
"I WANT YOU BOYS TO MEET OUR NEW OFFICE MAN IN CHARGE OF INTERPRETING FIELD NOTES!!"
M. J. Davis '53

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INSTRUCTIONS TO CREW CHIEFS

I. ORGANIZATION

Survey crews will operate as independent units under the general direction of the Party Chief. The Crew Chief is responsible for all phases of conduct and operation of the crew under his supervision. Quantity and quality of work performed by the crew shall be the direct responsibility of the Crew Chief. Any work delegated to other crew members shall be carefully checked by him to insure its accuracy and conformance to proper procedure. For an example, if the notes are not neat and legible they will not be accepted.

The Crew Chief will plan the activities of the crew so that loss of time due to breakdowns and adverse weather are minimized. (Other jobs should be planned in advance for such circumstances.) Supplies are to be secured in advance of need to prevent holding up production. Personnel problems such as inefficiency, personality conflicts, etc., will be brought to the attention of the Party Chief.

II. EQUIPMENT

The care and protection of all equipment is the personal responsibility of the Crew Chief. Loss or destruction of equipment through carelessness or misuse may result in the employee paying for said equipment.

Vehicles shall be serviced regularly at the prescribed intervals and kept in good condition at all times. If you do not know the prescribed standards and procedures, FIND OUT. Vehicles are to be kept as clean and neat as possible. Interiors will also be kept clean and tools kept in proper storage place.

GENERAL RULES

1. Prepare your field books before work is started. Place a title page, index, and map of the general area of work on the first few pages of the field book. (See field book examples, Figures 1 through 4.)

2. Before each day's work is begun, write the date, weather, names of party members, and party members' jobs in the front of that day's set of notes in the field book.

3. Do not erase in the field books. Cross out and initial changes. If whole pages must be changed, mark "VOID" across the page.

4. Do not cramp your notes together, but do not waste space either.

5. Take care in the checking of instruments and notebooks.

6. If a mistake is made in the field, correct it or ask your supervisor about it. Do not try to cover it up. It is better to find mistakes in the field than in the office.

7. Be very careful with your notes because they are a permanent record and must explain to others what you have done in the field. Be careful they are not lost. They are valuable because of the considerable dollars invested in wages to produce them. Include any individual notes that may be taken and clip them in book or make reference to them for future use and design people to see.

8. At the end of each day, the crew chief shall review the day's notes for possible errors and shall initial the last page of work in the lower right hand corner.

9. Report any damage to instruments, no matter how small, immediately.

10. The party chief is to keep track of all equipment issued to the crew. Do not throw plumb bobs, chaining pins, HI sticks, or range poles.

11. Bear down on the pencil when writing on survey stakes.

NOTES

Beginning

Keep index up to date
Record project on front of each book
Record all abbreviations used in the notes
Make sure fly leaf is complete
Number each book
Number each page
Record beginning and ending dates
Record type of notes (Level, X-SEC, TRAV, TYPE III, STADIA, Road Log, Reconstruction)
Record location of project
Record road number or letters

Record Every Day

Give date

Check index

Record crew members:

- Give their position
- Show position changes and record time

Give instrument number:

- List any known faults
- List instrument checks (to be made every day)
- Note any correction made

Weather:

- Note date and time
- List night weather if it affects survey
- Note ground conditions
- Note temperature
- If weather changes, give change time

At a P.I.

Does the angle double?
Does the chaining check?
Has the point been referenced?
Have all facts of instrumentation been recorded?
Put rock mounts on P.I.'s in open (rocky ground only).
Reference every 4 P.I.'s (min.) or as a supervisor specifies.

Levels

Check the level every morning
Set BM and close back every 1,000 feet
Record location and description of all BM's
Close with no more error than 0.10 feet for transit surveys, 0.25 feet for compass surveys.
Turns will be read and recorded to the nearest 0.01 feet
Profile shots at stations will be recorded to the nearest 0.1 feet
Have the elevations been recorded?
Have elevations been transferred to cross-section books and checked.

Cross-Sections

Have all terrain features been shown? With distances? Add sections if necessary.
Be sure cross-sections are placed to pick physical features, not just every 50 feet.
Have all structures been shown? - L x W x H (size).
Buildings, fences, drain pipes (with size and length), bridges (all dimensions), etc.
Record all slope changes
Carefully record plus and minus signs
Be sure all turning points are recorded
Show zeros at centerline
Run cross-sections at least 50 feet from centerline
Note all evidence of rock, springs, swamps, etc.
Has all the pertinent data been recorded?

THINGS TO CHECK

Stationing

Horizontal distance
When chaining level, be sure the tape is truly horizontal

Slope Distance

Distance parallel to the line of sight
Set an exact point of pull
Check tension
Be sure the chain swings free
Chain distance ahead
Chain distance back from point ahead
Take extreme care in reading numbers. Read number before and after.

BASIC HAND SIGNALS

Right or Left: The corresponding arm is extended in the direction of the desired movement. A long, slow, sweeping motion of the hand indicates a long movement; a short, quick motion indicates a short movement. This signal may be given by the transitman in directing the chainman on line, by the levelman in directing the roadman for a turning point, by the chief of the party to any member, or by one chainman to another chainman.

Up or Down: The arm is extended upward or downward, with wrist straight. When the desired movement is nearly completed, the arm is moved toward the horizontal. The signal is given by the levelman.

All Right: Both arms are extended horizontally, and the forearms waved vertically. The signal may be given by any member of any party.

Plumb the Flag or Plumb the Rod: The arm is held vertically and moved in the direction that the flag or rod is to be plumbed. The signal is given by the transitman or levelman.

Give a Foresight: The instrumentman holds one arm vertically above his head.

Establish a Turning Point or Set a Hub: The instrumentman holds one arm above his head and waves it in a circle.

Turning Point or Benchmark: In profile leveling the rodman holds the rod horizontally above his head and then brings it down on the point.

Wave the Rod: The levelman holds one arm above his head and moves it from side to side.

Pick Up the Instrument: Both arms are extended outward and downward, then inward and upward, as they would be in grasping the legs of the tripod and shouldering the instrument. The signal is given by the chief of the party or by the head chainman when the transit is to be moved to another point.

NOTEKEEPING

I. Definition of Field Notes

Field notes are a written record, arranged in a manner peculiar to surveying, showing pertinent information, measurements, and observations made by you in the field during the course of a survey, to be used and interpreted by a person having some knowledge of surveying.

The part of this definition that usually causes difficulty is the statement that you must keep your notes so that they can be "used and interpreted by a person having some knowledge of surveying;" that is, someone other than yourself, a person who may have only a limited knowledge of surveying.

If you will make the following hypothetical assumptions, whether they are valid or not, and bear them in mind whenever you are keeping notes, you will have laid the ground rules for notekeeping.

Assume that the person using your notes:

a. Has poor eyesight
b. Is not clairvoyant
c. Will try to place the blame on the field notes, if anything is wrong.

If this is the assumed situation, to overcome it and to protect yourself your notes must be:

a. Neat, legible, and clear
b. Complete and self-explanatory
c. Honest and self-checking

Listed under Section III are some general points that must be observed if you are to keep good notes.

II. Importance of Field Notes

Of all the operations accomplished by a survey party, the most important by far is notekeeping. It is obvious that no matter how carefully field work is performed or how expert the party may be, all is rendered valueless if the field notes are not intelligible to others.

Frequently surveyors believe that they have done an adequate job of notekeeping if the field notes, reinforced by their memories, are sufficiently comprehensive to allow them to be used for an immediate purpose. Obviously, this is not true. Field notes must stand by themselves and be interpreted without recourse to questioning the person who prepared them.

Incomplete and unclear notes result in the following:

a. Lost time and additional costs for trying to decipher them.
b. Necessity of returning to the job to clarify the notes.
c. Erroneous information being placed on maps which can result in costly design errors.
d. Inability to defend the work to others, especially in court.
e. General mistrust of the party's work.

Actually, there is nothing difficult about keeping good notes if you understand how these notes are to be used and exercise the same amount of care and judgement in their preparation as you do in other survey procedures.

III. General Requirements of Good Notes

NEATNESS

a. Use a sharp pencil.
b. Make liberal use of enlarged details; avoid crowding descriptions or sketches.
c. Keep lettering parallel with or at right angles to the feature it refers to.
d. Before starting a sketch, decide what it is to show and organize it. Do not start in one corner of the page and let it grow. Often you will have a map or plat that is to scale; use it as a guide in selecting the size you want. Sketches should be drawn to approximate scale.
e. If you start a sketch that is not the correct size, void it and start over. Do not try to make the best of a bad start. A good drawing is worth a thousand words.
f. Do not lay the book where it will become dirty. Keep your hands clean.
g. Keep tabulated figures inside column rulings, not in the border. Keep digits and decimal points in vertical line.
h. Do not overlap figures on each other or on lines of sketches.

LEGIBILITY

a. Use Reinhardt's style of lettering for legibility and speed. (See Figure 1.)
b. Use pencil of at least 3-H hardness and press down so indentation is made in paper, but do not use a pencil so hard that notes are only readable in bright sunlight.
c. Use symbols and codes to keep notes compact.
d. Whenever possible, place north at top or left, and arrange sketch to read from bottom and right side of page.

CLARITY

a. Whenever possible start each day's work on a new page.
b. Plan ahead and select a note form that is appropriate for the particular survey.
c. Vary line weight when appropriate. Very often the use of colored pencils increases clarity, although colored pencils should not be used if the notes are to be photocopied.
d. Vary size of lettering for emphasis.
e. Arrowheads and leader lines should be light and sharp and held to a minimum.
f. Do not make ambiguous statements.
g. Use proper nomenclature.
h. Place a zero in front of number less than one. For example, 0.51 instead of .51.
i. Exaggerate details on sketches for clarity.
j. Line up descriptions and sketches so that it is clear what the descriptions refer to.
k. Show a north arrow on all sketches.

COMPLETENESS

a. Show all pertinent measurements and observations.
b. Record complete data. For example, "Mr. John M. Jones, Project Superintendent instructed me..."
c. Review your notes before leaving job site to be sure they are complete.
d. If you are in doubt about the need of recording any information, it is safer to record it.
e. Do not leave anything to be assumed.
f. If you intentionally leave something out, say so. For example, "Fence lines along north and west property lines not shown."

SELF-EXPLANATORY

a. Make maximum use of explanatory notes.
b. Place title at beginning of each type of work stating what the work is.
c. Show closing data with appropriate arithmetic checks and closures.
d. Record sufficient data so field computations can be checked later in the office.
e. Make your statements positive.
f. When a point is established by record, by prorate, or by intersection, etc., state this fact. For example, "Set lead and tack by proportional measurement."
g. Always cross-reference. When work is continued on another page, note this fact. Do not leave it to someone to guess.

HONESTY

a. Record exactly what you did in the field at the time you did it, not later from memory.
b. Do not record measurements made by others unless you note this fact.
c. Numbers should show degree of precision. For example, rod readings taken to the nearest 0.1 foot should be recorded 6.3, not 6.30.
d. If you have measured a distance to the nearest 0.01 foot but question the accuracy, note this. For example, 321.47' ± 0.10'.
e. Erasures are not permitted in field books. If an item is recorded in error, draw a line through it without destroying its legibility and record the correct item above.
f. Avoid copying notes. If it is absolutely necessary, the part copied must be so marked and the submitted as a part of the notes. For example, if the chaining notes are kept in a peg book and the totals are copied into the field book, the totals must be marked "copied from peg notes" and the peg book must be submitted as a part of the notes.
g. When adding pickup data to notes previously prepared, date and initial each new entry.
h. Record actual measurements, not what they are supposed to be.
i. Never, under any conditions, falsify notes. This is fraudulent and dishonest.

SELF-CHECKING

a. Field work and notes should be planned and kept in such a manner that the work can be checked without a return visit to the field; the office personnel should be able to take the field notes and, by calculation, prove the work to be correct. For example, in leveling, if you start and end on the same bench mark, the office person can check to see that all your turning point rod readings are reasonable, but he will not know whether the bench mark you used was the same one you described; there may be two spikes in the same telephone pole. Had you started at one bench mark and ended on a different one, the office could positively prove your work.
b. In boundary work or on building layout show the closing angles and distance you measured, not what they are supposed to be. Obviously, every distance you measure or rod you read cannot be checked, but the main scheme should be done in a way that is self-checking. It is a matter of judgement what part of the survey warrants checking. For example, to locate trees by one angle and one distance may be sufficient, but if you feel that their locations are important, perhaps you should, in addition, draw a sketch showing the distance between trees with the end trees tied to the property line. This will allow the office to check the correctness of the locations of all the trees.
c. It is of the utmost importance that, on every survey, check measurements be taken to prove the main scheme.
d. Repeat aloud values given for recording. For example: for recording a distance 124.68, call out "one, two, four, point, six, eight" for verification by the tapeman who submitted the measurement.

SKETCHES

Neat sketches are necessary to properly describe many situations. henever possible, sketches should be oriented such that increasing stations re shown progressing up the page. Also, the direction, North, should be hown in its proper relationship to the sketch. Note all such items as treams, phone line, fences, cutting block boundaries, road junctions, other urveys, etc.

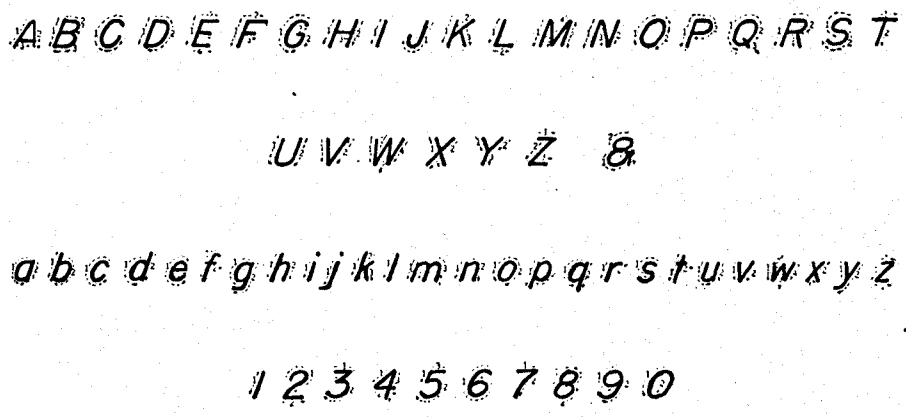


Figure 1 -- Suggested order and direction of strokes in freehand lettering on field sheets.

LIST OF STANDARD ABBREVIATIONS AND SYMBOLS

abutment	abut.	instrument point	△
acre	ac.	intersection	Inters.
angle point	∠	intersection angle	∠
approach	appr.	large rock	lge. r.
area	A.	latitude	lat.
average	avg.	left	lt.
Azimuth	Az.	linear feet	lin. ft.
back sight (levels)	B.S. (+)	longitude	long.
back sight (transit)	0	loose rock	L.R.
bench mark	B.M.	low water	L.W.
borrow	bor.	magnetic	mag.
bottom	bot.	material	matl.
bottom of bank	B.B.	mile	mi.
bottom of ditch	Dt.	mountain	mt.
boundary	bdy	north	N.
bridge	br.	number	no. or #
center line	℄	open top culvert	O.T.C.
center of stream	C.S.	perpendicular	⊥
channel change	ch. ch.	point	pt.
clearing	cl.	point of curve	P.C.
concrete	con.	point of intersection	P.I.
corner	cor.	point of tangency	P.T.
corrugated metal pipe	C.M.P.	point on curve	P.O.C.
creek	cr.	point on tangent	P.O.T.
cross-section	X sec.	private	pvt.
culvert	cul.	radius of curve	R.
curve	cv.	reference point	R.P.
cut	C.	reinforced concrete pipe	R.C.P.
departure	dep.	right	rt.
diameter	Dia.	right-of-way	R/W
diameter breast height	D.B.H.	same slope	S.S.
double angle	D.A.	section	sec.
drainage	dr.	solid rock	S.R.
draw bottom	D.B.	south	S.
east	E	spring	spr.
edge of road	E.R.	standard	std.
edge of water	E.W.	station	sta.
elevation	elev.	stone	st.
equation	Eq.	stream	str.
fence	fe.	thousand	M.
fill	F.	thousand board feet	M.B.F.
fore sight (levels)	F.S. (-)	toe of fill	T.F.
fore sight (transit)	◇	toe of slope	T.S.
grade	Gr.	toe of bank	T.B.
height of instrument	H.I.	turning point	⩘
high water	H.W.	turn-out	T.O.
highway	hwy.	west	W
hub and tack	H&T		

Creek, stream, and river banks are right and left when facing downstream.

ABBREVIATIONS COMMONLY USED

BD	BOTTOM OF DRAW
BR	BERM
CB	BACK OF CATCH BASIN
CK	POINT IN CREEK
DT	BOTTOM OF DITCH
EB	EDGE OF BOG
EC	EDGE OF CREEK
ER	EDGE OF ROAD
LR	LOOSE SURFACE ROCK
MC	MIDDLE OF CREEK
RO	ROCK OUTCROP
TC	TOP OF CUT
TF	TOE OF FILL
TO	TURNOUT
TR	TOP OF RIDGE
TR	TRAIL
TW	EDGE OF TRAVELWAY
⩘	TURNING POINT

TRANSIT TRAVERSE

1. A transit traverse is a first class survey. Instruments consist of an engineer's transit, engineer's level, and steel tape.

2. If the traverse is a continuation of another traverse, start the new line with a tie to the existing line by setting up over an old P.I., backsighting the old line, and turn and record the new traverse angle. Measure and record the distance from the old P.I. to the new P.I.

3. Distances are measured to the nearest hundredth of a foot.

4. All angles from P.I. to P.I. are turned to the right (as indicated in the sample notes). The angle should be doubled by flopping the instrument and turning the angle again so that the first angle is turned with the telescope in normal position nd the double angle turned with the telescope flopped (focusing screw on bottom). Record the original angle right and double angle in notes. Angles should be read to the smallest graduation which the instrument allows. Angles should double within ± 1' with T-16, ± 5" with T-2.

5. Read Stadia between P.I.'s as a check for distance (Do not record.)

6. There should be at least one intermediate station between P.I.'s. Stakes shall be set at all breaks, channels, banks, ridges, draws, cross drainages, or any spot that will require cross sections. When crossing streams or creeks, take a compass bearing of the waterway and record in traverse notes.

7. Deflection angles between tangents shall not exceed 30 degrees with connecting tangent lengths of not less than 60 feet, except that for switchbacks the allowable deflection angle may be as large as 45 degrees and the connecting tangent lengths not less than 40 feet.

8. Record stationing on stakes so that they can be read as you are proceeding up the line in increasing stations. Use double guard stakes on all P.I.'s. Stationing stakes are to be painted fluorescent red or orange.

9. Read and record the magnetic bearing ahead from each transit as a check on calculated bearings.

10. Crew chief should ask his supervisor as to what type of transit line ties will be used.

11. Notes on ties from traverse should be placed in a separate book if the number of ties is extensive, but placed in the traverse notes if a small number is involved.

12. When shooting stadia distances, the telescope is levelled and the rod reading difference between the outermost stadia hairs is read. This difference is multiplied by 100 to obtain distance in feet. If it is impossible to shoot stadia with the scope level, move the scope until a reading can be obtained on the rod and note the vertical angle on the vernier. Then:

Horiz. Distance = rod diff. x 100 x cosine of vertical angle.

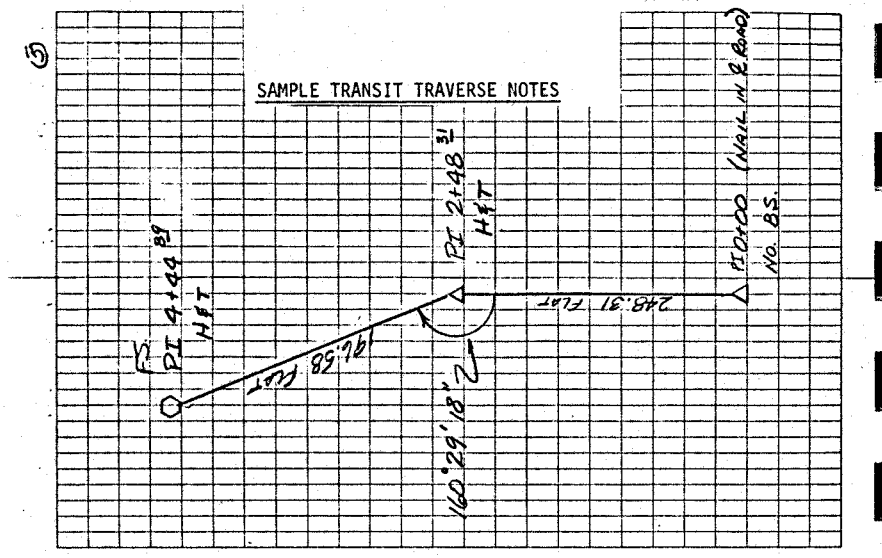
TRANSIT TRAVERSE CONTINUED

13. If P.I.'s are likely to be destroyed (such as on existing roads), they should be referenced according to outline on page 39.

14. Sample traverse notes are shown on Figure 2.

15. Before survey begins, state at the beginning of the fieldbook the date, weather, crew and assignments. Transit and number, vertical, elevation, HI starting station, bearing, starting station, and transit constant.

SAMPLE TRANSIT TRAVERSE NOTES



SEC	STA.	SL. DIST.	VERT ∠	∠ RT	BRG. AHD.
200	PI 2+48.51	196.97	86°23'12"	160°29'18"	
		196.17	86°23'12"	320°58'36"	
				DEC	
100	0+00	248.85	86°-12'-12"	NONE	

Figure 2

COMPASS TRAVERSE

1. A compass survey is a Class II traverse. Instruments consist of a staff compass, and steel chain.

2. Chaining is done with a steel chain. The distances are to be horizontal and to the nearest tenth of a foot.

3. Angles will be determined from the bearing of intersecting courses. Read and record the back and ahead bearings to the nearest half degree for each P.I. The two readings should not deviate by more than one degree. If a recheck shows a difference of more than one degree, record both bearings, continue the traverse, and bring the matter to your supervisor's attention.

6. Sample compass traverse notes are shown in Figure 3.

7. Procedures for a compass traverse are similiar to those for transit traverse. Read Transit Traverse for ties and general procedures that apply to traverses.

LEVEL INSTRUCTIONS

1. A level loop is made in conjunction with transit and compass surveys to establish elevations. Instruments consist of a steel chain, leveling rod, and either an engineer's level or a hand level.

2. Set T.B.M.'s at a maximum distance of each 1,000 feet.

3. Make sure turning points are solid. A short description of turning points in the notes may help you relocate it if necessary.

4. When using an engineer's level, read turning points to the nearest hundredth of a foot and any intermediate ground shots on stations, etc., to the nearest tenth of a foot. All shots with a hand level should be read to the nearest tenth of a foot.

5. All level loops will be closed. Each loop should have a maximum distance of 1,000 feet. When closing a level loop the sum of the F.S.'s and the B.S.'s should be the same. Maximum closing error for a hand level circuit is 0.5 ft. in a 1,000 ft. circuit. Maximum closing error when using an engineer's level is 0.1 ft. in a 1,000 ft. circuit for a transit survey, or 0.25 ft. for compass survey.

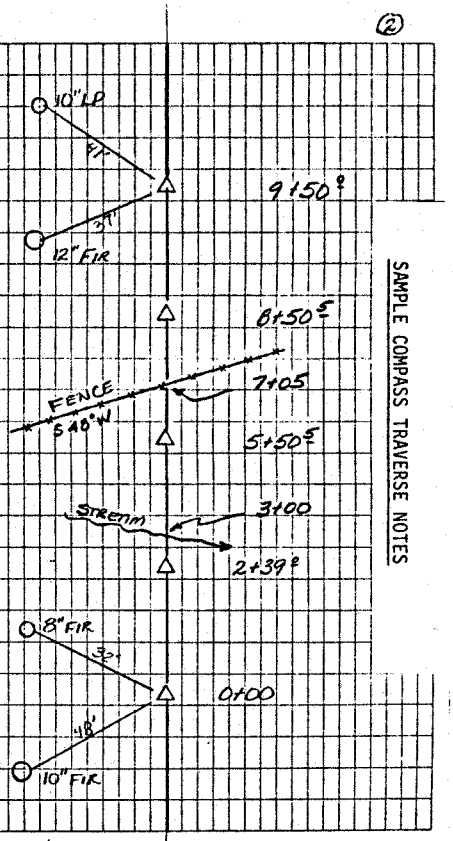
6. Elevations will be computed in the field. At the end of each level circuit, add backsites and foresights for closure.

7. Sample level notes are shown in Figure 4.

SEC	STA.	DIST.	AHD BRG	Back BRG
	9+50.0			
		99.5	N12°E	S12°W
	8+50.5			
		300.0	N10°W	S10°E
	5+50.5			
		311.5	N6°W	S6°E
	2+39.8			
		239.0	N2°E	S2°W
	0+00			

Figure 3

SAMPLE COMPASS TRAVERSE NOTES



STA.	(+) BS.	HI	(-) FS	ROD	ELEV.
	Circuit #1				
TBM #1					1000.00
	5.81	1005.81			
0+00				3.0	1002.8
0+50				4.2	1001.6
TP #1			4.31		1001.50
	5.03	1006.53			
1+00				3.6	1002.9
1+50				2.9	1003.6
TBM #2			7.38		999.15
	Closure Circuit #1				
	4.60	1003.75			
TP #3			5.46		998.29
	3.74	1002.03			
TBM #1			2.05		999.98

JA 6/30/83

$\Sigma BS = +19.18$ $\Sigma FS = -19.20$ error -0.02

Figure 4

REMARKS

TBM #1 is a SPIKE in BASE OF 10" FIR, 60' Rt of Station 0+00. Elevation was assumed.

STONE

Check Back to TBM #1

TBM #2 is the top of a white ROCK 10" on a side

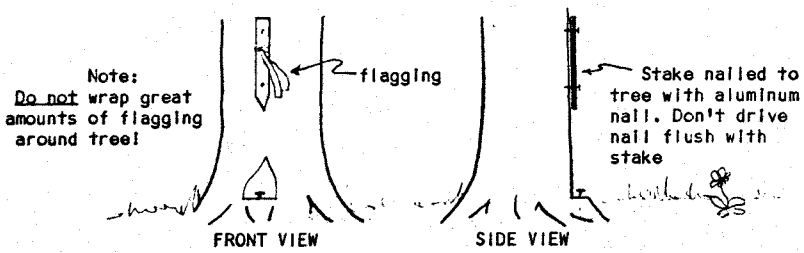
STONE

SAMPLE LEVEL NOTES

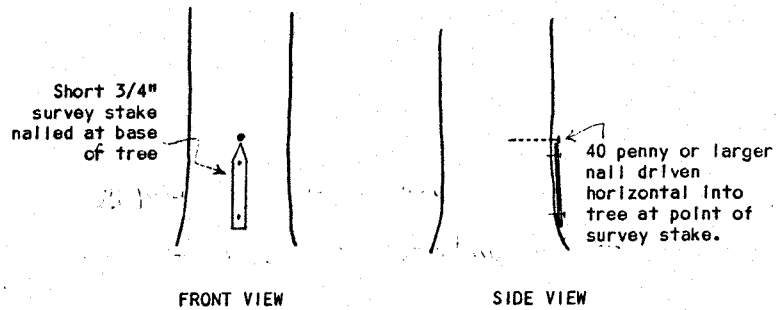
TEMPORARY BENCH MARKS (T.B.M.)

When a bench mark is set in a tree root, the notch will be no higher than 12 inches from the ground and cut to allow a rod at least 13 feet long to stand vertically and squarely on the mark. Minimum distance from "F" station to TBM is 40 feet.

On reconstruction projects , when possible, place TBM on side of tree away from road. When placing TBM's, avoid defacing trees. If a tree root is not available, use a short stake as shown below.



PRIMARY

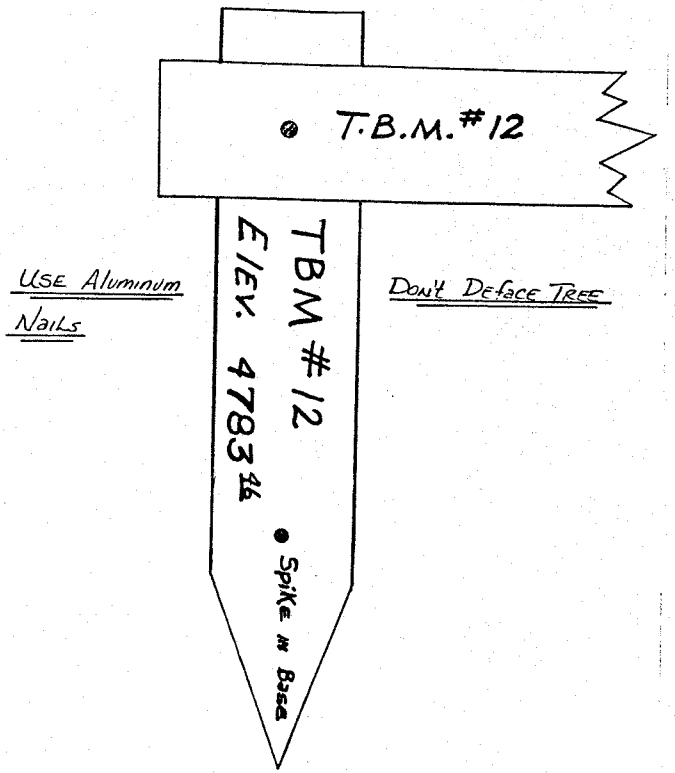


ALTERNATE

TEMPORARY BENCH MARK (T.B.M.)

A temporary bench mark is used to establish a known or assumed elevation near an existing survey. This elevation can then be used to re-establish the elevation of a point on the traverse. Below is an example of the marker stakes shown on previous page.

EXAMPLE T.B.M. STAKE



CROSS-SECTIONS

1. When cross-sectioning, be very careful to get the cross-sections at a 90° angle with the line or bisecting the angle at a P.I.

2. Cross-sections shall be taken at every point on the traverse.

3. Cross-sections shall be taken at all drainages. A description of the drainage channel will be included. If there is a live stream, cross-sections of the stream will also be included.

4. The crew chief should check with his supervisor as to whether cross-sections on any particular project are to be referenced by setting a hub at the end of the cross-section.

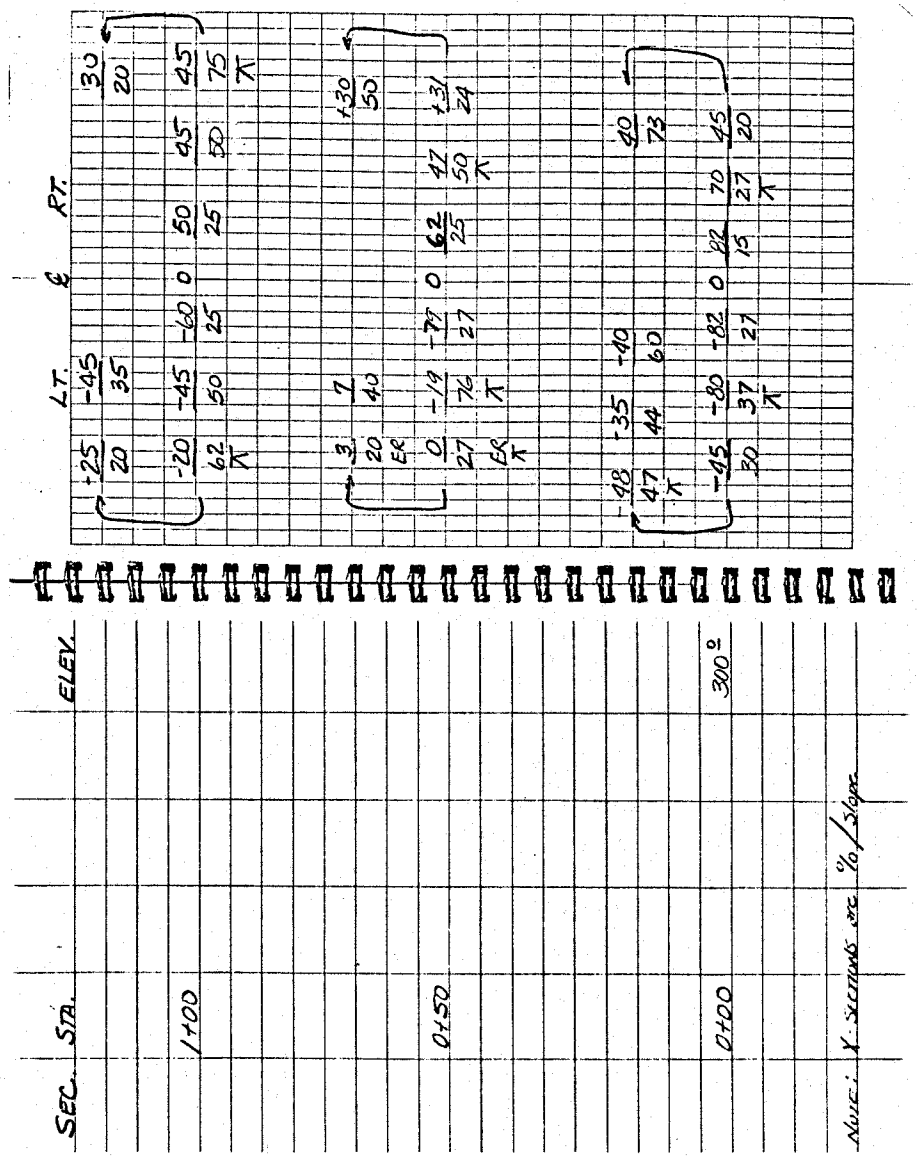
5. Typical notes shown for cross-sections on Figure 5 are for use of an abney or clinometer with percent slope and slope distance being recorded. This is the type of cross-section which will normally be used in preconstruction work. The method you use must be noted in the cross-section book.

6. The crew chief should obtain the length of the cross-section needed on any project; but in any case, the minimum should be 50 feet on each side of centerline.

7. Show a list of abbreviations used at the front of the cross-section book.

8. The center point of the cross section is entered as 0/0. Use plus signs when the reading is up and minus signs when the reading is down. Turning points are used when the "P" stake cannot be seen. The symbol ⋋ for turning point imples that succeeding topog shots were taken from that point. All data recorded after the ⋋ symbol refers back to the point where the ⋋ symbol appears.

SAMPLE CROSS-SECTION NOTES - FIGURE 5



CLASS III "P" LINE SURVEYS

The Class III survey is not necessarily a less accurate survey, but a less expensive method of gathering all the necessary and pertinent data to design a road. Some of the methods of data gathering are less accurate to a degree (such as chaining and profiles), but the final outcome after construction will be as accurate or better than the Class II method previously used. The major reasons for the increased accuracy are that the "P" line is now the final centerline and we are eliminating 99% of the horizontal offsets. The Crew Chief should work closely with the Locator so that he will know what the minimum radius curve for each road is and be aware of problem areas.

Equipment Needed:

4 HI sticks
4 Clinometers or Abneys well pegged for grade and cross sections
2 Hand-held Azimuth Compasses
1 100 ft Tape - cloth, nylon, or fiberglass
2 50 ft Tapes - cloth, nylon, or fiberglass
1 Brush Knife (extra blade and handle)
Wire Flags
Field Books, markers, pencils, etc
Stakes and ribbon when needed

GENERAL:
All instruments and tapes will be checked for accuracy prior to the days work. With a five-man crew, only one pass will be taken over the line. Grade, bearing, and chaining measurements are taken to the ahead station while cross sections are measured at the back station (rear chainman's position). No RP's or TBM's will be set. A tie line will be made at the beginning of the survey when starting off an existing road , unless a swing tie is called for (See Road Junctions).

The crew consists of:
1 head chainperson
1 rear chainperson
1 notekeeper
2 cross-sectioners

HORIZONTAL ALIGNMENT:
Horizontal alignment is the most important part of chaining. The flag line will be very accurately located; therefore, the "P" line will not vary by more than 5 feet left and right from the flagged line. Deviances of greater distances should be called to the attention of the locator for field review. The maximum cord length will be 75 feet. The maximum deflection angle used should be 15 degrees, except for a switchback, tight gulley or ridge, where 30 degrees is allowable. Alignment should be smooth throughout the line.

When placing "P" stations on the ground, an attempt should be made to place it where there will be uniform ground uphill and downhill on the cross-section. This will assure an accurate catch.

CHAINING:
Chaining will be done with a cloth or fiberglass tape and HI sticks or range pole. The distances are to be horizontal and within ±0.1 foot with each measurement. Stations should be to a whole foot, and usually to an even 5 feet in the absence of a clearly defined feature. Stations will be written on 3/8" x 1-1/2" x 24" wooden stakes. Begin stationing with 10+00 unless otherwise instructed.

GRADE AND BEARING:
The two people chaining will also be shooting grade and bearings, both ahead and back. A minimum amount of clearing between stations shall be done to allow centerline shots to be taken. Grade will be shot with clinometers or abneys using HI sticks. A percent grade ahead and back will be read and recorded. The limit of error is ±1%. The backsight is recorded in parentheses just above the foresight. Recheck the instruments if the readings start to vary consistantly by 1% or more. Watch for grade changes.

Traverse bearings will be taken as azimuth readings,using hand-held compasses, by both the head and rear chainmen. The readings will be recorded in the same manner as the grade. The limit of error for compass readings is ±2 degrees. To check the readings, the foresight and backsight should differ by 180 degrees. These instruments should also be checked prior to each day's work on a preset course. WATCH THE ALIGNMENT. Try to keep deflections under 30 degrees and use equal cord lengths.

CROSS SECTIONS:
Cross sections will be done with clinometers or abneys and read in percent slope. The distance is slope chained. HI sticks will be used and the shots taken at the rear chainman's HI stick. Judgement should be used to make sure the cross section will exceed the catch distance. As a guide, the slope length of the downhill and uphill legs of the cross section shall be 50 feet long on slopes less than 30%, 75 feet on slopes between 30% and 55%, 100 feet on slopes greater than 55%. A wire flag marking the cross section line is to be placed at 25 ft on the uphill cross section. This is used for line when construction staking. A bad 90 degree angle will make a narrow spot in the road. The cross sections must be accurate enough to slope chain to all the catches without having to field check them. (See also Cross-Sections). CHECK ALL INSTRUMENTS AT LEAST EVERY MORNING.

NOTE KEEPING:

- There is a use for each column in the field book; therefore, you should try not to overlap into another column. KEEP NOTES CLEAR AND CONCISE. (See Figure 6.)

- Try to keep the books neat and clean. Use a hard pencil to avoid smears.

- To keep the books from getting cluttered or crowded, there should only be three stations per page. The page should begin with a station and its cross section and end with the distance, bearing, and grade ahead. (See Figure 6.) With this method, the cross sections and chaining occurring will always be recorded on only one page.

- There should be no chaining busts as the notekeeper checks the addition with each station.

- Record all notes, classifications, and remarks opposite the correct station. Make extra room if necessary. Always give distance and bearing to object calling. (See Classification at end of text.)

- Use drawings wherever it will help clarify - junctions, creeks, roads. Leave a full page for the drawing.

- Initial all recordings that someone might question. Such as:
  - *+ and - cross section shots on same side or where + and - cross sections change sides
  - *Large deflection angles (over 30 degrees)
  - *Greater than allowable error in bearings or busts of any kind
  - *Cross-outs (Erasures are not to be made.)
  - *Drawings
  - *Changes in grade

- All books will have:
  1. On the front cover:
     - -sale name
     - -road number or name
     - -type of information contained in the book (Class III Survey, Road Logs, Profile, etc.)
     - -station to station included in the book
     - -book number and total number of books
  2. In the first part of book:
     - -address page - Nezperce N.F., Grangeville
     - -index page
     - -abbreviations page
     - -note telling procedures, instruments, declination, etc.
  3. Throughout the book:
     - -each page should be numbered
     - -begin each days work with date, weather, crew
     - -note any changes made in procedure or pertinent information

- Notes will be checked by Crew Chief and/or crew prior to being handed in.

- Notes should be handed in as soon as the road is completed so that elevations can be calculated.

CLASSIFICATION

DEPTH OF DUFF - Kick duff away until you reach mineral soil and measure the depth. Describe the type of duff.

Duff is a non-usable material such as needles, leaves, grass, roots and decomposed material.

SOIL TYPE - Describe as common; soil with very little rock, sandy, clay, and black dirt.

TREE SPECIES & AVERAGE DBH - List all species.

CLEARING - See chart for light, medium or heavy.

Canopy, downfall and brush can also be classified separately as light, medium, or heavy.

ROCKS - Describe rocks and give a distance and direction.

FLOAT ROCK - loose rock on the surface
SCATTERED ROCKS OR BOULDERS
PILES OF ROCK

CLASSIFY BOULDERS as:

Solid - need dynamite
Rippable - can use a dozer

COMMON TYPES OF ROCK:

Granite	Basalt	Shale
Quartz	Gneiss	GOLD

CREEKS

- a - Give name if there is one.
- b - Shoot bearings upstream and down; you may need an angle point and distance.
- c - Measure width and depth of water.
- d - Measure width and depth of high water.
- e - Measure width and depth of creek bed.
- f - Describe creek bottom as dirt, sandy, pebbles, rocks, etc.
- g - Shoot a percent grade upstream and down.

SPRINGS & WET AREAS - Give a distance and a direction (bearing) from a station. Also, give dimensions. Note any standing water and dimensions or describe signs of water such as ferns, bracken, alders.

DRAWS - Describe as deep or flat and as wet or dry. Shoot bearings up and down the draw.

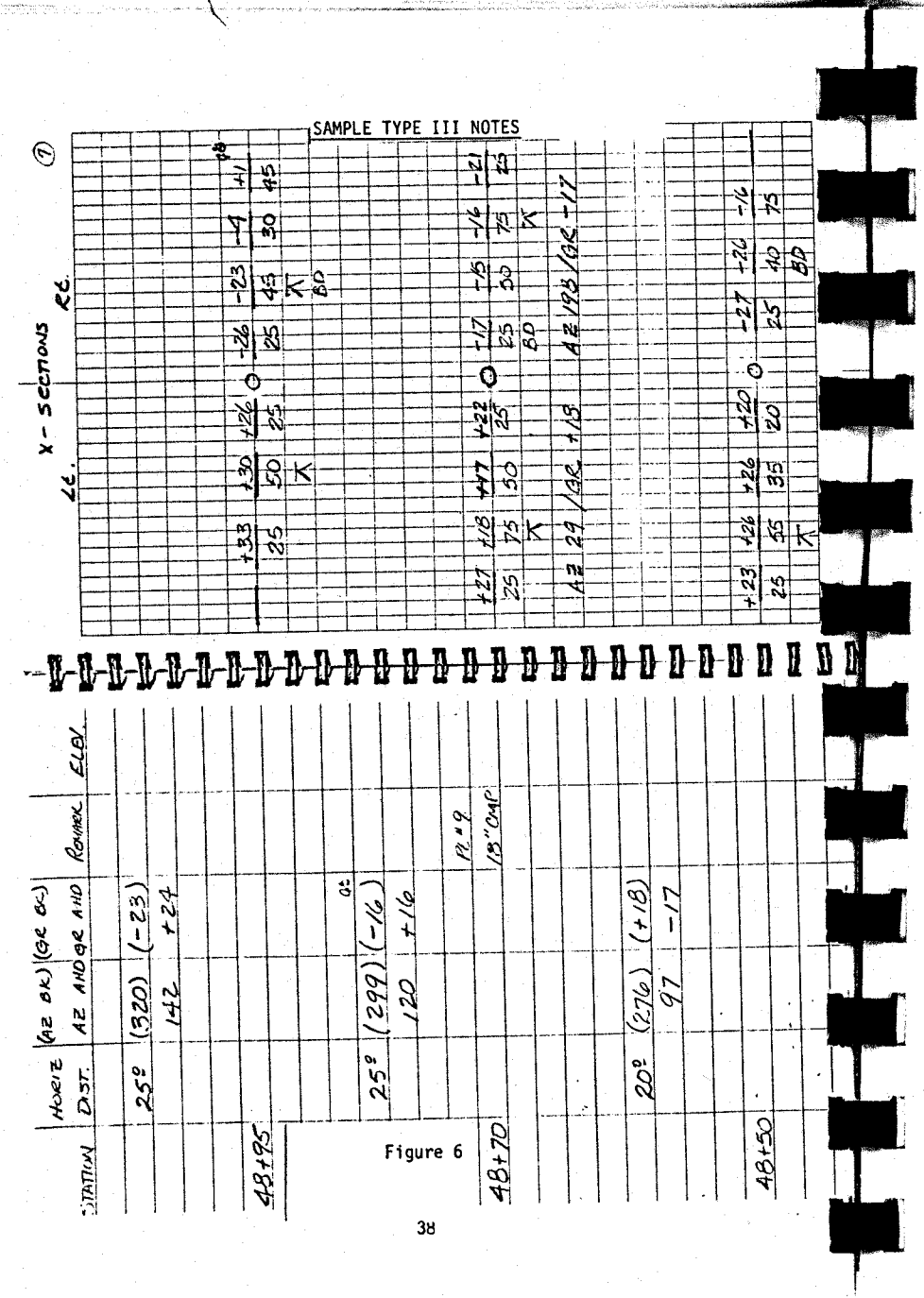
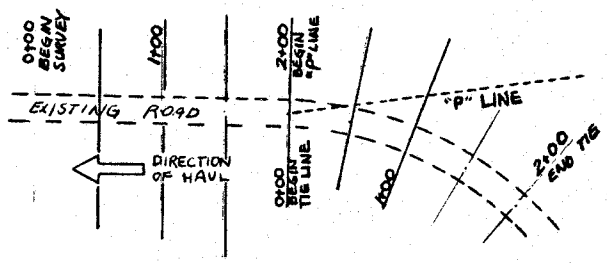


Figure 6

ROAD JUNCTIONS AND INTERSECTIONS:

I. When a survey intersects or begins off of an existing survey (such as an extension), tie into the traverse in at least two "P" line stations.

II. Use a tie line when a new survey begins off of an existing road.



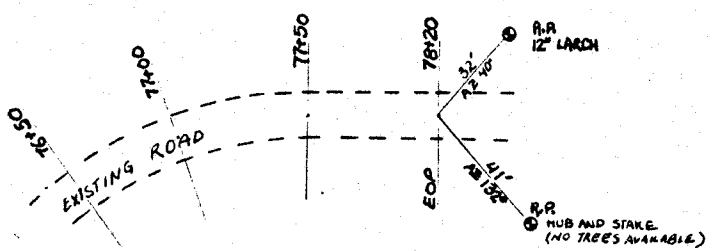
a) Use a drawing to describe the junction. Note any land features.

b) When a survey begins off of an existing road, survey shall include grade, alignment and cross section information on the road for a minimum of 200 feet in both directions of the intersection.

c) Tie lines will be one continuous line with stations running opposite to direction of haul. Record the common station(s) of the "P" line or road log.

d) X-sections will be taken at edge of road, toe fill and turn on downhill side. Uphill side, x-section will be taken at edge of road, ditch, top of cut and 25 ft beyond.

III. When the survey is on an existing road, a swing tie should be made at each end of the project.



a) "P" point should be referenced by at least two ties (one on either side of the road).

b) The RP shall consist of a stake securely nailed to a tree, labeled with the station and distance to the point referenced.

c) Include a sketch describing the RP's established.

CLASS FOUR

The Class IV Survey is called for on existing roads which have areas requiring more than just reconditioning to bring them up to standard. The methods used are the same as for Class III with some exceptions.

The P-line will run down the center of the road, beginning with 0+00. If there will be traffic over the area surveyed, the stakes will be offset into the cutbank. Show the offset distance so that centerline can be reset. The maximum chord length is 100 ft., less in curves. The stationing should be placed to pick up changes in road width, breaks in grade, sag points, existing pipe and open tops, flagged points, springs, slumps, sloughs, mileposts, and other significant features. Beginning and end of existing full width turnouts need to be stationed. For significant curves, station at least the beginning, middle, and end. More will be needed for tight curves.

Cross-sections at each station should include the travelway, road width, and the ditch, if one exists. Cross sections are taken to the top of cut, turn, on the uphill side and to the toe of fill, turn, on the downhill side. The turn shots should be for at least 25 feet. However, when existing ground is over 50%, the cross section on the uphill side should be 25 feet beyond top of cut, then turn for at least 25 feet. Extended x-sections may also be needed on below standard curves, where additional pipe is called for, or where extensive work is needed. Judgement needs to be used to insure having enough cross section information to determine catch points.

For additional information, see Class III "P" Line Surveys.

LAND CORNER TIES

1. Normally, property corners will be located in advance of the survey by the persons responsible for the survey flagline location. The crew chief will consult his supervisor as to land tie requirements.

2. If at all possible, have a copy of the GLO surveying notes for the area you are working in when making corner ties.

3. Start all ties from a P.I. point and run from P.I. to corner.

4. Turn angles and measure distance on the land tie with the same precision as required on the traverse.

5. The notes shall include a sketch and complete description of all corner data, including everything found. Also include the tie to bearing trees.

SITE SURVEYS

A bridge-site survey consists of studying and evaluating the overall conditions in the area, selecting the best site, and securing sufficient site data to design the appropriate structure.

Too much stress cannot be laid upon the value of a comprehensive and accurate bridge-site survey. Incorrect or inadequate information renders useless any nicety of design or detail. Lack of adequate information often makes it impossible to properly select the type of structure offering the greatest economy for the conditions at hand. A design predicated upon information which later proves incorrect, or incomplete is apt to involve changes or modifications after the contract has been let. Modification of plans generally involves expensive work, is often a source of contract claims, and delays in construction time.

Site surveys are required for all bridges and major roadway structures, such as major culverts, retaining walls, and stock passes. The type of survey made should be commensurate, to some degree, with the complexity of the site and the proposed structure. The design for a simple, single-span trail bridge may require very little field data, while that for a continuous steel and concrete highway bridge will require all available data.

In order to prevent structure design from lagging behind the design of the road, the site survey must be submitted to the bridge-design office as early as possible. The designing, detailing, quantity-estimating, and checking of the drawings generally require from two to three manweeks time after it has been worked into the design office schedule.

The data that must be obtained and transmitted to the design office is composed of the following:

Topographic Map. The topographic map should cover the area necessary to design and detail the structure and related improvements, such as dikes, channel improvements, bank protection, detour structures, and flood-stage overflow channels.

*Generally, the map should cover an area that extends 100 to 150 feet beyond the extreme limits of the proposed structure and improvement. The map should be drafted to a scale and contour interval such that the design organization can use it without redrafting. For submission to the design office, the map should be in pencil on a reproducible material which is durable and dimensionally stable, such as mylar film. All drafting should be such that reduction to half size can be accomplished. The following is provided to assist the locator in the survey and the map preparations:

*Stream gradient should be surveyed 150 feet up and 100 feet down stream.

1. Show proposed road and bridge centerline with true bearing and alignment data.

2. Show bench mark location, description, and elevation. State if the elevation is assumed or given and the source of the information.

3. Show stream name and direction of flow.

4. Show location and identification of all subsurface explorations (drill holes).

5. Show"North" arrow and a directional arrow with name and distance to nearest town.

6. Show section corners, landlines, and rights-of-way limits if within the area.

7. Locate and identify streambanks, types of ground cover in approach areas, edge of water, islands, gravel bars, drift jams, overflow channels, side streams, old channels, flood outlines, direction of highwater currents and points of impingement against banks, scour areas, horizontal extent of exposed bedrock in substructure areas, and other items of importance in location and design of the structure.

8. Locate manmade features, such as buildings, fences, ditches, pipelines, and utility lines. If the contractor's equipment must work near a utility line, indicate vertical and horizontal clearance. Existing roads and bridges should be shown with dashed lines and identified.

9. A map scale of 1 inch equal 10 feet should generally be used. Scales less than 1 inch equal 40 feet should not be used.

10. Contour interval should generally be 2 feet.

11. Show names or initials of individuals preparing map and the individual checking completed map. Show date completed, Forest, section, township, range if applicable, road name, bridge number, and related data.

12. Horizontal control consists of "P" or "L" line hubs and stationing, reference hubs and traverses along the stream for establishing base lines for dikes or channel changes. All linear measurements along the centerline of the bridge or substructure units should be to 0.01 feet. Measurements for structures, such as dikes and channel changes, should be to the nearest 0.1 feet. All transit angles should be to the nearest 20 seconds. Closure across the stream should be effected for all sites either by direct measurement or by triangulation. Evidence of this action should be documented in the data sent to the bridge design organization.

13. Vertical control consists of establishing the primary bench mark, intermediate bench marks, and elevations of appropriation hubs and traverse stations. Temporary bench marks used for obtaining contours and cross-sections for designing dikes, riprap, and channel changes should be to the nearest 0.1 feet. All bench marks to be used for construction purposes

hould be to 0.01 feet. No bench mark should be established without a closure f the level circuit for an accuracy check.

oth horizontal and vertical control for the bridge-site survey should be ased upon the same controls that are used for the overall road project.

urvey notes for the structure site particularly for major structures, should e kept in separate field books and also included in the site survey data sent o the design office.

STADIA SURVEY

1. A stadia survey is a second class survey. Instruments consist of an engineer's transit and Philadelphia rod.

2. If the traverse is a continuation of another traverse, start the new line with a tie to the existing line by setting up over the old P.I., backsiting the old line, and turn and record the new traverse angle. Measure and record the high, low, and rod readings.

3. Rod distances are measured to the nearest hundredth of a foot.

4. All angles from P.I. to P.I. are turned to the right (as indicated in the sample notes). Double the angle and record the original angle right and double angle in the notes. Angles should be read to the smallest graduation which the instrument allows.

5. Record stationing on stakes so that they can be read as one proceeds up the line in increasing stations. Use double guard stakes on all P.I.'s. Stationed stakes are to be painted red or orange. Guard should be placed with the station up on one and down on the other.

6. Leave the first half page blank for beginning criteria.

7. The station number distinguishes between P.I.'s and intermediate points. P.I.'s have the last two digits as zeros (100, 200, 300). Intermediate points ascend in increments of ten (110, 120, 130).

8. Be sure to occupy the last P.I. for back stadia readings.

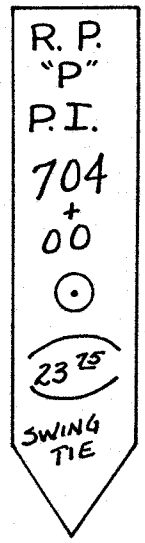
9. For ahead readings show upper, lower, and middle crosshair readings for every point shot to the nearest hundreth of a foot. For back readings, which are shown in parentheses, show upper, lower, and middle crosshair readings for shots to the preceeding P.I.

10. Record the vertical angle to the nearest minute for every shot taken. If vertical circle of instrument is 0° horizontal, record shots above horizontal with a "+" and shots below horizontal as "-".

11. Horizontal angles will be measured as angle right and will be recorded with an "H" behind them.

12. Sketch a diagram of the horizontal angle.

13. Record cross-sections on the right hand side of the page.



P.I. OR P.O.T. REFERENCING

R.P. Target Stake

Station

Generally, the reference point is a nail, centered here, that sticks out about ½ inch.

Horizontal distance from the reference point nail head to the P.I. hub tack measured with steel tape or stadia rod.

ACCURACY

Class I - Hundredths
Class II - Tenths

ccasionally, the reference point nail may be placed independently from the RP take if the stake cannot be handily placed at the proper elevation. These eviations from the general practice should be noted in the field notebook.

ll Class I P.I.'s will be referenced. For Class II survey, two consecutive .I.'s shall be referenced at approximately 1,000 foot intervals along "P" ine.

enerally, two targets with distances will suffice for referencing. If nportance of survey dictates or survey is on existing road where P.I. may be estroyed, a hub with tack plus a target should be used to permit accurate e-establishment of P.I.

CONSTRUCTION STAKING

REQUIREMENTS

PRECISION of construction staking shall meet the following precision requirements. Slope distance accuracy for setting slope stakes shall be 0.3 foot, or 2.0 percent of the slope distance, from the control point to the slope stake, whichever is the larger value. Horizontal and vertical accuracy for slope stake references and culvert refereences shall be 0.3 foot, or 2.0 percent of horizontal distance, measured from the construction stake to the reference, whichever is the larger value. Accuracy of horizontal measurement from the slope stake to the clearing limit shall be 1.0 foot.

SLOPE STAKES AND CLEARING LIMITS Slope stakes shall be set in the ground at catch points on both sides of the roadway. After slope stakes are set, the crew shall mark clearing limits on both sides of the road as shown in Exhibit A. Clearing shall be delineated by lath or flagging hung at least 4 feet above ground.

REFERENCING After each section has been staked, the crew shall set reference stakes which have recorded the vertical difference and the horizontal distance from the reference stake to the slope stake catch point. Station and information on the slope stake shall also be recorded on the reference stake as shown in Exhibits C and E. Both sides of the road shall be referenced. Reference stakes shall be set at a minimum horizontal distance of 15 feet beyond the clearing limits.

STAKING CULVERTS All culvert stake locations shall be determined by hand level or equivalent methods applied to the design typical sections and the original control line. Also, culverts shall be staked with stakes driven on the centerline of the culverts at the uphill slope stake and pipe outlet. Stakes shall be marked with the following information:

a. Diameter, length, and type of culvert (such as 18" x 36' CMP).

The length staked shall provide at least 2 feet of pipe extending beyond the toe-of-fill as described in Exhibit D.

b. The vertical and horizontal distance from the stake to the invert at the end of the pipe.

c. Flowline grade of the pipe.

The stakes shall be adequately referenced as to both horizontal and vertical control well beyond the anticipated construction limits and out of the flowline. Stakes shall be marked as shown in Exhibit E. The length of culverts shall be computed and displayed as shown in Exhibit D.

FIELD NOTES Field notes shall be kept in a standard format.

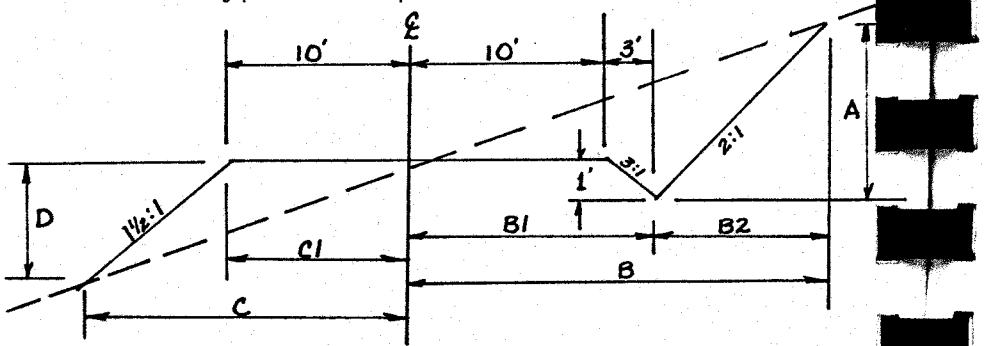
Crew names, positions, and dates shall be recorded in the fieldbooks at the beginning of each day's work. The party chief or notekeeper must sign or initial the beginning sheet of each day's work.

SLOPE STAKING PROCEDURE

EQUIPMENT NEEDED

Hand Level
Cut and Fill Rod
50-foot Tape
Yellow Ribbon for Clearing
Red and White Candy Stripe Ribbon for Pipes
Field Books, plans, and slope stake printouts
Wooden Stakes
Lathe When Needed

lethod for determining position of slope stake:



he cut dimension on the cut stake is the vertical distance shown as A to the ottom of the ditch. The horizontal distance shown on the slope stake is the orizontal distance from the slope stake to the centerline of the roadway (B). o find the position of the slope stake, follow this procedure: Determine the levation of a point on the slope that looks like it may be in the area of the lope stake. Subtract the elevation of the ditch bottom from the elevation of he point on the slope. You then have the vertical distance A as shown on the iagram. Multiply this distance (A) by the first number of the back slope atio for this section (1:1-multiply by 1, 3:1-multiply by 3). The distance rrived at by this is shown as (B2) on the diagram. Add this distance (B2) to he constant (B1) which is the roadway width and the ditch slope width to find . If B agrees (within limits set by the project engineer) with the orizontal distance you have measured from centerline you have the position of he slope stake. If this distance does not agree, you will have to move up or own the slope, and repeat this procedure until the slope stake position is ound. Then (unless instructed otherwise) set the reference point. This hall be set behind the slope stake. It shall show the cut from that point to he catch stake and the distance from that point to the catch stake orizontally and vertically. This R.P. will be set at 15 feet beyond the atch stake or will be set back far enough so that it will not be destroyed uring construction.

FILL SIDE

The same procedure shall be followed for the fill slope stake, except that all fills as shown on the slope stake shall be to the shoulder grade. The constant for fills shall be the distance shown as C1 on the diagram.

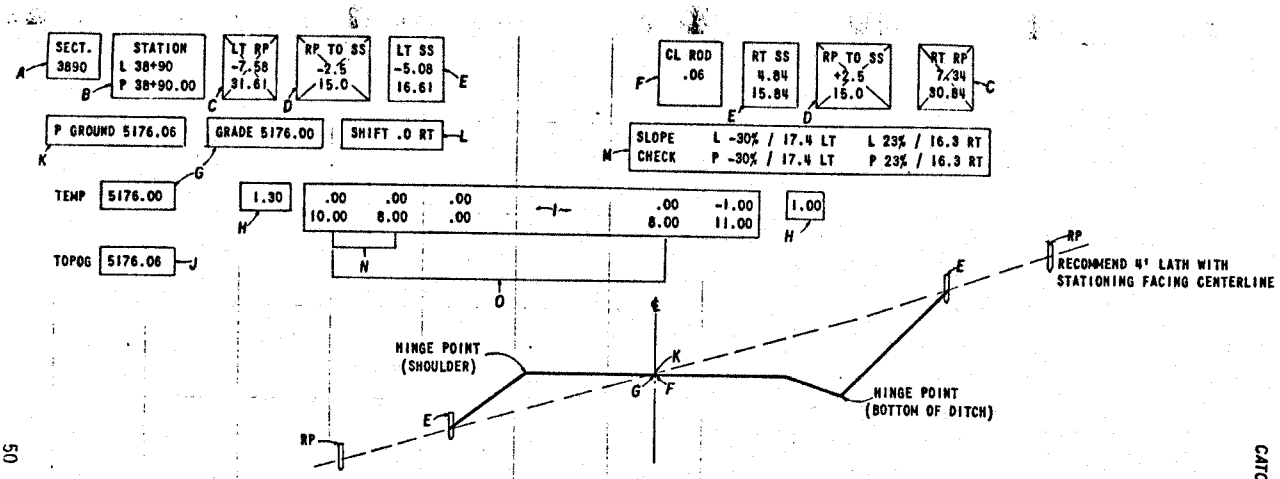
Fill slope stakes and fill R.P.'s shall be written in a like manner except the C shall be changed to F.

All slope stakes and R.P.'s shall have the station written on the reverse side. Unless instructed to do otherwise, a stake pencil shall be used to write the stakes, clearly and legibly. See Exhibit C for proper stake markings. Bear down on pencil--write on stake before painting to preserve writing.

Always consult the project engineer as to the ditch section, backslopes and fillslopes to be used when staking.

EXHIBIT A

CATCHPOINT PRINTOUT EXPLANATION



EXPLANATION FOR CATCHPOINT PRINTOUT

ITEM	INSTRUCTIONS FOR STAKING CREW
A - SECTION NUMBER	→ DISREGARD
B - "L" LINE AND "P" LINE STATIONS.	→ SEE SPS
C - LEFT AND RIGHT REFERENCE POINT, VERTICAL ROD (REFERENCED TO THE TEMPLATE HINGE POINT) OVER HORIZONTAL DISTANCE (REFERENCED TO THE "L" CENTERLINE). MINUS (-) SHOWN BEFORE VERTICAL ROD DISTANCES INDICATES FILL. NO SIGN INDICATES CUT. REFERENCE POINT (RP) IS THE LAST TOPOGRAPHIC POINT.	→ DISREGARD
D - VERTICAL ROD OVER HORIZONTAL DISTANCE FROM REFERENCE POINT RIGHT OR LEFT TO SLOPE STAKE. MINUS (-) SHOWN BEFORE VERTICAL ROD INDICATES FILL. PLUS (+) SHOWN BEFORE VERTICAL ROD INDICATES CUT.	→ DISREGARD - NOTE FIELD RP LOCATION IN STAKE BOOK.
E - LEFT AND RIGHT SLOPE STAKES. VERTICAL ROD (REFERENCED TO THE TEMPLATE HINGE POINT) OVER HORIZONTAL DISTANCE (REFERENCED TO THE "L" CENTERLINE). MINUS (-) SHOWN BEFORE VERTICAL ROD INDICATES FILL. NO SIGN INDICATES CUT.	→ RECORDED MEASUREMENTS MUST BE VERTICAL AND HORIZONTAL.
F - "L" CENTERLINE ROD TO GRADE ELEVATION (SEE ITEM G). MINUS SIGN (-) INDICATES FILL AT "L" CENTERLINE. NO SIGN INDICATES CUT AT "L" CENTERLINE.	
G - GRADE ELEVATION (USUALLY CENTERLINE).	
H - SLOPE RATIO OF CUT OR FILL SLOPE. ie. 1.30 = 1.3:1, 1.00 = 1:1, etc.	
I - TEMPLATE READINGS. VERTICAL ROD FROM GRADE OVER HORIZONTAL DISTANCE FROM "L" CENTERLINE.	
J - "L" GROUND ELEVATION.	
K - "P" GROUND ELEVATION.	
L - OFFSET DISTANCE FROM "P" CENTERLINE STATION TO "L" CENTERLINE STATION.	→ PLACE NEW STAKE AT 'L' CENTERLINE. DO NOT REMOVE "P" STAKE.
M - SLOPE CHECK. PERCENT SLOPE AND SLOPE DISTANCE FROM "L" CENTERLINE TO SLOPE STAKES. PERCENT SLOPE AND SLOPE DISTANCE FROM "P" CENTERLINE TO SLOPE STAKES.	
N - SLOUGH WIDENING.	

ISTANC LUS DI IGHT = JBGRADE = W.

EXHIBIT B

CONSTRUCTION STAKING SCHEMATIC

CLEARING RIBBON COLOR = YELLOW
CLEARING RIBBON SHALL BE INTERVISIBLE.
CMP RIBBON COLOR = RED & WHITE CANDY STRIP.
CONSTRUCTION & R.P. STAKES = WILL HAVE BRIGHT RED RIBBON AND OR RED HIGH VISIBILITY PAINT.
"P" LINE OFFSETS ARE SHOWN ON THE CATCH POINT PRINTOUTS.
POSITION OF CONSTRUCTION STAKES SHALL BE DETERMINED BY CATCH POINT PRINTOUTS AND SLOPE STAKE NOTES - EXCEPT ALL CULVERTS SHALL BE STAKED BY THE HAND LEVEL METHOD APPLIED TO THE DESIGN TYPICAL.

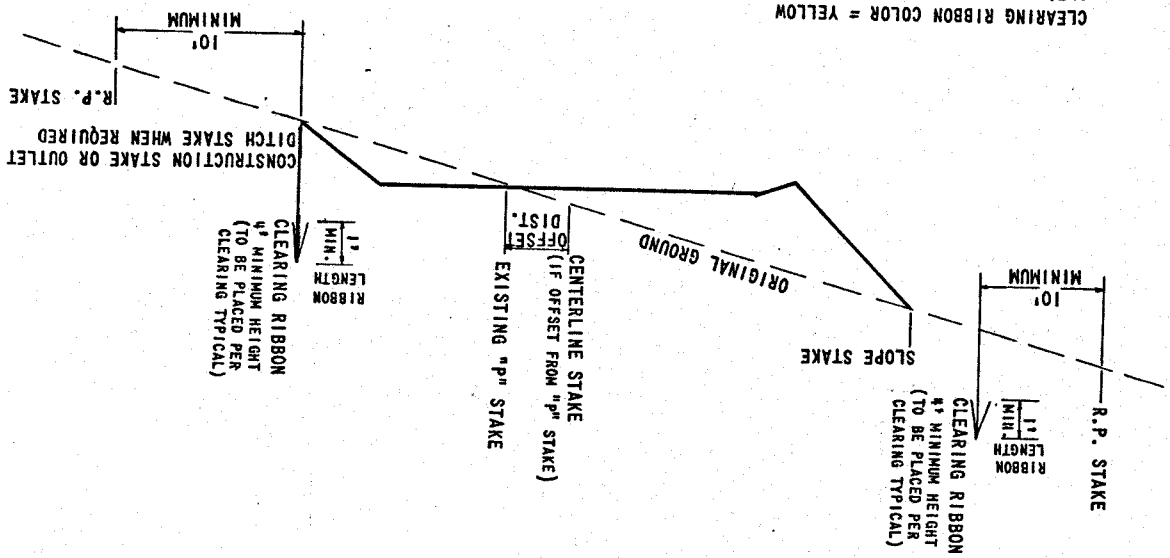
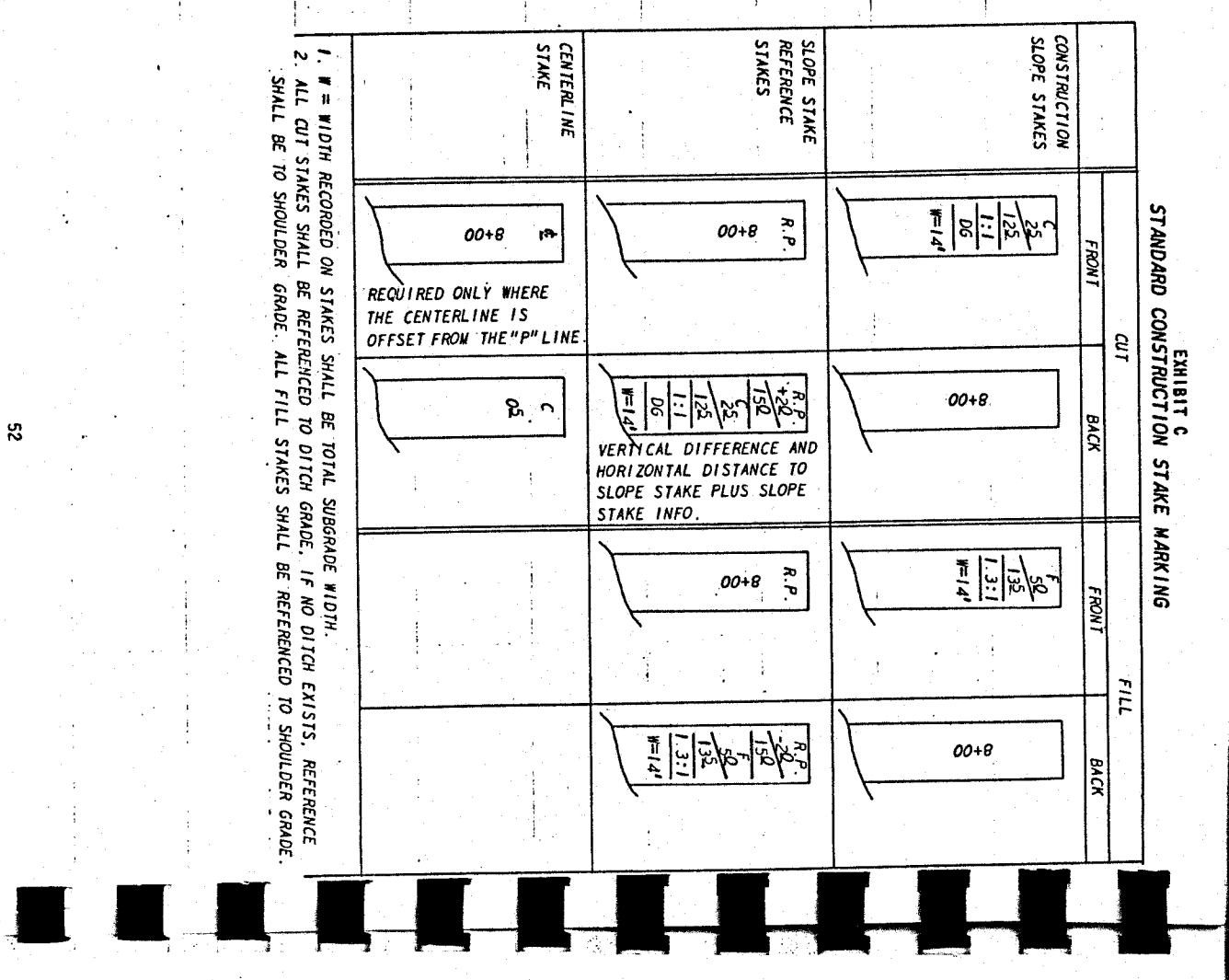


EXHIBIT C
STANDARD CONSTRUCTION STAKE MARKING



1. W = WIDTH RECORDED ON STAKES SHALL BE TOTAL SUBGRADE WIDTH.
2. ALL CUT STAKES SHALL BE REFERENCED TO DITCH GRADE. IF NO DITCH EXISTS, REFERENCE SHALL BE TO SHOULDER GRADE. ALL FILL STAKES SHALL BE REFERENCED TO SHOULDER GRADE.

SECT		STATION	LT RP	RP TO SS	LT SS	CL ROD	RT SS	RP TO SS	RT RP
3930	L	39+30			-14.50 a	-.94	10.67		
	P	39+30.00			35.85 b		28.67		

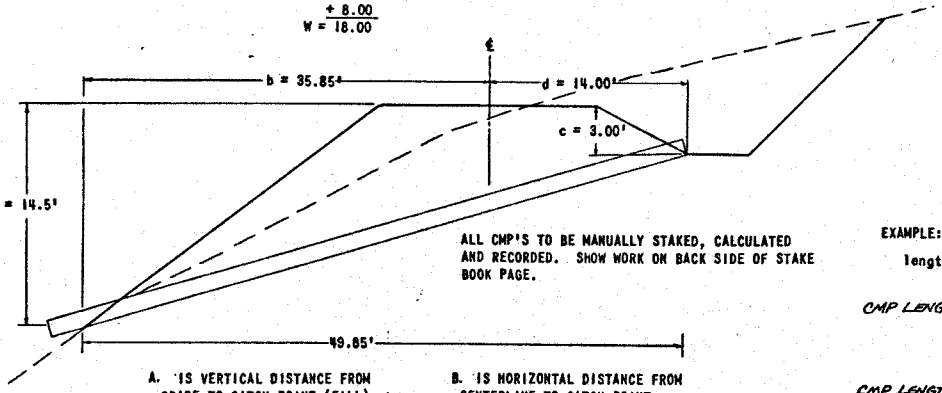
P GROUND 5174.26 GRADE 5175.20 SHIFT .0 RT

SLOPE L -32% / 20.6 LT L 31% / 28.5 RT
CHECK P -32% / 20.6 LT P 31% / 28.5%RT

TEMP 5175.20 1.30 .00 .00 .00 .00 -3.00 c 1.00
10.00 8.00 .00 8.00 14.00 d

'2' SLOUGH WIDENING

10.00
+ 8.00
W = 18.00



A. 'a' IS VERTICAL DISTANCE FROM GRADE TO CATCH POINT (FILL) MINUS VERTICAL DISTANCE FROM GRADE TO CMP INVERT

14.50
- 3.00
11.50

B. 'b' IS HORIZONTAL DISTANCE FROM CENTERLINE TO CATCH POINT (FILL) PLUS HORIZONTAL DISTANCE FROM CENTERLINE TO CMP INVERT

35.85
+14.00
49.85

NOTE: a, b, c, d POINT MAY VARY FROM DESIGN WHEN MEASURED ON GROUND. USE GROUND MEASUREMENTS.

GENERAL NOTES:

1. CMP TO BE SKEWED FOR BEST FIT LIVE WATER STREAMS.
2. CMP TO BE STAKED PER STAKE BOOK FOR INTERMITTENT CROSS DRAINS.
3. CMP TO BE STAKED AT A GRADE ≥ GRADE OF DITCH.

ALL CMP'S TO BE MANUALLY STAKED, CALCULATED AND RECORDED. SHOW WORK ON BACK SIDE OF STAKE BOOK PAGE.

EXHIBIT D
EXPLANATION FOR CMP STAKING

EXAMPLE:

length $= \sqrt{A^2 + B^2}$

CMP LENGTH $= \sqrt{(11.5)^2 + (49.85)^2}$

$= \sqrt{132.25 + 2485.02}$

$= \sqrt{2617.27}$

CMP LENGTH = 51.16 USE 54 FT. CMP FOR CMP WITH 0° SKEW

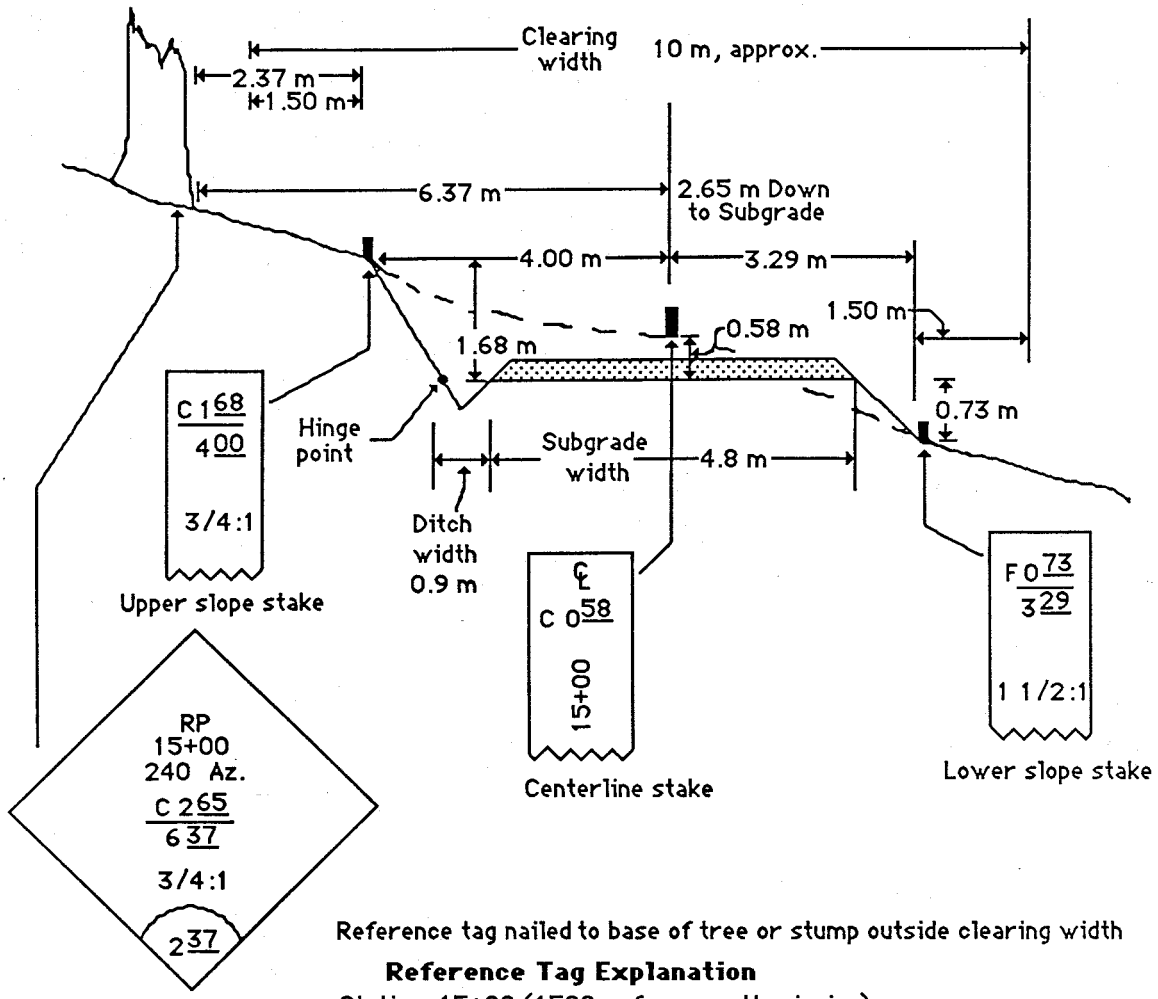
FOR CMP WITH SKEW DIVIDE LENGTH BY COS (SKEW °)

E.I. FOR SKEW = 20°

51.16 ÷ Cos 20° = 52.96

USE 56 FT. CMP

NOTE: ALLOW FOR A MINIMUM OF 2 FOOT BEYOND FILL, USING NEXT EVEN 2 FOOT LENGTH.



Reference tag nailed to base of tree or stump outside clearing width

Reference Tag Explanation

Station=15+00 (1500 m from road beginning)

= Planned centerline is 2.65 m below this point

=Centerline is 6.37 m horizontal distance away

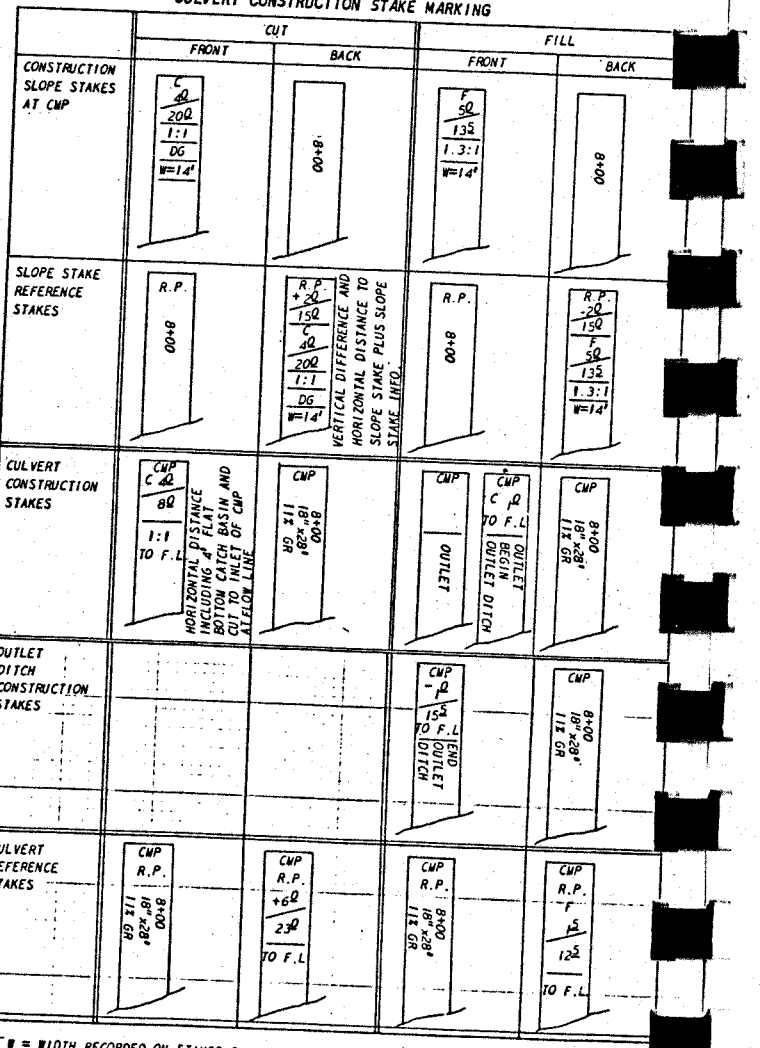
3/4:1=Cutslope steepness

=2.37 m to point where cutslope begins

240 Az.=Compass direction from RP to centerline stake

EXHIBIT E

CULVERT CONSTRUCTION STAKE MARKING



1. "W" = WIDTH RECORDED ON STAKES SHALL BE TOTAL SUBGRADE WIDTH, LESS DITCH.
2. F.L. = FLOW LINE OF CULVERT AT END OF CMP.
3. ALL CUT STAKES SHALL BE REFERENCED TO DITCH GRADE. IF NO DITCH EXISTS REFERENCE SHALL BE TO SHOULDER GRADE. ALL FILL STAKES SHALL BE REFERENCED TO SHOULDER GRADE.

*USE ONLY WHEN OUTLET DITCH IS REQUIRED. OUTLET DITCH SHALL HAVE A MINIMUM OF 1' FALL FROM PIPE AND A 2% MINIMUM GRADE.

RECONSTRUCTION

1. Locators will review the reconstruction work on-the-ground and will meet with the District to establish the work needed to be done and the standards it will be done to. This work shall comply with long-term transportation plans. If conflicts arise, the Preconstruction Engineer will work with the Districts to resolve those conflicts.

2. The Locators will write-up the results of their review and meeting and send to the Preconstruction Engineer. He will then distribute a copy of the Locator's notes to the Engineer in charge of reconstruction and a copy to the Design-Team-Leader. The project will be reviewed at this time for areas which need to be surveyed.

3. The Engineer in charge of reconstruction will determine turnout locations, CMP locations, etc., then will supervise the survey of the job according to the standards in item 4 below. If there are any special surveys that the locators or designers have called out, they will be done at this time.

4. As a minimum, the reconstruction surveys will have the following:

a. All pipes to be installed or lengthened will be staked or have a cross-section run to establish the length and structural excavation.

b. In areas where excavation or embankment is needed for turnouts, realignment, etc, a RSDS survey will be run with traverse, profiles, and cross-sections or the area will be directly staked. On small areas a time and equipment estimate may be made. Care must be made to have enough information so a package can be assembled in the winter.

d. The remainder of the reconstruction road will have a road log survey. If the road width is narrower than 11 feet, or more than 1 foot narrower than final design width, a full cross-section will be taken at that section, and on either side where the width is acceptable.

5. Notekeeping will be the same as with Class III surveys. However, at the beginning of each road, sketch the template used in staking. Show all typicals used (regular ditch typical, special ditch typical, 18" CMP catch basin, etc).

6. All reconstruction CMP's will be staked with both sides on the skew or to best fit ground. All typical 18-inch CMP catch basin will be 2.5 feet deep at a 2:1 slope from the shoulder with a 4 foot flat bottom. Regular ditches are 1 foot deep at a 3:1. Back slopes will be 1:1 and fill slopes 1.3:1, unless otherwise stated. (See last page for addition typicals).

7. Typical road widths are 14 feet for roads without a ditch and 12 feet for roads with a ditch; slough widening and curve widening are additional.

8. When staking turnouts on reconstruction, use 2/3 of the additional distance for the cut and 1/3 for the fill.

9. Clearing ribbons must be hung over the entire reconstruction job before it is completed. Be sure to hang clearing ribbon when staking at stations.

10. The party chief will inform the crew of areas where a class four is required. Under a class four, the crew will take grades, azmuths, and cross-sections. Cross-section shots should be at the locations shown on the drawing or as indicated by Engineer. (See Class IV Survey)

C.M.P. STAKING (RECONSTRUCTION)

1) Be sure a sketch of the template and typical used is included in this projects field books.

2) Determine width of existing road. From outside shoulder, set the centerline and inside edge of road according to template, being sure to blend road with sections either side of pipe. Set inlet dummy stake.

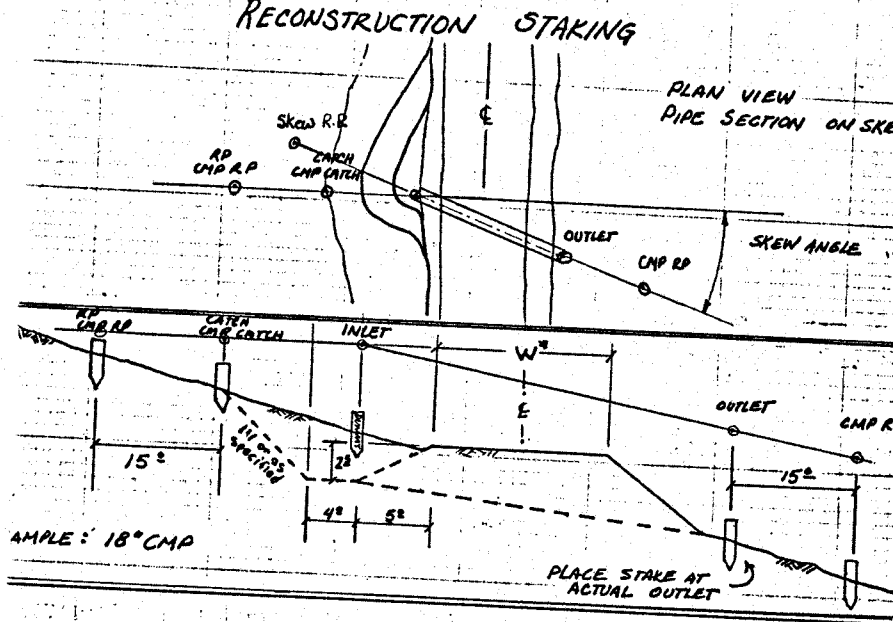
3) Determine ditch grade coming into pipe; set the minimum pipe grade needed: pipe grade = ditch grade + 2% or more.

4) Locate outlet, at the toe of fill unless otherwise specified. Calculate pipe grade. If grade is less than minimum grade from #3 above, either change the skew angle or use a ditchout. Determine cmp length; extend culvert 2 feet beyond toe of fill.

5) Stake outlet and set R.P. If ditchout used, it should be at same grade as CMP. Hang clear flagging.

6) Set R.P. on the uphill side, at or beyond the clearing limit, on the skew of the pipe and in line with the downhill stakes.

6) Stake uphill catch points and reference points on the centerline bisector (not on skew). Hang clear flagging as indicated.



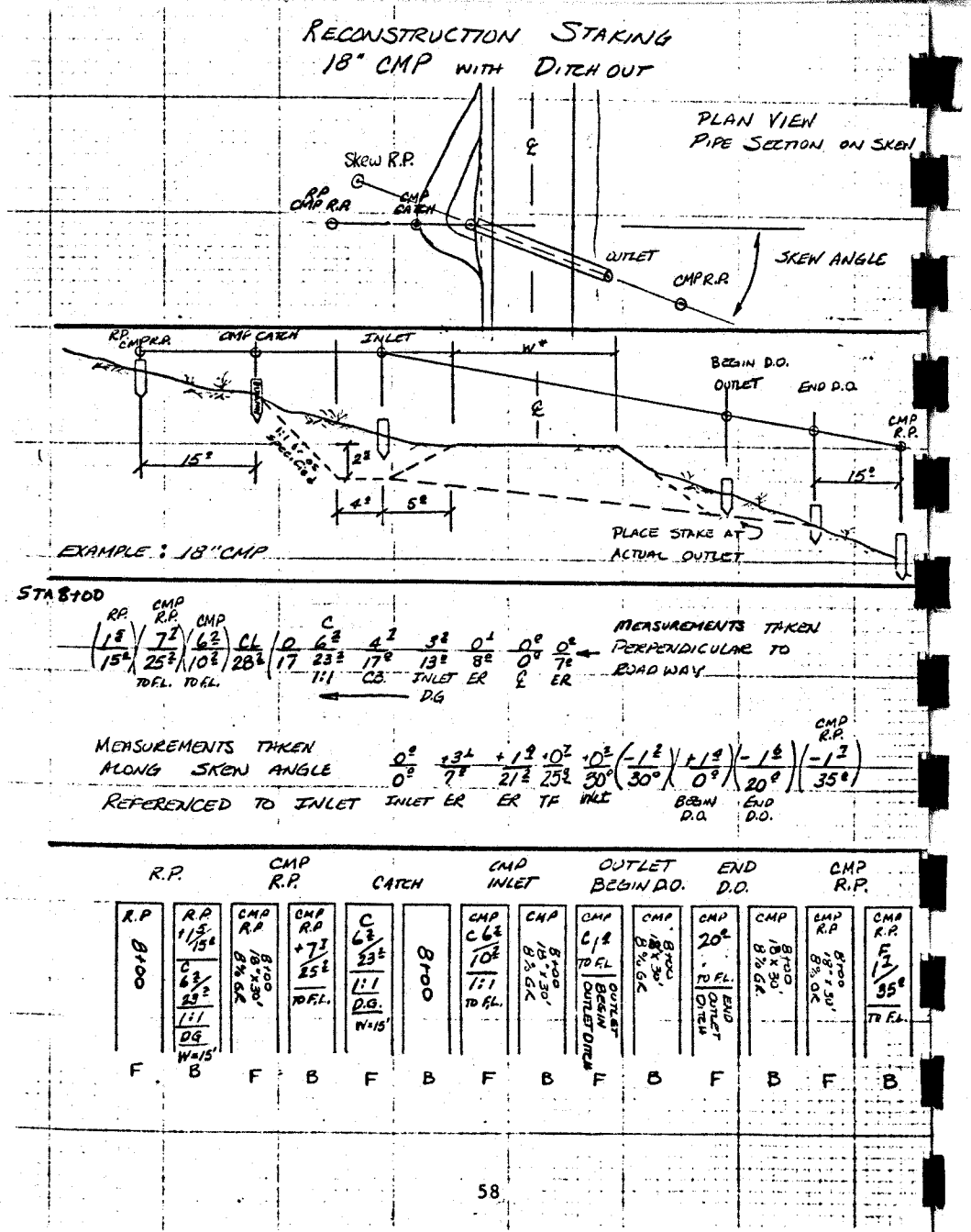
RD 15 / 15° (TO R.L.) — CMP RP 7 / 25 (TO R.L.) — CMP 6 / 10 (TO R.L.) — CL 28' — 0 / 17 — C 6 / 23 1:1 — +4 / 17 CB — +3 / 13 INLET — 0 / 8 ER — 0 / 0 ℄ — -0 / 7 DG

← MEASUREMENTS TAKEN ALONG THE PERPENDICULAR TO THE ROADWAY.

MEASUREMENTS TAKEN ALONG THE SKEW ANGLE REFERENCED TO INLET →

+0 / 0 INLET — +3 / 7 ER — +2 / 20 ER — -2 / 27 TF — -2 / 30 OUTLET — CMP RP -1 / 15

R.P.		CMP R.P.		CATCH		CMP CATCH		OUTLET		CMP RP	
R.P 8+00	RP -1 / 15 C 6 / 23 1:1 DG W=15	CMP RP 8+00 18"x 30' 8% GR	CMP RP 17 / 25 TO R.L.	C 6 / 23 1:1 DG W=15	8+00	CMP C 6 / 10 1:1 TO R.L.	CMP 8+00 18"x 30' 8% GR	CMP OUTLET	CMP 8+00 18"x 30' 8% GR DITCHOUT	CMP RP 8+00 18"x 30' 8% GRADE	CMP RP F 1 / 15 TO R.L.
FRONT	BACK	FRONT	BACK	FRONT	BACK	FRONT	BACK	FRONT	BACK	FRONT	BACK



ROAD LOGS

1. Begin stationing 0+00 at intersection of centerlines of both roads. Keep stakes intervisible with maximum spacing of 100 feet (less in curves). Offset stakes to cut bank. Show offset distance on stakes so centerline can be reset. Watch your offset angles.

2. The stationing should be placed to pick up all breaks in road width, breaks in grade, low points, existing pipe and open tops, flagged points, intersections with spurs, large rocks in subgrade and shoulders, springs, slumps, mileposts and anything else that could be of use. Beginning and end of the full width of turnouts also needs to be stationed. Turnouts are 10 ft. of width in addition to normal road width plus curve widening. Beginning of taper is not beginning of turnout.

3. Measurements will be to the nearest 0.5 feet minimum, unless otherwise stated. All measurements are horizontal.

4. Notekeeping will be done with the same workmanship and thoroughness as any other survey. Road log books will give date, weather, crew, title, and other pertinent data. In addition, at the beginning of each road's book, include the template given to the crew prior to survey.

5. In the remarks column, record beginning common station, existing pipes (with length and size), clearing information, gates, boundaries, large rocks protruding in roadway, stumps in cutbank, rock in cutbank, as well as a description for stations picked up in #2 above.

6. Include all necessary sketches. Use as many drawings as needed to better explain facts. This should include beginning and end of project, as well as each significant intersection, stream crossing, slump, etc. Use compasses and show deflection angle of streams, washouts, etc. (Angles are always stated as left or right of ahead tangent.)

7. See Figure 7, Sample Road Logs.

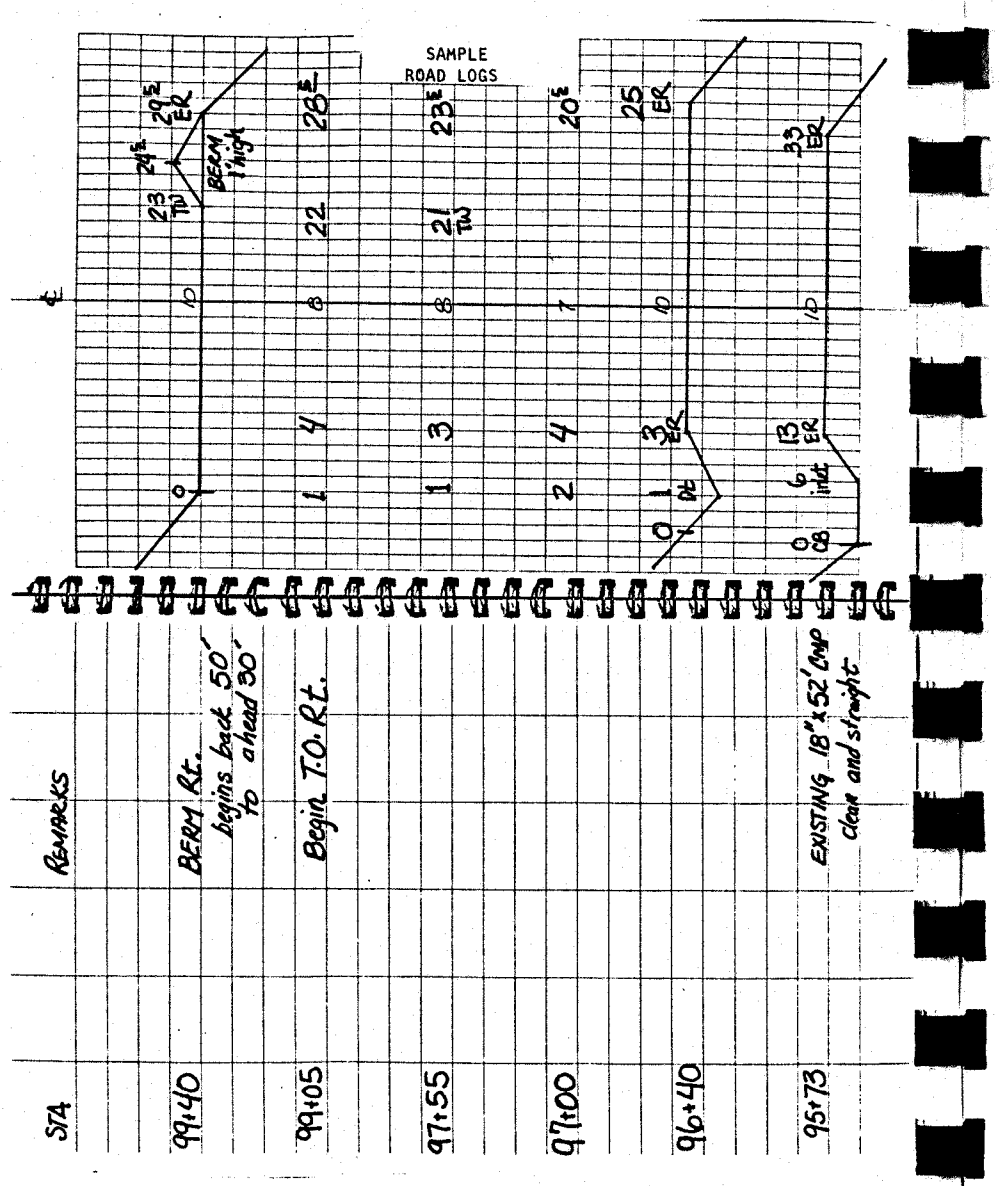


FIGURE 7

HYDRAULIC SURVEY

A stream channel survey shall be made at all structures and at CMP's 48-inch diameter and larger. The survey shall consist of a baseline, which extends a minimum of 150 feet up and 100 feet down the gradient of the stream, or as specified by the Engineer, up and downstream from the centerline of the road, and shall include cross-sections of the stream channel. The baseline shall be approximately parallel to the centerline of the stream.

Stationing shall start at the furtherest point upstream and station downstream. Azimuths and elevations are to be taken at each station. Stationing should not be spaced farther than 25 feet. Place stations where the stream changes directions, at rapids, log jams and at all obstructions.

Cross-sections of the stream channel shall be taken from the baseline perpendicular to the stream at not more than 25-foot intervals and at all obvious stream gradient changes. They shall extend at least 50 feet on each side of the stream beyond extreme high water to include flood plains and overflow channels. See Plate I for more details. High water marks, current water marks, and velocity of the stream shall be determined and recorded in the fieldbook. Cross-sections shall be taken by using horizontal and vertical distances.

When the roadway centerline is more than 10° askew to the stream, an additional cross-section perpendicular to the stream shall be taken at the roadway centerline.

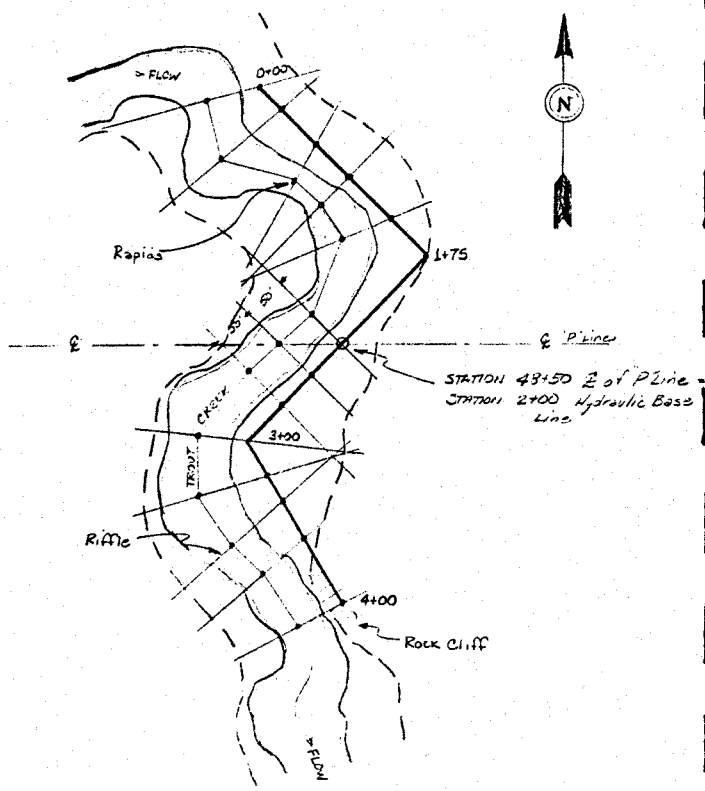
Reference as many of the roadway centerline stakes as possible to the hydraulic survey into the roadway survey.

Make a sketch showing roadway centerline, stream, and stationing. Photo should be taken if at all possible.

Describe stream channel and record in fieldbook. State of the channel is clean, grassy, mossy, scattered, straight or meandering. Is the bottom sandy, muddy, gravelly, or rocky?

Remember all the information is needed for the site map of the area.

SITE SURVEY



Notes:

1) Take cross-sections normal to stream channel.
2) Tie hydraulics survey into road survey (both horizontal and vertical).
3) Indicate visible high water mark on cross-section.
4) Take additional shots (top of water) as required for water profile.
5) Baseline extends 150 feet up and 100 feet down stream.
6) The profile shall extend at least 200 feet on each side of the ℄ of stream.
7) Draw a sketch - show baseline, creek and cross sect. locations as well as road ℄ .

SLOPE FAILURE SURVEYS

See the attached sketch site feature identification.

Following is a description of how slope failure surveys should be conducted:

I. Locate baseline at the center of the failure, along "L" (see drawing) in the direction of failure. Start baseline approximately 50 feet above the crown and extend approximately 50 feet beyond tip of toe.

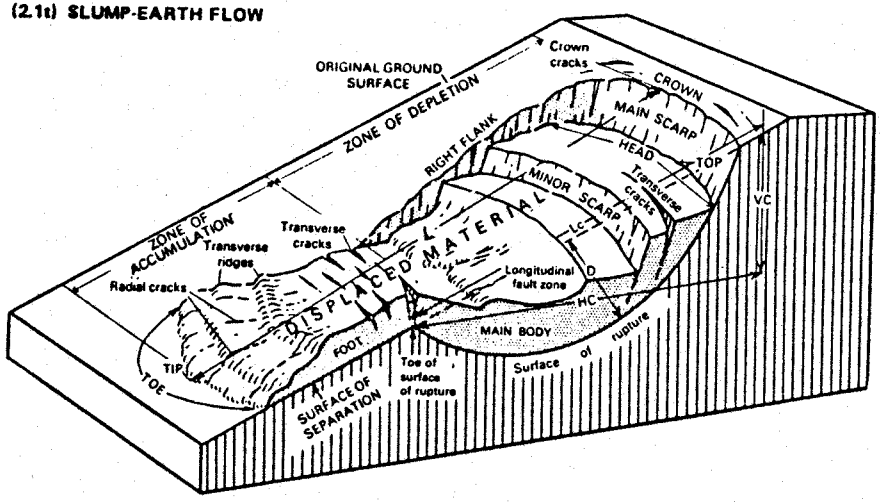
For failures along existing roads, complete road template should be included in baseline to a minimum of 50 feet above top of cut, for fill failures and a minimum of 50 feet below toe of fill for cut slope failures.

II. The following features should be identified and located in baseline/cross-section surveys:

A. Right and Left Flank
B. Crown
C. Main and minor scarps.
D. Any transverse, crown or flank cracks.
E. Transverse ridges.
F. Any zones of seepage and/or wet areas.

III. Cross-sections from baseline, in I above, should extend a minimum of 50 feet beyond the right and left flanks.

(2.1t) SLUMP-EARTH FLOW



NOMENCLATURE

MAIN SCARP—A steep surface on the undisturbed ground around the periphery of the slide, caused by the movement of slide material away from undisturbed ground. The projection of the scarp surface under the displaced material becomes the surface of rupture.

MINOR SCARP—A steep surface on the displaced material produced by differential movements within the sliding mass.

HEAD—The upper parts of the slide material along the contact between the displaced material and the main scarp.

TOP—The highest point of contact between the displaced material and the main scarp.

TOE OF SURFACE OF RUPTURE—The intersection (sometimes buried) between the lower part of the surface of rupture and the original ground surface.

TOE—The margin of displaced material most distant from the main scarp.

TIP—The point on the toe most distant from the top of the slide.

FOOT—That portion of the displaced material that lies downslope from the toe of the surface of rupture.

MAIN BODY—That part of the displaced material that overlies the surface of rupture between the main scarp and toe of the surface of rupture.

FLANK—The side of the landslide.

CROWN—The material that is still in place, practically undisplaced and adjacent to the highest parts of the main scarp.

ORIGINAL GROUND SURFACE—The slope that existed before the movement which is being considered took place. If this is the surface of an older landslide, that fact should be stated.

LEFT AND RIGHT—Compass directions are preferable in describing a slide, but if right and left are used they refer to the slide as viewed from the crown.

SURFACE OF SEPARATION—The surface separating displaced material from stable material but not known to have been a surface on which failure occurred.

DISPLACED MATERIAL—The material that has moved away from its original position on the slope. It may be in a deformed or undeformed state

ZONE OF DEPLETION—The area within which the displaced material lies below the original ground surface.

ZONE OF ACCUMULATION—The area within which the displaced material lies above the original ground surface.

AGGREGATE SOURCE SURVEYS

Purpose

An aggregate source survey is performed to retrieve data to make an accurate map for aggregate removal and minimize impacts on other Forest resources.

Survey Type

Cloth tape, clinometer and compass survey should provide, in most cases, sufficient accuracy for geotechnical needs.

Required Information

All natural and man-made features should be picked up and noted. The main items that should be picked up and noted are as follows:

Natural Features

1. Creeks and streams adjacent to the source.
2. All slope breaks.
3. Tops and bottoms of any rockout crops.

Man-Made Features

1. Top and bottom of cut and fill slopes.
2. Ditch lines.
3. Any roads - permanent or temporary - both shoulders.
4. Any drainage structures - inlet and outlet + size.
5. Drill holes - will be identified on the ground.
6. Geophysical surveys - note and locate both ends of any seismic and/or resistivity survey - will be identified on the ground.

In addition to the above (a) the baseline should have a traverse, with bearings and lengths between stations, and profile run on it, (b) a permanent TBM should be set far enough away from the site to eliminate any possibility of disturbance during source operations. A baseline will be located at the site, prior to arrival of the survey crew, by the Geotechnical Section.

R.P.'s

R.P.'s will be established for each baseline end point and be set well away from the proposed construction area. Many times the baseline has to be re-established after construction for remeasure or to expend the Pit. If most of the R.P.'s are gone, this may be impossible.

The Survey Crew will receive the following prior to going to the site:

1. A site sketch (see attached example) showing:
   a) approximate location and length of the baseline,
   b) approximate location of important features such as drill holes and geophysical surveys,
   c) length of cross-sections both sides of the baseline,

d) preferred maximum distance between stations.

2. A location map showing the aggregate source location, identification number, and source name.

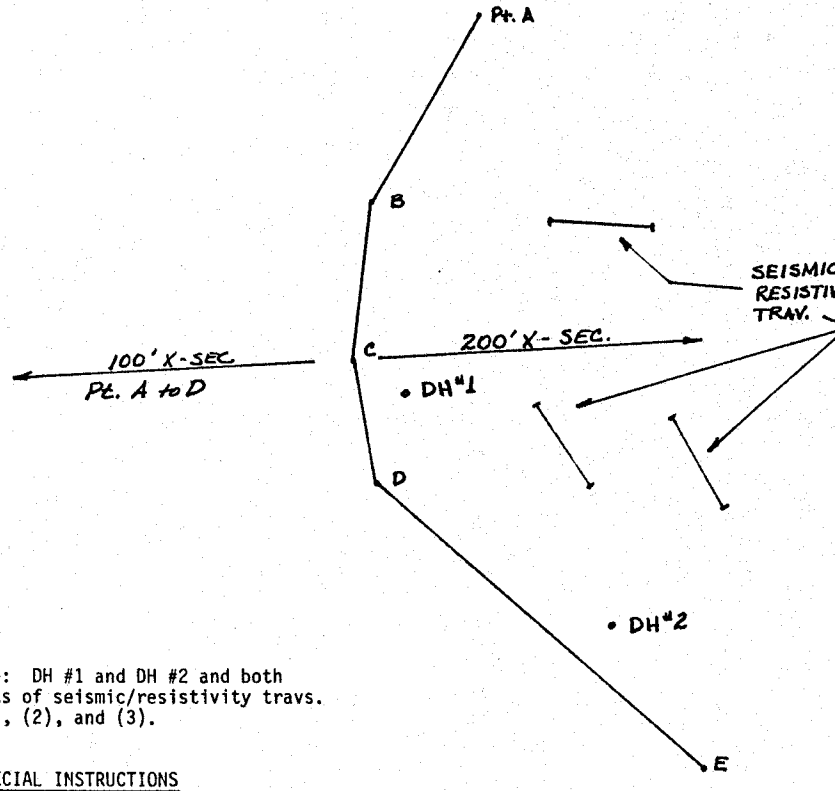
3. Any other information necessary for the survey.

The Survey Crew should provide a survey book properly identified with the source name and number and containing:

1. Baseline tranverse and profile.
2. Cross-sections.
3. An approximate scale site sketch.
4. Explanation of any and all symbols.
5. Ties and location of TBM set for the survey.

NO NAME QUARRY - 32 - 8 - 33.3

Baseline points identified by red and white striped and yellow flagging.



Tie: DH #1 and DH #2 and both ends of seismic/resistivity travs. (1), (2), and (3).

SPECIAL INSTRUCTIONS

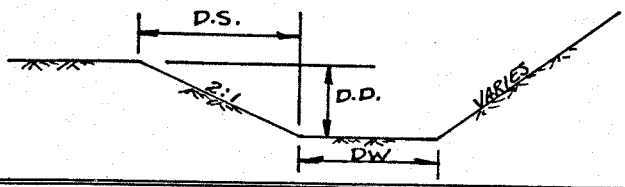
Pt. A to Pt. D	X-SEC	200' Uphill
		100' Downhill
Pt. D to Pt. E	X-SEC	200' Uphill
		50' Downhill

Drill holes and geophysical surveys identified by red and white flagging.

FLAGGING COLORS

Location	orange glo	final spec. road location
	orange	specified road location
	red	temporary road location
	white	information
Survey	red/white stripe	culvert sections
	yellow	clearing
	chartreuse glo	information
	white	information
Geotechnical	red/white stripe plus yellow	traverse point or drill hole

	DS	DD	DW
STANDARD DITCH	3.0	-1.0	0.0
4' FLAT BOTTOM SP.DT.	4.0	-2.0	4.0
18" CMP CATCH BASIN	5.0	-2.5	4.0
24" CMP CATCH BASIN	6.0	-3.0	4.0
36" CMP CATCH BASIN 48" CMP CATCH BASIN	No catch basins on livewater pipes. Need one ft. min. cover on cmp's. See Engineer if catch basin is called for.		
DROPPED INLET	3.0	-1.0	2.0



SPECIAL INLET STRUCTURE