Designation: D 6232 – 03

Standard Guide for
Selection of Sampling Equipment for Waste and Contaminated Media Data Collection Activities[1]

This standard is issued under the fixed designation D 6232; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This guide covers criteria that should be considered when selecting sampling equipment for collecting environmental and waste samples for waste management activities (see Guides D 4687, D 5730, D 6009, D 6051, and Practice D 5283). This guide includes a list of equipment that is used and is readily available. Many specialized sampling devices are not specifically included in this guide. However, the factors that should be weighed when choosing any piece of equipment are covered and remain the same for the selection of any piece of equipment. Sampling equipment described in this guide includes automatic samplers, pumps, bailers, tubes, scoops, spoons, shovels, dredges, coring and augering devices. The selection of sampling locations is outside the scope of this guide.

1.1.1 Table 1 lists selected equipment and its applicability to sampling matrices, including water (surface and ground), sediments, soils, liquids, multi-layered liquids, mixed solid-liquid phases, and consolidated and unconsolidated solids. The guide does not address specifically the collection of samples of any suspended materials from flowing rivers or streams. Refer to Guide D 4411 for more information.

1.2 Table 2 presents the same list of equipment and its applicability for use based on compatibility of sample and equipment; volume of the sample required; physical requirements such as power, size, and weight; ease of operation and decontamination; and whether it is reusable or disposable.

1.3 Table 3 provides the basis for selection of suitable equipment by the use of an Index.

1.4 Lists of advantages and disadvantages of selected sampling devices and line drawings and narratives describing the operation of sampling devices are also provided.

1.5 The values stated in both inch-pound and SI units are to be regarded separately as the standard. The values given in parentheses are for information only.

1.6 This guide offers an organized collection of information or a series of options and does not recommend a specific course of action. This guide cannot replace education or experience and should be used in conjunction with professional judgement. Not all aspects of this guide may be applicable in all circumstances. This guide is not intended to represent or replace the standard of care by which the adequacy of a given professional service must be judged, nor should this document be applied without consideration of a project's many unique aspects. The word "Standard" in the title of this guide means only that it has been approved through the ASTM consensus process.

1.7 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

D 1452 Practice for Soil Investigation and Sampling by Auger Borings[2]
D 1586 Test Method for Penetration Test and Split-Barrel Sampling of Soils[2]
D 1587 Practice for Thin-Walled Tube Geotechnical Sampling of Soils[2]
D 3550 Practice for Ring-Lined Barrel Sampling of Soils[2]
D 4136 Practice for Sampling Phytoplankton with Water-Sampling Bottles[3]
D 4342 Practice for Collecting of Benthic Macroinvertebrates with Ponar Grab Sampler[3]
D 4343 Practice for Collecting Benthic Macroinvertebrates with Ekman Grab Sampler[3]
D 4348 Practice for Collecting Benthic Macroinvertebrates with Holme (Scoop) Grab Sampler[3]
D 4387 Guide for Selecting Grab Sampling Devices for Collecting Benthic Macroinvertibrates[3]
D 4411 Guide for Sampling Fluvial Sediment in Motion[4]
D 4448 Guide for Sampling Groundwater Monitoring Wells[5]

[1] This guide is under the jurisdiction of ASTM Committee D34 on Waste Management and is the direct responsibility of Subcommittee D34.01.01 on Planning for Sampling.

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[2] *Annual Book of ASTM Standards*, Vol 04.08.
[3] *Annual Book of ASTM Standards*, Vol 11.05.
[4] *Annual Book of ASTM Standards*, Vol 11.02.
[5] *Annual Book of ASTM Standards*, Vol 11.04.

TABLE 1 Equipment Selection—Matrix Guide

Equipment (May be used for discrete sample collection)	Water and Waste Water			Sediment	Soil	Waste				
	Surface Water	Ground Water	Point Discharge			Liquid	Multi-Layer Liquid	Mixed Phase Solid/Liquid	Consolidated Solid	Unconsolidated Solid
Pumps and Siphons										
Automatic Sampler—Non volatiles	*D 6538^G	*D 6538^G	-	-	N	N	N	-	-	-
Automatic Composite Sampler—Volatiles	*		*	-	-	-	-	-	-	-
Air/Gas Displacement Pump		*D 4448^G	*	-	-	-	*	-	-	-
Piston Displacement Pump		*D 4448^G	*	-	-		N	-	-	-
Bladder Pumps		*D 4448^G	*	-	-	N	N	-	-	-
		D 6771^P		-	-	-	-	-	-	-
Peristaltic Pump	*	*D 4448^G	*	-	-	*	*	N	-	-
Centrifugal Submersible Pump	*	*	*	-	-	N	N	-	-	-
Gear Drive Pump	*	*	*	-	-	N	N	-	-	-
Progressing Cavity Pump	*	*	*	-	-	N	N	-	-	-
Inertia Lift Pump	-	*	-	-	-	-	-	-	-	-
Dredges										
Ekman Dredge	-	-	-	*D 4387^G	-	-	-	-	-	-
				D 4343^P						
Petersen Dredge	-	-	-	*D 4387^G	-	-	-	-	-	-
Ponar Dredge	-	-	-	*D 4387^G	-	-	-	-	-	-
				D 4342^P						
Discrete Depth Samplers										
Bacon Bomb	*D 6759^P	-	-	-	-	*D 6759^P	N	-	-	-
Kemmerer Sampler	*D 4136^P	-	-	-	-	*D 6759^P	N	-	-	-
	D 6759^P	-	-	-	-	-	-	-	-	-
Syringe Sampler	*D 5743^G	-	N	-	-	*D 6759^P	*D 6759^P	*D 6759^P	-	-
	D 6759^P	-	-	-	-	-	-	-	-	-
Peristaltic Pump	*D 6759^P	*D 4448^G	*D 6759^P	-	-	*D 6759^P	*D 6759^P	N	-	-
Lidded Sludge/Water Sampler	-	-	-	-	-	N	N	*D 6759^P	-	N
Discrete Level Sampler	*D 6759^P	*	*D 6759^P	-	-	*D 6759^P	*D 6759^P	-	-	-
Push Coring Devices										
Temporary G.W. Sampler	-	*	-	-	-	N	-	-	-	-
Penetrating Probe Sampler	-	-	-	N	*	-	-	N	-	*
Split Barrel Sampler	-	-	-	*	*D 1586^{TM}	-	-	N	-	N
					*D 4700^G					
Concentric Tube Thief	-	-	-	-	-	-	-	-	-	*
Trier	-	-	-	-	*	-	-	N	-	*D 5451^P
										*E 300^P
Thin Walled Tube	-	-	-	*D 4823^G	*D 1587^P	-	-	-	-	*
					D 4700^G					
Coring Type w/Valve	-	-	-	N	*D 4823^G	-	-	*	-	*
Miniature Core Sampler	-	-	-	N	*D 4547^G	-	-	-	-	N
					D 6418^P					
Modified Syringe Sampler	-	-	-	N	*D 4547^G	-	-	-	-	N
Soft Sediment Sampler	-	-	-	*	N	-	-	N	-	N
Rotating Coring Devices										
Screw Auger	-	-	-	-	-	-	-	-	*	-
Rotating Corer	-	-	-	*D 4823^G	*D 4700^G	-	-	-	*	-
Augering Devices										
Bucket Auger	-	-	-	N	*D 1452^P	-	-	-	-	*D 1452^P
					D 4700^G					
					*D 6907^P					*D 6907^P
Flighted Auger	-	-	-	*	*	-	-	-	N	N
Captive Screw Auger	-	-	-	-	-	-	-	-	N	*
Peat Borer	-	-	-	*	*	-	-	-	-	N
Liquid Profile Devices										
COLIWASA	-	-	-	-	-	*D 5495^P	*D 5495^P	-	-	
						D 5743^G	D 5743^G			
Reuseable Point Sampler	N	-	N	-	-	*	*	*	-	-
Drum Thief	-	-	-	-	-	*	*	*	-	-
Valved Drum Sampler	-	-	-	-	-	*	*	*	-	-
Plunger Type Sampler	N	-	N	-	-	*D 5743^G	*D 5743^G	*D 5743^G	-	-
Liquids Profiler	N	-	N	-	-	*D 6759^P	*D 6759^P	*D 6759^P	-	-
Surface Sampling Devices (Liquids)										
Bailer	N	*D 4448^G	-	-	-	N	N	-	-	-
		*D 6699^P	-	-	-	-	-	-	-	-
Point Sampling Bailer	N	*D 4448^G	-	-	-	N	N	-	-	-
		*D 6699^P	-	-	-	-	-	-	-	-

TABLE 1 *Continued*

Equipment (May be used for discrete sample collection)	Water and Waste Water			Sediment	Soil	Waste				
	Surface Water	Ground Water	Point Discharge			Liquid	Multi-Layer Liquid	Mixed Phase Solid/Liquid	Consolidated Solid	Unconsolidated Solid
Differential Pressure Bailer	-	*D 6699^P	-	-	-	N	N	-	-	-
Dipper	*D 5358^P	-	*D 5013^P	-	-	*D 5358^P	-	*D 5358^P	-	-
Liquid Grab Sampler	*	-	N	-	-	*	*	*	-	-
Swing Jar Sampler	*	-	N	N	-	*	*	N	-	-
Passive Sampler, Bag Type	*	*	-	-	-	-	-	-	-	-
Passive Sampler, Chamber Type	-	*	-	-	-	-	-	-	-	-
Surface Sampling Devices (Solids)										
Impact Devices	-	-	-	-	-	-	-	-	*	-
Spoon	N	-	N	-	*D 4700^G	N	N	-	-	N
Scoops and Trowel	-	-	-	N	*D 4700^G	N	-	N	-	*
Shovels	-	-	-	N	*D 4700^G	-	-	N	-	*
Multi-Level Sampling Devices										
Dedicated Type 1	-	*	-	-	N	-	-	-	-	-
Dedicated Type 2	-	*	-	-	N	-	-	-	-	-
Portable	-	N	-	-	*	-	-	-	-	-

* Equipment may be used with this matrix N =Not equipment of choice but use is possible -As indicated
^{G} =ASTM Guide ^{TM} =ASTM Test Method ^{P} = ASTM Practice

D 4547 Practice for Sampling Waste and Soils for Volatile Organics[5]
D 4687 Guide for General Planning of Waste Sampling[5]
D 4700 Guide for Soil Sampling from the Vadose Zone[2]
D 4823 Guide for Core Sampling Submerged, Unconsolidated Sediments[3]
D 5013 Practices for Sampling Wastes from Pipes and Other Point Discharges[3]
D 5079 Practices for Preserving and Transporting Rock Core Samples[6]
D 5088 Practice for Decontamination of Field Equipment Used at Nonradioactive Waste Sites[6]
D 5283 Practice for Generation of Environmental Data Related to Waste Management Activities: Quality Assurance and Quality Control Planning and Implementation[5]
D 5314 Guide for Soil Gas Monitoring in the Vadose Zone[6]
D 5358 Practice for Sampling with a Dipper or Pond Sampler[5]
D 5451 Practice for Sampling Using a Trier Sampler[5]
D 5495 Practice for Sampling with a Composite Liquid Waste Sampler COLIWASA[5]
D 5633 Practice for Sampling with a Scoop[5]
D 5679 Practice for Sampling Consolidated Solids in Drums or Similar Containers[5]
D 5680 Practice for Sampling Unconsolidated Solids in Drums or Similar Containers[5]
D 5730 Guide for Site Characterization for Environmental Purposes with Emphasis on Soil, Rock, the Vadose Zone and Ground Water[6]
D 5743 Practice for Sampling Single or Multilayered Liquids, With or Without Solids, in Drums or Similar Containers[5]
D 5784 Guide for Use of Hollow-Stem Augers for Geoenvironmental Exploration and the Installation of Subsurface Water-Quality Monitoring Devices[6]
D 6001 Guide for Direct-Push Water Sampling for Geoenvironmental Investigations[6]
D 6009 Guide for Sampling Waste Piles[5]
D 6044 Guide for Representative Sampling and Management of Waste and Contaminated Media[5]
D 6051 Guide for Composite Sampling and Field Subsampling for Environmental Waste Management Activities[5]
D 6063 Guide for of Sampling Drums and Similar Containers by Field Personnel[5]
D 6151 Practice for Using Hollow-Stem Augers for Geotechnical Exploration and Soil Sampling[6]
D 6282 Guide for Direct Push Soil Sampling for Environmental Site Characterizations[6]
D 6286 Guide for Selection of Drilling Methods of Environmental Site Characterization[6]
D 6418 Practice for Using the Disposable En Core Sampler for Sampling and Storing Soil for Volatile Organic Analysis[5]
D 6538 Guide for Sampling Wastewater with Automatic Samplers[5]
D 6634 Guide for the Selection of Purging and Sampling Devices for Ground Water Monitoring Wells[6]
D 6640 Practice for the Collection and Handling of Soils Obtained in Core Barrel Samplers for Environmental Investigations[5]
D 6661 Practice for Field Collection of Organic Compounds from Surfaces Using Wipe Sampling[5]
D 6699 Practice for Sampling Liquids Using Bailers[5]
D 6759 Practice for Sampling Liquids using Grab and Discrete Depth Samplers[5]
D 6771 Practice for Low-Flow Purging and Sampling for Wells and Devices Used for Ground-Water Qualtiy Investigations[6]
D 6907 Practice for Sampling Soils and Contaminated Media with Hand-Operated Bucket Augers[5]

[6] *Annual Book of ASTM Standards*, Vol 04.09.

TABLE 2 Sampling Equipment Selection Guide

Equipment	Chemical	Physical	Effect on Sample	Volume Range	Physical	Ease of Operation	Decon	Disposal or Reuse
Pumps and Siphon								
Automatic Sampler–Nonvolatiles	•	•	√	U	B/P	•	•	R
Automatic Composite Sampler–Volatiles	•	•	√	U	B/P	•	•	R
Air/Gas Displacement Pump	•	•	•	U	P/S/W	•	•	R
Piston Displacement Pump	•	•	•	U	P/S/W	•	•	R
Bladder Pumps	√	•	√	U	P/S/W	•	•	R
Peristaltic Pump	•	•	√	U	B/P	•	√	R
Centrifugal Submersible Pump	•	•	•	U	P/S/W	√	•	R
Gear Drive Pump	•	•	•	U	B/P	√	•	D/R
Progressive Cavity Pump	•	•	•	U	P	√	•	R
Inertia Lift Pump	•	•	√	U	B/N	√	√	R
Dredges								
Ekman Dredge	√	√	•	0.5-3.0	N	•	•	R
Petersen Dredge	√	√	•	0.5-3.0	W	•	•	R
Ponar Dredge	√	√	•	0.5-3.0	W	•	•	R
Discrete Depth Samplers								
Bacon Bomb	•	√	√	0.1-0.5	N	√	•	R
Kemmerer Sampler	•	√	√	1.0-2.0	N	√	•	R
Syringe Sampler	√	√	√	0.2-0.5	N	√	√	R
Lidded Sludge/Water Sampler	√	•	•	1.0	S/W	•	•	R
Discrete Level Sampler	√	•	√	0.2-0.5	N	√	•	R
Push Coring Devices								
Temporary G.W. Sampler	√	√	√	0.1-0.3	P/S/W	•	•	R
Penetrating Probe Sampler	√	√	√	0.2-2.0	S/W	•	√	R
Split Barrel Sampler	√	√	•	0.5-30.0	S/W	√	√	R
Concentric Tube Theif	√	√	√	0.5-1.0	N	√	√	R
Trier	√	√	√	0.1-0.5	N	√	√	R
Thin Walled Tube	√	√	•	0.5-5.0	S/W	√	√	R
Coring Type w/Valve	√	√	√	0.2-1.5	N	√	√	R
Miniature Core Sampler	√	√	√	0.01-0.05	N	√	√	D
Modified Syringe Sampler	√	√	√	0.01-0.05	N	√	√	D
Soft Sediment Sampler	√	√	√	1.6-7.0	N	√	√	R
Rotating Coring Devices								
Screw Auger	√	√	•	0.1-0.3	N	•	√	R
Rotating Coring Device	√	√	•	0.5-1.0	B/P	√	√	R
Augering Devices								
Bucket Auger	√	√	•	0.2-1.0	N	•	√	R
Flighted Auger	•	√	•	U	P/S/W	•	√	R
Captive Screw Auger	√	√	√	1-2	P	√	√	R
Peat Borer	√	√	√	0.3	S	√	√	R
Liquid Profiling Devices								
COLIWASA	√	•	√	0.5-3.0	N	√	•	D/R
Reuseable Point Sampler	√	√	√	0.2-0.6	N	√	√	R
Drum Thief	√	•	√	0.1-0.5	N	√	•	D/R
Valved Drum Sampler	√	√	√	0.3-1.6	N	√	√	D/R
Plunger Type Sampler	√	•	√	0.2-U	N	√	√	D/R
Liquids Profiler	•	√	√	1.3-4.0	N	√	√	R
Surface Sampling Devices (Liquids)								
Bailer	•	√	•	0.5-2.0	N	√	√	D/R
Point Sampling Bailer	•	√	√	0.5-2.0	N	√	√	R
Differential Pressure Bailer	√	√	√	0.04-1.0	N	√	√	R
Dipper	√	√	√	0.5-1.0	N	√	√	R
Liquid Grab Sampler	√	√	√	0.5-1.0	N	√	√	R
Swing Jar Sampler	•	√	√	0.5-1.0	N	√	√	R
Passive Sampler, Bag Type	√	√	√	0.1-0.2	N	√	√	D/R
Passive Sampler, Chamber Type	√	√	√	1-4	W/S	•	•	D/R
Surface Sampling Devices (Solids)								
Impact Devices	•	•	•	N/A	B/P	√	√	R
Spoon	√	√	•	N/A	N	√	√	R
Scoops and Trowel	√	√	•	0.1-0.6	N	√	√	R
Shovels	√	√	•	1.0-5.0	N	√	√	R
Multi-Level Sampling Devices								
Dedicated Type 1	√	√	√	U	W/S	•	•	D/R
Dedicated Type 2	√	√	√	U	W/S	•	-	D
Portable	√	√	√	0.01	N	•	•	DR

• = Significant operation consideration
√ = Not a significant operational consideration

Range of Volume (liters)
U = Unlimited
N/A = Not Applicable

Physical Requirements:
B = Battery W = Weight
P = Power S = Size
N = No limitations

Disposal and Reuse:
R = Reusable
D = Single-Use

E 300 Practice for Sampling Industrial Chemicals[7]
E 1391 Guide for Collection, Storage, Characterization, and Manipulation of Sediments for Toxicological Testing[3]

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *consolidated*, *adj*—a compact solid not easily compressed or broken into smaller particles.

3.1.2 *decontamination*, *n*—the process of removing or reducing to a known level undesirable physical or chemical constituents, or both, from a sampling apparatus to maximize the representativeness of physical or chemical analyses proposed for a given sample.

3.1.3 *data quality objectives (DQOs)*, *n*—qualitative or quantitative statement(s) derived from the DQO process describing the problem(s), the decision rule(s) and the uncertainties of the decision(s) stated in the context of the problem.

3.1.4 *environmental data*, *n*—defined for use in this document to mean data in support of environmental activities.

3.1.5 *matrix*, *n*—the principal constituent(s) of a material.

3.1.6 *unconsolidated*, *adj*—defined for use in this guide to mean uncemented or uncompacted material that is easily separated into smaller portions.

3.1.7 *representative sample*, *n*—a sample collected in such a manner that it reflects one or more characteristics of interest (as defined by the project objectives) of a population from which it was collected. **(D 6044)**

4. Summary of Guide

4.1 This guide discusses important criteria which should be considered when choosing sampling equipment.

4.1.1 Criteria discussed in this guide include physical and chemical compatibility, sample matrix, sample volume, physical requirements, ease of operation and decontamination. Costs are considered, where appropriate.

4.2 A limited list of sampling equipment is presented in two separate tables. The list attempts to include a variety of different types of equipment. However, this list is in no way all inclusive, as there are many excellent pieces of equipment not included. Table 1 lists matrices (surface and ground water, stationary sediment, soil and mixed phase wastes) and indicates which sampling devices are appropriate for use with these matrices. It also includes ASTM method references (draft standards are not included). Table 2 indicates physical requirements (such as battery), electrical power, and weight; physical and chemical compatibility; effect on matrix; range of volume; ease of operation; decontamination; and reusability. Table 3 provides sampler type selection process based upon the sample type and matrix to be sampled.

[7] *Annual Book of ASTM Standards*, Vol 15.05.

TABLE 3 Index of Sampling Equipment

Media Type	Sampler Type	Section	Sample Type
Consolidated Solid	Rotating Corer	(7.6.2)	Surface or Depth, Undisturbed
	Screw Auger	(7.6.1)	Surface, Disturbed
	Impact Device	(7.11.1)	Surface, Disturbed
Unconsolidated Solid	Lidded Sludge	(7.4.4)	Discrete, Composite
	Penetrating Probe	(7.5.2)	Discrete, Undisturbed
	Split Barrel	(7.5.3)	Discrete, Undisturbed
	Concentric Tube Thief	(7.5.4.1)	Surface, Disturbed, Selective
	Trier	(7.5.4.2)	Surface, Relatively Undisturbed, Selective
	Thin Walled Tube	(7.5.5)	Surface or Depth, Undisturbed
	Coring Type w/Valve	(7.5.6)	Surface or Depth, Disturbed
	Bucket Auger	(7.7.1)	Surface or Depth, Disturbed
	Flighted Auger	(7.7.2)	Surface or Depth, Disturbed
	Captive Screw Auger	(7.6.3)	Discrete, Disturbed
	Soft Sediment Sampler	(7.5.9)	Surface, Undisturbed
	Peat Borer	(7.7.3)	Discrete, Relatively Undisturbed
	Spoon	(7.11.2)	Surface, Disturbed, Selective
	Scoops/Trowel	(7.11.3)	Surface, Disturbed, Selective
	Shovel	(7.11.4)	Surface, Disturbed
	Miniature Core	(7.5.7)	Surface, Undisturbed
	Modified Syringe	(7.5.8)	Surface, Undisturbed
Soil	Penetrating Probe	(7.5.2)	Discrete, Undisturbed
	Split Barrel	(7.5.3)	Discrete, Undisturbed
	Trier	(7.5.4.2)	Surface, Relatively Undisturbed, Selective
	Thin Walled Tube	(7.5.5)	Surface or Depth, Undisturbed
	Coring Type w/Valve	(7.5.6)	Surface or Depth, Disturbed
	Bucket Auger	(7.7.1)	Surface or Depth, Disturbed
	Flighted Auger	(7.7.2)	Surface or Depth, Disturbed
	Soft Sediment Sampler	(7.5.9)	Surface, Undisturbed
	Peat Borer	(7.7.3)	Discrete, Relatively Undisturbed
	Spoon	(7.11.2)	Surface, Disturbed, Selective
	Scoops/Trowel	(7.11.3)	Surface, Disturbed, Selective
	Shovel	(7.11.4)	Surface, Disturbed
	Miniature Core	(7.5.7)	Surface, Undisturbed
	Modified Syringe	(7.5.8)	Surface, Undisturbed
	AutoSampler, Non V.	(7.2.1)	Shallow, Composite-Suspended Solids only

TABLE 3 *Continued*

Media Type	Sampler Type	Section	Sample Type
	Peristaltic Pump	(7.2.4)	Shallow, Discrete or Composite-Suspended Solids Only
	Syringe Sampler	(7.4.3)	Shallow, Discrete, Disturbed
	Lidded Sludge/Water	(7.4.4)	Discrete, Composite
	Penetrating Probe	(7.5.2)	Depth, Discrete, Undisturbed
	Split Barrel	(7.5.3)	Depth, Discrete, Undisturbed
	Soft Sediment Sampler	(7.5.9)	Surface, Undisturbed
	Peat Borer	(7.7.3)	Discrete, Relatively Undisturbed
	Trier	(7.5.4.2)	Surface, Semi-solid only, Selective
	Coring Type w/Valve	(7.5.6)	Depth, Disturbed
	COLIWASA	(7.8.1)	Shallow, Composite, Semi-liquid only
	Reuseable Point	(7.8.1.2)	Shallow, Discrete
Mixed Solid/Liquid	Plunger Type	(7.8.4)	Shallow, Discrete
	Liquids Profiler	(7.8.5)	Depth, Composite-Suspended Solids only
	Drum Thief	(7.8.2)	Shallow, Composite-Semi-Liquid only
	Valved	(7.8.3)	Shallow, Composite-Semi-Liquid only
	Dipper	(7.4.9)	Shallow, Composite
	Liquid Grab	(7.4.10)	Shallow, Composite-Suspended Solids only
	Swing Jar	(7.4.11)	Shallow, Composite
	Scoops/Trowel	(7.11.13)	Shallow, Composite, Semi-solid only
	Shovel	(7.11.14)	Shallow, Composite, Semi-solid only
	Ekman Dredge	(7.3.1)	Bottom Surface, Soft only, Disturbed
	Petersen Dredge	(7.3.2)	Bottom Surface, Rocky or Soft, Disturbed
	Ponar	(7.3.3)	Bottom Surface, Rocky or Soft, Disturbed
	Penetrating Probe	(7.5.2)	Bottom Surface or Depth, Undisturbed
	Split Barrel	(7.5.3)	Bottom Surface or Depth, Relatively Undisturbed
Sediments	Thin Walled Tube	(7.5.5)	Bottom Surface or Depth, Undisturbed
	Coring Type w/Valve	(7.5.6)	Bottom Surface or Depth, Disturbed
	Bucket Auger	(7.7.1)	Bottom Surface, Disturbed
	Soft Sediment	(7.5.9)	Bottom Surface, Undisturbed
	Peat Borer	(7.7.3)	Discrete, Relatively Undisturbed
	Rotating Corer	(7.6.2)	Bottom Surface, Undisturbed if solid
	Scoops, Trowel	(7.11.3)	Exposed Surface only, Disturbed, Selective
	Shovel	(7.11.4)	Exposed Surface only, Disturbed
	Minature Core	(7.5.7)	Exposed Surface only, Undisturbed
	Modified Syringe	(7.5.8)	Exposed Surface only, Undisturbed
	Auto Splr. - Non Vols.	(7.2.1)	25-ft Lift, Discrete or Composite
	Auto Splr. - Vols.	(7.2.1)	25-ft Lift, Discrete
	Peristaltic Pump	(7.2.4)	Shallow(25-ft), Discrete
	Centrifugal Sub. Pump	(7.2.5)	Depth, Discrete
	Gear Drive Pump	(7.2.6)	Depth, Discrete
Surface Water	Progressing Cavity Pump	(7.2.7)	Depth, Discrete
	Bacon Bomb	(7.4.1)	Depth, Discrete
	Kemmerer	(7.4.2)	Depth, Discrete
	Discrete Level	(7.4.5)	Depth, Discrete
	Plunger Type	(7.8.4)	Shallow (12-ft), Discrete
	Liquids Profiler	(7.8.5)	Shallow, Composite
	Dipper	(7.4.9)	Shallow (10-ft.), Composite
	Liquid Grab	(7.4.10)	Shallow (6-ft), Composite
	Swing Jar	(7.4.11)	Shallow, (10-ft), Composite
	Spoon	(7.11.12)	Shallow (1-in.), Composite
	Air/Gas Displacement	(7.2.2.1)	Depth, Discrete
	Piston Displacement	(7.2.2.2)	Depth, Discrete
Ground Water	Bladder Pump	(7.2.3)	Depth, Discrete
	Peristaltic Pump	(7.2.4)	25-ft Lift, Discrete
	Centrifugal Sub. Pump	(7.2.5)	Depth, Discrete
	Gear Drive Pump	(7.2.6)	Depth, Discrete
	Progressing Cavity Pump	(7.2.7)	Depth, Discrete
	Inertia Lift Pump	(7.2.8)	Depth Discrete
	Discrete Level	(7.4.5)	Depth, Discrete
	Temp. Ground Water	(7.5.1.1)	Depth, Discrete
	Bailer	(7.4.6)	Depth, Composite
	Point Sampling Bailer	(7.4.7)	Depth, Discrete
	Diff. Pressure Bailer	(7.4.8)	Depth, Discrete
	Bag Type Diffusion	(7.9.1)	Depth Discrete
	Chamber Type Diffusion	(7.9.2)	Multiple Depths, Discrete
	Dedicated Multi-Level	(7.10.1)	Multiple Depths, Discrete
	Portable Multi-Level	(7.10.2)	Multiple Depths, Discrete, Pore water
	AutoSplr. -Non Vols.	(7.2.1)	Shallow (25-ft), Discrete or Composite
	Auto Splr. - Vols.	(7.2.1)	Shallow (25-ft), Discrete
	Gear Drive Pump	(7.2.6)	Depth, Discrete
	Progressing Cavity Pump	(7.2.7)	Depth, Discrete
Liquid Effluent	Peristaltic Pump	(7.2.4)	Shallow (25-ft), Discrete

TABLE 3 *Continued*

Media Type	Sampler Type	Section	Sample Type
	Centrifugal Sub. Pump	(7.2.5)	Depth, Discrete
	Bacon Bomb	(7.4.1)	Depth, Discrete
	Kemmerer	(7.4.2)	Depth, Discrete
	Syringe Sampler	(7.4.3)	Shallow (8-ft), Discrete
	Discrete Level	(7.4.5)	Depth, Discrete
	Reuseable Point	(7.8.1.2)	Shallow (8-ft), Discrete
	Valved Sampler	(7.8.3)	Shallow, Discrete
	Plunger Type	(7.8.4)	Shallow (12-ft), Discrete
	Liquids Profiler	(7.8.5)	Shallow, Composite
	Dipper	(7.4.9)	Shallow (10-ft), Composite
	Liquid Grab	(7.4.10)	Shallow (6-ft), Composite
	Swing Jar	(7.4.11)	Shallow (10-ft), Composite
	Spoon	(7.11.12)	Shallow (1-in.), Composite
Liquid	Air/Gas Displacement	(7.2.2.1)	Depth, Discrete
	Piston Displacement	(7.2.2.2)	Depth, Discrete
	Bladder Pump	(7.2.3)	Depth, Discrete
	Peristaltic Pump	(7.2.4)	Shallow (25-ft), Discrete
	Centrifugal Sub. Pump	(7.2.5)	Depth, Discrete
	Gear Drive Pump	(7.2.6)	Depth, Discrete
	Progressing Cavity Pump	(7.2.7)	Depth, Discrete
	Syringe Sampler	(7.4.3)	Shallow (8-ft), Discrete
	Lidded Sludge/Water	(7.4.4)	Shallow (8-ft), Discrete
	Discrete Level	(7.4.5)	Depth, Discrete
	Temp. Ground Water	(7.5.1.1)	Depth, Discrete
	COLIWASA	(7.8.1)	Shallow (4-ft), Composite
	Reuseable Point	(7.8.1.2)	Shallow (8-ft), Discrete
	Plunger Type	(7.8.4)	Shallow, (12-ft), Discrete
	Liquids Profiler	(7.8.5)	Shallow, Composite
	Drum Thief	(7.8.2)	Shallow (3-ft), Composite
	Valved Sampler	(7.8.3)	Shallow (8-ft), Composite
	Bailer	(7.4.6)	Depth, Discrete
	Point Sampling Bailer	(7.4.7)	Depth, Discrete
	Diff. Pressure Bailer	(7.4.8)	Depth, Discrete
	Dipper	(7.4.9)	Shallow (10-ft), Composite
	Liquid Grab	(7.4.10)	Shallow (6-ft), Composite
	Swing Jar	(7.4.11)	Shallow, (10-ft), Composite
	Spoon	(7.11.2)	Shallow (1-in.), Composite
	Scoops & Trowel	(7.11.3)	Shallow, (1-in.), Composite
Multi Layer Liquid	Air/Gas Displacement	(7.2.2.1)	Depth, Discrete
	Piston Displacement	(7.2.2.2)	Depth Discrete
	Bladder Pump	(7.2.3)	Depth, Discrete
	Peristaltic Pump	(7.2.4)	Shallow(25-ft), Discrete
	Centrifugal Sub. Pump	(7.2.5)	Depth, Discrete
	Gear Drive Pump	(7.2.6)	Depth, Discrete
	Progressing Cavity Pump	(7.2.7)	Depth, Discrete
	Syringe Sampler	(7.4.3)	Shallow (8-ft), Discrete
	Discrete Level	(7.4.5)	Depth, Discrete
	Temp. Ground Water	(7.5.1.1)	Depth, Discrete
	COLIWASA	(7.8.1)	Shallow (4-ft), Composite
	Reuseable Point	(7.8.1.2)	Shallow (8-ft), Discrete
	Plunger Type	(7.8.4)	Shallow, (12-ft), Discrete
	Liquids Profiler	(7.8.5)	Shallow, Composite
	Drum Thief	(7.8.2)	Shallow (3-ft), Composite
	Valved Sampler	(7.8.3)	Shallow (8-ft), Composite
	Bailer	(7.4.6)	Depth, Discrete
	Point Sampling Bailer	(7.4.7)	Depth, Discrete
	Diff. Pressure Bailer	(7.4.8)	Depth, Discrete
	Dipper	(7.4.9)	Shallow (10-ft), Composite
	Liquid Grab	(7.4.10)	Shallow (6-ft), Composite
	Swing Jar	(7.4.11)	Shallow (10-ft), Composite
	Spoon	(7.11.2)	Shallow (1-in.), Composite

5. Significance and Use

5.1 Although many technical papers address topics important to efficient and accurate sampling investigations (DQOs, study design, QA/QC, data assessment (see Guides D 4687, D 5730, D 6009, D 6051, and Practice D 5283)), the selection and use of appropriate sampling equipment is assumed or omitted.

5.2 The choice of sampling equipment can be crucial to the task of collecting a sample appropriate for the intended use.

5.3 When a sample is collected, all sources of potential bias should be considered, not only in the selection and use of the sampling device, but also in the interpretation and use of the data generated. Some major considerations in the selection of sampling equipment for the collection of a sample are listed below:

5.3.1 The ability to access and extract from every relevant location in the target population, 5.3.2 The ability to collect a sufficient mass of sample such that the distribution of particle sizes in the population are represented, and

5.3.3 The ability to collect a sample without the addition or loss of constituents of interest.

5.4 The characteristics discussed in 5.3 are particularly important in investigations when the target population is heterogeneous such as when particle sizes vary, liquids are present in distinct phases, a gaseous phase exists or material from different sources are present in the population. The consideration of these characteristics during the equipment selection process will enable the data user to make appropriate statistical inferences about the target population based on the sampling results.

6. Selection Criteria

6.1 Refer to Table 1 and Table 2 for a summary of matrix compatibility and selection criteria. Refer to Table 3 for an index of sampling equipment based upon sample type and matrix to be sampled.

NOTE 1—Information on sample containers and equipment used in sampling that is not used in the actual collection of the sample is not within the scope of this guide.

6.2 *Compatibility*—It is important that sampling equipment, other equipment which may come in contact with samples (such as gloves, mixing pans, knives, spatulas, spoons, etc.) and sample containers be constructed of materials that are compatible with the matrices and analytes of interest. Incompatibility may result in the contamination of the sample and the degradation of the sampling equipment. Appropriate sampling equipment must be compatible chemically and physically.

6.2.1 *Chemical Compatibility*—The effects of a matrix on the sampling equipment is usually considered in the light of the analytes, or groups of analytes of interest. For example, polyvinyl chloride (PVC) has been found to degrade in the presence of many organic compounds; therefore, it would be preferable to collect ground water samples for organic analyses using polytetrafluoroethylene (PTFE), stainless steel, or glass sampling equipment **(1, 2)**.[8] Acids, bases, and high chloride ground water in coastal areas, and wastes with high concentrations of solvents may also degrade many types of sampling equipment over time. The residence or contact time, the time the sample is in contact with the sampling equipment, may be significant in terms of chemical interaction between the sampled matrix and the equipment.

6.2.1.1 The choice of materials used in the construction of sampling devices should be based upon a knowledge of what constituents may be present in the sampling environment because the constituents and materials may interact chemically or be incompatible. Consult available chemical compatibility charts.

6.2.2 *Physical Compatibility*—The sampling equipment should also be compatible with the physical characteristics of the matrices to be sampled. Equipment used to dig or core (shovels, augers, coring type samplers) should be constructed of material that will not deform during use, or be abraded by the material being sampled. Equipment abrasion may result in the contribution of contaminants to the sample being collected. For example, plastic or glass would not be appropriate for difficult to access matrices, and stainless steel equipment may contribute small amounts of metals if significantly abraded by the matrix.

6.3 *Equipment Effects on the Matrix*:

6.3.1 *Equipment Design*— Samples collected using inappropriate sampling equipment may not provide *representative samples* **(1, 3)**. An example of equipment design influencing sample results is a sampler which excludes certain sized particles from a soil matrix or waste pile sample. The shape of some scoops may influence the distribution of particle sizes collected from a sample **(1)**. Dredges used to collect river or estuarine stationary sediments may also exclude certain sized particles, particularly the fines fraction which may contain a significant percentage of some contaminants such as polynuclear aromatic hydrocarbons (PAHs).

6.3.2 *Equipment Use*— Inappropriate use of sampling equipment can influence analytical results. For example, if a displacement pump (bladder, piston or air/gas displacement) is used to purge a well and the intake is placed below the well screen, sediment in the sump can be put into suspension and become part of the water sample **(4)**. Excessive vacuum generated by sampling pumps can cause loss of volatile constituents or change valence states of some ions. The use of bailers for well purging and sample collection also may cause increased turbidity levels in ground water samples. When sampling containerized liquids, insertion of a COLIWASA-sampler at too fast a rate may prevent it from collecting a representative, depth integrated sample.

6.4 *Sample Volume Capabilities*—Most sampling devices will provide adequate sample volume. However, the sampling equipment volumes should be compared to the volume necessary for all required analyses including the additional amount necessary for quality control (QC), split and repeat samples **(4, 5)**. Sampling devices that may not provide an adequate volume would be small diameter glass tubes and triers. In this case the investigator must consider the following options:

6.4.1 A similar device with an increased capacity,

6.4.2 An alternate device with an increased capacity, or

6.4.3 Modification of an existing device (often difficult or impractical).

6.4.4 If these alternatives are not acceptable or available, then the investigator must consider the collection of multiple aliquots to fulfill the sample volume requirement. The effect of multiple aliquots on the data quality collection objectives should be considered.

6.5 *Physical Requirements*—Sampling equipment selection should always consider factors such as the size and weight of the equipment, power requirements (battery/110V), and ancillary equipment required (drill rig for split barrel samplers). Most sampling equipment used in the collection of environmental samples is relatively easy to transport and use in the field. The use of equipment with significant physical requirements may impede the progress of a sampling investigation.

[8] The boldface numbers given in parentheses refer to a list of references at the end of the text.

6.6 *Ease of Operation*—Much of the equipment used for environmental sampling is rather simple to employ. Samples may be collected easily as long as properly selected equipment is used with adequate consideration of the matrix of interest. Sampling errors may occur as a result of inadequate consideration of matrix effects, and poor collection techniques **(1, 3)**. Training requirements should focus on the proper use of equipment in varying environmental matrices.

6.7 *Decontamination and Reuse of Equipment*:

6.7.1 *Decontamination (Practice D 5088)*—Inadequate decontamination of sampling equipment can result in significant errors in analytical results. When choosing sampling equipment, ease of decontamination must be a consideration. Pumps, automatic samplers, Kemmerer samplers and dredges require more effort to decontaminate than does a bailer or split barrel sampler. The investigator should consider decontamination requirements prior to the study to avoid significant delays.

6.7.2 *Reuse*—Due to the expense of materials associated with modern sampling equipment (stainless steel, PTFE), most equipment is reusable following proper decontamination. Some equipment such as bailers may be disposed of after use or dedicated to a sampling point to save time during extensive field investigations. Drum thieves and COLIWASA samplers are typically not reused, particularly when waste samples have been collected.

6.8 *Cost*—Detailed information on the cost of sampling equipment is not contained within this guide. Cost is usually a major consideration in the process of sampling equipment selection. In general, the cost of PTFE and stainless steel equipment will be greater than equipment made of glass, PVC, or other plastics. However, the life expectancy for PTFE or stainless steel equipment is usually longer. In addition, labor costs for decontamination of reusable equipment versus the disposal costs of single use equipment are considerations. Comments on costs are included in the "Advantages and Limitations" tables, where appropriate.

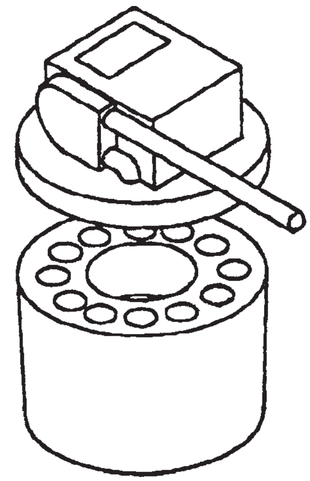

FIG. 1 Automatic Sampler—Non Volatiles

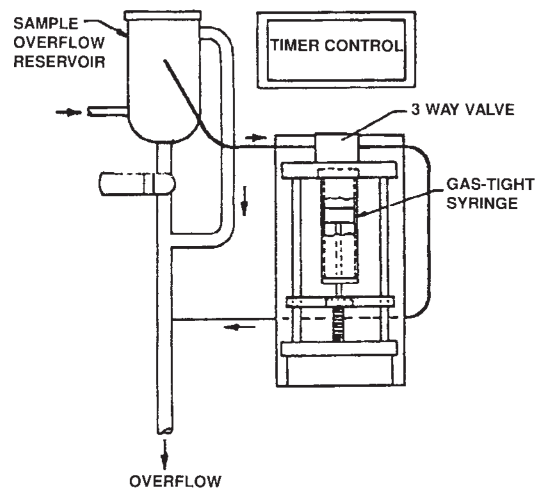

FIG. 2 Automatic Composite Sampler—Volatiles

7. Sampling Equipment

7.1 Presented below are brief descriptions of some sampling equipment used in waste management and in the collection of environmental samples as they relate to waste management activities **(6)**. This is by no means an inclusive list of the sampling equipment that is available to investigators. There are many pieces of equipment that have been designed for specific sampling needs. In addition, investigators may design their own pieces of equipment for a specific project. In all these instances, an investigator must keep in mind the criteria for sampling equipment selection which have been discussed previously in this guide.

7.2 *Pumps and Siphons (Guide D 4448)*— Pumps used for the collection of waste and environmental liquid samples for waste management include automatic samplers and displacement, bladder, peristaltic, and centrifugal pumps.

7.2.1 *Automatic Samplers (Guide D 6538.* Fig. 1 *and* Fig. 2*)*—Automatic samplers may be used when samples are to be collected at frequent intervals. They frequently are used in waste-water collection systems and treatment plants, but they also can be used during stream sampling investigations. They may be used to collect time composite or flow proportional samples. In the flow proportional sampling mode, the samplers are activated by a compatible flow meter. Peristaltic and vacuum pumps commonly are employed as the sampling mechanism. Automatic samplers designed specifically for the collection of samples for volatile organic analyses are available. See Table 4 for advantages and limitations.

NOTE 2—Flow proportional samples also can be collected using a

TABLE 4 Automatic Samplers—Advantages and Limitations

Advantages	Limitations
Can collect either grab samples over time or a composite sample	May be unsuitable for samples requiring volatile organic analysis or samples containing dissolved gases
Will operate unattended	Need power source/battery
Versatile—can be programmed to sample proportional to flow	May be difficult to decontaminate due to design or construction materials, or both
	May be incompatible with liquid streams containing a high percentage of solids

discrete sampler and a flow recorder and manually compositing the individual aliquots in flow proportional amounts.

7.2.2 *Displacement Pumps (Guide D 4448, Practice D 6771)*—Displacement pumps are designed for ground water sampling and mechanically force a discrete column of water to the surface. The air displacement pump uses compressed air while the piston displacement pump uses an actuating rod powered either from the surface or from a separate sealed air or electric actuator. (See Table 5 for advantages and limitations.)

7.2.2.1 The air displacement pump (Fig. 3) operates by applying a positive pressure to the gas line causing the inlet check valve of the sampling device to close and the sample discharge line check valve to open, forcing the contents to the surface. Cyclical removal of gas pressure will cause the flow to stop, the discharge line check valve to close and the inlet check valve of the sampling device to open, allowing the sampling device to fill.

7.2.2.2 The piston displacement pump (Fig. 4) uses a mechanically operated plunger to deliver the sample to the surface at the same time as the chamber fills. It has a flexible flap valve on the piston and an inlet check valve.

7.2.3 *Bladder Pumps*— Bladder pumps are used for sampling ground water and are constructed with a flexible bladder inside a rigid sample container. There are two types. The squeeze type (Fig. 5) has the bladder connected to the sample discharge line. The chamber between the bladder and the sampler body is connected to the gas line. The expanding type (Fig. 6) has the bladder connected to the gas line with the sample discharge line connected to the chamber surrounding the bladder.

7.2.3.1 The pump operates by applying a positive pressure to the gas line causing either the bladder to expand or be compressed, dependant on the type. The sampler inlet valve closes and the sample discharge valve opens forcing the contents of the sampler up the discharge line. Cyclic removal of the gas pressure causes the flow to stop, the sample valve to close and the sampler inlet valve to open, allowing the sampler to refill. See Table 6 for advantages and limitations.

7.2.4 *Peristaltic Pump* **(4)**—A peristaltic pump is a suction lift pump which is used at the ground surface (see Fig. 7*(a)*). A length of PTFE or other suitable tubing is placed in the liquid and the other end is connected to the piece of flexible tubing which has been threaded around the rotor of the peristaltic pump. A second piece of PTFE or other suitable tubing is connected to the discharge end of the flexible tubing to allow the water to be containerized (see Fig. 7*(b)*), sampled etc. If the pump tubing is not compatible with the sample parameters of concern, a modification to the system is necessary.

TABLE 5 Displacement Pumps—Advantages and Limitations

Advantages	Limitations
Commonly constructed on PVC, or stainless steel, or both, but can be constructed of PTFE to reduce risk of contamination when trace levels of organics are of interest	Potential loss of dissolved gases and VOCs from the pumped sample or contamination from the driving gas
	Large gas volume required
Ease to decontaminate (air displacement)	May be difficult to decontaminate (piston displacement)

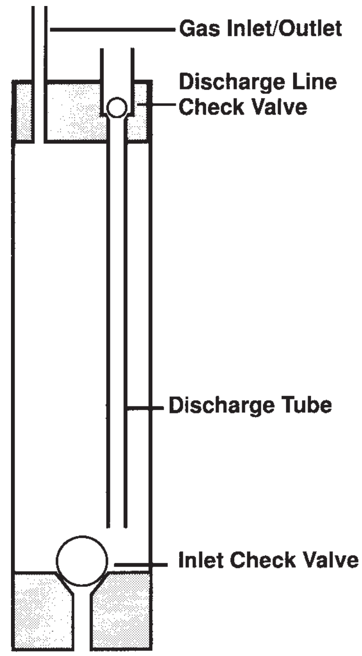

FIG. 3 Air/Gas Displacement Pump

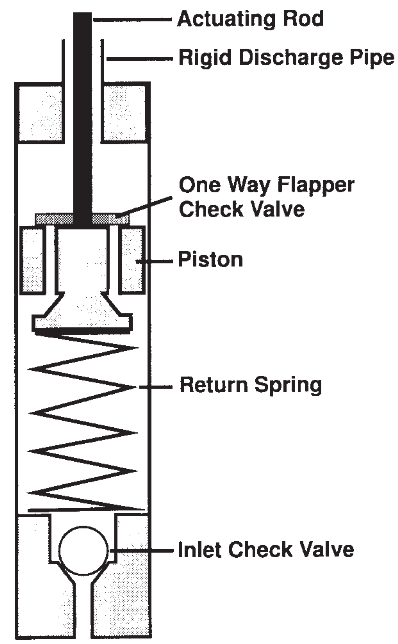

FIG. 4 Piston Displacement Pump

7.2.4.1 The modification (see Fig. 7*(c)*) consists of a peristaltic pump using PTFE tubing and a PTFE insert to collect samples without the sample coming into contact with the pump. This is accomplished by placing the PTFE insert into the opening of a clean glass container. The PTFE tubing connects the container to the pump and the sample source.

7.2.4.2 The operation of the peristaltic pump results from the rotor compressing the flexible tubing causing a vacuum to be applied to the inlet tubing. The water is drawn up the inlet tubing and into the container, without coming into contact with the pump flexible tubing.

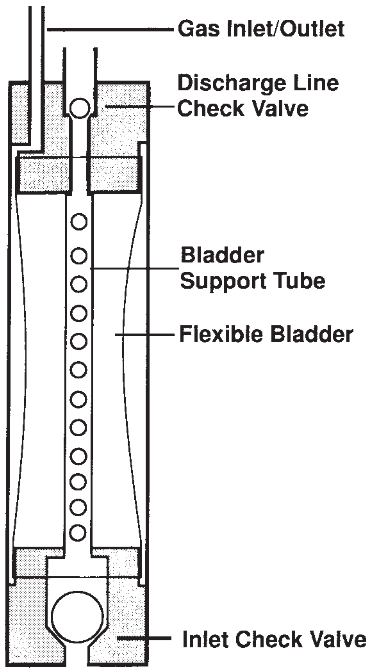

FIG. 5 Bladder Pump—Squeeze Type

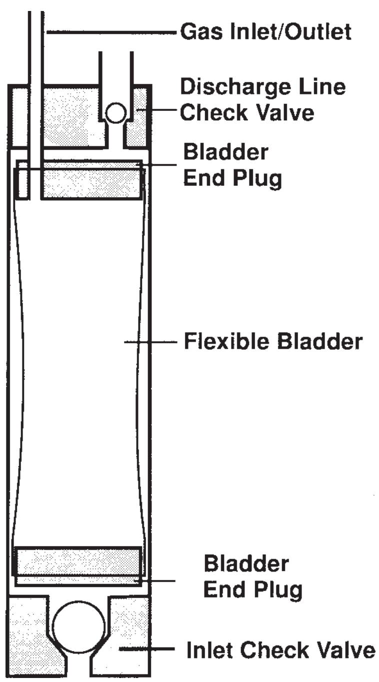

FIG. 6 Bladder Pump—Expanding Type

7.2.4.3 Samples for purgeable organic compounds analyses may be collected by attaching the PTFE tubing to the intake side of the peristaltic pump, pumping the tubing full of the liquid, disconnecting the tubing, and allowing the PTFE tube to drain into the sample vials. A peristaltic pump also can be used to mix and sample liquids from drums (see Guide D 6063). See Table 7 for advantages and limitations.

7.2.5 *Centrifugal Submersible Pump (Guide D 4448, Practice D 6771, see* Fig. 8*)* — Centrifugal submersible pumps may be used for purging and sampling monitoring wells, waste

TABLE 6 Bladder Pumps—Advantages and Limitations

Advantages	Limitations
Suitable for sampling liquids containing volatile organic compounds	Requires compressed air or gas and a controller
Available in a variety of materials, such as PTFE, stainless steel, PVC, etc.	Potential contamination from the bladder or housing materials, or both
Have an operational pumping head of up to 60 m (200 ft)	Decontamination (depending on design) can be difficult

water impoundments or point discharges. Water contacting parts may be made of PTFE and stainless steel. The motor cavity may be either filled with air, deionized, or distilled water that may be replaced as necessary. The pump may be controlled by either a 12v (DC) or a 110/220v (AC) converter. Flow rates range from 9 gal per minute down to 100 mL per minute. The pump discharge hose may be made of PTFE or other suitable material.

7.2.5.1 Operation of the pump relies upon the rotation of a set of impellers, powered by an electric motor. Water is drawn into the centrifugal pump by slight suction and then pressurized by the impellers working against fixed stator plates. The pressurized water is then driven to the surface through the discharge hose. The speed at which the impellers are driven controls the pressure applied and thence the flow rate. See Table 8 for advantages and limitations.

7.2.6 *Gear Drive Pump (Guide D 6634)*—Gear drive pumps may be used for purging and sampling monitoring wells, impoundments or point discharges. Water contacting parts are usually made from stainless steel and PTFE fluorocarbon, (Fig. 9). These electric pumps are usually driven by a surface controller; they have limited purging capability, but can be used to sample liquids containing VOCs and mobile colloids.

7.2.6.1 The pump body contains a DC electric motor, usually 12 or 24V (DC). This drives two gears within a pump cavity that draw water into the pump and delivers it to the surface through the discharge line. The pump speed controls the pressure and thence the flow. Heat may be generated and cavitation may occur when these pumps are operated for extended periods at high speed. See Table 9 for advantages and limitations.

7.2.7 *Progressing Cavity Pump (Guide D 6634, see Fig. 10)*—Progressing cavity pumps may be used to purge and sample monitoring wells as well as sample impoundments and point discharges. They are also known as helical rotor pumps. The pump design lends itself to use in sampling liquids containing VOCs, but care should be exercised to limit pump speed to minimize overheating. The output capacity of this pump design is limited.

7.2.7.1 Progressing Cavity Pumps feature a helical rotor within a stator. In operation a cavity is formed between the rotor and stator that moves upwards as shown in Fig. 10. This carries the trapped water to the discharge and thence to the surface. They are usually made from stainless steel and EPDM or Buna-N with PTFE fluorocarbon or PE seals. See Table 10 for advantages and limitations.

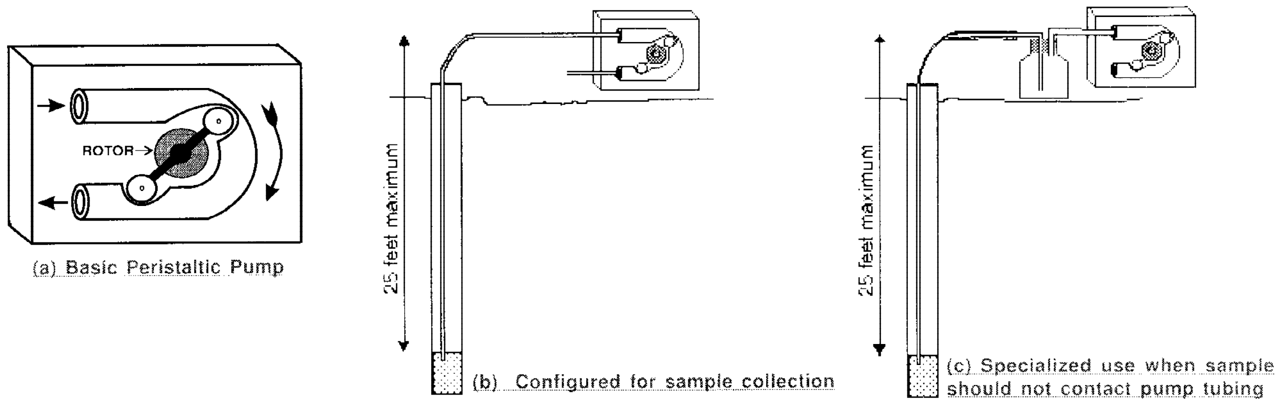

FIG. 7 Peristaltic Pump

TABLE 7 Peristaltic Pumps—Advantages and Limitations

Advantages	Limitations
May be used in small diameter (1 in.) wells	Depth to the liquid surface cannot exceed about 7.6 m (25 ft)
Decontamination of the pump motor is not necessary	May cause a loss of dissolved gases including volatile organic compounds
Easy to replace the pump tubing without decontamination.	

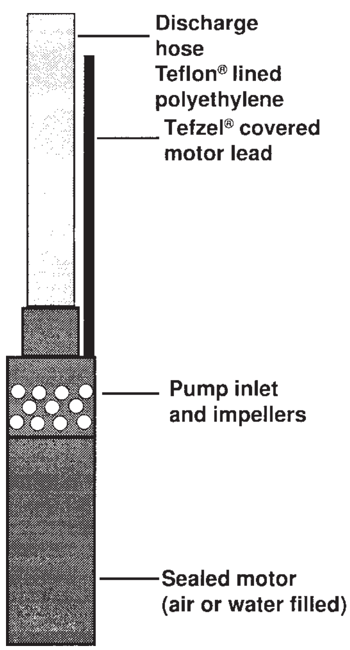

FIG. 8 Centrifugal Submersible Pump

TABLE 8 Centrifugal Submersible Pumps—Advantages and Limitations

Advantages	Limitations
Constructed of materials easily decontaminated, stainless steel and PTFE	Requires an electric power source
May be used to pump liquids up to a 76 m (250 ft) head	May be incompatible with liquids containing a high percentage of solids
Flow rate is adjustable	Portable use may require a winch or reel system
	May not be suitable for collecting samples of liquids containing volatile organic compounds

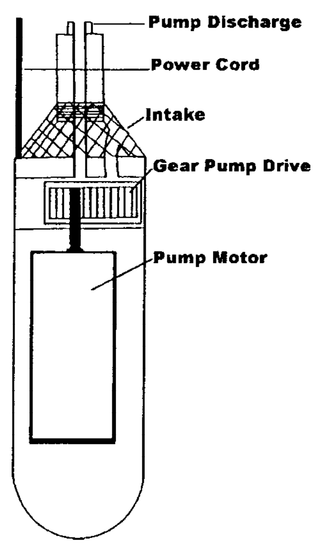

FIG. 9 Gear Drive Pump

7.2.8 *Inertia Lift Pump (Guide D 4448, see Fig. 11)*—consists of a rigid or semi-rigid discharge tube with a check valve installed on the lower end. They may be used to purge and sample monitoring wells or other bodies of liquid. In use the assembly is lowered into the liquid at the level desired for sampling. Rapid up down motion applied to the upper end of the tube forces the liquid up the tube to the surface. They may be used to sample liquids containing VOCs, but may cause degassing through excessive mechanical disturbance to the water column.

7.2.8.1 Construction materials may be selected to satisfy the needs of the sampling plan. The tubing selected needs to have sufficient rigidity to allow the reciprocating motion to be applied to the check valve submerged in the liquid being sampled. The operation of the sampler may be facilitated with the use of a mechanical reciprocating device, either electrically or engine driven. Care needs to be taken to limit excessive movement to prevent excessive mixing of liquids thereby

TABLE 9 Gear Drive Pump—Advantages and Limitations

Advantages	Limitations
Constructed of materials easily decontaminated, stainless steel and PTFE	Requires an electric power source
May be used to pump liquids up to a 53 m (175 ft) head	May be incompatible with liquids containing a high percentage of solids
Flow rate is adjustable	Low discharge rate (1.4 gpm maximum) may make them unsuitable for purging large volumes of water
Portable and easily disassembled for decontamination	

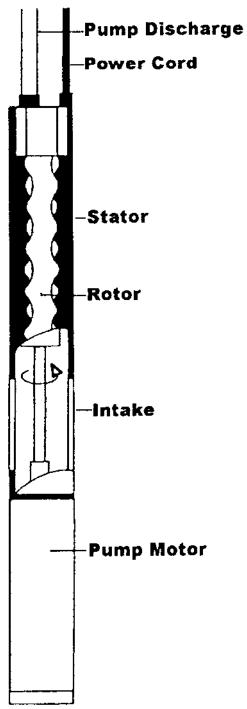

FIG. 10 Progressing Cavity Pump

TABLE 10 Progressing Cavity Pump—Advantages and Limitations

Advantages	Limitations
May be used to pump liquids up to a 55 m (180 ft) head	Requires an electric power source
Flow rate is adjustable	May be incompatible with liquids containing a high percentage of solids
Cavitation free design	Low discharge rate (1.2 gpm maximum) may make them unsuitable for purging large volumes of water
	Difficult to disassemble and decontaminate
	Construction materials may be incompatible with some sample matrices.

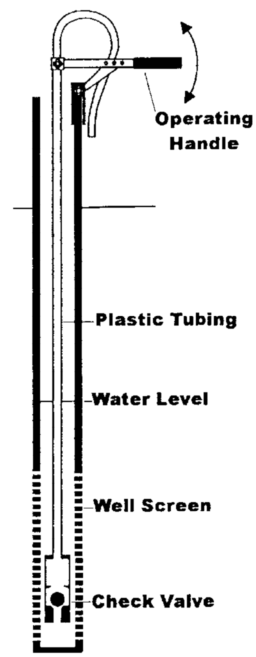

FIG. 11 Inertia Lift Pump

TABLE 11 Inertia Lift Pump—Advantages and Limitations

Advantages	Limitations
May be used to pump liquids up to a 80 m (260 ft) head	May requires an electric or engine driven power source for extended use in deep wells
Low cost and simple to use	May cause excessive disturbance to the liquid column
Not subject to damage from use in dry wells or in presence of suspended solids	May dislodge surface materials on well casing above water column
Easily disassembled for decontamination, if required	Tubing and check valve may be externally damaged by the well casing and screen during use through abrasion
May be used in very small diameter water columns	

increasing degassing and turbidity in collected samples. See Table 11 for advantages and limitations.

7.3 *Dredges (Guides D 4342, D 4343, and D 4387, Practice D 4348)*—Dredges are used for the collection of submerged sediments and semi-consolidated sludge.

7.3.1 *Ekman*—The Ekman dredge (Fig. 12) has only limited usefulness in environmental sampling. It performs well where bottom material is unusually soft, as when covered with organic sludge or light mud. It is unsuitable, however, for sandy, rocky, and hard bottoms. It is also too light to use in streams with high flow velocities. It should not be used from a bridge more than a few feet above the water, because the spring mechanism which activates the sampler can be damaged by the messenger if dropped from too great a height.

7.3.2 *Petersen*—The Petersen dredge (Fig. 13) can be used for routine analyses when the bottom is rocky, in very deep water, or when the stream velocity is high. The dredge should be lowered very slowly as it approaches the bottom, because it can displace and miss lighter materials if allowed to drop freely.

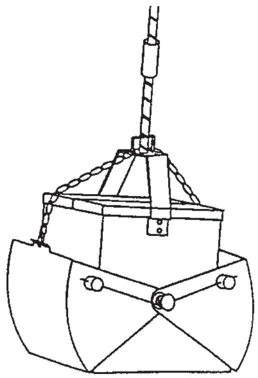

FIG. 12 Ekman Dredge

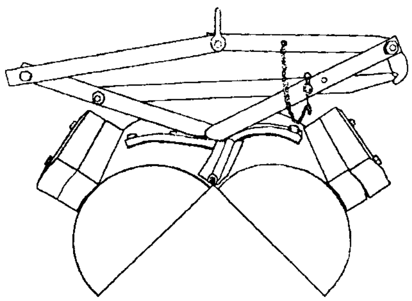

FIG. 13 Petersen Dredge

7.3.3 *Ponar*—The Ponar dredge (Fig. 14) is a modification of the Petersen dredge and is generally similar in size and weight. Smaller, lighter versions are also available. It has been modified by the addition of side plates and a screen on top of the sample compartment. The screen over the sample compartment permits water to pass through the sampler as it descends thus reducing the "shock wave". The Ponar dredge is easily operated by one person in the same fashion as the Petersen dredge. The Ponar dredge is one of the most effective samplers for general use on all types of substrates. See Table 12 for advantages and limitations.

7.4 *Discrete Depth Samplers (Guide D 4448)*—These samplers are used in lakes, ponds, impoundments and wells to collect samples at a specific depth or location in the body of liquid. Other types of discrete depth samplers are also available. (For shallow tanks and drums, refer to Section 7.8).

7.4.1 *Bacon Bomb*—The bacon bomb sampler (Fig. 15), originally designed for sampling oil, can be used for discrete depth sampling in stationary bodies of water, lakes, or waste.

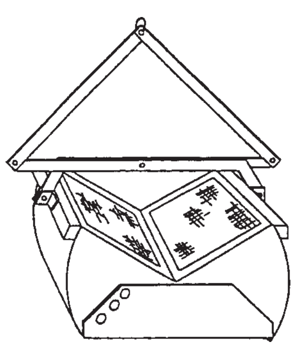

FIG. 14 Ponar Dredge

TABLE 12 Dredges—Advantages and Limitations

Advantages	Limitations
Ability to sample most types of stationary sediments from silt to granular material	Are not capable of collecting undisturbed samples
Light weight Ponar dredges are available	Are not capable of collecting a representative lift or repeatedly sampling to the same depth and position
	Petersen and other dredges with extra weights are very heavy
	Care must be taken to minimize disturbance and sample washout as the dredge is retreived through the liquid column
	May be difficult to decontaminate due to construction or materials
	Not suitable for use in rough waters
	Not useful if the bottom to be sampled is covered with vegetation

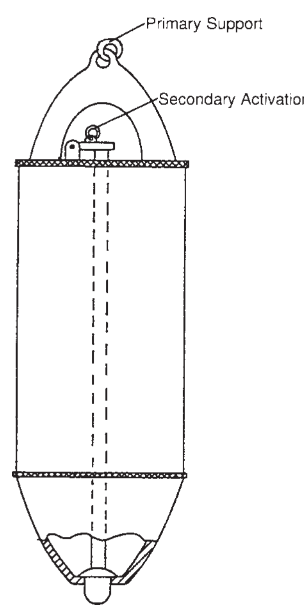

FIG. 15 Bacon Bomb

The primary advantage of this sampler over other discrete samplers is that it can be constructed of stainless steel and that it remains closed until it is triggered to collect the sample by raising the actuator rod with a second line and allowing the sampler to fill. Once a sample is collected, the device is closed by releasing the second line and the sampler is returned to the surface by raising the primary support line. The sample may then be transferred to a collection container. See Table 13 for advantages and limitations.

7.4.2 *Kemmerer*—The Kemmerer (Fig. 16) sampler is a stainless steel or brass cylinder with rubber stoppers that leave the ends open while being lowered in a vertical position to allow free passage of water through the cylinder. The Kemmerer is operated by sending a messenger down a rope when the sampler is at the designated depth, to cause the

TABLE 13 Bacon Bomb—Advantages and Limitations

Advantages	Limitations
Sampler is not opened until the desired sample depth is reached	May be difficult to decontaminate due to design or construction materials
	Only commercially available with a sample capacity of 500 mL
	Sampling device construction material may not be compatible with parameters of concern

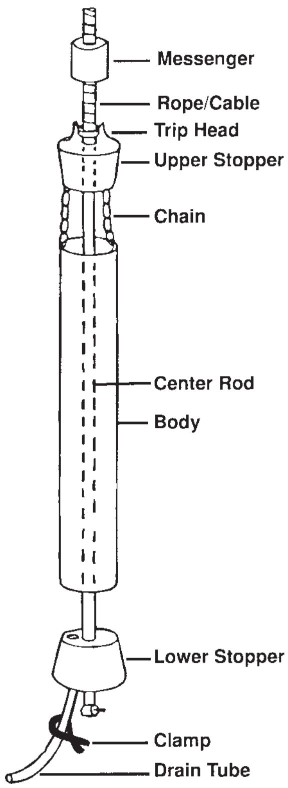

FIG. 16 Kemmerer Sampler

stoppers to close the cylinder, which is then raised. Water is removed through a valve to fill sample containers. With multiple depth samples, care should be taken not to stir up bottom sediment and thus bias the sample. All PTFE construction is available. See Table 14 for advantages and limitations.

7.4.3 *Syringe Sampler (*Fig. 17*)* —A syringe sampler is used to sample highly viscous liquids, sludges and tar-like substances. It can also draw samples when only a small amount remains at the bottom of a tank or drum. Syringe samplers are available commercially, they usually include a piston assembly consisting of a T-handle, safety locking nut, control rod (PTFE covered aluminum rod facilitates operation of the piston) piston body assembly, sampling tube assembly, and standard bottom valve or coring bottom. The assembled sampler with the bottom valve opened is positioned at the sampling point. By raising the T-handle, the sample is drawn into the sampler. The bottom valve is closed by pressing down on the sampler against the side or bottom of the container. To empty the sampler, open the bottom valve and extrude the sampler into a container by pushing down on the T-handle. See Table 15 for advantages and limitations.

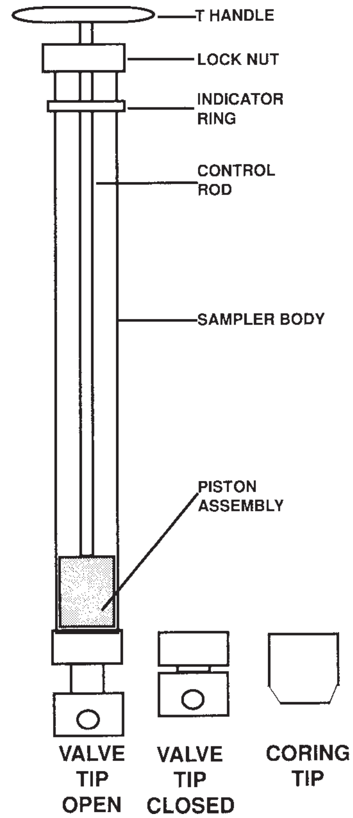

FIG. 17 Syringe Sampler

TABLE 14 Kemmerer—Advantages and Limitations

Advantages	Limitations
Able to sample at discrete depths	Sampling container is exposed to medium being sampled while being lowered to sampling point
	May be difficult to decontaminate due to construction or materials

7.4.4 *Lidded Sludge/Water Sampler*—A stainless steel sampling device used to collect sludges or waste fluids in a 1- L glass jar (see Fig. 18). The jar is removed and transported to the laboratory. No transfer of the sample to another container is necessary; this decreases handling and cross contamination. A PTFE insert is placed in the lid and is replaced between

TABLE 15 Syringe Sampler—Advantages and Limitations

Advantages	Limitations
Simple to use and decontaminate, all sample contacting parts are PTFE	With viscous materials, more materials may end up on the outside of the sampler than inside it
Ability to sample at discrete depths, including the bottom of the container	
May be used to depths of about 1.8 m (6 ft)	

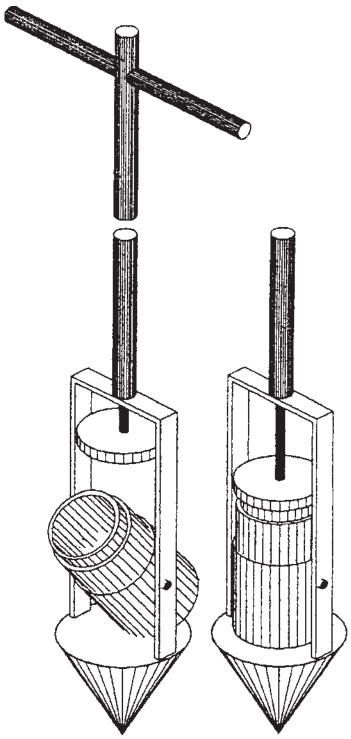

FIG. 18 Lidded Sludge/Water Sampler

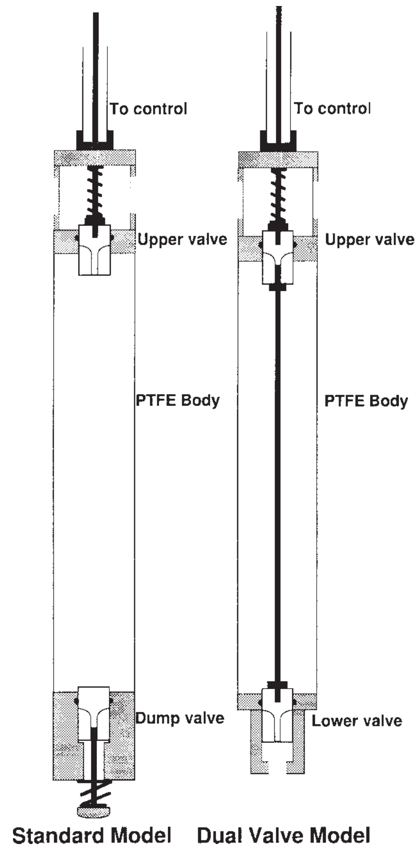

FIG. 19 Discrete Level Sampler

collection of samples. Handle extensions with depth markings are available to allow sampling from difficult to access areas.

7.4.4.1 The lidded sludge sampler is lowered into the sludge. When the jar is at the desired depth, the top actuator handle is rotated to upright the jar and close the lid. The jar is removed by lifting it from the holder. For samples containing more than 40 % solids, a cutter is added to the jar which cuts the sludge allowing it to fall into the jar. This device can be used in tanks, tank trucks and ponds. See Table 16 for advantages and limitations.

7.4.5 *Discrete Level Sampler (*Fig. 19*)* —A sampler that can be used to sample liquids in drums, tanks, surface waters or wells. It is fitted with manually operated valve or valves on the ends of the sample collection chamber. Made from PTFE and stainless steel and designed to be reusable. The sampler is assembled with either a rigid control tube and rod or a flexible tube and inner cable attached to the upper end of the sampler. The proximal ends of the controls are provided with a handle and inner rod or cable actuator. The standard model is provided with an upper manually operated valve for filling and a lower spring retained dump valve for emptying. The dual valve model has manually operated valves at each end.

7.4.5.1 The sampler is lowered into the liquid column to the desired sampling level. The valve or valves are opened manually and the liquid sample collected. The valve or valves are closed before removing the sampler from the liquid column. The collected sample may be taken to the laboratory in the sampler body by replacing the valves with solid PTFE end caps. Alternatively, the standard model may be emptied by pressing the dump valve against the side of the sample collection container. The dual valve model may be emptied by opening the valves manually or with the use of a metering device attached to the lower end of the sampler (not shown). See Table 17 for advantages and limitations.

7.4.6 *Bailer (See Guide D 4448, Practice D 6699)*—A bailer is essentially a length of PTFE, stainless steel or PVC pipe with a check valve on the bottom (see Fig. 20). Preferably, the top should be closed, except for a pouring opening, to keep matter on the inside of the well casing from falling into the bailer while sampling. The bottom valve allows the bailer to fill with sample and retain it while being brought to the surface. Bailers are available in numerous sizes to accommodate a wide variety of well sizes, as either reusable or single-use sampling devices. See Table 18 for advantages and limitations.

7.4.6.1 When using a top-emptying bailer, samples can be recovered with a minimum of aeration if care is taken to gradually lower the bailer until it contacts the water surface and

TABLE 16 Lidded Sludge/Water Sampler—Advantages and Limitations

Advantages	Limitations
Sampler is not opened until desired depth is reached, allowing collection of samples from discrete depths	Thick sludge is difficult to sample with the device
Sturdy construction, prevents personnel contact with the sample	Equipment is heavy
Bottles and lids are unique to each sample container; decontamination of these is not required	Limited to one bottle size

TABLE 17 Discrete Level Sampler—Advantages and Limitations

Advantages	Limitations
May be easily decontaminated	May be unsuitable for sampling liquids containing a high percentage of solids
May be used to sample liquids in most environmental situations	Sample chamber capacities 240 to 475 mL
Sample quality minimally affected by liquids above the sampling point	
Remote operation for hazardous environments.	

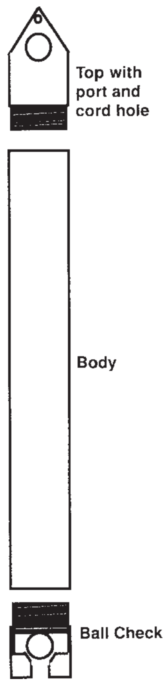

FIG. 20 Bailer

is then allowed to sink as it fills. The bailer should be raised to the surface slowly. When transferring the bailer contents to a sample container, the bailer should be tipped only enough that a slow discharge from the top of the bailer is allowed to flow into the container.

7.4.6.2 Bottom-emptying bailers with controlled flow valves are also available. This type of bailer is particularly good for collecting samples for volatile organic analyses (VOA) since they minimize agitation of the sample.

7.4.7 *Point Sampling Bailer (see Guide D 4448, Practice D 6699)*—The point-sampling bailer is similar in construction to the bailer described in the prior section. A point-source bailer has an additional check valve at the top of the body (see Fig. 21). As the bailer is lowered through the liquid column the liquid flows through the bailer. At the sampling point the two check valves will close to contain the sample and prevent mixing with the liquids above as the sampler is retrieved. See Table 19 for advantages and limitations.

TABLE 18 Bailer—Advantages and Limitations

Advantages	Limitations
Simple to use	Unable to collect samples from specific depths below the liquid surface
External power source not required	Transfer of sample from top-emptying bailer to sample container may aerate sample if not poured carefully
Relatively economical compared to other sampling methods; a separate bailer could be dedicated to each well	May disturb sample in water column if the bailer is lowered too rapidly
Can be made from almost any material that is compatible with the parameters of interest	May be chemically incompatible with certain matrices unless constructed of resistant material

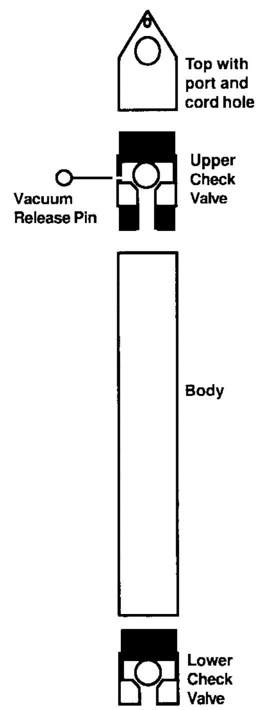

FIG. 21 Point Sampling Bailer

7.4.8 *Differential Pressure Bailer (Practice D 6699)*—The differential-pressure bailer comprises a sealed tubular body with two small diameter tubes built in to the removable top (see Fig. 22). Usually, it is made from stainless steel to provide sufficient weight to allow it to sink quickly to the sampling point. Hydrostatic pressure allows the bailer to fill through the lower tube at the same time as displacing air through the upper tube. See Table 20 for advantages and limitations.

7.4.9 *Dipper (See Practice D 5358, D 6759)*—This sampling device is used to collect liquid samples at or near the surface of ponds, pits, lagoons, and so forth (see Fig. 23). The sampler can consist of a variety of pieces of equipment assembled in a manner to obtain a sample. One type consists of an adjustable clamp attached to the end of a piece of metal tubing. The tubing forms the handle; the clamp is used to

TABLE 19 Point Sampling Bailer—Advantages and Limitations

Advantages	Limitations
Simple to use	Bailer may be compromised as it is lowered through contaminated layers in the liquid column
Allows sample collection at a specific depth in the liquid column	Requires a means to unseat the upper check valve to break the vacuum as the sample is eluted through the lower check valve using a bottom emptying device

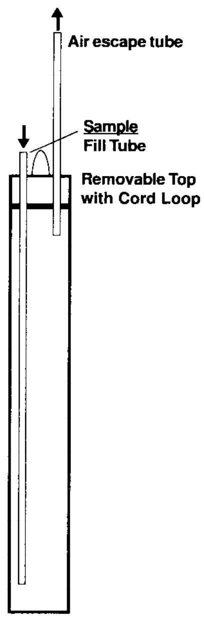

FIG. 22 Differential Pressure Bailer

TABLE 20 Differential Pressure Bailer—Advantages and Limitations

Advantages	Limitations
Simple to use	Decontamination requires care to ensure that all parts of the device, including the air escape and sample entry tubes, are clean
Allows sample collection at a specific depth in the liquid column, without risk of contaminants in upper layers compromising the sample	

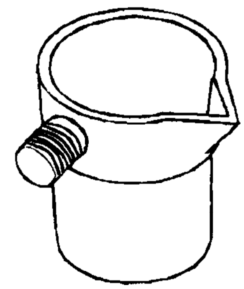

FIG. 23 Dipper

TABLE 21 Dipper—Advantages and Limitations

Advantages	Limitations
Inexpensive	When liquids are stratified, it cannot be used to obtain a sample containing the same proportions of the strata as the location being sampled
When attached to a rigid tube, can reach easily 3-4 m (10 to 13 ft) away from the person collecting samples	Can be used only to obtain surface samples

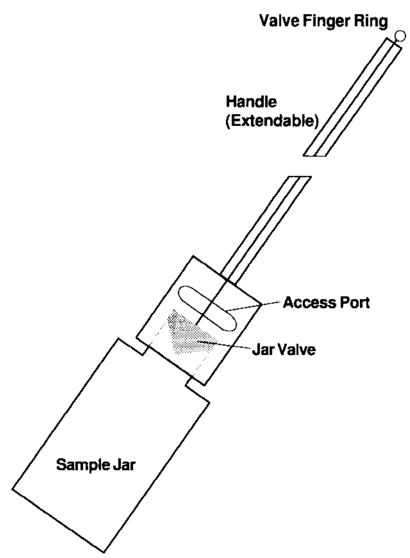

FIG. 24 Liquid Grab Sampler

secure a beaker, sample container, and so forth. Another device is made using a stainless steel scoop clamped to a movable bracket that is attached to a piece of rigid tube. The scoop may face either toward or away from the person collecting the sample, and the angle of the scoop to the pipe is adjustable. See Table 21 for advantages and limitations.

7.4.10 *Liquid Grab Sampler (D 6759)*—The liquid grab sampler is used to collect liquid or slurry samples at specific depths beneath the liquid surface of ponds, pits and lagoons (see Fig. 24). Usually, it is made from polypropylene or PTFE with an aluminum or stainless steel handle and stainless steel fittings. The sampling jar, usually glass but plastic is available, is threaded into the sampler head assembly and lowered to the desired position beneath the liquid surface. The value is opened, by pulling up on the finger ring, to allow the jar to fill and then closed before retrieving the sample. See Table 22for advantages and limitations.

7.4.11 *Swing Jar Sampler (D 6759)*—The swing jar sampler comprises an extendable aluminum handle attached to a plastic jar holder using pivot (see Fig. 25). The open top jar is held in the holder with an adjustable clamp. The pivot allows samples to be collected at different angles. It may be used to sample liquids, powders or small solids at distances of up to 3½ m (12 ft). Normally used with high density polyethylene sample jars. See Table 23 for advantages and limitations.

7.5 *Push Coring Devices (Practice D 1587 and Guides D 4700, D 6001, D 6282)*:

7.5.1 *Direct Push Devices*:

TABLE 22 Liquid Grab Sampler—Advantages and Limitations

Advantages	Limitations
Simple and easy to use	Care in use is required to prevent breakage of the glass sample jar
May be used to sample ponds, impoundments, tanks, drums and through manholes	Construction materials should be compatible with the media being sampled
The closed sampler prevents contaminants in upper layers compromising the collected sample	
The filled sampling container may be capped, stored, and shipped	

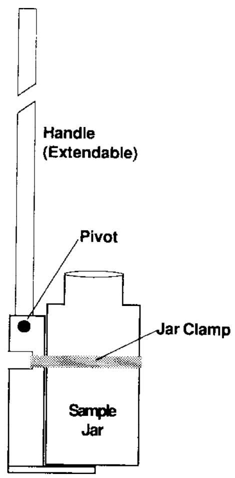

FIG. 25 Swing Jar Sampler

TABLE 23 Swing Jar Sampler—Advantages and Limitations

Advantages	Limitations
Simple and easy to use	Cannot collect discrete samples
Easily adaptable to sample jars of different sizes and materials	Construction materials should be compatible with the media being sampled
The filled sampling container may be capped, stored and shipped	Care required to prevent breakage when using a glass sample jar

7.5.1.1 *Temporary Ground Water Penetration Sampler*—This sampler is a specialized device pushed hydraulically into a water-bearing zone at a selected depth for discrete ground water sampling (see Fig. 26). This device may be used in conjunction with a hollow-stem auger where the center plug is removed and then the device is inserted into the auger and pushed or driven to the required location in the aquifer. The device is then opened to allow entry of water and subsequently closed and retrieved. The device can also be used as a temporary well. Use of this device reduces the volume of soil which may have to be handled as an investigative derived waste. See Table 24 for advantages and limitations.

7.5.2 *Penetrating Probe Samplers (*Fig. 21 *and* Fig. 22*)*—Probe samplers can be used for sampling soil vapor, soil, and ground water. These samplers range in construction from a simple small diameter tube (usually less than 25 mm (1 in.) in diameter with a hard detachable point that are hand-driven to more complex devices that are rig-driven and can be opened after penetrating the ground surface.

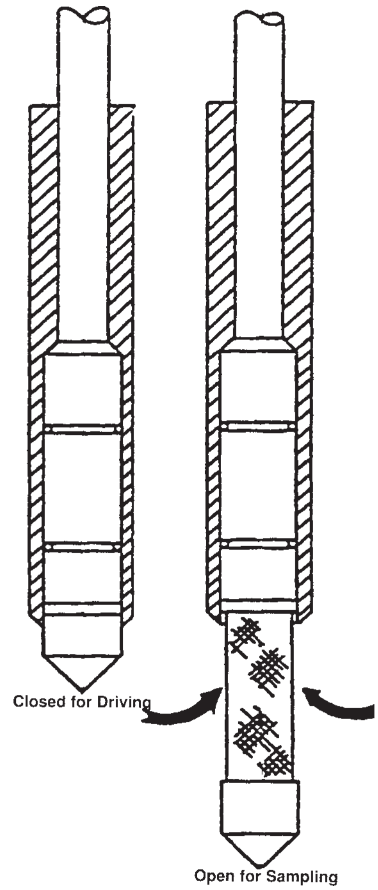

FIG. 26 Temporary Ground Water Penetration Sampler

TABLE 24 Temporary Ground Water Penetration Sampler—Advantages and Limitations

Advantages	Limitations
Provides discrete depth ground water samples without the installation of a monitoring wall	Volume of sample is limited which may influence the type of analysis possible
Can aid in more appropriate placement of permanent monitoring wells when used with onsite analytical methods	Requires the use of a drill or direct push rig and some specialized training for use
Can be used to rapidly and inexpensively collect samples for expedited site characterization	May be physically incompatible with matrices that result in refusal of the direct push device
Can be used in depths reached by appropriate drilling equipment	
Reduces investigative derived waste	

7.5.2.1 The rig-driven probe samplers generally consist of single or multiple threaded steel tubes, 50 mm (2 in.) or more in diameter with detachable hard steel tips and are pushed or hydraulically driven into the subsurface materials. Some probes are equipped with adjustable screens or retractable inner

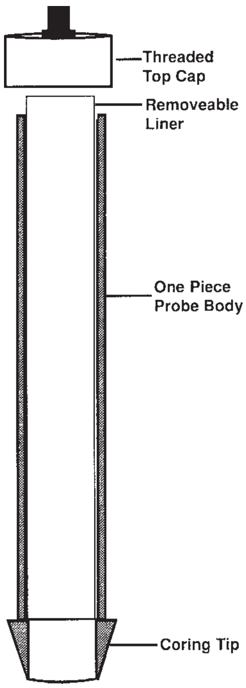

FIG. 27 Penetrating Probe Sampler for Hand Use

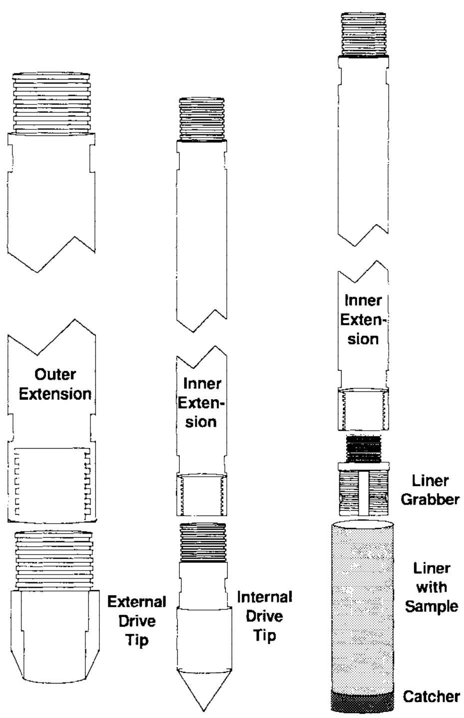

FIG. 28 Penetrating Probe Sampler for Rig Use

rods to allow for sampling of soil vapor or ground water (see Guide D 5314). Ground water can be retrieved using a peristaltic pump or miniature bailer. (See 7.2.4 on peristaltic pumps.) Soil samples can be collected at discrete intervals using specialized attachments.

7.5.2.2 Samples can be prepared for on-site analysis in a field laboratory or off site depending upon volumes obtained (see D 6640) and the use of the data as determined by the data quality objectives process. See Table 19 for advantages and limitations.

7.5.3 *Split-Barrel*— (See Test Method D 1586 and Practice D 3550) A split-barrel sampler is used to collect soil samples at depth. The sampler consists of a length of steel tubing split longitudinally and equipped with a drive shoe and a drive head (see Fig. 29 and Fig. 30). They are available in a variety of diameters and lengths.

7.5.3.1 The sampling tube can be driven manually, or mechanically with a drill rig drive weight assembly or hydraulically pushed using rig hydraulics.

7.5.3.2 Drill and direct-push rigs offer the capability of collecting soil samples from greater depths. For all practical purposes, the depth of investigation achievable by this method is controlled only by the depth of soil overlying bedrock, which may be in excess of 31 m (100 ft).

7.5.3.3 When used in conjunction with drilling, split-barrel samplers are usually driven either inside a hollow-stem auger or inside an open borehole after rotary drilling equipment has been temporarily removed. The barrel is driven with a 140 lb drop hammer through a distance of up to 24 in. (61 cm) and removed. If geotechnical data is also required, the number of blows with the hammer for each 6 in. (15.2 cm) driven interval also is recorded (see Test Method D 1586).

7.5.3.4 Split-barrel samplers may be used to obtain 1.52 m (5 ft) foot long, continuous samples approximately 7.6 to 12.7-cm (3 to 5-in.) in diameter. These devices are located inside a five foot hollow stem auger section and advanced with the auger during drilling. As the auger advances, the central core of soil moves into the sampler and is retained until retrieval.

7.5.3.5 Split-barrel samplers are sometimes used with liners. The advantage of a liner is that the sample can be removed from the sampler with a minimum amount of disturbance; and, if used correctly, they can minimize contamination of the samples. Liners are often used in situations where volatile

TABLE 25 Penetrating Probe Sampler—Advantages and Limitations

Advantages	Limitations
Can be used to rapidly collect samples for expedited site characterization	Limited sample volume
Versatile, generally 15–20 locations a day can be sampled for soil vapor, ground water, soil, or any combination	Penetration can be limited by composition of subsurface materials
	Use can be limited by depth to target media such as deeper ground water or accessibility of placement unit
These samplers can reduce the costs of more expensive off-site analyses	May be physically incompatible with matrices that result in refusal of the direct push device
Reduces investigative derived wastes	

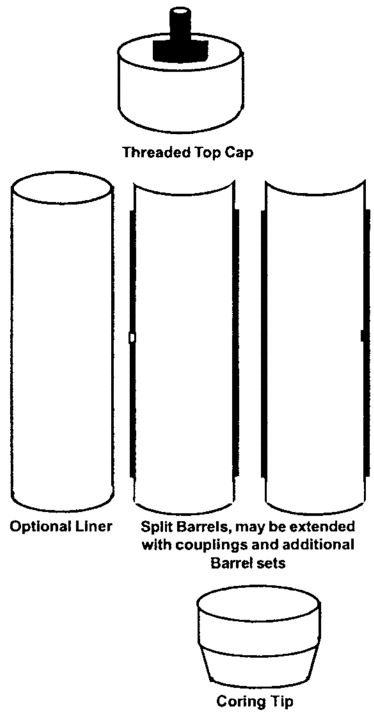

FIG. 29 Split-Barrel (also known as) Split Core Sampler

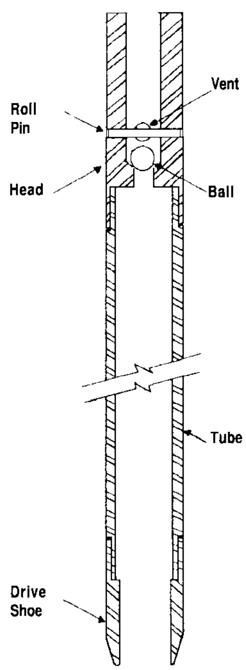

FIG. 30 Split-Barrel Sampler For Rig Use

organic compounds are constituents of concern or where there is an interest in trace elements or compounds. It is important that the investigator chooses liners composed of materials that are chemically compatible with the matrix and constituents of concern. For sub-sampling see Practice D 6640.

7.5.3.6 Split-barrel samplers may be fitted with a core-catcher immediately behind the drive tip. This will allow the sampler to collect samples of wet or cohesionless soils. See Table 26 for advantages and limitations.

TABLE 26 Split-Barrel Samplers—Advantages and Limitations

Advantages	Limitations
Provides a relatively undisturbed sample, providing the sample particle size is significantly smaller than the sampler inside diameter	Usually requires a drill or direct push rig for deep samples up to 30 m (100 ft) below the soil surface
Since the sample is not extruded, fewer volatile organic compounds may be lost	The sample is exposed to the atmosphere, potentially allowing loss of volatile organic compounds, unless subsampling is immediately performed
Samples collected in capped liners can be stored for limited times before subsampling	

7.5.4 *Concentric Tube Thief and Trier (See Practices D 5451 and E 300)*—These devices can be used for sampling powdered or granular materials or wastes in piles or in bags, drums or similar containers.

7.5.4.1 The concentric tube thief (Fig. 31) consists of two slotted telescoping tubes, constructed of stainless steel, brass or other material. The outer tube has a conical, pointed tip on one end that allows the thief to penetrate the material being sampled. The thief is opened and closed by rotating the inner tube.

7.5.4.2 The trier (Fig. 32) is essentially a tube with a slot that extends along most of its length. The tip and edges of the tube slot are sharpened to allow the trier to cut a core of the material to be sampled when rotated after insertion into the material. Commercially available triers are usually constructed from stainless steel. See Table 27 for advantages and limitations.

7.5.5 *Thin-Walled Tube (See Practice D 1587)*—This is generally constructed of stainless steel and has a beveled leading edge, that is twisted and pushed directly into the soil. This type of sampling device is particularly useful if a relatively undisturbed sample is required (see Fig. 33). The

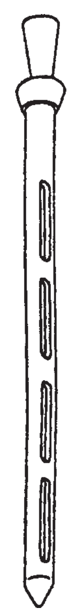

FIG. 31 Concentric Tube Thief

FIG. 32 Trier

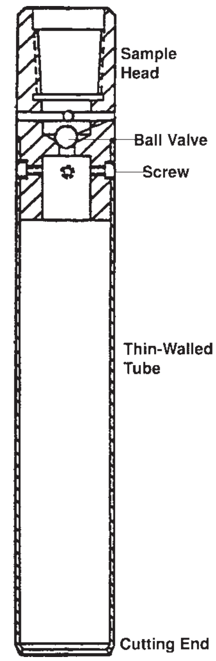

FIG. 33 Thin-Walled Tube

TABLE 27 Tube Thief and Trier—Advantages and Limitations

Advantages	Limitations
Concentric tube thief is best used in dry, unconsolidated materials	Does not collect samples containing all particle sizes if the diameter of the largest solid particle is greater than one third of the slot width
The trier is best for moist or sticky materials	Samples may not be representative

TABLE 28 Thin-Walled Tube Sampler—Advantages and Limitations

Advantages	Limitations
Provides a core sample	Cannot be used in gravel or rocky soils
Collects a relatively undisturbed sample which minimizes loss of volatiles	Loss of volatile organic compounds possible if the sample is extruded
Can be deployed down a bore hole to collect deep samples	Samples containing VOCs cannot be stored in the liner
Inexpensive and easily decontaminated	Not effective in cohesionless soils

sampling device is removed from the push head, then the sample is extruded from the tube into a pan or sample container with a spoon or special extruder. Even though the push head is equipped with a check valve to help retain samples, the thin-wall tube will generally not retain all soils. Thin-walled tubes come in a variety of sizes and may be used in conjunction with drills, from hand-held to full sized drill rigs. See Table 28 for advantages and limitations.

7.5.6 *Coring Type Sampler With Valve (see Guide D 4823 and Practice D 5680)*—This is designed for sampling sediments, sludges and free flowing powders (see Fig. 34). It is a stainless steel cylindrical sampler with a non-return valve at the lower end behind a coring or augering tip. The sample will normally be collected in an optional liner. It is operated by attaching a handle or an extension with a handle to the top of the coring device. The corer is lowered to the sampling point, pushed into the material being sampled and then removed. To recover the sample, the top cap is removed and the contents emptied into a sample container. Alternatively, the liner can be removed and capped on both ends for subsequent shipment to a laboratory. See Table 29 for advantages and limitations.

7.5.7 *Miniature Core Sampler (see Practice D 6418)*—This device is designed to collect and store small volume soil samples and allow transportation to a laboratory for subsequent chemical analysis of VOCs. Constructed from an inert composite polymer, the device consists of a coring body, a plunger, and an end cap (Fig. 35). Stainless steel handles are available to assist in collecting and subsequently extruding the sample. The sampler is available in sizes to allow collection of volumetric samples of approximately 5 and 25 g. Air-tight sealing is achieved with viton O-rings placed on the plunger and in the cap. This device may be used to retrieve samples of soil from the ground surface or trench walls. Also, it is used frequently to collect subsamples from soil cores. See Table 30 for advantages and limitations.

7.5.8 *Modified Syringe Sampler (see Guide D 4547)*—This sampler is used for collecting a small volume sample from a material surface or more usually to subsample a core for subsequent VOC analysis. The sample then is transferred immediately to a vial for transportation and analysis. This device is available commercially or made by modifying a plastic, disposable syringe. The lower end and the attachment for a needle and plunger cap are removed (see Fig. 30). The plunger is pushed in until it is flush with the cut end. The syringe sampler is then pushed into the soil core to collect the

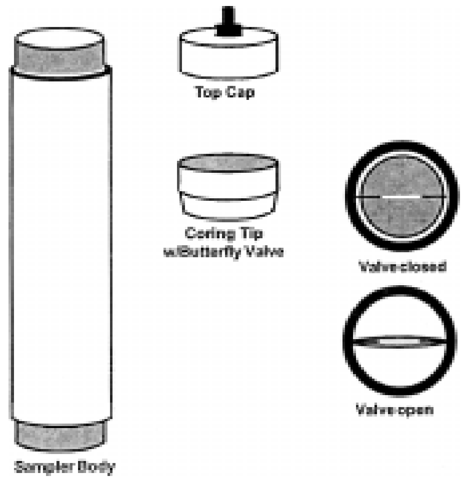

FIG. 34 Coring Sampler with Butterfly Valve

TABLE 29 Coring Type Sampler with Valve—Advantages and Limitations

Advantages	Limitations
Provides a core sample of semi-liquid materials	Cannot be used in gravel or large particle sediments or sludges
Easily decontaminated	Samples containing VOCs cannot be stored and transported in the liner
May be used in drums and small containers as well as tanks, lagoons, and waste impoundments	
Usually hand operated	

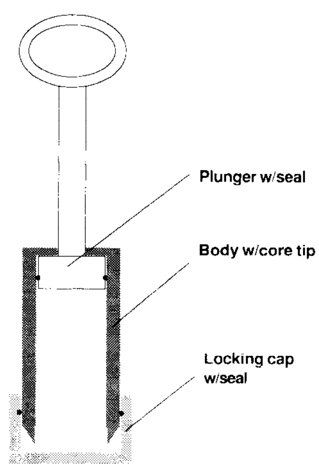

FIG. 35 Miniature Core Sampler

sample which then should be placed in a prepared, air-tight glass vial for transport to a laboratory until analysed. The vial mouth should have a diameter larger than the syringe barrel. See Table 25 for advantages and limitations.

7.5.9 *Soft Sediment Sampler* (Fig. 37)—Designed for sampling saturated soft materials either on the surface or beneath liquids. It is constructed from stainless steel with aluminum guide rods used for placement. This sampler collects a 2- or 4-in. square core sample up to 6-ft long. The sampler is comprised of two angular blades, one with a sample retaining flap valve, the other with an alignment block used to position the blades correctly. The blades are driven consecutively to collect an undisturbed sample. See Table 32 for advantages and limitations.

TABLE 30 Miniature Core Sampler—Advantages and Limitations

Advantages	Limitations
Provides a core sample from a soil surface or trench wall	Difficult to use in dry sandy materials
Collects a relatively undisturbed sample	Care required to ensure that soil does not compromise the end cap seals
Sampler is designed as a single use device for collection, storage and transportation of samples containing VOCs.	Cost may be a consideration for this single use device
Collects a sample of suitable size for analysis. Laboratory or field subsampling is not required	
Sliding plunger prevents air entrapment and allows sample extrusion	

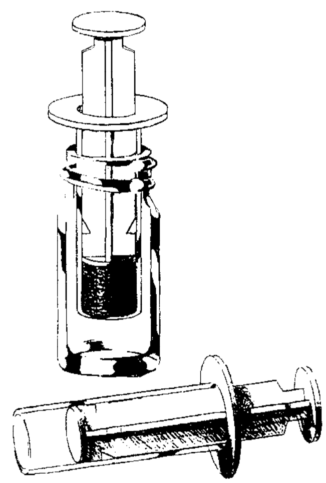

FIG. 36 Modified Syringe Sampler

TABLE 31 Modified Syringe Sampler—Advantages and Limitations

Advantages	Limitations
Provides a core sample if sampled from a soil surface or trench wall	Difficult to use in dry sandy materials
Collects a relatively undisturbed sample	Care required to ensure device is clean before use
Sampler is a low cost single use device	
Collects a sample suitable for VOC analysis, laboratory, or field subsampling is not required	
Sliding plunger prevents air entrapment and allows sample extrusion	

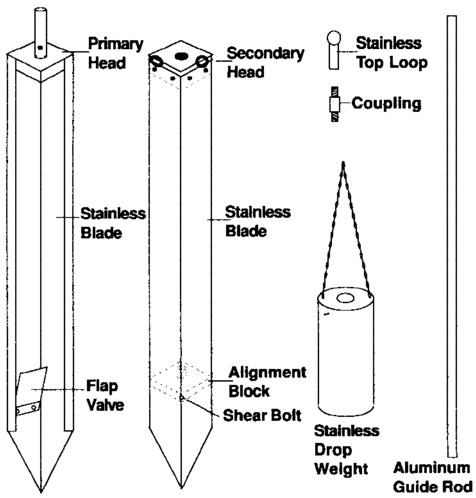

FIG. 37 Soft Sediment Sampler

TABLE 32 Soft Sediment Sampler—Advantages and Limitations

Advantages	Limitations
Provides a core sample	May require a floating platform for use in sampling beneath liquids
Collects a relatively undisturbed profile sample	May require a winch or additional personnel, or both, for recovery of long samples from beneath a deep liquid layer
May be used to collect samples beneath liquids up to 30 ft deep	
Manually operated, usually with one person	

7.6 *Rotating Coring Devices*—Includes a screw auger that collects cuttings of consolidated materials and rocks, a rotating corer that collects cores of consolidated materials, and a captive screw auger that is used to collect samples of semi-consolidated materials.

7.6.1 *Screw Augers*—For sampling consolidated solids, such as construction materials, soft rock, and wood. These augers are similar to drill bits and can be operated by hand (brace and bit) or powered by a portable electric drill (see Fig. 38). As the auger advances into the material being sampled, the cuttings move up the auger stem to the surface where they are collected for the sample. See Table 33 for advantages and limitations.

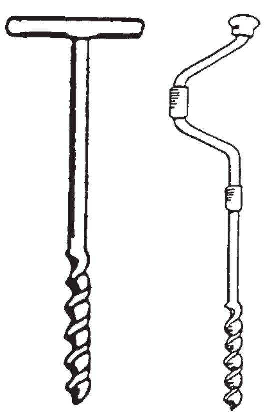

FIG. 38 Screw Augers

7.6.2 *Rotating Coring Device*—This device is used to obtain a core of consolidated solid (see Fig. 39). It consists of a diamond or carbide tipped open steel cylinder attached to an electric drill. The drill may be hand held or mounted on a stand placed on the ground surface. Water is usually used to cool and lubricate the cutting edge. The core barrel diameter ranges from 5 to 15 cm (2 to 6 in.). See Table 34 for advantages and limitations.

7.6.3 *Captive Screw Auger*—The captive screw auger (See Fig. 40) may be used to sample semi-consolidated materials in piles or drums. The stainless steel chisel tipped flighted (screw) auger is contained within a 1¼ in. (3.2 cm) diameter by up to 42 in. (107 cm) long stainless steel tube. It may be driven with either an electric, hydraulic or air powered motor. The device may be inserted into the drum through the bung hole. When operated, the chisel tipped flighted auger cuts into the sample and carries the recovered portion up the flights to the collection container at the top of the sampler. This may be emptied by pouring from the port into a sample container. The sampler cuts a core through the material being sampled, allowing collection of a disturbed, composite sample. See Table 35 for advantages and limitations.

7.7 *Auger (See Practices D 1452, D 6907 and Guide D 4700)*—Augers are used primarily to collect soil samples and fine sediments. They work by rotating and pushing the auger into the material to be sampled. Many different types and designs are available, ranging from the hand-held to portable power-driven to pick-up or van mounted to full-scale drill rigs. These augers are used for sampling unconsolidated materials.

7.7.1 *Bucket Augers (*Fig. 41*)*—Typically, bucket augers with cutting heads are pushed and twisted into the media and removed as the buckets are filled. The auger holes are advanced one bucket at a time. The practical depth of investigation using a hand auger is related to the material being sampled. In sands, augering is usually easily accomplished, but the depth of investigation is controlled by the depth at which sands begin to cave. At this point, auger holes usually begin to collapse and cannot practically be advanced to lower depths, and further samples, if required, must be collected using some type of pushed or driven device. Hand augering may also become difficult in tight clays or cemented sands. At depths approaching 20 ft (6 m), torquing of hand auger extensions becomes so severe that in resistant materials, powered methods must be used if deeper samples are required.

7.7.1.1 When a vertical sampling interval has been established, one bucket auger is used to advance the auger hole to the first desired sampling depth. If the sample at this location is to be a vertical composite of all intervals, the same bucket may be used to advance the hole, as well as collect subsequent

TABLE 33 Screw Augers—Advantages and Limitations

Advantages	Limitations
Allows collection of a sample from a solid material	Destroys layers and soil horizons and cannot obtain an undisturbed sample

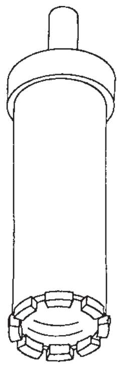

FIG. 39 Rotating Corer

TABLE 34 Rotating Corer—Advantages and Limitations

Advantages	Limitations
Can obtain a solid core	Need power and water source
	Difficult to operate
	May affect integrity of the matrix

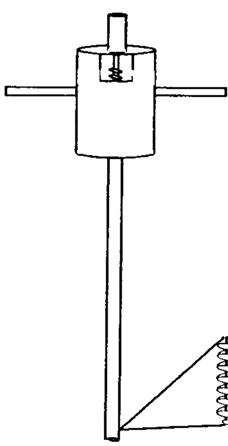

FIG. 40 Captive Screw Auger

TABLE 35 Captive Screw Auger—Advantages and Limitations

Advantages	Limitations
Allows sampling of semi solid, consolidated samples in both drums and pile	Requires an external power source (air/gas/hydraulic/electric)
All stainless steel construction	Collects only disturbed samples
May be used in hazardous environments	Care needed when sampling materials containing volatile organic compounds

samples in the same hole. However, if discrete grab samples are to be collected to characterize each depth, a clean bucket auger must be used to collect the next sample. The top several inches of material should be removed from the bucket to minimize chances of cross-contamination of the sample from fall-in of material from the upper portions of the hole.

7.7.1.2 The Planer type bucket auger may be used to remove loose material from the bottom of an augered hole, prior to core sampling. It also may be used to collect samples of solid materials from the bottom of drums and tanks. See Table 36 for advantages and limitations.

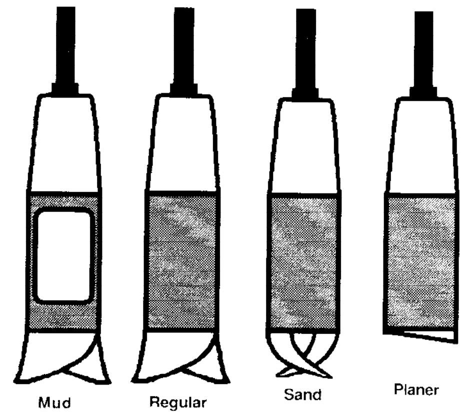

FIG. 41 Bucket Augers

TABLE 36 Bucket Augers—Advantages and Limitations

Advantages	Limitations
Easy and quick for shallow subsurface samples	Collects only disturbed samples
	Inappropriate for sampling soils for volatile organic compounds

7.7.2 *Flighted Augers (See Practice D 1452, Practice D 6151, Guide D 5784, Guide D 6286)*—Flighted augers are most often used for accessing sampling points below the ground surface and may be used directly for collecting disturbed samples, usually for on-site evaluation (Fig. 42). Flighted augers are always driven with an external power source. They are available in sizes from 2 in. (5.1 cm) to over 24 in. (61 cm) in diameter with either a solid or hollow stem to which the flights are attached. Auger sections are made in

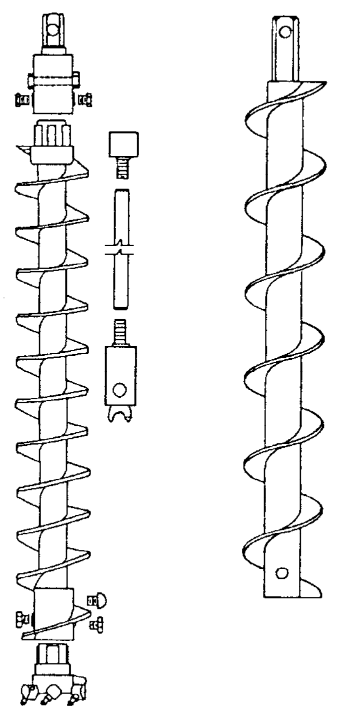

FIG. 42 Flighted Augers

TABLE 37 Flighted Augers—Advantages and Limitations

Advantages	Limitations
Can collect samples from immediately below the ground surface to considerable depths	Requires an external power source to drive the auger and usually heavy truck mounted equipment to transport, deploy and operate
Primarily used to access a sampling point	
	Inappropriate for directly sampling soils for volatile organic compounds

lengths from 2 ft (61 cm) to 6 ft (1.83 m) long with couplings on each end to allow attachment of additional sections during the drilling process.

7.7.2.1 Flighted augers are provided with a cutting tip on the lower end of the first flight. Hollow stem models are also provided with a plug or removable drive tip to prevent soil from entering the stem during drilling. During use the soil travels up the flights to the surface as the auger turns. This soil may be examined for classification and evidence of gross contamination but would usually not be used for chemical analysis as it may not be totally representative owing to mixing and sloughing that may occur as it travels to the surface.

7.7.2.2 Samples for chemical analysis would usually be collected using a core sampler (D 1586, D 1587, D 3550, D 4700). The sampler would be deployed through the central cavity of a hollow stem auger, after removing the end plug. A solid stem aguer would be removed and a core sampler inserted in the hole created by the auger. See Table 37 for advantages and limitations.

7.7.3 *Peat Borer* **(7)**—This device was originally designed to sample bog and salt marsh sediments for paleoecological analysis and to collect uncompressed cores in poorly decomposed woody peat. It may also be used to sample soft sediments in shallow water conditions (Fig. 43). Recent applications (**7**) demonstrated its usefulness in sampling contaminated sediments below water to depths of 25 ft (6.4 m).

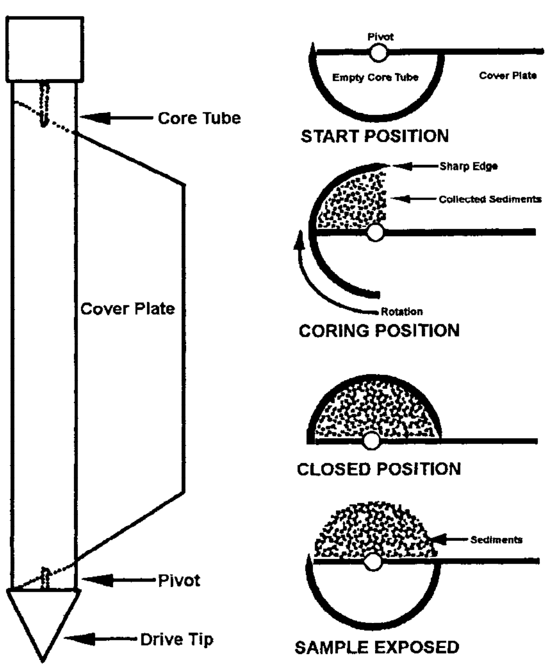

FIG. 43 Peat Borer

7.7.3.1 The sampler consists of a stainless steel coring tube with one longtitudinal wall sharpened and a stainless steel cover plate pivoted at the center of the core tube cavity. The sampler has Delrin lower and upper ends designed to both facilitate insertion into the material to be sampled and allow attachment of deployment extensions on the upper end. The sampler collects a 19.6 in. (50 cm) long core by 2.2 in. (5.4 cm diameter) with a half circle cross-section.

7.7.3.2 The sampler is assembled with the cover plate enclosing the core tube to prevent entry of material as it is pushed to the sampling point. The sample is then collected by rotating the sampler in a clockwise direction until the sharp edge of the coring tube is in contact with the cover plate. The sampler is then withdrawn and the sample exposed by rotating the cover plate in a counterclockwise direction. See Table 38 for advantages and limitations.

7.8 *Liquid Profile Devices*:

7.8.1 *COLIWASA (See Practice D 5495 and Practice D 5743)*—The COLIWASA (Composite Liquid Waste Sampler) is used to obtain a vertical column of liquid of the sampled material (see Figs. 38 and 39). It's most common use is for sampling containerized liquids, such as tanks, barrels, and drums. It may also be used for pools and other open bodies of stagnant liquids. They can be constructed of any material that would be compatible with the samples being collected.

7.8.1.1 COLIWASAs are available commercially with different types of stoppers and locking mechanisms, but all operate using the same principle. In use, the device is lowered into the liquid, tapered end first. The COLIWASA should be open at both ends so that the material flows through it as it is lowered to the desired sampling depth. This must be done slowly because the container may contain solid material which might break the tube and injure the sampler, and slowly lowering the tube allows the liquid phases to stay in equilibrium with the COLIWASA sampler.

7.8.1.2 The reuseable point sampler (Fig. 46) is used in the same way as the COLIWASA. In addition it may be used to sample at a specific point in the liquid column. This sampler is usually made of PTFE.

7.8.1.3 Once the COLIWASA has filled, the stopper mechanism is seated and both tubes are withdrawn from the material together. By manipulating the inner tube, the sampler can control the rate of flow of sampled liquid into the sample container. See Table 39 for advantages and limitations.

7.8.2 *Drum Thief (See Guide D 5743)*—A drum thief is a 1.3 m (4 ft) long tube used to sample liquids in drums and

TABLE 38 Peat Borer—Advantages and Limitations

Advantages	Limitations
Portable and operable by one person	Materials of construction, Delrin, aluminum and stainless steel may pose concerns in highly contaminated media.
Capable of collecting a discrete, relatively undisturbed sample.	
	Unsuitable for deployment in compacted media.
Generates virtually no IDW	

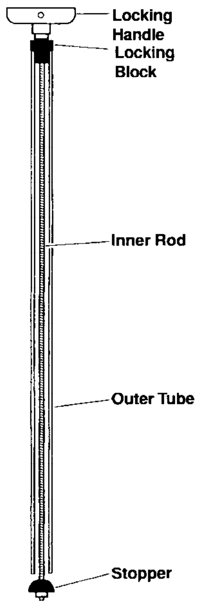

FIG. 44 Original COLIWASA

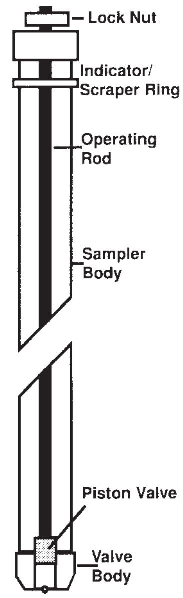

FIG. 46 Reuseable Point Sampler

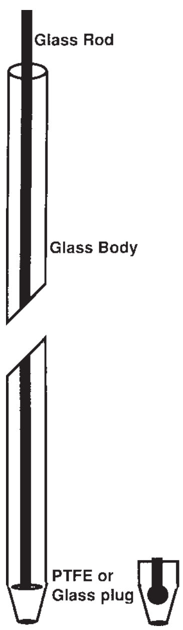

FIG. 45 Single Use COLIWASA

TABLE 39 COLIWASA—Advantages and Limitations

Advantages	Limitations
Simple to use	Depth to sample limited to length of sampler
Reuseable and single use models available	Stopper mechanism may not allow collection of approximately the bottom inch of material
Inexpensive	High viscosity fluids difficult to sample
	May break if made of glass and used in consolidated matrices
	If constructed of glass and reused, decontamination may be difficult

similar containers. It is usually made of glass, but can be constructed of other materials (see Fig. 47). In most instances, glass tubes with a 1 cm (½ in. or less) inside diameter work best. The tube is inserted into the opening of the drum or barrel as far as possible. The open end is then sealed either with the thumb or a rubber stopper to hold the sample in the tube while removing the tube from the container. The sample is then placed in an appropriate container, and the procedure repeated until an adequate amount of sample is collected. See Table 40 for advantages and limitations.

7.8.3 *Valved Sampler*—This device allows collection of a vertical column of liquid from a drum or tank (see Fig. 48). It may be constructed from PTFE for reuse or polypropylene for single use. The device is operated by first opening the top plug and the bottom valve and then lowering it vertically and slowly into the liquid to allow levels inside and outside to equalize. The top plug is closed manually and the bottom valve is pressed against the side or bottom of the container to close it. To empty the sampler, the contents are poured from the top into a suitable container. See Table 41 for advantages and limitations.

7.8.4 *Plunger-Type Sampler (see Practice D 5743)*—The plunger-type sampler is used to obtain a vertical column of liquid or slurries from drums, tanks, or similar containers. It is made from high density polyethylene or PTFE with an optional glass sampling tube (see Fig. 49). It has an open lower end and a fixture at the upper end to hold a sampling bottle. The device is lowered into the liquid to be sampled, the plunger is engaged to secure the sample aliquot, and the cord or rod is raised to transfer the sample directly into the sampling bottle or jar. The plunger can be pushed back down the sampling tube to reset the sampler. They are available in lengths suitable for sampling drums, road tankers, and rail cars. See Table 42 for advantages and limitations.

FIG. 47 Drum Thief

TABLE 40 Drum Thief—Advantages and Limitations

Advantages	Limitations
Simple to use	Depth to sample limited to length of sampler
Usually single use	High viscosity fluids difficult to sample
Inexpensive	Drum size tubes have a small volume capability, possibly requiring repeated use to obtain a sample. Larger sizes are available, however, two or more people may be required
	May be difficult to hold sample in the tube
	May break if used in consolidated matrices
	If made of glass and reused, decontamination may be difficult

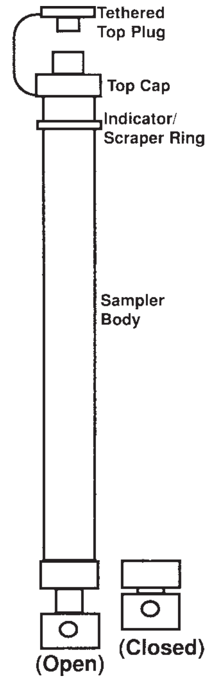

FIG. 48 Valved Sampler

TABLE 41 Valved Sampler—Advantages and Limitations

Advantages	Limitations
Simple to use	Bottom valve prevents collection of the bottom 1.25 cm (½ in.)
Reusable if made from PTFE; single use if made from polypropylene	High viscosity liquids may be difficult to sample
Unbreakable and can sample to depths of about 6.5 m (21 ft), using body extensions	

7.8.5 *Liquids Profiler*—The sampler is made from clear PVC and is provided with 1-ft depth markings on the 5-ft sampler body sections, a check valve on the lower section and a cord on the upper section (see Fig. 50). Its primary use is to allow measurement and sampling of settleable solids as would be found in sewage treatment plants, waste settling ponds, and impoundments containing waste materials. In use, it is assembled, using threaded connections to the length needed and lowered into the liquid to allow it to fill. A slight tug on the cord will set the check valve and allow it to be removed. The levels of settleable solids can be measured using the markings. It may be emptied by pressing the protruding pin on the lower end against a hard surface, or it may be pushed in and held manually. See Table 43 for advantages and limitations.

7.9 *Passive Water Sampling Devices (See Fig. 51 and Fig. 52)*—Comprise a group of samplers used to sample ground water, usually monitoring wells. They rely upon the diffusion of chemical ions and compounds across a semipermeable membrane. The device consists of a sealed chamber with a semipermeable window or a bag made from a semipermeable material. The container is filled with deionized water and then deployed in the media to be sampled. Over time, an equilibrium will be established between the ion and compound concentrations in the media being sampled and the the sampler. The sampler is then removed from the media and the sealed chamber immediately opened or directly subsampled for on site analysis. Alternatively a sample may be placed into a container suitable for shipment to a laboratory for analysis.

7.9.1 *Bag-type Diffusion Sampler*—Comprises a sealed bag made from a semipermeable plastic with a means to allow filling and removal of any trapped air, a support frame of inert material that will prevent the filled bag from failure when in air, a weight to allow the device to sink to the sampling point and a means to allow lowering and retreival from the media being sampled. All components of this sampler may be cleaned and reused, except for the sealed bag which is considered a single use item. See Table 44 for advantages and limitations.

7.9.2 *Chamber-Type Diffusion Sampler*—Comprises a central support rod or tube with horizontal holes along its length to allow placement of short tubular sampling containers. Certain models also have a flexible disc placed between each successive chamber to allow for isolation and allow for zone

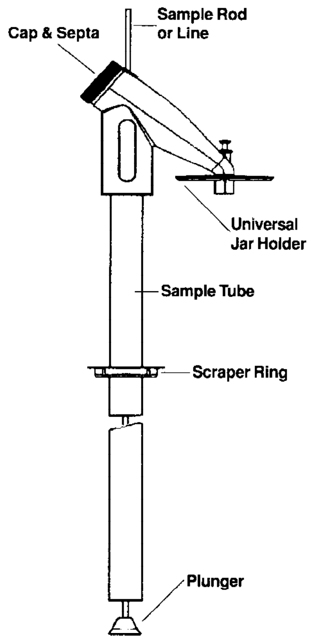

FIG. 49 Plunger Type Sampler

TABLE 42 Plunger Type Sampler—Advantages and Limitations

Advantages	Limitations
Simple to use	Care needed when using a glass sampling tube
Provides a sealed collection system	Heavy contamination may be difficult to remove, particularly when a glass sampling tube is used
May be used as either a reusable or single use device	
Relatively inexpensive and available in various lengths	

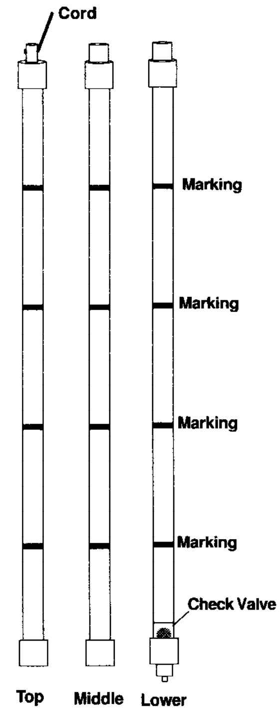

FIG. 50 Liquids Profiler

TABLE 43 Liquids Profiler—Advantages and Limitations

Advantages	Limitations
Allows length measurement of liquid/settleable solids columns of any length	Suitable for sampling non-caustic liquids
Easily assembled and used	High viscosity materials may be difficult to sample
Unbreakable in normal use and reusable	

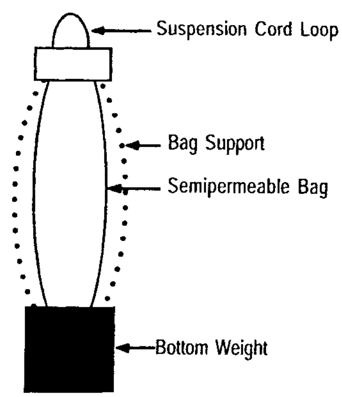

FIG. 51 Bag-Type Passive Sampler

sampling. Each sealed chamber is provided with a semipermeable mebrane on one or both ends. The assembly would be carefully lowered into the well and left to allow for ion equilibrium to be established. On removal, the sealed chambers can be capped and sent to a chemical analysis facility. See Table 45 for advantages and limitations.

7.10 *Multi-Level Sampling Devices (See Figs. 53-55)*—are inserted into a hole in the ground for the purpose of either identifying contaminants or collecting samples of soil gas or ground water, or both, at specific locations in the hole. Those designed for multi-level sampling in saturated soils are normally dedicated and therefore left permanently in the ground. Types designed for in-situ identification of contaminants as well as sampling are usually recoverable as they are made from an inflatable, flexible, closed-end tube.

7.10.1 *Dedicated Multi-Level Samplers*—comprise a series of sampling ports placed in a casing and separated by inflatable packers or bentonite contained in annular sacks. The sampling ports in each monitoring zone are either fitted with a sampling pump connected directly to the surface or are provided with a valued sampling port that may be accessed by a sampling mechanism, lowered into the inner well casing. A second type employs a multi-cavity tube. Each cavity is ported at a specific depth to allow sampling and each cavity is sealed below the sampling point. Systems employing inflatable packers and not bentonite sacks are usually removable and therefore reusable.

7.10.2 *Portable (Reusable) Multi-Level Sampler*—comprises a strong but flexible tubular membrane with an

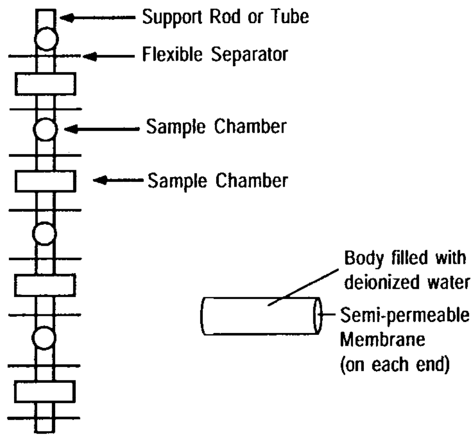

FIG. 52 Chamber-Type Passive Sampler

TABLE 44 Bag-type Passive Sampler—Advantages and Limitations

Advantages	Limitations
Simple, low cost construction	Requires time for diffusion to occur(days-weeks)
Easily assembled and used in wells of any diameter	Sample volume limited to size of sampling container
As no water is removed from the formation, may be used to sample wells with very low recovery potential	Membranes affected by excessive heat and high concentrations of some solvents

TABLE 45 Chamber-Type Passive Sampler—Advantages and Limitations

Advantages	Limitations
Allows several zones to be sampled when used with separators	Requires time for diffusion to occur(days-weeks)
As no water is removed from the formation, may be used to sample wells with very low recovery potential	Requires care in assembly, installation and recovery to prevent damage and hang-up
	Usually requires wells or boreholes to be of 2 or 4-in diameter

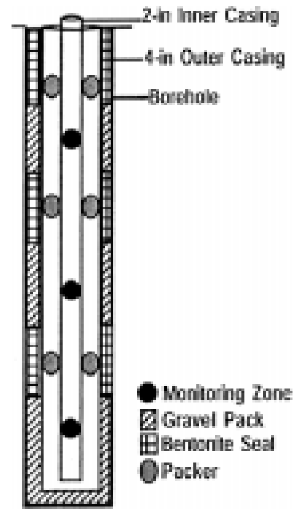

FIG. 53 Dedicated Multi-Level Type 1, Ground Water Monitoring System

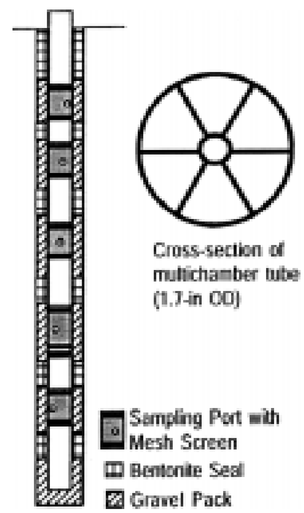

FIG. 54 Dedicated Multi-Level Type 2, Ground Water Monitoring System

internal tether attached to the sealed distal end. The proximal end of the tubular membrane is attached to an enclosed canister with reel. The system is deployed by pressurizing the canister interior and unwinding the tether and attached tubular membrane. It automatically deploys itself into the borehole. A series of sampling ports, sensor strips or absorbent patches may be attached to or through the external wall of the membrane to allow sampling of the borehole wall at predetermined depths. Systems may be used for dedicated or portable sampling. Depending on field conditions, the interior of the membrane may be filled with air, water or dry sand for portable use. Permanent installations may use bentonite grout as a fill material. In situations where there is concern about hole collapse, a dual tubular membrane system may be deployed to prevent this, when the sampling tubular membrane is removed. Removal of an installed tubular membrane is accomplished by releasing the air pressure or removing other fill materials and winding in the tether and membrane onto the reel in the canister.

7.11 *Surface Sampling Devices*:

7.11.1 *Impact Devices (*Fig. 56, *see Practice D 5679)*—These devices are used for sampling consolidated solids. The most common "device" is a hammer and hand chisel. Another device is the pneumatic chisel where compressed air takes the place of the hammer. See Table 48 for advantages and limitations.

7.11.2 *Spoon (*Fig. 57*)* —A spoon may be used to sample particulate materials on the ground surface or from an open container or waste pile. Small samples of liquid may also be collected with this device, although it is not the preferred method. Made from stainless steel or PTFE they can be easily cleaned for re-use. Plastic spoons may be used as they are inexpensive and can be considered a single use item. See Table 49 for advantages and limitations.

7.11.3 *Scoops and Trowels (See Practice D 5633)*—These have limited application for collecting surface soil samples but may be used for solid waste sampling. These devices come in different sizes and materials (see Fig. 58). Unpainted stainless

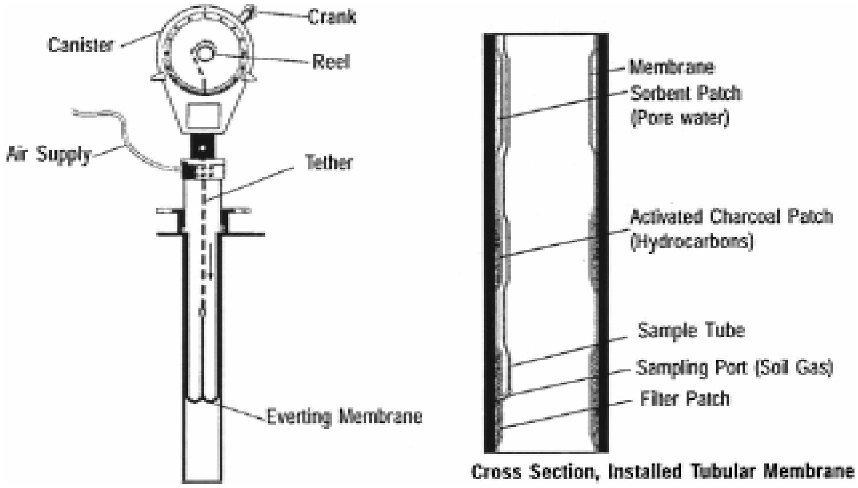

FIG. 55 Portable Multi-Level, Below Ground Monitoring System

TABLE 46 Dedicated Multi–Level Ground Water Monitoring Systems—Advantages and Limitations

Advantages	Limitations
Allows several zones to be sampled or monitored consecutively or simultaneously	Requires expertise beyond that needed for conventional monitoring well installation and subsequent use
Significantly lower installation costs, compared to conventional cluster wells	System material costs may be a consideration, Type 1
Low material and installation costs, (Type 2)	

TABLE 47 Portable Multi-Level Below Ground Monitoring System—Advantages and Limitations

Advantages	Limitations
Allows sampling and physical parameter measurement directly from the borehole wall	Requires expertise beyond that needed for conventional monitoring well installation and subsequent use
Each system is custom configured for a specific borehole	May be difficult to install in boreholes subject to collapse, unless special techniques are employed
Low material and installation costs and reusable	

steel is preferred. Scoops are available from laboratory and field equipment supply houses, trowels can be obtained from hardware stores. See Table 50 for advantages and limitations.

7.11.4 *Shovels*—Shovels used for environmental sample retrieval are usually made from stainless steel or suitable plastic materials (see Fig. 59). Their primary use is collection of surface materials or large samples from waste piles. Their other use is the mixing of large sample volumes as may be required for the collection and mixing of composite samples. See Table 51 for advantages and limitations.

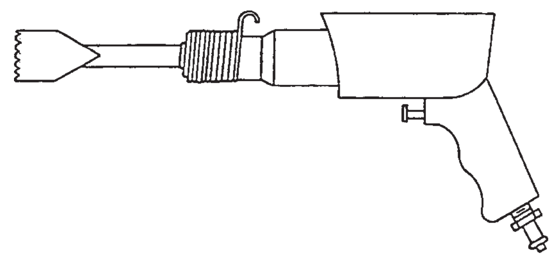

FIG. 56 Impact Device

TABLE 48 Impact Devices—Advantages and Limitations

Advantages	Limitations
Can obtain a sample of a solid material by chipping or flaking at the surface of the material	Pneumatic system needs an air source
	May not collect all layers of a heterogeneous solid

FIG. 57 Spoon

8. Keywords

8.1 environmental; liquid; monitoring; sampling; sampling equipment; sediment; soil; waste management; water

TABLE 49 Spoon—Advantages and Limitations

Advantages	Limitations
Inexpensive	Small sample volume
Easy to use and clean	Cannot be used to collect samples for VOC analysis
	A single sample may not be representative

TABLE 50 Scoops and Trowels—Advantages and Limitations

Advantages	Limitations
Easy to use and clean	May affect the matrix during sample collection by selecting certain particle sizes
Inexpensive	May not be constructed in a shape that is compatible with the dimensions of the matrix
	May exacerbate the loss of volatile organic compounds by disturbance

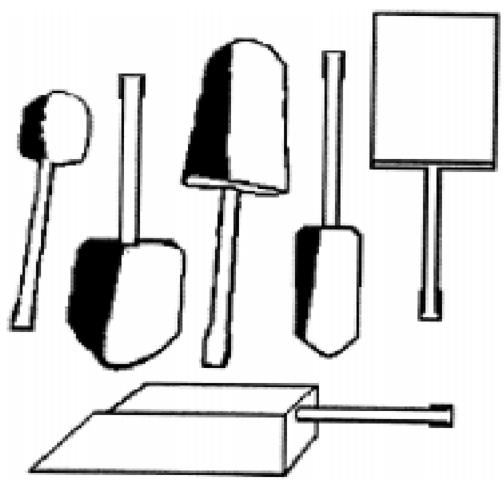

FIG. 58 Stainless Steel Scoops

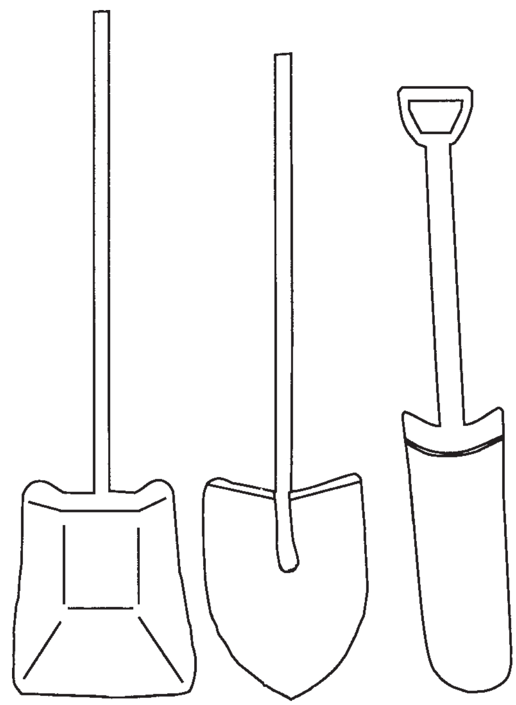

FIG. 59 Stainless Steel Shovels

TABLE 51 Shovels—Advantages and Limitations

Advantages	Limitations
Easy to use and clean	For surface use only
Rugged for use with hard materials	Cannot be easily used to fill sample containers
	Cannot be used to collect samples for VOC analysis

APPENDIX

(Nonmandatory Information)

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