DURHAM URBAN OBSERVATORY REPORT

ASSISTANCE IN PUBLIC ADMINISTRATION DECISIONS:
IMPLEMENTATION OF DIGITIZED LOCATION CHARACTERS IN THE MANAGEMENT DATA FILE OF THE DURHAM PUBLIC SAFETY PROGRAM

PART II

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D U R H A M U R B A N O B S E R V A T O R Y

R E P O R T

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ABSTRACT

This research effort is intended to aid in the development of a program of optimal utilization of computer facilities and data base by the Department of Public Safety of the City of Durham, North Carolina. To accomplish such an objective, a three element work program was designed and implemented. Part I involved the collection and coding of relevant personnel information with related analysis of such data. Part II entailed the manipulation of locational information by gird coordinates in the GBF/DIME file (Geographic Base File/Dual Independent Map Encoding). The third stage of the research involved the production of an annotated, indexed bibliography of relevant citations on the use of computers and computer technology in administrative decision-making for police and public safety programs. This bibliography has been produced as a separate working paper.

ACKNOWLEDGEMENTS

Our thanks go to the individuals in the Department of Public Safety who assisted in the preparation of this report especially Mr. William Robbins. A special thanks to Ms. Priscilla Blackwell of the Durham Urban Observatory for her help in the preparation of the final draft.

OVERVIEW

This study of the implementation of digitized locational characters into Durham, North Carolina's Public Safety Programs' data files consisted of two activities. The first activity was an evaluation of the Census Geographic Base File/Dual Independent Map Encoding (BGF/DIME) File, a computerized map, as a vehicle for converting the address identifications of Public Safety incidents to geo-codes that identify the location of the incidents in a coordinate system.[1] The second activity demonstrations consisted of summary reports generated from the coordinate geo-codes. Both activities are pertinent to the present direction of the Durham Police Department and fit into A Master Plan for Criminal Justice Information Systems for the State of North Carolina as outlined in priority IV in chapter seven of this plan.[2]

The evaluation of the DIME File as a vehicle for converting the address identifications of public safety incidents to geo-codes consisted of (1) matching the addresses of recorded public safety incidents during July, 1975, with an address range of the DIME File to obtain coordinate geo-codes for the recorded incident, (2) evaluation of the accuracy of the assignment of coordinates, and (3) enumeration of the shortcomings of the existing DIME File as a vehicle for obtaining coordinate geo-codes for recorded public safety incidents. Eighty-six percent of the recorded incidents for the month of July 1975 were assigned coordinates via the DIME File. The assigned coordinates are the North Carolina State Planes coordinates.[3] Evaluation of the accuracy of the assignment of coordinates was based on site visits of a sample of the recorded incidents. The site visits determined the correct placement of the incident and allowed for a determination of a corrected assignment of coordinates. Based on this sample coordinates can be assigned to entries with an average error of fifty-four feet from the corrected coordinates via the DIME File.

Shortcomings of the DIME File as a vehicle for assigning coordinate geo-codes to recorded public safety incidents include failure of the DIME File to cover all of the area served by the public safety network and divergence of the address

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[1]Reference to the DIME File in this study is to the Census Geographic Base File/ Dual Independent Map Encoding (GBF/DIME) Files, commonly called DIME Files. The particular DIME File used in this study is the file for the Durham, North Carolina Standard Metropolitan Area.

[2](North Carolina) Governor's Committee on Law and Order. 1974. A Master Plan for Criminal Justice Information Systems for the State of North Carolina. (North Carolina) Governor's Committee on Law and Order, Raleigh.

[3]The geographic basis of these coordinates is found in Doran, P.C., 1976 Geodetic Surveys and the North Carolina Coordinate System. Memo. Paper, May, 1961. (North Carolina) Division of Geodetic Survey, Raleigh.

range of the DIME File from the actual addresses in the street segment. Ninety-six percent of the segments had addresses different from that of the DIME File. Improvement beyond this level of accuracy will require the development of a new computer map or a reworking of the DIME File.

Uses of coordinate geo-codes was demonstrated by recreating the grid-cell system presently being used to summarize public safety incidents. A comparison of the mapping from the digitized data with a mapping made from map references of the recorded public safety incidents was made. Mapping from coordinate geo-coded data was found to be more effective than mapping from map references in three ways. First, the digitized mapping gave more accuracy than the mapping by map references. Second, the map references do not need to be entered in the records of the incidents. Third, the use of digitized data give greater flexibility for mappings which is useful in a management information system.

COORDINATE GEO-CODES VIA THE DIME FILE

Coordinates for data entries were obtained from the DIME File and an evaluation of the effectiveness of the DIME File as a vehicle for obtaining coordinates for the records was made. The address of each recorded public safety incident was matched with an address range of the DIME File to obtain North Carolina State Planes Coordinates for the entry. Applicability of the technique and accuracy of the results were emphasized in the evaluation.

The DIME File is a computerized file which combines address information with North=south/east-west coordinated information sufficient and necessary to describe the street network of Durham, North Carolina. By considering each street as a series of lines and each intersections of streets with streets, streams and jurisdiction boundaries as nodes the region covered by the file can be viewed as a series of interrelated nodes, lines and enclosed areas. For each segment of a street, i.e., the length between two nodes the file contains the following information: The identification of the "from" node and "to" node by the North Carolina State Planes Coordinates, the street type, the address range on the right side of the street and the address range on the left side of the street.[4]

Address identifications were converted to North Carolina State Planes Coordinates by matching each address from recorded public safety incidents with an address range from the DIME File, The data used in the study consisted of the major crimes for the month of July, 1975. The matches were of two types, matches with nodes were assigned the coordinates that identify the node. Matches within an address range were assigned coordinates on the basis of the distance of the entry from the nodes and whether on the right or left of the street segment.

The coordinates for an entry within an address range were calculated by two adjustments to the coordinates of the "from" node.[5] The first adjustment was to add the east-west and north-south changes in the coordinates necessary to put the entry at a point between the two nodes separating the length of the segment, in proportion to the address in the address range. The second adjustment was to add east-west and north-south changes in the coordinates necessary to place the entry 50 feet to the left or right of the segment.[6]

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[4]For additional details of the DIME File see The Uses of GBF/DIME, Census Use Study, Report No. 15, U.S. Department of Commerce.

[5]The adjustments are simplifications of trigonometric functions of right triangles. As an example the directional change in the latitudinal distance between the nodes divided by the directional change in the longitudinal distance is the tangent of the angle formed by the segment and the longitudinal axis.

[6]A computer program written in the BASIC language to compute the coordinates and the "to" node coordinates comprises Appendix A of this report.

The first adjustments to the "from" node coordinates were the change in the east-west direction between the "from" node and the "to" node multiplied by the proportion that the address of the entry is through the address range and the change in the north-south direction multiplied by the same proportion. The proportion was found for general cases by dividing the difference of the address number of the recorded incident less the address number of the "from" node, by the difference of the address number of the "to" node less the address number of the "from" node.

$$\text{proportion through range} = \frac{\text{address of entry less address number of "from" node}}{\text{address of "to" node less address of "from" node}}$$

When address ranges include nonexistent addresses, such as when the address range goes through ninety-nine, the proportion was taken to be the number of lots from the beginning node times a width of fifty feet, divided by the distance between the nodes. If the calculated proportion was greater than one, the proportion of the distance between the node was assigned the value of five-tenths. The east-west change was computed by subtracting the east-west coordinate of the "from" node from the east-west coordinate of the "to" node. The north-south change was found by subtracting the north-south coordinate of the "from" node from the north-south coordinate of the "to" node.

To put the recorded public safety incident fifty feet to the side of the segment a second north-south and east-west adjustment to the coordinates was made. The second east-west adjustment was as follows:

$$\text{second east-west adjustment} = \frac{50 \text{ feet}}{\sqrt{1 + \frac{(\text{east-west change between nodes})^2}{\text{north-south change between nodes}}}}$$

The direction of this east-west change is the same as the direction of the east-west change between the nodes if 1) the address is in the right address range of the DIME File and 2) the opposite direction of the east-west change of the address is in the left address range. The second north-south adjustment was as follows:

$$\text{second north-south adjustment} = \frac{\text{Signed east-west Change between nodes}}{\text{Signed north-south Change between nodes}} * \text{Signed second east-west adjustment}$$

To attain an acceptable level of matches of the address of the records with address ranges of the DIME File non-computer matching was done. This was necessary to overcome the "dirty data" problem. In this study the "dirty data" problem consists of variation of spelling of street names, variation in street designation such as "Road" rather than "Street," et cetera. This problem would not exist in an actual implementation in that the validity of the address would be determined at the time the incident was recorded as a record.

Other reasons for failure to match are listed below. Further analysis of the failures to match is based on these reasons and excludes the "dirty data" problem. These reasons for failure to match are: 1) The record was identified by a place rather than a street address. In this case no locational information was available on the record as reproduced from the City's data file. 2) Location of the recorded incident was outside the area covered by the DIME File. 3) The street direction was not included in the records. This was a problem for streets that have north-south or east-west ends. 4) The street named in the record is not in the DIME File. In most of these cases the address of the record is outside the area covered by the DIME File. 5) Information required to complete the match is missing from the DIME File. The most commonly missing information is the lack of coordinates of one or both nodes of the DIME File. 6) Two streets are know by the same name.

Eighty-six percent of the records were assigned coordinates via the DIME File (see Table 1 for summary of matchings). The eighty-six percent excludes the three percent of the total records for which no addresses were available. The eighty-six percent is a lower bound on the matching with good control of the records of the incidents at the time of recording.[7] To improve on this rate will require that the problems listed above be corrected.

TABLE 1

Summary of Matches of Addresses of Durham Public Safety Records With the Census DIME File

	Number of Records	Per cent of All Records	Per cent of Records with Addresses
Total number of records	602	100	-
Records with no addresses	16	3	-
Records with addresses	586	97	100
Matching with DIME	506	84	86
Failures to Match	80	13	14

[7] Control of the records at the time of recording means that the record of the incidents is checked for validity checks are in use by the Police Department in Charlotte, North Carolina.

To evaluate the accuracy of the assignment of coordinates a random sample of ten percent of the matched records was analyzed.[8] The address of each record in the sample was visited to determine the segment of the DIME File in which the address is located and the correct proportion through the segment. This was compared to the coordinates which were determined by the monitored assignment and to the coordinates as would have been assigned by the procedure above without any judgement considerations for obvious misrepresentation of the coordinates.

The site visits revealed that the address ranges of the DIME File and the actual addresses of the segment are divergent. Divergences which were found are:

1. Address range in the DIME File exceeds the actual range of addresses. Common cases are listing of the last address as 99th in the block where the actual ending address is much lower, and the listing of the beginning address as the last valid address of the previous segment.

2. Multiple blocks are included in one segment of the DIME File.

3. Erroneous address labeling of nodes that are half-blocks. The common error is to label the first segment address through 50 although the actual range for the whole block is less than 50.

Ninety-six percent of the segments had address ranges different than as indicated in the DIME File. The magnitude of this divergence was estimated to be an average of 31 addresses per segment side, i.e., 31 additional addresses in DIME File than actually on the street making up the segment.[9] The av rage error of the procedure of assigning coordinates without monitoring was 75 feet.[10] With monitoring some improvement was made. With monitoring the error was estimated to average 54 feet per point.[11] Recorded incidents matching nodes had an error of zero, which means that theerror is larger than if only the incidents with errors are considered.

In summary, the DIME File is effective in establishing the coordinates within the bounds of the coordinates of the "From" and "To" nodes. A strict programmable procedure will give an error of 75 feet. With monitoring by a well-informed person the error is cut to 54 feet. Improvement beyond this will require that the DIME File be reworked.

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[8]A random sample is part of the whole selected on the basis chance. This type of selection is the part guarantees that characteristics of the whole have equal chance of being included in the sample; a selection of a part that is representative of the whole.

[9]Based on a 95% probability the number is estimated to be twenty-nine or greater. That is the chance of being lower than 29 is less than 5 out of 100.

[10]Based on a 95% probability the error is estimated to be between 49 and 101 feet.

[11]Based on a 95% probability the error is estimated to be between 35 and 73 feet.

DEMONSTRATIONS OF REPORTS FROM COORDINATE GEO-CODES

The use of coordinate geo-codes in generating summary reports was demonstrated and the effectiveness of creating reports from coordinate geo-codes was evaluated by recreating from the geo-coded data the grid-cell system presently being used to summarize public safety incidents.[12] The present grid-cell system was mapped using the map reference letters and numbers from the records. The same grid-cell system was mapped using the geo-code locational characters. A comparison of the two mappings was made to evaluate the effectiveness of mapping by digitized coordinates.

The grid-cell system presently being used by the Durham public safety program consists of cells one-half mile by one-half mile and is coordinated with the North Carolina State Planes Coordinates. The map of grid-cells consists of twenty-one cells by seventeen cells, labelled in the north-south direction by map reference numbers one through twenty-one and in the east-west direction by the map reference letters "A" through "R" with the exclusion of "I". The specific reference to the North Carolina State Planes Coordinates is the point between map reference letters "A" and "B" and the map reference numbers nine and ten with coordinates north-south 820,000 feet and east-west 2,010,000 feet. The map of this grid-cell system is generated by adding one half-mile to this referenced point.

Mapping of the July, 1975 crime incidents using the map reference letters and numbers of the records to assign the values to the cells were made via computer in tabular and graphic displays. The graphic displays have the map of the City of Durham overlayed on the computer printout. The July 1975 crime incidents are shown in a tabular display by cells on page 9, "Major Crimes - July - Durham, North Carolina - all records," which is the same display as generated by the Durham Police Department. A graphic display by levels of crimes for the same records is shown on page 11, "Major Crimes - July - Durham, North Carolina - all records" with the legend of the levels on page 10.

To form a basis from which to evaluate the effectiveness of mapping by coordinates mappings as above were made using only records that were matched with the DIME File. The July crime incidents, which were matched with the DIME File are shown in tabular form on page 12, "Major Crimes - July - Durham, North Carolina - that matched with DIME File." A graphic display is shown on page 14 with the legend of the levels on page 13.

Mappings of the matched records from the coordinate geo-codes were made in tabular and graphic display. The July, 1975 crime incidents assigned to the cells according to the coordinates of the incidents are shown in tabular form on page 15. and graphic form on page 16, "Major Crimes - July - Durham, North Carolina - assigned to cells by coordinates." The legend to the graphic display is on page 13.

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[12] A computer program to map the recorded incidents into a grid-cell system comprises Appendix B of this report.

Mapping from the digitized data is more effective than mapping by map reference letters and numbers. This conclusion is based on the following considerations. First, the digitized mapping gave a more accurate mapping than the mapping by map reference letters and numbers. This is based on visits to the streets, spot checks of the data against maps, and comparison of the mapping with a street map over laying the grid-cell system. In both mappings the major street patterns are noticeable.

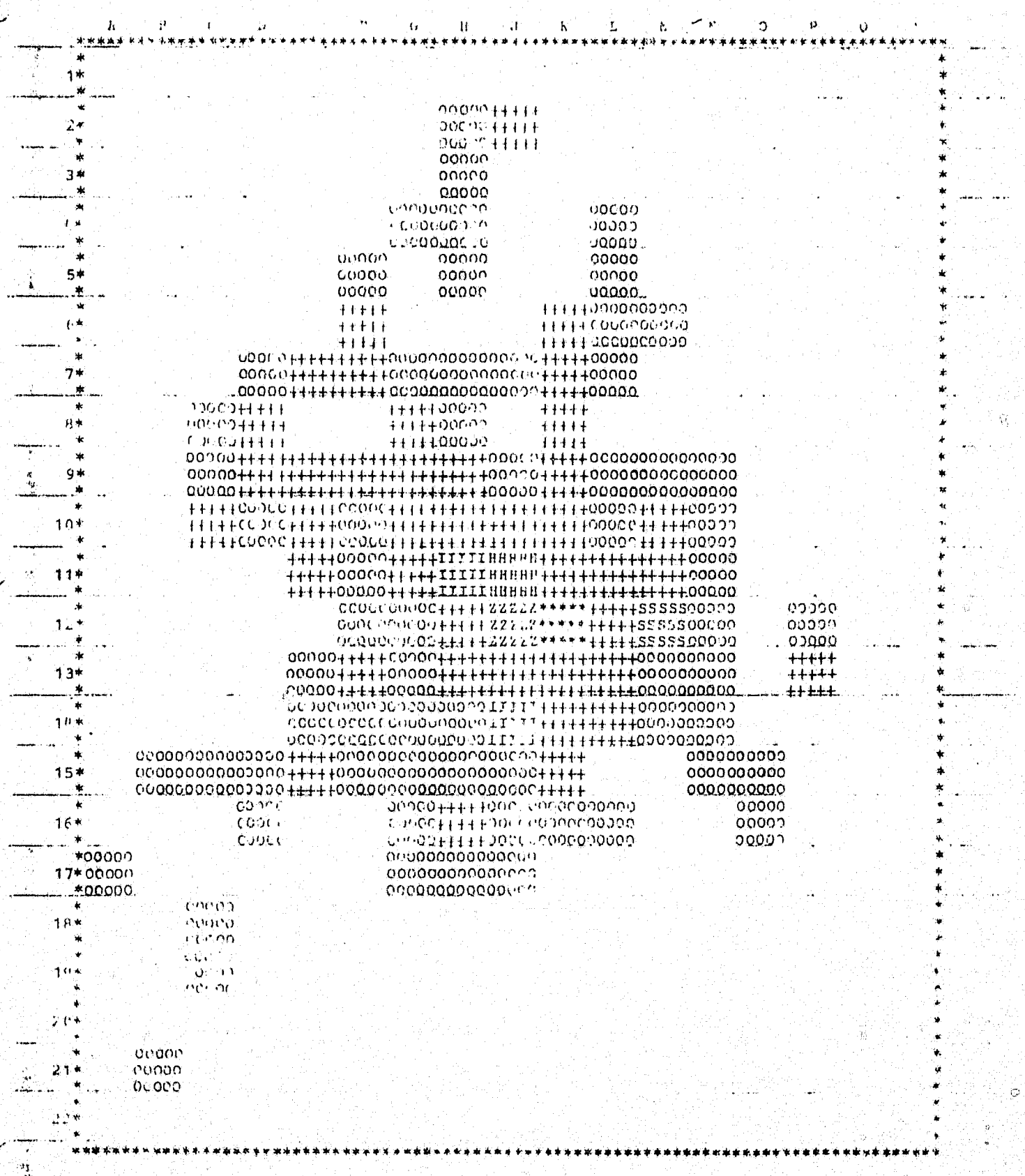
MAJOR CRIMES - JULY - DURHAM, NORTH CAROLINA - ALL RECORDS

ROW	COLUMN A	B	C	D	E	F	G	H	J	K	L	M	N	O	P	Q	R
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	1.0	0.0	0.0	0.0	3.0	2.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	1.0	0.0	2.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0	5.0	0.0	0.0	0.0	5.0	4.0	2.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	1.0	0.0	8.0	1.0	2.0	1.0	8.0	3.0	0.0	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	2.0	7.0	0.0	0.0	5.0	3.0	0.0	11.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	3.0	0.0	0.0	7.0	7.0	8.0	2.0	7.0	1.0	1.0	1.0	0.0	0.0	0.0	0.0
9	0.0	0.0	11.0	2.0	10.0	1.0	5.0	9.0	6.0	7.0	2.0	5.0	1.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	7.0	2.0	8.0	17.0	38.0	11.0	6.0	6.0	3.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0	3.0	4.0	11.0	30.0	22.0	6.0	26.0	4.0	0.0	2.0	0.0	0.0
12	0.0	0.0	0.0	0.0	2.0	3.0	3.0	12.0	12.0	14.0	6.0	3.0	2.0	0.0	3.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	2.0	1.0	3.0	15.0	11.0	5.0	2.0	1.0	0.0	0.0	0.0	0.0
14	0.0	2.0	3.0	1.0	5.0	1.0	2.0	1.0	4.0	8.0	0.0	0.0	1.0	2.0	0.0	0.0	0.0
15	0.0	0.0	2.0	2.0	0.0	0.0	2.0	13.0	3.0	2.0	2.0	0.0	0.0	1.0	0.0	0.0	0.0
16	1.0	0.0	0.0	0.0	0.0	0.0	3.0	1.0	1.0	3.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	0.0	0.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

MAJOR CRIMES - JULY - DURHAM, NORTH CAROLINA - *LEGEND*

#####	GREATER THAN OR EQUAL	45.0		
XXXXX	GREATER THAN OR EQUAL	40.0	AND LESS THAN	45.0
HHHHH	GREATER THAN OR EQUAL	35.0	AND LESS THAN	40.0
ZZZZZ	GREATER THAN OR EQUAL	30.0	AND LESS THAN	35.0
SSSSS	GREATER THAN OR EQUAL	25.0	AND LESS THAN	30.0
*****	GREATER THAN OR EQUAL	20.0	AND LESS THAN	25.0
IIIII	GREATER THAN OR EQUAL	15.0	AND LESS THAN	20.0
$$$$$	GREATER THAN OR EQUAL	10.0	AND LESS THAN	15.0
+++++	GREATER THAN OR EQUAL	5.0	AND LESS THAN	10.0
00000	GREATER THAN	0.0	AND LESS THAN	5.0

BLANK EQUALS 0.0



MAJOR CRIMES - JULY - DURHAM, NORTH CAROLINA - *THAT MATCHED WITH DIME FILE*

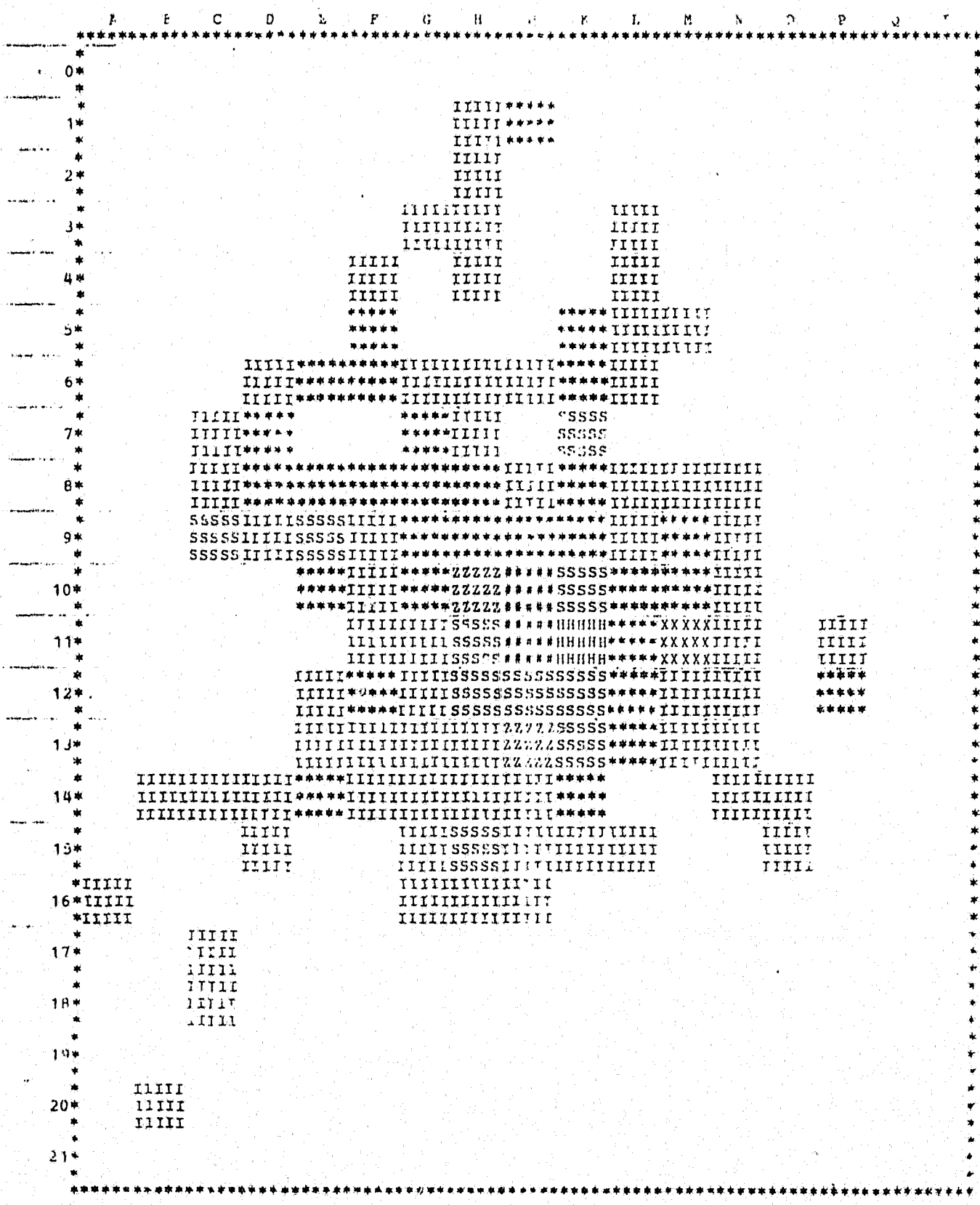
	COLUMN																
ROW	A	B	C	D	E	F	G	H	J	K	L	M	N	O	P	Q	R
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.0	9.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0	3.0	2.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	1.0	0.0	2.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0	5.0	0.0	0.0	0.0	5.0	4.0	2.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	1.0	8.0	8.0	1.0	2.0	1.0	6.0	3.0	0.0	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	2.0	7.0	0.0	0.0	5.0	3.0	0.0	11.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	3.0	8.0	5.0	7.0	7.0	8.0	2.0	7.0	1.0	1.0	1.0	0.0	0.0	0.0	0.0
9	0.0	0.0	11.0	2.0	10.0	1.0	5.0	9.0	6.0	7.0	2.0	5.0	1.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	7.0	2.0	8.0	18.0	38.0	11.0	6.0	6.0	4.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0	3.0	4.0	11.0	34.0	22.0	6.0	26.0	4.0	0.0	2.0	0.0	0.0
12	0.0	0.0	0.0	0.0	2.0	8.0	3.0	12.0	12.0	14.0	6.0	4.0	2.0	0.0	7.0	0.0	0.0
13	0.0	0.0	0.0	0.0	2.0	2.0	1.0	3.0	15.0	11.0	6.0	2.0	1.0	0.0	0.0	0.0	0.0
14	0.0	2.0	3.0	1.0	5.0	1.0	2.0	1.0	4.0	8.0	0.0	0.0	1.0	2.0	0.0	0.0	0.0
15	0.0	0.0	0.0	2.0	0.0	0.0	2.0	13.0	3.0	2.0	2.0	0.0	0.0	1.0	0.0	0.0	0.0
16	1.0	0.0	0.0	0.0	0.0	0.0	3.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	0.0	0.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

MAJOR CRIMES - JULY - DURHAM, NORTH CAROLINA - LEGEND

##### ##### #####	GREATER THAN OR EQUAL	30.0			
XXXXX XXXXX XXXXX	GREATER THAN OR EQUAL	25.0	AND LESS THAN	30.0	
HHHHH HHHHH HHHHH	GREATER THAN OR EQUAL	20.0	AND LESS THAN	25.0	
ZZZZZ ZZZZZ ZZZZZ	GREATER THAN OR EQUAL	15.0	AND LESS THAN	20.0	
SSSSS SSSSS SSSSS	GREATER THAN OR EQUAL	10.0	AND LESS THAN	15.0	
***** ***** *****	GREATER THAN OR EQUAL	5.0	AND LESS THAN	10.0	
IIIII IIIII IIIII	GREATER THAN	0.0	AND LESS THAN	5.0	

BLANK AREAS EQUALS 0.0

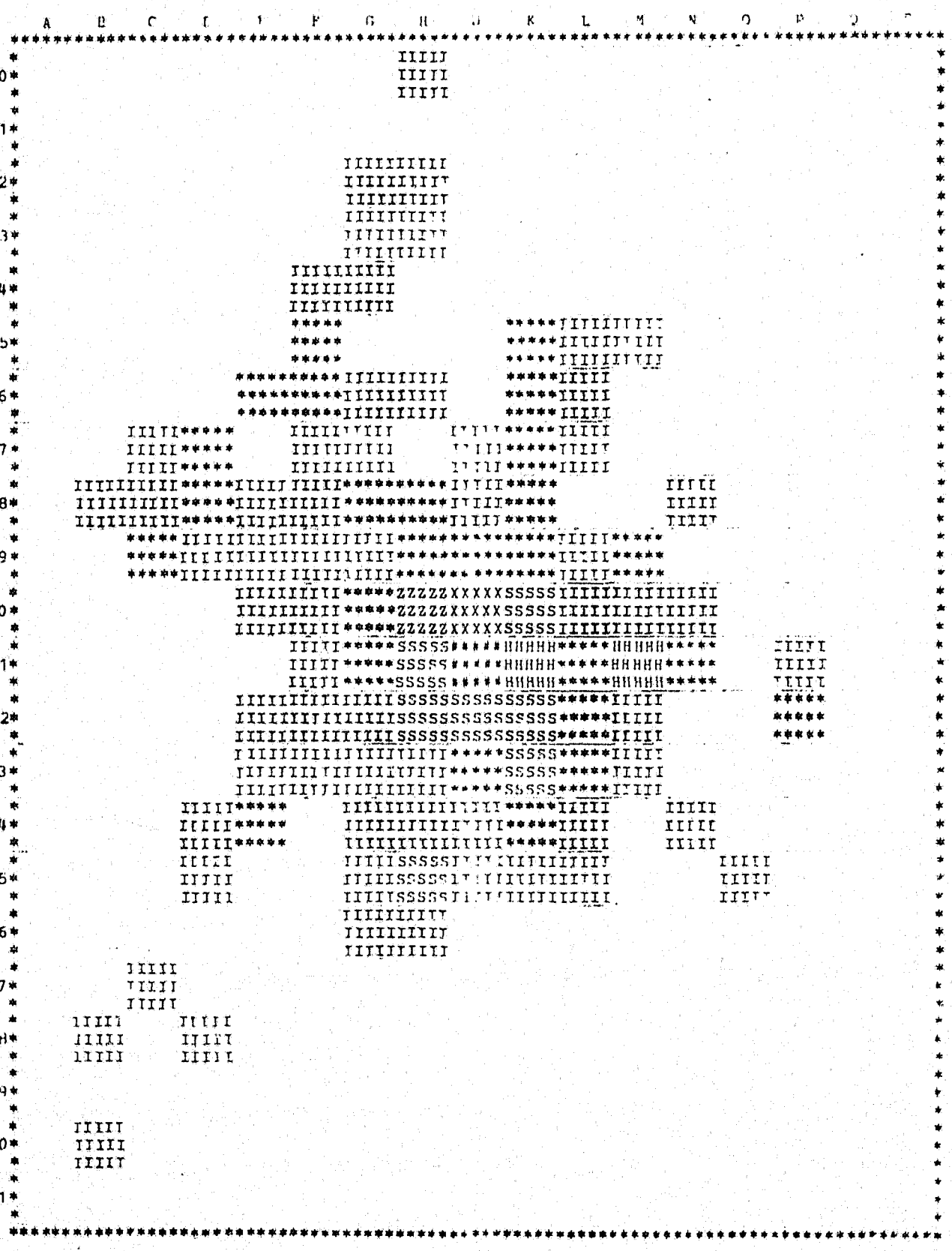
MAJOR CRIMES - JULY - DURHAM, NORTH CAROLINA - *THAT MATCHED WITH DIME FILE*



MAJOR CRIMES – JULY – DURHAM, NORTH CAROLINA – ASSIGNED TO CELLS BY COORDINATES

ROW	COLUMN A	B	C	D	E	F	G	H	J	K	L	M	N	O	P	Q	R
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0	1.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0	5.0	0.0	0.0	0.0	5.0	1.0	2.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	5.0	9.0	1.0	2.0	0.0	5.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	3.0	7.0	0.0	1.0	4.0	0.0	1.0	7.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	1.0	2.0	5.0	3.0	4.0	6.0	9.0	3.0	9.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0
9	0.0	0.0	7.0	1.0	3.0	4.0	4.0	9.0	8.0	6.0	3.0	6.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	2.0	2.0	9.0	18.0	28.0	13.0	4.0	4.0	1.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0	4.0	5.0	11.0	37.0	20.0	6.0	24.0	5.0	0.0	2.0	0.0	0.0
12	0.0	0.0	0.0	0.0	2.0	3.0	1.0	12.0	14.0	11.0	5.0	4.0	0.0	0.0	6.0	0.0	0.0
13	0.0	0.0	0.0	0.0	2.0	3.0	1.0	2.0	9.0	11.0	5.0	2.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	1.0	5.0	0.0	2.0	1.0	4.0	5.0	1.0	0.0	1.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.0	2.0	0.0	0.0	2.0	12.0	2.0	2.0	2.0	0.0	0.0	2.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0	0.0	3.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18	0.0	1.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

MAJOR CRIMES - JULY - DURHAM, NORTH CAROLINA - ASSIGNED TO CELLS BY COORDINATES



Second, the map reference letters and numbers do not need to be entered in the records of incidents. With monitoring to obtain valid addresses at the initial recording of an incident and an extended geo-coding base file, extended DIME File, coordinates can be assigned to virtually all incidents from the addresses alone. The extensions of the DIME File must include corrections of segments information in the File, addition of more nodes, and extending the File to cover the total area covered by the Durham public safety program. The primary corrections of segment information are the correction of the number of lots in the segment and the inclusion of missing information.

Third, the use of digitized data give greater flexibility for mappings that can be used in the management information system. Grid-cell systems of any size can be generated from the digitized data, whereas, only the original grid-cell system can be generated by map reference letters and numbers. With digitized data, incidents can be retrieved for rectangular areas and for areas within specific radii of any point.

APPENDIX A

A computer program written in BASIC Language to compute coordinates for the Recorded public safety incidents from the "from" node Coordinates and the "to" nodes Coordinates.

COORD

```
10  REM THIS IS THE FINAL VERSION AT 7:00 P.M. APRIL,25, 1975
20  REM THIS ONE SETS THE POINT TO THE SIDE  50 FEET.
30  REM  THIS PROGRAM IS TO CACULATE THE COORDINATES OF ENTRIES FROM
40  REM  THE POLICE FILE.  THIS CALCULATION REQUIRES INFORMATION FROM
50  REM  THE SEGMENT MATCH OF THE DIME FILE.
60  PRINT "ENTRY ADDRESS";
70  INPUT A1
80  PRINT "FROM NODE ADDRESS";
90  INPUT A2
100  PRINT "TO NODE ADDRESS";
110  INPUT A3
120  PRINT "IS THE ENTRY A LEFT OF RIGHT ADDRESS?  (L-LEFT  R-RIGHT)";
130  INPUT B$
140  PRINT "FROM X";
150  INPUT X1
160  PRINT "FROM Y";
170  INPUT Y1
180  PRINT "TO X";
190  INPUT X2
200  PRINT "TO Y";
210  INPUT Y2
220  D1=A1-A2
230  D2=A3-A2
240  P1=(D1+2)/D2
250  PRINT "CALCULATED PROPORTION",P1
260  PRINT "DOES THIS PROPORTION SEEM REASONABLE? (Y-YES  N-NO)";
270  INPUT A$
280  IF A$="Y" THEN 540
290  PRINT "WHAT IS THE AVERAGE LOT WIDTH";
300  INPUT W1
310  IF B$="R" THEN 340
320  D1=(D1/2)+1
330  GOTO 350
340  D1=D1/2
350  PRINT "THE NUMBER OF LOTS FROM THE 'FROM' NODE IS",D1
360  PRINT "IS THIS NUMBER REASONABLE? (Y-YES  N-NO)";
370  INPUT A$
380  IF A$="Y" THEN 410
390  PRINT "WHAT IS THE NUMBER OF LOTS FROM THE 'FROM' NODE";
400  INPUT D1
410  L1=D1*W1
420  REM  CALCULATE THE LENGTH OF THE SEGMENT
430  PRINT "CHANGE IN X",(X2-X1),"CHANGE IN Y",(Y2-Y1)
440  S1=(Y2-Y1)↑2+(X2-X1)↑2
450  L2=SQR(S1)
460  PRINT "LENGTH OF THE SEGMENT",L2
470  P1=L1/L2
480  PRINT "THE PROPORTION BASED ON LOT SIZE IS ",P1
490  IF P1>1 THEN 510
500  GOTO 540
510  PRINT "THE PROPORTION OF THE DISTANCE THROUGH THE ADDRESS RANGE"
520  PRINT "IS SET TO 0.5"
530  P1=.5
```

```
540  PRINT
550  PRINT "IS THIS PROPORTION ACCEPTABLE?  (Y-YES  N-NO)";
560  INPUT A$
570  IF A$="Y" THEN 610
580  PRINT "WHAT IS A REASONABLE PROPORTION";
590  INPUT P1
600  PRINT "CHANGES IN THE COORDINATES X";P1*(X2-X1);"Y";P1*(Y2-Y1)
610  X3=X1+P1*(X2-X1)
620  Y3=Y1+P1*(Y2-Y1)
630  PRINT "COORDINATED OF POINT ALONG THE SEGMENT"
640  PRINT "X      ";X3;"      Y      ";Y3
650  REM SECOND CHANGES IN THE COORDINATES
660  Z0=(X2-X1)/(Y2-Y1)
670  PRINT "CHANGE IN X DIVIDED BY THE CHANGE IN Y IS ";Z0
680  Z1=1+Z0↑2
690  Z2=SQR(Z1)
700  Z3=50/Z2
710  IF Z0>0 THEN 770
720  IF (X2-X1)>0 THEN 750
730  IF B$="L" THEN 820
740  GOTO 890
750  IF B$="L" THEN 890
760  GOTO 820
770  IF (X2-X1)>0 THEN 800
780  IF B$="L" THEN 830
790  GOTO 820
800  IF B$="L" THEN 820
810  GOTO 890
820  PRINT "ADDITION TO X IS";-Z3
830  X4=Z0*Z3
840  X4=X3-Z3
850  W1=Z0*Z3
860  PRINT "ADDITION TO Y IS ";W1
870  Y4=Y3+W1
880  GOTO 940
890  PRINT "ADDITION OF X IS";Z3
900  X4=X3+Z3
910  W1=Z0*Z3
920  PRINT "ADDITION TO Y IS";-W1
930  Y4=Y3-W1
940  PRINT "COORDINTES OF THE ENTRY"
950  PRINT "X      ";X4;"      Y      ";Y4
960  PRINT "ARE MORE COORDINATES TO BE CALCULATED?  (Y-YES  N-NO)";
970  INPUT A$
980  IF A$="N" THEN 1010
990  PRINT
1000  GOTO 60
1010  END
```

APPENDIX B

A Computer Program to Map Coordinate Geo-coded Data into a Grid-cell System Written in FORTRAN language.

```
C      THIS PROGRAM IS DESIGNED TO PLOT ISO-CLINES FOR REAL VARIABLES.  IT
C IS SET UP FOR THE  GRID-CELL SYSTEM PRESENTLY BEING USED FOR REPORTING
C AND MANAGEMENT OF POLICE ACTIONS WITHIN THE CITY OF DURHAM, N. C.  THIS
C PROGRAM PROCESSES THE DATA TO MATCH THE CELLS VIA THE MAP REFERENCE.
C THIS PROGRAM WILL TAKE UP TO 14 GROUPS OR ISO-CLASSES OF WHICH ONE IS
C FOR THE VALUE ZERO, ANOTHER IS FOR THE VALUES GREATER THAN ZERO AND LESS
C THAN THE SMALLEST INTERVAL DESIGNATION, AND ONE IS FOR VALUES GREATER
C THAN THE LARGEST INTERVAL DISIGNATION.
C
C      THE ISO-VARIABLE NAME COMPOSES THE FIRST DATA CARD.  THE ISO-VARIABLE IS
C LOCATED IN COLUMNS 1 THROUGH 80 AND IS PRINTED AS IT APPEARS ON THE CARD.
C THE SECOND DATA CARD CONTAINS THE INTERVAL DESIGNATIONS.  THE SECOND DATA
C CARD FOLLOWS THE FOLLOWING LAY-OUT WITH ALL VALUES BEING RIGHT ADJUSTED:
C
C      NUMBER OF INTERVAL DIVISIONS NOT TO EXCEED 12          COLUMNS  1-5
C
C      VALUE OF HIGHEST INTERVAL DIVISION                     COLUMNS  6-11
C
C      VALUES OF SECOND HIGHEST INTERVAL DIVISION             COLUMNS 12-17
C
C      VALUES OF THIRD HIGHEST INTERVAL DIVISION              COLUMNS 18-23
C
C      VALUE OF FOURTH HIGHEST INTERVAL DIVISION              COLUMNS 24-29
C
C          *    *    *                                          *  *  *
C
C          *    *    *                                          *  *  *
C
C          *    *    *                                          *  *  *
C
C     VALUE OF SMALLEST INTERVAL DIVISION                     COLUMNS 72-77
C
C
C
C
C LIST OF VARIABLES:
C
```

```
C XJJ(I), I=1,14        THE ISO-CLASS VARIABLE USED FOR STORTING OF CHARACTORS
C                       USED TO DISIGNATE ISO-CLASSES.
C
C XJ(I), I=1,17         THE ISO-CLASS VARIABLES USED FOR PRINTING THE ISO-CLASSES.
C
C GISO(I,J), I=1,22     THE CELL VALUE OF THE QUANTITY TO BE PLOTED FOR ROW I AND
C              J=1,17   COLUMN J.
C
C X(I), I=1,12          THE INTERVAL DIVISIONS.
C
C MG                    THE NUMBER OF DIVISIONS TO BE USED.
C
      DIMENSION X(12), GISO(22,17)
      REAL*4 TI(20)
      REAL*8 XJJ(14)
      REAL*8 XJ(17)
      REAL*8 MAPA
      REAL*8 XMAP(17)
      REAL*8 STNOS,STDIR,STNA(3),STNAS,MAPL
      INTEGER OFF1,OFF2,OFF3,STNO,DAY,YEAR,HOUR,OFFIC,DIST,TEAM
      DATA XJJ /'######','XXXXXX','HHHHHH','ZZZZZ','SSSSS','*****','IIIII',
     1 '$$$$$$','++++++','OOOOOO','======','------','......','      '/
      DATA XMAP /'A','B','C','D','E','F','G','H','J','K','L','M','N','O'
     1,'P','Q','R'/
      READ(1,101) (TI(I),I=1,20)
  101 FORMAT(20A4)
      READ(1,253)MG, (X(I),I=1,12)
  253 FORMAT(I5,12F6.0)
      DO 274 I=1,22
      DO 274 J=1,17
  274 GISO(I,J)=0.0
C
C     THE FOLLOWING SECTION READS IN INDIVIDUAL REPORTS AND ACCUMULATES
C THE VALUES FOR EACH CELL.
C
C     THIS VARIABLE MAY BE READ DIRECTLY AS GISO(I,J) OR THE VALUE FOR EACH
C CELL MAY BE COMPUTED FOLLOWING THIS STATEMENT.
```

```
C
C THIS PROGRAM WILL PROCESS INDIVIDUAL RECORDS TO ACCUMULATE HISTORY OF THE
C MONTH AND TO ACCUMULATE TO CELL VALUES.
C
  889 CONTINUE
      MAPC = 0
C
C * * *
C
C READ POLICE DATA
C
C * * *
C
C LIST OF VARIABLES -- MACHINE NAME, DISCRIPTION, AND LOCATION ON POLICE RECORD
C
C
C   MACHINE          DISCPRIPTION                                LOCATION
C   NAME                                                         IN RECORD
C
C   OFF1     * * *  OFFENSE CODE - MAJOR CLASSIFICATION          1  -  2
C
C   OFF2     * * *  OFFENSE CODE - CAT.  IN CLASS               3
C
C   OFF3     * * *  OFFENSE CODE - MINOR CAT.                   4
C
C   STNO     * * *  STREET NUMBER                               5  -  8
C
C   STNOS    * * *  STREET NUMBER SUFFIX                       9
C
C   STDIR    * * *  STREET DIRECTION                          10
C
C   STNA(I)  * * *  STREET NAME PART I (I = 1-3)               11  - 28
C
C   STNAS    * * *  STREET NAME SUFFIX                        29  - 32
C
C   MONTH    * * *  MONTH OF REPORTED INCIDENT                 33  - 34
C
```

```
C   DAY      * * *  DAY OF REPORTED INCIDENT                35  - 36
C
C   YEAR     * * *  YEAR OF REPORTED INCIDENT               37  - 38
C
C   HOUR     * * *  HOUR OF REPORTED INCIDENT               39  - 40
C
C   MIN      * * *  MINUTE OF REPORTED INCIDENT             41  - 42
C
C   OFFIC    * * *  OFFICER MAKING REPORT                   43  - 46
C
C   MAPL     * * *  MAP REFERENCE LETTER                    47
C
C   MAPN     * * *  MAP REFERENCE NUMBER                    48  - 49
C
C   DIST     * * *  POLICE DISTRICT                         50  - 51
C
C   TEAM     * * *  POLICE TEAM                             52  - 53
C
C
C
      READ(1,100) OFF1,OFF2,OFF3,STNO,STNOS,STDIR,STNA(1),STNA(2),
     1    STNA(3),STNAS,MONTH,DAY,YEAR,HOUR,MIN,OFFIC,MAPL,MAPN,DIST,
     2    TEAM,XCOOR,YCOOR
  100 FORMAT(I2,I1,I1,I4,2A1,2A8,A2,A4,5I2,I4,A1,3I2,6X,F7.0,3X,F6.0)
      IF(OFF1 .EQ. 0) GO TO 900
      IF (XCOOR .LT. 0 01) GO TO 889
C
C  CONVERT COORDINATES TO MAP REFERENCE AND CELLS OF THE GRID
C
      DIM=2640.0
      DO 299 K=1,17
      XLIM=2007360.0 + K*DIM
      IF(XCOOR .LT. XLIM) MAPC = K
      IF(XCOOR .LT. XLIM) GO TO 298
  299 CONTINUE
      WRITE(3,903)
      GO TO 889
```

```
C READ ANOTHER CARD
  298 CONTINUE
      DO 300 I=1,22
      YLIM=846400 - I*DIM
      IF(YCOOR .GT. YLIM) MAPR=I
      IF(YCOOR .GT. YLIM) GO TO 902
  300 CONTINUE
      WRITE(3,903)
      GO TO 889
  903 FORMAT(1H ,'A CARD FAILED TO MATCH')
  902 GISO(MAPR,MAPC) = GISO(MAPR,MAPC) + 1
      WRITE(3,99999)XCOOR,YCOOR,MAPR,MAPC
99999 FORMAT(1H ,2F15.2,2I10)
      GO TO 889
  900 CONTINUE
C
C TABLE VALUES FOR CELLS IN THE REPORTING AREA
C
      WRITE(3,239)
      DO 301 I=1,5
  301 WRITE(3,260)
      WRITE(3,254) (TI(I),I= 20)
  254 FORMAT(1H ,1X,20A4)
      WRITE(3,261)
  261 FORMAT(1H0,9X,'+',53X,'COLUMN')
      WRITE(3,262)
  262 FORMAT(1H ,4X,'ROW',2X,'+',4X,'A',5X,'B',5X,'C',5X,'D',5X,'E',5X,'
     1F',5X,'G',5X,'H',5X,'J',5X,'K',5X,'L',5X,'M',5X,'N',5X,'O',5X,'P',
     25X,'Q',5X,'R')
      WRITE(3,263)
  263 FORMAT(2X,'++++++++++++++++++++++++++++++++++++++++++++++++++++++++
     1+++++++++++++++++++++++++++++++++++++++++++++++++++')
      KP=0
      DO 264 N=1,22
      K=N-1
      KP=KP+1
C
```

```
C KP IS A SPACING CONTROL TO CAUSE LINES TO BE PRINTED IN GROUPS OF FIVE
C
      WRITE(3,267) K, (GISO(N,J), J=1,17)
  267 FORMAT(1H ,I7,2X,'+',17F6.1)
      IF(KP .NE. 5) GO TO 264
      KP=0
      WRITE(3,266)
  266 FORMAT(1H ,9X,'+')
  264 CONTINUE
C
C LEGEND OF MAP
C
      WRITE(3,239)
  239 FORMAT(1H1)
      WRITE(3,201) (TI(I), I=1,20)
  201 FORMAT(1H ,20A4)
  290 FORMAT(1H0,5X,A5)
      WRITE(3,290) XJJ(1)
      WRITE(3,293) XJJ(1),X(1)
  293 FORMAT(1H ,5X,A5,5X,23H GREATER THAN OR EQUAL ,F7.1)
      WRITE(3,291) XJJ(1)
      DO 288 M=2,MG
      WRITE(3,290) XJJ(M)
      WRITE(3,289) XJJ(M), X(M), X(M-1)
  289 FORMAT(1H ,5X,A5,5X,23H GREATER THAN OR EQUAL ,F7.1,16H  AND LESS
     1THAN ,F7.1)
      WRITE(3,291) XJJ(M)
  291 FORMAT(1H ,5X,A5)
  288 CONTINUE
      WRITE(3,290) XJJ(MG+1)
      WRITE(3,292) XJJ(MG+1), X(MG)
  292 FORMAT(1H ,5X,A5,5X,36H GREATER THAN     0.0  AND LESS THAN ,F7.1)
      WRITE(3,291) XJJ(MG+1)
      WRITE (3,294)
  294 FORMAT(1H0,4X,24H BLANK AREAS EQUALS 0.0 )
C
C PLOT THE CITY OF DURHAM
```

```
C
      WRITE (3,239)
      WRITE(3,202) (TI(I),I=1,20)
  202 FORMAT(1H ,10X,20A4)
      DO 259 I=1,5
  259 WRITE(3,260)
  260 FORMAT(1H )
      WRITE(3,206)
  206 FORMAT(1H ,12X,'A',4X,'B',4X,'C',4X,'D',4X,'E',4X,'F',4X,'G',4X,'H
     1',4X,'J',4X,'K',4X,'L',4X,'M',4X,'N',4X,'O',4X,'P',4X,'Q',4X,'R')
      WRITE(3,204)
  204 FORMAT(1H ,9X,'*************************************************************
     1*************************************')
      DO 255 K=1,22
      DO 250 J=1,17
      IF (GISO(K,J) .GE. X(1)) XJ(J) = XJJ(1)
      IF (GISO(K,J) .GE. X(1)) GO TO 250
      DO 251 M=2,MG
      IF(GISO(K,J) .GE. X(M) .AND. GISO(K,J) .LT. X(M-1)) XJ(J) = XJJ(M)
      IF(GISO(K,J) .GE. X(M)) GO TO 250
  251 CONTINUE
      IF(GISO(K,J) .LE. 0.0) XJ(J) = XJJ(14)
      IF(GISO(K,J) .LE. 0.0) GO TO 250
      XJ(J) = XJJ(MG+1)
  250 CONTINUE
      DO 257 N=1,3
      WRITE(3,256) (XJ(J), J=1,17)
      IF(N .NE. 2) GO TO 257
      M=K-1
      WRITE(3,205) M
  205 FORMAT(1H+,7X,I2)
  257 WRITE(3,203)
  203 FORMAT(1H+,9X,'*',85X,'*')
  256 FORMAT(1H ,10X,17A5)
  255 CONTINUE
      WRITE(3,204)
      STOP
      END
```

END