SAMPLING WITH THE US DH-48 DEPTH-INTEGRATING SUSPENDED-SEDIMENT SAMPLER

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Sampling with the US DH-48 Depth-Integrating Suspended-Sediment Sampler

Characteristics

Description: The US DH-48 is a lightweight sampler used for collection of isokinetic depth-integrated suspended-sediment samples where wading rod suspension is used (Figure 1). The instrument can sample to within 3 ½ inches of the streambed. The sampler consists of a streamlined aluminum casting, 9 5/8 inches long (less nozzle), which partially encloses a round pint glass milk bottle sample container (must be purchased separately). The sampler weighs 4 1/2 pounds including the sample container. A plastic (dyed yellow) or brass nozzle extends horizontally from the nose of the sampler body. A streamlined projection, pointing toward the rear on the side of the sampler head, accommodates the air exhaust port from which air may escape from the bottle as the sample is being collected. A standard 1/2 inch wading rod (must be purchased separately) is threaded into the top of the sampler body for suspending the sampler. The sample container is held in place and sealed against a neoprene gasket in the sampler head by a hand-operated spring-tension bottle retainer at the rear of the sampler.

Sample container: The sampler is designed for use with a round pint glass milk bottle. A gasket inside the front of the sampler provides a seal between the sampler and sample container. To install the sample container the bottle retainer is pulled rearward and swiveled to either side of the centerline of the sampler to provide clearance for inserting the bottle. The bottle can then be slid into the body of the sampler while making sure the bottle mouth seats squarely on the gasket. Removal of the sample container is accomplished by reversing the procedure.

Sampler function: When the sampler containing a sample bottle is submerged and oriented into the flow (nozzle horizontal and pointed upstream) a continuous stream filament is discharged into the sample container during the entire time of submergence, even after the sample bottle is completely filled. The air in the sample container displaced by the sample may escape through the air exhaust port. A fixed head differential of 11/16 inch between the intake nozzle and the air exhaust port facilitates sampling in stream with low velocities or slack water. If the bottle becomes entirely full, the sample may not be representative and should be discarded. Although the capacity of the sample bottle is approximately 470 mL, the tilt of the bottle is such that any sample containing more than 420 mL of a water-sediment mixture may be in error. In order to provide sufficient sample for a laboratory analysis, the length of time the sampler remains submerged should be adequate to produce a sample volume greater than 375 mL but not exceed 420 mL. It is generally preferable to save an initial sample smaller than 375 mL and sample the stream vertical a second time, or even a third time. Each of the supplemental samples should be collected in the same sample bottle. However, sufficient latitude in minimum sample volumes should be permitted to obviate retaking a large number of samples.

Limitations

Velocity limitations: The US DH-48 sampler will collect acceptable flow weighted samples in streams with velocities from 1 to 9 ft/sec. An acceptable velocity range is one at which a representative flow weighted sample is collected at a sampler inflow efficiency between 90% and 110%. Inflow efficiency is defined as the ratio of the sample velocity entering the nozzle to the ambient stream velocity. An inflow efficiency of 100% is referred to as isokinectic. A graphical presentation of inflow efficiencies for the US DH-48 is presented in (figure 2)[1].

Depth limitation: The US DH-48 sampler will collect flow-weighted samples to a maximum depth of approximately 9 ft at sea level. This depth is much greater than can be waded. To sample at depths greater than wade-able, wading rod extensions (available from FISP in 1- and 3-foot lengths) can be added to the sampler. The sampler can then be deployed from a low bridge or boat.

Maximum safe wading depths depend on the size of the field technician, the stream velocity, and the streambed material. A wading factor can be easily determined by multiplying the depth (in feet) of the stream by the stream velocity (in ft/sec). For safety, a stream condition that produces a factor of 10 or greater should not be waded. In addition, if the stream depth is greater than three feet caution should be used. A field technician that is 5 ft tall weighing 120 lbs should likely avoid streams with 3-ft and greater depths. However, a field technician that is 6 ft tall and weighs 200 lbs would normally be able to wade 3-ft deep streams with little difficulty. It is important that field technicians know and strictly adhere to their personal wading limits. Additional caution should be used when the streambed is composed of loose or slippery material. Algae coated cobbles can be as slippery and dangerous as ice. Safety should always be a field technician's first priority. Always wear a personal flotation device when collecting a wading sample.

Unsampled zone: The US DH-48 can sample to within 3 1/2 inches of the streambed. This unsampled zone is due to the distance between the nozzle and the bottom of the sampler.

Transit rate limitations: The transit rate (R_t) is the speed of lowering and raising the sampler in the sampling vertical. A transit rate diagram for the US DH-48 is presented in figure 3[2,3]. Acceptable transit rates for the US DH-48 sampler can be selected by using this diagram. The light blue shaded area of the transit rate diagram corresponds to combinations of sampling depths, transit rates, and mean velocities that will produce sample volumes between 300 and 420 mL. The dark blue shaded area of the transit rate diagram corresponds to combinations of sampling depths, transit rates, and mean velocities that will produce sample volumes less than 300 mL. The white or non shaded areas of the transit rate diagram corresponds to combinations of sampling depths, transit rates, and mean velocities that will produce overfilled samples (to the left of the shaded areas) or compression induced excessive nozzle inflow velocities (to the right of the shaded areas).

The following factors should be considered when selecting a transit rate:

1. R_t must be fast enough so that the bottle is not overfilled.
2. R_t must be slow enough to obtain a sample of sufficient volume to provide enough sediment for analysis.
3. R_t must be slow enough to not exceed the approach angle limit. The approach angle limit for the US DH-48 (and all isokinetic FISP samplers) is 0.4 the mean stream velocity.
4. R_t must be slow enough to not exceed the compression rate limit.

Instruction for use of the US DH-48 sampler

Sampler inspection: The sampler body should be inspected for damage and missing parts. Both ends of the exhaust port should be clear and unobstructed. The exhaust port can be damaged if the sampler is struck against a rock while sampling or dropped during transportation. An obstructed air exhaust port can adversely affect the sampler inflow efficiency. The threads in nozzle hole and wading rod receptacle should be checked for stripping and obstructions. The threads in the wading rod receptacle can be chased with a 3/8-20 NS threading tap. The threads in the nozzle hole can be chased with a 7/16-20 NF threading tap. Check the bottle retainer for adequate tension to hold the sample container in place. Check the gasket seat area inside the head of the sampler for burrs and obstructions that would interfere with the seating of the gasket.

The sampler nozzle, bottle gasket, sampler container, wading rod, and wading rod extensions should also be inspected. Plastic nozzles produced by FISP for the US DH-48 sampler are dyed yellow and the brass nozzles are stamped with the numerals “48”. The nozzle should be straight with no visible signs of damage. The bore should also be inspected for straightness and any signs of burrs or deformity. The threads on the nozzle should be checked for damage. If thread damage is found the threads can be chased with a 7/16-20 NF threading die. If damage or burrs are found in the bore or at either opening it should be discarded and replaced with a new nozzle.

FISP recommends neoprene gaskets for the US DH-48 sampler. If the gasket is hard to the touch, torn, or deformed to the point that it will not fit flush in the gasket seat area of the sampler, it should be discarded and replaced with a new gasket. The gasket is press fit by hand into the seat in the head of the sampler. If the gasket is in good condition, it should remain in place once it is pressed into the seat. No adhesives or mechanical devices are required to retain the gasket in the sampler.

A 1-pint glass milk bottle is the recommended sample container for the US DH-48 sampler. It should be inspected for cracks or chips and should be cleaned prior to going to the field. Cracked bottles should be replaced. A bottle with a chipped area can be used if it does not impair the soundness of the bottle and the chip is not in the mouth area of the bottle and would prevent an adequate seal with the bottle gasket.

The wading rod and any wading rod extensions should be checked for damage to the screw threads. If damage is found, the threads can be chased with a 3/8-20 NS threading die. The female threads of wading rod extensions can be chased with a 3/8-20 NS threading tap. Attempting to mate a wading rod or wading rod extension with damaged threads to a US DH-48 sampler can damage the threads in the softer material (aluminum) of the US DH-48.

Sampler assembly: Once the sampler body and associated equipment has been checked for damage, screw the wading rod into the top the sampler. If the stream depth is near 3 ft deep or greater, a wading rod extension can be added to allow easier control of the sampler in the deeper streams. Wading rod extensions are available in 1- and 3-ft lengths.

The nozzle should be screwed into the sampler by hand. FISP strongly advises that wrenches and pliers not be used to install the nozzle. It is easy to over tighten the nozzle and damage the threads. If the threads in the sampler and on the nozzle are not damaged, the use of tools to insert the nozzle should not be required.

The final step in the assembly of the sampler is installation of the sample container (1-pint milk bottle). The sampler should be turned upside down and the bottle retainer rotated approximately 90° to the left or right of the centerline of the sampler. This will allow the bottle to be slid into the sampler body. Once the bottle is in place and its mouth pressed against the gasket; the bottle retainer should be pulled rearward to clear the base of the bottle, turned until it is centered over the base of the bottle, and tension gently released to press the bottle against the gasket. To assure the mouth of the bottle is properly sealed against the bottle gasket, the bottle should be rotated left and right. To check for an air-tight seal between the bottle and the sampler; place a short length of clean flexible tubing over the nozzle, block the air exhaust port with a finger, and gently blow (by mouth) into the tube that is attached to the nozzle. Do not place mouth directly on the sampler or nozzle. They may be contaminated from previous sampling. No air should escape from the sampler. If air escapes, the bottle should be reseated against the bottle gasket and rechecked.

Sampling: Prior to collecting a sample, measure or estimate the mean stream velocity. The time required to fill the sample container to 395 mL can be selected from table 1. The transit rate can be determined by dividing the sampling time by two times the depth of the stream. Once calculated, the transit rate diagram in figure 4 should be checked to determine that it falls within acceptable limits.

Example:

If $V_{(\text{mean stream velocity})}$ = 4.0 ft/sec,

$T_{(\text{sampling time})}$ = 10 (selected from table 1).

For a stream with $D_{(\text{stream depth})}$ = 2.5 ft,

$R_t = (2 \times D_{(\text{stream depth})}) \div T_{(\text{sampling time})} = (2 \times 2.5 \text{ ft}) \div 10 \text{ sec} = 0.5$ ft/sec.

This example assumes that a sample of 395 mL is collected.

The transit rate can also be selected by using the transit rate diagram. Using the information from the previous example; draw a horizontal line on the diagram that corresponds to the depth of 4 ft. Next select a point on the previously drawn line in the middle of the light blue shaded area. From this point draw a vertical line to intercept the bottom axis. The number that corresponds to the intersection of the vertical line and the bottom axis is multiplied by the mean stream velocity to produce the transit rate.

When wading a stream to collect a sample, the field technician should attempt to minimize flow resistance and maximize stability. By turning sideways the force of the water that would push the field technician downstream can be minimized. Using this stance while slightly bending the upstream knee and leaning into the flow will increase stability.

The sampler should be held away from the field technician's body and as far upstream as possible while still maintaining stability (figure 4). The wading rod should be held vertically with the sampler and nozzle pointing upstream and as far away from any disturbance to the flow caused by the field technician. Using a constant transit rate, previously selected, lower the sampler through the water until it reaches the bottom. Care should used to avoid breaking the sample bottle as it touches the bottom and to prevent stirring up loose sediment that could bias the sample. Once the sampler touches the bottom, immediately reverse the direction of the transit and raise the sampler, using the same transit rate, until it clears the surface of the water. If sample volumes are not being composited, cap and label each bottle. Each sample label should contain adequate information to identify the sample and to satisfy the purposes of the investigation. The following items are suggested:

- Name of stream
- Location of the cross section
- Location of the vertical
- Stream depth covered by the sample
- Stage of the stream
- Date
- Time of day
- Identification of personnel
- Sampling time
- Water temperature
- Coordination with sample groups
- Serial number of sample

Questions and comments regarding sampler operation should be addressed to:

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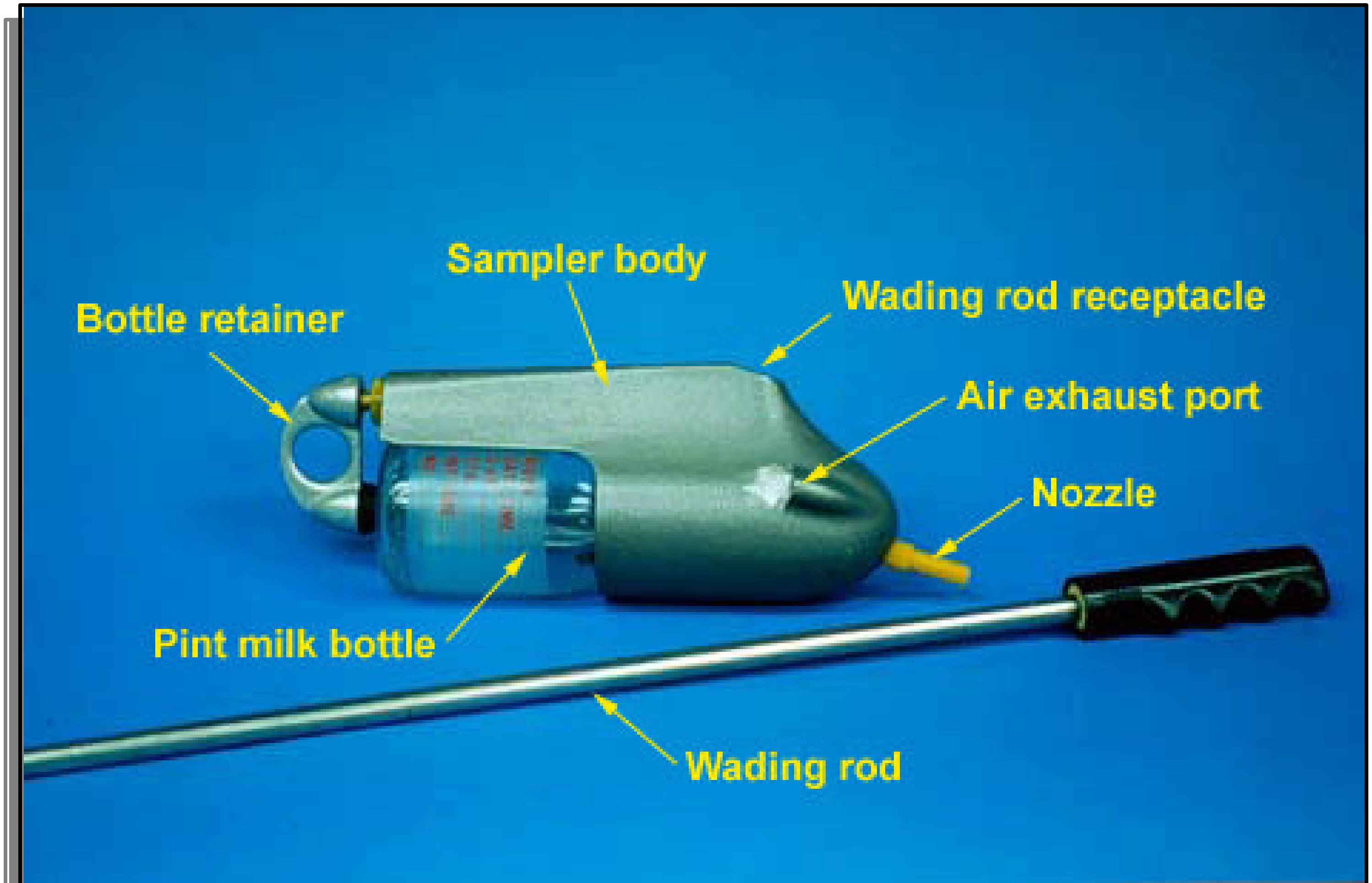


Figure 1. US DH-48 Suspended-Sediment Sampler

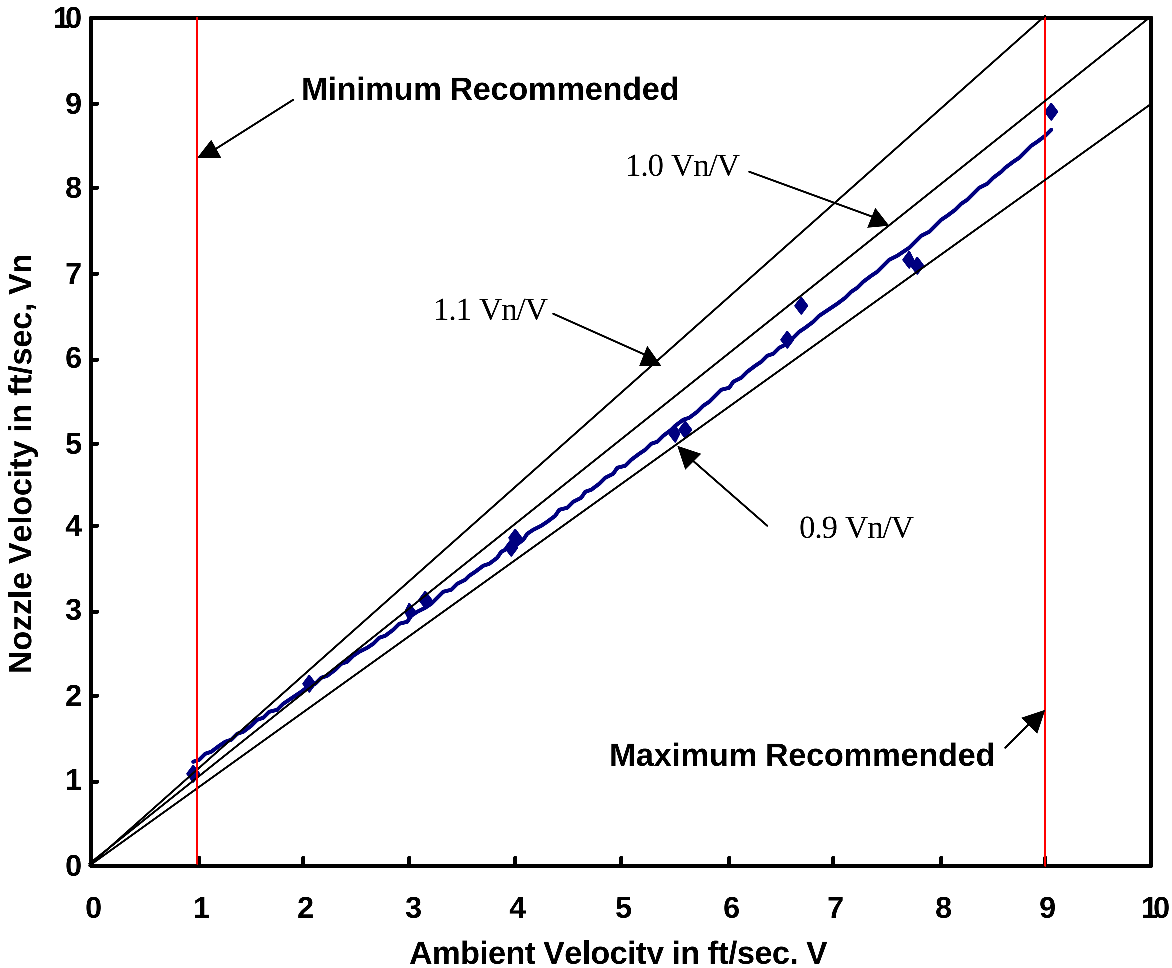
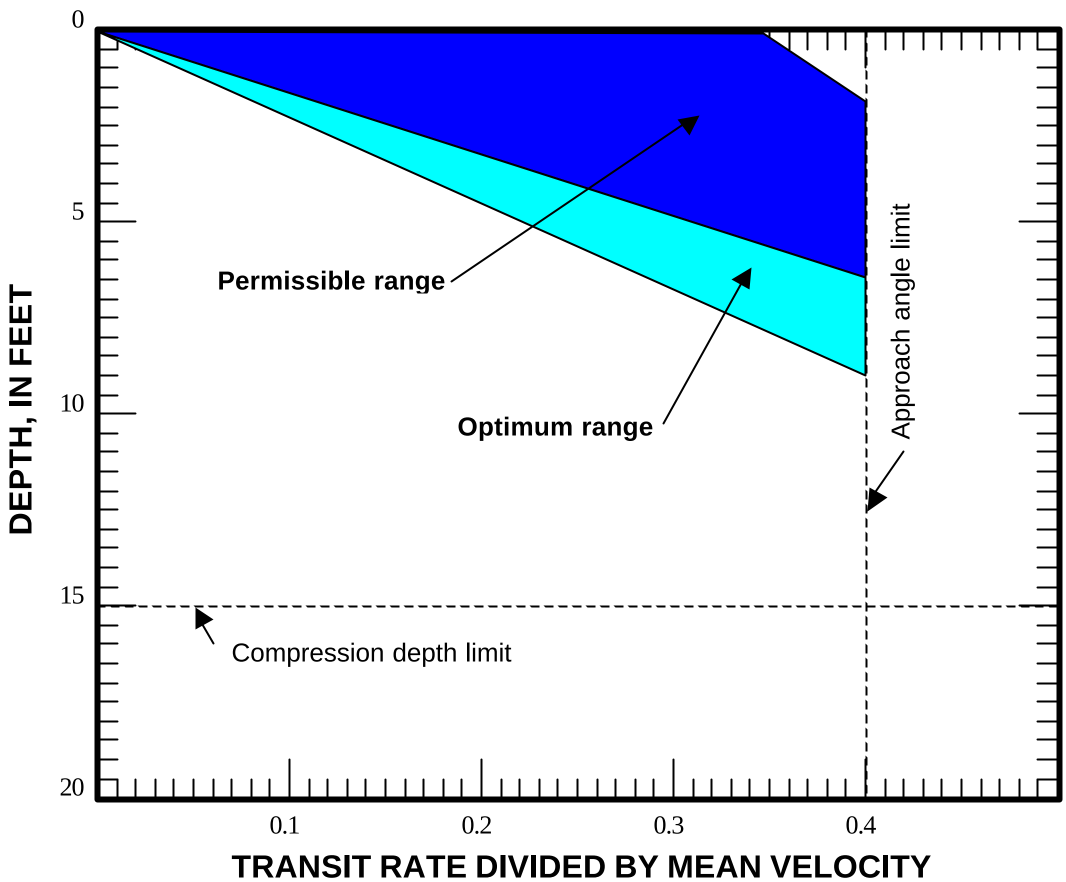


Figure 2. Inflow Efficiency diagram for the US DH-48



Note: The following configuration and volumes were used to produce this diagram. The total volume of the sampler container was 470 mL. The maximum optimum sample volume was 420 mL. The minimum optimum sample volume was 300 mL.

Figure 3. Transit Rate Diagram for the US DH-48 sampler

Figure 4. Proper wading sampling stance using a US DH-48 sampler

Velocity in ft/sec	Volume in ml	Time in seconds
1.0	395	41
1.2	395	34
1.4	395	29
1.6	395	26
1.8	395	23
2.0	395	20
2.2	395	19
2.4	395	17
2.6	395	16
2.8	395	15
3.0	395	14
3.2	395	13
3.4	395	12
3.6	395	11
4.0	395	10
4.8	395	9
5.2	395	8
5.8	395	7
6.8	395	6
7.6	395	5
9.0	395	4

TABLE 1. Filling times for the US DH-48 Sampler