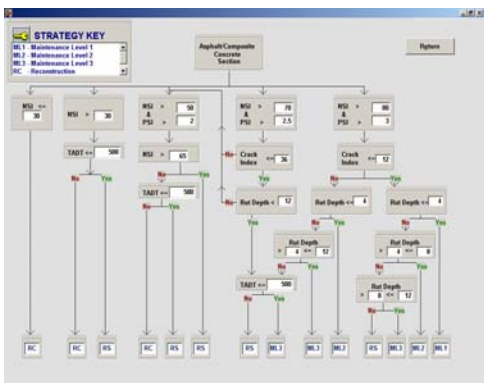
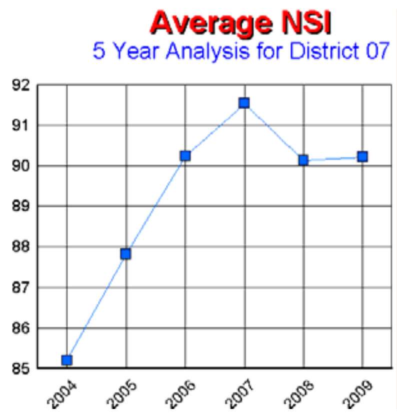
P. O. P.

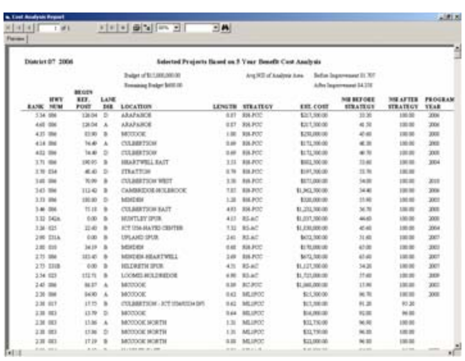
P avement

O ptimization

P rogram







Materials and Research Division

Pavement Management Section-Version 2.2 Jan, 2006

TABLE OF CONTENTS PAGE NO.

INTRODUCTION:

The Pavement Optimization Program(POP) has been developed by the Nebraska Dept. of Roads-Materials and Research Division-Pavement Management Section with the assistance of the Information Systems Division. This program allows you to investigate your current pavement ratings, look at the associated photos and link to our Mandli Roadview Explorer. It also has a life cycle cost analysis which prompts you to enter an analysis period and annual budgets. A yearly output report shows those selected sections that would be improved based on the budget and the benefit cost ratio. There is also a graph of the NSI after each year's improvements.

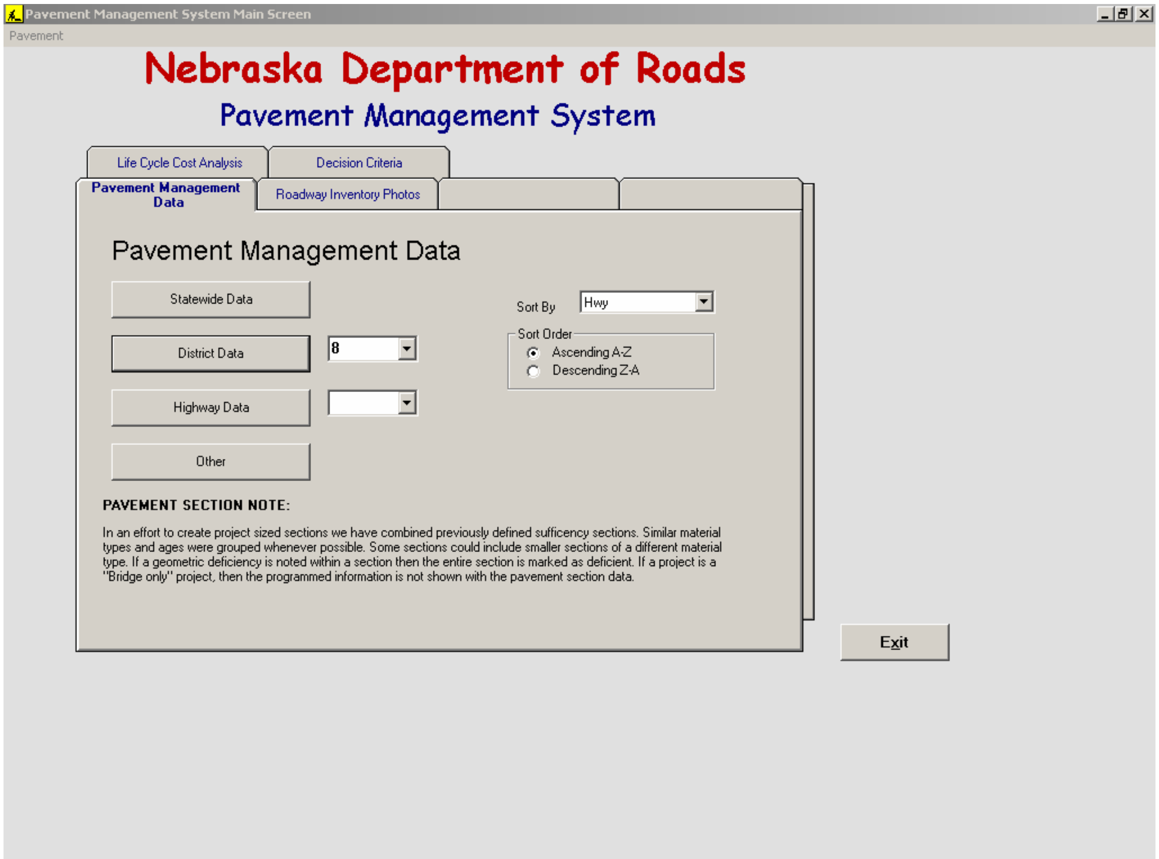
This program is loaded with pavement design sections as compared to needs sections which are used in the annual inventory book.

The program display is designed for a specific resolution. If you can not see the entire page on your screen, it is because your resolution is not setup the same as POP. The resolution should be 1024 x 768 pixels. To set this you right click on the desktop and select "Properties". Under the "Settings" tab you will find the screen area settings. Move the selection bar to get the appropriate setting(1024 x 768). Select "Apply" and "OK".

If you need any further help, we are here to assist you. You can call/email Dan Nichols(479-4873)/dnichols@dor.state.ne.us or Dave Medinger(479-4807) /dmedinge@dor.state.ne.us if you have any questions.

STARTING THE PROGRAM:
After POP has been installed you will have an ICON called POP on your desktop. Double click to start the program.

OPENING SCREEN:

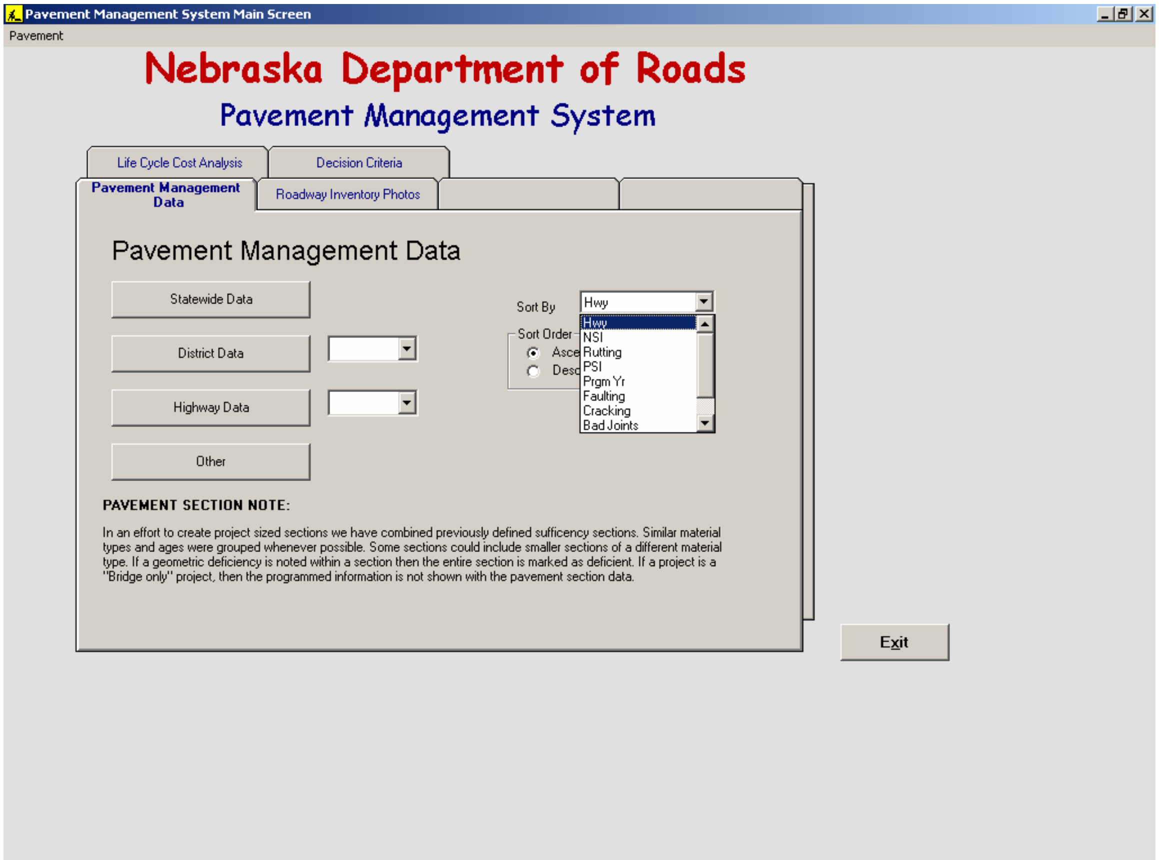


This first screen gives you four screens to select from with the tabs shown at the top. The screens are listed below:

Pavement Management Data,
Roadway Inventory Photos,
Life Cycle Cost Analysis,
Decision Criteria,

The screen that is selected as a default is the Pavement Management Data screen.

PAVEMENT MANAGEMENT DATA:

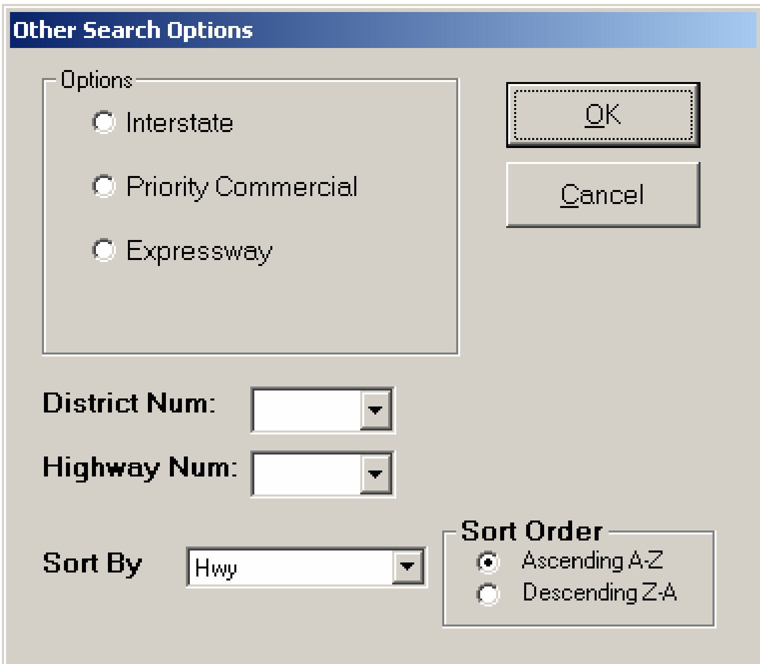


On this screen you select either Statewide Data, District Data, Highway Data or Other to pull up the pavement sections that you are interested in.

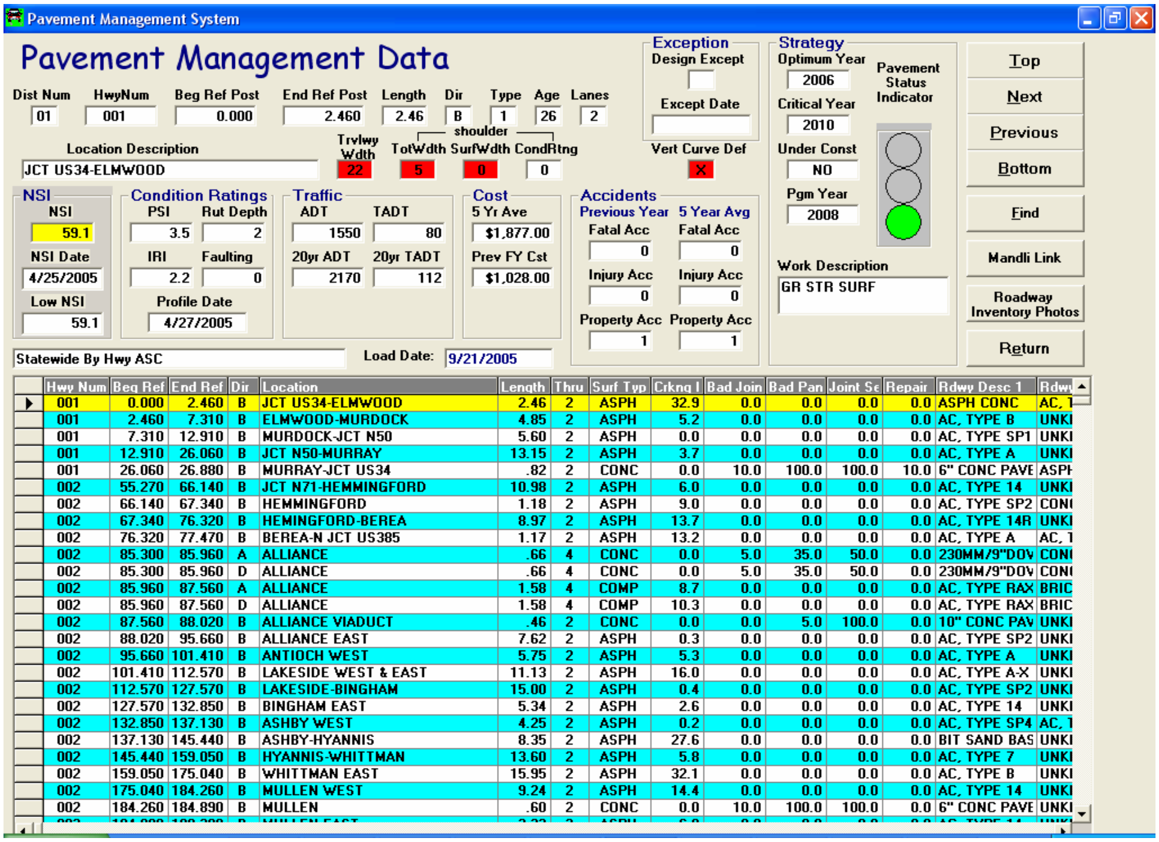
Pull downs next to the district or highway give you the possible selections. You must choose a number in the appropriate box before you select by District Data or Highway Data.

Your data is sorted by Highway and Reference Post in ascending order as a default. The Sort By pull down on the right side of the screen allows you to sort by any one of the columns listed. You can also select ascending or descending order for the column chosen.

The “Other” selection allows you to select further by Interstate, Priority Commercial or Expressway within a District or Highway.   The sort feature is also available on this “Other” option selection.



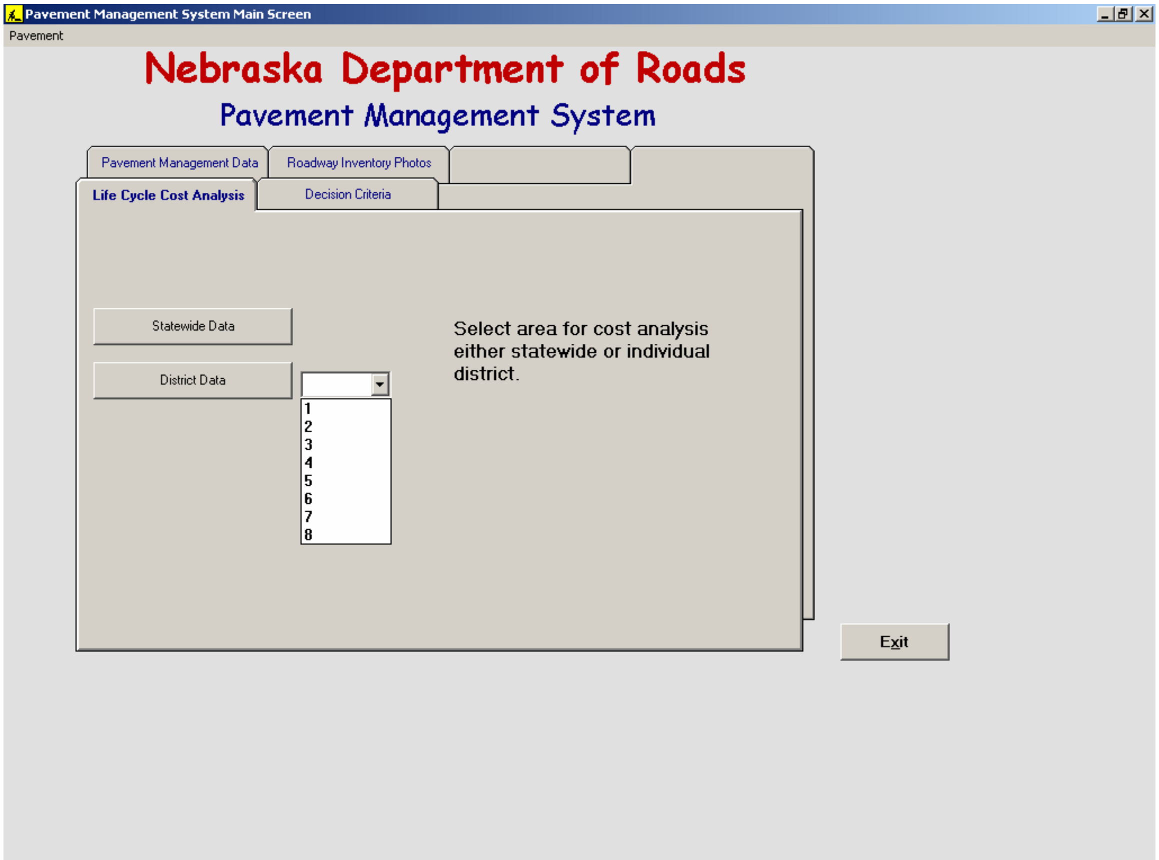
PAVEMENT MANAGEMENT DATA SCREEN:



The Pavement Management Data screen will come up with summarized data on the top portion and tabulated data below. There is a space above the tabulated data that tells what kind of data you have selected and how it sorted and also the date of the data collection and the date the database was loaded. We will supply an updated database on an annual basis. The top portion gives you the inventory data and condition data. Also are shown are the traffic counts, accident rates, maintenance strategies, costs and design exceptions. As you move from one record to another on the bottom tabulated data, you will see that record summarized on the top portion. You will also see the use of a stoplight with standard colors to flag critical(red), fair(yellow) or good(green) sections. This is called our Pavement Status Indicator. These colors are affected by future programmed improvements(excluding contracted maintenance).

The lower tabulated information has all of the data that we store for a section. You can use the bottom scroll bar to move over several times to see all of the additional data. We have selected the data that should be more useful to appear to the far left. You can select a section by clicking with the mouse or using the up/down arrow keys or use the Top/Next/Previous/Bottom/Find keys provided on the top right. The Find feature allows you to search for the beginning of a highway. The Return button will take you back to the previous screen. There is also a direct link to the Mandli Roadview Explorer and the roadway condition photos taken for the section highlighted. (Refer to the Roadway Inventory Photos instructions for further details.)

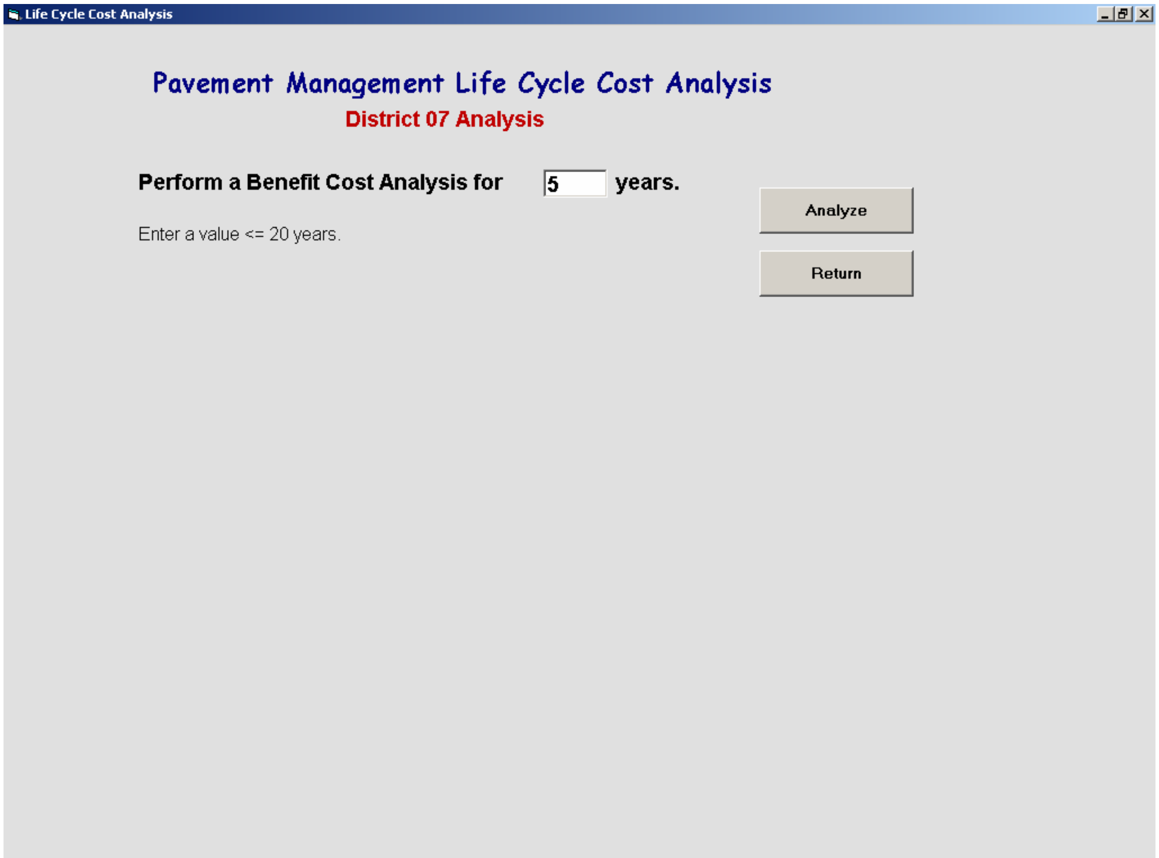
LIFE CYCLE COST ANALYSIS:



The Life Cycle Cost Analysis applies the specified annual budget to determine the best strategy for improvement based on benefit/cost ratios at the network level.

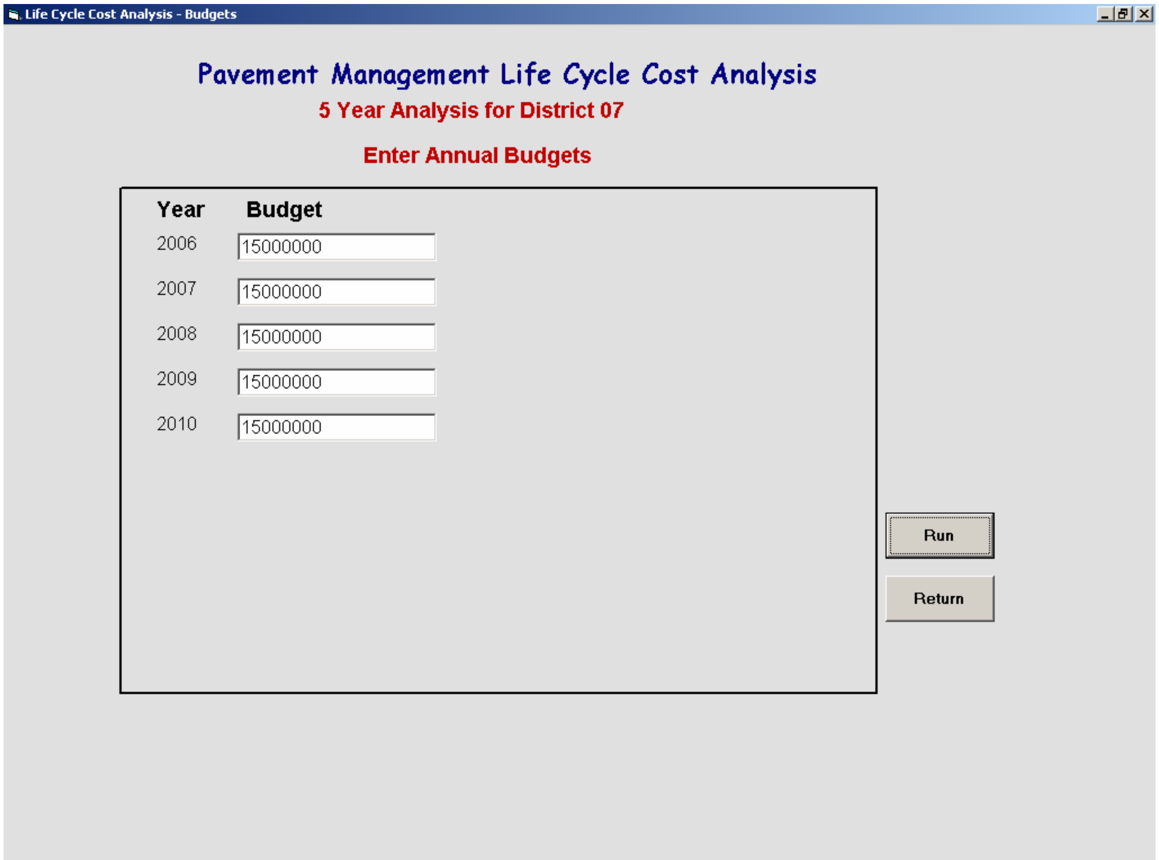
This screen allows you to select sections by Statewide Data or District Data. If you select District Data, you must enter a District Number first. The interstate system is excluded from the Life Cycle Cost Analysis.

LIFE CYCLE COST ANALYSIS:

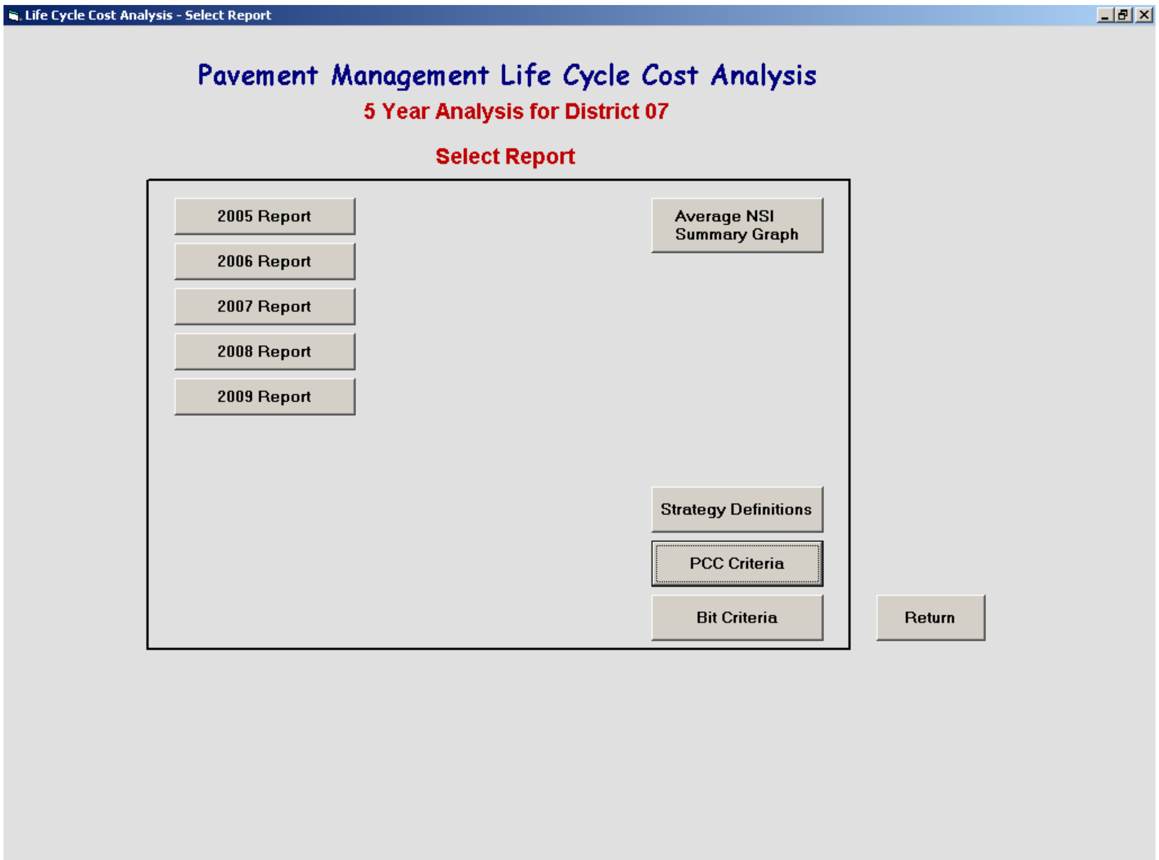


This first screen of the life cycle cost analysis is where you enter the number of years that you want to run the analysis. After you enter the year(maximum of 20) you select ANALIZE.

BUDGETS:
The annual budgets are entered on this screen. You must put in a value for every year shown. After you have entered the budgets select RUN to continue the analysis.

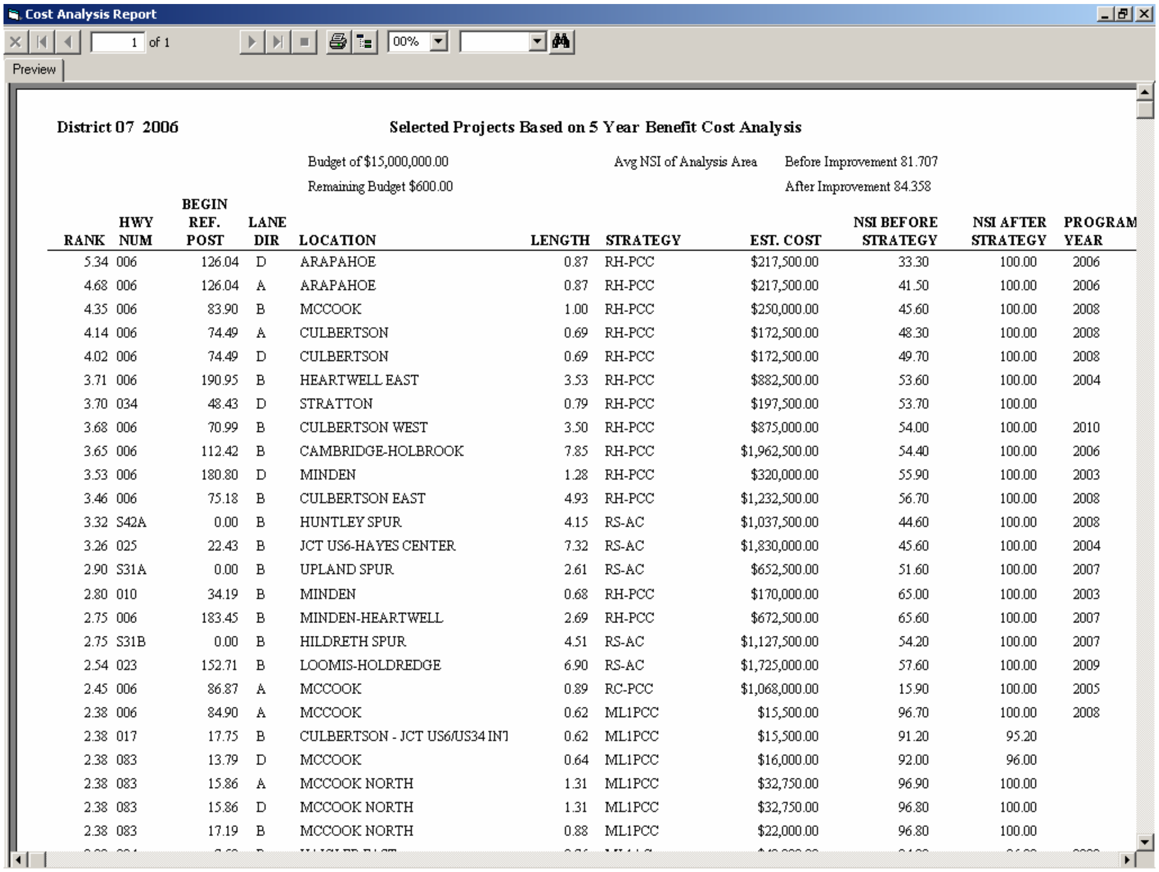


This is the Report Selection screen. It allows you to view the annual reports of the selected sections for improvements for the budgets inputted. On the top right you can select a summary graph for the NSI rating. Also, on the bottom right side you can select the window which takes you to the Strategy Definitions, PCC Criteria or Bit Criteria.



REPORTS:

The report for each year shows which sections were selected for improvement within the budget constraints. The lists are sorted by the largest benefit/cost ratio. Costs are shown for strategies and totaled at the end of the time period.



District 07 2006

Selected Projects Based on 5 Year Benefit Cost Analysis

Budget of $15,000,000.00 — Avg NSI of Analysis Area — Before Improvement 81.707

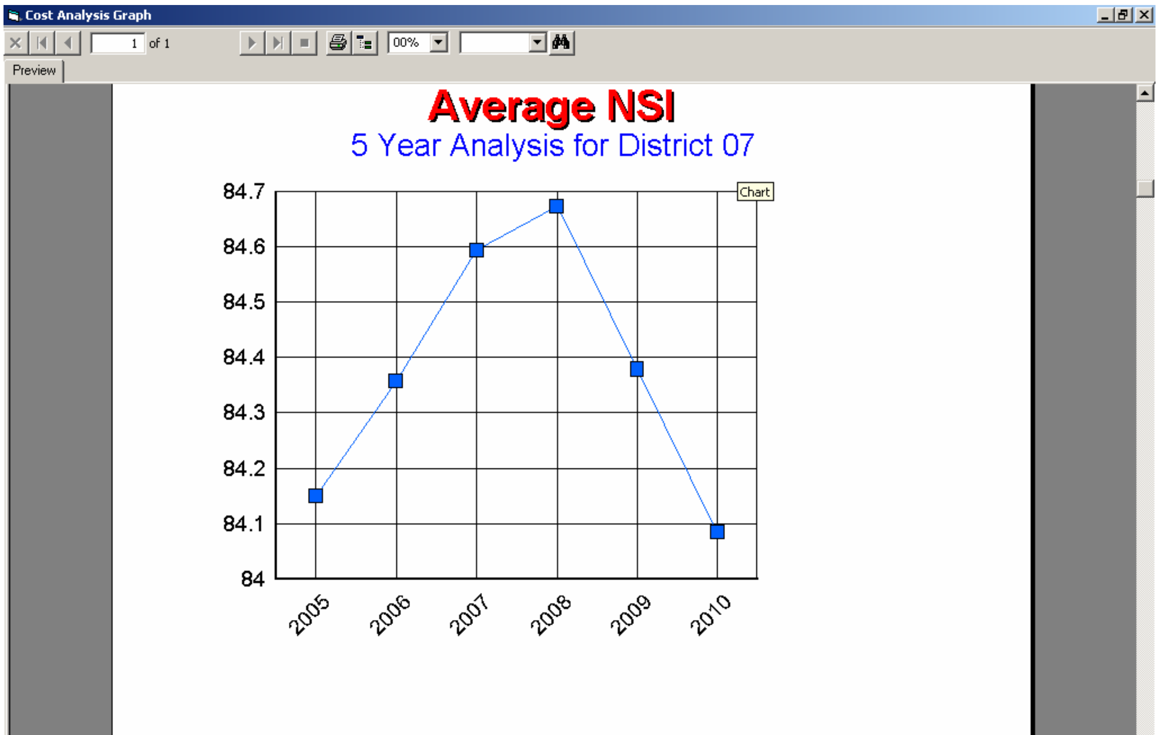
Remaining Budget $600.00 — After Improvement 84.358

RANK	HWY NUM	BEGIN REF. POST	LANE DIR	LOCATION	LENGTH	STRATEGY	EST. COST	NSI BEFORE STRATEGY	NSI AFTER STRATEGY	PROGRAM YEAR
5.34	006	126.04	D	ARAPAHOE	0.87	RH-PCC	$217,500.00	33.30	100.00	2006
4.68	006	126.04	A	ARAPAHOE	0.87	RH-PCC	$217,500.00	41.50	100.00	2006
4.35	006	83.90	B	MCCOOK	1.00	RH-PCC	$250,000.00	45.60	100.00	2008
4.14	006	74.49	A	CULBERTSON	0.69	RH-PCC	$172,500.00	48.30	100.00	2008
4.02	006	74.49	D	CULBERTSON	0.69	RH-PCC	$172,500.00	49.70	100.00	2008
3.71	006	190.95	B	HEARTWELL EAST	3.53	RH-PCC	$882,500.00	53.60	100.00	2004
3.70	034	48.43	D	STRATTON	0.79	RH-PCC	$197,500.00	53.70	100.00	
3.68	006	70.99	B	CULBERTSON WEST	3.50	RH-PCC	$875,000.00	54.00	100.00	2010
3.65	006	112.42	B	CAMBRIDGE-HOLBROOK	7.85	RH-PCC	$1,962,500.00	54.40	100.00	2006
3.53	006	180.80	D	MINDEN	1.28	RH-PCC	$320,000.00	55.90	100.00	2003
3.46	006	75.18	B	CULBERTSON EAST	4.93	RH-PCC	$1,232,500.00	56.70	100.00	2008
3.32	S42A	0.00	B	HUNTLEY SPUR	4.15	RS-AC	$1,037,500.00	44.60	100.00	2008
3.26	025	22.43	B	JCT US6-HAYES CENTER	7.32	RS-AC	$1,830,000.00	45.60	100.00	2004
2.90	S31A	0.00	B	UPLAND SPUR	2.61	RS-AC	$652,500.00	51.60	100.00	2007
2.80	010	34.19	B	MINDEN	0.68	RH-PCC	$170,000.00	65.00	100.00	2003
2.75	006	183.45	B	MINDEN-HEARTWELL	2.69	RH-PCC	$672,500.00	65.60	100.00	2007
2.75	S31B	0.00	B	HILDRETH SPUR	4.51	RS-AC	$1,127,500.00	54.20	100.00	2007
2.54	023	152.71	B	LOOMIS-HOLDREDGE	6.90	RS-AC	$1,725,000.00	57.60	100.00	2009
2.45	006	86.87	A	MCCOOK	0.89	RC-PCC	$1,068,000.00	15.90	100.00	2005
2.38	006	84.90	A	MCCOOK	0.62	ML1PCC	$15,500.00	96.70	100.00	2008
2.38	017	17.75	B	CULBERTSON - JCT US6/US34 INT	0.62	ML1PCC	$15,500.00	91.20	95.20	
2.38	083	13.79	D	MCCOOK	0.64	ML1PCC	$16,000.00	92.00	96.00	
2.38	083	15.86	A	MCCOOK NORTH	1.31	ML1PCC	$32,750.00	96.90	100.00	
2.38	083	15.86	D	MCCOOK NORTH	1.31	ML1PCC	$32,750.00	96.80	100.00	
2.38	083	17.19	B	MCCOOK NORTH	0.88	ML1PCC	$22,000.00	96.80	100.00	

Use the toolbars with arrows on the top of the screen to navigate through the report. To print this report, select the printer icon at the top of the screen. Close this screen to return to the previous screen.

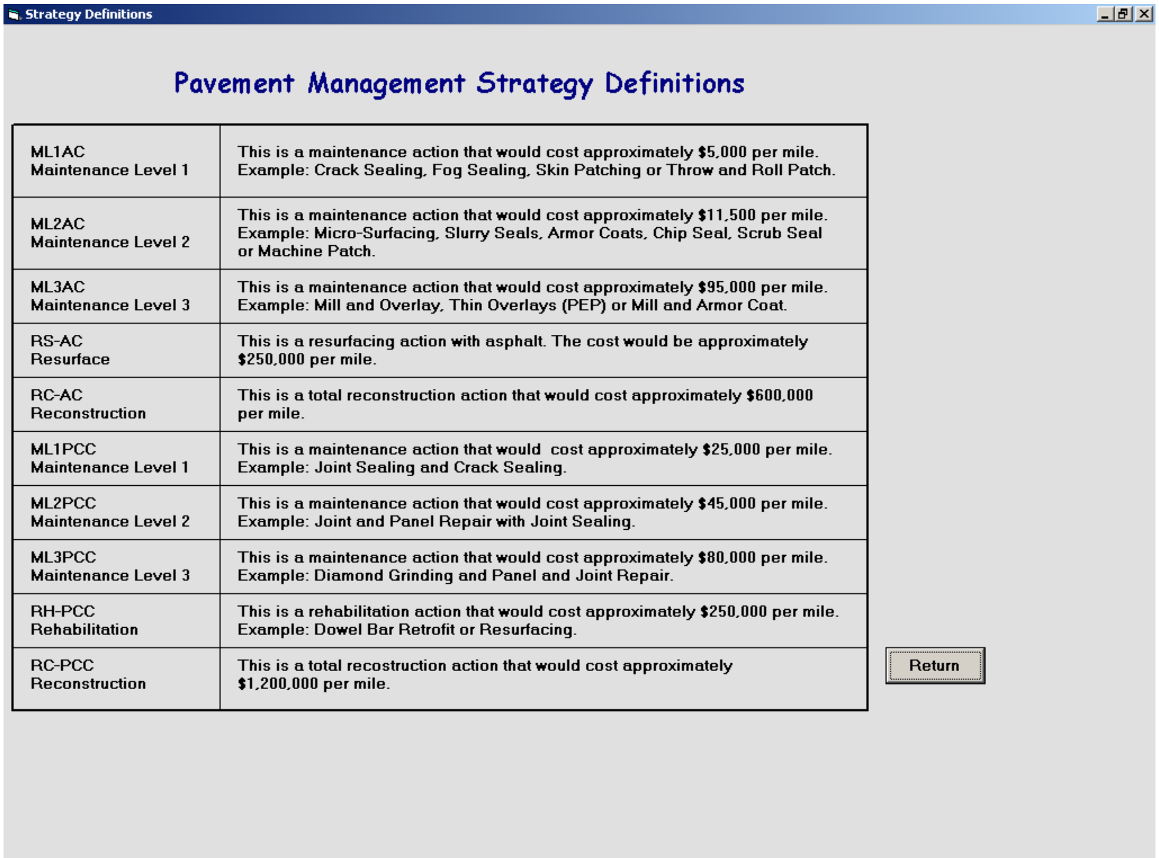
NSI GRAPH:

The Graph shows you the Average NSI rating for each year after the improvement strategies have been performed.



ANALYSIS YEAR	BUDGET	REMAINING_BUDGET	AVERAGE_NSI
2005	$0.00	$0.00	84.15
2006	$15,000,000.00	$600.00	84.36
2007	$15,000,000.00	$900.00	84.59
2008	$15,000,000.00	$4,695.00	84.67
2009	$15,000,000.00	$1,765.00	84.38
2010	$15,000,000.00	$1,700.00	84.08

STRATEGIES:



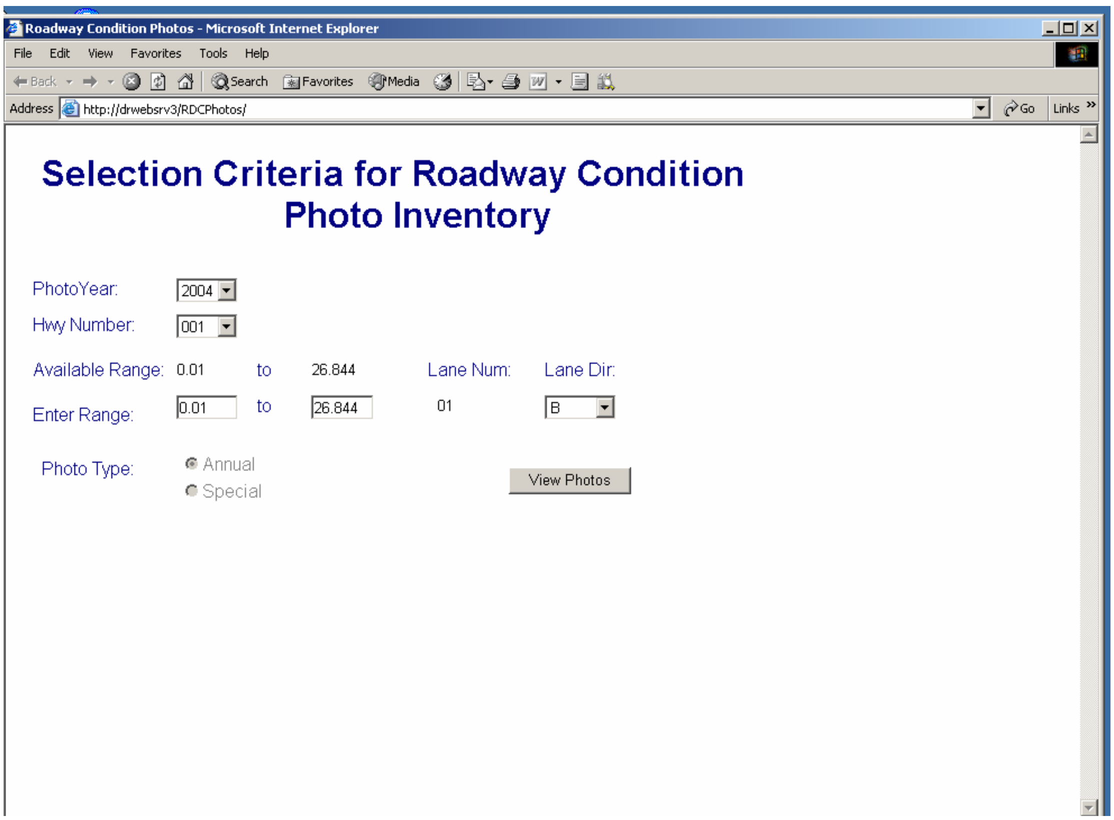
ML1AC Maintenance Level 1	This is a maintenance action that would cost approximately $5,000 per mile. Example: Crack Sealing, Fog Sealing, Skin Patching or Throw and Roll Patch.
ML2AC Maintenance Level 2	This is a maintenance action that would cost approximately $11,500 per mile. Example: Micro-Surfacing, Slurry Seals, Armor Coats, Chip Seal, Scrub Seal or Machine Patch.
ML3AC Maintenance Level 3	This is a maintenance action that would cost approximately $95,000 per mile. Example: Mill and Overlay, Thin Overlays (PEP) or Mill and Armor Coat.
RS-AC Resurface	This is a resurfacing action with asphalt. The cost would be approximately $250,000 per mile.
RC-AC Reconstruction	This is a total reconstruction action that would cost approximately $600,000 per mile.
ML1PCC Maintenance Level 1	This is a maintenance action that would cost approximately $25,000 per mile. Example: Joint Sealing and Crack Sealing.
ML2PCC Maintenance Level 2	This is a maintenance action that would cost approximately $45,000 per mile. Example: Joint and Panel Repair with Joint Sealing.
ML3PCC Maintenance Level 3	This is a maintenance action that would cost approximately $80,000 per mile. Example: Diamond Grinding and Panel and Joint Repair.
RH-PCC Rehabilitation	This is a rehabilitation action that would cost approximately $250,000 per mile. Example: Dowel Bar Retrofit or Resurfacing.
RC-PCC Reconstruction	This is a total recostruction action that would cost approximately $1,200,000 per mile.

These are the predicted strategies that come from the decision trees and related costs. All costs shown include overhead costs of 37.5% for Engineering and Contingencies.

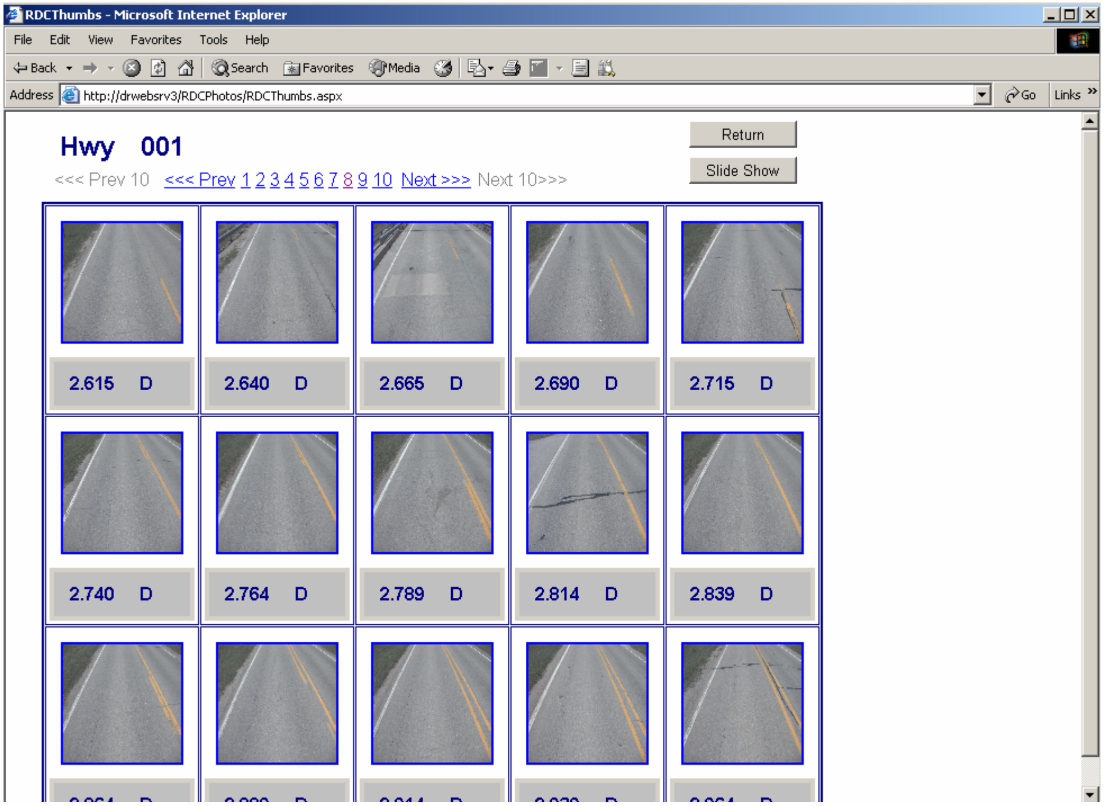
The PCC and BIT decision trees can be viewed from here.(see the section on decision trees for further instructions on these.)

ROADWAY INVENTORY PHOTOS:

This can be activated by selecting the roadway condition photo link on the right side of the Pavement Management Data screen or by going into the Roadway Inventory Photos screen and clicking on the camera symbol. If you access the photos from the Pavement Management Data screen it will go directly to the section that is highlighted and retrieve the most recent photo available. If you access the photos from the Roadway Condition Photos screen shown below, then you need to select the year and enter the highway and reference posts for the section desired.

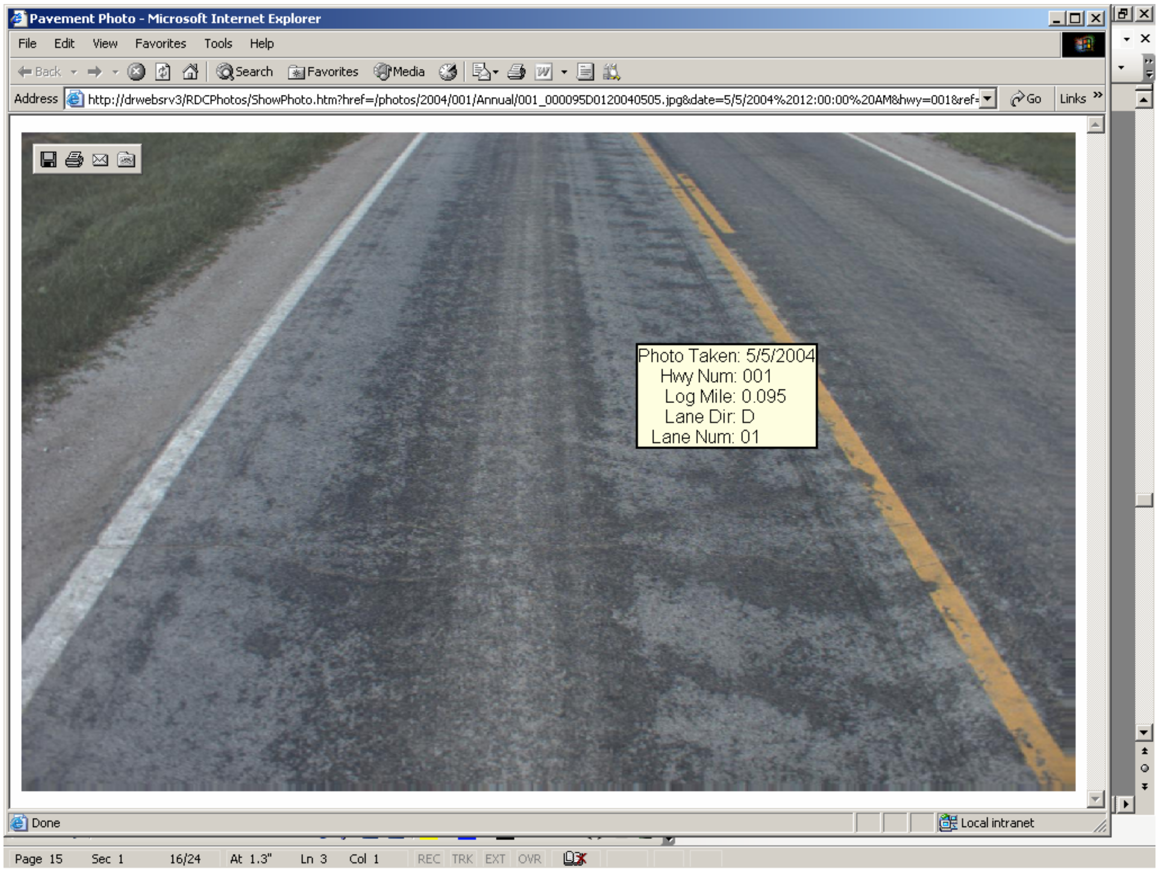


You should choose the most recent photos and enter you highway and reference post range desired. You can also select Lane Number and Lane Direction. Typically you will view the Annual photos as the selection shows. If there are Special photos then that option would be highlighted and available for selecting.



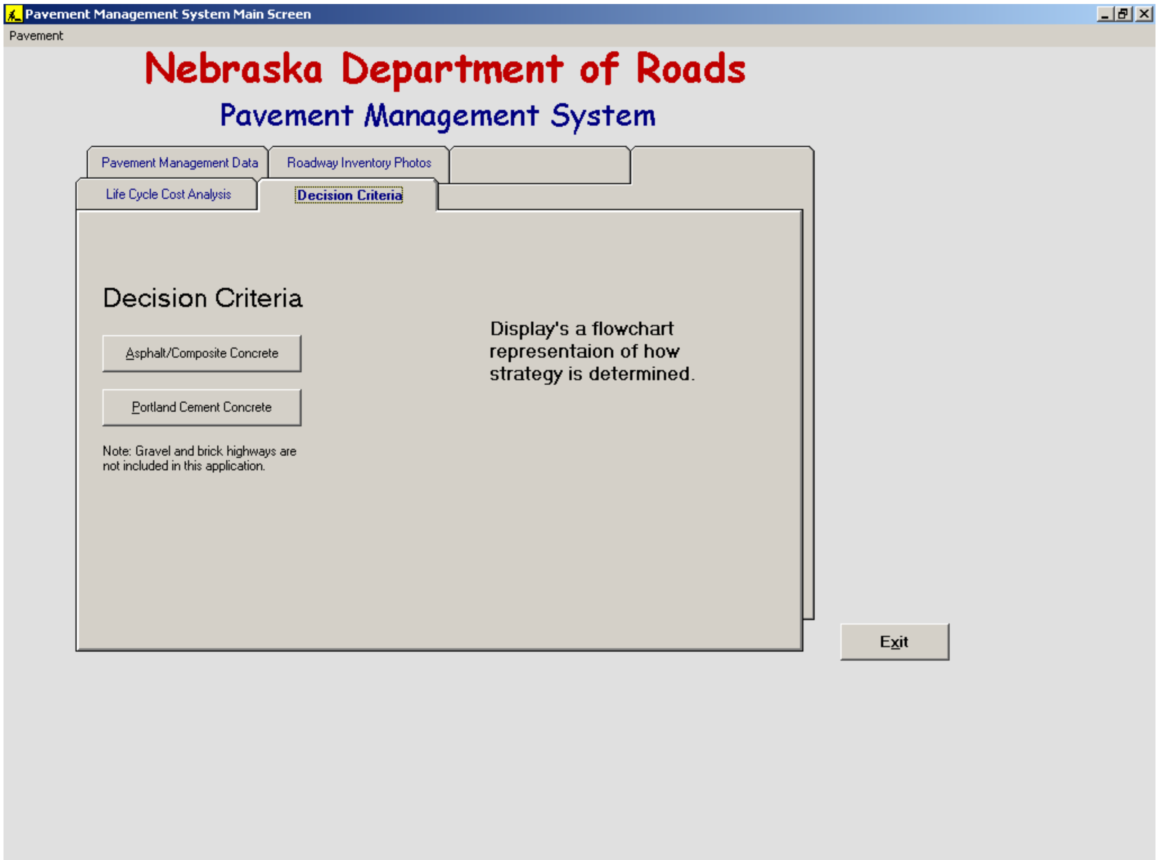
The photos are stored in blocks of 20 photos per sheet and you can click on the "Next" to see the next sheet or the "Next 10" sheets. You can select a photo to enlarge it. The Slide Show button is not functioning at this time.

A single left click will maximize a single photo.



A right click on the single enlarged photo tells you when it was taken. Close this to return to the Pavement Management Data screen.

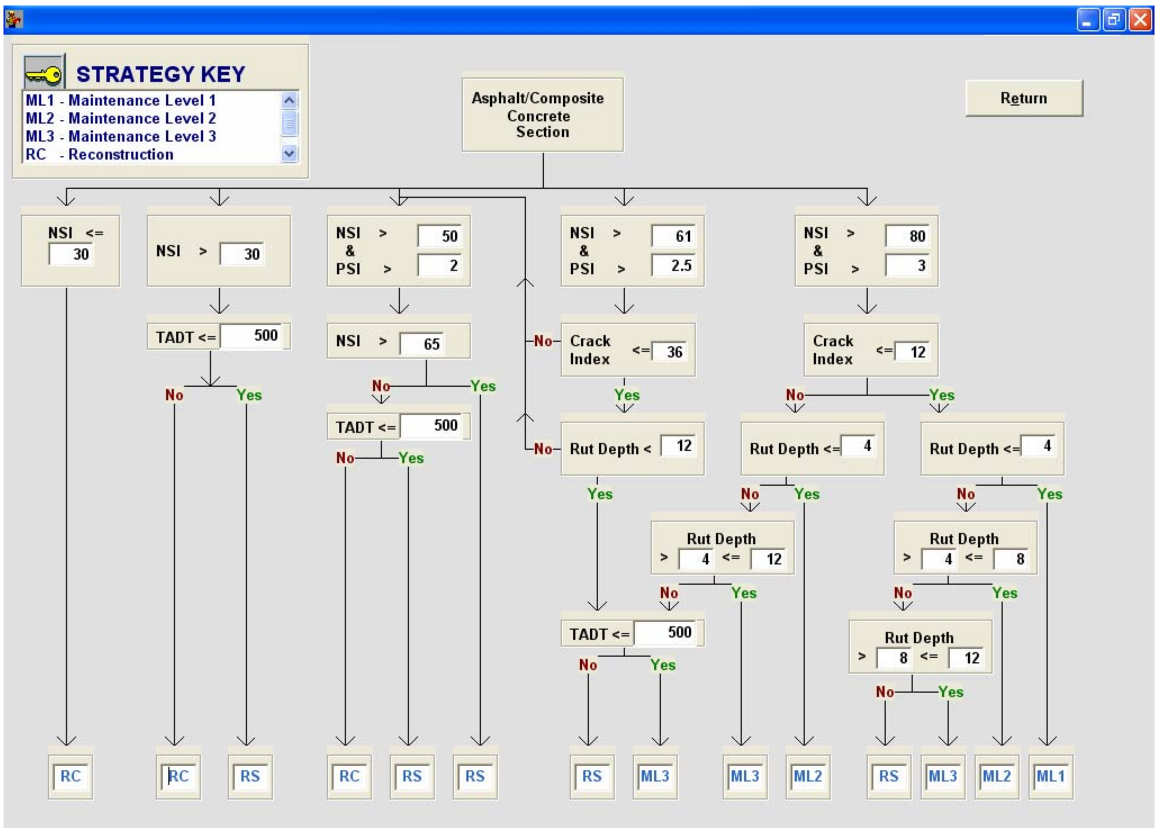
DECISION CRITIERIA:



The strategies selected during the optimization and analysis are based on these decision flowcharts. The values used on the chart come from past experience and engineering judgment from the last 15 years of data. There is a flowchart for Asphaltic Concrete(AC) and one for Portland Cement Concrete(PCC).

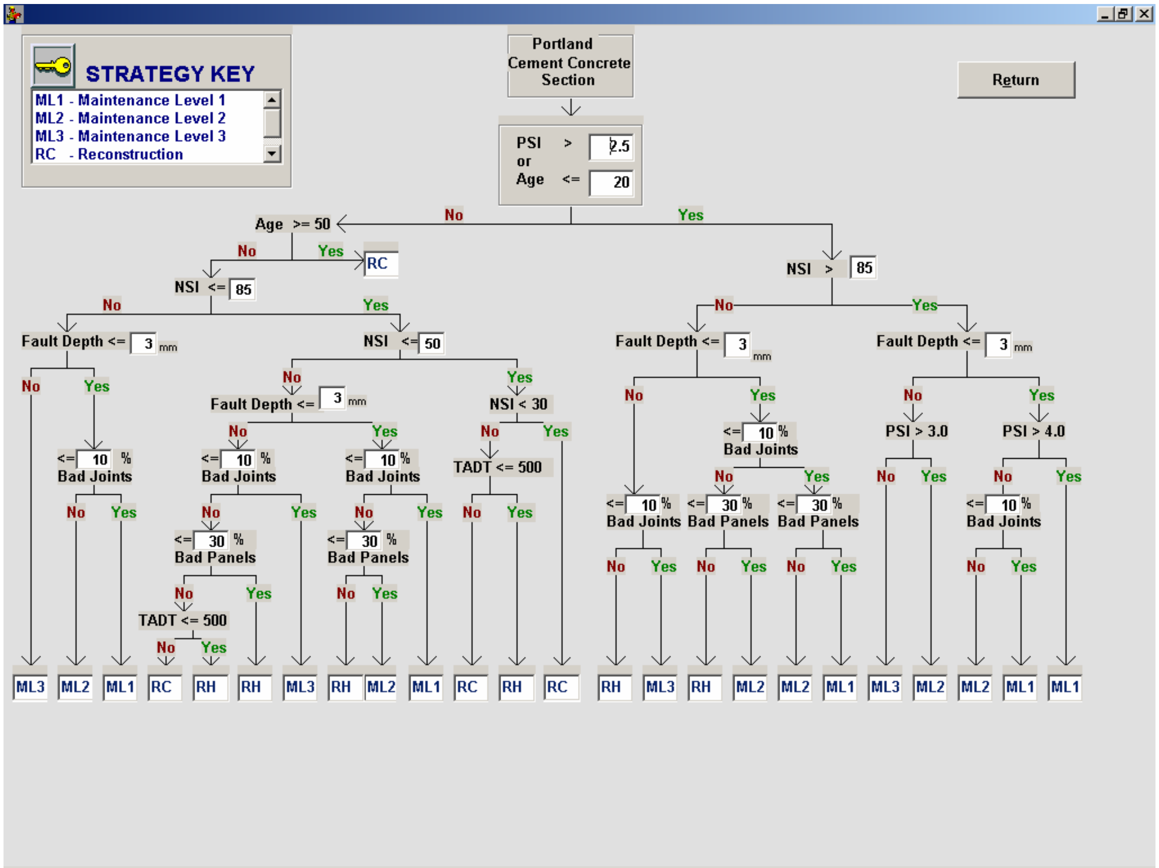
AC DECISION CRITERIA:

A pavement section must have had at least 3 years since the last improvement before it goes into the decision tree. Also, if the section has a NSI > 80 and the PSI > 3.0 and the crack index < 6 and the rut depth < 6mm then no action is required so it doesn't go through the decision tree.
Each qualifying section falls through this tree and lands on only one strategy. Actions can be ML1, ML2, ML3, RS, AND RC as conditions worsen. The first thing it checks is the NSI and PSI. Then it checks the cracking, rutting and TADT's to determine the most appropriate strategy.



The "Strategy Key" at the upper left corner defines the strategies and approximate costs.

PCC DECISION CRITERIA:



A pavement section must have had at least 7 years since the last improvement before it goes into the decision tree. Also, if the section has faulting < 2.5mm and the bad joints < 10% and the bad panels < 30% and joint seal < 50% then no action is required so it doesn’t go through the decision tree.

Each qualifying records data falls through this tree an falls on only one strategy. Actions can be ML1, ML2, ML3, RH, and RC as conditions worsen. The first thing checked is the PSI and Age. Then it checks the NSI, Faulting, Bad Joints and Bad Panels to determine the most appropriate strategy. Select Return to go to the previous screen.

GLOSSARY:

Cracking Index-This is a measure of the amount of cracking observed on the pavement. The index is a function of the extent and severity of these distresses.

Faulting-The average faulting at joints in mm.

IRI-International Roughness Index is measured in mm/m.

Joint Distress-This indicates the percentage of PCC joints observed to be spalled for the sample section.

NSI-Nebraska Serviceablity Index. This represents the condition of the pavement and is used for development of remaining life values. It is on a scale of 0 to 100 with 0 being the worst and 100 being the best.

PSI-Present Serviceability Index. This is a numerical value indication the ride quality of the pavements. PSI is a function of roughness IRI, cracking and rutting. It is a on a scale of 0 to 5 with 0 being the worst condition and 5 being the best.

Rutting-The average rut depth measured with Nebraska's profilometer in mm.

Slab Cracking-The percentage of slabs observed to be cracked for the sample section.

Thermal Cracking-This index reflects the severity and extent of transverse and random block cracking. The index is expressed as an index on a scale of 0 to 100 with 0 being the best and 100 being the worst.

Transverse Cracking-This is a condition observed for cracks that are predominately perpendicular to the pavement centerline.

TADT-Truck Average Daily Traffic.

Joint Seal-A PCC factor denoting if the nominal joint seal at a sample site is OK or deficient.

Program Year-The year in which a resurfacing or reconstruction is going to be performed.

Optimum Year-The best year for resurfacing a pavement based on the historical and current pavement condition. It is the year when the benefit to cost ratio of resurfacing a pavement is at a maximum.

Critical Year-The year at which most of the traveling public, and engineers would find the pavement in unacceptable condition. Pavement distress is of such magnitude that complete reconstruction is often needed.

Profile Date-This is the date that the pavement had the roughness and rutting data collected by the profilometer.

NSI Date-This is the date that the visual condition ratings were collected.

APPENDIX "A" (POP PARAMETERS)

Bituminous/Composite Sections:

OPTIMUM VALUES(Criteria for "No Action Required", All must occur)

	RDCP0108 field name
NSI > 80	RESTRN_IDX_AMT
And PSI > 3.0	MPSI
And Crack Index < 6	CRKNG_IDX_AMT
And Rut Depth < 6 mm	AVG_RUTD_AMT

YEARLY DETERIORATION RATES

NSI (- 2.5 points)
PSI (- 0.1 points)
Crack Index (+ 3.0 points)
Pred Age (+1)
Rut Depth (+ 2.0 default) (+ 1.0 for ML3) and (+ 0.5 for RSAC and RHAC and DT_CMPLTD > JAN, 2000)

Once an strategy selection causes a slower rate of deterioration, then keep using that rate until another strategy causes an even slower rate.

IMPROVEMENT VALUES FOR STRATEGIES

Maintenance Level 1(ML1AC)

NSI	+1.5
PSI	NA
Crack Index	NA
Rut Depth	NA

Maintenance Level 2(ML2AC)

NSI	+3.0
PSI	+0.1
Crack Index	(crack/2)
Rut Depth	(rut/2)

Maintenance Level 3(ML3AC)

NSI	96
PSI	3.5
Crack Index	0.0
Rut Depth	0

Resurface(RS2AC)

NSI	100
PSI	4.5
Crack Index	0.0
Rut Depth	0
Pred Age	0

Reconstruction(RCAC)

NSI	100
PSI	4.5
Crack Index	0.0
Rut Depth	0
Pred Age	0

If a bituminous/composite section is selected for an improvement strategy, then it is locked out of the decision making for 3 years. On the 4th year it falls through the decision making again.

Portland Cement Concrete Sections:

OPTIMUM VALUES(Criteria for "No Action Required", All must occur)

	RDCP0108 field name
Fault Depth < 2.5mm	FAULT_AMT
And Bad Joints < 10%	JNT_DSTRSS_AMT
And Bad Panels < 30%	SLAB_CRKNG
And Crack Seal < 50%	CNC_PAV_JS_P

YEARLY DETERIORATION RATES

NSI (- 1.5 points)
PSI (- 0.1 points)
Crack Seal (+10%)
Bad Joints (+2)
Bad Panels (+2)
Pred Age (+1)
Fault Depth (+0.375 default) (+0.15 for RCPCC and RHPCC and DT_CMPLTD > JAN, 2000)

Once an strategy selection causes a slower rate of deterioration, then keep using that rate until another strategy causes an even slower rate.

IMPROVEMENT VALUES FOR STRATEGIES

Maintenance Level 1(ML1PCC)

NSI	+ 4.0
PSI	+ 0.1
Fault Depth	NA
% Bad Joints	NA
% Bad Panels	NA
Crack Seal	0%

Maintenance Level 2(ML2PCC)

NSI	+ 8.0
PSI	+ 0.3
Fault Depth	NA
% Bad Joints	0%
% Bad Panels	0%
Crack Seal	0%

Maintenance Level 3(ML3PCC)

NSI	+ 12.0
PSI	+ 0.6
Fault Depth	0.0mm
% Bad Joints	0%
% Bad Panels	0%
Crack Seal	0%

Rehabilitation(RHPCC)

NSI	100
PSI	4.5
Fault Depth	0.0mm
% Bad Joints	0%
% Bad Panels	0%
Crack Seal	0%
Pred Age	0

Reconstruction(RCPCC)

NSI	100
PSI	4.5
Fault Depth	0.0mm
% Bad Joints	0%
% Bad Panels	0%
Crack Seal	0%
Pred Age	0

If a Portland cement concrete section is selected for an improvement strategy, then it is locked out of the decision making for 7 years. On the 8th year it falls through the decision making again.

Some of our section data is not always up to date when there is a construction project in progress. We would like to include these sections in the future scenarios but we need to have like-new conditions in the data to start with. If the section is 1 year old then we need to check the NSI, rutting or faulting to see if they are in the correct range, then set the appropriate distresses to like-new as listed below. These are designated by an asterisk(*) in the first space of the Location information column.

BITUMINOUS

IF PRED AGE = 1
AND NSI < 90
OR RUTD AMT > 3
THEN SET NSI = 100, PSI = 4.5, RUTTING = 0, AND CRACKING INDEX = 0

PCC

IF PRED AGE = 1
AND NSI < 90
OR FAULT AMT > 2
THEN SET NSI = 100, PSI=4.8, FAULTING AMT = 0, JOINT DISTRESS = 0,
SLAB CRACKING = 0, AND CRACK SEAL = 0.

This check and update should be performed before the sections are deteriorated. They will then pass the optimal test and no action is required for year 1. After a few years of deterioration they will fail the optimal test and require action as suggested by the decision tree.

FORMULAS FOR THE BENEFIT COST RATIO:

(Life of strategy * Improvement in NSI)/Unit cost per mile for that strategy.

BITUMINOUS

ML1AC = (4 * 1.5)/5 + (cracking index amt/10)

ML2AC = (6 * 3.0)/11.5 + (avg. rutting depth/10)

ML3AC = 8 *(96 - current NSI)/95

RSAC = 15 *(100 - current NSI)/250

RCAC = 20 *(100 - current NSI)/600

CONCRETE

ML1PCC = (8 * 4.0)/25 + (joint seal %)/100

ML2PCC = (10 * 8.0)/45 + (((bad panels + bad joints)/2)/100)

ML3PCC = (12 * 12.0.)/80 + (fault amt/10)

RHPCC = 15 * (100 - current NSI)/250

RCPCC = 35 * (100 - current NSI)/1200