

The Highway Condition Projection Model

*For Use in Estimating Highway
Condition and Funding Needs*

November 1992

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Introduction

Origin

The Capital District Transportation Committee is the Metropolitan Planning Organization for New York's Capital District. The computer program used by the CDTC Staff in its long-range planning to project highway condition is an adaptation of the New York State Department of Transportation Highway Condition Projection Model computer program from the early 1980's. The NYSDOT HCPM program is described in *Transportation Analysis Report 17* and *Transportation Analysis Report 35* both by David T. Hartgen. In brief, the model takes current highway condition scores and checks them against a matrix of repair policy. If a repair is specified, the condition of the road is upgraded and the cost of the repair along with other pertinent information is saved. If no repair is specified, the road is deteriorated by the yearly amount.

System Requirements

The model runs on IBM Personal Computers and compatibles with more than 500 kilobytes of free RAM. It requires less than 320 kb of disk space to install, but can produce output files of 2 megabytes or more depending on the number of years simulated. Therefore, the program can be run on a floppy diskette depending on the size of the diskette and the number of years simulated. In order to run the program properly, you need the following line in your computers config.sys file at boot up: "device=d:\path\ansi.sys", where "d:\path\" is the drive and path which contains the MSDOS file "ansi.sys", and presumably the rest of your MSDOS command files. Config.sys is found in the root or top directory. If this line is not in the config.sys file, the program will have screen formatting difficulties but will still accept data and produce the same result as if the line were in the file. You should use any editor to add this line to the file, then reboot. If added at the end of the file, it won't alter the way your system runs otherwise. Ansi.sys is a memory resident program that uses very little (4k) RAM.

Differences Between CDTC and NYSDOT Programs

There are differences between the NYSDOT model and the CDTC version. However, these differences are not in the basic procedure, and the two versions could, theoretically, produce the same results. The CDTC version was originally written to provide regional information with emphasis on total cost and condition of the entire road system over 30 years, rather than to provide a list of specific road segments needing improvement over a one to five-year period. Since then, the CDTC model has been upgraded to provide for the latter as well.

Use

The model can be used to determine future funding needs by running it without funding constraint, or by running it by trial and error until specified conditions are reached. It can also be used to project conditions at specific funding levels.

Data Required

To run the HCPM the following information must be provided:

- 1) **Condition Scores.** These files can have any name the user wishes. However, the output is named automatically from these filenames. Therefore, the following convention will be beneficial: "NNYY.TYP", where "NN" is a description of the roads (such as "CD" for "Capital District"), "YY" is the year of the data and "TYP" is the type of data being used ("GRP" if the segments are grouped by score and "SEG" if each individual segment is listed in the file). On the first line of this data file must be the year the scores were taken (e.g., "1989"). The second line must contain the name of the type of roads the scores represent (such as "Non-State Federal-Aid") in the way the user wants it to appear in the output. The condition data must be grouped by pavement type and may be entered as total lane-miles for each condition score. An example of this is found on page 12 in Appendix A. Or, scores may be read in one segment at a time, with the name of each segment appearing next to its data. An example of a file like this is found on page 13 in Appendix A. If the names of the segments are used, the word "NAMES" must appear on the first line of the file. A blank space must separate it from the year of the data. In this case, the first line would be "1989 NAMES". On the line before each group of scores must be the pavement type of those scores (for example, "rigid", "flexible" or "overlay"). The pavement types in this file must be identical to the pavement types in the corresponding deterioration rate file and repair matrix file, including capitalization. The line after each group of scores must be blank, including the last line of the file. The file containing these data must, like all FORTRAN program data files, be in precise format specifications. A sample data file is included on the diskette with the program.
- 2) **Deterioration Rates.** These are located in the file "detrates.dat" and are defined as the number of points (in its NYSDOT condition rating) a road will lose every year if no contract maintenance takes place. Deterioration rates were originally taken from *Transportation Analysis Report 35* by David T. Hartgen (page 9). These rates are constant, i.e. the same for every year a given road deteriorates. Since that time, it has been discovered that the deterioration of roads differs depending on the score of the road. Therefore, the New York State Department of Transportation published variable deterioration rates in 1986. Another set of deterioration rates included on the CDTC HCPM diskette, "detrates.lfa" and "detrates.loc" are the variable deterioration rates for local roads (federal-aid and non-federal-aid, respectively) in New York's Capital District as found by CDTC. These rates were found by using condition data taken every other year from 1983 to 1991, eliminating scores that increased by more than one point from one year to the next, and averaging the deterioration of each remaining segment for each condition score. These rates differ slightly from those found by the Department of Transportation, but produce a very similar deterioration curve when plotted. They are in the data file "detrates.dat", and are displayed in Table 1 on page 4. The actual data file

"detrates.lfa" is in Appendix A on page 14. The user may produce a file with constant deterioration rates. However, testing by CDTC has determined that constant deterioration rates give unreliable results for a five year period, although for a thirty year period there may be no significant difference in the final year between results obtained from constant and variable rates. The files with the deterioration rates may be changed using standard ASCII file word processors and editors. The user may have a different deterioration rate file for each different class of data. Data classes are described on page 6.

Table 1

Deterioration Rates

For Capital District Non-State Federal-Aid Roads
(Empirically Derived from Data for the Period 1983-91)

Condition Level	Flexible	Overlay	Rigid
10	.400	*.433	*1.000
9	.340	.354	*.500
8	.170	.216	.393
7	*.124	.130	*.135
6	.085	.124	*.129
5	.078	*.122	.110
4	.062	.092	--
3	--	--	--

Notes: *Deterioration rates are expressed in points per year. Deterioration rates below condition level 4 for flexible and overlay pavements and below condition level 5 for rigid pavements cannot be calculated since there is very little pavement mileage below these levels in the Capital District in the seven year period 1983-91. Rates with an "*" have been adjusted to provide a smoother deterioration curve.*

- 3) **Repair Matrix.** This matrix is located in the file "matrix.dat". The data for Capital District local federal-aid roads appears in Appendix A on page 15 and is in the file

"matrix.lfa" on the diskette accompanying this documentation. The files on the diskette for Capital District local non-federal-aid and state roads are "matrix.loc" and "matrix.nys", respectively. For each pavement type, a list of repair actions for each condition score is provided. If there is no action cited for a given condition score, then there should be no repair to a road of that pavement type and score. An example, the local federal-aid repair matrix for the Capital District, is shown in Table 2 on page 5. The user may have a different repair matrix file for each different class of data. Data classes are described on page 6.

Table 2

Repair Actions by Pavement Type and Condition Score

<u>Pavement</u>	Condition Scores									
	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>	<u>6</u>	<u>7</u>	<u>8</u>	<u>9</u>	<u>10</u>
rigid	1	1	1	1	1	5				
flexible	1	1	1	1	1	5				
overlay	1	1	1	1	1	5				

- 4) **Repair Data.** This data is located in the file "repairs.dat", a sample of which is explained in Figure 1 on page 7. The files on the diskette for state roads, and the Capital District's local federal-aid and local non-federal-aid roads are "repair.nys" "repair.lfa" and "repair.loc" respectively. The file "repairs.lfa" is found in Appendix A on page 15. These data files include the cost per two-lane-miles and expected improvement in condition score due to each repair. The number of times a repair strategy can be performed (without a greater repair being performed) before the model will skip it, is also provided. If the maximum number of repetitions of an action is reached, the program will skip over it, allowing the road to deteriorate, and go on to the next greatest repair. *(For example, an overlay pavement with condition score six requires repair number five, according to its repair matrix (Table 2 on page 5). If repaired, the road will then have a condition score of ten (9.5 rounds to ten). After 13 years of deterioration (Table 1 on page 4), it will again be at a condition score of six, and will again require repair number five. Implementation of the repair gives it a condition score of ten, and it will again deteriorate for another 13 years when it will have a condition score of six a third time.*

One can see that if this is allowed to happen indefinitely the road will never need repairs other than resurfacing (repair number five). Logical long-term maintenance management would dictate some form of reconstruction at some point because roads cannot be resurfaced indefinitely. Therefore, the CDTC program uses limits to the number of repetitions for each repair (in this case, repair number five) before going on to the next greatest repair. In our example, the road is requiring repair number five for the third time. However, the maximum number of times it is allowed to be done before going on to a greater repair is two. This is found in the data in Figure 1 on page 7. Therefore, the model will recognize it has gone as far as it can with repair number five and will act as if it never saw the five in the matrix (Table 2 on page 5) and deteriorate the road instead of repairing it. The road will eventually need repair number one, be repaired, and the process will start over again.) The repairs with nine as their maximums are the reconstructions. Putting a nine in that column tells the computer there is no limit. In field four of the data there is either an asterisk ("*") or a blank. The repairs with asterisks can have their maximums (field 3) altered by the user while running the program. The data file remains the same, but the program uses the new data. Here, a nine means literally "9", not "no limit" as with the reconstructions. The user-friendliness of the program makes this all very easy and clear. The numbers in field 1 represent the magnitude of the repair; the higher the number, the greater the repair. The description of the repairs are in field 5. Also provided in this group of input data is the resulting pavement type if the improvement is done.

Program Prompted Responses. There are several questions the program asks the user at run-time. For each input, the last user input is the default. Hitting nothing but the <Enter> key in response to a given prompt tells the computer to use the default value except in the case of funding limits (in which case the variable funding file is used). These default responses are kept in the file "default.dat".

- 6) **Data Classes.** The program allows a user to specify classes of data, such as "State Roads" or "Local Federal-Aid Roads" by filename extension. After the user picks the class he desires, the program would find in a subdirectory of the program directory called "data", the "matrix.ext", "repair.ext", "detrates.ext", "funding.ext" and "priority.ext" data files corresponding to his choice. The user defines these choices himself by creating a data file called "class.dat" (in a subdirectory of the program directory called "data"), an example of which is found in Table 3 on page 8. The three letters in the first field are the filename extension on the data files to be read as input. The next field is the name for the class of data corresponding to the data filename extension on that same line. This is the description that the program will display when prompting for a data class. This eliminates the need to copy data files into default names with the extension "dat". The program accepts up to nine data classes.

Figure 1

Repair Strategy Data

For Capital District Non-State Federal-Aid Roads

Data Fields:

<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>	<u>6</u>	<u>7</u>	<u>8</u>	<u>9</u>
9	1	9		Local Reconstruction	8.0		.284	1
5	5	2	*	Resurface (incl. t & l)	3.5		.160	0

Description of the Data Fields:

1. Order of the magnitude of repair.
2. Repair action number.
3. Allowable repetitions of the repair before doing a greater repair
4. A "*" means field three can be changed by the user during program execution.
5. Name of the repair action.
6. Increase in the condition score because of the repair.
7. Not used by the program anymore.
8. Cost per two-lane miles of the repair.
9. Resulting pavement type:
 - 0: No change
 - 1: First pavement in the repair matrix file
 - 2: Second pavement in the repair matrix file
 - 3: Third pavement in the repair matrix file

Table 3
Data Class File

Note: In an actual class file, there is only one space separating the extension from the name of the data class.

<u>Filename Extension</u>	<u>Name Of Data Class</u>
lfa	Local Federal Aid
loc	Local Non-Federal Aid
nys	New York State

Additional Features

In addition to what has been described so far there are additional features.

- 1) **Priority of Repairs.** If the user decides to repair the roads according to a set of priorities, a set of defaults found in the file "priority.dat" will be used unless the user changes them while running the program. If he does, the new values are saved as defaults. The user should have no need to edit this file outside of the program. One can also define priority files for different classes. The higher the priority number in relation to the priorities for other scores, the higher likelihood of the road being repaired.
- 2) **Print Options.** The program allows the user to choose between three printer options. The LaserJet option will send the necessary codes to a Hewlett Packard LaserJet. The dot matrix options will format the output appropriately, but will not set the proper parameters on the printer. Therefore, the user should make sure the printer is set to a vertical spacing and font to match his selection when selecting a dot matrix option. If, when using a dot matrix printer set to condensed print and that option is chosen at run-time, the printout seems to have form feeds at inappropriate places; this indicates that the line spacing is not set properly on the printer. For condensed print, it should be set at or about 90 lines per page.
- 3) **Output.** The program produces four output files. One of them is sent to the printer and destroyed before the program terminates. It contains the answers to the user prompts. Of the three that remain on the disk, only one is sent to the printer. It contains the information most users would want, such as: average score, percent poor, percent fair and cost for repairs, for each year of the run. This file has the extension "out". Another file, with the extension "rep" contains information on the roads repaired each year. The other file, with the extension "scr" contains condition scores for each segment for each year. The "rep" and "scr" files are provided for those users who find them useful. They should be destroyed from time to time if they are not needed since they can be large. The three output files that remain on disk are named by the program with a name based on the condition input filename. The output files are named according to the convention "AAAA-BC.EXT", where "AAAA" is the first four characters of the condition input filename, "B" is "S" if the input data was by segment and "G" if it was by group, "C" is "U" if the dollars are unconstrained and "C" if they are constrained, and "EXT" is the extension "out", "rep" or "scr" as described above.
- 4) **Funding Limits.** The program reads all segments at once and performs the calculations for all segments before advancing to the next year. Therefore, in accordance with the reason for its creation, it can be constrained by funding availability if desired. Running the model constrained by funding availability in many cases means having enough money to repair some, but not all, of a road or group of roads in a given year. In this case the program will split the segment, repairing only the part for which there is money to repair

and deteriorating the rest. In previous versions of the CDTC model, roads needing repair were repaired in the order of their scores from lowest to highest, so when the money ran out, the roads in the worst condition would have been repaired. However, in practice there are many criteria, in addition to condition, that determine which roads are repaired first such as traffic volume, functional classification, jurisdiction and politics. Therefore, the program has been modified to enable the user to simulate repair of the roads needing repair in any given year, in either random order, from worst score to best score, and from best score to worst score. In the random order repair mode, in a funding limited scenario, in any given year, some roads being repaired could have a higher condition score than some that didn't get repaired. This seems to reflect better what happens in practice. Also, the user may specify that priority be given to roads with certain scores.

- 5) **Variable Funding.** The program allows the user to specify variable funding, such as \$5 million per year for each of the first five years and then \$3 million per year for each year after that. This data is in the file "funding.dat". The user may also use different files for different data classes. The file "funding.lfa" is found in Appendix A on page 16.
- 6) **Forcing Specific Repairs.** A user may want to supply a list of road segments to be repaired first if there is not enough money to repair all roads in a given year. These are called "forced repairs". This feature requires an additional data file containing the year (one to 99) that each forced repair is to take place and the number of each segment to be forced to be repaired that respective year. If a segment specified for repair in a certain year does not need repair in that year, based on its condition score, it is not repaired that year, but will be checked the next year, and every subsequent year to see if a repair is indicated until it is repaired. The roads for which repairs are being forced in this manner are repaired first, then the remaining funds are spent on other roads needing repair. Currently, a user must run the HCPM and check the output files to determine the number of a segment to include in this data file. The file containing this data can have any name and must be specified when the program prompts for the filename. It is generally a good idea to give this file a name similar to the file with the road scores. An example of a forced repair file is in Appendix A on page 16.
- 7) **Randomized Condition Scores.** Condition scores are read in as whole numbers. Therefore, there are groups of roads with the same initial score. These roads would be treated the same throughout the length of the simulation unless the model ran out of money during a given year and split the group. In that case there would then be two groups, instead of one, being treated the same. This would result in unrealistically large year-to-year differences in average scores and percent fair and poor, as entire groups of roads would be repaired one year and none the next. This is because in practice if several roads are scored a "7", for example, they are probably not all exactly "7" in reality, but are really spanning the whole range of condition from "6.5" to "7.5" that could still be rounded to "7". The program, now, during execution, gives the user the **option** of randomizing the input in this fashion. This function changes every road score to a random real number with a rounded value equal to its integer value. This produces smoother, more realistic differences in averages and percentages from year to year. The

randomization will not prevent duplicate runs of the HCPM from producing duplicate results because the program reads from a file of random numbers called "random.dat".

- 8) **Tracing Individual Segments.** Examining the output from certain runs of the HCPM to follow a particular segment can be difficult, depending on the parameters of the run. Therefore, at run-time, the program gives the user the option of tracing particular segments by segment number.
- 9) **Saving Condition Scores.** The program gives the user the option of saving the final conditions as a new input file.
- 10) **Splitting Segments.** This is different from splitting a segment when the money for a given year is exhausted. When grouping segments by condition score in the input, the user can end up with one segment for each score. This nullifies the randomization of condition scores detailed on page 10. Therefore, the option is given to the user to split each segment into as many segments as he desires, up to a total of 1700 segments. Informal tests by CDTC indicate that at least 500 total segments are needed to give satisfactory results. Therefore, if less than 500 segments are in the input file, the user should consider splitting the segments (in essence, multiplying the number of segments) by whatever number will result in at least 500 segments. For example, if one pavement type is being used and segments are grouped so that there are only eight segments ranging in score from 3 to 10, these segments could be split by a factor of 100, resulting in 800 segments. Note that the only factor significantly effecting the speed of the program is the number of segments. The more segments there are, the longer it takes the program to run.
- 11) **Reconstruction for Reasons Other than Condition.** Strange as it may seem to a lay person, many roads are intentionally reconstructed even though their condition calls for a resurfacing. This could be done for realignments, safety, drainage or capacity improvements, as well as other reasons. This occurs more when state or federal money is involved in an improvement than it does when local money exclusively is used. This feature allows the user to specify that some roads be reconstructed for reasons other than road condition. The user is prompted to enter the likelihood that a road needing resurfacing will be reconstructed instead.

Appendix A - Data Files

Grouped Condition Scores

The following is file "fa85.grp". This stands for "1985 scores for local federal-aid roads grouped by score" for New York's Capital District. Since the pavement types named in the file determine which sets of deterioration rates will be used in the program, if only one pavement type is used, as is the case here, it should either be a representative pavement type or a non-existent one that has deterioration rates reflective of the highway system in general.

```
1985
Non-State Federal-Aid
overlay
 3      2.0
 4     43.0
 5    154.0
 6    386.0
 7    390.0
 8    257.0
 9     36.0
10      6.0
```

Condition Scores by Segment

The following is file "fa85.seg". This stands for "1985 scores for local federal-aid roads by segment" for New York's Capital District. Please note that this is a greatly abbreviated file. The actual file would have over 500 segments. At the bottom of the page is a description of each field.

1985 NAMES

Non-State Federal-Aid

rigid

8	.6	100	1	Clinton Ave	Broadway-Pearl St
8	.4	100	1	Clinton Ave	Pearl St-Ten Broeck Ave
8	.4	100	1	Everett Road	Town Line to I-90
8	.5	100	1	Everett Road	I-90 to Watervliet Ave

flexible

8	.5	111	3	Lydius St East	Bellevue St-Foxwood Dr
9	.3	111	3	Lydius St East	Foxwood Dr-Woodhaven Rd
8	4.9	111	3	Lydius St East	Woodhaven Rd-Old State
6	.6	312	4	Lake Hill Rd (CR 58)	Goode St(CR 57)-NY 50
8	.5	300	1	Clark Street	Lincoln Ave-Union Ave
8	.2	300	1	Marion Ave	Excelsior Ave-NY 50
8	.8	300	1	West Ave	West Circular-Congress
6	.8	300	1	West Ave	Congress St-Albany St
6	.7	300	1	West Ave	Albany St-NY 50
7	.7	300	1	West Ave	West Circular St-

overlay

7	.2	100	1	Belvedere Ave	Breavator St-Clermont St
6	.5	100	1	Belvedere Ave	Clermont St-Western Ave
9	.3	100	1	Bender St	Krumkill Rd-Buckingham
8	.3	100	1	Berkshire Blvd	Colonial Ave-Ormond St
7	.8	100	1	Berkshire Blvd	Ormond St-Hillcrest St
7	.5	100	1	Berkshire Blvd	Hillcrest St-Russell Rd
8	.8	100	1	Bertha St	Delaware Ave-NY 9W
9	1.7	100	1	Albany Shaker Rd	City Line-US 9
7	1.3	100	1	Albany Shaker Rd	US 9-NY 377

The field descriptions for the lines with the segments follows. The line showing is the last line the sample above.

Condition Score	Lane Miles	Area MCD	Type	Segment Name	Limits
7	1.3	100	1	Albany Shaker Rd	US 9-NY 377

Deterioration Rates

The following is the file "detrates.lfa". This stands for "Deterioration rates for local federal-aid roads" for New York's Capital District. The deterioration rates are grouped by pavement type and are shown in reverse order of road score (i.e., from 10 to 1). Deterioration rates may differ from area to area.

```
rigid
1.0
.50
.39
.14
.13
.11
.10
.10
.10
.10
flexible
.40
.34
.17
.12
.10
.10
.1
.1
.1
.1
overlay
.43
.35
.22
.13
.12
.12
.10
.10
.10
.10
```

Repair Policy Matrices

The following is the file "matrix.lfa" and contains the repair numbers for New York's Capital District local federal-aid roads for each pavement type from condition 1 to condition 10. A more detailed explanation is found in Table 2 on page 5.

```
rigid
 1  1  1  1  1  5
flexible
 1  1  1  1  1  5
overlay
 1  1  1  1  1  5
```

Repair Data

The following is the file "repairs.lfa" and contains the repair data used for Capital District local federal-aid roads. Roads in another area might have different data for the same type of roads. A more detailed explanation is found in Figure 1 on page 7.

```
9  1  9 Local Reconstruction          8.0  8.0  .284  1
5  5  2*Resurface (incl. t & l)      3.5  3.5  .160  0
```

Variable Funding

The following is the file "funding.lfa" and contains the CDTC's estimates of funding for local federal-aid roads in the Capital District from 1986 to 1991 in 1989 dollars adjusted for inflation and construction inflation. These numbers could vary greatly from one area to another. The two-digit number on the left of the dollars is the year. This is allowed strictly for the benefit of the user, so he can tell what year the funding is for. In other words, the first two spaces are not used by the computer.

```
86  5.5
87  5.5
88  5.5
89  5.5
90 12.54
91  9.18
```

Forced Repairs

The following is an example of a file containing the necessary data to force repairs on certain roads. The first number on each line is the year in the simulation that the segment number (the other number on each line) should be repaired. For example, the first line indicates, segment number 17 is to be repaired in the third year of the simulation.

```
3  17
2  78
2  79
3 139
3 519
2 541
4 546
4 547
```

Appendix B - Example Application

Background

The CDTC staff was in contact with the Niagara Frontier Transportation Committee (NFTC), the MPO for the Buffalo area, to obtain data to run the model for roads outside the CDTC area. Condition data was available from NFTC for 1885, 1989 and 1991. For other data, NFTC conducted interviews with officials from some of the major local units of government (the City of Niagara Falls, and the Counties of Niagara and Erie). This covered approximately 70 percent of the roads. For the remainder, reasonable assumptions and calculations were made. The interviews were short since the local officials already used the NYSDOT windshield scoring method and had most of the necessary data readily available. Below is a detailed description of how the data was obtained.

- 1) **Deterioration Rates.** Deterioration rates were calculated for the roads in question by the method described on page 3. Calculating deterioration rates from data taken four years apart (1985 and 1989) was considered too unreliable. This is because if a road had condition score 10 in 1985, it could deteriorate to 8 or 7 by 1989 and deterioration for each score would be unknown. Therefore, only the 1989 and 1991 condition scores were used. The deterioration rates for overlay and flexible pavements were found to be close to those of the CDTC roads. Deterioration rates for rigid pavements appeared unreliable due to an insufficient sample. Therefore, the CDTC deterioration rates for rigid pavements were used. NFTC deterioration rates are found in Table 4 on page 18.

Table 4
NFTC Deterioration Rates

For Non-State Federal-Aid Roads
(Empirically Derived from Data for the Period 1989-91)

Condition Level	Flexible	Overlay	Rigid
10	.51	.40	1.000
9	.40	.34	.500
8	.21	.26	.393
7	.20	.14	.135
6	.13	.11	.129
5	.10	.10	.10
4	.10	.10	.10
3	.10	.10	.10

Notes: *Deterioration rates are expressed in points per year. Deterioration rates below 0.1 points per year are rounded up to 0.1 to provide a more realistic lower limit. Those for rigid pavements were unreliable and the CDTC data was used (and shown here) instead. Some of the rigid deterioration rates were adjusted to provide a smoother deterioration curve as shown on Table 1 on page 4.*

- 2) **Repair Matrix.** The policy of repair matrix was easily obtained since the local officials had the same definitions of reconstruction and resurfacing as the MPO. Those surveyed said they resurface roads with condition score 6 and reconstruct roads with condition score 5. This data (found in Table 5 on page 19) was the same as that found in the Capital District. Therefore, it was assumed that those not interviewed repaired roads in the same manner.

Table 5

NFTC Repair Actions by Pavement Type and Condition Score

<u>Pavement</u>	Condition Scores									
	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>	<u>6</u>	<u>7</u>	<u>8</u>	<u>9</u>	<u>10</u>
rigid	1	1	1	1	1	5				
flexible	1	1	1	1	1	5				
overlay	1	1	1	1	1	5				

- 3) **Repair Costs.** The interviews indicated very consistent resurfacing and reconstruction costs. The only other government of large magnitude, the City of Buffalo, was assumed to have similar repair costs. This covered approximately 75 percent of the federal-aid miles in the area. What remained were the towns and villages. Their repairs were assumed to be of less magnitude and, therefore, less expensive. It was assumed that their costs were halfway between those found by NFTC in the interviews and those found in the Capital District. The different costs were pro-rated by mile and averaged. A chart which should make these calculations evident is in Figure 2 on page 20. For consistency with the CDTC data, all dollars are from 1989.

Figure 2**Calculations of Repair Costs for Niagara Frontier**

<u>Unit of Government</u>	<u>Lane Miles</u>	<u>Reconstruct Cost/Ln-Mi (1992 K\$)</u>	<u>Calculated Weight</u>	<u>Resurface Cost/Ln-Mi (1992 K\$)</u>	<u>Calculated Weight</u>
Erie County	933	500	466455	100	93291
Niagara Co.	192	500	95850	70	13419
City of Niagara	37	450	16452	100	3656
City of Buffalo (Assumed)	243	500	121485	100	24297
All Others (Assumed)	246	320	78589	90	22103
Total/Average	1650	472	778831	95	156766
Cost/Lane-Mile (1989 K\$)		564		114	

- 4) **Spending.** Spending on non-state roads from the last two years was obtained from the two counties, covering almost 60 percent of the miles. It was assumed that the rest of the governments were spending the same per mile, that 80 percent of the road repair money was being spent on federal-aid roads and that the spending from the preceding years was about 30 percent greater. These estimates came directly from NFTC. The model assumes construction dollars are worth the same from year to year. This has not been the case recently, so adjustments were made to account for the difference. Adjustments were then made to the spending to reflect this. Spending was converted to 1989 dollars for consistency with the CDTC data. The chart in Figure 3 on page 21 contains this shows this operation. The funding for each year was then loaded into the model.

Figure 3

Spending Calculations Chart for Niagara Frontier

<u>Year</u>	<u>Construction Inflation</u>	<u>U.S.Dollar Inflation</u>	<u>Actual Spending Increase</u>	<u>Spending (Current Dollars)</u>	<u>Spending (1989\$)</u>
1988	5%	4%	-1%	14.5	14.4
1989	5%	5%	0%	14.5	14.6
1990	4%	6%	2%	9.6	9.8
1991	-14%	3%	17%	8.2	9.6

Results

The output from the model using this data is in figure 4 on page 22. It is actual unaltered output from a laser printer. The model was run using 1985 data to project conditions in 1991. The output can, therefore, be compared with the actual 1991 road conditions to demonstrate the accuracy of the model. The model projected percent poor and fair of 27 percent and 29 percent, respectively. In actuality, the numbers were 25 percent and 30 percent, respectively. The average score was projected to be 6.33. In reality, it was 6.32. The accuracy of the run should not be determined by looking at these common indicators of systems pavement condition alone. The percent of miles at each condition score projected by the model should be compared to that of the most recent survey as well. That comparison is found in figure 5 on **Error! Bookmark not defined.** It is the last page of this document. The average error was 1.3 percent miles per condition score. This means that if the percent of miles at a given condition score was 20, the model would have projected 21.3 or 18.7 on the average.

Figure 4

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Capital District Transportation Committee
Highway Condition Projection Model (HCPM)

Roads: NFTC Non-State FAUS
Funding: Variable
Repair Order: Random Order
Lane-Miles: 1781

Year	% Poor	% Fair	Mean	Cost (m\$)	Avg. \$/Yr	Mi`s Rep.	\$/Mi Rep.	Cost By Action 1	Action 5
1985	18	26	6.8						
1986	17	27	6.7	14.4	14.4	47	.306	11.3	3.1
1987	19	26	6.7	14.4	14.4	50	.288	10.8	3.6
1988	21	27	6.6	14.4	14.4	34	.424	13.2	1.2
1989	23	28	6.5	14.5	14.4	46	.315	11.6	2.9
1990	25	28	6.4	9.8	13.5	33	.297	7.6	2.2
1991	27	29	6.3	9.6	12.9	39	.246	6.5	3.1
Total Cost (6 Years)				77.1	12.9	249	.310		

Total Lane-Miles By Action 108 142

A "poor" pavement is defined as having a score of 5 or less.
A "fair" pavement is defined as having a score of 6.

Percent of Miles by Score from 1 to 10: .0, .1, 1.1, 7.3, 18.3, 28.6, 28.6, 9.9, 4.3, 1.7, Average = 6.33

Repetition of Action Policy				Deterioration Rates		
Act #	Of # Rep	Description of Policy	Cost Per 2 Ln-Mi	Score	rigid	flexible
1	9	Local Reconstruction	1.128	10	1.00	.51
.40						
5	2	Resurface (incl. t & l)	.228	9	.50	.40
.34						
				8	.39	.21
.26						
				7	.14	.20
.14						
				6	.13	.13
.11						

.10	5	.11	.10
.10	4	.10	.10
.10	3	.10	.10
.10	2	.10	.10
.10	1	.10	.10

