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Field Notes

Volume 6 Number 11 November 1974

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Washington Office Engineering News

Reader's Exchange

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 the 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.

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

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FIELD NOTES

SOMETHING YOU SHOULD KNOW ABOUT OIL HEATING SYSTEMS

By Herman Gardner
Engineering Technician, Wenatchee National Forest

The energy crisis and resultant fuel oil price escalation prompted a recent heating system efficiency and economy study on the Lake Wenatchee District, Wenatchee National Forest. The study involved nine buildings that are heated by forced warm air furnaces with gun-type atomizing oil burners.

The initial inspection led to the conclusion that the heating systems had probably never been adjusted other than by eyeball methods, and tenants were generally unaware of deficiencies. Obvious problem indicators were:

- The draft regulators (barometric dampers) were not level, some were stuck, and all were very dirty.
- The burner flame had blowtorch characteristics, short and white with a noticeable loud sound.
- Three furnaces were installed in small closets that either had no combustion air source or had the air source intentionally blocked for the mistaken purpose of conserving heat. One was closed to prevent escaping heat from melting roof snow which caused ice buildup on the eaves. These furnaces were obtaining combustion air from their own flues, as further evidenced by the amount of soot and oily dust in the closets.

At the conclusion of the visual inspection, the Forest decided to invest in a combustion checking kit consisting of:

- A *Bacharach CO_2 Analyzer* costing $62.10. This measures CO_2 stack emissions. The analyzer is inserted into a small hole between the furnace breach and the damper, which allows a flue gas sample to be taken at this point and expanded to read percent of CO_2.
- A *Tempoint Dial Thermometer* costing $13.80. This measures flue gas temperatures at the furnace or boiler outlet.

- A *Pocket Draft Gage* costing $16.39. This measures flue draft (vacuum in inches of water).

This basic kit provided the means for minor adjustments and an increase in combustion efficiency. No attempt was made to clean furnaces, change nozzles, improve fireboxes, or check oil pump pressure, but in every instance, combustion efficiency was increased with only minor adjustments. The following table reflects the results of these adjustments:

Bldg. Number	BEFORE ADJUSTMENT			AFTER ADJUSTMENT			REMARKS
	Stack Temp. (°F)	% CO_2	% Efficiency	Stack Temp. (°F)	% CO_2	% Efficiency	
2071 (Office)	600	8.5	73	500	10	79	Plugged small air leak under burner. Damper dirty and not level. Changed damper setting from .06" to .035".
1206 (Residence)	670	9	72	570	12	76	Damper set in sloping pipe and could not level or adjust. Oversize nozzle or too much draft might account for excessive stack temperature.
1202 (Residence)	630	8.5	72	540	9	77	Flame ragged. New nozzle or centering of nozzle in burner tube might reduce excess air.
1200 (Residence)	550	4.5	60	510	9.5	78	Excess soot in stack.
1209 (Residence)	720	8	67	620	11	77	Smaller nozzle might reduce stack temperature.
1211 (Residence)	600	6	65	550	9.5	76	
2270 (Shop)	600	5.5	63	520	8.5	75	
1301 (Bunkhouse)	500	6	70	350	13	84	Door to furnace closet closed. Combustion air obtained from flue.
2271 (Fire Warehouse)	650	7.5	68	650	9	72	Needs new and perhaps smaller nozzle or centering of nozzle in burner tube to improve combustion and lower stack temperature.

When adjustments are necessary, people should be aware of and understand the possible consequences. Following is a procedural outline for checking oil burner efficiency with added reference to precautions that should be taken:

Step 1. Set the thermostat well above room temperature to maintain the fire. Punch or drill a 1/4-inch hole in the emission pipe at least 6 inches away from the draft regulator and within 12 inches of the furnace. Check the stack temperature and percent of CO_2 using instructions supplied with the analyzer. Calculate combustion efficiency using the analyzer chart. Generally, modern oil burning equipment is engineered to standards that provide about a 500° F stack temperature, a 10-percent CO_2 emission, and approximately 80-percent combustion efficiency.

Precaution 1. When the oil burner is located in a small room or closet there should be adequate provision for combustion air. Building codes generally call for 2 square inches of opening to the outside air for each 1000 Btu per hour of burner capacity. For example, a given burner has a nozzle supplying #2 oil at a rate of one gallon per hour. Knowing that #2 oil yields approximately 140,000 Btu, the minimum opening can be computed as follows:

$$\frac{140{,}000 \text{ Btu}}{1{,}000 \text{ Btu}} \times 2 \text{ square inches} = 280 \text{ square inches}$$

A room without sufficient air forces the burner to consume combustion gases from its own flue, usually around the barometric damper, and the percent of oxygen (O_2) may be very low.

Step 2. The draft regulator should be checked to see that the axis is level and the face is plumb. It should be free moving in its pivot bearing and free of any dirt that might affect its balance. Insert the draft gage stem in a 1/4-inch hole and, following the instructions, set the draft regulator to maintain a .02 to .05 vacuum (inches of water). Efficiency is greater at .02 than at .05, but the draft must be sufficient to carry combustion by-products out of the firebox and up the flue.

Precaution 2. Look for and repair visible air leaks in the firebox. All combustion air should be introduced through the burner.

Step 3. Observe the flame through the inspection glass or firebox openings. A ragged flame with streams of liquid, unvaporized oil hitting the firebox wall indicates either the need for a new nozzle or improper oil pressure. If fuel atomization is good, as indicated by the flame, proceed with adjustment by closing the primary air supply shutter until there is a soft yellow- or orange-colored flame with smoke showing at the tip. Open the shutters until the smoke disappears. Close the inspection hole if open, and proceed outside the building to observe possible smoke emission from the chimney. If smoke is visible, the burner air supply shutter must be opened slightly and the process repeated until no smoke emission is visible.

Precaution 3. A smoking burner is improperly adjusted and the furnace will soon need cleaning. Carbon and soot will accumulate rapidly and may bridge the gap between ignition points. This situation could lead to an explosion, a fire, or a combination of both. Remember that extra air is better than too little air.

If the nozzle and oil pump are suspect, *do not* attempt an adjustment or repair. Hire a qualified expert to analyze and correct the malfunction.

Step 4. Repeat the check of the stack temperature and percent of CO_2 using instructions supplied with the analyzer. Calculate the combustion efficiency using the analyzer chart. If adjustment efforts have been successful, there will be a corresponding increase in percent readings.

Precaution 4. Be sure that there are no combustion odors at the furnace and no smoke from the chimney.

These efficiency checks are easily understood, and complete instructions for operation are provided with the analyzer, thermometer, and draft gage. Generally, you are striving for a clean-burning combination that will produce about 80-percent combustion efficiency. Do not attempt to get more at the expense of a smoky, hazardous fire. If the 80-percent range cannot be attained, then have the furnace cleaned, the fire chamber checked for leaks, the nozzle analyzed for type and size, and the oil pressure checked.

Always enlist the services of a professional if you are not confident of your own ability to perform Steps 1 through 4. Insist that your repairman supply you with combustion efficiency figures the next time he cleans your furnace or adjusts your burner.

Anyone interested in pursuing this subject in more depth should read "Fuels and Combustion," and "Automatic Fuel-Burning Equipment" in the guide published by the American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE), 345 East 47th Street, New York, NY 10017.

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SPECIFICATION FOR ENVIRONMENT PROTECTION

By Joel M. Marshik
Civil Engineer, Sawtooth National Forest

Protecting the environment during a construction operation is a problem facing many engineers. Proper protection measures begin in the office with the designer and continue on in the field with the inspector. But neither the designer nor the inspector performs the actual construction operation; the contractor does. Therefore, if the contractor is expected to protect the environment, he must know what is to be protected and, in some instances, how to protect it.

Informing the contractor of what he will be required to do is accomplished by the contract and the various documents that make it up (e.g., general provisions, specifications, and drawings.) Any one of these can be used to inform the contractor about the protection measures required of him. The purpose of this article is to describe a new specification that the Army Corps of Engineers, Seattle District, has adopted to inform and educate the contractor about environmental protection measures.

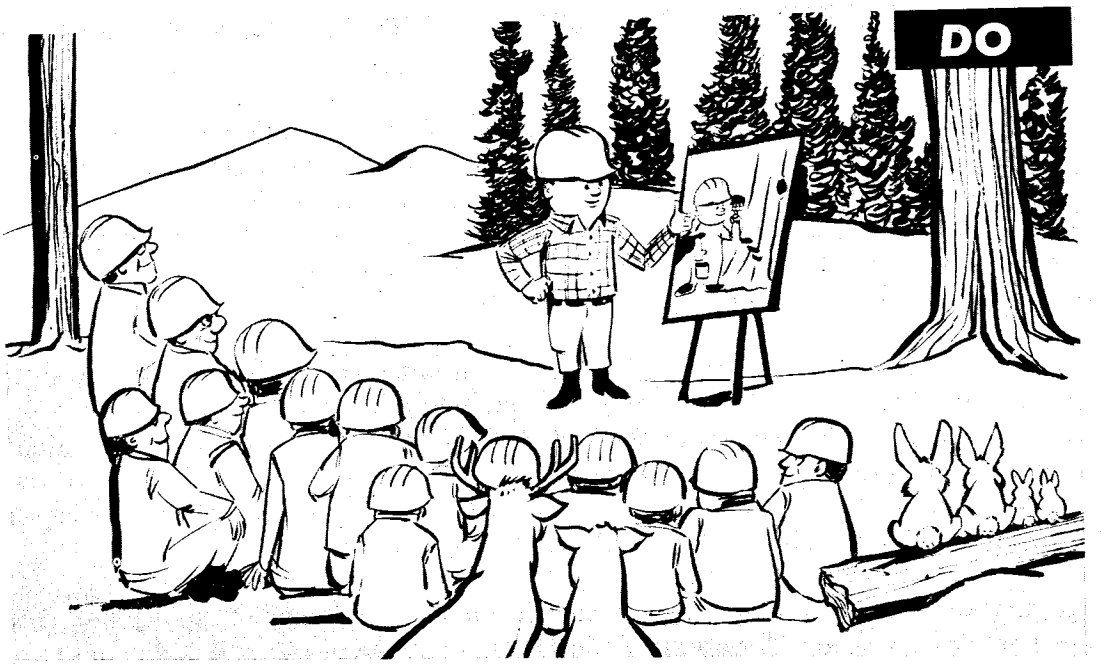
The specification, entitled *Environment Protection,* resulted from a desire by the Corps to improve their present methods. They felt that before improvements could be achieved, better communication between office and field personnel was necessary. In many instances, what the designer intended, the contractor built, and the inspector enforced were not the same. A committee was formed to resolve these differences and make a recommendation. The specification is a result of that committee's recommendation.

In addition to the specification, they also created a manual or pamphlet supplement. The manual provides in cartoon form some important environmental do's and don'ts to the contractor and his labor force. The following paragraph from the first page of the specification illustrates how the manual and the specification complement each other:

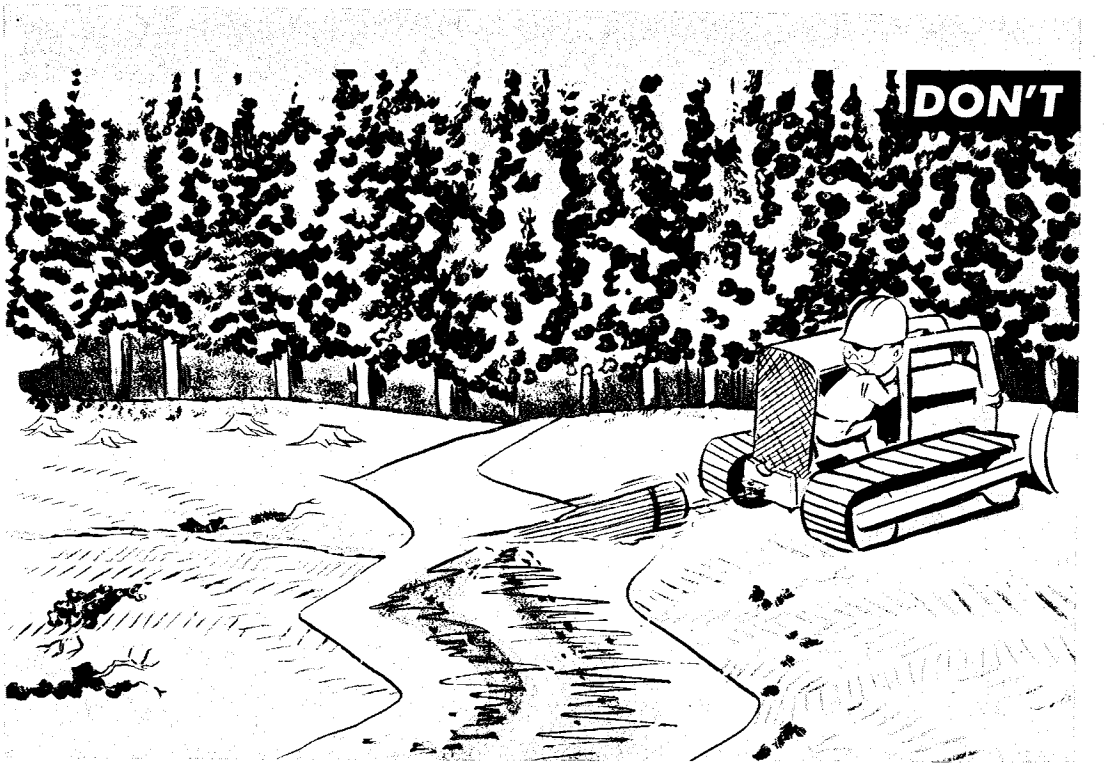
> "ILLUSTRATED ENVIRONMENTAL PROTECTION MEASURES. Some of the environmental protection measures included in these specifications have been selected as subjects for illustrations. These illustrated environmental protection measures are identified and numbered as EPM's in the section of the specification to which they apply. The illustrations are included in a pamphlet entitled *Environmental Protection Measures for Construction Operations,* dated March 1971. EPM's 1 through 32 are referenced in these specifications. The equipment and methods identified in the pamphlet as 'do's' illustrate approved methods and concepts to accomplish the respective contractual environmental requirements in a general way. They

are not intended to provide detail guidance. All work must be accomplished in strict accordance with the specification. The Contractor shall prevent practices identified as 'don'ts' in the pamphlet."

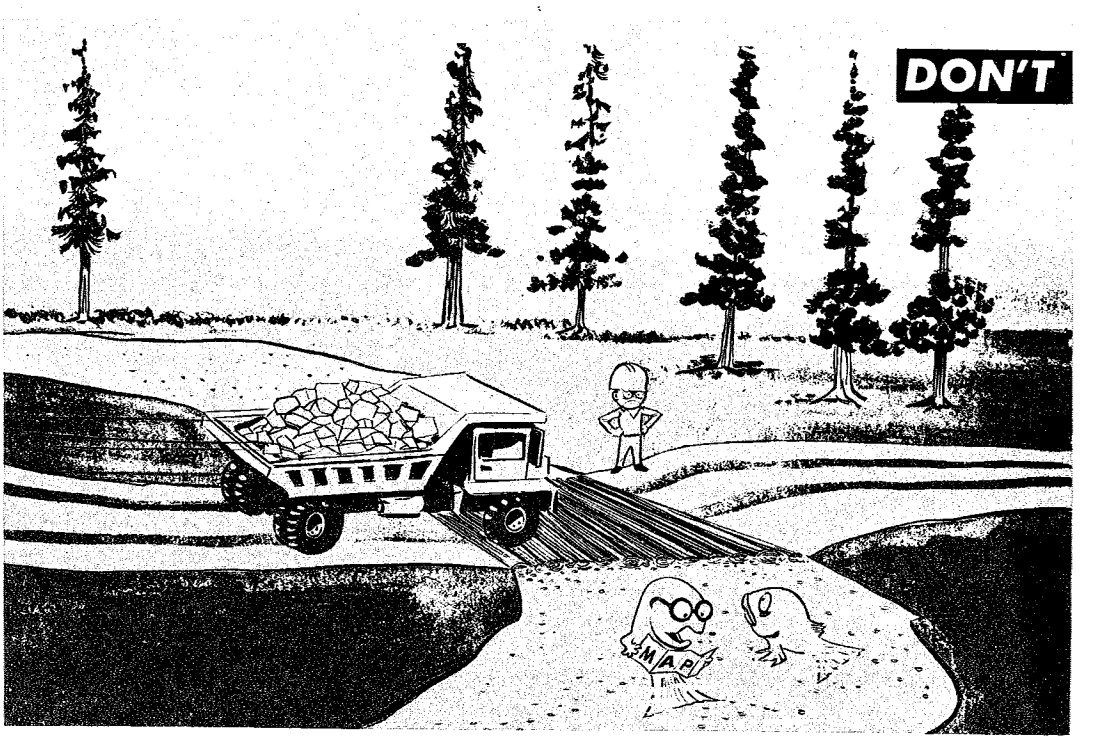
Besides improving techniques, the Corps hoped the new specification would develop a positive attitude toward the importance of protecting the environment. To help accomplish this, the specification established several guidelines concerning on-the-job training sessions and regular meetings between the contracting officer and the contractor. EPM No. 1 illustrates the requirement for monthly training. The remaining EPM's deal specifically with a variety of construction operations, as the following examples illustrate.



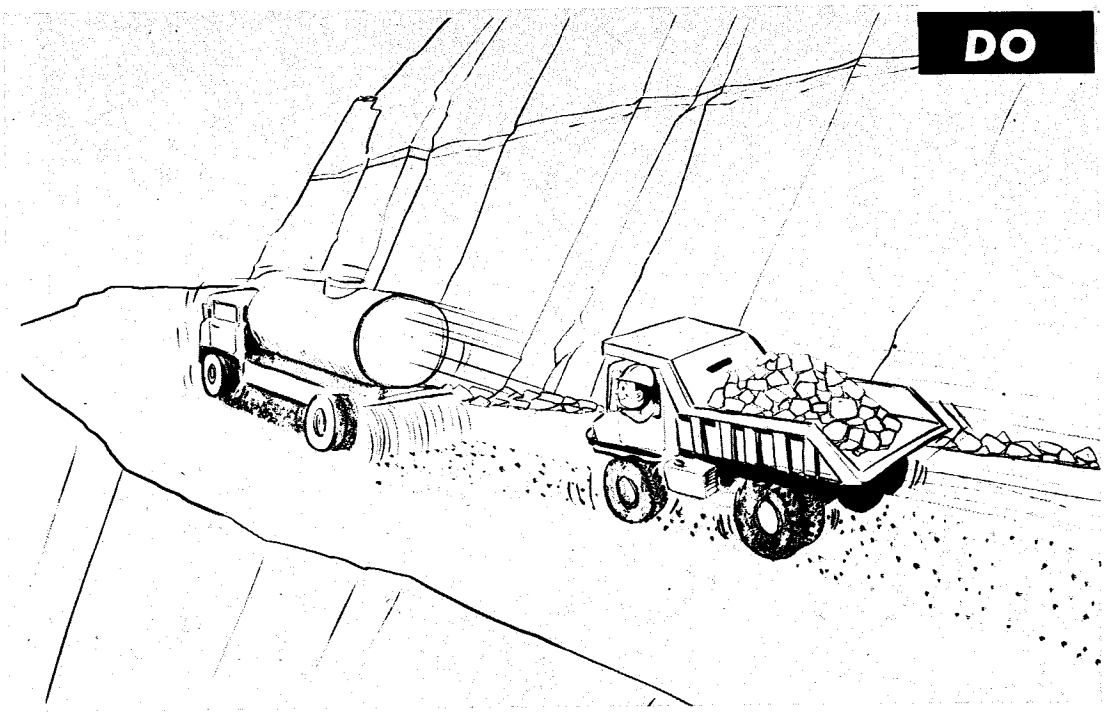
EPM No. 1.—The Contractor shall conduct frequent on the job training courses, not less than monthly, for the purpose of emphasizing the environmental protection requirements of the contract. He shall emphasize that prevention of damage to the environment is the primary goal and that restoration should be necessary only when damage is unavoidable.



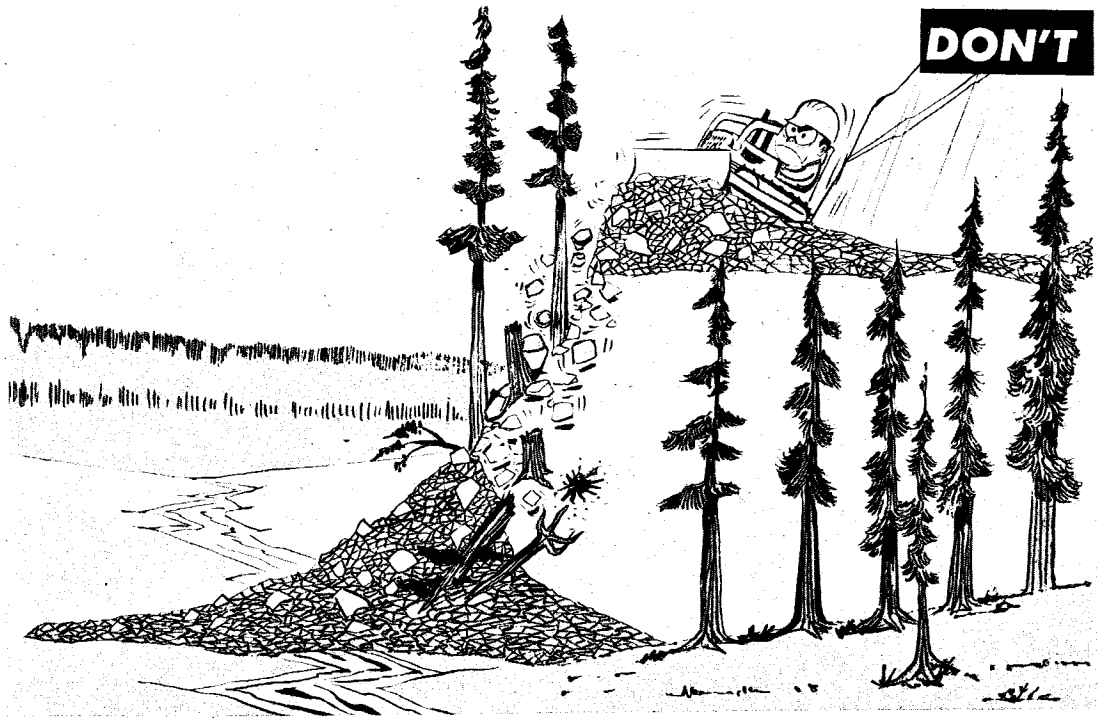
EPM No. 19.—The use of equipment within streams shall be held to that necessary for preparing a base for culverts and for channel diversion only.



EPM No. 21.—The Contractor shall perform all work in a manner to prevent any interference or disturbance to the safe passage and spawning of game fish.



EPM No. 23.—Approved temporary methods of stabilization consisting of sprinkling, chemical treatment, light bituminous treatment or equal methods shall be provided to control dust.



EPM No. 27.—Waste materials shall not be dumped on slopes.

The Corps realizes that this specification will not solve all problems involving construction and the environment, but it has reduced the number. They now have a specification that draws attention to the environment and makes the contractor aware of how important protection of that environment is. Before this specification was issued, protection of the environment was covered by scattered statements in the various documents making up the contract. The contractor never knew exactly what was expected of him. Now he is able to see what protection measures will be necessary and to bid the project accordingly. An increase in costs will result, but protection of the environment is not cheap. Once serious damage is done, it may be irreparable at any cost.

The author wishes to acknowledge the assistance of Sydney Steinborn, Chief, Engineering Division, Department of the Army, Seattle District, Corps of Engineers, who provided a copy of the specification, *Environment Protection,* the pamphlet, *Environmental Protection Measures for Construction Operations,* and a contract using both of these. In addition, "Environmental Design and Construction Response on Highway Relocations for Mountain Reservoirs" by P. L. Cole and S. Steinborn, which appeared in the March 1974 issue of *Journal of the Construction Division, ASCE,* was helpful in preparing this article.

Editor's Note: ***Environmental Protection Measures for Construction Operations*** *may be purchased for 25¢ per copy from:*

Office of Administrative Services
U.S. Army Corps of Engineers
Seattle District
1519 Alaska Way, South
Seattle, Washington 98134

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WASHINGTON OFFICE ENGINEERING NEWS

OPERATIONS

Harold L. Strickland
Assistant Director

REMOTE SENSING

Chief and Staff recently determined that remote sensing responsibilities would be assigned to National Forest Systems. The Director of Engineering was assigned the primary responsibility for maintaining effective communication and coordination throughout the Forest Service and with non-Forest Service organizations on remote sensing.

Remote sensing involves the use of electromagnetic energy, special equipment, and often aircraft or space platforms to gather data from great distances for measuring or interpreting physical information.

We are currently investigating several applications of remote sensing technology to National Forest Programs. Primarily, this involves the use of remote sensing research results and new equipment and technology to collect and display earth resources data to be used in land management activities. Following are brief descriptions of activities presently under way in this area:

- Cooperative efforts with NASA on a program known as Forestry Applications Project (FAP) are being continued at the Johnson Space Center in Houston. The purpose of this program is to investigate the application of remote sensing technology for the inventory of forest resources. The project scope addressed data collection and interpretation in such categories as timber, wildlife, soil, and range using multispectral scanners, a multispectral camera, a metric camera, and a thermal scanner. The use of high altitude infrared photography has met with limited success in the areas of land use surveys, land form mapping, and erosion. There have been varying degrees of success in the areas of vegetation mapping, canopy closure, and crown diameter determination. An accomplishment report, *Forestry Application Project Accomplishment, FY 1974* will be released in November.

- Early this summer, the Forest Service entered into a cooperative agreement with McDonnell Douglas Astronautics Company, the State of Utah Soil Conservation Service, and the University of Utah to investigate the generation of thematic map overlays for such problems as urban encroachment, agriculture inventory, recreation impact, water pollution, geologic hazards, and natural resource location. The program is attempting to show that multispectral data combined with multistage sampling and computer processing can generate useful map overlays on a production basis.

It has shown that computer analysis of multispectral data may provide information for solving resource management problems. Although a final determination of the number of categories that can be classified or the accuracy of boundary placement has not been made, it is clear that traditional techniques for generating this type of information will undergo change in the next few years. It was also found that most of the problems of the resource managers could not be solved with the spectral resolution of the ERTS multispectral scanner. Although ERTS is invaluable for large areas at the national level, regional needs can now be met only by high altitude aircraft flights, while local areas will require even lower level flights to collect the required data.

- We are cooperating with the Laboratory for Applications of Remote Sensing (LARS) at Purdue University through the Institute for Arctic and Alpine Research (INSTAAR) at Colorado University in the use of ERTS-1 imagery to identify and catalog ecosystem components in high-elevation, alpine-type zones in Colorado and Wyoming. To date, model plots have been established at several locations to facilitate ground truth.

- Remote sensing researchers at the Pacific Southwest Forest and Range Experiment Station continued to work on reflectance pattern recognition in the Black Hills area of South Dakota. They are attempting to develop improved computer processing of ERTS tapes for automatic classification and mapping from multispectral scanner data. An improved technique was developed for obtaining good quality prints and enlargements of ERTS imagery. Automatic classification of eight land use types in a west Georgia test site showed strong possibilities for effective processing of multispectral scanner data.

Progress reports of these ongoing activities will be published periodically to keep you abreast of current status. As new projects are launched, we intend to keep you informed as to the nature and scope of the activity.

In redeeming our responsibility in the remote sensing field we will be continually searching for new developments and applications for remote sensing technology. We would appreciate hearing from you if you become aware of any project activity or other information in the area of remote sensing.

TECHNOLOGICAL IMPROVEMENTS

Heyward T. Taylor
Assistant Director

EPA WATER QUALITY PROTECTION GUIDE – LOGGING ROADS

During the month of September, the Washington Office, and several Regions and Experiment Stations received from the Environmental Protection Agency (EPA) a rough draft of *Water Quality Protection Guide – Logging Roads.* The Washington Office Engineering Staff Unit was selected to make a unified response to EPA for the Forest Service. Using the comments supplied by Forest Service Regions and Stations, as well as the Washington Office comments, a unified response was prepared as a joint effort by both Consultation and Standards and Technological Improvements. On September 22, the Forest Service's response to the 312-page report was delivered to EPA Region X in Seattle, Washington. Our response contained 16 pages of detailed comments and 3 pages of general comments. Serious concerns were expressed to EPA regarding publishing the report in its present form. Although it is not feasible to restate all the specific comments on the EPA Guide that were made, the following comments, extracted from the general comments, express some of our main concerns about the report:

- The Guide does not establish a frame of reference or perspective with respect to sedimentation. According to the U.S. Geological Survey, each square mile of the conterminous United States produces 185 tons of sediment annually. The rivers of the United States discharge 491 million tons of sediment per year. In the Region X area, the Columbia River alone discharges 15.6 million tons of sediment yearly. It would be helpful if the report told the reader the amount of sediments that are produced in the Pacific Northwest area and provided answers supported by documented data for the following questions:

  Of the total sediment production, what percent is due to man-associated causes and what percent is due to natural causes?

  Of the portion due to man, what percent is due to silvicultural activities?

  Of the portion due to silvicultural activities, what percent is due to logging roads?

  Of the portion due to logging roads, what percent is due to logging roads that have been planned, designed, constructed, maintained, and operated in conformity with good engineering practices?

  What was the effect on water quality over a period of time for that portion of sediment attributed to properly engineered and managed logging roads?

- Repeatedly throughout the Guide, the reader is told that logging roads are the principal source of sedimentation. In fact, the Guide states that 90 percent of accelerated erosion in forested watersheds has been attributed to roads. It also states that back slopes

contribute up to 85 percent of the first-year road sedimentation and up to 30 percent of the total road sedimentation. All this implies a great deal of preciseness in measurements – not only precision as to quantity of sedimentation, but precision as to the pinpoint source of such sedimentation. Unfortunately, the state of the art in measuring and locating sources of sedimentation is not as precise nor unchallengeable as the previous statements imply.

- Although the Guide itself describes the difficulties of sediment measurement and the inexactness of sediment source location, it nevertheless quotes numerous studies that attribute the sediment source with great assurance to logging roads. We would be remiss if we did not acknowledge that many of the quotations are from Forest Service authored reports. Nonetheless, in view of the previously stated difficulties with sediment source measurement and location, it would seem the Guide would be far more objective and better accepted if it qualified many of the statements and quotations and pointed out the imprecision on which the statements are based. Furthermore, we believe the report would be far more credible if the aforementioned difficulties on sediment measurement and sediment source location were brought out very early in the Guide and fully discussed.

- The Guide gives no information or guidance with respect to the levels of sedimentation that would be tolerable to flora and fauna, nor does the Guide give information on the threshold level of sedimentation with respect to water quality deterioration. Engineers need to know what level of sedimentation is a hazard to public health and safety. Armed with such knowledge, engineers can design an array of sediment minimizing devices and procedures so as to prevent sedimentation beyond the total allowable sedimentation. Of course, the levels should be realistic, with full consideration of the costs and the benefits for a particular level of sedimentation. The Guide does not really address this problem. It would seem that, as the Guide is presently written, absolutely no sedimentation is tolerable. Logging roads in the Pacific Northwest are located in steep, treacherous, mountainous terrain. Even if zero sedimentation were possible for logging roads, it would come at an exorbitant price. This price would be directly transferred to the consumers of wood products and would substantially contribute to inflation. The Guide could make a meaningful contribution to the state of the art if it would identify tolerable levels of sedimentation and discuss the costs and the benefits of designing, constructing, maintaining, and operating logging roads within these tolerable levels.

The aforementioned general comments were reinforced by many detailed comments which related to specific portions of the Guide. We are hopeful that EPA will consider the Forest Service reservations on the Guide and make appropriate revisions. We have offered to meet with EPA and work with them in preparing useful guidelines on the protection of water quality as affected by logging roads.

Editor's Note: *This news item and the related activity were a joint effort between Technological Improvements and Consultation and Standards.*

CONSULTATION AND STANDARDS

Charles R. Weller
Assistant Director

LASER RANGE POLE

The LASER Range Pole has been used for one year and there have been some difficulties in using it. However, in general, it has functioned well when used within its inherent limits. In fact, it has functioned so well we have ordered two more from RCA. The two new models will include needed improvements. Important improvements will be in range, the ability to recognize center, and the elimination of false readings.

The range is expected to extend to 2-1/2 miles for average daylight and 5 miles for night work. The filters and photomultipliers have been improved to eliminate blank readings on center line. The signal carrier will be improved to eliminate the possibility of false readings that now occur frequently.

Recently, 5-watt radios were added to the system. The range of the radio has been improved by the addition of the 5-watt RCA walkie-talkie. The 5-watt RCA replaces a 1-watt Bell & Howell.

The new radios have not improved the center light problem. On shots of one-half to one mile in rugged terrain, it is sometimes difficult to get a center line light reading. The left and right lights indicate about where the center line is because they get the full signal. The blank center line light occurs because the reflected LASER is often only half the intensity of either left or right. The reduced intensity is because the prism splits the reflected light.

The present system is still very usable even though the center line lights do not always light up during daylight hours. The ability to box in the center line by noting left and right readings down to a 5-to-10-second split is almost always adequate. This provides accuracies of 1 in 40,000.

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READER'S EXCHANGE

This section of FIELD NOTES is designed to provide you with an opportunity to share brief descriptions of work under way, successful experiences, problems, requests for assistance, or brief news items.

We anticipate evaluating in some depth the use of bentonite to add plasticity to an aggregate lacking PI and having maximum fines. I would appreciate relevant references and your experiences with mix design, control testing, construction methods, maintenance, evaluation techniques, and cost analyses of bentonite beneficiated aggregate surfacing.

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Duluth, Minnesota 55801
218-727-6692, ext. 396

Improved Utilization and Disposal of Logging Residue will be a featured topic at the winter meeting of the American Society of Agricultural Engineers at the Conrad Hilton Hotel in Chicago. During the 3 days (December 10-12) of Forest Engineering sessions, 24 papers will be given on the various aspects of improved logging techniques, utilization (new products from logging residues), and treatment (disposal) of logging residues. Speakers will be from industry, research, and engineering with all of the latest information on these timely subjects. Complete information is available on request from the American Society of Agricultural Engineers, 2950 Niles Road, St. Joseph, Michigan 49085.

Don Sirois
Mechanical Engineer
Washington Office

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GPO 882-435