Life-Cycle Asset Management Plan for the WAR-63 PRIORITY PROJECT

WARREN COUNTY, OHIO

Warren County Transportation Improvement District

June 2019

LIFE-CYCLE ASSET MANAGEMENT PLAN

WAR-63 PRIORITY PROJECT

WARREN COUNTY, OHIO

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Executive Summary

The WAR 63 Priority Project will install a life-cycle-cost-based management plan that will deliver and maintain a safe, high-performing transportation facility, with a partnership in oversight and performance between the Ohio DOT and the grant applicant.

Current pavement condition is generally good (PCR is 75 though-out most of the project length), and this proposal is not a remedy for failure to maintain the roadway.

An asset management plan that optimizes the investment and identifies a sustainable source of revenues for operation and maintenance to minimize life cycle costs is outlined in a technical memorandum titled *Life-Cycle Asset Management Plan for the WAR 63 Priority Project* [LINK], and the recommendations are included in this proposal. Development of the plan included an in-depth look at user-costs utilizing *Real*Cost *v2.5*, a product of U.S. DOT, FHWA, Office of Asset Management.

The Ohio DOT is the owner of the facility (State Route 63 in Warren County, Ohio). Ohio DOT does not have the resources, despite a recent gas-tax increase, to contribute to capital expansion costs, but recognizes the need for, and critical timing of, the project. It has therefore partnered with the Warren County TID, the grant applicant, which will provide up to 50% of the capital costs necessary to match the BUILD application request. In recognition of the importance of maintaining the facility in a state of good repair, the Ohio DOT will make available $450,000 of operating funds programmed for surface wearing course replacement to be used toward the project. Culvert replacement is not currently programmed by the Ohio DOT and is scheduled in the No Build Life-Cycle Asset Management Plan for year 11 (2031).

As owner, Ohio DOT recognizes its responsibility to include the improved facility in its Transportation Asset Management Plan (TAMP). Certain aspects of the final project may be outside of what Ohio DOT considers necessary attributes of the project. These will be considered "betterments", and alternative technical proposals will only be accepted during the design-build procurement process if required asset management activities can find an appropriate "home" – an agency that has sufficient funding and technical expertise to accept responsibility for the ongoing activities necessary to support the design element. Because this project is still in the development phase, this will entail evolutionary discussions until such time as bids are accepted, and community willingness to pay is established. Examples of such design considerations include innovative traffic and safety technologies, and alternative median treatments.

1.0 Introduction and Overview

Asset management is "a strategic and systematic process of operating, maintaining, and improving physical assets, with a focus on both engineering and economic analysis based upon quality information, to identify a structured sequence of maintenance, preservation, repair, rehabilitation, and replacement actions that will achieve and sustain a desired state of good repair (SOGR) over the life cycle of the assets at minimum practicable cost".[1]

A Life Cycle Plan for the WAR 63 Priority Project was developed for the No Build and two Build scenarios, a 4-Lane Undivided section and a 4-Lane Divided section.

A schedule of rehabilitation activities (those requiring maintenance of traffic) and the estimated agency costs, timing and frequency of these activities was developed for each of the three scenarios.

Additionally a schedule of annual preventive maintenance activities and costs not requiring maintenance of traffic activities was developed for each of the scenarios described.

*Real*Cost version 2.5, a software product and LCCA tool developed by the U.S. DOT Federal Highway Administration Office of Asset Management, was used to evaluate user costs associated with five strategic alternatives for the WAR-63 Priority Project.

*Real*Cost is most frequently used to evaluate comparative life-cycle costs of detail design options for a given project (different structure or pavement designs, for example). For the WAR-63 project, we have adapted the capabilities of the *Real*Cost tool to identify life-cycle costs associated with strategic alternatives incorporating different detail design conditions.

Section 2.0 provides a brief description of WAR 63 Priority Project, and introduces the various strategic scenarios studied.

Section 3.0 covers the methodology and approach to Life Cycle Costing and discusses the user costs associated with each scenario.

Section 4.0 identifies agency responsibilities.

Section 5.0 contains recommendations for project implementation.

[1] 23 CFR 515.5

2.0 Project Description and Scenarios Developed

A $25 million roadway improvement project is planned and proposed for a 3-mile priority section of Ohio Route 63 in Warren County, Ohio. The Warren County Transportation Improvement District (WCTID) is the lead local agency and primary local funder of construction costs. In partnership with the Ohio Department of Transportation, the project will be delivered in a design-build package, with certain performance elements attached to the project delivery.

As the primary local funder of the project, the WCTID is interested in project life cycle costs for best ways to address corridor capacity, safety and operational needs. Understanding life cycle costs is expected to help identify some of the performance-based Alternative Technical Concepts that may be appropriate to incorporate in the Design-Build project delivery package to be developed by ODOT and the WCTID in early 2020.

Life Cycle Cost Analysis (LCCA) is an engineering and economic analysis method for assessing the total cost of constructing, maintaining, and operating a facility over an extended period of time (typically 30 years). LCCA considers the costs incurred by both the implementing agency and the users of the facility.

Life cycle costs directly couple to, and help illuminate, Asset Management requirements for a given transportation investment.

*Real*Cost version 2.5, a software product and LCCA tool developed by the U.S. DOT Federal Highway Administration Office of Asset Management, was used to evaluate user costs associated with five strategic alternatives for the WAR-63 Priority Project. *Real*Cost can be used to evaluate comparative life-cycle costs of detail design options for a given project (different structure or pavement designs, for example). For the WAR-63 project, we have adapted the capabilities of the *Real*Cost tool to identify life-cycle costs at the larger scale of entire strategic alternatives incorporating different detail design conditions.

Because *Real*Cost calculates user costs (for example, costs extending from time penalties during construction or ongoing or periodic asset management activities) at a greater level of detail and confidence than *Cal-B/C*, the user cost outputs from the *Real*Cost tool allow identification and evaluation of the design parameters that most influence the important user cost metric.

*Real*Cost's capabilities were adapted to estimate the total (user and agency) discounted life cycle costs (absent vehicle operating, accident or emission costs) associated with the three alternative design strategies identified for the WAR-63 Priority Project. Each alternative strategy has a different performance profile which is accounted for and evaluated separately under the project Benefit-Cost work using the *Cal-B/C* analysis tool.

The three Strategies evaluated were:

1. No Build;
2. Four Lane Undivided;
3. Four Lane Divided;

Evaluating the No-Build scenario, Scenario 1, helps identify the costs borne by roadway users in continuing to operate and maintain an inadequate existing facility, compared to new investment scenarios.

Scenario 2 describes the "minimum build" design alternative: a four-lane undivided section with center turns lanes at access locations.

Scenario 3 is a four-lane divided section (grass median, with center turn lanes at access locations).

3.0 Methods and Approach

The methods used in Life Cycle Cost Analysis for the WAR-63 Priority Project follow guidance established by FHWA for application of the *Real*Cost tool. A deterministic cost analysis approach was used in the analysis.
Including identification of analysis period, there are six steps involved in FHWA's LCCA methodology[2]:

Step 1 Select analysis period
Step 2 Establish alternative design strategies
Step 3 Determine activity timing
Step 4 Estimate agency costs
Step 5 Compute life-cycle (including user) costs
Step 6 Evaluate the results

Step 1 – Select analysis period
An analysis period of 30 years or more is typical for life cycle cost evaluation in transportation[3]. A 31-year analysis period was selected for the WAR-63 Priority Project (construction plus a 30 year service life), which fully incorporates the first cycle of major roadway rehabilitation work, and, to appropriately simplify salvage value calculations per FHWA guidance corresponds to the structural life of six major culverts spanning the project corridor.

Step 2 – Establish alternative design strategies
*Real*Cost's capabilities were adapted to estimate the total (user and agency) discounted life cycle costs (absent vehicle operating, accident or emission costs) associated with three alternative design strategies identified for the WAR-63 Priority Project. Each alternative strategy has a different performance profile which is accounted for and evaluated separately under the project Benefit-Cost work using the *Cal-B/C* analysis tool.

Step 3 – Determine activity timing
A schedule of initial and future activities for implementation and ongoing management of each of the strategies was developed, including estimated timing, duration and frequency of for each activity.

Step 4 – Estimate agency costs

Agency costs for the initial construction and future costs of rehabilitation, maintenance and operation of each strategic alternative were estimated using developed component construction cost estimates and best professional judgments from team design and operations engineers.

[2] *Life-Cycle Cost Analysis RealCost User Manual* (FHWA, 2004)
[3] *Life-Cycle Cost Analysis RealCost User Manual version 2.5*, page 1 (FHWA, 2010)

Schedules of activity timing and agency costs can be found in **Appendix A**:

Table 1. *Activity Costs and Timing by Strategy*

Table 2. *Maintenance Cost Build – Minor and Regular Maintenance Costs*

Table 3. *Maintenance Cost Requiring no Maintenance of Traffic Input Values*

Step 5 – Compute life-cycle costs
There are two additional input components to computation of life-cycle costs:

First, Project Level Data was accumulated for each strategy.

These inputs and justification can be found in **Appendix B**:

Table 4. *Strategy Level Inputs*

Second, Activity Level Data was developed and complied for each strategy. These inputs and descriptions can be found in **Appendix C**:

Table 5. *Activity Level Inputs – No Build Strategy*

Table 6. *Activity Level Inputs – 4-Lane Undivided Strategy*

Table 7. *Activity Level Inputs – 4-Lane Divided Strategy*

From these inputs, *Real*Cost v. 2.5 was used to calculate the discounted agency and user life cycle costs for each strategy.

Step 6 – Evaluate results
The deterministic results of the life-cycle cost analysis were evaluated and compared among alternative strategies. **Appendix D** provides a summary of these results.

Table 8. *Summary of Results by Scenario*

4.0 Identification of Agency Responsibilities

Responsibility for rehabilitation and maintenance activities will be shared among responsible agencies depending upon acceptance of alternative technical concepts during design-build procurement as follows:

WARREN COUNTY TRANSPORTATION IMPROVEMENT DISTRICT
WAR-63 PRIORITY SEGMENT
LIFE CYCLE COST ASSET MANAGEMENT PLAN
AGENCY RESPONSIBILITIES

	Agency Cost Estimate 4-Lane Undivided (Present Value)	Agency Responsibility	Agency Cost Estimate 4-Lane Divided (Present Value)	Agency Responsibility
Rehabilitation Activities				
Pavement	$ 869,640	ODOT	$ 869,640	ODOT
Culverts	$ 74,450	ODOT	$ 86,860	TBD
Major Drainage Rehab	$ 85,110	ODOT	$ 85,110	ODOT
Major Shoulder Rehab	$ 263,530	ODOT	$ 263,530	ODOT
Guardrail Replacement	$ 41,620	ODOT	$ 41,620	ODOT
Major Median Rehab			$ 156,410	TBD
Median Barrier Replacement			$ 74,360	TBD
Overhead Sign/Signal Replacement	$ 392,530	ODOT	$ 404,600	TBD
Outage Requiring Maintenance of Traffic	$ 205,350	ODOT	$ 166,450	TBD
Subtotal Rehabilitation Activities	$ 1,932,230		$ 2,148,580	
Maintenance Costs - No MOT	Annual Cost (Current Dollars)		Annual Cost (Current Dollars)	
Pavement	$ 51,000	ODOT	$ 51,000	ODOT
Culverts	$ 6,000	ODOT	$ 7,000	TBD
Open Drainage	$ 2,000	ODOT	$ 2,000	ODOT
Shoulders	$ 15,000	ODOT	$ 15,000	ODOT
Guardrail				
Median			$ 4,000	TBD
Cable Barrier				
Signs and Signals	$ 6,000	ODOT	$ 7,000	
Outages				TBD
Subtotal Maintenance Costs	$ 80,000		$ 86,000	
Betterment Costs				
Technology	TBD	TBD	TBD	TBD
Stormwater	TBD	TBD	TBD	TBD
Subtotal WTP	TBD		TBD	

5.0 Recommendations

As project development continues, discussions with stakeholders and funding partners should also continue. Alternative Technical Concepts, which will be explored during the design-build process, may involve betterments that require partnership agencies to accept responsibility for ongoing maintenance and rehabilitation activities. Memorandums of Agreement should be developed following opening of DB ATC bids.

Appendix A – ACTIVITY TIMING AND ESTIMATE OF AGENCY COSTS

Table 1. *Activity Costs and Timing by Strategy*

Warren County Transportation Improvement District
Life Cycle Cost Analysis
WAR-SR-63
Minor and Regular Maintenance (No MOT Required)

	No Build				4-Lane Divided				4-Lane Undivided			
	Cost per Occurance	Frequency of Occurance (Number per Time Period)	Time Period	Annual Cost	Cost per Occurance	Frequency of Occurance (Number per Time Period)	Time Period	Annual Cost	Cost per Occurance	Frequency of Occurance (Number per Time Period)	Time Period	Annual Cost
Pavement												
Snow Removal/Pretreatment	$ 3,000	8.00	Annual	$ 24,000	$ 5,000	8.00	Annual	$ 40,000	$ 5,000	8.00	Annual	$ 40,000
Crack Sealing/Pot Hole Repair	$ 5,400	3.00	Annual	$ 16,200	$ 3,600	3.00	Annual	$ 10,800	$ 3,600	3.00	Annual	$ 10,800
Subtotal				$ 40,200				$ 50,800				$ 50,800
Culverts												
Culvert Inspection (6)	$ 2,100	1.00	Annual	$ 2,100	$ 2,100	1.00	Annual	$ 2,100	$ 2,100	1.00	Annual	$ 2,100
Culvert Cleanout (6)	$ 5,000	0.50	Annual	$ 2,500	$ 7,000	0.50	Annual	$ 3,500	$ 10,000	0.50	Annual	$ 5,000
Subtotal				$ 4,600				$ 5,600				$ 7,100
Open Drainage												
Stormwater BMP Maintenance	$ -	0.00	Annual	$ -	$	0.00	Annual	$ -	$ -	0.00	Annual	$ -
Ditch Cleaning	$ 8,500	0.25	Annual	$ 2,125	$ 8,500	0.25	Annual	$ 2,125	$ 8,500	0.25	Annual	$ 2,125
Curb Inlet Cleanout	$ 1,000	0.25	Annual	$ 250	$ 1,000	0.25	Annual	$ 250	$ 1,000	0.25	Annual	$ 250
Subtotal				$ 2,375				$ 2,375				$ 2,375
Shoulders												
Mowing	$ 1,200	3.00	Annual	$ 3,600	$ 2,400	3.00	Annual	$ 7,200	$ 2,400	3.00	Annual	$ 7,200
Litter and Debris Cleanup	$ 1,200	2.00	Annual	$ 2,400	$ 1,200	2.00	Annual	$ 2,400	$ 1,200	2.00	Annual	$ 2,400
Sweeping and Vacuuming	$ 2,200	2.00	Annual	$ 4,400	$ 2,200	2.00	Annual	$ 4,400	$ 2,200	2.00	Annual	$ 4,400
ROW Fence Repair/Replacement	$ 8,500	0.10	Annual	$ 850	$ 8,500	0.10	Annual	$ 850	$ 8,500	0.10	Annual	$ 850
Subtotal				$ 11,250				$ 14,850				$ 14,850
Guardrail												
Median												
Mowing									$ 1,200	3.00	Annual	$ 3,600
Barrier												
Signs and Signals												
Signal Inspection/Timing	$ 2,100	1.00	Annual	$ 2,100	$ 2,100	1.00	Annual	$ 2,100	$ 2,100	1.00	Annual	$ 2,100
Bulb/Lamp/Sensor Replacement	$ 600	1.00	Annual	$ 600	$ 600	1.00	Annual	$ 600	$ 600	1.00	Annual	$ 600
Signal Repair/Maintenance	$ 3,000	0.25	Annual	$ 750	$ 3,000	0.25	Annual	$ 750	$ 3,000	0.25	Annual	$ 750
Sign Replacement (Traffic Control and Ground Mounted)	$ 24,000	0.10	Annual	$ 2,400	$ 24,000	0.10	Annual	$ 2,400	$ 36,000	0.10	Annual	$ 3,600
Subtotoal				$ 5,850				$ 5,850				$ 7,050
Outages												
Total				$ 64,275				$ 79,475				$ 85,775

Table 2. *Maintenance Cost Build – Minor and Regular Maintenance Costs*

Warren County Transportation Improvement District
Life Cycle Cost Analysis
WAR-SR-63
Minor and Regular Maintenance (No MOT Required)

	No Build				4-Lane Divided				4-Lane Undivided			
	Cost per Occurance	Frequency of Occurance (Number per Time Period)	Time Period	Annual Cost	Cost per Occurance	Frequency of Occurance (Number per Time Period)	Time Period	Annual Cost	Cost per Occurance	Frequency of Occurance (Number per Time Period)	Time Period	Annual Cost
Pavement												
Snow Removal/Pretreatment	$ 3,000	8.00	Annual	$ 24,000	$ 5,000	8.00	Annual	$ 40,000	$ 5,000	8.00	Annual	$ 40,000
Crack Sealing/Pot Hole Repair	$ 5,400	3.00	Annual	$ 16,200	$ 3,600	3.00	Annual	$ 10,800	$ 3,600	3.00	Annual	$ 10,800
Subtotal				$ 40,200				$ 50,800				$ 50,800
Culverts												
Culvert Inspection (6)	$ 2,100	1.00	Annual	$ 2,100	$ 2,100	1.00	Annual	$ 2,100	$ 2,100	1.00	Annual	$ 2,100
Culvert Cleanout (6)	$ 5,000	0.50	Annual	$ 2,500	$ 7,000	0.50	Annual	$ 3,500	$ 10,000	0.50	Annual	$ 5,000
Subtotal				$ 4,600				$ 5,600				$ 7,100
Open Drainage												
Stormwater BMP Maintenance	$ -	0.00	Annual	$ -	$	0.00	Annual	$ -	$	0.00	Annual	$ -
Ditch Cleaning	$ 8,500	0.25	Annual	$ 2,125	$ 8,500	0.25	Annual	$ 2,125	$ 8,500	0.25	Annual	$ 2,125
Curb Inlet Cleanout	$ 1,000	0.25	Annual	$ 250	$ 1,000	0.25	Annual	$ 250	$ 1,000	0.25	Annual	$ 250
Subtotal				$ 2,375				$ 2,375				$ 2,375
Shoulders												
Mowing	$ 1,200	3.00	Annual	$ 3,600	$ 2,400	3.00	Annual	$ 7,200	$ 2,400	3.00	Annual	$ 7,200
Litter and Debris Cleanup	$ 1,200	2.00	Annual	$ 2,400	$ 1,200	2.00	Annual	$ 2,400	$ 1,200	2.00	Annual	$ 2,400
Sweeping and Vacuuming	$ 2,200	2.00	Annual	$ 4,400	$ 2,200	2.00	Annual	$ 4,400	$ 2,200	2.00	Annual	$ 4,400
ROW Fence Repair/Replacement	$ 8,500	0.10	Annual	$ 850	$ 8,500	0.10	Annual	$ 850	$ 8,500	0.10	Annual	$ 850
Subtotal				$ 11,250				$ 14,850				$ 14,850
Guardrail												
Median												
Mowing									$ 1,200	3.00	Annual	$ 3,600
Barrier												
Signs and Signals												
Signal Inspection/Timing	$ 2,100	1.00	Annual	$ 2,100	$ 2,100	1.00	Annual	$ 2,100	$ 2,100	1.00	Annual	$ 2,100
Bulb/Lamp/Sensor Replacement	$ 600	1.00	Annual	$ 600	$ 600	1.00	Annual	$ 600	$ 600	1.00	Annual	$ 600
Signal Repair/Maintenance	$ 3,000	0.25	Annual	$ 750	$ 3,000	0.25	Annual	$ 750	$ 3,000	0.25	Annual	$ 750
Sign Replacement (Traffic Control and Ground Mounted)	$ 24,000	0.10	Annual	$ 2,400	$ 24,000	0.10	Annual	$ 2,400	$ 36,000	0.10	Annual	$ 3,600
Subtotoal				$ 5,850				$ 5,850				$ 7,050
Outages												
Total				$ 64,275				$ 79,475				$ 85,775

Table 3. ***Maintenance Cost Requiring No Maintenance of Traffic - Input Values***

WARREN COUNTY TRANSPORTATION IMPROVEMENT DISTRICT
WAR 63 PRIORITY SEGMENT
LIFE CYCLE COST ANALYSIS
MAINTENANCE COSTS - NO MOT

Activity	No Build	4-Lane Undivided	4-Lane Divided
Pavement	$ 40,000	$ 51,000	$ 51,000
Culverts	$ 5,000	$ 6,000	$ 7,000
Open Drainage	$ 2,000	$ 2,000	$ 2,000
Shoulders	$ 11,000	$ 15,000	$ 15,000
Guardrail			
Median			$ 4,000
Cable Barrier			
Signs and Signals	$ 6,000	$ 6,000	$ 7,000
Outages			
	$ 64,000	$ 80,000	$ 86,000

Appendix B – PROJECT LEVEL INPUT DATA BY SCENARIO

Table 4. *Strategy Level Inputs*

WARREN COUNTY TRANSPORTATION IMPROVEMENT DISTRICT
WAR 63 PRIORITY SEGMENT
LIFE CYCLE COST ANALYSIS
STRATEGY LEVEL INPUTS

	No Build	4-Lane Undivided	4-Lane Divided	Remarks
1. Economic Variables				
Value of Time for Passenger Cars ($/hour)	$ 14.80	$ 14.80	$ 14.80	U.S. DOT Benefit-Cost Guidance Appendix A
Value of Time for Single Unit Trucks ($/hour)	$ 28.60	$ 28.60	$ 28.60	U.S. DOT Benefit-Cost Guidance Appendix A
Value of Time for Combination Trucks ($/hour)	$ 28.60	$ 28.60	$ 28.60	U.S. DOT Benefit-Cost Guidance Appendix A
2. Analysis Options				
Include User Costs in Analysis	Yes	Yes	Yes	Recommended *Real* Cost Defualts
Include User Cost Remaning Life Value	Yes	Yes	Yes	Recommended *Real* Cost Defualts
Use Differential User Costs	Yes	Yes	Yes	Recommended *Real* Cost Defualts
User Cost Computation Method	Calculated	Calculated	Calculated	Recommended *Real* Cost Defualts
Include Agency Cost Remaining Life Value	Yes	Yes	Yes	Recommended *Real* Cost Defualts
Traffic Direction	Both	Both	Both	Recommended *Real* Cost Defualts
Analysis Period (Years)	31	31	31	Recommended *Real* Cost Defualts
Beginning of Analysis Period	2021	2021	2021	Recommended *Real* Cost Defualts
Discount Rate (%)	7.0	7.0	7.0	Recommended *Real* Cost Defualts
Number of Alternatives	2	2	2	Recommended *Real* Cost Defualts
3. Traffic Data				
AADT Construction Year (total for both directions)	20,600	20,600	20,600	Current AADT
Cars as Percentage of AADT (%)	91.0%	91.0%	91.0%	
Single Unit Trucks as % of AADT (%)	2.0%	2.0%	2.0%	ODOT Traffic Count Database
Combination Trucks as % of AADT (%)	7.0%	7.0%	7.0%	Recommended *Real* Cost Defualts
Annual Growth Rate of Traffic (%)	3.0%	3.2%	3.2%	ODOT SHIFT Tool and Reasoned Judgement
Speed Limit Under Normal Operating Conditions (mph)	55	55	55	Posted Speed
Number of Lanes in Each Direction During Normal Conditions	1	2	2	Design
Free Flow Capacity (vphpl)	1500	1900	1900	Reasoned Judegement
Rural or Urban Hourly Traffic Distribution	Rural	Rural	Rural	Straddles Unbanized Boundary
Queue Dissipation Capacity (vphpl)	1100	1100	1100	Reasoned Judegement
Maximum AADT (total for both directions)	40,000	40,000	40,000	ODOT SHIFT forecast tool
Maximum Queue Length (miles)	1.0	1.0	1.0	Alternate Route Available

Appendix C – ACTIVITY LEVEL INPUT DATA BY SCENARIO

Table 5. *Activity Level Inputs – No Build Strategy*

WARREN COUNTY TRANSPORTATION IMPROVEMENT DISTRICT
WAR 63 PRIORITY SEGMENT
LIFE CYCLE COST ANALYSIS
ACTIVITY LEVEL INPUTS
NO BUILD STRATEGY

	Initial Construction	Expansion	Pavement	Culverts	Major Drainage Rehabilitation	Major Shoulder Rehabilitation	Guardrial Replacement	Major Median Rehabilitation	Median Barrier Replacement	Overhead Sign & Signal Replacement	Outages Requiring Maintenance of Traffic*
Activity 1											
Agency Construction Cost			$ 450,000	$ -	$ -	$ -	$ -			$ -	$ 55,000
Work Zone User Costs			Calculated	Calculated	Calculated	Calculated	Calculated			Calculated	Calculated
Work Zone Duration (days)			60	0	0	0	0			0	1
Number of Lanes Open in Each Direction During Work Zone			0.5	0.5	1.0	0.5	0.5			0.5	0.5
Activity Service Life (years)			11	11	5	11	10			11	2
Activity Structural Life (years)			11	11	5	11	10			11	0
Maintenance Frequency (years)			1	1	1	1	0			1	0
Agency Maintenance Cost			$ 40,000	$ 5,000	$ 2,000	$ 11,000	$ -			$ 6,000	$ -
Work Zone Length (miles)			3.00	0.00	0.00	0.00	0.00			0.00	0.10
Work Zone Speed Limit (mph)			40	40	50	25	25			40	25
Work Zone Capacity (vphpl)			500	500	500	500	500			750	500
Traffic Hourly Distribution			Week Day 1	Week Day 1	Week Day 1	Week Day 1	Week Day 1			Week Day 1	Week Day 1
Time of Day Lane Closures (24 hour clock)			7:00 - 15:00	7:00 - 15:00	7:00 - 15:00	7:00 - 15:00	7:00 - 15:00			7:00 - 15:00	7:00 - 15:00
Activity 2											
Agency Construction Cost			$ 3,515,000	$ 576,000	$ 180,000	$ 123,000	$ 77,000			$ 473,000	
Work Zone User Costs			Calculated	Calculated	Calculated	Calculated	Calculated			Calculated	
Work Zone Duration (days)			120	54	30	30	20			6	
Number of Lanes Open in Each Direction During Work Zone			0.5	0.5	1.0	0.5	0.5			0.5	
Activity Service Life (years)			15	25	15	10	18			15	
Activity Structural Life (years)			25	30	15	10	18			15	
Maintenance Frequency (years)			1	1	1	1	0			1	
Agency Maintenance Cost			$ 40,000	$ 5,000	$ 2,000	$ 11,000	$ -			$ 6,000	
Work Zone Length (miles)			3.00	0.20	3.00	3.00	0.50			0.10	
Work Zone Speed Limit (mph)			40	40	50	25	25			40	
Work Zone Capacity (vphpl)			500	500	750	500	500			750	
Traffic Hourly Distribution			Week Day 1	Week Day 1	Week Day 1	Week Day 1	Week Day 1			Week Day 1	
Time of Day Lane Closures (24 hour clock)			7:00 - 15:00	7:00 - 15:00	7:00 - 15:00	7:00 - 15:00	7:00 - 15:00			7:00 - 15:00	
Activity 3											
Agency Construction Cost			$ 450,000		$ 180,000	$ 123,000	$ 77,000			$ 473,000	
Work Zone User Costs			Calculated		Calculated	Calculated	Calculated			Calculated	
Work Zone Duration (days)			60		30	30	20			6	
Number of Lanes Open in Each Direction During Work Zone			0.5		1.0	0.5	0.5			0.5	
Activity Service Life (years)			5		11	10	3			5	
Activity Structural Life (years)			15		15	10	18			15	
Maintenance Frequency (years)			1		1	1	0			1	
Agency Maintenance Cost			$ 40,000		$ 2,000	$ 11,000	$ -			$ 6,000	
Work Zone Length (miles)			3.00		3.00	3.00	0.50			0.10	
Work Zone Speed Limit (mph)			40		50	25	25			40	
Work Zone Capacity (vphpl)			500		750	500	500			750	
Traffic Hourly Distribution			Week Day 1		Week Day 1	Week Day 1	Week Day 1			Week Day 1	
Time of Day Lane Closures (24 hour clock)			7:00 - 15:00		7:00 - 15:00	7:00 - 15:00	7:00 - 15:00			7:00 - 15:00	

*Outages occur every 2 years -Activity 1 is repeated 16 times

Table 6. *Activity Level Inputs – 4-Lane Undivided Strategy*

WARREN COUNTY TRANSPORTATION IMPROVEMENT DISTRICT
WAR 63 PRIORITY SEGMENT
LIFE CYCLE COST ANALYSIS
ACTIVITY LEVEL INPUTS
4-LANE UNDIVIDED STRATEGY

	Initial Construction	Expansion	Pavement	Culverts	Major Drainage Rehabilitation	Major Shoulder Rehabilitation	Guardrial Replacement	Major Median Rehabilitation	Median Barrier Replacement	Overhead Sign & Signal Replacement	Outages Requiring Maintenance of Traffic*
Activity 1											
Agency Construction Cost	$ 24,000,000		$ -	$ -	$ -	$ -	$ -			$ -	$ 55,000
Work Zone User Costs	Calculated		Calculated	Calculated	Calculated	Calculated	Calculated			Calculated	Calculated
Work Zone Duration (days)	365		0	0	0	0	0			0	1
Number of Lanes Open in Each Direction During Work Zone	1.0		1.0	1.0	1.0	1.0	1.0			1.0	1.0
Activity Service Life (years)	31		16	31	16	11	18			16	4
Activity Structural Life (years)	31		16	31	16	11	18			16	0
Maintenance Frequency (years)	0		1	1	1	1	0			1	0
Agency Maintenance Cost	$ -		$ 51,000	$ 6,000	$ 2,000	$ 15,000	$ -			$ 6,000	$ -
Work Zone Length (miles)	3		0.00	0.00	0.00	0.00	0.00			0.00	0.10
Work Zone Speed Limit (mph)	40		40	40	40	25	25			40	40
Work Zone Capacity (vphpl)	500		500	500	500	500	500			500	750
Traffic Hourly Distribution	Week Day 1		Week Day 1	Week Day 1	Week Day 1	Week Day 1	Week Day 1			Week Day 1	Week Day 1
Time of Day Lane Closures (24 hour clock)	7:00 - 15:00		7:00 - 15:00	7:00 - 15:00	7:00 - 15:00	7:00 - 15:00	7:00 - 15:00			7:00 - 15:00	7:00 - 15:00
Activity 2											
Agency Construction Cost			$ 750,000		$ 180,000	$ 123,000	$ 159,000			$ 945,000	
Work Zone User Costs			Calculated		Calculated	Calculated	Calculated			Calculated	
Work Zone Duration (days)			75		30	30	20			24	
Number of Lanes Open in Each Direction During Work Zone			1.0		1.0	2.0	1.5			1.0	
Activity Service Life (years)			15		15	10	13			15	
Activity Structural Life (years)			15		15	10	18			15	
Maintenance Frequency (years)			1		1	1	0			1	
Agency Maintenance Cost			$ 51,000		$ 2,000	$ 15,000	$ -			$ 6,000	
Work Zone Length (miles)			3.00		3.00	3.00	0.50			0.10	
Work Zone Speed Limit (mph)			40		50	25	25			40	
Work Zone Capacity (vphpl)			500		500	500	500			500	
Traffic Hourly Distribution			Week Day 1		Week Day 1	Week Day 1	Week Day 1			Week Day 1	
Time of Day Lane Closures (24 hour clock)			7:00 - 15:00		7:00 - 15:00	7:00 - 15:00	7:00 - 15:00			7:00 - 15:00	
Activity 3											
Agency Construction Cost						$ 123,000					
Work Zone User Costs						Calculated					
Work Zone Duration (days)						30					
Number of Lanes Open in Each Direction During Work Zone						2.0					
Activity Service Life (years)						10					
Activity Structural Life (years)						10					
Maintenance Frequency (years)						1					
Agency Maintenance Cost						$ 15,000					
Work Zone Length (miles)						3.00					
Work Zone Speed Limit (mph)						25					
Work Zone Capacity (vphpl)						500					
Traffic Hourly Distribution						Week Day 1					
Time of Day Lane Closures (24 hour clock)						7:00 - 15:00					

*Outages occur every 4 years -Activity 1 is repeated 8 times

Table 7. *Activity Level Inputs – 4-Lane Divided Strategy*

WARREN COUNTY TRANSPORTATION IMPROVEMENT DISTRICT
WAR 63 PRIORITY SEGMENT
LIFE CYCLE COST ANALYSIS
ACTIVITY LEVEL INPUTS
4-LANE DIVIDED STRATEGY

	Initial Construction	Expansion	Pavement	Culverts	Major Drainage Rehabilitation	Major Shoulder Rehabilitation	Guardrial Replacement	Major Median Rehabilitation	Median Barrier Replacement	Overhead Sign & Signal Replacement	Outages Requiring Maintenance of Traffic*
Activity 1											
Agency Construction Cost	$ 28,000,000		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 55,000
Work Zone User Costs	Calculated		Calculated	Calculated	Calculated	Calculated	Calculated	Calculated	Caculated	Calculated	Calculated
Work Zone Duration (days)	365		0	0	0	0	0	0	0	0	1
Number of Lanes Open in Each Direction During Work Zone	1.0		1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Activity Service Life (years)	31		16	31	16	11	18	11	20	16	5
Activity Structural Life (years)	31		16	31	16	11	18	11	20	16	0
Maintenance Frequency (years)	0		1	1	1	1	1	1	1	1	0
Agency Maintenance Cost	$ -		$ 51,000	$ 7,000	$ 2,000	$ 15,000	$ -	$ 4,000	$ -	$ 7,000	$ -
Work Zone Length (miles)	3		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10
Work Zone Speed Limit (mph)	45		40	40	50	40	25	50	50	40	40
Work Zone Capacity (vphpl)	1000		500	500	750	750	500	1150	1150	750	750
Traffic Hourly Distribution	Week Day 1		Week Day 1	Week Day 1	Week Day 1	Week Day 1	Week Day 1	Week Day 1	Week Day 1	Week Day 1	Week Day 1
Time of Day Lane Closures (24 hour clock)	7:00 - 15:00		7:00 - 15:00	7:00 - 15:00	7:00 - 15:00	7:00 - 15:00	7:00 - 15:00	7:00 - 15:00	7:00 - 15:00	7:00 - 15:00	7:00 - 15:00
Activity 2											
Agency Construction Cost			$ 750,000		$ 180,000	$ 123,000	$ 159,000	$ 153,000	$ 366,000	$ 945,000	
Work Zone User Costs			Calculated		Calculated	Calculated	Calculated	Calculated	Calculated	Calculated	
Work Zone Duration (days)			75		30	30	20	30	70	24	
Number of Lanes Open in Each Direction During Work Zone			1.0		1.0	2.0	1.5	1.5	2.0	1.0	
Activity Service Life (years)			15		15	10	13	10	11	15	
Activity Structural Life (years)			15		15	10	18	10	20	15	
Maintenance Frequency (years)			1		1	1	1	1	1	1	
Agency Maintenance Cost			$ 51,000		$ 2,000	$ 15,000	$ -	$ 4,000	$ -	$ 7,000	
Work Zone Length (miles)			3.00		3.00	3.00	0.50	3.00	3.00	0.10	
Work Zone Speed Limit (mph)			40		50	40	25	50	50	40	
Work Zone Capacity (vphpl)			500		750	750	500	1150	1150	750	
Traffic Hourly Distribution			Week Day 1		Week Day 1	Week Day 1	Week Day 1	Week Day 1	Week Day 1	Week Day 1	
Time of Day Lane Closures (24 hour clock)			7:00 - 15:00		7:00 - 15:00	7:00 - 15:00	7:00 - 15:00	7:00 - 15:00	7:00 - 15:00	7:00 - 15:00	
Activity 3											
Agency Construction Cost						$ 123,000		$ 153,000			
Work Zone User Costs						Calculated		Calculated			
Work Zone Duration (days)						30		30			
Number of Lanes Open in Each Direction During Work Zone						2.0		1.5			
Activity Service Life (years)						10		10			
Activity Structural Life (years)						10		10			
Maintenance Frequency (years)						1		1			
Agency Maintenance Cost						$ 15,000		$ 4,000			
Work Zone Length (miles)						3.00		3.00			
Work Zone Speed Limit (mph)						40		50			
Work Zone Capacity (vphpl)						750		1150			
Traffic Hourly Distribution						Week Day 1		Week Day 1			
Time of Day Lane Closures (24 hour clock)						7:00 - 15:00		7:00 - 15:00			

*Outages occur every 5 years -Activity 1 is repeated 6 times

Appendix D – SUMMARY OF RESULTS BY SCENARIO

Table 8. *Summary of Results by Scenario*

WARREN COUNTY TRANSPORTATION IMPROVEMENT DISTRICT
WAR 63 PRIORITY SEGMENT
LIFE CYCLE COST ANALYSIS
SUMMARY INCLUDING INITIAL CONSTRUCTION PERIOD COSTS

ACTIVITIES	NO BUILD					
	Undiscounted Sum		Present Value (Discounted at 7%)		Equivalent Uniform Annual Cost	
	Agency Cost	User Cost	Agency Cost	User Cost	Agency Cost	User Cost
Initial Build	$ -	$ -	$ -	$ -	$ -	$ -
Expannsion	$ -	$ -	$ -	$ -	$ -	$ -
Pavement	$ 4,532,000	$ 8,141,320	$ 2,544,770	$ 5,308,310	$ 203,060	$ 423,590
Culverts	$ 529,000	$ 1,755,620	$ 309,750	$ 1,143,360	$ 24,720	$ 91,240
Major Drainage Rehab	$ 368,000	$ 835,680	$ 191,840	$ 313,930	$ 15,310	$ 25,050
Major Shoulder Rehab	$ 554,000	$ 3,226,790	$ 216,760	$ 1,149,860	$ 17,300	$ 91,760
Guardrail Replacement	$ 89,830	$ 2,139,850	$ 42,850	$ 1,006,350	$ 3,420	$ 80,300
Major Median Rehab	$ -	$ -	$ -	$ -	$ -	$ -
Median Barrier Replacement	$ -	$ -	$ -	$ -	$ -	$ -
Overhead Sign/Signal Replacement	$ 761,130	$ 335,310	$ 330,380	$ 145,530	$ 26,620	$ 11,730
Outages Requiring MOT	$ 880,000	$ 770,740	$ 384,710	$ 326,980	$ 30,700	$ 26,090
	$ 7,713,960	$ 17,205,310	$ 4,021,060	$ 9,394,320	$ 321,130	$ 749,760

ACTIVITIES	4 LANE UNDIVIDED					
	Undiscounted Sum		Present Value (Discounted at 7%)		Equivalent Uniform Annual Cost	
	Agency Cost	User Cost	Agency Cost	User Cost	Agency Cost	User Cost
Initial Build	$ 24,000,000	$ 13,319,210	$ 24,000,000	$ 13,319,210	$ 1,915,130	$ 1,062,830
Expansion	$ -	$ -	$ -	$ -	$ -	$ -
Pavement	$ 2,229,000	$ 6,259,140	$ 869,640	$ 2,120,190	$ 63,390	$ 169,180
Culverts	$ 180,000	$ -	$ 74,450	$ -	$ 5,940	$ -
Major Drainage Rehab	$ 238,000	$ 2,445,910	$ 85,110	$ 828,510	$ 6,790	$ 66,110
Major Shoulder Rehab	$ 666,000	$ 2,265,130	$ 263,530	$ 656,230	$ 21,030	$ 52,360
Guardrail Replacement	$ 114,830	$ 927,460	$ 41,620	$ 336,150	$ 3,320	$ 26,820
Major Median Rehab	$ -	$ -	$ -	$ -	$ -	$ -
Median Barrier Replacement	$ -	$ -	$ -	$ -	$ -	$ -
Overhead Sign/Signal Replacement	$ 1,119,000	$ 1,942,020	$ 392,530	$ 657,830	$ 31,320	$ 52,490
Outages Requiring MOT	$ 440,000	$ 320,800	$ 205,350	$ 87,920	$ 16,390	$ 7,020
	$ 28,986,830	$ 27,479,670	$ 25,932,230	$ 18,006,040	$ 2,063,310	$ 1,436,810

ACTIVITIES	4-LANE DIVIDED					
	Undiscounted Sum		Present Value (Discounted at 7%)		Equivalent Uniform Annual Cost	
	Agency Cost	User Cost	Agency Cost	User Cost	Agency Cost	User Cost
Initial Build	$ 28,000,000	$ 854,290	$ 28,000,000	$ 854,290	$ 2,234,310	$ 68,170
Expansion	$ -	$ -	$ -	$ -	$ -	$ -
Pavement	$ 2,229,000	$ 6,259,140	$ 869,640	$ 2,120,190	$ 69,390	$ 169,180
Culverts	$ 210,000	$ -	$ 86,860	$ -	$ 6,930	$ -
Major Drainage Rehab	$ 238,000	$ 1,628,730	$ 85,110	$ 551,710	$ 6,790	$ 44,020
Major Shoulder Rehab	$ 666,000	$ 381,410	$ 263,530	$ 129,700	$ 21,030	$ 10,350
Guardrail Replacement	$ 114,830	$ 927,460	$ 41,620	$ 336,150	$ 3,320	$ 26,820
Major Median Rehab	$ 418,000	$ 110,770	$ 156,410	$ 37,670	$ 12,480	$ 3,010
Median Barrier Replacement	$ 201,300	$ 77,580	$ 74,360	$ 28,660	$ 5,930	$ 2,290
Overhead Sign/Signal Replacement	$ 1,148,000	$ 1,284,610	$ 404,600	$ 435,140	$ 32,290	$ 34,720
Outages Requiring MOT	$ 330,000	$ 220,700	$ 166,450	$ 65,570	$ 13,280	$ 5,230
	$ 33,555,130	$ 11,744,690	$ 30,148,580	$ 4,559,080	$ 2,405,750	$ 363,790