ENGINEERING TECHNICAL INFORMATION SYSTEM

FIELD NOTES ● TECHNICAL REPORTS ● TEXTS

DATA RETRIEVAL ● CURRENT AWARENESS

# Field Notes

Volume 5 Number 9 September 1973

Tractor Mounted Implement Hitch (Crawler and Wheel Skidder)

Implement-Carrying Hitch for a 4-wheel Skidder

Computer Plot Culvert Design

Washington Office Division of Engineering News

FOREST SERVICE ● U.S. DEPARTMENT OF AGRICULTURE

# ENGINEERING FIELD NOTES

This publication is a monthly newsletter published to exchange engineering information and ideas of a technical or administrative nature among Forest Service personnel. The text in this publication represents the personal opinions of the respective author and must not be construed as recommended or approved procedures, mandatory instructions, or policy, except by FSM references.

This publication is not intended to be exclusively for engineers. However, because of the type of material in the publication, all engineers and engineering technicians should read each issue.

This publication is distributed from the Washington Office directly to all Regional, Station, and Area Headquarters. If you are not now receiving a copy and would like one, ask your Office Manager or the Regional Information Coordinator to increase the number of copies sent to your office. Use Form 7100-60 for this purpose. Copies of back issues are also available from the Washington Office and can be ordered on Form 7100-60.

Material submitted to the Washington Office for publication should be reviewed by the respective Regional Office to see that the information is current, timely, technically accurate, informative, and of interest to engineers Service-wide (FSM 7113). The length of material submitted may vary from several sentences to several typewritten pages. However, short articles or news items are preferred. The Washington Office will edit for grammar only. All material submitted to the Washington Office should be typed double-spaced, and all illustrations should be original drawings or glossy black and white photos.

Each Region has an Information Coordinator to whom field personnel should submit both questions and material for publication. The Coordinators are:

| | | | |
|---|---|---|---|
| R-1 | Bob Hinshaw | R-6 | Kjell Bakke |
| R-2 | Allen Groven | R-8 | Ernest Quinn |
| R-3 | Dan Roper | R-9 | Ron Pokrandt |
| R-4 | Fleet Stanton | R-10 | Gerald Coghlan |
| R-5 | Jim McCoy | WO | Al Colley |

Coordinators should direct questions concerning format, editing, publishing dates, etc., to Fran Owsley, Editor, Division of Engineering, Forest Service, USDA, Washington, D. C. 20250.

# TRACTOR MOUNTED IMPLEMENT HITCH (CRAWLER AND WHEEL SKIDDER)

By Jerry L. Edwards
Mechanical Engineer, Region 8

## *INTRODUCTION*

Implement hitches of various kinds have been used in attaching planting equipment and fire plows to prime movers for many years. However, many of these hitches are spinoffs of agricultural equipment and were not designed specifically for forestry use. Recently, a model of a vertical lift hitch, developed by the San Dimas Equipment Development Center, was used on the National Forests in Alabama. Its performance was not totally satisfactory because of mechanical and hydraulic malfunctions. Following this unsuccessful attempt to use an already designed piece of equipment to meet our needs, the San Dimas Equipment Development Center was assigned an ED&T project. Subsequently this project resulted in a contract with the Pettibone Michigan Corporation to develop an implement hitch for a 4-wheel skidder (fig. 1). At the same time, Region 8 issued a development contract to Southern Iron and Equipment Company (SIECO) to provide an implement hitch for a crawler tractor (fig. 2).

## *CRITERIA FOR EVALUATION*

The development of the two hitches cited above was completed and evaluated during the summer and fall of 1971. The criteria used in the evaluation of both of these hitches were basically the same. The criteria are listed below:

- **Useful Life** – Twelve years.
- **Mountability** – Connection time required to change from tree planter to fire plow not to exceed 5 minutes; and connection time required to change from fire plow to tree planter not to exceed 15 minutes. Mounting and connection must meet the following requirements:
  - Mounting: to be interfaced with machines of like size.
  - Connection: hitch to mate with each implement with no more than three connection pins and four hydraulic hoses.
- **Motion** – Individual actions are to be hydraulically controlled *(lift, lateral and tilt).*

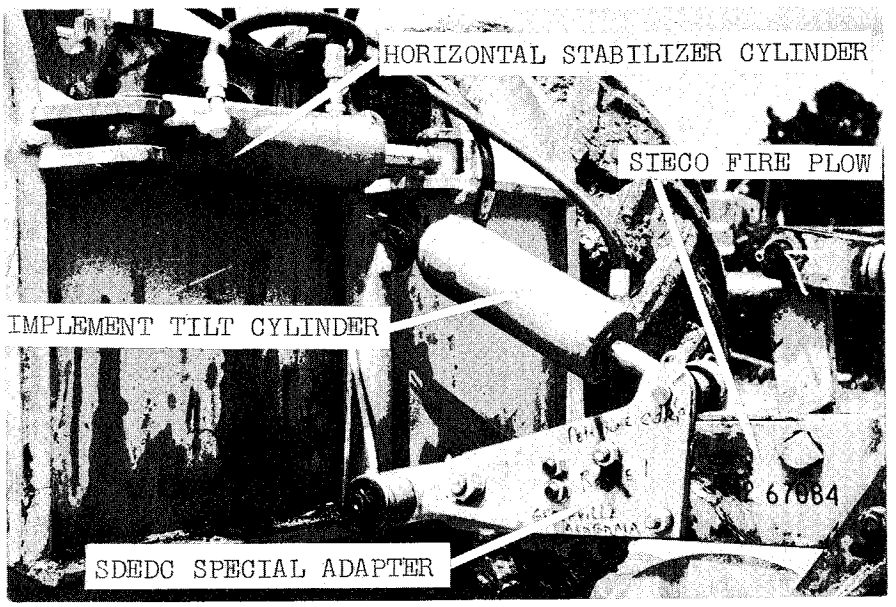



*Figure 1. – Skidder Implement Hitch with Fire Plow*

  - Lift: Minimum *height* to be equal to prime mover ground clearance; minimum *depth of penetration* to be 12 inches below ground level.
  - Lateral (swing): A minumum of 45 degrees to each side of center.
  - Tilt: From a horizontal position minimum upward tilt to be 30 degrees and minimum downward tilt to be 15 degrees.
- **Angle of Departure** – 20 degrees minimum.
- **Down Pressure** – 3000 pounds minimum (hydraulically applied).

## *PRIME MOVERS EMPLOYED*

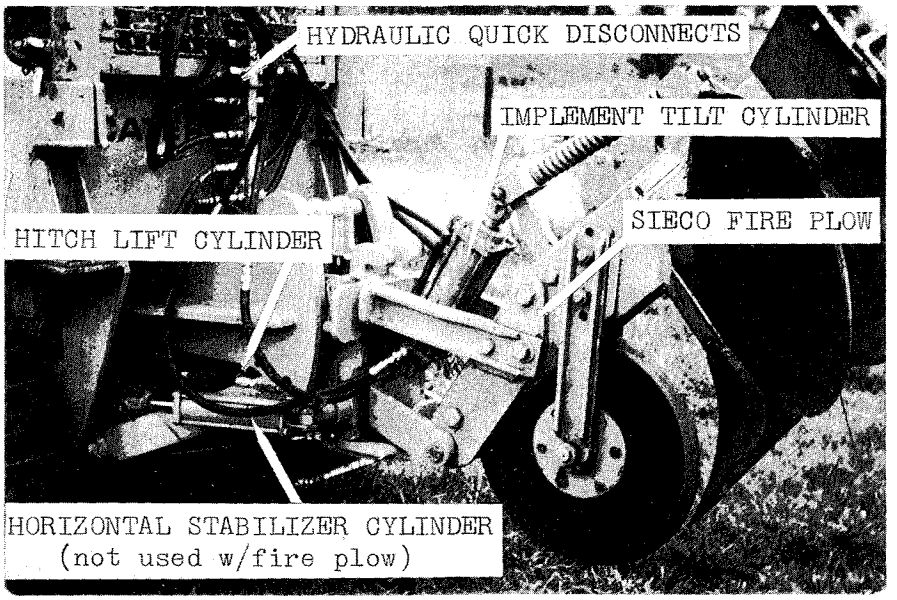
The skidder and crawler tractor used in the development of these implement hitches are identified as:

- Model 501, 4-Wheel Drive Skidder, 1969 Forester Pettibone
- Model D4 Crawler Tractor, 1970 Caterpillar

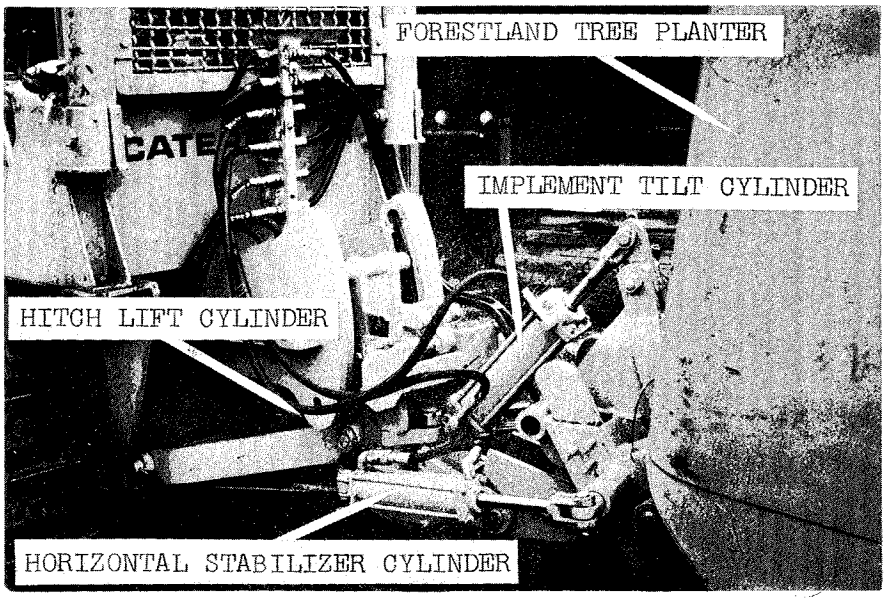
## *EVALUATION AND RESULTS*

The evaluation of each hitch was conducted in three stages as follows:

- Initial specification compliance and factory field test.
- Field evaluation at a selected site and under controlled conditions.
- Reliability testing under normal day to day actual work conditions.




*A. Implement Hitch with Fire Plow*




*B. Implement Hitch with Tree Planter*

*Figure 2. – Crawler Tractor Implement Hitch*

Both hitches have completed Stages One and Two and have gone one complete planting and fire season into Stage Three. The hitches operated per the design criteria and are considered as a useful and functioning tool by field users.

The application of a skidder as a prime mover for a fire plow is being questioned by the Resource Managers. The hitch is not considered as a factor, rather the prime mover itself. Evaluation will continue into the feasibility of the skidder for the fire application.

The costs of additional hitches are as follows:

- Skidder Type – approximately $4000 (cost is considered extremely high; however, not totally prohibitive).
- Crawler Tractor Type – approximately $2500 (considered reasonable).

*Editor's Note: The article that follows is a memo written for the record by Dan W. McKenzie and supplements the above article.*

# IMPLEMENT-CARRYING HITCH FOR FOUR-WHEEL SKIDDER

By Dan W. McKenzie
Equipment Development Center, San Dimas, California

**TO:** The Record 9/25/72

On February 10, 1972, I was in Region 8 with Jim Moore, Jerry Edwards and Jim Fuller. We viewed the 4-wheel skidder implement-carrying hitch at Centerville, Alabama. The 4-wheel skidder, a Forester Pettibone 501, equipped with the implement-carrying hitch was pulling a forestland tree planter. The unit was working very well. The unit was not being operated with down pressure as it was not needed. However, the operator reported the ability of the hitch to apply down-pressure was very helpful in freeing the unit when it was stuck on several occasions. The bottom hydraulic line of the implement tilt cylinder was broken but they were able to operate without it by extending the cylinder to the fully extended position. This hydraulic line will be repaired after the planting season.

The following comparison was compiled from information received from the Oakmulgee Ranger District after completion of the planting with the Pettibone 501 skidder equipped with implement-carrying hitch pulling the Whitfield forestland tree planter. A vertical lift hitch modified to mount on the skidder was used in FY 1971. The implement-carrying hitch was used in FY 1972.

| | FY 71 Vertical Lift Hitch | FY 72 Implement-Carrying Hitch | Percent Change |
|---|---|---|---|
| Number Seedlings Planted | 241,500 | 276,000 | +13 % |
| Number Acres | 404 | 468 | +16 % |
| Average Trees Per Acre | 598 | 589 | – |
| Number Working Days | 50 | 38 | -24 % |
| Average Daily Production | 4,830 | 7,290 | +51 % |
| Maximum Daily Production | 8,000 | 11,500 | +44 % |
| Cost Per Acre | $25.54 | $19.50 | -23 % |

The areas that were planted in both 1971 and 1972 were of similar terrain and of similar site preparation treatment, KG blade and root rake. The same three-man crew operated the planting machine during both seasons. As can be seen from the tabulated data above, costs were reduced by 23 percent and the average daily production rate was increased by 51 percent. This means the work that was done in 3 days using the verticle-life hitch was done in 2 days by using the implement-carrying hitch. This increased production rate can be attributed to: (1) the increased tractor speed made possible by the hitch because of the contour-following characteristics and, (2) the elimination of downtime due to the hitch and implement breakage. The increased travel speed is a result of the contour-following feature of the hitch resulting in being able to operate at higher speeds and negotiate areas without lifting the planter. The reduced downtime due to reduced breakage can be attributed to the hitch design that allows the implement to move when unusual loads are applied to the implement which would result in high bending stresses rather than tension loads. One problem reported with the unit was the planter operator had difficulty keeping the tractor operator from going too fast.

● ● ● ● ● ● ● ● ●

## COMPUTER PLOT CULVERT DESIGN

By Allan A. Johnson, Civil Engineer
Rogue River National Forest

The plots now available from the Region 6 computer road design system provide a fast and accurate method to design culvert lengths. The two plots used are Catch Point and Profile Grade Plot (CAP), and Road Width and Catch Point Plot (ROP). The general use of these plots is described in the Engineering Computer Application Handbook, FSH 7109.16 Chapter 100.

The CAP plot gives the vertical projections of design grade, L-line ground profile, and the left and right side top-of-cut and toe-of-fill lines (catch points). The ROP plot provides a plan view of the road, and plots the road centerline, the left and right edge of road, and the left and right catch points.

Using scaled distances from the computer plots the designer can determine graphically the culvert lengths. Skew and grade of the pipe will both be compensated for. The procedure to use is as follows:

- After the final design earthwork run, obtain the CAP and ROP plots from the computer.

- Line in the profile grade, and left and right catch points on the CAP plot. Line in shoulder, left and right road edges on the ROP plot. (See figs. 1 and 2.)

- Review of the two plots should reveal culvert locations necessary as a result of through fills, etc. After culvert locations are determined, we are now ready to calculate the lengths.

- Our review of the plots shows we need a culvert to drain the low spot at Station 60+54. The outlet will discharge at Station 60+17. (Refer to figs. 1 and 2.)

- Because the scale on the ROP plot (fig. 1) is 1 in. = 100 ft along stationing, and 1 in. = 10 ft for distances from centerline to catch points, we can't get plan view length of culvert by scaling directly. To get plan view length of this culvert we scale 49.9 ft from A to B parallel to 1 in.= 10 ft scale line and compute 37 ft from B to C by calculating the stationing difference. (60+54 – 60+17 = 37 ft) We now have right triangle dimensions and can lay out the triangle graphically to get the plan view length of the culvert.

- Lay out to scale AB (49.9 in.) and BC (37 ft) on Figure 3, draw in the hypotenuse AC for the triangle. AC is the plan view length of the culvert; scaling this distance we get 62.0 ft (1 in. = 10 ft is a convenient scale to use.) At this time we can obtain the skew angle to the culvert; measuring angle ACB we get 54 degrees as the culvert skew angle.

- We now have to correct the plan view length for the drop in the culvert. On steep grades this can increase the length considerably. Refer to the CAP plot to get the vertical drop. This distance is DE in Figure 2. In the CAP plot, the scale is 1 in. = 100 ft parallel to the stationing and 1 in. = 10 ft vertically. Measuring DE in the CAP plot parallel to the 1 in. = 10 ft scale line, we get 18.1 ft. We again have a right triangle formed by the plan view length of 62.0 ft and the vertical drop of 18.1 ft. Lay out to scale AC (62.0 ft) and DE (18.1 ft) on Figure 3 and draw in AE which is the true length of the culvert. Scaling AE we get the true length of the culvert of 64.5 ft. Rounding to the nearest even foot, we get 66 ft for the design culvert length.

- If desired for the plans, we can compute the grade of the culvert as follows:

$$\frac{18.1}{64.5} \times 100 = 28 \text{ percent}$$

This completes the design for this culvert.

Qualifying Notes:

- This solution assumes that excessively skewed L-line cross-sections, often resulting when using an offset design, have been corrected during the design stage.

- The ROP plot used does not show curvature, and instead shows a straight line alignment. In this example, if a 56 degree curve existed through stations 60+17 and 60+54, the actual plan view length would be 64.0 ft and true length 66.0 ft. This error is acceptable for design lengths however. (Staked lengths are usually used to order culverts from suppliers.)

*Editor's Note: The Road Design System (RDS) can be revised to automatically compute culvert lengths. Region 3 is presently designing a form to allow the designer to specify the station, skew, and size of any culvert. If you have any suggestions or comments, contact your regional engineering RDP coordinator. He will see that your ideas are considered by those who are revising the RDP.*

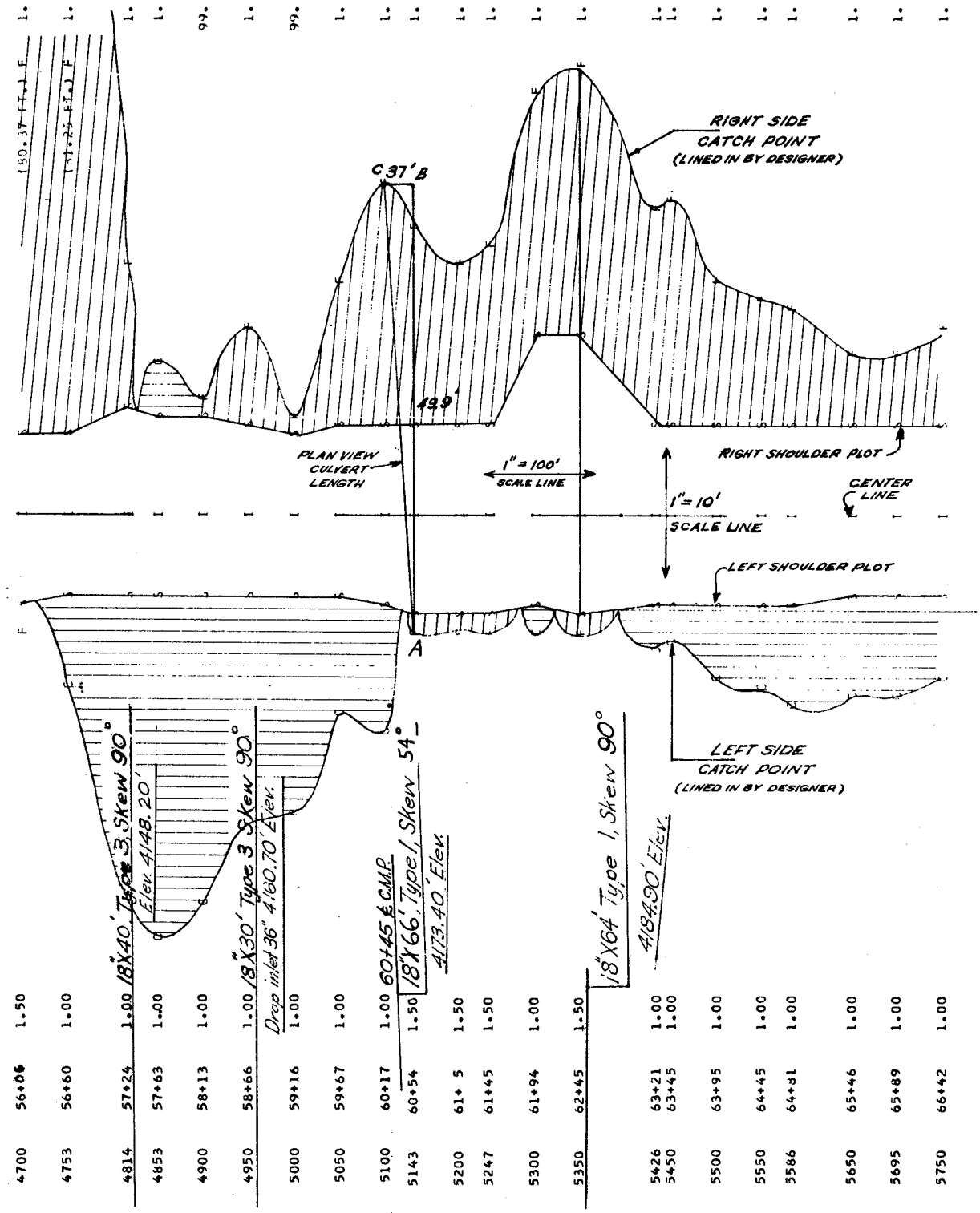



*Figure 1. – Computer Plot Culvert Design – Road Width and Catch Point Plot, (ROP)*

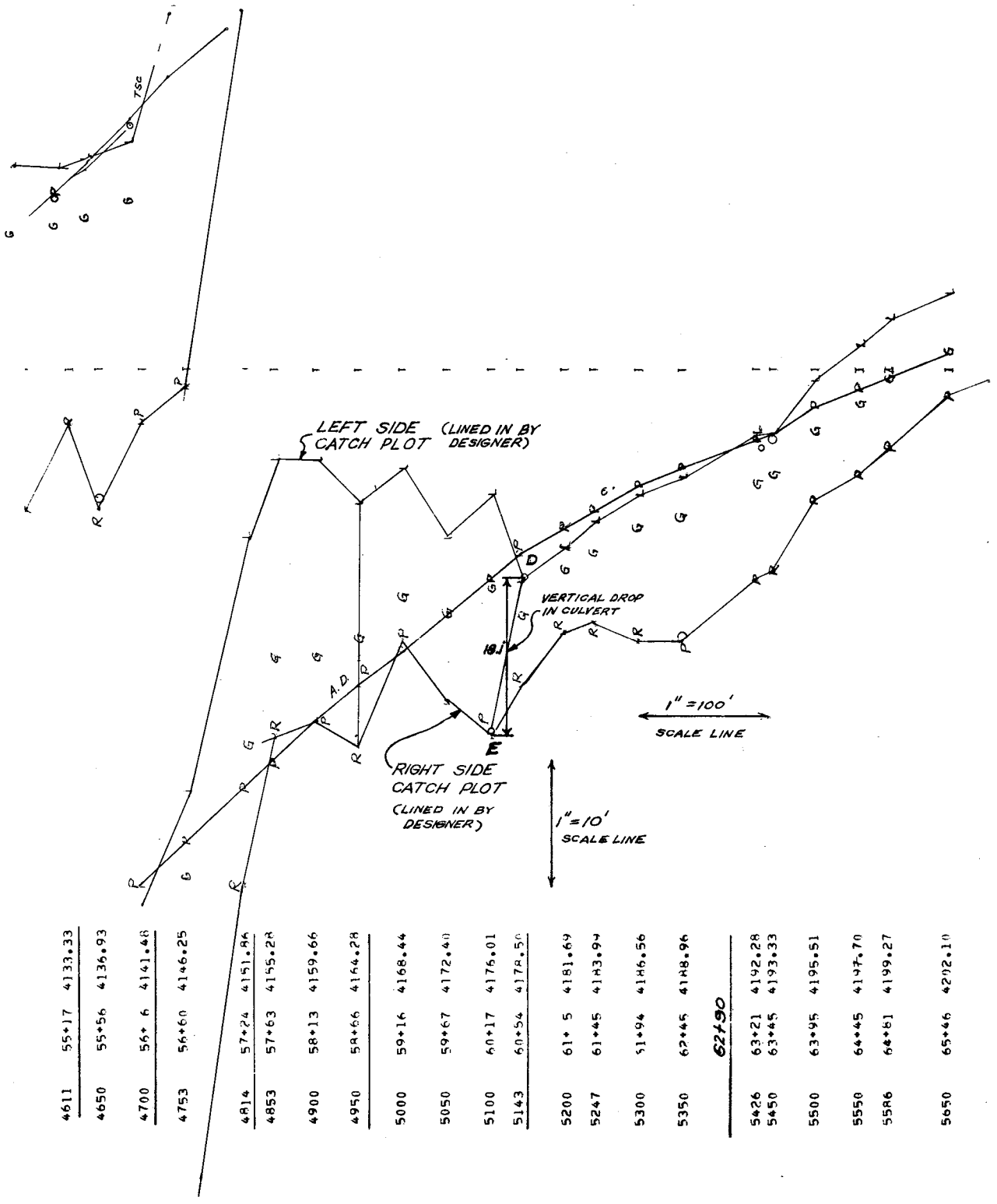



*Figure 2. — Computer Plot Culvert Design — Catch Point and Profile Grade Plot, (CAP)*

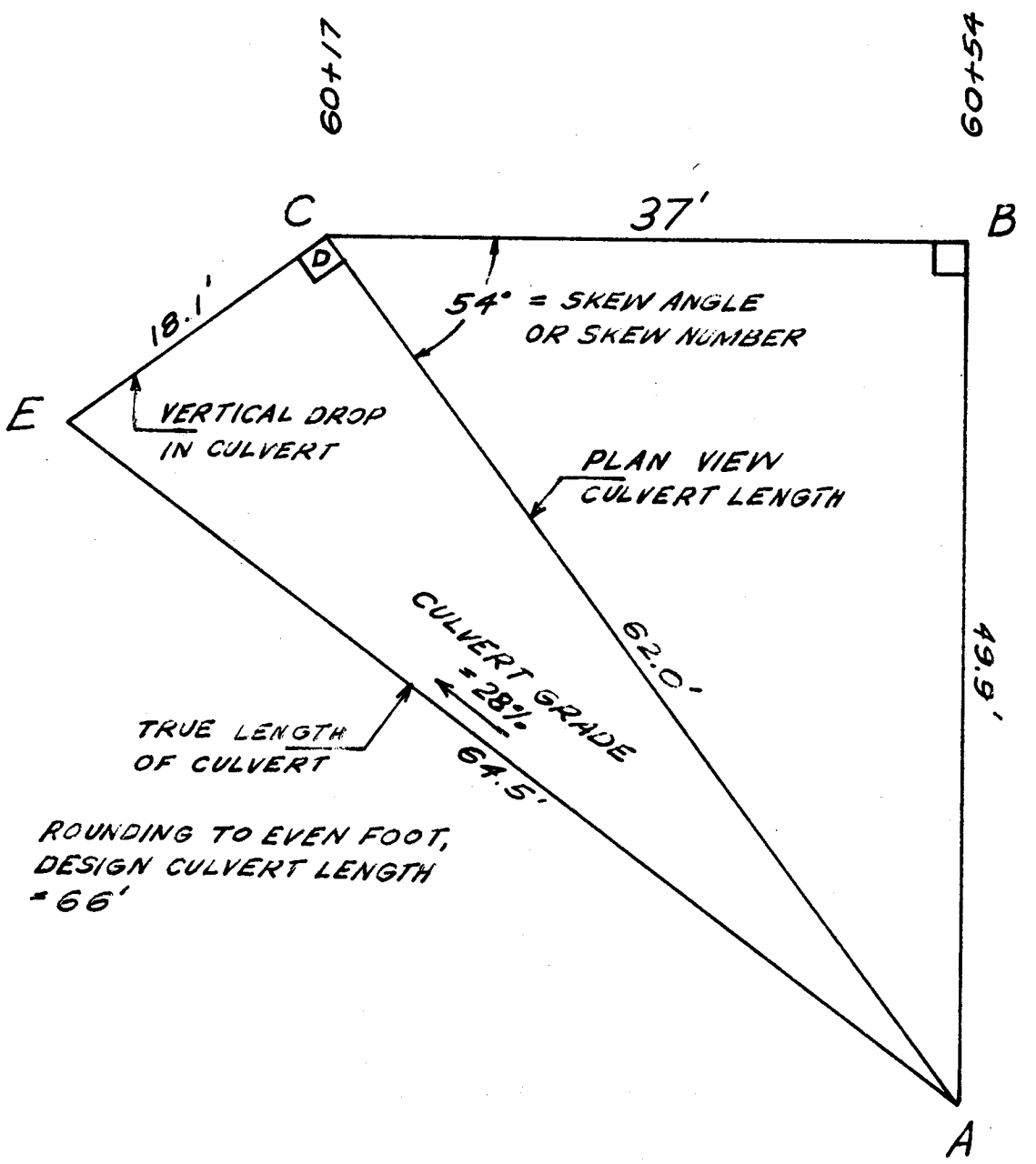



*Figure 3. — Scaled Layout Used in Determining Length of Culvert*

## *CONSULTATION AND STANDARDS*

Charles R. Weller
Assistant Director

***Environmental Protection Agency (EPA) Drinking Water Supply Survey.*** The Forest Service is now actively participating in a Service-wide condition survey of drinking water supplies offered to the public. The Washington Office of the EPA Water Supply Division will survey approximately 120 water systems located in Regions 2, 5, and 8. In the month of July, the survey was completed on three forests in Region 5.

EPA has previously completed similar surveys of facilities at the Corps of Engineers, Bureau of Reclamation, National Park Service, and Federal Highway Administration (Interstate highway roadside rest areas).

Through these surveys the EPA plans to broaden its base of knowledge of water systems serving the public and to develop a set of recommendations for needed improvements. The surveys should prove beneficial to the Forest Service in its current efforts in the Potable Water System Program.

• • • • • • • • •

## *TECHNOLOGICAL IMPROVEMENTS*

Heyward T. Taylor
Assistant Director

***New Computer Center for Forest Service.*** The Department of Agriculture recently announced the establishment of a Departmental Computer Center at Fort Collins, Colorado. The center will be equipped with a UNIVAC 1108 with an EXEC 8 operating system. See the following news item on EXEC 8. The major portion of Forest Service computer applications will be performed at Fort Collins. The Road Design System (RDS) will be one of the first systems to be installed there.

It is anticipated that the center will become operational in November or December.

***RDS and EXEC 8.*** In Regions 2, 3, 8 and 9, the Forest Service Road Design System is now being exclusively run on the UNIVAC 1108 EXEC 8 operating system. The EXEC 8 system permits individual data storage and program files for each of these Regions. This feature will allow faster updating, quicker turnaround and more interaction and versatility in our computer programs.

***Memorandum of Understanding between Forest Service and Army Materiel Command.*** Two memorandums of Understanding (MOU's) have been signed by the Chief of the Forest Service and the Commanding General of the Army Materiel Command. The MOU's establish general guidelines for conducting programs of mutual technical interest, and provide for transfer of technology and assistance between the two agencies. Each specific project agreed upon must be covered by a supplemental agreement. For the Forest Service, these are coordinated through the Secretary of the Equipment Development and Test Board in the Washington Office. One supplemental agreement has been signed and two more are under negotiation.

• • • • • • • • • •

## *OPERATIONS*

Harold L. Strickland
Assistant Director

***Geometronics Technology Development.*** We recently reported the adoption of the Base Series Mapping Program – a program designed to incorporate all spatial information of interest to the Forest Service into a compatible multilayer system. As with all new systems, there is a lot of work needed between saying it will happen and making it happen.

Our Geometronics unit in the Washington Office has the job of developing and applying the technology to "make it happen." Figure 1 illustrates the processes being developed. Several "bits and pieces" are now under trial use. User guides should be available within the next year.

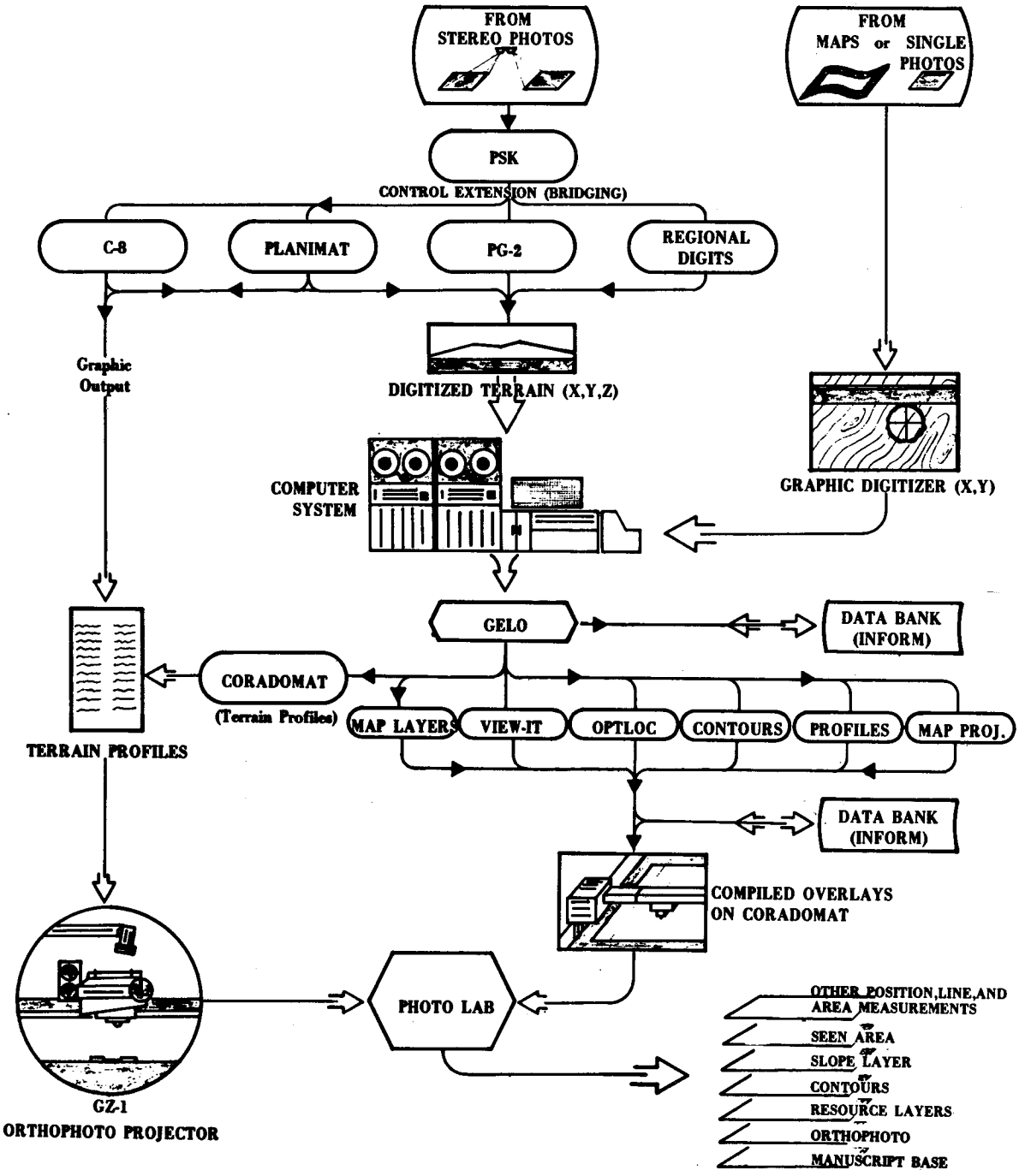



*Figure 1. — Geometronics System Demonstration Processes, Washington Office Geometronics*

Various phases of the total process are under the technical direction of project leaders. Their responsibilities are generally as follows:

- *W. C. (Bill) Albee.* Cartographic systems – automated acquisition, processing and display of spatial information.

- *R. P. (Ray) Allison.* Nonconventional photogrammetry, remote sensing and classified systems.

- *R. O. (Dick) Mahan.* Engineering photogrammetry, terrain analysis and orthophotos.

In addition to being technical experts, these men serve as our primary liaison with Project "INFORM" to insure compatibility between our mapping and information systems.

These processes are designed to be responsive to both the needs of resource management and the opportunities of available technology. You can help us do a better job by making your needs known through normal channels.