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Field Notes

Volume 3 Number 12 December 1971

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FOREST SERVICE • U.S. DEPARTMENT OF AGRICULTURE

ENGINEERING FIELD NOTES

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FIELD NOTES

TESTIMONY BY ROBIN HARRISON
AT THE
ENVIRONMENTAL PROTECTION HEARING

Denver, Colo. - October 1, 1971

FOREWORD

The Environmental Protection Agency (EPA) hearings were held at the request of Congress to furnish information on all aspects of noise pollution required to comply with the Clean Air Act Amendments of 1970. (PL 91-604 Title IV, Sec. 402)

The EPA has held eight hearings on noise pollution to assist Congress in making legislation on noise pollution--one of our serious pollution problems.

Mr. Harrison is an employee of the Forest Service Equipment Development Center, San Dimas, Calif., and a member of the Sierra Club Noise Pollution Subcommittee. He is an expert on off-the-road vehicle noise and represented the Sierra Club at the Hearing on Recreational Noise held in Denver, Colo., October 1, 1971.

Following is Mr. Harrison's testimony as a witness for the Sierra Club.

Fran Owsley, WO
Division of Engineering

TESTIMONY BY ROBIN HARRISON
AT THE
ENVIRONMENTAL PROTECTION AGENCY HEARING
ON RECREATIONAL NOISE

Denver, Colo. - October 1, 1971
(Representing the Sierra Club)

My name is Robin Harrison; I am educated as a mechanical engineer; my specialty is acoustics. I represent the 140,000 nationwide members of the Sierra Club. Since the subject of this hearing is recreational noise, it may be pertinent to say that I am also a user of motorized recreational vehicles--having owned some 54 motorcycles, boats, jeeps, etc., in my life. I will briefly discuss what the Sierra Club's stand has been on noise in general, what we feel are significant areas of noise pollution in recreation, and what we feel should be done to alleviate the noise problem.

The Sierra Club's involvement with noise pollution began May 4, 1946, when the board of directors voted to reiterate its opposition to the use of airplanes in wilderness areas. This opposition arose mainly from the noise created by such use and we still feel that aircraft are incompatible with wilderness areas, wild areas, and primitive areas. The club has since then made recommendations about the use of aircraft, trail cycles, snowmobiles, and vehicles in general, and has made specific recommendations regarding land use planning, airport sites, research, legislation, and jurisdiction of noise pollution problems.

The Sierra Club believes that one of the most valuable aspects of outdoor recreation is the peace of mind and restoration of spirit that come from the separation of man from his normal, noisy existence. We believe that these quiet little islands in time are a necessary part of the enjoyment of the outdoors, and we therefore oppose the use of any noisemakers in any wilderness-type area.

I would like to concentrate my testimony on three particular areas of noise pollution which the Club feels deserve your immediate and special attention: aircraft flyover, motorcycle, and snowmobile noise.

There are other sources of noise pollution that are common and increasing. Outboard motors, portable generators, and chain saws cause serious problems in localized areas. The noise of transportation to and within developed camps and parks is of growing concern. However, airplanes, motorcycles, and snowmobiles are by far the worst noise offenders in our outdoor recreation areas.

Aircraft flyover noise is a serious detriment to the enjoyment of outdoor recreation areas for many people. While engaged in research near the Sespe Condor area of the Los Padres National Forest, I was unable to take acoustic data for fully 20 percent of the workday because of aircraft flyover noise. The impact of aircraft flyover noise on other recreation areas such as Mt. Whitney, Calif., cannot be over-emphasized. There are helicopter and fixed wing sightseeing tours flown in such areas as the Grand Canyon every day. Each sightseeing plane, holding four to eight tourists, disturbs hundreds on the ground.

We, therefore, recommend that agencies responsible for routing aircraft, both military and civil, insist that speeds, altitudes, and route locations be so arranged as to minimize the noise impact on heavily used outdoor recreation areas, areas of special interest, wilderness areas, and areas especially fragile to noise pollution, such as certain wildlife preserves.

The second area of major concern to us is the noise pollution caused by motorcycles and motor scooters. The number of users of off-road recreational motorcycles and scooters is increasing rapidly. At the end of 1970, there were approximately 2,300,000 "pleasure" motorcycles in the United States. This compares with about 1/2 million total motorcycles in 1960 (U.S. Department of Commerce figures). It is noteworthy that Senate Bill 1016 and House Bill 5275, now under consideration by the U.S. Congress, single out recreational motor vehicles as a significant noise source.

The concern over motorcycle noise has also grown rapidly. We do recognize the excellent work done by such groups as the

Motorcycle Industries Council[1] to persuade motorcycle dealers and owners to sell and use muffler-equipped motorcycles and to operate them in a manner that will not result in excessive noise. However, we feel that all but the quietest motorcycles are louder than they need to be, from a technical point of view, and believe that with continuing effort, the motorcycle industry could produce motorcycles that emit no more than 75 dbA at 50 feet under maximum noise conditions. Indeed, according to the Motorcycle Industry Council's own testimony, at least three popular motorcycles now meet this criterion.[2]

We, therefore, recommend a Federal standard for all motorcycles sold in the United States of 75 dbA under these conditions, effective in no more than four years. The possibility of further reductions should be studied.

One possible impediment to the development of a quiet motorcycle is the lack of a universal standard for the measurement of motorcycle noise. We, therefore, recommend that the Environmental Protection Agency immediately start work on establishing a noise measurement method for motorcycles and, for that matter, for snowmobiles and other off-road vehicles, taking into account the excellent work done so far by the Society of Automotive Engineers and other similar organizations.

The club recognizes that motorcycles have a legitimate place in undeveloped areas. However, we believe that motorcycles should be excluded from all wilderness areas, all wild and primitive areas, and all National Parks, except on established motor vehicle roads, and we believe that in other areas motorcycles should be restricted to established roadways except where it is definitely shown that their off-road use will not be of detriment to any aspects of the land.

1/ Motorcycle Industries Council, Inc., Raymond Lucia, 1001 Connecticut Ave., Washington, D. C. 20036
Motorcycle Owners, Riders, and Enthusiasts, Russ Sanford, P. O. Box 26062, Sacramento, California 95826

2/ "Noise Control - Hearings before the Subcommittee on Public Health & Environment, June 1971, Serial No. 92-30," p. 449. Government Printing Office, Washington, D. C. 20402

It is well established that many motorcycle riders remove the effective muffler from their machines, in the mistaken belief that this will increase the power of their equipment. We, therefore, recommend a study into the motivations of such thinking and an educational program in conjunction with industry groups for the elimination of this type of thinking and activity. Tests have shown that carefully engineered exhaust mufflers do not reduce power from most small engines. Actually, power may be increased if the exhaust system is properly designed.

Perhaps the most serious noise hazard faced by wilderness areas throughout the United States is that presented by the snowmobile and the all-terrain vehicle. Whereas motorcycles and other motor vehicles are largely limited to trails and roads, snowmobiles have nearly absolute freedom throughout the winter forest. The damage that they do to wildlife and flora has been the subject of much research, but as of now, this damage can only be estimated. The effect on wildlife of the noise from these machines may be devastating. Imagine, for example, what must happen to the physiology of a hibernating bear when he is awakened by a charging pack of snowmobilers outside his cave.

The snowmobile industry has generally conceded that it will soon produce snowmobiles to the SAE standard of 82 db measured at 50 feet. (See SAE J192). The 82 dbA at 50 feet standard has been adopted, or will become effective for 1973 models, in Canada, New York, Minnesota, and Illinois. Other states are considering similar legislation. We do not feel that this is sufficient, but that a 70 db snowmobile should be required as quickly as is feasible, within certainly no more than three years, with subsequent reductions of noise level in years following.

Exactly what would this 12 db reduction mean?

The background level of the average forest is approximately 45 dbA. An 82 db at 50 foot snowmobile, then, is inaudible at 1,000 feet, whereas a 70 db snowmobile would be inaudible at only 375 feet. Both distance estimates are probably conservative. Recent work done in Canada suggests that an 82 db snowmobile is audible at distances nearly twice those mentioned. Under special conditions such as very still winter forests, these snowmobiles are audible at much greater distances.

The following table gives hypothetical "vanishing distances," that is, the distance one must be removed from a snowmobile before it is inaudible in a 45 db background. A "terrain loss" of 2 db per hundred feet is assumed. It is also assumed that at distances greater than 500 feet, sound is propagated over the top of trees, so the maximum loss due to the forest is 10 db. Since most of the energy of snowmobile noise is concentrated below 1,000 Hz the assumption that molecular losses in air are about 0.1 db per hundred feet is reasonable.

Snowmobile Noise Level at 50 Ft.	Approximate Vanishing Distance, Feet
92	2600
82	1000
75	500
70	375
65	270
60	185

Research done by the National Research Council of Canada indicates that a 70 dbA at 50-foot noise level could probably not be achieved with existing designs of snowmobiles, thus major redesign would be necessary. However, the California legislature is considering, and Montana has passed, bills requiring snowmobiles and all-terrain vehicles manufactured after January 1972 to achieve a sound level of no more than 75 dbA at 50 feet.

The Sierra Club firmly believes that snowmobiles and all-terrain vehicles must be restricted to established roadways and tracks unless it can be definitely shown by the land managing agency that their off-road and trail use would not be detrimental to the environment. They must be rigidly excluded from all wilderness areas. We feel that in a majority of even non-wilderness outdoor recreation areas the noise pollution aspects of these vehicles makes them unsuitable for use except in locations set aside especially for their exclusive enjoyment.

In general, if I had to characterize the feelings of non-motorized remote area users towards any vehicle noise in two words, I would say "extremely negative." The intrusion of this noise into the "wilderness experience" might be illustrated by a recent personal encounter. I was climbing along the shoreline north of Ensenada in Baja, Calif. All I could hear were gulls and waves. I was completely immersed in my surroundings, completely happy with a restorative kind of happiness that only those who love wild places can know. The eternity of the sea and the majesty of the cliffs had taken me away, at least for a little while, from the cacophony of our current life style. Then, even louder than the ocean, a trio of motorcycle riders appeared on the edge of the cliff. They were having a great time, romping over the plain. But the presence of their noise ruined my enjoyment of the place. I resented their noise, I resented them--and remember, I am a motorcyclist myself.

In summary, the Sierra Club believes that all mechanical equipment and its attendant noise should be rigorously excluded from all wilderness areas, all wild areas, and all National Parks. We believe that the motorized outdoor recreationist has a legitimate place, but that his equipment must be silenced and he should be limited to those areas in which the noise of his machinery is not detrimental to the environment. Freedom from unnatural noise is a major feature of wilderness. Most wildernesses are held in public ownership. The encroachment upon that freedom by any group or individual has the effect of reducing or destroying the essence of wilderness, which must be preserved.

. . . .

DEVELOPMENT REPORT ON 24-INCH RECTANGULAR OVERSIDE DRAIN

By D. D. McCarthy, Civil Engineer
Angeles National Forest

In the granitic soils of southern California it is common practice to use overside drains for most roadway drainage and, in many cases, cross drainage. The overside drain is generally an inlet structure to collect the water off the roadway and funnel it through the road berm into a flume down the fill slope to a natural drainage channel. In the past, numerous types of structures have been used. One by one they have evolved, been used, and then discontinued, for reasons of either economics or inefficiency.

The types most widely used by the Forest Service have been the Mueller apron and flume, the corrugated metal half-round flumes, and most recently the 12-inch rectangular corrugated metal flume and inlet, commonly referred to as the Type "D".

The Mueller apron and flume was a very good structure. It had excellent inlet flow qualities but the flume did create problems from a maintenance standpoint. The flume was 8 inches wide and 12 inches deep. It was too narrow to clean out with an ordinary shovel when the flume began to plug from brush and debris. The 8-inch width of flume made it susceptible to plugging by debris and brush coming into it from the sides and from the roadway. Fabrication of the Mueller was special ordered because it was not mass produced. Because the configuration required many individual hand operations during the manufacturing its cost was relatively high. The cost was about $57.00 per apron (inlet section) in the early to middle 1950's. The present estimate of cost ranges from $80-$100 per inlet section.

The corrugated metal half-round flumes, currently in use, have a number of undesirable features only partly balanced by their availability. The most undesirable characteristic is the flow condition at the inlet. The half-round inlet has a sharp-edged orifice causing a turbulent flow resulting in splashing, and jumping in the first few feet of the flume. Water also ponds at the inlet as a head is built up to overcome the entrance loss. The ponding action reduces the velocity of the water which allows debris to deposit at the inlet. As debris is deposited, a chain reaction of debris catching more debris which diverts the flow against the berm and results in either plugging of the inlet or washing the berm from around the inlet structure. In order to make the half-round inlets function and to prevent berm failure, it is necessary to do extensive inlet reinforcement and berm protection work. Soil-cement sack walls which are sometimes given a cement-sand mortar plaster coat to improve appearance and to improve inlet flow conditions are usually used for reinforcement and protection. Another commonly used method of reinforcement is asphalt-concrete mix placed over the natural soil berm. Recently several alternate methods of inlet-berm protection have been tried. One method is a cement-sand or soil-cement mortar reinforced with wire mesh and placed on the natural soil berm. A trial installation of Kaiser Chemicals Poly-Urethane material sprayed on a compacted soil berm is currently being evaluated. These methods all are functional if properly applied but they all have serious drawbacks. The soil-cement sack walls are very, very expensive to install. The other methods are more economical but present maintenance problems because they are all subject to cracking when hit by grader blades or under wheel loads of trucks. The Poly-Urethane method has not been in service long enough for full evaluation but it has been damaged by vandals on one of the test installations.

The Type "D" is a corrugated galvanized metal flume with a 12-inch bottom and 8-inch sides. The corrugations are parallel to the direction of flow. The inlet is a galvanized sheet metal taper with an inlet width of 18 inches and a height of 12 inches. The structure as presently used has poor inlet flow qualities causing a turbulent flow condition in the first 15 feet of the flume. With an improved inlet design it will be a very good intercepting dip drainage structure for flows not exceeding 3 c.f.s. clear flow.

With the thought in mind of developing a satisfactory overside drainage structure using available material and a design which conforms to current manufacturing techniques, Angeles National Forest Engineers went to work on the problem. A local fabricator of corrugated metal products (Pacific Corrugated Culvert Company) expressed interest in the project and offered the cooperation of its shops toward the development of a satisfactory overside drainage structure. Through an exchange of information concerning the field problems involved and a discussion of what was desired in the way of a structure, what stock materials were available and the manufacturing processes, an understanding was reached by those involved as to what was desired and the methods available to obtain the desired product.

With this information gleaned from the previous conferences, the Forest Service began work on the design of an inlet structure. It was possible to design with economy in mind by knowing what processes were readily available and what stock materials were available. Using 16-gage corrugated steel culvert stock sheets 37-1/2 x 76 inches with 2 2/3 x 1/2-inch corrugations as a basic size, an inlet structure was designed. The sheets were formed on a 28-inch radius to form the inlet sides and wings for berm protection. The bottom of the inlet and the cutoff to prevent undercutting were of smooth galvanized 16-gage sheet metal. The bottom and cutoff were from a single piece of standard stock material which minimized waste of material. The inlet bottom and cutoff plate were welded to the curved wings with one continuous weld on the inside. This method of fabrication and assembly was the most simple and economical way of manufacture in comparison with other alternatives and resulted in a structure rigid enough for field use and still light enough to be handled by two men.

The bottom of the inlet was placed on a 1-1/2:1 slope which is the maximum slope that should be constructed in the granitic soils where these structures were planned for use. This drop within the throat of the inlet discourages lodging of debris and prevents, to a large extent, ponding action on the roadway. This theory during the design stage was verified by subsequent field testing.

A starter section was designed with built-up sides using the corrugated galvanized 16-gage stock material in standard stock sizes for economy. Material waste and labor processes were held to a minimum for economy.

The flume was simply designed using stock culvert sheets 48-1/2 inches wide, giving a 24-inch wide flume with 12-inch sides. The flume sections were 117 inches long. Each of the starter sections used half a flume section with built-up sides of 25-1/2 x 60 inches culvert sheet stock cut diagonally.

The cost of the inlet and starter section is $51. 40 and the flume costs $1. 75 per lineal foot.

Three inlets were fabricated and installed on the Los Pinetos Road #3N17. The installations were as easily made as with the half-round aprons and no flumes nor headwall berm protection was done. The savings by not having to do inlet proection work amounted to $75. 00-$100. 00 per structure.

The comparison of costs, installation being equal, between the 24-inch rectangular and 36-inch, 30-inch and 24-inch half-rounds is as follows:

Overside drainage structure with 80 feet of flume (typical):

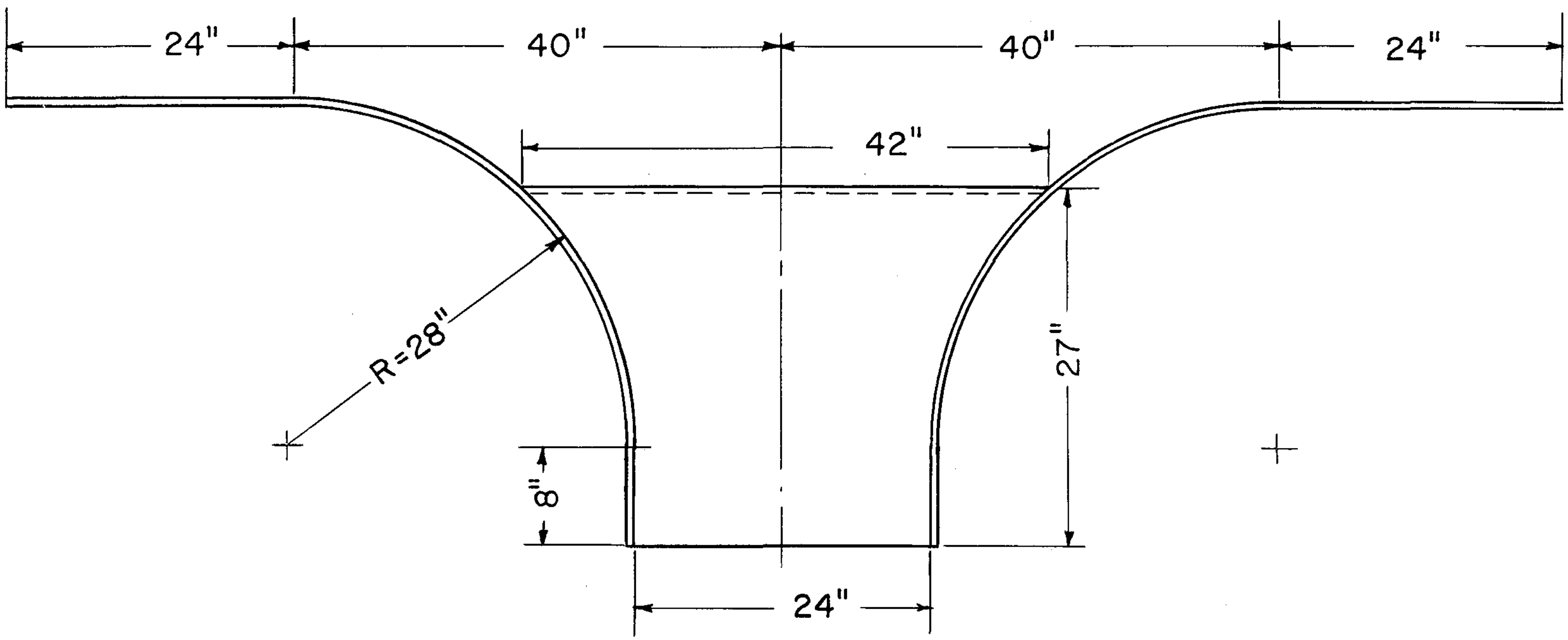
	Rect.	Half-round flumes		
	24-inch	36-inch	30-inch	24-inch
Inlet & starter	$ 51.40	$ 38.90	$ 27.88	$ 19.35
Flume	140.00	180.00	150.40	123.20
Inlet & berm protection	--	75.00	65.00	50.00
	$191.40	$293.90	$243.28	$192.55

It can, therefore, be justified economically to replace the 24-inch, 30-inch and 36-inch half-round drainage structures with the 24-inch rectangular inlet and flume.

On the basis of the field test of the 24-inch rectangular inlet and flume when it was subjected to a low in excess of 1,000 gal. per min. or 2.31 c.f.s., it is believed that the structure would have handled three times that quantity as a conservative estimate, or about 7 c.f.s. clear flow. The flow pattern into the inlet and through the flume was very smooth, with virtually no turbulence, jump or splash. In every way it outperformed the designers' expectations, and some possible problems which had been anticipated did not develop. It matches any previous design, including the Mueller, for performance and is economically far ahead of anything of comparable capacity.

These flumes generate flows of high velocity; therefore, if the outlet is not on a solid rock surface, an artificial energy dissipator should be installed to prevent erosion at the outlet of the flume.

A common problem of all overside drainage structures is that of erosion alongside the flume by water collected on the slope. Soil cement sack checks laid alongside the flume at about 15-foot intervals to divert the surface flow into the flume will stop the erosion. Usually one or two sacks are sufficient at each check point. See figures 1 through 12.



PLAN VIEW

FIGURE I.--INLET SECTION FOR 24 INCH RECTANGULAR FLUME

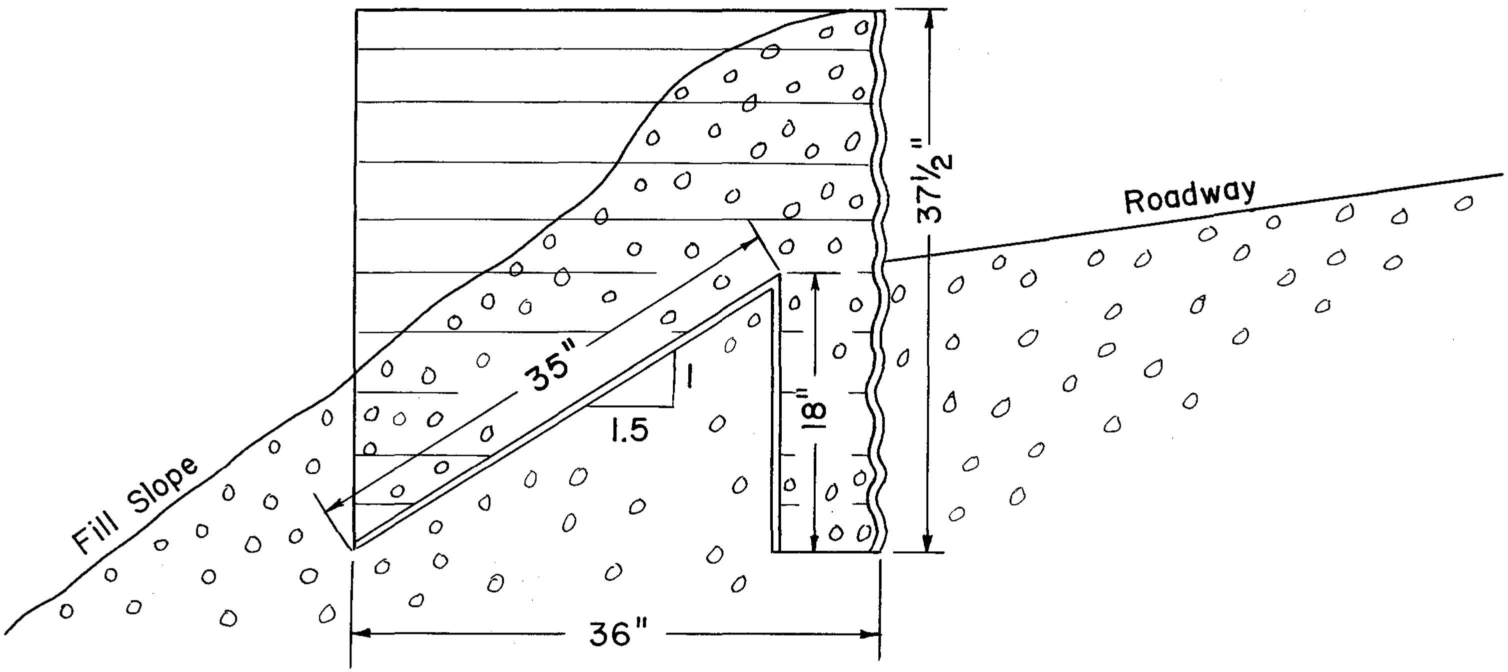


FIGURE 2.--ELEVATION-SIDE

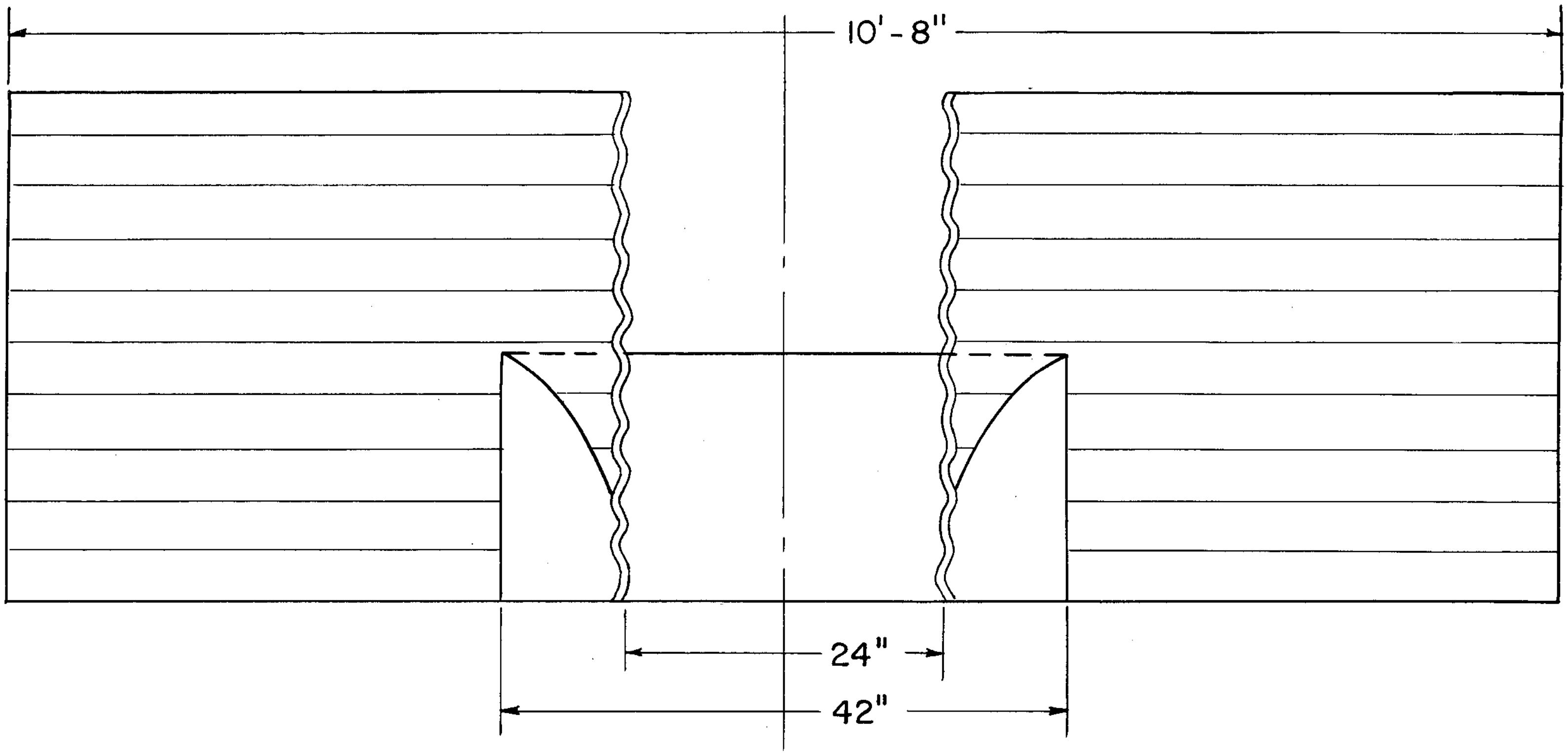
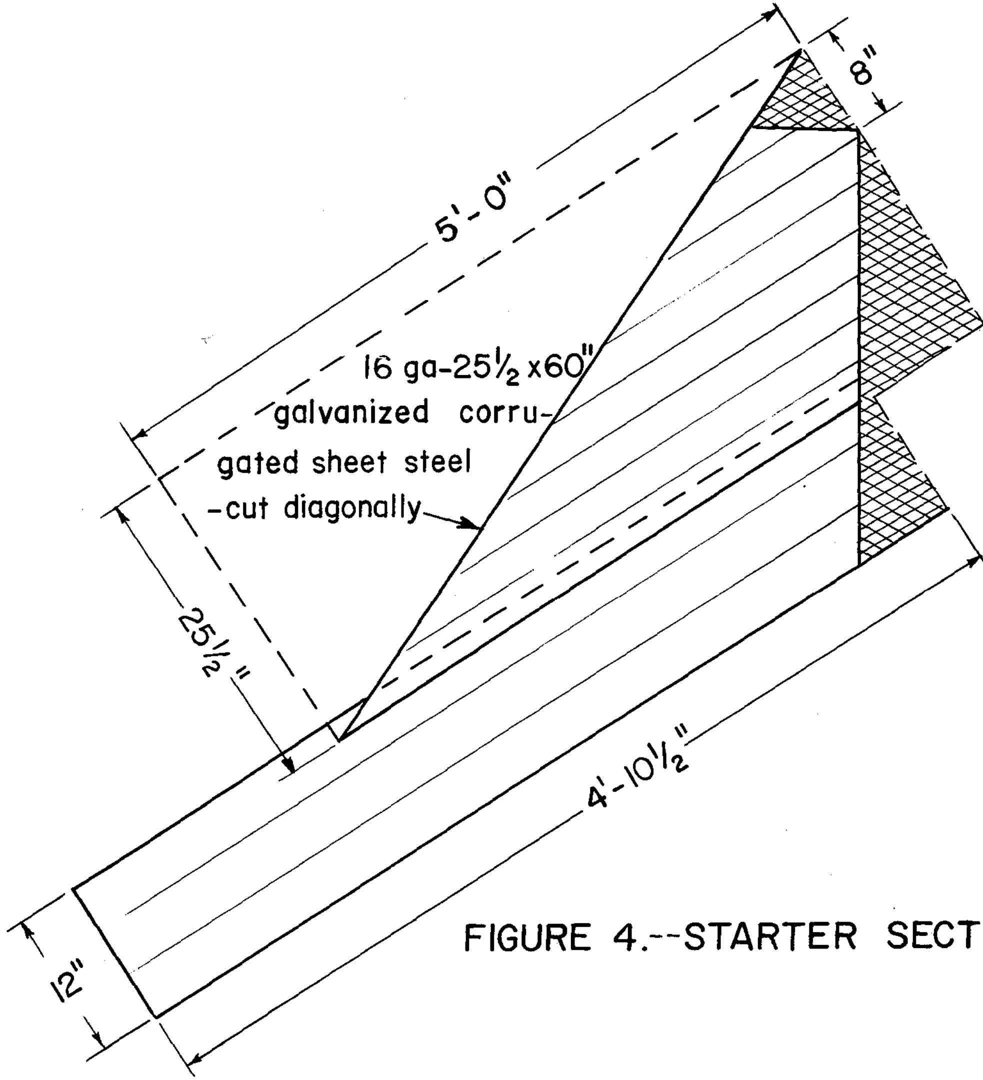


FIGURE 3.--ELEVATION-FRONT VIEW



Note :
cross-hatched
is waste

FIGURE 4.--STARTER SECTION

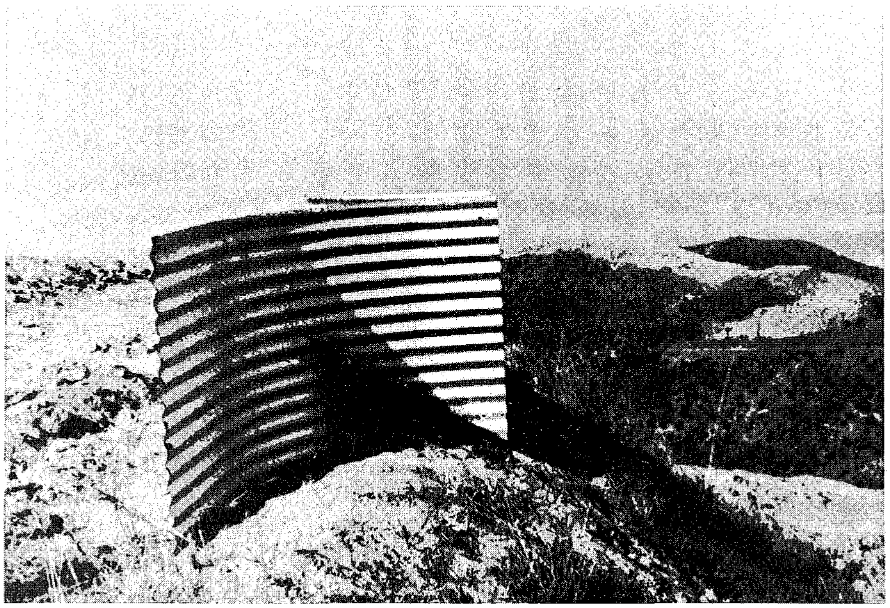


Figure 5.--Side view of the 24-inch rectangular flume inlet structure designed and constructed for installation on 1-1/2:1 slope.

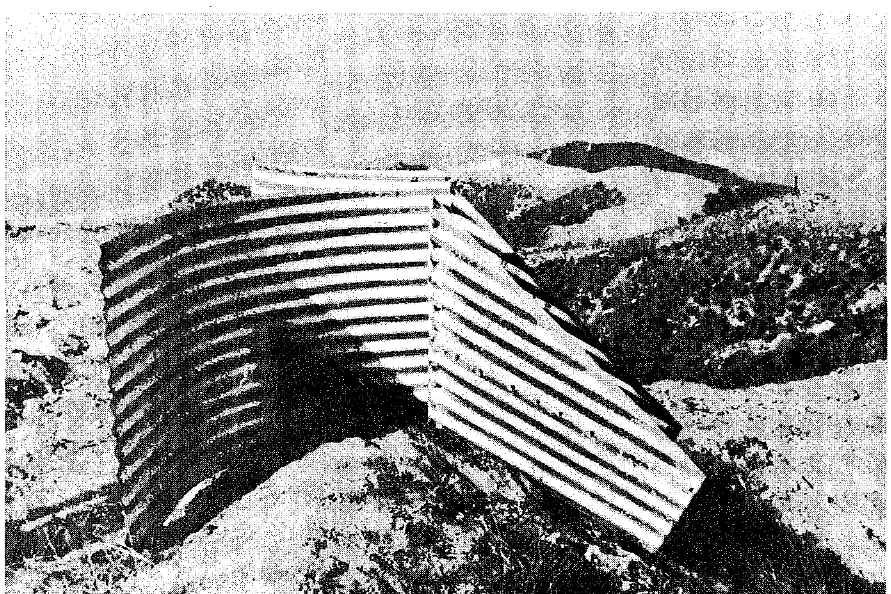


Figure 6.--Inlet and starter section for 24-inch rectangular flume.

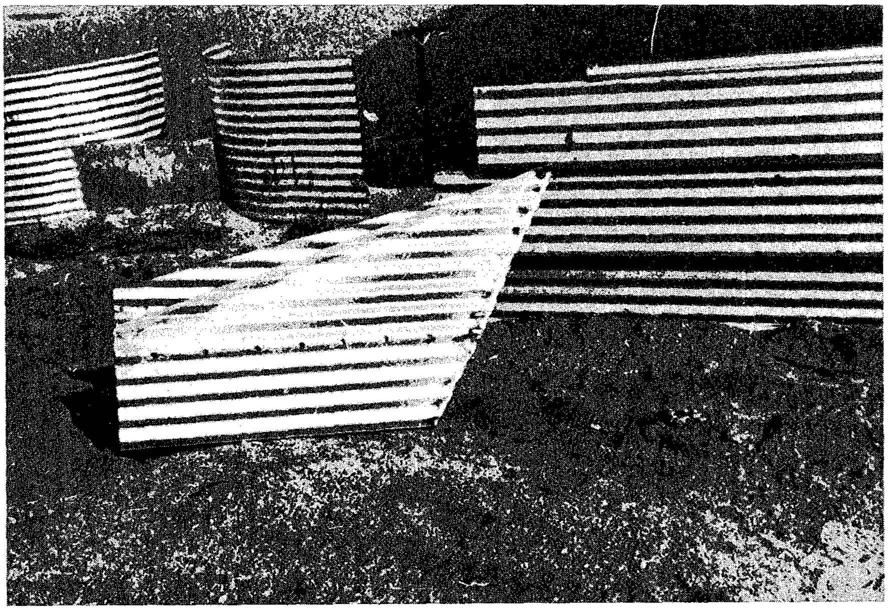


Figure 7. --Unassembled starter section in foreground and inlet structure in background. Note toe-cutoff plate extends to bottom of wings.

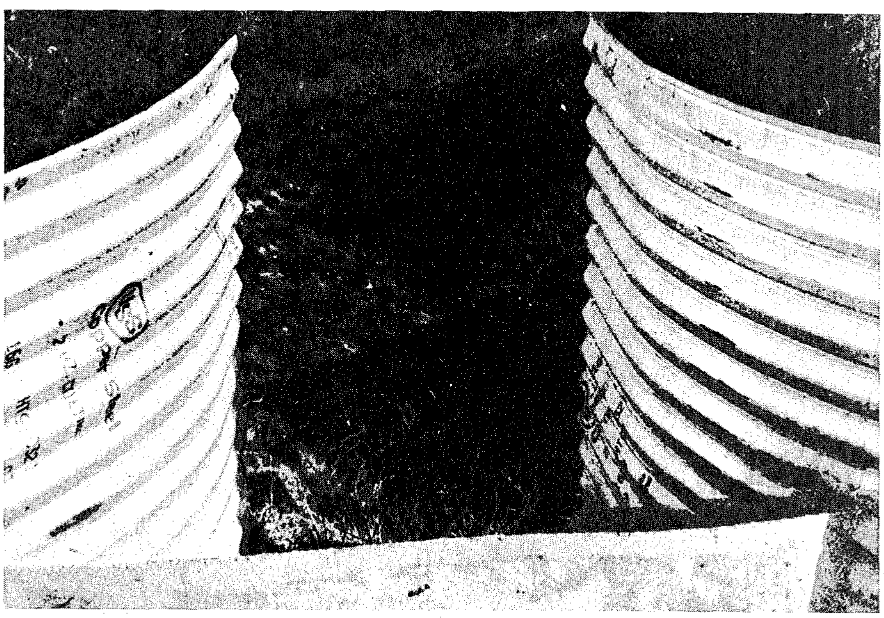


Figure 8. --Throat of inlet. The cutoff plate and bottom of inlet throat will be of a single piece of sheet metal in future structures. A machine break will replace the welded angle joint used in this prototype model.

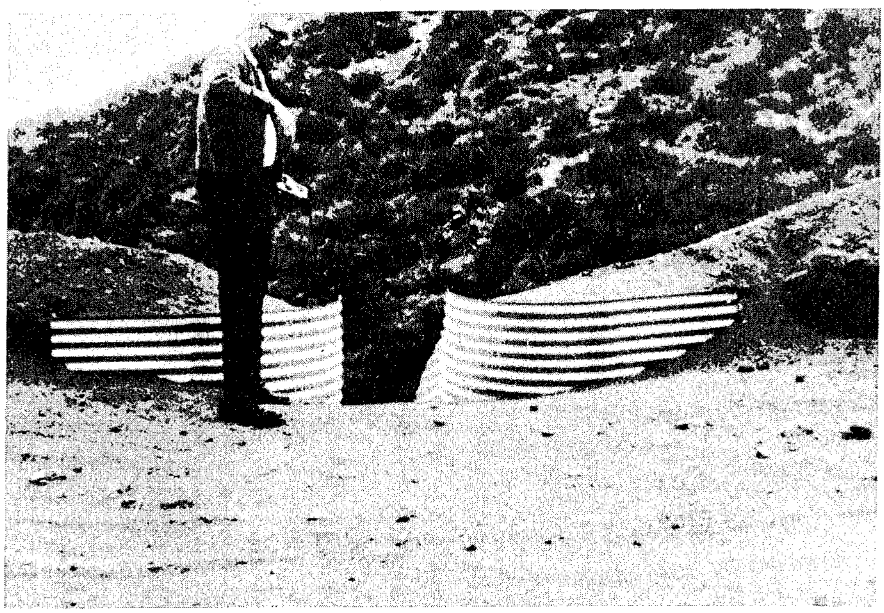


Figure 9. --Installed 24-inch rectangular flume inlet structure.

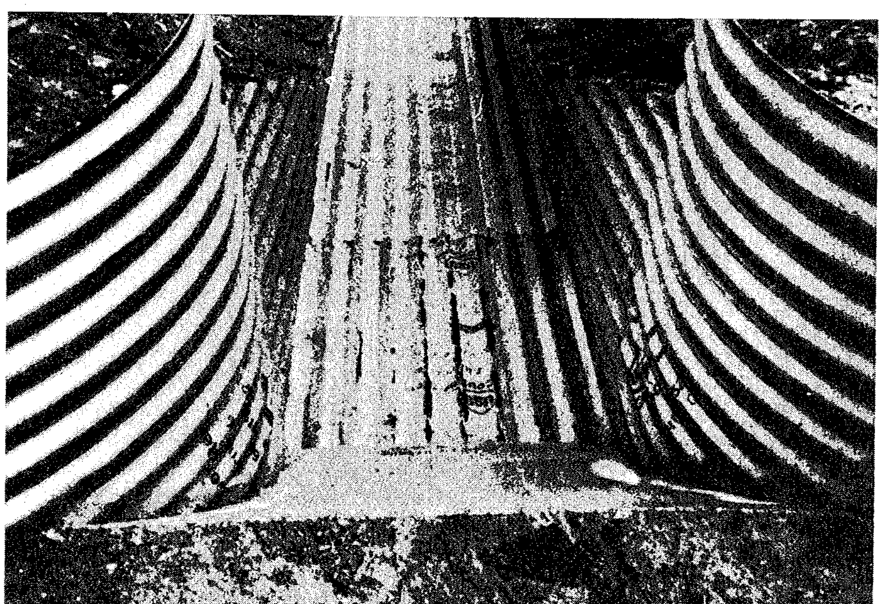


Figure 10. --Steep drop in throat of inlet provides initial acceleration for debris to prevent plugging by debris accumulation.

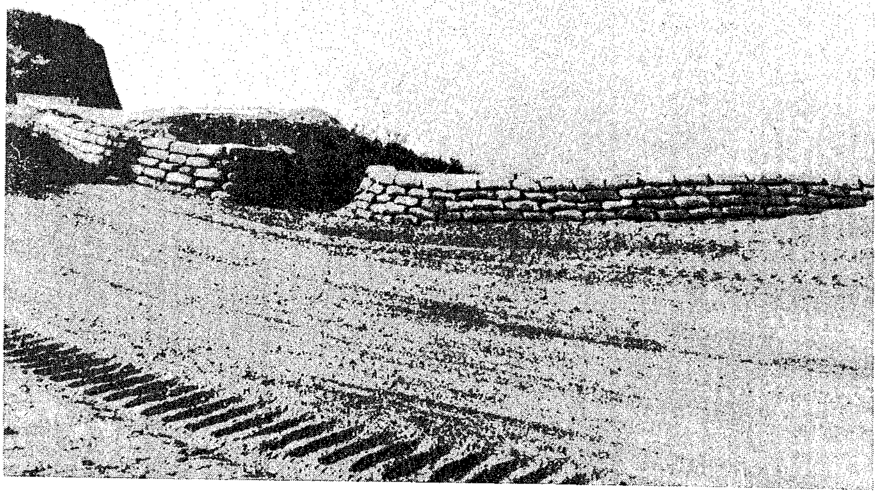


Figure 11. --Soil-cement sack inlet for half-round flume.

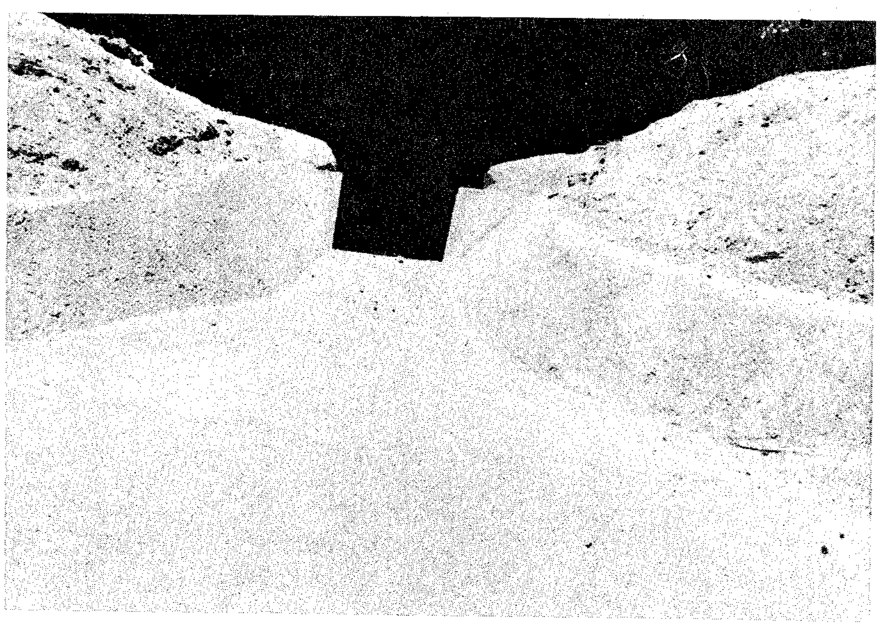


Figure 12. --Soil-cement inlet for 12-inch rectangular flume presently in use.