forest management note

Note No. 37 Northern Forestry Centre Edmonton, Alberta

A PROGRAMMED PROCEDURE FOR EVALUATING THE EFFECT OF FOREST MANAGEMENT ON WATER YIELD

Evaluating the effect of various timber management schemes on annual water yield is difficult. To assist foresters in this task the U.S. Forest Service produced the WRENSS (Water Resources Evaluation of Non-point Silvicultural Sources) handbook (U.S. Forest Service 1980). It is a collection of table-and-chart procedures for evaluating the effects of forest management (cutting of the forest, change in composition, and reforestation) on water quality, quantity, and timing. This Note deals only with the application of the handbook's Chapter 3, by C.A. Troendle and C.F. Leaf, on the estimation of annual water yield from basins located in regions of significant snowfall. The procedure was developed for distinct U.S. regions and can be applied to regions in Canada that have comparable climates (Table 1). The procedure on water yield evaluation will simply be referred to as WRENSS in the remainder of this Note.

To make the WRENSS procedure easier to use, the original handbook version has been translated into FORTRAN-77; this was done on the Amdahl mainframe computer of the University of Alberta, in Edmonton. Users of that system can run the program by typing "$RUN VSAS:WRENSS". Two versions are also available for microcomputers of the IBM-PC standard: a compiled MS-FORTRAN version (nearly identical to the FORTRAN-77 version), and a Lotus 1-2-3 V2.0 spreadsheet version. The MS-FORTRAN version is technically simple to use because the program leads the user into a step-by-step execution of the procedure. The spreadsheet version is technically more complex to use because it requires some knowledge of spreadsheet operation. It is, however, more flexible in terms of what it can do. Copies of either version can be obtained from this author at the Northern Forestry Centre by sending a standard two-sided double density diskette in a self-addressed, postpaid mailer. This Note describes some specifics of the FORTRAN versions of the program. All remarks concerning the basic programming assumptions also apply to the spreadsheet version.

Table 1. Canadian climate-forest regions similar to snow-dominated regions listed in the WRENSS procedure

Region	Location	Characteristics
1	Eastern Canada	Deciduous or coniferous forest
4	Interior British Columbia	Dry snow packs, ponderosa and lodgepole pine
5	West coast	Wet snow, Douglas-fir and hemlock-spruce
6	Alberta east slopes	Lodgepole pine and spruce-fir

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The FORTRAN versions of WRENSS are interactive, which means that the computer asks or prompts the user for the next piece of information or input data. Inputs are divided into four blocks: basin description, basin climate, vegetation description, and treatment description (Table 2). The use of these blocks facilitates input correction and modification. On demand, all inputs are stored in an output file, along with a detailed listing of the results.

Table 2. Summary of inputs required by the WRENSS program

Basin description

Name of the basin
Area of the basin (km^2)
Hydrological region (Table 1)
Presence or absence of wind scour of snow in large openings
Area of the basin exposed north, south, and east + west (km^2)
Number and area of units within each aspect (km^2)

Basin climate

Precipitation by season (mm) (Table 3)
Average wind speed for the winter months (m/sec)
Approximate number of days with a reasonably continuous snow cover

Vegetation description

Vegetation type (Table 1)
Actual basal area of stand (m^2/ha)
Maximum basal area of stand (m^2/ha)

Treatment description (by unit)

Total area cut or in openings (km^2)
Basal area of trees left in the cuts (m^2/ha)
Average windward length of openings (m)
or
Average size of openings (ha)
or
Approximate number of openings
Height of trees surrounding the openings (m)
Roughness coefficient

In the basin description the user must provide the appropriate region number (Table 1), the total area of the basin, the area of the basin exposed north, east + west and south, and within each of these aspects, the number and area of units. These units should be portions of the basin that have a homogeneous aspect, vegetation type, and treatment. For example, a 10-km^2 basin might have 5 km^2 exposed north, 4 km^2 exposed east + west, and 1 km^2 exposed south. The north aspect may present two different vegetation types or contain cut blocks of two significantly different sizes, in which case it should be described as two units. The maximum number of units per aspect has been set at four. East + west aspect should be used for flat basins.

The question on wind scour in the basin description block, if answered with a "yes", will cause the program to compute snow redistribution due to the scouring effect of wind on the snowpack in large forest openings greater than 14 tree heights (14 H) in windward length.[1] Snow from large openings (if such openings are present) is blown into the remaining forest of the unit; the amount transported depends on the size, windward length, and roughness (to be explained later) of the openings. There is also some sublimation loss from the transported snow. Because precipitation from seasons 1 and 2 is assumed to be snow, snow redistribution can cause different precipitation values to be printed in the output table for the "forest" and "open" columns of those seasons. Users from areas where snowpacks are generally cold and dry should acknowledge the presence of wind scour. This option might not be applicable in areas where snow is more cohesive or often crusty from winter rains.

Precipitation is entered by season (Table 3). Wind speed is entered next in metres per second and should be the average wind speed expected for the winter months. For example, a moderately windy location might have monthly average wind speeds of about 5 m/sec (measured 10 m above the ground or above the canopy) in winter. A very calm location might show average wind speeds of about 1 m/sec.

Wind speed is used to compute direct snowpack evaporation, also termed the *in situ* sublimation loss. A snowpack exposed to a dry wind, even at temperatures below 0°C, will lose a substantial amount of water over time. Computations are based on an average air temperature of −5°C and a relative humidity of 70%, resulting in an *in situ* sublimation loss of about 0.15 mm/day at wind

[1] The limit between "large" and "small" openings in the handbook is 15 H, but 14 H offers a smoother transition between the curves controlling snow redistribution in the two size classes of openings.

Table 3. Season definitions for WRENNS regions

Region	Season	Dates
1	1	October 1 to January 1
	2	February 1 to April 30
	3	May 1 to September 30
4 and 6	1	October 1 to February 28
	2	March 1 to June 30
	3	July 1 to September 30
5	1	October 1 to December 29
	2	December 30 to March 28
	3	March 29 to June 26
	4	June 27 to September 30

speeds of 1 m/sec. The base-line or maximum loss in the program is thus 0.15 mm/day multiplied by the wind speed entered as an input. Base line loss is reduced by coefficients based on opening size and basal area left in the opening, because both variables indicate a sheltering of the snow from the wind. After daily snow loss has been computed the number of days with snow cover is used to compute the total annual loss. This total loss is split equally between seasons 1 and 2 and is abstracted from the snowpack remaining in the openings after snow redistribution, with no effect from roughness. Once again, this form of snow loss might not be as applicable to the snowpacks of the east or west coast as it is to those of the Alberta foothills. A wind speed of 0 metres per second will effectively turn the option off.

The vegetation description block requires three inputs: forest cover type (see Table 1), actual basal area of stand in m^2/ha, and expected basal area of stand at maturity. If the modeled stand is mature, actual and maximum basal areas are identical. At that point the program converts actual and maximum basal areas into actual and maximum cover densities through species- and region-dependent curves. These cover densities are not directly equal to measurable variables such as crown closure but represent the "hydrological utilization" of the site. It is the ratio of actual over maximum cover density that is finally used to compute evapotranspiration (ET). This ratio is always equal to 1 for a mature stand and 0 for a cut with no residual timber left in the openings. For these two cases, computed ET will be identical for all forest types within a given region because the conversion of basal area to cover density is the only species-dependent function in WRENSS.

The treatment description block starts with a request for the sum of open areas on the unit in square kilometres. An answer of 0 terminates the input phase. If this sum is greater than 0 the program asks for an average windward length of opening. This windward length is the edge to edge dimension of the opening along the axis of dominant winds. If this length is unknown (0 as answer to the prompt) the program asks for the average opening size in hectares, assumes that the openings are square, and computes windward length as the square root of this average opening area. If the average size of cut block is unknown (0 as answer to the prompt) the program requires the approximate number of openings on the unit and assumes that all openings are square and of equal size to compute an approximate windward length. I have mentioned the snow redistribution due to wind scouring that takes place in large (>14 H) openings. Small openings have the opposite effect; they trap and accumulate more snow than the forest. The precipitation values in the output table will clearly reflect this when small openings are applied to a significant portion of the forest.

The three last inputs in the treatment description block are the basal area left in the opening, the height of trees bordering the opening in metres, and, if the windward length of the openings exceeds 13 H, the roughness coefficient. The basal area left in the opening is used to compute a cover density ratio as described earlier. It is also used to reduce wind speed in the computation of *in situ* sublimation loss. Tree height is used to compute opening windward length in units of tree heights. Finally, the roughness coefficient is a measure of the snow-catching efficiency of an area and should be roughly equal to the depth of snow that will ultimately be retained by the opening following extreme wind scouring conditions. The default value is set at 0.3 m and the assumed snow density is 0.35 g/cm^3. *In situ* sublimation is not affected by roughness.

One point should be noted concerning large openings: the program assigns snow transported from the large openings to the forested portion of the same unit only. If the unit is entered as 100% open (nonforested) and wind scouring of large openings has been specified as present, the program will compute only 99% of the unit as being cut. The 1% remaining uncut will receive the transported snow. In such a case, millimetre precipitation in the "forest" column of the output table will be huge, possibly even exceeding the print format (the program prints a series of stars, "*"), but this is of no consequence for the final answer.

The program is designed to eliminate repetitive inputs for different units or for different runs through the procedure. For all questions requiring a numerical

answer, a "current" value is also printed that can be left unchanged by pressing "C". The program offers many opportunities for verifying and altering the inputs. A short example of an output file is given in Appendix 1, and a listing of the FORTRAN version is given in Appendix 2. The data in the output file can be used to check the program copies.

P.Y. Bernier
September 1986

REFERENCE

U.S. Forest Service. 1980. An approach to water resources evaluation of non-point silvicultural sources (a procedural handbook). U.S. Environ. Prot. Agency, Environ. Res. Lab., Off. Res. Dev., Athens, Georgia.

APPENDIX 1

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NAME OF BASIN: Cabin Creek
HYDROLOGIC REGION #  6
WIND SCOURING:  EXTENSIVE
AREA OF BASIN (SQ.KM)=   2.07
AREA IN N, E+W AND SOUTH ASPECTS:   0.00  1.50  0.57
PRECIP (MM) FOR OCT01-FEB28:   266
PRECIP (MM) FOR MAR01-JUN30:   193
PRECIP (MM) FOR JUL01-SEP30:   235
WINDSPEED (M/SEC): 1.00
NUMBER OF DAYS WITH CONTINUOUS SNOW COVER: 120.


INPUTS FOR UNIT 1 OF 2, ASPECT:EAST+WEST
AREA OF UNIT:                 1.00SQ.KM
TREE TYPE:                     SPRUCE-FIR
BASAL AREA OF STAND:        35.00 SQ.M/HA
MAXIMAL  BASAL AREA:        35.00 SQ.M/HA
TOTAL AREA OF CUTS:          0.50 SQ.KM
BASAL AREA IN CUTS:          0.00 SQ.M/HA
HEIGHT OF TREES:            20.00 M
WINDWARD LENGTH OF CUTS: 316.23 M
ROUGHNESS COEFFICIENT:       0.30 M


INPUTS FOR UNIT 2 OF 2, ASPECT:EAST+WEST
AREA OF UNIT:                 0.50SQ.KM
TREE TYPE:                     WEST.LARCH
BASAL AREA OF STAND:        15.00 SQ.M/HA
MAXIMAL  BASAL AREA:        15.00 SQ.M/HA
TOTAL AREA OF CUTS:          0.49 SQ.KM
BASAL AREA IN CUTS:          0.00 SQ.M/HA
HEIGHT OF TREES:             6.00 M
WINDWARD LENGTH OF CUTS: 700.00 M
ROUGHNESS COEFFICIENT:       0.30 M


INPUTS FOR UNIT 1 OF 1, ASPECT:SOUTH
AREA OF UNIT:                 0.57SQ.KM
TREE TYPE:                     SPRUCE-FIR
BASAL AREA OF STAND:        35.00 SQ.M/HA
MAXIMAL  BASAL AREA:        35.00 SQ.M/HA
TOTAL AREA OF CUTS:          0.28 SQ.KM
BASAL AREA IN CUTS:          0.00 SQ.M/HA
HEIGHT OF TREES:            20.00 M
WINDWARD LENGTH OF CUTS: 316.23 M
ROUGHNESS COEFFICIENT:       0.30 M
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**** OUTPUT FOR EACH UNIT

UNIT 1 OF ASPECT EAST+WEST
SEASON     PRECIP(MM)        ET(MM)          FLOW(MM)
         FOREST  OPEN     FOREST  OPEN     FOREST OPEN
   1      287.  219.        48.   29.      239.  190.
   2      205.  167.       121.   83.       84.   83.
   3      235.  234.       202.  127.       33.  106.

UNIT 2 OF ASPECT EAST+WEST
SEASON     PRECIP(MM)        ET(MM)          FLOW(MM)
         FOREST  OPEN     FOREST  OPEN     FOREST OPEN
   1     5713.   79.        48.   29.     5665.   50.
   2     3171.   72.       153.   52.     3017.   20.
   3      235.  194.       202.  123.       33.   70.

UNIT 1 OF ASPECT SOUTH
SEASON     PRECIP(MM)        ET(MM)          FLOW(MM)
         FOREST  OPEN     FOREST  OPEN     FOREST OPEN
   1      286.  219.        66.   40.      220.  179.
   2      204.  167.       170.  114.       34.   52.
   3      235.  234.       202.  127.       33.  106.


****  OUTPUT FOR THE WHOLE BASIN

SEASON:OCT01-FEB28
      *......NORTH......*....EAST+WEST....*......SOUTH.....*
         FOREST     OPEN   FOREST     OPEN   FOREST     OPEN
PRECIP(MM)   0.       0.     394.     150.     286.     219.
ET(MM)       0.       0.      48.      29.      66.      40.
FLOW(MM)     0.       0.     345.     121.     220.     179.

SEASON:MAR01-JUN30
      *......NORTH......*....EAST+WEST....*......SOUTH.....*
         FOREST     OPEN   FOREST     OPEN   FOREST     OPEN
PRECIP(MM)   0.       0.     263.     120.     204.     167.
ET(MM)       0.       0.     121.      68.     170.     114.
FLOW(MM)     0.       0.     141.      52.      34.      52.

SEASON:JUL01-SEP30
      *......NORTH......*....EAST+WEST....*......SOUTH.....*
         FOREST     OPEN   FOREST     OPEN   FOREST     OPEN
PRECIP(MM)   0.       0.     235.     214.     235.     234.
ET(MM)       0.       0.     202.     125.     202.     127.
FLOW(MM)     0.       0.      33.      89.      33.     106.

YEARLY FLOW IN MM:   339.   ****IN CU.DAM=   702.2

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APPENDIX 2

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C     ***********************************************************
C     *                                                         *
C     *     WRENSS PROCEDURE FOR HYDROLOGICAL PROVINCES 1,4,5,6 *
C     *                                                         *
C     *      HANDBOOK REFERENCE:                                *
C     *            AN APPROACH TO WATER RESOURCES EVALUATION    *
C     *            OF NON-POINT SILVICULTURAL SOURCES           *
C     *            USDA FOR. SER. AUGUST, 1980                  *
C     *            INTERAGENCY AGREEMENT EPA-IAG-D6-0660        *
C     *            PUBL. REF. # EPA-600/8-80-012                *
C     *                                                         *
C     *      PROGRAMMED BY:                                     *
C     *            PIERRE Y. BERNIER                            *
C     *            NORTHERN FORESTRY CENTRE                     *
C     *            5320-122 STREET                              *
C     *            EDMONTON, ALBERTA  T6H 3S5                   *
C     *                                                         *
C     *      MARCH, 1986                                        *
C     *                                                         *
C     ***********************************************************
C
C
C..................... GLOSSARY OF VARIABLES ....................
C
C  ADJPRE(J,K,L,M)   ADJUSTED PRECIP. (IN) AFTER SNOW REDISTRIBUTION
C  AREA              AREA OF BASIN (SQ.KM)
C  ASP(L)            FRACTION OF BASIN PER ASPECT (INPUT AS %)
C  BA(K,L,M)         BASAL AREA (SQFT) OF CUT & UNCUT (INPUT AS SQM)
C  BAMAX(L,M)        MAXIMUM BASAL AREA (SQFT) FOR MATURE STAND
C  CD(K)             COVER DENSITY (%) OF CUT AND UNCUT
C  CDMAX             MAXIMUM COVER DENSITY
C  CO1(3,ITREE(L,M)) COEFF. TO CONVERT BASAL AREA TO COVER DENSITY
C  CO2N(2,2,L,J)     COEFF. TO COMPUTE ET MODIFIER COEFFICIENTS
C  CO3N(4,L,J)       COEFF. TO COMPUTE ET FROM ADJPRE
C  ET(J,K,L,M)       EVAPOTRANSPIRATION PER J,K,L (IN)
C  ETMC(J,K,L,M)     ET MODIFIER COEFF. COMPUTED FROM CD
C  FLO               TOTAL ANNUAL FLOW OF BASIN (IN)
C  FLO4(J,K,L,M)     FLOW (IN) PER J,K,L AND M
C  ITREE(L,M)        VEGETATION TYPE (SEE TOP OF SUB. QUEST1)
C  J                 SEASON COUNTER, 1=WINTER OR EARLY WINTER
C  JSEAS             NUMBER OF SEASONS
C  K                 1=FOREST, 2=OPENINGS
C  L                 ASPECT COUNTER 1=N, 2=E+W, 3=S
C  M                 UNIT COUNTER
C  MNUM(L)           NUMBER OF UNITS PER ASPECT (MAXIMUM=4)
C  N                 PROVINCE COUNTER 1=1, 2=4, 3=5, AND 4=6
C  NAME              NAME OF BASIN
C  NPROV             PROVINCE NUMBER (SEE WRENSS HANDBOOK)
C  NRP1-8            OPTIONS OFFERED TO USER
C  OPEN(L,M)         FRACTION OF BASIN IN CUTS (INPUT AS %)
C  OPLGTH(L,M)       WINDWARD LENGTH OF OPENING (IN TREE HEIGHTS)
C  PRECP(J)        SEASONAL PRECIPITATION (INCHES, INPUT IN CM)
C  ROUGH(L,M)        ROUGHNESS COEFFICIENT FOR OPENINGS
C  TREEH(L,M)        HEIGHT OF TREES (FT, INPUT AS M)
C  UAREA(L,M)        AREA OF UNITS (IN SQ. KM)
C
C
C
      BLOCK DATA
      COMMON/INPUT/NPROV,N,AREA,MNUM(3),ASP(3),PRECP(4),ITREE(3,4),
     *             TREEH(3,4),BA(2,3,4),BAMAX(3,4),UAREA(3,4),WSPEED,
     *             ROUGH(3,4),JSEAS,OPEN(3,4),OPLGTH(3,4),SNODAY
      COMMON/COEFF/CO1(3,10),CO21(2,2,3,4),CO22(2,2,3,4),CO23(2,2,3,4)
     *            ,CO24(2,2,3,4),CO31(4,3,4),CO32(4,3,4),CO33(4,3,4)
     *            ,CO34(4,3,4)
      COMMON/ANSWER/NRP1,NRP2,NRP3,NRP4,NRP5,NRP6,NRP7,NRP8,IYES,NYES
      CHARACTER * 1 NRP1,NRP2,NRP3,NRP4,NRP5,NRP6,NRP7,NRP8,IYES,NYES
C
      DATA CO1 / 5.5, 0.27, -0.0004, 4.1, 0.20, -0.0002,
     *           4.5, 0.30, -0.0003, 2.9, 0.21, -0.0003,
     *           1.2, 0.15, -0.0002,
     *           2.6, 0.40, -0.0006,-1.2, 0.39, -0.0006,
     *           4.5, 0.30, -0.0003, 3.3, 0.28, -0.0004,
     *           2.9, 0.21, -0.0003 /
      DATA CO21/ 1.12,  0.0, 1.24,-0.24, 1.09,-0.02, 1.16,-0.16,
     *           1.06,-0.06, 1.06,-0.06,
     *           0.87, 0.20, 0.94, 0.06, 0.87, 0.20, 0.94, 0.06,
     *           0.87, 0.20, 0.94, 0.06,
     *           0.52, 0.80, 0.84, 0.16, 0.52, 0.80, 0.84, 0.16,
     *           0.52, 0.80, 0.84, 0.16,
     *            0.0,  0.0,  0.0,  0.0,  0.0,  0.0,  0.0,  0.0,
     *            0.0,  0.0,  0.0,  0.0/
      DATA CO22/ 0.60, 0.80, 1.00,  0.0, 0.60, 0.80, 1.00,  0.0,
     *           0.60, 0.80, 1.00,  0.0,
     *           1.10,-0.16, 1.04,-0.04, 1.07,-0.10, 1.04,-0.04,
     *           1.04,-0.04, 1.04,-0.04,
     *           0.44, 1.22, 1.00,  0.0, 0.55, 0.90, 1.00,  0.0,
     *           0.60, 0.80, 1.00,  0.0,
     *            0.0,  0.0,  0.0,  0.0,  0.0,  0.0,  0.0,  0.0,
     *            0.0,  0.0,  0.0,  0.0/
      DATA CO23/ 0.55, 0.90, 1.00,  0.0, 0.55, 0.90, 1.00,  0.0,
     *           0.55, 0.90, 1.00,  0.0,
     *           1.25,-0.50, 1.00,  0.0, 0.88, 0.24, 1.00,  0.0,
     *           0.53, 0.94, 1.00,  0.0,
     *           0.40, 1.20, 1.00,  0.0, 0.53, 0.94, 1.00,  0.0,
     *           0.62, 0.76, 1.00,  0.0,
     *           1.02, 0.86, 1.90,-0.90, 0.96, 0.76, 1.68,-0.68,
     *           0.90, 0.68, 1.48,-0.48/
      DATA CO24/ 0.60, 0.50, 0.70, 0.30, 0.60, 0.50, 0.70, 0.30,
     *           0.60, 0.50, 0.70, 0.30,
     *           0.80, 0.26, 0.86, 0.14, 0.77, 0.32, 0.86, 0.14,
     *           0.73, 0.40, 0.86, 0.14,
     *           0.63, 0.74, 1.00,  0.0, 0.63, 0.74, 1.00,  0.0,
     *           0.63, 0.74, 1.00,  0.0,
     *            0.0,  0.0,  0.0,  0.0,  0.0,  0.0,  0.0,  0.0,
     *            0.0,  0.0,  0.0,  0.0/
      DATA CO31/ 1.45,  0.0,   0.00, 99., 1.92,  0.0,   0.00, 99.,
     *           2.40,  0.0,   0.00, 99.,
     *          -1.56, 2.82,-0.5650, 2.0, 1.60, 0.50,-0.1000, 2.0,
     *           1.90, 0.62,-0.1250, 2.0,
     *           4.42, 1.12,-0.0317, 16., 4.31, 1.35,-0.0422, 16.,
     *           4.47, 1.46,-0.0450, 16.,
     *            0.0,  0.0,   0.00, 0.0,  0.0,  0.0,   0.00, 0.0,
     *            0.0,  0.0,   0.00, 0.0/
      DATA CO32/ 1.40,  0.0,   0.00, 99., 1.80,  0.0,   0.00, 99.,
     *           2.30,  0.0,   0.00, 99.,
     *          -0.64, 1.38,-0.0716, 11.,-0.78, 1.43,-0.0653, 11.,
     *          -1.37, 1.73,-0.0802, 11.,
     *           0.10, 2.57,-0.1846, 9.0, 0.10, 2.57,-0.1846, 9.0,
     *           0.10, 2.57,-0.1846, 9.0,
     *            0.0,  0.0,   0.00, 0.0,  0.0,  0.0,   0.00, 0.0,
     *            0.0,  0.0,   0.00, 0.0/
      DATA CO33/ 1.60,  0.0,   0.00, 99., 2.20,  0.0,   0.00, 99.,
     *           3.00,  0.0,   0.00, 99.,
     *           1.20,  0.0,   0.00, 99., 1.70,  0.0,   0.00, 99.,
     *           2.20,  0.0,   0.00, 99.,
     *          -1.76, 2.11,-0.1631, 10.,-0.60, 1.40,-0.0639, 10.,
     *          -1.12, 1.54,-0.0493, 10.,
     *           0.83, 2.72,-0.2756, 5.0, 0.47, 3.01,-0.2492, 5.0,
     *          -0.19, 3.68,-0.2792, 5.0/
      DATA CO34/ 1.30,  0.0,   0.00, 99., 1.90,  0.0,   0.00, 99.,
     *           2.60,  0.0,   0.00, 99.,
     *           0.68, 0.38,-0.0084, 22., 1.09, 0.60,-0.0180, 15.,
     *           0.28, 1.33,-0.0661, 9.3,
     *           1.68, 1.24,-0.0589, 8.4, 1.68, 1.24,-0.0589, 8.4,
     *           1.68, 1.24,-0.0589, 8.4,
     *            0.0,  0.0,   0.0, 0.0,  0.0,  0.0,   0.0, 0.0,
     *            0.0,  0.0,   0.0, 0.0/-
      DATA NRP1,NRP2,NRP3,NRP4,NRP5,NRP6,NRP7,NRP8,IYES,NYES/'N',
     *          'N','N','N','N','N','N','Y','Y','y'/
      DATA NPROV,AREA,MNUM,UAREA/0,0.,0,0,0,0,0.,0.,0.,0.,0.,
     *           0.,0.,0.,0.,0.,0.,0./
      END
C
C
C
      COMMON/INPUT/NPROV,N,AREA,MNUM(3),ASP(3),PRECP(4),ITREE(3,4),
     *             TREEH(3,4),BA(2,3,4),BAMAX(3,4),UAREA(3,4),WSPEED,
     *             ROUGH(3,4),JSEAS,OPEN(3,4),OPLGTH(3,4),SNODAY
      COMMON/COEFF/CO1(3,10),CO21(2,2,3,4),CO22(2,2,3,4),CO23(2,2,3,4)
     *            ,CO24(2,2,3,4),CO31(4,3,4),CO32(4,3,4),CO33(4,3,4)
     *            ,CO34(4,3,4)
      COMMON/CORE/CDMAX,CD(2),ETMC(4,2,3,4),ADJPRE(4,2,3,4),ET(4,2,3,4)
     *            ,FLO4(4,2,3,4)
      COMMON/BUFFER/IPRE(4),ITRE,B,BX,BB,CAREA,TREH,OP,XROUGH
      COMMON/ANSWER/NRP1,NRP2,NRP3,NRP4,NRP5,NRP6,NRP7,NRP8,IYES,NYES
      CHARACTER * 1 NRP1,NRP2,NRP3,NRP4,NRP5,NRP6,NRP7,NRP8,IYES,NYES
      COMMON/TITLE/NAME(15)
C
C
C.....DECIDE ON WHERE TO WRITE THE OUTPUT
      CALL QUEST1
C.....READ DESCRIPTION OF BASIN, VEGETATION AND TREATMENT
   10 CALL QUEST2
C.....WRITE BASIN DESCRIPTION TO FILE
      IF(NRP6.EQ.IYES.OR.NRP6.EQ.NYES) CALL OUT1
C.....DO FOR ALL ASPECTS
      DO 20 L=1,3
         IF(ASP(L).LE.0.) GO TO 20
C.....   DO FOR ALL UNITS
         DO 15 M=1,MNUM(L)
C.....      COMPUTE ET MODIFIER COEFFICIENTS
            CALL ETMOD(L,M)
C.....      COMPUTE ADJUSTED PRECIPITATION FOR FOREST AND OPENINGS
            CALL ADJPRC(L,M)
C.....      COMPUTE EVAPOTRANSPIRATION AND STREAMFLOW
   15       CALL ETCOM(L,M)
   20 CONTINUE
C.....PRINT THE RESULTS
      CALL OUT2
C.....NEXT MOVE BY USER OF THE PROGRAM?
      CALL QUEST3
C.....AN OTHER RUN WITH THE PROGRAM
      GO TO 10
      END
C
C
C
C
      SUBROUTINE ETMOD(L,M)
      COMMON/INPUT/NPROV,N,AREA,MNUM(3),ASP(3),PRECP(4),ITREE(3,4),
     *             TREEH(3,4),BA(2,3,4),BAMAX(3,4),UAREA(3,4),WSPEED,
     *             ROUGH(3,4),JSEAS,OPEN(3,4),OPLGTH(3,4),SNODAY
      COMMON/COEFF/CO1(3,10),CO21(2,2,3,4),CO22(2,2,3,4),CO23(2,2,3,4)
     *            ,CO24(2,2,3,4),CO31(4,3,4),CO32(4,3,4),CO33(4,3,4)
     *            ,CO34(4,3,4)
      COMMON/CORE/CDMAX,CD(2),ETMC(4,2,3,4),ADJPRE(4,2,3,4),ET(4,2,3,4)
     *            ,FLO4(4,2,3,4)
C.....THIS SUBROUTINE COMPUTES THE ET MODIFIER COEFFICIENTS FROM ACTUAL
C.....AND MAX. COVER DENSITY, BOTH FOR FOREST AND CUTS (K).
C.....FIRST, CONVERT BASAL AREA TO COVER DENSITY.
C
      CDMAX=CO1(1,ITREE(L,M))+CO1(2,ITREE(L,M))*BAMAX(L,M)+
     *      CO1(3,ITREE(L,M))*(BAMAX(L,M)**2)
      DO 10 K=1,2
         IF(K.EQ.1.AND.OPEN(L,M).GE.1.) GO TO 10
         IF(K.EQ.2.AND.OPEN(L,M).LE.0.) GO TO 10
         CD(K)=CO1(1,ITREE(L,M))+CO1(2,ITREE(L,M))*BA(K,L,M)+
     *         CO1(3,ITREE(L,M))*(BA(K,L,M)**2)
         CD(K)=AMIN1(CD(K),BA(K,L,M))
         CDMAX=AMIN1(CDMAX,BAMAX(L,M))
```

```
C.....   NOW, COMPUTE ET MOD. COEFF. BY SEASON (J) AND ASPECT (L)
C.....   CHOOSE THE PORTION OF CURVE TO BE USED:
         MM=1
         IF(CD(K).GE.CDMAX/2.) MM=2
         CX=CD(K)/CDMAX
         DO 10 J=1,JSEAS
            IF(N.EQ.1) ETMC(J,K,L,M)=CO21(1,MM,L,J)+CO21(2,MM,L,J)*CX
            IF(N.EQ.2) ETMC(J,K,L,M)=CO22(1,MM,L,J)+CO22(2,MM,L,J)*CX
            IF(N.EQ.3) ETMC(J,K,L,M)=CO23(1,MM,L,J)+CO23(2,MM,L,J)*CX
            IF(N.EQ.4) ETMC(J,K,L,M)=CO24(1,MM,L,J)+CO24(2,MM,L,J)*CX
C.....      ELIMINATE ETMC IF NO FOREST OR NO CUTS.
C.....      ETMC CANNOT BE GREATER THAN 1 (PERS. COMM. C.A.TROENDLE)
            ETMC(J,K,L,M)=AMIN1(1.,ETMC(J,K,L,M))
            IF(K.EQ.1.AND.OPEN(L,M).GE.1.0) ETMC(J,K,L,M)=0.
            IF(K.EQ.2.AND.OPEN(L,M).LE.0.0) ETMC(J,K,L,M)=0.
C.....      ETMC CANNOT BE GREATER THAN 1 (PERS. COMM. C.A.TROENDLE)
            ETMC(J,K,L,M)=AMIN1(1.,ETMC(J,K,L,M))
   10 CONTINUE
      RETURN
      END
C
C
C
C
      SUBROUTINE ADJPRC(L,M)
      COMMON/INPUT/NPROV,N,AREA,MNUM(3),ASP(3),PRECP(4),ITREE(3,4),
     *             TREEH(3,4),BA(2,3,4),BAMAX(3,4),UAREA(3,4),WSPEED,
     *             ROUGH(3,4),JSEAS,OPEN(3,4),OPLGTH(3,4),SNODAY
      COMMON/COEFF/CO1(3,10),CO21(2,2,3,4),CO22(2,2,3,4),CO23(2,2,3,4)
     *            ,CO24(2,2,3,4),CO31(4,3,4),CO32(4,3,4),CO33(4,3,4)
     *            ,CO34(4,3,4)
      COMMON/CORE/CDMAX,CD(2),ETMC(4,2,3,4),ADJPRE(4,2,3,4),ET(4,2,3,4)
     *            ,FLO4(4,2,3,4)
      COMMON/ANSWER/NRP1,NRP2,NRP3,NRP4,NRP5,NRP6,NRP7,NRP8,IYES,NYES
      CHARACTER * 1 NRP1,NRP2,NRP3,NRP4,NRP5,NRP6,NRP7,NRP8,IYES,NYES
      DIMENSION R(2)
C.....THIS SUBROUTINE COMPUTES ADJUSTED WINTER PRECIP. (SNOW) ACCORDING
C.....TO OPENING SIZE AND PERCENT OF BASIN CUT.
C
C.....DO FOR ALL SEASONS
      DO 30 J=1,JSEAS
         R(1)=1.
         R(2)=1.
C.....   REDISTRIBUTION OF PRECIP. OCCURS IN THE WINTER MONTHS ONLY.
         IF(J.GT.2) GO TO 20
C
C.....   FIRST, COMPUTE THE EFFECT OF IN-SITU SUBLIMATION
C.....   COMPUTE AN EFFECTIVE OPENING DIAMETER AS AFFECTED BY REGROWTH
         EFFLGH=OPLGTH(L,M)*AMIN1(1.,2.*AMAX1(0.0,0.3-(CD(2)/CDMAX)))
C.....   COMPUTE A DAILY SUBL. LOSS, WITH WIND MODIFIED BY OPENING DIAM.
         DAYLOS=.15*WSPEED*(.0214+.0067*EFFLGH+.00084*EFFLGH**2)
C.....   COMPUTE SUBLIMATION LOSS BY SEASON, LOSS < OR = TO PRECIP.
         SEALOS=(DAYLOS*SNODAY/2)/25.4
C
C.....   THE PROCEDURE IS DIFFERENT FOR OPENINGS LARGER THAN 14H.
         IF(OPLGTH(L,M).GE.14) GO TO 10
C
C.....   COMPUTE SNOW RETENTION COEFF. FOR OPENINGS <14H :
         R(2)=1-0.040409*OPLGTH(L,M)+.581189*(1-1/EXP(OPLGTH(L,M)))
C.....   MODIFY RESULT IF MORE THAN 50% OF THE BASIN IS CUT:
         IF(OPEN(L,M).GT.0.5) R(2)=1.+(R(2)-1)*(0.5/OPEN(L,M))
C.....   COMPUTE COEFF. FOR FORESTED PORTION OF THE BASIN:
         IF(OPEN(L,M).LT.1.0) R(1)=(1-R(2)*OPEN(L,M))/(1-OPEN(L,M))
         GO TO 25
C
C.....   PROCEDURE FOR OPENINGS >14H.
   10    P=PRECP(J)/12.
         D=TREEH(L,M)*OPLGTH(L,M)
         A=0.14**(TREEH(L,M)*0.001)
         B=0.14**((D-5.*TREEH(L,M))*0.0001)
         C=0.14**(D*0.0001)
         PZ2=AMAX1(0.,P-0.35*ROUGH(L,M))
         PZ1=PZ2/3.
C.....   PRECIPITATION SWEPT FROM THE OPENING
         PR=(5*TREEH(L,M)*PZ1)+PZ2*(D-13*TREEH(L,M))
C.....   PRECIPITATION SWEPT INTO THE FOREST (CUFT/FT)
         Q=AMIN1(PR,5000.*(PZ2*AMAX1(0.,(A-B))+PZ1*(B-C)))
C.....   FRACTION OF PRECIP LEFT IN OPENINGS:
         R(2)=(P-PR/D)/P
C.....   DO NOT COMPUTE R(1) IF ALL THE BASIN IS CUT (OPEN(L,M)=1.0)
         IF(OPEN(L,M).GE.1.0) GO TO 20
C.....   ACCUMULATION COEFF. FOR FOREST(=1 IF NO SNOW FROM OPENINGS)
         R(1)=(P+(Q/D)*OPEN(L,M)/(1.-OPEN(L,M)))/P
C
C.....   IS THERE WIND SCOURING IN THE LARGE OPENINGS?
         IF(NRP8.EQ.IYES.OR.NRP8.EQ.NYES) GO TO 25
   20    R(1)=AMIN1(1.,R(1))
         R(2)=AMAX1(1.,R(2))
   25    IF(OPEN(L,M).GE.1.0) R(1)=0.
         IF(OPEN(L,M).LE.0.0) R(2)=0.
C.....   COMPUTE ADJUSTED PRECIPITATION:
         ADJPRE(J,1,L,M)=PRECP(J)*R(1)
         ADJPRE(J,2,L,M)=PRECP(J)*R(2)
C.....   REMOVE THE IN-SITU SUBLIMATION
         ADJPRE(J,2,L,M)=AMAX1(0.,ADJPRE(J,2,L,M)-SEALOS)
   30 CONTINUE
      RETURN
      END
C
C
C
C
      SUBROUTINE ETCOM(L,M)
      COMMON/INPUT/NPROV,N,AREA,MNUM(3),ASP(3),PRECP(4),ITREE(3,4),
     *             TREEH(3,4),BA(2,3,4),BAMAX(3,4),UAREA(3,4),WSPEED,
     *             ROUGH(3,4),JSEAS,OPEN(3,4),OPLGTH(3,4),SNODAY
      COMMON/COEFF/CO1(3,10),CO21(2,2,3,4),CO22(2,2,3,4),CO23(2,2,3,4)
     *            ,CO24(2,2,3,4),CO31(4,3,4),CO32(4,3,4),CO33(4,3,4)
     *            ,CO34(4,3,4)
      COMMON/CORE/CDMAX,CD(2),ETMC(4,2,3,4),ADJPRE(4,2,3,4),ET(4,2,3,4)
     *            ,FLO4(4,2,3,4)
      DIMENSION CO3(4,3,4)
C.....THIS SUBROUTINE COMPUTES ET AND FLOW BY SEASON (J), CUT AND
C.....UNCUT (K), ASPECT (L) AND UNIT (M) AS MODIFIED BY THE COVER
C.....DENSITY RELATED ET MODIFIER COEFFICIENTS.
      DO 20 J=1,JSEAS
         DO 20 K=1,2
            IF(K.EQ.1.AND.OPEN(L,M).GE.1.) GO TO 20
            IF(K.EQ.2.AND.OPEN(L,M).LE.0.) GO TO 20
            DO 10 I=1,4
               IF(NPROV.EQ.1) CO3(I,L,J)=CO31(I,L,J)
               IF(NPROV.EQ.4) CO3(I,L,J)=CO32(I,L,J)
               IF(NPROV.EQ.5) CO3(I,L,J)=CO33(I,L,J)
   10          IF(NPROV.EQ.6) CO3(I,L,J)=CO34(I,L,J)
C.....      COMPUTES ET
            P=AMIN1(ADJPRE(J,K,L,M),CO3(4,L,J))
            ET(J,K,L,M)=AMAX1(0.,(CO3(1,L,J)+CO3(2,L,J)*P+
     *                CO3(3,L,J)*(P**2))*ETMC(J,K,L,M))
C.....      COMPUTE WATER AVAILABLE FOR FLOW (INCHES):
   20       FLO4(J,K,L,M)=(ADJPRE(J,K,L,M)-ET(J,K,L,M))
      RETURN
      END
C
C
C
C
      SUBROUTINE QUEST1
      COMMON/ANSWER/NRP1,NRP2,NRP3,NRP4,NRP5,NRP6,NRP7,NRP8,IYES,NYES
      CHARACTER * 1 NRP1,NRP2,NRP3,NRP4,NRP5,NRP6,NRP7,NRP8,IYES,NYES
      CHARACTER * 15 NFILE
C.....IN THIS SUBROUTINE, THE USER DEFINES THE NAME OF THE FILE
C.....WHERE RESULTS OF CALCULATION ARE TO BE ROUTED.
      WRITE(6,5)
    5 FORMAT('  WRENSS PROCEDURE......UPDATE 3.0, MARCH 1986 ',//,
     *       '  PRESS ''C'' AND ''RETURN'' AT PROMPTS REQUIRING A ',/,
     *       '     NUMERICAL ANSWER TO LEAVE THE CURRENT VALUE ',/,
     *       '     UNCHANGED',//,
     *       '  PLEASE REPORT PROBLEMS TO:',/,
     *       '            P.Y.BERNIER',/,
     *       '            NORTHERN FORESTRY CENTRE
     *       '            CANADIAN FORESTRY SERVICE
     *       '            5320-122 STREET',/,
     *       '            EDMONTON, ALTA  T6H 3S5',/,
     *       '            TEL: 1-403-435-7210',//)
      WRITE(6,10)
   10 FORMAT(' DO YOU WANT RESULTS ROUTED TO A FILE?')
      READ(5,20)NRP6
   20 FORMAT(A1)
      IF(NRP6.NE.IYES.AND.NRP6.NE.NYES) RETURN
   25 WRITE(6,30)
   30 FORMAT(' RESULTS WILL BE STORED IN TEMPORARY FILE ',
     *       ' "RESULTS.DAT"',/,' REMEMBER TO SAVE IT TO A ',
     *       ' PERMANENT FILE AT THE END OF THIS SESSION')
C     READ(5,40)NFILE
C  40 FORMAT(A15)
      OPEN (UNIT=8,NAME='RESULTS.DAT',TYPE='NEW')
      RETURN
      END
C
C
C
C
      SUBROUTINE QUEST2
      COMMON/CORE/CDMAX,CD(2),ETMC(4,2,3,4),ADJPRE(4,2,3,4),ET(4,2,3,4)
     *            ,FLO4(4,2,3,4)
      COMMON/INPUT/NPROV,N,AREA,MNUM(3),ASP(3),PRECP(4),ITREE(3,4),
     *             TREEH(3,4),BA(2,3,4),BAMAX(3,4),UAREA(3,4),WSPEED,
     *             ROUGH(3,4),JSEAS,OPEN(3,4),OPLGTH(3,4),SNODAY
      COMMON/TITLE/NAME(15)
      COMMON/BUFFER/IPRE(4),ITRE,B,BX,BB,CAREA,TREH,OP,XROUGH
      COMMON/ANSWER/NRP1,NRP2,NRP3,NRP4,NRP5,NRP6,NRP7,NRP8,IYES,NYES
      CHARACTER * 1 NRP1,NRP2,NRP3,NRP4,NRP5,NRP6,NRP7,NRP8,IYES,NYES
      CHARACTER*9 ASPECT
      CHARACTER*12 SEASON
      CHARACTER*10 TRETYP
      CHARACTER*50 CHOICE
C
C.....THIS SUBROUTINE READS ALL INPUT DATA.
C
C.....INITIALIZE VARIABLES
      DO 1 J=1,4
    1    IPRE(J)=0
      ASP1=0.
      ASP2=0.
      ASP3=0.
      ITRE=0
      B=0.
      BB=0.
      BX=0.
      CAREA=0.
      CSIZE=0.
      TREH=0.
      OP=0.
      XROUGH=0.3
      LC=999
      MC=999
    2 IF(NRP2.EQ.IYES.OR.NRP2.EQ.NYES) GO TO 127
C
C***** BASIN DESCRIPTION ******************************************
**
      WRITE(6,5)
    5 FORMAT(////////////////' ****** BASIN DESCRIPTION ******')
      IF(NRP1.EQ.IYES.OR.NRP1.EQ.NYES) GO TO 102
C
   10 WRITE(6,20)NPROV
```

```
   20 FORMAT(/' ENTER THE HYDROLOGIC REGION...1,4,5 OR 6: ',/,
     *          ' CURRENT ONE IS:',I1)
      READ(5,*,ERR=30)NPROV
   30 N=NPROV
      IF(N.GT.1) N=N-2
      IF(N.LT.1.OR.N.GT.4) GO TO 10
      JSEAS=3
      IF(NPROV.EQ.5)JSEAS=4
C
C.....NAME OF BASIN
      WRITE(6,40)
   40 FORMAT(/,' ENTER THE NAME OF THE BASIN: ')
      READ(5,50) NAME
   50 FORMAT(15A2)
C
C.....WIND SCOUR
      WRITE(6,35)
   35 FORMAT( ' IS WIND SCOUR EXTENSIVE IN THE LARGE OPENINGS?')
      READ(5,131)NRP8
C
C.....AREA OF BASIN
      WRITE(6,55) AREA
   55 FORMAT(/' ENTER THE AREA OF BASIN IN SQ.KM: ',/,
     *        ' CURRENT AREA IS:',F7.2)
      READ(5,*,ERR=57)AREA
C
C.....AREA OF ASPECTS
   57 WRITE(6,60)
   60 FORMAT(' ENTER THE AREA (SQ.KM) OF BASIN EXPOSED NORTH,'
     *       ,' EAST+WEST AND SOUTH',/
     *       ,' EX: 10.3, 4, 5.12',//,' CURRENT AREAS ARE:')
      WRITE(6,62) ASP1,ASP2,ASP3
   62 FORMAT(' ',3F6.2)
      READ(5,*,ERR=63)ASP1,ASP2,ASP3
   63 XASP=ASP1+ASP2+ASP3
      IF(XASP+0.001.GT.AREA.AND.XASP-0.001.LT.AREA) GO TO 70
      WRITE(6,65)AREA
   65 FORMAT(' ***ERROR*** SUM OF ASPECTS IS NOT EQUAL TO BASIN',
     *       ' AREA (',F6.2,'SQ.KM)')
      GO TO 57
   70 ASP(1)=ASP1/AREA
      ASP(2)=ASP2/AREA
      ASP(3)=ASP3/AREA
      DO 100 L=1,3
         IF(ASP(L).LE.0) GO TO 100
         IF(L.EQ.1)ASPECT='NORTH    '
         IF(L.EQ.2)ASPECT='EAST+WEST'
         IF(L.EQ.3)ASPECT='SOUTH    '
C
C.....   FIND NUMBER AND AREA OF UNITS IN EACH ASPECT
   75    WRITE(6,80) ASPECT
         WRITE(6,82) MNUM(L)
   80    FORMAT(/////' ENTER THE NUMBER (MAX.=4) OF UNITS IN ASPECT '
     *          ,9A)
   82    FORMAT(' CURRENT NUMBER IS:',I2)
         READ(5,*,ERR=85)MNUM(L)
C
C.....   IF ONLY ONE UNIT IN THE ASPECT L
   85    IF(MNUM(L).EQ.1) UAREA(L,1)=ASP(L)*AREA
         IF(MNUM(L)-1)75,100,87
C.....   IF MORE THAN ONE UNIT IN ASPECT L
   87    XAREA=0.
         X=AREA*ASP(L)
         WRITE(6,90)MNUM(L),ASPECT
   90    FORMAT(' ENTER AREA (SQ.KM) OF EACH OF THE',I2,' UNITS',
     *          ' IN ASPECT ',9A)
         WRITE(6,91) X
   91    FORMAT(' TOTAL AREA OF ASPECT IS (SQ.KM):',F6.2,/,
     *          ' CURRENT AREAS OF UNITS  ARE:')
         WRITE(6,86) (UAREA(L,M),M=1,MNUM(L))
   86    FORMAT(' ',4F8.2)
         READ(5,*,ERR=92)(UAREA(L,M),M=1,MNUM(L))
   92    XAREA=0.
         DO 95 M=1,MNUM(L)
   95       XAREA=XAREA+UAREA(L,M)
         IF(XAREA.GE.ASP(L)*AREA-0.001.AND.XAREA.LE.ASP(L)*AREA+0.001)
     *      GO TO 100
         X=ASP(L)*AREA
         WRITE(6,97) X
   97    FORMAT(' ***ERROR*** SUM OF UNITS IS NOT EQUAL TO AREA',
     *          ' OF ASPECT (', F5.2,'SQ.KM)')
            GO TO 75
  100 CONTINUE
C
C.....CORRECTIONS?
  102 CALL CHECK(1,1,1)
      WRITE(6,105)
  105 FORMAT(' DO YOU WISH TO MODIFY THE BASIN DESCRIPTION?')
      READ(5,131) NRP7
      IF(NRP7.EQ.IYES.OR.NRP7.EQ.NYES) GO TO 10
  131 FORMAT(A1)
C
C
C
C.....DO FOR ALL ASPECTS
  127 CONTINUE
         IF(NRP3.EQ.IYES.OR.NRP3.EQ.NYES) GO TO 190
C
C
C
C*****   BASIN CLIMATE ****************************************
         WRITE(6,137)
  137    FORMAT(/////////////// ****** BASIN CLIMATE ******')
         IF(NRP1.EQ.IYES.OR.NRP1.EQ.NYES) GO TO 182
C
         WRITE(6,140)
  140    FORMAT(/' ENTER PRECIP BY SEASON IN MM OF WATER')
  145    DO 165 J=1,JSEAS
         IFIRST=(N*10)+J
         IF(IFIRST.EQ.11) SEASON='OCT01-JAN31:'
         IF(IFIRST.EQ.12) SEASON='FEB01-APR30:'
         IF(IFIRST.EQ.13) SEASON='MAY01-SEP30:'
         IF(IFIRST.EQ.21) SEASON='OCT01-FEB28:'
         IF(IFIRST.EQ.22) SEASON='MAR01-JUN30:'
         IF(IFIRST.EQ.23) SEASON='JUL01-SEP30:'
         IF(IFIRST.EQ.31) SEASON='OCT01-DEC29:'
         IF(IFIRST.EQ.32) SEASON='DEC30-MAR28:'
         IF(IFIRST.EQ.33) SEASON='MAR29-JUN26:'
         IF(IFIRST.EQ.34) SEASON='JUN27-SEP30:'
         IF(IFIRST.EQ.41) SEASON='OCT01-FEB28:'
         IF(IFIRST.EQ.42) SEASON='MAR01-JUN30:'
         IF(IFIRST.EQ.43) SEASON='JUL01-SEP30:'
  150    WRITE(6,155) SEASON
  155    FORMAT(' FOR ',12A)
         WRITE(6,160) IPRE(J)
  160    FORMAT(' CURRENT VALUE IS ',I8,'MM')
         READ(5,*,ERR=165)IPRE(J)
C......  CONVERT TO INCHES
  165    PRECP(J)=FLOAT(IPRE(J))/25.4
C
C ...... WIND SPEED
         WRITE(6,167)WSPEED
  167    FORMAT(' ENTER THE AVERAGE WIND SPEED IN METRES/SECOND',/,
     *          ' THE CURRENT VALUE IS:',F5.2)
         READ(5,*,ERR=170) WSPEED
C
C......  DAYS WITH SNOW COVER
  170    IF(WSPEED.LE.0) GO TO 182
         WRITE(6,172)SNODAY
  172    FORMAT(' ENTER THE NUMBER OF DAYS WITH SNOW ON THE',
     *       ' GROUND',/,' THE CURRENT VALUE IS:',F5.0)
         READ(5,*,ERR=182)SNODAY
C
C ...... CORRECTIONS?
  182    CALL CHECK(L,M,2)
  183    WRITE(6,185)
  185    FORMAT(' DO YOU WISH TO MODIFY THE BASIN CLIMATE?')
         READ(5,131,ERR=183) NRP7
         IF(NRP7.EQ.IYES.OR.NRP7.EQ.NYES) GO TO 145
C
C
      DO 600 L=1,3
      IF(LC.NE.999.AND.L.NE.LC) GO TO 600
         IF(ASP(L).LE.0.) GO TO 580
         IF(L.EQ.1) ASPECT='NORTH    '
         IF(L.EQ.2) ASPECT='EAST+WEST'
         IF(L.EQ.3) ASPECT='SOUTH    '
         DO 550 M=1,MNUM(L)
            IF(MC.NE.999.AND.M.NE.MC) GO TO 550
  190       IF(NRP4.EQ.IYES.OR.NRP4.EQ.NYES) GO TO 290
C
C
C
C*****      STAND CHARACTERISTICS ****************************
            WRITE(6,192)M,MNUM(L),ASPECT
  192       FORMAT(///////////////' ****** STAND CHARACTERISTICS ',
     C            '******',/,
     *            ' UNIT',I2,' OF',I2,',   ASPECT: ',9A)
            IF(NRP1.EQ.IYES.OR.NRP1.EQ.NYES) GO TO 275
C
C.....      TREE TYPE
  193       CHOICE='CONIF.(1) OR DECIDUOUS (2):                    '
            IF(N.EQ.1) GO TO 195
            CHOICE='SPRUCE-FIR(3), LODGEPOLE(4) OR PONDEROSA(5):   '
            IF(N.EQ.2) GO TO 195
            CHOICE='HEMLOCK-SPRUCE(6) OR DOUG. FIR(7):             '
            IF(N.EQ.3) GO TO 195
            CHOICE='SPRUCE-FIR(8), WEST. LARCH(9) OR LODGEPOLE(10):  '
  195       WRITE(6,200) CHOICE
  200       FORMAT(/' ENTER TREE TYPE: ',50A)
            WRITE(6,201) ITRE
  201       FORMAT(' CURRENT TYPE IS:',I2)
            READ(5,*,ERR=202) ITRE
  202       ITREE(L,M)=ITRE
            NX=ITREE(L,M)
            IF(N.EQ.1.AND.NX.LE.2) GO TO 225
            IF(N.EQ.2.AND.(NX.GE.3.AND.NX.LE.5)) GO TO 225
            IF(N.EQ.3.AND.(NX.GE.6.AND.NX.LE.7)) GO TO 225
            IF(N.EQ.4.AND.NX.GE.8) GO TO 225
            WRITE(6,205)
  205       FORMAT(' ***ERROR***  TREE TYPE DOES NOT MATCH REGION')
            GO TO 195
C
C.....      BASAL AREA OF STAND
  225       WRITE(6,230)B
  230       FORMAT(/' ENTER STAND BASAL AREA IN SQ.M/HA: ',/,
     *          ' CURRENT ONE IS:',F6.2)
            READ(5,*,ERR=232)B
  232       IF(B.GT.70) WRITE(6,235)
  235       FORMAT(' ***WARNING*** LARGE BASAL AREA...RELATIONSHIPS',
     *          ' WILL BE EXTRAPOLATED')
C
C.....      MAXIMUM BASAL AREA
            WRITE(6,260) BX
  260       FORMAT(/' ENTER MAX BASAL AREA OF MATURE STAND, SQ.M/HA:',
     *          /,' CURRENT ONE IS:',F6.2)
            READ(5,*,ERR=262)BX
  262       IF(BX.GE.B) GO TO 270
            WRITE(6,265)
  265       FORMAT('  ***ERROR*** ACTUAL BASAL AREA EXCEEDS MAXIMUM')
            GO TO 225
  270       BA(1,L,M)=B*4.354
            BAMAX(L,M)=BX*4.354
C
C.....      CORRECTIONS?
  275       CALL CHECK(L,M,3)
```

```
  277       WRITE(6,280)
  280       FORMAT(' DO YOU WISH TO MODIFY THE STAND',
     *             ' CHARACTERISTICS?')
            READ(5,131,ERR=277) NRP7
            IF(NRP7.EQ.IYES.OR.NRP7.EQ.NYES) GO TO 193
  290       IF(NRP5.EQ.IYES.OR.NRP5.EQ.NYES) GO TO 550
C
C
C
C*****      TREATMENT*************************************************
**
            WRITE(6,292)M,MNUM(L),ASPECT
  292       FORMAT(//////////////// ****** TREATMENT ******',/,
     *             ' UNIT',I2,' OF',I2,',   ASPECT: ',9A)
            IF(NRP1.EQ.IYES.OR.NRP1.EQ.NYES) GO TO 525
C
C.....      TOTAL AREA OF CUTS
  295       WRITE(6,300)UAREA(L,M),CAREA
  300       FORMAT(/' ENTER TOTAL AREA OF CUTS IN UNIT (SK.KM):',/,
     *              ' TOTAL AREA IN UNIT IS (SQ.KM):          ',F6.2,/,
     *              ' CURRENT AREA OF CUTS IN UNIT IS (SQ.KM):',F6.2)
            READ(5,*,ERR=302) CAREA
  302       IF(CAREA-UAREA(L,M)) 310,307,303
  303       WRITE(6,305)UAREA(L,M)
  305       FORMAT(' ***ERROR*** AREA OF CUT EXCEEDS AREA OF UNIT (',
     *              F6.2,'SQ.KM)' )
            GO TO 295
  307       WRITE(6,308)
  308       FORMAT(' ***** WARNING:  A 100% CUT MIGHT CAUSE',
     *              ' ARTIFICIAL LOSS OF SNOW.',/,
     *              ' LEAVE A SMALL PORTION UNCUT (0.1% FOR EXAMPLE)'
     *              ' TO AVOID THIS PROBLEM')
  310       IF(CAREA.LE.0.) GO TO 510
C
C.....      BASAL AREA LEFT IN CUTS
            WRITE(6,360) BB
  360       FORMAT(/' ENTER BASAL AREA LEFT IN CUT (SQ M/HA), ',/,
     *              ' CURRENT ONE IS:',F6.2)
            READ(5,*,ERR=370)BB
C
C.....      HEIGHT OF SURROUNDING TREES
  370       WRITE(6,390) TREH
  390       FORMAT(/' ENTER HEIGHT OF SURROUNDING TREES, IN M, ',/,
     *              ' CURRENT ONE IS:',F6.1)
            READ(5,*,ERR=400)TREH
  400       IF(CAREA.GE.UAREA(L,M)) GO TO 340
C
C.....      WINDWARD LENGTH
            WRITE(6,420) OP
  420       FORMAT(/' ENTER WINDWARD LENGTH OF CUTS IN METRES'
     *             ,/,' ENTER 0 IF UNKNOWN, '
     *             ,/,' CURRENT ONE IS:',F6.1)
            READ(5,*,ERR=430)OP
  430       IF(OP.GT.0.) GO TO 445
C
C.....      AVERAGE CUT BLOCK SIZE
  435       WRITE(6,330) CSIZE
  330       FORMAT(/' ENTER AVERAGE SIZE OF CUT BLOCKS, IN HA, ',/,
     *              ' ENTER 0 IF UNKNOWN,',/,
     *              ' CURRENT SIZE IS:',F6.2)
            READ(5,*,ERR=332)CSIZE
  332       IF(CSIZE-AMAX1(.001,AMIN1(CSIZE,CAREA*100)))437,440,333
  333       WRITE(6,335)CAREA
  335       FORMAT(' ***ERROR*** AVERAGE SIZE EXCEEDS TOTAL AREA CUT',
     *              ' (',F6.3,'SQ.KM)')
            GO TO 435
  340       CSIZE=UAREA(L,M)*100.
            GO TO 440
C
C.....      LAST CHANCE FOR ESTIMATING WINDWARD LENGTH OF OPENINGS
  437       WRITE(6,438)
  438       FORMAT(/' YOU MUST ENTER AN APPROXIMATE NUMBER OF CUT',
     *              ' BLOCKS ON THE UNIT')
            READ(5,*,ERR=437)NCUT
            IF(NCUT.LE.0) GO TO 437
            CSIZE=CAREA*100/NCUT
  440       OP=(CSIZE**0.5)*100.
  445       IF(OP/TREH.LT.13) GO TO 510
C
C.....      ROUGHNESS COEFFICIENT
            WRITE(6,500) XROUGH
  500       FORMAT(/' ENTER ROUGHNESS COEFFICIENT',/,
     *              ' CURRENT VALUE IS:',F4.2,'M')
            READ(5,*,ERR=510)XROUGH
C
C
C.....      PERFORM APPROPRIATE TRANSFORMATIONS
  510       OPEN(L,M)=CAREA/UAREA(L,M)
            IF(CAREA.LE.0.) GO TO 525
            BA(2,L,M)=BB*10.76/2.471
            TREEH(L,M)=TREH*3.28
            OPLGTH(L,M)=OP/TREH
            ROUGH(L,M)=XROUGH*3.28
C
C.....      CORRECTIONS?
  525       CALL CHECK(L,M,4)
  530       WRITE(6,526)
  526       FORMAT(' DO YOU WISH TO MODIFY THE TREATMENT ',
     *              ' DESCRIPTION?')
            READ(5,131,ERR=530)NRP7
            IF(NRP7.EQ.IYES.OR.NRP7.EQ.NYES) GO TO 295
  550     CONTINUE
C
C
C.....    INITIALIZE VALUES AT 0.
  580     DO 590 J=1,JSEAS
            DO 590 M=1,4
              DO 590 K=1,2
                ET(J,K,L,M)=0.
                ADJPRE(J,K,L,M)=0.
  590           FLO4(J,K,L,M)=0.
  600 CONTINUE
C
C
C
C
C*****CORRECTIONS? ***************************************************
****
  605 NRP1='Y'
      NRP2='Y'
      NRP3='Y'
      NRP4='Y'
      NRP5='Y'
      LC=999
      MC=999
  607 WRITE(6,610)
  610 FORMAT(//////////,' DO YOU WANT TO MAKE ANY FURTHER ',
     *       ' CORRECTIONS?',/,
     *       ' ENTER THE PROPER NUMBER TO:',/,
     *       '     CHECK BASIN DESCRIPTION      (1)',/,
     *       '     CHECK BASIN CLIMATE          (2)',/,
     *       '     CHECK STAND CHARACTERISTICS (3)',/,
     *       '     CHECK TREATMENT DESCRIPTION (4)',/,
     *       '     CONTINUE                     (5)',/,
     *       '     STOP EXECUTION               (6)')
      READ(5,*,ERR=607)LL
      GO TO (620,625,630,635,690,700)LL
  620 NRP2='N'
      GO TO 675
  625 NRP3='N'
      GO TO 675
  630 NRP4='N'
      GO TO 640
  635 NRP5='N'
  640 WRITE(6,645)
  645 FORMAT(' WHICH ASPECT?   NORTH     (1)',/,
     *       '                 EAST+WEST (2)',/,
     *       '                 SOUTH     (3)')
      READ(5,*,ERR=640)LC
      IF(MNUM(LC)-1)650,2,660
  650 WRITE(6,655)
  655 FORMAT(' NO UNIT ON THIS ASPECT...UNITS CAN BE ADDED BY',
     *       ' CORRECTING THE BASIN DESCRIPTION')
      GO TO 605
  660 WRITE(6,665)
  665 FORMAT(' WHICH UNIT? ')
      READ(5,*,ERR=660)MC
      IF(MC.LE.MNUM(LC)) GO TO 675
      WRITE(6,670)MNUM(LC)
  670 FORMAT(' THERE ARE ONLY',I2,' UNITS ON THIS ASPECT,',/,
     *       ' UNITS CAN BE ADDED BY CORRECTING THE BASIN DESCRIPTION')
      GO TO 605
  675 GO TO 2
  690 CONTINUE
      RETURN
  700 WRITE(6,710)
  710 FORMAT(' ARE YOU SURE?')
      READ(5,131)NRP1
      IF(NRP1.NE.IYES.AND.NRP1.NE.NYES) GO TO 605
      STOP
      END
C
C
C
C
      SUBROUTINE CHECK(L,M,LL)
      COMMON/INPUT/NPROV,N,AREA,MNUM(3),ASP(3),PRECP(4),ITREE(3,4),
     *             TREEH(3,4),BA(2,3,4),BAMAX(3,4),UAREA(3,4),WSPEED,
     *             ROUGH(3,4),JSEAS,OPEN(3,4),OPLGTH(3,4),SNODAY
      COMMON/BUFFER/IPRE(4),ITRE,B,BX,BB,CAREA,TREH,OP,XROUGH
      COMMON/TITLE/NAME(15)
      COMMON/ANSWER/NRP1,NRP2,NRP3,NRP4,NRP5,NRP6,NRP7,NRP8,IYES,NYES
      CHARACTER * 1 NRP1,NRP2,NRP3,NRP4,NRP5,NRP6,NRP7,NRP8,IYES,NYES
      CHARACTER*9 ASPECT
      CHARACTER*10 TRETYP
C.....THIS SUBROUTINE PRINTS A SUMMARY OF INPUTS TO SCREEN
      IF(L.EQ.1) ASPECT='NORTH    '
      IF(L.EQ.2) ASPECT='EAST+WEST'
      IF(L.EQ.3) ASPECT='SOUTH    '
      GO TO (5,15,20,25)LL
C
    5 ASP1=ASP(1)*AREA
      ASP2=ASP(2)*AREA
      ASP3=ASP(3)*AREA
      WRITE(6,800)NPROV
  800 FORMAT(///' HYDROLOGIC REGION # ',I2)
      WRITE(6,810) NAME
  810 FORMAT(' NAME OF BASIN: ',15A2)
      WRITE(6,815)NRP8
  815 FORMAT(' WIND SCOUR OF SNOW EXTENSIVE IN AREA?   ',A1)
      WRITE(6,820)AREA
  820 FORMAT(' AREA OF BASIN (SQ.KM)= ',F6.2)
      WRITE(6,830) ASP1,ASP2,ASP3
  830 FORMAT(' AREA (SQ.KM) IN N, E+W AND SOUTH ASPECTS: ',3F6.2)
      DO 10 LZ=1,3
         IF(ASP(LZ).LE.0.) GO TO 10
         IF(LZ.EQ.1) ASPECT='NORTH    '
         IF(LZ.EQ.2) ASPECT='EAST+WEST'
         IF(LZ.EQ.3) ASPECT='SOUTH    '
         WRITE(6,831)ASPECT
  831    FORMAT(/' AREA (SQ.KM) OF UNIT(S) IN ASPECT ',9A)
         WRITE(6,832)UAREA(LZ,1),UAREA(LZ,2),UAREA(LZ,3),UAREA(LZ,4)
  832    FORMAT(2X,4F10.2)
   10    CONTINUE
      RETURN
C
```

```
   15 DO 17 J=1,JSEAS
   17    IPRE(J)=0.5+PRECP(J)*25.4
      WRITE(6,833)JSEAS
  833 FORMAT(///,' PRECIPITATION FOR THE',I2,' SEASONS (MM):')
      WRITE(6,834)(IPRE(J),J=1,JSEAS)
  834 FORMAT(2X,4I8)
      WRITE(6,835) WSPEED
  835 FORMAT(' WINDSPEED (M/SEC)=',F5.0)
      IF(WSPEED.GT.0.)WRITE(6,836)SNODAY
  836 FORMAT(' NUMBER OF DAYS WITH CONTINUOUS SNOW COVER=',F5.0)
      RETURN
C
   20 B=BA(1,L,M)/4.354
      BX=BAMAX(L,M)/4.354
      ITRE=ITREE(L,M)
      WRITE(6,837)M,MNUM(L),ASPECT
  837 FORMAT(///,' FOR UNIT ',I1,' OF ',I1,',   ASPECT: ',9A)
      IF(ITREE(L,M).EQ.1) TRETYP='CONIFEROUS'
      IF(ITREE(L,M).EQ.2) TRETYP='DECIDUOUS '
      IF(ITREE(L,M).EQ.3) TRETYP='SPRUCE-FIR'
      IF(ITREE(L,M).EQ.4) TRETYP='LODGEPOLE '
      IF(ITREE(L,M).EQ.5) TRETYP='PONDEROSA '
      IF(ITREE(L,M).EQ.6) TRETYP='HEM-SPRUCE'
      IF(ITREE(L,M).EQ.7) TRETYP='DOUG.FIR  '
      IF(ITREE(L,M).EQ.8) TRETYP='SPRUCE-FIR'
      IF(ITREE(L,M).EQ.9) TRETYP='WEST.LARCH'
      IF(ITREE(L,M).EQ.10)TRETYP='LODGEPOLE '
      WRITE(6,850)TRETYP
  850 FORMAT(' TREE TYPE:          ',10A)
      WRITE(6,855)B
  855 FORMAT(' BASAL AREA OF STAND:',F6.2,' SQ.M/HA')
      WRITE(6,860)BX
  860 FORMAT(' MAXIMAL  BASAL AREA:',F6.2,' SQ.M/HA')
      RETURN
C
C
   25 CAREA=OPEN(L,M)*UAREA(L,M)
      IF(CAREA.LE.0.) GO TO 27
      BB=BA(2,L,M)/4.354
      TREH=TREEH(L,M)/3.28
      OP=OPLGTH(L,M)*TREH
      XROUGH=ROUGH(L,M)/3.28
C
   27 WRITE(6,865)M,MNUM(L),ASPECT
  865 FORMAT(///' FOR UNIT',I2,' OF',I2,',   ASPECT: ',9A)
      WRITE(6,870) CAREA
  870 FORMAT(' TOTAL AREA OF CUTS: ',F6.2,'SQ.KM')
      IF(CAREA.LE.0.) GO TO 30
      WRITE(6,875)BB
  875 FORMAT(' BASAL AREA IN CUTS:  ',F6.2,' SQ.M/HA')
      WRITE(6,880)TREH
  880 FORMAT(' HEIGHT OF TREES:     ',F6.2,' M')
      WRITE(6,885)OP
  885 FORMAT(' WINDWARD LENGTH OF CUTS:'F6.1,' M')
      IF(OPLGTH(L,M).LT.15) GO TO 30
      WRITE(6,890)XROUGH
  890 FORMAT(' ROUGHNESS COEFFICIENT:',F7.1,' M')
   30 RETURN
      END
C
C
C
C
      SUBROUTINE QUEST3
      COMMON/INPUT/NPROV,N,AREA,MNUM(3),ASP(3),PRECP(4),ITREE(3,4),
     *             TREEH(3,4),BA(2,3,4),BAMAX(3,4),UAREA(3,4),WSPEED,
     *             ROUGH(3,4),JSEAS,OPEN(3,4),OPLGTH(3,4),SNODAY
      COMMON/ANSWER/NRP1,NRP2,NRP3,NRP4,NRP5,NRP6,NRP7,NRP8,IYES,NYES
      CHARACTER * 1 NRP1,NRP2,NRP3,NRP4,NRP5,NRP6,NRP7,NRP8,IYES,NYES
C.....THIS SUBROUTINE ASKS THE USER WHETHER HE WANTS TO CONTINUE
C.....USING THE PROGRAM OR NOT.
   50 WRITE(6,100)
  100 FORMAT(' DO YOU WISH TO USE THE PROGRAM AGAIN?  ')
      READ(5,300,ERR=50)NRP1
  300 FORMAT(A1)
      IF(NRP1.EQ.IYES.OR.NRP1.EQ.NYES) GO TO 105
      WRITE(6,102)
  102 FORMAT(' ARE YOU SURE?')
      READ(5,300,ERR=50)NRP1
      IF(NRP1.NE.IYES.AND.NRP1.NE.NYES) GO TO 105
      IF(NRP6.NE.IYES.AND.NRP6.NE.NYES) GO TO 104
  104 STOP
C
  105 WRITE(6,110)
  110 FORMAT(' SAME BASIN?  ')
      READ(5,300,ERR=105)NRP2
      IF(NRP2.EQ.IYES.OR.NRP2.EQ.NYES) GO TO 115
      NRP1='N'
      NRP3='N'
      NRP4='N'
      NRP5='N'
      RETURN
C
  115 NRP1='Y'
      WRITE(6,120)
  120 FORMAT(' SAME BASIN CLIMATE? ')
      READ(5,300,ERR=115) NRP3
C
  125 WRITE(6,130)
  130 FORMAT(' SAME STAND CHARACTERISTICS?  ')
      READ(5,300,ERR=125)NRP4
C
  135 WRITE(6,140)
  140 FORMAT(' SAME TREATMENT?  ')
      READ(5,300,ERR=135)NRP5
C
      RETURN
      END
C
C
C
C
      SUBROUTINE OUT1
      COMMON/INPUT/NPROV,N,AREA,MNUM(3),ASP(3),PRECP(4),ITREE(3,4),
     *             TREEH(3,4),BA(2,3,4),BAMAX(3,4),UAREA(3,4),WSPEED,
     *             ROUGH(3,4),JSEAS,OPEN(3,4),OPLGTH(3,4),SNODAY
      COMMON/TITLE/NAME(15)
      COMMON/ANSWER/NRP1,NRP2,NRP3,NRP4,NRP5,NRP6,NRP7,NRP8,IYES,NYES
      CHARACTER * 1 NRP1,NRP2,NRP3,NRP4,NRP5,NRP6,NRP7,NRP8,IYES,NYES
      CHARACTER*9 ASPECT
      CHARACTER*12 SEASON
      CHARACTER*10 TRETYP
      CHARACTER*50 CHOICE
      DIMENSION IPR(4)
C.....THIS SUBROUTINE ECHOES THE INPUTS TO AN OUTPUT FILE SELECTED IN
C.....SUBROUTINE QUEST1
C
      ASP1=AREA*ASP(1)
      ASP2=AREA*ASP(2)
      ASP3=AREA*ASP(3)
C
      WRITE(8,810) NAME
  810 FORMAT(' NAME OF BASIN: ',15A2)
      WRITE(8,800)NPROV
  800 FORMAT(' HYDROLOGIC REGION # ',I2)
      IF(NRP8.EQ.IYES.OR.NRP8.EQ.NYES) WRITE(8,805)
      IF(NRP8.NE.IYES.AND.NRP8.NE.NYES) WRITE(8,807)
  805 FORMAT(' WIND SCOURING:  EXTENSIVE')
  807 FORMAT(' WIND SCOURING:  NOT EXTENSIVE')
      WRITE(8,820)AREA
  820 FORMAT(' AREA OF BASIN (SQ.KM)= ',F6.2)
      WRITE(8,830) ASP1,ASP2,ASP3
  830 FORMAT(' AREA IN N, E+W AND SOUTH ASPECTS: ',3F6.2)
      DO 10 J=1,JSEAS
         IPR(J)=(PRECP(J)*25.4)+0.5
         IFIRST=(N*10)+J
         IF(IFIRST.EQ.11) SEASON='OCT01-JAN31:'
         IF(IFIRST.EQ.12) SEASON='FEB01-APR30:'
         IF(IFIRST.EQ.13) SEASON='MAY01-SEP30:'
         IF(IFIRST.EQ.21) SEASON='OCT01-FEB28:'
         IF(IFIRST.EQ.22) SEASON='MAR01-JUN30:'
         IF(IFIRST.EQ.23) SEASON='JUL01-SEP30:'
         IF(IFIRST.EQ.31) SEASON='OCT01-DEC29:'
         IF(IFIRST.EQ.32) SEASON='DEC30-MAR28:'
         IF(IFIRST.EQ.33) SEASON='MAR29-JUN26:'
         IF(IFIRST.EQ.34) SEASON='JUN27-SEP30:'
         IF(IFIRST.EQ.41) SEASON='OCT01-FEB28:'
         IF(IFIRST.EQ.42) SEASON='MAR01-JUN30:'
         IF(IFIRST.EQ.43) SEASON='JUL01-SEP30:'
         WRITE(8,832) SEASON,IPR(J)
  832    FORMAT(' PRECIP (MM) FOR ',A12,I6)
   10 CONTINUE
      WRITE(8,833) WSPEED
  833 FORMAT(' WINDSPEED (M/SEC):',F5.2)
      IF(WSPEED.GT.0.0) WRITE(8,834)SNODAY
  834 FORMAT(' NUMBER OF DAYS WITH CONTINUOUS SNOW COVER:',F5.0)
      DO 50 L=1,3
         IF(L.EQ.1) ASPECT='NORTH    '
         IF(L.EQ.2) ASPECT='EAST+WEST'
         IF(L.EQ.3) ASPECT='SOUTH    '
         IF(ASP(L).LE.0.) GO TO 50
         DO 40 M=1,MNUM(L)
            WRITE(8,835)M,MNUM(L),ASPECT
  835       FORMAT(///,' INPUTS FOR UNIT',I2,' OF',I2,', ASPECT:',9A)
            WRITE(8,840)UAREA(L,M)
  840       FORMAT(' AREA OF UNIT:            ',F6.2,'SQ.KM')
            IF(ITREE(L,M).EQ.1) TRETYP='CONIFEROUS'
            IF(ITREE(L,M).EQ.2) TRETYP='DECIDUOUS '
            IF(ITREE(L,M).EQ.3) TRETYP='SPRUCE-FIR'
            IF(ITREE(L,M).EQ.4) TRETYP='LODGEPOLE '
            IF(ITREE(L,M).EQ.5) TRETYP='PONDEROSA '
            IF(ITREE(L,M).EQ.6) TRETYP='HEM-SPRUCE'
            IF(ITREE(L,M).EQ.7) TRETYP='DOUG.FIR  '
            IF(ITREE(L,M).EQ.8) TRETYP='SPRUCE-FIR'
            IF(ITREE(L,M).EQ.9) TRETYP='WEST.LARCH'
            IF(ITREE(L,M).EQ.10)TRETYP='LODGEPOLE '
            WRITE(8,850)TRETYP
  850       FORMAT(' TREE TYPE:                  ',10A)
            B=BA(1,L,M)/4.354
            WRITE(8,855)B
  855       FORMAT(' BASAL AREA OF STAND:     ',F6.2,' SQ.M/HA')
            BX=BAMAX(L,M)/4.354
            WRITE(8,860)BX
  860       FORMAT(' MAXIMAL  BASAL AREA:     ',F6.2,' SQ.M/HA')
            CAREA=UAREA(L,M)*OPEN(L,M)
            WRITE(8,865)CAREA
  865       FORMAT(' TOTAL AREA OF CUTS:      ',F6.2,' SQ.KM')
            IF(CAREA.LE.0.) GO TO 40
            BB=(BA(2,L,M)/4.354)+0.0001
            WRITE(8,875)BB
  875       FORMAT(' BASAL AREA IN CUTS:      ',F6.2,' SQ.M/HA')
            TREH=TREEH(L,M)/3.28
            WRITE(8,880)TREH
  880       FORMAT(' HEIGHT OF TREES:         ',F6.2,' M')
            OP=OPLGTH(L,M)*TREH
            WRITE(8,885)OP
  885       FORMAT(' WINDWARD LENGTH OF CUTS: ',F6.2,' M')
            IF(OPLGTH(L,M).LT.15) GO TO 40
            XROUGH=ROUGH(L,M)/3.28
            WRITE(8,890)XROUGH
  890       FORMAT(' ROUGHNESS COEFFICIENT:     ',F4.2,' M')
   40    CONTINUE
   50 CONTINUE
      END
C
C
```

```
C
C
      SUBROUTINE OUT2
      COMMON/INPUT/NPROV,N,AREA,MNUM(3),ASP(3),PRECP(4),ITREE(3,4),
     *             TREEH(3,4),BA(2,3,4),BAMAX(3,4),UAREA(3,4),WSPEED,
     *             ROUGH(3,4),JSEAS,OPEN(3,4),OPLGTH(3,4),SNODAY
      COMMON/CORE/CDMAX,CD(2),ETMC(4,2,3,4),ADJPRE(4,2,3,4),ET(4,2,3,4)
     *            ,FLO4(4,2,3,4)
      COMMON/TITLE/NAME(15)
      COMMON/ANSWER/NRP1,NRP2,NRP3,NRP4,NRP5,NRP6,NRP7,NRP8,IYES,NYES
      CHARACTER * 1 NRP1,NRP2,NRP3,NRP4,NRP5,NRP6,NRP7,NRP8,IYES,NYES
      CHARACTER * 12 SEASON
      CHARACTER * 9 ASPECT
C
C.....THIS SUBROUTINE PRINTS ALL RESULTS OF THE CALCULATIONS
C.....FIRST, CONVERT TO METRIC
      DO 100 J=1,JSEAS
         DO 100 K=1,2
            DO 100 L=1,3
               DO 100 M=1,MNUM(L)
                  ADJPRE(J,K,L,M)=ADJPRE(J,K,L,M)*25.4
                  ET(J,K,L,M)=ET(J,K,L,M)*25.4
  100             FLO4(J,K,L,M)=FLO4(J,K,L,M)*25.4
C.....PRINT, IF DESIRED, RESULTS FROM INDIVIDUAL UNITS TO OUTPUT FILE
      IF(NRP6.NE.IYES.AND.NRP6.NE.NYES) GO TO 210
      WRITE(8,105)
  105 FORMAT(///,'***** OUTPUT FOR EACH UNIT')
      DO 200 L=1,3
         IF(ASP(L).LE.0.) GO TO 200
         IF(L.EQ.1) ASPECT='NORTH    '
         IF(L.EQ.2) ASPECT='EAST+WEST'
         IF(L.EQ.3) ASPECT='SOUTH    '
         DO 190 M=1,MNUM(L)
            WRITE(8,110)M,ASPECT
  110       FORMAT(//,' UNIT',I2,' OF ASPECT ',9A)
            WRITE(8,120)
  120       FORMAT(' SEASON     PRECIP(MM)        ET(MM) ',
     *            '        FLOW(MM)',/,'          FOREST  OPEN    ',
     *            '  FOREST  OPEN     FOREST OPEN')
            DO 190 J=1,JSEAS
               WRITE(8,130)J,(ADJPRE(J,K,L,M),K=1,2),(ET(J,K,L,M),
     *                     K=1,2),(FLO4(J,K,L,M),K=1,2)
  130          FORMAT('    ',I2,5X,F5.0,F6.0,6X,F5.0,F6.0,5X,F5.0,F6.0)
  190    CONTINUE
  200 CONTINUE
      WRITE(8,205)
  205 FORMAT(////,'*****  OUTPUT FOR THE WHOLE BASIN')
C.....COMPUTE INTERMEDIATE VALUES AND TOTAL FLOW
  210 FLO=0.
      DO 5 J=1,JSEAS
         DO 5 L=1,3
            DO 5 K=1,2
               W=0.
               X=0.
               Y=0.
               Z=0.
               DO 5 M=1,MNUM(L)
                  IF(K.EQ.1)V=UAREA(L,M)*(1.-OPEN(L,M))
                  IF(K.EQ.2)V=UAREA(L,M)*OPEN(L,M)
                  FLO=FLO+FLO4(J,K,L,M)*V
                  W=W+V
                  X=X+ET(J,K,L,M)*V
                  Y=Y+FLO4(J,K,L,M)*V
                  Z=Z+ADJPRE(J,K,L,M)*V
                  IF(M.NE.MNUM(L)) GO TO 5
                  ET(J,K,L,1)=0.
                  FLO4(J,K,L,1)=0.
                  ADJPRE(J,K,L,1)=0.
               IF(W.LE.0.) GO TO 5
               ET(J,K,L,1)=X/W
               FLO4(J,K,L,1)=Y/W
               ADJPRE(J,K,L,1)=Z/W
    5 CONTINUE
      FLO=FLO/AREA
C.....IN CUBIC DECAMETRES TOTAL FLOW IS:
      CUDAM=FLO*AREA
C
C.....NOW, PRINT:
      DO 60 J=1,JSEAS
            IFIRST=(N*10)+J
            IF(IFIRST.EQ.11) SEASON='OCT01-JAN31 '
            IF(IFIRST.EQ.12) SEASON='FEB01-APR30 '
            IF(IFIRST.EQ.13) SEASON='MAY01-SEP30 '
            IF(IFIRST.EQ.21) SEASON='OCT01-FEB28 '
            IF(IFIRST.EQ.22) SEASON='MAR01-JUN30 '
            IF(IFIRST.EQ.23) SEASON='JUL01-SEP30 '
            IF(IFIRST.EQ.31) SEASON='OCT01-DEC29 '
            IF(IFIRST.EQ.32) SEASON='DEC30-MAR28 '
            IF(IFIRST.EQ.33) SEASON='MAR29-JUN26 '
            IF(IFIRST.EQ.34) SEASON='JUN27-SEP30 '
            IF(IFIRST.EQ.41) SEASON='OCT01-FEB28 '
            IF(IFIRST.EQ.42) SEASON='MAR01-JUN30 '
            IF(IFIRST.EQ.43) SEASON='JUL01-SEP30 '
         WRITE(6,10) SEASON
         WRITE(6,20)
         WRITE(6,30)((ADJPRE(J,K,L,1),K=1,2),L=1,3)
         WRITE(6,40)((ET(J,K,L,1),K=1,2),L=1,3)
         WRITE(6,50)((FLO4(J,K,L,1),K=1,2),L=1,3)
C.....   PRINT TO OUTPUT FILE
         IF(NRP6.NE.IYES.AND.NRP6.NE.NYES) GO TO 15
         WRITE(8,10) SEASON
         WRITE(8,20)
         WRITE(8,30)((ADJPRE(J,K,L,1),K=1,2),L=1,3)
         WRITE(8,40)((ET(J,K,L,1),K=1,2),L=1,3)
         WRITE(8,50)((FLO4(J,K,L,1),K=1,2),L=1,3)
   15    CONTINUE
   10    FORMAT(/,' SEASON:',12A)
   20    FORMAT('       *......NORTH......*....EAST+WEST....*',
     *'......SOUTH.....*',/,
     *'          FOREST     OPEN   FOREST     OPEN   FOREST',
     *'     OPEN')
   30    FORMAT(' PRECIP(MM)',F5.0,5F9.0)
   40    FORMAT(' ET(MM)    ',F5.0,5F9.0)
   50    FORMAT(' FLOW(MM)  ',F5.0,5F9.0)
   60    CONTINUE
C
      WRITE(6,70)FLO,CUDAM
      IF(NRP6.NE.IYES.AND.NRP6.NE.NYES) GO TO 90
      WRITE(8,70 )FLO,CUDAM
      WRITE(8,80)
   70 FORMAT(/' YEARLY FLOW IN MM: ',F6.0,'   ****IN CU.DAM=',F8.1)
   80 FORMAT(//,'*************************************',/////)
   90 RETURN
      END
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