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JPL SP 43-33

LUMIS

LAND USE MANAGEMENT AND INFORMATION SYSTEMS

COORDINATE ORIENTED PROGRAM DOCUMENTATION

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California 91103

Prepared for
Office of Technology Utilization
and
Office of Applications
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

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16. Abstract

The LUMIS program has designed an integrated geographic information system to assist program managers and planning groups in metropolitan regions. Described is the series of computer software programs and procedures involved in data base construction using the census DIME file and point-in-polygon architectures.

The system is described in two parts: (1) instructions to operators with regard to digitizing and editing procedures, and (2) application of the four data base construction algorithms: ROTATE (to achieve map registration), CHAIN (to assure the topological integrity of polygon files), DACS (DIME AREA CENTROID SYSTEM alternative to CHAIN), and PIOS (the polygon intersection overlay system for tabulating land use acreages within administrative districts).

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PREFACE

This work was sponsored by the Office of Technology Utilization of the National Aeronautics and Space Administration through Contract No. NAS 7-100.

This document is one of two principal systems specifications documents to be generated by the LUMIS program. While this document addresses the problem of software and procedures involved in data base construction using the census DIME file and point-in-polygon architectures, the other[1] presents the problem of data base interrogation.

[1] Bryant, N.A., Yu, T.C., and Landini, A.J., LUMIS Interactive Graphics Operating Instructions and System Specifications, SP 43-31. Jet Propulsion Laboratory, Pasadena, California, August 15, 1976.

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ABSTRACT

The LUMIS program has designed an integrated geographic information system to assist program managers and planning groups in metropolitan regions. Described is the series of computer software programs and procedures involved in data base construction using the census DIME file and point-in-polygon architectures.

The system is described in two parts: (1) instructions to operators with regard to digitizing and editing procedures, and (2) application of the four data base construction algorithms: ROTATE (to achieve map registration), CHAIN (to assure the topological integrity of polygon files), DACS (DIME AREA CENTROID SYSTEM alternative to CHAIN), and PIOS (the polygon intersection overlay system for tabulating land use acreages within administrative districts).

LUMIS

LAND USE MANAGEMENT INFORMATION SYSTEM

Coordinate Oriented Program Documentation

1.0 INTRODUCTION

1.1 The System

The LUMIS project considers two distinct data types identified as nominal and ordinal. Nominal data refers to that information which is geographically located using a political addressing system such as the individual house and street address. Ordinal data is data geographically referenced using a classical X and Y coordinate system such as latitude and longitude. To reconcile nominal and ordinal data the LUMIS provides users with a set of Census Bureau related procedures that aggregate street addressed data to politically defined geographical zones. Those nominally labeled zones are then ordinally identified through the process of digitization with X and Y coordinates describing their perimeter.

1.2 The Process

Once the coordinate files have been produced for both the nominal and ordinal polygons the LUMIS allows for the comparison of associated data bases. Before this comparison takes place LUMIS first requires that the raw digitized coordinates be converted to state plane coordinates and that they be subjected to a graphic edit.

The graphic edit allows for the correction of a variety of syntax errors possible in the digitizing procedures. After those errors have been corrected the coordinate files are then passed to the CHAIN and ROTATE programs.

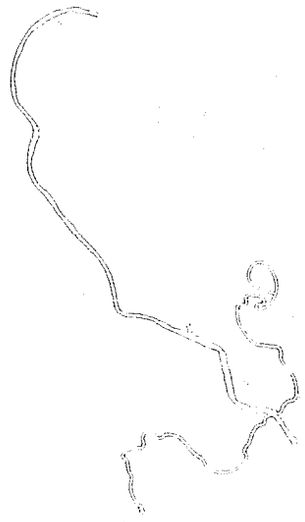
ROTATE produces a geographically true X and Y coordinate file from raw digitized or converted coordinate data referenced to any standard map system. That is done to transform coordinates oriented to a digitizing table to coordinates oriented to true ground position. In accomplishing that ROTATE considers both scale and rotation factors.

CHAIN incorporates procedures to link line segments by coordinate locations around unique political or nominally labeled polygons. Those procedures produce multiple records for polygons in which a boundary line has to be used twice, for example, once for each block found on either side of a street.

Where Census Bureau defined nominal polygons are used such as census tract or census block, it is not necessary to create a unique file of X and Y coordinates through the digitizing procedure to define their perimeters. A set of such coordinates have already been prepared by the Census Bureau through their DIME file creation efforts and those coordinates can be modified for use with LUMIS through the DACS program.

Once the nominal polygon coordinate file and ordinal polygon coordinate file have been completed, the comparison of data associated with each polygon type can take place through the map-like overlay of computer processing. This overlaying of nominal and ordinal polygons takes place in the PIOS program. The output from that effort represents the final LUMIS data product and is used as input to the LUMIS interactive graphics system, proprietary data base management systems, or the installation unique information management systems.

Figure 1 is a flow chart that illustrates the relationships between the various LUMIS coordinate oriented programs and procedures. That same figure also provides a reference to the various sections found in this Report.



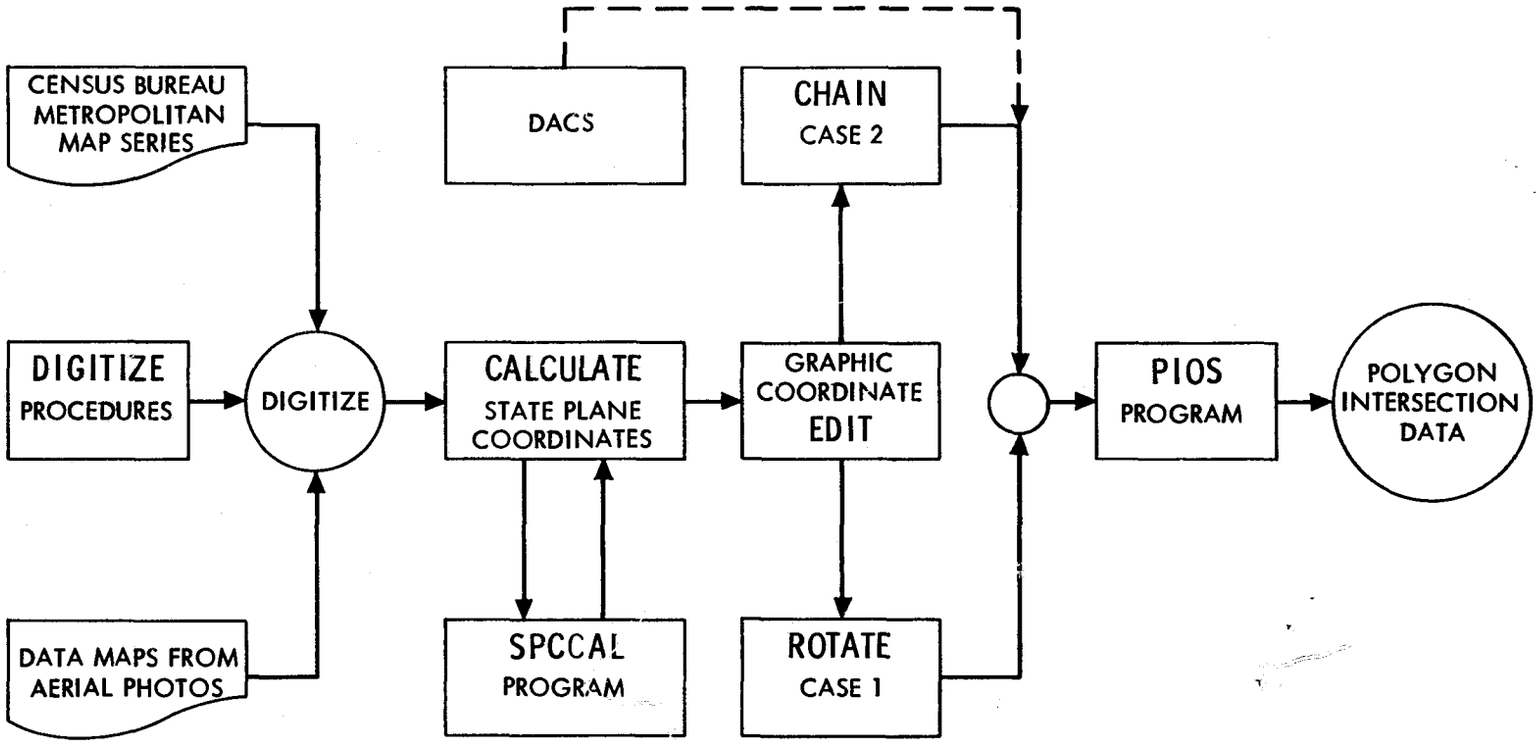


Figure 1. LUMIS Land Use Management Information System – Organization of Coordinate Oriented Program Documentation

2.0 DIGITIZING PROCEDURES

2.1 Introduction

Digitizing is the mechanical process by which X and Y coordinates are determined that ordinally describe the outline or perimeter of any mapped polygon. In that process a piece of equipment referred to as a digitizer is used. That machine is similar in appearance and operation to a traditional drafting machine, and consists of a table and cursor.

There are numerous sets of digitizing procedures and techniques available. Their use depends on the equipment employed, the software being used, and the types of uses the coordinates are later subjected to. After reviewing these available procedures and techniques LUMIS evolved its own unique set of digitizing procedures, and they fell into two case types.

The first case type dealt with digitizing ordinal polygons and is always used with mapped and aerial photo data. The second type is for use with nominal polygons and was designed to be used only when Census Bureau DIME coordinate files were not available or nominal polygons other than those defined by the Census Bureau were to be used.

2.2 Case 1: General Map Case

In preparing the data maps from interpreted aerial photos the cartographer has to insure that the numbers identifying unique polygons are consecutive, i.e. (POLYNO = 1, 2, 3, 4....N). A doughnut polygon or polygon with smaller polygons within it has to be digitized with the inside polygon following the mother polygon. Thus in addition to each polygon being given a sequence number, beginning with one, it is also given a PTYPE or polygon type classification number. All mother polygons are given PTYPE numbers of 10 regardless of their POLYNO or sequence number. All mutually exclusive interior or doughnut polygons are given PTYPE numbers of 11, with inclusive interior polygons being given increasing sequential type numbers. The most interior polygon will always have the highest PTYPE number.

After completing interpretation mapping and polygon identification numbering the map is set up on the digitizer table at any orientation, and

taped down. The digitizer and keypunch are then turned on. The map setup record is established with KSET equal to 1 or other successive numbers depending on the number of map setups for a run. This is recorded on cards or tapes depending on the digitizer being used. Then the map tolerance record is created as indicated in Figure 2 and explained in the text.

2.2.1 Map tolerance record establishes the limits in calibration of the digitized coordinate reference points and the overall perimeter of the polygon to follow.

NPOLY – Total number of polygons for a map setup.

M – Number of control points provided as calculated and digitized reference records.

X0TOL, Y0TOL, and THETOL are user specified tolerance levels in the solution of a digitized origin (X0, Y0 in inches) and the rotation angle (θ - in minutes of arc) between digitized map and accepted reference source.

Sometimes NPOLY is not known until the digitizing is finished for a given setup. Thus the NPOLY value may at times be entered after the digitization is complete. The number of control points (M) is entered for the map, followed by the tolerance levels for the digitizer origin and the rotation angle solutions (X0TOL, Y0TOL, THETOL).

The California State Plane Coordinates (SPC) records follow. Those records contain the SPC's of the M control points, and are computed at a later time according to the procedures outlined for calculating the state plane coordinates.

Control points are selected in the four corner areas as much as possible to avoid problems later in the ROTATE program's least square analysis.

The coordinates of the M control points are digitized in the same order as the SPC coordinates are to be calculated.

Control point cards (digitized reference records) are created by moving the digitizing cursor to each of the map control points, in the proper order, and then pressing the digitizer register button.

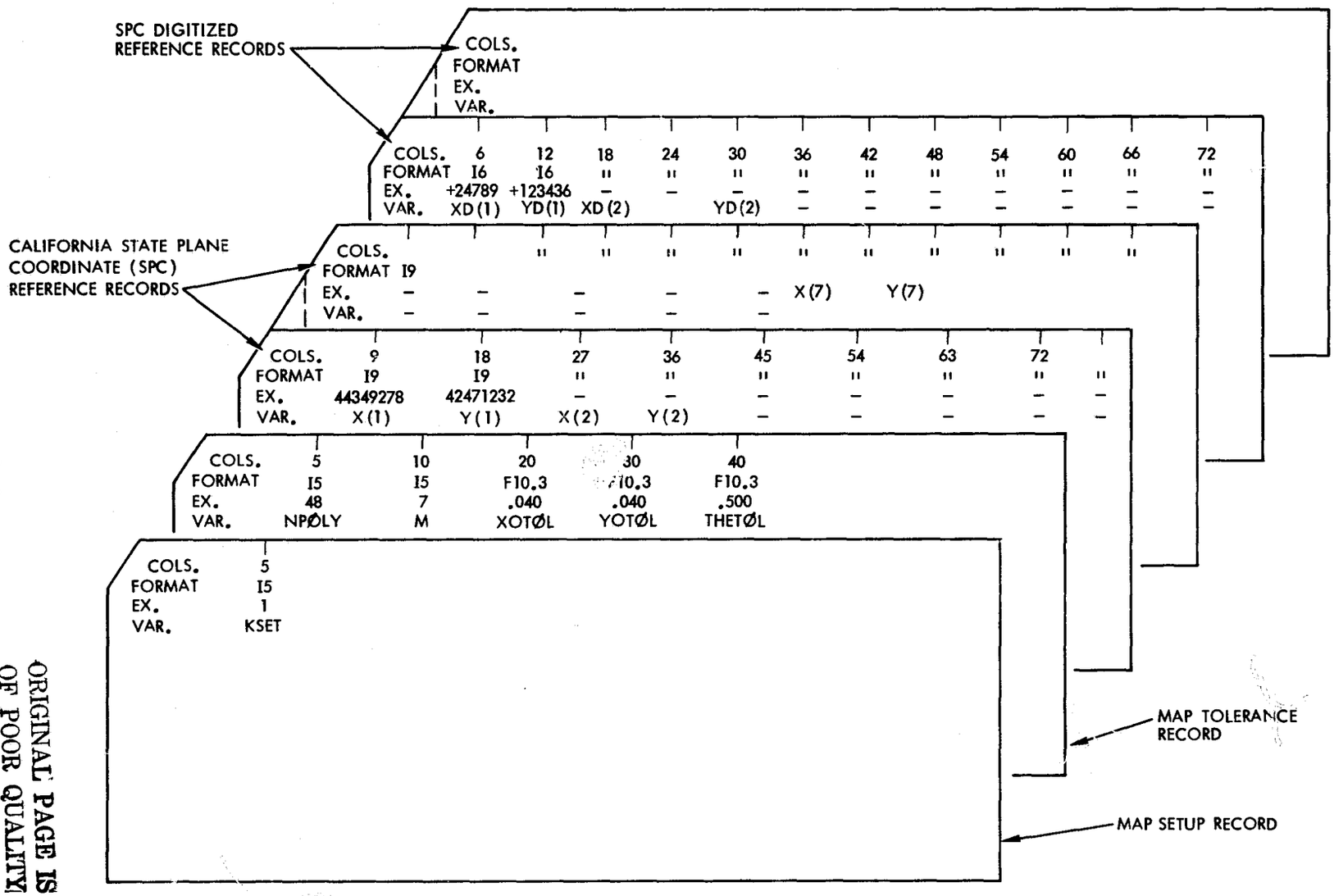


Figure 2. Raw Digitized Map File Control Card Layout for Map Cases 1 and 2

2.2.2 Control reference points are calculated from an existing reference source by the user. They are given in tenths of a foot without a decimal point. In this case the control points are in California Zone 7 State Plane Coordinates, but any legitimate earth coordinate system is acceptable. One through M coordinates are coded with four or less pairs per card.

Digitized reference points are entered in the same order as the control reference points in thousands of an inch, without the decimal point. One through M coordinates are coded with six or less pairs per card.

Digitization of the map polygons is then performed. (See Figure 3.) For each polygon of the map setup which corresponds to the initial setup cards of Figure 2, a polygon designation record is created using the keypunch machine directly. A polygon limit record is then created.

A polygon description record, polygon limit record, and polygon boundary record are required for each polygon digitized (NPOLY) in a map setup (KSET).

2.2.3 Polygon description record contains control information for each polygon:

MAPNO: Map number for the digitized polygon.

MAPOL: Total number of polygons on a map. This could, but does not necessarily equal NPOLY (number of polygons in a map setup).

LUCODE: Identifying information code.

POLYNO: Sequence number of polygon, 1 to MAPOL.

PTYPE: Designates doughnut polygons, or polygons within polygons; normal polygons are digitized number 10. Numbers larger than 10 indicate succeeding doughnut polygons.

2.2.4 Polygon limit record. One limit record is required for each polygon.

XMIN, YMIN, XMAX, YMAX: The minimum X, minimum Y, maximum X, and maximum Y digitized coordinates, respectively, of the polygon.

NP: Total number of digitized coordinates in a polygon.

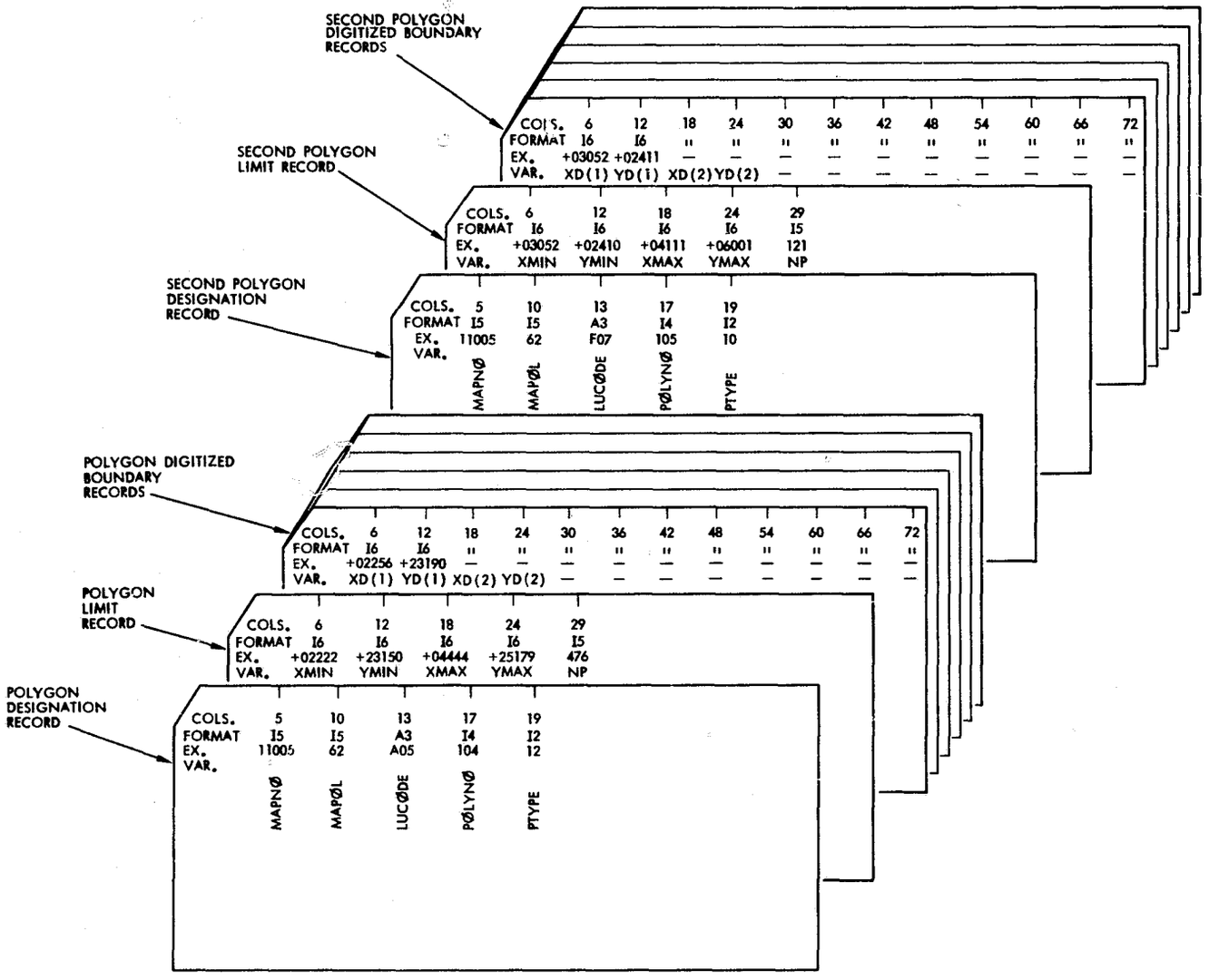


Figure 3. Raw Digitized Map File Layout Resulting from Digitizing Map Case 1

To create the polygon limit record, the digitizing cursor is set just outside of the left-most border of the polygon to be digitized. The section "left-most" implies the smallest X coordinate as defined by the digitizer table. Only this minimum X coordinate is digitized and not the Y. It must be insured that this XMIN is less than any X coordinate contained on the polygon boundary.

Next the cursor is placed on the digitizer table just below the lowest polygon point. Just the Y coordinate was digitized as YMIN.

Then the cursor is placed just to the right of the right-most polygon point and the X coordinate digitized as XMAX and finally the cursor is placed above the highest polygon point and the Y coordinate digitized as YMAX. If the digitizing cursor has no provision for entering only one component of a pair, it would be a simple matter to read the coordinate from the digital read out on the console and then enter it by hand on the terminal or keypunch.

It should be noted that the output polygon limit record contains the SPC minima and maxima, not the transformed digitized minima and maxima (if the rotation angle is large enough, the two sets of minima and maxima may be the same).

The number of points (NP) for the polygon is taken from the map (if properly prepared) or by counting the number of polygon digitized boundary records when finished. If this number is N, it is multiplied as 6 by (N-1) and this product added to the number of pairs of coordinates on the list record to obtain NP. The suggested alternative is for the photo interpreter who creates the map to indicate the digitization points at a density sufficient to adequately reflect line curvature. In so doing, he could indicate the point count before digitization commenced.

Finally, the polygon digitized boundary records are created either by running the cursor counterclockwise around the polygon boundary and digitizing at the preselected points, or at the operators' discretion. The polygon is closed by digitizing the first point again at the finish.

2.2.5 Polygon digitized boundary records. One set of digitized coordinates is required for each polygon.

XD(1), YD(1), ---XD(NP), YD(NP): Digitized coordinates of polygon.

2.3 Case 2: MMS Map Case

In digitizing maps of the Case 2 type users largely follow Case 1 procedures. Generally only four (4) control points are used for the MMS maps (M=4) since these maps were compiled on the State Plane Coordinate base and hence a more accurate transformation from digitizer coordinates to SPC's can be effected than with other map projections.

The control points are located and their State Plane Coordinates determined by finding the SPC tic marks on the base map's margins, and connecting the similar tics with a straight edge and hard lead (4H) pencil. Then the four intersection points are digitized and the SPC's read off the map margins. If there is an insufficient number of SPC tic marks on the map base, users should select a point in each of the four corners that can be easily identified on a USGS quad, and the SPC's identified according to the method described for calculating the State Plane Coordinates.

Digitization of the street segments is then performed, in any arbitrary order and direction. See Figure 4. All street segments are digitized for each tract, and each tract is a unit unto iself, i.e., each tract contains the header records of Figure 2 (except the map setup records, which in this case indicate the number of tracts which are to be processed). Thus each tract has a map tolerance record where NPOLY is the number of street segments in the tract. The SPC reference and SPC digitized reference records follow for each census tract, even though those records may have been precisely the same for several tracts on the same MMS map.

Blocks are digitized as units in a tract, therefore geographic reference control points must be established per each tract. Each map contains one or more tracts. A map tolerance record, control reference record and digitized reference record are also required.

2.3.1 A map tolerance record establishes the limits in calibration of the digitized coordinate reference points and the overall perimeter of the polygon to follow.

NPOLY — Total number of blocks in a tract.

M — Number of control points provided as calculated and digitized reference records.

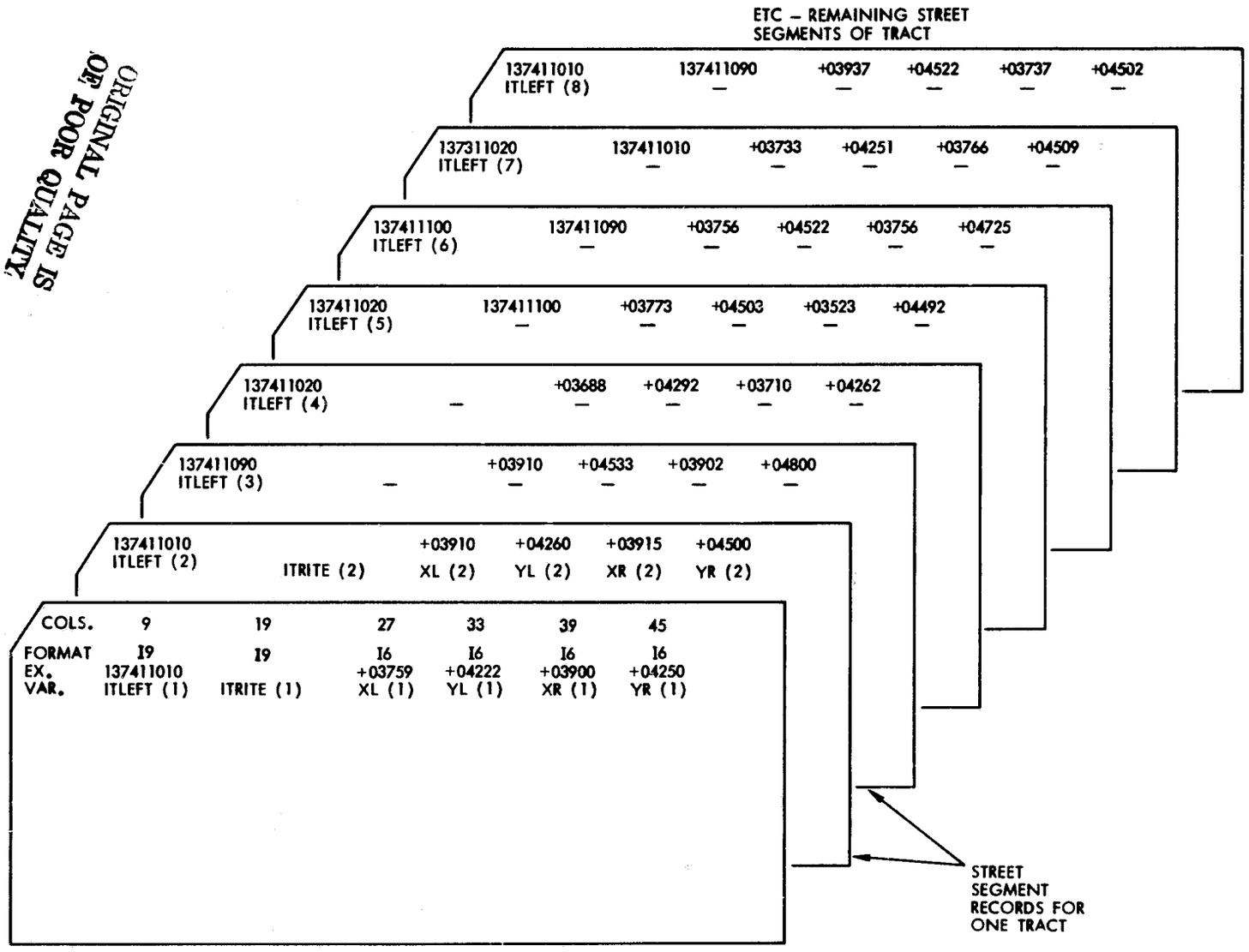


Figure 4. Raw Digitized Map File Layout Resulting from Digitizing Map Case 2

X0TOL, Y0TOL, and THETOL are user specified tolerance levels in the solution of digitized origin (X0, Y0 in inches) and the rotation angle (α – in minutes of arc) between digitized map and accepted reference source.

2.3.2 Control reference points are calculated from an existing reference source by the user. They are given in tenths of a foot without a decimal point. In the LUMIS test case the control points were in California Zone 7 State Plane Coordinates, but any legitimate earth coordinate system is acceptable. One through M coordinates are coded with four or less pairs per card.

2.3.3 Digitized reference points are entered in the same order as the control reference points in thousands of an inch, without the decimal point. One through M coordinates are coded with six or less pairs per card.

Digitizing the MMS maps can be performed by one person as the data maps were if the census areal units are prepunched by a simple FORTRAN program. Then the digitizing operator need only to place the punched records into the keypunch feeder in the same order as the street segments which he proposed to digitize. Since the LUMIS project involved several thousand census blocks in the Santa Monica Mountains, this procedure was followed to automate and expedite the digitizing procedure. However, for a limited amount of digitizing such as that which might have been performed by the City of Los Angeles to update the census areal units each year, a two-person method was suggested. Figure 4 illustrates the card deck setup for that method.

In the "limited amount of digitizing" technique, the digitizing operator places the cursor on the node at the tail end of the arrow along the street segment. He then calls the block designator on the left of the street segment (137411010) to the person on the keypunch, who then punched this designator. Note the ". 0" of the tract number (1374. 01) was dropped, as redundant information, a "0" was added to the block number (101), and the tract and block numbers were joined. The implied ". 0" of the block number was to allow for future block splitting and necessary decimal designators.

The tract and block number to the right of the street segment are then called out to the keypuncher who punches the number as shown. The keypuncher then presses the space bar. The digitizing operator presses the

digitizing button, thus recording on the card the X, Y coordinates of the starting node. The digitizing operator moves the cursor along the arrow to the ending node of the segment and again presses the button thus recording the digitizing table coordinates of this node. The keypuncher releases this card and sets a new card into the keypunch for the next street segment.

The digitizing operator meanwhile marks this segment on the map so that he will not redigitize it later. The procedure then is repeated, segment by segment, in any arbitrary order, until the tract is finished. Note that the tract right field for segments on the census tract boundary (that is, the designator for an area outside of the tract presently being digitized) is simply left blank. In the case where a census block is entirely within another census block (forming what is termed a "Doughnut Hole"), the block right is also left blank.

Link records for each street segment in a census tract are required.

2.3.4 Street Segment Record. Each record contains the left and right census tract/block for a segment and the beginning and ending coordinates. If a segment is missing a tract/block right, the coordinates are coded but the right position is left blank.

ITLEFT = Tract/block left of street segment (1 to MPOLY)

ITRITE = Tract/block right of street segment (1 to NPOLY)

XL, YL = X and Y coordinates of the beginning made for segment.

XR, YR = X and Y coordinate of the ending node for a segment.

3.0 CALCULATING THE STATE PLANE COORDINATES

3.1 Introduction

The following discussion describes the theory and methodology for calculating the State Plane Coordinates (SPCs) of the control points used in the digitizing process. These procedures are only used for the General Map Cases because the SPCs for the special MMS Map Case are determined at the time of digitization. The tools required for calculating the SPCs include:

1. New, unfolded USGS Quad
2. Digitizer
3. SPCCAL computer program (Appendix I)

3.2 Procedure

Place the new USGS quadrangle on the digitizer table, and aline it parallel to the bottom and sides. Use the digitizer to insure that the X coordinate of the left map edge (not paper edge) differs by no more than .001 inch between the top and bottom of the map. (If the paper has stretched, this accuracy cannot be obtained; secure a new quad.) Use the same method for the Y coordinate of the bottom left and right map edges. Then tape the quad securely and mark the control points on the map. Locate the four 2-1/2 minute and longitude tic marks surrounding each of the control points.

It is suggested that these 2-1/2 minute tic marks be used for determining the control points' SPCs instead of the actual SPC tic marks provided on the map margins for two reasons: (1) there is an insufficient number of tic marks on the margin to establish a dependable grid on the topographic map, especially when considering that (2) the SPC grid cannot be linear on a topographic map projection.

The State Plane Coordinates for the 2-1/2 minute intersection tics can then be obtained from the U.S. Coast and Geodetic Survey Plane Coordinate Intersection Tables (2-1/2-minute), SP-327, a copy of which can be obtained from the Los Angeles County Engineer's Office or the Superintendent of Public Documents.

With the SPCs of the four bounding 2-1/2 minute intersections known, they can be designated (X_1, Y_1), (X_2, Y_2), (X_3, Y_3), and (X_4, Y_4) representing the southwest, southeast, northwest, and northeast tic marks respectively. (See Figure 4.) Since the SPCs form a curvilinear coordinate system on the topographic map, a four-way interpretation for the X and Y coordinates of each control point can then be made.

Using the digitizer, establish the origin at the first control point and measure (to the nearest .001 inch) the X and Y displacements to two diagonal 2-1/2 minute intersections. The four resulting numbers are named x_1, x_2, y_1, y_2, and refer to the segments created by an imaginary perpendicular north-south line drawn through the center of the control point (Figure 5). To obtain the most accurate results, it is best to remeasure the four distances several times (reoriginating on each occasion), then average the results. Repeat this procedure for each control point, proceeding in the same order as the points were digitized on the mylar base map.

3.3 Calculations

The four SPC solutions for each of the X and Y coordinates of the control points can now be calculated by:

$$X = X_1 + 2000x_1 + \frac{y_1}{y_1 + y_2}(X_3 - X_1)$$

$$X = X_3 + 2000x_1 - \frac{y_2}{y_1 + y_2}(X_3 - X_1)$$

$$X = X_2 - 2000x_2 + \frac{y_1}{y_1 + y_2}(X_4 - X_2)$$

$$X = X_4 - 2000x_2 - \frac{y_2}{y_1 + y_2}(X_4 - X_2)$$

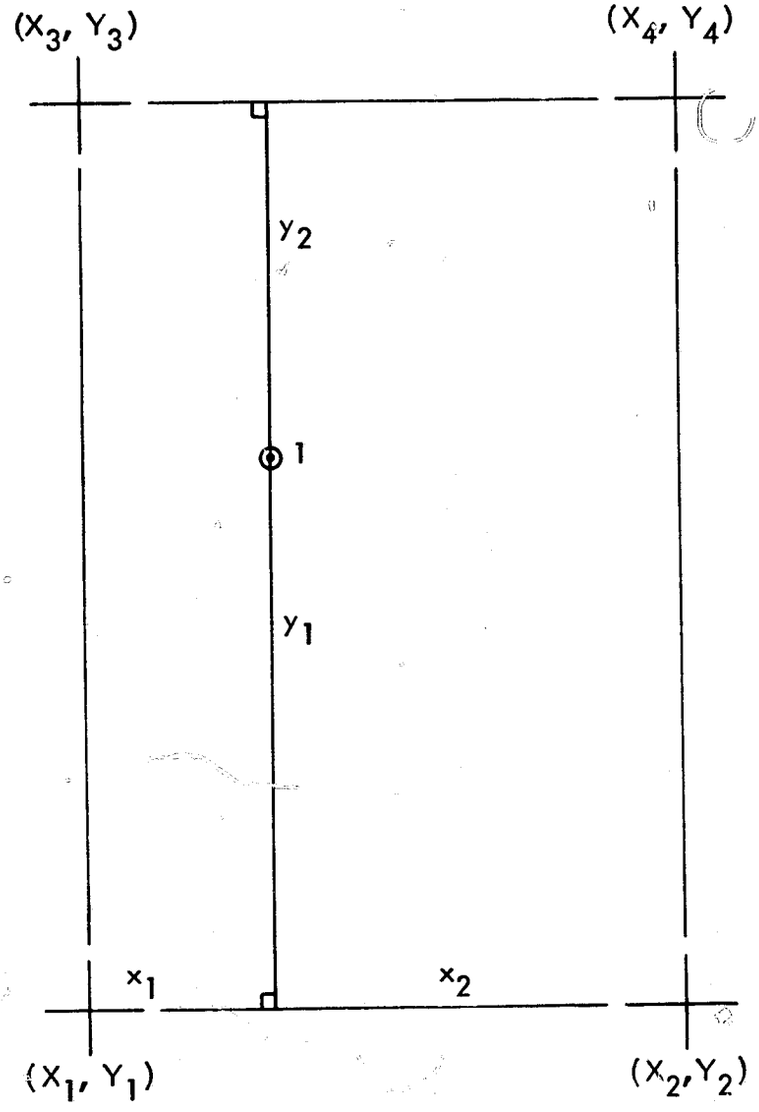


Figure 5. Geographic Position Determination of Control Point 1

$$Y = Y_1 + 2000y_1 - \frac{x_1}{x_1 + x_2}(Y_1 - Y_2)$$

$$Y = Y_2 + 2000y_1 + \frac{x_2}{x_1 + x_2}(Y_1 - Y_2)$$

$$Y = Y_3 - 2000y_2 - \frac{x_1}{x_1 + x_2}(Y_3 - Y_4)$$

$$Y = Y_4 - 2000y_2 + \frac{x_2}{x_1 + x_2}(Y_3 - Y_4)$$

The SPCCAL program performs the above mathematics. The four X and Y solutions should always agree to within 3 to 30 feet of each other. If the corresponding range of solutions should ever exceed 30 feet, the x_1, y_1, x_2, y_2 distances should be remeasured and run through the SPCCAL program until they meet the specified tolerance. The SPCCAL program prints an error message when the tolerance is exceeded. An example of the calculations for the SPCs of a land use control point is exhibited in Figure 6.

The State Plane Coordinates of the control points may then be punched onto cards for inclusion in the ROTATE program (see Figure 7).

LUMIS PROJECT TEST SITE

WOODLAND HILLS

LAND USE MAP 17001

REFERENCE POINT 1: INTERSECTION OF VALLEY CIRCLE BOULEVARD AND NORTHBOUND FEEDER OFF VENTURA FREEWAY

ELEVATION: 900 FEET

GRID TICS

	SW1	SE 2	NW 3	NE 4
LATITUDE	34° 07' 30"	34° 07' 30"	34° 10'	34° 10'
LONGITUDE	118° 40'	118° 37' 30"	118° 40'	118° 37' 30"
X	4085806.8	4098417.5	4085856.4	4098460.8
Y	4158058.9	4158020.2	4173221.8	4173183.2

x_1 = 4.455 INCHES $\quad X_3 - X_1 = 49 \quad Y_1 - Y_2 = 39$

x_2 = 1.840 INCHES $\quad X_4 - X_2 = 43 \quad Y_3 - Y_4 = 39$

y_1 = 6.610 INCHES $\quad y_1 / \Sigma y = .8732 \quad x_1 / \Sigma x = .7077$

y_2 = 0.960 INCHES $\quad y_2 / \Sigma y = .1268 \quad x_2 / \Sigma x = .2923$

	X	Y
	4094760	4171251
	4094760	4171251
	4094776	4171274
	4094776	4171274
AVERAGE:	4094768	4171262

Figure 6. SPC Calculation for Land Use Control Point

SPCCAL IS A COMPUTER PROGRAM THAT CALCULATES THE CONTROL POINT SPCs FOR INPUT TO THE ROTATE PROGRAM.

DECK SETUP:

	COLUMN	VARIABLE	DESCRIPTION
CARD 1			
	1-5	NUMAP	NUMBER OF MAPS FOR WHICH CONTROL POINT SPCs ARE TO BE CALCULATED IN THIS COMPUTER RUN. (INTEGER)
CARD 2			
	1-10	MAPNO	MAP NUMBER (EX. 17001) FOR WHICH SPCs ARE TO BE CALCULATED. (INTEGER)
	11-15	NCONPT	NUMBER OF CONTROL POINTS. (INTEGER)
CARD 3			
			SPC COORDINATES OF THE FOUR 2-1/2 MINUTE LATITUDE-LONGITUDE TIC MARKS SURROUNDING THE FIRST CONTROL POINT. (SEE FIGURE (4).) PUNCH THESE COORDINATES (TO ONE DIGIT AFTER THE DECIMAL POINT) IN THE FORM OF X_1, X_2, X_3 X_4, Y_1, Y_2, Y_3, Y_4, RIGHT JUSTIFIED TO EVERY TENTH COLUMN.
CARD 4			
			x_1, x_2, y_3, y_4 (IN THAT ORDER) DIGITIZER MEASURED DISTANCES (IN INCHES) TO THE 2-1/2 MINUTE INTERSECTIONS.

REPEAT ONE SET OF CARDS 3 AND 4 FOR EACH CONTROL POINT.
FOR THE SECOND MAP, REPEAT CARD 2 FOLLOWED BY THE NECESSARY SETS OF CARDS 3 AND 4.

Figure 7. State Plane Coordinate CALculation (SPCCAL)

4.0 EDITING PROCEDURES

4.1 Introduction

Editing the MMS Census Tract and General Map Raw Digitized Map Files is the process through which all syntax errors are removed for input to the CHAIN or ROTATE programs. The procedures for editing the two different map cases are fundamentally the same, but the individual steps are performed with varying emphasis.

The following items are needed in the editing process:

1. Original mylar base map
2. Plotter program and plot of digitized data
3. Printout of raw data
4. Light table

The mylar base is the actual map that was digitized. A listing of the plotter editing program for the general map case is in Appendix II, and for the special MMS map case Appendix III. The editing programs were written for a UNIVAC 1108 Computer using CALCOMP plotter commands.

4.2 General Map

Taking the mylar base map, overlay it on top of each individual plot, and search for obvious errors like missing polygons, truncated or incorrectly digitized boundaries, extraneous lines, off registration, and control point errors. Small gaps and overlaps between polygon boundaries are normal and should not cause concern. Minor boundary errors are best repaired by locating the coordinates of the neighboring polygon's common boundary, and substituting those coordinates in the problem polygon. To use this method, plot the problem border on graph paper marking the location of each coordinate. Note the beginning and end point of the error segment, and locate similar points in the neighboring polygon.

Insert the correct coordinates and rectify the polygon's total number of points (NP) if there was a change.

This method is rather tedious, however, so if the boundary error is serious, it is easier to throw out the polygon and redigitize it as a separate setup within the map.

Often times the raw data cards become shuffled or blank cards manage to mix with the data. These types of errors show up as extraneous lines criss-crossing inside or through polygons. Off-registration is usually caused by the plotter, digitizer, or digitizer person losing origin. In most cases, the error can be corrected by determining the X and Y displacement, pulling the polygon(s) out, and treating them as a separate setup with their control points being a combination of the original control points and the displacement.

If the general map was digitized in several setups rather than all at once, inspect the plot of each setup individually, then combine them (using the plotted control points) over a light table and check for off-registration, bad control points, and missing polygons.

There are a number of errors that the visual inspection of the plotted maps will not find. Among these include incorrect land use codes (LUCODE), number of points (NP), polygon types (PTYPE), and minimum-maximum coordinates. The plotter editing program printout is most useful in spotting these kinds of problems. Its main feature (other than to create the plot) is that it counts the number of points in each polygon, and prints that number out. The most common error by far, is an incorrect NP, and such an error will always abort the ROTATE program. The editing program also prints out the regular polygon information like MAPNO, LUCODE, POLYNO, NP, digitized data, etc., but in an easily read format.

The procedure for editing the NP is simply to scan the printout comparing the computer counted NP against the digitizer's specified NP. This method not only catches wrong NPs, but also out-of-sequence header cards ("polygon designation records") and min-max cards ("polygon limit record"), and also blank cards. As for checking the LUCODE and PTYPE, each polygon in the printout must be individually checked against the mylar base map.

It is very important that no PTYPE errors pass uncorrected, as one error could falsify the polygon overlay area calculations of many neighboring polygons. For the same reason, if a polygon is removed for redigitizing as a separate setup (and all redigitized polygons must become separate setups),

careful note must be taken to determine if it is a polygon PTYPE 11 or greater. If it is, then all the polygons from the previous PTYPE 10 to the last PTYPE 11 or greater in the series (i.e., all polygons within the PTYPE 10) must also be redigitized in the new setup. This is because the polygon overlay program subtracts the area of all PTYPE 11 (or greater) polygons from the polygon they are within. Users should replot and reedit map setups in which there were a lot of errors. Redigitized polygons also should be replotted. Once all this editing is done, the raw digitized map file is ready to be inputted to the ROTATE program.

4.3 MMS Maps

The MMS census tract plotter editing program (Appendix III) produces two plots of each census tract. Along each line segment in the first plot, the sequence number describing the order in which the segment was digitized is printed. In the second plot, the block number of the polygon on either side of the segment is printed. The procedure for editing the MMS raw digitized map file involves the visual comparison of the plotted census tract shapes with the actual base map.

The base map can be overlayed directly on top of the plot, but this method does not work well when the street (line) segments stimulate curved block boundaries as in hilly areas. The kinds of errors encountered include incorrect block numbers, double digitized street segments, missing segments, common nodes greater than tolerance (.045 inch) apart, and incorrectly digitized "doughnut holes". (A doughnut hole census block should be treated like a census tract, i.e., the outside block number left blank.) Between census tracts, checks must be made to insure that the common boundaries are similar. Adding new nodes is accomplished by drawing an X and Y axis through a close existing node, measuring the X and Y displacement to the new node, and adding that displacement to the coordinates of the known node. (An existing node's coordinates are located by referring to the sequence number of its line segment, then finding that line in the editing program printout.) When the entire census tract has been corrected, it should be replotted and reedited again.

4.4 CHAIN

The next step is to run the raw digitized data through the CHAIN program, which will flag all the remaining uncaught errors and print the street segments in the bad census block. The error can be found by closely reexamining the census block's plot, or by manually CHAINing the street segment coordinates in the printout until two nodes are found to be greater than tolerance distance (. 045 inch) apart. A common error is to have an incorrectly numbered street segment not only abort the census block it is missing from, but also the census block of the wrongly specified number. When using the CHAIN program for editing purposes, it is a good idea to modify the program so that it does not produce punched cards at each turn-around. When all the blocks finally CHAIN properly, the program can then be run conventionally to convert the digitized street segments to State Plane Coordinates.

5.0 ROTATE

5.1 Introduction

The ROTATE program is written in FORTRAN IV and produces a geographically true X and Y coordinate data base from raw digitized data referenced to any standard map system. These ROTATE corrected coordinates then act as input to PIOS (Polygon Information Overlay System) where polygon intersection statistics are calculated. Raw digitized coordinates such as those corrected by ROTATE are produced when geographically oriented researchers decide to incorporate thematically mapped data, like soils data, geological data or vegetative data into a LUMIS data base. These data maps when digitized are not usually assigned true X and Y coordinates, but rather coordinates that are relative to the digitizer table and the position of the data map to that table. Hence ROTATE's purpose is to adjust those raw digitized coordinates to their relative true ground locations.

5.2 Methodology

To produce geographically true X and Y coordinates the ROTATE program is broken into two major components. The first component operates with the data cards prepared for each unique data map. These initial map setup records describe the geographic coordinates of the digitizer table origin, and the table-to-geographic coordinate system relationship from which a scaling factor and rotation angle are computed. In the first component of ROTATE there is a check that insures control point accuracies meet user specified tolerances.

That check for control point accuracies requires a digitizer table-to-ground coordinate transformation. This transformation is solved by program ROTATE using a least squares solution having four unknown variables. These unknowns are:

1) XO . . . . . Control map X axis ground location
2) YO . . . . . Control map Y axis ground location
3) SCos θ . . . . . Scaling Factor S times the cosine θ
4) SSin θ . . . . . Scaling Factor S times the sine θ

5.2.1 The scaling factor S is expressed in a ground coordinate system of feet per inch on the map.

5.2.2 The rotation angle θ representing the difference between the map orientation on the digitizing table and true North-South is expressed in degrees, minutes and seconds. The scaling factor and rotation angle are calculated from SCos θ and SSin θ in a simple triginometric equation.

These variables are then used in the least square transformation equation R as follows:

$X = X + SNx$	Transformation Equation
$S =$	Scaling Factor
$X = \begin{pmatrix} XO \\ YO \end{pmatrix}$	Rotated Coordinates
$N = \begin{pmatrix} \text{Cos}\,\theta & \text{Sin}\,\theta \\ -\text{Sin}\,\theta & \text{Cos}\,\theta \end{pmatrix}$	Rotation Angle
$x = \begin{pmatrix} XDi \\ YDi \end{pmatrix}, \; i = 1, M$	Digitized Coordinates
$X = \begin{pmatrix} Xi \\ Yi \end{pmatrix}, \; i = 1, M$	Surveyed SPC

ROTATE uses the least square approach to increase the accuracy of the basic transformation equation. This approach will produce a transformation factor (SN) that when applied will change all digitized coordinates to their ground truth equivalents. In the transformation equation, surveyed X-Y coordinates (X) and digitized X-Y coordinates for the control points (x) are expressed as arrays, M sets in length.

5.2.3 The surveyed control points (Xi, Yi, i = 1, M) correspond to the digitized control points (XDi, TDi, i = 1, M). In the transformation equation the error between surveyed and digitized control points is averaged using the least squares method.

5.2.4 The transformation equation used in ROTATE creates two equations per control point, one for X and one for Y, so only two control points are required, M = 2. However, the least squares solution can accommodate up to eight points. For greater accuracy the maximum number are suggested. Using the computed transformation factor, each digitized control point X and Y coordinate is entered into the equation and the measured coordinate is solved for. If this computed equivalent of the surveyed X-Y coordinate is not found to be within the used specified tolerances (X0TOL, Y0TOL, or THETOL), a message is printed out by the program indicating the degree of error and processing is stopped.

For example, a tolerance of 0.045 was used in the LUMIS Santa Monica Mountains Study. This was felt appropriate because LUMIS is a block level system and the boundaries should rarely be in error of more than the width of a secondary street, 84 ft. At a scale of approximately 1 inch = 2,000 ft., an error of 0.045 inches on the digitizing table corresponds to a geographical ground error of 90 ft.

Once the equation is formulated and tested the remaining polygons are rotated through angle θ and scaled by the factor S. Each map set up must follow this same procedural construction of an equation, testing and processing of the polygons which follow.

5.3 Program

ROTATE written in FORTRAN IV, consists of a main program having two phases, and two subroutines. The subroutines perform matrix inversion and multiplication required by the least square algorithm. The main program itself is divided into two logical phases.

5.3.1 Phase I. The main program first phase calculates the unknown in a least squares equation for each map set-up from the calculated and the digitized control coordinates. The equation is tested by reentering the digitized control points to determine if the calculated control points can be found within user specified tolerances.

5.3.2 Phase II. The second phase reads data points for each polygon, enters them into the equation formed in Phase I. It then makes the adjustment in the digitized coordinates for rotation angle and scaling factor, and writes the adjusted coordinates to an output file.

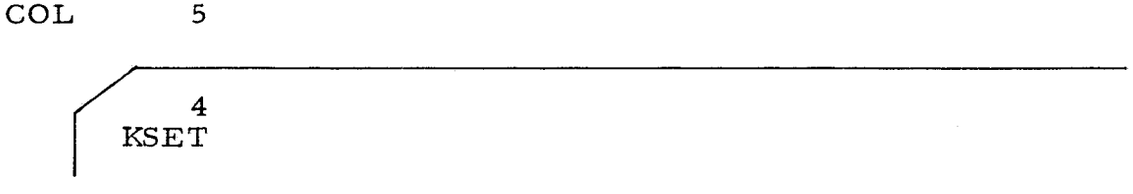
There are two subroutines used in ROTATE, RATMUL and INVERSE. Subroutine RATMUL multiplies a matrix times its transpose. The regression algorithm performs this task on the original digitized matrix and on its inverse as part of the least squares formula. Subroutine INVERSE defines the inverted matrix of the original digitized data and its transpose.

5.3.2.1 Input. The ROTATE program uses as its input a card file with the following sets of information: the control specifications, the digitized calculated control points, and the digitized polygon min-max and boundary points, Figure 8.

5.3.2.2 Output. The ROTATE program produces as output a listing of transformation solution, rotation angle and a scaling factor, input digitized coordinates for each polygon, a listing and deck of transformed geographic coordinates, and any error condition messages that are invoked.

5.4 Overall Specifications

The polygons are entered as sets (KSET) within an established geographic reference system, or map setup. One map may be coded as one or more setups depending on the number of times a reference is required. The first card in the deck is coded as follows:



5.5 Phase I Specifications

Phase I requires as input the following information: map tolerance record, control reference record, digitized reference record.

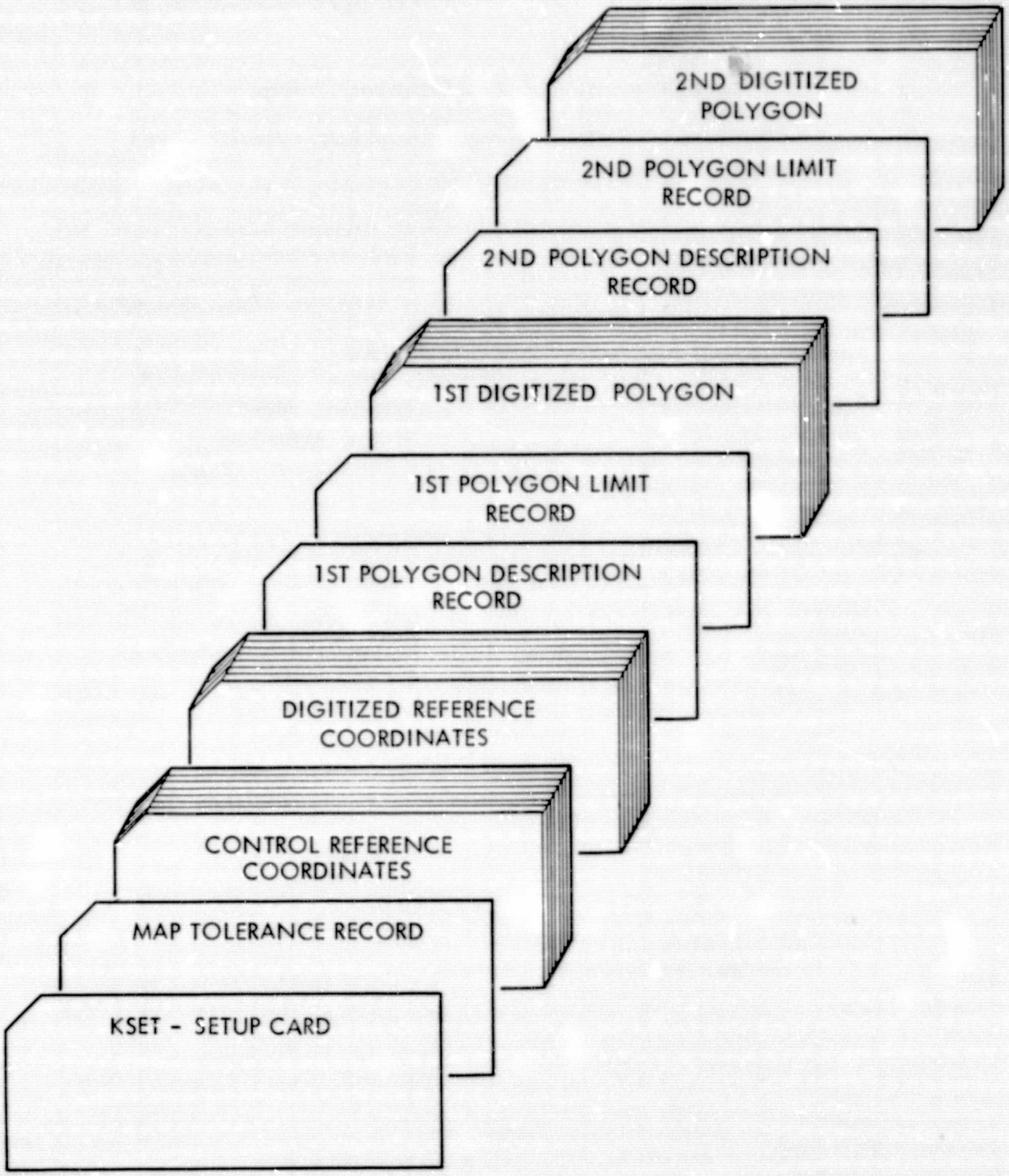


Figure 8. Deck Setup for ROTATE Showing Multiple Map Models

5.5.1 Map tolerance record establishes the limits in calibration of the digitized coordinate reference points and the overall parameter of the polygon to follow.

NPOLY - Total number of polygons for a map setup.

M - Number of control points provided as calculated and digitized reference records.

X0TOL, Y0TOL, THETOL, user specified tolerance levels in the solution of digitized origin (X0, Y0 in inches) and the rotation angle (θ - in minutes of arc) between digitized map and accepted reference source.

COL	5	10	20	30	40
	48	7	.045	.045	.500
	NPOLY	M	X0TOL	Y0TOL	THETOL

5.5.2 Control reference points are calculated from an existing reference source by the user. They are given in tenths of a foot without a decimal point. In this case the control points are in California Zone 7 State Plane Coordinates, but any legitimate earth coordinate system is acceptable. One through M coordinates are coded with four or less pairs per card in the following format:

COL	9	18	27	36	ETC....	72
	44349278	42471232				
	X(1)	Y(1)	X(2)	Y(2)	ETC....	

5.5.3 Digitized reference points are entered in the same order as the control reference points in thousands of an inch, without the decimal point. One through M coordinates are coded with six or less pairs per card in the following format:

COL	6	12	18	24	30	36	ETC....	72
	+24789	+123436						
	XD(1)	YD(1)	XD(2)	YD(2)			ETC....	

Upon completion of Phase I the user will receive a message as to the status of the job. The message indicates the calculated scaling factor and rotation angle. If the transform equation fails the tolerance checks, an error message appears.

Problems that arise in rotating data points include syntax errors and/or incorrectly digitized or poorly placed control points. In either case, it is suggested that the program's punched output be deleted until a normal termination is achieved in the first phase.

There are two possible means to correct the error condition without redigitizing the control points: either reduced the number of data points or increase the acceptable tolerances. Since a minimum of two points are required, it is possible to discard all but the last two data points. In the cases where variation is slight, the acceptable tolerance can be increased.

In extreme cases of inaccuracy or when the data points are poorly placed, i.e., too close together or in a linear arrangement, they should be recoded. Recoded control points should make use of the old points, adding only those control points necessary to correct the problems of improper placement.

5.6 Phase II Specifications

If Phase I is completed without errors, Phase II begins with a polygon description record, polygon limit record, and polygon boundary record. One set of these records are required for each polygon digitized (NPOLY) in a map setup (KSET).

5.6.1 Polygon descriptor record contains control information for each polygon:

MAPNO: Map number for the digitized polygon.

MAPOL: Total number of polygons on a map. This could, but does not necessarily equal NPOLY (number of polygons in a map setup).

LUCODE: Identifying information code.

POLYNO: Sequence number for polygon, 1 to MAPOL

PTYPE: Designates doughnut polygons, or polygon without polygons; normal polygons are digitized number 10. Numbers larger than 10 indicate succeeding doughnut polygons.

COL	5	10	13	17	19
	11005	62	A05	104	12
	MAPNO	MAPOL	LUCODE	POLYNO	PTYPE

5.6.2 Polygon limit record. One limit record is required for each polygon. It should be noted that the output polygon limit record contains the SPC minima and maxima, not the transformed digitized minima and maxima (if the rotation angle is large enough, the two sets of minima and maxima may be the same). These limits (in SPC's) are important since they "box in" the map polygons for efficiency in the PIOS overlay techniques.

XMIN, YMIN, XMAX, YMAX: The minimum X, minimum Y, maximum X, and maximum Y digitized coordinates respectively of the polygon.

NP: Total number of digitized coordinates in polygon. Format follows:

COL	6	12	18	24	27
	+02222	+23150	+04444	25179	476
	XMIN	YMIN	XMAX	YMAX	NP

5.6.3 Polygon digitized boundary records. One set of digitized coordinates is required for each polygon.

XD(1), YD(1), ---XD(NP), YD(NP): Digitized coordinates of polygon.

Format follows:

COL	6	12	18	24	30	36	ETC....	72
	+02256	+23190						
	XD(1)	YD(1)	XD(2)	YD(2)				

5.7 Program Output

The program produces a card file which can later be used directly in PIOS as the minor polygon file. The cards are grouped by polygon with a control card, minimum-maximum card and polygon record description.

5.7.1 The control card contains the following data formatted as indicated:

Column	Format	Descriptor
1-5	I5	Polygon Descriptor (MAPNO)
6-10	I5	Number of Polygon on a Map (MAPOL)
11-13	A3	Land Use Code Identification (LUCODE)
14-17	I4	Sequence Number of Polygon (POLYNO)
18-19	I2	Polygon Type, complete or Doughnut Polygon (PTYPE)

5.7.2 The minimum and maximum record is formatted as follows:

Column	Format	Descriptor
1-9	I9	Minimum X coordinate value of the Polygon (XMIN)
10-18	I9	Minimum Y coordinate value of the Polygon (YMIN)
19-27	I9	Maximum X coordinate value of the Polygon (XMAX)
28-36	I9	Maximum Y coordinate value of the Polygon (YMAX)
37-41	I5	The number of coordinate pairs describing a Polygon (N)

5.7.3 The boundary record is recorded as X and Y values in a 8I9 format, four pairs per card. The number of cards to follow is determined by the data points N divided by four rounded up.

6.0 CHAIN

6.1 Introduction

CHAIN was created to prepare a coordinate data base, referenced to a standard geographic coordinate, as input to PIOS (Polygon Information Overlay System) from a raw digitized street network and political boundary such as a metropolitan map series.

6.2 Methodology

CHAIN also makes use of the basic least squares transformation equations with four unknowns developed for ROTATE. The table-to-ground equations use the same unknowns as those in ROTATE;

1) X0. . . . . Control map X axis ground location

2) Y0. . . . . Control map Y axis ground location

3) SCosθ. . . . . Scaling Factor S times the cosine θ

4) SSinθ . . . . . Scaling Factor S times the sine θ

The scaling factor S is expressed in a ground coordinate system of feet per inch on the map.

Two to four control points are required by the CHAIN Program. Since the original MMS maps are more accurate than ordinal input maps used by ROTATE, four coordinates are sufficient to maintain the same level of accuracy as eight in ROTATE. The least squares solution is again tested against user specified tolerances.

CHAIN also incorporates an algorithm to link segments by node coordinate around digitized blocks and to produce multiple records for those units which a boundary segment must use twice.

CHAIN must link digitized street segment nodes and check the polygon for completeness before segments can be transformed. Thus CHAIN will correct for minor digitizing errors or point to the node where major errors exist.

The technique used to build the block file starts by digitizing records for each link of the block shown in the top half of Figure 9.

Looking at Blocks 101, 102, 109, and 110, the coordinates are digitized in the following manner:

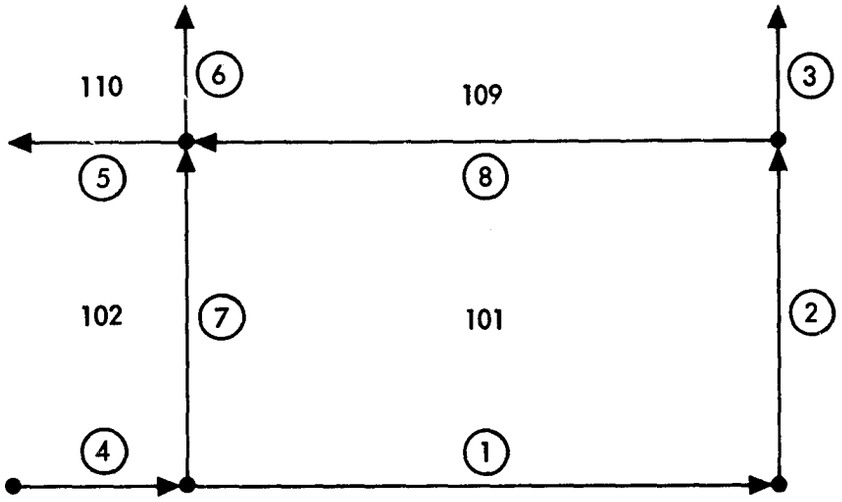
	Block Lft	Block Rt	Begin	X-Y	FHD	X-Y
1)	101		+03759	+04222	+03900	+04250
2)	101		+03910	+04260	+03915	+04500
3)	109		+03910	+04533	+03902	+04800
4)	102		+03688	+04292	+03710	+04262
5)	102	110	+03773	+04503	+08523	+04472
6)	110	109	+03756	+04522	+03756	+04725
7)	102	101	+03733	+04251	+03766	+04509
8)	101	109	+03937	+04522	+03777	+04502

In the Chaining Program each record which has two sides, (5) (6) (7) and (8) are "reversed - duplicated, " that is the left block becomes the right block, from and to coordinates are reversed, and the segment is duplicated.

Segments not under consideration are then "erased" from the duplicated file. These records, tract boundary records, will be considered at a later time.

The file is sorted by the left block producing the file shown in the bottom half of Figure 9. The coordinates are then "matched" by ending and beginning nodes for each block according to user specified mapping tolerance (X0TOL, Y0TOL). Cul-de-sacs fall at the end of each block segments. They are retained only for graphic presentation and do not provide any information to PIOS.

The coordinates accepted by the CHAIN edit program are averaged, and transformed to state plane coordinates.



SAMPLE MAP SHOWING SEGMENT IDENTIFICATION FOR BLOCK 101

		BLOCK LEFT	BLOCK RT	FROM X-Y		TO X-Y	
	(1)	101		+03759	+04222	+03900	+04250
	(2)	101		+03910	+04260	+03915	+04500
	(8)	101	109	+03937	+04522	+03777	+04502
(REV)	(7)	101	102	+03766	+04509	+03733	+04251
	(4)	102		+03688	+04292	+03710	+04262
	(7)	102	101	+03733	+04251	+03766	+03509
	(5)	102	110	+03773	+04503	+03523	+04492

BLOCK CHAINING TECHNIQUE USED BY THE CHAIN PROGRAM FOR SAMPLE MAP SHOWN

Figure 9. Block Chaining

6.3 Program

CHAIN makes use of block boundary segments digitized as single lines separating two units left and right. The program checks for a complete set of boundary elements surrounding each block and splits the boundary segments into left and right corresponding to their respective blocks. It then transforms the block file coordinates from a table coordinate file to a standard geographic coordinate system, maintaining scale and table rotation limit checks.

The CHAIN Program is written in three phases.

Phase I:

Determines, for each census tract, the geographic coordinates of the digitized X-Y origin, map scale, rotating angle to convert digitized coordinates to a standard reference system and tests to determine if control points exceed user specified tolerance.

Phase II:

Reverses and duplicates segments which are boundaries for a block coded with left and right geographic codes and produces a complete boundary file for each block.

Phase III:

Transforms the standard scale and rotation angle of the polygon produced in Phase II, and converts all records for each tract so they will conform to the geographic reference system established in Phase I.

Control coordinates must fall within accepted limits and blocks must chain, i.e., start and end on the same node, to be continued into Phase III, transformation. Failure of the file Phase I or II will generate an error message and stop processing.

6.3.1 Input. The control specifications, digitized and calculated control points, and digitized segment file are shown in Figure 10.

6.3.2 Output. Output includes a listing of the transformation solution, rotation and scaling factors, input digitized coordinates, listing and deck of transformed geographic coordinates, and any error messages that are invoked.

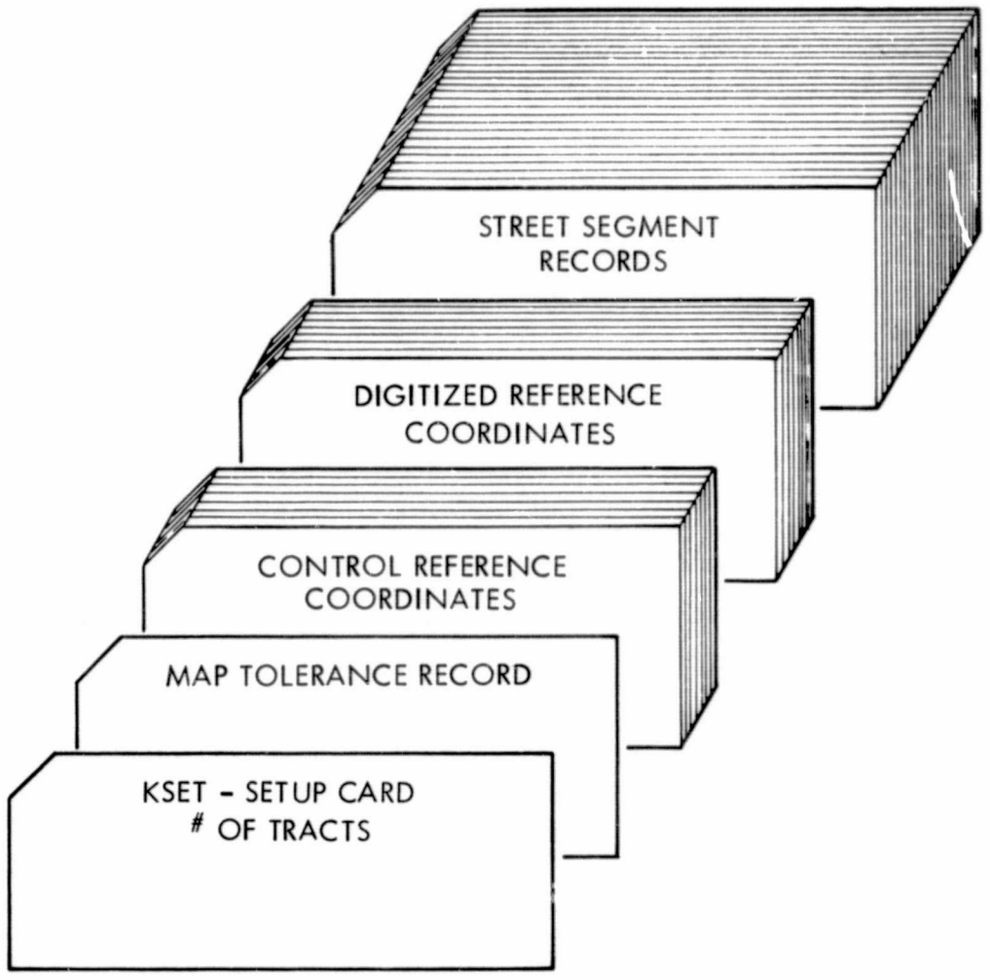


Figure 10. Deck Setup for Chain for Multiple Block Boundaries

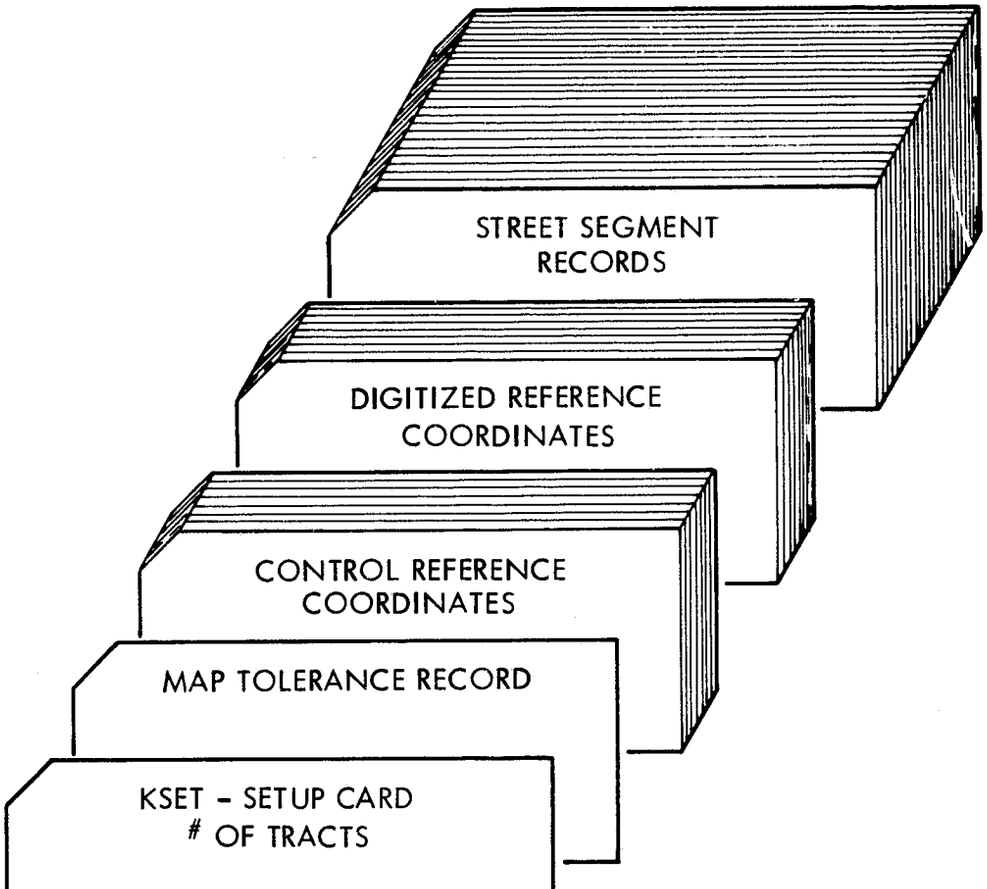


Figure 10. Deck Setup for Chain for Multiple Block Boundaries

6.4 Overall Specifications

Blocks are digitized as units in a tract, therefore geographic reference control points must be established per each tract. Each map contains one or more tracts.

COL	5
	4
	KSET

6.5 Phase I Specifications

Phase I requires as input the following information: map tolerance record, control reference record, digitized reference record.

6.5.1 Map tolerance record establishes the limits in calibration of the digitized coordinate reference points and the overall parameter of the polygon to follow.

NNPOLY - Total number of blocks in a tract.

M - Number of control points provided as calculated and digitized reference records.

X0TOL, Y0TOL, THETOL, user specified tolerance levels in the solution of digitized origin (X0, Y0 in inches) and the rotation angle (θ - in minutes of arc) between digitized map and accepted reference source.

COL	5	10	20	30	40
	48	7	.045	.045	.500
	NPOLY	M	X0TOL	Y0TOL	THETOL

6.5.2 Control reference points are calculated from an existent reference source by the user. They are given in tenths of a foot without a decimal point. In this case the control points are in California Zone 7 State Plane Coordinates, but any legitimate earth coordinate system is acceptable. One through M coordinates are coded with four or less pairs per card in the following format:

COL	9	18	27	36	ETC....	72
	44349278	424712321				
	X(1)	Y(1)	X(2)	Y(2)		

6.5.3 Digitized reference points are entered in the same order as the control reference points in thousands of an inch, without the decimal point. One through M coordinates are coded with six or less pairs per card in the following format:

COL	6	12	18	24	30	36	ETC...	72
	+24789	+12345						
	XD(1)	YD(1)	XD(2)	YD(2)				

Upon completion of the Phase I, the user will receive a message as to the status of the job. The message indicates the calculated scaling factor and rotation angle.

6.6 Phase II Specifications

If Phase I is completed without errors, Phase II requires link records for each street segment in a census tract.

Street segment record. Each record contains the left and right census tract/block for a segment and the beginning and ending coordinates. If a segment is missing a tract/block right, the coordinates are coded but the right position is left blank as shown in Figure 11.

ITLEFT = Tract/block left of street segment (1 to MPOLY)

ITRITE = Tract/block right of street segment (1 to NPOLY)

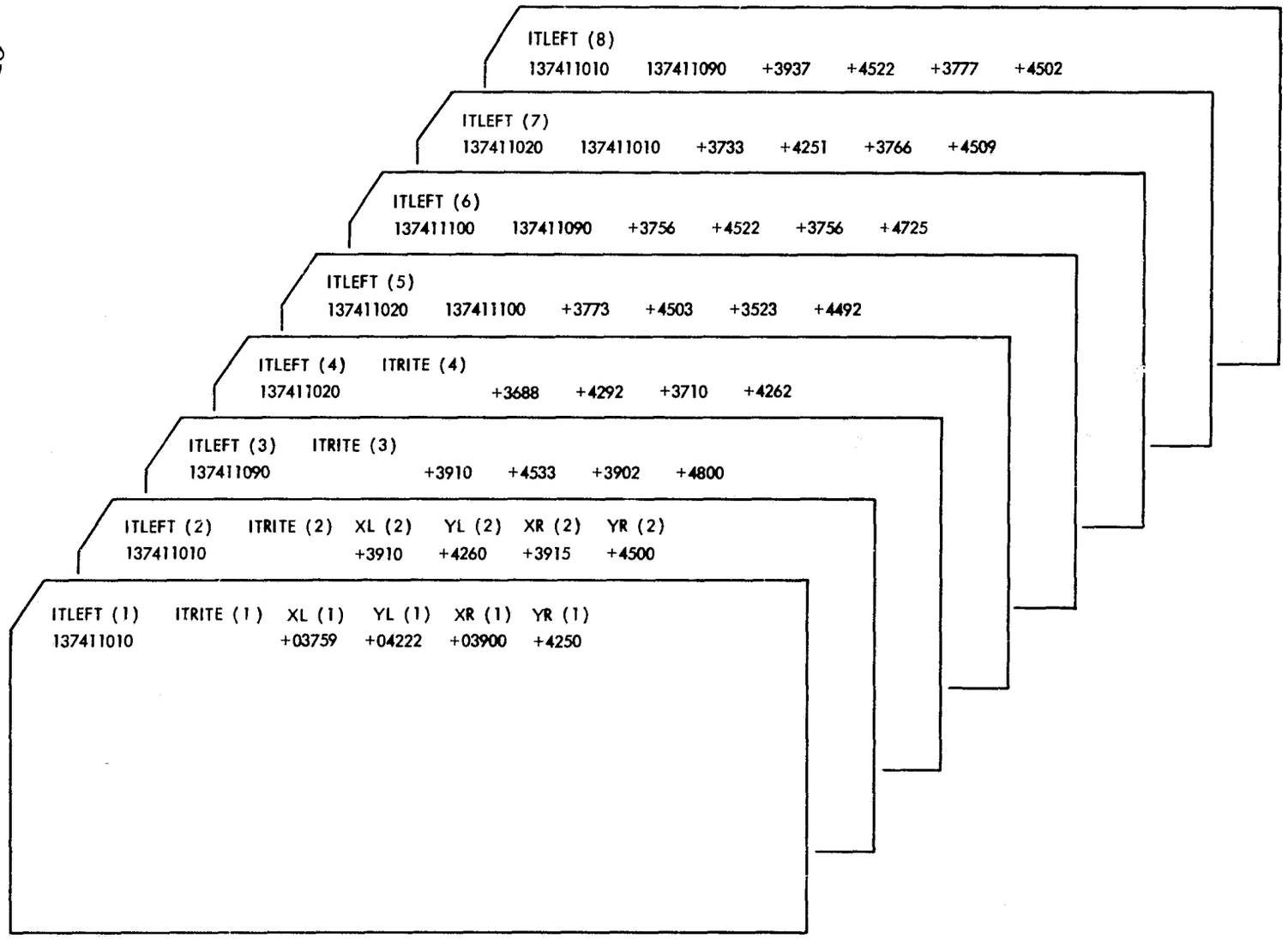


Figure 11. Sample Block Boundary File Layout

XL, YL = X and Y coordinates of the beginning node for a segment.

XR, YR = X and Y coordinate of the ending node for a segment.

COL	9	18	26	32	38	44
	137411020 ITLEFT	137411100 ITRITE	+03773 XL	+04503 YL	+03523 XR	+04492 YR

7.0 DIME AREA CENTROID SYSTEM (DACS)

7.1 Introduction

The DIME Area Centroid System (DACS) was modified and adapted to the LUMIS project as an alternative to the CHAIN program to create a census tract/block polygon input to PIOS (Polygon Intersect Overlay System) from the DIME file. The DACS program translates a segment record structure used in the DIME file to a single sided polygon outline file which is used by PIOS.

DACS was originally developed by the Census Use Study, a Division of the Bureau of the Census. It was designed to produce edited and reformatted subfiles from the original DIME format. The subfiles can be used in computer mapping, area calculations, and adjacency problems. The editing feature allows the user to correct the file at the same time.

This documentation describes the basic program logic, and data input and output files in the program. This version includes corrections and modifications made by the Jet Propulsion Laboratory to create a PIOS input file. The program and modifications are written in FORTRAN IV for use with an IBM 360/370 computer, but can be adapted to other systems.

7.2 Methodology

DACS is written in three phases. These phases deal with the creating of a single sided segment intermediate subfile, a sort, and editing and reformatting an output file.

An intermediate subfile is created from all boundary segments for a selected region: census tract, census block group, or block which is identified by having two different right and left regions. The data for each boundary is written to the subfile twice, once unaltered as the boundary to the first polygon, and then with the beginning and ending node reversed to create a boundary for the second polygon. The final file contains separate records for each left boundary using counterclockwise orientation, and true records for the right boundary.

In Figure 12 segment A to B has a left side with census tract 1011.00 block 101 and a right tract of 1013.00 block 101. The first segment is written to the subfile as tract 1011.00 block 101 and coordinate for nodes A to B. The second segment is for tract 1013.00 coordinates from B to A, putting that tract on the left side with relation to this X-Y coordinate.

In the sort step, the subfile is sorted from the leftmost region in preparation for the third step.

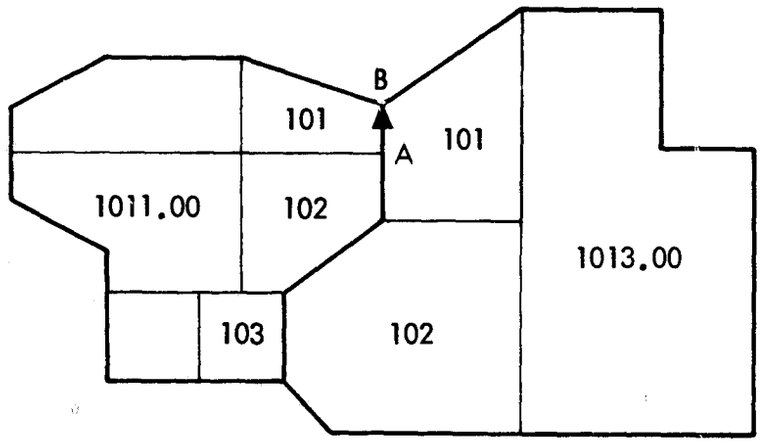
In the third step, the program edits the file, performs any necessary calculations and reformats the output. All the boundary lines for one region are read in and stored. The array is then passed to the chaining edit program to determine if the segments are for one or more closed loops. If the segments do not close, the user is notified of the condition by a printed message and all calculations are skipped, (see Figure 13A). If the segments form more than one closed loop (Figure 13B), a message indicating the condition is printed, but in this case calculations are not allowed to proceed.

Regions accepted by the chaining test are passed to routines to calculate the centroid coordinates and the area, build lists of adjacent regions, or reformat the segments for use in mapping and overlay programs. The complete documentation for area, adjacency and centroid routines is available through the Census Bureau.

The subroutine to reformat the DIME file for PIOS input is appended to the third step of DACS. The subroutine first modifies the tract and block identifiers by removing the case to form the description record. Minimum and maximum coordinates are determined through a simple logical test, at the same time counting the number of coordinate pairs to form the second polygon record, minimum and maximum coordinates. Finally the X, Y coordinates which describe the polygon are written to a subfile in sets of four as specified for PIOS input.

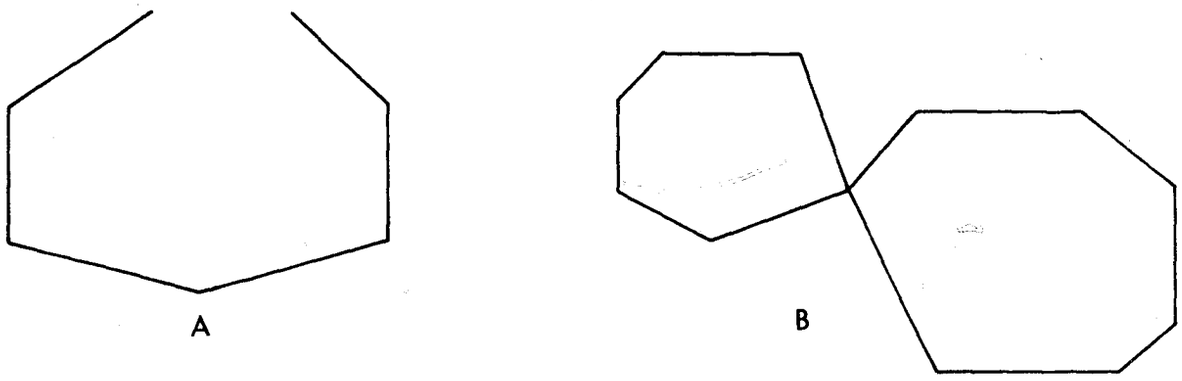
7.3 Program

The DIME Area Centroid System (DACS) consists of two programs designed to calculate areas and locate centroids of user-specified blocks, tracts, block groups, or other local areas defined in a DIME File. For each region



Map showing boundary segment A-B dividing census tract 1011.00 and 1013.00. Each segment in the DIME file is identified by both the left and the right geocodes making each polygon independent. DACS can then convert DIME files into complete polygon boundary description for PIOS input.

Figure 12. Boundary Segment Dividing Census Tract



Examples of two possible polygons edited by the DACS program.
A. A block which will not chain.
B. A block which chains, but with more than one closed polygon.

Figure 13. DACS Edited Polygons

considered, DACS produces, at user request, a tape listing X and Y coordinates of the boundary segment endpoints forming the polygon vertices and/or type and printed listings of adjacent regions. The centroids and boundary coordinates are useful as input to computer mapping programs such as GRIDS and SYMAP, and as input to polygon overlay programs, such as PIOS.

Errors and anomalies in the area and centroid values, identified by the program, are helpful in locating coding errors in the input file.

DACS is written as a preprocessor, sort and calculation program. These are used in three distinct phases.

Phase I:

The first program, DACS presort, uses an input DIME file tape to prepare an intermediate file; the intermediate file passes the control parameters and the selected boundary segments will be used in the calculation program; thus two programs can be thought of as phases of the same program.

Phase II:

The second phase sorts the output from the preprocessor so that all the segments from a region will be in one location on the file.

Phase III:

The third phase performs the actual computations, edits the file and writes any output files. It reads the sorted intermediate tape and stores segment data for a region internally. When the first record for a different region is encountered, the accumulated data is passed to subroutine CHAIN.

Subroutine CHAIN checks to see if the region's boundary segments form one or more closed loops. If they do not, a message to notify the user of the condition is printed, and calculations are skipped. If they form more than one closed loop, another message is printed; however, in this case, calculation is allowed to proceed.

Data for a valid region is used in subroutine CALC, which computes the area and centroid coordinates. Subroutine POLYPT then determines whether or not the centroid lies within the region boundary. If it lies outside

the boundary, an appropriate message is printed, and the centroid X and Y coordinates are set equal to those of the nearest boundary segment node. Subroutine REFMT reformats the data into a file which can be used by PIOS.

There are a maximum of four output tapes created by DACS. The area and centroid data, with identifying region number, are written onto the first tape, a mapping file onto a second tape, an adjacency file is written onto a third, and PIOS formatted file is written to a fourth tape.

7.3.1 Input. The preprocessor program uses a standard 300 character formatted DIME file or a binary file depending on the user specification and the control parameters. The control parameters are read as cards and passed to the second program as the first input record.

7.3.2 Output. Four output files can be produced by DACS. A file of polygon areas and centroids is created in each run as a standard output. The remaining files are optional, and a mapping file, an adjacency file and a PIOS formatted file.

The mapping file consists of endpoints or vertices of each region's boundary segments. The record to describe a polygon is written in succession and in a format usable by SYMAP.

The adjacency file lists all regions bordering the region analyzed; one adjacent region is listed per record, and all records pertaining to a region occur in succession.

The PIOS compatible file is an 80 character file similar to the mapping file, but is formatted differently. Each polygon has a description record, minimum and maximum X, Y coordinates and the vertices written as four per record.

DACS will also list the polygon's area, and its centroid coordinates — or an adjacency list at the user's request.

The user is continuously notified of error conditions. Possible error conditions include improperly defined regions and anomalies in centroid location, as well as errors in the coding of the original DIME file.

Possible file error conditions can occur because:

a) The polygon has more than 2000 segments.

b) The segments form more than one polygon.

c) The segments do not close.

d) A segment on the file must be reversed before proceeding with processing.

e) The centroid of the polygon falls outside the polygon and must be adjusted.

The polygon only stops processing in case a) or c); in all other cases a warning is printed and processing continues.

7.4 Phase I Specifications:

DACS preprocessor, Phase I, has two input types: a card deck and the tape file. The card deck passes control specifications to the program to determine the input and output selections, and the area of study. The first card, the problem card, selects the user options. This is followed by a series of cards which selects the required census tracts, blocks, etc. contained in the study area.

If SELECT cards are included, the program performs calculations only for the regions identified by the cards; if REJECT cards are included, it considers all regions except those identified. If neither SELECT nor REJECT cards are used, the program calculates areas and centroids for all regions in the file.

Input: Profile Cards

File — Type of input file

1-6 character or binary

KALL — Type of region to be considered

11-14 TRCS for tracks

BLKS for blocks

RGNS for regions identified by area codes

BGPS for block groups; if left blank, the program assumes tracts are desired.

CODE – Type cards used to define the study area,

19-24 selection or rejection

SELECT if selection cards follow

REJECT if rejection cards follow

Blank if neither selection nor rejection cards are included.

ELECT – Type of region specified on selection or

27-30 rejection cards to follow.

TRCS for tracts

BLKS for blocks

RGNS for regions identified by area codes

BGRP for block groups

Blank if no cards are included.

AREA – Units in which area is to be calculated

46-49 SQFT for square feet

SQMI for square miles

ACRE for acres

If left blank, the program will calculate areas in square feet

OPTION – Optional output file specified.

59 1 if printout of areas and centroids desired

0 if printout not desired

60 1 if tape with SYMAP boundary coordinates desired

0 if tape not desired

61 1 if "adjacency list" is to be produced (tape and printer)

0 if "adjacency list" not desired.

62 1 if tape with PIOS boundary coordinate desired

0 if tape not desired.

TITLE – Title that will appear at the top of each page of

69-80 printed output.

```
COL          6      14          24      30      49     62 69          80
    BINARY  TRCS  SELECT  TRCS  SQFT  0100  CENSUS---.
```

SELECTION/REJECTION CARDS. ONE CARD

For each tract, block, or region to be selected or rejected.

If regions specified are tracts:

1-3	Blank
4-9	Tract number

If regions specified are blocks:

1-6	Tract number
7-9	Block number

If regions specified are identified by area code:

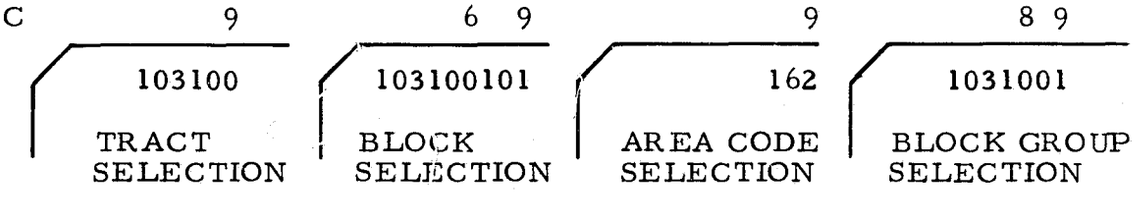
1-6	Blank
7-9	Area Code

If regions specified are block groups

1-2	Blank
3-8	Tract number
9	Block group number

Restrictions and Assumptions

Number of selection/rejection cards = 2000.
Number of boundary segments for any region specified = 2000



Input: tape

A standard Census Bureau tape is the second input to DACS preprocessor. The program will accept either a standard 300 byte character file or a 324 byte binary file as input.

Output: tape

The output from DACS preprocessor is an intermediate tape file with information about output options and a description of all boundary segments selected from the original ACG-DIME File.

The first record of the tape is the control record.

Format is as follows:

Columns	Format	Data Item
19-29	F11.0	Multiplier, to convert calculated area to proper units.
30-33	A4	Units (SQFT, SQMI, or ACRE)
34-37	A4	Region type (TRCS, BLKS, BGRP, or RGNS)
38-41	4I1	Code to specify selection of output options
42-53	3A4	Title, to appear on output page

The remainder of the records describe the boundary segments.

Boundary segments are those having different "right" and "left" regions. Data for each such segment in the original file is written twice on the intermediate tape-once with its original orientation, once with orientation reversed (i.e., with "left" and "right," "from" and "to" designations switched).

Format for each segment record is as follows:

Columns	Format	Data Item
1-9	I9	"Left" region
10-18	I9	"Right" region
19-27	I9	Segment serial number
28-37	I9	"From" node
38-47	I9	"To" node
48-57	I9	"From" node x coordinate
58-67	I9	"From" node y coordinate
67 bytes		Record length

7.5 Phase II Specifications:

Before it is used as input to the DACS calculation program, the tape must be sorted by "left" region (Columns 1-9).

7.6 Phase III Specifications:

The calculation program requires very little user involvement with the exception of JCL requirements.

Input: The calculation program accepts the output file from the sort step directly without modification.

Output: The program has one output tape that is standard with three additional optional tapes.

Area-centroid tape is a file with the polygon area and its centroid produced on each run. The record format is as follows:

Columns	Format	Data Item
1-10	I10	The key used in the selection of block, track, block group, block or right justified block group is preceded by tract number or local area.
11-30	F20.5	Area (in user-specified units)
31-40	I10	Centroid "x" coordinate (map miles)
41-50	I10	Centroid "y" coordinate (map miles)

Record length = 50 bytes.

The "computer mapping" option produces a tape with coordinates of end point modes of each region's boundary segments, all pertaining to a particular region occurring in succession. Output is written to File 11.

Record format as follows:

Columns	Format	Data Item
11-20	F10.0	"From" note y coordinate.
21-30	F10.0	"From" node x coordinate.
70-76	I7	Number of left-hand tract, block, block group, or local area.
77-80	I3	Sequence number of segment in the list of boundary segments for the region.

Record length = 80 bytes.

The "adjacency list" tape option produces a tape containing a list of all regions (blocks, tracts, block groups, or special local areas) bordering on each region considered. One adjacent region is listed per record, and all records pertaining to a particular region occur in succeeding records. Output is written to File 12.

Record format is as follows:

Columns	Format	Data Item
1-15	I15	Region number
15-30	I15	Adjacent region number

Record length = 30 bytes.

The "PIOS data file" tape has three record types; description record, minimum maximum coordinates, and polygon boundary record. Output is written to File 13, Record format is as follows:

Record Type 1

Columns	Format	Data Item
1-5	I5	Census tract ID deleting first digit of suffix.
6-10	I5	Block ID deleting first digit of suffix.
11-13	A3	Block ID — first three numbers
14-17	I4	Sequence number.
18-19	I2	Polygon type

Record Type 2

Columns	Format	Data Item
1-9	I9	Minimum x coordinate
10-18	I9	Minimum y coordinate
19-27	I9	Maximum x coordinate
28-36	I9	Maximum y coordinate
37-41	I5	Number of coordinate pair describing polygon.

Record Types

Columns	Format	Data Item
1-9	I9	X Value
10-18	I9	Y Value
19-27	I9	X Value
28-36	I9	Y Value
37-45	I9	X Value
46-54	I9	Y Value
55-63	I9	X Value
64-72	I9	Y Value

Printed Output

For the properly defined regions considered, the user may request a printout of area and centroid coordinates and/or a polygon adjacency list.

8.0 POLYGON INTERSECTION OVERLAY SYSTEM (PIOS)

8.1 Introduction:

The polygon overlay program is part of the PIOS (Polygon Intersection Overlay System); it uses output data from the ROTATE and CHAIN programs to compute statistics for major and minor polygon intersections. PIOS was originally developed for the San Diego Comprehensive Planning Organization (CPO by Environmental Systems Research Institute (ESRI) of Redlands, California). The system was designed and implemented in 1971 under a contract from CPO to ESRI to digitize soils polygons for San Diego County and then quantify soils type within Traffic Analysis Zones (TAZ), which are nominal statistical areas used for planning purposes by CPO.

This documentation describes the program logic and the data files of the Polygon Information Overlay System program Version 75, (PIOS-75). This version includes the modifications which the Jet Propulsion Laboratory has made to PIOS II, in order to accommodate a specific land use polygon overlay problem. This modified version retains PIOS II, which was created for the CPO in San Diego. PIOS-75 will run on either the Univac 1108, or the IBM 360/370 computers.

8.2 Methodology:

PIOS numerically overlays any general set of ordinarily defined polygons. These are identified as a major and a minor polygon, and their overlay produces a residual polygon of their intersections. This residual polygon can be overlaid with a third polygon, and so forth, each overlay producing a residual polygon of common intersection. This overlay system is conceptually similar to a "cookie cutter."

The census blocks are the major polygons in the overlay technique employed in LUMIS. In the Los Angeles test eight digitized ordinal maps became the minor polygons. Major polygons, after processing with the polygon overlay software, contained the information overlaid from the minor polygon. These minor polygons while proposed were never created from land use and natural resource maps, slope maps, elevation maps, geology maps, landslide and fault maps, soil maps, and air pollution indices.

PIOS reads all minor (land use) polygons and stores their approximate location, i.e., the minimum and maximum boundaries or window. The window technique allows complex polygons to be treated as boxes which are sorted and manipulated in their general format until a more accurate definition is required. This technique permits more efficient computational analysis of a complex polygon file.

Having windowed the minor polygon file and stored it in a temporary direct access file, the program reads the major polygon file (census blocks). Before any analysis of overlapping polygon takes place the program breaks up the major polygon into strips (see Figure 14). New points are generated at strip boundaries so that each strip is wholly contained.

The logic of this stripping technique is not unique, but it does provide for substantial increase in program efficiency. Briefly the strips reduce the amount of core storage required by the program by only retaining that portion of the polygon that is being analyzed for intersection at one time. The number of strips is determined by the tradeoff between efficiency gained in the processing, and the core storage requirements necessary to run the program. As the complexity of polygons increases, the efficiency gained by increasing the number of strips also increases. The point-in-polygon technique uses directed line segments in the positive X-direction of slope zero; line segments so directed will not cross over onto another strip. For the LUMIS test the major polygons were broken down into 16 strips of equal height.

After the major polygon (census block) has been stripped a minor polygon (land use) is read in to compute the intersection points, if any. Each point in the minor polygon is tested for being in or out of the major polygon.

If the minor polygon is determined to be inside the major polygon, there are three possible options.

Case 1 – The land use polygon is completely and totally contained within the census tract polygon.

Case 2 – The census tract polygon is completely contained within the land use polygon.

Case 3 – Part of the land use polygon resides within the census tract polygon, and a residual polygon is formed.

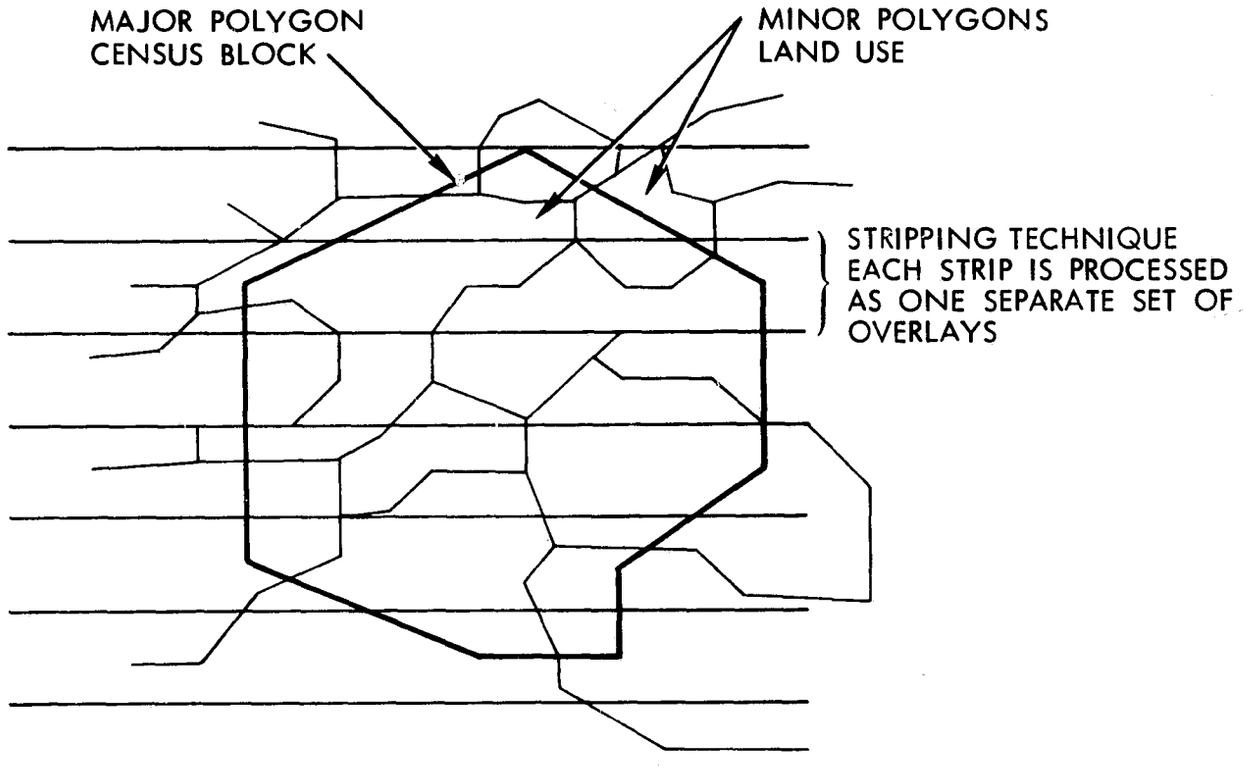


Figure 14. PIOS Stripping Method

In Case 1, PIOS-75 writes the entire land use polygon to the output file. In Case 2, the entire census tract polygon is written to the output file. In Case 3, PIOS-75 effectively cuts off and saves the part of the land use polygon which resides within the census tract. By creating two residual polygons from the original minor polygon, Figure 15 geographically displays Cases 1-3.

In Case 3, each segment of a minor polygon must be analyzed individually for being either completely inside, completely outside, or intersecting the major polygon. If the segment intersects the major polygon, it is entering or leaving. This is graphically pictured in Figure 16.

Four possible actions taken are tabulated below:

Example	Action Taken
A to B	Throw away point A. Do not consider segment as part of polygon.
B to C	Find intersection B'. Determine direction on major polygon. Follow major polygon until it goes out of minor polygon F'.
C to D D to E E to F	Add points to the line segment defining the new polygon being calculated.
F to G	Find intersection F'. Determine direction on major polygon. Follow major polygon until it goes out of minor polygon B'.

After selecting one of these actions, a new polygon is developed and subsequently computed for area.

PIOS-75 will examine each land use polygon in sequential order while looking for a match. If after checking all land use polygons no match is found, the main program will request the next census tract to be read in for the same review. If it finds no match between any land use polygon and census tract polygon, the program will terminate.

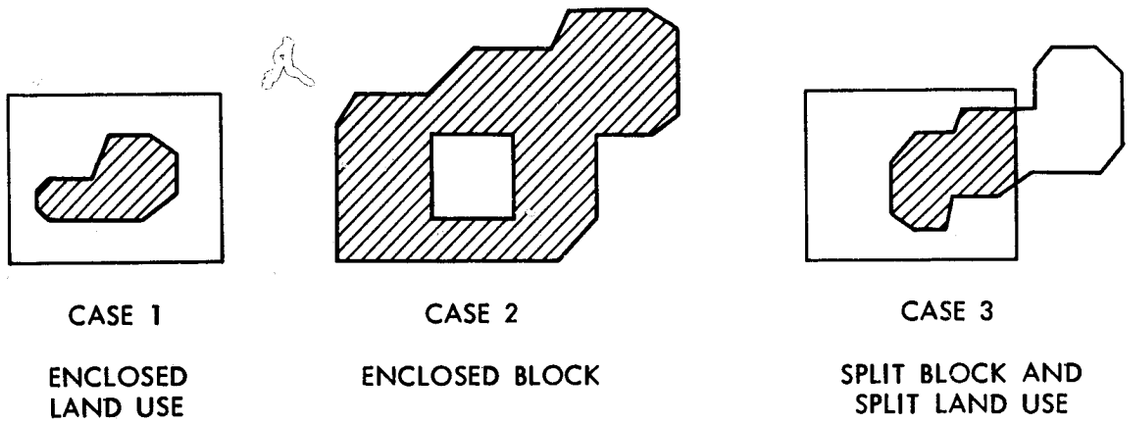


Figure 15. Example of Alternative Block and Land Use Intersections

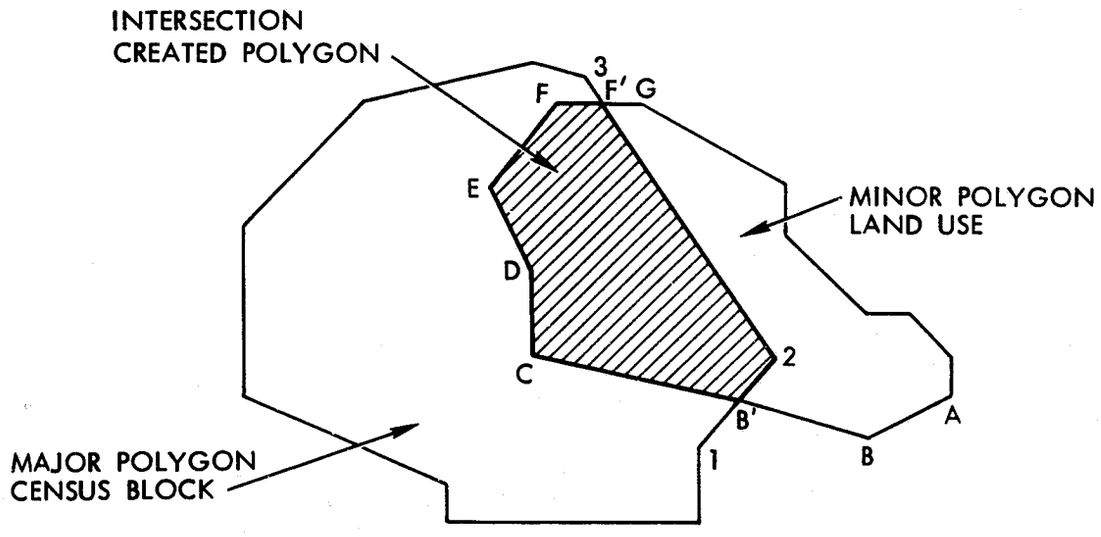


Figure 16. An example of identifying unique polygons created by intersecting blocks and land use

As part of the JPL improvements to PIOS, the program lists census tracts and blocks, the residual land use area, and percentage each makes of the entire tract per each run. The listing also includes those tracts for which no overlay was possible as well as those for which the entire census tract fell into one minor polygon. Further abstractions or summaries can be derived from the output listing to meet the users needs.

The summary can be used as a preliminary means of checking for errors in the PIOS run. A better means for error checking is to sum all the residual areas and check the total against the original polygon as illustrated in Figure 17. A second supplemental program is provided for error checking. The second program uses as input the original minor polygon file (12) and the residual polygon file (14).

The residual file must first be sorted by land use map and code, polygon number, census tract and block. The program will aggregate and list the residual polygon coded for a land use map and type and number. If the entire land use was overlaid, the listings should show the polygon as 100% overlayed by blocks. In case of partial overlay, the results can be used to estimate the amount of coverage.

8.3 Program:

PIOS is used to determine the common area of two overlapping polygons. The program will overlay one or more "major" polygons onto the "minor" polygon file. Each major polygon is compared with each minor polygon for possible overlap. Both the major and minor polygons have a predefined "window" associated with them in the form of minimum and maximum X and Y coordinates. If the major and minor "windows" overlap, then the program uses a specialized version of the relatively common point-in-polygon technique to determine if any overlap actually exists. If two polygons do overlap, a polygon representing the overlap area is structured using the existing coordinates of the major and minor polygons. Once the structuring process is complete, the area of the new polygon is calculated and sorted in a "residual" polygon file for later use in tabular or graphic report generating programs. This process is illustrated in Figure 18.

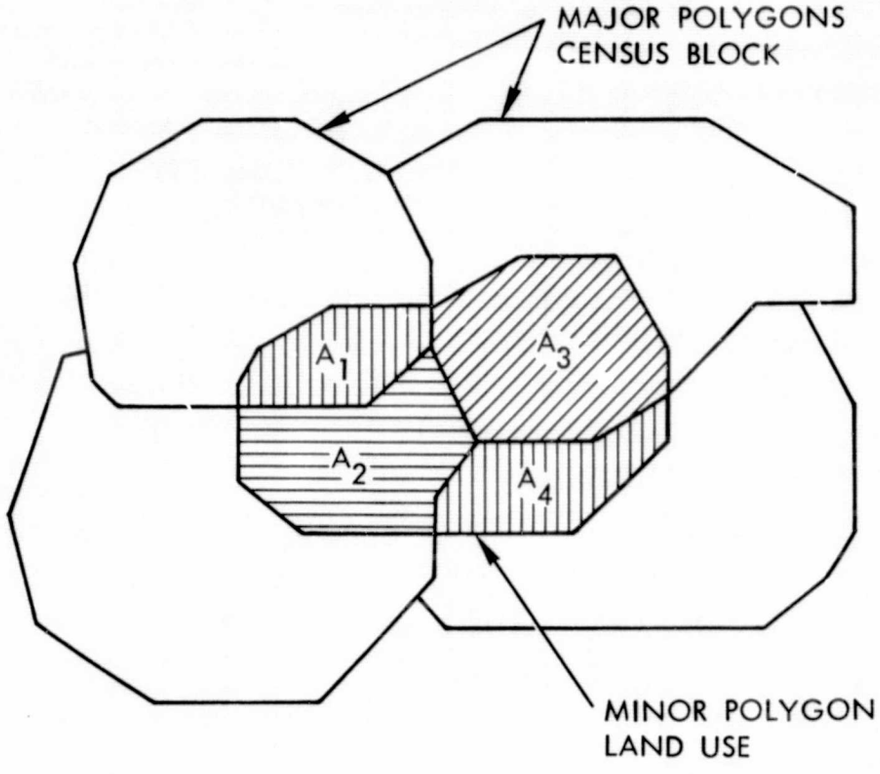


Figure 17. Reconstruction of Minor Polygons from Multiple Intersection Polygons ($A_1 + A_2 + A_3 + A_4$)

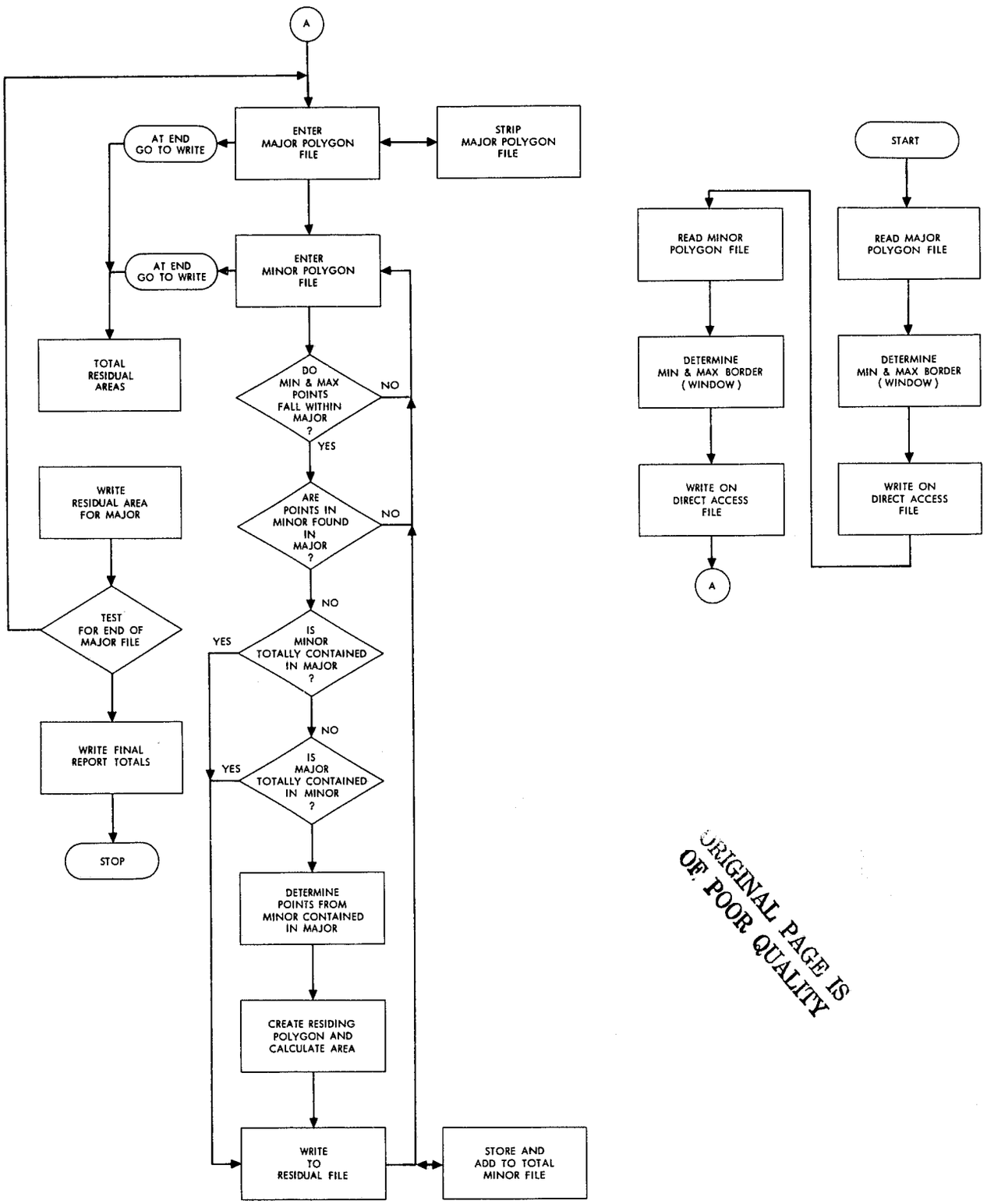


Figure 18. Flow Chart PIOS Program

The program is written as a series of FORTRAN IV subroutines invoked by the main program DRIVER.

Subroutine POLYRD (polygon read) is used to read each of the polygons in from the external file storage medium. The subroutine makes use of random-access techniques for reading both the major and minor polygon files. It also performs the function of calculating centroids from the coordinate arrays of simple and containment type polygons.

The function LEVEL is used to provide level indicies for the polygon overlay procedure. Major polygons are "stripped" into 16 horizontal sections or levels. When the points in the minor polygon boundary are submitted for the point-in-polygon examination, the levels of the major polygon could potentially contain the minor point. Then, only the line segments which make up that level are used by the PIP subroutine.

Subroutine PIP (point-in-polygon) determines whether a point on the minor polygon boundary is located inside or outside of the major polygon boundary. Establishing this relationship for each of the minor polygon vertices is the foundation of the overlay process.

Subroutine STPSUB (step subroutine) is used in conjunction with the residual structuring process. In cases where the direction of digitizing is not known and an intersection of major and minor boundaries is encountered, this subroutine provides an indication of the direction to "step" next.

Subroutine AREAOF is called by subroutine POLYRD to determine the area of a polygon, using the cross product. It also determines if the polygon has been digitized in the correct clockwise direction by the sign of the resulting area. If the polygon was digitized in the wrong counterclockwise direction, the polygon is reversed.

8.4 Input Files:

The input files to the polygon overlay program are both in the same format. The files are differentiated by the program in that one is considered as the major file, the other as the minor file. The choice of which is the major file is the users'. The major polygons are usually the larger polygons, and the minor polygons would normally be those that are wholly or partially

contained within the major polygon. The major polygon file is identified as File 11 and the minor polygon file is File 12. Polygons from File 12 are matched up with, or overlayed upon, data from File 11. In the LUMIS project the census block was the major polygon file and land use was the minor polygon file. Figure 19 illustrates the deck setup for PIOS.

PIOS will process both simple and complex polygons. "Doughnut holes" within complex polygons will be written to the output file with negative acreages. This facilitates later summation processes and tabular reporting requirements. The only limitation on input files is that if a minor polygon file contains more than 1,000 polygons, only the first 1,000 will be used in the overlay process. Larger files can be processed by enlarging the internal storage arrays in the polygon overlay program, which increases the core storage requirements.

8.5 Output Files:

The three files created by the PIOS are similar in content and somewhat redundant: The residual file, File 14, is a polygon file that contains the areas that were found to be common between the major and minor polygons. Each polygon contains the tract and block number of the major polygon and the land use code, polygon number and type code of the minor polygon, the calculated area of the polygon (in acres) and the coordinates of the polygon verticies.

The second output file, File 13, is a condensed version of the residual file. It contains the same information for each polygon as the residual file but the boundary coordinates are excluded. This file is more efficiently used in tabular summation programs and reporting applications than the residual file.

The third output file, File 15, is a condensed version of the census tract file. It contains the census tract and block identification and total area of census blocks.

8.5.1 File 11 — Major polygon file. It is a direct access file with census tract and block records. The file contains records 80 characters in length. Each census block is made up of three record types: a descriptor record, a MIN/MAX record, and the boundary points.

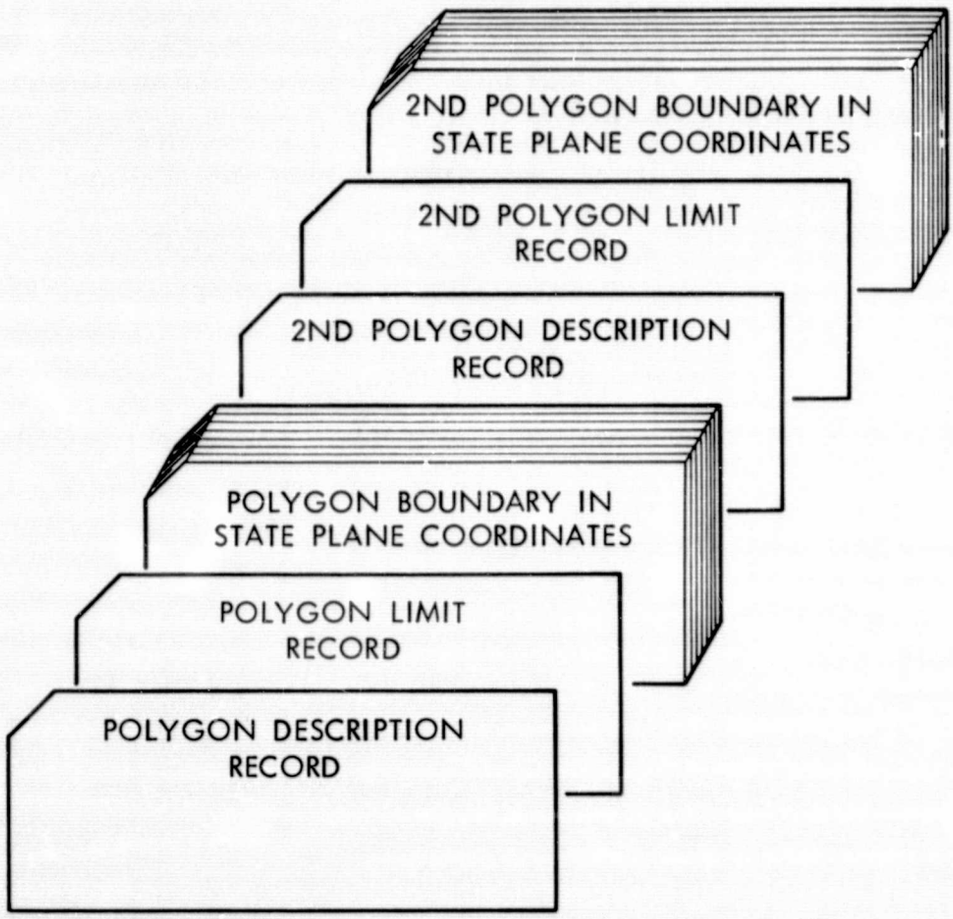


Figure 19. Major or Minor Polygon File Required by PIOS

The major polygon descriptor record contains basic identification information to describe the minimum and maximum points and the boundary record to follow. The following data names are used by the program:

MAPNO: The census tract identification number is the census tract number with the first number of the suffix deleted. Since this number is always zero, it can be deleted to save space in later processing.

MAPOL 1 (2): or LUCODE (2): The block number identification number is the census block number with the first number of the suffix deleted. As in the case of the census tract, this number can be deleted without losing information.

LUCODE (1): The block number is repeated in this space dropping the entire suffix. This number serves as a filler in processing the census tract file, but is important in processing the minor file.

LUCODE (3): The map sequence number denotes the sequence in relation to all the census tracts coded in a map.

MAPOL 1 (2): The polygon-type code describes the character of each polygon. A normal polygon is coded 10. Doughnut polygons, (polygons within polygons) are coded by numbers larger than 10, starting with 11. Two mutually exclusive doughnut holes are coded 11, while nested polygons follow in order: 11, 12, --. All digitized doughnut holes must follow the parent.

COL	5	10	13	17	19
	13511	1010	101	2	10

8.5.2 File 12 — Minor polygon file. It is a direct access with the land use or ordinal polygons. The file contains records 80 characters in length. Each land use polygon is described by three record types similar to the census tract input with minor modifications and different data names.

The record 1 minor polygon descriptor record contains basic identification information for the minimum and maximum points and boundary records to follow.

The following data names are used in the Program:

SPMAP: The identification number of the ordinal/land use map that is being processed.

SPPOLY (1): The total numbers of polygons coded using a map
or identification number.
SPCODE:

SPCODE (1): The identification code identifies the land use type as defined in the land use map legend.

SPCODE (3): The sequence number denotes the sequence in relation to the total number of polygons coded in a map.

SPPOLY (2): The polygon-type code describes the character of each polygon. A normal polygon is coded 10. Doughnut polygons (polygons within polygons) are coded by numbers larger than 10, starting with 11. Two mutually exclusive doughnut holes are coded 11, while nested polygons follow in order: 11, 12, --. All digitized doughnut holes must follow the parent.

COL	5	10	13	17	19
	17401	80	X03	60	10

8.5.3 Record 2 major/minor – min/max record. The Min/Max Record describes the extreme points of the polygon or the Minimum X and Y coordinate and the Maximum X and Y coordinate, and the number of coordinate pairs which will follow to describe the polygon's perimeter.

Column	Format	Data Item
1-9	I9	xmin - The minimum x coordinate value of the polygon
10-18	I9	ymin - The minimum y coordinate value of the polygon
19-27	I9	xmax - The maximum x coordinate value of the polygon
28-36	I9	ymax - The maximum y coordinate value of the polygon
37-41	I5	n - The number of coordinate pairs describing the polygon

8.5.4 Record 3 to 3+N/4 pairs major/minor record. Polygon boundary record (S) - This set of records describes the polygon boundaries in terms of x and y coordinate pairs starting with x, y to x, y

Column	Format	Data Item
1-9	I9	x value
10-18	I9	y value
19-27	I9	x value
28-36	I9	y value
37-45	I9	x value
46-54	I9	y value
55-63	I9	x value
64-72	I9	y value

8.5.5 End of File records. A sequence of four 9's (9999) is recognized by the IBM 360/370 program as an end of file when located in bytes 1-4. A sequence of five 9's (99999) is recognized by the U1108 program as an end of file when located in bytes 1-5. The last two records of each direct access file (File 11, 12, 13 and 14) should contain these codes.

8.6 Output:

File 13 contains the residual polygon produced by the PIOS Program. Each record is stored on a direct access device as a 37-character record. The record incorporates the residual polygon census tract identification with the land use codes and the polygon area. The record output is in the following format:

Column	Format	Data Item
1-5	I5	Census tract numbers of major polygon involved in the overlay.
6-10	I5	Block number of major polygon involved in the overlay.
11-15	I5	Land use map or minor polygon in overlay.
16-18	A3	Land use identification information code.
19-22	I4	Polygon sequence number or land use involved in the overlay.
23-37	F15.2	Area of the residual polygon file.

File 14 contains essentially the same descriptive information as File 13, the census tract and land use code in an 80-column format. It adds to this information a series of x and y coordinates that describe the residual polygon that is formed in the overlay process.

8.6.1 Record 1

Column	Format	Data Item
1-5	I5	Census Tract
6-10	I5	Census Block number
11-15	I5	Land use map
16-18	A3	Land use map identification code
19-22	I4	Sequence number of the land use polygon
23-37	F15.2	Area of the residual polygon
38-80		Blank

Polygon Boundary Coordinate Pairs

8.6.2 Record 2 thru 2+N/4

Column	Format	Data	Item
1-9	F9.1	X_1	Value
10-18	F9.1	Y_1	Value
19-27	F9.1	X_2	Value
28-36	F9.1	Y_2	Value
37-45	F9.1	X_3	Value
46-54	F9.1	Y_3	Value
55-63	F9.1	X_4	Value
64-72	F9.1	Y_4	Value

File 15 is the second abbreviated file produced by PIOS. This file contains the same identification information found on the census tract descriptor record: tract, block, and sequence number.

Census tract area calculated in the PIOS Program is added forming the final data item on the record. The record is 29 characters in length and written on a direct access device in the following format:

Column	Format	Data Item
1-5	I5	Census tract number of major polygon
6-10	I5	Block number of major polygon
11-14	I4	Sequence number of block with census tract
15-29	F15.2	Area of the block

APPENDIX I

SPCCAL PROGRAM LISTING

```
C   STATE PLANE COORDINATE CALCULATION PROGRAM (SPCCAL)
    5 FORMAT (I5)
   10 FORMAT (I10,I5)
   15 FORMAT(- GENERAL MAP NO.-,I10)
   30 FORMAT (8F10.1)
   32 FORMAT (- CONTROL POINT-,1X,I2)
   35 FORMAT (4F10.8)
   40 FORMAT (2F10.1)
   45 FORMAT (-****************-)
   50 FORMAT (-  -)
   70 FORMAT (- **********************************-)
   80 FORMAT (- CONTROL POINT EXCEEDS ERROR FACTOR-)
   90 FORMAT (2F10.1,4X,-ERROR-)
C
C  INPUT NUMBER OF MAPS FOR WHICH THE CONTROL POINT SPC S ARE TO BE CALCULATED.
C
    1 READ (5,5) NUMAP
      DO 8 J=1,NUMAP
      WRITE (6,70)
      WRITE (6,50)
C
C  INPUT THE MAP NUMBER (MAPNO) AND TOTAL NUMBER OF CONTROL POINTS (NCONPT)
C
      READ (5,10) MAPNO, NCONPT
      WRITE (6,15) MAPNO
      WRITE (6,50)
      DO 20 I=1, NCONPT
C
C  THE X1, X2, X3, X4, Y1, Y2, Y3, Y4 SPC COORDINATES OF THE FOUR 2 1/2 MINUTE
C  LATITUDE-LONGITUDE INTERSECTIONS ARE READ IN.
C
      READ (5,30) A,B,C,D,E,F,G,H
      WRITE (6,32) I
      WRITE (6,50)
C
C  THE (SMALL LETTER X,Y) X1, X2, Y1, Y2 DIGITIZER MEASURED DISTANCES ARE READ
C
C  O=X1
C  P=X2
C  Q=Y1
C  R=Y2
C
      READ (5,35) O,P,Q,R
      O = O*2000.
      P = P*2000.
      Q = Q*2000.
      R = R*2000.
```

```
      X1 = A+O+(Q/(Q+R))*(C-A)
      X2 = C+O-(R/(Q+R))*(C-A)
      X3 = B-P+(Q/(Q+R))*(D-B)
      X4 = D-P-(R/(Q+R))*(D-B)
      Y1 = E+Q-(O/(O+P))*(E-F)
      Y2 = F+Q+(P/(O+P))*(E-F)
      Y3 = G-R-(O/(O+P))*(G-H)
      Y4 = H-R+(P/(O+P))*(G-H)
      Z1 = (X1+X2)/2.0
      Z2 = (X3+X4)/2.0
      Z3 = (Y1+Y2)/2.0
      Z4 = (Y3+Y4)/2.0
      Z5 =DABS(Z2-Z1)
      Z6 =DABS(Z4-Z3)
      IF (Z5 .GT. 30.0) GO TO 60
      IF (Z6 .GT. 30.0) GO TO 60
      T1 = (X1+X2+X3+X4)/4.0
      T2 = (Y1+Y2+Y3+Y4)/4.0
      WRITE (6,40) X1,Y1
      WRITE (6,40) X2, Y2
      WRITE (6,40) X3,Y3
      WRITE (6,40) X4,Y4
      WRITE (6,50)
      WRITE (6,40) Z5,Z6
      WRITE (6,50)
      WRITE (6,40) T1,T2
      IF (I .EQ. NCONPT) GO TO 43
      WRITE (6,45)
   43 WRITE (6,50)
      GO TO 20
   60 WRITE (6,80)
      WRITE (6,50)
      WRITE (6,40) X1,Y1
      WRITE (6,40) X2,Y2
      WRITE (6,40) X3,Y3
      WRITE (6,40) X4,Y4
      WRITE (6,50)
      WRITE (6,90) Z5,Z6
      IF (I .EQ. NCONPT) GO TO 44
      WRITE (6,45)
   44 WRITE (6,50)
   20 CONTINUE
    8 CONTINUE
      STOP
      END
```

```
C
C  ***** SAMPLE DATA *****
C
     2
     17002    5
 4111065.3 4123669.9 4111102.5 4123700.8 4173149.8 4173121.4 4188312.8 4188284.5
     4.003     2.308      .160     7.432
 4111065.3 4123669.9 4111102.5 4123700.8 4173149.8 4173121.4 4188312.8 4188284.5
     5.566      .744     1.892     5.701
 4123638.9 4136249.6 4123669.9 4136274.4 4157958.5 4157935.3 4173121.4 4173098.3
     2.193     4.110     5.703     1.881
 4136249.6 4148860.4 4136274.4 4148878.9 4157935.3 4157917.3 4173098.3 4173080.3
      .780     5.527     7.075      .497
 4136249.6 4148860.4 4136274.4 4148878.9 4157935.3 4157917.3 4173098.3 4173080.3
     3.740     2.569     3.796     3.776
     17003    5
 4136249.6 4148860.4 4136274.4 4148878.9 4157935.3 4157917.3 4173098.3 4173080.3
     5.315      .998     4.287     3.288
 4148860.4 4161471.1 4148878.9 4161483.5 4157917.3 4157904.5 4173080.3 4173067.4
      .270     6.042     4.977     2.599
 4148860.4 4161471.1 4148878.9 4161483.5 4157917.3 4157904.5 4173080.3 4173067.4
     1.598     4.714     7.242      .333
 4148860.4 4161471.1 4148878.9 4161483.5 4157917.3 4157904.5 4173080.3 4173067.4
     1.930     4.381     3.705     3.869
 4148860.4 4161471.1 4148878.9 4161483.5 4157917.3 4157904.5 4173080.3 4173067.4
     4.244     2.067     4.188     3.387
```

APPENDIX II

PLOTTER EDITING PROGRAM LISTING

General Map Case

```
      INTEGER PTYPE,POLYNO
      DIMENSION XD(6000),YD(6000),STATEP(16),FRM(2)
      READ(5,500)JOE
      IF( JOE.EQ.999 .OR. JOE.EQ.777)GO TO 5
C- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  500 FORMAT(I4)
  600 FORMAT(1H ,10X,I4,I5)
 1000 FORMAT(2I5,A3,I4,I2)
 1002 FORMAT(4F6.3,I5)
 1004 FORMAT(12F6.3)
 1006 FORMAT(A5,2X,I3)
 1008 FORMAT(9X,I1)
 2000 FORMAT(1H0,10X'MAPNO  MAPOL  UCODE  POLYNO  PTYPE'/
     $ 1H , 9X,I6,   I5,5X,A3,4X,I4,5X,I2/1H ,9X,35('-') )
 2001 FORMAT(1H ,1X,'CONTROL POINTS*',7(2F7.3,2X) )
 2002 FORMAT(1H ,10X,'XMIN    YMIN    XMAX    YMAX   NP=',I4,
     * 5X,'**COUNTED**',I4,'**',
     $/1H ,6X,4F8.3)
 2003 FORMAT(1H ,2X,90('-') )
 2004 FORMAT(1H0,10X'DIGITIZED POINTS BY CARDS/LINE')
 2005 FORMAT(1H0,2X,'PLOTTING')
 2006 FORMAT(1H ,10X,I4,'*', 6(2F7.3,2X) )
 2007 FORMAT(1H1,2X,A5,2X,A5,2X,A5/1H ,2X,'----------------------')
 2008 FORMAT(1H0,60('* ') )
C- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
C
      CALL PLOTS(0,0,20)
      CALL PLOT(0.0,-10.0,-3)
      CALL PLOT(0.0, 1.50,-3)
      IM = 3
    5 IFRAME = 0
      IF( JOE.EQ.999)GO TO 1
C
C
    2 READ(5,1006,END=900)ITITLE,ISKIP2
      IF( JOE.EQ.777)GO TO 3
      CALL SYMBOL(0.0,-0.218, 0.1875,ITITLE, 0.0, 5)
      CALL NEWPEN(2)
      ENCODE(709,IADDR),IM
  709 FORMAT('AT-',I2)
      CALL SYMBOL( 0.950, -0.218, 0.1875, IADDR, 0.0, 5)
      IM = IM + 1
    3 IFRAME = 0
      IERR=0
      XM = 999.000
      YM = 999.000
      XMX = -999.000
      YMX = -999.00
      WRITE(6,2007)ITITLE,ITITLE,ITITLE
      REWIND 25
C
C
      READ(5,1008,ERR=900,END=900)ISTART
      IF( ISKIP2.EQ.999) READ(5,1004) (XD(N),N=1,14)
      IRN = ISTART*2
      READ(5,1004)(STATEP(I),I=1,IRN)
      DO 12 I = 1,IRN,2
      XM = MIN( XM,STATEP(I) )
      YM = MIN( YM,STATEP(I+1) )
   12 XMX = MAX(XMX,STATEP(I) )
      WRITE(6,2001)( STATEP(I),I=1,IRN)
```

```
      WRITE(6,2003)
C
C
    1 IF( IERR.EQ.999)GO TO 9
      READ(5,1000,END=9,ERR=900)MAPNO,MAPOL,LUCODE,POLYNO,PTYPE
      GO TO 7
    6 READ(0,1000,END=9,ERR=900)MAPNO,MAPOL,LUCODE,POLYNO,PTYPE
    7 IERR = 999
      READ(5,1002          )XMIN,YMIN,XMAX,YMAX,NP
      XM = MIN(XM,XMIN)
      YM = MIN(YM,YMIN)
      XMX = MAX(XMX,XMAX)
      IF( JOE.EQ.999)WRITE(6,600)J,NP
      IFRAME = IFRAME + 1
C
C
      J = 0
      DO 13 L = 1,6000,6
      M = L+5
      I = L
      READ(5,1004,ERR=14,END=16) ( XD(N),YD(N),N=I,M)
   13 J = J + 6
      GO TO 16
   14 IERR = 1
   16 N = J-6
      DO 15 I=N,J
      IF( XD(I+1))15, ,15
      J = I
      GO TO 4
   15 CONTINUE
C
C
    4 IF( JOE.EQ.999)GO TO 1
      IF( JOE.EQ.888)GO TO 8
      WRITE(6,2000)MAPNO,MAPOL,LUCODE,POLYNO,PTYPE
      WRITE(6,2002)NP,J,XMIN,YMIN,XMAX,YMAX
      WRITE(6,2004)
      NC = 0
      DO 21 N = 1,J,6
      M = N+5
      NC = NC + 1
      IF( M.GT.J)M=J
   21 WRITE(6,2006)NC,( XD(NN),YD(NN),NN=N,M)
      WRITE(6,2008)
    8 WRITE(25)J ,(XD(I),YD(I),I=1,J )
      IF( IERR.EQ.1)GO TO 6
      GO TO 1
C
C
    9 IF( JOE.EQ.999)GO TO 999
      WRITE(6,2005)
      IF(JOE.EQ.777)GO TO 2
      ENCODE(707,FRM)IFRAME
  707 FORMAT(I3,' POLYGONS')
      CALL SYMBOL( 0.0, -.468, 0.125, FRM, 0.0, 12)
      J = 0
      REWIND 25
      CALL NEWPEN(2)
      DO 11 I =1,IRN,2
   11 CALL SYMBOL(STATEP(I)-XM, STATEP(I+1)-YM, 0.1875, 3, 0.0, -1)
      CALL NEWPEN(1)
```

```
   10 READ(25)K ,(XD(I),YD(I),I=1,K )
      J = J + 1
      IPEN = 3
      DO 20 I = 1,K
      IF( XD(I) )20,20,
      CALL PLOT(XD(I)-XM, YD(I)-YM,IPEN)
   20 IPEN = 2
      IF( IFRAME.EQ.J)GO TO 99
      GO TO 10
   99 CALL PLOT(ABS(XMX-XM+2.00),0.0, -3)
      GO TO 2
C
  900 IF( JOE.EQ.777)GO TO 999
      CALL FACTOR(0.5)
      CALL PLOT(2.5, 0.0, 999)
  999 STOP
      END
```

APPENDIX III

PLOTTER EDITING PROGRAM LISTING

MMS Map Case

```
      DIMENSION DATA(14)
      COMMON IONOF
 1002 FORMAT(A3)
 2000 FORMAT(1H0,130('*'))
      READ(5,1002) IONOF
      IF(IONOF .EQ. 'ON') CALL PLOTS
      IF(IONOF .EQ. 'OFF') CALL PLOTS(0,0,20)
      REWIND 27
C                                                              3,1=I 001 OD
      CALL TPLT
      REWIND 25
      REWIND 26
      WRITE(6,2000)
      CALL BNDRY
  100 CONTINUE
      END FILE 27
      REWIND 27
      WRITE(6,2001)
 2001 FORMAT(1H1)
  105 CONTINUE
      READ(27,END=200) DATA
      WRITE(6,2002) DATA
      GO TO 105
  200 CONTINUE
 2002 FORMAT(1H ,14A6)
      CALL PLOT(0.,0.,999)
      END
"TFOR,IS  TPLT,TPLT
      SUBROUTINE TPLT
      COMMON IONOF
      DIMENSION DATA(14)
C
 1000 FORMAT(5XA3,7XA3,2X4F6.3)
 1001 FORMAT(13A6,A2//)
 1003 FORMAT(13A6,A2)
 2000 FORMAT(1H0,5X'POINTS',I5,3X'XMIN,XMAX,YMIN,YMAX =',4F10.3)
 2001 FORMAT(1H0,'BAD POINT',I4,2(3XA3),4F10.3)
 2002 FORMAT(1H ,I4,3XA3,3XA3,F10.3,F9.3,F13.3,F9.3)
 2003 FORMAT(1H0,'LINE  LEFT  RIGHT       XL        YL             XR
     *YR'/)
 2004 FORMAT(1H+,11X'*')
 2005 FORMAT(1H ,14A6)
 2006 FORMAT(1H1,14A6/)
 3001 FORMAT(I3)
C
      DPR=57.2957B
      FACT=1.
      IF(IONOF .EQ. 'OFF') FACT=2.
      HT=.125/FACT
      CALL FACTOR ( FACT )
C
    5 NPTS=0
      REWIND 25
      READ(5,1001,END=400) DATA
      WRITE(27) DATA
      WRITE(6,2006) DATA
      XMIN=1000.
      XMAX=-1000.
      YMIN=1000.
      YMAX=-1000.
    1 CONTINUE
```

```
      READ ( 5,1000, END=200,ERR=2 ) NUM1, NUM2, X1, Y1, X2, Y2
      IF ( NUM1 .EQ. '000' ) GO TO 1
      IF(NUM1 .EQ. ' ' .AND. NUM2 .EQ. ' ') GO TO 1
      IF ( FLD (6,6,NUM1 ) .EQ. '------+' ) GO TO 1
      NPTS=NPTS+1
      XMIN=MIN(XMIN,X1,X2)
      XMAX=MAX(XMAX,X1,X2)
      YMIN=MIN(YMIN,Y1,Y2)
      YMAX=MAX(YMAX,Y1,Y2)
      WRITE(25) NUM1,NUM2,X1,Y1,X2,Y2
      GO TO 1
    2 READ(0,1003) DATA
      WRITE(6,2005) DATA
      GO TO 1
  200 CONTINUE
        IF ( NPTS .EQ. 0 ) GO TO 400
      END FILE 25
      DO 500 I12=1,2
      NL=0
      IF(I12 .EQ. 2) GO TO 202
      YSIZE=YMAX-YMIN
      WRITE(6,2000) NPTS,XMIN,XMAX,YMIN,YMAX
      WRITE(6,2003)
  202 CONTINUE
      CALL SYMBOL(0.,-.25,.140,DATA,0.,60)
      REWIND 25
  201 CONTINUE
      READ(25,END=300) NUM1,NUM2,X1,Y1,X2,Y2
      NL=NL+1
      IF(I12 .EQ. 1) WRITE(6,2002) NL,NUM1,NUM2,X1,Y1,X2,Y2
      IF(I12 .EQ. 2) ENCODE(3001,NL1) NL
      CALL SYMBOL(X1-XMIN,Y1-YMIN,.06,1,0.,-1)
      CALL SYMBOL(X2-XMIN,Y2-YMIN,.06,2,0.,-2)
       AL=SQRT ((X2-X1)**2+(Y2-Y1)**2)
      IF ( AL .GE. 3*HT ) GO TO 203
      IF(I12 .EQ. 1) WRITE(6,2004)
      GO TO 201
  203 XC=(X1+X2)/2.
      YC=(Y1+Y2)/2.
      CALL ANGLE(X2-X1,Y2-Y1,THETA,$205)
      THD=THETA*DPR
      CS=COS(THETA)
      SN=SIN(THETA)
      XOF=1.5*HT*CS
      YOF=1.5*HT*SN
      XOF1=.020*SN
      YOF1=.020*CS
      IF(I12 .EQ. 2) NUM1=NL1
      CALL SYMBOL(XC-XOF-XOF1-XMIN,YC-YOF+YOF1-YMIN,HT,NUM1,THD,3)
      IF(I12 .EQ. 2) GO TO 201
      XOF2=(.020+HT)*SN
      YOF2=(.020+HT)*CS
      CALL SYMBOL(XC-XOF+XOF2-XMIN,YC-YOF-YOF2-YMIN,HT,NUM2,THD,3)
      GO TO 201
  205 WRITE(6,2001) NPTS,NUM1,NUM2,X1,Y1,X2,Y2
      GO TO 201
  300 CONTINUE
      IF(YSIZE*FACT .LT. 16.) GO TO 305
      CALL PLOT(XMAX-XMIN+2.,0.,-3)
      GO TO 500
  305 IF(I12 .EQ. 1) CALL PLOT(0.,YSIZE+1.,-3)
```

```
      IF(I12 .EQ. 2) CALL PLOT(XMAX-XMIN+2.,-YSIZE-1.,-3)
  500 CONTINUE
      GO TO 5
  400 CONTINUE
      RETURN
      END
*TFOR,ISFBT   ANGLE,ANGLE
      SUBROUTINE ANGLE(X,Y,THETA,$)
C
C     SUBROUTINE TO DETERMINE ANGLE (0 TO 2*PI) FROM X-Y PAIR
C
      PI=3.1415926
C
      IF(X)10,20,30
C
C     SECOND OR THIRD QUADRANT
C
   10 IF(Y)11,12,11
   11 THETA=PI+ATAN(Y/X)                    " THIRD QUADRANT
      RETURN
   12 THETA=PI                              " 180 DEGREES
      RETURN
C
C     ON Y AXIS (PI/2 OR 3*PI/2)
C
   20 IF(Y)21,22,23
   21 THETA=1.5*PI                          " 270 DEGREES
      RETURN
   22 RETURN 4                              " DEGENERATE CASE
   23 THETA=PI/2.                           " 90 DEGREES
      RETURN
C
C     FIRST OR FOURTH QUADRANT
C
   30 IF(Y)31,32,31
   31 THETA=ATAN(Y/X)                       "
      IF(THETA .LT. 0.) THETA=2.*PI+THETA
      RETURN
   32 THETA=0.
      RETURN
      END
*TFOR,ISFBT  BNDRY,BNDRY
      SUBROUTINE BNDRY
      DIMENSION DATA(2)
C
 1000 FORMAT(5XA3,7XA3,2X4F6.3)
 1001 FORMAT(6XA6,A1//)
 2000 FORMAT(1H ,A3,4F10.3)
C
C
      DATA HT/.125/
      DATA XMIN,XMAX,YMIN,YMAX/1000.,-1000.,1000.,-1000./
      NPTS=0
      REWIND 25
      REWIND 26
      CALL FACTOR(1.)
    5 CONTINUE
      READ(5,1001,END=400) DATA
      XMN=1000.
      XMX=-1000.
      YMN=1000.
```

```
      YMX=-1000.
    1 CONTINUE
      READ(5,1000,END=200) NUM1,NUM2,X1,Y1,X2,Y2
      IF(NUM2 .NE. ' ') GO TO 1
      IF(NUM1 .EQ. ' ') GO TO 1
      NPTS=NPTS+1
      XMIN=MIN(XMIN,X1,X2)
      XMAX=MAX(XMAX,X1,X2)
      YMIN=MIN(YMIN,Y1,Y2)
      YMAX=MAX(YMAX,Y1,Y2)
      XMN=MIN(XMN,X1,X2)
      XMX=MAX(XMX,X1,X2)
      YMN=MIN(YMN,Y1,Y2)
      YMX=MAX(YMX,Y1,Y2)
      WRITE(25) NUM1,X1,Y1,X2,Y2
      GO TO 1
  200 CONTINUE
      WRITE(26) DATA,XMN,XMX,YMN,YMX
      GO TO 5
  400 CONTINUE
      IF(NPTS .EQ. 0) RETURN
      END FILE 25
      END FILE 26
      REWIND 25
      REWIND 26
  401 CONTINUE
      READ(26,END=410) DATA,XMN,XMX,YMN,YMX
      CALL SYMBOL((XMN+XMX)/2.-XMIN-3.5*HT,(YMN+YMX)/2.-YMIN-.5*HT,HT,
     *  DATA,0.0,7)
      GO TO 401
  410 CONTINUE
  411 READ(25,END=420) NUM1,X1,Y1,X2,Y2
C     WRITE(6,2000) NUM1,X1,Y1,X2,Y2
      CALL SYMBOL(X1-XMIN,Y1-YMIN,.06,1,0.,-1)
      CALL SYMBOL(X2-XMIN,Y2-YMIN,.06,2,0.,-2)
      GO TO 410
  420 CONTINUE
      CALL PLOT(XMAX-XMIN+4.,0.,-3)
      RETURN
      END
```

APPENDIX IV

ROTATE PROGRAM LISTING

```
C YOU MUST DIMENSION THE NUMBER OF ROWS OF A(*,4), THE NUMBER OF COLUMNS    00010
C OF AT(4,*) AND ATAT(4,*), AND THE NUMBER OF COMPONENTS OF B(*) AND       00020
C C(*) EQUAL TO TWO TIMES THE NUMBER OF CONTROL POINTS USED ON MAP         00030
      DOUBLE PRECISION A(12,4), AT(4,12), ATAT(4,12), B(12), C(12),       00040
     1X(12), Y(12), XD(12), YD(12), U(4), ATA(4,4)                        00050
      DIMENSION K1(4), L1(4), THETA(2), THECOM(2,3), IX(12), IY(12)       00060
      INTEGER XX                                                          00070
 10   FORMAT(I5)                                                          00080
 11   FORMAT(8F9.1)                                                       00090
 12   FORMAT(2I5,3F10.3)                                                  00100
 13   FORMAT(12F6.3)                                                      00110
 213  FORMAT(2X,12F7.3)                                                   00120
 14   FORMAT(1H1)                                                         00130
 15   FORMAT(/////,' FOLLOWING IS A CHECK ON THE MAP ROTATION, ORIGIN DI  00140
     1SPLACEMENT, AND SCALING FACTOR')                                    00150
 16   FORMAT(/////,' THE TWO INDEPENDENT SOLUTIONS FOR THE CALIFORNIA ZO  00160
     1NE 7 STATE PLANE COORDINATES OF THE')                               00170
 229  FORMAT(' DIGITIZATION ORIGIN (X0,Y0) AND THE TABLE TO MAP ROTATION  00180
     1 ANGLE THETA ')                                                     00190
 17   FORMAT(//,14X,'X0',19X,'Y0',14X,'THETA')                            00200
 18   FORMAT(/,2F20.1,3X,F4.0,' DEG ',F4.0,' MIN ',F4.0,' SEC')           00210
 19   FORMAT(2I5,A3,I4,I2)                                                00220
 219  FORMAT(1X,2I5,A3,I4,I2)                                             00230
 20   FORMAT(4F6.3,I5)                                                    00240
 220  FORMAT(' THE SCALING FACTOR S = ',F10.1)                            00250
 221  FORMAT(//,' MAP NUMBER, NUMBER OF POLYGONS FOR MAP, LAND USE OR PO  00260
     1LYGON CODE, POLYGON TYPE')                                          00270
 222  FORMAT(//,' FOR THIS POLYGON-MIN X, MIN Y, MAX X, MAX Y, NUMBER OF  00280
     1 POINTS IN POLYGON')                                                00290
 223  FORMAT(//,' ALL DIGITIZED COORDINATES AND TRANSFORMED ZONE 7')      00300
 224  FORMAT(' CALIFORNIA STATE PLANE COORDINATES FOR THIS POLYGON')      00310
 232  FORMAT(' FOLLOW IN GROUPS OF TWELVE PAIRS')                         00320
 233  FORMAT(//)                                                          00330
 225  FORMAT(//,' YOUR X0 ORIGIN REFERENCE SOLUTIONS DISAGREE BY MORE TH  00340
     1AN ',F10.3,' INCHES FOR MAPSETUP ',I5,' FOR CONTROL POINTS ',8I3)   00350
 226  FORMAT(//,' YOUR Y0 ORIGIN REFERENCE SOLUTIONS DISAGREE BY MORE TH  00360
     1AN ',F10.3,' INCHES FOR MAPSETUP ',I5,' FOR CONTROL POINTS ',8I3)   00370
 227  FORMAT(//,' YOUR THETA ROTATION SOLUTIONS DISAGREE BY MORE THAN ',  00380
     1F10.3,' MINUTES FOR MAP SETUP ',I5)                                 00390
 228  FORMAT(4I10,I5)                                                     00400
 329  FORMAT(4I9,I5)                                                      00410
 230  FORMAT(' FOR THESE CONTROL POINTS, THE MAP POSITION IS OFF BY ')    00420
 231  FORMAT(F15.3)                                                       00430
 235  FORMAT(8I10)                                                        00440
 236  FORMAT(8I9)                                                         00450
C     ************************************************************      T0451
C     *                        PHASE  I                          *      T0452
C     *    CALCULATE NORTH-SOUTH ROTATION ANGLE, SCALING FACTOR &*      T0453
C     *    TEST FOR VARIATION IN CONTROL PARAMETERS > THAN TOLERANCE*   T0454
C     ************************************************************      T0455
      READ(5,10) KSET                                                     00460
C                                                                         T0461
C     READ KSET - NUMBER OF MAP SETUPS                                    T0462
C                                                                         T0463
C     BEGIN MAJOR LOOP OF PROGRAM - IBIG                                  T0464
C                                                                         T0465
      DO 100 IBIG = 1,KSET                                                00470
      READ(5,12) NPOLY,M,XOTOL, YOTOL, THETOL                             00480
C                                                                         T0481
C     READ POLYGON TOLERANCE CONTROL CARD                                 T0482
C                                                                         T0483
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C     NPOLY      TOTAL NUMBER OF POLYGONS                              T0484
C     M          NUMBER OF CONTROL POINTS                              T0485
C     XOTOL      X COORDINATE TOLERANCE LEVEL                          T0486
C     YOTOL      Y COORDINATE TOLERANCE LEVEL                          T0487
C     THETOL     ROTATION ANGLE TOLERANCE LIMIT                        T0488
C                                                                      T0489
C                                                                      T0490
      WRITE(6,12)NPOLY,M,XOTOL, YOTOL, THETOL                          00491
      M3 = MOD(M,4)                                                    00500
      IF(M3.NE.0) GO TO 23                                             00510
      M3 = 4                                                           00520
 23   IF(M.LE.4) GO TO 21                                              00530
      M1 = (M-1)/4                                                     00540
      DO 25 I2 = 1,M1                                                  00550
      ISUB = 4*(I2-1)                                                  00560
 25   READ(5,11) (X(ISUB+I3),Y(ISUB+I3),I3 = 1,4)                      00570
C                                                                      T0571
C     READ CALCULATED SPC CONTROL POINTS                               T0572
C                                                                      T0573
C     X     CONTROL POINT X                                            T0574
C     Y     CONTROL POINT Y                                            T0575
C                                                                      T0576
      ISUB = 4*M1                                                      00580
      GO TO 22                                                         00590
 21   ISUB = 0                                                         00600
 22   READ(5,11) (X(ISUB + I3),Y(ISUB + I3), I3 = 1,M3)                00610
      M3 = MOD(M,6)                                                    00620
      IF(M3.NE.0) GO TO 28                                             00630
      M3 = 6                                                           00640
 28   IF(M.LE.6) GO TO 27                                              00650
      M1 = (M-1)/6                                                     00660
      DO 30 I2 = 1,M1                                                  00670
      ISUB = 6*(I2-1)                                                  00680
 30   READ(5,13) (XD(ISUB+I3), YD(ISUB+I3), I3 = 1,6)                  00690
C                                                                      T0691
C     READ DIGITIZED CONTROL POINTS                                    T0692
C                                                                      T0693
C     XD    DIGITIZED CONTROL POINT X                                  T0694
C     YD    DIGITIZED CONTROL POINT Y                                  T0695
C                                                                      T0696
      ISUB = 6*M1                                                      00700
      GO TO 29                                                         00710
 27   ISUB = 0                                                         00720
 29   READ(5,13) (XD(ISUB+I3),YD(ISUB+I3),I3 = 1,M3)                   00730
C                                                                      T0731
C     INITIAL ARRAYS AND INPUT DATA                                    T0732
C     FROM CALCULATED & DIGITIZED COORDINATES                          T0733
C                                                                      T0734
      MM1 = 2*M                                                        00740
      DO 50 I = 1,M                                                    00750
      I1 = 2*I-1                                                       00760
      A(I1,1) = 1.                                                     00770
      A(I1,2) = 0.                                                     00780
      A(I1,3) = XD(I)                                                  00790
      A(I1,4) = YD(I)                                                  00800
      B(I1) = X(I)                                                     00810
      I1 = I1+1                                                        00820
      A(I1,1) = 0.                                                     00830
      A(I1,2) = 1.                                                     00840
      A(I1,3) = YD(I)                                                  00850
      A(I1,4) = -XD(I)                                                 00860
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 50   B(I1) = Y(I)                                                    00870
      DO 34 I = 1,4                                                   00880
      DO 34 J = 1,MM1                                                 00890
 34   AT(I,J) = A(J,I)                                                00900
      CALL RATMUL(ATA,AT,A,4,MM1,4)                                   00910
      CALL INVERS(ATA,4)                                              00920
      CALL RATMUL(ATAT,ATA,AT,4,4,MM1)                                00930
      DO 36 I = 1,4                                                   00940
      U(I) = 0.                                                       00950
      DO 36 J = 1,MM1                                                 00960
 36   U(I) = U(I) + ATAT(I,J)*B(J)                                    00970
   60 UX = U(3)*U(3) + U(4)*U(4)                                      00980
      S = SQRT(UX)                                                    00990
      UX=U(3)/S                                                       01000
      THETA(1) = ARCOS(UX)                                            01010
      UX=U(4)/S                                                       01020
      THETA(2) = ARSIN(UX)                                            01030
      IF(U(3).GE.0.) GO TO 263                                        01040
      THETA(1) = 3.14159265-THETA(1)                                  01050
 263  CONTINUE                                                        01060
      DO 45 I = 1,2                                                   01070
      THETA(I) = ABS(THETA(I))                                        01080
      IF(U(3).GE.0.) GO TO 260                                        01090
      IF(U(4).GE.0.) GO TO 261                                        01100
      THETA(I) = 3.14159265 + THETA(I)                                01110
      GO TO 262                                                       01120
 261  THETA(I) = 3.14159265 - THETA(I)                                01130
      GO TO 262                                                       01140
 260  IF(U(4).GE.0.) GO TO 262                                        01150
      THETA(I) = 6.28318530 - THETA(I)                                01160
 262  CONTINUE                                                        01170
      THETA(I) = THETA(I)*180./3.14159265                             01180
      THECOM(I,1) = AINT(THETA(I))                                    01190
      DUM = (THETA(I)-THECOM(I,1))*60.                                01200
      THECOM(I,2) = AINT(DUM)                                         01210
      DUM = (DUM-THECOM(I,2))*60.                                     01220
 45   THECOM(I,3) = AINT(DUM)                                         01230
C                                                                     T1231
C     WRITE HEADING "FOLLOWING IS A CHECK ON"                         T1232
C                                                                     T1233
      WRITE(6,14)                                                     01240
      WRITE(6,15)                                                     01250
      WRITE(6,16)                                                     01260
      WRITE(6,229)                                                    01270
      WRITE(6,17)                                                     01280
      DO 47 I = 1,2                                                   01290
 47   WRITE(6,18) U(1),U(2),THECOM(I,1),THECOM(I,2),THECOM(I,3)       01300
C                                                                     T1301
C     WRITE RESULTS OF ROTATION FROM CALCULATED AND DIGITIZED POINTS  T1302
C                                                                     T1303
C     U(1)            ORIGIN X0                                       T1304
C     U(2)            ORIGIN Y0                                       T1305
C     THECOM(I,1)     ROTAION DEGREES                                 T1306
C     THECOM(I,2)     ROTAION MINUTES                                 T1307
C     THECOM(I,3)     ROTAION SECONDS                                 T1308
C                                                                     T1309
      WRITE(6,220) S                                                  01310
C                                                                     T1311
C     WRITE SCALING FACTOR - S                                        T1312
C                                                                     T1313
C     TEST FOR ROTATION ANGLE AND SCALING FACTOR WITHIN TOLERANCE     T1314
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C 2

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C                                                                       T1315
      DO 32 I = 1,MM1                                                   01320
      C(I) = 0.                                                         01330
      DO 32 J = 1,4                                                     01340
 32   C(I) = C(I) + A(I,J)*U(J)                                         01350
      DO 33 I = 1,MM1                                                   01360
      UX=(C(I)-B(I))/S                                                  01370
      C(I) = ABS(UX)                                                    01380
   33 CONTINUE                                                          01390
      K = 0                                                             01400
      L = 0                                                             01410
      DO 37 I = 1,M                                                     01420
      I1 = 2*I-1                                                        01430
      IF(C(I1).LT.XOTOL) GO TO 40                                       01440
      K = K+1                                                           01450
      K1(K) = I                                                         01460
 40   I1 = 2*I                                                          01470
      IF(C(I1).LT.YOTOL) GO TO 37                                       01480
      L = L+1                                                           01490
      L1(L) = I                                                         01500
 37   CONTINUE                                                          01510
      IF(K.NE.0) GO TO 97                                               01520
      IF(L.NE.0) GO TO 97                                               01530
      IF(ABS((THETA(1)-THETA(2))*60.).GT.THETOL) GO TO 97               01540
C                                                                       T1541
C     COMPLETION OF TOLERANCE CHECKS                                    T1542
C                                                                       T1543
C     ************************************************************      T1544
C     *                          PHASE  II                       *      T1545
C     *     SCALE AND ROTATE DIGITIZED POINTS, MIN-MAX & BOUNDARIES *   T1546
C     *     CODED WITHIN THE FRAMWORK OF THE GEO-REF SYSTEM - PHASE  I  * T1547
C     ************************************************************      T1548
C                                                                       T1549
      DO 65 I = 1,2                                                     01550
 65   THETA(I) = THETA(I)*3.14159265/180.                               01560
      THETA(1) = (THETA(1)+THETA(2))/2.                                 01570
      A(1,1) = S*COS(THETA(1))                                          01580
      A(1,2) = S*SIN(THETA(1))                                          01590
      A(2,1) = -A(1,2)                                                  01600
      A(2,2) = A(1,1)                                                   01610
      WRITE(6,14)                                                       01620
      DO 102 I8 = 1,NPOLY                                               01630
      READ(5,19) MAPNO,MAPOL,LUCODE,POLYNO,PTYPE                        01640
C                                                                       T1641
C     READ POLYGON CONTROL CARD                                         T1642
C                                                                       T1643
C     MAPNO      MAP NUMBER FOR THE POLYGONS THAT FOLLOW                T1644
C     MAPOL      TOTAL NUMBER OF POLYGONS ON MAP                        T1645
C     LUCODE     LAND USE OF POLYGON CODE                               T1646
C     POLYNO     SEQUENCE NUMBER OF POLYGON  U TO MAPOL                 T1647
C     PTYPE      POLYGON TYPE-KEY TO DONUT POLYGONS                     T1648
C                NORMAL POLYGONS ARE CODED 10                           T1649
C                                                                       T1650
      READ(5,20) XMIN,YMIN,XMAX,YMAX,NP                                 01651
C                                                                       T1652
C     READ MINMUM & MAXIMUM COORDINATES                                 T1653
C                                                                       T1654
C     XMIN MINIMUM X COORDINATE                                         T1655
C     YMIN MINIMUM Y COORDINATE                                         T1656
C     XMAX MAXIMUM X COORDINATE                                         T1657
C     YMAX MAXIMUM Y COORDINATE                                         T1658
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C     NP    NUMBER OF POINTS IN POLYGON                                  T1659
C                                                                        T1660
      XX = (NP-1)/6                                                      01661
      NP1 = 1 +XX                                                        01670
      I3E = NP-6*(NP1-1)                                                 01680
      NPE = (NP1+1)/2                                                    01690
      NPER = (2*NPE)-NP1                                                 01700
      WRITE(6,14)                                                        01710
      WRITE(6,221)                                                       01720
      WRITE(6,219)MAPNO,MAPOL,LUCODE,POLYNO,PTYPE                        01730
C                                                                        T1731
C     WRITE POLYGON CONTROL CARD                                         T1732
C                                                                        T1733
      WRITE(7,19) MAPNO,MAPOL,LUCODE,POLYNO,PTYPE                        01740
      WRITE(6,222)                                                       01750
      DO 75 I = 1,4                                                      01760
      IF(I.EQ.4) GO TO 79                                                01770
      IF(I.EQ.3) GO TO 78                                                01780
      IF(I.EQ.2) GO TO 77                                                01790
C                                                                        T1791
C     ROTATE AND SCALE MINIMUM AND MAXIMUM COORDINATES                   T1792
C                                                                        T1793
      DUM1 = XMIN                                                        01800
      DUM2 = YMIN                                                        01810
      GO TO 76                                                           01820
 77   DUM1 = XMAX                                                        01830
      DUM2 = YMIN                                                        01840
      GO TO 76                                                           01850
 78   DUM1 = XMIN                                                        01860
      DUM2 = YMAX                                                        01870
      GO TO 76                                                           01880
 79   DUM1 = XMAX                                                        01890
      DUM2 = YMAX                                                        01900
 76   C(I) = U(1)  + A(1,1)*DUM1 + A(1,2)*DUM2                           01910
 75   B(I) = U(2)  + A(2,1)*DUM1 + A(2,2)*DUM2                           01920
      XMIN = C(1)                                                        01930
      DO 80 I = 2,4                                                      01940
      IF(XMIN.LE.C(I)) GO TO 80                                          01950
      XMIN = C(I)                                                        01960
 80   CONTINUE                                                           01970
      XMAX = C(1)                                                        01980
      DO 82 I = 2,4                                                      01990
      IF(XMAX.GE.C(I)) GO TO 82                                          02000
      XMAX = C(I)                                                        02010
 82   CONTINUE                                                           02020
      YMIN = B(1)                                                        02030
      DO 84 I = 2,4                                                      02040
      IF(YMIN.LE.B(I)) GO TO 84                                          02050
      YMIN = B(I)                                                        02060
 84   CONTINUE                                                           02070
      YMAX = B(1)                                                        02080
      DO 86 I = 2,4                                                      02090
      IF(YMAX.GE.B(I)) GO TO 86                                          02100
      YMAX = B(I)                                                        02110
 86   CONTINUE                                                           02120
      IXMIN = INT(XMIN*10)                                               02130
      IYMIN = INT(YMIN*10)                                               02140
      IXMAX = INT(XMAX*10)                                               02150
      IYMAX = INT(YMAX*10)                                               02160
C                                                                        T2161
C     ROTATION AND SCALING COMPLETED FOR MIN-MAX COORDINATES             T2162
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C                                                                       T2163
      WRITE(6,228) IXMIN,IYMIN,IXMAX,IYMAX,NP                           02170
C                                                                       T2171
C     WRITE MINIMUM AND MAXIMUM COORDINATES TO PRINTER AND CARD FILE    T2172
C                                                                       T2173
      WRITE(7,329) IXMIN,IYMIN,IXMAX,IYMAX,NP                           02180
      WRITE(6,223)                                                      02190
      WRITE(6,224)                                                      02200
      WRITE(6,232)                                                      02210
C                                                                       T2211
C     BEGIN SCALING AND ROTATION FOR POLYGON BOUNDARY                   T2212
C                                                                       T2213
      DO 55 ISM = 1,NPE                                                 02220
      WRITE(6,233)                                                      02230
C                                                                       T2231
C     COMPLEX ROUTINE FOR COMPENSATING TO VARIATION IN INPUT FORMAT     T2232
C                                                                       T2233
C     NP    NUMBER OF COORDINATE PAIRS                                  T2234
C     NPU   NUMBER OF CARDS TO BE READ                                  T2235
C     I3E   PARTIAL COORDINATE PAIRS REMAINING AFTER COMPLETE CARD READ T2236
C     NPE   NUMBER OF GROUPS OF COORDINATES                             T2237
C     NPER 1-IF LAST SET CONTAINS ONLY ONE CARD                         T2238
C                                                                       T2239
      IF(ISM.NE.NPE) GO TO 61                                           02240
      IF(NPER.EQ.1) GO TO 63                                            02250
      READ(5,13) (XD(I2),YD(I2), I2 = 1,6)                              02260
      IBEG = 7                                                          02270
      IEND = 6 + I3E                                                    02280
      GO TO 64                                                          02290
 63   IBEG = 1                                                          02300
      IEND = I3E                                                        02310
C                                                                       T2311
C     READ POLYGON POINT CARDS IN SETS OF TWO                           T2312
C                                                                       T2313
 64   READ(5,13) (XD(I2), YD(I2), I2= IBEG,IEND)                        02320
      GO TO 67                                                          02330
 61   CONTINUE                                                          02340
      DO 62 IL=1,2                                                      02350
      LSUB = 6*(IL-1)                                                   02360
 62   READ(5,13) (XD(LSUB+I2),YD(LSUB+I2),I2=1,6)                       02370
 67   CONTINUE                                                          02380
      IF(ISM.EQ.NPE) GO TO 68                                           02390
      NPP = 12                                                          02400
      GO TO 69                                                          02410
 68   NPP = 6*(1-NPER) + I3E                                            02420
 69   CONTINUE                                                          02430
C                                                                       T2431
C     END OF POLYGON READ ROUTINE                                       T2432
C                                                                       T2433
C     CALCULATE ROTATION SCALING FACTOR                                 T2434
C                                                                       T2435
      DO 70 I = 1,NPP                                                   02440
      X(I) = U(1)  + A(1,1)*XD(I) + A(1,2)*YD(I)                        02450
 70   Y(I) = U(2)  + A(2,1)*XD(I) + A(2,2)*YD(I)                        02460
      IF(ISM.EQ.NPE) GO TO 81                                           02470
      DO 140 IL=1,2                                                     02480
      LSUB = 6*(IL-1)                                                   02490
 140  WRITE(6,213) (XD(LSUB+I2),YD(LSUB+I2),I2=1,6)                     02500
C                                                                       T2501
C     WRITE COORDINATES TO PRINTER                                      T2502
C                                                                       T2503
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      GO TO 72                                                          02510
 81   IF(NPER.EQ.1) GO TO 141                                           02520
      WRITE(6,213) (XD(I2),YD(I2), I2=1,6)                              02530
      IBEG = 7                                                          02540
      IEND = 6+I3E                                                      02550
      GO TO 142                                                         02560
 141  IBEG = 1                                                          02570
      IEND = I3E                                                        02580
 142  WRITE(6,213) (XD(I2),YD(I2), I2=IBEG,IEND)                        02590
 72   IF(ISW.EQ.NPE) GO TO 74                                           02600
C                                                                       T2601
C     CONVER COORDINATES TO INTEGER                                     T2602
C                                                                       T2603
      DO 56 I2 = 1,12                                                   02610
      IX(I2) = X(I2)*10                                                 02620
 56   IY(I2) = Y(I2)*10                                                 02630
      DO 143 IL=1,3                                                     02640
      LSUB = 4*(IL-1)                                                   02650
      WRITE(6,235) (IX(LSUB+I2),IY(LSUB+I2),I2=1,4)                     02660
C                                                                       T2661
C     WRITE INTEGER COORDINATES TO CARD FILE                            T2662
C                                                                       T2663
 143  WRITE(7,236) (IX(LSUB+I2),IY(LSUB+I2),I2=1,4)                     02670
      GO TO 55                                                          02680
 74   XX = (NPP-1)/4                                                    02690
      NP2 = 1+XX                                                        02700
      I4E = NPP - 4*(NP2-1)                                             02710
      DO 57 I2=1,NPP                                                    02720
      IX(I2) = X(I2)*10                                                 02730
 57   IY(I2) = Y(I2)*10                                                 02740
      DO 145 IL = 1,NP2                                                 02750
      LSUB = 4*(IL-1)                                                   02760
      IF(IL.EQ.NP2) GO TO 147                                           02770
      WRITE(6,235) (IX(LSUB+I2),IY(LSUB+I2), I2=1,4)                    02780
      WRITE(7,236) (IX(LSUB+I2),IY(LSUB+I2), I2=1,4)                    02790
      GO TO 145                                                         02800
 147  WRITE(6,235) (IX(LSUB+I2),IY(LSUB+I2), I2=1,I4E)                  02810
      WRITE(7,236) (IX(LSUB+I2),IY(LSUB+I2), I2=1,I4E)                  02820
 145  CONTINUE                                                          02830
 55   CONTINUE                                                          02840
 102  CONTINUE                                                          02850
      GO TO 100                                                         02860
C                                                                       T2861
C     ERROR CONDITION                                                   T2862
C                                                                       T2863
 97   IF(K.EQ.0) GO TO 98                                               02870
      WRITE(6,225) XOTOL,IBIG,(K1(I), I = 1,K)                          02880
      WRITE(6,230)                                                      02890
      DO 87 I = 1,K                                                     02900
      IWR = 2*K1(I)-1                                                   02910
 87   WRITE(6,231) C(IWR)                                               02920
 98   IF(L.EQ.0) GO TO 99                                               02930
      WRITE(6,226) YOTOL,IBIG,(L1(I), I = 1,L)                          02940
      WRITE(6,230)                                                      02950
      DO 88 I = 1,L                                                     02960
      IWR = 2*L1(I)                                                     02970
 88   WRITE(6,231) C(IWR)                                               02980
 99   IF(ABS((THETA(1)-THETA(2))*60.).LE.THETOL) GO TO 100              02990
      WRITE(6,227) THETOL,IBIG                                          03000
 100  CONTINUE                                                          03010
      STOP                                                              03020
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      END                                                                   03030
      SUBROUTINE RATMUL(C,A,B,I,J,K)                                        03040
      DOUBLE PRECISION C(4,4), A(I,J), B(J,K)                               03050
      DO 100 IR = 1,I                                                       03060
      DO 100 JC = 1,K                                                       03070
      C(IR,JC) = 0.                                                         03080
      DO 100 L = 1,J                                                        03090
      C(IR,JC) = C(IR,JC) + A(IR,L)*B(L,JC)                                 03100
  100 CONTINUE                                                              03110
      RETURN                                                                03120
      END                                                                   03130
      SUBROUTINE INVERS(ATA,N)                                              03140
      DOUBLE PRECISION ATA(N,N), A(4,4)                                     03150
      DIMENSION XTA(4,4)                                                    03160
  302 FORMAT(1X, ' NO SLOUTION. A 0 EXISTS ON THE MAIN DIAGONAL FOR')       03170
  303 FORMAT(' ROW NUMBER ',I3,' COLUMN NUMBER ',I3)                        03180
  301 FORMAT(' REMEMBER-ROWS MAY HAVE BEEN SWITCHED PREVIOUS TO THIS ')     03190
  304 FORMAT(' POINT. NO MORE SWITCHING POSSIBLE')                          03200
      DO 300I = 1,N                                                         03210
      DO 306 JJ = 1,N                                                       03220
      XTA(I,JJ)=ATA(I,JJ)                                                   03230
  306 A(I,JJ) = 0.0                                                         03240
  300 A(I,I) = 1.0                                                          03250
      DET = 1.0                                                             03260
      DO 341 IH = 1,N                                                       03270
      IG = IH                                                               03280
      IF (ABS(XTA(IH,IH)).GE.1.E-10) GO TO 332                              03290
C SWAP ROWS                                                                 03300
  305 IG = IG+1                                                             03310
      IF (IG.LE.N) GO TO 308                                                03320
      WRITE(6,302)                                                          03330
      WRITE(6,303) IH, IH                                                   03340
      WRITE(6,301)                                                          03350
      WRITE(6,304)                                                          03360
      GO TO 381                                                             03370
  308 IF (ABS(XTA(IG,IG)).LT.1.E-10) GO TO 305                              03380
      DET = (-1.0)*DET                                                      03390
      DO 324JJ = 1,N                                                        03400
      C = ATA(IH,JJ)                                                        03410
      D = A(IH,JJ)                                                          03420
      ATA(IH,JJ) = ATA(IG,JJ)                                               03430
      A(IH,JJ) = A(IG,JJ)                                                   03440
      ATA(IG,JJ) = C                                                        03450
  324 A(IG,JJ) = D                                                          03460
  332 DIAG = ATA(IH,IH)                                                     03470
      DET = DET*DIAG                                                        03480
      DO 334JJ = 1,N                                                        03490
      ATA(IH,JJ) = ATA(IH,JJ)/DIAG                                          03500
  334 A(IH,JJ) = A(IH,JJ)/DIAG                                              03510
      IF(IH .EQ. N) GO TO 336                                               03520
      II = IH+1                                                             03530
      DO 340I = II, N                                                       03540
      DIAG = ATA(I,IH)                                                      03550
      DO 340JJ = 1,N                                                        03560
      ATA(I,JJ) = ATA(I,JJ) - (DIAG*ATA(IH,JJ))                             03570
  340 A(I,JJ) = A(I,JJ) - (DIAG*A(IH,JJ))                                   03580
  341 CONTINUE                                                              03590
  336 IN1 = N-1                                                             03600
      DO 348 I = 1,IN1                                                      03610
      IH = N+1-I                                                            03620
      II = IH - 1                                                           03630
```

```
352 DIAG = ATA(II,IH)                                                  03640
    IG = N                                                             03650
346 IF(IG .EQ. 0) GO TO 342                                            03660
    ATA(II,IG) = ATA(II,IG) - (DIAG*ATA(IH,IG))                        03670
    A(II,IG) = A(II,IG) - (DIAG*A(IH,IG))                              03680
    IG = IG - 1                                                        03690
    GO TO 346                                                          03700
342 IF(II .EQ. 1) GO TO 348                                            03710
    II = II-1                                                          03720
    GO TO 352                                                          03730
348 CONTINUE                                                           03740
354 DO 380 I = 1,N                                                     03750
    DO 380 J = 1,N                                                     03760
380 ATA(I,J) = A(I,J)                                                  03770
381 RETURN                                                             03780
    END                                                                03790
```

APPENDIX V

CHAIN PROGRAM LISTING

```
C YOU MUST DIMENSION THE NUMBER OF ROWS OF A(*,4), THE NUMBER OF COLUMNS    00010
C OF AT(4,*) AND ATAT(4,*), AND THE NUMBER OF COMPONENTS OF B(*) AND       00020
C C(*) EQUAL TO TWO TIMES THE NUMBER OF CONTROL POINTS USED ON MAP         00030
C MAKE SURE THAT LAST BLOCK DIGITIZED IS AN INTERNAL BLOCK                 00040
C AND NOT ON TRACT BOUNDARY                                               00050
      INTEGER XX                                                          00060
      DIMENSION A(8 ,4),AT(4,8 ),ATAT(4,8 ),B(8 ),C(8 ),X(12),Y(12),      00070
     1XD(12),YD(12),    K1(4),L1(4),U(4),ATA(4,4),THETA(2),THECON(2,3),    00080
     2IX(12),IY(12),ITLEFT(1000),ITRITE(1000),IBLOCK(100),XH(100),        00090
     3YH(100)                                                             00100
      DIMENSION XL(1000), YL(1000), XR(1000), YR(1000), KTBL(100)         00110
 10   FORMAT(I5)                                                          00120
 11   FORMAT(8F9.1)                                                       00130
 12   FORMAT(2I5,3F10.3)                                                  00140
 13   FORMAT(12F6.3)                                                      00150
 213  FORMAT(2X,12F6.3)                                                   00160
 14   FORMAT(1H1)                                                         00170
 15   FORMAT(/////,' FOLLOWING IS A CHECK ON THE MAP ROTATION, ORIGIN DI  00180
     1SPLACEMENT, AND SCALING FACTOR')                                    00190
 16   FORMAT(/////,' THE TWO INDEPENDENT SOLUTIONS FOR THE CALIFORNIA ZO  00200
     1NE 7 STATE PLANE COORDINATES OF THE')                               00210
 229  FORMAT(' DIGITIZATION ORIGIN (X0,Y0) AND THE TABLE TO MAP ROTATION  00220
     1 ANGLE THETA ')                                                     00230
 17   FORMAT(//,14X,'X0',19X,'Y0',14X,'THETA')                            00240
 18   FORMAT(/,2F20.1,3X,F4.0,' DEG ',F4.0,' MIN ',F4.0,' SEC')           00250
 19   FORMAT(2I5,I3,I4,I2)                                                00260
 219  FORMAT(1X,2I5,I3,I4,I2)                                             00270
 20   FORMAT(4F6.3,I5)                                                    00280
 220  FORMAT(' THE SCALING FACTOR S = ',F10.1)                            00290
 221  FORMAT(//,' TRACT NUMBER, BLOCK NUMBER-WITH AND WITHOUT DECIMAL,    00300
     1POLYGON NUMBER, POLYGON TYPE')                                      00310
 222  FORMAT(//,' FOR THIS POLYGON-MIN X, MIN Y, MAX X, MAX Y, NUMBER OF  00320
     1 POINTS IN POLYGON')                                                00330
 223  FORMAT(//,' ALL DIGITIZED COORDINATES AND TRANSFORMED ZONE 7')      00340
 224  FORMAT(' CALIFORNIA STATE PLANE COORDINATES FOR THIS POLYGON')      00350
 232  FORMAT(' FOLLOW IN GROUPS OF TWELVE PAIRS')                         00360
 233  FORMAT(//)                                                          00370
 225  FORMAT(//,' YOUR X0 ORIGIN REFERENCE SOLUTIONS DISAGREE BY MORE TH  00380
     1AN ',F10.3,' INCHES FOR MAPSETUP ',I5,' FOR CONTROL POINTS ',8I3)   00390
 226  FORMAT(//,' YOUR Y0 ORIGIN REFERENCE SOLUTIONS DISAGREE BY MORE TH  00400
     1AN ',F10.3,' INCHES FOR MAPSETUP ',I5,' FOR CONTROL POINTS ',8I3)   00410
 227  FORMAT(//,' YOUR THETA ROTATION SOLUTIONS DISAGREE BY MORE THAN ',  00420
     1F10.3,' MINUTES FOR MAP SETUP ',I5)                                 00430
 228  FORMAT(4I9,I5)                                                      00440
 230  FORMAT(' FOR THESE CONTROL POINTS, THE MAP POSITION IS OFF BY ')    00450
 231  FORMAT(F10.3)                                                       00460
 235  FORMAT(8I9)                                                         00470
 240  FORMAT(1X,I9,I10,1X,4F6.3)                                          00480
 241  FORMAT(//,' BLOCK ',I9,' DID NOT CHAIN PROPERLY, THE STREET SEGMEN  00490
     1TS FOLLOW ')                                                        00500
 243  FORMAT(//, ' THE NON-POLYGON CUL DE SACS FOLLOW')                   00510
 245  FORMAT(I9,I10,1X,4F6.3)                                             00520
C     ********************************************************************T0521
C     *                        PHASE  I                                  *T0522
C     *    CALCULATE NORTH-SOUTH ROTATION ANGLE, SCALING FACTOR &        *T0523
C     *    TEST FOR VARIATION IN CONTROL PARAMETERS > THAN TOLERANCE     *T0524
C     ********************************************************************T0525
      READ(5,10) KSET                                                     00530
C                                                                         T0531
C     READ KSET - NUMBER OF CENSUS TRACTS                                 T0532
C                                                                         T0533
```

```
C     BEGIN MAJOR LOOP OF PROGRAM - IBIG                                T0534
C                                                                       T0535
      DO 100 IBIG = 1,KSET                                              00540
      READ(5,12) NPOLY,M,XOTOL, YOTOL, THETOL                           00550
C                                                                       T0551
C     READ POLYGON TOLERANCE CONTROL CARD                               T0552
C                                                                       T0553
C     NPOLY      TOTAL NUMBER OF POLYGONS                               T0554
C     M          NUMBER OF CONTROL POINTS                               T0555
C     XOTOL      X COORDINATE TOLERANCE LEVEL                           T0556
C     YOTOL      Y COORDINATE TOLERANCE LEVEL                           T0557
C     THETOL     ROTATION ANGLE TOLERANCE LIMIT                         T0558
C                                                                       T0559
C     COMPLEX ROUTINE TO READ COORDINATES IN STRING FORMAT              T0560
C                                                                       T0561
      M3 = MOD(M,4)                                                     00562
      IF(M3.NE.0) GO TO 23                                              00570
      M3 = 4                                                            00580
 23   IF(M.LE.4) GO TO 21                                               00590
      M1 = (M-1)/4                                                      00600
      DO 25 I2 = 1,M1                                                   00610
      ISUB = 4*(I2-1)                                                   00620
 25   READ(5,11) (X(ISUB+I3),Y(ISUB+I3),I3 = 1,4)                       00630
C                                                                       T0631
C     READ CALCULATED SPC CONTROL POINTS                                T0632
C                                                                       T0633
C     X     CONTROL POINT X                                             T0634
C     Y     CONTROL POINT Y                                             T0635
C                                                                       T0636
      ISUB = 4*M1                                                       00640
      GO TO 22                                                          00650
 21   ISUB = 0                                                          00660
 22   READ(5,11) (X(ISUB + I3),Y(ISUB + I3), I3 = 1,M3)                 00670
      M3 = MOD(M,6)                                                     00680
      IF(M3.NE.0) GO TO 28                                              00690
      M3 = 6                                                            00700
 28   IF(M.LE.6) GO TO 27                                               00710
      M1 = (M-1)/6                                                      00720
      DO 30 I2 = 1,M1                                                   00730
      ISUB = 6*(I2-1)                                                   00740
 30   READ(5,13) (XD(ISUB+I3), YD(ISUB+I3), I3 = 1,6)                   00750
C                                                                       T0751
C     READ DIGITIZED CONTROL POINTS                                     T0752
C                                                                       T0753
C     XD    DIGITIZED CONTROL POINT X                                   T0754
C     YD    DIGITIZED CONTROL POINT Y                                   T0755
C                                                                       T0756
      ISUB = 6*M1                                                       00760
      GO TO 29                                                          00770
 27   ISUB = 0                                                          00780
 29   READ(5,13) (XD(ISUB+I3),YD(ISUB+I3),I3 = 1,M3)                    00790
C                                                                       T0791
C     INITIAL ARRAYS AND INPUT DATA                                     T0792
C     FROM CALCULATED & DIGITIZED COORDINATES                           T0793
C                                                                       T0794
      MM1 = 2*M                                                         00800
      DO 50 I = 1,M                                                     00810
      I1 = 2*I-1                                                        00820
      A(I1,1) = 1.                                                      00830
      A(I1,2) = 0.                                                      00840
      A(I1,3) = XD(I)                                                   00850
```

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      A(I1,4) = YD(I)                                                    00860
      B(I1) = X(I)                                                       00870
      I1 = I1+1                                                          00880
      A(I1,1) = 0.                                                       00890
      A(I1,2) = 1.                                                       00900
      A(I1,3) = YD(I)                                                    00910
      A(I1,4) = -XD(I)                                                   00920
 50   B(I1) = Y(I)                                                       00930
      DO 34 I = 1,4                                                      00940
      DO 34 J = 1,MM1                                                    00950
 34   AT(I,J) = A(J,I)                                                   00960
      CALL RATMUL(ATA,AT,A,4,MM1,4)                                      00970
      CALL INVERS(ATA,4)                                                 00980
      CALL RATMUL(ATAT,ATA,AT,4,4,MM1)                                   00990
      DO 36 I = 1,4                                                      01000
      U(I) = 0.                                                          01010
      DO 36 J = 1,MM1                                                    01020
 36   U(I) = U(I) + ATAT(I,J)*B(J)                                       01030
 60   S = SQRT(U(3)*U(3) + U(4)*U(4))                                    01040
      THETA(1) = ARCOS(U(3)/S)                                           01050
      THETA(2) = ARSIN(U(4)/S)                                           01060
      IF(U(3).GE.0.) GO TO 263                                           01070
      THETA(1) = 3.14159265-THETA(1)                                     01080
 263  CONTINUE                                                           01090
      DO 45 I = 1,2                                                      01100
      THETA(I) = ABS(THETA(I))                                           01110
      IF(U(3).GE.0.) GO TO 260                                           01120
      IF(U(4).GE.0.) GO TO 261                                           01130
      THETA(I) = 3.14159265 + THETA(I)                                   01140
      GO TO 262                                                          01150
 261  THETA(I) = 3.14159265 - THETA(I)                                   01160
      GO TO 262                                                          01170
 260  IF(U(4).GE.0.) GO TO 262                                           01180
      THETA(I) = 6.28318530 - THETA(I)                                   01190
 262  CONTINUE                                                           01200
      THETA(I) = THETA(I)*180./3.14159265                                01210
      THECOM(I,1) = AINT(THETA(I))                                       01220
      DUM = (THETA(I)-THECOM(I,1))*60.                                   01230
      THECOM(I,2) = AINT(DUM)                                            01240
      DUM = (DUM-THECOM(I,2))*60.                                        01250
 45   THECOM(I,3) = AINT(DUM)                                            01260
C                                                                        T1261
C     WRITE HEADING "FOLLOWING IS A CHECK ON"                            T1262
C                                                                        T1263
C                                                                        T1264
C     WRITE RESULTS OF ROTATION FROM CALCULATED AND DIGITIZED POINTS     T1265
C                                                                        T1266
C     U(1)            ORIGIN X0                                        T1267
C     U(2)            ORIGIN Y0                                        T1268
C     THECOM(I,1)     ROTAION DEGREES                                  T1269
C     THECOM(I,2)     ROTAION MINUTES                                  T1270
C     THECOM(I,3)     ROTAION SECONDS                                  T1271
C                                                                        T1272
      WRITE(6,14)                                                        01273
      WRITE(6,15)                                                        01280
      WRITE(6,16)                                                        01290
      WRITE(6,229)                                                       01300
      WRITE(6,17)                                                        01310
      DO 47 I = 1,2                                                      01320
 47   WRITE(6,18) U(1),U(2),THECOM(I,1),THECOM(I,2),THECOM(I,3)          01330
      WRITE(6,220) S                                                     01340
```

```
C                                                                       T1341
C     WRITE SCALING FACTOR - S                                          T1342
C                                                                       T1343
C     TEST FOR ROTATION ANGLE AND SCALING FACTOR WITHIN TOLERANCE       T1344
C                                                                       T1345
      DO 32 I = 1,MM1                                                   01350
      C(I) = 0.                                                         01360
      DO 32 J = 1,4                                                     01370
 32   C(I) = C(I) + A(I,J)*U(J)                                         01380
      DO 33 I = 1,MM1                                                   01390
 33   C(I) = ABS((C(I)-B(I))/S)                                         01400
      K = 0                                                             01410
      L = 0                                                             01420
      DO 37 I = 1,M                                                     01430
      I1 = 2*I-1                                                        01440
      IF(C(I1).LT.XOTOL) GO TO 40                                       01450
      K = K+1                                                           01460
      K1(K) = I                                                         01470
 40   I1 = 2*I                                                          01480
      IF(C(I1).LT.YOTOL) GO TO 37                                       01490
      L = L+1                                                           01500
      L1(L) = I                                                         01510
 37   CONTINUE                                                          01520
      IF(K.NE.0) GO TO 97                                               01530
      IF(L.NE.0) GO TO 97                                               01540
      IF(ABS((THETA(1)-THETA(2))*60.).GT.THETOL) GO TO 97               01550
C                                                                       T1551
C     COMPLETION OF TOLERANCE CHECKS                                    T1552
C                                                                       T1553
      DO 65 I = 1,2                                                     01560
 65   THETA(I) = THETA(I)*3.14159265/180.                               01570
      THETA(1) = (THETA(1)+THETA(2))/2.                                 01580
      A(1,1) = S*COS(THETA(1))                                          01590
      A(1,2) = S*SIN(THETA(1))                                          01600
      A(2,1) = -A(1,2)                                                  01610
      A(2,2) = A(1,1)                                                   01620
      WRITE(6,14)                                                       01630
C                                                                       T1631
C     ************************************************************      T1632
C     *                        PHASE  II                         *      T1633
C     *    REVERSE AND DUPLICATE SEGMENTS WHICH SERVE AS A BOUNDARY *   T1634
C     *    TO TWO BLOCKS AND CHECK FOR SAME BEGINNING AND ENDING COORD *T1635
C     ************************************************************      T1636
C                                                                       T1637
      DO 102 IB = 1,NPOLY                                               01640
 102  READ(5,245) ITLEFT(IB),ITRITE(IB),XL(IB),YL(IB),XR(IB),YR(IB)    01650
      NP1 = 2*NPOLY - 1                                                 01660
      DO 370 I = 1,NPOLY                                                01670
      ITLEFT(NPOLY+I) = ITRITE(I)                                       01680
      ITRITE(NPOLY+I) = ITLEFT(I)                                       01690
      XL(NPOLY + I) = XR(I)                                             01700
      YL(NPOLY+I) = YR(I)                                               01710
      XR(NPOLY+I) = XL(I)                                               01720
 370  YR(NPOLY+I) = YL(I)                                               01730
C WE WANT TO GET RID OF ALL TRACT BOUNDARY SEGMENTS WITH OTHER THAN     01740
C PRESENT TRACT ON LEFT.                                                01750
C WE ASSUME THAT LAST SEGMENT DIGITIZED (NPOLY) HAS OUR DESIRED TRACT   01760
C ON LEFT. IT IS AN INTERNAL BLOCK.                                     01770
      NURTRK = ITLEFT(NPOLY)/10000                                      01780
      I = 0                                                             01790
 372  I = I+1                                                           01800
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```
  363  IACHTR = ITLEFT(I)/10000                                          01810
       IF(I.GT.NP1) GO TO 375                                            01820
       IF(NURTRK .EQ. IACHTR) GO TO 372                                  01830
       DO 373 I1 = I,NP1                                                 01840
       ITLEFT(I1) = ITLEFT(I1+1)                                         01850
       ITRITE(I1) = ITRITE(I1+1)                                         01860
       XL(I1) = XL(I1+1)                                                 01870
       YL(I1) = YL(I1+1)                                                 01880
       XR(I1) = XR(I1+1)                                                 01890
  373  YR(I1) = YR(I1+1)                                                 01900
       NP1 = NP1-1                                                       01910
       GO TO 363                                                         01920
  375  IF(NURTRK .EQ. IACHTR) GO TO 377                                  01930
       NP1 = NP1 - 1                                                     01940
  377  CONTINUE                                                          01950
       CALL SORT6(ITLEFT,ITRITE,XL,YL,XR,YR,NP1)                         01960
       NP1 = NP1+1                                                       01970
       I = 1                                                             01980
       IBLKS = 0                                                         01990
  374  IBLKS = IBLKS + 1                                                 02000
       IBLOCK(IBLKS) = ITLEFT(I)                                         02010
       KTBL(IBLKS) = 0                                                   02020
  376  KTBL(IBLKS) = KTBL(IBLKS) + 1                                     02030
       I = I +1                                                          02040
       IF(I .GT. NP1) GO TO 378                                          02050
       IF((IBLOCK(IBLKS)) .NE. (ITLEFT(I))) GO TO 374                    02060
       GO TO 376                                                         02070
  378  CONTINUE                                                          02080
C IBLKS IS THE NUMBER OF BLOCKS IN THIS TRACT                           02090
C NOW WE'LL CHAIN THE BLOCK TOGETHER IN SEQUENTIAL ORDER                02100
       IBEGF = 0                                                         02110
       IENDF = 0                                                         02120
       DO 380 I10 = 1,IBLKS                                              02130
       NSEG = KTBL(I10)                                                  02140
       NUMBLK = IBLOCK(I10)                                              02150
       IBEGF = IENDF + 1                                                 02160
       IENDF = IENDF + NSEG                                              02170
       NCULS = 0                                                         02180
       IMARK = IENDF                                                     02190
       DO 382 I1 = IBEGF, IENDF                                          02200
       IF(IMARK .LT. I1) GO TO 386                                       02210
       IF(NUMBLK .NE. ITRITE(I1)) GO TO 382                              02220
  385  IF(NUMBLK .EQ. ITRITE(IMARK)) GO TO 384                           02230
C SWITCH CUL DE SAC TO END OF BLOCK SEGMENTS                            02240
       IDUM2 = ITRITE(I1)                                                02250
       DUM3 = XL(I1)                                                     02260
       DUM4 = YL(I1)                                                     02270
       DUM5 = XR(I1)                                                     02280
       DUM6 = YR(I1)                                                     02290
       ITRITE(I1) = ITRITE(IMARK)                                        02300
       XL(I1) = XL(IMARK)                                                02310
       YL(I1) = YL(IMARK)                                                02320
       XR(I1) = XR(IMARK)                                                02330
       YR(I1) = YR(IMARK)                                                02340
       ITRITE(IMARK) = IDUM2                                             02350
       XL(IMARK) = DUM3                                                  02360
       YL(IMARK) = DUM4                                                  02370
       XR(IMARK) = DUM5                                                  02380
       YR(IMARK) = DUM6                                                  02390
C FINISHED SWITCHING                                                    02400
       GO TO 382                                                         02410
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```
 384  NCULS = NCULS + 1                                                    02420
      IMARK = IMARK - 1                                                    02430
      IF(IMARK .LT. I1) GO TO 386                                          02440
      GO TO 385                                                            02450
 382  CONTINUE                                                             02460
 386  CONTINUE                                                             02470
C CUL DE SACS ARE NOW AT END OF BLOCK SEGMENTS                             02480
      NSEG1 = NSEG - NCULS                                                 02490
C NOW WE'LL MATCH ENDS OF SEGMENTS TO BEGINNINGS OF OTHER SEGMENTS         02500
C NSEG1 IS THE NUMBER OF BLOCK SEGMENTS EXCLUDING CUL DE SACS              02510
      I1 = IBEGF                                                           02520
      IEND1 = IENDF - NCULS                                                02530
      IS = IBEGF                                                           02540
 390  IS = IS + 1                                                          02550
 393  IF(IS .GT. IEND1) GO TO 392                                          02560
      IF(ABS(XR(I1) - XL(IS)) .GT. XOTOL) GO TO 390                        02570
      IF(ABS(YR(I1) - YL(IS)) .GT. YOTOL) GO TO 390                        02580
C IS MARKS THE NEXT SEGMENT LINK OF THIS BLOCK                             02590
C SWITCH THIS SEGMENT BACK TO THE ONE FOLLOWING I1                         02600
      I1 = I1 + 1                                                          02610
      IDUM2 = ITRITE(I1)                                                   02620
      DUM3 = XL(I1)                                                        02630
      DUM4 = YL(I1)                                                        02640
      DUM5 = XR(I1)                                                        02650
      DUM6 = YR(I1)                                                        02660
      ITRITE(I1) = ITRITE(IS)                                              02670
      XL(I1) = XL(IS)                                                      02680
      YL(I1) = YL(IS)                                                      02690
      XR(I1) = XR(IS)                                                      02700
      YR(I1) = YR(IS)                                                      02710
      ITRITE(IS) = IDUM2                                                   02720
      XL(IS) = DUM3                                                        02730
      YL(IS) = DUM4                                                        02740
      XR(IS) = DUM5                                                        02750
      YR(IS) = DUM6                                                        02760
      IS = I1 + 1                                                          02770
      GO TO 393                                                            02780
 392  IF(I1 .EQ. IEND1) GO TO 394                                          02790
C BLOCK DID NOT CHAIN IF YOU REACHED HERE                                  02800
 395  WRITE(6,241) NUMBLK                                                  02810
      DO 396 I2 = IBEGF, IENDF                                             02820
 396  WRITE(6,240)ITLEFT(I2),ITRITE(I2), XL(I2), YL(I2), XR(I2), YR(I2)    02830
      GO TO 380                                                            02840
 394  IF(ABS(XR(IEND1)-XL(IBEGF)) .GT. XOTOL) GO TO 395                    02850
      IF(ABS(YR(IEND1)-YL(IBEGF)) .GT. YOTOL) GO TO 395                    02860
C IF YOU REACHED HERE, BLOCK CHAINED OK                                    02870
C NOW WE'LL AVERAGE THE DOUBLY DIGITIZED NODES                             02880
C SINCE THE DIGITIZATION AGREES WITHIN TOLERANCE LIMITS                    02890
C                                                                          T2891
C     ************************************************************         T2892
C     *                        PHASE  III                        *         T2893
C     *    SCALE AND ROTATE DIGITIZED POINTS, MIN-MAX & BOUNDARIES *         T2894
C     *    CODED WITHIN THE FRAMWORK OF THE GEO-REF SYSTEM - PHASE  I *      T2895
C     ************************************************************         T2896
C                                                                          T2897
      MAPNO = NUMBLK/10000                                                 02900
      MAPOL = NUMBLK - (MAPNO*10000)                                       02910
      LUCODE = MAPOL/10                                                    02920
      NPOLYO = I10                                                         02930
      NPTYP = 10                                                           02940
      XH(1) = (XL(IBEGF)+XR(IEND1))/2.                                     02950
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      YH(1) = (YL(IBEGF)+YR(IEND1))/2.                                  02960
      NP = NSEG1+1                                                      02970
      XH(NP) = XH(1)                                                    02980
      YH(NP) = YH(1)                                                    02990
      DO 300 I1 = 2,NSEG1                                               03000
      IMARK1 = IBEGF+I1-2                                               03010
      IMARK2 = IBEGF+I1-1                                               03020
      XH(I1) = (XR(IMARK1)+XL(IMARK2))/2.                               03030
  300 YH(I1) = (YR(IMARK1)+YL(IMARK2))/2.                               03040
  316 CONTINUE                                                          03050
      XMIN = XH(1)                                                      03060
      YMIN = YH(1)                                                      03070
      XMAX = XH(1)                                                      03080
      YMAX = YH(1)                                                      03090
      DO 302 I1 = 2,NP                                                  03100
      IF(XMIN .LE. XH(I1)) GO TO 302                                    03110
      XMIN = XH(I1)                                                     03120
  302 CONTINUE                                                          03130
      DO 304 I1 = 2,NP                                                  03140
      IF(YMIN .LE. YH(I1)) GO TO 304                                    03150
      YMIN = YH(I1)                                                     03160
  304 CONTINUE                                                          03170
      DO 306 I1 = 2,NP                                                  03180
      IF(XMAX .GE. XH(I1)) GO TO 306                                    03190
      XMAX = XH(I1)                                                     03200
  306 CONTINUE                                                          03210
      DO 308 I1 = 2,NP                                                  03220
      IF(YMAX .GE. YH(I1)) GO TO 308                                    03230
  308 CONTINUE                                                          03240
      YMAX = YH(I1)                                                     03250
      XX = (NP-1)/6                                                     03260
      NP1 = 1 +XX                                                       03270
      I3E = NP-6*(NP1-1)                                                03280
      NPE = (NP1+1)/2                                                   03290
      NPER = (2*NPE)-NP1                                                03300
      WRITE(6,14)                                                       03310
      WRITE(6,221)                                                      03320
      WRITE(6,219)MAPNO,MAPOL,LUCODE,NPOLYO,NPTYP                       03330
      WRITE(7,19) MAPNO,MAPOL,LUCODE,NPOLYO,NPTYP                       03340
      WRITE(6,222)                                                      03350
      DO 75 I = 1,4                                                     03360
      IF(I.EQ.4) GO TO 79                                               03370
      IF(I.EQ.3) GO TO 78                                               03380
      IF(I.EQ.2) GO TO 77                                               03390
      DUM1 = XMIN                                                       03400
      DUM2 = YMIN                                                       03410
      GO TO 76                                                          03420
   77 DUM1 = XMAX                                                       03430
      DUM2 = YMIN                                                       03440
      GO TO 76                                                          03450
   78 DUM1 = XMIN                                                       03460
      DUM2 = YMAX                                                       03470
      GO TO 76                                                          03480
   79 DUM1 = XMAX                                                       03490
      DUM2 = YMAX                                                       03500
   76 C(I) = U(1)  + A(1,1)*DUM1 + A(1,2)*DUM2                          03510
   75 B(I) = U(2)  + A(2,1)*DUM1 + A(2,2)*DUM2                          03520
      XMIN = C(1)                                                       03530
      DO 80 I = 2,4                                                     03540
      IF(XMIN.LE.C(I)) GO TO 80                                         03550
      XMIN = C(I)                                                       03560
```

```
80    CONTINUE                                                          03570
      XMAX = C(1)                                                       03580
      DO 82 I = 2,4                                                     03590
      IF(XMAX.GE.C(I)) GO TO 82                                         03600
      XMAX = C(I)                                                       03610
82    CONTINUE                                                          03620
      YMIN = B(1)                                                       03630
      DO 84 I = 2,4                                                     03640
      IF(YMIN.LE.B(I)) GO TO 84                                         03650
      YMIN = B(I)                                                       03660
84    CONTINUE                                                          03670
      YMAX = B(1)                                                       03680
      DO 86 I = 2,4                                                     03690
      IF(YMAX.GE.B(I)) GO TO 86                                         03700
      YMAX = B(I)                                                       03710
86    CONTINUE                                                          03720
      IXMIN = INT(XMIN*10)                                              03730
      IYMIN = INT(YMIN*10)                                              03740
      IXMAX = INT(XMAX*10)                                              03750
      IYMAX = INT(YMAX*10)                                              03760
      WRITE(6,228) IXMIN,IYMIN,IXMAX,IYMAX,NP                           03770
      WRITE(7,228) IXMIN,IYMIN,IXMAX,IYMAX,NP                           03780
      WRITE(6,223)                                                      03790
      WRITE(6,224)                                                      03800
      WRITE(6,232)                                                      03810
      DO 55 ISM = 1,NPE                                                 03820
      WRITE(6,233)                                                      03830
      IF(ISM.NE.NPE) GO TO 61                                           03840
      IF1 = (NPE-1)*2*6                                                 03850
      IF(NPER.EQ.1) GO TO 63                                            03860
      DO 310 I2 = 1,6                                                   03870
      XD(I2) = XH(IF1+I2)                                               03880
310   YD(I2) = YH(IF1+I2)                                               03890
      IBEG = 7                                                          03900
      IEND = 6 + I3E                                                    03910
      GO TO 64                                                          03920
63    IBEG = 1                                                          03930
      IEND = I3E                                                        03940
64    DO 312 I2 = IBEG,IEND                                             03950
      XD(I2) = XH(IF1+I2)                                               03960
312   YD(I2) = YH(IF1+I2)                                               03970
      GO TO 67                                                          03980
61    CONTINUE                                                          03990
      DO 314 I2 = 1,12                                                  04000
      IF1 = (ISM-1)*2*6                                                 04010
      XD(I2) = XH(IF1+I2)                                               04020
314   YD(I2) = YH(IF1+I2)                                               04030
67    CONTINUE                                                          04040
      IF(ISM.EQ.NPE) GO TO 68                                           04050
      NPP = 12                                                          04060
      GO TO 69                                                          04070
68    NPP = 6*(1-NPER) + I3E                                            04080
69    CONTINUE                                                          04090
      DO 70 I = 1,NPP                                                   04100
      X(I) = U(1)  + A(1,1)*XD(I) + A(1,2)*YD(I)                        04110
70    Y(I) = U(2)  + A(2,1)*XD(I) + A(2,2)*YD(I)                        04120
      IF(ISM.EQ.NPE) GO TO 81                                           04130
      DO 140 IL=1,2                                                     04140
      LSUB = 6*(IL-1)                                                   04150
140   WRITE(6,213) (XD(LSUB+I2),YD(LSUB+I2),I2=1,6)                     04160
      GO TO 72                                                          04170
```

```
81    IF(NPER.EQ.1) GO TO 141                                          04180
      WRITE(6,213) (XD(I2),YD(I2), I2=1,6)                             04190
      IBEG = 7                                                         04200
      IEND = 6+I3E                                                     04210
      GO TO 142                                                        04220
141   IBEG = 1                                                         04230
      IEND = I3E                                                       04240
142   WRITE(6,213) (XD(I2),YD(I2), I2=IBEG,IEND)                       04250
72    IF(ISM.EQ.NPE) GO TO 74                                          04260
      DO 56 I2 = 1,12                                                  04270
      IX(I2) = X(I2)*10                                                04280
56    IY(I2) = Y(I2)*10                                                04290
      DO 143 IL=1,3                                                    04300
      LSUB = 4*(IL-1)                                                  04310
      WRITE(6,235) (IX(LSUB+I2),IY(LSUB+I2),I2=1,4)                    04320
143   WRITE(7,235) (IX(LSUB+I2),IY(LSUB+I2),I2=1,4)                    04330
      GO TO 55                                                         04340
74    XX = (NPP-1)/4                                                   04350
      NP2 = 1+XX                                                       04360
      I4E = NPP - 4*(NP2-1)                                            04370
      DO 57 I2=1,NPP                                                   04380
      IX(I2) = X(I2)*10                                                04390
57    IY(I2) = Y(I2)*10                                                04400
      DO 145 IL = 1,NP2                                                04410
      LSUB = 4*(IL-1)                                                  04420
      IF(IL.EQ.NP2) GO TO 147                                          04430
      WRITE(6,235) (IX(LSUB+I2),IY(LSUB+I2), I2=1,4)                   04440
      WRITE(7,235) (IX(LSUB+I2),IY(LSUB+I2), I2=1,4)                   04450
      GO TO 145                                                        04460
147   WRITE(6,235) (IX(LSUB+I2),IY(LSUB+I2), I2=1,I4E)                 04470
      WRITE(7,235) (IX(LSUB+I2),IY(LSUB+I2), I2=1,I4E)                 04480
145   CONTINUE                                                         04490
55    CONTINUE                                                         04500
      IF(NCULS .EQ. 0) GO TO 380                                       04510
      NPTYP = 99                                                       04520
      WRITE(6,243)                                                     04530
      NP = NCULS*2                                                     04540
      NPM1 = NP-1                                                      04550
      NCULS = 0                                                        04560
      DO 320 I1 = 1,NPM1,2                                             04570
      IMARK = (I1+2)/2                                                 04580
      XH(I1) = XL(IEND1 + IMARK)                                       04590
      YH(I1) = YL(IEND1 + IMARK)                                       04600
      XH(I1+1) = XR(IEND1 + IMARK)                                     04610
320   YH(I1+1) = YR(IEND1 + IMARK)                                     04620
      GO TO 316                                                        04630
380   CONTINUE                                                         04640
      GO TO 100                                                        04650
97    IF(K.EQ.0) GO TO 98                                              04660
      WRITE(6,225) XOTOL,IBIG,(K1(I), I = 1,K)                         04670
      WRITE(6,230)                                                     04680
      DO 87 I = 1,K                                                    04690
      IWR = 2*K1(I)-1                                                  04700
87    WRITE(6,231) C(IWR)                                              04710
98    IF(L.EQ.0) GO TO 99                                              04720
      WRITE(6,226) YOTOL,IBIG,(L1(I), I = 1,L)                         04730
      WRITE(6,230)                                                     04740
      DO 88 I = 1,L                                                    04750
      IWR = 2*L1(I)                                                    04760
88    WRITE(6,231) C(IWR)                                              04770
99    IF(ABS((THETA(1)-THETA(2))*60.).LE.THETOL) GO TO 100             04780
```

```
      WRITE(6,227) THETOL,IBIG                                          04790
  100 CONTINUE                                                          04800
      STOP                                                              04810
      END                                                               04820
      SUBROUTINE SORT6(ITL,ITR,XL,YL,XR,YR,N)                           04830
      DIMENSION XL(1000), YL(1000), XR(1000), YR(1000),ITL(1000),       04840
     1ITR(1000)                                                         04850
      DO 20 I = 1,N                                                     04860
      IF(ITL(I) .LE. ITL(I+1)) GO TO 20                                 04870
      K = I + 2                                                         04880
   10 K = K-1                                                           04890
      IF(K .LT. 2) GO TO 20                                             04900
      IF(ITL(K-1) .LE. ITL(K)) GO TO 20                                 04910
      IDUM1 = ITL(K)                                                    04920
      IDUM2 = ITR(K)                                                    04930
      DUM3 = XL(K)                                                      04940
      DUM4 = YL(K)                                                      04950
      DUM5 = XR(K)                                                      04960
      DUM6 = YR(K)                                                      04970
      ITL(K) = ITL(K-1)                                                 04980
      ITR(K) = ITR(K-1)                                                 04990
      XL(K) = XL(K-1)                                                   05000
      YL(K) = YL(K-1)                                                   05010
      XR(K) = XR(K-1)                                                   05020
      YR(K) = YR(K-1)                                                   05030
      ITL(K-1) = IDUM1                                                  05040
      ITR(K-1) = IDUM2                                                  05050
      XL(K-1) = DUM3                                                    05060
      YL(K-1) = DUM4                                                    05070
      XR(K-1) = DUM5                                                    05080
      YR(K-1) = DUM6                                                    05090
      GO TO 10                                                          05100
   20 CONTINUE                                                          05110
      RETURN                                                            05120
      END                                                               05130
      SUBROUTINE RATMUL(C,A,B,I,J,K)                                    05140
      DIMENSION C(I,K), A(I,J), B(J,K)                                  05150
      DO 100 IR = 1,I                                                   05160
      DO 100 JC = 1,K                                                   05170
      C(IR,JC) = 0.                                                     05180
      DO 100 L = 1,J                                                    05190
      C(IR,JC) = C(IR,JC) + A(IR,L)*B(L,JC)                             05200
  100 CONTINUE                                                          05210
      RETURN                                                            05220
      END                                                               05230
      SUBROUTINE INVERS(ATA,N)                                          05240
      DIMENSION ATA(N,N), A(4,4)                                        05250
  302 FORMAT(1X, ' NO SLOUTION. A 0 EXISTS ON THE MAIN DIAGONAL FOR')   05260
  303 FORMAT(' ROW NUMBER ',I3,' COLUMN NUMBER ',I3)                    05270
  301 FORMAT(' REMEMBER-ROWS MAY HAVE BEEN SWITCHED PREVIOUS TO THIS ') 05280
  304 FORMAT(' POINT. NO MORE SWITCHING POSSIBLE')                      05290
      DO 300I = 1,N                                                     05300
      DO 306 JJ = 1,N                                                   05310
  306 A(I,JJ) = 0.0                                                     05320
  300 A(I,I) = 1.0                                                      05330
      DET = 1.0                                                         05340
      DO 341 IH = 1,N                                                   05350
      IG = IH                                                           05360
      IF (ABS(ATA(IH,IH)).GE.1.E-10) GO TO 332                          05370
C SWAP ROWS                                                             05380
  305 IG = IG+1                                                         05390
```

```
      IF (IG.LE.N) GO TO 308                                            05400
      WRITE(6,302)                                                      05410
      WRITE(6,303) IH, IH                                               05420
      WRITE(6,301)                                                      05430
      WRITE(6,304)                                                      05440
      GO TO 381                                                         05450
  308 IF (ABS(ATA(IG,IG)).LT.1.E-10) GO TO 305                          05460
      DET = (-1.0)*DET                                                  05470
      DO 324JJ = 1,N                                                    05480
      C = ATA(IH,JJ)                                                    05490
      D = A(IH,JJ)                                                      05500
      ATA(IH,JJ) = ATA(IG,JJ)                                           05510
      A(IH,JJ) = A(IG,JJ)                                               05520
      ATA(IG,JJ) = C                                                    05530
  324 A(IG,JJ) = D                                                      05540
  332 DIAG = ATA(IH,IH)                                                 05550
      DET = DET*DIAG                                                    05560
      DO 334JJ = 1,N                                                    05570
      ATA(IH,JJ) = ATA(IH,JJ)/DIAG                                      05580
  334 A(IH,JJ) = A(IH,JJ)/DIAG                                          05590
      IF(IH .EQ. N) GO TO 336                                           05600
      II = IH+1                                                         05610
      DO 340I = II, N                                                   05620
      DIAG = ATA(I,IH)                                                  05630
      DO 340JJ = 1,N                                                    05640
      ATA(I,JJ) = ATA(I,JJ) - (DIAG*ATA(IH,JJ))                         05650
  340 A(I,JJ) = A(I,JJ) - (DIAG*A(IH,JJ))                               05660
  341 CONTINUE                                                          05670
  336 IN1 = N-1                                                         05680
      DO 348 I = 1,IN1                                                  05690
      IH = N+1-I                                                        05700
      II = IH - 1                                                       05710
  352 DIAG = ATA(II,IH)                                                 05720
      IG = N                                                            05730
  346 IF(IG .EQ. 0) GO TO 342                                           05740
      ATA(II,IG) = ATA(II,IG) - (DIAG*ATA(IH,IG))                       05750
      A(II,IG) = A(II,IG) - (DIAG*A(IH,IG))                             05760
      IG = IG - 1                                                       05770
      GO TO 346                                                         05780
  342 IF(II .EQ. 1) GO TO 348                                           05790
      II = II-1                                                         05800
      GO TO 352                                                         05810
  348 CONTINUE                                                          05820
  354 DO 380 I = 1,N                                                    05830
      DO 380 J = 1,N                                                    05840
  380 ATA(I,J) = A(I,J)                                                 05850
  381 RETURN                                                            05860
      END                                                               05870
```

APPENDIX VI

DACS PROGRAM LISTING

```
C                                                                       DAC00010
C                          'DACS  -  PHASE I'          (PRESORT)        DAC00020
C     GL FARNSWORTH ( CENSUS USE STUDY,  (301) 763-7094 )               DAC00030
C           CHANGES TO 6/27/72                                          DAC00040
C                                                                       DAC00050
C     OCTOBER, 1970                                                     DAC00060
C    THIS ROUTINE SETS UP THE SEGMENT RECORDS WHICH CAN ADEQUATELY DESCRDAC00070
C      ALL REGIONS BY BOUNDING.                                         DAC00080
C                                                                       DAC00090
C                                                                       DAC00100
      IMPLICIT INTEGER (A-Z)                                            DAC00110
      INTEGER*2 NREC(22)                                                DAC00120
      REAL XREC(80),XFILE
      DIMENSION RECD(11),SLIST(2000),IREC(80),RECS(11)
      DIMENSION TITLE(3)                                                DAC00140
      EQUIVALENCE (IREC(1),XREC)
      COMMON NCODE,COUNT,RECD,SLIST                                     DAC00150
      DATA NINES,INFILE,OUTFIL/999999999,8,9/                           DAC00170
      DATA  BLOC ,  TRAC,  REGN, BLANK,  SLCT,  RJCT, BNRY             DAC00180
     X  /  'BLKS', 'TRCS','RGNS', ' ' , 'SELE','REJE' , 'BINA'  /       DAC00190
      DATA  ACRES,  SQFT,  SQMI                                         DAC00200
     X   / 'ACRE', 'SQFT','SQMI' /                                      DAC00210
      DATA   BGPS   /'BGPS'/                                            DAC00220
      SLIST(1) = NINES                                                  DAC00230
      COUNT=0                                                           DAC00240
      READ( 5, 20 ) FILE, XFILE, CALC, CODE, ELECT, AREA, OPTION, TITLE
   20 FORMAT(A4,A6,A4,4X,A4,4X,A4,15X,A4,9X,I4,6X,3A4 )
      IF( CALC .EQ. BLANK )   CALC = TRAC                               DAC00270
      IF( AREA  .EQ. BLANK)  AREA  = SQFT                               DAC00280
      WRITE(6, 21 )  FILE, XFILE, TITLE, AREA, OPTION
   21 FORMAT( '1  INPUT FILE IN ',A4,A6, 'FORMAT'/
     X          '  TITLE = ', 3A4/  '   AREA IN ',A4/' OPTION=',I4 // )  DAC00300
      IF( CALC .NE. BLOC ) GO TO 1                                      DAC00310
      LCODE =  6                                                        DAC00320
      WRITE(6,1000)                                                     DAC00330
      GO TO 5                                                           DAC00340
    1 IF( CALC .NE. TRAC ) GO TO 2                                      DAC00350
      LCODE =  10                                                       DAC00360
      WRITE(6, 1010)                                                    DAC00370
      GO TO 5                                                           DAC00380
    2 IF( CALC .NE. REGN ) GO TO 3                                      DAC00390
      LCODE =  8                                                        DAC00400
      WRITE(6, 1020)                                                    DAC00410
      GO TO 5                                                           DAC00420
    3 IF( CALC .NE. BGPS ) GO TO 4                                      DAC00430
      LCODE =  6                                                        DAC00440
      WRITE(6, 1025)                                                    DAC00450
      GO TO 5                                                           DAC00460
    4 WRITE( 6, 1030 )  CALC, CODE, ELECT, AREA, OPTION,TITLE           DAC00470
      RECIN = 0                                                         DAC00480
      RECOUT= 1                                                         DAC00490
      GO TO 800                                                         DAC00500
C                                                                       DAC00510
 1000 FORMAT( '0  AREAS AND CENTROIDS OF CENSUS BLOCKS REQUESTED'/  )   DAC00520
 1010 FORMAT( '0  AREAS AND CENTROIDS OF CENSUS TRACTS REQUESTED'/  )   DAC00530
 1020 FORMAT( '0  AREAS AND CENTROIDS OF AREA CODES REQUESTED'   /  )   DAC00540
 1025 FORMAT( '0  AREAS AND CENTROIDS OF BLOCK GROUPS REQUESTED' /  )   DAC00550
C                                                                       DAC00560
 1030 FORMAT( '1  UNUSABLE CONTROL CARD SPECIFICATION'  //              DAC00570
     X        'CALCULATE ',A4,4X,A4,'CT  ',A4,2X,A4,I3, 3A4 )           DAC00580
C                                                                       DAC00590
```

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    5 RCODE = LCODE + 1                                                    DAC00600
      IF( CODE .EQ. BLANK) GO TO 9                                         DAC00610
      SELECT = 3                                                           DAC00620
      IF( CODE .EQ. SLCT ) SELECT = 100                                    DAC00630
      IF( CODE .EQ. RJCT ) SELECT = 0                                      DAC00640
      IF( SELECT .EQ. 3 ) GO TO 4                                          DAC00650
    8 ECODE = 100                                                          DAC00660
      IF( ELECT .EQ. BLOC )  ECODE = 7                                     DAC00670
      IF( ELECT .EQ. BGPS )  ECODE = 7                                     DAC00680
      IF( ELECT .EQ. TRAC )  ECODE = 11                                    DAC00690
      IF( ELECT .EQ. REGN )  ECODE = 9                                     DAC00700
      IF( ECODE .GT. 11   )  GO TO 4                                       DAC00730
C                                                                          DAC00720
    9 AMULT = 0                                                            DAC00740
      IF( AREA  .EQ. ACRES)  AMULT = 640                                   DAC00750
      IF( AREA  .EQ. SQFT )  AMULT = 5280 * 5280                           DAC00760
      IF( AREA  .EQ. SQMI )  AMULT = 1                                     DAC00770
      IF( AMULT .EQ. 0 ) GO TO 4                                           DAC00710
C                                                                          DAC00780
      WRITE( OUTFIL, 1090 )  AMULT, AREA, CALC, OPTION, TITLE              DAC00790
 1090 FORMAT( 18X,I11, 2A4, I4, 3A4)                                       DAC00800
      IF( CODE .EQ. BLANK )  GO TO 80                                      DAC00810
   10 READ( 5, 22, END=80 )  TRACT                                         DAC00820
C                                                                          DAC00830
C     THE  VARIABLE 'TRACT' MAY ACTUALLY BE BLOCK, BG, OR REGION           DAC00840
C                                                                          DAC00850
   22 FORMAT(  I9  )                                                       DAC00860
C                                                                          DAC00870
      IF( TRACT .GE. NINES )  GO TO 80                                     DAC00880
C                                                                          DAC00890
      IF (ELECT.EQ.BLOC) TRACT = TRACT*1000 + BLOCK                        DAC00900
      IF(COUNT) 30, 30, 40                                                 DAC00910
   30 SLIST(1)=TRACT                                                       DAC00920
      COUNT=1                                                              DAC00930
      GO TO 10                                                             DAC00940
   40 DO 50 I=1, COUNT                                                     DAC00950
      IF(SLIST(I) - TRACT) 50, 10, 60                                      DAC00960
   50 CONTINUE                                                             DAC00970
      COUNT=COUNT + 1                                                      DAC00980
      SLIST(COUNT)=TRACT                                                   DAC00990
      GO TO 10                                                             DAC01000
   60 COUNT=COUNT + 1                                                      DAC01010
      J=COUNT                                                              DAC01020
   70 K=J - 1                                                              DAC01030
      SLIST(J)=SLIST(K)                                                    DAC01040
      J=J - 1                                                              DAC01050
      IF(J .GT. I) GO TO 70                                                DAC01060
      SLIST(I)=TRACT                                                       DAC01070
      GO TO 10                                                             DAC01080
   80 IF( COUNT  .EQ. 0 ) WRITE( 6,1040)                                   DAC01090
C                                                                          DAC01100
      IF( COUNT  .GT. 0 ) WRITE( 6,1050) COUNT, ELECT, CODE                DAC01110
     X                                  ,(SLIST(N),N=1,COUNT)               DAC01120
C                                                                          DAC01130
 1040 FORMAT(  '0   ALL  AREAS  TO  BE  PROCESSED' )                       DAC01140
 1050 FORMAT(  '0  LIST OF', I6, 2X, A4, ' TO BE ', A4, 'CTED.'  //        DAC01150
     X      (  / 12I'0 ) )                                                 DAC01160
C                                                                          DAC01170
  500 RECIN=0                                                              DAC01180
      RECOUT=0                                                             DAC01190
C                                                                          DAC01200
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C                                                                       DAC01210
C   READ DIME FILE RECORD AND SELECT REQUIRED INFORMATION
C
  550 IF(FILE.EQ.BNRY) GO TO 555
      READ(INFILE,560,END=800)RECD(1),RECD(3),RECD(5),LINK,RECD(10),
     XRECD(11),RECD(2),RECD(4),RECD(8),RECD(9),RECD(6),
     XRECD(7),FX,FY,TX,TY
  560 FORMAT(28X,A1,16X,2(I3,2X),29X,I7,2I6,19X,4I4,2(13X,I5,1X),
     X54X,4I7)
      GO TO 558
  555 READ(INFILE,END=800) IREC
  558 CONTINUE
C
C   NONE STREET CODE
      RECD(1)=IREC(22)
C   FROM NODE NUMBER AND MAP NUMBER
      RECD(2)=IREC(3)
      RECD(3)=IREC(4)
C   TO NODE NUMBER AND MAP NUMBER
      RECD(4)=IREC(6)
      RECD(5)=IREC(7)
C   BLOCK NUMBER, LEFT AND RIGHT
      RECD(6)=IREC(30)
      RECD(7)=IREC(31)
C   PLACE CODE, LEFT AND RIGHT
      RECD(8)=IREC(44)
      RECD(9)=IREC(45)
C   TRACT NUMBER, LEFT AND RIGHT
      RECD(10)=IREC(32)
      RECD(11)=IREC(33)
C   STATE PLANE COORDINATES FOR FROM AND TO NODES
      FX=XREC(70)
      FY=XREC(71)
      TX=XREC(73)
      TY=XREC(74)
C
C   SAVE RECORD GEO-CODES
      DO 90 J=1,11
      RECS(J)=RECD(J)
   90 CONTINUE
C
C
C   SEQUENCE NUMBER
C
      LINK=IREC(13)
C
      RECIN=RECIN + 1                                                   DAC01290
C                                                                       DAC01300
C                                                                       DAC01310
C    MAKE BLOCK NUMBERS UNIQUE BY COMBINING WITH TRACT NUMBERS.         DAC01320
C                                                                       DAC01330
      IF( LCODE .NE. 6      )  GO TO 5651                               DAC01340
C                                                                       DAC01350
      DO 565 K = 6,7                                                    DAC01360
      J = K+4                                                           DAC01370
      RECD(K) = MOD(RECD(K),10) + RECD(K)/100*10
      RECD(J) = MOD(RECD(J),10) + RECD(J)/100*10
      RECD( K ) =  RECD(K) + RECD(J)*10000                              DAC01380
      IF( CALC  .EQ. BGPS  )  RECD(K) = RECD(K) / 100                   DAC01390
  565 CONTINUE                                                          DAC01400
C                                                                       DAC01410
```

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C                                                                       DAC01420
C                                                                       DAC01430
C     SELECT ONLY BOUNDARY SEGMENTS.                                    DAC01440
C                                                                       DAC01450
C                                                                       DAC01460
 5651 KEYL = RECD( LCODE )                                              DAC01470
      KEYR = RECD( RCODE )                                              DAC01480
      IF (KEYL.EQ.KEYR) GO TO 550                                       DAC01490
C                                                                       DAC01500
C                                                                       DAC01510
C
C    ENCODE NODE AND MAP NUMBERS. ALL RESULTING #'S UNIQUE IN TRACT
      DO 566 I=2,4,2
      RECD(I)=RECD(I)+10000*RECD(I+1)
 566  CONTINUE
C
      IF (COUNT.EQ.0) GO TO 575                                         DAC01640
      IF( ISKIP( RECS( ECODE ) , SELECT ) .EQ. 1 ) GO TO 5801
C                                                                       DAC01660
C                                                                       DAC01670
C     KEYR IS REGION TO LEFT OF SEGMENT WHEN DIRECTION IS REVERSED. TX, TDAC01680
C       FROM NODE COORDINATES.                                          DAC01690
C                                                                       DAC01700
C                                                                       DAC01710
  575 WRITE (OUTFIL,570) KEYR, KEYL, LINK, RECD(4), RECD(2), TX,TY      DAC01720
      RECOUT=RECOUT + 1                                                 DAC01730
  580 IF (COUNT.EQ.0) GO TO 581                                         DAC01740
 5801 IF( ISKIP( RECS( ECODE-1 ),SELECT ) .EQ. 1 ) GO TO 550
C                                                                       DAC01760
C                                                                       DAC01770
C     KEYL IS COUNTERPART SEGMENT OF KEYR, TO DESCRIBE BOUNDARY OF ADJOINDAC01780
C       REGION.                                                         DAC01790
C                                                                       DAC01800
C                                                                       DAC01810
  581 WRITE (OUTFIL,570) KEYL, KEYR, LINK, RECD(2), RECD(4), FX, FY
  570 FORMAT( 3I9, 4I10)
      RECOUT = RECOUT+1                                                 DAC01830
      GO TO 550                                                         DAC01840
  800 WRITE (OUTFIL,810) NINES                                          DAC01850
  810 FORMAT (I9)                                                       DAC01870
      END FILE OUTFIL                                                   DAC01880
      WRITE(6,850) RECIN, RECOUT                                        DAC01890
  850 FORMAT('0  PRESORT PROCESSING COMPLETED' /// 10X, I6, ' RECORDS INDAC01900
     X' // 10X, I6, ' RECORDS PASSED TO SORT')                          DAC01910
      CALL  EXIT                                                        DAC01920
      STOP                                                              DAC01930
      END                                                               DAC01940
      FUNCTION         ISKIP ( KEY, SELECT )                            DAC01950
      IMPLICIT INTEGER(A-Z)                                             DAC01960
      COMMON NCODE,COUNT,RECD,SLIST                                     DAC01970
      DIMENSION RECD(11),SLIST(2000)                                    DAC01980
      ISKIP  =  0                                                       DAC01990
      TOP=1                                                             DAC02000
      BOTTOM=COUNT                                                      DAC02010
      TRACT=KEY                                                         DAC02020
   10 IF(  BOTTOM  .LT. TOP ) GO TO 301                                 DAC02030
      MIDPT = TOP + (BOTTOM-TOP)/2                                      DAC02040
      IF( TRACT - SLIST(MIDPT) ) 15, 100, 20                            DAC02050
   15 BOTTOM = MIDPT - 1                                                DAC02060
       GO TO 10                                                         DAC02070
   20 TOP = MIDPT + 1                                                   DAC02080
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      GO TO 10                                                          DAC02090
  100 ISKIP  =  1                                                       DAC02100
      IF(  SELECT .EQ. 100)ISKIP=0                                      DAC02110
      RETURN                                                            DAC02120
  301 IF(  SELECT .EQ. 100) ISKIP = 1                                   DAC02130
      RETURN                                                            DAC02140
      END                                                               DAC02150
```

```
      IMPLICIT INTEGER (8-Y)                                                DACC00010
      INTEGER*2 ND(4)                                                       DACC00020
      DIMENSION NQ(2),NS(3)                                                 DACC00030
      EQUIVALENCE (NQ(1),ND(1))                                             DACC00040
      DOUBLE PRECISION ZMULT                                                DACC00050
      DIMENSION TITLE(3), OPTION(3)                                         DACC00060
       DIMENSION  TLIST(2000)                                               DACC00070
      COMMON     ELIST( 2000, 5 ) , ZMULT                                   DACC00080
C                                                                           DACC00090
      DATA  R,  INFILE, OUT1, OUT2,    EOF    , MAX , AREA, ATOTAL, ASUBDACC00100
     X  /   1,    9,      10,   11 , 999999999,2000 , 0.0 ,  0.0,    0.0 DAC 00110
      LOGICAL PIOS / .FALSE. /                                              DACC00120
       LOGICAL  ADJ / .FALSE. /                                             DACC00130
      LOGICAL   LIST  / .FALSE. / , BNDS   / .FALSE. /                      DACC00140
      DATA    NUM  / 0 / ,  BGRP / 'BGPS'  /                                DACC00150
      DATA  BLKS  / 'BLKS' /  , TDRPT /0/, DROPT /0/                        DACC00160
      DATA BLANK /' '/ , IA /'A'/                                           DACC00170
C                                                  *                      DACC00180
C                                            OPTION  PROCESSING           DACC00190
C                                                                           DACC00200
      CNT=0                                                                 DAC 00210
      READ(5,5001,ERR=9999) AMULT,LNITS,KALC,OPTION,TITLE                   DAC 00220
 5001 FORMAT(F10.0,2A4,3I1,3A4)                                             DAC 00230
C                                                                           DACC00240
      ZMULT = AMULT * .00000001                                             DACC00250
      IF (OPTION(1) .EQ. 1) LIST = .TRUE.                                   DACC00260
      IF (OPTION(2) .EQ. 1) BNDS = .TRUE.                                   DACC00270
      IF (OPTION(3) .EQ. 1) ADJ  = .TRUE.                                   DACC00280
       READ( INFILE, 5002, END=500) KEY, TLIST(1), (ELIST(1,J),J=1,5)       DAC 00290
 5002 FORMAT(7I9)                                                           DAC 00300
      WRITE(6,5014) TITLE, KALC, UNITS, OPTION, KEY                         DACC00310
 5014 FORMAT( '1', 10X, 'U. S. BUREAU OF CENSUS  -  DIME AREA-CENTROID      DACC00320
     XYSTEM (DACS)' //  25X, 3A4 // 11X, 'CALCULATIONS ARE FOR ',A4,       DACC00330
     X ' IN ',A4,5X,3I1,' IS OPTION'/// 5X, 'FIRST AREA IS',I11  // )       DACC00340
  100 R=R+1                                                                 DACC00350
      IF(  R .LT. MAX )  GO TO 120                                          DACC00360
      WRITE(6,5003) KALC, KEY, MAX                                          DACC00370
 5003 FORMAT( // ' *** ', A4, I11, ' HAS',I5, ' CR MORE SEGMENTS' )         DACC00380
      DROPT = DROPT + 1                                                     DACC00390
      NIX = -1                                                              DACC00400
  105  READ( INFILE, 5002, END=500)KEYX, TLIST(1), (ELIST(1,J),J=1,5)       DAC 00410
      NIX = NIX + 1                                                         DACC00420
      IF( KEYX .EQ. KEY ) GO TO 105                                         DACC00430
      WRITE( 6, 5004 )  NIX                                                 DACC00440
 5004 FORMAT( 24X, I5, ' SEGMENTS CROPPED.  NO  CALCULATIONS' // )          DACC00450
      NIX  =  0                                                             DACC00460
      R = 2                                                                 DACC00470
C                                                                           DACC00480
C                                                                           DACC00490
  120  READ( INFILE, 5002, END=500)KEYX, TLIST(R), (ELIST(R,J),J=1,5)       DAC 00500
C                                                                           DACC00510
      IF( KEYX .EQ. KEY ) GO TO 100                                         DACC00520
C                                                                           DACC00530
C  $              *                                                         DACC00540
C  $  PROCESSING  *                                                         DACC00550
C  $              *                                                         DACC00560
C                                                                           DACC00570
  130 NUM = NUM + 1                                                         DACC00580
C                                                                           DACC00590
      NBLS    = R-1                                                         DACC00600
      AREA    = 0.0                                                         DACC00610
```

```
      CENTX  = 0                                                        DACC00620
      CENTY  = 0                                                        DACC00630
      IND    = 0                                                        DACC00640
      CALL  CHAIN (  NBLS, COMPS, CLOSES, RVSLS )                       DACC00650
      IF( COMPS .NE. CLOSES ) GO TO 140                                 DACC00660
      IF( COMPS .EQ.  1     ) GO TO 150                                 DACC00670
C                                                                       DACC00680
      WRITE( 6,5005) KALC, KEY, COMPS                                   DACC00690
C                                                                       DACC00700
 5005 FORMAT( '0*** ',A4, I11, ' HAS', I3, ' BOUNDED REGIONS - CHECK' )DACC00710
      GO TO 150                                                         DACC00720
C                                                                       DACC00730
  140 WRITE( 6,5006) KALC, KEY, COMPS, CLOSES                           DACC00740
 5006 FORMAT( '0*** ',A4, I11, ' HAS', I3, ' COMPONENTS.  ONLY',I3,' ARDAC 00750
     X CLOSED.  REGION  NOT PROCESSED' )                                DACC00760
C                                                                       DACC00770
      WRITE( 6, 5007 )                                                  DACC00780
      DO 145 I = 1,NBLS                                                 DACC00790
      NO(1) = ELIST(I,2)                                                DACC00800
      NO(2) = ELIST(I,3)                                                DACC00810
      NS(1) = ELIST(I,1)                                                DACC00820
      NS(2) = ELIST(I,4)                                                DACC00830
      NS(3) = ELIST(I,5)                                                DACC00840
145   WRITE(6,5097)  NO, NS                                             DACC00850
5097  FORMAT(2(5X,A2,I5),3I12)                                          DACC00860
C                                                                       DACC00870
 5007 FORMAT(  '0   SEGMENT  LISTING: '    //                         DACC00880
     X   FROM NODE     TO NODE  REC NUMBER    FROM X      FROM Y' /)   DAC 00890
C                                                                       DACC00900
      DROPT = DROPT + 1                                                 DACC00910
C                                                                       DACC00920
      GO TO 1000                                                        DAC 00930
C                                                                       DACC00940
  150 CALL  CALC( NBLS, AREA, CENTX, CENTY , MX, MY )                   DACC00950
C                                                                       DACC00960
      IF( AREA .LE. 0.0 ) DROPT = DROPT + 1                             DACC00970
C                                                                       DACC00980
      IF( CENTX .NE. 0 ) CALL POLYPT( NBLS, CENTX, CENTY, IND,MX,MY)    DACC00990
      IF(.NOT. BNDS ) GO TO 1000                                        DACC01000
C                                                                       DACC01010
      SYMAP=IA                                                          DACC01020
      KEY1=KEY/10000                                                    DACC01030
      KEY2=MOD(KEY,10000)                                               DACC01040
      KEY2=KEY2*100                                                     DACC01050
            DO  180  I = 1, NBLS                                        DACC01060
      KEY2=KEY2+I                                                       DACC01070
      WRITE(OUT2,5011) KEY1,SYMAP,ELIST(I,5),ELIST(I,4),ELIST(I,1),     DACC01080
     XKEY2                                                              DACC01090
 5011 FORMAT(I5,4X,A1,2I10,20X,I10,13X,I7)                              DACC01100
      SYMAP=BLANK                                                       DACC01110
  180 CONTINUE                                                          DACC01120
C                                                                       DACC01130
      KEY2=KEY2+1                                                       DACC01140
      WRITE(OUT2,5011) KEY1,SYMAP,ELIST(1,5),ELIST(1,4),ELIST(1,1),     DACC01150
     XKEY2                                                              DACC01160
C                                                                       DACC01170
 1000 IF( LIST ) WRITE(6,5008)KALC, KEY, NBLS, AREA, UNITS, CENTX,CENTYDACC01180
 5008 FORMAT( //5X, A4, I11, I9, ' SEGMENTS.  AREA =', F15.5,1X, A4    DACC01190
     X        /       29X    ,      '    CENTROID  IS :',2I15    )     DACC01200
      IF (PIOS) CALL REPNT (NBLS,KEY)                                   DACC01210
C                                                                       DACC01220
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      IF(RVSLS .GT. 0) WRITE(6,5015) RVSLS                              DAC 01230
 5015 FORMAT( 9X, I11, ' REVERSALS  - CHECK FOR POSS. ERRORS.' )        DACC01240
      IF( IND .GE. 0 )  GO TO 1100                                      DACC01250
C                                                                       DACC01260
      CALL ADJUST ( NBLS, CENTX, CENTY, NODE )                          DACC01270
C                                                                       DACC01280
                  WRITE(6,5009) NODE , CENTX, CENTY                     DAC 01290
 5009 FORMAT( / 9X, 'CENTROID WAS OUTSIDE  BOUNDARY - ADJUSTED TO NODE'DACC01300
     X  I11   /      29X    ,     'NEW CENTROID  IS :',2I15     )      DACC01310
C                                                                       DACC01320
 1100 WRITE( OUT1, 5010 ) KEY, AREA, CENTX, CENTY                       DACC01330
C                                                                       DACC01340
 5010 FORMAT( I10, F20.5, 2I10 )                                        DACC01350
C                                                                       DACC01360
      ASUB   =  ASUB + AREA                                             DACC01390
      ATOTAL=  ATOTAL + AREA                                            DACC01400
C                                                                       DACC01410
 1150  IF( ADJ   )  CALL ADJNCY ( NELS, KEY , TLIST )                   DACC01420
      DO 1200 I=1,5                                                     DAC 01430
 1200 ELIST(1,I)= ELIST(R,I)                                            DACC01440
C                                                                       DACC01450
 1250 KEY = KEYX                                                        DACC01460
      R = 2                                                             DACC01470
C                                                                       DACC01480
C                                                                       DACC01490
 1300 IF( KEY .LT. EOF ) GO TO 120                                      DACC01500
C                                                                       DACC01510
      IF( TDRPT .EQ. 0 ) TDRPT = DRCPT                                  DACC01520
      WRITE(6,5013)  NUM, KALC, TDRPT, ATOTAL, UNITS                    DACC01530
 5013 FORMAT( '1'  / 1X, 10('----') // I10, 1X, A4, ', ', I6, ' OMITTEDDACC01540
     X       // 5X, 'TOTAL AREA IS' , E13.5, 1X, A4 // 1X, 10('----') )DACC01550
      GO TO 1350                                                        DAC 01560
  500 KEYX= EOF                                                         DACC01570
      GO TO 1250                                                        DACC01580
C                                                                       DACC01590
 9999 WRITE(6,5099)                                                     DACC01600
C                                                                       DACC01610
 5099 FORMAT( '1  ERROR  IN  FIRST  RECORD' )                           DACC01620
      WRITE(6,5001)I, AMULT, UNITS, KALC, OPTION, TITLE                 DACC01630
 1350 STOP                                                              DAC 01640
      END                                                               DACC01650
      SUBROUTINE CHAIN (NBLS,COMPS,CLOSES,RVSLS)                        DAC 01660
C                                                                       DACC01670
C                                                                       DACC01680
C     THIS SUBROUTINE IS IDENTICAL TO THAT USED  IN THE DIME EDIT PACKAGDACC01690
C                                                                       DACC01700
C                                                                       DACC01710
C                                                                       DACC01720
C                                                                       DACC01730
      IMPLICIT INTEGER (A-Z)                                            DACC01740
      DOUBLE PRECISION  ZMULT                                           DACC01750
      DIMENSION HOLDER(5),ELIST(2000,5)                                 DACC01760
      COMMON ELIST,ZMULT                                                DACC01770
      BEGIN  = 1                                                        DACC01780
      END    = 1                                                        DACC01790
      COMPS  = 0                                                        DACC01800
      RVSLS  = 0                                                        DACC01810
      CLOSES = 0                                                        DACC01820
      HEAD = ELIST(BEGIN,2)                                             DACC01830
      TAIL = ELIST(END,3)                                               DACC01840
      IF( NBLS - 1 )  1250, 1200, 1000                                  DACC01850
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```
 1000 IF( HEAD .EQ. TAIL )  GO TO 1200                                  DACC01860
      START = END + 1                                                   DACC01870
      IF( START .GT. NBLS )  GO TO 1200                                 DACC01880
            DO 1100 I = START, NBLS                                     DACC01890
      IF (ELIST(I,3).EQ.HEAD) GO TO 3000                                DACC01900
      IF (ELIST(I,2).EQ.TAIL) GO TO 2000                                DACC01910
 1100       CONTINUE                                                   DACC01920
            DO 1150 I = START, NBLS                                     DACC01930
      I1 = I + 1                                                        DACC01940
         IF (I.EQ.NBLS) I1 = 1                                          DACC01950
         IF (ELIST(I,2).EQ.HEAD) GO TO 2990                             DACC01960
      IF (ELIST(I,3).EQ.TAIL) GO TO 1990                                DACC01970
 1150       CONTINUE                                                   DACC01980
 1200 COMPS = COMPS + 1                                                 DACC01990
      IF( HEAD .EQ. TAIL )      CLOSES = CLOSES + 1                   DACC02000
 1250 IF( END .GE. NBLS )  RETURN                                       DACC02010
CHAIN **                                                                DACC02020
            ELIST(END,1) = -ELIST(END,1)                                DACC02030
      IF (CLOSES.GE.2) GO TO 1400                                       DACC02040
C                                                                       DACC02050
C   THE FOLLOWING SECTION REARRANGES THE ORDER OF SEGMENTS IN THE CHAIN DACC02060
C       PERMIT CHAINING AS ONE COMPONENT FOR FIGURE EIGHT OR CHECKERBOADACC02070
C       CONFIGURATIONS, VIZ.                                            DACC02080
C                                                                       DACC02090
C               XXXXXXXX                XXXX         XXX               DACC02100
C               X      X                X   X       X   X   XXXXXXXX  DACC02110
C               X      X                 X   X     X     X X       X   DACC02120
C               XXXXXXXXXXXXXXXX         X   XX X       X         X   DACC02130
C                      X         X        X    X         X XXXXXXXXX   DACC02140
C                      X         X         XXXX XXX    X              DACC02150
C                      X         X                 XXX                 DACC02160
C                      XXXXXXXXXX                                       DACC02170
C                                                                       DACC02180
C       ARE TYPES OF REGIONS WHICH CONTAIN ONLY ONE COMPONENT BUT WHICH DACC02190
C       THE PROGRAM CAN INTERPRET AS HAVING TWO OR THREE CLOSED COMPONENDACC02200
C                                                                       DACC02210
      CLOSES = 0                                                        DACC02220
      COMPS = 0                                                         DACC02230
      J1 = END + 1                                                      DACC02240
      END1 = END                                                        DACC02250
      DO 1300 K1 = 1,END1                                               DACC02260
      HEAD = ELIST (K1,3)                                               DAC 02270
      DO 1300 I = J1,NBLS                                               DACC02280
      IF (ELIST(K1,3).EQ.ELIST(I ,2)) GO TO 2000                        DACC02290
 1300 CONTINUE                                                          DACC02300
      DO 1350 K1 = 1,END1                                               DACC02310
      HEAD = ELIST (K1,2)                                               DAC 02320
      DO 1350 I = J1,NBLS                                               DACC02330
      I1 = I + 1                                                        DACC02340
      IF (I.EQ.NBLS) I1 = 1                                             DACC02350
      IF (ELIST(K1,3).EQ.ELIST(I ,3)) GO TO 1990                        DACC02360
 1350 CONTINUE                                                          DACC02370
      CLOSES = 1                                                        DACC02380
      COMPS = 1                                                         DACC02390
C                                                                       DACC02400
C                                                                       DACC02410
 1400 END = END + 1                                                     DACC02420
      BEGIN = END                                                       DACC02430
      HEAD = ELIST(BEGIN,2)                                             DACC02440
      TAIL = ELIST(END,3)                                               DACC02450
      GO TO 1000                                                        DACC02460
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 1990 TEMP = ELIST(I,2)                                                 DACC02470
      ELIST(I,2) = ELIST(I,3)                                           DACC02480
      ELIST(I,3) = TEMP                                                 DACC02490
      TEMPY = ELIST(I,5)                                                DACC02500
      TEMPX = ELIST(I,4)                                                DACC02510
      ELIST (I,4) = ELIST (I1,4)                                        DACC02520
      ELIST (I,5) = ELIST (I1,5)                                        DACC02530
      ELIST(I1,4) = TEMPX                                               DACC02540
       ELIST(I1,5) = TEMPY                                              DACC02550
      RVSLS      =  RVSLS + 1                                           DACC02560
 2000 END = END + 1                                                     DACC02570
      IF( END .EQ. I )  GO TO 2050                                      DACC02580
      DO 2010  K=1,5                                                    DACC02590
 2010 HOLDER(K) = ELIST(I,K)                                            DACC02600
      TEMP = I                                                          DACC02610
 2020 TEMP = TEMP - 1                                                   DACC02620
      DO 2025 K=1,5                                                     DACC02630
 2025 ELIST(TEMP+1,K) = ELIST(TEMP,K)                                   DACC02640
      IF( TEMP .GT. END )  GO TO 2020                                   DACC02650
      DO 2030 K=1,5                                                     DACC02660
 2030 ELIST(END,K) = HOLDER(K)                                          DACC02670
 2050 TAIL = ELIST(END,3)                                               DACC02680
      GO TO 1000                                                        DACC02690
 2990 TEMP = ELIST(I,2)                                                 DACC02700
      ELIST(I,2) = ELIST(I,3)                                           DACC02710
      ELIST(I,3) = TEMP                                                 DACC02720
      TEMPY = ELIST(I,5)                                                DACC02730
      TEMPX = ELIST(I,4)                                                DACC02740
      ELIST (I,4) = ELIST (I1,4)                                        DACC02750
      ELIST (I,5) = ELIST (I1,5)                                        DACC02760
      ELIST(I1,4) = TEMPX                                               DACC02770
      ELIST(I1,5) = TEMPY                                               DACC02780
      RVSLS      =  RVSLS + 1                                           DACC02790
 3000 END = END + 1                                                     DACC02800
      DO 3010  K=1,5                                                    DACC02810
 3010 HOLDER(K) = ELIST(END,K)                                          DACC02820
      TEMP = END                                                        DACC02830
 3020 TEMP = TEMP - 1                                                   DACC02840
      DO 3030 K=1,5                                                     DACC02850
 3030 ELIST(TEMP+1,K) = ELIST(TEMP,K)                                   DACC02860
      IF( TEMP .GT. BEGIN )  GO TO 3020                                 DACC02870
      IF( I .EQ. END )  I = BEGIN                                       DACC02880
      DO 3100 K=1,5                                                     DACC02890
      ELIST(BEGIN,K) = ELIST(I,K)                                       DACC02900
 3100 ELIST(I,K) = HOLDER (K)                                           DACC02910
      HEAD = ELIST (BEGIN,2)                                            DACC02920
      GO TO 1000                                                        DACC02930
      END                                                               DAC 02940
      SUBROUTINE         ADJUST( NBLS, CX, CY, NODE )                   DAC 02950
C                                                                       DACC02960
C        ROUTINE TO ADJUST BAD CENTROIDS                                DACC02970
C        TO NEAREST NODE                                                DACC02980
C                                                                       DACC02990
      IMPLICIT  INTEGER (B-Y)                                           DACC03000
      DOUBLE PRECISION  ZMULT                                           DACC03010
      COMMON  ELIST( 2000, 5 ),  ZMULT                                  DACC03020
C                                                                       DACC03030
      ND  =   0                                                         DACC03040
      DO 101 I = 1,NBLS                                                 DACC03050
      DX  =  CX-ELIST(I,4)                                              DACC03060
      DY  =  CY-ELIST(I,5)                                              DACC03070
```

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      AXY =  DX * DX  +  DY * DY                                        DACC03080
      IF( I .EQ. 1 ) GO TO 100                                          DACC03090
      IF( A  .LT.  AXY )  GO TO 101                                     DACC03100
  100 A = AXY                                                           DACC03110
      NO  =  I                                                          DACC03120
  101 CONTINUE                                                          DACC03130
      IF( NO  .LE.  C )  GO TO 200                                      DACC03140
      CX =  ELIST(NO,4)                                                 DACC03150
      CY =  ELIST(NO,5)                                                 DACC03160
      NODE = ELIST(NO,2)                                                DACC03170
      RETURN                                                            DACC03180
C                                                                       DACC03190
  200 CX =  0                                                           DACC03200
      CY =  0                                                           DACC03210
      NODE =0                                                           DACC03220
      RETURN                                                            DACC03230
      END                                                               DAC 03240
            SUBROUTINE  CALC( NSEG, AREA, CX, CY, MINX, MINY )          DAC 03250
C                                                                       DACC03260
      IMPLICIT INTEGER ( B-Y )                                          DACC03270
      DIMENSION   ELIST(2000,5)                                         DACC03280
      COMMON  ELIST,  ZMULT                                             DACC03290
      DOUBLE PRECISION  ZMULT, ARSIX, A, DX,DY, X1,Y1, X2,Y2            DACC03300
      DIMENSION ARS(10)                                                 DAC 03310
      BEGIN = 1                                                         DACC03320
      NAR = 0                                                           DACC03330
      A = 0                                                             DACC03340
      DX = 0                                                            DACC03350
      DY = 0                                                            DACC03360
C                                                                       DACC03370
C                                                                       DACC03380
C      USE  FIRST  COORDINATES  TO REDUCE  ALL  OTHERS                  DACC03390
C                                                                       DACC03400
C                                                                       DACC03410
      MINX = ( ELIST(1,4) / 10000 ) * 10000                             DAC 03420
      MINY = ( ELIST(1,5) / 10000 ) * 10000                             DAC 03421
C                                 CHECK FOR MULTIPLE BOUNDARIES         DACC03440
    5 NAR = NAR + 1                                                     DACC03450
      DO 20 I = BEGIN, NSEG                                             DACC03460
      IF( ELIST(I,1)  ) 10,20,20                                        DACC03470
   10 END = I                                                           DACC03480
      GO TO 30                                                          DACC03490
   20 CONTINUE                                                          DACC03500
      END = NSEG                                                        DACC03510
C                                                                       DACC03520
C                                                                       DACC03530
C      REDUCING  COORDINATES  AND USE OF  DOUBLE PRECISION              DACC03540
C      MINIMIZES TRUNCATION AND ROUNDING ERRORS.                        DACC03550
C                                                                       DACC03560
C                                                                       DACC03570
   30   X1 = ELIST(END,4) - MINX                                        DACC03580
        Y1 = ELIST(END,5) - MINY                                        DACC03590
      DO 100 K = BEGIN,END                                              DACC03600
        X2 =  ELIST( K,4) - MINX                                        DACC03610
        Y2 =  ELIST( K,5) -MINY                                         DACC03620
C                                                                       DACC03630
      A  =  A +  (X2-X1) * (Y1+Y2)                                      DACC03640
C                                                                       DACC03650
        X1 = X2                                                         DACC03660
        Y1 = Y2                                                         DACC03670
C                                                                       DACC03680
```

```
  100 CONTINUE                                                          DACC03690
C                              ACCUMULATE  AREAS IN 'ARS'               DACC03700
C                                                                       DACC03710
      ARS(NAR) = -A                                                     DACC03720
       A = 0.0000000                                                    DACC03730
C                          COMPUTE  CENTROID OF LARGEST AREA ONLY       DACC03740
      BEGIN = END + 1                                                   DACC03750
      IF( END .LT. NSEG ) GO TO 5                                       DACC03760
      BEGIN = 1                                                         DACC03770
      AB = ARS(1)                                                       DACC03780
      IAB= 1                                                            DACC03790
      A = AB                                                            DACC03800
            IF(NAR .EQ. 1 ) GO TO 180                                   DACC03810
      IF (NAR.GT.10) GO TO 500                                          DAC 03811
C                                                                       DAC 03812
            DO 150 I = 2,NAR                                            DACC03820
            A = A + ARS(I)                                              DACC03830
            IF( ARS(I) .LE. AB ) GO TO 150                              DACC03840
                                          AB = ARS(I)                   DACC03850
                                         IAB = I                        DACC03860
  150       CONTINUE                                                    DACC03870
  180 AREA = A * ZMULT                                                  DACC03880
      IF( A .EQ. 0.0 ) GO TO 500                                        DACC03890
      IF(NAR .EQ.  1 ) GO TO 200                                        DACC03900
       K = 1                                                            DACC03910
            DO 185 I = 1, NSEG                                          DACC03920
            IF( ELIST(I,1) .GE. 0 ) GO TO 185                           DACC03930
            K = K + 1                                                   DACC03940
            IF( K  -   IAB )185,183,184                                 DACC03950
  183       BEGIN = I + 1                                               DACC03960
            GO TO 185                                                   DACC03970
  184       END = I                                                     DACC03980
            A = AB                                                      DACC03990
            GO TO 200                                                   DACC04000
  185       CONTINUE                                                    DACC04010
            END = NSEG                                                  DACC04020
            A = AB                                                      DACC04030
  200 X1 =  ELIST(END,4) - MINX                                         DACC04040
      Y1 =  ELIST(END,5) - MINY                                         DACC04050
      ARSIX = A * 3.0                                                   DACC04060
C                                                                       DACC04070
C     NOTE  THAT   X1 AND Y1  ARE ALREADY SET                           DACC04080
C                                                                       DACC04090
       DO 300 K = BEGIN,END                                             DACC04100
        X2  =  ELIST( K,4) -  MINX                                      DACC04110
        Y2  =  ELIST( K,5) -  MINY                                      DACC04120
C                                                                       DACC04130
       DX   =  DX + ( Y2 - Y1 ) * (X1*X1 + X1*X2 + X2*X2 ) / ARSIX      DACC04140
       DY   =  DY + ( X2 - X1 ) * (Y1*Y1 + Y1*Y2 + Y2*Y2 ) / ARSIX      DACC04150
C                                                                       DACC04160
        X1  =  X2                                                       DACC04170
        Y1  =  Y2                                                       DACC04180
C                                                                       DACC04190
  300  CONTINUE                                                         DACC04200
C                                                                       DACC04210
       CX   =  DX + MINX                                                DACC04220
       CY = -DY + MINY                                                  DACC04230
C                                                                       DACC04240
C                                                                       DACC04250
C                                                                       DACC04260
C                                                                       DACC04270
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C                                                                       DACC04280
      RETURN                                                            DACC04290
  500 CX    =   0                                                       DACC04300
      CY    =   0                                                       DACC04310
      RETURN                                                            DACC04320
      END                                                               DAC 04330
      SUBROUTINE REFMT(NBLS,KEY)                                        DAC 04340
      IMPLICIT  INTEGER (A-Z)                                           DACC04350
      DIMENSION ELIST(2000,5)                                           DACC04360
      COMMON ELIST                                                      DACC04370
      KEY1=KEY/100CC                                                    DACC04380
      KEY2=MOD(KEY,100CC)                                               DACC04390
      WRITE(13,100) KEY1,KEY2                                           DACC04400
  100 FORMAT(1X,2I5)                                                    DACC04410
      XMIN=ELIST(1,4)                                                   DACC04420
      XMAX=ELIST(1,4)                                                   DACC04430
      YMIN=ELIST(1,5)                                                   DACC04440
      YMAX=ELIST(1,5)                                                   DACC04450
      DO 10 J=2,NBLS                                                    DACC04460
      IF(XMIN.GT.ELIST(J,4)) XMIN=ELIST(J,4)                            DACC04470
      IF(XMAX.LT.ELIST(J,4)) XMAX=ELIST(J,4)                            DACC04480
      IF(YMIN.GT.ELIST(J,5)) YMIN=ELIST(J,5)                            DACC04490
      IF(YMAX.LT.ELIST(J,5)) YMAX=ELIST(J,5)                            DACC04500
   10 CONTINUE                                                          DACC04510
      WRITE(13,200) XMIN,YMIN,XMAX,YMAX,NBLS                            DACC04520
  200 FORMAT(4I9,I5)                                                    DACC04530
      M2=0                                                              DACC04540
      MK=NBLS                                                           DACC04550
   20 CONTINUE                                                          DACC04560
      M1=M2+1                                                           DACC04570
      M2=M2+4                                                           DACC04580
      IF(MK.LT.4) M2=NBLS                                               DACC04590
      WRITE(13,300) (ELIST(M,4),ELIST(M,5),M=M1,M2)                     DACC04600
  300 FORMAT(4(2I9))                                                    DACC04610
      MK=MK-4                                                           DACC04620
      IF(MK.GE.0) GO TO 20                                              DACC04630
        RETURN                                                          DACC04640
      END                                                               DAC 04650
      SUBROUTINE          INSECT       ( IXY, IND )                     DAC 04660
C     SUBROUTINE  TO  CHECK  TWO LINE SEGMENTS    FOR INTERSECTION      DACC04670
C                                                                       DACC04680
C     THE ENDPOINTS OF THE LINES ARE TRANSMITTED (INTEGER BINARY)       DACC04690
C     IN THE ARRAY 'IXY'  (FIRST  8  ELEMENTS) ( X-Y X-Y  X-Y X-Y  )    DACC04700
C                                                                       DACC04710
C     THE VARIABLE 'IND' IS RETURNED:  0  IF NO INTERSECTION            DACC04720
C                                     -1  IF LINES ARE COINCICENT       DACC04730
C                                     +1  IF THEY INTERSECT             DACC04740
C                                    THE COORDINATES OF INTERSECTION    DACC04750
C                              ARE RETURNED IN IXY(9) AND IXY(10)       DACC04760
C                                                                       DACC04770
C                                                                       DACC04780
      DIMENSION IXY (10),XY(8),S(2),P(2)                                DACC04790
      IND = 0                                                           DACC04800
      X = 0                                                             DACC04810
      Y = 0                                                             DACC04820
C                                                                       DACC04830
C     RETURN IF NO INTERSECTION POSSIBLE                                DACC04840
C                                                                       DACC04850
C                                    CROSS PRODUCT CALCULATION          DACC04860
       ACX = IXY(1) - IXY(5)                                            DACC04870
       ACY = IXY(2) - IXY(6)                                            DACC04880
```

```
      ADX = IXY(1) - IXY(7)                                              DACC04890
      ADY = IXY(2) - IXY(8)                                              DACC04900
C                                                                        DACC04910
      BCX = IXY(3) - IXY(5)                                              DACC04920
      BCY = IXY(4) - IXY(6)                                              DACC04930
      BDX = IXY(3) - IXY(7)                                              DACC04940
      BDY = IXY(4) - IXY(8)                                              DACC04950
      A1 =  (ACX * ADY - ACY * ADX)                                      DACC04960
      A2 =                                (BCX * BDY - BCY * BDX)        DACC04970
      IF  ( A1 * A2  .GT. 0.0 )RETURN                                    DACC04980
      R =  (ACX * BCY - ACY * BCX) * (ADX * BDY - ADY * BDX)             DACC04990
      IF  ( R  .GT. 0.0)RETURN                                           DACC05000
C  CHECK COLINEARITY                                                     DACC05010
      IF(A1.EQ.0 .AND. A2.EQ. 0) GO TO 2220                              DACC05020
C  CALCULATE INTERSECTION                                                DACC05030
      R = 0.0                                                            DACC05040
      IF (A1 .NE. 0 ) R= 1./(1. + ABS(A2/A1))                            DACC05050
      X = IXY(1) + (IXY(3) - IXY(1)) * R                                 DACC05060
      Y = IXY(2) + (IXY(4) - IXY(2)) * R                                 DACC05070
C  ROUND TO NEAREST INTEGER                                              DACC05080
      IXY(9) = X + SIGN(.5,X)                                            DACC05090
      IXY(10) = Y + SIGN(.5,Y)                                           DACC05100
      IND =1                                                             DACC05110
      RETURN                                                             DACC05120
C  COLINEAR CHECK FOR OVERLAP (COINCIDENCE)                              DACC05130
 2220 IF (ACX *BCX .LT. 0) IND = -1                                      DACC05140
      IF (ADX *BDX .LT. 0) IND= -1                                       DACC05150
      RETURN                                                             DACC05160
      END                                                                DAC 05170
      SUBROUTINE         POLYPT  (N, NX, NY, IND, MINX, MINY )           DAC 05180
C                                                                        DACC05190
C     ROUTINE  TO  DETERMINE  WHETHER  A  POINT  IS  WITHIN  A  POLYGONDACC05200
C                                                                        DACC05210
C      THE POLYGON BOUNDARY SEGMENTS ARE IN ELIST(I,4), ELIST(I,5)      DACC05220
C     THE NUMBER OF SEGMENTS IS 'N'                                      DACC05230
C                                                                        DACC05240
C    'IND' IS RETURNED:  +1  IF  PT. IS INSIDE                           DACC05250
C                         0  IF  PT. IS ON THE BOUNDARY                  DACC05260
C                        -1  IF  PT. IS OUTSIDE                          DACC05270
C                                                                        DACC05280
      DIMENSION  LXY(10),ELIST (2000,5)                                  DACC05290
      COMMON  ELIST, ZMULT                                               DACC05300
          INTEGER ELIST                                                  DACC05310
      DOUBLE  PRECISION  ZMULT                                           DACC05320
      IX =  NX -  MINX + 1                                               DACC05330
      IY =  NY -  MINY + 1                                               DACC05340
      IND = 0                                                            DACC05350
      INDX =0                                                            DACC05360
           XX=100000.                                                    DACC05370
      KOUNT =  KOUNT + 1                                                 DACC05380
      LXY(1) = 0                                                         DACC05390
      LXY(2) = IY                                                        DACC05400
      LXY(3) = IX                                                        DACC05410
      LXY(4) = IY                                                        DACC05420
      LXY(9) = 0                                                         DACC05430
      LXY(10)= 0                                                         DACC05440
      IT = 1                                                             DACC05450
      GO TO 2000                                                         DACC05460
C                                                                        DACC05470
C                                                                        DACC05480
C                                                                        DACC05490
```

```
C           DRAW A LINE FROM THE POINT  TO THE Y-AXIS AND COUNT THE NUMDACC05500
C           OF INTERSECTIONS WITH BOUNDARY SEGMENTS.  ODD IS INSIDE,EVEDACC05510
C                 OUTSIDE                                              DACC05520
C               IF AN INTERSECTION OCCURS AT A NODE                    DACC05530
C               CHANGE THE Y COORDINATE AT THE AXIS AND START OVER     DACC05540
C                                                                      DACC05550
 1000 IT = IT + 1                                                      DACC05560
      LXY (2) = LXY (2) + IY/10 + 1                                    DACC05570
      IF (IT.GT.5) RETURN                                              DACC05580
 2000 INDX = 0                                                         DACC05590
      DO 3000 I = 1,N                                                  DACC05600
      I1 = I + 1                                                       DACC05610
      IF (I.EQ.N) I1 = 1                                               DACC05620
      LXY (5) = ELIST(I ,4) - MINX + 1                                 DACC05630
      LXY (6) = ELIST(I ,5) - MINY + 1                                 DACC05640
      LXY (7) = ELIST(I1,4) - MINX + 1                                 DACC05650
      LXY (8) = ELIST(I1,5) - MINY + 1                                 DACC05660
CHECK FOR PT AT A NODE                                                 DACC05670
C                                                                      DACC05680
      DO 2110 L=5,7,2                                                  DACC05690
      IF (LXY(L).EQ.IX.AND.LXY(L+1).EQ.IY) RETURN                      DACC05700
 2110 CONTINUE                                                         DACC05710
      CALL  INSECT( LXY, INT )                                         DACC05720
      IF (INT) 1000,3000,2400                                          DACC05730
C                                                                      DACC05740
CHECK FOR PT. ON  BOUNDARY                                             DACC05750
C                                                                      DACC05760
 2400 IF (LXY(9).EQ.IX.AND.LXY(10).EQ.IY) RETURN                       DACC05770
C                                                                      DACC05780
CHECK FOR INTERSECTION WITH A CORNER                                   DACC05790
C                                                                      DACC05800
      DO 2500 J=6,8,2                                                  DACC05810
      IF( LXY(9)  .NE. LXY(J-1) ) GO TO 2500                           DACC05820
      IF (LXY(10).EQ.LXY(J))   GO TO 1000                              DACC05830
 2500 CONTINUE                                                         DACC05840
      INDX = INDX + 1                                                  DACC05850
 3000 CONTINUE                                                         DACC05860
      IND = 1                                                          DACC05870
      IF((INDX/2) * 2 .EQ. INDX ) IND = -1                             DACC05880
      RETURN                                                           DACC05890
      END                                                              DAC 05900
            SUBROUTINE  ADJNCY (NBLS, KEY,LIST )                       DAC 05910
C                                                                      DACC05920
C     ADJACENCY  LIST                                                  DACC05930
C                                                                      DACC05940
      DIMENSION   LIST(2000)                                           DACC05950
      DATA    NOUT3   / 12 /                                           DACC05960
      NEND = NBLS - 1                                                  DACC05970
      DO  1200  I  = 1, NEND                                           DACC05980
      IF( LIST(I) .LT. 0 ) GO TO 1200                                  DACC05990
      NEXT= I + 1                                                      DACC06000
      N   = LIST(I)                                                    DACC06010
C                                      UNDUPLICATE  LIST               DACC06020
          DO  1100  J = NEXT, NBLS                                     DACC06030
          IF( LIST(J) .EQ. N ) LIST(J) = -1                            DACC06040
1100      CONTINUE                                                     DACC06050
1200  CONTINUE                                                         DACC06060
C                                      PRINT AND COPY LIST             DACC06070
      WRITE(6, 1300 )  KEY                                             DACC06080
1300  FORMAT(  '0     LIST OF  ADJACENT  AREAS  FOR', I11/)            DACC06090
      DO  1500  I  = 1, NBLS                                           DACC06100
```

```
      IF( LIST(I) .LE. 0  ) GO TO 1500                          DACC06110
      WRITE(6,1400) LIST(I)                                     DACC06120
1400  FORMAT( 50X, I11 )                                        DACC06130
      WRITE(NOUT3,1450 )  KEY, LIST(I)                          DACC06140
1450  FORMAT( 2I15 )                                            DACC06150
C                                                               DACC06160
1500  CONTINUE                                                  DACC06170
      RETURN                                                    DACC06180
      END                                                       DAC 06190
```

APPENDIX VII

PIOS PROGRAM LISTING

```
C      ||| CORRECTED VERSION OF PIOS/75 WITH FIVE (5) FILES                    00010000
C        DRIVER/LA                                                            00020000
C        |||| LATEST UPDATE JUNE 23 '75 ||||                                  00030000
       INTEGER ENDOF(20)                                                      00040000
       DATA ENDOF/'9999','9   ',12*'     '/                                   00050000
        DIMENSION P(3000),Q(3000)                                             00060000
        DIMENSION X(3000),Y(3000),XLE(1300),YLE(1300),XHE(1300)               00070000
        DIMENSION YHE(1300),IRE(1300)                                         00080000
       DIMENSION INTSP(20,2)                                                  00090000
       DIMENSION NSTPL(16),LSTP(16,2,50),XSTR(3000),YSTR(3000)                00100000
       DIMENSION BL(16),BH(16)                                                00110000
       REAL*8 A,B,C,D,E,F,DET,P0,T0                                           00120000
       COMMON /ALPHA/IV1,IV2,IV3,IV4,IV5                                      00130000
       REAL LUAREA                                                            00140000
       INTEGER    MAPNO,MAPOL1(2),LUCODE(3)                                   00150000
       INTEGER    SPMAP,SPPOLY(2),SPCODE(3)                                   00160000
       INTEGER    FILL/'     '/                                               00170000
C                                                                             00180000
       LOGICAL  DONUT/.FALSE./,OUT/.FALSE./                                   00190000
       LOGICAL IFLAG                                                          00200000
       LOGICAL ALLIN,ALLOUT,FLAG,PQ(3000),DIAG,PRTOUT/.FALSE./                00210000
       ITERRY=0                                                               00220000
       DEFINE FILE 11(3000,80,E,IV1)                                          00230000
       DEFINE FILE 12(3000,80,E,IV2)                                          00240000
       DEFINE FILE 13(3000,39,E,IV3)                                          002500
       DEFINE FILE 14(3000,80,E,IV4)                                          00260000
       DEFINE FILE 15(3000,31,E,IV5)                                          002700
C*************************************************************************00280000
C                                                                             00290000
C                                                                             00300000
C * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * 00310000
C         MAIN PROGRAM FOR POLYGON OVERLAY                                    00320000
C * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * 00330000
C                                                                             00340000
C  READ TEST POLYGON                                                          00350000
C                                                                             00360000
C     MAX - THE NUMBER OF POINTS IN THE POLYGON                               00370000
C     YMAX - THE MAXIMUM Y VALUE                                              00380000
C     YMIN - THE MINIMUM Y VALUE                                              00390000
C     X -  X-COORDINATES                                                      00400000
C     Y -  Y-COORDINATES                                                      00410000
C                                                                             00420000
C  DEFINE I/O UNITS                                                           00430000
C                                                                             00440000
C                                                                             00450000
C       BE SURE TO EXPAND ALL ARRAYS AND DEFINE FILES TO                      00460000
C       ACCOMODATE YOUR NEEDS                                                 00470000
C                                                                             00480000
C       ONLY ONE CARD IMAGE IS READ IN ON UNIT 5;  PRTOUT                     00490000
C       .TRUE. IN COLS COLS 1-6 WILL RESULT IN FILE 14 BEING PRINTED OUT      00500000
C       1 IN COLS COL  1 WILL RESULT IN FILE 14 BEING PRINTED OUT             00510000
C       0 IN COL  COL  1 WILL RESULT IN FILE 14 NOT BEING PRINTED OUT         00520000
C                                                                             00530000
C     READ (5,20)PRTOUT                                                       00540000
   20 FORMAT (I1)                                                             00550000
       IV1=1                                                                  00560000
       IV2=1                                                                  00570000
       IV3=1                                                                  00580000
       IV4=1                                                                  00590000
       IV5=1                                                                  00600000
       FIND (13'1)                                                            00610010
```

```
      FIND (14'1)                                                       00620020
      FIND (15'1)                                                       00630030
      WRITE (6,2700)                                                    00640000
 2700 FORMAT  (' CLUGE CALLED BY DRIVER/LA EMG |||||')                  00650000
      CALL CLUGE                                                        00660000
      WRITE (6,2710)                                                    00670000
 2710 FORMAT  (' RETURNED FROM CLUGE EMG ||||')                         00680000
      FIND (11'1)                                                       00690000
      FIND (12'1)                                                       00700000
      IV1=1                                                             00710000
      IV2=1                                                             00720000
C                       |||| CLUGE USED ONLY FOR TEST CASE             00730000
C                       |||| BRINGS IN TEST DATA                       00740000
      IUNIT=5                                                           00750000
      JUNIT=6                                                           00760000
      INTZ=11                                                           00770000
      INSP=12                                                           00780000
      IASC=6                                                            00790000
      IZZ=13                                                            00800000
C                                                                       00810000
C  SET SWITCH FOR DIAGNOSTIC PRINT OUT                                  00820000
C                                                                       00830000
      ICNT=1                                                            00840000
      DO 50 I=1,1300                                                    00850000
   30 READ (12'IV2,40,ERR=70) MAPOL1,XLE(I),YLE(I),XHE(I),              008600
     1YHE(I),N,(X(K),Y(K),K=1,N)                                        00870000
   40 FORMAT (2I5/4F9.0,I5/(8F9.0))                                     008800
      IF (N.LE.3000)GO TO 45                                            00890000
   42 FORMAT (' MAPNO, N=  ',2(I5,2X))                                  00900050
      WRITE(6,44) MAPOL1,N                                              009100
   44 FORMAT (' ----- ERROR---ERROR----TOO MANY POINTS',/,' ',I5,2X,    00920000
     1I5,' N= ',I6,' PIOS/II  TERMINATED')                              009300
      STOP                                                              00940000
   45 NMPOLY=I                                                          00950000
      WRITE(6,42) MAPOL1 (1),N                                          009600
      MAPNO = MAPOL1 (1)                                                009601
C     CALCULATE RECORD COUNT                                            00970000
      IRE(I)=ICNT                                                       00980000
      ICNT=ICNT+2+(N+3)/4                                               00990000
      IF (MAPNO.EQ.99999) GO TO 70                                      01000000
   50 CONTINUE                                                          01010000
      WRITE (6,60)                                                      01020000
   60 FORMAT (1X,' MORE THAN 1300 POLYGONS-- PROCESS FIRST 1300.')      01030000
   70 CONTINUE                                                          01040000
      DIAG=.FALSE.                                                      01050000
   80 CONTINUE                                                          01060000
C                                                                       01070000
C     SEARCH FOR SPECIFIED TRAFFIC ZONE                                 01080000
C                                                                       01090000
C                                                                       01100000
C  READ MAJOR POLYGON                                                   01110000
C                                                                       01120000
      CALL POLYR2 (6930,MAPNO,MAPOL1,LUCODE,LUAREA,XMIN,YMIN,XMAX,YMAX,M01130000
     1AX,X,Y,INTZ,FAC,DONUT,OUT,IV1)                                    01140000
      WRITE(15'IV5,86) MAPNO,MAPOL1(1),LUCODE(3),MAPOL1(2),LUAREA       011500
      WRITE(7,86)      MAPNO,MAPOL1(1),LUCODE(3),MAPOL1(2),LUAREA       011501
   86 FORMAT (2I5,I4,I2,F15.2)                                          011502
      FIND (15'IV5)                                                     01170000
C                                                                       01180000
C                                  SET THE SIGNIFIGANCE VALUE FOR THE   01190000
C                                  APPROXIMATION FOR THE INTERSECTIONS  01200000
```

```
C                                                                       01210000
      SIG=.01                                                           01220000
C                                                                       01230000
C                                     INITIALIZE THE UPPER AND LOWER    01240000
C                                     BOUNDS FOR XX AND YY.             01250000
      YY=0.0                                                            01260000
      XX=1.0E6                                                          01270000
      M=MAX-1                                                           01280000
C                                     FIND THE LOWER LEFT VERTEX OF     01290000
C                                     THE MAJOR POLYGON.                01300000
      DO 110 J=1,M                                                      01310000
      IF (Y(J)-YY) 110,100,90                                           01320000
   90 YY=Y(J)                                                           01330000
      XX=X(J)                                                           01340000
      IJ=J                                                              01350000
      GO TO 110                                                         01360000
  100 IF (X(J)-XX) 90,110,110                                           01370000
  110 CONTINUE                                                          01380000
C                                                                       01390000
C                                     OUTPUT DIAGNOSTICS IF REQUESTED   01400000
C                                                                       01410000
C   COMPUTE AND PRINT LEVELS                                            01420000
C                                                                       01430000
C                                     SET VALUE OF THE STRIPPING        01440000
C                                     EXPONENT                          01450000
C                                                                       01460000
      NP=2                                                              014700
      ISTP=2**NP                                                        01480000
      STEP=(YMAX-YMIN)/ISTP                                             01490000
      BLOW=YMIN-STEP                                                    01500000
      DO 120 J=1,ISTP                                                   01510000
      BLOW=BLOW+STEP                                                    01520000
      BHIH=BLOW+STEP                                                    01530000
      BL(J)=BLOW                                                        01540000
      BH(J)=BHIH                                                        01550000
  120 CONTINUE                                                          01560000
      BH(ISTP)=YMAX                                                     01570000
C                                                                       01580000
C   INITIALIZE LEVEL AND STRING LISTS                                   01590000
C                                                                       01600000
      DO 130 IC=1,16                                                    01610000
      NSTPL(IC)=0                                                       01620000
      DO 130 IA=1,20                                                    01630000
      DO 130 IB=1,2                                                     01640000
  130 LSTP(IC,IB,IA)=0                                                  01650000
      ISTRG=0                                                           01660000
C                                                                       01670000
C   START STRING ASSIGNMENTS                                            01680000
C                                                                       01690000
      XLAST=X(IJ)                                                       01700000
      YLAST=Y(IJ)                                                       01710000
      NDX=IJ                                                            01720000
      LLEV=LEVEL(YLAST,YMIN,STEP,ISTP,YMAX)                             01730000
      ISTRG=ISTRG+1                                                     01740000
      XSTR(ISTRG)=XLAST                                                 01750000
      YSTR(ISTRG)=YLAST                                                 01760000
      NSTPL(LLEV)=NSTPL(LLEV)+1                                         01770000
      ILS=NSTPL(LLEV)                                                   01780000
      NF=ISTRG                                                          01790000
C                                                                       01800000
C   LOOP THRU POINTS                                                    01810000
```

```
C                                                                       01820000
      DO 340 J=2,MAX                                                    01830000
      NDX=MOD(NDX,M)+1                                                  01840000
      XCUR=X(NDX)                                                       01850000
      YCUR=Y(NDX)                                                       01860000
      LEVC=LEVEL(YCUR,YMIN,STEP,ISTP,YMAX)                              01870000
      IF (LLEV.NE.LEVC) GO TO 160                                       01880000
C                                                                       01890000
C   SAME LEVEL - SAME STRING                                            01900000
C                                                                       01910000
      IF (YCUR.NE.YSTR(ISTRG)) GO TO 140                                01920000
      IF (XCUR.NE.XSTR(ISTRG)) GO TO 140                                01930000
      GO TO 150                                                         01940000
  140 ISTRG=ISTRG+1                                                     01950000
      XSTR(ISTRG)=XCUR                                                  01960000
      YSTR(ISTRG)=YCUR                                                  01970000
  150 CONTINUE                                                          01980000
      GO TO 300                                                         01990000
C                                                                       02000000
C  DIFFERNT LEVEL                                                       02010000
C                                                                       02020000
  160 CONTINUE                                                          02030000
C                                                                       02040000
C  DEFINE DIRECTION                                                     02050000
C                                                                       02060000
      IDIR=LEVC-LLEV                                                    02070000
      IF (IDIR.LT.0) GO TO 220                                          02080000
C                                                                       02090000
C  POSITIVE DIRECTION                                                   02100000
C  CLOSE LAST LEVEL                                                     02110000
C                                                                       02120000
  170 YTEMP=BH(LLEV)                                                    02130000
      XTEMP=(XCUR-XLAST)*(YTEMP-YLAST)/(YCUR-YLAST)+XLAST               02140000
      IF (YTEMP.NE.YSTR(ISTRG)) GO TO 180                               02150000
      IF (XTEMP.NE.XSTR(ISTRG)) GO TO 180                               02160000
      GO TO 190                                                         02170000
  180 ISTRG=ISTRG+1                                                     02180000
      XSTR(ISTRG)=XTEMP                                                 02190000
      YSTR(ISTRG)=YTEMP                                                 02200000
  190 CONTINUE                                                          02210000
      IF (NF.NE.ISTRG) GO TO 200                                        02220000
      NSTPL(LLEV)=NSTPL(LLEV)-1                                         02230000
      GO TO 210                                                         02240000
  200 LSTP(LLEV,1,ILS)=NF                                               02250000
      LSTP(LLEV,2,ILS)=ISTRG                                            02260000
  210 CONTINUE                                                          02270000
C   START NEW LEVEL                                                     02280000
      LLEV=LLEV+1                                                       02290000
      NSTPL(LLEV)=NSTPL(LLEV)+1                                         02300000
      ILS=NSTPL(LLEV)                                                   02310000
      NF=ISTRG                                                          02320000
      IF (LLEV.LT.LEVC) GO TO 170                                       02330000
      GO TO 270                                                         02340000
C                                                                       02350000
C  NEGATIVE DIRECTION                                                   02360000
C   CLOSE LAST LEVEL                                                    02370000
C                                                                       02380000
  220 YTEMP=BL(LLEV)                                                    02390000
      XTEMP=(XCUR-XLAST)*(YTEMP-YLAST)/(YCUR-YLAST)+XLAST               02400000
      IF (YTEMP.NE.YSTR(ISTRG)) GO TO 230                               02410000
      IF (XTEMP.NE.XSTR(ISTRG)) GO TO 230                               02420000
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      GO TO 240                                                          02430000
  230 ISTRG=ISTRG+1                                                      02440000
      XSTR(ISTRG)=XTEMP                                                  02450000
      YSTR(ISTRG)=YTEMP                                                  02460000
  240 CONTINUE                                                           02470000
      IF (NF.NE.ISTRG) GO TO 250                                         02480000
      NSTPL(LLEV)=NSTPL(LLEV)-1                                          02490000
      GO TO 260                                                          02500000
  250 LSTP(LLEV,1,ILS)=NF                                                02510000
      LSTP(LLEV,2,ILS)=ISTRG                                             02520000
  260 CONTINUE                                                           02530000
C                                                                        02540000
C  START NEW LEVEL                                                       02550000
C                                                                        02560000
      LLEV=LLEV-1                                                        02570000
      NSTPL(LLEV)=NSTPL(LLEV)+1                                          02580000
      ILS=NSTPL(LLEV)                                                    02590000
      NF=ISTRG                                                           02600000
      IF (LLEV.GT.LEVC) GO TO 220                                        02610000
      GO TO 270                                                          02620000
  270 IF (YCUR.NE.YSTR(ISTRG)) GO TO 280                                 02630000
      IF (XCUR.NE.XSTR(ISTRG)) GO TO 280                                 02640000
      GO TO 290                                                          02650000
  280 ISTRG=ISTRG+1                                                      02660000
      XSTR(ISTRG)=XCUR                                                   02670000
      YSTR(ISTRG)=YCUR                                                   02680000
  290 CONTINUE                                                           02690000
  300 XLAST=XCUR                                                         02700000
      YLAST=YCUR                                                         02710000
  310 CONTINUE                                                           02720000
C                                                                        02730000
C  CLOSE LAST STRING                                                     02740000
C                                                                        02750000
      IF (NF.NE.ISTRG) GO TO 320                                         02760000
      NSTPL(LLEV)=NSTPL(LLEV)-1                                          02770000
      GO TO 330                                                          02780000
  320 LSTP(LLEV,1,ILS)=NF                                                02790000
      LSTP(LLEV,2,ILS)=ISTRG                                             02800000
  330 CONTINUE                                                           02810000
C                                                                        02820000
C  LOOP ON MINOR POLYGONS                                                02830000
C                                                                        02840000
C                                                                        02850000
C * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * 02860000
C  READ MINOR POLYGON                                                    02870000
C * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * 02880000
C                                                                        02890000
C                                                                        02900000
      IOVER=0                                                            02910000
      DO 910 IW=1,NMPOLY                                                 02920000
C     CHECK AND SEE IF EVEN ONE CORNER IS IN THIS MAJOR POLYGON          02930000
      IF (YHE(IW).LT.YMIN) GO TO 910                                     02940000
      IF (YLE(IW).GT.YMAX) GO TO 910                                     02950000
      IF (XHE(IW).LT.XMIN) GO TO 910                                     02960000
      IF (XLE(IW).GT.XMAX) GO TO 910                                     02970000
C     IF GET THIS FAR, THEN HAVE AN OVERLAP.                             02980000
      NN=IRE(IW)                                                         02990000
      FIND (12*NN)                                                       03000000
      IV2=NN                                                             03010050
      CALL POLYRD (&910,SPMAP,SPPOLY,SPCODE,SPAREA,PXMIN,PYMIN,PXMAX,PYM03020000
     1AX,NPTS,P,Q,INSP,FAC,DONUT,OUT,IV2)                                03030000
```

```
C                                                                       03040000
C     IS MINOR POLYGON OUTSIDE OF TRAFFIC ZONE                          03050000
  340 ALLIN=.TRUE.                                                      03060000
      ALLOUT=.TRUE.                                                     03070000
C                                                                       03080000
      SPCODE(2)=LUCODE(2)                                               03090000
      DO 490 I=1,NPTS                                                   03100000
      PP=P(I)                                                           03110000
      QQ=Q(I)                                                           03120000
      IF (QQ.LT.YMIN) GO TO 470                                         03130000
      IF (QQ.GT.YMAX) GO TO 470                                         03140000
      IF (PP.LT.XMIN) GO TO 470                                         03150000
      IF (PP.GT.XMAX) GO TO 470                                         03160000
      J=LEVEL(QQ,YMIN,STEP,ISTP,YMAX)                                   03170000
      JK=NSTPL(J)                                                       03180000
      FLAG=.FALSE.                                                      03190000
      IF (JK.EQ.0) GO TO 460                                            03200000
      DO 450 JJ=1,JK                                                    03210000
      YREM=-1.0                                                         03220000
      JL=LSTP(J,1,JJ)                                                   03230000
      JM=LSTP(J,2,JJ)-1                                                 03240000
      DO 450 JN=JL,JM                                                   03250000
      YP=YSTR(JN)                                                       03260000
      YYP=YSTR(JN+1)                                                    03270000
      XP=XSTR(JN)                                                       03280000
      XXP=XSTR(JN+1)                                                    03290000
      IF (QQ.GT.YP.AND.QQ.GT.YYP) GO TO 440                             03300000
      IF (QQ.LT.YP.AND.QQ.LT.YYP) GO TO 440                             03310000
      IF (PP.GT.XP.AND.PP.GT.XXP) GO TO 440                             03320000
      IF (QQ.NE.YP) GO TO 370                                           03330000
      IF (PP.EQ.XP) GO TO 430                                           03340000
      IF (QQ.EQ.YREM) GO TO 400                                         03350000
      YREM=YP                                                           03360000
      LAST=JN                                                           03370000
  350 LAST=LAST-1                                                       03380000
      IF (LAST.EQ.0) GO TO 450                                          03390000
      IF (QQ.EQ.YSTR(LAST)) GO TO 350                                   03400000
      YLAST=YSTR(LAST)                                                  03410000
      NEXT=JN                                                           03420000
  360 NEXT=NEXT+1                                                       03430000
      IF (NEXT.GT.ISTRG) GO TO 450                                      03440000
      IF (QQ.EQ.YSTR(NEXT)) GO TO 360                                   03450000
      YNEXT=YSTR(NEXT)                                                  03460000
      IF (QQ.GT.YLAST.AND.QQ.GT.YNEXT) GO TO 450                        03470000
      IF (QQ.LT.YLAST.AND.QQ.LT.YNEXT) GO TO 450                        03480000
      IF (PP.LT.XP) GO TO 420                                           03490000
      GO TO 450                                                         03500000
  370 IF (QQ.NE.YYP) GO TO 410                                          03510000
      IF (PP.EQ.XXP) GO TO 430                                          03520000
      IF (QQ.EQ.YREM) GO TO 400                                         03530000
      YREM=YYP                                                          03540000
      LAST=JN+1                                                         03550000
  380 LAST=LAST-1                                                       03560000
      IF (QQ.EQ.YSTR(LAST)) GO TO 380                                   03570000
      YLAST=YSTR(LAST)                                                  03580000
      NEXT=JN+1                                                         03590000
  390 NEXT=NEXT+1                                                       03600000
      IF (QQ.EQ.YSTR(NEXT)) GO TO 390                                   03610000
      YNEXT=YSTR(NEXT)                                                  03620000
      IF (QQ.GT.YLAST.AND.QQ.GT.YNEXT) GO TO 450                        03630000
      IF (QQ.LT.YLAST.AND.QQ.LT.YNEXT) GO TO 450                        03640000
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      IF (PP.LT.XXP) GO TO 420                                          03650000
      GO TO 450                                                         03660000
  400 IF (YP.NE.YYP) YREM=-1.0                                          03670000
      GO TO 450                                                         03680000
  410 YREM=-1.0                                                         03690000
      IF (PP.LE.XP.AND.PP.LE.XXP) GO TO 420                             03700000
      IF (XP.EQ.XXP) GO TO 430                                          03710000
      IF (YP.EQ.YYP) GO TO 430                                          03720000
      XTEMP=(XP-XXP)*(QQ-YYP)/(YP-YYP)+XXP                              03730000
      IF (PP.GT.XTEMP) GO TO 450                                        03740000
      IF (PP.EQ.XTEMP) GO TO 430                                        03750000
  420 FLAG=.NOT.FLAG                                                    03760000
      GO TO 450                                                         03770000
  430 FLAG=.TRUE.                                                       03780000
      GO TO 460                                                         03790000
  440 YREM=-1.0                                                         03800000
  450 CONTINUE                                                          03810000
  460 CONTINUE                                                          03820000
      IF (FLAG) GO TO 480                                               03830000
  470 PQ(I)=.FALSE.                                                     03840000
      ALLIN=.FALSE.                                                     03850000
      GO TO 490                                                         03860000
  480 PQ(I)=.TRUE.                                                      03870000
      ALLOUT=.FALSE.                                                    03880000
  490 CONTINUE                                                          03890000
      IF (ALLOUT) WRITE (6,500) SPPOLY,SPCODE                           03900000
  500 FORMAT (1X,'ALLOUT',I5,1X,I2,1X,A3,1X,I5,1X,I4)                   03910000
      IF (ALLIN) GO TO 880                                              03920000
      IF (ALLOUT) GO TO 900                                             03930000
C                                                                       03940000
C * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * 03950000
C   BUILD THE INTERSECTING POLYGONS                                     03960000
C     * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * 03970000
C                                                                       03980000
C     AN ARRAY IS CONSTRUCTED THAT CONTAINS ALL THE POINTS OF THE       03990000
C     INTERSECTING POLYGON(S)                                           04000000
C                                                                       04010000
C     THE MINOR POLYGON IS SEARCHED IN A SERIAL MANNER. AS EACH PAIR    04020000
C     OF POINTS ARE ENCOUNTERED THE FOLLOWING CASES AND ACTIONS         04030000
C     OCCUR                                                             04040000
C                                                                       04050000
C     I-1   I                                                           04060000
C                                                                       04070000
C     OUT   OUT      POINT I IS NOT ADDED TO THE ARRAY                  04080000
C                                                                       04090000
C     OUT   IN       THE MAJOR POLYGON IS SEARCHED TO FIND THE LINE     04100000
C                    SEGMENT THAT INTERSECTS WITH THE MINOR POLYGON.    04110000
C                    THIS IS ACCOMPLISHED BY FIRST SEARCHING FOR LINE   04120000
C                    SEGMENTS THAT INTERSECT WITH THE RECTANGULAR       04130000
C                    REGION DEFINED BY THE POINTS I-1 AND I. EACH       04140000
C                    LINE SEGMENT THAT DOES SO IS TESTED FOR INTERSECTION 04150000
C                    WITH THE LINE FORMED BY I-1 , I. AT LEAST ONE      04160000
C                    SUCH INTERSECTION MUST OCCUR (OR THE POINT I       04170000
C                    WOULD BE OUT). THE POINT OF INTERSECTION IS ADDED TO 04180000
C                    THE ARRAY. STEPPING IS CONTINUED ON THE            04190000
C                    MINOR POLYGON.                                     04200000
C                                                                       04210000
C     IN    IN       THE POINT I IS ADDED TO THE ARRAY                  04220000
C                                                                       04230000
C     IN    OUT      THE MAJOR POLYGON IS SEARCHED FOR THE INTERSECTION. 04240000
C                    THE INTERSECTION POINT IS ADDED TO THE ARRAY.      04250000
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C                  NOW STEPPING IS PERFORMED ON THE MAJOR POLYGON        04260000
C                  IN THE DIRECTION SUCH THAT THE POINTS ARE IN THE      04270000
C                  MINOR POLYGON. THESE POINTS ARE ADDED TO THE ARRAY.   04280000
C                  WHEN THE STEPPING CAUSES A POINT TO BE OUT OF         04290000
C                  THE MINOR POLYGON THE INTERSECTION POINT IS FOUND,    04300000
C                  BY SEARCHING THE MINOR POLYGON. AND IS ADDED TO       04310000
C                  THE ARRAY.  STEPPING THEN RESUMES ON THE MINOR        04320000
C                  POLYGON WHERE IT WAS LAST INTERRUPTED.                04330000
C                                                                        04340000
      WRITE (6,7001)MAPNO,MAPOLI(1),SPMAP,SPCODE(1),SPCODE(3)            04350000
 7001 FORMAT (' START BUILD- MAJOR ',I5,2XI5,2X,'MINOR ',I5,2XA3,2X,I4)  04360000
      NINTS=0                                                            04370000
      J=0                                                                04380000
      I=1                                                                04390000
      IF (PQ(I)) GO TO 560                                               04400000
C     POINT  I  IS OUT                                                   04410000
  510 I=I+1                                                              04420000
      IF (I.GT.NPTS) GO TO 790                                           04430000
      IF (.NOT.PQ(I)) GO TO 510                                          04440000
C                                                                        04450000
C     POINT I-1 WAS OUT, POINT I IS IN                                   04460000
C     FIND INTERSECTION BY SEARCHING MAJOR POLYGON                       04470000
C                                                                        04480000
      K=0                                                                04490000
  520 K=K+1                                                              04500000
      IF (K.GT.(ISTRG-1)) GO TO 530                                      04510000
C                                                                        04520000
C     FIND SPAN                                                          04530000
C                                                                        04540000
      Y1=YSTR(K)                                                         04550000
      Y2=YSTR(K+1)                                                       04560000
      V1=Q(I-1)                                                          04570000
      V2=Q(I)                                                            04580000
      IF (Y1.LT.V1.AND.Y2.LT.V1.AND.Y1.LT.V2.AND.Y2.LT.V2) GO TO 520     04590000
      IF (Y1.GT.V1.AND.Y2.GT.V1.AND.Y1.GT.V2.AND.Y2.GT.V2) GO TO 520     04600000
      X1=XSTR(K)                                                         04610000
      X2=XSTR(K+1)                                                       04620000
      U1=P(I-1)                                                          04630000
      U2=P(I)                                                            04640000
      IF (X1.LT.U1.AND.X2.LT.U1.AND.X1.LT.U2.AND.X2.LT.U2) GO TO 520     04650000
      IF (X1.GT.U1.AND.X2.GT.U1.AND.X1.GT.U2.AND.X2.GT.U2) GO TO 520     04660000
C                                                                        04670000
C     TEST FOR INTERSECTION                                              04680000
C                                                                        04690000
      A=X2-X1                                                            04700000
      B=U1-U2                                                            04710000
      C=Y2-Y1                                                            04720000
      D=V1-V2                                                            04730000
      DET=A*D-C*B                                                        04740000
      IF (DET.EQ.0) GO TO 520                                            04750000
      E=U1-X1                                                            04760000
      F=V1-Y1                                                            04770000
      T0=(D*E-B*F)/DET                                                   04780000
      P0=(A*F-C*E)/DET                                                   04790000
      IF (T0.LT.0.0.OR.P0.LT.0.0) GO TO 520                              04800000
      IF (T0.GT.1.0.OR.P0.GT.1.0) GO TO 520                              04810000
      XINT=T0*X2+(1.0-T0)*X1                                             04820000
      YINT=T0*Y2+(1.0-T0)*Y1                                             04830000
      J=J+1                                                              04840000
      X(J)=XINT                                                          04850000
      Y(J)=YINT                                                          04860000
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      NINTS=NINTS+1                                                    04870000
      INTSP(NINTS,1)=J                                                 04880000
      GO TO 560                                                        04890000
  530 CONTINUE                                                         04900000
      IERR=1                                                           04910000
      WRITE (6,540) IERR                                               04920000
  540 FORMAT (' COULD NOT FIND INTERSECTION AT CHECK POINT ',I5)        04930000
      WRITE (6,550) SPMAP,SPPOLY                                       04940000
  550 FORMAT (1X,I5,1X,A3,1X,I2)                                       04950000
      WRITE (6,620) P(I),Q(I),P(I-1),Q(I-1)                            04960000
      GO TO 910                                                        04970000
C     POINT  I  IS IN                                                  04980000
  560 J=J+1                                                            04990000
      X(J)=P(I)                                                        05000000
      Y(J)=Q(I)                                                        05010000
      IF (I.GT.1) GO TO 570                                            05020000
      NINTS=NINTS+1                                                    05030000
      INTSP(NINTS,1)=J                                                 05040000
  570 CONTINUE                                                         05050000
      I=I+1                                                            05060000
      IF (I.GT.NPTS) GO TO 580                                         05070000
      IF (PQ(I)) GO TO 560                                             05080000
      GO TO 590                                                        05090000
  580 INTSP(NINTS,2)=J                                                 05100000
      GO TO 790                                                        05110000
  590 CONTINUE                                                         05120000
C                                                                      05130000
C     POINT I IS OUT,POINT I-1 WAS IN                                  05140000
C     FIND INTERSECTION BY S MAJOR POLYGON                             05150000
C                                                                      05160000
      K=0                                                              05170000
  600 K=K+1                                                            05180000
      IF (K.GT.(ISTRG-1)) GO TO 610                                    05190000
C                                                                      05200000
C     FIND SPAN                                                        05210000
C                                                                      05220000
      Y1=YSTR(K)                                                       05230000
      Y2=YSTR(K+1)                                                     05240000
      V1=Q(I-1)                                                        05250000
      V2=Q(I)                                                          05260000
      IF (Y1.LT.V1.AND.Y2.LT.V1.AND.Y1.LT.V2.AND.Y2.LT.V2) GO TO 600   05270000
      IF (Y1.GT.V1.AND.Y2.GT.V1.AND.Y1.GT.V2.AND.Y2.GT.V2) GO TO 600   05280000
      X1=XSTR(K)                                                       05290000
      X2=XSTR(K+1)                                                     05300000
      U1=P(I-1)                                                        05310000
      U2=P(I)                                                          05320000
      IF (X1.LT.U1.AND.X2.LT.U1.AND.X1.LT.U2.AND.X2.LT.U2) GO TO 600   05330000
      IF (X1.GT.U1.AND.X2.GT.U1.AND.X1.GT.U2.AND.X2.GT.U2) GO TO 600   05340000
C                                                                      05350000
C     TEST FOR INTERSECTION                                            05360000
C                                                                      05370000
      A=X2-X1                                                          05380000
      B=U1-U2                                                          05390000
      C=Y2-Y1                                                          05400000
      D=V1-V2                                                          05410000
      DET=A*D-C*B                                                      05420000
      IF (DET.EQ.0) GO TO 600                                          05430000
      E=U1-X1                                                          05440000
      F=V1-Y1                                                          05450000
      T0=(D*E-B*F)/DET                                                 05460000
      P0=(A*F-C*E)/DET                                                 05470000
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      IF (T0.LT.0.0.OR.P0.LT.0.0) GO TO 600                              05480000
      IF (T0.GT.1.0.OR.P0.GT.1.0) GO TO 600                              05490000
      XINT=T0*X2+(1.0-T0)*X1                                             05500000
      YINT=T0*Y2+(1.0-T0)*Y1                                             05510000
      J=J+1                                                              05520000
      X(J)=XINT                                                          05530000
      Y(J)=YINT                                                          05540000
      GO TO 630                                                          05550000
  610 IERR=2                                                             05560000
      WRITE (6,540) IERR                                                 05570000
      WRITE (6,550) SPMAP,SPPOLY                                         05580000
      WRITE (6,620) P(I),Q(I),P(I-1),Q(I-1)                              05590000
  620 FORMAT (4F10.0)                                                    05600000
      GO TO 910                                                          05610000
  630 CONTINUE                                                           05620000
C                                                                        05630000
C           |||||||||||||||| SECTION REMOVED JPL  ||||||||||             05640000
C                                                                        05650000
  700 IDIR=1                                                             05660000
      K=K+1                                                              05670000
      XE=XSTR(K)                                                         05680000
      YE=YSTR(K)                                                         05690000
  710 XB=XINT                                                            05700000
      YB=YINT                                                            05710000
  720 CALL STPSUB (XB,YB,XE,YE,SPX,SPY,NOSTP)                            05720000
      DO 740 L=1,NOSTP                                                   05730000
      XB=XB+SPX                                                          05740000
      YB=YB+SPY                                                          05750000
      CALL PIP (XB,YB,IND,P,Q,NPTS)                                      05760000
  730 IF (IND.EQ.0) GO TO 750                                            05770000
  740 CONTINUE                                                           05780000
C     IF IT GETS HERE THE END POINT IS IN                                05790000
      J=J+1                                                              05800000
      X(J)=XE                                                            05810000
      Y(J)=YE                                                            05820000
C     TAKE NEXT POINT                                                    05830000
      K=K+IDIR                                                           05840000
      IF (K.EQ.0) K=ISTRG-1                                              05850000
      IF (K.GT.(ISTRG-1)) K=1                                            05860000
      XB=XE                                                              05870000
      YB=YE                                                              05880000
      XE=XSTR(K)                                                         05890000
      YE=YSTR(K)                                                         05900000
      GO TO 720                                                          05910000
  750 CONTINUE                                                           05920000
C     POINT (XB-SPX,YB-SPY) WAS IN AND (XB,YB) IS OUT                    05930000
  760 L=0                                                                05940000
  770 L=L+1                                                              05950000
      IF (L.EQ.NPTS) GO TO 780                                           05960000
      Y1=Q(L)                                                            05970000
      Y2=Q(L+1)                                                          05980000
      V1=YB                                                              05990000
      V2=YB-SPY                                                          06000000
      IF (Y1.LT.V1.AND.Y2.LT.V1.AND.Y1.LT.V2.AND.Y2.LT.V2) GO TO 770     06010000
      IF (Y1.GT.V1.AND.Y2.GT.V1.AND.Y1.GT.V2.AND.Y2.GT.V2) GO TO 770     06020000
      X1=P(L)                                                            06030000
      X2=P(L+1)                                                          06040000
      U1=XB                                                              06050000
      U2=XB-SPX                                                          06060000
      IF (X1.LT.U1.AND.X2.LT.U1.AND.X1.LT.U2.AND.X2.LT.U2) GO TO 770     06070000
      IF (X1.GT.U1.AND.X2.GT.U1.AND.X1.GT.U2.AND.X2.GT.U2) GO TO 770     06080000
```

```
C                                                                       06090000
C       TEST FOR INTERSECTION                                           06100000
C                                                                       06110000
        A=X2-X1                                                         06120000
        B=U1-U2                                                         06130000
        C=Y2-Y1                                                         06140000
        D=V1-V2                                                         06150000
        DET=A*D-C*B                                                     06160000
        IF (DET.EQ.0.0) GO TO 770                                       06170000
        E=U1-X1                                                         06180000
        F=V1-Y1                                                         06190000
        T0=(D*E-B*F)/DET                                                06200000
        P0=(A*F-C*E)/DET                                                06210000
        IF (T0.LT.0.0.OR.P0.LT.0.0) GO TO 770                           06220000
        IF (T0.GT.1.0.OR.P0.GT.1.0) GO TO 770                           06230000
        XINT=T0*X2+(1.0-T0)*X1                                          06240000
        YINT=T0*Y2+(1.0-T0)*Y1                                          06250000
        J=J+1                                                           06260000
        X(J)=XINT                                                       06270000
        Y(J)=YINT                                                       06280000
        INTSP(NINTS,2)=J                                                06290000
        I=I-1                                                           06300000
        GO TO 510                                                       06310000
  780   IERR=3                                                          06320000
        WRITE (6,540) IERR                                              06330000
        WRITE (6,550) SPMAP,SPPOLY                                      06340000
        WRITE (6,620) U1,V1,U2,V2                                       06350000
        GO TO 910                                                       06360000
C                                                                       06370000
C                                                                       06380000
  790   CONTINUE                                                        06390000
C                                                                       06400000
C                                                                       06410000
C   FIND MINIMUM X AND Y VALUES                                         06420000
        TXMIN=1.0E+9                                                    06430000
        TYMIN=1.0E+9                                                    06440000
        TXMAX=0.                                                        06450000
        TYMAX=0.                                                        06460000
        DO 800 I=1,J                                                    06470000
        IF (X(I).LT.TXMIN) TXMIN=X(I)                                   06480000
        IF (Y(I).LT.TYMIN) TYMIN=Y(I)                                   06490000
        IF (X(I).GT.TXMAX) TXMAX=X(I)                                   06500000
        IF (Y(I).GT.TYMAX) TYMAX=Y(I)                                   06510000
  800   CONTINUE                                                        06520000
C   TRANSLATE COORDINATES                                               06530000
        DO 810 I=1,J                                                    06540000
        X(I)=X(I)-TXMIN                                                 06550000
        Y(I)=Y(I)-TYMIN                                                 06560000
  810   CONTINUE                                                        06570000
        AREA=0.0                                                        06580000
        NQPTS=0                                                         06590000
        DO 830 I=1,NINTS                                                06600000
        IJ=INTSP(I,1)+1                                                 06610000
        IK=INTSP(I,2)                                                   06620000
        IF (IJ.GT.IK) GO TO 830                                         06630000
        NQPTS=NQPTS+1                                                   06640000
        P(NQPTS)=X(IJ-1)+TXMIN                                          06650000
        Q(NQPTS)=Y(IJ-1)+TYMIN                                          06660000
        DO 820 II=IJ,IK                                                 06670000
        NQPTS=NQPTS+1                                                   06680000
        P(NQPTS)=X(II)+TXMIN                                            06690000
```

```
      Q(NQPTS)=Y(II)+TYMIN                                                      06700000
  820 AREA=AREA+Y(II)*X(II)-Y(II)*X(II-1)+Y(II-1)*X(II)-Y(II-1)*X(II-1)          06710000
  830 CONTINUE                                                                  06720000
  840 AREA=((ABS(AREA)/2.0)/43560.0)*FAC                                        06730000
C                                                                               06740000
C          AREA ALGORITHM DOESN'T SEEM TO WORK                                  06750000
C                                                                               06760000
      AREA=0.0                                                                  06770000
      CALL AREAOF (AREA,NQPTS,P,Q,IFLAG)                                        06780000
      IF (DONUT) AREA=-AREA                                                     06790000
      WRITE (6,7002)MAPNO,MAPOL1(1),SPMAP,SPCODE(1),SPCODE(3)                   06800000
 7002 FORMAT (' ENDOF BUILD- MAJOR ',I5,2XI5,2X,'MINOR ',I5,2XA3,2X,I4)         06810000
      WRITE (14'IV4,850)MAPNO,MAPOL1(1),SPMAP,SPCODE(1),SPCODE(3),AREA,         06820000
     1TXMIN,TYMIN,TXMAX,TYMAX,NQPTS,(P(I),Q(I),I=1,NQPTS)                       06830000
  850 FORMAT( 3I5,A3,I4,F15.2/4F9.0,I5/(8F9.0))                                 068400
  860 FORMAT(3I5,A3,I4,I2,F15.2)                                                068500
  861 FORMAT (' ',3I5,A3,I4,F15.2)                                              06860000
      WRITE (6,861)MAPNO,MAPOL1(1),SPMAP,SPCODE(1),SPCODE(3),AREA               06870000
      WRITE(13'IV3,860)MAPNO,MAPOL1(1),SPMAP,SPCODE(1),SPCODE(3),               068800
     CSPPOLY(2),AREA                                                            068801
      WRITE(9,860)MAPNO,MAPOL1(1),SPMAP,SPCODE(1),SPCODE(3),SPPOLY(2),          068802
     *AREA                                                                      068803
  870 FORMAT (' ',3I5,F8.0,1X,A3,2I5,A6,F8.0)                                   06890000
      IOVER=1                                                                   06900000
      GO TO 910                                                                 06910000
C* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *06920000
C     ALL THE MINOR POLYGON POINTS ARE IN                                       06930000
C* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *06940000
  880 CONTINUE                                                                  06950000
C                                  OTHERWISE THE AREA IN THE RECORD           06960000
C                                  IS GOOD. FLOAT IT FOR COMPUTATION          06970000
      AREA=SPAREA                                                               06980000
      IF (DONUT) AREA=-AREA                                                     06990000
C                                  WRITE OUT THE POLYGON AREA                 07000000
      WRITE (6,7003)LUCODE(1),LUCODE(3),SPCODE(1),SPCODE(3)                     07010000
 7003 FORMAT (' ALLIN------- MAJOR ',A3,2X,I4,2X,'MINOR ',A3,2X,I4)             07020000
  890 WRITE (6,861)MAPNO,MAPOL1(1),SPMAP,SPCODE(1),SPCODE(3),AREA               07030000
      WRITE(13'IV3,860)MAPNO,MAPOL1(1),SPMAP,SPCODE(1),SPCODE(3),               070400
     CSPPOLY(2),AREA                                                            070401
      WRITE(9,860)MAPNO,MAPOL1(1),SPMAP,SPCODE(1),SPCODE(3),SPPOLY(2),          070402
     *AREA                                                                      070403
      NQ=NPTS+1                                                                 07050000
      WRITE (14'IV4,850)MAPNO,MAPOL1(1),SPMAP,SPCODE(1),SPCODE(3),AREA,         07060000
     1PXMIN,PYMIN,PXMAX,PYMAX,NPTS,(P(IJ),Q(IJ),IJ=1,NPTS)                      07070000
      IOVER=1                                                                   07080000
      GO TO 910                                                                 07090000
C* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *07100000
C    POLYGON IS ALL OUT                                                         07110000
C* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *07120000
  900 CONTINUE                                                                  07130000
C                                                                               07140000
C  SINCE ALL THE POLYGON POINTS ARE OUT IT COULD BE THAT THE SOIL               07150000
C  POLYGON COMPLETELY SURROUNDS THE TRAFFIC ZONE.  IF ONE POINT OF THE          07160000
C  TRAFFIC ZONE IS IN THE SOIL POLYGON THEN ALL OF IT IS IN.                    07170000
C                                                                               07180000
      CALL PIP (XSTR(1),YSTR(1),IND,P,Q,NPTS)                                    7190000
      IF (IND.EQ.0) GO TO 910                                                   7200000
C                                                                               07210000
C  IT IS IN SO WRITE THE AREA OUT TO SUMS FILE.                                 07220000
C                                                                               07230000
      AREA=LUAREA                                                               07240000
```

```
      IF (DONUT) AREA=-AREA                                                 07250000
      NQ=MAX+1                                                              07260000
      WRITE (6,7004)LUCODE(1),LUCODE(3),SPCODE(1),SPCODE(3)                 07270000
 7004 FORMAT (' ALLOUT------ MAJOR ',A3,2X,I4,2X,'MINOR ',A3,2X,I4)         07280000
      WRITE (14'IV4,850)MAPNO,MAPOL1(1),SPMAP,SPCODE(1),SPCODE(3),AREA,     07290000
     1XMIN,YMIN,XMAX,YMAX,MAX,(X(IJ),Y(IJ),IJ=1,MAX)                        07300000
      WRITE (6,870) SPMAP,MAPOL1,LUAREA,SPCODE,FILL,AREA                    07310000
      WRITE(13'IV3,860)MAPNO,MAPOL1(1),SPMAP,SPCODE(1),SPCODE(3),           073200
     CSPPOLY(2),AREA                                                        073201
      WRITE(9,860)MAPNO,MAPOL1(1),SPMAP,SPCODE(1),SPCODE(3),SPPOLY(2),      073202
     *AREA                                                                  073203
      IOVER=1                                                               07330000
C                                                                           07340000
C  CAN LOOP HERE ON MINOR POLYGONS                                          07350000
C                                                                           07360000
  910 CONTINUE                                                              07370000
  920 WRITE (6,950) INSP,MAPOL1(1)                                          07380000
C                              REPLACEMENT IN CODE                          07390000
      FIND (12'1)                                                           07400000
      IV2=1                                                                 07410050
      GO TO 80                                                              07420000
  930 CONTINUE                                                              07430000
      WRITE (6,950) INTZ                                                    07440000
  940 CONTINUE                                                              07450000
  950 FORMAT (' EOF ON FILE ',I5,'. MAJOR POLYGON= ',I5,///)                07460000
      WRITE (6,960)                                                         07470000
  960 FORMAT (' PROCESSING ENDED AT EOD')                                   07480000
C                             4 EOF'S ON FILE 13                            07490000
      DO 980 J=1,4                                                          07500000
      WRITE (13'IV3,970) (ENDOF(I),I=1,6)                                   07510000
  970 FORMAT (8A4,A2)                                                       07520000
  980 CONTINUE                                                              07530000
C                           4 EOF'S ON FILE 14                              07540000
      DO 1000 J=1,4                                                         07550000
      WRITE (14'IV4,990) (ENDOF(I),I=1,12)                                  07560000
  990 FORMAT (20A4)                                                         07570000
 1000 CONTINUE                                                              07580000
      DO 1001 J=1,4                                                         07590000
      WRITE (15'IV5,971)(ENDOF(I),I=1,7)                                    07600000
  971 FORMAT (7A4)                                                          076'0000
 1001 CONTINUE                                                              07620000
C     IF (.NOT.PRTOUT)GOTO 1999                                             07630000
      FIND (11'1)                                                           07640010
      IV1=1                                                                 07650015
      WRITE (6,1109)                                                        07660020
 1109 FORMAT (' FILE-11---')                                                07670025
      DO 1130 IJ=1,10                                                       07680030
 1110 READ (11'IV1,851)SPMAP,SPCODE(2),SPCODE(1),SPCODE(3),SPPOLY(2),ARE076900
     1A,TXMIN,TYMIN,TXMAX,TYMAX,NQPTS,(P(I),Q(I),I=1,NQPTS)                 07700040
  851 FORMAT(2I5,A3,I4,I2,F15.2/4F9.0,I5/(8F9.0))                           077001
      FIND (11'IV1)                                                         07710045
      WRITE (6,1021) SPMAP,SPCODE(2),SPCODE(1),SPCODE(3),SPPOLY(2),AREA,077200
     1TXMIN,TYMIN,TXMAX,TYMAX,NQPTS,(P(I),Q(I),I=1,NQPTS)                   07730055
 1130 CONTINUE                                                              07740060
      WRITE(6,1201)                                                         077401
 1201 FORMAT(' FILE-12---')                                                 077402
      IV2=1                                                                 077403
      FIND (12'1)                                                           077404
      DO 1230 IJ=1,10                                                       07750065
 1210 READ (12'IV2,851)SPMAP,SPCODE(2),SPCODE(1),SPCODE(3),SPPOLY(2),ARE077800
     1A,TXMIN,TYMIN,TXMAX,TYMAX,NQPTS,(P(I),Q(I),I=1,NQPTS)                 07790085
```

```
      FIND (12'IV2)                                                          07800090
      WRITE(6,1021) SPMAP,SPCODE(2),SPCODE(1),SPCODE(3),SPPOLY(2),AREA,      078100
     1TXMIN,TYMIN,TXMAX,TYMAX,NQPTS,(P(I),Q(I),I=1,NQPTS)                    07820094
 1230 CONTINUE                                                              07830098
C                                    PRINT OUT 14 ON REQUEST                07840000
      FIND (14'1)                                                           07850000
      IV4=1                                                                 07860050
      WRITE (6,1005)                                                        07870060
 1005 FORMAT (' FILE-14 ---')                                               07880070
      DO 1030 IJ=1,10                                                       07890080
 1010 READ (14'IV4,850)MAPNO,MAPOLI(1),SPMAP,SPCODE(1),SPCODE(3),AREA,      079000
     1TXMIN,TYMIN,TXMAX,TYMAX,NQPTS,(P(I),Q(I),I=1,NQPTS)                    07910000
      FIND (14'IV4)                                                         07920000
      WRITE (6,1020) MAPNO,MAPOLI(1),SPMAP,SPCODE(1),SPCODE(3),AREA,        079300
     1TXMIN,TYMIN,TXMAX,TYMAX,NQPTS,(P(I),Q(I),I=1,NQPTS)                    07940000
 1020 FORMAT (' ',3I5,A3,I4,F15.2/' ',4F10.0,I5/(' ',8F10.0))               079500
 1021 FORMAT (' ',2I5,A3,I4,I2,F15.2/' ',4F10.1,I5,/(' ',8F10.1))           079501
 1030 CONTINUE                                                              07960000
 1999 CONTINUE                                                              07970090
      STOP                                                                  07980000
C                                                                           07990000
      END                                                                   08000000
C        POLYRD/TIDY                                                        08010000
C        |||||||  LATEST VERSION 9 JUNE '75 ||||||                         08020000
      SUBROUTINE POLYRD(*,MAPNO,POLYNO,CODE,AREA,XMIN,YMIN,XMAX,            08030000
     1    YMAX,N,X,Y,INUNIT,FAC,DONUT,OUT,/INV/)                            08040000
      DIMENSION X(1),Y(1)                                                   08050000
      INTEGER   MAPNO,POLYNO(2),CODE(3)                                     08060000
      LOGICAL DONUT,OUT                                                     08070000
      LOGICAL IFLAG                                                         08080000
      FAC=1.0                                                               08090000
      DONUT=.FALSE.                                                         08100000
   10 CONTINUE                                                              08110000
      INQ=INV                                                               08120000
      READ (INUNIT'INV,20,ERR=150) MAPNO,CODE(2),CODE(1),CODE(3),ITYPE,     08130000
     1AREA,XMIN,YMIN,XMAX,YMAX,N,(X(K),Y(K),K=1,N)                          08140000
   20 FORMAT (2I5,A3,I4,I2,F15.2/4F9.0,I5/(8F9.0))                          081500
C                                    SOFTWARE EOF FLAG                      08160000
      IF (MAPNO.EQ.99999) GO TO 150                                         08170000
      IF (MAPNO.EQ.00000) GO TO 150                                         081701
C                              CALCULATE AREA FOR POLYGON                   08180000
      IFLAG=.FALSE.                                                         08190000
C        SKIP IF AREAOF CALLED PREVIOUSLY ON THIS P-GON                     08200000
      IF (AREA)30,25,30                                                     08210000
   25 CALL AREAOF (AREA,N,X,Y,IFLAG)                                        08220000
      IF (.NOT.IFLAG)GOTO 30                                                08230000
      FIND (INUNIT'INQ)                                                     08240000
      WRITE(6,200)MAPNO,CODE(2),CODE(3)                                     082500
  200 FORMAT (' REVERSED POLYGON ',I5,2X,I5,2X,I4)                          08260000
      WRITE (INUNIT'INQ,20) MAPNO,CODE(2),CODE(1),CODE(3),ITYPE             08270000
     1,AREA,XMIN,YMIN,XMAX,YMAX,N,(X(K),Y(K),K=1,N)                         08280000
   30 CONTINUE                                                              08290000
      IF (ITYPE.EQ.10) GO TO 40                                             08300000
      DONUT=.TRUE.                                                          08310000
      GO TO 60                                                              08320000
C  40 DO 50 J=2,N                                                           08330000
C     IQ=J-1                                                               08340000
C     X(IQ)=X(J)          THIS PART FOR CENTRIOD ONLY                      08350000
C     Y(IQ)=Y(J)                                                           08360000
C  50 CONTINUE                                                             08370000
C     N=N-1                                                                08380000
```

```
   40  CONTINUE
       NOR=N
       ND2=N/2
    60 POLYNO(1)=CODE(2)
       POLYNO(2)=ITYPE
       IF (X(1).NE.X(N)) GO TO 70
       IF (Y(1).EQ.Y(N)) GO TO 130
    70 DIST=SQRT((ABS(X(1)-X(N)))**2.+(ABS(Y(1)-Y(N)))**2.)
       DIST2=SQRT((ABS(X(1)-X(N-1)))**2.+(ABS(Y(1)-Y(N-1)))**2.)
       IF (DIST.LE.DIST2) GO TO 110
       N=N-1
       IF (N.GT.ND2) GO TO 90
       N=NOR
       WRITE (6,80) N
   80  FORMAT (' POLYGON PUT BACK IN ORIGIONAL STATE N= ',I4)
       DIST=SQRT((ABS(X(1)-X(N)))**2.+(ABS(Y(1)-Y(N)))**2.)
       GO TO 110
    90 WRITE (6,100) N
   100 FORMAT (' POLYGON NOW HAS',I4,' PCINTS')
       GO TO 70
   110 N=N+1
       X(N)=X(1)
       Y(N)=Y(1)
       IF (DIST.LT.10.) GO TO 130
       WRITE (6,120) DIST
   120 FORMAT (' WARNING...CLOSING DISTANCE = ',F8.2)
   130 CONTINUE
       IF (.NOT.DONUT) GO TO 140
       DONUT=.TRUE.
       OUT=.TRUE.
   140 RETURN
   150 RETURN 1
   160 WRITE (6,165)INUNIT,INV
   165 FORMAT (' AREA WRITE ERROR FROM POLYRD',/,' FILE= ',I5,3X,
      1' RECORD= ',I5,'--RUN TERMINATED--')
       STOP
C
       END
C |||||||||||||||||||||||||||||||||||||||||||||
C        SUBROUTINE AREAOF
C        ||||||| LATEST VERSION  9 JUNE '75 ||||||||
C        CALCULATES AREA OF ANY POLYGON  USING VECTOR ANALYSIS METHOD.
C        AREA= AREA TO BE DETERMINED
C           AND DIRECTION OF POINTS  IE CLOCKWISE OR COUNTER-CLOCKWISE
C        N=    NUMBER OF POINTS
C        X=    ARRAY OF X VALUES
C        Y=    ARRAY OF Y VALUES
C        IFLAG= DIRECTION FLAG
C 11111111111111111111111111111111111111111111111111
       SUBROUTINE AREAOF(AREA,N,X,Y,IFLAG)
       DIMENSION X(1),Y(1),X1(1501),Y1(1501)
       LOGICAL IFLAG
C                        INDICATES POLYGON WAS CLOCKWISE OR NOT
       IFLAG=.FALSE.
       AREA=0.0
       M=N-1
       DO 50 L1=2,M
       A=X(L1)-X(1)
       B=Y(L1)-Y(1)
       A1=X(L1+1)-X(1)
       B1=Y(L1+1)-Y(1)
```

```
   50 AREA= AREA+A*B1-A1*B                                                  09000000
      IF (AREA)75,75,51                                                    09010000
   51 IFLAG=.TRUE.                                                         09020000
C                                                                          09030000
C                                                                          09040000
C     IF AREA IS NEGATIVE POINTS ARE COUNTER CLOCK-WISE---FIX IT           09050000
C                                                                          09060000
C                  FOR CASE WITH EVEN NO. OF POINTS                        09070000
C                  FOR CASE WITH EVEN NO. OF POINTS                        09080000
      J=0                                                                  09090000
      N2=N/2                                                               09100000
      N3=2*N2                                                              09110000
C                     ODD CASE                                             09120000
      IF (N.NE.N3)J=1                                                      09130000
C                                                                          09140000
C      FIRST SAVE CONTENTS OF CELLS IN FIRST HALF OF ORIG ARRAY            09150000
C                                                                          09160000
      DO 55 I=1,N2                                                         09170000
      X1(I)=X(I)                                                           09180000
      Y1(I)=Y(I)                                                           09190000
C                                                                          09200000
C          THEN MOVE BACK HALF OF ARRAY TO FRONT HALF, IN REVERSE ORDER    09210000
C                                                                          09220000
      X(I)=X(N-I+1)                                                        09230000
      Y(I)=Y(N-I+1)                                                        09240000
   55 CONTINUE                                                             09250000
C                                                                          09260000
C          NOW FILL BACK HALF OF ORIG WITH REVERSED FIRST HALF FROM HOLD    09270000
C                                                                          09280000
      N2=N2+1+J                                                            09290000
      DO 60 I=N2,N                                                         09300000
      J=J+1                                                                09310000
C             CAN SKIP THE PIVIT CELL WHEN N IS ODD                        09320000
      X(I)=X1(N2-J)                                                        09330000
      Y(I)=Y1(N2-J)                                                        09340000
   60 CONTINUE                                                             09350000
C                            1/2 AREA OF A PARALLELOGRAM                   09360000
   75 AREA=(.5*(ABS(AREA)))/43560.0                                        09370000
      RETURN                                                               09380000
      END                                                                  09390000
C 1111111111111111111111111111111111111111111111111111                    09400000
      SUBROUTINE STPSUB (XB, YB, XE, YE, SPX, SPY, NOSTP)                  09410000
C                                                                          09420000
      DLX = XE - XB                                                        09430000
      DLY = YE - YB                                                        09440000
C                                                                          09450000
C                                     COMPUTE THE LENGTH OF THE VECTOR     09460000
C                                     SQUARED                              09470000
      DIST = DLX ** 2 + DLY **2                                            09480000
C                                                                          09490000
      IF (DIST .GT. 20000.)  GO TO 5                                       09500000
C                                                                          09510000
      SPX = DLX                                                            09520000
      SPY = DLY                                                            09530000
      NOSTP = 1                                                            09540000
C                                                                          09550000
      GO TO 50                                                             09560000
C                                                                          09570000
    5 CONTINUE                                                             09580000
C                                                                          09590000
      I = 0                                                                09600000
```

```
C                                                                       09610000
   10 CONTINUE                                                          09620000
C                                                                       09630000
      IF (DIST .LE. 20000.) GO TO 20                                    09640000
C                                                                       09650000
      I = I + 1                                                         09660000
C                                     HALVE THE MAGNITUDE OF THE VECTOR 09670000
C                                     UNTIL THE MAGNITUDE IS LESS THAN  09680000
C                                     OR EQUAL TO THE VALUE OF .1       09690000
C                                     NOTE...  DIST IS THE SQUARE OF THE09700000
C                                     MAGNITUDE.                        09710000
      DIST = DIST / 4.                                                  09720000
C                                                                       09730000
      GO TO 10                                                          09740000
C                                                                       09750000
   20 CONTINUE                                                          09760000
C                                     COMPUTE THE SLOPE, IF DEFINED     09770000
      IF(ABS(DLX) .LT..005 )  GO TO 30                                  09780000
C                                                                       09790000
      SLOPE = DLY / DLX                                                 09800000
C                                                                       09810000
C                                     COMPUTE INCREMENTAL VECTORS       09820000
C                                                                       09830000
      SPX = SIGN (SQRT(DIST / (1. + SLOPE ** 2)), DLX)                  09840000
      SPY = SLOPE * SPX                                                 09850000
C                                                                       09860000
      GO TO 40                                                          09870000
   30 CONTINUE                                                          09880000
C                                                                       09890000
C                                     COMPUTE THE SPY VECTOR INCREMENT  09900000
C                                     IF SLOPE IS UNDEFINED             09910000
      SPX = 0.                                                          09920000
      SPY = SIGN (SQRT(DIST), DLY)                                      09930000
C                                                                       09940000
   40 CONTINUE                                                          09950000
C                                     NUMBER OF INCREMENTS              09960000
      NOSTP = 2 ** I                                                    09970000
C                                                                       09980000
   50 CONTINUE                                                          09990000
      RETURN                                                            10000000
      END                                                               10010000
      FUNCTION LEVEL(Y,YMIN,STEP,ISTP,YMAX)                             10020000
      BLOW=YMIN                                                         10030000
      DO 10 I=2,ISTP                                                    10040000
      BLOW=BLOW+STEP                                                    10050000
      BHIH=BLOW+STEP                                                    10060000
      IF(I .EQ. ISTP) BHIH = YMAX                                       10070000
      IF(Y.LE.BLOW) GO TO 10                                            10080000
      IF(Y.GT.BHIH) GO TO 10                                            10090000
      LEVEL=I                                                           10100000
      GO TO 20                                                          10110000
   10 CONTINUE                                                          10120000
      LEVEL=1                                                           10130000
   20 RETURN                                                            10140000
      END                                                               10150000
C ||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||| 10160000
      SUBROUTINE PIP(PP,QQ,IND,X,Y,N)                                   10170000
      DIMENSION X(N),Y(N)                                               10180000
      LOGICAL SWT                                                       10190000
C                                                                       10200000
C*********************************************************************10210000
```

```
C                                                                       10220000
C                                                                       10230000
C * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * 10240000
C    POINT-IN-POLYGON SUBROUTINE                                        10250000
C * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * 10260000
C                                                                       10270000
C                                                                       10280000
C   THE PURPOSE OF THIS SUBROUTINE IS TO DETERMINE IF THE POINT,        10290000
C   (PP,QQ), IS IN THE POLYGON DEFINED BY THE ARRAYS X AND Y,           10300000
C   WHICH ARE OF LENGTH N.    IND=0 IF THE POINT IS NOT IN THE          10310000
C   POLYGON, AND IND=1 IF THE POINT IS IN THE POLYGON                   10320000
C                                                                       10330000
C   THE METHOD USED IS TO DRAW A DIRECTED LINE SEGMENT FROM THE         10340000
C   POINT  (PP,QQ) TO (INFINITY,QQ).   HENCE THE LINE STARTS FROM       10350000
C   (PP,QQ) AND LIES IN THE PLUS X DIRECTION WITH SLOPE ZERO.           10360000
C   IF THIS DIRECTED LINE SEGMENT CROSSES THE POLYGON SIDES AN ODD      10370000
C   NUMBER OF TIMES THE POINT (PP,QQ) IS IN THE POLYGON. IF THE         10380000
C   DIRECTED LINE SEGMENT CROSSES THE POLYGON SIDES AN EVEN NUMBER OF   10390000
C   TIMES THE POINT LIES OUTSIDE OF THE POLYGON. IF THE POINT           10400000
C   LIES ON THE SIDE OF THE POLYGON IT IS CONSIDERED IN THE POLYGON.    10410000
C                                                                       10420000
C                                    SWT IS SET TO FALSE. AT THE        10430000
C                                    END OF THE ROUTINE IF SWT IS TRUE  10440000
C                                    THE POINT IS CONSIDERED IN THE     10450000
C                                    POLYGON. EACH TIME IT IS           10460000
C                                    DETERMINED THAT THE DIRECTED LINE  10470000
C                                    SEGMENT CROSSES THE POLYGON SIDE   10480000
C                                    THE VALUE OF SWT IS FLIPPED. HENCE 10490000
C                                    IF THE NUMBER OF CROSSINGS IS ODD  10500000
C                                    THE VALUE OF SWT WILL BE TRUE.     10510000
      SWT=.FALSE.                                                       10520000
C                                    IN CONSIDERING THE POINTS IN       10530000
C                                    THE POLYGON ARRAYS, POINTS I AND   10540000
C                                    I+1 ARE CONSIDERED IN EACH LOOP.   10550000
C                                    THEREFORE THE LOOP LIMIT           10560000
C                                    PARAMETER IS SET TO N-1            10570000
      M=N-1                                                             10580000
C                                    AT TIMES IN THE ALGORITHM IT IS    10590000
C                                    NECESSARY TO KEEP TRACK OF THE LAST 10600000
C                                    Y VERTEX COORDINATE. SINCE ALL Y   10610000
C                                    VALUES ARE POSITIVE -1 IS USED AS A 10620000
C                                    NULL VALUE                         10630000
      YREM=-1                                                           10640000
C                                    IND IS SET TO ZERO AND CHANGED     10650000
C                                    TO ONE LATER IF NEED BE            10660000
      IND=0                                                             10670000
C                                                                       10680000
C                                                                       10690000
C     LOOP THRU THE POLYGON POINTS                                      10700000
C                                                                       10710000
C                                                                       10720000
      DO 10 I=1,M                                                       10730000
C                                    STORE ARRAY VARIABLES INTO         10740000
C                                    SCALARS TO ELIMINATE UNNECESSARY   10750000
C                                    INDEXING                           10760000
      YP=Y(I)                                                           10770000
      YYP=Y(I+1)                                                        10780000
      XP=X(I)                                                           10790000
      XXP=X(I+1)                                                        10800000
C                                                                       10810000
C     THE LINE SEGMENT DEFINED BY (XP,YP) AND (XXP,YYP) IS CONSIDERED   10820000
```

```
C                                                                       10830000
C                                     IF THE POINT IS COMPLETELY ABOVE  10840000
C                                     THE LINE SEGMENT THERE WILL       10850000
C                                     BE NO CROSSING.                   10860000
C                                                                       10870000
      IF(QQ.GT.YP.AND.QQ.GT.YYP) GO TO 77                               10880000
C                                                                       10890000
C                                     LIKEWISE IF THE POINT IS BELOW    10900000
C                                                                       10910000
      IF(QQ.LT.YP.AND.QQ.LT.YYP) GO TO 77                               10920000
C                                                                       10930000
C                                     OR COMPLETELY TO THE RIGHT OF BOTH 10940000
C                                     POINTS XP AND XXP                 10950000
C                                                                       10960000
      IF(PP.GT.XP.AND.PP.GT.XXP) GO TO 77                               10970000
C                                                                       10980000
C                                                                       10990000
C * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * 11000000
C     CONSIDER THE SPECIAL CASE WHEN QQ=YP OR BRANCH AROUND.            11010000
C      IN THIS CASE THE POLYGON SIDE CAN COME UP TO THE POINT.          11020000
C     TURN AROUND AND GO BACK. OR IT CAN ACTUALLY CROSS IT              11030000
C                                                                       11040000
C * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * 11050000
      IF(QQ.NE.YP) GO TO 20                                             11060000
C                                     ARE THE POINTS (PP,QQ) AND (XP,YP) 11070000
C                                     THE SAME. IF SO THE POINT IS      11080000
C                                     CONSIDERED IN.                    11090000
      IF(PP.EQ.XP) GO TO 30                                             11100000
C                                     IF THIS VERTEX WAS INCOUNTERED LAST 11110000
C                                     TIME THRU THE LOOP THEN BRANCH OUT; 11120000
 9999 CONTINUE                                                          11130000
C                                     OTHERWISE THE CROSSING GETS COUNTED 11140000
C                                     TWICE.                            11150000
      IF(QQ.EQ.YREM) GO TO 40                                           11160000
C                                     REMEMBER THE VERTEX SO IT CAN BE  11170000
C                                     SKIPPED NEXT TIME THRU.           11180000
      YREM=YP                                                           11190000
C                                     SEARCH BACKWARD UNTIL THERE       11200000
C                                     IS A VERTEX POINT WITH A Y VALUE  11210000
C                                     NOT QQ                            11220000
      LAST=I                                                            11230000
   50 LAST=LAST-1                                                       11240000
      IF(LAST.EQ.0)GO TO 10                                             11250000
      IF(QQ.EQ.Y(LAST)) GO TO 50                                        11260000
      YLAST=Y(LAST)                                                     11270000
C                                     SEARCH FOWARD UNTIL THERE IS A    11280000
C                                     VERTEX POINT WITH A Y VALUE NOT QQ. 11290000
      NEXT=I                                                            11300000
   60 NEXT=NEXT+1                                                       11310000
      IF(NEXT.GT.N)GO TO 10                                             11320000
      IF(QQ.EQ.Y(NEXT)) GO TO 60                                        11330000
      YNEXT=Y(NEXT)                                                     11340000
C                                     IF QQ IS GREATER THAN BOTH THEN   11350000
C                                     THERE IS NO CROSSING.             11360000
C                                                                       11370000
      IF(QQ.GT.YLAST.AND.QQ.GT.YNEXT) GO TO 10                          11380000
C                                                                       11390000
C                                     IF QQ IS LESS THAN BOTH THERE     11400000
C                                     IS NO CROSSING                    11410000
C                                                                       11420000
      IF(QQ.LT.YLAST.AND.QQ.LT.YNEXT) GO TO 10                          11430000
```

```
C                                                                       11440000
C                                    CHECK FOR CROSSING                 11450000
      IF(PP.LT.XP) GO TO 70                                             11460000
      GO TO 10                                                          11470000
C                                                                       11480000
C                                                                       11490000
C * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * 11500000
C     CONSIDER THE SPECIAL CASE WHEN QQ=YYP OR BRANCH AROUND.           11510000
C      IN THIS CASE THE POLYGON SIDE CAN COME UP TO THE POINT,          11520000
C     TURN AROUND AND GO BACK, OR IT CAN ACTUALLY CROSS IT              11530000
C * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * 11540000
C                                                                       11550000
   20 IF(QQ.NE.YYP) GO TO 80                                            11560000
C                                    ARE THE POINTS(PP,QQ) AND (XXP,YYP) 11570000
C                                    THE SAME. IF SO THE POINT IS       11580000
C                                    CONSIDERED IN.                     11590000
      IF(PP.EQ.XXP) GO TO 30                                            11600000
C                                    IF THIS VERTEX WAS INCOUNTERED LAST 11610000
C                                    TIME THRU THE LOOP THEN BRANCH OUT; 11620000
C                                    OTHERWISE THE CROSSING GETS COUNTED 11630000
C                                    TWICE.                             11640000
      IF(QQ.EQ.YREM) GO TO 40                                           11650000
C                                    REMEMBER THE VERTEX SO IT CAN BE   11660000
C                                    SKIPPED NEXT TIME THRU.            11670000
      YREM=YYP                                                          11680000
C                                    SEARCH BACKWARD UNTIL THERE        11690000
C                                    IS A VERTEX POINT WITH A Y VALUE   11700000
C                                    NOT QQ                             11710000
      LAST=I+1                                                          11720000
   90 LAST=LAST-1                                                       11730000
      IF(QQ.EQ.Y(LAST)) GO TO 90                                        11740000
      YLAST=Y(LAST)                                                     11750000
C                                    SEARCH FOWARD UNTIL THERE IS A     11760000
C                                    VERTEX POINT WITH A Y VALUE NOT QQ. 11770000
      NEXT=I+1                                                          11780000
  100 NEXT=NEXT+1                                                       11790000
      IF(QQ.EQ.Y(NEXT)) GO TO 100                                       11800000
      YNEXT=Y(NEXT)                                                     11810000
C                                    IF QQ IS GREATER THAN BOTH THEN    11820000
C                                    THERE IS NC CROSSING.              11830000
C                                                                       11840000
      IF(QQ.GT.YLAST.AND.QQ.GT.YNEXT) GO TO 10                          11850000
C                                                                       11860000
C                                    IF QQ IS LESS THAN BOTH THERE      11870000
C                                    IS NO CROSSING                     11880000
C                                                                       11890000
      IF(QQ.LT.YLAST.AND.QQ.LT.YNEXT) GO TO 10                          11900000
C                                                                       11910000
C                                    CHECK FOR CROSSING                 11920000
      IF(PP.LT.XXP) GO TO 70                                            11930000
      GO TO 10                                                          11940000
C                                    RESET TO NULL VALUE                11950000
   40 IF(YP.NE.YYP) YREM=-1.0                                           11960000
      GO TO 10                                                          11970000
C                                    IF THE PROGRAM FLOW GETS TO HERE   11980000
C                                    AND PP IS COMPLETELY TO THE LEFT OF 11990000
C                                    THE LINE SEGMENT THERE IS A        12000000
C                                    CROSSING                           12010000
C                                                                       12020000
   80 YREM=-1.0                                                         12030000
      IF(PP.LE.XP.AND.PP.LE.XXP) GO TO 70                               12040000
```

```
C                                                                       12050000
C                                  IF THE LINE SEGMENT IS VERTICAL      12060000
C                                  THE POINT IS ON THE SIDE AND HENCE   12070000
C                                  IS IN                                12080000
      IF(XP.EQ.XXP) GO TO 30                                            12090000
C                                  IF THE LINE SEGMENT IS HORIZONTAL    12100000
C                                  THE POINT IS ON THE SIDE AND HENCE   12110000
C                                  IS IN.                               12120000
      IF(YP.EQ.YYP) GO TO 30                                            12130000
C                                  COMPUTE THE X COORDINATE             12140000
C                                  VALUE OF THE INTERSECTION OF THE     12150000
C                                  LINE SEGMENT FROM (-INFINITY,QQ) TO  12160000
C                                  (INFINITY,QQ)AND THE SEGMENT         12170000
C                                  (XP,YP),(XXP,YYP)                    12180000
C                                                                       12190000
      XTEMP=(XP-XXP)*(QQ-YYP)/(YP-YYP)+XXP                              12200000
C                                                                       12210000
C                                  IF PP IS TO THE RIGHT THERE IS NO    12220000
C                                  CROSSING                             12230000
      IF(PP.GT.XTEMP) GO TO 10                                          12240000
C                                  IF PP IS ON THE LINE THE POINT       12250000
C                                  IS IN                                12260000
      IF(PP.EQ.XTEMP) GO TO 30                                          12270000
C                                  OTHERWISE THERE IS A CROSSING        12280000
C                                  AND SWT IS FLIPPED.                  12290000
   70 SWT=.NOT.SWT                                                      12300000
      GO TO 10                                                          12310000
C                                  THE POINT IS ON THE SIDE AND         12320000
C                                  IS DEFINED AS IN.                    12330000
   30 SWT=.TRUE.                                                        12340000
      GO TO 200                                                         12350000
   77 YREM=-1.0                                                         12360000
   10 CONTINUE                                                          12370000
  200 CONTINUE                                                          12380000
C                                  IF SWT IS TRUE SET IND TO 1          12390000
      IF(SWT) IND=1                                                     12400000
      RETURN                                                            12410000
      END                                                               12420000
C                                                                       12430000
C!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!12440000
C                                                                       12450000
C     CLUGE                                                             12460000
C     ROUTINE TO READ CARDSFOR MAJOR,MINOR POLYGONS ONTO FILE11,        12470000
C       AND FILE12                                                      12480000
      SUBROUTINE CLUGE                                                  12490000
      INTEGER IBUF(20)                                                  12500000
      INTEGER MINR/'MINR'/,IEND/'END '/,MORE/'MORE'/                    12510000
      INTEGER NINE,NIN,BLANK(17)                                        125101
      DATA NINE /'9999'/, NIN /'9   '/, BLANK /17*'    '/               125102
      DATA ICT /'1378'/                                                 125103
      COMMON /ALPHA/IV1,IV2,IV3,IV4,IV5                                 12520000
      IV1=1                                                             12530000
      IV2=1                                                             12540000
      FIND (11'1)                                                       12550000
      FIND (12'1)                                                       12560000
C                          START BY READING MAJOR POLY CARDS            12570000
C                  MAJOR FIRST                                          12580000
   10 READ (3,100,END=20) (IBUF(I),I=1,20)                              125900
      IF (IBUF(1).LT.ICT) GO TO 10                                      125901
  100 FORMAT (20A4)                                                     12610000
C     WRITE (6,111)(IBUF(I),I=1,20),IV1                                 12680000
```

```
      WRITE (11'IV1,100)(IBUF(I),I=1,20)                          12690000
  111 FORMAT (' FROM 11 ',20A4,' IV1= ',I6)                       12700000
      FIND (11'IV1)                                               12710000
      GO TO 10                                                    12720000
   20 CONTINUE                                                    127300
      DO 21 J=1,3                                                 127301
   21 WRITE(11'IV1,100) NINE,NIN,BLANK                            127302
   30 READ (4,100,END=40) (IBUF(I),I=1,20)                        127303
      WRITE(12'IV2,100) (IBUF(I),I=1,20)                          127304
C     WRITE (6,112)(IBUF(I),I=1,20)                               12740000
  112 FORMAT ('  FROM 12 ',20A4,' IV2=',I6)                       127500
      FIND (12'IV2)                                               12760000
      GO TO 30                                                    127700
   40 CONTINUE                                                    12830000
      DO 31 J=1,5                                                 128301
   31 WRITE(12'IV2,100) NINE,NIN,BLANK                            128302
      FIND (11'1)                                                 12840000
      FIND (12'1)                                                 12850000
      IV1=1                                                       12860000
      IV2=1                                                       12870000
      DO 511 IJ=1,10                                              12880000
      READ (11'IV1,100)(IBUF(I),I=1,20)                           12890000
      FIND (11'IV1)                                               12900000
      WRITE (6,111) (IBUF(I),I=1,20),IV1                          129100
  511 CONTINUE                                                    12920000
      DO 611 IJ=1,10                                              12930000
      READ (12'IV2,100)(IBUF(I),I=1,20)                           12940000
      FIND (12'IV2)                                               12950000
      WRITE (6,112) (IBUF(I),I=1,20),IV2                          129600
  611 CONTINUE                                                    12970000
      RETURN                                                      12980000
      END                                                         12990000
```

APPENDIX VIII

MAJOR POLYGON DATA REPORT PROGRAM LISTING

```
      DIMENSION PTAREA(30), PERCT(30), PDIFF (30)
      INTEGER   SUMAP(30),SUCODE(30),SUORDR(30),SUTYPE(30)
      INTEGER CTRNO,BLKNO,CTORDR,CTTYPE
      INTEGER BLANK
      LOGICAL SKIP
      DATA BLANK /4H
      SKIP = .FALSE.
      LINECT=0
    1 CONTINUE
      WRITE (6,2001)
 2001 FORMAT(1H1,52X, 'S U M M A R Y  O U T P U T'/
     *48X, 'LOS ANGELES-SANTA MONICA STUDY AREA')
      WRITE (6,2002)
 2002 FORMAT(56X, 'MAJOR POLYGON FILE')
      WRITE (6,2003)
 2003 FORMAT(1X, 'CENSUS   CENSUS  POLY  POLY     LAND USE   LAND USE  '
     1,'POLY  POLY     ORIGINAL AREA     RESIDUAL AREA   DIFFERENCE',
     2 '   PERCENT   NUM OF')
      WRITE (6,2004)
 2004 FORMAT(1X, ' TRACT    BLOCK  NUM   TYPE        MAP         CODE    '
     2,'NUM   TYPE',61X,'RES POLY')
      WRITE (6,2005)
 2005 FORMAT (1H+ '______   ______  ____  ____     ________   _______  '
     2,'____  _____     ____________     ____________   '.
     3 '__________   _______  ________'/)
      IF(LINECT.EQ.0)GO TO 5
      LINECT=0
      GO TO 59
    5 INUM = 0
      PTAREA (1) = 0.0
      PERCT(1) = 0.0
      PDIFF(1)=0.0
      SUMAP(1)=0
      SUCODE(1)=0
      SUORDR(1)=0
      SUTYPE(1)=0
C     READ (15'IV5,101) CTRNO,BLKNO,CTORDR,CTTYPE,CTAREA
      READ (15    ,101) CTRNO,BLKNO,CTORDR,CTTYPE,CTAREA
  101 FORMAT (2I5,I4,I2,F15.2)
      IF (CTRNO.EQ.99999) GO TO 999
      TOAREA = TOAREA + CTAREA
      IF(SKIP) GOTO 15
C   10 READ(13'IV3,102) MAPNO,MAPNO1,LUMAP,LUCODE,LUORDR,LUTYPE,AREA
   10 READ(13    ,102) MAPNO,MAPNO1,LUMAP,LUCODE,LUORDR,LUTYPE,AREA
  102 FORMAT(3I5,A3,I4,I2,F15.2)
   15 CONTINUE
      SKIP = .FALSE.
      IF (MAPNO-CTRNO) 10,20,30
   20 IF(MAPNO1-BLKNO) 10,40,30
   40 INUM = INUM + 1
      PTAREA(INUM) = AREA
      PERCT(INUM) = 100.*AREA/CTAREA
      PDIFF(INUM)=CTAREA-AREA
      SUMAP(INUM)=LUMAP
      SUCODE(INUM)=LUCODE
      SUORDR(INUM)=LLORDR
      SUORDR(INUM)=LLORDR
      SUTYPE(INUM)=LLTYPE
      IF(PERCT(INUM).LT.0.009) PERCT(INUM)=0.00
      IF (LUTYPE.LE.10) GO TO 50
      PTAREA(INUM) = -PTAREA(INUM)
```

```
      PERCT  (INUM) = -PERCT  (INUM)
      PDIFF(INUM) = -PDIFF(INUM)
   50 CONTINUE
      TOTPR = TOTPR + PTAREA(INUM)
      GO TO 10
   30 CONTINUE
      MCTRNO = MOD (CTRNO,10)
      MBLKNO = MOD (BLKNO,10)
      CTRNO = CTRNO/10*100+MCTRNO
      BLKNO = BLKNO/10*100+MBLKNO
      STOT=0.0
      SDIFF=0.0
      SPERD=0.0
      IF(LINECT.GT.50)GO TO 1
   59 CONTINUE
      IF(INUM.LE.0) GO TO 61
      DO 60 J=1,INUM
      LINECT=LINECT+1
   65 CONTINUE
      WRITE(6,201) SUMAP(J),SUCODE(J),
     *SUORDR(J),SUTYPE(J),PTAREA(J)
  201 FORMAT(34X,    I5,7X,A3,6X,I2,4X,I9,18X,F18.2)
      STOT=STOT+PTAREA(J)
   60 CONTINUE
      SDIFF=CTAREA-STOT
      SPERD=100.*SDIFF/CTAREA
      WRITE(6,203) CTRNO,BLKNO,CTORDR,CTTYPE,CTAREA,STOT,SDIFF,SPERD,
     *INUM
  203 FORMAT(1X,I6,4X,I5,3X,I2,I6,6X,  'TOTAL'
     *,2F18.2,F13.2,F9.2,I8/)
      GO TO 62
   61 CONTINUE
      WRITE(6,204) CTRNO,BLKNO,CTORDR,CTTYPE,CTAREA
  204 FORMAT(1X,I6,4X,I5,3X,I2,4X,I2,36X,                          1F18.2,
     *4X,'*** NO RESIDUAL OVERLAY POLYGON FOUND ***'/)
   62 CONTINUE
      LINECT=LINECT+2
      SKIP = .TRUE.
      GO TO 5
  999 CONTINUE
      WRITE(6,202) TCAREA,TOTPR
  202 FORMAT(1H0,'TOTAL AREA OF CENSUS TRACTS=',F15.2/
     *       1H0,'TOTAL AREA OF RESIDUAL POLYGONS=',F15.2)
      END
```

APPENDIX IX

MINOR POLYGON DATA REPORT PROGRAM LISTING

```
CFILE 10=TD/SORTED/RESID13,UNIT=DISK,RECORD=15,BLOCKING=40
CFILE 11=TD/LU13E,UNIT=DISK,RECORD=15,BLOCKING=40
C      DEFINE FILE 10 (3000,80,E,I1)
C      DEFINE FILE 11 (3000,80,E,I2)
       DIMENSION SAREA(30),ISBLK(30)
       I1=1
       I2=1
       IERRS=0
       ICTR=0
       JCTR=0
       JUMP=0
       ASSIGN 100 TO JUMP
       ASSIGN 200 TO IGO
       AREA1=0.
       AREA2=0.
       TOT1=0.
       TOT2=0.
       IITA2=0
       ILINES=0
     1 WRITE (6,2021)
  2021 FORMAT(1H1,52X, 'S U M M A R Y  O U T P U T'/
      *48X, 'LOS ANGELES-SANTA MONICA STUDY AREA')
       WRITE (6,2022)
  2022 FORMAT(56X, 'MINOR POLYGON FILE')
       WRITE (6,2023)
  2023 FORMAT(1X,'CENSUS   CENSUS        LAND USE   LAND USE  POLY  POLY'
      1,'       ORIGINAL AREA       RESIDUAL AREA     DIFFERANCE  ',
      2 '   PERCENT   NUM OF')
       WRITE (6,2024)
  2024 FORMAT(1X, ' TRACT    BLOCK          MAP         CODE     NUM   ',
      2'TYPE',70X,'RES POLY')
       WRITE (6,2025)
  2025 FORMAT (1H+ '_____________        ____________________________'
      1,'__       ___________      ___________     ________      '
      2,'_______   ________')
       WRITE(6,2001)
       IF(ILINES.EQ.0)GO TO 5
       GO TO 205
C      READ(10'I1,1000) IMAP,ITAZ,ILUC,IPOLY,ITYPE,AREA1
     5 READ(10   ,1000) IMAP,IBLK,ITAZ,ILUC,IPOLY,ITYPE,AREA1
  1000 FORMAT (I5,I5,I5,A3,I4,I2,    F15.2)
       ILINES=ILINES+6
       INUM=1
C      FIND(10'I1)
       ICTR=ICTR+1
C   33 READ(11'I2,1000) JMAP,JTAZ,JLUC,JPOLY,JTYPE,AREA2,N
       READ(11   ,1001) JMAP,JTAZ,JLUC,JPOLY,JTYPE,AREA2,N
  1001 FORMAT (I5,   I5,A3,I4,I2,    F15.2/ 36X,I5)
C      FIND(11'I2)
       A=N
       A=(A/5.0)+.9
       N=A
       I1=I1+N+1
       JCTR=JCTR+1
C   10 READ(10'I1,1000) IIMAP,IITAZ,IILUC,IIPOLY,IITYPE,AREAI,N
    10 READ(10   ,1000) IIMAP,IIBLK,IITAZ,IILUC,IIPOLY,IITYPE,AREAI
       IF(IIMAP.EQ.99999) GO TO 900
C      FIND(10'I1)
       ICTR=ICTR+1
    20 IF(IIMAP.NE.IMAP)GO TO 30
       IF(IILUC.NE.ILUC)GO TO 30
```

```
      IF(IIPOLY.NE.IPOLY)GO TO 30
      IF(IITYPE.NE.ITYPE)GO TO 30
      ISBLK(1)=IBLK
      SAREA(1)=AREA1
      AREA1=AREA1+AREAI
      INUM=INUM+1
      SAREA(INUM)=AREAI
      ISBLK(INUM)=IIBLK
      GO TO 10
   30 GO TO JUMP,(100,140,200)
   40 IMAP=IIMAP
      IBLK=IIBLK
      ITAZ=IITAZ
      ILUC=IILUC
      IPOLY=IIPOLY
      AREA1=AREAI
      ITYPE=IITYPE
      INUM=1
      GO TO 10
C  100 READ(11'I2,1000)JJMAP,JJTAZ,JJLUC,JJPOLY,JJTYPE,AREAJ,N
  100 READ(11    ,1001)JJMAP,JJTAZ,JJLUC,JJPOLY,JJTYPE,AREAJ,N
      IF(JJMAP.EQ.99999) GO TO 900
      A=N
      A=(A/5.0)+.9
      N=A
      I2=I2+N+1
C     FIND(11'I2)
      JCTR=JCTR+1
      IF(JJTYPE.GT.10)AREAJ=-AREAJ
  120 IF(JJMAP.NE.JMAP)GO TO 130
      IF(JJLUC.NE.JLUC)GO TO 130
      IF(JJPOLY.NE.JPOLY)GO TO 130
      IF(JJTYPE.NE.JTYPE)GO TO 130
      AREA2=AREA2+AREAJ
      GO TO 100
  130 GO TO IGO,(200)
  140 JTYPE=JJTYPE
      JMAP=JJMAP
      JTAZ=JJTAZ
      JLUC=JJLUC
      JPOLY=JJPOLY
      AREA2=AREAJ
      GO TO 100
  200 IF(IPOLY.NE.JPOLY)GO TO 320
      ASSIGN 140 TO JUMP
      DELTA=AREA2-AREA1
      IF(AREA2.EQ.0.0)GO TO 210
      DPCT=(ABS(DELTA)/AREA2)*100.0
      IF(ILINES.LT.50)GO TO 210
      GO TO 1
  205 ILINES=5
  210 CONTINUE
      DO 215 J=1,INUM
      MBLKNO = MOD (ISBLK(J),10)
      ISBLK(J) = ISBLK(J)/10*100+MBLKNO
      WRITE(6,2015) ISBLK(J),JMAP,JLUC,JPOLY,JTYPE,SAREA(J)
 2015 FORMAT(11X,I5,8X,I6,7X,A3,6X,I2,4X,I2,8X,F13.2)
      ILINES=ILINES+1
  215 CONTINUE
      MIMAP = MOD (IMAP,10)
      IMAP = IMAP/10*100+MIMAP
```

```
      WRITE(6,2002)IMAP,JMAP ,JLUC,JPOLY,JTYPE,AREA2,AREA1,DELTA,
     1DPCT,INUM
      ILINES=ILINES+1
      TOT1=TOT1+AREA1
      TOT2=TOT2+AREA2
      IF(DELTA.NE.0.0)IERRS=IERRS+1
      GO TO 40
  320 IF(IPOLY.LT.JPOLY)GO TO 350
      GO TO 360
  350 ASSIGN 200 TO JUMP
      WRITE(6,2001)
      WRITE(6,2003)IMAP,      ILUC,IPOLY,ITYPE,AREA1
      WRITE(6,2001)
      GO TO 40
  360 WRITE(6,2001)
      WRITE(6,2004)JMAP,      JLUC,JPOLY,JTYPE,AREA2
      WRITE(6,2001)
      GO TO 140
  900 WRITE(6,2001)
      DELTA=TOT2-TOT1
      DPCT=(ABS(DELTA)/TOT2)*100.0
      WRITE(6,2005)TOT2,TOT1,DELTA,DPCT
      A=IERRS
      B=JCTR
      C=(A/B)*100.0
      WRITE(6,2006)JCTR,ICTR,IERRS,C
      STOP
 2000 FORMAT('1','MAP      TAZ    LUC  POLYGON  TYPE     ORIGINAL AREA',
     1     '   RESIDUAL AREA    DIFFERENCE     PERCENT',
     2     '  RESIDUAL POLYGONS')
 2001 FORMAT(1X)
 2002 FORMAT(I7,18X,I5,7X,A3,6X,I2,4X,I2,6X,F15.2,5X,F15.2,5X,
     1F10.2,5X,F6.2,7X,I2/)
 2003 FORMAT(25X,I5,7X,A3,6X,I2,4X,I2,6X,F15.2,4X,
     1     '**** UNMATCHED RESIDUAL POLYGON ****')
 2004 FORMAT(25X,I5,7X,A3,6X,I2,4X,I2,6X,F15.2,4X,
     1     '**** UNMATCHED ORIGINAL POLYGON ****')
 2005 FORMAT('0','**** OVERALL TOTALS *****',10X,F10.2,6X,F10.2,6X,
     1     F10.2,4X,F6.2)
 2006 FORMAT(1X,'ORIGINAL POLYGONS',I5,' RESIDUAL POLYGONS',I5,
     1     ' ERRORS',I5,' PERCENT',F7.2)
      END
```