

STANDARD OPERATING PROCEDURE
TITLE: Initial Determination of Tree
Characteristics and Repeated Measurement
of Branch and Whorl Variables

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- 1.0 **General Discussion**
- 1.1 **Purpose of Procedure**

Evaluation of the crown and bole condition of each tree includes whole crown evaluations, evaluation of branch variables, and evaluation of whorl variables. These evaluations are performed by visual estimates of the entire crown, and evaluations of branch and whorl variables on branches pruned from the tree.
- 1.2 **Measurement Principle**

The main measurement method is visual estimation. Direct measurements are made to determine tree height.
- 1.3 **Measurement Interferences and Their Minimization**

See Section 6.0
- 1.4 **Ranges and Typical Values of Measurement Obtained by this Procedure**

See Section 4.1
- 1.5 **Typical Quantifiable Limits, Precision, and Accuracy**

See Section 6.0
- 1.6 **Responsibilities of Personnel**

Paul Miller, Susan Schilling, David Jones and Anthony Gomez are trained as a team to do field data acquisition and data processing.
- 1.7 **Definitions**

See Section 2.3
- 1.8 **Related Procedures**
- 2.0 **Apparatus, Instrumentation, Reagents and Forms**
- 2.1 **Apparatus and Instrumentation**
 - 1. Measuring tapes
 - 2. tree height finder or inclinometer
 - 3. pole pruner
- 2.2 **Reagents**

None required.
- 2.3 **Forms**

Tree and whorl data may be collected on data sheets or entered into a field data recorder (FDR) using software available from the data archiving group. The next step is to merge the data into the overall database and calculate the OII (Ozone Injury Index). If the data were collected in a FDR, following the directions in the FDR manual (Appendix SOP for Plot Location and Tree Selection) the data were downloaded to a PC and any errors edited. The electronic files were then copied to a floppy diskette.

If the data were on data sheets (except site data Figure 1) the data were entered on a PC using software available from Project 4451, Riverside Fire Lab. After proofreading, copies of the electronic data files as well as the original data sheets are archived. Site data does not need to be entered on the PC but copies of the site data sheets and maps are included with the

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electronic copies of the tree and whorl data. These data are proofread, reformatted and entered into the database.

Database description

The relational database is made up of several files related by a key field for each site. The key field is an ID composed of an abbreviation of the site name, the plot number and the tree tag number. Every site has one "plot" file containing one record for each tree tagged. Other fields in the plot file contain data such as whether the tree is alive now and other information that will not change such as elevation. There is one "tree" file for each year data is collected. A tree file has one record for each live tree in the plot and contains data relating to crown and bole condition. There is one "whorl" file for each year data is collected. The whorl file contains all the data collected from the whorls and has one record for each whorl. A yearly OII index file is created from data in the tree and whorl files by the dBase program, Index.prg, and contains the calculated OII for each live tree. A complete listing of the variables included in the FOREST relational database is as follows:

Plot	Tree	Whorl	Index
ID	ID	ID	ID
Forest	Date	Branch#	OII
Site	Position	Whorl#	VI
Plot #	Species	Chlor. Mottle	RET
Tag	DBH	Retention	LGT
Crew	Ht.	Ndl. length	CD
Aspect	% Live Crown	Biotic Inj.	Avg fol.len.
Slope	LC Ratio	Abiotic Inj.	Height
Elevation	Rock	Comment	DBH
Landform	Mistletoe		Ndl. Len avg.
Slope Pos.	Conk		
Community	Bark Beetle		
Year	Fire Scar		
Alive	Lightning Scar		
Year dead	Broom		
	Microrelief		
	Bole comment		
	Fol. len. branch 1		
	Fol. len. branch 2		
	Fol. len. branch 3		
	Fol. len. branch 4		
	Fol. len. branch 5		

3.0 **Calibration Standards**

See Section 6.0

4.0 **Procedures**

4.1 **General Flow Diagram**

The data variables shown in Section 2.3 are collected either at the plot establishment phase or annually. Plot data is collected only at the beginning of the project. Tree data and whorl data are obtained annually and the ozone injury index (OII) and constituent variables are calculated annually. Whole tree and crown evaluations may be recorded on a data sheet (Figure 2) or in the FDR and consist of:

- percent bare rock (observe to nearest 10%, within a radius of 20X dbh of each tree)
- species (Jeffrey or ponderosa)
- crown position (open-grown, dominant, codominant, intermediate, or overtopped) (Figure 7)
- tree height (Figure 14)
- dbh (Figure 8)
- percent live crown (Figure 15)
- mistletoe (Figure 16)

Each of the following bole injury observations should be recorded as 0=none, 1=slight or <25%, 2=moderate or > 25%:

- conks
- beetles
- witches brooms
- Fire scars
- Mechanical injury
- Lightning scars

If there is any other observation of the condition of the bole you feel is important (leaning, split, dead top), record it on the data sheet or in the bole comment field in the FDR.

Branch and whorl level data:

On each tree randomly prune 5 terminal side branchlets (smallest side branch with a full complement of needle whorls for a given tree) from five major branches (attached to the bole) from mid or upper-portion of the lower crown. Prune branches only from trees where repeated annual branch extractions are possible. Do not use branches with dead terminal buds or other defects.

On each branch measure:

- length of foliage (base node of last whorl to node previous

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to current year needles). If current year needles are missing, measure length of foliage from base node of last whorl of needles to base node of second-oldest whorl (Figure 17)

- number of whorls of needles. A whorl must have > 25% of fascicles retained to be considered a whorl. If the current year or any year other than the oldest whorl (with > 25% fascicle retention) is missing, count the missing whorl(s) as part of whorl retention (Figure 17)

On each whorl of each of the 5 branches record on the data sheet (Figure 2) or in the FDR:

- severity of ozone injury on foliage, chlorotic mottle, is scored as the percentage of foliar discoloration in six injury classes.

- 0 = 0% chlorotic mottle (CM)
- 1 = 1-6%
- 2 = 7-25%
- 3 = 26-50%
- 4 = 51-75%
- 5 = > 75%

- percent retention of fascicles in each whorl

- 1 = 1-33%
- 2 = 34-66%
- 3 = > 67%

- common needle length in each whorl (common needle length is measured in centimeters by inserting a ruler into the center of the whorl and obtaining representative needle length for the whorl. Be certain needle tips have not been removed by chewing insects)

- nearest 0.5 cm

- biotic injury on foliage (CI=chewing injury; SI = sucking injury; FI = fungal injury; OTH = other injury - note in comments)

- 0 = 0%
- 1 = 1-25%
- 2 = > 25%

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- abiotic injury on foliage (WF = winter fleck; OTH = other)
 - 0 = 0%
 - 1 = 1-25%
 - 2 = > 25%

4.2 Start up

Not Applicable

4.3 Routine Operations

It is essential that estimates of chlorotic mottle be made in direct sunlight in order to differentiate color. On cloudy days it is best to stop. Also, early morning light and evening light is insufficient.

4.3.1 Procedural Tips:

Prune all branches from 10-15 trees and set them at the base of each tree. The ideal crew size includes a pruner, certified data reader and data recorder.

Use ball point pen to write the number of each branch on the cut surface or if resin is too heavy slice off a 1-2 cm strip of bark with one stroke of a knife blade and write the branch number (1 to 5) on the newly cut surface. This numbering is needed for those branches which will be randomly selected (2 branches from 5 trees in each plot) and submitted for quality assurance determinations.

For reference bring a copy of the "cheat sheet" (Figure 18).

The certified data reader will make all measurements on branches, usually starting with the current year whorl of each branch. It is usually faster to read all variables (mottle, fascicle retention, needle length, biotic and abiotic injuries for one whorl at a time.

4.3.2 Safety

The primary safety concerns are those typical of work in the lower elevations of western mountains (climate, topography, flora, fauna). In addition, the use of pole-pruner can be hazardous under adverse conditions of slope, inclement weather (lightning), and fatigue.

A Job hazard analysis has been prepared to cover possible problems. Most center around the use of the telescoping pole pruner and some obvious points include: Do not raise the pole pruner when near power lines. Do not work and stay away from the pole pruner if there is lightning within 2 miles.

Be aware that back injuries could result from hoisting the pole pruner from ground to vertical when fully extended. It is better to lean it against a tree branch or crown and extend it section by section. In this process it is possible that one

section could collapse unexpectedly if the ferrule is not completely locked. In that event fingers or other parts of the hand could receive a very nasty bruise. Leather work gloves are very helpful.

Wear a hard hat because dead branch stubs, cones or the pruned branches themselves are constantly raining down. Safety glasses are also advised to prevent direct injury from a weighty falling object and also to protect eyes from the accumulation of fine debris that is dislodged from bark and needles.

Steep slopes are more hazardous because the pruner's attention is less focused on immediate surroundings while trying to get positioned to prune a branch.

Be alert to poison oak and rattlesnakes.

Try to avoid working alone and in any case carry a HT radio or cellular phone so that assistance could be requested.

4.4

Shut down

Not Applicable

5.0

Quantification

The index calculated as a measure of chronic ozone injury is a modified version of the additive Eridanus Injury Index -EII proposed by Duriscoe (1987). The index is based on four main effects that ozone air pollution is known to have on pines:

1. production of chlorotic mottle symptoms that reduces photosynthesis;
2. accelerated senescence of needles and subsequent reduced whorl retention from ozone stress which also reduces the amount of carbon fixation;
3. reduced percent live crown as lower branches die first in ozone declining trees;
4. reduced needle length in newly initiated needles as carbon reserves become limiting (Miller et al., 1963).

Whorl retention is weighted 40 out of 100; mottle is weighted 40 out of 100; needle length is weighted 10 out of 100; and live crown ratio is rated 10 out of 100. Thus the injury index reflects the degree of pollution injury at the branch level and then is averaged over multiple branches to give a tree level score. The maximum injury score is a 100 and indicates a tree that has only one whorl of needles remaining, greater than 40% chlorotic mottle injury on that whorl, very short needles (1

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centimeter or less), and a percent live crown of less than 10%. The minimum index score is zero and indicates a tree with no chlorotic mottle symptoms on any of the foliage (an asymptomatic tree). The index also operates on the assumption that if no chlorotic mottle is present on any needles, i.e. if the chlorotic mottle factor is zero, then reductions in whorl retention, live crown ratio, and needle length cannot be attributed to ozone air pollution.

The index weights whorl retention (40%) and chlorotic mottle (40%) greater than the other index components, percent live crown (10%), avg needle length (10%) and is therefore not strictly monotonic (Muir and McCune, 1988). The increased emphasis on whorl retention and mottle is based on physiological studies by Patterson (1989). Patterson's work also indicates that all whorls are significant contributors of fixed carbon. Therefore, we believe that the index does fulfill the requirements elucidated by McCune and Muir (1988) for assessing pollution injury on vascular plants. Specifically, if an index is not strictly monotonic there should be a valid reason for increased emphasis on any one factor.

The following discussion elucidates some of the most important caveats of the Ozone Injury Index (OII):

1) Chlorotic mottle: has a relatively linear effect in reducing net photosynthesis of Jeffrey and ponderosa pine up to approximately 40% of needle surface. After 40% of the surface area is affected, the effect of increasing levels of mottle on photosynthesis is negligible. Therefore, when the visible injury ratings of the whorls are averaged for a branch all ratings above 3 are set to 3. If no chlorotic mottle is present on any whorl, the injury index is zero. Injury Classes are defined in Section 6. Mottle injury is also weighted by the whorl on which it occurs. If only 2 whorls are present on a branch the mottle rating from each is weighted equally. If there are three whorls the mottle is weighted, .35, .35, .30 for the 1st, 2nd, and 3rd whorls, respectively. If the branch has four or more whorls, the mottle is weighted .28, .28, .24, .20 for the 1st, 2nd, 3rd, and 4th whorls. Mottle appearing on a 5th or older whorl does not contribute to the index and is used only to delineate a symptomatic/asymptomatic branch. The maximum mottle score is 40, the minimum score is zero (a mottle injury score of zero implies an overall OII of zero).

2) Whorl Retention: Based on the retention of five annual whorls indicating a healthy ponderosa pine (Munz and Keck, 1973). Although Jeffrey pines can be expected to retain eight or more whorls, the use of five as a threshold for ozone effects is

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reasonable since retention of more than five whorls indicates a relatively healthy pine tree. If a pine has chlorotic mottle on whorls six or older the mottle factor of the injury index will indicate the tree is symptomatic even though the whorl retention factor of the index will record no injury. A pine is not likely to be even moderately impacted if it retains more than five whorls of needles. Whorl retention, and percentage of fascicles retained per whorl (1 = 1-33%; 2 = 34-66%; 3 = 67-100%), are scored on the data sheet (Figure 2) to indicate missing whorls or portions of missing whorls due to insect predation, fungi, or other stresses (non-air pollution causal agents). The index computes whorl retention as fractions of whole whorls (i.e., 1.0, .66, .33), except for less than one whorl retention. Branches with less than one whorl are considered to have a full whorl in the index, since retention of 1 whorl or less produces the maximum injury score (50) for whorl retention (see example below). Maximum injury score for whorl retention is 40 (only 1 whorl of needles), minimum score is 0 (five or more full whorls of needles).

3) Modal Needle Length: Length in centimeters of representative needles measured in the middle of each year's whorl of needles (assumes maximum expansion of the needle has occurred). Assumes the needle length of a very healthy ponderosa to be 21 centimeters and Jeffrey pine needle to be 19 centimeters. Needle lengths shorter than 1 centimeter are computed as 1 centimeter. Maximum injury score for needle length is 10 (needles 1 centimeter or less), minimum score is 0 (needles 21 or 19 centimeters or greater).

4) Percent Live Crown: The proportion of the total crown that has any live branches with any number of live needles (Figure 15). Assumes a crown retention of 10% as a minimum value. Maximum injury score for percent live crown is 10 (10% or less of the bole with live branches), minimum score is 0 (80% or more of bole with live branches).

Equation for Calculating the Ozone Injury Index (OII)

$$OII = VI + RET + LGT + CD$$

Where:

VI = Visible Injury (Chlorotic Mottle)
RET = Number and of Needle Whorls Present and Fascicle Retention
LGT = Modal Length of Needles (Average all whorls)
CD = Percent Live Crown

Each of the four variables require individual calculation prior to being summed. These calculations provide averaging and introduce the specified weightings:

Visible Injury (Chlorotic Mottle) (VI)

Includes weighted average of up to the first four whorls.

5+ Whorls: $VI=1+\{40*((CM1*.28)+(CM2*.28)+(CM3*.24)+(CM4*.20))/3\}$
4 Whorls: $VI=40*((CM1*.28)+(CM2*.28)+(CM3*.24)+(CM4*.20))/3$
3 Whorls: $VI=40*((CM1*.35)+(CM2*.35)+(CM3*.30))/3$
2 Whorls: $VI=40*((CM1*.50)+(CM2*.50))/3$
1 Whorl : $VI=40*(CM1)/3$

Where:

CM1 is the average mottle on all current year whorls (except if mottle rating of a whorl is > 3 it is set to 3 before average is calculated).
CM2 is the average mottle on all one-year-old whorls, and so on to CM4.

Retention (RET)

If oldest whorl on any branch is 1:

$RET=10*\{5-[WR1*.33]\}$

If oldest whorl on any branch is 2-6:

$RET=10*\{5-[(oldest\ whorl-2)+(sum\ fas.\ ret.\ 2\ oldest\ whorls*.33)]\}$

If oldest whorl on any branch is > 6:

RET=0

Where:

WR1=Average fascicle retention of all current year whorls on all 5 branches.

WR2=Average fascicle retention of all one-year-old whorls on all 5 branches.

WR3= " " " " " two-year-old " " " "

Needle Length (LGT)

If species is Jeffrey pine:

$LGT=(18-Len)*10/18$

If species is ponderosa pine:

$LGT=(21-Len)*10/21$

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Where:

Len is the average needle length of all whorls.

Percent Live Crown (CD)

$$CD = (80 - \text{percent live crown}) * 10 / 70$$

OII calculation example.

BRANCH	WHORL	CM	RET	NL	
1	1	0	3	20.5	
1	2	0	3	17.5	
1	3	0	3	21.0	
1	4	1	1	13.0	
2	1	0	3	17.0	
2	2	0	3	18.5	
2	3	0	3	20.0	
2	4	5	3	14.0	
3	1	0	3	16.5	
3	2	0	3	17.5	
3	3	0	3	21.0	
3	4	1	2	11.5	
4	1	0	3	21.0	
4	2	0	3	20.0	
4	3	0	3	20.0	
4	4	1	2	15.0	
4	5	0	0	0	(THIS WHORL IS MISSING)
4	6	2	1	15.0	
5	1	0	3	18.0	
5	2	0	3	17.0	
5	3	1	3	19.0	
5	4	1	1	13.0	
5	5	0	0	0	(THIS WHORL IS MISSING)
5	6	0	1	13.0	

CHLOROTIC MOTTLE

OLDEST WHORL IS 6

$$CM1 = (0+0+0+0+0) / 5 = 0$$

$$CM2 = (0+0+0+0+0) / 5 = 0$$

$$CM3 = (0+0+0+0+1) / 5 = .2$$

$$CM4 = (1+3+1+1+1) / 5 = 1.4$$

$$VI = 1 + \{40 * [(0 * .28) + (0 * .28) + (.2 * .24) + (1.4 * .20)] / 3\} = 5.37$$

RETENTION OLDEST WHORL IS 6

FASCICLE RETENTION OF 2 OLDEST WHORLS IS:

$$WR5 = 0$$

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$$WR6 = (0+0+0+1+1)/5 = .4$$

$$RET = 10*\{5-[(6-2)+((0+.4)*.33)]\} = 8.67$$

NEEDLE LENGTH

LEN=17.2, SPECIES IS PONDEROSA

$$LGT=(21-17.2)*10/70 = 1.81$$

LIVE CROWN

PERCENT LIVE CROWN = 66

$$CD=(80-66)*10/70 = 2$$

$$OII=VI+RET+LGT+CD = 5.37 + 8.67 + 1.81 + 2.0 = 17.85$$

6.0 Quality Control

Tree data

Objectives:

species	agreement by at least 2 observers
crown position	agreement by at least 2 observers
percent bare rock	$\pm 10 \%$
tree height	± 0.4 m
percent live crown	$\pm 5 \%$
DBH	± 0.2 cm
mistletoe	± 1 category (out of 6 total).
conks	Agreement by at least 2 observers of presence/absence
beetles	" " "
witches brooms	" " "
Fire scars	" " "
Mechanical injury	" " "
Lightning scars	" " "

Quality assurance: To insure that data collection meets the acceptable data quality objectives, the project will perform or delegate the remeasurement of tree variables on 10% of the trees in each plot. The percent frequency of misclassification or > 10% difference in measured variables will be recorded. An independent remeasurement by the QA crew will also be done.

Branch and whorl data:

Objectives:

Foliated length	± 1.5 cm
Number of whorls	± 1
Chlorotic Mottle	± 1 class
Retention	± 1 class
Needle length	± 1.5 cm
Biotic injury	± 1 category
Abiotic injury	± 1 category

Quality assurance: Branch and whorl variables are remeasured by an independent QA person. The following steps are followed on each of the three plots to assure consistent quality data collection. These procedures require that the crew has numbered each branch and returned them to the shady side of the tree from which they were cut.

- 1) At the end of each field sampling day, randomly select 2 trees from the total scored that day, until you have a total of 5 QA trees identified for each plot.

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- 2) From the 2 trees selected that day, randomly select 2 branches.
- 3) Tag each branch with Plot and Tree number. The branch number should already be on the cut end of the branch, be sure it is still legible.
- 4) Bag the branches in plastic and keep them refrigerated until all 5 QA trees have been scored for one plot.
- 5) Box up the 10 plot branches, being sure to insulate the box with paper or equivalent material and include data printouts or copies of data sheets for those branches.
- 6) Mail box of branches to the trained QA monitor.

The independent QA monitor reports the results of the remeasurements to the individual cooperators. Results for all cooperators/plots were summarized in a report.

Training and Certification

At least one member of each data collection crew will be a Certified Data Collector. A Certified Data Collector will have completed at least one full session of training (2 days-1 classroom, 1 field) and returned for the current year's field training day (2nd day of the full session). Only a Certified Data Collector may score branches.

The yearly training session will be scheduled no more than 1 month before the first crew is to begin collecting data. The training session will consist of 1 full day in the classroom and 1 full day in the field. New trainees will attend both days, returning crews will be required to attend only the second (field) day. The classroom day will begin with presentations of the purpose of Project FOREST and overviews of the data collection methods. In the afternoon, sub-groups will rotate between trainers to receive hands-on training in scoring branch and whorl variables. The field day will begin with training on tree variables to be collected that year, demonstrations of cutting branches, and a review of QA procedures. The each sub-group will be assigned two trees from which they will cut 2 branches. Each member of the crew will score the branches. The groups will rotate to the next 2 trees (the branches will have been cut already by the previous group and left at the base of the tree). After all the branches have been scored by all the groups, the data sheets will be collected. The QA person will also score the branches. The trainee's data sheets will be corrected against the QA using the data quality standards outlined above. Any trainee who is not within acceptable QA limits will be retrained in the problem area and retested.

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7.0 **References**

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Figure 1. Site data sheet.

MANAGEMENT UNIT/SITE: _____ PLOT NAME/NUMBER: _____ CREW: _____
TOPO MAP: _____ LANDUSE: _____ DATE: _____
PLOT LOCATOR TREE (SPECIES, DBH, CHARACTERISTICS): _____
ELEVATION: _____ LATITUDE: _____ LONGITUDE: _____
COMPASS BEARING AT STARTING POINT: _____ %SLOPE: _____ ASPECT: _____
FOREST TYPE/COMMUNITY (3 MAIN TREE SPECIES): _____ SITE INDEX _____
UNDERSTORY VEGETATION: _____
SLOPE POSITION: summit shoulder backslope headslope footslope terrace bottom
LANDFORM: ridgetop spur-ridge noseslope headslope sideslope cove draw

SKETCH IN LOCATION OF EACH TREE (WITH TREE NUMBER), AS ACCURATELY AS POSSIBLE.
SKETCH IN SECTION OF ROAD, TRAIL, OR PROMINENT GEOGRAPHIC FEATURE TO FACILITATE RELOCATING PLOT IN FUTURE.
ATTACH APPROACH LOGS AND PHOTOS OF PLOTS IF AVAILABLE

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Figure 2. Tree and whorl data sheet.

FOREST:		SITE:		PLOT:		TAG:						
CREW:		COMMUNITY:		ASPECT:		SLOPE:		ELEVATION:				
DATE:		LANDFORM:		SLOPE POSITION:								
		WHORL								UNITS USED:		
SP	#	FOL LEN	#	CM	FR	NL	BIOTIC	ABIOTIC	COMMENT	DBH _____	HT _____	
AGE	1		1							FOL LEN _____	NL _____	
			2									
			3									
			4									
SNDX			5									
			6									
POS			7									
			8									
HT	2		1									
			2									
			3									
DBH			4									
			5									
MREL			6									
			7									
			8									
ROCK	3		1									
			2									
MIST			3									
			4									
CONK			5									
			6									
BEET			7									
			8									
FIRE	4		1									
			2									
			3									
			4									
MECH			5									
			6									
LIGT			7									
			8									
BROM	5		1									
			2									
			3									
			4									
%LC			5									
			6									
LCR			7									
			8									

FR = FAS RET (WHOLE WHORL)
 0 = NONE
 1 = 1 - 33%
 2 = 34 - 66%
 3 = 67 - 100%

CHL. MOTTLE
 0 = NONE
 1 = 1 - 6%
 2 = 7 - 25%
 3 = 26 - 50%
 4 = 51 - 75%
 5 = 76 - 100%

ABIOTIC INJURY
 0 = NONE
 1 = < 25%
 2 = > 25%

BIOTIC INJURY
 0 = NONE
 1 = < 25%
 2 = > 25%

MREL
 PL = PLANAR
 CC = CONCAVE
 CX = CONVEX

BOLE INJ
 0 = ABSENT
 1 = PRESENT
 2 = SEVERE

MIST: 0 - 6

%LC = % LIVE CROWN

LCR = LIVE CROWN RATIO (FILL-IN)

ROCK = % ROCK IN 20X TREE DIA AREA

SNDX = SITE INDEX

Figure 8. Crown Position Classes: D = Dominant, C = Codominant, I = Intermediate, S = Suppressed, OG = Open Grown.

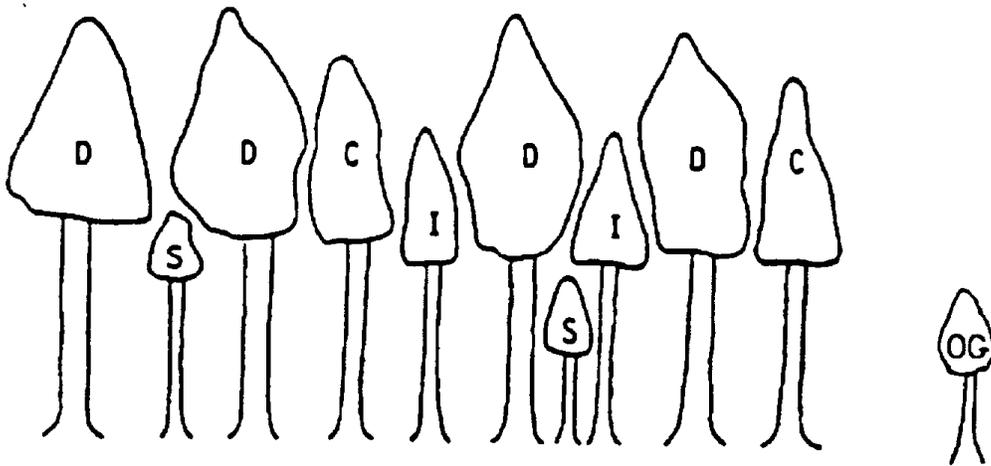
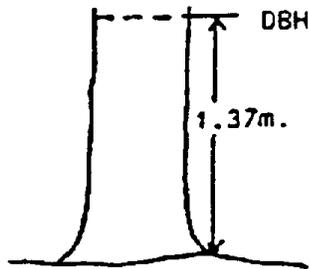
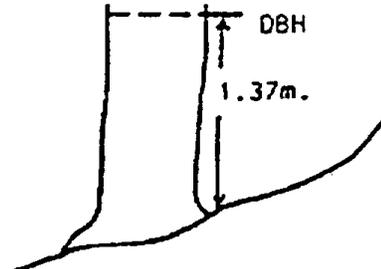


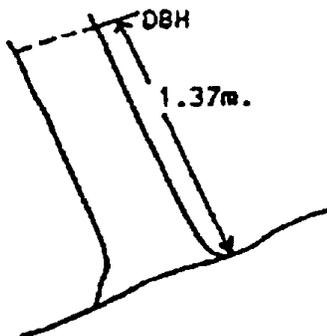
Figure 9. Proper method for measurement of diameter at breast height (dbh) of the tree bole.



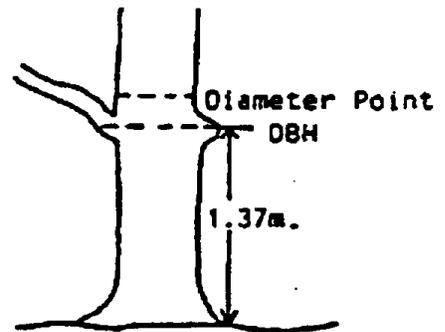
Tree on Level Ground



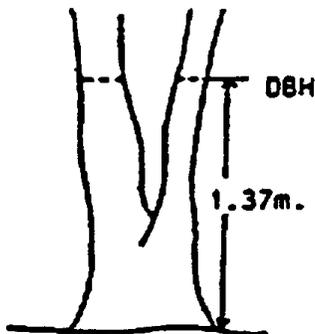
Tree on Slope



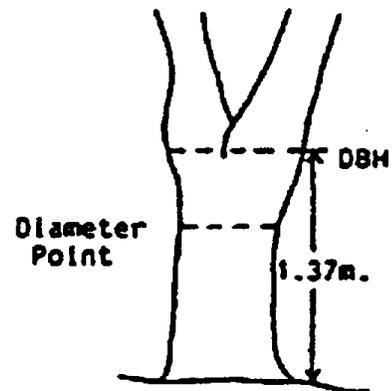
Leaning Tree



Tree with Branch/Deformity
at Breast Height



Tree Forked Below Breast Height



Tree Forked Above Breast Height

Figure 13. Microrelief types to be evaluated under the drip line of each tree. Types are planar, concave, and convex.

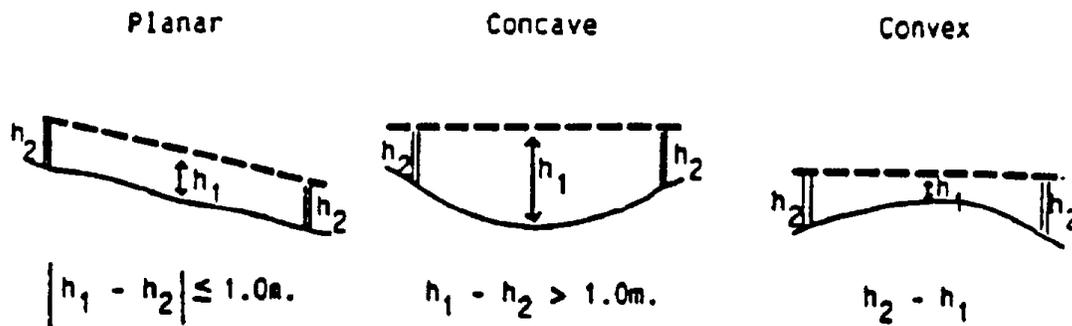


Figure 14. Forest Inventory Method for determining tree heights.

Principle of height measurement with the Abney level and similar hypsometers.

$$A = \text{TAN ANGLE } a \times D$$
$$B = \text{TAN ANGLE } b \times D$$
$$\text{TREE HEIGHT} = A + B$$

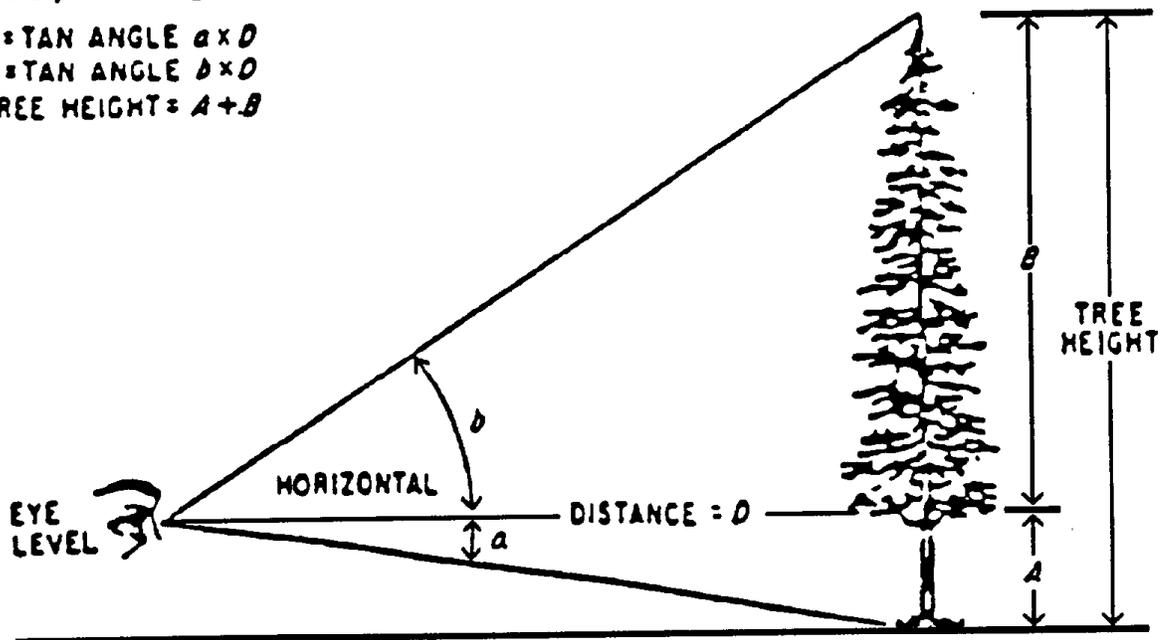


Figure 15. Measurement of Percent Live Crown and examples as contrasted with measurement of Live Crown Ratio.

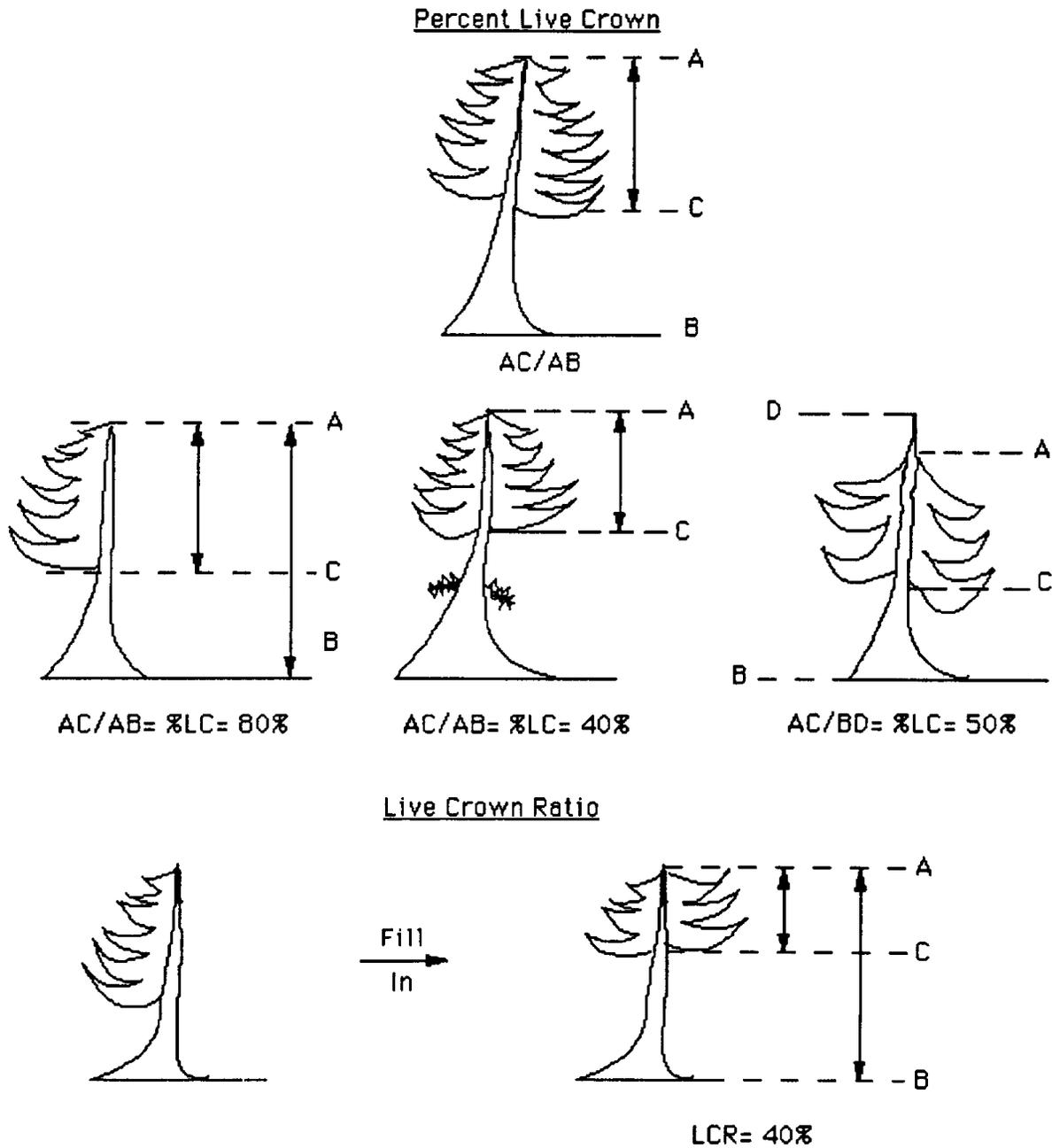


Figure 16. Description and example of Hawksworth 6 class mistletoe rating system.

Hawksworth 6-class Mistletoe Rating System

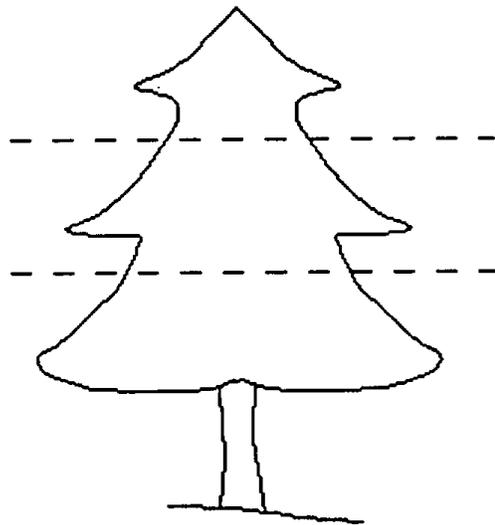
Step 1: Divide live crown into thirds.

Step 2: Rate each third separately.
Assign each third either 0, 1, or 2 as described below:

0 - No visible infection

1 - Light, less than 1/2 branches
have mistletoe plants

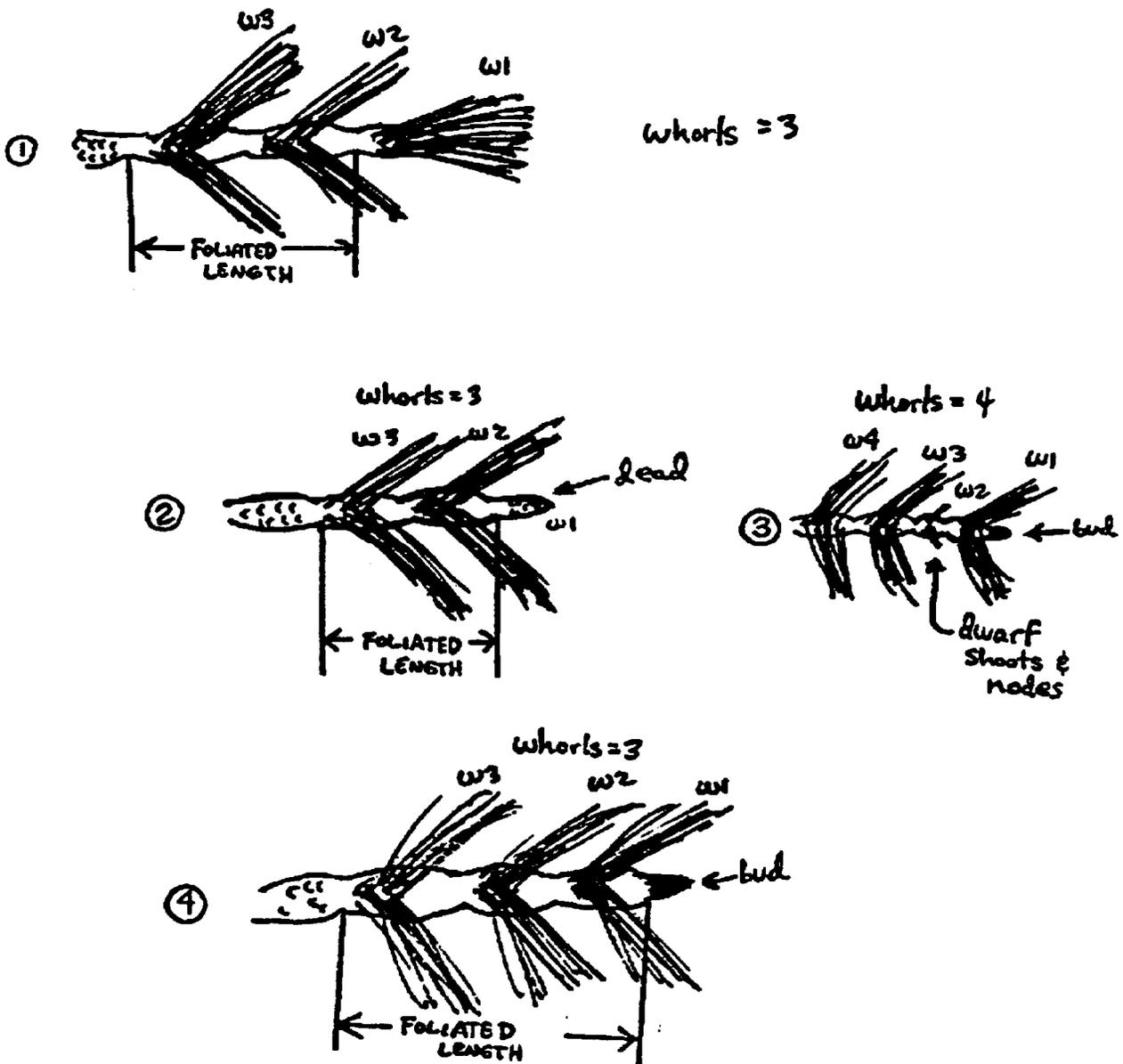
2 - heavy, more than 1/2 of
branches have mistletoe
plants and/or brooms.



Step 3: Add ratings of thirds to obtain
total tree rating.

<u>Total Rating</u>	<u>Infection Level</u>
0	none
1 or 2	light
3 or 4	moderate
5 or 6	heavy

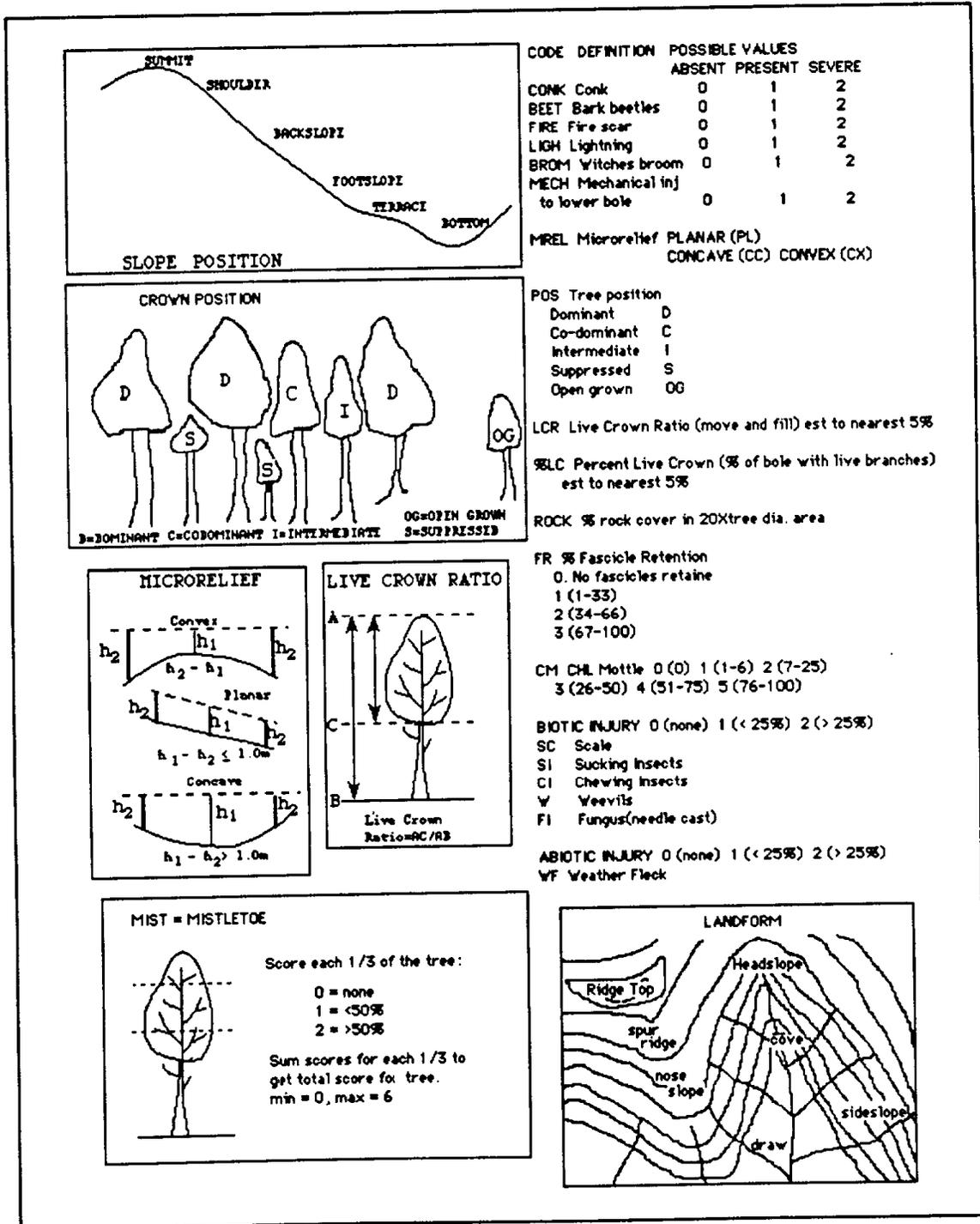
Figure 17. Example of number of whorls of needles on branches with partially or completely missing whorls and measuring the foliated length of a branch.



STANDARD OPERATING PROCEDURE
 TITLE: Initial Determination of Tree
 Characteristics and Repeated Measurement
 of Branch and Whorl Variables

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 NUMBER: RFL 25

Figure 18. Quick reference sheet of site, tree and branch variables to be taken to the field.



1.0 **General Discussion**

Needles from branches cut during the 1991 ozone injury survey are collected for weighing and chemical analysis.

1.6 **Responsibilities of Personnel**

The Ozone Injury Survey field crew is responsible for gathering cut branches and putting them in correctly labeled bags.

Trained technicians are responsible for removing and grouping the age classes of needles from the branches and placing the groups in bags labeled with tree and age class.

The laboratory technician is responsible for weighing the dried needles and transferring the bags to the laboratory for chemical analysis.

1.8 **Related Procedures**

Standard Operating Procedures:

RFL 25 Initial Determination of Tree Characteristics and Repeated Measurement of Branch and Whorl Variables

RFL 27 Needle Harvest 1992 - Collection Method

RFL 28 Separation and Weighing of Needles by Age Class and Processing of Data

RFL 29 Chemical Processing of Needle and Leaf Harvest Samples

2.0 **Apparatus, Instrumentation, and Forms**

Mettler PK 36 balance

4.0 **Procedures**

After the ozone injury data has been collected for a tree, the cut branches are to be gathered and placed in a bag labeled with the plot and tree number. The bags are brought back to the laboratory.

A technician removes each age class of needles from the branches, bundling all same age needles from a tree together. Each age class is placed in a paper bag labeled with the plot, tree, and age class.

The bags of needles are placed in a drying oven for 48 hours at 70° C. The bags of dried needles are kept in plastic bags until they can be weighed.

Several of the empty paper needle bags are weighed to get an average bag weight. The needles are weighed without removing them from the paper bag. The plot, tree, age class, and weight is recorded on paper by the technician. After weighing all the needle bags, the data is to be transferred to an electronic form. The plot, tree number, age class and weight should be typed into a computer spreadsheet such as Excel or Lotus 123. The average empty bag weight can then be subtracted yielding the dry needle weight.

The weighed bags of needles are transferred to the laboratory for grinding and chemical analysis.

7.0 **References**

1.0 **General Discussion**

A sample of each age class needles from branches cut during the 1992 ozone injury survey is collected and brought to the laboratory for chemical analysis.

1.6 **Responsibilities of Personnel**

The Ozone Injury field crew is responsible for collecting the samples and putting them in correctly labeled bags.

1.8 **Related Procedures**

Standard Operating Procedures:

- RFL 25 Initial Determination of Tree Characteristics and Repeated Measurement of Branch and Whorl Variables
- RFL 26 Needle Harvest 1991 - Collection Method
- RFL 28 Separation and Weighing of Needles by Age Class and Processing of Data
- RFL 29 Chemical Processing of Needle and Leaf Harvest Samples

2.0 **Apparatus, Instrumentation, and Forms**

3.0 **Calibration Standards**

4.0 **Procedures**

After the ozone injury data has been collected for a tree, a sample of each age class of needles from all 5 branches is to be placed in a bag labeled with the plot, tree number, and age class. The sample from each branch should be no less than 5 or more than 12 fascicles. The bags of needles are brought back to the laboratory for drying, grinding, and chemical analysis.

7.0 **References**

1.0 **General Discussion**

This document provides procedures for the separation of ponderosa pine needles by age class from 5 branches cut during annual plot foliage evaluation, the weighing of each age class of needles and processing of the data.

1.6 **Responsibilities of Personnel**

Field technicians are responsible for removing the needles from the branches, grouping them by age class, and bagging them. The lab technician is responsible for weighing the samples and entering the data. The data manager is responsible for integrating the data into the database.

1.8 **Related Procedures**

Standard Operating Procedures:

- RFL 25 Initial Determination of Tree Characteristics and Repeated Measurement of Branch and Whorl Variables
- RFL 26 Needle Harvest 1991 - Collection Method
- RFL 27 Needle Harvest 1992 - Collection Method
- RFL 29 Chemical Processing of Needle and Leaf Harvest Samples

2.0 **Apparatus, Instrumentation, Reagents, and Forms**

2.1 **Apparatus and Instrumentation**

1. Table in a well lit area (outside or under good lights)
2. Mettler PK 36 balance
3. IBM compatible microcomputer
4. Database software: dBase IV v1.5
5. Text editor: Word Perfect 5.1

3.0 **Calibration Standards**

4.0 **Procedures**

4.2 **Start-up**

The cut branches from each tree should be together in a labelled bag. dBase must be installed and running correctly. A dBase file named NDLWT91.DBF with the structure listed in figure 4.2 must be in a sub-directory that dBase can be run from. A text editor capable of outputting in ASCII format must be available for entry of the weight data.

4.3 **Routine Operation**

The laboratory supervisor receives the bags labeled with plot-tree each containing the 5 cut branches from 1 tree. Each whorl (age class) of needles is removed from the branch and placed on the table. Same age class needles from all 5 branches of each tree are collected together and put in a paper bag labeled with plot-tree-age class. Age class is 1 for current year needles, 2 for last year's needles and so on. The paper bags are put in a drying oven for 48 hours at 70° C. After they come out of the oven the bags are kept in plastic trash bags until they are weighed. Several bags are weighed to get an average "bag weight". This will be used to get the "net" needle weight after the needles are weighed in their bags. Each bag of needles is then weighed and the bag label and weight written in a notebook. The data in the notebook is then typed into a text file with the format as in figure 4.3. Data

entry person will check the typed data against the original for errors and give an electronic and paper copy of the data to the data manager. The data manager will check the format of the data and append it to the database file, NDLWT91.DBF. The data manager will use the "bag weight" to calculate the "net" needle weight. The original bag and needle weight will be dropped from the database file. If a Lab ID has been assigned to the sample it will be entered in the Lab ID field, else the Lab ID field will be 0. Using the last digit of the Field ID the Year the needles grew is entered. If the last digit is one the Year is the current year, if the digit is 2 the Year is the current year minus 1. A printed copy of the database file and the paper copy will be filed.

- 5.0 **Quantification**
 Net needle weight = bag and needle wt - average bag wt
- 6.0 **Quality Control**
- 7.0 **References**

FIGURE 4.2

Structure for database: NDLWT91.DBF
 Number of data records: 777
 Date of last update : 02/10/93

Field	Field Name	Type	Width	
1	LAB_ID	Character	8	Lab assigned ID number
2	ID	Character	12	Field ID number
3	YEAR	Numeric	2	Year needles grew
4	WEIGHT	Numeric	5.1	Needle weight(gms)

FIGURE 4.3

Col. 1: Field ID, the number on the bag
 Col. 2: Weight of bag and needles(gms)

1-2-1	23.9
1-4-1	20.1
1-7-1	19.4
1-10-1	28.3
2-204-1	14.2
2-205-1	31.4
2-218-1	24.7
3-501-1	25.1
3-502-1	32.6
3-509-1	42.8
1-2-2	22.9
1-4-2	10.1
1-7-2	13.4
1-10-2	24.3
2-204-2	34.2
2-205-2	21.4
2-218-2	14.7
3-501-2	15.1
3-502-2	11.6
3-509-2	12.8

1.0 **General Discussion**

The needle samples of ponderosa pine and white fir, and the leaf samples of black oak were collected from plots 1, 2 and 3 of the Barton Flats study area as outlined in RFL 26 and RFL 27. The needle samples were separated by age class as outlined in RFL 28. The samples were analyzed for concentrations of carbon, nitrogen, sulfur, calcium, magnesium, sodium, potassium, and phosphorus; not all samples were analyzed for all elements.

1.1 **Purpose of Procedure**

The purpose of the procedure was to compare the elemental concentrations of tree foliage both within and between plots, within and between species, between needle age classes, and between collections occurring in different years.

1.8 **Related Procedure List**

Standard Operating Procedures:

- RFL 26 . Needle Harvest 1991 - Collection Method
- RFL 27 Needle Harvest 1992 - Collection Method
- RFL 28 Separation and Weighing of Needles by Age Class and Processing of Data
- LM 2.1 Sample Grinding
- LM 2.9 Multi-Element Analysis: Perchloric Digest
- LM 2.13 Elemental Combustion Analysis: Plant Tissue
- LM 6.5B Measurement of Perchloric Phosphorus - TRAACS 800
- LM 6.9 Measurement of Cations - Perkin Elmer 5000

4.0 **Analytical Procedures**

4.1 **Grinding**

The tissue samples were ground to pass a 20 mesh sieve as outlined in LM SOP 2.1.

4.2 **Perchloric Digest**

Before analyzing for calcium, magnesium, sodium, potassium or phosphorus, the samples were digested in a nitric/perchloric acid mixture as outlined in LM SOP 2.9.

4.2.1 **Calcium, Magnesium, Sodium, Potassium Determinations**

The concentrations of calcium, magnesium, sodium, and potassium were determined using atomic absorption spectrophotometry as outlined in LM SOP 6.9.

4.2.2 **Phosphorus Determinations**

The concentrations of phosphorus were determined using automated colorimetry as outlined in LM SOP 6.5B.

4.3 **Carbon, Nitrogen and Sulfur Determinations**

The concentrations of carbon, nitrogen, and sulfur were determined using combustion gas chromatography as outlined in LM SOP 2.13.

7.0 **References**

Laboratory Methods and Training Manual. Forest Fire Laboratory.
USDA Forest Service.

1.0 General Discussion**1.1 Purpose of Procedure**

This procedure is used to measure volumetric soil water content in the surface soil under the canopy of a mixed coniferous forest and in surrounding areas and to document seasonal changes in the water content of those soils.

1.2 Measurement Principles

The soil moisture meter used the principle of time domain reflectometry to directly measure the water content of the soil. Two parallel metal transmission rods are inserted into the soil to a known depth and a microwave pulse is transmitted down these wave guides. The speed with which the pulse is transmitted down the wave guides is dependent upon the dielectric constant (K) of the material surrounding the wave guides. Soil is composed of heterogeneous mixtures of air, mineral and organic particles, and water. Because the K for water is 40 to 80 times greater than those for air or mineral particles, the speed of propagation of the microwave pulse is primarily controlled by the water content of the soil. The instrument measures the time required for a microwave pulse to travel down the known length of the wave guides, calculates an apparent dielectric constant (Ka) for the soil sample, and compares the reading with Ka's established by careful measurements of known volumes of water in soil. This calibration curve is used to convert field measurements of Ka to the volumetric water content of the soil.

1.3 Measurement Interferences

Slight variations in the bonding strength between water molecules and different mineral components of the soil can vary the calibration curves for soil water content of different soil types. Empirical studies of Ka's for different soil types have shown that these variations are on the order of 2% or less (Topp et al. 1980).

1.4 Ranges and Typical Values of Measurements Obtained

Full field capacity of these mountain soils is about 30% water. Typical summer measurements are in the range of 10 to 15 %, and droughted soils measure 5% soil moisture content.

1.5 Typical Quantifiable Limits, Precision, and Accuracy

Not tested

1.6 Responsibilities and Personnel

P.J. Temple, UCR

1.7 Definitions

Time domain reflectometry - the measurement of volumetric soil water contents by measurement of the apparent dielectric constant of the soil sample.

Wave guides - metal rods inserted into the soil to a known depth, used to transmit microwave pulses.

1.8 Related Procedures

Soil water content is an important environmental variable

controlling stomatal conductance. Data on soil water is used in models of stomatal conductance and transpiration.

2.0 **Apparatus, Instrumentation, Forms**

2.1 **Instrumentation**

Trase System I, Model 6050XI, time domain reflectometer, SoilMoisture Corp, Santa Barbara, CA, equipped with 15 cm wave guides.

2.2 **Forms**

No special forms are used to record readings from this instrument. Data are entered into a field notebook.

3.0 **Calibration Standards**

Not Applicable

4.0 **Procedures**

4.1 **Routine Operations**

After the instrument has been turned on, a zero reading is taken. The wave guides are inserted their full length into the soil and the volumetric soil water content is recorded. Five to six measurements are taken at each site to establish an average soil water content for a 1 m² sampling site.

5.0 **Quantification**

Not Applicable

6.0 **Quality Control**

All data are collected according to the operating instructions given in the operating instructions manual. The instrument is factory-calibrated and is returned to the factory for periodic adjustment and maintenance.

7.0 **References**

Topp, G.C., J.L. Davis, and A.P. Annan. 1980. Electromagnetic determination of soil water content: measurement in coaxial transmission lines. Water Resour. Res. 16: 579-582.

- 1.0 **General Discussion**
- 1.1 **Purpose of Procedure**

This procedure is used to measure the rate of stomatal conductance of conifer foliage of seedlings and saplings and at various locations within the canopies of mature trees in the mixed conifer forest. Measurements of rates of stomatal conductance can be used with ambient ozone concentration data to determine diurnal and seasonal cycles of ozone flux to tree foliage.
- 1.2 **Measurement Principle**

The driving force for transpiration in plant leaves is the water vapor concentration gradient between ambient air and internal air spaces in the sub-stomatal cavity. The null-balance steady-state porometer measures this concentration gradient and converts it to a rate of stomatal conductance using pre-programmed equations stored in the instrument's microprocessors.
- 1.3 **Measurement Interferences**

Water on the leaf surface will interfere with measurements because the instrument cannot distinguish internal from external sources of water vapor. Thus the instrument cannot be used in the rain or if the leaves are covered with dew. Instrument error also increases at extreme humidity ranges, so no measurements are taken if ambient relative humidity is greater than 90% or less than 10%.
- 1.4 **Ranges and Typical Values of Measurements**

Rates of stomatal conductance for ponderosa and Jeffrey pines in the field range from 0 to a maximum of $0.10 \text{ mol m}^{-2} \text{ s}^{-1}$. Typical summer values range from 0.02 to $0.06 \text{ mol m}^{-2} \text{ s}^{-1}$.
- 1.5 **Typical Quantifiable Limits, Precision, and Accuracy**

Not tested
- 1.6 **Responsibilities and Personnel**

P.J. Temple, UCR
- 1.7 **Definitions**

Null-balance porometer - an instrument that uses a flow of dry air through a cuvette to balance the transpiration rate of the leaf so as to maintain a steady-state humidity in the chamber surrounding the leaf. The humidity of the air entering the chamber is known (typically at or close to 0%), so the rate of stomatal conductance can be calculated using the humidity of the air in the chamber, the flow rate of the air entering the chamber, leaf area enclosed, and leaf and air temperatures.
- 1.8 **Related Procedures**

Environmental conditions, including ambient temperature, relative humidity, photosynthetically-active light intensity, and soil water content, are measured concurrently with conductance measurements.

2.0 **Apparatus and Instrumentation**

2.1 **Instrumentation**

Null-balance, steady-state porometer (Model 1600, Licor Inst. Co., Lincoln, NE), equipped with a cuvette specifically designed for conifer foliage.

2.2 **Forms**

All instrument readout data are recorded in the field in a field notebook at the time of measurement. No special forms are used.

3.0 **Calibration Standards**

Not Applicable

4.0 **Procedures**

4.2 **Start-up**

Silica gel desiccant is replaced with fresh dry desiccant prior to any measurements and the internal batteries are recharged. The porometer is assembled in the field and tested for leaks, then the cuvette is allowed to equilibrate to ambient environmental conditions for 15 minutes prior to use.

4.3 **Routine Operations**

A single fascicle of three pine needles is carefully placed in the cuvette and the air flow to the cuvette is balanced using a potentiometer controlling a mass-flow controller. A measurement is taken within 15 to 30 seconds and the data are recorded. Three to five fascicles per needle age class per position on the tree are measured in rapid succession. Leaf area enclosed in the cuvette is determined by measurement of the diameter of the three-needle fascicle, using an electronic digital caliper.

5.0 **Quantification**

The porometer records stomatal conductance in units of cm s^{-1} . These data are converted to $\text{mol m}^{-2} \text{s}^{-1}$ using the formula (Nobel 1991):

$$g (\text{mol m}^{-2} \text{s}^{-1}) = 0.446 g (\text{cm s}^{-1}) (273/t+273) (p/101.3)$$

where t = ambient temperature, $^{\circ}\text{C}$
 p = atmospheric pressure, kPA

6.0 **Quality Control**

All procedures and limitations documented in the operating manual are followed. Measurements are taken quickly and carefully to minimize influencing stomatal conductance. The instrument is returned to the factory annually for calibration of all sensors, for software updates, and for routine maintenance.

7.0 **References**

Nobel, P.S. (1991) Physicochemical and Environmental Plant Physiology. Academic Press, San Diego.

1.0 **General Discussion**

INTRODUCTION

At the level of the plant canopy, models of deposition provide an air-to-surface transfer rate based on a combination of processes governing turbulent transport in the free atmosphere, diffusion on or near the leaf surface in the gas phase and interfacial transport between the gas and either a liquid (cell surface) or solid (cuticle) surface. The turbulent forces operating in the free atmosphere are common to all atmospheric pollutants and are modeled using bulk flow parameters. Conversely, diffusion is a molecular process and is therefore specific for both the individual pollutant (e.g., molecular size) and the surface for deposition (e.g., leaf). Interfacial transport, also governed by molecular processes, determines the ease of pollutant transport across an interface.

The objectives of this document are to document the methodology for estimating atmospheric dry deposition at the Barton Flats Site using the Big Leaf Model. This objective was met by providing a synopsis of the model's fundamentals coupled with a line by line print out of the code.

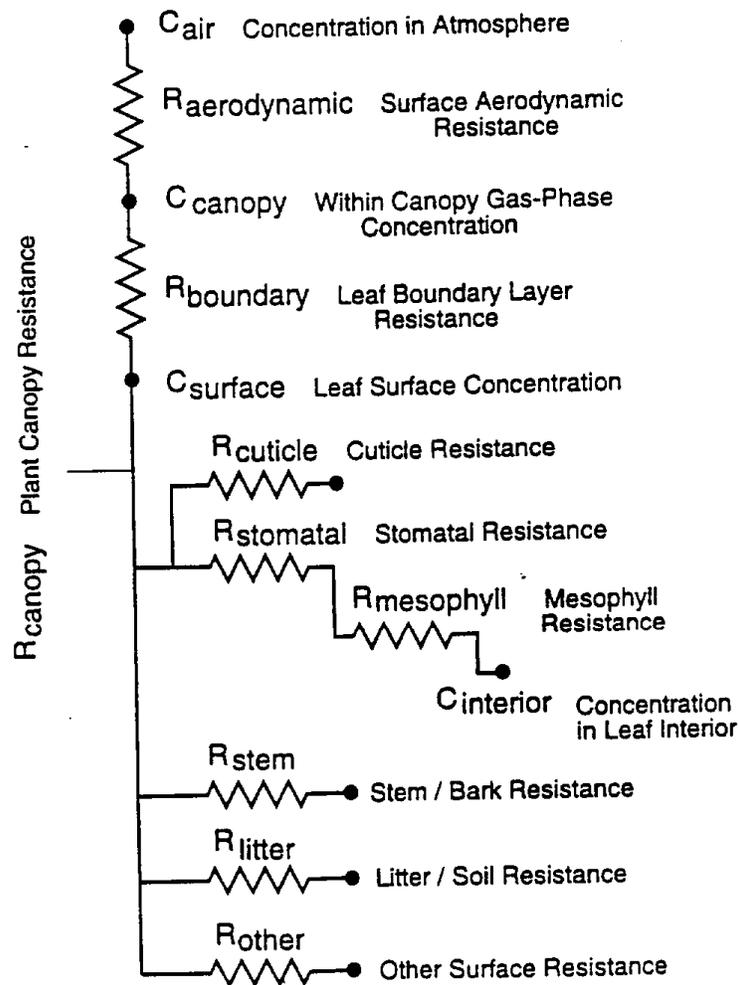
GENERAL PROPERTIES OF THE BIG LEAF MODEL

One of the most commonly used canopy-level models to simulate the deposition of pollutant gases and particles to forests is the Big Leaf Model (Baldocchi et al., 1987; Taylor et al., 1988; Hicks et al., 1991; Taylor and Constable, in press). This process-driven code has its origins in modeling the fluxes of mass and momentum in agricultural landscapes and accounts for many of the processes governing deposition at the canopy level (Figure 1). The model's principal feature is an array of resistances including aerodynamic ($R_{\text{aerodynamic}}$), leaf boundary layer ($R_{\text{boundary layer}}$), soil (R_{soil}), stem (R_{stem}), and a canopy surface (R_{surface}) resistance. The last is divided into three resistances operating in series or parallel: cuticular (R_{cuticle}), stomata (R_{stomata}) and mesophyll ($R_{\text{mesophyll}}$). The equations are solved via Ohm's Law and are gas-specific, based on the analogy to H_2O vapor.

The model is parameterized for an individual forest canopy (individual or multiple species) to account for the species-specific features that underline R_{surface} , $R_{\text{boundary layer}}$ and $R_{\text{aerodynamic}}$ and the site's unique environmental conditions (e.g., light, temperature, relative humidity). The most common calculation in the model is deposition ($\text{moles m}^{-2} \text{h}^{-1}$) estimated inferentially as the product of air concentration (mol m^{-3}) and deposition velocity (V_g in units of cm s^{-1} or m h^{-1}). The V_g

Figure 1: Schematic diagram showing the array of resistances operating within the Big Leaf Model, which is used to simulate pollutant gas deposition to plant canopies (adapted from Baldocchi et al. 1987).

Big Leaf Model



STANDARD OPERATING PROCEDURE

TITLE: Modelling Atmospheric Deposition to
Forests in Southern California: A
Manual of Fundamentals, Methods and
Procedures

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NUMBER: RFL 32

differs for each gas and particle and is scaled to account for differences in particle mass. The time step of the model is hourly.

The V_g is analogous to the leaf conductance (g) parameter used by physiological ecologists, with the distinction being that V_g is a vertically integrated measure through the canopy accounting for all deposition surfaces. Scaling from V_g to g , is done by dividing by the leaf area index (LAI) (Hanson and Lindberg 1991). The model operates as a single big leaf or as a number of layers, with each layer having a separate input file to account for changes in $R_{\text{aerodynamic}}$, R_{surface} and atmospheric concentration of the pollutant gases in the canopy.

Canopy aerodynamic resistance ($R_{\text{aerodynamic}}$) is estimated by a combination of meteorological (e.g., wind speed, wind direction) and canopy architecture (e.g., LAI) data. This resistance largely governs V_g for particles/aerosols and highly reactive trace gases (e.g., HNO_3), where R_{surface} approaches zero.

The most significant source of uncertainty in the Big leaf Model is R_{surface} , in general and R_{stomata} , particularly. The prominence of R_{stomata} is most important for pollutant gases whose deposition sites are within the leaf interior (e.g., O_3 , SO_2 , NO_2 , Hg^0). The uncertainty arises from the degree to which R_{stomata} varies as a function of the environment (e.g., light, temperature, vapor pressure, water potential, CO_2) and plant species. The net outcome is that R_{stomata} for a given pollutant at a specific site may range diurnally from ∞ to near zero.

The characterization of R_{stomata} is important and must be addressed experimentally at several times during the growing season on a site specific and pollutant-specific basis. The manner in which R_{stomata} is parameterized is straightforward. Values for R_{stomata} are derived by scaling the maximum R_{stomata} as a function of hourly values for light, air temperature, relative humidity, and plant water status. Each of these must be experimentally derived and numerically coded to match the species, leaf age class and site conditions. Once coded, the model estimates R_{stomata} in units of s cm^{-1} (projected leaf area basis), and this value is integrated to achieve a landscape-level R_{stomata} for H_2O vapor using LAI (either for land area as a whole or summed by age class). Subsequently, the estimate of canopy-level R_{stomata} is scaled for each pollutant gas via analogy to H_2O (or experimental data), and the reciprocal value, V_g is calculated (Hanson and Lindberg 1991).

There are many processes controlling pollutant deposition that are common among pollutants, and this has fostered the development and application of analog models based on the pathways for H₂O vapor and CO₂. The analogy between CO₂, H₂O vapor and most pollutant gases is not complete, and many pollutants show a very marked divergence due to their unique physiochemical properties. The most notable consequences of these differences are that the sites of pollutant gas deposition may be very different from those of CO₂ or H₂O. Some pollutants exhibit an "effective compensation point" and gas-phase and liquid-phase scavenging reactions on the leaf surface and within the leaf interior.

Pollutant deposition is also scale dependent as one moves both vertically within a canopy and horizontally across a landscape. There is a pronounced shift in processes controlling deposition from purely turbulent events to ones based on molecular processes at the gas-liquid interface. Similarly, there is a horizontal scale that affects deposition, such that the form and rate of deposition vary among plant communities.

Big Leaf Model

The Big Leaf Model was adapted to the Barton Flats Site by identifying a number of site specific criteria. The same procedure can be used for any site. The key factors that were selected are outlined below.

1. Site latitude and longitude
2. Growing-season leaf area index or LAI (dimensionless)
3. Dormant-season leaf area index (dimensionless)
4. Growing season duration
5. Growing season foliar biomass (Kg ha⁻¹)
6. Dormant season foliar biomass (Kg ha⁻¹)
7. Minimum stomatal resistance to H₂O (sec cm⁻¹)

Big Leaf Code

The following information is of two types. The first is a print out of the code introduction as seen on the screen by the user (Figure 2). It identifies a number of parameters and queries the user for this information. The second is the line by line code as it exists in the model. The code is printed verbatim.

This version was modified during June 1992, July 1993, and January 1993 to include Barton Flats Ponderosa Pine as canopy #14. This program was revised by S. Lindberg from an original program by the NOAA-ATDD group in Oak Ridge (Hicks et al 1991). The code was further modified by N. Beaulieu at DRI to include *Pinus ponderosa*, *Abies concolor* and *Quercus kelloggii* at Barton

Figure 2: Computer screen display of Big Leaf Model Code Introduction

WOULD YOU LIKE PRINTER OUTPUT (Y/N)? ____
ANSWER (Y)es OR (N)o

----- DEPOSITION VELOCITY MODEL -- VERSION 87507-SL11 -----
WHAT IS TODAY'S DATE?
...PRESS RETURN TO IGNORE ____
ENTER THE MET DATA SET FILE NAMES --
UP TO 20 DIFFERENT MET FILES CAN BE HANDLED SEQUENTIALLY.
THEY MUST BE FROM THE SAME SITE, SEASON, AND YEAR.
ENTER NAME WITHOUT EXTENSION--(.PRN IS ADDED ADTOMATICALLY)
WHAT IS MET DATA FILE NAME?--PRESS RETURN IF ALL HAVE BEEN
ENTERED:

THE NUMBER OF DATA SETS TO BE READ IS: 1
HAVE THESE MET FILES BEEN CHECK FOR QUALITY (Y/N)? ____

----- DEPOSITION VELOCITY MODEL -- VERSION 87507-SL11 -----
WHAT IS YEAR OF FIRST DAY OF DATA?
NOTE! ALL DATA IN ANY DRY PERIOD MUST BE FROM
THE SAME CALENDAR YEAR. SPLIT PERIODS CROSSING
JAN. 1ST INTO TWO PARTS -- ONE FROM EACH YEAR.
ENTER LAST 2 DIGITS OF YEAR: 19 ____
WHAT IS THE SITE ID CODE (2 LETTERS)? ____
SHOULD THE SEASON BE GROWING (1) OR DORMANT (2)? ____

STANDARD OPERATING PROCEDURE
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DEPOSITION VELOCITY MODEL -- VERSION 87505-SL11

HOW DO YOU WANT THE CALCULATED VD'S TO BE SUMMARIZED?
HOURLY (H), DIURNAL CYCLE (D), OR LINEAR-AVERAGED VD'S (L)
-- HOURLY IS ONE VD FOR EACH HOUR OF MET DATA.
-- DIURNAL IS A MEAN VD FOR EACH HOUR AVERAGED OVER
THE WHOLE PERIOD AND OUTPUT AS 24 HOURLY MEANS.
-- LINEAR AVERAGE (L) IS THE GRAND MEAN FOR THE ENTIRE
DRY PERIOD AND IS THE FORM USED FOR ROUTINE IFS
COMPUTATIONS.

ENTER H, D, OR L ---> _____

HOURLY FILES

THE PROGRAM CAN STORE EACH HOURLY VD CALCULATION
FOR ANALYSIS OF SHORT TERM TRENDS.

WOULD YOU LIKE HOURLY INFO. STORED IN A FILE ON DISK (Y/N)? _____

WOULD YOU LIKE RAW MET DATA STORED IN THE FILE WITH
THE CALCULATED Vd's (Met)?
OR WOULD YOU LIKE THE COMPUTED RESISTANCES STORED WITH
THE CALCULATED Vd's (Res)?

ANSWER M(et) OR R(esistances)---> _____

WOULD YOU LIKE HOURLY RESISTANCES STORED IN FILE:
RESHOUR.DAT (Y/N)? _____

WHAT IS THE NAME OF DESIRED FILE? _____

LINEARLY-AVERAGED FILES

WOULD YOU LIKE THE CALCULATED DRY PERIOD MEAN VD'S STORED TO
DISC IN THE FILE VD.DAT (Y/N)? _____

WHAT IS THE NAME OF THE DESIRED FILE? _____
-- PRESS RETURN FOR NO STORE.

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DORMANT SEASON CANOPY CONSIDERED
SITE: BARTON FLATS PONDEROSA
YEAR: 1992

DO YOU WANT TO (V)IEW RESULTS
OR ALLOW THEM TO (S)CROLL (V/S)?

F09212.PRN							
DAY	TIME	NVD	CWET	DAY	TIME	NVD	CWET
366	100	721	0	366	1300	733	0
366	200	722	0	366	1400	734	0
366	300	723	0	366	1500	735	0
366	400	724	0	366	1600	736	0
366	500	725	0	366	1700	737	0
366	600	726	0	366	1800	738	0
366	700	727	0	366	1900	739	0
366	800	728	0	366	2000	740	0
366	900	729	0	366	2100	741	0
366	1000	730	0	366	2200	742	0
366	1100	731	0	366	2300	743	0
366	1200	732	0	366	2400	744	0

DATA STARTS, JUL. DAY 336 AT 100
DATA ENDS, JULIAN DAY 366 AT 2400

LAST MET DATA FILE COMPLETED
PRESS RETURN TO EXIT

Flats as canopy options 14, 15 and 16, respectively to estimate dry deposition velocities (VD's) from meteorological measurements, canopy leaf area and species, and pollutant characteristics.

Site Characteristics and Meteorological Data

This version of the program is written to read directly from PC files the hourly mean meteorological data from each site, plus some descriptive data on canopy characteristics and site location.

Meteorological Data

The meteorological data are read from either a space- or comma-delimited file. Space delimited files are output from a lotus spreadsheet by doing a print/file command to create a *.PRN file (set the right margin to 240 so the data fit on one line, and use the other/unformatted option). Because of a glitch in the way that lotus outputs these files, you must edlin each *.PRN file before the model will read it correctly. Lotus does not add an EOF marker, which the basic compiler requires to read a space delimited file. Just typing "edlin" and file.Name followed by an "e" is sufficient to add the EOF marker. Comma delimited files are the *.PRN files created when you read your CR-21 meteorological data tapes into the PC using the supplied "tape" program.

File Formats

This version will read the meteorological data in the form of one hour's worth of means (i.e., the way the data is now summarized by the CR-21's) for all variables in a single line of input. Since the CR-21's at most sites output these values on two lines (Tables 1 and 2), the format needs to be edited into one line. This can be done several ways by Basic, Pascal, or Fortran programs, or by creation of a *.PRN file from an appropriately formatted lotus spreadsheet.

Order of Input Variables

This version takes the following order and units of meteorological variables:

1. Data type identification, 1=hourly average==id (program variable name)
2. Year of data == yr
3. Julian day (starting over at 1 each year) = jd
4. Time (ex. 1400); Hour at end of hourly average == ihrmin
5. Julian day + ihrmin/24 == dday
6. Temp (degrees cent.) == Vavat
7. Relative humidity (%) == vavrh

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8. Mean wind speed (m/s) == vavws
9. Mean wind direction (degrees) == vavwd
10. Std. dev. of wind dir., Sigma theta (degrees) == vsdwd
11. Vector wind speed (m/s) == vctrws
12. Vector wind direction (m/s) == vctrwd
13. Maximum wind speed (m/s) == vmwg
14. Minimum wind speed (m/s) == mnws
15. Ozone concentration, ppb == ozne
16. Fraction of hour that wetness sensor was wet == vtwet
17. Solar radiation (watts per sq. Meter) = vavtr
18. Temperature inside shelter (degrees cent.) == Shtmp
19. Datalogger battery voltage == vlts
20. Number of observations in hourly average (except ozone) ==
nsmpls
21. Number of observations in hourly average for ozone ==
no3smpls
22. Datalogger program id == signature

Different Formats

If you want to change the input order, or change from one to two tables of input meteorological data, rewrite the program lines:

```
input
#1, id, yr, jd, ihrmin, dday, vavat, vavrh, vavws, vavwd, vsdwd, vc
trws, vctr
wd, vmwg, mnws, ozne, vtwet, vavtr, shtmp, vlts, nsmpls, no3smpls
, signature
```

(in the main program just inside calcloop) and

```
input
#1, d, year%, jdc%, d, d
(in procedure yearfilevalidity).
```

Site Characteristic Data

This is already in the file "sitechar.dat". Fill it in on the appropriate line of the file as follows: site code (in quotes), site name (in quotes, not to exceed 27 characters), leaf area index for growing season, LAI for dormant season, a code for the canopy type (see comments of procedure setcanopy), [note if you have a mixed canopy, you must run the model once for each canopy type, using the LAI for each individual canopy, and then linearly combine the resultant VD's to represent the full stand (i.e, add the separate VD values for each stand type)], latitude, and longitude (in degrees to nearest tenth), growing season, foliar biomass, and dormant season biomass (in kg/ha). Separate all values by commas.

List of chemical species (includes gases and particles):

- 1 - HNO₃
- 2 - SO₂
- 3 - O₃
- 4 - NO₂
- 5 - NH₃
- 6 - Aerosols (Vg calculated from ra, rb, and rc estimated from sigma theta and windspeed)
- 7 - Particles (two values, one from submicron radionuclide measurement and one ignoring rc, calc from u* & ra, and termed VDpart).

The key program variables are listed below along with the units for estimation

ri=average solar radiation (w/m²)
u=average wind speed (m/sec)
sigth=standard deviation of wind direction (radians)
ntemp=temperature in integer form (deg c)
cwet=0 if canopy not wet, 1 if it is
rainwet=1 if canopy wet with rain, 0 if wet with dew/fog
par=photosynthetically active radiation (w/m²)
rrs=basic stomatal resistance (sec/m)
fe=vapor pressure deficit correction
fw=water stress correction factor
ft=thermal stress correction factor
rrm=mesophyll resistance (sec/m)
rso=overall resistance via stomata (sec/m)
rc=resistance for canopy (sec/m)
ra=aerodynamic resistance (sec/m)
rb=quasi-laminar boundary resistance (sec/m)
r=total resistance (sec/m)
vd=dry deposition velocity (cm/sec)
rsm=minimum stomatal resistance (sec/m)
b=coefficient controlling stomatal conductance (w/m²)
c=limiting cuticular resistance (sec/m)
rlai=leaf area index
rsoil=soil resistance (sec/m)

7.0 **References**

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APPENDIX

PROGRAM STATEMENTS BEGIN BELOW. STATEMENTS WITH , '**', BEFORE THEM ARE COMMENTS EXPLAINING THE PROGRAM STATEMENTS.

```

$INCLUDE "TBWINDO.INC"          '**LIBRARY CONTAINING WINDOW PROPERTIES.
GOSUB PRINTWINDOW              '**PROMPT USER FOR PRINTER USE (QPRNTR$).

**DECLARE AND INITIALIZE VARIABLES, ARRAYS, AND CONSTANTS.

DEFINT I-N: DEFSNG A-H,O-Z: OPTION BASE 1

**INITIALIZE RB (BOUNDARY RESISTANCE),RC (CANOPY RESISTANCE).
**INITIALIZE VD (DEP. VEL'S),VDPART (PARTICLE DEPOSITION VELOCITIES).
**INITIALIZE R (TOTAL RESISTANCE),SC (SCHMIDT NUMBER),C (CUTICULAR
RES.).

DIM RB(6),RC(6),VD(6,1000),VDPART(1000),R(6),SC(6),C(6),AVVD(6),DFN$(20)

**INITIALIZE RSO (STOMATAL RESISTANCE),RSOIL (SOIL RESISTANCE).
**INITIALIZE RBAV() (AVERAGE BOUNDARY RESISTANCE).
**INITIALIZE RCAV() (AVERAGE CUTICULAR RESISTANCE).

DIM RSO(6),RBAV(6),RCAV(6),RSOIL(6)

DIM AVVDLAV(6)
NVDLAV=0: AVDPLAV=0: MAXVD=1000: TOPT=0   '**MAXVD IS MAX # OF DEP.
VELS.
DIM AVVDWK(6,24),NVDWK(24),AVDPWK(24)

'ASSIGN SCHMIDT NUMBER (SC()) VALUES TO CORRESPONDING ARRAY LOCATIONS.
'EXAMPLE: SC(1) CORRESPONDS TO SPECIES #1 (HNO3)
'SPECIES ARE LISTED AMONG LINES 730-810
SC(1)=1.07: SC(2)=1.25: SC(3)=1.07: SC(4)=1.07: SC(5)=1.07:SC(6)=10000

'ASSIGN LIMITING CUTIC. RESISTANCES (C()) TO CORRESPONDING ARRAY
LOCATIONS.
C(1)=.005: C(2)=5000!: C(3)=10000!: C(4)=10000!:C(5)=5000!:C(6)=.005

'ASSIGN SOIL RESISTNACE (RSOIL()) VALUES TO CORRESPONDING ARRAY
LOCATIONS.
RSOIL(1)=1000!: RSOIL(2)=1500!: RSOIL(3)=1500!:RSOIL(4)=1500!
RSOIL(5)=1500!: RSOIL(6)=1500!

PR=.15/.25: HRSDATA=0: AVMF=0           '** PR IS PRANDTL NUMBER.
PI=3.141592: FIR=.54                   '** FIR IS FRACTION OF RADIATION THAT IS
INFRARED.
RADCON=PI/180!                         '** CHANGES DEGREES TO RADIANS.

FOR I=1 TO MAXVD                       '**INITIALIZE VDPART() AND VD( , ) ARRAYS.
VDPART(I)=-1!: FOR J=1 TO 6: VD(J,I)=-1!: NEXT J
NEXT I:BEEP
NSPEC=6:K=1                            '**NSPEC REPRESENTS THE NUMBER OF SPECIES, K COUNTS FILES.
VERSION$="DEPOSITION VELOCITY MODEL -- VERSION 87507-SL11" '**WINDOW

```

TITLE.

```
GOSUB DATEnFILES      '**PROMPT USER FOR DATE AND MET FILE NAMES.
GOSUB VERIFYQUALITY  '**VERIFY THAT FILES HAVE BEEN CHECKED FOR QUALITY.
GOSUB YEARnFILEVALIDITY '**PROMPT FOR YEAR AND CHECK THAT FILES CONTAIN
                        '**PROPER YEAR AND JULIAN DAY INFORMATION.
GOSUB SITEnSEASON    '**PROMPT USER FOR SITE CODE AND SEASON.
GOSUB SUMMARYREQUEST '**PROMPT USER FOR LINEAR, DIURNAL, OR HOURLY
                        '**SUMMARY.
GOSUB SETCANOPY      '**SET CANOPY VALUES FOR SPECIFIED SITE.
GOSUB OUTPUTFORMATS '**INITIALIZE OUTPUT FORMATS FOR
SCREEN, FILES, PRINTER.
```

K=1

```
'**RESET FILE COUNTER.
FILELOOP:
'**LOOP TO READ MET. FILES STARTS HERE.
IF DFN$(K)=".PRN" THEN GOTO OKEXIT  '**IF NO FILES TO PROCESS, JUMP
TO PROGRAM
'**SUMMARIZATION.
IF QPRINTR$="Y" THEN GOSUB LPRINTSTARTFILE ELSE GOSUB
STARTFILEWINDOW
```

```
OPEN DFN$(K) FOR INPUT AS #1      '**DFN$(K) REPRESENTS USER-ENTERED
MET.FILE.
```

NVD=0:STARTD=0:STARTT=0:ROW%=2:COL%=1:LOOPCOUNT%=1

```
'**NVD IS THE NUMBER OF DEPOSITION VELOCITIES
'**STARTD IS THE STARTING JULIAN DAY
'**STARTT IS THE STARTING TIME
'**ROW%,COL%, AND LOOPCOUNT% DETERMINE OUTPUT LOCATIONS WITHIN WINDOW
```

```
GOSUB SCROLLWINDOW '**PROMPT USER FOR VIEWABLE OR SCROLLING SCREEN
                        '**OUTPUT.
GOSUB OUTPUTWINDOW  '**CREATE WINDOW TO DISPLAY CALCULATION RESULTS.
CALCLOOP:
IF EOF(1)<>0 THEN GOTO OUTFLOOP  '**IF END OF FILE, JUMP TO END OF
CALC. LOOP.
```

```
'**INPUT DATA FROM USER SPECIFIED MET. FILE.
'**NOTE! THIS VERSION SET UP FOR IFS DATA FROM LOTUS *.PRN FILE(22
VARS).
'**LISTING OF INPUT ORDER AND VARIABLE DEFINITIONS FOUND AMONG
' '**COMMENTED LINES 440-670.
```

```
INPUT      #1, ID, YR, JD, IHRMIN, DDAY, VAVAT, VAVRH, VAVWS, VAVWD, VSDWD, VCTRWS,
VCTRWD, VMWG, MNWS, OZNE, VTWET, VAVTR, SHTMP, VLTS, NSMPLS, NO3SMPLS,
SIGNATURE
```

```
IF NVD<>0 THEN GOTO INCNVD
IF QPRNTR$="N" THEN GOTO SETSTART LPRINT "DATA STARTS --> JULIAN DAY
";JD;" AT ";IHRMIN:GOTO SETSTAR
SETSTART: STARTD=JD:STARTT=IHRMIN      '**STORE STARTING JULIAN
```

```

DAY AND TIME.
INCNVD:
NVD=NVD+1                '**INCREMENT VELOCITY DEPOSITION NUMBER.

'**PERFORM CALCULATIONS

U=VAVWS: IF U>90! OR U<0! THEN GOTO OUTFRANGE
SIGTH=VSDWD: IF SIGTH=0! THEN SIGTH=.0001 ELSE IF SIGTH>90! THEN GOTO
OUTFRANGE
RI=VAVTR: IF RI>1600 OR RI<-10 THEN GOTO OUTFRANGE ELSE IF RI<1! THEN
RI=1!
SIGTH=SIGTH*RADCON: IF RI<10! AND SIGTH>.2 THEN SIGTH=.2
IF VAVR>90! OR VAVAT<-50 THEN GOTO OUTFRANGE
IF VAVRH<50 AND VAVAT<-45 THEN GOTO OUTFRANGE '**MEANS T OR RH SENSOR
OUT
CWET=0:RAINWET=0

'** WETNESS TESTS, MUST BE WET >50% OF THE HOUR TO BE WET
'** CWET = 1 WHEN WETNESS > 50%, CWET = 0 WHEN WETNESS <=50%

IF VTWET>.5 AND VTWET <=1 THEN CWET=1
IF VTWET<=.5 AND VAVRH>98! AND VAVRH<110! THEN CWET=1
IF VAVRR<50 AND VAVRR>0! THEN CWET=1
IF CWET=0 THEN RAINWET=0 ELSE IF CWET=1 AND VAVRR>0 AND VAVRR<50 THEN
RAINWET=1
IF QAV$="H" AND QPRNTR$="Y" THEN LPRINT
"WS-----SIGTHETA-----RAD'N----- WETNESS"
IF QAV$="H" AND QPRNTR$="Y" THEN LPRINT U,SIGTH,RI,CWET
IF RI<=1! THEN GOTO SPECLOOP

'**COMPUTE THE SOLAR ELEVATION ANGLE (BETA)

RL=(CSNG(IYR)-1977!)*365!+CSNG(JD)+28123!
X=(-1!+.9856*RL)*RADCON
D=2!*.0167*SIN(X)+1.25*.01674^2*SIN(2!*X)
S=(-79.828+.9856*RL)*RADCON+D
D2=SIN(23.44*RADCON)
BS1=D2*SIN(S)
DEC=ATN(BS1/SQR(-BS1*BS1+1!))
SINDEC=SIN(DEC): COSDEC=COS(DEC)
E=9.4564*SIN(2!*S)/COSDEC-4!*D/RADCON
E=E/60!
SINLAT=SIN(RLATA*PI/180!): COSLAT=COS(RLATA*RADCON)
R=(75!-RLONG)/15!
TIM024=IHRMIN/100!
SOLTIM=TIM024+R+E
HRANGL=(SOLTIM-12!)*.2618
COSHR=COS(HRANGL)
BS2=SINLAT*SINDEC+COSLAT*COSDEC*COSHR
BETA=ATN(BS2/SQR(-BS2*BS2+1!)) '**ELEVATION ANGLE OF SUN IN RADIANS
IF BETA<=0! THEN BETA=.01
ZEN=PI-BETA '**ZENITH ANGLE
RU=35!/(1224!*COS(ZEN)*COS(ZEN)+1!)^.5
RDVIS=600!*2.7182^(-.185*RU)*COS(ZEN)

```

```

RSVIS=.4*(600!-RDVIS)*COS(ZEN)
WA=1320!*.077*(2!*RU)^.3
RDIR=(720!*2.7182^(-.06*RU)-WA)*COS(ZEN)
RSIR=.6*(720!-WA-RDIR)*COS(ZEN)
RVT=RDVIS+RSVIS
RIT=RDIR+RSIR
RATIO=RI/(RVT+RIT)
FVSB=RDVIS/RVT*(1!-((.9-RATIO)/.7)^.67) '**FRACTION OF LIGHT THAT IS
    BEAM
FVD=1-FVSB '**FRACTION OF LIGHT THAT IS DIFFUSE

'**BIG-LEAF COMPUTATION OF STOMATAL RESISTANCE WEIGHTED ACCORDING TO
' '**SUNLIT AND SHADED LEAF AREA AND THE PAR ON THOSE LEAVES

PARBEAM=FVSB*RI*(1!-FIR)
PARDIFUS=FVD*RI*(1!-FIR)*.5 '**PAR FOR SHADED LEAVES
RLSUN=2!*(1!-EXP(-.5/SIN(BETA))*RLAI)*SIN(BETA)
RLSHADE=RLAI-RLSUN
PARB=PARBEAM*.5/SIN(BETA)+PARDIFUS '**PAR FOR SUNLIT LEAVES
DEF FNRSTOM(PAR)=RSM+B*RSM/PAR
GOTO SPECLOOP

'**OUTPUT TO UNIT #3 AND THE SCREEN THE DATE AND TIME OF BAD DATA TO
    AVOID
' '**SKIPPED RECORD ( FOR CONTINUITY)

OUTOFRANGE:
REM IF DFOUT$<>" THEN PRINT #3, USING "#####";JD,IHRMIN
REM IF DFOUT$<>" THEN PRINT #3, "OUT OF RANGE DATA FOUND AS NOTED
    ABOVE"
CALL PRTWINDOW(ROW%,COL%,"OUT OF RANGE DATA AT DAY=")
CALL PRTWINDOW(ROW%,COL%+25,STR$(JD))
CALL PRTWINDOW(ROW%,COL%+30,"TIME=")
CALL PRTWINDOW(ROW%,COL%+35,STR$(IHRMIN)):ROW%=ROW%+1:COL%=COL%+1 BEEP
IF QPRNTR$="Y" THEN LPRINT "*****OUT OF RANGE

IF QAV$="H" THEN GOTO FILECONT ELSE GOTO FILECLOSE
SPECL OOP:
FOR I=1 TO NSPEC '**LOOP TO DETERMINE VALUES FOR SPECIES OF LINES
    880-970
IF RI>1! THEN RRS=(RLSUN/FNRSTOM(PARB)+RLSHADE/FNRSTOM(PARDIFUS))^-1
    ELSE
RRS=2000!
FE=1!
FW=1!
IF TOPT=0 THEN FT=1: GOTO DORRS
IF ICANPY=5 THEN FT=1!: GOTO DORRS '** ONLY IF CANOPY IS BARE SOIL
IF ICANPY=7 THEN FT=1!: GOTO DORRS '**IF CANOPY IS LOB PINE
IF VAVAT<=TMIN OR VAVAT>=TMAX THEN FT=.001: GOTO DORRS
TBETA=(TMAX-TOPT)/(TOPT-TMIN): TA=1!/((TOPT-TMIN)*((TMAX-TOPT)^TBETA))
FT=TA*(VAVAT-TMIN)*((TMAX-VAVAT)^TBETA)
DORRS:
RRS=RRS/(FE*FW*FT)
RRS=RRS*SC(I)/PR

```

```

RRM=0!
RSO(I)=RRS+RRM: IF RSO(I)=0! THEN RSO(I)=.001 ELSE IF RSO(I)>10000! THEN
  RSO(I)=10000!

  *** ACCOUNT FOR CUTICULAR RESISTANCE AND LEAF AREA INDEX.
  *** CONSIDER CANOPY WETNESS WHEN CALC. CANOPY RESISTANCE.

IF CWET=0 THEN RC(I)=(RSO(I)^-1+RLAI/C(I))^-1: GOTO DOAEROSOLS
IF I=1 THEN RC(I)=1!
  *** HNO3 ONLY
IF (I=2 OR I=5) AND RAINWET=0 THEN RC(I)=250!/RLAI  ***SO2 OR NH3
  (DEW/FOG)
IF (I=2 OR I=5) AND RAINWET=1 THEN RC(I)=1000!  ***SO2 OR NH3 (RAIN)
IF (I>=3 AND I<=5) THEN RC(I)=1000!  *** OZONE, NO2, AND AEROSOLS
  *** ACCOUNT FOR SOIL RESISTANCE

DOAEROSOLS:
IF I<=6 THEN RC(I)=((RC(I)^-1)+(RSOIL(I)^-1))^-1 ELSE
  RC(I)=(U*SIGTH)*100
IF CWET=0 THEN GOTO NEXTI  *** CONSIDER CANOPY WETNESS WHEN DETERMINING
  RC

  *** IF WETNESS DETECTED, THEN LIMIT SPECIES 1-5
ON I GOTO IJUMPB,IJUMPA,IJUMPA,IJUMPA,IJUMPA,IJUMPA,JUMPAEROSOL
IJUMPA:
IF RC(I)>1000 THEN RC(I)=1000!
GOTO JUMPAEROSOL
IJUMPB:
IF RC(I)>.2 THEN RC(I)=.2  *** FOR AEROSOLS, USE DOUBLE-SIDED LAI
JUMPAEROSOL:
IF I=6 THEN RC(I)=RC(I)/2!
NEXTI:
NEXT I
RADN=U*SIGTH*SIGTH
IF SIGTH>.175 AND RI>100! THEN RA=9!/RADN ELSE RA=4!/RADN
  ***SIGTH OF .175=10 DEGREES
  *** SL HAS REVISED THE ORIGINAL MINIMUM U VALUES TO MATCH CSI ANEMOMETER
  ***CHARACTERISTICS
IF U<.48 AND RI<100! THEN RA=1500!: U=.12
IF U<.48 AND RI>=100! THEN RA=10!: U=.12
USTAR=(U/RA)^.5  ***ESTIMATE THE VDPART FROM U* (= FROM RA, U, AND
  SIGTHET)
VDPART(NVD)=(1!/(.002*USTAR)+RA)^-1
IF SIGTH>.175 AND RI>100! THEN VDPART(NVD)=(1!/(.02*USTAR)+RA)^-1
VDPART(NVD)=VDPART(NVD)*100!  *** CONVERT FROM m/sec TO cm/sec
FOR I=1 TO NSPEC
RB(I)=2!*(1!/(.4*USTAR))
RB(I)=RB(I)*(SC(I)/PR)^(2!/3!)
R(I)=RA+RB(I)+RC(I)
VD(I,NVD)=100!/R(I)
NEXT I

  *** OUTPUT VD RESULTS TO DISC, PRINTER, OR SCREEN.

```

```

IF DFOUT$="" THEN GOTO FILECONT      '**IF NO STORE, JUMP OVER STORAGE
INSTRUCTIONS
IF NVD>1 THEN GOTO PRINTFILE      '**PRINT TO FILE THE SITE, YEAR, AND
SEASON
REM      PRINT #3,NSTLOC$,IYR;"SEASON=";LOPT;"(1=GROWING, 2=DORMANT)"
'**PRINT TO FILE THE VARIABLE NAMES
REM      PRINT #3,"VAR'S= DAY,TIME, [PLUS WS, WD,SIGTHET,T,RH,RN, &
WETNESS IF REQUESTED] [OR PLUS RA, RB(HNO3,SO2,O3,NH3), AND
RC(HNO3,SO2,O3,NH3) IF REQUESTED]"
'**PRINT CALCULATED INFORMATION TO FILE
REM      PRINT #3,"AND VDHNO3, VDS02, VD03, VDNO2, VDNH3,VDAERO,
VD(submicron radionuclides) & VD(part)"
PRINTFILE:
IF OUTFORM$="R" THEN PRINT #3, USING FORMOUT1$;
JD;IHRMIN;RA;RB(1);RB(2);RB(3);RB(4);RB(5);RB(6);RC(1);RC(2);RC(3);RC(4)
;RC(5);RC(6);VD(1,NVD);V
D(2,NVD);VD(3,NVD);VD(4,NVD);VD(5,NVD);VD(6,NVD);VDPART(NVD);OZNE:GOTO
FILECONT
IF OUTFORM$="M" THEN PRINT #3, USING FORMOUT2$;
JD;IHRMIN;U;VAVWD;SIGTH;VAVAT;VAVRH;RI;VTWET;VD(1,NVD);VD(2,NVD);VD(3,NV
D);VD
(4,NVD);VD(5,NVD);VD(6,NVD);VDPART(NVD)
FILECONT:
IHRNDX=IHRMIN/100

'**LOOPCOUNT DETERMINES THE LOCATION OF THE OUTPUT TO BE DISPLAYED
'**WITH RELATION TO ROW% AND COL%

IF LOOPCOUNT%=13 THEN ROW%=2
IF LOOPCOUNT%>12 THEN COL%=42
IF LOOPCOUNT%<25 THEN GOTO DODISPLAY
IF SCROLL$="S" THEN GOTO SETLOCATION
GOSUB VIEWMORE      '**PROMPT USER TO CONTINUE VIEWING SCREEN OUTPUT.
SETLOCATION:
LOOPCOUNT%=1:ROW%=2:COL%=1
DODISPLAY:
GOSUB OUTPUTDISPLAY      '**DISPLAY OUTPUT WITHIN OUTPUT WINDOW.
ROW%=ROW%+1:LOOPCOUNT=LOOPCOUNT+1      '**INCREMENT ROW% AND LOOPCOUNT.
IF QAV$<>"H" THEN GOTO LNR
IF QPRNTR$="N" THEN GOTO LNR

'**PRINT THE HOURLY CALCULATED VD'S AND RESISTANCES

LPRINT USING FORM1$;JD,IHRMIN,NVD,RA,RB(1),RC(1),VD(1,NVD)
LPRINT USING FORM2$;RA,RB(2),RC(2),VD(2,NVD)
LPRINT USING FORM3$;RA,RB(3),RC(3),VD(3,NVD)
LPRINT USING FORM4$;RA,RB(4),RC(4),VD(4,NVD)
LPRINT USING FORM5$;RA,RB(5),RC(5),VD(5,NVD)
LPRINT USING FORM6$;RA,RB(6),RC(6),VD(6,NVD)
LPRINT USING FORM7$;VDPART(NVD):LPRINT
GOTO ISEOF
'** AVERAGE TIMES TOGETHER TO GET DIURNAL CYCLE (24 TABLES)
LNR:
IF QAV$="L" THEN GOTO SUMHOURLY

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IF NVD>1 THEN GOTO SKIPINIT1
FOR M=1 TO 24
FOR L=1 TO NSPEC: AVVDWK(L,M)=0!: NEXT L
NVDWK(M)=0: AVDPWK(M)=0!
NEXT M
SKIPINIT1:
IF VD(1,NVD)<0! THEN GOTO ISEOF
FOR L=1 TO NSPEC: AVVDWK(L,IHRNDX)=AVVDWK(L,IHRNDX)+VD(L,NVD): NEXT L
NVDWK(IHRNDX)=NVDWK(IHRNDX)+1: AVDPWK(IHRNDX)=AVDPWK(IHRNDX)+VDPART(NVD)
GOTO ISEOF
'***SUM THE HOURLY VALUES FOR CALC. OF GRAND MEANS FOR ENTIRE PERIOD.
SUMHOURLY:
IF NVD>1 THEN GOTO SKIPINIT2
FOR L=1 TO NSPEC
AVVD(L)=0!: RBAV(L)=0!: RCAV(L)=0!
NEXT L: N=0: AVVDP=0!: RAAV=0!
SKIPINIT2:
IF VD(1,NVD)<0 THEN GOTO ISEOF
FOR L=1 TO NSPEC: AVVD(L)=AVVD(L)+VD(L,NVD): RBAV(L)=RBAV(L)+RB(L):
RCAV(L)=RCAV(L)+RC(L): NEXT L
AVVDP=AVVDP+VDPART(NVD): RAAV=RAAV+RA: N=N+1
ISEOF:
IF EOF(1)<>0 THEN GOTO OUTFLOOP
GOTO CALCLOOP '***THIS IS THE END OF THE OVERALL CALC. LOOP
OUTFLOOP:
CLOSE #1: IF QPRNTR$="Y" THEN LPRINT "DATA ENDS --> JULIAN DAY ";JD;" AT
";IHRMIN:
LPRINT
IF QPRNTR$<>"N" THEN GOTO AVEDIURNAL
GOSUB ENDFILEWINDOW '***DISPLAY ENDING FILE INFORMATION.

'***IF QAV$=L (LINEAR SUMMARY) DISPLAY MESSAGE OF HOURLY AVERAGING
IF QAV$="L" THEN CALL PRTWINDOW(3,2,"*** VD'S AVERAGED FOR ALL
DATA"):GOTO
DISPMEANS

AVEDIURNAL:
IF QAV$="H" AND QPRNTR$="Y" THEN GOTO FILECLOSE ELSE IF QAV$="H" THEN
GOTO INCK
'*** AVE. THE DEP. VELOCITIES BY HOUR OF DAY AND OUTPUT THEM FOR DIURNAL
' '***CYCLE
FOR M=1 TO 24
IF NVDWK(M)=0 THEN GOTO NEXTM
FOR L=1 TO NSPEC: AVVDWK(L,M)=AVVDWK(L,M)/NVDWK(M): NEXT L
AVDPWK(M)=AVDPWK(M)/NVDWK(M)
ITIME=(M*100)
IF QPRNTR$="N" THEN GOTO INCK
LPRINT USING FORMW1$;ITIME,NVDWK(M),AVVDWK(1,M)
LPRINT USING FORMW2$;AVVDWK(2,M)
LPRINT USING FORMW3$;AVVDWK(3,M)
LPRINT USING FORMW4$;AVVDWK(4,M)
LPRINT USING FORMW5$;AVVDWK(5,M)
LPRINT USING FORMW6$;AVVDWK(6,M)
LPRINT USING FORMW7$;AVDPWK(M):LPRINT

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NEXTM:
NEXT M
GOTO FILECLOSE
DISPMEANS:
  **PRINT OR DISPLAY THE GRAND MEANS (WHEN LINEAR CALCULATIONS
  REQUESTED).
  IF NVD=0 AND QPRNTR$="Y" THEN LPRINT "NO DATA AVAILABLE FOR
  CALCULATIONS":
  LPRINT: GOTO FILECLOSE
  IF NVD=0 AND QPRNTR$="N" THEN CALL PRTWINDOW(3,10,"NO DATA AVAILABLE FOR
  CALCULATIONS"): GOTO FILECLOSE
  FOR L=1 TO NSPEC:
  AVVD(L)=AVVD(L)/NVD:RBAV(L)=RBAV(L)/NVD:RCAV(L)=RCAV(L)/NVD: NEXT
  AVVDP=AVVDP/NVD:RAAV=RAAV/NVD
  IF QPRNTR$="N" THEN GOTO MEANVIEW
  **PRINT THE GRAND MEAN CALCULATED VD'S AND RESISTANCES
  LPRINT USING FORML1$;NVD,RAAV,RBAV(1),RCAV(1),AVVD(1)
  LPRINT USING FORML2$;RAAV,RBAV(2),RCAV(2),AVVD(2)
  LPRINT USING FORML3$;RAAV,RBAV(3),RCAV(3),AVVD(3)
  LPRINT USING FORML4$;RAAV,RBAV(4),RCAV(4),AVVD(4)
  LPRINT USING FORML5$;RAAV,RBAV(5),RCAV(5),AVVD(5)
  LPRINT USING FORML6$;RAAV,RBAV(6),RCAV(6),AVVD(6)
  LPRINT USING FORML7$;AVVDP: LPRINT
  GOTO FILECLOSE
  MEANVIEW:
  GOSUB VIEWMEANS          **PROMPT USER TO VIEW CALCULATED LINEAR MEANS.
  GOSUB DISPLAYMEANS      **DISPLAY CALCULATED LINEAR MEANS.

  **PREPARE TO WRITE TO FILE VDOUT$
  IF VDOUT$="" THEN GOTO FILECLOSE ELSE OPEN VDOUT$ FOR APPEND AS #2
  IF LOPT=1 THEN SEAS$="GS" ELSE SEAS$="DS"
  ** PRINT TO FILE VDOUT$ VARIABLES: VAR'S: SITE-ID, YEAR, SEASON,
  ** DRYEXP#, END-DAY, VDHNO3, VDSO2, VDO3, VDNO2, VDNH3, VDAERO,
  ** VD(PART)
  PRINT #2, USING FORMOUT3$;NSTID$,IYR,SEAS$,DRYXNO$,JD,AVVD(1),AVVD(2),
  AVVD(3),AVVD(4),AVVD(5),AVVD(6),AVVDP
  FILECLOSE:
  BEEP:CLOSE INCK:
  K=K+1
  IF DFN$(K)=".PRN" GOTO OKEXIT **IF NO MORE FILES, JUMP TO CLOSING.
  GOSUB VIEWNEXTFILE **PROMPT USER TO BEGIN PROCESSING NEXT FILE.
  GOTO FILELOOP **LOOP TO PROCESS NEXT FILE.
  OKEXIT:
  GOSUB EXITWINDOW **PROMPT USER TO EXIT PROGRAM.
  GOTO TERMINATE **GO TO END OF PROGRAM.

  **ASSIGN VALUE TO WARNING$ FOR DISPLAY IN WARNING WINDOW BADJD:
  WARNING$="ERROR IN INPUT DATA -- FILE DOES NOT BEGIN WITH A PROPER
  JULIAN DAY#"
  COL%=3 **SET COL% TO ALLOW FOR APPROPRIATE POSITION IN WARNING
  WINDOW
  GOTO WARNINGWINDOW **JUMP TO CREATE WARNING WINDOW
  **SET VALUE TO WARNING$ AND COL%
  NOFILES:

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WARNING$="NO MET DATA FILES HAVE BEEN ENTERED":COL%=19
WARNINGWINDOW:
CALL QFILL(1,1,25,80,32, FNATTR%(15,1)) COLOR 0,7
  **CREATE A WINDOW TO DISPLAY A WARNING MESSAGE BEFORE PROGRAM
  TERMINATION
CALL MAKEWINDOW(9,5,6,73, FNATTR%(0,7),2,0,0)
CALL TITLEWINDOW(2,DFN$(K))
CALL PRTWINDOW(2,COL%,WARNING$)
CALL PRTWINDOW(3,21,"THE PROGRAM MUST BE TERMINATED")
CALL PRTWINDOW(4,25,"*****PRESS RETURN*****")
LOCATE 13,35:INPUT,TERM$:CALL REMOVEWINDOW **PROMPT FOR
EXIT AND **REMOVE WARNING WINDOW.
TERMINATE:
CLS
END **CLEAR SCREEN AND END PROGRAM

/*****
PRINTWINDOW:
  **CREATE WINDOW AND PROMPT FOR USER INPUT REGARDING PRINTER OUTPUT.
  THE
  **ASSIGNED VARIABLE IS QPRNTR$.

CALL QFILL(1,1,25,80,32, FNATTR%(0,7))
CALL MAKEWINDOW(2,16,6,53, FNATTR%(15,1),2,1,1)
CALL PRTWINDOW(2,6,"WOULD YOU LIKE PRINTER OUTPUT (Y/N)?")
STG$=SPACE$(1) **STG$ REPRESENTS THE SIZE OF THE INPUT BOX IN THE
WINDOWS
CALL PRTWINDOW(3,8,"ANSWER (Y)es OR (N)o")
INPUTBOX1:
LOCATE 4,59:PRINT STG$ **CREATE BOX IN WINDOW FOR INPUT
LOCATE 4,59:INPUT,QPRNTR$ **INPUT USER SELECTION FROM KEYBOARD
  **CHECK THAT INPUT STRING DOESN'T CONSIST OF MORE THAN ONE CHARACTER.
IF LEN(QPRNTR$)>1 THEN STG$=SPACE$(LEN(QPRNTR$)):GOTO INPUTBOX1
QPRNTR$=UCASE$(QPRNTR$) **CONVERT ALL SELECTIONS TO UPPERCASE
  **CHECK VALIDITY OF INPUT
IF QPRNTR$<>"Y" AND QPRNTR$<>"N" OR QPRNTR$="" THEN GOTO INPUTBOX1
CALL REMOVEWINDOW
IF QPRNTR$="Y" THEN LPRINT
CHR$(27);CHR$(15);"-----ATDD DEPOSITION VELOCITY MODEL
----- VERSION 87057-SL11-----":LPRINT RETURN

/*****
DATEnFILES:
  **CREATE WINDOW TO PROMPT FOR DATE AND FILE NAMES. VARIABLES ASSIGNED
  ARE
  **TODAT$ AND DFN$().
CALL MAKEWINDOW(2,9,21,66, FNATTR%(15,1),2,1,1)
CALL TITLEWINDOW(2,VERSION$)
CALL PRTWINDOW(2,5,"WHAT IS TODAY'S DATE?")
CALL PRTWINDOW(3,7,"...PRESS RETURN TO IGNORE") **MAKE DATE ENTRY
OPTIONAL
STG$=SPACE$(18)
LOCATE 5,43:PRINT STG$:LOCATE 5,43:INPUT,TODAT$
  **PROMPT FOR DATE

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CALL PRTWINDOW(5,5,"ENTER THE MET DATA SET FILE NAMES --")
CALL PRTWINDOW(6,7,"UP TO 20 DIFFERENT MET FILES CAN BE HANDLED
SEQUENTIALLY.")
CALL PRTWINDOW(7,7,"THEY MUST BE FROM THE SAME SITE, SEASON, AND YEAR.")
CALL PRTWINDOW(9,5,"ENTER NAME WITHOUT EXTENSION--(.PRN IS ADDED
AUTOMATICALLY)")
CALL PRTWINDOW(10,5,"WHAT IS MET DATA FILE NAME?--PRESS RETURN IF ALL
HAVE BEEN")
CALL PRTWINDOW(11,5,"ENTERED: ")
  **ROW% AND COL% ALLOW FOR INPUT DISPLAY OF MULTIPLE FILES
STG$=SPACE$(8):COL%=14:ROW%=14 INPUTBOX2:
LOCATE ROW%,COL%:PRINT STG$:LOCATE ROW%,COL%:INPUT,DFN$(K) 'PROMPT FOR
FILE
  **CHECK THAT THE FILE NAME LENGTH DOESN'T EXCEED 8 CHARACTERS
IF LEN(DFN$(K))>8 THEN STG$=SPACE$(LEN(DFN$(K))):GOTO INPUTBOX2
DFN$(K)=DFN$(K)+".PRN" ** ADD .PRN TO ENTERED FILE NAME
IF DFN$(K)=".PRN" GOTO KNUMBER **".PRN" MEANS THE LAST FILE HAS BEEN
ENTERED
K=K+1:ROW%=ROW%+1 **INCREMENT K AND ROW%
IF ROW%<=19 AND K<=20 THEN GOTO INPUTBOX2 **DETERMINE POSITION OF
INPUT BOX
IF K>20 GOTO KNUMBER
  **ALLOW UP TO 20 FILES
COL%=COL%+20:ROW%=13:GOTO INPUTBOX2
KNUMBER:
IF K=1 THEN GOTO NOFILES **IF K=1, NO FILES WERE ENTERED; END PROGRAM
NUMFILE%=K 'NUMBERFILES% REPRESENTS NUMBER OF FILES ENTERED
RETURN

*****
VERIFYQUALITY:
  **CREATE WINDOW TO DISPLAY #OF FILES TO BE READ AND PROMPT FOR QUALITY
  **VERIFICATION CHECK.
CALL MAKWINDOW(5,12,7,65,FNATTR%(15,4),2,1,1)
CALL PRTWINDOW(1,2,"THE NUMBER OF DATA SETS TO BE READ IS:")
CALL PRTWINDOW(1,41,STR$(NUMFILE%-1)) 'DISPLAY NUMBER OF FILES TO BE
READ
CALL PRTWINDOW(3,2,"HAVE THESE MET FILES BEEN CHECK FOR QUALITY (Y/N)?")
STG$=SPACE$(1) **RESET INPUT BOX SIZE
  **PROMPT FOR RESPONSE AND CHECK ITS VALIDITY
INPUTBOX3:
LOCATE 8,65:PRINT STG$:LOCATE 8,65:INPUT,QAQC$
IF LEN(QAQC$)>1 THEN STG$=SPACE$(LEN(QAQC$)):GOTO INPUTBOX3
QAQC$=UCASE$(QAQC$)
IF QAQC$<>"Y" AND QAQC$<>"N" OR QAQC$="" THEN GOTO INPUTBOX3
IF QAQC$="Y" THEN GOTO VQEND **IF FILES CHECKED FOR QUALITY, CONTINUE
STG$=SPACE$(1):CALL PRTWINDOW(5,2,"DO YOU WANT TO USE QUESTIONABLE DATA
IN CALCULATIONS (Y/N)?")
  **PROMPT FOR RESPONSE AND CHECK ITS VALIDITY
INPUTBOX4:
LOCATE 10,74:PRINT STG$:LOCATE 10,74:INPUT,QQDAT$
IF LEN(QQDAT$)>1 THEN STG$=SPACE$(LEN(QQDAT$)):GOTO INPUTBOX4
QQDAT$=UCASE$(QQDAT$)

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IF QQDAT$ <> "N" AND QQDAT$ <> "Y" OR QQDAT$ = "" THEN GOTO INPUTBOX4
**GOTO END OF PROGRAM IF QUESTIONABLE DATA ISN'T DESIRED IN
  CALCULATIONS
IF QQDAT$ = "N" THEN CALL REMOVEWINDOW:CALL REMOVEWINDOW:GOTO
TERMINATE
VQEND:
CALL REMOVEWINDOW:CALL REMOVEWINDOW
RETURN

/*****
YEARnFILEVALIDITY:
**CREATE WINDOW TO PROMPT FOR THE CALENDER YEAR AND CHECK ITS VALIDITY.
**IF THE YEAR IS INCORRECT, A WARNING MESSAGE IS DISPLAYED AND THE YEAR
  IS
**ASSIGNED TO CORRESPOND WITH THE YEAR LISTED WITHIN THE FILE.
**CHECK FILE VALIDITY -- A FILE IS VALID IF IT HAS AN APPROPRIATE JULIAN
  DAY
**READ AS THE THIRD VARIABLE FROM THE MET FILE. IF A PROPER JULIAN DAY
  DOES
**NOT EXIST, A WARNING MESSAGE IS DISPLAYED AND THE PROGRAM IS
  TERMINATED.
CALL MAKEWINDOW(2,9,15,66, FNATTR%(15,1),2,1,1)
CALL TITLEWINDOW(2,VERSION$)
CALL PRTWINDOW(2,5,"WHAT IS YEAR OF FIRST DAY OF DATA?")
CALL PRTWINDOW(3,10,"NOTE! ALL DATA IN ANY DRY PERIOD MUST BE FROM")
CALL PRTWINDOW(4,10,"THE SAME CALENDAR YEAR. SPLIT PERIODS CROSSING")
CALL PRTWINDOW(5,10,"JAN. 1ST INTO TWO PARTS -- ONE FROM EACH YEAR.")
CALL PRTWINDOW(6,5,"ENTER LAST 2 DIGITS OF YEAR: 19")
STG$=SPACE$(2) **RESET INPUT BOX SIZE
**PROMPT FOR DATA YEAR AND CHECK ITS VALIDITY
INPUTBOX5:
LOCATE 8,46:PRINT STG$:LOCATE 8,46:INPUT,YR%
**LINE 1535 CONTAINS THE FUNCTION STR$( ). IT CONVERTS AN INTEGER VALUE
**TO A STRING. HOWEVER, IT INSERTS A SPACE IN FRONT OF THE STRING.
  THUS,
**THE NEXT LINE COMPARES LENGTH VALIDITY OF THE STRING WITH 3 NOT 2.
YR$=STR$(YR%):IF LEN(YR$)>3 THEN STG$=SPACE$(LEN(YR$)-1):GOTO INPUTBOX5
IYR%=YR%+1900
FOR K=1 TO NUMFILE%-1 **START LOOP TO CHECK F-1 FILES FOR YEAR AND
  JULIAN DAY.
OPEN DFN$(K) FOR INPUT AS #1
** CHECK THAT JULIAN DAYS (JDC%) ARE ONLY 1-366 AND
** USER-ENTERED YEAR (YEAR%) CORRESPONDS WITH MET DATA FILE YEAR.
JDC%=0:YEAR%=0
INPUT #1,D,YEAR%,JDC%,D,D,D,D,D,D,D,D,D,D,D,D,D,D,D,D,D,D,D,D,D
IF JDC%<1 OR JDC%>366 THEN GOTO BADJD
IF IYR%=1900 THEN IYR%=YEAR%:GOTO CLOSESITECHAR 'IF NO YEAR
  ENTERED,SET=TO FILE YEAR
IF YEAR%<>IYR% THEN IYR%=YEAR%:GOSUB BADYR 'YEAR MISMATCH?FIX AND WARN
  USER
CLOSESITECHAR:
CLOSE #1
NEXT K
RETURN

```

```

*****
SITESEASON:
**CREATE WINDOW TO PROMPT FOR SITE CHARACTERISTICS AND GROWING SEASON.
**THE ENTERED SITE CHARACTERISTIC CODE IS SEARCHED FOR IN FILE
  SITECHAR.DAT.
**IF FOUND, THE LINE OF DATA CORRESPONDING TO THE CODE IS READ FROM THE
  FILE.
**IF THE CODE IS NOT FOUND, THE USER IS PROMPTED TO RE ENTER.
**VARIABLE SET LOPT (SEASON -- 1 FOR GROWING, 2 FOR DORMANT).
FLAI$="SITECHAR.DAT" 'SITECHAR.DAT CONTAINS SITE SPECIFIC
  CHARACTERISTICS
CALL PRTWINDOW(8,5,"WHAT IS THE SITE ID CODE (2 LETTERS)?")
STG$=SPACE$(2)
INPUTBOX6:
LOCATE 10,52:PRINT STG$:LOCATE 10,52:INPUT,NID$ '**PROMPT FOR SITE CODE
**CHECK FOR VALIDITY OF ENTERED SITE CODE
IF NID$="" THEN GOTO INPUTBOX6
IF LEN(NID$)>2 THEN STG$=SPACE$(LEN(NID$)):GOTO INPUTBOX6
OPEN FLAI$ FOR INPUT AS #2
CHKEOF:
IF NOT EOF(2) THEN GOTO READSITE
CALL PRTWINDOW(9,5,"CHECK STATION CODE (IT'S NOT IN TABLE) AND TRY
  AGAIN")
CLOSE#2:GOTO INPUTBOX6
NSTLOC$=""
** READ FROM SITECHAR.DAT
READSITE:
**READ FROM FILE SITECHAR.DAT, SITE CHARACTERISTICS.
INPUT #2,NSTID$,NSTLOC$,RLEAF,RLLESS,ICANPY,RLATA,RLONG,BIOMGS,BIOMDS
IF NSTID$<>NID$ THEN GOTO CHKEOF '**CHECK EXISTANCE OF
  ENTERED SITE CODES.
CLOSE #2

**DETERMINE WHETHER SEASON IS GROWING (1) OR DORMANT(2)
CALL PRTWINDOW(11,5,"SHOULD THE SEASON BE GROWING (1) OR DORMANT (2)?")
STG$=SPACE$(1)
**PROMPT FOR SEASON AND CHECK IT VALIDITY.
INPUTBOX7:
LOCATE 13,63:PRINT STG$:LOCATE 13,63:INPUT,LOPT
LPT$=STR$(LOPT):IF LEN(LPT$)>2 THEN STG$=SPACE$(LEN(LPT$)-1):GOTO
  INPUTBOX7
IF LOPT<1 OR LOPT>2 THEN GOTO INPUTBOX7
CALL REMOVEWINDOW
IF LOPT=2 THEN RLAI=RLLESS ELSE RLAI=RLEAF
IF RLAI=0! THEN RLAI=.0001
RETURN

*****
SETCANOPY:
**SET CANOPY VALUES ACCORDING TO CANOPY VALUE DETERMINED BY ENTERED
  SITE **CODE.
** ICANPY = 1 IF CANOPY IS MAIZE, 2 IF CHEST OAK, 3 IF SPRUCE, 4 IF
  GRASS,
** ICANPY = 5 IF BARE SOIL, 6 IF BALSAM FIR, 7 IF LOB PINE, 8 IF WHITE

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PINE,
** ICANPY = 9 IF MAPLE, 10 IF DOUG FIR, 11 IF RED ALDER, 12 IF BEECH,
** ICANPY = 13 IF SLASH PINE, 14 IF PONDEROSA PINE, 15 IF WFIR, 16 IF
KELOAK.
ON ICANPY GOTO MAIZE,OAK,SPRUCE,GRASS,SOIL,BFIR,LPINE,WPINE,MAPLE,DFIR,
RALDER,BEECH,SPINE,PPINE
MAIZE:
RSM=242!: B=66!: TOPT=25!: TMAX=45!: TMIN=5!: GOTO CANOPYEND
**MAIZE (1)
OAK:
RSM=100!: B=22!: TOPT=25!: TMAX=45!: TMIN=10!: GOTO CANOPYEND
**OAK (2)
SPRUCE:
RSM=232!: B=25!: TOPT=9!: TMAX=35!: TMIN=-5!
**RED SPRUCE (3)
IF LOPT=1 THEN VDNUC=.000021*BIOMGS ELSE VDNUC=.000021*BIOMDS: GOTO
CANOPYEND
GOTO CANOPYEND
GRASS:
RSM=50!:B=20!:TOPT=25!:TMAX=45!:TMIN=5!
**GRASS (4)
GOTO CANOPYEND ** RSM & B ARE GUESSES FOR GRASS
SOIL:
RSM=10000: B=.00001: GOTO CANOPYEND ** Ft WILL BE SET TO 1
BELOW,SOIL(5)
BFIR:
RSM=210!: B=25! **FT WILL BE SET TO 1 BELOW,BALSAM FIR (6)
IF LOPT=1 THEN VDNUC=.000021*BIOMGS ELSE VDNUC=.000021*BIOMDS: GOTO
CANOPYEND
GOTO CANOPYEND
LPINE:
RSM=200!: B=54! **FT WILL BE SET TO 1 BELOW, LOB PINE (7)
IF LOPT=1 THEN VDNUC=.000021*BIOMGS ELSE VDNUC=.000021*BIOMDS: GOTO
CANOPYEND
GOTO CANOPYEND
WPINE:
RSM=600!: B=30!
**WHITE PINE (8)
IF LOPT=1 THEN VDNUC=.000021*BIOMGS ELSE VDNUC=.000021*BIOMDS :GOTO
CANOPYEND
GOTO CANOPYEND
MAPLE:
RSM=150!: B=40!
**MAPLE (9)
IF LOPT=1 THEN VDNUC=.000031*BIOMGS ELSE VDNUC=.000031*BIOMDS: GOTO
CANOPYEND
GOTO CANOPYEND
DFIR:
RSM=300!: B=25!
**DOUGLAS FIR (10)
IF LOPT=1 THEN VDNUC=.000021*BIOMGS ELSE VDNUC=.000021*BIOMDS: GOTO
CANOPYEND
GOTO CANOPYEND
RALDER:

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```

RSM=110!: B=40!
'***RED ALDER (11)
IF LOPT=1 THEN VDNUC=.000031*BIOMGS ELSE VDNUC=.000031*BIOMDS: GOTO
  CANOPYEND
GOTO CANOPYEND
BEECH:
RSM=300!: B=40!
'***AM. BEECH (12)
IF LOPT=1 THEN VDNUC=.000031*BIOMGS ELSE VDNUC=.000031*BIOMDS :GOTO
  CANOPYEND
GOTO CANOPYEND
SPINE:
RSM=1100!: B=17!
'***SLASH PINE (13)
IF LOPT=1 THEN VDNUC=.000021*BIOMGS ELSE VDNUC=.000021*BIOMDS :GOTO
  CANOPYEND
GOTO CANOPYEND
PPINE:
RSM=370!: B=25!: TOPT=30!: TMAX=45!: TMIN=5!
'***PONDEROSA PINE (14)
IF LOPT=1 THEN VDNUC=.000021*BIOMGS ELSE VDNUC=.000021*BIOMDS: GOTO
  CANOPYEND
GOTO CANOPYEND
WFIR:
RSM=370!: B=25!: TOPT=30!: TMAX=45!: TMIN=5!
'***WHITE FIR (15)
IF LOPT=1 THEN VDNUC=.000021*BIOMGS ELSE VDNUC=.000021*BIOMDS: GOTO
  CANOPYEND
GOTO CANOPYEND
KELOAK:
RSM=370!: B=25!: TOPT=30!: TMAX=45!: TMIN=5!
'***CALIFORNIA BLACK OAK (16)
IF LOPT=1 THEN VDNUC=.000021*BIOMGS ELSE VDNUC=.000021*BIOMDS: GOTO
  CANOPYEND
GOTO CANOPYEND
CANOPYEND:
RETURN

```

'*****

OUTPUTFORMATS:

'**SPECIFY OUTPUT FORMATS FOR OUTPUT FILES, AND SCREEN AND PRINTER
OUTPUT.

```

FORM1$=" JD=### TIME=#### NVD=#### N=1 HNO3 -
RA=####.### RB=####.### RC=####.### VD=##.### CM/SEC"
FORM2$=" SO2 -
RA=####.### RB=####.### RC=####.### VD=##.###"
FORM3$=" O3 -
RA=####.### RB=####.### RC=####.### VD=##.###"
FORM4$=" NO2 -
RA=####.### RB=####.### RC=####.### VD=##.###"
FORM5$=" NH3 -
RA=####.### RB=####.### RC=####.### VD=##.###"
FORM6$=" AEROSOLS -
RA=####.### RB=####.### RC=####.### VD=##.###"

```

```

FORM7$=""
VD(part)=##.###"
FORMW1$="" TIME=#### NVD=#### HNO3 - VD=##.###
CM/SEC" SO2 - VD=##.###"
FORMW2$="" O3 - VD=##.###"
FORMW3$="" NO2 - VD=##.###"
FORMW4$="" NH3 - VD=##.###"
FORMW5$="" AEROSOLS - VD=##.###"
FORMW6$="" PARTICLES - VD(part)=##.###"
FORMW7$=""
FORML1$="" JD=ALL TIME=ALL NVD=#### =N HNO3 -
RA=####.### RB=####.### RC=####.### VD=##.### CM/SEC" SO2 -
FORML2$="" RA=####.### RB=####.### RC=####.### VD=##.###" O3 -
FORML3$="" RA=####.### RB=####.### RC=####.### VD=##.###" NO2 -
FORML4$="" RA=####.### RB=####.### RC=####.### VD=##.###" NH3 -
FORML5$="" RA=####.### RB=####.### RC=####.### VD=##.###" AEROSOLS -
FORML6$="" RA=####.### RB=####.### RC=####.### VD=##.###" PARTICLES -
FORML7$=""
VD(part)=##.###"
FORMD1$=""####.###"
FORMD2$=""#####.###"
FORMD3$=""#.###"
FORMOUT1$=""### #### ##.## ##.## ##.## ##.## ##.## ##.## ##.##
###.## #####.## ##.## ##.## ##.## ##.## ##.## ##.## ##.##
#####.## #####.## #####.## #####.## #####.## #####.## #####.##
#####.###"
FORMOUT2$=""### #### #.# ## #.# #.# ##.## ##.## ##.##
###.## #####.## ##.## ##.## ##.## ##.## ##.## ##.## ##.##
FORMOUT3$=""\\ #### \\ \ \ ## ##.## ##.## ##.## ##.##
#.## #.# ##.## ##.##"
RETURN

```

```

/*****
SUMMARYREQUEST:
**CREATE WINDOW TO PROMPT FOR HOURLY, LINEAR, OR DIURNAL CALCULATION
SUMMARY.
CALL MAKEWINDOW(3,8,15,66,FNATTR%(15,1),2,1,1)
CALL TITLEWINDOW(2,VERSION$)
CALL PRTWINDOW(2,3,"HOW DO YOU WANT THE CALCULATED VD'S TO BE
SUMMARIZED?")
CALL PRTWINDOW(3,5,"HOURLY (H), DIURNAL CYCLE (D), OR LINEAR-AVERAGED
VD'S (L)")
CALL PRTWINDOW(4,7,"-- HOURLY IS ONE VD FOR EACH HOUR OF MET DATA.")
CALL PRTWINDOW(5,7,"-- DIURNAL IS A MEAN VD FOR EACH HOUR AVERAGED
OVER")
CALL PRTWINDOW(6,11,"THE WHOLE PERIOD AND OUTPUT AS 24 HOURLY MEANS.")
CALL PRTWINDOW(7,7,"-- LINEAR AVERAGE (L) IS THE GRAND MEAN FOR THE
ENTIRE")
CALL PRTWINDOW(8,11,"DRY PERIOD AND IS THE FORM USED FOR ROUTINE IFS")

```

```

CALL PRTWINDOW(9,11,"COMPUTATIONS.")
CALL PRTWINDOW(11,3,"ENTER H, D, OR L --->")
STG$=SPACE$(1)
'***PROMPT FOR SUMMARIZATION STYLE AND CHECK RESPONSE VALIDITY.
INPUTBOX8:
LOCATE 14,34:PRINT STG$:LOCATE 14,34:INPUT,QAV$
IF LEN(QAV$)>1 THEN STG$=SPACE$(LEN(QAV$)):GOTO INPUTBOX8
QAV$=UCASE$(QAV$)

IF QAV$<>"H" AND QAV$<>"D" AND QAV$<>"L" OR QAV$="" THEN GOTO INPUTBOX8
CALL REMOVEWINDOW
IF QAV$="H" THEN GOSUB HOURLY
IF QAV$="L" THEN GOSUB LINEAR
RETURN

/*****
HOURLY:
'***CREATE A WINDOW TO PROMPT USER FOR TYPE OF HOURLY SUMMARY --RES. OR
MET.--
'***AND DETERMINE WHICH FILE (IF ANY) TO OPEN FOR OUTPUT OF CALCULATION
RESULTS.
CALL MAKEWINDOW(3,7,20,68,FNATTR%(15,2),2,1,1)
CALL TITLWINDOW(2," HOURLY FILES ")
CALL PRTWINDOW(2,3,"THE PROGRAM CAN STORE EACH HOURLY VD CALCULATION")
CALL PRTWINDOW(3,3,"FOR ANALYSIS OF SHORT TERM TRENDS.")
CALL PRTWINDOW(5,3,"WOULD YOU LIKE HOURLY INFO. STORED IN A FILE ON DISK
(Y/N)?")
STG$=SPACE$(1) '***RESET INPUT BOX SIZE.
'***PROMPT FOR STORAGE RESPONSE AND CHECK ITS VALIDITY.
INPUTBOX9:
LOCATE 8,70:PRINT STG$:LOCATE 8,70:INPUT,STORE$
IF LEN(STORE$)>1 THEN STG$=SPACE$(LEN(STORE$)):GOTO INPUTBOX9
STORE$=UCASE$(STORE$)
IF STORE$<>"N" AND STORE$<>"Y" THEN GOTO INPUTBOX9
IF STORE$="N" THEN GOTO HEND '***ELSE, DETERMINE WHICH FILE TO OPEN
CALL PRTWINDOW(7,3,"WOULD YOU LIKE RAW MET DATA STORED IN THE FILE
WITH")
CALL PRTWINDOW(8,3,"THE CALCULATED Vd's (Met)?")
CALL PRTWINDOW(9,3,"OR WOULD YOU LIKE THE COMPUTED RESISTANCES STORED
WITH")
CALL PRTWINDOW(10,3,"THE CALCULATED Vd's (Res.)?")
CALL PRTWINDOW(12,3,"ANSWER M(et) OR R(esistances) --->")
STG$=SPACE$(1)
INPUTBOX10:
LOCATE 15,45:PRINT STG$:LOCATE 15,45:INPUT,OUTFORM$
'***PROMPT FOR R OR M
IF LEN(OUTFORM$)>1 THEN STG$=SPACE$(LEN(OUTFORM$)):GOTO INPUTBOX10
OUTFORM$=UCASE$(OUTFORM$)
IF OUTFORM$<>"M" AND OUTFORM$<>"R" THEN GOTO INPUTBOX10 'CHECK RESPONSE
VALIDTY
CHOOSEFILE:
IF OUTFORM$="M" GOTO HOURLYMET
'***DETERMINE USER'S RESISTANCE FILE REQUESTS
CALL PRTWINDOW(14,3,"WOULD YOU LIKE HOURLY RESISTANCES STORED IN FILE:")

```

```

CALL PRTWINDOW(15,3,"RESHOUR.DAT (Y/N)?"):STG$=SPACE$(1)
'***PROMPT FOR RESPONSE AND CHECK ITS VALIDITY
INPUTBOX11:
LOCATE 18,30:PRINT STG$:LOCATE 18,30:INPUT,CHKHR$
IF LEN(CHKHR$)>1 THEN STG$=SPACE$(LEN(CHKHR$)):GOTO INPUTBOX11
'***DETERMINE WHETHER TO ASSIGN FILE NAME TO DFOUT$
IF CHKHR$="Y" THEN DFOUT$="RESHOUR.DAT":GOTO CHKOPEN
GOTO CHKSTORE
HOURLYMET:
'*** DETERMINE USER'S MET. FILE DESIRES
CALL PRTWINDOW(14,3,"WOULD YOU LIKE HOURLY MET. INFO. STORED IN FILE:")
CALL PRTWINDOW(15,3,"METHOUR.DAT (Y/N)?"):STG$=SPACE$(1)
'***PROMPT FOR RESPONSE AND CHECK ITS VALIDITY
INPUTBOX12:
LOCATE 18,30:PRINT STG$:LOCATE 18,30:INPUT,CHKHR$
IF LEN(CHKHR$)>1 THEN STG$=SPACE$(LEN(CHKHR$)):GOTO INPUTBOX12
'***DETERMINE WHETHER TO ASSING FILE NAME TO DFOUT$
IF CHKHR$="Y" THEN DFOUT$="METHOUR.DAT":GOTO CHKOPEN
CHKSTORE:
IF CHKHR$<>"Y" AND CHKHR$<>"N" THEN GOTO CHOOSEFILE
'***CHECK FOR Y OR N
IF CHKHR$<>"N" THEN GOTO CHKOPEN '***LOOP FOR PROPER RESPONSE
CALL PRTWINDOW(17,3,"WHAT IS THE NAME OF DESIRED FILE?")
STG$=SPACE$(12)
LOCATE 20,45:PRINT STG$:LOCATE 20,45:INPUT,DFOUT$ '***PROMPT FOR FILE
NAME
CHKOPEN:
IF DFOUT$<>" " THEN OPEN DFOUT$ FOR APPEND AS #3
HEND:
CALL REMOVEWINDOW
RETURN

'*****
LINEAR:
'***DETERMINE USER'S LINEARLY-AVERAGED FILE REQUESTS.
'***CREATE WINDOW TO PROMPT FOR STORAGE IN FILE VD.DAT OR USER-NAMED
FILE.
CALL MAKEWINDOW(5,7,8,68, FNATTR%(15,2), 2,1,1)
CALL TITLEWINDOW(2," LINEARLY-AVERAGED FILES ")
CALL PRTWINDOW(2,3,"WOULD YOU LIKE THE CALCULATED DRY PERIOD MEAN VD'S
STORED TO")
CALL PRTWINDOW(3,3,"DISC IN THE FILE: VD.DAT (Y/N)?")
STG$=SPACE$(1) '***RESET INPUT BOX SIZE
'***PROMPT FOR RESPONSE AND CHECK ITS VALIDITY
INPUTBOX13:
LOCATE 8,44:PRINT STG$:LOCATE 8,44:INPUT,DSKSTR$
IF LEN(DSKSTR$)>1 THEN STG$=SPACE$(LEN(DSKSTR$)):GOTO INPUTBOX13
DSKSTR$=UCASE$(DSKSTR$) '***CONVERT RESPONSE TO CAPITALS
'***CHECK FOR INPUT VALIDITY
IF DSKSTR$<>"Y" AND DSKSTR$<>"N" OR DSKSTR$="" THEN GOTO
INPUTBOX13
IF DSKSTR$="Y" THEN VDOUT$="VD.DAT":GOTO LEND '***IF DSKSTR$=Y ASSIGN
FILE NAME '***TO VDOUT$
CALL PRTWINDOW(5,3,"WHAT IS THE NAME OF THE DESIRED FILE?")

```

```

CALL PRTWINDOW(6,5,"-- PRESS RETURN FOR NO STORE")
STG$=SPACE$(12)          '**RESET INPUT BOX SIZE
LOCATE 10,49:PRINT STG$:LOCATE 10,49:INPUT,VDOUT$ '**PROMPT FOR FILE
NAME LEND:
CALL REMOVEWINDOW
RETURN

```

```

'*****

```

```

LPRINTSTARTFILE:
'**PRINTS FILE NAME,SITE AND YEAR OF DATA. BEFORE CALCULATIONS BEGIN.
LPRINT:LPRINT:LPRINT
LPRINT "DEPOSITION VELOCITIES FOR MET FILE NAMED ";DFN$(K);"TODAY IS
";TODAT$
LPRINT " SITE LOCATION IS ";NSTLOC$
LPRINT " YEAR OF DATA IS ";IYR
IF QAV$="H" THEN LPRINT " VD'S CALC'D FOR EACH HOUR THROUGH PERIOD"
GOTO LPRINTSEASON
IF QAV$="D" THEN LPRINT " VD'S AVERAGED BY HOUR OF DAY TO SHOW DIURNAL
CYCLE"
GOTO LPRINTSEASON
LPRINT " VD'S AVERAGED FOR ALL DATA DURING DRY PERIOD"

```

```

'**QAV$="L"
LPRINTSEASON:
IF LOPT=1 THEN LPRINT " GROWING SEASON CANOPY CONSIDERED":GOTO LSFEND
LPRINT " DORMANT SEASON CANOPY CONSIDERED"

'**LOPT = 2
LSFEND:
RETURN

```

```

'*****

```

```

STARTFILEWINDOW:
'**CREATE WINDOW TO DISPLAY SEASON, SITE, AND YEAR BEFORE CALCULATIONS
BEGIN.
CALL MAKEWINDOW(2,4,5,35, FNATTR%(15,1),2,1,1)
'**DISPLAY SEASON IN WINDOW
IF LOPT=1 THEN CALL PRTWINDOW(1,1,"GROWING SEASON CANOPY
CONSIDERED"):GOTO DISPLAYSITE
IF LOPT=2 THEN CALL PRTWINDOW(1,1,"DORMANT SEASON CANOPY CONSIDERED")
'**DISPLAY SITE AS DETERMINED FROM ENTERED SITE CODE AND FILE
SITECHAR.DAT
DISPLAYSITE:
'**IF NSTLOC$>27 TRUNCATE TO ENSURE STRING WILL FIT IN WINDOW.
IF LEN(NSTLOC$)>27 THEN TNSTLOC$=MID$(NSTLOC$,1,27) ELSE
TNSTLOC$=NSTLOC$
CALL PRTWINDOW(2,1,"SITE:"):CALL PRTWINDOW(2,7,TNSTLOC$)
'**DISPLAY YEAR
CALL PRTWINDOW(3,1,"YEAR:"):CALL PRTWINDOW(3,6,STR$(IYR))
RETURN

```

```

'*****

```

```

SCROLLWINDOW:
'**CREATE WINDOW TO PROMPT FOR SCROLLING OR VIEWABLE SCREEN OUTPUT

```

```

RESULTS.
CALL MAKEWINDOW(8,20,4,37, FNATTR%(15,4), 2,1,1):STG$=SPACE$(1)
CALL PRTWINDOW(1,2,"DO YOU WANT TO (V)IEW RESULTS")
CALL PRTWINDOW(2,2,"OR ALLOW THEM TO (S)CROLL (V/S)?")
'***PROMPT FOR INPUT AND CHECK ITS VALIDITY
INPUTBOX14:
LOCATE 10,54:PRINT
  STG$:LOCATE10,54:INPUT, SCROLL$:SCROLL$=UCASE$(SCROLL$)
IF LEN(SCROLL$)>1 THEN STG$=SPACE$(LEN(SCROLL$)):GOTO INPUTBOX14
IF SCROLL$<>"S" AND SCROLL$<>"V" OR SCROLL$="" THEN GOTO INPUTBOX14
CALL REMOVEWINDOW
RETURN

```

```

'*****
OUTPUTWINDOW:
'***CREATE WINDOW FOR DISPLAY OF CALCULATED RESULTS.
CALL MAKEWINDOW(9,4,15,74, FNATTR%(15,2), 2,1,1)
CALL TITLWINDOW(2,DFN$(K)) '***TITLE IS FILE BEING PROCESSED
'***DISPLAY COLUMN HEADING WITHIN OUTPUT WINDOW
CALL PRTWINDOW(1,2,"DAY-----TIME-----NVD---CWET")
CALL PRTWINDOW(1,43,"DAY-----TIME-----NVD---CWET")
RETURN

```

```

'*****
VIEWMORE:
'***CREATE WINDOW WHICH WILL PROMPT USER TO CONTINUE VIEWING CALCULATION
'***RESULTS.
CALL MAKEWINDOW(6,25,3,30, FNATTR%(15,1), 2,1,1)
CALL PRTWINDOW(1,3,"PRESS RETURN TO CONTINUE")
LOCATE 7,52:INPUT,CONT$:CALL REMOVEWINDOW
RETURN

```

```

'*****
OUTPUTDISPLAY:
'***DISPLAY CALCULATION RESULTS WITHIN OUTPUT WINDOW ON SCREEN.
'***DISPLAY JULIAN DAY (JD)
CALL PRTWINDOW(ROW%,COL%,STR$(JD))
'***DISPLAY TIME (IHRMIN)
IF IHRMIN<1000 THEN CALL PRTWINDOW(ROW%,COL%+9,STR$(IHRMIN)):GOTO
  DISPNVD
CALL PRTWINDOW(ROW%,COL%+8,STR$(IHRMIN))
'***DISPLAY VELOCITY DEPOSITION NUMBER
DISPNVD:
IF NVD<10 THEN CALL PRTWINDOW(ROW%,COL%+18,STR$(NVD)):GOTO DISPWET
IF NVD<100 THEN CALL PRTWINDOW(ROW%,COL%+17,STR$(NVD)):GOTO DISPWET
IF NVD<1000 THEN CALL PRTWINDOW(ROW%,COL%+16,STR$(NVD))
'***DISPLAY WETNESS
DISPWET: CALL PRTWINDOW(ROW%,COL%+25,STR$(CWET))
RETURN

```

```

'*****
VIEWMEANS:
'***CREATE WINDOW TO PROMPT FOR USER RESPONSE TO VIEW MEAN VD'S AND
  RES'S.

```

```

CALL MAKEWINDOW(6,11,3,62, FNATTR%(15,4),2,1,1)
CALL PRTWINDOW(1,1,"PRESS RETURN TO DISPLAY CALCULATED MEAN VD'S AND
RESISTANCES")
LOCATE 7,71:INPUT,CONT$:CALL REMOVEWINDOW
RETURN

```

```

'*****
DISPLAYMEANS:
**CREATE WINDOW TO DISPLAY THE GRAND MEAN CALC'D VD'S & RESISTANCES.
CALL MAKEWINDOW(8,3,12,72, FNATTR%(15,1),2,1,1)
CALL TITLEWINDOW(2,"MEAN CALCULATIONS")
CALL PRTWINDOW(1,2,"JD=ALL, TIME=ALL, NVD=")
CALL PRTWINDOW(1,23,STR$(NVD))
CALL PRTWINDOW(3,2,"HNO3 - RA=")
CALL PRTWINDOW(4,2,"SO2 - RA=")
CALL PRTWINDOW(5,2,"O3 - RA=")
CALL PRTWINDOW(6,2,"NO2 - RA=")
CALL PRTWINDOW(7,2,"NH3 - RA=")
CALL PRTWINDOW(8,2,"AEROSOLS - RA=")
ROW%=11:PWROW%=3
FOR I=1 TO NSPEC
LOCATE ROW%,20:PRINT USING FORMD1$;RAAV
CALL PRTWINDOW(PWROW%,26,"RB=")
IF I<>NSPEC THEN RBFORM$=FORMD1$:RBROW%=34 ELSE
RBFORM$=FORMD2$:RBROW%=33
LOCATE ROW%,RBROW%:PRINT USING RBFORM$;RBAV(I)
CALL PRTWINDOW(PWROW%,40,"RC=")
LOCATE ROW%,47:PRINT USING FORMD1$;RCAV(I)
CALL PRTWINDOW(PWROW%,53,"VD=")
LOCATE ROW%,60:PRINT USING FORMD3$;AVVD(I)
CALL PRTWINDOW(PWROW%,64,"CM/SEC")
ROW%=ROW%+1:PWROW%=PWROW%+1
NEXT I
**DISPLAY PARTICLE SUMMARIES
CALL PRTWINDOW(10,2,"PARTICLES- VD(PART)=")
LOCATE 18,26:PRINT USING FORMD3$;AVVDP
RETURN

```

```

'*****
ENDFILEWINDOW:
**CREATE WINDOW TO DISPLAY STARTING AND ENDING JUL.DAY AND TIME.
CALL MAKEWINDOW(2,42,5,37, FNATTR%(15,1),2,1,1)
CALL PRTWINDOW(1,2,"DATA STARTS, JUL. DAY")
CALL PRTWINDOW(1,23,STR$(STARTD)):CALL PRTWINDOW(1,28,"AT")
CALL PRTWINDOW(1,30,STR$(STARTT))
CALL PRTWINDOW(2,2,"DATA ENDS, JULIAN DAY")
CALL PRTWINDOW(2,23,STR$(JD)):CALL PRTWINDOW(2,28,"AT")
CALL PRTWINDOW(2,30,STR$(IHRMIN))
RETURN

```

```

'*****
VIEWNEXTFILE:
**CREATE WINDOW TO PROMPT FOR USER TO ALLOW FOR PROCESSING OF
NEXT FILE.

```

```

CALL MAKEWINDOW(5,23,3,35, FNATTR%(15,1),2,1,1)
CALL PRTWINDOW(1,1,"PRESS RETURN TO PROCESS NEXT FILE")
**PROMPT FOR RESPONSE AND REMOVE ALL OPEN WINDOWS TO AVOID DUPLICATION
**OVERLOAD
LOCATE 6,56:INPUT,CONT$:CALL REMOVEWINDOW:CALL REMOVEWINDOW:CALL
REMOVEWINDOW:CALL REMOVEWINDOW
IF QAV$="L" THEN CALL REMOVEWINDOW **IF QAV$=L THERE IS AN EXTRA
WINDOW
RETURN

```

```

EXITWINDOW:
IF QPRNTR$="Y" THEN LPRINT "LAST MET FILE COMPLETED"
**CREATE WINDOW TO PROMPT FOR USER APPROVAL TO EXIT
CALL MAKEWINDOW(5,44,4,30, FNATTR%(15,4),2,1,1)
CALL PRTWINDOW(1,1,"LAST MET DATA FILE COMPLETED")
CALL PRTWINDOW(2,5,"PRESS RETURN TO EXIT"):LOCATE 7,69:INPUT,EXT$
**REMOVE ALL REMAINING WINDOWS
CALL REMOVEWINDOW:CALL REMOVEWINDOW:CALL REMOVEWINDOW:CALL
REMOVEWINDOW
IF QAV$="L" THEN CALL REMOVEWINDOW **IF QAV$=L THERE IS AN EXTRA
WINDOW
RETURN

```

```

BADYR:
**WARN USER OF IMPROPER YEAR ENTRY AND COMPENSATION, AND RETURN TO
**PROCESSING.
CALL MAKEWINDOW(9,5,6,73, FNATTR%(0,7),2,0,0)
CALL PRTWINDOW(2,3,"YEAR LISTED IN MET DATA FILE DOES NOT CORRESPOND
WITH ENTERED YEAR")
CALL PRTWINDOW(3,15,"** ITS VALUE HAS BEEN SET TO THAT IN DATA FILE")
CALL PRTWINDOW(4,25,"*****PRESS RETURN*****")
LOCATE 13,35:INPUT,BDYR$: CALL REMOVEWINDOW
RETURN
**RETURN TO PROCESSING

```

Big Leaf Model Code

1.0 **General Discussion**

NuCM was developed as part of the Electric Power Research Institute's Integrated Forest Study primarily to examine the effects of atmospheric deposition on forest nutrient cycling (Liu et al 1991a and b; Johnson and Lindberg 1991). The NuCM model links the soil-solution chemical components of ILWAS model (Gherini et al 1985) with traditional conceptual models of forest nutrient cycling on a stand level. NuCM differs from ILWAS in that it is oriented toward stand-level as opposed to watershed-level nutrient cycling. As a consequence, NuCM has a simpler hydrologic module and a more sophisticated vegetation cycling module. The available nutrients in soil strata and vegetation pools and the fluxes between them are explicitly tracked and provided as model output. The model can be used to simulate forest response to atmospheric deposition and to various management practices (e.g., application of fertilizers). Factors included in the model allow the user to easily increase or decrease atmospheric deposition loads. A full description of NuCM is given by Liu et al (1991 a and b); only details pertinent to the current simulations are repeated here.

The forested ecosystem is represented as a series of vegetation and soil components. The model provides for both an overstory and understory, each of which can be divided into canopy, bole, and roots. Tree growth is a function of user-defined stand developmental stage and the availability of nutrients and moisture. Translocation of nutrients prior to senescence is also user-defined. The understory is simulated in a similar manner to the overstory, except that its "incident precipitation" is the overstory's throughfall and its biomass nutrient concentrations are allowed to be different.

Using mass balance and transport formulations, the model tracks 16 solution-phase components including the major cations and anions (analytical totals), ANC (acid-neutralizing capacity), an organic acid analog, and total aluminum (Liu et al 1991a and b). The concentrations of hydrogen ion, aluminum and carbonate species, and organic acid ligands and complexes are then calculated based upon the 16 components. The acid-base characteristics of the forest soil solution are computed by the model to properly account for the influence of hydrogen-ion concentration on cation exchange and mineral weathering.

The model routes precipitation through the canopy and soil layers, and simulates evapotranspiration, deep seepage, and lateral flow. The soil includes multiple layers (up to ten), and each layer can have different physical and chemical characteristics. The movement of water through the system is

simulated using the continuity equation, Darcy's equation for permeable media flow, and Mannings equation for free surface flow. Percolation occurs between layers as a function of layer permeabilities and differences in moisture content. Lateral flow occurs in those layers with saturated moisture contents. The lower portion of a layer with average moisture level approaching saturation is also allowed to produce lateral flow. This is achieved using a linearization of Darcy's equation to account for variation in moisture content within that horizon (Liu et al 1991a and b).

The model simulates processes which occur in the canopy, bole, and roots. The canopy intercepts wet and dry deposition and stores a fraction of the precipitation volume on the leaf surfaces, up to a user-defined interception storage capacity. The solution stored on the canopy undergoes chemical reaction with constituents on the leaf surface (e.g., foliar exudates), provides for direct nutrient uptake by the leaf, and is subject to concentration by evaporation. Dry deposition (gaseous, aerosol, and particulate matter) is enhanced by the canopy in proportion to the leaf area index (LAI).

The nutrient pools associated with soil solution, the soil exchange complex, soil minerals, and soil organic matter are all tracked explicitly. The processes which govern interactions among these pools include decay, nitrification, anion adsorption, cation exchange and mineral weathering. Litter decay is represented as a series reaction with first order dependencies on the reactant concentrations and C/N ratios. The decay products include nutrients and organic matter - both solid (e.g., humus) and solution phase (e.g., organic acids). The nutrients produced enter the solution phase where they are available for uptake by vegetation or the exchange complex, and for transport from the forest floor by percolation and/or lateral flow.

The model simulates the noncompetitive adsorption of sulfate, phosphate, and organic acid. Sulfate adsorption can be simulated in NuCM using either linear or Langmuir adsorption isotherms. In these simulations, the Langmuir isotherm was used:

$$\text{Langmuir: } X = \frac{(X_{\text{max}})(b)(\text{SO}_4^{2-})}{1 + (b)(\text{SO}_4^{2-})} \quad 1)$$

where X_{max} = maximum sulfate that can be adsorbed on soil (a constant)
and b = a constant.

NuCM incorporates pH-dependent SO_{42} adsorption into the Langmuir equation by setting $b = K (\text{H}^+)^2$, where K is an equilibrium constant for the equation,

$$K = (\text{XH}_2\text{SO}_4 / (\text{Xs} (\text{H}^+)^2 (\text{SO}_4^{2-}))) \quad 2)$$

which describes the reaction:



where XH_2SO_4 = the number of sites onto which SO_{42} is adsorbed
= X in equation 1)

Xs = unfilled adsorption sites

and $\text{X}_{\text{max}} = \text{XH}_2\text{SO}_4 + \text{Xs}$

Phosphate adsorption in the model is represented by a linear isotherm.

Cation exchange is represented by the Gapon equation:

$$(\text{XM}^{a+} (\text{M}^{b+})^{1/b} / \text{XM}^{b+} (\text{M}^{a+})^{1/a}) = Q \quad 4)$$

Where X = Exchange phase equivalent fraction,

() = Soil Solution Activity (moles/L)

M^{a+} = Cation of valence a

M^{b+} = Cation of valence b

and Q = Selectivity Coefficient (constant).

Mineral weathering reactions are normally slow and are described in the model using rate expressions with dependencies on the mass of mineral present and solution-phase hydrogen-ion concentration taken to a fractional power. Both mineral weathering rates and hydrogen ion dependencies are specified by the user, in contrast to the ILWAS model.

Model input is based on measurable parameters. All input is accomplished using a series of menus or automatic transfer of data from previously entered files. The model uses such data to compute selectivity coefficients for each soil layer simulated. Model output options include nutrient pool sizes, fluxes between components, the relative contribution or loss by process, and soil solution and adsorbed concentrations versus time. Long-term nutrient loss or accumulation can be tracked by following annual pool and flux charts. In these simulations, output data files were created and imported into EXCEL spreadsheets for the purposes of rearranging graphical presentations.

Calibration of NUCM

NUCM will be calibrated using data from the Barton Flats Study according to the procedures outlined in the User's Manual (Munson et al 1992). This included input data files for physiographic, meteorological and atmospheric chemistry data; vegetation biomass, nutrient concentrations and growth data; soil physical data (horizon depths, bulk density, hydraulic conductivities, water retention characteristics, root distribution and uptake properties, and temperature); soil chemical data (primary minerals, mineral dissolution rates, mineral stoichiometries, and anion adsorption isotherm parameters); organic matter decay rates, and nitrification rates. Model parameters which were of no particular consequence to our ecosystem and interests, or for which no site-specific data were available (such as organic acid adsorption, phosphate adsorption, snowmelt characteristics, fractions of leachable nutrients in litter, etc.) were left as in the original model formulation (Liu et al 1991a and b). Multiple year simulations are conducted by repeating meteorological, precipitation, and air chemistry data inputs for the desired number of iterations.

As a consequence of NUCM's structure, calibrations were fairly accurate for some parameters which were largely a direct consequence of input data (i.e., vegetation and soil exchangeable contents) but less accurate for other parameters which were calculated less directly (e.g., atmospheric dry deposition, forest floor nutrient contents, leaching). In this context, there are two noteworthy items: 1) soil total nutrient contents were calculated from mineral composition and stoichiometry rather than directly from total concentrations, and 2) the first soil layer includes litter, and thus the properties of this layer were the average of litter and A horizon of the mineral soil. Soil chemical data requirements precluded the option of making layer 1 simply a litter layer. Calibration for parameters that were simulated, such as forest floor content, uptake, and leaching was done by trial and error.

During the process of calibration, soil hydraulic conductivity, the "Evapotranspiration coefficient", and saturated hydraulic conductivities were used to match model output with known evapotranspiration rates, soil water flux and lateral flow values. Organic matter decay and nitrification rates were adjusted to obtain a compromise among acceptable rates of vegetation growth, forest floor change, and nitrate leaching.

7.0

References

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1.0 **General Discussion**

Chemical analyses resulting from branch washes yields solution chemical concentrations which are of little use until they are related back to the surface area of the washed branch.

1.1 **Purpose of Procedure**

The purpose of this procedure is to describe, in detail, the method used for measuring branch surface area for ponderosa pine, white fir and black oak.

1.8 **Related Procedures**

Standard Operating Procedures:

RFL 10 Branch Washing (Field Work)

RFL 11 Chemical Processing of Branch Washing Samples

2.0 **Apparatus**

1. metric ruler (mm)
2. optical micrometer
3. Licor model 3100 surface area meter

4.0 **Procedures**

The measurement of surface area, regardless of species, is basically the same. A small subsample of the collected foliage is separated from the bulk collected foliage. The surface area of this subsample is determined, either directly or by dimension measurement and calculations. The subsample and bulk sample are dried and weighed. The surface area of the entire bulk collection can now be calculated from the subsample to bulk sample ratio.

4.1 **Ponderosa Pine**

Ten needles were randomly selected from each branch sample. These ten needles were removed, measured for length (using a mm ruler) and width (using an optical micrometer), oven dried at 70°C, and weighed. The remainder of the needles were oven dried at 70°C and weighed. In addition, the branch stem was measured for length and diameter. Many ponderosa pine branch washes were performed before the needles were fully extended. Since it was not possible to determine the surface area of the branch without destructively harvesting the branch, the average needle length of the branch was determined. By comparing this average needle length with the final average needle length, the branch surface area at that time was calculated.

4.1.1 **Ponderosa Pine Calculations**

Individual Needle Area = circumference x length; in mm
= (2.364 x width) x length

Total Needle Area =

$$\frac{10 \text{ needle weight} + \text{remaining needle weight}}{10 \text{ needle weight}} \times 10 \text{ needle area sum}$$

Stem Area = pi x diameter x length; in mm

$$\text{Total Area} = \frac{\text{average needle length}}{\text{final average needle weight}} \times \text{total needle area} + (\text{stem area})$$

$$\text{Conversion to m}^2 = \text{mm}^2 / 1,000,000$$

4.2 White Fir

Ten needles were randomly selected from each branch sample. These ten needles were removed, measured for length (using a mm ruler), width, and height (using an optical micrometer), oven dried at 70°C, and weighed. The remainder of the needles were oven dried at 70°C and weighed. In addition, the branch stem was measured for length and diameter.

4.2.1 White Fir Calculations

$$\begin{aligned} \text{Individual Needle Area} &= \text{circumference} \times \text{length; in mm} \\ &= ((2 \times \text{sqrt}((w/2 \times w/2) + (h \times h))) + \\ &\quad w) \times \text{length} \end{aligned}$$

$$\begin{aligned} \text{Total Needle Area} &= \\ \frac{10 \text{ needle weight} + \text{remaining needle weight}}{10 \text{ needle weight}} &\times 10 \text{ needle area sum} \end{aligned}$$

$$\text{Stem Area} = \pi \times \text{diameter} \times \text{length; in mm}$$

$$\text{Total Area} = \text{total needle area} + \text{stem area}$$

$$\text{Conversion to m}^2 = \text{mm}^2 / 1,000,000$$

4.3 Black Oak

Ten leaves were randomly selected from each branch sample. These ten leaves were removed, measured for actual single sided surface area using a Licor model 3100 surface area meter. Both the ten subsample leaves and the remainder of the leaves were oven dried at 70°C, and weighed. In addition, the branch stem was measured for length and diameter.

4.3.1 Black Oak Calculations

$$\text{Total Leaf Area} = \text{Sum of leaf areas} \times 2$$

$$\text{Stem Area} = \pi \times \text{diameter} \times \text{length; in mm}$$

$$\text{Total Area} = \text{total leaf area} + \text{stem area}$$

$$\begin{aligned} \text{Conversion to mm}^2 &= \text{cm}^2 / 100 \\ \text{m}^2 &= \text{mm}^2 / 1,000,000 \end{aligned}$$

7.0 References

1.0 **General Discussion**

1.1 **Purpose of Procedure**

The purpose of this standard operating procedure is to describe the materials needed and procedures employed to construct and place an inexpensive, passive line collector which is used to collect dry deposition and fog samples.

1.8 **Related Procedures**

Standard Operating Procedure:

RFL 06 Construction of Rain and Throughfall Collectors

RFL 36 Fog/Dry Deposition Collection Method

2.0 **Apparatus, Instrumentation, Supplies, and Forms**

2.1 **Apparatus and Instrumentation**

2.1.1 **Description**

The passive fog/dry deposition collector is essentially a series of nylon lines arranged in parallel to intercept fog or dry deposition pollutants which pass through the collector. The exposed nylon lines allow dry deposition to adhere and fog to condense; the fog condensate runs down the nylon line, through a funnel, and into a 500 ml polypropylene bottle. At each sampling, two samples are collected from each unit; the solution found in the fog condensate bottle and a sample generated by rinsing the nylon lines. Because of the passive nature of the collectors, the samples collected are composite samples representative of both dry deposition and fog.

Each collector consists of two Buchner funnel bases which were attached using three tri-sided plexiglass rods. Using the existing holes in the Buchner funnels, 108 nylon lines were strung between the funnels. The funnel piece was removed from the Buchner funnel on top of the collector leaving only the Buchner base which was then sealed with parafilm. The bottom Buchner funnel of the collector was left intact.

The completed collector unit was placed into a modified rain and throughfall collector for support. Each collector was placed under a 48 x 48 inch frame covered with polyethylene sheet as protection from rain and snow.

2.1.2 **Maintenance**

Occasionally a heavy snow would cause the polyethylene sheeting protecting the collectors to sag; this would in turn cause the plexiglass rods to break. These rods were easily replaceable in the field as needed.

2.2 **Supplies**

- A. 90 mm diameter Buchner funnel (2), plastic, two pieces
 - Buchner base - 105 mm diameter, 55 mm height
 - Buchner funnel - 105 mm diameter, 125 mm height
- B. Tri-sided support rods (3), plexiglass
 - 600 mm length, 12.5 mm side width

- C. Nylon bolts/nuts (12), 25 mm length, 4.8 mm diameter
- D. Nylon collector lines (108), 1.65 mm diameter
Each line 610 mm length, 500 mm exposed length
Total exposed length of 108 strings - 54000 mm
- E. 48 inch x 48 inch aluminum tube frame covered with
polyethylene sheeting
- F. Modified rain and throughfall collector
- G. Fence posts (9), 6 ft length
- H. Metal bolts/nuts (12), 25 mm length, 4.8 mm diameter
- I. Power drill with 2 and 3 mm drill bits
- J. Duct tape
- K. Collection bottle, 500 ml, polypropylene, narrow mouth

4.0

Procedures

4.1

Construction

To aid in the construction and placement of the fog/dry deposition collectors, Figure 1 is included outlining details.

Each Buchner funnel base (A) is manufactured with 127 holes in the bottom plate. These holes are arranged in seven circles with decreasing number of holes per circle as you approach the center of the Buchner base as follows: 36, 30, 24, 18, 12, 6, and 1 hole. These holes must be enlarged, using a power drill and 2 mm drill bit, to allow the nylon lines to easily pass through the holes and still allow fog condensate and rinse water to drain through and into the collection funnel.

The two Buchner funnel bases (A) are attached together using three tri-sided support rods (B). Drill two 3 mm holes at each of three locations on the Buchner funnel base walls as shown. Set the tri-sided rods against the bottom plate of the Buchner base aligned with these holes. Mark the hole locations on the rods, drill using a 3 mm bit, and attach the rods to the Buchner bases using nylon bolts and nuts (C); for ease of assembly, have the bolt head inside/nut outside.

The nylon lines are placed through the 108 holes in the four outside circles of the Buchner funnel bases. Using a 60 meter piece of nylon line (D), place one end of the line through the Buchner base, from the inside, and tie a secure knot on the outside. Thread the nylon line between the top and bottom Buchner bases until all 108 holes in the four outer circles are filled with nylon line. Tie a secure knot in the nylon line where it exits the Buchner base for the final time; trim and discard any excess nylon line. Soak the entire collector in NPW for 24 hours, change the NPW and soak the collector for an additional 24 hours. Seal the top Buchner funnel base plate with parafilm, place a clean Buchner funnel on the bottom plate and carefully place the fog/dry deposition collector in a plastic bag for transport to the field.

4.2 Placement

Three sites were chosen for placement of the fog collectors:
Heartbar; near established plots

Barton Flats; near meteorological station

Crestline; approximately 1 mile north of Camp Paivika

At each site, three fog/dry deposition collectors were set up. Each collector was placed under a 48 x 48 inch aluminum frame covered with polyethylene sheeting (E). The frame was assembled by drilling 3 mm holes through the aluminum and attaching the frame pieces together using metal bolts(H). A 60 inch square of polyethylene sheeting was cut for each frame; each side of this sheet was wrapped around the frame and taped to the underside of the sheet using duct tape(J). At each location, nine fence posts(G) were driven into the ground in the pattern shown; the three middle posts were installed so 5.5 feet remained above ground, the six outside posts were installed so 4 feet remained above ground. The frames were attached as shown; because of the difference in post heights, the frames were installed at a slant to limit rain and snow build up.

Modified rain and throughfall collectors(F) were set up under each frame; these modified rain and throughfall collectors provided support for the fog/dry deposition collectors. The modifications included removal of the following parts (as outlined in RFL-06):

RFL 06: I3 - measuring tube

RFL 06: I4 - funnel

RFL 06: M,N,O,P,Q - cover arm w/trigger line and weight

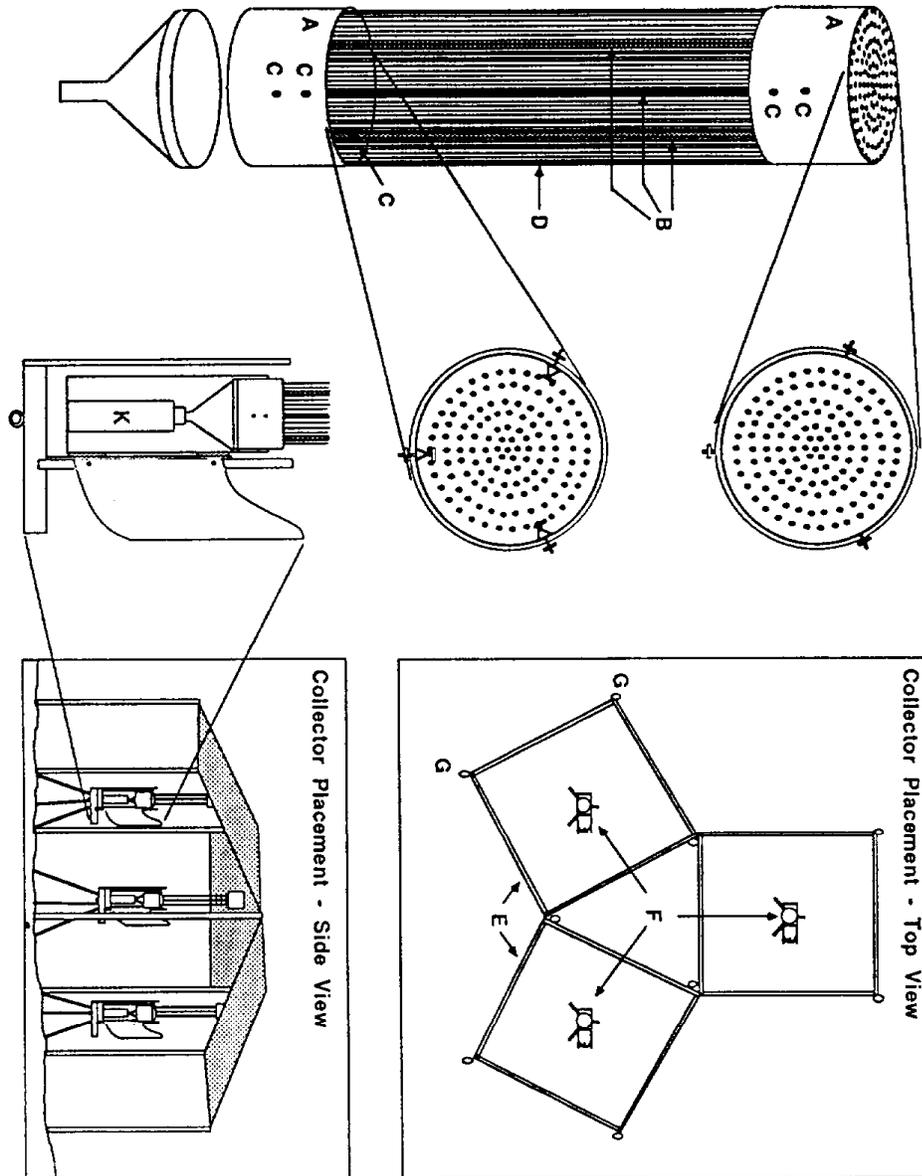
RFL 06: J,K,L - trigger post/lock/mount

Once assembled, a clean collection bottle(K) was placed in the rain and throughfall collector outer cylinder(RFL 06:I2). Fog/dry deposition collectors slid into the modified rain and throughfall collector outer cylinder; if necessary the fog/dry deposition collector was secured to the outer cylinder using duct tape(J). Each collector was positioned so the top of the fog/dry deposition collector was in contact with the polyethylene sheeting protecting it.

7.0 References

Glaubig, Robert and Anthony Gomez. "A Simple, Inexpensive Rain and Canopy Throughfall Collector."

Figure 1. Construction and Placement of Fog/Dry Deposition Collector.



1.0 **General Discussion**

1.1 **Purpose of Procedure**

The purpose of this standard operating procedure is to describe the materials needed and procedures employed to collect fog/dry deposition samples using the passive fog/dry deposition collector outlined earlier.

1.8 **Related Procedures**

Standard Operating Procedure:

RFL 35 Construction and Placement of Passive Fog/Dry Deposition Collectors

RFL 37 Chemical Processing of Fog/Dry Deposition Samples

2.0 **Apparatus, Instrumentation, Supplies, and Forms**

2.1 **Apparatus and Instrumentation**

2.1.1 **Description**

The passive fog/dry deposition collector is essentially a series of nylon lines arranged in parallel to intercept fog or dry deposition pollutants which pass through the collector. The exposed nylon lines allow dry deposition to adhere and fog to condense; the fog condensate runs down the nylon line, through a funnel, and into a 500 ml polypropylene bottle.

At each sampling, two samples are collected from each unit; the solution found in the fog condensate bottle and a sample generated by rinsing the nylon lines with NPW. Because of the passive nature of the collectors, the samples collected are composite samples representative of both dry deposition and fog.

2.2 **Supplies**

- A. Polypropylene Sprayer; pump pressure; filled with NPW
- B. Teflon Rinse Sheet; (500 mm x 500 mm)
- C. Replacement Condensate Bottles; 500 ml; 3 per site
- D. Rinse Collection Bottles; 500 ml; 3 per site
- E. Blank Collection Bottles; 60 ml; 1 per site
- F. Duct Tape

2.3 **Forms**

All data and notes for this procedure were recorded in a bound composition book; no forms were used.

3.0 **Calibration Standards**

Not applicable

4.0 **Procedures**

4.1 **Fog Condensate/Fog Dry Deposition Rinse Collection**

The fog/dry deposition collector is carefully removed from holder; duct tape is removed if necessary. The fog condensate bottle is removed from the outer cylinder and sealed using the screw lid from the new fog condensate bottle; The bottle is placed in an ice chest for transport to the lab. Notes were taken to record unusual aspects such as bottle overflow, broken nylon lines, support rods, etc. The pre-weighed rinse bottle is placed into the outer cylinder and the collector funnel

placed into the rinse bottle. The Teflon sheet(B) was placed on the outside of the collector nylon lines but inside the support rods as shown in Figure 1; this arrangement exposes 1/3 of the collector lines to direct spray. The lines are sprayed with NPW from the sprayer(A). After approx. 75 ml of rinse solution is collected in the bottle, the spray is stopped. The Teflon rinsing sheet is rotated clockwise to expose the next 1/3 of the collector lines. The lines are again sprayed with NPW and an additional 75 ml is collected. The Teflon sheet is again rotated clockwise to expose the final third of the nylon lines and the final 75 ml of line rinse is collected. The collector funnel is removed from the rinse bottle. The rinse bottle is removed from the outer cylinder, sealed and placed in an ice chest for transport to the lab. The new, pre-weighed fog condensate bottle is placed into the outer cylinder and the collector funnel is placed into the bottle. The fog/dry deposition collector is secured into the outer cylinder; duct tape is used if necessary. At each site a blank rinse sample was taken by spraying approx. 50 ml NPW into a 60 ml bottle.

4.2 **Laboratory Processing**

Once in the lab the fog condensate samples and rinse samples are weighed to determine the bottle and sample weight; sample weights are determined by subtracting the bottles weights determined earlier. Samples are analyzed as outlined in RFL 37, Chemical Processing of Fog/Dry Deposition Samples. If samples are not analyzed within 24 hours they are frozen for later analysis.

Fog condensate and fog/dry deposition rinse sample bottles are scrubbed, rinsed 3x with deionized water, and rinsed 3x with NPW. Bottles are allowed to air dry completely before next use. As outlined above, all bottles are weighed before transporting to the field.

4.3 **Collection Scheduling**

Fog condensate and fog/dry deposition rinse samples were collected approximately every two weeks.

5.0 **Quantification**

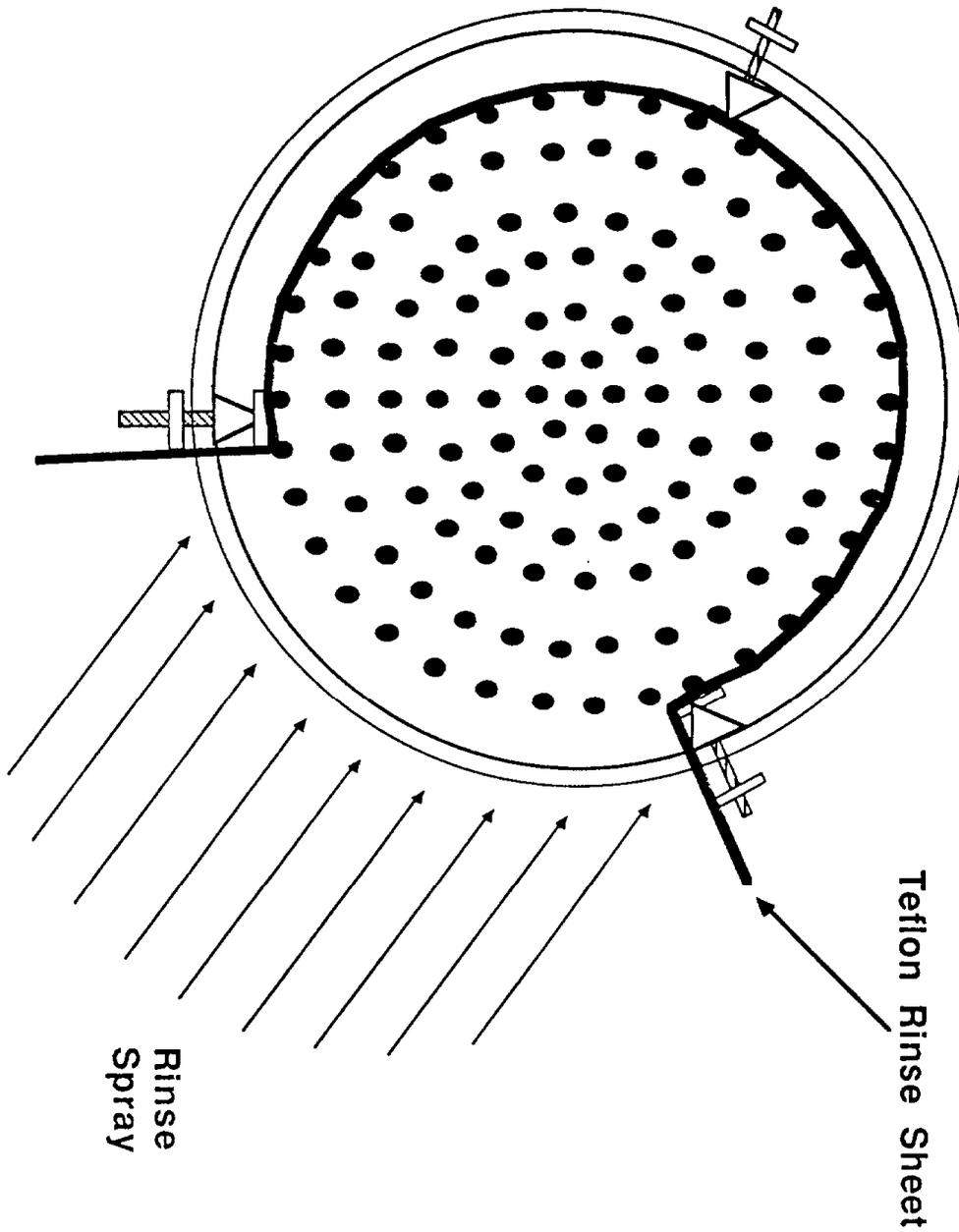
Not Applicable

6.0 **Quality Control**

Not Applicable

7.0 **References**

Figure 1. Teflon Rinse Sheet Placement.



1.0 **General Discussion**

Fog condensate and fog/dry deposition rinse samples were collected as outlined in RFL 36. These samples were analyzed for chloride, nitrate, sulfate, ammonium, calcium, magnesium, sodium, and potassium, and electrical conductivity. In addition, the condensate samples were analyzed for pH.

1.1 **Purpose of Procedure**

The purpose of this standard operating procedure is to describe the procedures used to analyze the fog/dry deposition samples collected using the deposition collector outlined in RFL 35.

1.8 **Related Procedures**

Standard Operating Procedure:

- RFL 35 Construction and Placement of Passive Fog/Dry Deposition Collectors
- RFL 36 Fog/Dry Deposition Collection Method
- LM 6.1 Measurement of pH
- LM 6.2 Measurement of Electrical Conductivity
- LM 6.3 Measurement of Low Level Anions - Dionex
- LM 6.6 Measurement of Ammonium and Nitrate - TRAACS
- LM 6.9 Measurement of Cations - Perkin Elmer 5000

2.0 **Apparatus, Instrumentation, Supplies, and Forms**

2.2 **Supplies**

- A. Sartorius Analytical Balance
- B. 15 ml centrifuge tubes
- C. NPW

4.0 **Procedures**

Two types of samples are collected from the fog/dry deposition collector: fog condensate and fog/dry deposition line rinses. These samples are prepared and analyzed identically with one exception; only fog condensate samples are analyzed for pH.

4.1 **Dilution**

Once samples were weighed they were transferred into 15 ml centrifuge tubes for analysis. For samples containing greater than 15 ml of solution, representative samples of the solutions were merely poured into the 15 ml tubes to approx. the 14 ml mark. Any samples remaining in the bottles were stored frozen until the analyses were complete. On those samples containing less than 15 ml solution, the entire sample was poured into a tared, 15 ml centrifuge tube, and the sample weight was recorded. NPW was added to the tube to approx. the 14 ml mark, and the weight was recorded; from these weights the dilution factor was calculated: $DF = \frac{\text{sample weight}}{\text{sample and NPW weight}}$. The samples in the 15 ml tubes, which were frozen when not in use, were used for the analyses outlined below.

4.2 **pH Determinations**

The pH of each non-diluted, fog condensate sample was determined as outlined in LM SOP 6.1.

4.3 **Anion Determinations**

The concentrations of anions chloride, nitrate and sulfate were

- determined using ion chromatography as outlined in LM SOP 6.3.
- 4.4 **Cation Determinations**
The concentrations of calcium, magnesium, sodium and potassium were determined using atomic absorption spectrophotometry as outlined in LM SOP 6.9.
- 4.5 **Ammonium Determinations**
The concentrations of ammonium were determined using automated colorimetry as outlined in LM SOP 6.6.
- 4.6 **Electrical Conductivity Determinations**
The electrical conductivity of non-diluted samples was determined as outlined in LM SOP 6.2.
- 7.0 **References**
Laboratory Methods and Training Manual. Forest Fire Laboratory
USDA Forest Service.

APPENDIX I

**LABORATORY METHODS AND
TRAINING MANUAL**

Forest Fire Laboratory
Forest Service, USDA
4955 Canyon Crest Drive
Riverside, CA 92507

Written by Bob Glaubig



LABORATORY METHODS AND TRAINING MANUAL

**FOREST FIRE LABORATORY
USDA FOREST SERVICE
4955 CANYON CREST DRIVE
RIVERSIDE, CA 92507
ROBERT A. GLAUBIG**

The Laboratory Methods and Training Manual outlines the analytical procedures used at the Forest Fire Laboratory. The following document is an abridged version, containing only those procedures used during analysis of samples from the following studies:

Assessment of acidic deposition and ozone effects on conifer forests in the San Bernardino mountains

Ecosystem-level Alterations in soil nutrient cycling: An integrated measure of cumulative effects of acidic deposition on a mixed conifer forest in Southern California

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1. LABORATORY PRACTICES

1.2 MAINTAINING DEIONIZED WATER, DISTILLED WATER AND NANOPURE WATER QUALITY

The Electrical Conductivity of the Deionized Water (DIW), and the Nanopure Water (NPW) will be checked weekly and recorded in the Laboratory Log.

The monitor lights on the deionized and distilled columns will be checked weekly.

1.3 CLEANING AND USING GLASSWARE AND PLASTICWARE (Revised 10/88)

1.3.1 CLEANING PROCEDURES

1.3.1.1 WASHING

Glassware/Plasticware should be rinsed out once with tap water immediately after use to avoid salt formation/sample crusting then placed in dirty labware area. Used soil will be placed into USED SOIL bucket for disposal into dumpster; DO NOT put soil down sink. Glassware/plasticware which has contained soil will be placed into SOIL LABWARE tub for special washing according to Sec. 1.3.1.5.

Remove temporary tape and marker labels from all glassware/plasticware.

When necessary perform detergent washing as outlined in Sec. 1.3.1.2.1

When necessary perform soaking as outlined in Sec. 1.3.1.2.2 - 1.3.1.2.4

Rinse with Deionized water (DIW) 3 times.

Place on drying rack or screen; allow to air dry. If quick turn around time is required glassware can be placed in 100 C oven until dry. NOTE: Be careful of placing certain plastic ware in oven.

Place dry glassware/plasticware into correct cabinets according to labeling code. Digest tubes will be placed into racks and covered with saran wrap or foil.

Before using stored glassware/plasticware, always rinse out with NPW or solution matrix to remove any accumulated dust.

1.3.1.2 CLEANING SOLUTIONS

1.3.1.2.1 DETERGENTS

All laboratory cleaning requiring the use of a detergent will be done with LIQUI-NOX, a low residue, phosphate-free detergent.

Composition: Concentrated LIQUI-NOX will be placed into a polypropylene

squirt bottle.

Applications: ALL glassware/plasticware which requires washing either alone or as a pretreatment to an acid treatment.

Procedure: Glassware/plasticware should be washed inside and out using tap water, conc. LIQUI-NOX, and brushes and/or sponges.

Rinse well until TOTALLY free of suds; this will always be a minimum of 3 times.

1.3.1.2.2 WEAK ACID SOLUTION

Composition: Approx. 0.1 M HCl; 10 ml conc. HCl / liter DIW

Application: For use on glassware and plasticware involved

in trace metal extraction and analysis; such as
Cu, Fe, Zn, Mn, Pb, Cd.

ALL new plasticware

ALL glassware/plasticware which contained soil

Procedure: Allow glassware or plasticware to soak in tub containing the acid solution for 2 days. Plastic tub containing acid solution will remain in hood and covered at all times. DO NOT PLACE METAL OBJECTS INTO ACID BATH.

1.3.1.2.3 CHROMERGE

Composition: Chromic/Sulfuric acid (make according to instructions)
Application: Pipets which are visibly dirty or which display beading
Procedure: Outlined in Sec 1.3.1.3

1.3.1.2.4 HF/HCl SOLUTION

Composition: 185 ml 6N HCL, 15 ml Conc. HF acid
Application: For use on very dirty glassware containing materials which cannot be removed by scrubbing or pre-treatments (ie. Fe ppt., coatings, etc.).
Procedure: Add small amounts of the solution to the insides of the glassware using a squirt bottle. Swirl around several times, allow to set for no more than 30 minutes. Squirt bottle of HF/HCl solution will be stored and used in hood. DO NOT USE ON VOLUMETRIC GLASSWARE OR ON PLASTICWARE.
Reference: Carl Nelson, U.C. Riverside, Soil and Environmental Sci.

1.3.1.3 PIPET WASHING

After use pipets will be stored in a cylinder containing 0.5 M HCl.

The use of Chromerge on pipets will be limited to pipets which have been used for organic solutions or those which have visible organic or Fe coating or solution beading. When used, Chromerge is drawn up into the pipet then drained back into Chromerge container. Because of the high H₂SO₄ content in Chromerge, pipets MUST be taken through the pipet washing procedure after Chromerge treatment.

1.3.1.4 WASHING SCHEDULE

Chem Lab staff will make assignments for washing the laboratory glass/plasticware. That individual MUST remember to perform the following tasks:

1. Wash dirty labware according to above procedures
2. Put away clean, dry labware in correct storage areas

Pipet washing will occur when enough pipets have accumulated.

Special areas will be set aside in the labware cabinets for SHORT TERM storage of glassware which has gone through a special cleaning procedure in preparation for specific use. Please label this labware with your name and when it will be used.

1.3.1.5 GLASSWARE/PLASTICWARE CONTAINING SOIL

Glassware/plasticware which has contained soil should be placed into the SOIL LABWARE dishpan. Glassware/plasticware containing soil will be washed according to the washing procedure outlined in Sec.1.3.1.1. A summary of this procedure is LIQUI-NOX scrub (Sec. 1.3.1.2.1), 1.0 M HCl soak (Sec.

1.3.1.2.2), 3 DIW rinses.

1.3.1.6 GLASSWARE/PLASTICWARE LABELING

All glassware/plasticware will be labeled with a permanent identification code using one of the following methods:

1. Extra-Fine Tipped Sharpie on the white enameled marking areas,
2. Etched into glassware using a diamond or carbide tipped pen,
3. Paint Pen.

The coding scheme will consist of each labware type having a letter prefix followed by an upto three digit number as follows:

Digestion Tubes	000
Volumetrics	V 000
Pipets	P 000

Individual scientist's glassware will be marked with the scientist's name in place of the identification code and stored in a separate area.

1.3.1.7 SPECIAL WASHING PROCEDURE - BELL STREAM SAMPLES

BOTTLE WASHING PROCEDURE

After all analyses have been done and results approved by Lab Manager the bottles will be washed according to the following procedure:

1. Dump out sample and rinse well with DIW until free of sediment and clean; 1 or 2 rinses
2. If bottles are visually dirty (precipitate, film, organic coatings) then they should be washed with a bottle brush until clean and rinsed again with DIW; NOTE: Soap washing will also occur on a regular basis as determined by the Lab Manager.
3. Rinse twice with small amounts of NPW
4. Drain bottles and replace into project box UPSIDE DOWN in the following arrangement:

```
:-----:
:22 23 24 25 26 27 28:
:15 16 17 18 19 20 21:
: 8  9 10 11 12 13 14:
: 1  2  3  4  5  6  7:
:_____:
```

Place bottle caps on top of the upside down bottles, place a new data sheet into plastic cover and into the box; close box

1.3.2 USAGE: VOLUMETRIC GLASSWARE AND PLASTICWARE

As stated in the RFP LAT.

1.3.3 USAGE: MECHANICAL PIPETTS AND DISPOSABLE TIPS

1.3.3.1 GILSON AUTO DILUTOR

The Gilson Auto Dilutor will be flushed well with diluent (sample matrix) prior to use; a 10 min auto flush is sufficient.

The Gilson Auto Dilutor will be calibrated prior to every use. Before any dilution are made the exact dilution factor will be determined as follows:

1. Adjust Dilutor to proper settings
2. Weigh a vial full of sample (Vial A/Reading 1)

3. Weigh an empty vial (Vial B/Reading 1)
4. Draw up sample from Vial A
5. Pipet sample and diluent into Vial B
6. Reweigh Vial A (Reading 2) and Vial B (Reading 2)
7. Calculate the correct dilution factor:

$$\text{Dil. Factor} = \frac{(\text{Vial B Reading 2}) - (\text{Vial B Reading 1})}{(\text{Vial A Reading 1}) - (\text{Vial A Reading 2})}$$
8. Repeat above procedure one more time
9. Calculate average and st. dev. of the two dilution factors
 Calculate % st. dev. as equal to st. dev. / mean x 100
10. If % st. dev. is larger than 3% then dilution is too large and not accurate.

The Gilson Auto Dilutor will be flushed well with NPW after use; a 10 min auto-flushing is sufficient.

1.5 MAINTAINING ANALYTICAL STANDARDS

1.5.1 STOCK SOLUTIONS

Pre-made analytical stock solutions (such as atomic absorption stocks) will be stored in an area located near the instrument they are used with. Stock solutions will be made using AR grade chemicals which have been dried @ 105 C and stored in the AR chemical dessicator box. Stock solutions will be labeled with the following:

1. Chemical Composition (including matrix ie. KCl, AmOAc)
2. Preparation Date
3. Preparer's Initials

Stock solutions will be stored in the Chem lab refrigerator. The above information, along with the volumetric no. used, will be recorded on Stock Solution Documentation sheets and placed in the Laboratory Log.

1.5.2 STANDARD SOLUTIONS

Stock solutions to be used for making standards must be poured into a separate container; NO PIPETTING FROM STOCK SOLUTION CONTAINERS WILL BE ALLOWED. Standards Solutions will be labeled with the following:

1. Chemical Composition (including matrix ie KCl or AmOAc)
2. Preparation Date
3. Preparer's Initials

Standard Solution Documentation sheets will be filled out and placed in the Laboratory Log.

1.5.3 STOCK/SOLUTION SURVIVAL TIME

The following is a list of maximum time that each stock or standard solution will be kept:

Stock Solutions	
Stocks containing NO ₃ , NO ₂ , NH ₄ , PO ₄ , SO ₄	1 month
Stocks containing Total N, Total P	1 month
All other stocks	2 months
Standard Solutions	
Standards containing NO ₃ , NO ₂ , NH ₄ , PO ₄ , SO ₄	2 weeks
Standards containing Total N, Total P	1 month
All other standards	1 month

1.6 WEIGHING

1.6.1 BALANCE SET UP AND OPERATION

The two Sartorius balances located in the weighing room and micrp lab are connected to the AT&T PC 6300 computer for inter-active collection of weight data. To operate, turn on the adjacent computer; the computer prompts will instruct you how to proceed. Within each balance case will be a container of indicating silica gel; silica gel helps to maintain a dry atmosphere inside the balance. This container should be opened and replaced into the case when dry samples are to be weighed (such as dried plants or plant tissues, oven-dried soil, non-hydrated chemicals, etc).

When you are through with the balance you should:

1. Close up the container of indicating silica gel (if applicable)
2. Replace any chemicals or materials to their correct location
3. Clean up the balance and adjacent area with a damp Kim-wipe
4. If it is not being used, shut off the computer

NOTE: THE WEIGHING OF SOILS SHOULD NEVER BE DONE CONCURRENTLY WITH PLANT TISSUES OR CHEMICALS.

1.6.2 MAINTENANCE

The calibration of each balance will be checked weekly using the calibration weights which are stored in the balance drawer, Follow the calibration procedure on the Weighing Procedure disk. Place this calibration printout sheet into the Laboratory Log.

1.6.3 RULES OF CHEMICAL USE

*** PLEASE SEE CHEMICAL INVENTORY DOCUMENTATION ***

1.8 CONTROLLING LABORATORY SAMPLE HANDLING/CUSTODY

1.8.1 SAMPLE LOGGING

When samples are to be logged in, fill out the LABORATORY LOG-IN SHEET leaving the types of analyses blank and return it to the Data Manager who will give you the correct no. of sample ID labels.

Attach these labels to the samples, complete the LAB SAMPLE INVENTORY sheet and turn it in to the Data Manager

1.8.2 SAMPLE CUSTODY

1.8.3 LABORATORY SAMPLE HANDLING

1.8.4 ARCHIVING OF SAMPLES

1.9 RECORDING AND REPORTING DATA

The following is the procedure for ALL analytical runs:

pH/E.C. Runs

Each run of 30 samples will include:

- 2 Replicates of the check sample xx.99902
- less than or equal to 26 samples

2 Replicates of 2 samples chosen at random from above samples

Note: Replicates should not be run next to each other.

Atomic Absorption Spectrophotometry

*** PLEASE SEE ATOMIC ABSORPTION SPECTROPHOTOMETRY PROCEDURE ***

TRAACS 800 Runs

Each tray will include:

- 1 Primer
- 5 Standards

- 1 High
- 2 Lows
- 3 Intermediates
- 2 Replicates of Check Standard xx.99914
- * less than or equal to 38 samples
- 2 Replicates of 2 samples chosen at random from above samples
- 3 Intermediates
- Back to * if additional sample are to be run
- Gain - High Standard

Dionex Runs

Each tray will include:

- 5 Standards
- 1 Wash
- 2 Replicates of Check Standard
 - Low Anions xx.99913 1:2 Dilution
- 40 or less samples
- 1 Wash
- 1 High Standard

Data File Format for all analytical runs will be the following:

MMDDIII# ... for month,day,operator initials,and run no. for that day
ie. 0809BAG1, or 1202ILY3

When inputting the type of analysis you MUST use the FLAC (Four Letter Analysis Code) assigned for that analysis.

When you are through with a run, fill out the DATA SUBMITTAL SHEET (including deletions), attach it to raw data sheets and place them into Data Manager's In-box.

1.10 INSTRUMENT TRAINING AND SCHEDULING

1.10.1 TRAINING

Before an individual is allowed to use the TRAACS 800 system, Perkin-Elmer 5000, or Dionex 4000i system, that individual must receive training on the instrument. Authorization of instrument use will only be granted when that individual has completed an entire run in the presence of the Laboratory Manager or the person assigned that duty by the Laboratory Manager.

1.10.2 SCHEDULING

Scheduling the use of an instrument will be done by the Laboratory Manager who will assign day-to-day priority for sample analysis.

1.11 ROUTINE MAINTAINANCE

PROCEDURE: The items listed below are to be performed or checked at regular intervals, recorded in Laboratory Log, and corrected if necessary

1.11.1 Daily ...

1. Morning - wash down counters
2. Check water level in upstairs distilled tanks, turn on distilled tanks if necessary.

1.11.2 Weekly ...

1. Check E.C. of NPW and DIW; record in Laboratory Log
2. Check to make sure large deionizing tank is still good; light must be ON.
3. Check calibration of both analytical balances using weight check set and Calibration program; place calibration printout in Laboratory Log.

1.11.3 Every 2 Weeks ...

1. Dispose of standards containing NO₃, NO₂, NH₄, PO₄, SO₄

1.11.4 Every 1 Month ...

1. Dispose of Total N and P Standards and Stocks
2. Dispose of Stocks containing NO₃, NO₂, NH₄, PO₄, SO₄

1.11.5 Every 2 Months ...

1. Dispose of other Stock Solutions
2. Dispose of other Standard Solutions

1.11.6 Every 3 Months ...

1. TRAACS 800
 - a. Change pump tubes
 - b. Adjust temperature of heater baths if necessary

2. FOLIAR INORGANIC ANALYSIS

2.1 SOP SAMPLE GRINDING (Revised 12/09/94)

2.1.1 SCOPE AND PURPOSE

This procedure is performed to prepare plant tissue samples for acid digesting and digest chemical analysis and elemental combustion analysis of total nitrogen, carbon and sulfur.

2.1.2 MATERIALS AND METHODS

2.1.2.1 EQUIPMENT

- * Thomas Wiley mill - intermediate model -OR- model ED-5
- * Shop vacuum
- * Compressed air; house air w/filter system
- * Nylon hair paint brush; small
- * Whirl Pak bag or other sample container

2.1.3 PROCEDURES

2.1.3.1 SAMPLE DRYING

1. Place tissue sample into paper bag
2. Place samples into 70° C oven for 24 hours

2.1.3.2 SAMPLE GRINDING

1. Choose the correct grinder size based on sample size:
 - The intermediate size will lose less sample but take a longer time when grinding large samples
 - The Model ED-5 size will grind large samples quickly but will lose a larger amount of the sample
2. Place a labeled Whirl-Pak bag under grinder outlet
3. Remove the sample to be ground from the oven.
4. Place the bag contents onto a CLEAN sheet of paper
5. Turn on the grinder
6. Carefully pour the sample into the grinder receiver; push sample into grinder neck with the plunger
7. Once entire sample has been placed into grinder, allow grinder to run for one minute
8. Turn off grinder
9. On small tissue samples, it may be necessary to carefully brush the sample from the grinder sieve into the sample bag; this is done to assure enough sample is obtained.
10. Seal Whirl Pak bag
11. Dis-assemble the grinder
12. Vacuum out all remaining tissue from the grinder and grinder parts
13. Use compressed air to blow out any remaining tissue from grinder
14. Re-assemble grinder

2.9 SOP ELEMENT ANALYSIS: PERCHLORIC DIGEST - Ca, Mg, Na, K, Mn, Zn, Fe, P
(Revised 01/11/90)

2.9.1 SCOPE AND PURPOSE

This procedure is a modification of procedure of Page and Ganje (UCR). Perchloric digests are to be used on plant tissues for the analysis of Ca, Mg, K, Na, Fe, Mn, Zn, P. Analysis of soils can also be performed by increasing the sample size as outlined below.

NOTE: DURING THE DIGESTION AND ACID MIXING STAGES OF THIS PROCEDURE, IT IS REQUIRED THAT YOU WEAR A LAB COAT AND PROTECTIVE EYEWEAR

2.9.2 MATERIALS AND SUPPLIES

2.9.2.1 EQUIPMENT

- * Analytical Balance (0.0001 g sensitivity)
- * Digestion Block with 75 ml (or 50 ml) calib. digestion tubes (numbered)
- * 5 ml repipet
- * Glassware necessary to prepare standards
- * See Sec. 6.9

2.9.2.2 CHEMICALS/REAGENTS

- * Conc. HNO₃
- * HClO₄ (approx. 70%)
- * 1000⁴mg Ca/l stock
- * 1000 mg Mg/l stock
- * 1000 mg K/l stock
- * 1000 mg Na/l stock
- * 1000 mg Fe/l stock
- * 1000 mg Mn/l stock
- * 1000 mg Zn/l stock
- * 250 mg P/l stock ... 0.549 g KH₂PO₄ / 500 ml

Standards:

The standards for these analyses are made up in the digest matrix; this is accomplished through the following:

1. Run 20 blank samples (digest solution only) through the digest proc., cool, and wash the contents of 10 tubes into a 100 ml volumetric using NPW. Bring to 100 ml volume with NPW. Do this same procedure for the second set of 10 tubes. Combine the two 100 ml volumetrics into one container. NOTE: This must be done using 2.0 ml digest
2. Add 13.3 ml (or 33.3 ml) of this solution to each 100 ml volumetric

Ca, Mg, K, Na, Fe, Mn, Zn, Standards

- | | |
|-------------------|--|
| Temporary Stock 1 | 200 mg Mg, 100 mg Na, 50 mg Mn, Zn, Fe / liter NPW |
| | 20.0 ml of 1000 mg Mg/liter stock |
| | 10.0 ml of 1000 mg Na/liter stock |
| | 5.0 ml of 1000 mg Mn/liter stock |
| | 5.0 ml of 1000 mg Zn/liter stock |
| | 5.0 ml of 1000 mg Fe/liter stock |
| | Make to 100.0 ml with NPW |
| Temporary Stock 2 | 100 mg Ca, K; 20 mg Mg; 10 mg Na; 5 mg Mn, Zn Fe/liter NPW |
| | 25.0 ml 1000 mg Ca/liter stock |
| | 25.0 ml 1000 mg K/liter stock |
| | 25.0 ml Temporary Stock 1 |
| | Make to 250.0 ml with NPW. |

Standards

Ca, K/Mg/Na/Mn, Zn, Fe (mg/l)	Temp. Stock 2 added (ml)
0.0/0.0/0.0/0.00	0.0 / 250 ml
5.0/1.0/0.5/0.25	5.0 / 100 ml
10.0/2.0/1.0/0.50	10.0 / 100 ml
20.0/4.0/2.0/1.00	50.0 / 250 ml
35.0/7.0/3.5/1.75	35.0 / 100 ml
50.0/10.0/5.0/2.50	50.0 / 100 ml

P Standards

Temporary Stock 3 250.0 mg P / liter NPW

0.549 g KH₂PO₄ / 500 ml NPW

Temporary Stock 4 10.0 mg P / liter NPW

20.0 ml of Temp Stock 3 / 500 ml NPW

Standards

mg P/l	ml of Temp. Stock 4 / 100 ml
0.0	0.0
0.5	5.0
1.0	10.0
2.0	20.0
4.0	40.0
6.0	60.0

Remember to add 13.3 ml of digest solution above to each 100 ml volumetric
33.3 ml of digest solution must be added to each 250 ml volumetric
Standards should be refrigerated @ 4 C.

2.9.3 PROCEDURES

2.9.3.1 SAMPLE PREPARATION

1. Foliar samples should be oven-dried at 70 C, ground to pass a 1 mm screen, and stored in Whirl Pak Bags.
2. Weigh out 0.2000 - 0.2050 g of each sample into a 75 ml digestion tube; use 0.1333 - 0.1366 g for 50 ml tubes. Tube numbers MUST be recorded.
NOTE: Use one data file per rack

Weights of xx.99905 must be weighed out exactly:
0.2000 - 0.2005 g / 75 ml tubes; 0.1333 - 0.1337 g / 50 ml tubes
NOTE: Sample replicates should be entered into computer as Rx.xxxxx
ie. a 1988 samples would be R8.08768
3. Heat up digestion block to 60±10 C.
4. Add 2 ml of acid mixture to each 75 ml tube; (1.33 ml for 50 ml tubes)
This must be done in the hood. NOTE: Acid Mixture composition below
5. Place tubes into the 60±10 C digestion block for 30 minutes or until reaction has subsided.
6. Increase digestion block to 120±10 C, continue heating tubes for 3 hours.
7. Remove tubes from block and allow to cool.
8. Dilute to 75 ml (or 50 ml) mark with NPW and MIX WELL.
9. Transfer to polypropylene storage bottle. Label bottles with Sample ID
Perchloric Digest, Tube no., and Date
10. Place samples in refrigerator.
NOTE: Soil samples can also be run using the above procedure however,
0.5000 g soil is used.

NOTE: EVERY rack of 40 will contain the following:

- 1 blank tube (xx.99952)
- 2 pine needles NBS 1575 SRM tubes (xx.99905)
- 2 replicates of samples chosen at random;

NOTE: Sample replicates should be labeled as Rx.xxxxx as mentioned above

Acid Mixture Composition

One Block	Two Block
80 ml HNO ₃	150 ml HNO ₃
40 ml HClO ₄ (70%)	75 ml HClO ₄ (70%)

2.9.3.2 ATOMIC ABSORPTION OPERATION

Follow procedure outlined in Sec 6.10 using acid-matrix standards outlined above.

2.13 SOP ELEMENTAL COMBUSTION ANALYSIS - PLANT TISSUE: TOTAL C, N, S

2.13.1 SCOPE AND PURPOSE

The purpose of this procedure is to determine the concentration of carbon, nitrogen and sulfur in ground plant tissue using a Carlo Erba NA1500 combustion gas chromatograph analyzer.

2.13.2 MATERIALS AND SUPPLIES

2.13.2.1 EQUIPMENT

- * Carlo Erba NA 1500 combustion gas chromatograph
- * Sartorius analytical balance
- * Small spatula
- * Tweezers; two pair
- * Tin sample cups
- * NIST Pine #1575 - Standard
- * Pine composite survey standard

2.13.2.2 CHEMICALS/REAGENTS

- * See Carlo Erba operation manual

2.13.3 PROCEDURES

2.13.3.1 OPERATION

1. Check gas cylinder volumes and pressures:

Oxygen	25
Comp. Air	50
Helium	36
2. Check that sum of current counter reading and number of samples to be run is less than 220 ... if not replace combustion tube as outlined
3. Replace magnesium perchlorate in water trap as outlined
4. Turn carrier gas(He) from STBY to FLOW (clockwise)
5. Adjust M pressure to 95
Adjust R pressure to 112
6. Adjust oxygen pressure to 150
7. Turn purge from OFF to ON (counter-clockwise)
8. Check all parameters:

LEFT	50	(C X 10)
RIGHT	103	(C X 10)
OVEN	81	(C) [84 for S only runs]
FIL TEMP	190	(C)
CYCLE STOP	75	(SEC X 10)
SAMPLE START	XX	(SEC) [varies with tube]
SAMPLE STOP	60	(SEC)
OXY INJ STOP	82	(SEC)
PEAK ENABLE	2	(SEC X 10)
9. Release FURN STBY button (must be out)
Release FIL OFF button (must be out)
10. If not currently on main menu screen ...
Type EAGER [ENTER] at any DOS prompt
Delete scratch files
11. [LOAD] TISSUE.EAD [CONFIRM]
12. Det./Integr. parameters [EDIT]
First Sample: 1
Last Sample: xx; where xx is equal to last sample on data sheet
Sample being acquired: 1
[UPDATE] [UPDATE]; if changes were made

13. Sample Table [EDIT]

Choose correct filename for run according to date (see below)

DATE	PREFIX								
1	A	2	B	3	C	4	D	5	E
6	F	7	G	8	H	9	I	10	J
11	K	12	L	13	M	14	N	15	O
16	P	17	Q	18	R	19	S	20	T
21	U	22	V	23	W	24	X	25	Y
26	Z	27	AA	28	BB	29	CC	30	DD
31	EE								

Input correct filename into filename spaces 1 - 12

Make sure pointer is on row 13

[EDIT ROW]

[FILL SAMPLE TABLE]

Number of samples : xx; where xx is equal to no. of sample - 12

File Name Root : correct letter prefix from above

First Suffix: 13

First Suffix: 13

[REPLACE]

Enter all correct sample names according to data sheet

Enter all correct weights according to balance print out(s)

Check to make sure all data in sample table is complete

[UPDATE] [UPDATE]

14. Component Table [EDIT]

Choose correct components

[UPDATE] [UPDATE]; if changes were made

[SAVE]

Change method file to "Fmmddiii.EAD

[CONFIRM]

15. Turn (clockwise) bottom sampler tray (0-49) to space 1

Load all samples into bottom sampler tray

16. Install top sampler tray (50-99) with stop peg lined up with dot on tray

Load all samples into top sampler tray

Place cover and securing screw back onto sampler

17. Make sure that right oven is at 1020 C; left oven is at 500 C

18. Make sure that you have enough paper for the entire run; printer on-line

19. [RUN] [START ANALYSIS]

20. [RUN] [MONITOR DETECTOR]

2.13.3.2 SHUTDOWN

When run is completed ...

1. Back off oxygen all the way

2. Turn purge from ON to OFF (clockwise)

3. Turn carrier gas from FLOW to STDBY (counter-clockwise)

4. Depress FURN STBY button

Depress FIL OFF button

2.13.3.3 DATA PROCESSING

NOTE: Make sure the correct method is loaded before beginning processing

1. [[]] [Quit monitor detector(s)]

2. [View] [View chromatograms]

3. Starting with sample number 3; ie. M3 or T3 ...

[File] [Load chromatogram] Filename [Confirm]

Correct nitrogen and sulfur baselines as needed

If changes were made: [File] [Save chromatogram] [Confirm] [Confirm]

4. When baseline corrections for ALL samples have been made:

[[]] [Quit view chromatogram]

5. Calc. & report parameters [EDIT]

Change: Reports(s) on DISK

Append for summary YES

[UPDATE]

- [OK]
6. [Recalculation] [Reset for calculation] [Confirm]
 7. [Recalculation] [Recalculation]
 - Reintegrate chromatogram: NO
 - Save Chromat. after reint.: NO
 - First Sample to recalculate: 8
 - Last Sample to Recalculate: XX; where XX is the number of last sample
 8. [Confirm]
 - After all files have been recalculated:
 - {View} [View calibration curves]
 - {Print} [Print calibration]
 - {Component} ["next component"]
 - {Print} [Print calibration]
 9. [[]] [Quit calibration curves]
 10. [[]] [Quit] [Confirm]
 11. Type COMBUST [ENTER]
 12. Follow prompts ...
 13. Check main printout to assure that all peaks are properly labeled

2.13.3.4 REPLACING COMBUSTION TUBES

1. Go through shut down procedure above
2. Allow furnace temperature to come down to around 800 degrees
3. Remove sampler by unscrewing sampler foot and carrier-in fitting, lift off
4. Remove furnace front cover
5. CAREFULLY unscrew bottom tube fitting using wrench and pliers; top ring should turn to right
6. Remove bottom o-ring and carefully pull tube out of furnace; place into a large beaker to cool
7. Repack tube as outlined on following page
8. Place top o-ring onto top of tube about 0.5 cm from top of tube
9. CAREFULLY slide combustion tube into the furnace
10. Place autosampler back into place; slightly tighten foot fitting
11. Place footing, metal ring, and o-ring onto bottom of tube; o-ring should be about 0.5 cm from bottom of tube
12. Carefully attach and tighten bottom fitting
13. Attach sampler carrier gas line; tighten both footing and carrier gas line
14. RESET COUNTER
15. Leak test system as outlined

2.13.3.5 REPLACING WATER TRAP MAGNESIUM PERCHLORATE

1. Turn carrier flow to standby
2. Remove inlet screw cap from water trap (inlet from combustion tube)
3. Remove quartz wool plug
4. Remove magnesium perchlorate from trap until no longer caked
5. Add new magnesium perchlorate until up to level
6. Replace quartz wool plug
7. Replace inlet screw cap fitting
8. Leak test system as outlined

2.13.3.6 SYSTEM LEAK TESTING

1. Turn carrier gas to FLOW (clockwise)
2. Attach M vent cap
3. Turn M needle valve to 100; back off valve all the way
4. Check if pressure drop is less than 10 KPA in 3 minutes
If not; tighten all fittings and goto 3 to re-leak test
5. Turn M needle back to 100
6. Remove vent plug; re-attach vent fitting
7. Readjust M needle to 95
8. If combustion tube was changed, check flowrates; carrier gas should be 104 ml/min; reference should be 40
9. Goto startup procedure

2.13.3.7 MAINTENANCE SCHEDULE

Every 200+ samples: Remove combustion tube, allow to cool, repack comb. tube
Leak test

Every Run: Replace magnesium perchlorate in water trap
Leak test

4. SOIL PHYSICAL ANALYSIS

4.1 SOP SAMPLE PREPARATION: AIR-DRY SOILS

4.1.1 SCOPE AND PURPOSE

The purpose of this procedure is to dry and prepare soils in a uniform method as a pre-treatment to other soil analysis methods.

4.1.2 MATERIALS AND SUPPLIES

4.1.2.1 EQUIPMENT

- * 2 mm Brass Sieve
- * Wooden Rolling Pen
- * Brown Wrapping Paper
- * Area in Butler Building to Lay Out Samples
- * Soil Storage Containers; wide mouth bottles, whirl-pack bags

4.1.3 PROCEDURES

4.1.3.1 SAMPLE PREPARATION

1. Place soil samples onto a piece of brown paper in an area which is out of the way in the Butler building
2. Remove and discard large rocks and other discrete particles
3. Using a CLEAN rolling pin, gently crush soil aggregates and spread soil out to dry
4. Once air dry, pass the soil through a CLEAN 2 mm brass sieve; use a pestle to gently crush aggregates to pass through the sieve.
5. Discard roots, rocks, etc which do not pass through sieve.
6. Place air-dry, sieved soils into storage containers (wide-mouth bottles for large samples, whirl-pack bags for small samples). If only a sub-sample will be saved, ensure that the soil is properly mixed before taking that sub-sample.
7. Clean up ALL equipment between samples.

4.2 SOP MEASUREMENT OF SOIL MOISTURE CONTENT

4.2.1 SCOPE AND PURPOSE

This procedure is used to determine the moisture content of soils and report these results on an oven dry basis. It will be used in conjunction with other procedures such as KCl extracts (Sec 5.11) and saturation extracts (Sec. 5.11)

4.2.2 MATERIALS AND SUPPLIES

4.2.2.1 EQUIPMENT

- * Analytical Balance (0.0001 g sensitivity)
- * Oven capable of maintaining 105 ± 2 C
- * Metal Soil Cans Which Are Numbered
- * Dessicator

4.2.2.2 CHEMICALS/REAGENTS

- * Dessicant - Drierite

4.2.3 PROCEDURES

1. Place empty numbered soil cans (w/lids on bottom) into 105 C oven for 24 hrs
2. Remove cans from oven and place into dessicator
3. Replace lids onto top of cans
4. Record sample no., can no., can tare wt. and can plus wet soil wt. according to 'Weighing Procedures' program
5. Dry soil in 105 C oven for 48 hrs w/lids on bottom
6. Remove cans from oven and place into dessicator
7. Replace lids onto top of cans
8. Record can no. and can plus dry soil wt. according to 'Weighing Procedures' program

4.3 SOP SAMPLE PREPARATION: SHATTERBOXING

4.3.1 SCOPE AND PURPOSE

This procedure is performed to pulverize a soil, or rock sample, in preparation for analysis in the elemental combustion analyzer; Sec 5.13.

4.3.2 MATERIALS AND METHODS

4.3.2.1 EQUIPMENT

- * SPEX Industries Shatter Box
- * 30 second timer
- * Kim wipes
- * Nano pure water
- * Whirl Pak bags or other sample container

4.3.3 PROCEDURES

4.3.3.1 SAMPLE DRYING

1. Place small sub sample of soils into labeled tin pans
2. Place tin pans and samples into 70° C oven for 24 hours
3. Remove samples from oven and place in dessicator until cool
4. Transfer samples into labeled Whirl Pak bags

4.3.3.2 SAMPLE SHATTERBOXING

1. Place shatter box pan, inner ring and inner weight onto the platform
2. Transfer dried soil from bag into the shatter box inner chamber
3. Place cover on the shatter box pan and tighten down; push up safety
4. Turn on shatter box for 30 seconds
5. Transfer sample from the shatter box pan onto a clean sheet of paper
6. Transfer sample from paper into original Whirl Pak bag
7. Wash the pan, ring, weight and lid with tap water
8. Rinse the pan, ring, weight, and lid with nanopure water
9. Dry the pan, ring, weight and lid with Kim wipes

4.6 SOP PARTICLE SIZE ANALYSIS: HYDROMETER METHOD

4.6.1 SCOPE AND PURPOSE

The purpose of this procedure is to determine the percentage of sand (2.00-0.05 mm), silt (0.05-0.002mm), and clay (<0.002mm) in the whole soil. This procedure is a modification of Method 43 (pg 545) in Methods of Soil Analysis, Agronomy 9.

4.6.2 MATERIALS AND SUPPLIES

4.6.2.1 EQUIPMENT

- * 250 ml wide-mouth bottles (1 per sample)
- * 1 liter calibrated cylinder (1 per sample)
- * Analytical Balance (0.01g sensitivity)
- * Soil Mixing Plunger
- * Stop Watch
- * Hydrometer
- * Thermometer (0-100 C)
- * Hot Plate

4.6.2.2 CHEMICALS/REAGENTS

- * Na Hexametaphosphate (NaHMP) 25.0 g / liter NPW

4.6.3 PROCEDURE

4.6.3.1 SAMPLE PRETREATMENT FOR ORGANIC REMOVAL

1. Obtain approx. 60 g of soil which has been treated according to Sec. 4.1, place into 250 ml beaker and record beaker no.
2. Add 45 ml of NPW and mix by swirling
3. Cautiously add 1 ml of 30% H₂O₂ and cover with watch glass; gently swirl beaker
4. After initial reaction subsides, add additional 30% H₂O₂ and heat beaker on hot plate (90 C) for 1 hr. Repeat H₂O₂ addition and heating until reaction is complete.
5. When reaction is complete, decant solution and soil into 250 ml wide-mouth bottle, rinse beaker into bottle using NPW squirt bottle.
6. Centrifuge bottle and soil @ 3000 rpm for 15 min
7. Carefully decant off solution and discard
8. Add 200 ml of NPW
9. Shake on platform shaker for 1 hr
10. Centrifuge bottle and soil @ 3000 rpm for 15 min
11. Carefully decant off solution and discard
12. Repeat steps 8 - 11 one more time
13. Remove soil from bottle using spatula and place onto #42 whatman filter paper. Place filter paper into 105 C oven until dry
14. Gently scrape soil off filter paper, grind soil gently using mortar and pestle and place into storage container.

4.6.3.2 PARTICLE SIZE ANALYSIS

1. Place 40.0 g of treated, oven-dried soil into 250 ml wide-mouth bottle
2. Add 200 ml of NaHMP solution
3. Shake on platform shaker for 60 minutes
4. Rinse contents into 1 liter cylinder using NPW; bring upto volume with NPW
5. Add 200 ml NaHMP solution to another 1 liter cylinder; bring to volume with NPW
6. Place watch glasses on both cylinders and allow to equilibrate overnight
7. Place clean hydrometer into blank graduate cylinder
8. Record this blank reading (Rb) and solution temperature (Tb)
9. Mix soil suspension in graduate cylinder COMPLETELY
10. Record start time, hit stop watch
11. Quickly but gently place clean, dry hydrometer into cylinder
12. Record 35s, 55s, and 75s readings
13. Repeat steps 13-16 one more time
14. Gently remove hydrometer from cylinder and wipe dry

15. Gently place hydrometer into cylinder 30s before each reading
 16. Record reading. Gently remove hydrometer and wipe dry
- NOTE: All readings will be recorded onto Particle Size Analysis Sheet (Fig 4-1)
17. Calculate % sand, silt, and clay for each soil

5. SOIL CHEMICAL ANALYSIS

5.1 SOP MEASUREMENT OF pH: NANOPURE WATER, 0.01 M CaCl₂, 1 M KCl EXTRACTION

5.1.1 SCOPE AND PURPOSE

The purpose of this procedure is to determine the pH of 2:1 soil extracts using either nanopure water, 0.01 M CaCl₂ or 1 M KCl.

5.1.2 MATERIALS AND SUPPLIES

5.1.2.1 EQUIPMENT

- * Altex 71 pH meter w/combo electrode
- * pH/E.C. Procedure program (on hard disk)
- * Squirt bottle filled with NPW
- * Platform Shaker

5.1.2.2 CHEMICALS/REAGENTS

- * pH 4, pH 10 Buffers
- * Nanopure Water
- * 0.01 M CaCl₂
 - Stock Solution 4.0 M CaCl₂: prepared as follows:
58.81 g CaCl₂ 2H₂O / 100 ml NPW
 - 0.01 M CaCl₂: prepared as follows:
5.0 ml of 4M stock / 2 liters NPW
adjust to between pH 5 and 6.5 using Ca(OH)₂ or HCl
- * 1 M KCl: prepared as follows:
74.56 g KCl / liter NPW; adjust pH to between 5 and 6.5 using KOH
or HCl

5.1.3 PROCEDURES

5.1.3.1 SAMPLE PREPARATION

The following can be performed using either of the three extractants:

1. Samples should be air-dried as outlined in Sec 4.1
2. Add 10.0 g soil to 60 ml, conical bottom centrifuge tubes
3. Add 20.0 ml of extractant to each tube
4. Cap tubes and shake for 15 minutes on platform shaker
5. Centrifuge tubes @ 3000 rpm for 15 minutes
6. Follow procedure in Sec 6.1 for determination of pH. On samples, pH electrode tip should be setting just above the soil:solution interface; NOT PUSHED INTO SOIL

Add 2.5 ml .1 N HCL to 250 ml volumetric and 1 ml to 100 ml volumetric after bringing to volume

5.3.3 PROCEDURES

5.3.3.1 Extraction of Bases (cations)

1. Make 2.5 L 0.5 M SrCl₂ 6 H₂O. 266.6g/2l volumetric 66.66g/500ml vol.
2. Run one blank and 36 samples and 2 replicates
3. To each syringe add 0.5 grams filter pulp. Press down so surface is even.
4. Place syringe in rack and secure all syringes together.
5. Add 40 ml NPW on filter pulp.
6. Set timer to 1 hour and switch extractor on.
7. After water has been extracted switch off extractor.
8. Add 10 ml of 0.5M SrCl₂ and switch on extractor.
9. Press down filter pulp again and run to completion.
10. Add 4.00 grams soil on top of filter pulp.
11. Add 5.0 ml 0.5 M SrCl₂ to soil using autopipet; wash sides of syringe.
12. Add 45 ml 0.5 M SrCl₂ to reservoir using repipet.
13. Set timer for 2 hours and turn on.
14. Take off syringe and shake well.
15. Save 13 mls in a 15 ml orange cap centrifuge tube.
16. Be sure to do two duplicates (not using the replicas).
17. Add 4 drops of 0.1 M HCl to each tube.
18. Freeze samples.

5.3.3.2 Cation Exchange Capacity Determination

1. Use the samples and extraction setup above
2. Place 5.0 ml of 1 M KCl onto soil using an autopipette
3. Put reservoir syringe in place; add 45 ml of 1 ml KCl to reservoir
4. Extract this 50 ml of KCl overnight (12-16 hours)
5. Remove lower syringe, squeeze out all KCl to waste
6. Re-assemble syringes for extraction
7. Add 25 ml of 95% ethanol to top of soil; use squirt bottle to wash down syringe sides
8. Begin extracting ethanol; set on 1 hour
9. When remaining head is 5 ml, add 25 ml ethanol to the reservoir syringe, using squirt bottle wash syringe sides as added; continue extraction
10. Remove lower syringes, squeeze out all ethanol to waste
11. Re-assemble syringes for extractions
12. Add 15 ml 95% ethanol to the top of soil; use squirt bottle to wash down syringe sides
13. Begin extracting ethanol; set on 1 hour
14. When remaining head is 5 ml, add 35 ml ethanol to the reservoir syringe, using squirt bottle wash syringe sides as adding; continue extraction
15. Remove lower syringes, squeeze out all ethanol to waste
16. Re-assemble syringes for extractions
17. Add 15 ml of 95% ethanol to the top of soil using squirt bottle; wash down syringe sides
18. Begin extracting ethanol; set on 1 hour
19. When remaining head is 5 ml, add 35 ml ethanol to the reservoir syringe, using squirt bottle wash syringe sides; continue extraction
20. When extraction is over, determine the E.C. of each final ethanol wash
21. Reassemble syringes
22. If E.C.'s are greater than 20 umhos, repeat steps 19 - 23 again
23. Add 5.0 ml of 1 M NH₄Cl on top of soil; DO NOT wash down sides
24. Put reservoir syringe in place; add 45.0 ml of 1 M NH₄Cl in reservoir syringe; use graduated cylinder
25. Extract 1 M NH₄Cl; set on 2 hours
26. When extraction is complete, remove bottom syringe, mix sample well, and place sub-sample into labeled 15 ml screw cap tube. In addition to all samples, collect two duplicate samples also

27. Run samples on atomic absorption for K: turned burner head
wave length 769.9
standards (mg/l): 0, 50, 100
(in 1 M NH4Cl) 200, 400, 600
FLAC ACTK
Suppressant 3000 ppm La/Cs

C.E.C. Calculation $\text{meq}/100\text{g} = (\text{mg K}/\text{l}) / 39.102 * 0.05 / 4.0 * 100 * (\% \text{H}_2\text{O})$
where % H2O is in decimal form ie. 3.4% H2O is 1.034

5.10 SOP MULTI-ELEMENT ANALYSIS:

PERCHLORIC DIGEST FOR Ca, Mg, K, Na, Fe, Mn, Zn, P

This procedure is identical to SOP Multi-Element Analysis: Perchloric Digest for Ca, Mg, Na, K, Fe, Mn, Zn, P with the exception that 0.5000 g soil is digested instead of 0.2000 g tissue. Follow procedure outlined in Sec 2.9.

5.13 SOP ELEMENTAL COMBUSTION ANALYSIS - SOIL: TOTAL C, N

5.13.1 SCOPE AND PURPOSE

The purpose of this procedure is to determine the concentration of carbon and nitrogen in soil samples using a Carlo Erba NA1500 combustion gas chromatograph analyzer.

5.13.2 MATERIALS AND SUPPLIES

5.13.2.1 EQUIPMENT

- * Shatter box
- * Carlo Erba NA 1500 combustion gas chromatograph
- * Sartorius analytical balance
- * Small spatula
- * Tweezers; two pair
- * Tin sample cups
- * NIST Montana soil
- * Survey soil

5.13.2.2 CHEMICALS/REAGENTS

- * See Carlo Erba operation manual

5.13.3 PROCEDURES

5.13.3.1 OPERATION

1. Check gas cylinder volumes and pressures:
 - Oxygen 25
 - Comp. Air 50
 - Helium 36
2. Check that sum of current counter reading and number of samples to be run is less than 75 ... if not replace combustion tube as outlined
3. Replace magnesium perchlorate in water trap as outlined
4. Turn carrier gas(He) from STBY to FLOW (clockwise)
5. Adjust M pressure to 95
Adjust R pressure to 112
6. Adjust oxygen pressure to 150
7. Turn purge from OFF to ON (counter-clockwise)
8. Check all parameters:

LEFT	50	(C X 10)
RIGHT	103	(C X 10)
OVEN	81	(C)
FIL TEMP	190	(C)
CYCLE STOP	75	(SEC X 10)
SAMPLE START	XX	(SEC) [varies with tube]
SAMPLE STOP	60	(SEC)
OXY INJ STOP	82	(SEC)
PEAK ENABLE	2	(SEC X 10)
9. Release FURN STBY button (must be out)
Release FIL OFF button (must be out)
10. If not currently on main menu screen ...
Type EAGER [ENTER] at any DOS prompt

Delete scratch files
11. [LOAD] N&C-SOIL.EAD [CONFIRM]
12. Det./Integr. parameters [EDIT]
 - First Sample: 1
 - Last Sample: xx; where xx is equal to last sample on data sheet
 - Sample being acquired: 1[UPDATE] [UPDATE]; if changes were made

13. Sample Table [EDIT]

Choose correct filename for run according to date (see below)

DATE	PREFIX								
1	A	2	B	3	C	4	D	5	E
6	F	7	G	8	H	9	I	10	J
11	K	12	L	13	M	14	N	15	O
16	P	17	Q	18	R	19	S	20	T
21	U	22	V	23	W	24	X	25	Y
26	Z	27	AA	28	BB	29	CC	30	DD
31	EE								

Input correct filename into filename spaces 1 - 12

Make sure pointer is on row 13

[EDIT ROW]

[FILL SAMPLE TABLE]

Number of samples : xx; where xx is equal to no. of sample - 12

File Name Root : correct letter prefix from above

First Suffix: 13

First Suffix: 13

[REPLACE]

Enter all correct sample names according to data sheet

Enter all correct weights according to balance print out(s)

Check to make sure all data in sample table is complete

[UPDATE] [UPDATE]

14. Component Table [EDIT]

Choose correct components

[UPDATE] [UPDATE]; if changes were made

[SAVE]

Change method file to "Fmmddiii.EAD

[CONFIRM]

15. Turn (clockwise) bottom sampler tray (0-49) to space 1

Load all samples into bottom sampler tray

16. Install top sampler tray (50-99) with stop peg lined up with dot on tray

Load all samples into top sampler tray

Place cover and securing screw back onto sampler

17. Make sure that right oven is at 1020 C; left oven is at 500 C

18. Make sure that you have enough paper for the entire run; printer on-line

19. [RUN] [START ANALYSIS]

20. [RUN] [MONITOR DETECTOR]

5.13.3.2 SHUTDOWN

When run is completed ...

1. Back off oxygen all the way

2. Turn purge from ON to OFF (clockwise)

3. Turn carrier gas from FLOW to STDBY (counter-clockwise)

4. Depress FURN STBY button

Depress FIL OFF button

5.13.3.3 DATA PROCESSING

NOTE: Make sure the correct method is loaded before beginning processing

1. [[]] [Quit monitor detector(s)]

2. [View] [View chromatograms]

3. Starting with sample number 3; ie. M3 or T3 ...

[File] [Load chromatogram] Filename [Confirm]

Correct nitrogen and sulfur baselines as needed

If changes were made: [File] [Save chromatogram] [Confirm] [Confirm]

4. When baseline corrections for ALL samples have been made:

[[]] [Quit view chromatogram]

5. Calc. & report parameters [EDIT]

Change: Reports(s) on DISK

Append for summary YES

[UPDATE]

- [OK]
6. [Recalculation] [Reset for calculation] [Confirm]
 7. [Recalculation] [Recalculation]
 - Reintegrate chromatogram: NO
 - Save Chromat. after re-int.: NO
 - First Sample to recalculate: 8
 - Last Sample to Recalculate: XX; where XX is the number of last sample
 8. [Confirm]
 - After all files have been recalculated:
 - [View] [View calibration curves]
 - [Print] [Print calibration]
 - [Component] ["next component"]
 - [Print] [Print calibration]
 9. [[]] [Quit calibration curves]
 10. [[]] [Quit] [Confirm]
 11. Type COMBUST [ENTER]
 12. Follow prompts ...
 13. Check main printout to assure that all peaks are properly labeled

5.13.3.4 REPLACING COMBUSTION TUBES

1. Go through shut down procedure above
2. Allow furnace temperature to come down to around 800 degrees
3. Remove sampler by unscrewing sampler foot and carrier-in fitting, lift off
4. Remove furnace front cover
5. CAREFULLY unscrew bottom tube fitting using wrench and pliers; top ring should turn to right
6. Remove bottom o-ring and carefully pull tube out of furnace; place into a large beaker to cool
7. Repack tube as outlined on following page
8. Place top o-ring onto top of tube about 0.5 cm from top of tube
9. CAREFULLY slide combustion tube into the furnace
10. Place autosampler back into place; slightly tighten foot fitting
11. Place footing, metal ring, and o-ring onto bottom of tube; o-ring should be about 0.5 cm from bottom of tube
12. Carefully attach and tighten bottom fitting
13. Attach sampler carrier gas line; tighten both footing and carrier gas line
14. RESET COUNTER
15. Leak test system as outlined

5.13.3.5 REPLACING WATER TRAP MAGNESIUM PERCHLORATE

1. Turn carrier flow to standby
2. Remove inlet screw cap from water trap (inlet from combustion tube)
3. Remove quartz wool plug
4. Remove magnesium perchlorate from trap until no longer caked
5. Add new magnesium perchlorate until up to level
6. Replace quartz wool plug
7. Replace inlet screw cap fitting
8. Leak test system as outlined

5.13.3.6 SYSTEM LEAK TESTING

1. Turn carrier gas to FLOW (clockwise)
2. Attach M vent cap
3. Turn M needle valve to 100; back off valve all the way
4. Check if pressure drop is less than 10 KPA in 3 minutes
 - If not; tighten all fittings and goto 3 to re-leak test
5. Turn M needle back to 100
6. Remove vent plug; re-attach vent fitting
7. Readjust M needle to 95
8. If combustion tube was changed, check flowrates; carrier gas should be 104 ml/min; reference should be 40
9. Goto startup procedure

5.13.3.7 MAINTENANCE SCHEDULE

Every 200+ samples: Remove combustion tube, allow to cool, repack comb. tube
Leak test
Every Run: Replace magnesium perchlorate in water trap
Leak test

6.1 SOP MEASUREMENT OF pH

6.1.1 SCOPE AND PURPOSE

The measurement of solution pH will be used for several applications:

- * surface and subsurface waters (streams, lake, wells, etc.)
- * artificial fogs used in acid-fog treatments
- * soil solutions
- * soil extract pH (after extraction described in Sec. 5.12)

6.1.2 MATERIALS AND METHODS

6.1.2.1 EQUIPMENT

- * Altex 71 pH meter w/combination electrode
- * AT&T PC 6300 computer
- * pH/E.C. Procedures program on hard disk

6.1.2.3 CHEMICALS/REAGENTS

- * pH 4 buffer
- * pH 10 buffer
- * 4 M KCl saturated w/AgCl
- * squirt bottle with nanopure water

6.1.3 PROCEDURES

NOTES: pH electrode should be left soaking in vial of pH 7 buffer when not in use; fill hole should be covered with parafilm when not in use. Always keep inside solution level to within 1 inch of fill hole; if not add filling solution (4M KCl saturated with AgCl). To operate pH meter, install pH/E.C. procedures disk, turn on computer, and follow computer program prompting for actual procedure

The maximum number of samples that can be run between instrument calibrations is 26. In addition, each run must have an initial AND random from the samples above.

6.2 SOP MEASUREMENT OF ELECTRICAL CONDUCTIVITY

6.2.1 SCOPE AND PURPOSE

The measurement of solution electrical conductivity (E.C.) will be used for several applications:

- * surface and subsurface waters (streams, lake, wells, etc.)
- * artificial fogs used in acid-fog treatments
- * soil solutions

6.2.2 MATERIALS AND METHODS

6.2.2.1 EQUIPMENT

- * YSI Model 32 Conductance Meter w/1.0 ml bulb cell (constant 1.0)
- * AT&T PC 6300 computer
- * pH/E.C. Procedures program on hard disk

6.2.2.2 CHEMICALS/REAGENTS

- * Electrical Conductivity Standard (75 or 1000 umho)
- * Nanopure water

6.2.3 PROCEDURES

NOTE: Bulb-type E.C. cell should be stored containing nanopure water. To operate E.C. meter, install pH/E.C. procedure disk, turn on AT&T computer, follow computer prompts for actual procedure.

The maximum number of samples which can be run between instrument calibrations is 26. In addition, each run must have an initial AND final above.

6.3.1 SCOPE AND PURPOSE

The purpose of this procedure is to determine low level concentrations of chloride, nitrate, phosphate, and sulfate using a low retention time, AS4A Anion Separator. This procedure is a modification of the DIONEX version of EPA Method 300.0 with eluant matching; as needed.

6.3.2 MATERIALS AND SUPPLIES

6.3.2.1 EQUIPMENT

- * Dionex 4000i
- * Sample cups with filter caps

6.3.2.2 CHEMICALS/REAGENTS

- * Na₂CO₃
- * NaHCO₃
- * NH₄F
- * NaCl
- * KNO₃
- * KH₂PO₄
- * Na₂SO₄

Eluant: 0.90 mM Na₂CO₃
 0.85 mM NaHCO₃

Preparation: Eluant Stock: 180 mM Na₂CO₃
 170 mM NaHCO₃

Place 19.1 g Na₂CO₃ into 1 liter volumetric
Add 14.3 g NaHCO₃
Add approx. 500 ml of DEGASSES NPW
Dissolve on magnetic stirrer
Make to 1 liter volume using DEGASSED NPW

To make final eluant:
Add 10.0 ml of Eluant Stock to a 2 liter volumetric
Make to 2 liter volume using DEGASSED NPW

Regenerent: 25 mM H₂SO₄

Preparation: Place 3.0 ml of conc. H₂SO₄ into a 4 liter container
Dilute to 4 liter volume using NPW

Sample Loop Volume: Approx. 120 ul "Sample Loop A"

Standards

Stock 1 2000 mg/l NO₃; 1000 mg/l F, Cl, PO₄, SO₄,
 1.950 g NH₄F
 1.648 g NaCl
 3.262 g KNO₃ liter NPW
 1.433 g KH₂PO₄
 1.479 g Na₂SO₄

Note: as always these salts should be oven dried and cooled in a dessicator prior to use

Temporary Stock 2 20.0 mg/l NO₃; 10.0 mg/l F, Cl, PO₄, SO₄
 10.0 ml of Stock 1 / 1000 ml NPW

Standards

mg/l	NO3	F,Cl,PO4,SO4	ml of Temp. Stock 2 per 100 ml vol
	0.4	/ 0.2	2.0
	1.0	/ 0.5	5.0
	2.0	/ 1.0	10.0
	4.0	/ 2.0	20.0
	8.0	/ 4.0	40.0
	12.0	/ 6.0	60.0

6.3.3 PROCEDURES

6.3.3.1 SYSTEM RUN

Start Up Procedure ...

1. Turn on He; check to see that tank pressure, eluant and regenerent are sufficient for entire run. Check to see that sample loop "A" is installed.
2. Set He line pressure to 75 psi
3. Make sure lids are tight on eluant and 2 regenerent bottles and release valves are closed. **Make sure waste container is empty.**
4. Turn on Eluant Degas System power switch; turn on sample switch
5. Turn on proper eluant switch (usually 1) for correct eluant, CHECK TO SEE IF YOU HAVE ENOUGH ELUANT FOR THE ENTIRE RUN. CHECK TO SEE IF YOU HAVE ENOUGH REGENERENT SOLUTION FOR THE ENTIRE RUN
6. Open priming block valve to see if liquid is coming out ... if not system will have to be primed with syringe
7. Turn gradient pump to local, turn conductivity detector to local Turn CELL on ... Turn AUTO OFFSET on
8. Check to see that proper % of each diluent is used
ie. [%] [1] 100
[%] [2] 0
9. Place regenerent waste line into waste container
10. Turn on eluant switch 6
11. Turn gradient pump to start
12. Wait until pressure is up above 900 and pump is stroking evenly if pump is not stroking evenly, or is making noise press gradient pump STOP; system will need to be primed with syringe.
13. DO NOT CONTINUE UNTIL CONDUCTIVITY READING IS STABLE !!

System Calibration

1. Prompt will be 'C:\>' or 'C:\WINDOWS\>'
2. Type WIN [ENTER]
Many of the remaining commands are performed with the use of the mouse:
 < > will mean move arrow to that component
 [C] will mean press left side mouse button
 [DC] will mean press left side mouse button twice quickly
< > [Pull down] < > will mean move arrow to first < > hold down mouse button while moving to second < >, release button
3. <WINDOWS> [DC]; Note: if this prompt cannot be found than goto step 4
4. <AI400> [DC]
5. <RUN.EXE> [DC]
6. Change sampler from remote to local
Change Module Sys 1 from LOCAL to REMOTE
Change Module Sys 2 from LOCAL to REMOTE
Change Conductivity Detector from LOCAL to REMOTE
Change Gradient Pump from LOCAL to REMOTE
7. <LOAD> [Pull down] <METHOD>
8. <LANION> [DC]
9. <OK> [C]
10. Place mid standard into sample vial and into sampler
11. Turn on printer, place to top of new sheet. Check to see if you have enough paper.
12. Turn sampler from hold to run
13. <RUN> [Pull down] <START>

14. <OK> [C]; * Calibration run is in progress *
Wait until sample is over to continue

Run Set Up

Method Programming

0. <[=]> [Pull Down] <CLOSE>
1. <METHOD.EXE> [DC]
2. <FILE> [Pull down] <OPEN>
3. <LANION.MET> [DC]
4. <SETTING> [Pull down] <REPORT>
5. Enter new filename ... (file format mmddiin)
6. Enter new retention time ... it should be time of last peak on the calibration run just performed plus 2 minutes, rounded up to whole min.
7. <OK> [C]
8. <SETTING> [Pull down] <COMPONENT>
You will want to adjust your retention times to match those found on the calibration run just performed ... Look on print out of calibration run, note where it says RET TIME, take these values for each component and enter them into the retention time windows
9. You will want to delete any FLACs which are not desired from component table. You should check to make sure standard concentrations are the same as in component table.
10. <[=]> [Pull down] <CLOSE>
11. <FILE> [Pull down] <SAVE>
12. CHANGE file name to match above new file ... (format mmddiin)
13. <SAVE> [C]
14. <[=]> [Pull down] <CLOSE>

Schedule Programming

1. <SCHEDULE.EXE> [DC]
2. <FILE> [Pull down] <OPEN>
3. <LANION> [DC]
4. CHANGE method from 'Enter File Name' to filename (format mmddiin)
<Enter File Name> [C] 'mmddiin' [ENTER]
5. CHANGE datafile from 'Enter File Name' to filename (format mmddiin)
<Enter File name> [C] 'mmddiin' [ENTER]
6. Enter correct sample name and dilution for each sample:
<Sample Name Space> [C] 'Correct sample name' [ENTER]
<Dilution> [C] 'Correct Dilution' [ENTER]
Continue until all sample names and dilutions are input
NOTE: Every run must consist of the following:
6 Autocalcs
Wash
xx.99923 Survey Standard
Wash
<= 50 samples
Duplicate of a random above sample
Duplicate of a random above sample
Wash
xx.99923 Survey Standard
Wash
High Standard
7. <EDIT> [Pull down] <COPY>
Change insert until it reads the following:
From Inject(s) 1 - 1
To Inject(s) 2 - X ; where X is last sample no.

Sample	X Datafile	Dilution
X Method	X Volume	X Int. Std. Conc.
8. <OK> [C]
9. <FILE> [Pull down] <SAVE>
10. CHANGE 'LANION.SCH' to above filename (Format mmddiin)
11. <SAVE> [C]
12. <FILE> [Pull down] <PRINT>; * Schedule is printing out *

13. <[=]> {Pull down} <CLOSE>

System Run

1. Load all standards and samples into sampler in order on schedule sheet
2. <RUN.EXE> [DC]
3. Change sampler from HOLD to RUN
Change other four buttons from LOCAL to REMOTE
4. <LOAD> [Pull down] <METHOD>
5. <above method name,mmddiin.met> [DC]
6. <OK> [C]
7. <LOAD> [Pull down] <SCHEDULE>
8. <above method name, mmddiin.sch> [DC]
9. <OK> [C]
10. <RUN> [Pull down] <START>
11. <OK> [C]; * Run is now in progress *

Checking Calibration

When run is over ...

1. <[=]> [Pull down] <CLOSE>
2. <CALPLOT.EXE> [DC]

3. <FILE> [Pull down] <OPEN METHOD>
4. <above file name, mmddiin.met> [DC]
5. <FILE> [Pull down] <PRINT>
6. <ALL COMPONENTS> [C]
<2 PLOTS PER PAGE> [C]
<OK> [C]; * Calibration curves are being printed out *
7. Visually inspect calibration curves for fit, goto reanalysis if necessary
8. Go through the data checking procedure for the DIONEX

System Shutdown

1. Turn off N2 and He tanks
2. Turn off printer
3. Turn off monitor
4. Press gradient pump to STOP
5. Turn Pressure System to OFF ... OPEN CAP ON FIRST REGEN BOTTLE
6. Press Conductivity Detector to LOCAL
7. Press Conductivity Cell to off
8. Change sampler from RUN to HOLD
9. Hang REGEN waste line on top of eluant bottle

6.5 SOP MEASUREMENT OF KJELDAHL NITROGEN AND PHOSPHORUS - TRAACS 800
SOP MEASUREMENT OF PERCHLORIC NITROGEN AND PHOSPHORUS - TRAACS 800

6.5.1 SCOPE AND PURPOSE

(Revised 2/03/89)

This procedure will be used to measure nitrogen and phosphorus in Kjeldahl digests prepared in Sec. 2.3 -or- in perchloric digests prepared in 2.9.

6.5.2 MATERIALS AND SUPPLIES

6.5.2.1 EQUIPMENT

- * TRAACS 800
- * Sample Cups

6.5.2.2 CHEMICALS/REAGENTS

- * Reagents Needed:
 - Digest Nitrogen: Sodium Hypochlorite
Buffer
Salic/Prusside
 - Digest Phosphorus: 5.4% H2SO4 for sample wash
Ascorbic Acid
Acid/Salt
Molybdate/Antimony
 - Wash Lines(4): NPW
- * Standards in acid matrix outlined in Sec. 2.3 or 2.9

6.5.3 PROCEDURE

Prior to beginning analyses, make sure the following have been done:

- * Both correct manifolds are installed, and correct lines are attached
- * 660 nm optical filters are in both assemblies
- * ALL reagents are fresh and available in sufficient amounts
 - Nitrogen - Sodium Hypochlorite must be made fresh daily
 - Phosphorus - Ascorbic Acid must be made every week
- * Standards are available and at room temperature
- NOTE: These are mixed standards in an acid digest matrix
- * Digests are at room temperature
- * DIW Containers are full OF FRESH NPW, waste containers are empty

NOTE: All analysis runs will consist of either one or two digest trays. A single digest tray will never be broken up into several analysis runs. When placing replicates into autosampler tray ALWAYS place the reps in correct order; the first rep should be analyzed before the second rep. The digest BLANK should be the first sample of each tray to be analyzed.

Start Up Procedure ...

0. Fill out TRAACS Autosampler Arrangement Sheet as follows:

- 1 Rack Runs: 5 Standards, wash, digest blank (xx.99951 or xx.99952), xx.99905 standard, all samples, 2 duplicates, xx.99905 standard
- 2 Rack Runs: 5 Standards, wash, (tray 1) digest blank(xx.99951 or xx.99952), xx.99905 standard, all samples, 2 duplicates, xx.99905 standard, wash (tray 2), digest blank(xx.99951 or xx.99952), xx.99905 standard, all samples, 2 duplicates, xx.99905 standard

NOTE: Washes are 0/0 standards; chosen duplicates cannot be replicates

1. Turn on compressed air; adjust to 26 psi
2. Turn on: Sampler
Printer

Main Console
Computer

3. Press [F3]
4. Press [F4]
Type in B1 [ENTER]; should respond "*** error -129 from sendcmd"
5. Press [F4]
Type in CK [ENTER]; should respond "0"; if not system is NOT working
6. Place Sample Wash line into 5.4% H2SO4 solutions
7. Place REAGENT lines into container of 4 ml sodium lauryl sulfate/liter NPW
Place DIW lines into NPW
8. Latch on pump platens
9. Press [F4] OP1 [ENTER]
10. Establish a good bubble pattern; will take about 10 min.
11. Press [F4] CG1 13 [ENTER]
Press [F4] CG2 13 [ENTER]
12. Press [F9]; will prompt "which channels?"
Press 1 2 [ENTER]; will prompt "chart speed?"
Press 20 [ENTER]
13. Press [F4] CB1 100
Press [F4] CB2 100
14. Observe channel readings on bottom of screen, should read between 5 and 10
If Not:
Adjust Channel 1 Reading:
Enter new CB1 no. other than 100, lowering CB1 no. will lower channel reading; raising CB1 no. will raise channel reading
ie. to lower channel 1 reading you would press [F4] CB1 90 [ENTER] where 90 is a no. lower than 100
ie. to raise channel 1 reading you would press [F4] CB1 110, [ENTER] where 110 is a no. greater than 100
Adjust Channel 2 Reading:
Enter new CB2 no. other than 100 similar to above;
ie. press [F4] CB2 90 [ENTER]
15. When both channel reading are between 5 and 10 write down exact readings
16. Place reagent lines into correct containers; NOTE: Molybdate line should be placed in 1 minute after others.
17. After about 10 minutes write down new channel readings
18. Calculate reagent absorbance for each channel as follows:
Reagent Absorbance = (Reagent Reading - Water Reading) / 100
Check that the reagent absorbances for each channel are within allowable ranges for that method
Nitrogen: Reagent Absorbance < 0.08
Phosphorus: Reagent Absorbance < 0.02
System Programming ...
1. Press [F2]; will prompt "Are you sure you want to quit? (Y/N)"
Press Y [Enter]
2. Press [F7]
3. Enter the following onto the screen:
For 1 Digest Tray Runs ... KDIGEST1 -OR- PDIGEST1 [ENTER] [ENTER]
For 2 Digest Tray Runs ... KDIGEST2 -OR- PDIGEST2 [ENTER] [ENTER]
4. [F5]
5. [Page Down]
6. One Tray Runs ...
Go down to Tray Protocol and enter correct no. of samples(S); this correct no. is number of samples and blanks in tray plus 1 (usually 43).
Two Tray Runs ...
On two tray runs the first tray is as above; the second tray no. of samples is number of samples and blanks in tray plus 1
In addition, you will have to change second 00 to correct no. (usually 49)
[ENTER] [ENTER]
7. [PAGE DOWN]
8. Enter all sample ID's and Dilution Factors as on Autosampler Sheet
9. [PAGE UP] [PAGE UP]
10. Change filename to correct format ... (mmddiii#)
[ENTER] [ENTER]
11. [F6]

12. [F4] [F4]
13. [F2]
14. Press B: [ENTER] DIR/P [ENTER] 'check to see if file name has been saved'

Loading Sampler ...

Sampler will be loaded in the same manner that the standards and samples were entered into file ...

- 1 rack run: 5 standards,wash,xx.9995x,xx.99905,samples,xx.99905
- 2 rack run: 5 standards,wash,xx.9995x,xx.99905,samples,xx.99905,wash,xx.9995x,xx.99905,samples,xx.99905

Setting Base & Gain ...

1. C: [ENTER]
 2. Gateway [ENTER]
 3. [F3]
 4. [F9]; will prompt 'which channel?'
 5. 1 2 [ENTER]; will prompt "chart speed?"
 6. 20 [ENTER]
 7. Check to see if channel readings are between 5 and 10, if not adjust using [F4] CB1 XXX, and [F4] CB2 XXX commands as before
 8. [F4] SI [ENTER]
 9. [F4] SS [ENTER]
 10. 'leave probe in sample cup for approx. 5 minutes'
 11. [F4] SI [ENTER]
 12. 'when sample comes through and readings start to increase, it is time to adjust gain to bring high standard reading to between 85 and 90'
- Channel 1
- If channel reading is too low then [F4] CG1 30 [ENTER], where 30 is any no. greater than 13 (current gain setting)
 If channel reading is too high then [F4] CG1 7 [ENTER], where 7 is any no. greater than 13 (current gain setting)
 Adjust using [F4] CG1 # [ENTER] until reading is between 85 and 90
- Channel 2
- Similar procedure as channel 1 except command is [F4] CG2 # [ENTER] adjust until reading is between 85 and 90
13. Allow readings to come back to level baselines
 As before adjust reading to between 5 and 10
 Channel 1 use [F4] CB1 # [ENTER]
 Channel 2 use [F4] CB2 # [ENTER]
 14. [F4] SI [ENTER]
 15. [F4] SS [ENTER]
 - Leave probe in sample for approx. 5 min
 16. [F4] SI [ENTER]
 'When sample comes through and channel readings increase, check to see that channel readings stabilize between 85 and 90, if not adjust as before
 Channel 1 [F4] CG1 # [ENTER]
 Channel 2 [F4] CG2 # [ENTER]
 17. 'When channel readings come back to level baseline adjust as before if not between 5 and 10:
 Channel 1 [F4] CB1 # [ENTER]
 Channel 2 , [F4] CB2 # [ENTER]
 18. [F2]; prompt "are you sure you want to quit? (y/n)"
 Y [ENTER]

System Run ...

1. Make sure there is a smooth bubble pattern
2. Set printer to top of new sheet
3. [F3]
4. [F9]; prompt "which channels?"
5. 1 2 [ENTER]; prompt "chart speed?"
6. 30 [ENTER]

7. Adjust baseline if readings are not between 5 and 10 using CB1, CB2 commands 8. [F7]
8. 'Input filename you saved before' [ENTER]
9. Operators Name 'your name'[ENTER]
10. 'Modify comments if desired' [ENTER]
11. 'Enter filename for saving chart .. same as input filename" [ENTER]
12. Press [CTRL] and B simultaneously
NOTE: It may be necessary to refill the intermediate standard cup during the run ... pay attention to its level
13. After last sample, run will stop and data will be printed out
14. [F2]; will prompt "Are you sure you want to quit? (Y/N)"
Y [ENTER]

Shutdown Procedure ...

1. Place molybdate pump line into container of 4 ml SLS/liter NPW
2. Wait 1 minute
3. Place all REAGENT lines (not DIW) into container of 4 ml SLS/liter NPW
4. Allow to pump for 10 minutes
5. Press [F3] [ENTER]
6. Press [F4] QP1 [ENTER]; this should turn off the pump
7. Unlatch the pump platens
8. Turn off compressed air
9. Place all lines into an empty beaker to drain
10. Turn off: Main Console
Sampler
11. Press [F2]; prompt 'Are you sure you want to quit?'
12. Press Y [ENTER]

Data Retrieval ...

1. Press [F4]
2. Find correct file for your run; this will be a 'mddiii#.chr' file
3. Press [F6] 'mddiii#.chr' [ENTER]
4. Set printer paper to new sheet
5. Press [F9]; prompt 'which channel ?'
6. 1 [ENTER]
7. [ENTER]
8. [PRINTSCREEN] 1
9. After printing [ENTER]
10. Press [F9]; prompt 'which channel ?'
11. 2 [ENTER]
12. [ENTER]
13. [PRINTSCREEN] 1
14. After printing [ENTER]
15. [F2]
16. Upon visual examination of the calibration curves, if a calibrant should be eliminated from the curve goto Reanalysis Of Data.
If the standard curves look acceptable, and the intermediate beginning and ending standards are within the acceptable error range then you are through and should give data printout to Data Manager.

Reanalysis Of Data ...

1. Press [F7]
2. Input correct filename [ENTER] [ENTER]
3. Press [F5]
4. Press [] until you are down to calibrant values
5. Delete unwanted calibrant by moving the remaining calibrants over
6. Press [PAGEDOWN]
7. Press [] until you are down to tray protocol
8. Place an 'N' into the protocol where the undesired calibrant was originally ie. change 'P,5C>1,H@1,etc'. to 'P,4C>1,N,H@1,etc.'
Remember ... if the undesired calibrant was also a gain cup that must also be nulled out
9. Change filename to NEW name; Press [F6]
10. Press [F4] [F4]

11. Press [F5]
12. Enter Chart Filename; it will be a 'mmddiii#' [ENTER]
13. Press [F7]; Enter Input Filename; it will be a 'mmddiii#' [ENTER]
14. Advance printer to top of new page
15. Input NEW filename [ENTER]
16. After results have printed out ... goto Data Retrieval again

- 5 Standards (high to low), xx.99914 standard, all samples (<100), 2 sample dups, xx.99914
1. Turn on compressed air, adjust to 26 psi
 2. Turn on: Sampler
Printer
Main Console
Computer
 3. Press [F3]
 4. Press [F4]
Type in B1 [ENTER]; should respond "*** error -129 from sendcmd"
 5. Press [F4]
Type in CK [ENTER]; should respond "0"; if not system is NOT working
 6. Place Sample Wash line into NPW container
 7. Place remaining lines into container of 4 ml Brij/liter NPW
 8. Latch on pump platen for both channels
 9. Press [F4] OP1 [ENTER]
 10. Establish a good bubble pattern; will take about 10 min.
 11. Press [F4] CG1 13 [ENTER]
 12. Press [F9]; will prompt "which channels?"
Press 1 [ENTER]; will prompt "chart speed?"
Press 20 [ENTER]
 13. Press [F4] CB1 100 [ENTER]
 14. Observe channel reading on bottom of screen, should read between 5 and 10
If Not:
Adjust Channel 1 Reading:
Enter new CB1 no. other than 100, lowering CB1 no. will lower channel reading; raising CB1 no. will raise channel reading
ie. to lower channel 1 reading you would press [F4] CB1 90 [ENTER] where 90 is a no. lower than 100
ie. to raise channel 1 reading you would press [F4] CB1 110, [ENTER] where 110 is a no. greater than 100
 15. When channel reading is between 5 and 10 write down exact reading
 16. Place reagent lines into correct containers
 17. After about 10 minutes write down new channel reading
 18. Calculate reagent absorbance for channel 1 as follows:
$$\text{Reagent Absorbance} = (\text{Reagent Reading} - \text{Water Reading}) / 100$$

Check that the reagent absorbances for channel 1 is within allowable ranges for that method ... Reagent Absorbance < 0.04

System Programming ...

1. Press [F2]; will prompt "Are you sure you want to quit? (Y/N)"
Press Y [Enter]
2. Press [F7]
3. Enter the following onto the screen:
NH41 [ENTER] [ENTER]
4. [F5]
5. [PAGE DOWN]
6. Go to Tray Protocol and enter the no. of samples (S;<100) [ENTER] [ENTER]
NOTE: If greater than 50 samples is used then insert a set of three I in the center of the sample set
7. [PAGE DOWN]
8. Enter all sample ID's and dilutions as on Auto Sampler Sheet
9. [PAGE UP] [PAGE UP]
10. Change filename to correct format (mmddiii#)
11. [ENTER] [ENTER]
12. [F6]
13. [F4] [F4]
14. [F2]
15. Press B: [ENTER] DIR/P [ENTER]

Loading Sampler ...

Sampler will be loaded in the same manner that the standards and samples

were entered into file ...

5 standards, xx.99914, all samples, 2 dups, xx.99914

Setting Base & Gain ...

1. C: [ENTER]
 2. Gateway [ENTER]
 3. [F3]
 4. [F9]; will prompt 'which channel?'
 5. 1 [ENTER]; will prompt "chart speed?"
 6. 20 [ENTER]
 7. Check to see if channel reading is between 5 and 10, if not adjust using [F4] CB1 XXX commands as before
 8. [F4] SI [ENTER]
 9. [F4] SS [ENTER]
 10. 'leave probe in sample cup for approx. 5 minutes'
 11. [F4] SI [ENTER]
 12. 'when sample comes through and readings start to increase, it is time to adjust gain to bring high standard reading to between 85 and 90'
Channel 1
If channel reading is too low then [F4] CG1 30 [ENTER], where 30 is any no. greater than 13 (current gain setting)
If channel reading is too high then [F4] CG1 7 [ENTER], where 7 is any no. greater than 13 (current gain setting)
Adjust using [F4] CG1 # [ENTER] until reading is between 85 and 90
 13. Allow reading to come back to level baseline
As before adjust reading to between 5 and 10
Channel 1 use [F4] CB1 # [ENTER]
 14. [F4] SI [ENTER]
 15. [F4] SS [ENTER]
- Leave probe in sample for approx. 5 min
16. [F4] SI [ENTER]
'When sample comes through and channel reading increase, check to see that channel reading stabilize between 85 and 90, if not adjust as before
Channel 1 [F4] CG1 # [ENTER]
 17. 'When channel reading come back to level baseline adjust as before if not between 5 and 10:
Channel 1 [F4] CB1 # [ENTER]
 18. [F2]; prompt "are you sure you want to quit? (y/n)"
Y [ENTER]

System Run ...

1. Make sure there is a smooth bubble pattern
2. Set printer to top of new sheet
3. [F3]
4. [F9]; prompt "which channels?"
5. 1 [ENTER]; prompt "chart speed?"
6. 30 [ENTER]
7. Adjust baseline if readings are not between 5 and 10 using CB1 commands
8. [F7]
9. 'Input filename you saved before' [ENTER]
10. Operators Name 'your name'[ENTER]
11. 'Modify comments if desired' [ENTER]
12. 'Enter filename for saving chart .. same as input filename' [ENTER]
13. Press [CTRL] and B simultaneously
14. After last sample, run will stop and data will be printed out
15. [F2]; will prompt "Are you sure you want to quit? (Y/N)"
Y [ENTER]

Shutdown Procedure ...

1. Place 4 reagent lines into container of 4 ml Brij/liter NPW

2. Allow to pump for 10 minutes
3. Press [F3]
4. Press [F4] QP1 [ENTER]; this should turn off the pump
5. Unlatch the pump platens
6. Turn off compressed air
7. Place 4 reagent lines into an empty beaker to drain
8. Turn off: Main Console
Sampler
9. Press [F2]; prompt 'Are you sure you want to quit?'
10. Press Y [ENTER]

Data Retrieval ...

1. Press [F4]
2. Find correct file for your run; this will be a 'mddiin.chr' file
3. Press [F6] 'mddiin.chr' [ENTER]
4. Set printer paper to new sheet
5. Press [F9]; prompt 'which channel ?'
6. 1 [ENTER]
7. [ENTER]
8. [PRINTSCREEN] 1
9. After printing [ENTER]
10. [F2]
11. Upon visual examination of the calibration curve, if a calibrant should be eliminated from the curve goto Reanalysis Of Data.
If the standard curve looks acceptable, and the intermediate beginning and ending standards are within the acceptable error range then you are through and should give data printout to Data Manager.

Reanalysis Of Data ...

1. Press [F7]
2. Input correct filename [ENTER] [ENTER]
3. Press [F5]
4. Press [] until you are down to calibrant values
5. Delete unwanted calibrant by moving the remaining calibrants over
6. Press [PAGE DOWN]
7. Press [] until you are down to tray protocol
8. Place an 'N' into the protocol where the undesired calibrant was originally ie. change 'P,5C>1,H@1,etc'. to 'P,4C>1,N,H@1,etc.'
Remember ... if the undesired calibrant was also a gain cup that must also be nulled out
9. Press [F6] [F6]
10. Press [F4] [F4]
11. Press [F5]
12. Enter Input Filename; it will be a 'filename.cht' extension [ENTER]
13. Press [F7]; Enter Input Filename [ENTER]
14. Advance printer to top of new page
15. Input NEW .cht filename [ENTER]
16. After results have printed out ... goto Data Retrieval again

6.9 SOP MEASUREMENT OF CATIONS - PERKIN ELMER 5000 (05/30/90)
Ca, Mg, Na, K, Mn, Zn, Fe - 2.0 mg/l

6.9.1 SCOPE AND PURPOSE

The measurement of Ca, Mg, Na, K, Mn, Zn, Fe will be used on any solution sample provided that a matching matrix in standards is used.

6.9.2 METHODS AND MATERIALS

6.9.1.1 EQUIPMENT

- * Perkin-Elmer 5000 Atomic Absorption Spectrophotometer
- * AT&T Computer w/A.A. Program
- * Using La/Cs Auto Addition

6.9.1.2 CHEMICALS/REAGENTS

- * 30,000 mg/L La/Cs as Cl salts (80.1 g LaCl₃ 7H₂O + 38.1 g CsCl/l NPW)
Every sample or standard will contain 10% of the above solution
- * 1000 mg/l Ca, K, Na, Mg, Mn, Zn Stock Solutions
- * Standards

Stock 1 100 mg/l Ca, Mg, Na, K, Mn, Zn
 10.0 ml of each 1000 mg/l Stock into a 100 ml volumetric
 Bring to 100 ml volume with NPW

Stock 2 2.0 mg/l Ca, Mg, Na, K, Mn, Zn
 5.0 ml of Stock 1 into a 250 ml volumetric
 Bring to 250 ml volume with NPW

Standards	mg/l Ca, Mg, Na, K, Mn, Zn	ml of Stock 2
	0.1	5/100 ml
	0.2	10/100 ml
	0.4	50/250 ml
	1.0	50/100 ml
	2.0	Stock 2

6.9.3 PROCEDURE

0. Make sure samples standards, and reference standards are available and at room temperature; xx.99921 is used for Ca, Mg, Na, K, Mn, Zn
1. Switch RUN/STANDBY switch to STANDBY
2. Switch Power to ON
Switch Automatic Burner Control to ON
3. Let system warm up for 5 minutes
4. Switch RUN/STANDBY to RUN
5. Check waste jug on floor: it must have at least 9 inches of water in it but it must not be full; DRAIN light must be ON
6. Turn on hood wall switch
7. Turn on wall compressed air; should be set to 70
8. Turn on acetylene tank valve.
Tank must read atleast 25; valve must be set to near 12.5
9. Place magnetic card for Program 2a into reader slot
10. Press RCL; replace magnetic card into notebook
NOTE: This Program 2a will load into Perkin-Elmer 5000 all parameters necessary to run Ca, Mg, Na, K, Mn, and Zn
11. Make sure burner is straight and safety wire is attached
12. Ca/Mg lamp is in lamp position 1
Na/K lamp is in lamp position 6
Mn lamp is in lamp position 4
Zn lamp is in lamp position 2
13. Press 1 RCL ... wait until there is a reading in the display
14. Using white card, adjust burner height using three knobs until beam is directly above the burner slot

15. Press SETUP
16. Slide lamp in and out of turret to maximize display reading ...
Adjust two lamp knobs until reading is maximized
NOTE: If reading becomes 99, use GAIN to reduce to 50
17. Press SETUP
18. Press 3 RCL ... wait until there is a reading on the display
19. Repeat Steps 15 - 17
- NOTE: Steps 20 - 23 are necessary only if you are running Mn and Zn
20. Press 5 RCL ... wait until there is a reading on the display
21. Repeat Steps 15 - 17
22. Press 6 RCL ... wait until there is a reading on the display
23. Repeat Steps 15 - 17
24. On Burner Control press 50 C2H2; press 50 AIR
25. Turn on sampler; hold sampler tray to prevent resetting
26. Make sure probe is in NPW; make sure suppressant probe is in La/Cs
27. Press FLAME ON
28. Press 1 RCL; allow flame to stabilize for 1 minute; press [AVG]
0.5 [T] [CONT]
29. Make sure probe is in NPW ... Press [AZ]
30. Place probe into vial of high standard (2 mg/l) ... use [MANUAL]
31. Wait 10 s
32. If reading is less than 0.050 then adjust burner position knobs slightly until reading is greater than 0.050 ... goto step 29
33. If reading is greater than 0.050 then press [HOLD]. Goto Step 34
34. Fill out Autosampler Arrangement Sheet as follows:
NOTE: Each run will consist of the following:
 - NPW (autozero)
 - 0.1 mg/l
 - 0.2 mg/l
 - 0.4 mg/l
 - 1.0 mg/l
 - 2.0 mg/l
 - NPW (wash)
 - xx.99921
 - Samples (Max. of 40)
 - Duplicate of above sample
 - Duplicate of above sample
 - xx.99921
 - Wash
 - NPW (zero)
 - 0.4 mg/l standard
35. Press [HOLD]
36. Turn on computer and printer
37. Press F1 (INPUT SAMPLE ID/DILUTIONS)
38. Enter correct information into computer
39. Load sampler as indicted on Arrangement Sheet

To Begin A Run

0. Turn on flame if not already on
Check to see if you have enough sample and standards for run
1. Put new NPW into ALL NPW tubes
2. Clear out program no. on autosampler control
3. Press F3 (RUN)
4. Follow computer prompts ...

To Analyze Data

1. Press F5 (FINAL REPORT)
2. Follow computer prompts

To Shut Down ...

1. With flame on, place both probes into NPW for 1 minute
2. Take probes out of NPW and allow to suck air for 1 minute

3. Turn off flame
4. Close acetylene tank
5. Press [CHK FLOW] until tank pressure drops to zero
6. Close compressed air valve
7. Press [CHK FLOW] until air pressure drops to zero
8. Turn off hood
9. Turn to STANDBY
10. Turn Automatic Burner Controller to OFF
11. Turn off Sampler
12. Wait 5 minutes
13. Turn A.A. to OFF
14. Turn OFF computer monitor and printer
15. Remove samples from tray

6.10 SOP MEASUREMENT OF CATIONS IN ACID DIGESTS - PERKIN ELMER 5000
Ca, K - 50 mg/l; Mg - 10 mg/l; Na - 5 mg/l; Mn, Zn, Fe - 2.5 mg/l (12/22/89)

6.10.1 SCOPE AND PURPOSE

The measurement of Ca, K, Mg in Kjeldahl Digests
The measurement of Ca, Mg, Na, K, Mn, Fe, Zn in Perchloric Digests

6.10.2 METHODS AND MATERIALS

6.10.1.1 EQUIPMENT

- * Perkin-Elmer 5000 Atomic Absorption Spectrophotometer
- * AT&T Computer w/A.A. Program
- * Using Suppressant Auto-addition

6.10.1.2 CHEMICALS/REAGENTS

- * 30,000 mg/L Cs/Sr as Cl salts(38.1 g CsCl + 91.2 g SrCl₃*6H₂O/l NPW)
- * 30,000 mg/L Cs/La as Cl salts(38.1 g CsCl + 80.1 g LaCl₃*7H₂O/l NPW)
- * 3,000 mg/L suppressant - 10% of 30,000 mg/L suppressant
- * Standards - See Sec 2.3 or Sec 2.9

6.10.3 PROCEDURE

0. Make sure you have the proper standards and samples at room temperature
NOTE: If Mn, Fe or Zn are to be run, the 15ml poly tubes must have been acid soaked in 0.1 M HCl for 24 hrs, rinsed well and dried
1. Switch RUN/STANDBY switch to STANDBY
2. Switch Power to ON
Switch Automatic Burner Control to ON
3. Let system warm up for 5 minutes
4. Switch RUN/STANDBY to RUN
5. Check waste jug on floor: it must have at least 9 inches of water in it but it must not be full; DRAIN light must be ON
When tank is full you should, pour out all water and refill to proper level with fresh DIW
6. Turn on hood wall switch
7. Turn on wall compressed air; should be set to 70
8. Turn on acetylene tank valve.
Tank must read atleast 25; valve must be set to near 12.5
9. Place magnetic card for Program 1A into reader slot(for Fe use card 1B)
10. Press RCL; replace magnetic card into notebook
NOTE: This Program 1A will load into Perkin-Elmer 5000 all parameters necessary to run Ca, Mg, Na, K, Mn, and Zn
This program 1B will load into Perkin-Elmer 5000 all parameters necessary to run Ca, Mg, Na, K, Mn, and Fe
11. Make sure burner is straight and safety wire is attached
12. Ca/Mg lamp is in lamp position 1
Na/K lamp is in lamp position 6
Mn/Fe lamp is in position 4
Zn lamp is in position 2
13. Press 1 RCL ... wait until finished
14. Using white card, adjust burner height using three knobs until beam is directly above the burner slot
15. Press SETUP
16. Slide lamp in and out of turret to maximize display reading ...
Adjust two lamp knobs until reading is maximized
NOTE: If reading becomes 99, use GAIN to reduce to 50
17. Press SETUP
18. Press 3 RCL ... wait until finished
19. Repeat Steps 15 - 17
20. Press 5 RCL ... wait until finished
21. Repeat Steps 15 - 17
22. Press 6 RCL ... wait until finished

23. Repeat Steps 15 - 17
24. On Burner Control press 50 C2H2; press 50 AIR
25. Turn on sampler; hold sampler tray to prevent resetting
26. Samples will be run with a splitter ... sample probe/suppressant probe however, on Zn run the suppressant probe will be plugged so that only sample is drawn up. Make sure probe is in FRESH NPW
Use 3,000 mg/L Cs/Sr suppressant for Perchloric digests
Use 3,000 mg/L Cs/La suppressant for Kjeldahl digests
27. Press FLAME ON; check for even flame pattern ... clean slit if necess.
28. Press 1 RCL; allow flame to stabilize for 1 minute; press [AVG]
0.5 [T] [CONT]
29. Make sure probe is in NPW ... Press [AZ]
30. Place probe into vial of high standard (50/10/5/2.5)
31. Wait 10 s
32. If reading is less than 0.90 adjust burner position knobs slightly until reading is greater than 0.90; goto Step 29 ... if reading is greater than 0.90 then turn off flame, PRESS [HOLD], and goto Step 33
NOTE: Abs reading will be slightly lower on Kjeldahl digests
33. Fill out Autosampler Arrangement Sheet ...

Each run will consist of a full digest rack

NOTE: Each run will consist of the following:

Autozero (Kjeldahl or Perchloric Matrix)
 5.0/1.0/0.5/0.25 Standard
 10.0/2.0/1.0/0.50 Standard
 20.0/4.0/2.0/1.00 Standard
 35.0/7.0/3.5/1.75 Standard
 50.0/10.0/5.0/2.5/Standard
 Wash (NPW)
 xx.99951 or xx.99952 (Blank)
 xx.99905
 Samples; (Max. of 35)
 Rx.xxxxx (Replicate)
 Rx.xxxxx (Replicate)
 Duplicate of above sample (cannot be replicate)
 Duplicate of above sample (cannot be replicate)
 xx.99905
 Wash (NPW)
 Autozero (Kjeldahl or Perchloric Matrix)
 Reslope (Standard 3)

34. Turn on computer, printer, and monitor
35. Press F1 (Input Sample ID/Dilutions)
36. Enter correct information into computer
37. Load Sampler as indicated on Arrangement Sheet

TO BEGIN A RUN ...

NOTE: Ca, Mn, Zn, Na, Fe ... straight burner head
Mg, K ... turned burner

0. Turn flame on ... check burner orientation;
NOTE: Check burner height every time you change orientation, check Ca absorbance every time you switch to a straight burner
1. Make sure an INPUT file exists for your run
2. Press F3 (RUN)
3. Enter name of INPUT file
4. Enter Data file name (MMDDIII#)
5. Make sure printer and sampler are on
6. Input correct information into sampler
7. Press [ENTER] on computer to begin run
8. Press [STOP/START] on sampler while holding tray

TO ANALYZE DATA ...

1. Press F5 Option (Final Report) ... follow commands

TO SHUT DOWN ...

1. With flame on, place both probes into NPW for 1 minute
2. Take probes out of NPW and suck air for 1 minute
3. Turn off flame
4. Close acetylene tank
5. Press [CHK FLOW] until tank pressure drops to zero
6. Close compressed air valve
7. Press [CHK FLOW] until air pressure drops to zero
8. Turn off hood
9. Turn to STANDBY
10. Turn Automatic Burner Controller to OFF
11. Turn off Sampler
12. Wait 5 minutes
13. Turn A.A. to OFF
14. Turn OFF computer monitor and printer
15. Remove sample tubes from tray