

Inclusion of LCCA in Alaska Flexible Pavement Design Software Manual



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Date 10/19/2012

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INE/AUTC 12.20

FHWA-AK-RD-13-07

REPORT DO	Form approved OMB No.						
Public reporting for this collection of information is c maintaining the data needed, and completing and revi including suggestion for reducing this burden to Was VA 22202-4302, and to the Office of Management a	stimated to average 1 hour per response, inc ewing the collection of information. Send c hington Headquarters Services, Directorate f nd Budget, Paperwork Reduction Project (07	luding the time for reviewing inst comments regarding this burden es or Information Operations and Re 04-1833), Washington, DC 2050	tructions, searching existing data sources, gathering and stimate or any other aspect of this collection of information, eports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, 03				
1. AGENCY USE ONLY (LEAVE BLANK) 2. REPORT DATE 3. REPORT TYPE AND DATES COVERED							
FHWA-AK-RD-13-07	October 2012	Final Report (08/200	09-09/2012)				
4. TITLE AND SUBTITLE			5. FUNDING NUMBERS				
Inclusion of LCCA in Alaska Flex	kible Pavement Design Softw	vare	AUTC #309023				
6. AUTHOR(S) Ming Lee, Bob McHattie, and Jua	nyu (Jenny) Liu		DTRT06-G-0011 T2-09-09				
7. PERFORMING ORGANIZATION NAME Alaska University Transportation Center	(S) AND ADDRESS(ES)		8. PERFORMING ORGANIZATION REPORT NUMBER				
P.O. Box 755900 Fairbanks, AK 99775-5900			INE/AUTC 12.20				
9. SPONSORING/MONITORING AGENCY Alaska Department of Transportation & Public	NAME(S) AND ADDRESS(ES) Facilities, Research, Development, an	d Technology Transfer	10. SPONSORING/MONITORING AGENCY REPORT NUMBER				
Research and Innovative Technology Adminis 1200 New Jersey Ave., SE, Washington, DC 2	tration (RITA), U.S. Dept. of Transpor 0590	tation (USDOT)	FHWA-AK-RD-13-07				
11. SUPPLENMENTARY NOTES							
12a. DISTRIBUTION / AVAILABILITY STA	ATEMENT		12b. DISTRIBUTION CODE				
No restrictions							
13. ABSTRACT (Maximum 200 words)							
Life cycle cost analysis is a key part for selecti Flexible Pavement Design software has been in analysis for a given project. Including LCCA i infrastructure performance while making more package capable of executing the economic co AKFPD manual, and case studies with comple for the program. It also added new modules, in other modules, "Mechanistic Pavement Design	ng materials and techniques that optim n use since 2004, there is no computerin n the AKFPD software would be of im cost-effective use of the design effort. st analysis and structural analysis funct te analysis processes to help the new us cluding "equivalent single axle loads c " and "Excess Fines Design."	ize the service life of a paven zed analysis tool available to mense benefit to pavement de This study seeks to update th ions. Upon completion, the p ser navigate the software. In t alculation" and "LCCA analy	nent in terms of cost and performance. While the Alask assist pavement engineers in developing this cost esigners, allowing them to routinely improve ne current AKFPD program and create a single software oroject will provide the updated software, a modified the past year, the project team developed a new layout ysis," and designed more user-friendly interfaces for tw	ta e VO			
14 KEVWOPDS: Payament design (Esuchn)	Life cycle costing (Esdmc) Life cycle	analycis (Esdm) Softwara (15. NUMBER OF PAGES				
17 ALT WORDS. Lavement design (Esusin).	, Ene cycle costing (Estinic), Ene cycle	anarysis (Esuii), Soitwale (.					
			16. PRICE CODE				
REPORT	OF THIS PAGE	OF ABSTRACT	FICATION 20. LIMITATION OF ABSTRACT				
Unclassified	Unclassified	Unclassifie	d N/A				
NSN 7540-01-280-5500			STANDARD FORM 298 (Rev. 2-98)				

Prescribed by ANSI Std. 239-18 298-1

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	SI* (MODERN	I METRIC) CONVER	SION FACTORS						
	APPRO	KIMATE CONVERSIONS	TO SI UNITS						
Symbol	When You Know	Multiply By	To Find	Symbol					
		LENGTH							
in	inches	25.4	millimeters	mm					
ft	feet	0.305	meters	m					
yd	yards	0.914	meters	m					
mi	miles	1.61	kilometers	кm					
. 2		AREA		2					
In ⁻	square inches	645.2	square millimeters	mm ²					
π	square teet	0.093	square meters	m m ²					
ya ac	square yard	0.836	square meters	(T) bo					
mi ²	square miles	2 59	square kilometers	km ²					
floz	fluid ounces	29.57	milliliters	ml					
dal	gallons	3 785	liters	1					
ft ³	cubic feet	0.028	cubic meters	m ³					
yd ³	cubic yards	0.765	cubic meters	m³					
	NOTE: Y	volumes greater than 1000 L shall be	e shown in m ³						
		MASS							
oz	ounces	28.35	grams	g					
lb	pounds	0.454	kilograms	kg					
Т	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")					
	-	TEMPERATURE (exact deg	rees)						
°F	Fahrenheit	5 (F-32)/9	Celsius	°C					
		or (F-32)/1.8							
		ILLUMINATION							
fc	foot-candles	10.76	lux	lx					
fl	foot-Lamberts	3.426	candela/m ²	cd/m ²					
	FC	DRCE and PRESSURE or S ⁻	TRESS						
lbf	poundforce	4.45	newtons	Ν					
lbf/in ²	poundforce per square inch	6.89	kilopascals	kPa					
	APPROXI	MATE CONVERSIONS F	ROM SI UNITS						
Symbol	When You Know	Multiply By	To Find	Symbol					
		LENGTH							
mm	millimeters	0.039	inches	in					
m	meters	3.28	feet	ft					
m	meters	1.09	yards	yd					
km	kilometers	0.621	miles	mi					
		AREA							
mm²	square millimeters	0.0016	square inches	in ²					
m²	square meters	10.764	square feet	ft ²					
m ²	square meters	1.195	square yards	yd²					
ha lum ²	hectares	2.47	acres	ac					
КП	square kilometers		square miles	ITH					
		VOLUME	a • 1						
mL	milliliters	0.034	fluid ounces	fl OZ					
L m ³	litters	0.204	gailons cubic foot	gai ^{#3}					
m ³	cubic meters	1 307	cubic vards	vd ³					
		MASS		yu					
a	grams	0.035	OUDCES	07					
9 ka	kilograms	2 202	pounds	lb					
Mg (or "t")	megagrams (or "metric ton'	') 1.103	short tons (2000 lb)	T					
<u> </u>	-	TEMPERATURE (exact deg	rees)						
°C	Celsius	1.8C+32	Fahrenheit	°F					
-									
lx	lux	0.0929	foot-candles	fc					
cd/m ²	candela/m ²	0.2919	foot-Lamberts	fl					
	FC	RCF and PRESSURE or S	TRESS						
N	n a undan a	0.225	poundforce	lbf					
	newtons								
kPa	kilopascals	0.145	poundforce per square inch	lbf/in ²					

*SI is the symbol for the International System of Units. Appropriate rounding should be made to comply with Section 4 of ASTM E380. (Revised March 2003)

Table of Contents

Addendum Part 1: Introduction and Installing the New Software1
Introduction1
Software Installation1
New Project
Addendum Part 2: Equivalent Single Axle Load (ESAL)—Calculations Using New Software
ESAL Calculation
Addendum Part 3: Life Cycle Cost Analysis (LCCA) Calculation—AKFPD Manual Chapter 9 & Calculations Using New Software
Life Cycle Cost Analysis

List of Figures

Figure 1 AKFPD 2012 Beta Software Setup Wizard	2
Figure 2 Select Installation Folder	3
Figure 3 Accessing Data Folder Properties	4
Figure 4 Uncheck Read-only Attribute of the Data Folder	5
Figure 5 Edit Security Setting of the Data Folder	6
Figure 6 Program Title Window	7
Figure 7 Creating a New Project in AKFPD2012	8
Figure 8 Project Info Dialog Box	9
Figure 9 Save As Dialog Box	. 10
Figure 10 Project Workbook	. 11
Figure 11 Modules/ESAL Calculation	. 12
Figure 12 ESAL Calculation Data Entry Window	. 13
Figure 13 ESAL Calculation Data Entry Window with Results	. 14
Figure 14 The ESAL Worksheet with Input Data and Calculation Results	. 15
Figure 15 Save the Project Workbook	. 16
Figure 16 Save the Project Workbook As Different Files (XML or Excel)	. 16
Figure 38 Cash Flow Diagram for Alternative #1	. 21
Figure 39 Cash Flow Diagram for Alternative #2	.21
Figure 40 Graphical Comparison of NPV of Alternatives #1 and #2	. 22
Figure 41 Creating a New Project in AKFPD2012	. 27
Figure 42 Project Info Dialog Box	. 28
Figure 43 Save As Dialog Box	. 29
Figure 44 Project Workbook	. 30
Figure 45 LCCA Worksheet	.31
Figure 46 Modules/Life Cycle Cost Analysis	. 32
Figure 47 Life Cycle Cost Analysis Input Data Window (A1/R1 Tab)	. 33
Figure 48 Life Cycle Cost Analysis Input Data Window (A1/R2 Tab)	. 34
Figure 49 Life Cycle Cost Analysis Data Input Window (A2/R1 Tab)	. 35
Figure 50 Life Cycle Cost Analysis Data Input Window (A2/R2 Tab)	.36
Figure 51 LCCA Worksheets (Alternative 1, Initial Construction)	. 37
Figure 52 LCCA Worksheets (Alternative 1, Rehabilitation at Years 15 and 25)	. 38
Figure 53 LCCA Worksheets (Alternative 1, Reconstruction at Year 32)	. 39
Figure 54 LCCA Worksheets (Alternative 2, Initial Construction)	. 40
Figure 55 LCCA Worksheets (Alternative 2, Rehabilitation at Years 15, 20 and 25)	.41
Figure 56 LCCA Worksheets (Alternative 2, Reconstruction at Year 30)	.42
Figure 57 LCCA Worksheets (Cash Flow Diagram)	. 43
Figure 58 LCCA Summary Worksheet (the Input Data portion)	.44
Figure 59 LCCA Summary Worksheet (the Output Data portion)	.44

Figure 60 Save the LCCA Worksheets as an Excel File	45
Figure 61 Save As an Excel File Dialog Box	46
Figure 62 LCCA Summary Copied to the Project Workbook	47
Figure 63 An AKFPD Project Files (Project Workbook and LCCA Worksheets)	48
Figure 64 Save the Project Workbook to the Original Project File	49
Figure 65 Save the Project Workbook as Different Files	50

List of Tables

Table 1 Performance Periods and Activity Timing for Sample Project	18
Table 2 Estimated Costs for Sample Project	19
Table 3 Cash Flow Table for Sample Project	20
Table 4 Spreadsheet Output from Sample Hypothetical Analysis	21
Table 5 Input Variables for the AKFPD2012 LCCA Example	24

Addendum Part 1: Introduction and Installing the New Software

Introduction

The Alaska Flexible Pavement Design (AKFPD) 2012 software is designed to implement the design analysis methods of the Alaska Flexible Pavement Design Manual of the Alaska Department of Transportation and Public Facilities (AKDOT&PF). The AKFPD 2012 software is programmed with Microsoft Visual Studio 2008 in the Windows 7 environment. The compiled software is a 64-bit application that is not compatible with legacy software executables that are 8-bit or older.

In the current edition, pavement design modules of Mechanistic Design and Excess Fine Design are made inactive, because the mechanistic design method requires an old executable Elsym5 (i.e., the file is *ElsymZ.exe*) to perform the calculation. However, Elsym5 is an 8-bit executable and cannot be run in the Windows 7 environment. Thus, since pavement design methods mechanistic design and excess fine are often used together, program features created for pavement design are all disabled in the current edition. It is expected that Elsym5 will be updated to 64 bit in a later date and pavement design features will be activated then.

The modules that are activated in the current edition are ESAL calculation and Life Cycle Cost Analysis (LCCA). The ESAL calculation component is essentially a graphical user interface that facilitates the data entry and ESAL calculation tasks that were previously performed by the engineers and analysts of AK DOT & PF using a Microsoft Excel spreadsheet. The LCCA component is a brand new software tool that is designed specifically for the new LCCA chapter (i.e., Chapter 9) of the Alaska Flexible Pavement Design Manual.

The AKFPD 2012 software adopts a workbook/worksheets approach similar to Microsoft Excel for project data and task management. That is, a workbook with multiple worksheets is first created and saved for a design/analysis project. Each worksheet of the workbook is then used to store the input and output data of a particular analysis (i.e., ESAL calculation and LCCA) pertaining to the project. For each analysis method, the AKFPD 2012 software uses specially designed user interfaces for data entry and analysis results together with the original inputs are written on the corresponding worksheets of the project workbook. The completed workbook can eventually be saved as an Excel file to facilitate reporting with Microsoft Word and Powerpoint.

Software Installation

Included with this Tutorial are the setup files for the Beta version of AKFPD 2012 software.

To install the software, simply run the setup.exe file by double clicking at the file in Windows Explorer. The Setup Wizard will appear to guide you through the setup process (Figure 1).

🛱 AKFPD 2012 Beta		
Welcome to the AKI	FPD 2012 Beta Setup	Wizard
The installer will guide you thro	ugh the steps required to install A	KFPD 2012 Beta on your computer.
WARNING: This computer prog Unauthorized duplication or dis or criminal penalties, and will be	gram is protected by copyright law tribution of this program, or any p e prosecuted to the maximum ext	w and international treatles. ortion of it, may result in severe civil ent possible under the law.
	Cancel	<back next=""></back>

Figure 1 AKFPD 2012 Beta Software Setup Wizard

After clicking next, the second dialog box asks you to specify the directory where the software is to be installed (Figure 2).

🖁 AKFPD 2012 Beta	
Select Installation Folder	
The installer will install AKFPD 2012 Beta to the following folder.	
To install in this folder, click "Next". To install to a different folde	r, enter it below or click "Browse".
<u>F</u> older:	
C:\Program Files\AUTC\AKFPD 2012 Beta\	Browse
	Disk Cost.,.
Install AKFPD 2012 Beta for yourself, or for anyone who uses	this computer:
O Everyone	
💽 Just me	
Cancel	< Back Next >

Figure 2 Select Installation Folder

After determining the directory to install the software, clicking Next will begin the installation process. When it is done, you will be notified that the installation is finished and a shortcut icon is placed on the computer desktop.

Before you can run the program, depending on the security setup of your computer and the directory you selected, if you install the software in the C:\Program Files(X86)\ directory you may need to make the data folder under the program directory available to all users:

- C:\Program Files(X86)\AUTC\AKFPD 2012\Data (Windows 7)
- C:\Program Files\AUTC\AKFPD 2012 \Data (Windows XP)

To do this, in Windows Explorer, find the two folders and use the right mouse button to access the Properties page of the folder (Figure 3).

RoadUpgradeSo Open NetTopologySuit Open in new window MapSuiteCore.dll Share with GeoAPI.dll Share with DesktopEdition.x Add to archive MapSuiteCore.xn Add to "Data.rar" DesktopEdition.dll Compress and email RoadUpgradeSo Compress to "Data.rar" and email RoadUpgradeSo Compine supported files in Acrobat
RoadUpgradeSo Image: Construct a security Send to Cut Copy Create shortcut Delete Rename Open folder location

Figure 3 Accessing Data Folder Properties

When the Properties page of the Data folder appears, first uncheck the Read-only attributes (Figure 4), because the software will read and write to files in this folder.

General Sharin	g Security	Previous Version	ns
1	Data		
Туре:	File folder		
Location:	C:\Users\N	//SL\Documents\V	isual Studio 2008\Projects\F
Size:	27.7 MB (2	9,071,425 bytes)	
Size on disk:	27.7 MB (2	9,073,408 bytes)	
Contains:	2 Files, 0 F	olders	
Created:	Thursday.	March 29, 2012, 7:	40:08 PM
Attributes:	Read-c	only (Only applies	to files in folder)
	Hidden		Advanced

Figure 4 Uncheck Read-only Attribute of the Data Folder

Next, go to the Security tab of the properties page. Make sure the user of the software have full control of the folder (Figure 5). If not, use the Edit button to assign full control to the intended user.

General Sharing Security Previo	ous Versions	
Object name: C:\Users\MSL\D	ocuments\Visual Studio 2	008\Projects
Group or user names:		
& SYSTEM		
MSL (MSL-PC\MSL)		
& Administrators (MSL-PC\Admin	nistrators)	
To change permissions, click Edit.	E	Edit
5		6.02
Permissions for MSL	Allow	Deny
Full control	×	*
Modify		
Read & execute	.9	H
List folder contents	-2	
Read	8	
Write	20	÷
For special permissions or advance	ced settings.	vanced
click Advanced.	nu	Valleeu
Learn shoul access control and pa	missions	
Lean about access control and pe	annasiona	

Figure 5 Edit Security Setting of the Data Folder

New Project

Upon launching the program, users are first greeted by the program title window that is to display the software version, authorship, and copyright ownership information (Figure 6). This window is also displayed after users go to Help/About AKFPD2012. This window will go away after a few seconds of lag time. After that the user will see the program main window of AKFPD 2012 (Figure 7).



Figure 6 Program Title Window

To perform an analysis with AKFPD2012, a new project is first created by going to File/New (Figure 7).

🔾 Ala	ska Flexib	le Paveme	ent Desig	1 2012			
File	Сору	Modules	View	Help			
	New						
	Open						
	Close All						
	Save						
	Save As	- P -					
	Print						
-	Exit	_					

Figure 7 Creating a New Project in AKFPD2012

On the ensuring dialog box Project Info (Figure 8), enter information that identifies the project. The Mechanistic Design options let users specify the design of a New pavement structure or an Overlay Design. After specifying project information, clicking at the **Save** button will open the typical Windows Save As dialog box (Figure 9).

Alaska Flexible Pavemer	nt Design 2012		
File Copy Modules	View Help		
Project Info			
Project Info Project Name		Designer	
Project Number		Date 02/07/2013 10:38 PM	
Number of Lanes	2 👻		
		Cancel Save	

Figure 8 Project Info Dialog Box

🔘 🐌 « Documents	Visual Studio 2008 Projects AKPFD2012	- ++ Search AKPFD2012 🔎
rganize • New folder		≣ → 0
Favorites E Desktop	Documents library AKPFD2012	Arrange by: Folder -
bownloads	Name	Date modified
Recent Places	E AKFPD 2012 Beta Installation	8/20/2012 11:08
Libraries	AKDOTPavementDesign	1/31/2013 12:01
	🖆 LifeCycleSpread.xml	2/9/2012 3:16 PM
A Music	MechanisticResultForm.xml	6/5/2012 9:30 PM
Pictures	😤 Example1.xml	8/20/2012 2:03 P
Uideos	Example Hypothetical LCCA-lcca.xml	9/29/2012 1:47 A
	🖺 Example Hypothetical LCCA.xml	9/29/2012 1:47 A 🖕
Computer	 ✓ [
File name: Exampl	e 1.xml	√
Save as type: XML file	s (*.xml)	•
Hide Folders		Save Cancel
File name: Example Save as type: XML file Hide Folders	s (*:xml)	Save Cancel

Figure 9 Save As Dialog Box

On the Save As dialog box, enter a file name (e.g., *Example 1.xml*) in the desired directory for the new project and click at the **Save** button. The project workbook (Figure 10) will appear after the file is successfully created. The *.xml file is the data format adopted for the AKFPD2012 software. Although the XML file format is common to many software, the files saved by AKFPD2012 are effectively processed and displayed by only the AKFPD2012 software.

Workbo	ook: Eliot Highway MP 102	-110								×
	А	В	С	D	E	F	G	н	Î	
1	Project Information:	Eliot Highway MP 102-110								
2	Project Nnumber.	MG-168								
3	Designer:	Angelina Jolie								
4	Date:	2/7/2013 10:38:34 PM								
5										
6	Number of Lanes:	2								_
7										
8										
9										- 1
10								_		
1										=
2										_
3										
4								_		
5										

Figure 10 Project Workbook

Figure 10 shows that a project workbook contains three worksheets: Project Info, ESAL, and LCCA. Project Info contains basic project information that was previously entered in the Project Info dialog box. Except for the Project Info sheet, each worksheet is designed to store the input and output variables of a particular pavement design analysis.

Addendum Part 2: Equivalent Single Axle Load (ESAL)—Calculations Using New Software

ESAL Calculation

To begin an ESAL calculation with the software, when the project workbook is opened, go to Modules/ESAL Calculation (Figure 11). This will bring up the ESAL Calculation data entry window (Figure 12).

Copy N	lodules	View Help					
	Basic F	Project Data					
-	ESAL C	Calculation					
Workb	Life Cy	cle Cost Analysis					•
-	A	В	C	D	E	F	E
1			-	Traffic Data for Des	ign and Historic ESALs		
2			Design Data Input				
3		Design Construction Year.					
4		Design Length in Years:					
5		Base Year.					
6		Base Year Total AADT:					
7		Growth Rate % per Year:					
8			and a second second second second		<u></u>		
9		% 0	Base Year AADT for Eacl	h Lane	4	-	
10		Lane		%			=
11		1		. Y			
12		2				-	
13		3				-	
14		4					
15		5					
10		6			-		
17			1.15	% AADT in			
18		Truck Category	Load Factor	Truck Category	<u></u>		
19		2-Axle			-		
20		3-Axle			-		
21		4-Axle					
22		5-Axie			-		
23		>=o-AXIe					
25		Total Design FSALe					- F
26		Total Design ESALS.			1		
		and the second second				1	
4 4 5 1	Project	Info ESAL LCCA					

Figure 11 Modules/ESAL Calculation

SAL Calculation: Eliot Highway MP 102-110	
Base Data	Historic Data
	Calculate Historic ESALs
Design Construction Year	Historic Construction Year
Base Year	
Base Year Total AADT	Backcast % per Year
Growth Rate % per Year	
Lane No. % of Base Year AADT by Lane	Lane No. % of Historic AADT by Lane
1	1
2	2
3	3
4	4
5	5
6	6
Truck Category Load Factor % AADT in Truck Category	Truck Category Load Factor % AADT in Truck Category
2-Axle 0.5	2-Axle 0.5
3-Axle 0.85	3-Axle 0.85
4-Axle 1.2	4-Axle 1.2
5-Axle 1.55	5-Axle 1.55
>=6-Axle 2.24	>=6-Axle 2.24
Total Design ESALs:	Total Historical ESALs:
Cancel	late Save/Close

Figure 12 ESAL Calculation Data Entry Window

The left hand side of the ESAL data window is for the design ESAL calculation. The right hand side is for historic ESAL calculation that is used for overlay pavement design. The total Design ESALs and the Total Historic ESALs text boxes are to be filled with the final results of the calculation. Historic ESAL calculation will not be carried out unless the Calculate Historic ESAL is checked. The Load Factor numbers are default values used by AK DOT & PF.

Once the data entry is completed, clicking at the **Calculate** button will perform the calculation and fill the two ESAL text boxes with the corresponding results. The **Calculate** button keeps the ESAL Calculation window open and active (see Figure 13) such that users can examine the results, change input data and recalculate if necessary.

ESAL Calculation:	ESAL Calculation				
Base Data			Historic Data		
			Calculate Histor	ric ESALs	
Design Construction	Year 2020		Historic Constructio	n Year 1990	_
Bas	e Year 2003				
Base Year Total	AADT 1600		Backcast % pe	erYear 1.6	
Growth Rate % per	Year 2.5				
Lane No.	% of Base Ye	ear AADT by Lane	Lane No.	% of Historic /	AADT by Lane
1	60		1	50	
2	40	-	2	50	_
3	0		3	0	
4	0		4	0	
5	0		5	0	
6	0		6	0	
Truck Category	Load Factor	% AADT in Truck Category	Truck Category	Load Factor	% AADT in Truck Category
2-Axle	0.5	2	2-Axle	0.5	2
3-Axle	0.85	4	3-Axle	0.85	4
4-Axle	1.2	4	4-Axle	1.2	4
5-Axle	1.55	3	5-Axle	1.55	3
>=6-Avle	2.24	1	>=6-Axle	2.24	1

Figure 13 ESAL Calculation Data Entry Window with Results

Once users are satisfied with the results, clicking at the **Save/Close** button will close the ESAL calculation window and copy the calculation results to the ESAL worksheet of the project workbook. If not already turned to, clicking at the ESAL tab of the workbook will turn to the ESAL worksheet (Figure 14).

A	0	C	D	E	1F	G	H		¥
			Traffic Data for Design a	nd Historic ESALs					
		Design Data Input					Historic Data Input		
	Design Construction Year		2020			Historic Construction Year		1990.	
	Design Longth in Years		17						
	Base Year		2003		_	Backcast % per Year		16	
	Base Veer Total AADT		1600						
	Growth Rate % per Year:		25						
-		of Base Year AADT for East	hLave			5	of Base Year AADT for Each	Lhne	1
	Lare		5			Lore		3	
	1		60			1		50	
	2		40			2		-90	
	3		0			3		- Q	
	4		0	1		4		0	
	5		0		2	5		0	-
	6		0			6		0	
					_				
	Truck Catigory	Losd Factor	S AADT in Truck Category			Truck Category	Losd Factor	S AADT in Truck Category	
	Z-Axie	0.5	2			2-Axie	0.5	2	
-	3-Axie	0,85	4			3-Axie	0.85	4	-
	4-AxW	12	-4			4-Axie-	1.2	4	1
	5-Axia	1.55	3			5-Axle	1.55	3	
	>=6-Aate	2.24	1		1	3+5-Axle	2.24	1	
	Total Design FSALs		NICOL I			Total History FSALs	16	00503	1
		Construction Year ESA	Calculations		1		Historic Construction Yes	r ESAL Calculations	
usix Califyliny	Design Lane AADT	* AADT in Truck Category	Load Factor for Truck Category	Construction Year ESALs	Truck Catilgory	Design Lares AADT	Truck Category	Load Factor for Truck Category	Historic Construction Vea ESALs
2-Axle	1461	.2	0.5	5333	2-Axle	756	2	0.6	2759
3-Azla	1461	4	0.35	18131	3-Axle	756	4	0.85	9382
6-Axde	1461	4	12	25597	d-Axle	756	4	12	13245
5-Axle	1463	3	1.55	24797	5-Axle	756	3	155	12831
>+6-Axle	1461	1	2.24	11945	swit-Aode	756	1	2.24	6181
	1		Total Construction Vear ESALs	85803			Total Histor	x Year ESALs	44396

Figure 14 The ESAL Worksheet with Input Data and Calculation Results

To save the workbook at its current state, users can go to **File/Save** (Figure 15). This will save the workbook to the original file (e.g., *Example 1.xml*).

ile Module	s View	Help				
New Ct	rl+N					
Open Ct	rl+0					
Close Ci	trl+C iula	ation				
Save C	trl+S	P		0	-	-
Save As	-	D	C	U Traffic Data for Desig	n and Historic ESALs	F
Drint C	trl±D		Design Data Input	Hame Data for Desig		
Fine C		Design Construction Year	Design Data input	2020		
EXIT C		Design Length in Years:		17		
5		Base Year:		2003		
6		Base Year Total AADT:		1600		
7		Growth Rate % per Year:		2.5		
8			7			
9	1	% c	of Base Year AADT for Each	Lane		
10		Lane		%	4	
11		1		60	12	
12		2		40		
13		3		0		
14		4		0		1.1.1
15		5		0		
16		6		0		
17						
18		Truck Category	Load Factor	% AADT in Truck Category		
19		2-Axle	0.5	2	1	
20		3-Axle	0.85	4		
21		4-Axle	1.2	4		
22	1	5-Axle	1.55	3	-	
23		>=6-Axle	2.24	1		
24						
25		Total Design ESALs:	1.	90256		
26				01-15		1
21		Design Lans	% AADT in	Lood Easter for	Construction Veer	
28 Truck C	ategory	AADT	Truck Category	Truck Category	ESALs	Truck Catego
29 2-A	xle	1461	2	0.5	5333	2-Axle
30 3-A	xle	1461	4	0.85	18131	3-Axle

Figure 15 Save the Project Workbook

Alternatively, the workbook can be saved as a different XML file (i.e., specific format for the AKPFD2012) or an Excel file (*.*xls*) that can be further processed in Microsoft Excel. To do this, go to **File/Save As**. The options of XML and Excel will appear (Figure 16).

C	Alask	a Flexible Pavem	nent Design 2012				
	File	Modules View	w Help				
	N	ew Ctrl+N					
r	0	oen Ctrl+O					
	C	ose Ctrl+C	ulation				
	S						
1			B		С	D Tarifia Data fas Dasias	E E
I		int Ctrl D	XIVIL		Docian Dete Innut	Traffic Data for Design	and historic ESALS
	PI	int Ctri+P	EXCEI	Year	Design Data niput	2020	
l	E	it CtrI+E	Desian Lenath in Y	ears:		17	
	5		Base	Year:		2003	
	6		Base Year Total A	ADT:		1600	
	7		Growth Rate % per	Year:		2.5	
	8						
	9			% of	Base Year AADT for Each	Lane	-
	10		Lane			%	
	11		1			60	
	12		2				
	14		3			0	· · · · · · · · · · · · · · · · · · ·
	15		5			0	<u> </u>
	16		6			0	
	17						
	18		Truck Category		Load Factor	% AADT in Truck Category	
	19		2-Axle		0.5	2	
	20		3-Axle		0.85	4	
	21		4-Axle		1.2	4	
	22		5-Axle		1.55	3	
	23		>=6-Axle		2.24	1	
	24		T-t-ID-size FC		4	700050	
	25		Total Design ES	ALS.		730230	
	20			Cr	Instruction Year ESAL	Calculations	
	28	Truck Category	Design Lane AADT		% AADT in Truck Category	Load Factor for Truck Category	Construction Year ESALs
	00	0.4.1	1401			0.5	5000

Figure 16 Save the Project Workbook As Different Files (XML or Excel)

Addendum Part 3: Life Cycle Cost Analysis (LCCA) Calculation—AKFPD Manual Chapter 9 & Calculations Using New Software

Life Cycle Cost Analysis

To demonstrate how to use AKFPD 2012 to run a life cycle cost analysis, a well established example is required. This part of the tutorial is taken from the section written for the new Life Cycle Cost Analysis chapter (Chapter 9) of the Alaska Flexible Pavement Design Manual. This section contains a well designed example with sufficient details to demonstrate a life cycle analysis scenario. Section 5.1 explains the details of the example and section 5.2 shows how to use AKFPD 2012 to carry out an LCCA for the example. For users who are not familiar with life cycle analysis methods, reviewing the entire chapter 9 of the Manual may be necessary.

3.1 Sample Hypothetical Analysis

Suppose it is proposed to repave an eight mile section of two lane rural highway. Two alternative design strategies have been developed. The subbase would be the same for either alternative and is thus ignored in the life cycle cost analysis. Alternative #1 includes a 3" asphalt concrete pavement and a 4" stabilized base course. In the future, annual preservation will be performed. Major rehabilitation will consist of a thick overlay, while a complete reconstruction will include a pavement structure exceeding the quality of the original (year 0) construction.

Alternative #2 consists of a 2" asphalt concrete pavement and an 8" base course. Future work includes routine annual preservation, minor rehabilitation with a thin overlay, and a major reconstruction with the same design as the original project.

The performance periods and activity timing for each of these alternatives are shown in Table 1:

	Alternative #1	Alternative #2
Initial Structure	3" asphalt concrete + 4" stabilized base	2" asphalt concrete + 8" base
Initial Construction	Year 0	Year 0
Routine Preservation	Annually	Annually
Rehabilitation	Major rehabilitation @ years 15 & 25 (thick overlay)	Minor rehabilitation @ years 15, 20 & 25 (thin overlay)
Reconstruction	Complete rebuild at year 32, lasting 20 years	Major rebuild at year 30, lasting 15 years

Table 1 Performance Periods and Activity Timing for Sample Project

Estimated costs are given in Table 2 shown below. Note that these are always stated as *real*, or *year zero*, costs. (It is not necessary to account for future inflation when listing future costs because of the *real* 4% discount rate that will be used in the analysis). User costs were obtained using Figure 9.1, Work Zone User Delay Cost Estimates, assuming daytime work for an eight mile, two lane rural highway and an assumed number of project days appropriate to the type of work. For example, for Alternative #1, if the initial construction requires 150 days, the AADT is 4500, and the value from the graph is 90, the calculated work zone user delay cost is \$972,000.

Table 2 Estimated Co	osts for Sam	ple Proiect
----------------------	--------------	-------------

	Alternative #1	Alternative #2
Agency costs		
Initial construction		
Engineering & contract administration	\$1,300,000	\$900,000
Construction	\$7,500,000	\$5,500,000
Traffic control	\$200,000	\$170,000
Rehabilitation (overlays)		
Engineering & contract administration	\$500,000	\$350,000
Construction	\$3,100,000	\$1,900,000
Traffic control	\$140,000	\$80,000
Reconstruction		
Engineering & contract administration	\$1,500,000	\$1,100,000
Construction	\$9,200,000	\$6,400,000
Traffic control	\$200,000	\$170,000
User costs		
Initial construction	\$972,000	\$1,296,000
Rehabilitation	\$432,000 (Year 15)	\$396,000 (Year 15)
	\$518,400 (Year 25)	\$435,600 (Year 20)
		\$475,200 (Year 25)
Reconstruction	\$1,404,000 (Year 32)	\$1,814,400 (Year 30)

The costs of routine preservation are assumed to be equal for both alternatives and are therefore not included in the analysis. If this is not the case, it would be necessary to include such preservation costs

for the years when they are expected to occur. To find the salvage value for each alternative, using the pro-rated life method, we proceed as follows:

For Alternative #1, the \$10,900,000 reconstruction cost at year 32 (shown in Table 3 and Figure 17) has a 20 year life. Thus, at year 35, its value will be $\left(\frac{17}{20}\right) \times (\$10,900,000) = \$9,265,000$.

For Alternative #2, the \$7,670,000 reconstruction cost at year 30 (shown in Table 3 and Figure 18) has a 15 year life. Thus, at year 35, its value will be $\left(\frac{10}{15}\right) \times (\$7,670,000) = \$5,113,333 \cong \$5,113,000$.

From the above activity timing and cost estimates, we can develop the following cash flow table and the cash flow diagrams shown in Figure 17 and Figure 18:

	Alt #1	Alt #1	Alt #2	Alt #2
Year	Agency Cost	User Cost	Agency Cost	User Cost
0	\$9,000,000	\$972,000	\$7,570,000	\$1,296,000
15	\$3,740,000	\$432,000	\$2,330,000	\$396,000
20			\$2,330,000	\$435,600
25	\$3,740,000	\$518,400	\$2,330,000	\$475,200
30			\$7,670,000	\$1,814,400
32	\$10,900,000	\$1,404,000		
35	-\$9,265,000		-\$5,113,000	

Table 3 Cash Flow Table for Sample Project





Figure 18 Cash Flow Diagram for Alternative #2

Computation of net present value for each alternative is based on the cash flow diagrams and a discount rate of 4%. We have separated the agency and user costs. The following spreadsheet shows the results of the analysis, which uses a simple $(1 + i)^{-n}$ formula to calculate present value for each cash flow.

Sample Hypothe	tical Life Cycle	Cost Analysis		C	iscount rate =	4%		
Column 1	Column 2	Column 3	Column 4	Column 5	Column 6	Column 7	Column 8	Column 9
7	Alt #1 Agency	PV Alt #1	Alt #1 User	PV Alt #1	Alt #2 Agency	PV Alt #2	Alt #2 User	PV Alt #2
Year	Cost	Agency Cost	Cost	User Cost	Cost	Agency Cost	Cost	User Cost
0	\$9,000,000	\$9,000,000	\$972,000	\$972,000	\$7,570,000	\$7,570,000	\$1,296,000	\$1,296,000
15	\$3,740,000	\$2,076,689	\$432,000	\$239,874	\$2,330,000	\$1,293,766	\$396,000	\$219,885
20					\$2,330,000	\$1,063,382	\$435,600	\$198,802
25	\$3,740,000	\$1,402,937	\$518,400	\$194,461	\$2,330,000	\$874,022	\$475,200	\$178,256
30					\$7,670,000	\$2,364,804	\$1,814,400	\$559,413
32	\$10,900,000	\$3,107,132	\$1,404,000	\$400,221				. ,
35	-\$9,265,000	-\$2,347,894		, ,	-\$5,113,000	-\$1,295,713		
	-		_				_	-
Column Sums		\$13,238,863		\$1,806,556		\$11,870,261	[\$2,452,356
Sum, NPV Agency & User Costs		[\$15,045,419			[\$14,322,617	

Tahla / Spraadchaat	Output from	Sample Hypothetical Analysis
$1 a \mu c + 3 \mu c a u s i c c c$		Jailiple Hypothetical Analysis
		1 /1 /

For this hypothetical example, Alternative #2 appears to be preferred. If only agency costs are considered (NPV of \$13,238,863 v. \$11,870,261), #2 is clearly the more economical with an NPV about \$1.5 million less than that of #1. If user costs are included, the preference is still for #2, but by considerably less (an NPV difference of about \$720,000). If user costs are considered very important, the agency might decide on Alternative #1.

A graphical presentation might be helpful as a visual means of seeing the results. Figure 19 summarizes the results of the basic analysis.



Figure 19 Graphical Comparison of NPV of Alternatives #1 and #2

3.2 Sample Hypothetical Analysis with AKFPD 2012

In this section, a demonstration of how to use the Life Cycle Cost Analysis (LCCA) component of the AKFPD2012 software to perform a LCCA analysis for the previous hypothetical example is provided. The LCCA component of the AKFPD2012 software is specifically designed to carry out analysis outlined in the new chapter 9 of the Alaska Flexible Pavement Design Manual. Thus the input and output variables of the LCCA component of the software are named and formulated to be consistent with the terminologies and methodologies set forth previously in this chapter.

Before the analysis can proceed with the software, additional variables are derived from those used for the hypothetical example. For example, the hypothetical example does not specify the pavement width, which is necessary if construction costs are to be estimated with unit costs $(\$/yd^2)$. It is thus assumed that the project is to be built with two 12-foot lanes, each with a 6-foot paved shoulder. The total treatment area for the 8-mile project is thus 168,960 yd². With the assumption of total treatment area, unit costs for the different construction and rehabilitation activities of the two alternatives are calculated based on the corresponding construction costs shown in Table 2. The calculated unit costs are shown in Table 5.

In addition, the previous example does not show the number of work days for the planned activities. It also does not specify the AADT growth rate that drives the user costs to increase for the same rehabilitation activities at different years (see Table 3). With the assumption of a 2% annual growth rate for AADT, the number of work days for the different construction and rehabilitation activities of the two alternatives are back-calculated from the user costs shown in Table 2. The number of work days are also shown in Table 5. The variables in highlighted rows are those that are back-calculated from the numbers in Table 1 and Table 3 with the assumption of 168,960 yd² total treatment area and 2% annual AADT growth rate.

Table 5 Input Variables for the AKFPD2012 LCCA Example

	Alternative 1	Alternative 2
Length (miles)	8	8
Pavement Width (12 foot lane and 6 foot paved shoulder)	36	36
Total Treatment Area (yd²)	168,960	168,960
Agency Cost		
Initial Construction		
Initial Construction Unit Cost (\$/yd ²)	\$44.39	\$32.55
Rehabilitation (Overlay)		
Rehabilitation Unit Cost (\$/yd2)	\$18.35	\$11.25
Re-Construction		
Re-Construction Unit Cost (\$/yd2)	\$54.45	\$37.88
User Cost		
Initial Construction		
Base AADT	4500	4500
Number of Work Days (rural daytime)	150	200
\$/(1000 AADT-lane mile-day)	\$90	\$90
Calculated User Cost (\$)	\$972,000	\$1,296,000
Rehabilitation 1		
Year	15	15
AADT Growth Rate (%/yr)	2%	2%
AADT (rounded)	6000	6000
Number of Work Days (rural daytime)	50	45

\$/(1000 AADT-lane mile-day)	\$90	\$90
Calculated User Cost (\$)	\$432,000	\$388,800
Rehabilitation 2		
Year	25	20
AADT Growth Rate (%/yr)	2%	2%
AADT (rounded)	7200	6500
Number of Work Days (rural daytime)	50	45
\$/(1000 AADT-lane mile-day)	\$90	\$90
Calculated User Cost (\$)	\$518,400	\$435,600
Rehabilitation 3		
Year		25
AADT Growth Rate (%/yr)		2%
AADT (rounded)		7,300
Number of Work Days (rural daytime)		45
\$/(1000 AADT-lane mile-day)		\$90
Calculated User Cost (\$)		\$475,200
Re-Construction		
Year	32	30
AADT Growth Rate (%/yr)	2%	2%
AADT (rounded)	8480	8150
Number of Work Days (rural daytime)	115	155
\$/(1000 AADT-lane mile-day)	\$90	\$90
Calculated User Cost (\$)	\$1,404,000	\$1,814,400

It is noted that the previous example in the new Chapter 9 of LCCA analysis uses a user-delay cost figure to estimate the work zone user delay cost for the hypothetical project. For the 8-mile project, the user

delay cost per (1000 AADT-Lane mile-day) is visually determined from the figure to be \$90 dollars for the rural, day-time construction curve.

Instead of using visual approximation with the delay cost figure, the user cost calculation performed by the AKPFD2012 software uses regression equations to calculate work zone delay unit costs. Four sets of equations are used, each represents a curve in the Figure. In the four sets of equations shown below, the variable **x** is the project work zone length and **y** is the work zone delay user cost per (1,000 AADT – lane mile - day). With the equations, the user delay cost for the rural 8-miles project is approximately \$81 dollars per (1,000 AADT – lane mile - day) by day-time construction.

When 0.25 =<x=<24,

Urban, Day y = 0.0074x4 - 0.4817x3 + 11.208x2 - 115.79x + 627.85 R² = 0.9954 Rural, day y = 0.0047x4 - 0.307x3 + 7.2593x2 - 74.424x + 349.64 R² = 0.9983 Urban night y = 0.0026x4 - 0.1721x3 + 4.0692x2 - 41.903x + 219.3 R² = 0.997 Rural, night y = 0.0025x4 - 0.151x3 + 3.2753x2 - 31.462x + 141.16 R² = 0.9974 When x = <0.25, y = y (0.25); Urban, Day y = y(0.25)=600.0; Rural, day y = y(0.25)=331.5Urban night y = y(0.25)=209.1Rural, night y = y(0.25)=133.5When 24 = <x, y = y(24)=100.8; Rural, day y = y(24)=60.2Urban night y = y(24)=45.0

Rural, night y = y(24)=14.7

To perform the analysis with AKFPD2012, a new project is first created by going to File/New (Figure 20).

Alask	a Flexibl	e Pavemer	t Design	2012				
File	Сору	Modules	View	Help				
Ne	ew		_	_				_
OF CL		1.00						
Sa	ve							
Sa	ve As	- 1						
Pri	int							
Ex	it	- 10						
-	-	-						

Figure 20 Creating a New Project in AKFPD2012

On the ensuring dialog box Project Info (Figure 21), enter information that can be used to identify the project. The Mechanistic Design function is not used for a LCCA, thus there is no need to specify the New or the Overlay Design option. After specifying project information, clicking at the **Save** button will open the typical Windows Save As dialog box (Figure 22).

Project Info Project Info Project Name Project Number Number of Lanes	Example Hypotentical LCCA Analysis MG-0680 2 •	Designer Bret Pitt Date 02/08/2013 08:27 AM
	_	Cancel Save

Figure 21 Project Info Dialog Box



Figure 22 Save As Dialog Box

On the Save As dialog box, enter a file name (e.g., *Example Hypothetical LCCA.xml*) in the desired directory for the new project and click at the **Save** button. The project workbook (Figure 23) will appear after the file is successfully created.

Workb	ook: Example Hypotentical	LCCA Analysis						1		×
	А	В	С	D	E	F	G	н	1	
1	Project Information:	Example Hypotentical LCCA Analysis								
2	Project Nnumber:	MG-0680								
3	Designer:	Bret Pitt								
4	Date:	2/8/2013 8:27:18 AM								
5	Number of Lense	2		-	-					
7	Number of Lanes.	2								
8										
9										
10										
11										
12										
13										
14										
15										
										*

Figure 23 Project Workbook

Figure 23 shows that a project workbook contains three worksheets: Project Info, ESAL, and LCCA. Except for the Project Info sheet, each worksheet is designed to store the input and output variables of a particular pavement design analysis. Clicking at the LCCA tab will turn the workbook to the LCCA worksheet (Figure 24).

٨	D	C	D	E	E	G	L	1
1 Project Information	8		U	-	1. I.	u	11	
2 Project Name	Sample Hypothetical LCCA Analysis			Analyst	Assistant Engineer			
2 Project Number	MGS-0680	-		Data	8/16/2012 10:33:23 AM			
4 Project Length (mi)	111111111111111111111111111111111111111		lance	Dute	0/10/2012 10:33:23 AM	Total treatment area (vd2)		
5 AADT			AADT Growth Rate (%/vr)		-	Project Setting		
6			101010101010111100(10)31			r tojoet ootting		
7 LCCA Information								LCCA Summary
8 Number of Alternative Design			Analysis Period (vrs)			Discount Bate		Loonounnury
q			r marjere r enee (j.e.)			bio bann r hare		
10 Alternative Information	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5			
11 Initial Construction								
12 Description								
13 Unit Cost								
14 Number of Work Days								
15 Construction Cost								
16 Eng/Admin Cost								
17 Traffic Control Cost								
18 Savage Cost								
19 Number of Rehab/Recon Activities								
20 R1 Description								
21 R1 Unit Cost								
22 R1 Number of Work Days								
23 R1 Construction Cost								
24 R1 Eng/Admin Cost								
25 R1 Traffic Control Cost								
26 R2 Description								
27 R2 Unit Cost								
28 R2 Number of Work Days								
29 R2 Construction Cost								
30 R2 Eng/Admin Cost								
31 R2 Traffic Control Cost								
32 R3 Description								
33 R3 Unit Cost								
34 R3 Number of Work Days								
35 R3 Construction Cost								

Figure 24 LCCA Worksheet

Figure 24 shows that the LCCA worksheets is formatted with cells that will be filled with LCCA variables. The columns B to F of the worksheet will be filled with input variables whose names are shown in the row headings (Column A). The cells of (Column I, Row 7) is labeled with LCCA Summary. Worksheet area beyond this cell will be filled with analysis output variables.

To perform a LCCA, go to Modules/Life Cycle Cost Analysis (Figure 25) to bring up the Life Cycle Cost Analysis Input Data window (Figure 26).

Сору	Modules View Help Basic Project Data									
	ESAL Calculation									_
	Life Cycle Cost Analysis									
								1	1 m	1000
1 We	orkbook: Example Hypotentical	LCCA Analysis						-		×
	A	В	C	D	F	F	G	н	Ĩ.	E
1	Project Information:	Example Hypotentical LCCA Analysis			_					-
2	Project Nnumber.	MG-0680	1							
3	Designer:	Bret Pitt	1							
4	Date:	2/8/2013 8:27:18 AM	1							
5			1							
6	Number of Lanes:	2								
7										
8										
9										
10	1									
11										
12										
13										-
14										-
15										
										+
	Project Info ESAL	LCCA	141				_	_		
1			the state of the s							

Figure 25 Modules/Life Cycle Cost Analysis

Life Cycle Analysis: Exam	ple Hypothetical LCCA	
PROJECT INFORMATIO		
Project Name	Analyst Diel Pill	
Project Number	MG-068 Date 2/19/2013 7:38:38	3 AM
Project Length (Miles)	8.00 Lanes 2 🗸 Total Treatment Area (yd2) 168,960	
AADT	4,500 AADT Growth Rate (%/yr) 2	🔘 Urban
Number of Alternative De	sign Strategies 2 Discount Rate (%)	4 👻
Description 3" as Engineering and Co Number of Rehabilita	phalt concrete + 4" stablized base New Construction Unit Cost (\$/yd2) 44.39 ontract Admin (\$) 1.300.000 Traffic Control (\$) 200,000 Number of work days 150 ion/Reconstruction activities involved 2	
Activity #1	Behab/Becon Unit Cost (\$/vd2) 18.35	
Engineering and	Contract Admin (\$) 500,000 Traffic Control (\$) 140,000 Number of work days	50
Salvage Cost (\$) 9.	265,000	
	Create/Update LCCA	Worksheets

Figure 26 Life Cycle Cost Analysis Input Data Window (A1/R1 Tab)

In the LCCA data input window, enter variables according to those shown in Table 1, Table 2 and Table 5. The data input window can let user specify a LCCA project of up to 5 alternatives. The number of alternatives is specified by selecting a number from the Number of Alternative Design Strategies pull down list. In the hypothetical example, there are two alternatives. After selecting 2 for the hypothetical example, the labels A1 and A2 will appear atop of the corresponding data entry tab for Alternative 1 and Alternative 2.

For each alternative, 5 distinct rehabilitation or reconstruction activities can be specified in the software. In the hypothetical example, for alternative 1, there is the initial construction, an identical (i.e., in terms of cost) rehabilitation activity that is performed at years 15 and 25, and a re-construction activity that is scheduled for year 32. Thus, all of the planned activities for alternative 1 (A1) are specified on the LCCA data input window by checking **Yes** for the initial construction and selecting **2** for the Number of Rehabilitation/Re-Construction activities involved (R1 and R2 will automatically appear after the selection). Figure 26 shows the data for the R1 rehabilitation activity scheduled for years 15

and 25, while Figure 27 shows the data tab for the R2 re-construction at year 32. Before switching to the A2 data tab, remember to enter the estimated savage cost (i.e., in cash flow amount) for Alternative 1.

Note that during data entry, if you have to stop midway before completing, you can go to File/Save to save the data you have just entered. The entered data will be written and saved in the project workbook.

PROJECT INFORMATIO	/N						
Project Name	Example Hypothetical LCCA			Analyst	Bret Pitt		
Project Number	MG-068				Date	2/19/2013 7:38	:38 AM
				T T		168.960	
Project Length (Milles)	8.00	Lanes	2 🔻	l otal i rea	atment Area (yo	(2) 100,500	
AADT	4,500 AADT Growth Rate	∋ (%/yr)	2 🔻	Pr	oject Setting	Q Rural	Urban
lumber of Alternative Des	sign Strategies 2 💌				Disc	count Rate (%)	4 -
1 42					Dist	Louni Nale (%)	4 ▼
Initial Construction	quired in the first year?	No					
Initial Construction New construction red Description 3" asy Engineering and Co Number of Rehabilitati	quired in the first year? Yes to halt concrete + 4" stablized base ntract Admin (\$) 1.300.000 on/Reconstruction activities involved	No Traffic Co 2 v	Control (\$)	New Construction 200,000	Unit Cost (\$/ydź Number of	2) 44.39 iwork days	150
Initial Construction New construction red Description 3" as Engineering and Co Number of Rehabilitati R1 R2 Activity #2 Description Co Engineering and C	quired in the first year? Yes Yes toncrete + 4" stablized base ntract Admin (\$) 1,300,000 on/Reconstruction activities involved mplete rebuild @ year 32, lasting 20 year Contract Admin (\$) 1,500,000	No Traffic C 2 -	Control (\$) Re ffic Control (\$)	New Construction 200,000 ehab/Recon Unit (Unit Cost (\$/yd2 Number of Cost (\$/yd2)	2) 44.39 work days 1 54.45	150

Figure 27 Life Cycle Cost Analysis Input Data Window (A1/R2 Tab)

Once data entry are completed for Alternative 1, clicking at the A2 tab to begin data entry for Alternative 2. Figure 28 and Figure 29 show the two Rehabilitation/Reconstruction data tabs for Alternative 2.

Life Cycle Analysis: Examp	ts	
PROJECT INFORMATIO	N	
Project Name	Example Hypothetical LCCA Analyst Bret Pitt	
Project Number	MG-068 Date 2/19/2013 7	:38:38 AM
Project Length (Miles)	8.00 Lanes 2 Total Treatment Area (yd2) 168,96	0
AADT	4,500 AADT Growth Rate (%/yr) 2	🔘 Urban
Number of Alternative Des	ign Strategies 2 Discount Rate (%) 4 ▼
Initial Construction New construction requ Description 2" aspl	ired in the first year? Yes No New Construction Unit Cost (\$/yd2)	2.55
Number of Rehabilitation	n/Reconstruction activities involved	
Activity #1 Description Mino	r rehab @ years 15, 20, and 25 (think overlay) Rehab/Recon Unit Cost (\$/yd2) 11.25	
Engineering and Co	3000 Traffic Control (\$) 80,000 Number of work days	45
Salvage Cost (\$) 511		
Salvage Cost (\$) 5.11		

Figure 28 Life Cycle Cost Analysis Data Input Window (A2/R1 Tab)

put Data LCCA Workshee	ets	
PROJECT INFORMATIO	DN	
Project Name	Example Hypothetical LCCA Analyst Bret Pitt	
Project Number	MG-068 Date 2/19/2013 7:38:38 A	Ν
Project Length (Miles)	8.00 Lanes 2 Total Treatment Area (yd2) 168,960	
AADT	4,500 AADT Growth Rate (%/yr) 2	Urban
Number of Alternative Des	sign Strategies 2 - Discount Rate (%)	•
New construction requ	uired in the first year? 🔍 Yes 🔘 No	
Description 2" asp	unred in the first year? Yes No ohalt concrete + 8" base New Construction Unit Cost (\$/yd2) 32.55 tract Admin (\$) 900,000 Traffic Control (\$) 170,000 Number of work days 200	
New construction req Description 2" asp Engineering and Cont Number of Rehabilitation R1 R2 Activity #2	uired in the first year? Yes No phalt concrete + 8" base New Construction Unit Cost (\$/yd2) 32.55 tract Admin (\$) 900,000 Traffic Control (\$) 170.000 Number of work days 200 ion/Reconstruction activities involved 2	
New construction req Description 2" asp Engineering and Cont Number of Rehabilitation R1 R2 Activity #2 Description Material	uured in the first year? Yes No ohalt concrete + 8" base New Construction Unit Cost (\$/yd2) 32.55 tract Admin (\$) 900,000 Traffic Control (\$) 170,000 Number of work days 200 ion/Reconstruction activities involved 2 37.88 ajor rebuild @ yaer 30, lasting 15 years Rehab/Recon Unit Cost (\$/yd2) 37.88	
New construction req Description 2" asp Engineering and Cont Number of Rehabilitation R1 R2 Activity #2 Description Mathematical Mathmatematical Mathematical Mathematical Mathemati	uired in the first year? Yes No bhalt concrete + 8" base New Construction Unit Cost (\$/yd2) tract Admin (\$) 900,000 Traffic Control (\$) 170,000 Number of work days 200 on/Reconstruction activities involved 2	55
New construction req Description 2" asp Engineering and Cont Number of Rehabilitation R1 R2 Activity #2 Description Ma Engineering and (Salvage Cost (\$) 5.1	uired in the first year? Yes No ohalt concrete + 8" base New Construction Unit Cost (\$/yd2) tract Admin (\$) 900,000 Traffic Control (\$) 170,000 Number of work days 200 ion/Reconstruction activities involved 2 37.88 ajor rebuild @ yaer 30, lasting 15 years Rehab/Recon Unit Cost (\$/yd2) 37.88 Contract Admin (\$) 1,100,000 Traffic Control (\$) 170,000 Number of work days 1 113,000 Itage Itage Itage Itage Itage Itage	55

Figure 29 Life Cycle Cost Analysis Data Input Window (A2/R2 Tab)

After all the corresponding input data are entered, click at the **Create/Update LCCA Worksheets** button. The LCCA Worksheets are created on the tab that is stacked behind the Input Data tab. Clicking at the LCCA Worksheets tab on the top of the window (i.e., next to Input Data) will show the LCCA worksheets (Figure 30) that are used to specify the construction years and the construction time setting (i.e., day vs. night). The **Cancel** button shown in the bottom of the window (see Figure 30) is to close the LCCA window without keeping the data entered. Clicking the **Close** button will close the window while keeping the data and analysis results in the project workbook.

My Life Cycle Analysis: Example Hypothetical LCCA

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		Work Zor	ne Setting		Agenc	y Cost					07.07.51
Year	Treatment	5 AC.1.		Contract &	Traffic	Const	ruction	Total Agency Cost(\$)	User Cost(\$)	Total Cost(\$)	Net Presen Value(NPV
_	-	Day/Night	No. of Days	Admin (\$)	Control (\$)	Unit Cost (\$/yd2)	Cost (\$)		1.1.1		
0	New Construction	Day Night	150	1,300,000	200,000	44.39	7,500,135	9,000,134	873,832	9,873,966	9,873,966
1	 R0 R1 R2 	DayNight	0	0	0	0.00	0	0	0	0	0
2	 R0 R1 R2 	DayNight	0	Ò.	0	0.00	0	0	0	0	0
3	 R0 R1 R2 	i Day	0	0	0	0.00	0	(0)	0	0	0
4	 R0 R1 R2 	Day Night	Ò	Ò	Ō	0.00	0	0	0	Ō	0
5	 R0 R1 R2 	Day Night	0	0	0	0.00	0	0	0	Ó.	0
6	 R0 R1 R2 	Day Night	0	0	0	0.00	0	0	0	0	0
7	 R0 R1 R2 	Day Night	0	0	0	0,00	0	0	0	0	0
8	 R0 R1 R2 	Day	0	0	0	0.00	0	0	0	0	0
4 1	Alternative	1 Alternat	ive 2 Cash	Flow LCC	A Summary						
								1	1		-

Figure 30 LCCA Worksheets (Alternative 1, Initial Construction)

For the hypothetical example, there are 4 LCCA worksheets: Alternative 1, Alternative 2, CFD (i.e., stands for Cash Flow Diagrams), and LCCA Summary. The Alternative sheets are for the specification of the years planned for all the rehabilitation/reconstruction activities. Figure 9.16 shows the data for the initial construction of Alternative 1. Numbers shown in red are input variables and those in blue are calculated by the software based on the input data and the analysis procedures presented earlier. To specify the construction year for a particular rehabilitation/reconstruction activity, simply click at the radio button corresponding to the scheduled activity at the planned year. Figure 31 and Figure 32 show the specification for Alternative 1.

Figure 31 shows that Rehabilitation activity R1 is to be performed at year 15 and 25. Both rehabilitation activities are planned to be day-time construction.

Data LC	CCA Workshe	ets									
15	 R0 R1 R2 	 ② Day ○ Night 	50	500,000	140,000	18.35	3,100,416	3,740,416	392.021	4,132,437	2,294,597
16	 R0 R1 R2 	 Day Night 	0	Ō	0	0.00	Ō	Ō	0	0	0
17	 R0 R1 R2 	DayNight	0	Ō	Ō	0.00	0	0	0	0	0
18	 R0 R1 R2 	DayNight	0	0	0	0.00	0	0	0	0	0
19	 R0 R1 R2 	DayNight	0	Ō	0	0.00	0	0	0	0	0
20	 R0 R1 R2 	 Day Night 	0	0	0	0.00	0	0	0	0	0
21	 R0 R1 R2 	Day Night	0	Ō	0	0.00	0	0	0	0	0
22	 R0 R1 R2 	Day Night	0	Ō	Ō	0.00	Ö _	Ō	0	0	0
23	 R0 R1 R2 	 Day Night 	0	Ō	0	0.00	0	0	0	0	0
24	 R0 R1 R2 	DayNight	0	0	0	0.00	0	0	0	0	0
25	 R0 R1 R2 	DayNight	50	500,000	140,000	18.35	3,100,416	3,740,416	477.871	4,218,288	1,582,352

Figure 31 LCCA Worksheets (Alternative 1, Rehabilitation at Years 15 and 25)

It is important to note that, if any of the unit costs (i.e., red cells in Figure 31) of a rehabilitation activity at a particular year is going to be different from those of a previous year, these different unit costs can be specified on the Alternative worksheet directly. For example, if in Figure 9.17 the administration cost at year 25 is going to be \$600,000 instead of \$500,000, you can simply change the number 500000 in the circled cell to 600000 and observe the calculated numbers in the blue cells change accordingly. Manual changes to the worksheet should only be applied to red cells as the blue cells are calculation results based on the numbers in the red cells.

Figure 32 shows that the day-time reconstruction activity is scheduled at year 32. The row labeled for year 35 is where the savage cost is stored. The very last row of the worksheet for Alternative 1 shows the calculated total Net Present Values (NPV) for the Savage Cost, Total Agency Cost, Total User Cost, and the Total Cost. Note that the Total Agency Cost number does not include the savage cost. Thus, the NPV Total Cost is the sum of the NPV Savage Cost, NPV Total Agency Cost, and NPV Total User Cost.

put Data LC	CA Workshee	ets										
25	 R0 R1 R2 	Day	50	500,000	140,000	18.35	3,100,416	3,740,416	477,871	4,218,288	1,582,352	
26	 R0 R1 R2 	Day Night	0	0	0	0.00	Ō	0	Ō	Ō	0	
27	 R0 R1 R2 	Day Night	Ø	Q	Q	0.00	0	0	0	Ø	0	
28	 R0 R1 R2 	Day Night	Ø	0	Ó	0.00	0	0	0	0	Ō	
29	 R0 R1 R2 	Day Night	Q.	Q	Q	0.00	0	0	Q	0	o	
30	 R0 R1 R2 	Day Night	0	0	0	0.00	0	0	0	Ō	0	
31	 R0 R1 R2 	Day Night	Q	Q	Q	0.00	0	0	0	0	0	
32	 R0 R1 R2 	Day Night	115	1,500,000	200,000	54.45	9,199,872	10,899,870	1,262,525	12,162,400	3,466,992	
33	 R0 R1 R2 	Day Night	Ø	0	0	0.00	0	0	0	0	0	
34	 R0 R1 R2 	Day Night	O	0	Ō	0.00	0	Ō	0	Ō	0	
35	Salvage Cost							-9,265,000		-9.265,000	-2.347.897	
IPV Salvage Cost	-2.347.897		NPV Total Agency Cost	15,587,247		NPV Total User Cost	1,630,658		NPV Total Cost	14,870,011		

Figure 32 LCCA Worksheets (Alternative 1, Reconstruction at Year 32)

The series of Figure 33 to Figure 35 show the data specification for Alternative 2.

Life Cycle Analysis: Example Hypothetical LCCA

Input Data LCCA Worksheets -Work Zone Setting Agency Cost Total Agency Cost(\$) User Cost(\$) Total Cost(\$) Net Present Value(NPV\$) Year Treatment Traffic Control (\$) Construction Contract & Admin (\$) Day/Night No. of Days Unit Cost Cost (\$) (\$/yd2) New Day 0 200 900,000 170,000 32.55 5,499,648 6,569,648 1,165,110 7,734,758 7,734,758 Construction Night @ R0 Day 0 0 0 0.00 0 0 0 0 0 1 © R1 Night C R2 R0 Day 2 @ R1 0 0 0 0.00 0 0 Ó 0 0 O Night O R2 @ R0 Day 3 0 0 0 0.00 0 0 0 0 0 **R1** O Night C R2 @ R0 Day 4 0 0 0 0.00 0 0 0 0 0 **R**1 O Night O R2 @ R0 Day 0 0 0 5 **R1** 0 0 0.00 0 0 0 Night O R2 R0 Day 0 0 0 0 0 0 6 **R1** 0 0 0.00 O Night @ R2 @ R0 Day 7 @ R1 0 0 0 0.00 0 0 0 0 0 O Night 0 R2 R0 Day 8 **R**1 0 0 0 0.00 0 0 0 0 0 O Night O R2 @ R0 Day 9 © R1 0 0 0 0.00 0 0 0 0 0 O Night O R2 R0 R0 O Day Alternative 1 Alternative 2 Cash Flow LCCA Summary I .

Figure 33 LCCA Worksheets (Alternative 2, Initial Construction)

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My Life Cycle Analysis: Example Hypothetical LCCA

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14	 R0 R1 R2 	 Day Night 	Q	0	0	0.00	0	0	Q	0	0
15	 R0 R1 R2 	Day Night	45	350,000	80,000	11.25	1,900,800	2,330,800	352,819	2,683,619	1,490,119
16	 R0 R1 R2 	 Day Night 	0	0	0	0,00	0	Q	0	0	0
17	 R0 R1 R2 	DayNight	0	Ő.	0	0,00	0	0	0	0	0
18	 R0 R1 R2 	 Day Night 	0	Q	0	0,00	0	0	0	0	0
19	 R0 R1 R2 	🔘 Day 🗇 Night	0	ō I	0	0.00	0	0	0	0	0
20	 R0 R1 R2 	 Day Night 	45	350,000	80,000	11.25	1,900,800	2,330,800	389,541	2,720,341	1,241,529
21	 R0 R1 R2 	 Day Night 	0	0	ò	0.00	0	0	0	0	0
22	 R0 R1 R2 	 Day Night 	0	0	0	0,00	0	0	0	0	0
23	 R0 R1 R2 	Day Night	0	Ö	Ō	0.00	0	0	0	0	0
24	 R0 R1 R2 	 Day Night 	Q	0	Q	0.00	0	0	0	0	0
25	 R0 R1 	Day	45	350,000	80,000	11.25	1,900,800	2,330,800	430,084	2,760,884	1,035,655

Figure 34 LCCA Worksheets (Alternative 2, Rehabilitation at Years 15, 20 and 25)

put Data	LCCA Workshee	ts										
26	@ R0 @ R1 @ R2	DayNight	0	0	0	0.00	0	0	0	0	0	ľ
27	@ R0 @ R1 @ R2	😟 Day 💮 Night	0	0	0	0.00	0	0	0	0	0	
28	@ R0 @ R1 @ R2	Day	0	0	0	0.00	0	0	0	0	0	
29	@ R0 @ R1 @ R2	Day Night	0	0	0	0.00	0	0	0	0	0	
30	© R0 © R1 @ R2	Day	155	1,100,000	170,000	37.88	6,400,205	7,670,205	1,635,586	9,305,791	2,869,152	
31	@ R0 @ R1 @ R2	Day Night	0	0	0	0.00	0	0	0	0	0	
32	@ R0 @ R1 @ R2	Day	0	0	0	0.00	0	0	0	0	0	
33	 R0 R1 R2 	Day	0	0	0	0.00	0	0	Ö	Ö	Ó	
34	 R0 R1 R2 	Day Night	0	0	0	0.00	0	0	0	0	0	
35	Salvage Cost							-5,113,000		-5,113,000	-1,295,715	
NPV Salva Cost	ge -1.295.715		NPV Total Agency Cost	12,166,799		NPV Total User Cost	2,204,414		NPV Total Cost	13.075.498		

Figure 35 LCCA Worksheets (Alternative 2, Reconstruction at Year 30)

Once the construction year and construction time specification are completed in the Alternative worksheets, an LCCA calculation is immediately completed by the AKFPD2012 software. The Cash Flow worksheet shows plots of the Cash Flow Diagrams for the two alternatives. Clicking at the Cash Flow tab will turn the worksheet to the plots (Figure 36)



Figure 36 LCCA Worksheets (Cash Flow Diagram)

In Figure 36, the cash flow numbers for the two alternatives at the planned construction years are plotted in Columns A to F. The total cash flow for each year of an alternative is divided into agency cost and user cost to enable the plotting of a stacked bar series for each alternative. The two CFD charts in Figure 36 essentially combine the three manually charted figures shown in Figure 17 to Figure 19.

Once you are satisfied with the analysis results, you can generate summary information for the alternatives specified. The summary information is to be written to the **LCCA Summary** worksheet. When the LCCA Summary worksheet is created, it is a blank worksheet. Clicking at the **LCCA Summary** tab now will open the worksheet (Figure 37 and Figure 38). Figure 37 shows the left hand side of the worksheet. This portion of the worksheet is written with the input data of the analysis. Scrolling to the right of the worksheet will show the analysis summary. The summary table shown in Figure 38 is specifically formatted to present the same summary information of the previous Table 4.

A	B	C	0	E	F	0	н	· 1.	3	ĸ	L
Project Information:	and the second										
Project Name.	Example Hypothetical LCCA			Analyst	Eret Pitt						
Project Number	MG-068			Date	2/19/2013 7 38 38 AM						
Project Length (mi)	8.00		Lanes	2		Tatal treatment area (yd2)	168,960				
AADT	4,500		AADT Growth Rote (%/yr):	2		Project Setting	Rural				
LCCA Information								LCCA Summe	KV.		
Number of Altrimative Design	2		Analysis Period (ym)	35		Discount Rate	4				
								Atemative 1			
Alternative Information	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Atternative 5			Year	Activity	Agency Cost	PV Agency Co
initial Construction	Yes	Yes							Construction	9000134	9000
Description	3" asphalt controls = 4" stablized base	2" asphall concrete = 5" base							15 R1	3740416	2078
Unit Cost	44.39	32.55							25 R1	3740416	5 1403
Number of Work Days	150	200							32 R2	10899870	3 3107
Construction Cost	745	5 5	468						35 Selvage Cost	9265000	2347
Eng/Admin Cost.	1.300.000	900.000						Column Sums			13239
Frattic Control Cost	200,000	170.000						NPV Sum	in the second se		
Salvage Cont	9.265,000	5,113,000						(Agency + U	int)		
Number of Rehats/Recon Activities	2	2									
R1 Description	Major rehab @ years 15 and 25 (thick overlay)	Minor rehisb @ years 15, 20, and 25 (think overla	a)								
R1 Unit Cost	18.35	11.25									
R1 Number of Work Days	50	45									
R1 Construction Cost	305	1 1	196								
R1 Eng/Admin Cost	\$00,000	360.000									
R1 Traffic Control Cost	140,000	80.000									
R2 Descention	Complete retuild 99 year 32 lasting 20 years	Marce rebuild (iv year 30 lasting 15 years)									
R21in#Cont	5445	17.28									
R2 Number of Work Days	115	184									
R2 Construction Cost	614	1 6	964								
R2 EnglAdmin Cost	1 500 000	1.100.000									
R2 Traffic Crateral Cost	780,000	121/200									
P3 Description	200.000	110.000									
Daline Cont											
D3 Marsher of Week David											
Charles of the Cont											
P3 East Admin Past											
HO Englishemin Cost											
HG Franc Control Cost											
He Lanciperi											
He Unit Colt											
FIG Number of Work Days											

Figure 37 LCCA Summary Worksheet (the Input Data portion)

iska	Hexable Pavement D	esign 2012 - (Life Cycle /	Analysis: E	xample Hypoth	ietical LCCA												
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ut D	ata LCCA Worksheet													_			
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2	Bret Pitt																
- 3	2/19/2013 7 38:38 AM																
4		Total treatment area (yd2)	168.960														
5		Project Setting	Runał														
6	-			LCCA Summer													
8		Discount Role	4	Surger Granned	<i>y</i>												
9		Distanti and		Alternative 1						Alternative 2							
10	Alternative 5			Year	Activity	Agency Cost	PV Agency Cost	User Cost	PV User Cost	Year	Activity	Agency Cost PV	Agency Cost	User Cost	PV User Cost		
11					0 New	9000134	9000134	873832	873832		0 New	6569648	6569648	1165110	1165110		
2					15 R1	3740416	2076920	392021	217675		15 R1	2330500	1294211	352819	195906		
3	1				25 R1	3740416	1403093	477871	179257		20 R1	2330800	1063747	389541	177781		
4					32 R2	10899870	3107094	1262525	359893		25 R1	2330800	874322	430084	161332		
5	1				35 Salvage Cost	-9265000	-2347894				30 R2	7670205	2364867	1635586	504282		
6				Column Sums			13239347		1630657		35:Salvage Cost	5113000	1295713				
7				(Agency + Lise	ri.			14870004		Column Sum	8		10871082		2204413		
										NPV Sum				13075495			
										(Agency + U	5419)						
9																	
21																	
22																	
23																	
24																	
25																	
26																	
20																	
29																	
30																	

Figure 38 LCCA Summary Worksheet (the Output Data portion)

It is noted that the results shown in Figure 38 are mostly different from those in Table 4 at the User Cost and PV User Cost columns. The difference is due to two primary factors: the different work zone user delay cost unit value (i.e., the figure-determined value \$90 used for Table 9.4 and the \$81 calculated by the software) and the AADT projection at different years (i.e., arbitrarily rounded values for Table 9.4 and precise values calculated with 2% growth rate by the software).

If the analyst is satisfied with the analysis results and wants to save the LCCA worksheets as a Microsoft Excel spreadsheet file (*.xls), this can be accomplished by going to File/Save As/Excel (Figure 39). Note

that to save the LCCA worksheets as an Excel file, the analyst needs to make sure that the LCCA worksheets of the Life Cycle Cost Analysis window is the current active window (i.e., the top window whose title bar is highlighted in a darker shade). To make sure that the LCCA worksheets is the active window, simply click at the title bar of the window Life Cycle Cost Analysis and observe that the clicked window is on top of other open windows and the title bar is in a darker shade than others.

When the Save As excel dialog box appears, enter the desired file name and file directory then click at Save (Figure 40).

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Γ	File	Copy N	lodule	s View He	lp	
		New				
r		Open				
I		open open	ble	Hypothetical L	CCA Analysis	
ł		Close All		21		
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I		Print		Excol	Sample Hypothetical LCCA Analysis	
L				Excel	MGS-0680	
		Exit	(mi)		8	
L	5	AADT			4500	
ł	6					
	7	LCCA Inform	nation			
	8	Number of A	lternati	ive Design	2	
	9		_			
L	10) Alternative	nforma	tion	Alternative 1	Alternative 2
	11	Initial Const	ruction		Yes	Yes
	12	2 Description			3" asphalt concrete + 4" stabilized base	2" asphalt concrete + 8" base
L	13	3 Unit Cost			44.39	32.55
	14	Number of V	Vork Da	iys	150	200
	15	5 Constructio	n Cost		7500134	
L	16	Eng/Admin	Cost		1300000	900000
	17	Traffic Cont	rol Cost	t	200000	170000
	18	Savage Cos	st		9265000	5113000
	19	Number of F	Rehab/F	Recon Activities	2	2
	20) R1 Descript	ion		Major rehabilitation @ years 15 & 25 (thick overlay)	Minor rehabilitation @ years 15
	21	R1 Unit Cos	t		18.35	11.25
	00	D1 Number	of Work	Deve	50	46

Figure 39 Save the LCCA Worksheets as an Excel File

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Figure 40 Save As an Excel File Dialog Box

Once the analysis data and results are examined, the entire analysis data set and results needs to be saved to the project workbook created in the beginning of the exercise. Clicking at the **Close** button on the lower right corner of the LCCA Worksheets Window. The LCCA window will then be closed and the LCCA data copied to the LCCA worksheet of the project workbook (Figure 41). In addition, after clicking the **Close** button of the LCCA Worksheets Window, a separate XML file is created to store the entire set of LCCA worksheets (i.e., Alternative 1, Alternative 2, CFD and LCCA Summary). This file is saved with the file name that begins with the original project file name and ends with "**-lcca**" to distinguish itself from the original project file.

Figure 42 shows a pair of such files displayed in a Windows Document Explorer. The **Example Hypothetical LCCA.xml** is the original project workbook (i.e., contains the Project Info, ESAL, Mechanistic, Excess Fine, and LCCA) and **Example Hypothetical LCCA-Icca.xml** is the LCCA worksheets (i.e., contains Alternative 1, Alternative 2, CFD and LCCA Summary).

noquies	view Help		_	_	_	_	_	_	_	_	
Workbao	k Sample Hypothetical L	CCA Analysis								-	0
1	A	B	C	-	D	E	F	G	H	1	-
Project	Information										
Project	Nome	Sample Hypothetical LCCA Analysis				Analyst	Assistent Engineer				
Project	Number	MGS-0680				Date	8/16/2012				
Project	Length (m)	8			Lanes	2		Total treatment area (yd2)	168960		
AADT		4500			AADT Growth Rate (%/vr)	2		Project Setting	Rural		
5								and the second sec			
LOCAN	nformation									LCCA Summe	si i
Number	r of Alternative Design	2			Analysis Period (yrs)	35		Discount Rate	4		
										Alternative 1	
Alternal	tive Information	Alternative 1	Alternative 2		Alternative 3	Alternative 4	Alternative 5			Yenr	
I Initial C	Construction	Yes	Yes								9
2 Descrip	otion	3" asphalt concrete + 4" stabilized base	2' asphalt concrete + 3' base								15
3. Unit Co	st	44.39	32.55								25
4 Number	r of Work Days	150	200								32
5 Constru	action Cost	750013	4	5499648							35
6 EnglAd	Imin Cost	1300000	900000							Column Sums	200
7 Traffic S	Control Cost	200000	120000							NPV Sum	A
s Savago	Cost	9265000	5113000							(Agency - os	sel.
A Number	r of Rebab/Recon Activities	2	2								
R1Dea	cription	Major rehabilitation @ years 15 & 25 (block overlay)	Minor rehabilitation @ years 15, 20.8 25 0m	n overlay)							
RILlat	Cost	18.36	11.25								
2 BINAR	nber of Work Davs	50	45								
1 RI Corr	struction Cost	310041	6	1900800				1.	1		
4 RIEra	Admin Cost	500000	350000								
E D1 Trat	tin Control Cost	140000	80000								
6 R2 Des	existion	Complete retraikt at year 32 Justing 20 years	Maint retuild at year 30 Jasting 15 years								
7 E2 Lat	Cost	Ed de	17.88								
2 DON-	nhar of Work Dava	116	165								
D P2 Car	allow from Crief	919927	2	6100205							
a D2 End	Admin Cost	1600000	1100000	0400203							
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Figure 41 LCCA Summary Copied to the Project Workbook

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Downloads	Name	Date modified	Туре	
	L AKDOTPavementDesign	1/31/2013 12:01 PM	File folder	
1 libraries	AKFPD 2012 Beta Installation	8/20/2012 11:08 PM	File folder	
Documents	Sakdot.ico	1/1/2011 5:57 AM	Icon	
A Music	AKDOTPavementDesign.sln	8/20/2012 11:08 PM	Microsoft Visual Studio.	
Pictures	AKDOTPavementDesign.suo	2/8/2013 8:15 AM	Visual Studio Solution	
Videos	AKFPD V6 Code.txt	5/3/2012 12:23 AM	Text Document	
	S AKFPDResultForm.xlsx	5/3/2012 12:26 AM	Microsoft Office Excel	
Computer	🔊 autclogo.jpg	6/17/2012 9:27 PM	JPEG image	
4- TI106040W0F (C·)	🖹 Example 1.xml	2/7/2013 10:42 PM	XML Document	
BD-BOM Drive (D:) Volumel abel	Example Hypothetical LCCA.xml	2/8/2013 8:30 AM	XML Document	
Jocal Disk (F:)	Example Hypothetical LCCA-lcca.xml	9/29/2012 1:47 AM	XML Document	
	🖹 Example1.xml	8/20/2012 2:03 PM	XML Document	
Network	ExcessFineExample.xml	9/29/2012 2:35 PM	XML Document	
- VILLER N	🛎 FormalDemo.xml	10/19/2012 6:44 AM	XML Document	
	😫 FormalDemo-Icca.xml	10/19/2012 2:30 AM	XML Document	
	hypotheticalexample.xls	8/20/2012 9:55 AM	Microsoft Office Excel	
	4	t.		

Figure 42 An AKFPD Project Files (Project Workbook and LCCA Worksheets)

To save the project workbook, simply go to File/Save (Figure 43). The workbook will be saved to the project file originally created (e.g., *Example Hypothetical LCCA.xml*).

Open Close All ble Hypothetical I			.CCA Analysis		
Save		A.	B	ĉ	E
Save A	5 +	tion	5	5	-
Duint			Sample Hypothetical I CCA Analysis		
Print			MGS-0680		
Exit		(mi)	8		Lanes
5 AAD	т		4500		AADT Grow
6					=
7 LCCA	A Informa	tion			
8 Numb	ber of Alte	ernative Design	2		Analysis Pe
9					
10 Alterr	ternative Information		Alternative 1	Alternative 2	Alternative 3
11 Initial	itial Construction		Yes	Yes	
12 Desc	escription		3" asphalt concrete + 4" stabilized base	2" asphalt concrete + 8" base	
13 Unit (nit Cost		44.39	32.55	
14 Numb	umber of Work Days		150	200	
15 Cons	Construction Cost		7500134 5499648		
16 Eng//	Eng/Admin Cost		1300000	900000	
17 Traffi	Traffic Control Cost		200000	170000	
18 Sava	Savage Cost		9265000	5113000	
19 Numl	ber of Rel	ab/Recon Activities	2	2	
20 R1 D	1 Description		Major rehabilitation @ years 15 & 25 (thick overlay)	Minor rehabilitation @ years 15, 20 & 25 (thin overlay)	
21 R1 U	nit Cost		18.35	11.25	
22 R1 N	umber of	Work Days	50	45	
23 R1 C	onstructio	n Cost	3100416	1900800	
	PI Pro	ject into ESAL	Mechanistic Excess Fine LCCA		

Figure 43 Save the Project Workbook to the Original Project File

Alternatively, the workbook can also be saved to another XML file of a different file name or save as an Excel workbook (

Figure 44).

Open ple Hypothetical I		ble Hypothetical I	ICCA Analysis		
C	lose All				
Sa	ave	A	В	C	
Sa	ave As 🔸	XML			
Print Ex Exit (mi)		Excel	Sample Hypothetical LCCA Analysis MGS-0680		
		(mi)	8		Lanes
5	AADT	N. C.Y	4500		AADT Grow
6					
7	LCCA Informat	tion	1		=
8	Number of Alte	ernative Design	2		Analysis Pe
9					
10	Alternative Information		Alternative 1	Alternative 2	Alternative 3
11	Initial Construct	ction	Yes	Yes	
12	Description		3" asphalt concrete + 4" stabilized base	2" asphalt concrete + 8" base	
13	Unit Cost		44.39	32.55	
14	Number of Wo	rk Days	150	200	
15	Construction C	Cost	7500134	5499648	
16	Eng/Admin Cost		1300000	900000	
17	Traffic Control Cost		200000	170000	
18	3 Savage Cost		9265000	5113000	
10	Number of Reh	ah/Recon Activities	2	2	
20	R1 Description	I COULT COULTE	Major rehabilitation @ years 15 & 25 (thick overlay)	Minor rehabilitation @ years 15, 20,8, 25 (thin overlay)	
21	R1 Unit Cost		18.35	11 25	
22	R1 Number of	Work Davs	50	45	
23	R1 Constructio	on Cost	3100416	1900800	-
124	A M Pro	ject Info ESAL	Mechanistic Excess Fine LCCA		E.

Figure 44 Save the Project Workbook as Different Files