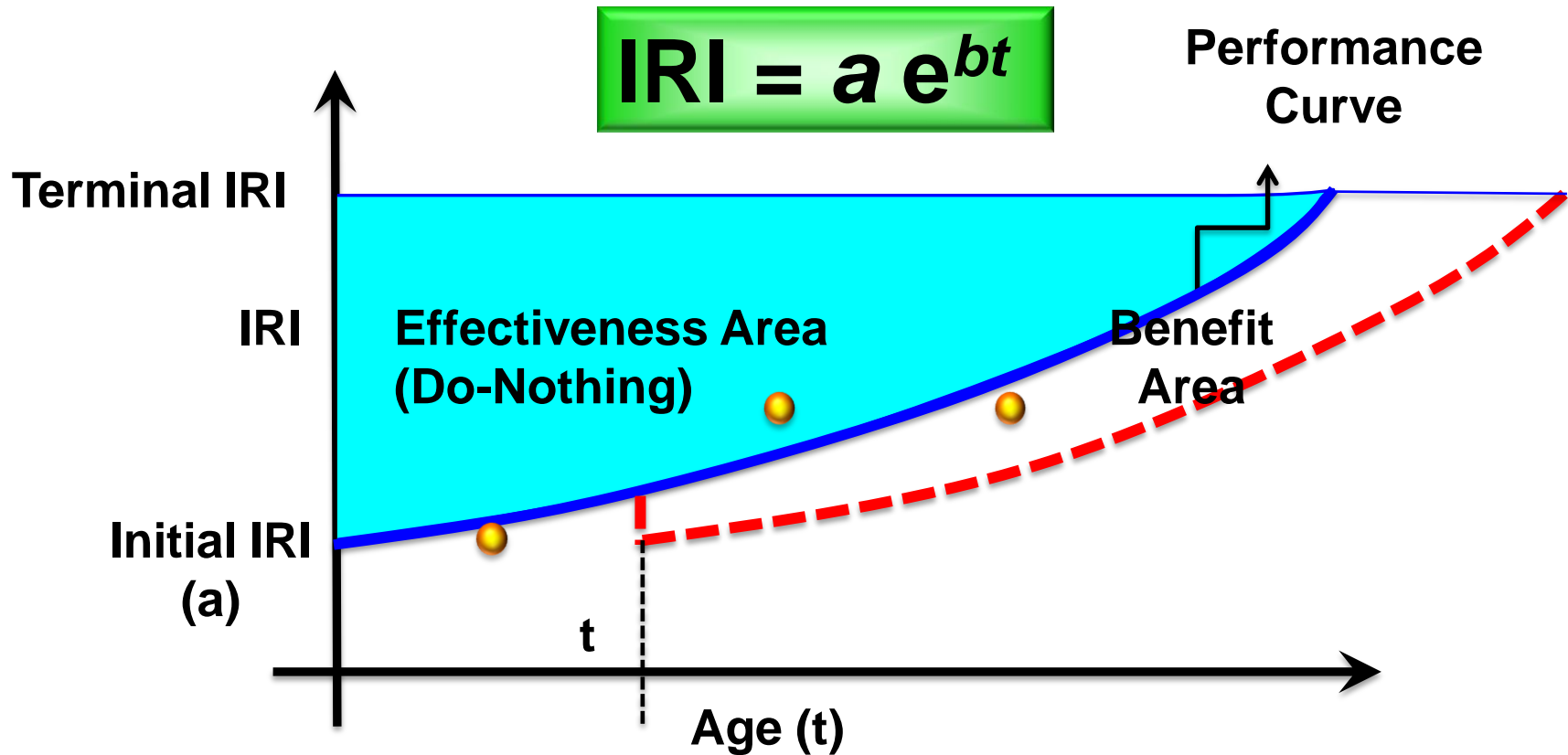
Chip Seal Section Criteria

- Single-layer surface treatment.
- Ignore sections that received other treatments at the same time as chip seal.

Control Section Criteria

- Flexible pavement only.
- No maintenance or rehabilitation treatments for a number of years.

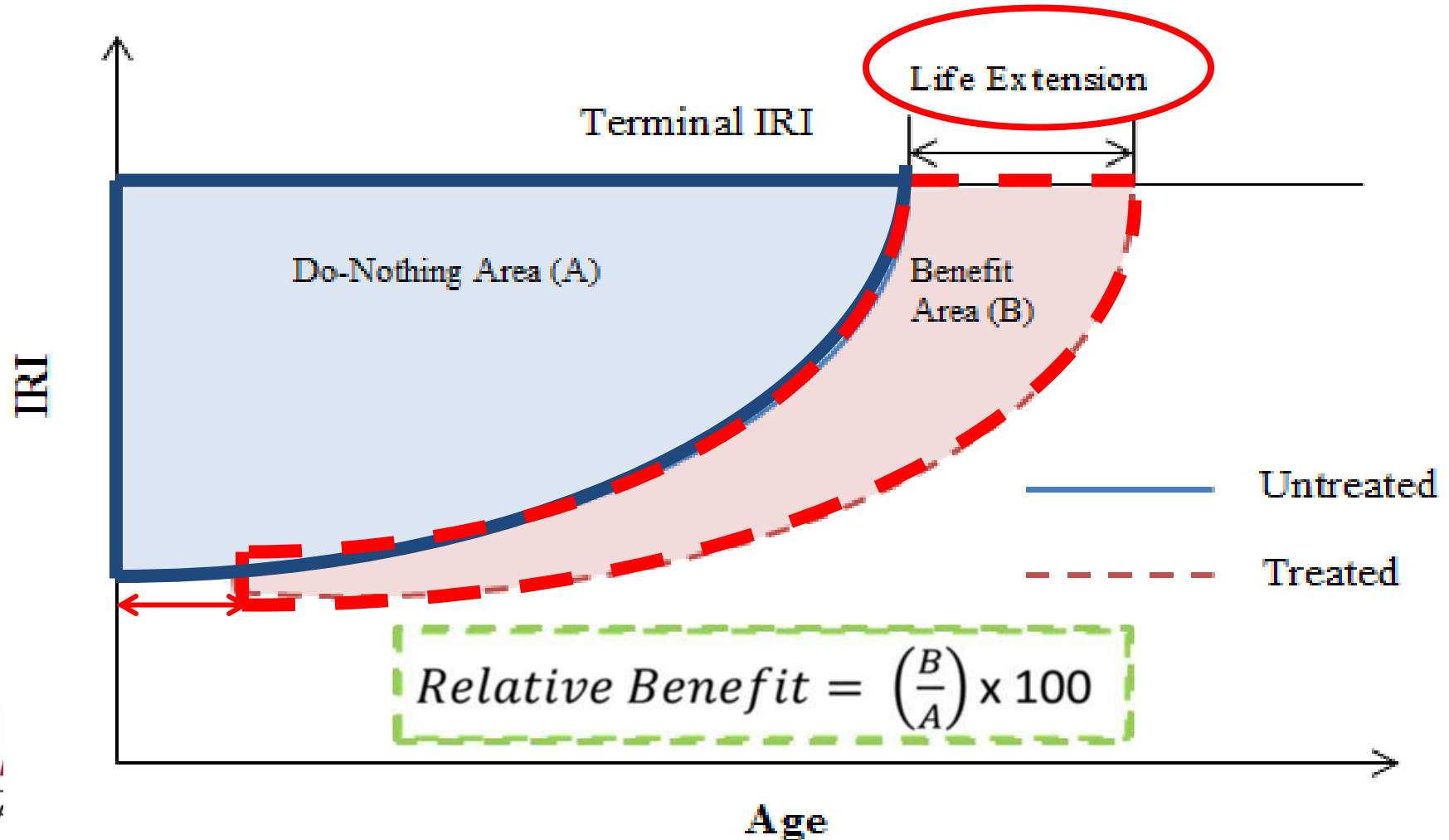
Initial Roughness and Modeling



Evaluation of Long-Term Effectiveness

- Extended service life.
- Relative Benefit.
- Benefit-Cost (B/C) Ratio.

Life Extension and Relative Benefit



Benefit-Cost Ratio

$$\textit{Benefit - Cost Ratio} = \left(\frac{B}{C}\right) \times 1000$$

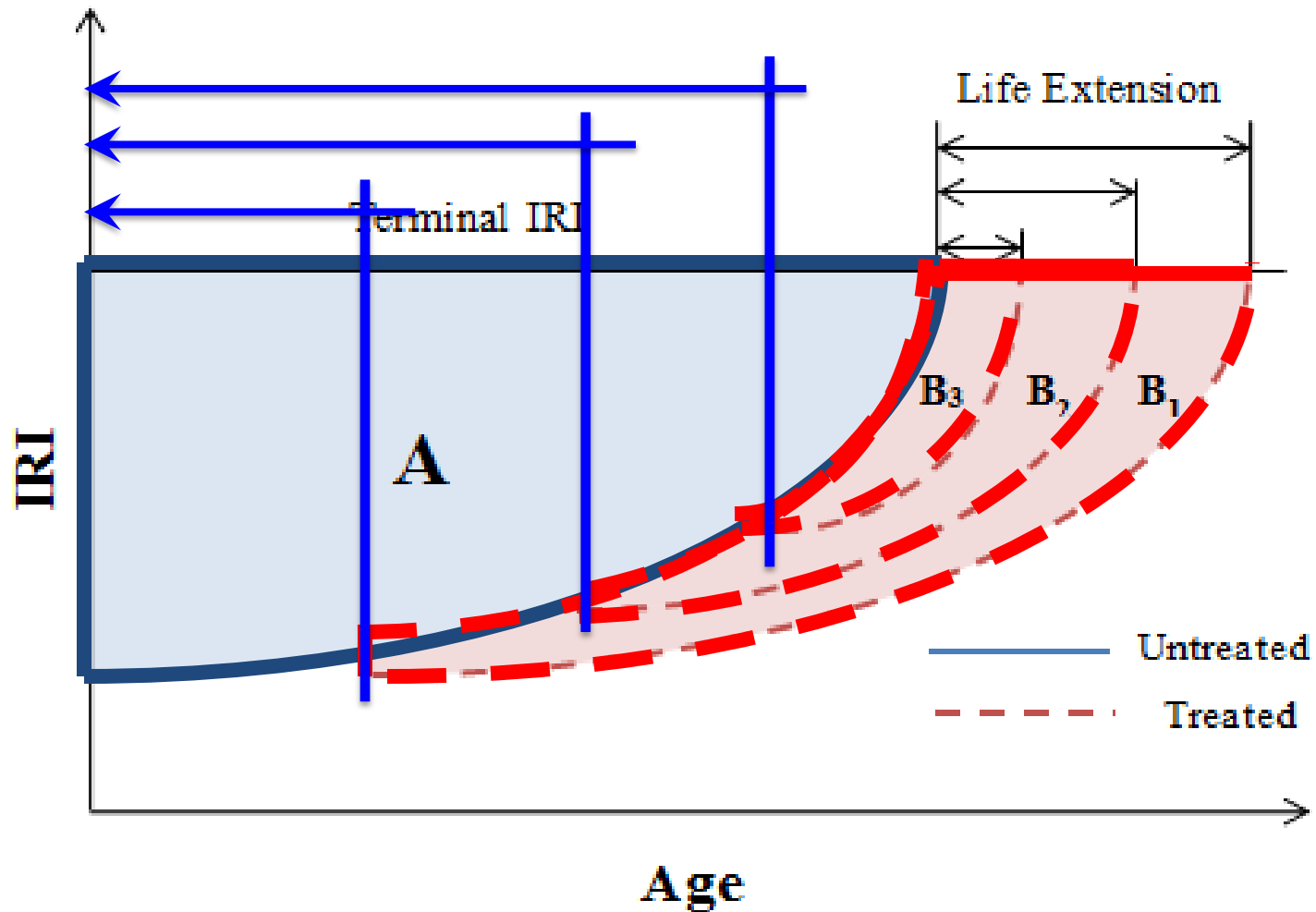
where:

B = Benefit Area (B) and

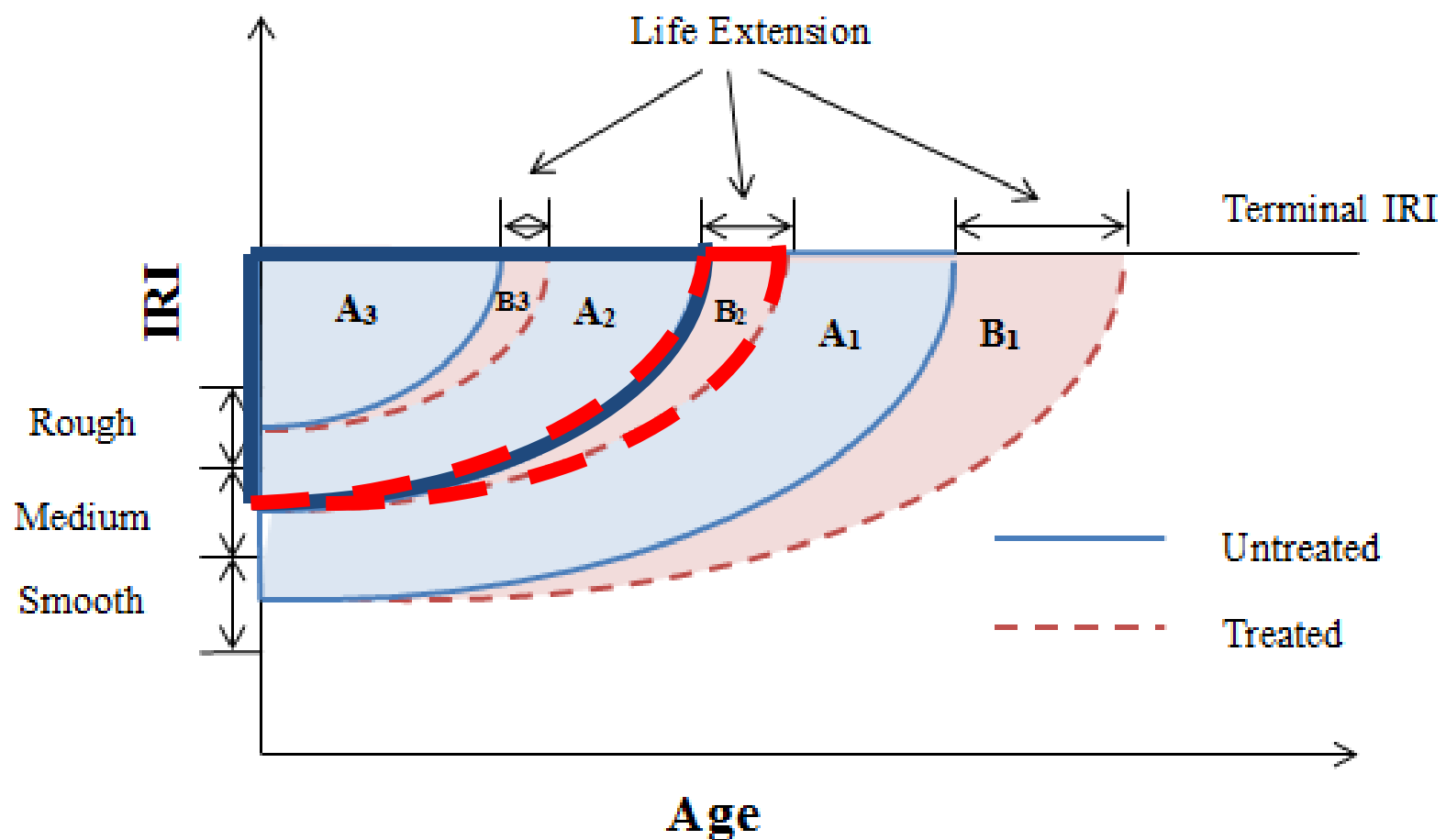
C = Cost (\$27,300 per lane-mile)

(Hajj, et al. 2011; Loria, et al. 2011)

Treatment Timing-Based (TT) Analysis



Initial Condition-Based (IC) Analysis



Climatic Regions, Initial Condition Categories and Normalization

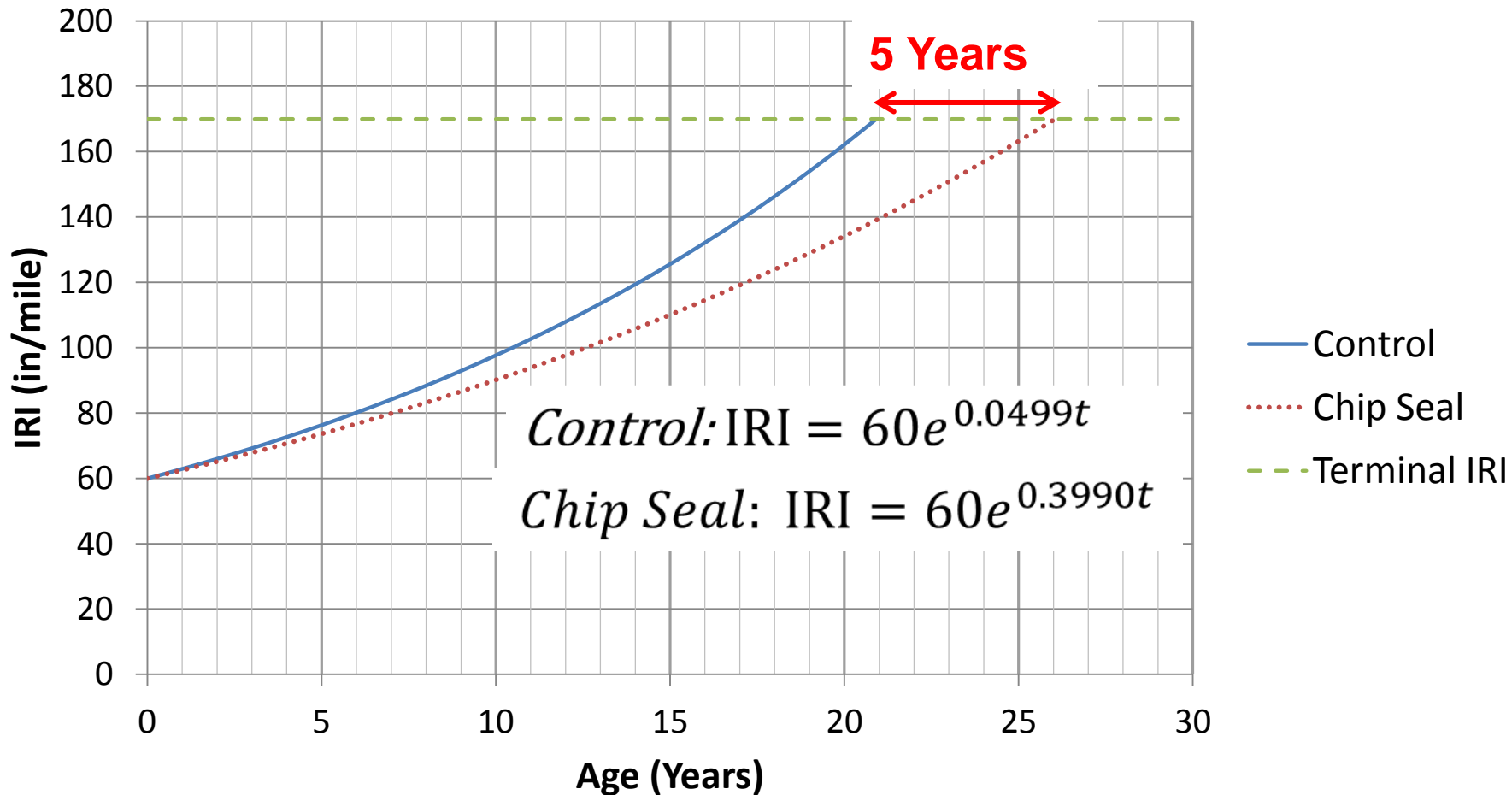
Initial Pavement Condition	Interval of Initial Roughness (in/mile)	Specified Initial Condition Value for Normalization (in/mile)	Climatic Regions
Smooth	40-80	60	Dry Freeze
			Dry Non-Freeze
			Wet Freeze
			Wet Non-Freeze
Medium	80-120	100	Dry Freeze
			Dry Non-Freeze
			Wet Freeze
			Wet Non-Freeze
Rough	120-160+	140	Dry Freeze
			Dry Non-Freeze
			Wet Freeze
			Wet Non-Freeze

Number of Climatic Regions and Sections

Climatic Region	Section Type	Number of Sections		
		Initial Condition		
		Smooth	Medium	Rough
Dry Freeze	Chip Seal	26	7	3
	Control	33	6	3
Dry Non-Freeze	Chip Seal	6	8	3
	Control	45	7	1
Wet Freeze	Chip Seal	20	16	3
	Control	27	7	2
Wet Non-Freeze	Chip Seal	15	6	5
	Control	40	23	2

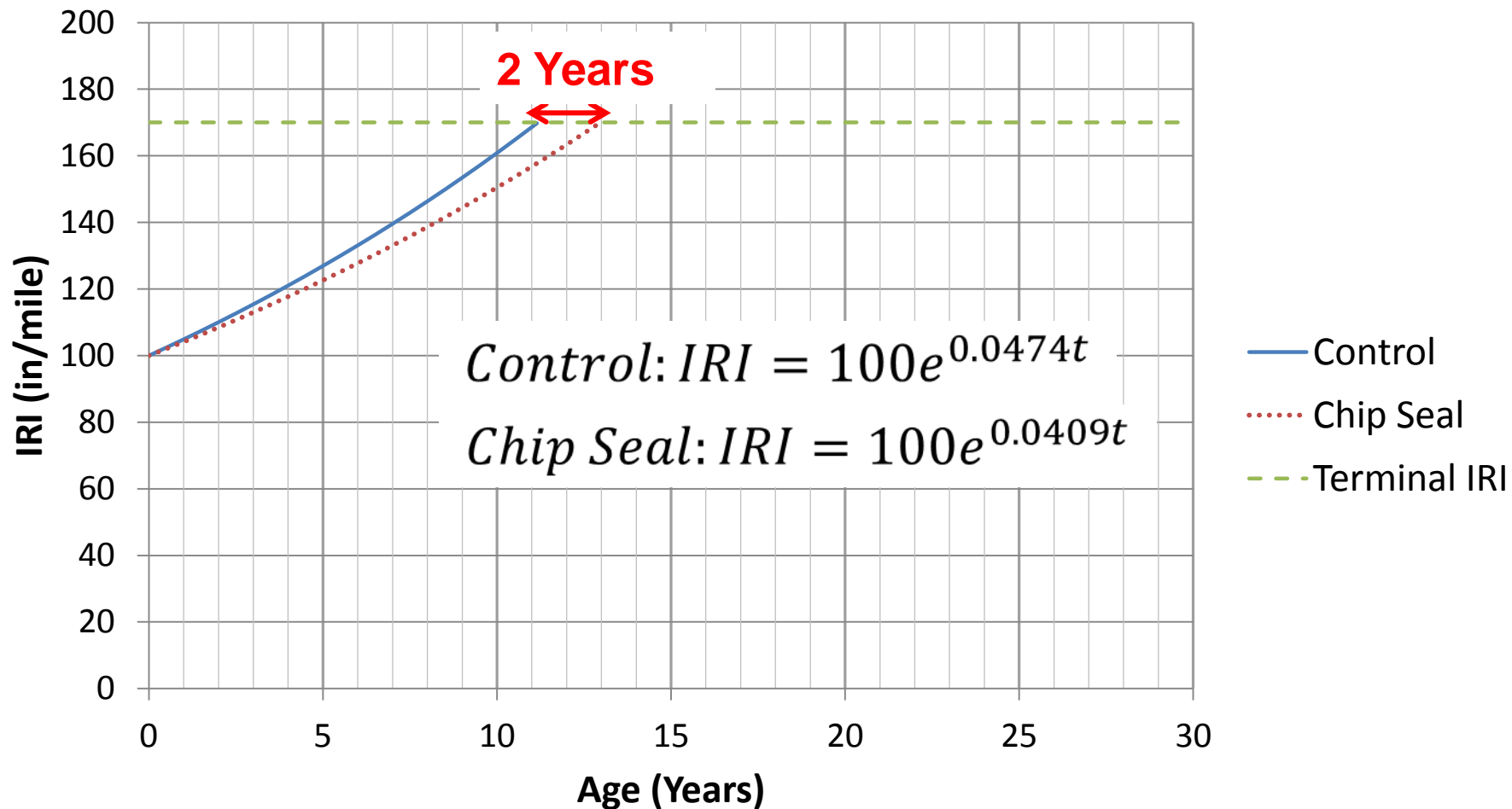
Normalized Performance Curves for Wet Freeze, Smooth Initial Condition

Wet Freeze, Smooth Initial Condition



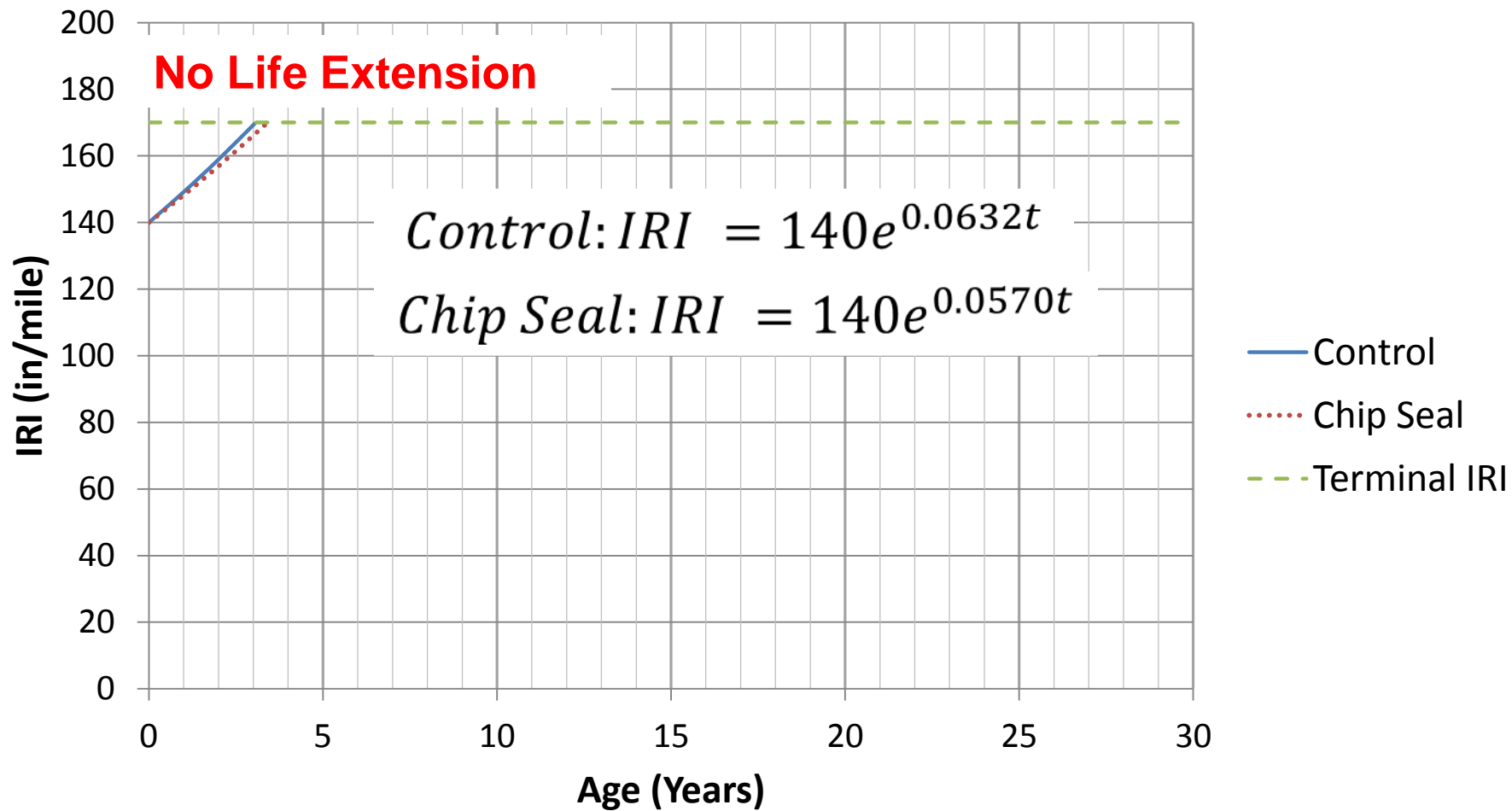
Normalized Performance Curves for Wet Freeze, Medium Initial Condition

Wet Freeze, Medium Initial Condition



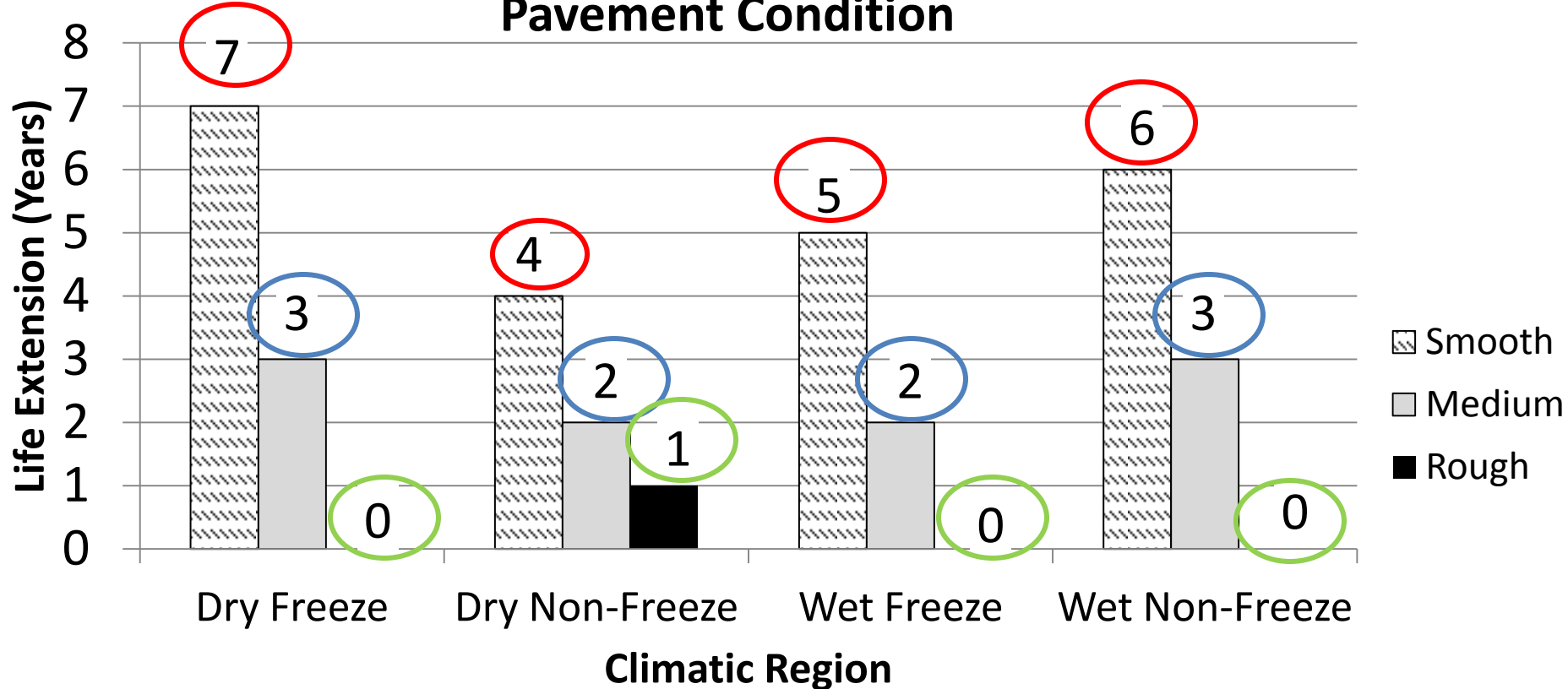
Normalized Performance Curves for Dry Freeze, Rough Initial Condition

Wet Freeze, Rough Initial Condition



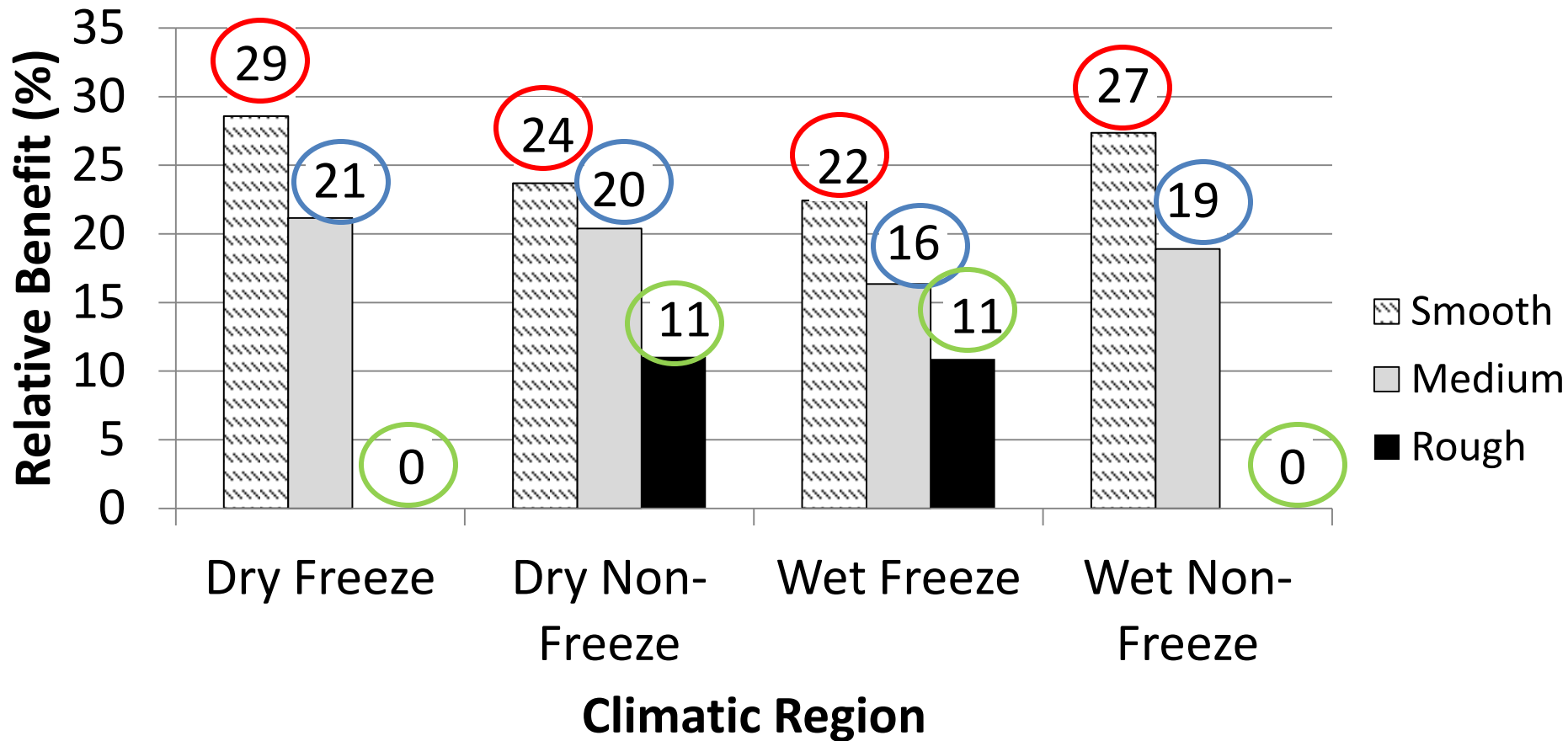
Life Extension Due to Chip Seal

Life Extension Due to Chip Seal Based on Initial Pavement Condition



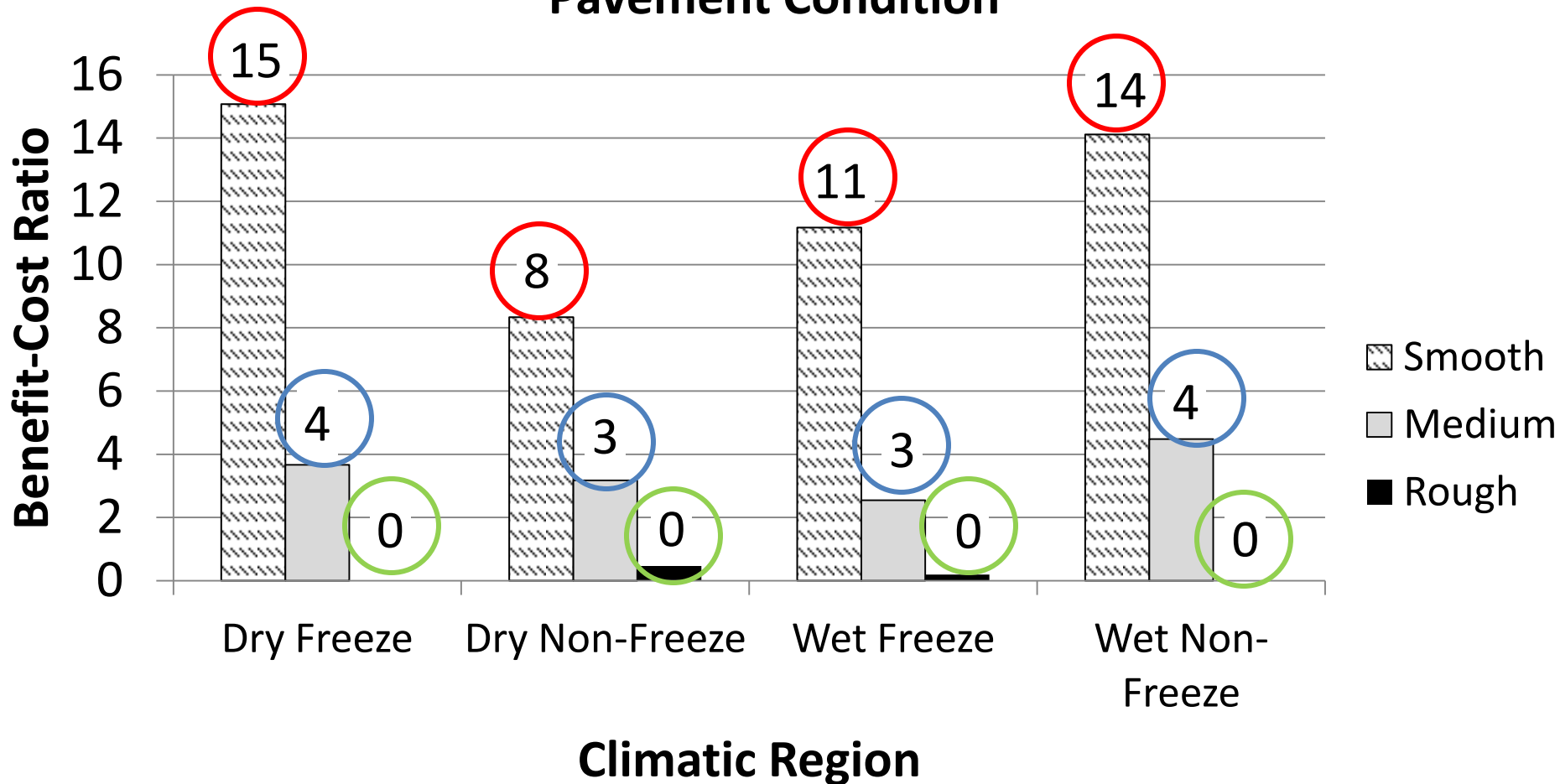
Relative Benefit

Relative Benefit of Chip Seal Based on Initial Pavement Condition



Benefit-Cost Ratio

Benefit-Cost Ratio for Chip Seal Based on Initial Pavement Condition



Conclusions

- Treated sections performed better than untreated sections, as assumed.
- **Chip Seal Life Extension:**
 - Smooth → 4-7 years
 - Medium → 2-3 years
 - Rough → 0-1 years
- **Chip Seal Relative Benefit:**
 - Smooth → 22-29 percent
 - Medium → 16-21 percent
 - Rough → 0-11 percent

Conclusions

- **Chip Seal Benefit-Cost Ratio:**
 - Smooth → 8-15
 - Medium → 3-4
 - Rough → Zero
- **Climate:**
 - No true correlation found between effectiveness, Traffic, and climatic conditions.

Thank You!

