

UNITED STATES DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE

---

Washington, D. C. 20250

Advisory ENG

To: State Conservation Engineers  
Heads, EWP Units

From: C. J. Francis, Director, Engineering Division

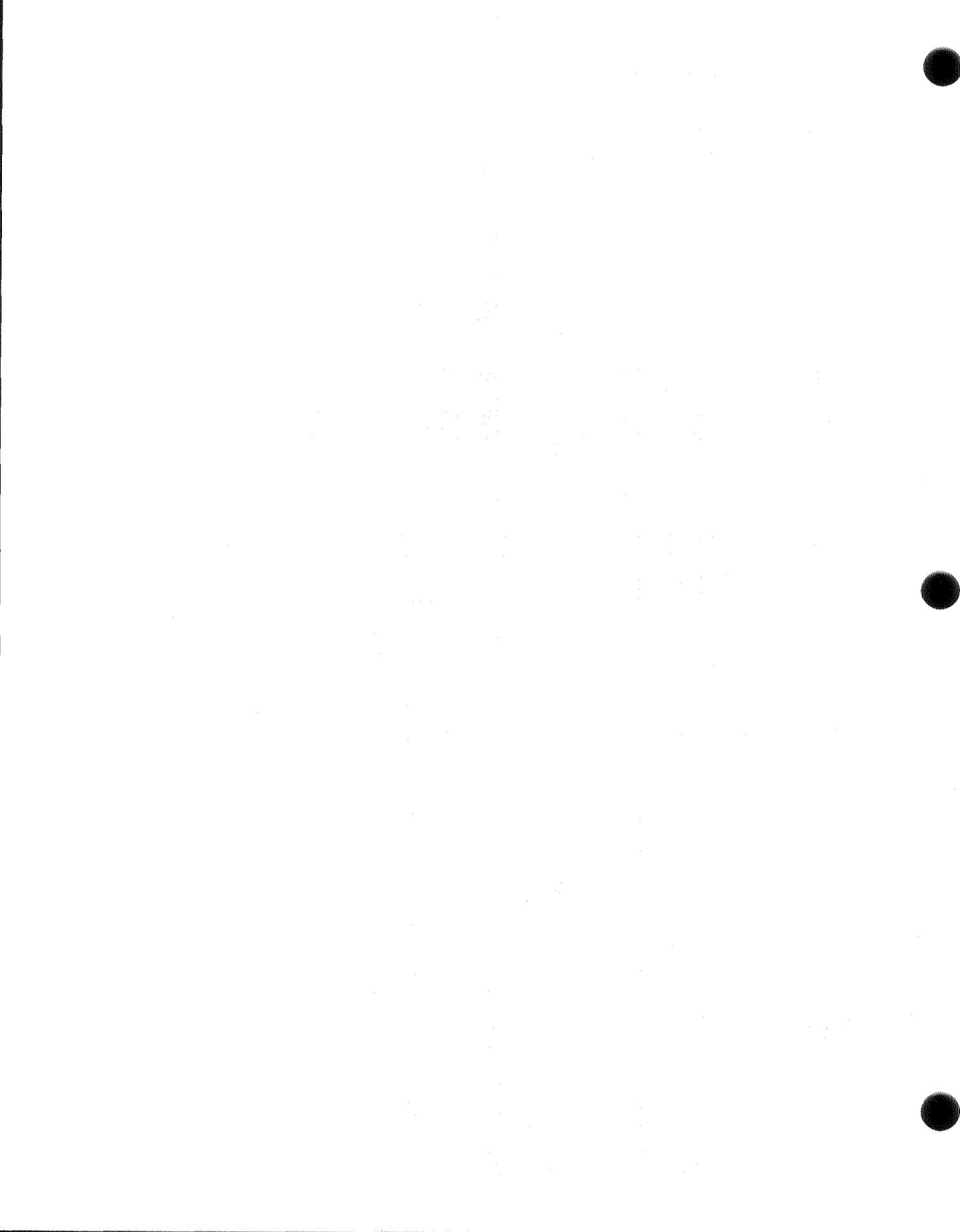
Re: Soil Mechanics Note No. 2: Lightweight Piston  
Sampler for Soft Soils and Loose Sands

One copy of Soil Mechanics Note No. 2: Lightweight Piston Sampler for  
Soft Soils and Loose Sands is attached. Extra copies may be ordered  
from the EWP units.



Attachment

STC  
EWP  
WD



August 1969

Soil Mechanics Note No. 2: Lightweight Piston Sampler for Soft Soils  
and Loose Sands

This technical note describes the adaptation and use of a lightweight piston sampler to collect undisturbed samples of soft clay and organic soils and saturated sands.

This sampler is an adaptation of one described by Harry R. Lee, Jr. in "Civil Engineering", July, 1963.

The sampler consists of a thin-walled sample tube with a special head for attachment to the drill rod. An O-ring on the head provides a seal with the sample tube. The head is vented with a 1/8-inch diameter hole to allow application of air pressure or vacuum to the interior of the tube. Attached to the head with a flexible cable is a 2-inch thick piston, also sealed with an O-ring, that is free to move up and down in the tube.

Figures 1 and 2 show details and dimensions of the sampling tube and piston.

During sampling operations, air pressure is applied through the sampler head to hold the piston in place at the bottom of the tube while positioning the sampler. After the sampler has been positioned at the bottom of the hole, the air pressure is released and the sampler is pushed into the soil. The piston moves upward with the intruded sample. In very soft soils, a slight vacuum is applied to the sampler as it is pushed to provide free rise of the piston without compressing the sample.

A slight vacuum is also applied to the system as the sampler is extracted from the hole to assist in retaining the sample in the tube.

Pressure and vacuum are provided by a portable, lightweight, hand-operated, double-acting, diaphragm pump connected to the sampler with polyethylene tubing.

Figure 3 shows the sampler and accessory equipment.

This sampler is lightweight and portable and can be hand-carried into marsh and bog areas not accessible to heavy equipment. It can be operated entirely by manual means to sample soft soils to depths of 8 to 10 feet. For sampling greater depths, an "A" frame with pull down rigging is recommended.

-----  
This Note prepared by the Staff, Soil Mechanics Unit, SCS, Lincoln, Nebraska,  
under direction of Rey S. Decker, Head, Soil Mechanics Unit.

It is not intended that this sampler serve as a substitute for conventional piston samplers where the latter can be used. It can be used, however, with light drilling equipment that is not capable of handling conventional piston samplers.

The sampler has been used to collect several good samples of saturated peat, OH and OL soils with natural moisture contents of 75 to 600% and dry densities of 10 to 55 pcf. It has also been used to collect good samples of loose, fine sands below the water table - SP and SM with standard penetration resistance values of 2 to 5 blows per foot. However, mechanized equipment is generally required to push the sampler into sandy soils.

Figures 4 and 5 show samples collected in coastal plain marshes of Louisiana and Maryland.

It should be emphasized that extreme care must be exercised in handling and transporting all samples of soft or loose material, such as those that can be collected with this sampler. Samples should be kept in an upright position and protected from vibration and shock.

#### Operating Notes

1. When assembling the sampler, the lower portion of the sample tube and the O-rings on the piston and the adapter head should be lubricated.
2. After assembling, it will probably be necessary to apply air pressure to force the piston to the bottom of the tube. Be sure that the piston does not become wedged at the bottom of the tube. Proper adjustment of the piston cable stop will eliminate this problem.
3. Apply air pressure to the piston while positioning the sampler in the hole. When sampling below the water table, approximately 0.5 psi pressure per foot of water depth will be required to hold the piston in place at the bottom of the tube. After positioning the sampler, release the pressure by opening the exhaust valve on the pressure tank or by depressing the valve in the end of the "quick connect" coupling. Uncouple the air line from the pressure side of the pump and connect it to the vacuum side.
4. Pushing the sampler into the soil should be accomplished by a slow, uniform thrust. In very soft soils, a partial vacuum should be applied to the piston as the sampler is pushed. This action counteracts the friction of the O-ring seal on the piston and starts the upward movement of the piston. It is desirable to retract the piston at about the same rate as the downward travel of the sampler.
5. Do not over push the sampler. Careful measurement of the length of drive will prevent this danger.

6. When the sampler has been pushed to the desired depth, rotate the sampler two full turns to shear the material at the end of the tube.
7. Apply or maintain a partial vacuum on the piston as the sampler is extracted from the hole. After extraction, insert an expanding packer in the bottom of the tube and release the vacuum. Carefully separate the sample tube from the adapter head. Remove the vacuum release screw from the piston head and carefully extract the piston from the tube by means of the cable attached to the adapter head. The sample tube should be maintained in a near vertical position from the time the sample is pulled through arrival at the testing facility.
8. The piston will not operate properly if sample tubes are dirty, rusted, dented, or distorted.

Special Components (see Figures 1, 2 and 3)

| <u>No.</u> | <u>Description</u>  | <u>Suggested Source</u>   | <u>Quantity</u> | <u>Approx. Unit Cost</u> |
|------------|---|---|-----------------|--------------------------|
| 1<br>1a    | Adapter head and<br>Aluminum Piston   | Local machine shop  | 1               | \$50                     |
| 2          | Sample tube, stainless steel or steel welded, flash removed, cadmium plated -- 3" OD, 2-7/8" ID, 17-1/2" long | Local machine shop  | varies          | \$12-\$18                |
| 3          | Pressure - vacuum pump:<br>Model 2008 Bennett Barrel Pump   | John Wood Co.,<br>Bennett Pump Division,<br>Muskegon, Mich.<br>(only known source)  | 1               | \$37                     |
| 4          | Air Tank: Non-shatterable,<br>500 cu.in. volume   | Local sources<br>(Army surplus)   | 1               | \$25                     |
| 5          | Combination pressure-<br>vacuum gage, 3-1/2" dial,<br>0-30 lbs. pressure and<br>0-30" vacuum                  | CENCO,<br>1700 Irving Park Road,<br>Chicago, Ill. 60613<br>Catalog No. 94035 or<br>equivalent                                 | 1               | \$10                     |
| 6          | 1/4" plug shutoff valve<br>with open exhaust for<br>air tank  | Circle Seal Products<br>Co., Inc., 2181 East<br>Foothill Blvd.,<br>Pasadena, Calif.<br>Part No. 9559B - 2MMQ<br>or equivalent | 1               | \$ 5                     |

| <u>No.</u> | <u>Description</u>                        | <u>Suggested Source</u>   | <u>Quantity</u>              | <u>Approx.<br/>Unit Cost</u> |
|------------|---|---|------------------------------|------------------------------|
| 7          | Quick-disconnect<br>couplers              | Local automotive<br>parts store   | 4 (complete)<br>1 (male end) | \$ 2.25                      |
| 8          | Air Hose                                  | Gates #4320 or<br>equivalent  | 3'                           | .50                          |
| 9          | Polyethylene tubing<br>5/16" OD, 3/16" ID | Bel-Art Products,<br>Paquannock, New Jersey<br>or numerous other<br>sources supplying<br>plastic tubing | ± 75'                        | .07                          |

Total cost of sampler - excluding sample tubes and carrying case -  
approximately \$150.

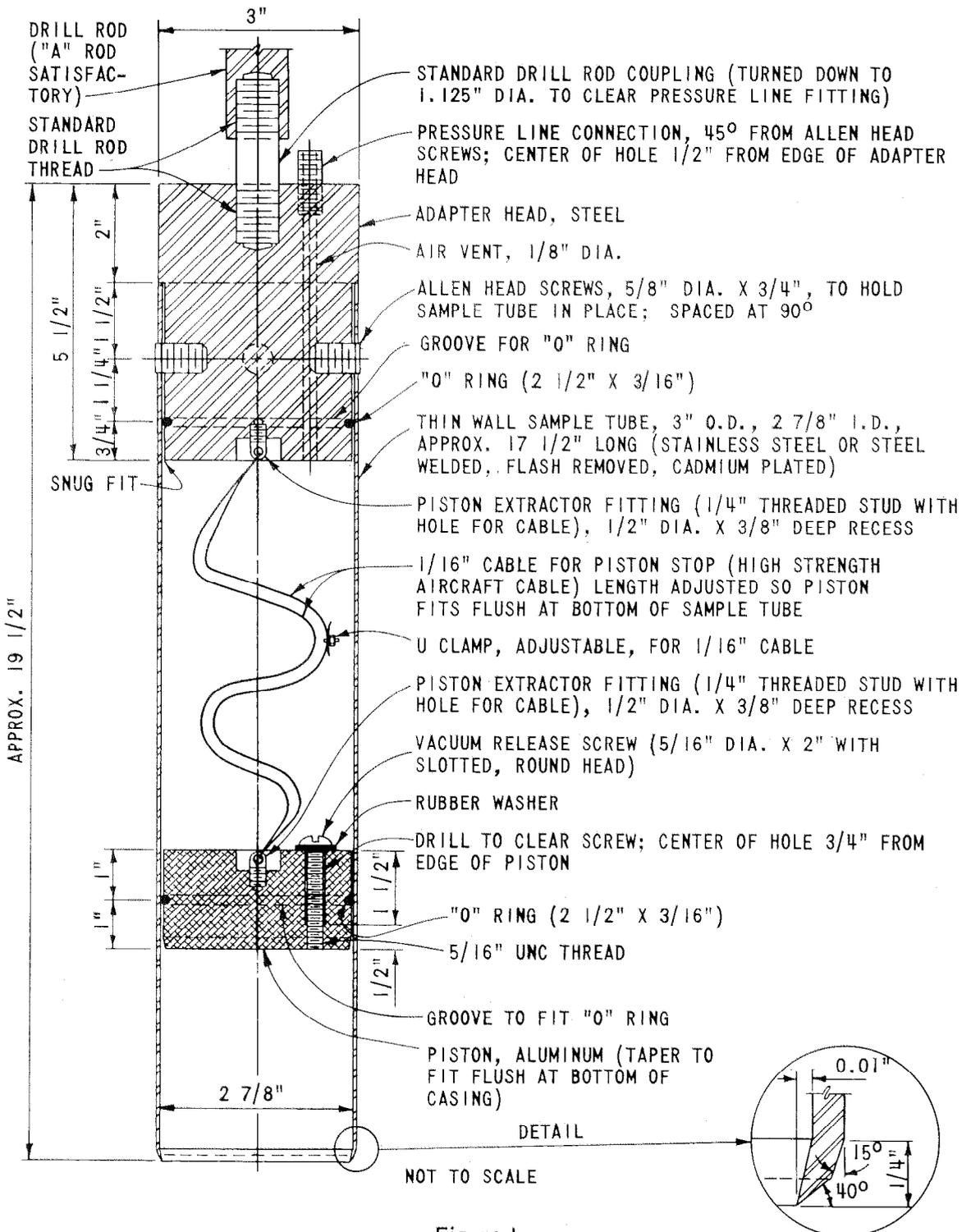


Figure 1.

## LIGHT WEIGHT PISTON SAMPLER FOR SOFT SOILS

(Adaptation of sampler by Harry R. Lee Jr. — *Civil Engineering*, July 1963)

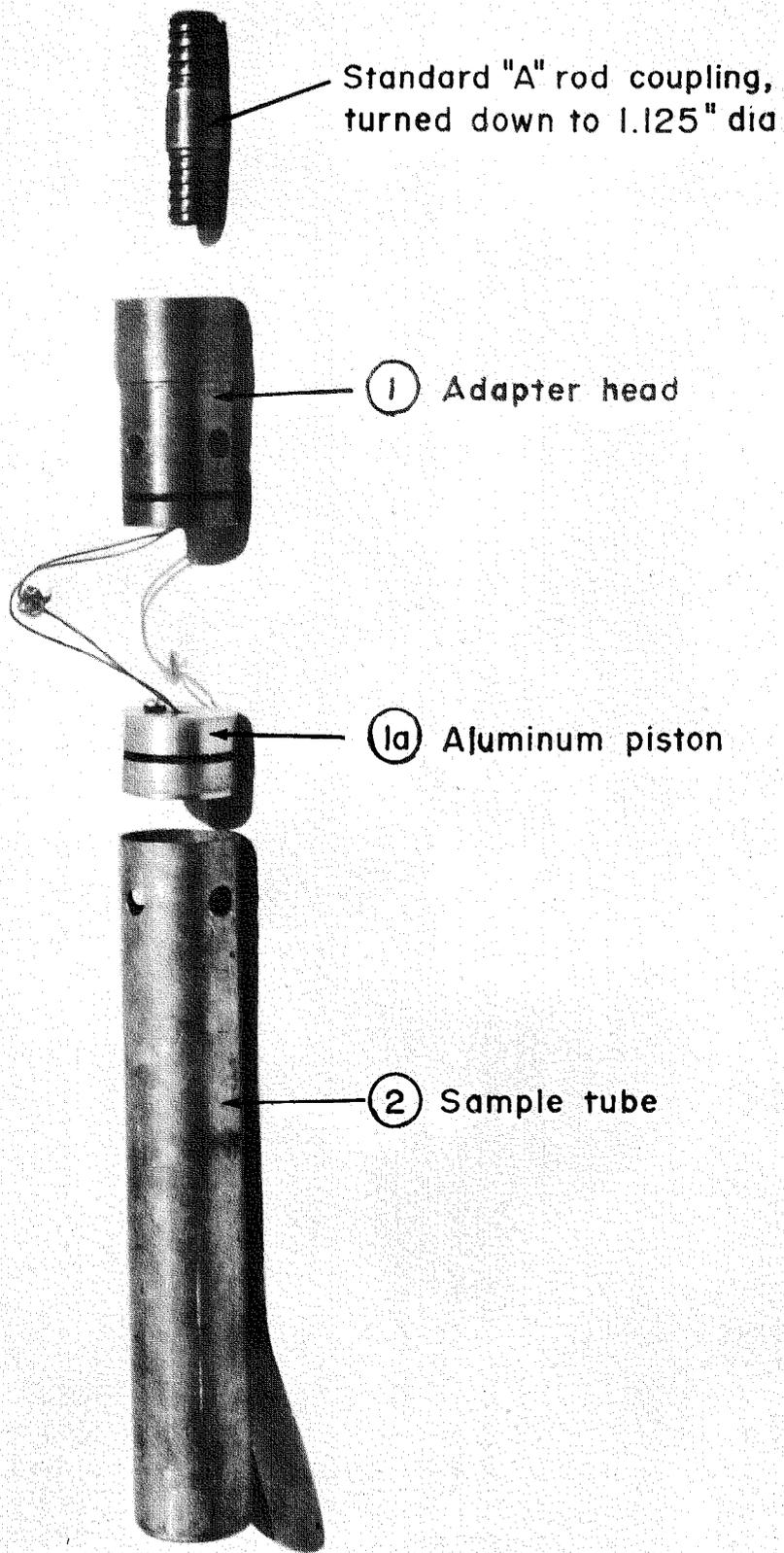


Figure 2

LIGHT WEIGHT PISTON SAMPLER  
SHOWING ADAPTER HEAD, PISTON, SAMPLE TUBE

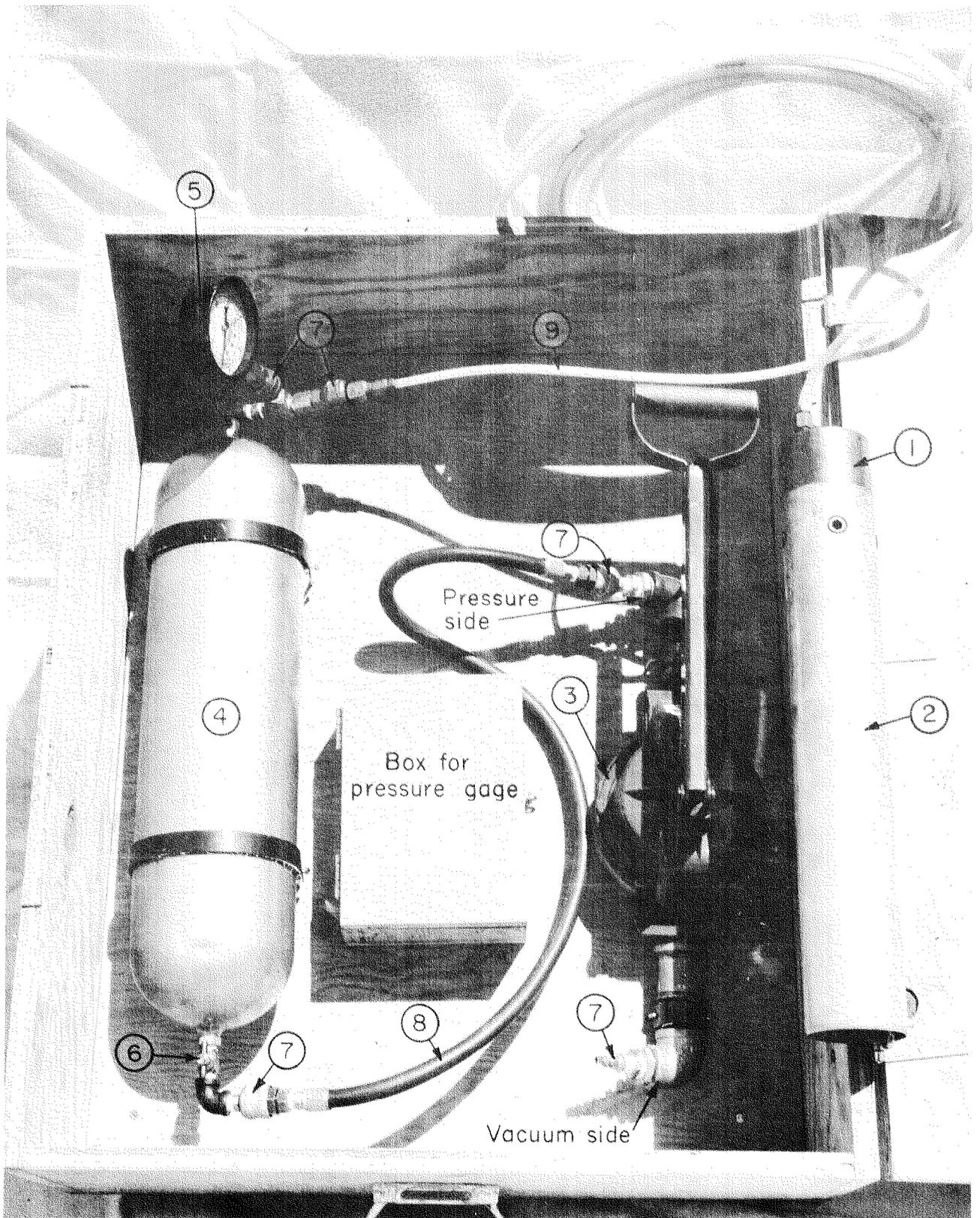
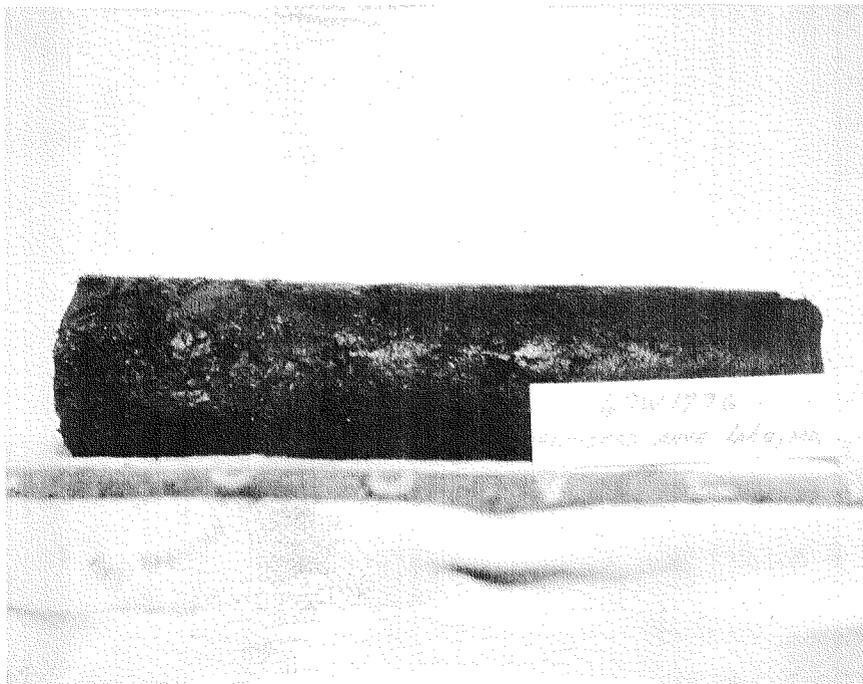


Figure 3  
LIGHT WEIGHT PISTON SAMPLER  
WITH PRESSURE-VACUUM ACCESSORIES



|                                |                                      |
|--------------------------------|--------------------------------------|
| Sample Depth .....             | 10' - 11'                            |
| Classification .....           | OH                                   |
| Natural Moisture .....         | 68-74%                               |
| LL (Natural Moisture) .....    | 75                                   |
| LL (Oven Dry) .....            | 44                                   |
| PI .....                       | 23                                   |
| Dry Density .....              | 55-60 pcf                            |
| Sensitivity (Vane Shear) ..... | 3-4                                  |
| Water Table .....              | 0.5' to 1.5' above<br>ground surface |

Figure 4. Sample from Louisiana Coastal Marsh



Sample Depth ..... 3' - 4'  
Classification ..... OH  
Natural Moisture ..... 150-580%  
LL (Natural Moisture) ..... Up to 120  
PI ..... ± 11%  
Dry Density ..... 10-30 pcf  
Organic Content (Ignition) ..... 30-50%  
Water Table ..... At ground surface

Figure 5. Representative Sample from Maryland Coastal Marsh

