United States
Department of
Agriculture

Forest
Service

Engineering Staff

Washington, D.C.

Engineering Field Notes

Engineering Technical Information System

Volume 14
Numbers 10—12
October-December
1982

Engineering Field Notes

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THE ENGINEERING FIELD NOTES SERIES is published periodically as a means of exchanging engineering-related ideas and information on activities, problems encountered and solutions developed, or other data that may be of value to Engineers Service-wide. Articles are usually less than six pages, and include material that is not appropriate for an Engineering Technical Report, or suitable for Engineering Management publications (FSM 1630 and 7113).

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Use of Mobile Hammermill for Inplace Processing of Oversize Rock

James R. Bassel, Transportation Staff Engineer,
San Dimas Equipment Development Center

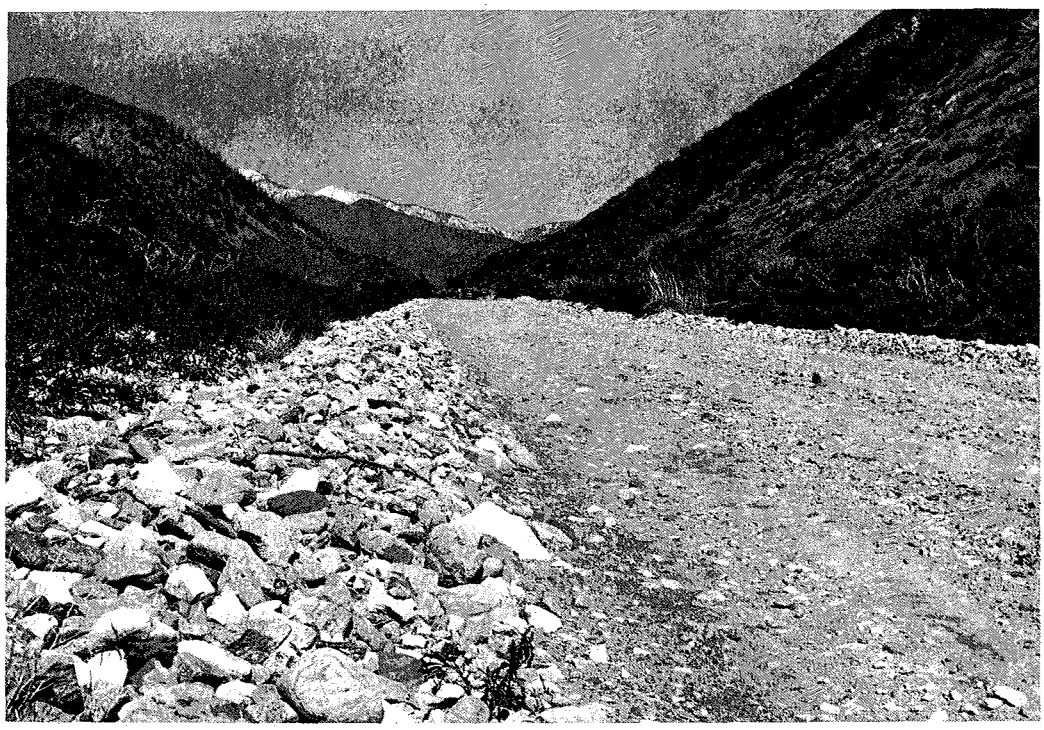


Figure 1.--Oversize material on existing road before maintenance activity.

When faced with the task of repairing an unsurfaced road that has oversize rock present, use of a mobile hammermill for the inplace processing of this rock should be seriously considered. Such a device--the Pettibone Corporation's model P-500 mobile rock crusher--is described in the San Dimas Equipment Development Center's Equipment Development and Test Report 7700-13, March 1979. The P-500 can effectively and efficiently reduce, in place, unwanted oversize material (figure 1) into a useful wearing course for an existing road (figure 2), or it can crush excavated rock into a base course for a new road.

Oversize rock can occur on existing roads

-- In ditches, as a result of bank sloughing;

-- As berms, formed at the side of the road by blading or raking; and

-- Embedded in the roadway, exposed by erosion or traffic.

The maintenance choices for dealing with the oversize rock include removing and disposing of the unwanted material, importing new material to provide overlays, or using a mobile hammermill to crush the unwanted material. This latter approach should be used more often than it presently is.

The use of a mobile hammermill essentially consists of the following steps:

1. Prepare the road: If necessary, scarify the road up to a depth of 6 inches (figure 3).

2. Windrow the material: Have a motor grader form a 1-1/2- by 3-foot wide windrow of 12-inch (maximum) diameter rock. If the windrow or rock exceeds these dimensions, the hammermill must be used at decreased speed or must make several passes to process the oversize material.

3. Water the windrow: Application of water helps control dust, increases hammer life, and aids in final compaction.

4. Crush the windrow: The hammermill is towed over the windrow to crush the material (figure 4).

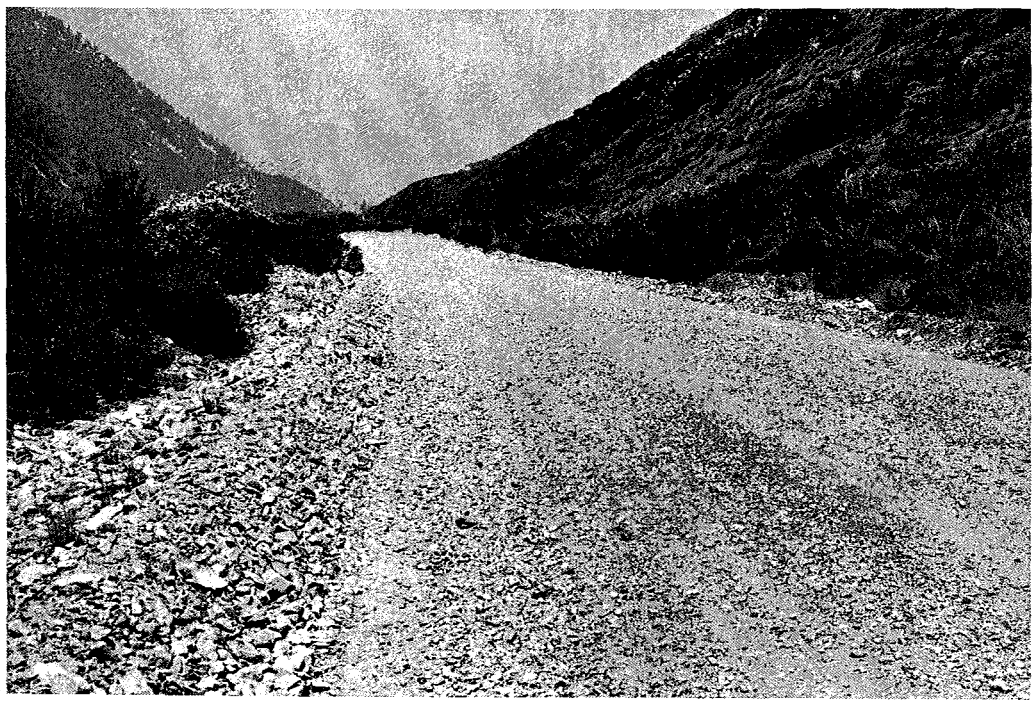


Figure 2.--Same road after maintenance with mobile hammermill.

5. Perform final dressing: The motor grader spreads and shapes the soil and the crushed rock and a roller compacts the mixture (figure 5).

Use of the mobile hammermill is one of many ways to make a usable maintainable road surface out of a road surface composed of oversized rock. As such, it should be considered as an alternative and costed out when selecting a solution. Regardless of the method of renovation, the road will need to be ripped, oversized rock gathered into a windrow, surface bladed, watered, gravel processed, etc. Since most of these costs are common, they will not be covered in the following cost data. The choice is to either remove the oversized material and replace it with gravel, or consider the oversized material as a resource and turn it into gravel.

Once a 1-1/2 feet high by 3-feet wide windrow has been formed, local costs can be used to determine cost of removal. Cost to reduce the oversized rock in place are as follows, with the machine processing approximately 1 windrow mile per day.

-- Operator and towing vehicle 50 hp or larger rubber-tired or crawler tractor	Use local rates
-- Hammermill Crusher monthly lease rate	$225-$300 per day

Figure 3.--Crawler tractor with a ripper scarifies the roadbed.

-- Hammer and pin replacement $200 per day

-- Fuel $30 per day

The P-500 is not presently being produced; however, factory-warranted rebuilt units are available. To obtain information on renting, leasing, or purchasing one of these, contact Pettibone Road Machinery Division, 1275 Bloomfield Avenue, Fairfield, N.J., 07006, (201) 575-6080.

Figure 4.--Hammermill crushes oversize rock in windrow.

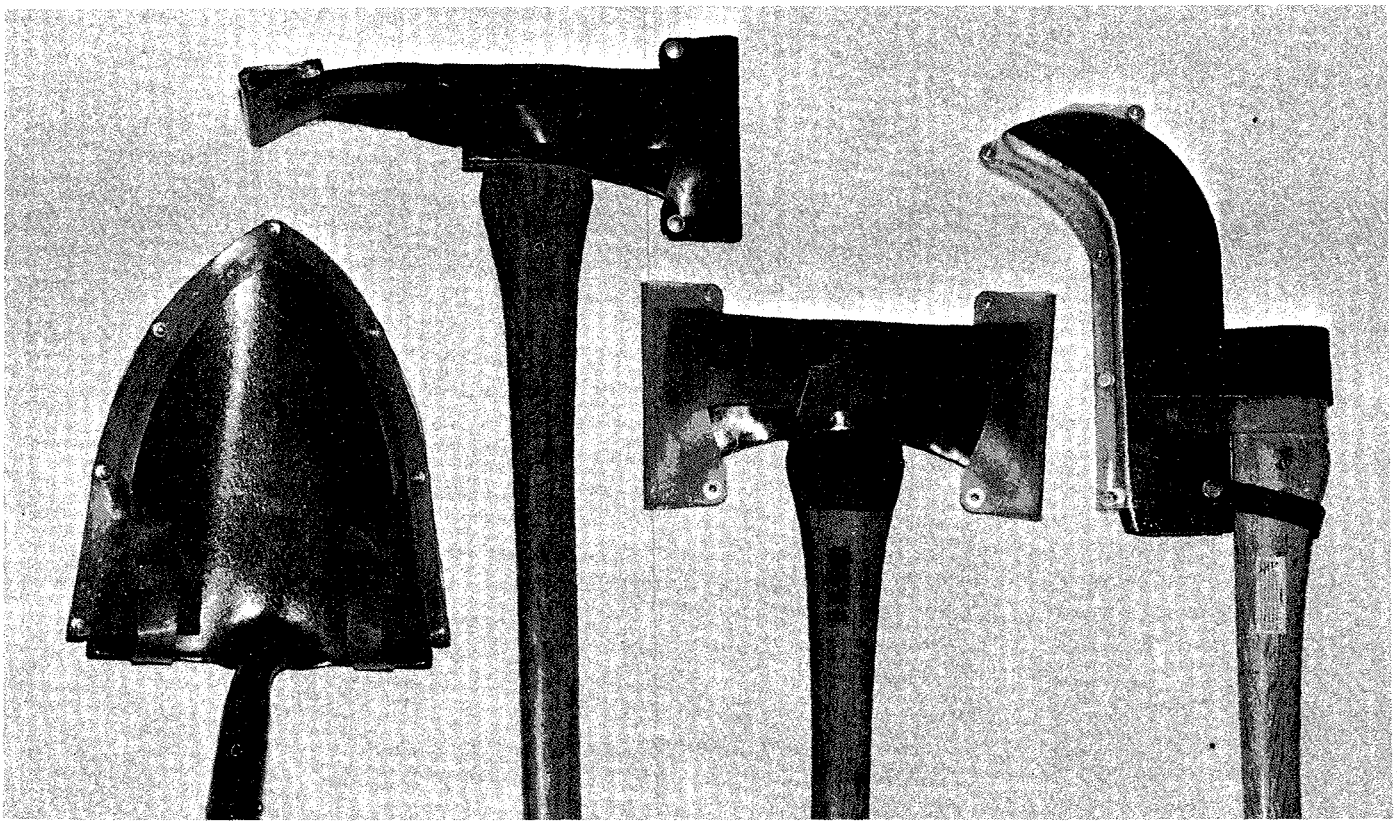
Figure 5.--Roller compacts mixed soil and crushed rock.

Sheaths for Forest Service Handtools

John H. Kim, P.E., Project Engineer, San Dimas Equipment Development Center

At the National Fire Equipment System meeting in 1974, a project was proposed to develop plastic sheaths for firefighting handtools. This decision was made because of increasing costs for leather and metal sheaths. These high costs led to reduced use of sheaths, which in turn resulted in more "makeshift" methods of covering the tools' sharp edges. Many sharp tools were left unsheathed, exposing the fire crews to potential injuries. Also, these unsheathed tools could be damaged by being dropped, thereby dulling the edges and affecting the firefighter's efficiency.

Preliminary investigations by the San Dimas Equipment Development Center revealed the possibility of using plastics, which would lower costs to less



Sharp edges of the shovel, Pulaski, doublebitted ax, and brush hook covered with protective plastic sheaths (McCleod not shown).

than $2 per sheath. In conjunction with the San Dimas Center, the Experimental Technology Incentives Program of the National Bureau of Standards provided some funds to develop a mold for the first plastic sheath to be produced, the Pulaski. Initial design of the Pulaski plastic sheath followed the pattern of current metal and leather sheaths. Prototype plastic sheaths were evaluated by fireline crews and, after some modifications, the General Services Administration purchased 70,000 of the sheaths and made them available to Government fire caches in 1978 for $1.50 each. (In 1978, leather sheaths were $2.95 and metal sheaths were $4.70 each.)

Once the Pulsaski plastic sheaths were in production, mold development for the production of other handtool sheaths followed rapidly. In addition to the Pulaski sheath mold, the Forest Service now owns molds for production of sheaths for the double-bitted ax, brush hook, shovel, and McCleod. Bids have been requested for production of plastic sheaths for the double-bitted ax, and these sheaths should soon be available in fire caches. At this time, plans are not firm for the production of sheaths for the brush hook, shovel, and McCleod.

This project has been one of our most cost-effective projects, and full implementation has been rapid. Total cost for the Pulaski sheath mold was $4,900, and cost-savings benefits over the next 5 years for this sheath alone are expected to be approximately $150,000. There will also be other intangible benefits in safety and work efficiency procedures.

Precast Cattleguard

Leon A. Bleggi, Civil Engineering Technician, Region 4

Amcor, Inc., recently marketed a precast cattleguard that can cut costs and reduce installation time. One was recently installed on a State highway in the Targhee National Forest, Idaho.

The typical excavation operation will require a backhoe, dump truck, and mechanical compactor. Excavation can be limited to the size of the cattleguard specified. The area should be subexcavated to 4 inches below finished grade and the soil compacted to at least 95 percent of the maximum density as determined by AASHTO T 99, Method C D. A 4-inch-thick bed of aggregate is then placed over the compacted soil and fine graded. The site is now ready for cattleguard placement.

The concrete portions of the cattleguard are available in three component lengths and bolt together in the field, forming a monolithic structural unit. The components' design insures that they act as an acceptable platform for the prefabricated grate and serve as a footing for the required highway loading.

The steel grate consists of channel members, continuously welded to standard I-beams. These structural components are dipped in primer prior to delivery. Fabrication tolerances range from plus or minus one-fourth inch. The grates rest on neoprene pads to protect the precast concrete. The cattleguards meet the AASHTO HS-20 design loading requirements.

This type of cattleguard requires only a fraction of the time normally needed for field assembly and installation. The sections are delivered to the job site by the manufacturer and set in place. Connecting bolts are then inserted through both sections and tightened, uniting the components. This operation takes about 20 to 30 minutes per unit to complete.

The entire installation can be completed in a day, and saves days--if not weeks--of construction time and substantial cost. Disruption of traffic flow should be minimal if a bypass is available for traffic use during construction.

A 38'-7-1/4" by 8'-0" cattleguard was installed on State Highway 31, east of Swan Valley, Idaho, in cooperation with the State of Idaho. The project was completed in a day, except for minor cleanup.

Cattleguard cleanouts present difficulties for road maintenance crews. Some require unbolting and removal of the entire grating; others have a cleanout section in the grate that traffic often vibrates loose. The individual grates of this cattleguard can be easily removed to gain access for cleaning.

The following table shows sizes and costs of precast cattleguards, excluding trucking costs (from Amcor, Inc. Ogden, Utah; and Idaho Falls, Idaho; March 1980). If wing braces are required, add $200.

Size	Cost
16'-0-1/2"	$2,300.76
20'-7-3/4"	3,111.40
23'-6-3/4"	3,454.38
28'-2"	4,265.02
31'-1"	4,608.00
35'-8-1/4"	5,408.92
38'-7-1/4"	5,751.90

Photographs show the site preparation for cattleguard placement (figure 1), construction of the cattleguard (figure 2), and the installed cattleguard (figure 3). Figure 4 is a detailed construction drawing of the unit.

Figure 1.--Site prepared for cattleguard placement.

Figure 2.--Connecting bolts are tightened to unite the components.

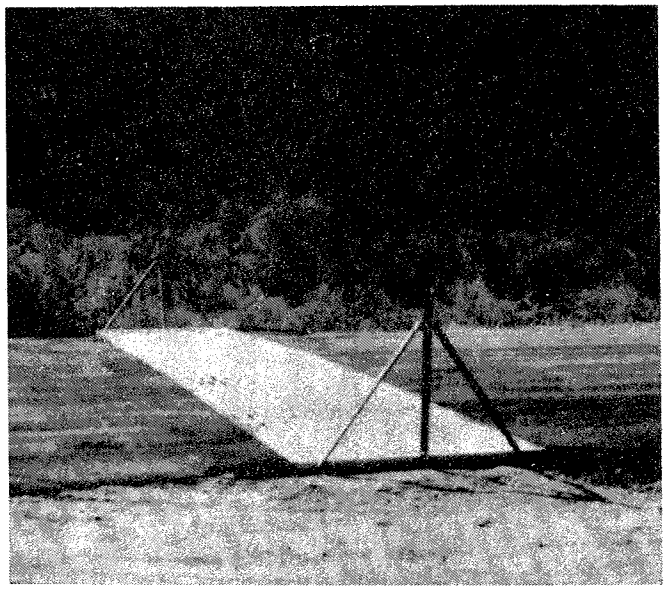


Figure 3.--Installed cattleguard east of Swan Valley, Idaho.

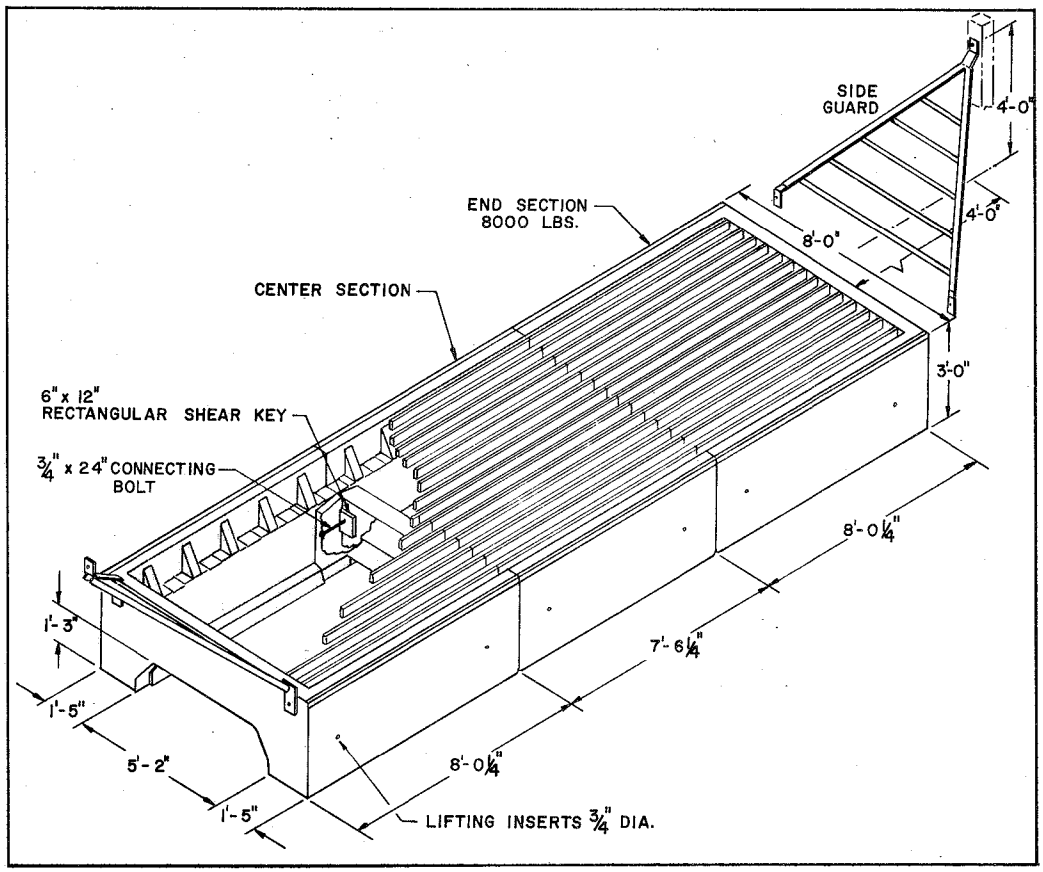


Figure 4.--Precast cattleguard marketed by Amcor©, Inc.

History & Development of Bulldozer Recalled by Earle L. Hall

M. R. Howlett, Director of Engineering, WO

Note: Tony Dean, retired Director of Engineering, recently shared the following reminiscence about Earle and the bulldozer with us. We hope you find it to be as interesting as we did.

The invention of the bulldozer as an engine of construction or destruction probably predates the invention of the wheel. Its history is recorded by various civilizations throughout the ages.

A bas-relief carved on the wall of an ancient Egyptian tomb depicts a group of workers or slaves operating a piece of construction equipment for clearing a building site or pushing debris over a bank. It appeared to be the trunk of a small tree with the limbs trimmed to form handles for pushing; across the butt was attached a cross member to act as a blade. A man at each end of the "blade" raised or lowered it as required.

The Greeks probably used a similar implement and had a word for it; the ancient Chinese employed the principle in some of their engineering projects. It is recorded in Aztec pictographs that they, too, "bulldozed" material before the wheel was known to them.

The word "bulldozer" with reference to an engine for moving material appears to be of railroad construction coinage dating from about 1865.

No individual can be credited with the invention of the modern bulldozer, but certainly the U.S. Forest Service, particularly Region 5, must be given credit for the important role it played in the bulldozer's development.

EARLY DEVELOPMENT

I remember many details of that development. In 1906, my father was confronted with the problem of clearing a dense growth of brush and boulders on our ranch in the San Gabriel Valley of California. A neighbor described an implement constructed by an enterprising and resourceful Mormon pioneer for a somewhat similar purpose, and he helped my father construct one. The front axle, wheels, and tongue of a farm wagon formed the chassis. The horses, hitched in the reverse

position, pushed the wheels ahead instead of pulling them. A metal-edged plank which formed the blade was attached in front of the wheels. The raising and lowering of the blade was accomplished by teetering the wagon tongue up or down. Operating the push scraper blade was arduous work, but the clearing was accomplished and the boulders and debris were shoved into a small ravine for further leveling.

Six years later, the contractor for whom I was working was confronted with the problem of back filling over the large Pasadena storm drain after the concrete had been poured. The drain ran along the west side of Broadway for several blocks in downtown Pasadena. The back fill material was hauled in horse-drawn wagons from the excavation heading and dumped on the pavement beside the trench to be shoveled into it by hand labor. The process was slow and costly. He asked if I had any idea for a solution of the problem. I told him that I thought my father's push scraper, as we called it, might be a practical method for back filling; further, there was an old farm buck rake in the equipment yard which I thought could be easily modified to push the back fill into the trench. He said, "Hop to it, son, and see what you can come up with." The old buck rake was purchased for the sum of $5, as I recall. The blacksmith, with his helper and myself, had it ready for trial the following day. A horse was hitched on either side as on the original buck rake. Although the first attempt at pushing in the back fill was a success, it was also a near disaster, because the push scraper, mounted on wheels without brakes, continued to roll ahead when the load had dropped away. One of the horses fell into the trench and the machine perched precariously on the edge.

The contraption was taken back to the shop and the blade repositioned to produce a plowing or side-casting action. The raising and lowering of it was accomplished by the same linkage used to raise and lower the teeth of the original buck rake.

With a little practice, the operator soon became quite proficient in back filling the trench.

The inspector on the job drew a sketch of the machine and discussed patenting it with me. He probably envisioned the future possibilities of the "bulldozer" much better than I. Although there were probably many other machines built to

serve a similar purpose, research I did in later years points to this as being the original "angle blade bulldozer."

In 1919, the American Brake Shoe Foundry in south San Francisco was in search of some method to replace the hand work usually employed for clearing the casting floor of sand after casting.

The San Francisco distributor of a small crawler tractor for whom I worked saw an opportunity to make a sale of a tractor if an adjustable blade attachment could be placed on the front of the tractor to push the sand off the floor. I was assigned to design and engineer the attachment. With the shop facilities and personnel of the foundry at my disposal, we hastily constructed a front blade attachment which could be raised and lowered by hydraulic power. The raising and lowering was activated by linkage to a hydraulic cylinder which took its oil supply from the pressure lubricating system of the engine; the raising and lowering of the blade was accomplished by the opening or closing of valves.

Although the trials demonstrated various deficiencies in design and construction, they did prove beyond a doubt that such a controlled type front attachment on a tractor was a practical and useful piece of equipment.

FOREST SERVICE BUYS TRACTORS

In 1926, the U.S. Forest Service purchased five small crawler tractors from me (I owned the distributorship for them at that time). They were to be used as pioneering units to pull a "road breaking plow" to build a trail over which a larger tractor could pull a scraper and grader to make a Forest road.

I delivered one of the tractors to the Log Springs Road Project of the California National Forest (now Mendocino) where Wilbur Huestis was Road Foreman. I was invited to stay overnight in camp with him, and after supper we discussed until far past midnight many problems of Forest Roads building, Fire Control, and other Forest activities. I became a ready convert to the Forest Service.

The next morning, trails with the tractor and breaking plow were made. Results were disappointing for several reasons: (1) the man holding the "breaking plow" could not stand up to the effort of holding the plow among roots and rocks; (2) there was a definite limit of side slope on which

the tractor could traverse; and (3) it was difficult to turn the tractor around with the plow trailing behind. The process was dangerous to the tractor and driver and "plow shaker."

Among the various pieces of equipment to be tried was a Martin Ditcher manufactured in Owensboro, Kentucky. It was a triangular plow-scraper pulled behind a team of horses or tractor to make a ditch, clean cutters, and the like. We tried pulling it in place of the plow, but results were also disappointing.

I insisted that the trail should be built ahead of the tractor by a front attachment whereby the tractor could operate in the most efficient position of being reasonably level. Mr. Huestis readily agreed and suggested that we might push the ditcher instead of pulling it. We chained it to the front of the tractor to push it and a trail was made. Though the contraption was not practically operable, it did prove that the principle of pushing the scraper blade attached ahead of the tractor was sound and feasible.

BACK FILLER PURCHASED

In 1927 or 1928, Region 6 of the Forest Service purchased a bunch back filler manufactured in Pomona, California, which was an angle blade tractor attachment assembly. It had a system of levers and weights to regulate the blade. Forest Service Engineers K. P. Cecil and Ted Flynn reported it to be quite efficient for clearing and pushing debris, though a bit cumbersome.

By this date, there were several tractor front attachments on the market designed to push or load material. The Walsh Manufacturing Company of Holyoke, Massachusetts, built one which employed a rocking blade for back filling or loading coal.

LeTourneau, Master, Wooldridge, and Baker were names found in the list of manufacturers of tractor scrapers, back fillers, and loading attachments.

By 1928, Region 5 of the Forest Service was doing much research toward development of a practicable trail-building unit and purchased several tractors and special units from me for the purpose; the results were not satisfactory, however.

NEW TRACTOR ATTACHMENT

In 1928, I sold my equipment business and took a temporary assignment with the Forest Service to design and build a tractor attachment for building a pioneer road. The work would be done

in cooperation with the Bureau of Public Roads Shops on Government Island. Under the supervision of Chester E. Jordan, Supervisor of Minor Roads and Trails and an ardent supporter of the idea, an experimental machine was built and tried. This invention was hydraulic powered, angle blade type and contained several features later adopted by construction equipment manufacturers who still use the features of the original back filler.

The machine was shipped to and demonstrated at the Forest Service Road Building and Equipment Demonstration on the Santa Barbara National Forest in the winter of 1928-29. While the performance of the machine did not fulfill my expectations because of mechanical difficulties, it did prove we had discovered a practical method of opening up a pioneer road regardless of the degree of the side slope. A back filler built by the Wooldridge Manufacturing Company gave an excellent demonstration of what could be expected with the use of a front-end attached blade for road building.

The Forest Service machine was returned to Government Island, where minor mechanical changes were made. It was then shipped to the John Hale-Letts Valley Road Project on the California National Forest (Mendocino), where several miles of road were pioneered and fills in gulches made. Later in 1929 it was used in the same Forest to build the Doe Peak-Buck Peak Ridge Trail and firebreak, a total of approximately 6 miles.

In 1930, the Forest Service contracted with the Davis Manufacturing Company for the construction of 11 of these units to be installed on Cletrac 30 tractors. Five of the units were shipped to Region 1, and I spent the summer demonstrating, exploring the use possibilities of the machine, and teaching operators.

An account of those activities can be found in Region 1's 50-year anniversary publication entitled "The Bulldozer, A Pioneer Step in Development of Machines for Forest Road Construction."

The other six machines were distributed to California Forests.

ROAD BUILDING

In 1931, Region 5 established a Model Forest Road Building Project on the Mendocino National Forest, known as the Colyear-Valentine Ridge Project. The road was practically built to completion by two angle blade bulldozers, one

a Wooldridge and the other a Hall design mounted on Model 55 Cletrac tractors. It was chosen as a typical problem project with creek to cross, gulches to fill, slopes to be cut, trees to fell, and rocks to be removed. Many Forest Service Officers, including Mr. Norcross, the Chief Engineer in the Washington Office, as well as several construction equipment manufacturers have visited this project.

In the winter of 1931-32, a small trail builder attachment was designed and built at Government Island Shops and mounted on a small crawler tractor to build foot trails. It was compact and very successful in its operation on the Squaw Creek District of the Shasta National Forest.

It was on the Horse Mt. fire that Forest Supervisor Tom Jones and myself built approximately three-quarters of a mile of fire line with the little trail maker and had the fire contained before the fire crew arrived. This demonstration was not given the publicity that I felt it was entitled to.

The disastrous Matilja fire of 1932 in the Santa Barbara (Los Padres) National Forest called for all possible fire fighters and equipment. I was dispatched from Government Island with a Cletrac 55 "bulldozer" to the Ozena Sector.

Several miles of fire break were made, all of which held except for a few expected spot fires carried over by high winds. This operation clearly demonstrated that the trailmaker-bulldozer was a potentially effective fire-fighting machine.

CONCLUSION

With the advent of the Civilian Conservation Corps Program, many bulldozers were purchased by the Forest Service and other Government agencies during the Depression era. They were of various design and manufacture. Some were patterned after the original Forest Service model, and others were based on a different type.

With the introduction of the bulldozer, as with many other innovations, there were many behind-the-scenes headaches, heartaches, and disappointments for the proponents of the idea and sponsors of the project.

While industry--in the oil fields, in highway construction, and in logging--and various heavy equipment manufacturers were discovering and experimenting with new methods to use tractor

power for construction, much credit must be given to the Forest Service for its contribution to the development of the bulldozer as a machine for road and highway construction, excavation, demolition, airport building, and the many other jobs for which it is now used.

Nominations for Handicapped Employee of the Year

Charles R. Frayer, a Civil Engineer Technician from Region 6, has received the USDA Outstanding Handicapped Employee of the Year Award signed by President Reagan. The award was presented October 4 at the Department's annual award ceremony honoring its handicapped employees.

Doreen C. Meussdorffer, a Supervisory Cartographic Technician, also from Region 6, received a Certificate of Recognition at the same ceremony. She and Frayer were the only Forest Service nominees for the departmental award, which last year was won by Steve R. Elliott of Region 2 Engineering.

Secretary of Agriculture Block was a featured speaker at the awards ceremony. John J. Franke, Deputy Secretary for Administration, presided.

Frayer works in Zone II Engineering, in the Colville National Forest Supervisor's Office, assigned to Newport, Washington. Frayer began his career with the Forest Service on the Wallowa-Whitman in 1972 as an engineering aide. He advanced from the position of draftsman to road designer, performing a variety of duties and receiving recognition several times for outstanding achievements.

In his 9 years with the Forest Service, he has been promoted three times to positions of increasing responsibility, including fieldwork requiring driving mountain roads, where he has maintained a perfect driving record.

He has also been effective in fire control, patrolling for fires, serving as radio dispatcher, in fire transportation, and in flying fire reconnaissance on the Wallowa-Whitman National Forest. His other responsibilities include designing roads, estimating costs, and assembling road contracts.

In 1978, he received a Certificate of Merit for outstanding accomplishment as a project team member and for interest and help on timber sale contracts. That year he also received a cash award for his extra efforts on the job and for his community service.

In May 1979, he received a USDA Superior Service Award for promoting employment for the handicapped

and for working with the community of LaGrande, Oregon, to improve working and living conditions for the handicapped.

Frayer lost the use of his legs in a 1970 car accident.

Doreen Meussdorffer is Group Leader and Assistant to the Head of Drafting in the Geometronics Group of the Engineering Division of Region 6, in Portland, Oregon.

Her current responsibilities include training new personnel in the use of drafting techniques. She began her Forest Service career as a drafting trainee 15 years ago.

She has been honored several times for her on-the-job and related service accomplishments. In 1979, she was awarded a USDA Certificate of Merit for exceptional work preparing multicolor maps depicting "Rare II" inventory status. "These maps set the standard nationally for 'Rare II' maps," according to her award certificate.

While with the Forest Service, Doreen has submitted eight employee suggestions, five of which have been adopted. Her latest, that the Forest Service make braille maps, has gone to the Washington Office but has been deferred because of lack of funds.

In addition to her cartographic responsibilities, Doreen has undertaken many jobs for the local chapter of the National Federation of Federal Employees. From 1977 to 1979, she was its president, and in 1980 she was vice president. She has been a member of the Federal Executive Board for 5 years and has chaired the Special Placement Program Subcommittee. In that capacity, she has conducted several workshops dealing with the supervision of handicapped employees and problems of disabled persons.

As a result of a congenital deformity, she has no fingers on either hand. Nonetheless, using ingenuity and determination, she has found ways to use cartographic tools and equipment to help produce Forest Service maps.

Forest Service Engineering is proud of the accomplishments of both these employees.

1982 Field Notes Article Awards

Cash awards and service certificates are awarded to the authors of three Field Notes articles in each calendar year as provided for in Forest Service Manual 7113. The awards will be distributed based on responses of Field Notes readers.

Did a Field Notes article help you in the performance of your job during 1982? Did information published in Field Notes help you save money or time? Did you learn a new way to perform a task? Did you note benefits that could result from improved methods described in an article?

If the answer to any of these questions is "yes," complete the article rating sheet on the following page. Select the three articles that were "most beneficial and useful"; rate these articles from 1 (highest) to 3; do not rate more than three articles. Wherever applicable, indicate the amount of money that was saved as a result of the article.

Cut out the page as indicated, fold carefully, and staple both ends of the folded sheet. The rating sheet must be received in the Washington Office by January 31, 1983, for your selections to be considered.

Articles in Field Notes are intended to provide useful information for engineering personnel working on the ground, as well as for those who manage or supervise systems.

If you have a new way of accomplishing a job or a better idea for handling problems, share your ideas and problem solutions or new methods. Write an article for Field Notes, and you may win a $100 cash award and certificate.

☆U.S. Government Printing Office : 1982 -381-227/2020

United States
Department of
Agriculture

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Washington, D.C.

Engineering Field Notes

Engineering Technical Information System

Volume 14
Numbers 10—12
October-December
1982

Corrections to

1982 Field Notes Article Awards

Corrections to

1982 Field Notes Article Awards

The name of the author of "Guidelines for Estimating Soil Support Values in Ochoco National Forest" was inadvertently dropped from page 21 of the October-December 1982 issue of Field Notes during the production process. To give author Bruce N. Jorenby an opportunity to be considered for a cash award or service certificate, a corrected page 21 is provided.

Please use this corrected page to cast your vote for the three "most beneficial and useful" Field Notes articles in 1982. Rate these articles from 1 (highest) to 3; do not rate more than three articles. Wherever applicable, indicate the amount of money that was saved as a result of the article.

Cut out the page as indicated, fold carefully, and staple both ends of the folded sheet. The rating sheet must be received in the Washington Office by January 31, 1983, for your selections to be considered.

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Article	Author	Choice (1, 2, 3)	$ Saved
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Fire Tower to Observation Platform	Richard D. Wilson, R-9	_____	_____
Hydropowered Pump Installation	Don Hillard, R-1	_____	_____
April-June			
The Forest Service Planning Process & Its Implications on Transportation Issues	Jerry Knaebel, WO	_____	_____
Improving Road Location & Network Design with Digital Terrain Models	W. H. Valentine, R-1	_____	_____
A Guide for Determining Minimum Road Width on Curves for Single-Lane Forest Roads	Carl Cain, R-1, and James A. Langdon, R-1	_____	_____
July-September			
Bottomless Arch Selection for Fish Passage	Roger V. White, R-1	_____	_____
Some Considerations in Using Wood for Energy	George Lippert, WO	_____	_____
Guidelines for Estimating Soil Support Values in Ochoco National Forest	**Bruce N. Jorenby, R-6**	_____	_____
October-December			
Use of Mobile Hammermill for Inplace Processing of Oversize Rock	James R. Bassel, San Dimas Equipment Development Center	_____	_____
Sheaths for Forest Service Handtools	John H. Kim, San Dimas Equipment Development Center	_____	_____
Precast Cattleguard	Leon A. Bleggi, R-4	_____	_____
History & Development of the Bulldozer	M. R. Howlett	_____	_____

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Volume 14 Numbers 10—12
October-December 1982

Engineering Field Notes