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EFFLUENT SAMPLING PORT DESIGN FOR
ONSITE WASTEWATER TREATMENT

Stricter regulations and management practices are prompting increased effluent sampling programs for performance-based onsite wastewater treatment systems. Effluent samples are collected and then analyzed and averaged to evaluate system performance. For onsite and other small flow wastewater treatment systems, the design of the sampling port plays an extremely important role in determining whether or not the sample collected is actually representative of system effluent. "The objective of sampling is to collect a portion of material small enough in volume to be transported conveniently and yet large enough for analytical purposes while still accurately representing the material being sampled. This objective implies that the relative proportions or concentrations of all pertinent components will be the same in the samples as in the material being sampled…"[1] If the sampling port is not properly designed, located and maintained, the sample collected will not be representative of system effluent. "Without proper sampling procedures, the results of such monitoring programs are neither useful nor valid, even with the most precise and accurate analytical measurement."[2] Erroneous data as a result of analyzing a non-representative sample will likely lead to an incorrect conclusion regarding system performance and compliance. Only when proper scientific sampling methods are being followed will a defensible sample be obtained.

When sampling effluent from onsite and other small flow treatment systems, most of the equipment required for sampling is transported from site to site. However, the sampling port must be built into the plumbing at system installation. Therefore, for proper sampling to take place, sampling port design and location must be considered prior to actual installation. While it may be convenient to collect an effluent sample from any number of locations downstream of treatment system processes, when the sampling port has not been properly designed, maintained and used, a non-representative sample will result.

GENERAL

Two types of samples are collected and analyzed to determine the characteristics of treatment system effluent; grab samples and composite samples. "A grab sample is one that is taken to represent one moment in time and is not mixed with any other samples. A grab sample is sometimes called an *individual* or *discrete* sample and will only represent sample conditions at the exact moment it is collected."[3] Grab samples are typically used for unstable parameters such as temperature, dissolved oxygen or pH.

"A composite sample is prepared by combining a series of grab [individual discrete] samples over known time or flow intervals. A composite sample shows the average composition of a flow stream over a set time or flow period if the sample is collected proportional to flow."[3] For both sampling methods, a properly designed, located and maintained sampling port is needed to insure the sample is representative of the effluent flow stream. Large municipal treatment plants frequently sample directly from an effluent channel with sufficient flow velocity to keep solids in suspension. With this configuration, a well mixed sample is likely. However, most onsite systems experience intermittent, gravity flow. As such, the velocity of the liquids and solids vary from turbulent and well mixed, to slow and consolidated, all the way to quiescent and well-settled. A properly designed sampling port will allow a representative sample to be taken by preventing the variables of flow velocity and solids settling from affecting the sample collected.

INFLUENT vs. EFFLUENT SAMPLING

A proper influent sampling port for onsite wastewater treatment systems is very impractical, if not impossible to design. Small commercial or large flow municipal treatment systems frequently sample the influent before it reaches the treatment plant. However, by that time, most raw sewage has been mixed with several types of wastewater, macerated by comminuting or pumping, or at least has begun to biologically break down in the collection system. Any of these processes tend to homogenize the waste enough that a small volume sample (aliquot) is more likely to represent the characteristics of the total waste stream.

Due to the short duration of flows from individual water using appliances, raw waste in a home sewer line is not likely to be homogenized with waste flowing at any other time period until after it enters the treatment plant. Whether the waste was macerated vegetable peelings from a garbage disposal or gray water from the clothes washer, the sewer line will likely only contain one or the other at any single point in time. Any sampler trying to collect influent may experience problems picking up food waste, paper products or other material that has not begun to biologically degrade. If it does pick up these concentrated solids in a small volume sample, the aliquot will not be representative of the total incoming flow. Consequently, it is usually assumed that the influent to an onsite treatment system is of typical domestic character and influent sampling is not performed, but effluent sampling is possible.

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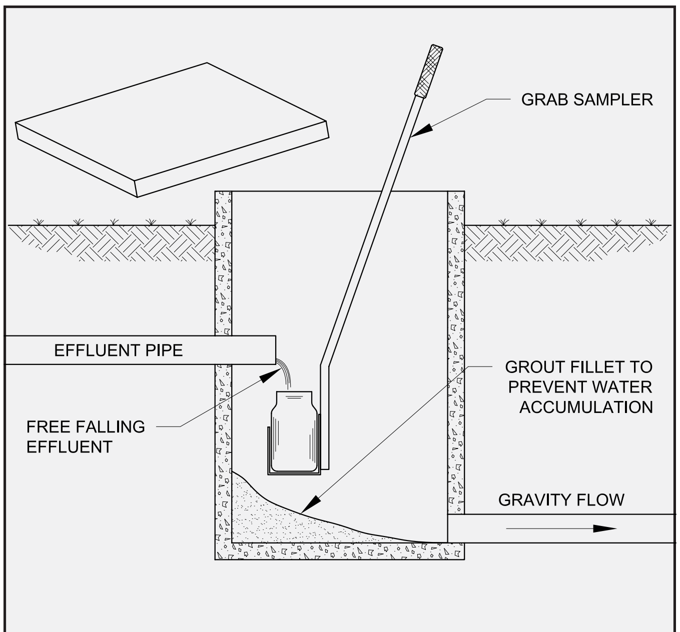
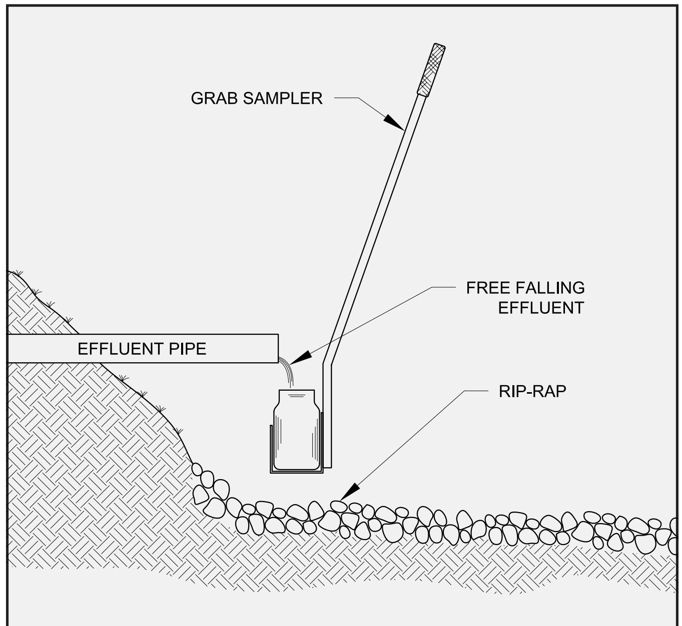
GRAB SAMPLING PORT

The design, location, maintenance and use of a grab sampling port will determine if a representative sample can be collected. Grab samples are typically taken to evaluate unstable effluent parameters that are subject to change on their own if stored in a composite sampler. Examples of these parameters are temperature, dissolved oxygen or bacteriological testing, such as fecal coliform. The location of the sampling port should be as close to the discharge of the treatment system as practical, but upstream of any process that would alter the parameters that are being tested. The primary design consideration for a grab sampling port is for the effluent flow stream to be free-falling at the point of collection, in order to prevent the accumulation of solids that occurs if the grab sample is withdrawn from a sump. The two most popular configurations for a grab sampling port are “in-line” or the end of an open discharge pipe. There are specific design considerations for each.



IN-LINE PIPE GRAB SAMPLING PORT

An in-line sampling port is traditionally used where sampling is needed downstream of a treatment system, but upstream of other processes, or where the downstream plumbing is inaccessible. The in-line sampling port is traditionally buried along with the system discharge plumbing and developed to grade. The in-line sampling port must be covered to prevent environmental factors such as dirt, vegetation and insects from contaminating any sample collected. The design of the sampling port structure must allow a minimum of 3" to 4" fall from inlet to outlet in order to provide sufficient room for a sample bottle to be placed under the inlet pipe. The inlet pipe should extend beyond the inside wall of the sampling port a sufficient length to insure that the effluent will free-fall from the end of the pipe into the sample bottle, and not trickle down the sidewalls of the structure. The interior sidewalls of the sampling port should provide sufficient working space to allow an open container to be withdrawn without contacting the sidewalls and contaminating the sample. The outlet of the sampling port should be at the bottom of the structure to prevent the accumulation of stagnant effluent, which could contaminate the sample. Finally, all interior surfaces of the port should be accessible from grade to facilitate cleaning prior to sample collection.



DISCHARGE PIPE GRAB SAMPLING PORT

The end of an open discharge pipe is also suitable as a grab sampling port if certain considerations are taken into account. First, there must be sufficient distance below the bottom of the pipe to allow a free-falling sample to be collected. This means that there must be 3" to 4" of vertical height between the bottom of the pipe and the surrounding grade or other discharge structures. If the open discharge pipe is going to be used for sample collection, it must also be accessible for cleaning of the pipe and collection of the sample. If the end of the effluent pipe is above an earthen bank, weeds, trees and other vegetation must be cleared from the area in order to prevent environmental contamination during sample collection. If the discharge pipe contains a rodent screen to prevent entry by small animals, it must be removed prior to sampling and the entire interior and exterior of the pipe must be cleaned. If bacteriological testing is to be performed, the pipe must also be sterilized prior to the collection of any sample. If the pipe is not cleaned prior to sample collection, dust, vegetation, insects, animal droppings and other material will contaminate the effluent and result in a non-representative sample being analyzed.

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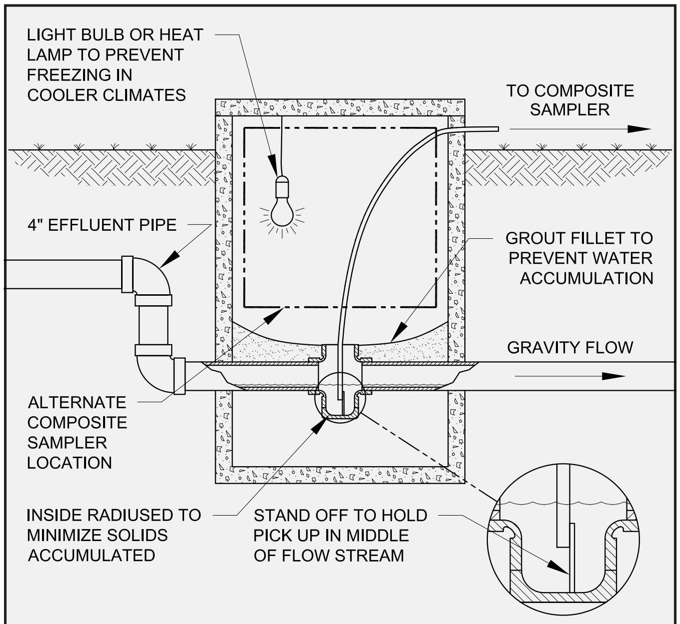
COMPOSITE SAMPLING PORT

As a composite sampling port is used to collect effluent over an extended period of time, the factors of design, location and maintenance play an even larger role in determining if a collected sample will be representative of the effluent flow stream. These considerations apply whether the composite sample is flow-proportional (where either the aliquot volume or sampling frequency varies in direct proportion to the effluent flow rate) or fixed-volume (where equal volume aliquots are withdrawn at equally spaced time periods). "A flow-proportional sample is more representative of the waste stream than a fixed-volume sample because it takes into account variations in wastewater characteristics that result from fluctuations in flow."[3]



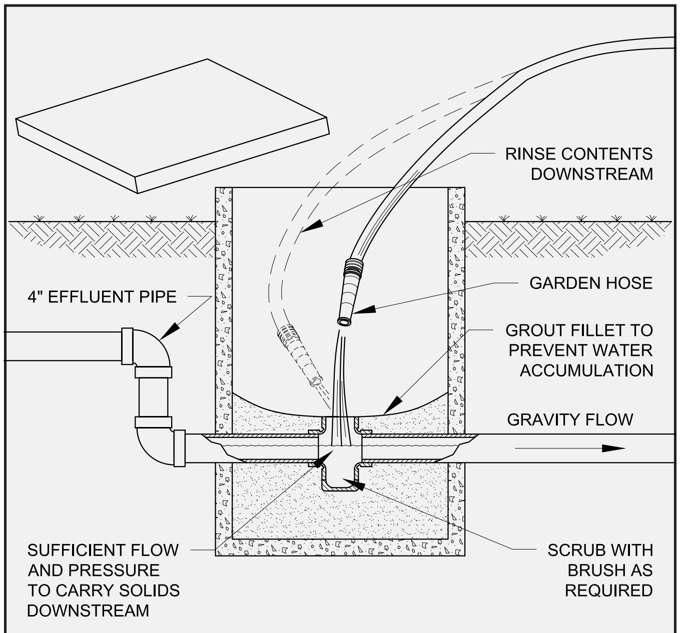
COMPOSITE SAMPLING PORT

The design of the composite sampling port must maintain the characteristics of the effluent as it flows through the port. The primary design consideration is to prohibit the accumulation of effluent solids that occurs if the effluent is allowed to collect in a large or improperly designed sump. A common characteristic of wastewater solids is to have a specific gravity greater than water, which allows gravity separation as part of the treatment process. This same characteristic, combined with the intermittent and variable flow rate in most onsite and small flow systems, allows effluent solids to settle in a sample port if it contains a sump. As most composite samples are collected periodically by automatic sampling equipment, any solids that have been allowed to settle and accumulate in the sampling port since the last sampling event will be withdrawn on the next sampling event. This will cause a higher concentration of solids in the sample than in the effluent flow stream at the time of collection. A false positive test will result, indicating higher suspended solids and related constituents than the treatment system is actually discharging on a continuing basis.

The composite sampling port should be a flow-through design with sufficient velocity to keep solids in suspension and not allow them to accumulate. Especially in a small flow situation, the flow channel, including any required sump in the sampling port, must be self-flushing and carefully designed to keep the flow moving at sufficient velocity to maintain the solids in suspension. It must also be deep enough to allow a reasonable volume of effluent to be removed by the pump at each sampling event. The design should also allow for the sampling pump pickup device to be elevated from the bottom of the port. If allowed to sit on the bottom, the pickup device can trap solids, especially on the upstream side. The solids may then be picked up due to the increased velocity induced by the sampling pump, which would result in a non-representative sample.

The location of the sampling port should be as close to the discharge of the treatment system as practical. The port and automatic sampler must also be protected from freezing temperatures, flooding and other environmental factors.

Even a properly designed sampling port must be maintained by periodically purging biological growth from all wetted surfaces, as constituents in low flow systems tend to accumulate growth in these areas. This material must be regularly removed before it is dislodged by the velocity of the sampling pump and transferred to the effluent sample.



SAMPLING PORT CLEANING

Usually a mild "pressure wash" with a garden hose or similar device will dislodge this growth. Since these solids can be withdrawn by the suction of the sampling pump, this type of maintenance procedure must be performed daily, or more frequently if needed to minimize the growth of biological solids. However, sufficient fall must be designed into the port to prohibit the back up of water into the treatment plant during sampling port maintenance.

SAMPLING FOR PERFORMANCE EVALUATION

The primary use of an effluent sampling port is to evaluate treatment system performance in order to verify compliance with specific discharge limits, or to compare the performance of individual systems. However, in actual installations, even with a properly designed effluent sampling port, performance evaluation of onsite treatment systems is extremely difficult to do. When universities or other third-party certifiers establish a standardized format for performance testing, the logistics of influent and effluent flow patterns become predictable and useful. By comparison, field evaluations of an onsite treatment system must take into consideration that influent waste characteristics can only be assumed, and representative effluent sampling must be collected in conjunction with a non-standardized flow pattern. In a typical gravity flow system, the effluent flow pattern parallels the influent flow rate and time frame. Using the very low effluent rates typical of an onsite system to actuate a flow-proportional composite sampler can be very challenging. Coordinating a time-based composite sampler to a non-standardized flow pattern is equally challenging, as flow patterns vary from household to household. Flow patterns also vary within a given household from day to day and throughout the day. Considering the difficulties of using a composite sampler on a treatment system serving an individual home, it is easy to understand why some people attempt to use grab samples for performance evaluation.

Even the best designed grab sampling port will still not allow representative sampling for performance evaluation of an onsite wastewater treatment system. By definition, a proper grab sample represents the flow stream only at the point in time the sample was taken. This makes grab samples invalid for use in a performance evaluation of an onsite treatment system. Effluent grab samples are inadequate for performance evaluations even in municipal treatment plants where there is less variation in the characteristics of both influent and effluent flow streams. To evaluate this premise, a Field Investigations Section of the U.S. Environmental Protection Agency conducted a study of sampling methods and data variability using a 1.5 million gallon per day treatment plant serving an Air Force base. In this study, grab samples of the flow stream were collected. Concurrently, flow proportional composite samples were collected with automatic sampling equipment at the same sampling location. When a table was constructed comparing the removal efficiencies calculated by using proper composite samples to data from the collection of grab samples "the table clearly indicates the fallacy of relying upon single grab samples and demonstrates that varying collection time will change apparent plant efficiency over a broad range. Looking at the efficiencies resulting from collecting one sample per day for three days it can be seen that the removals ranged from -103 to +70 percent."[4] In another study conducted by the same organization, where grab samples were compared with composite samples, their conclusion was even more forthright. "The data clearly indicate the inadequacy of relying upon a limited number of grab samples for determining wastewater characteristics or plant performance."[4]

Performance evaluations of onsite treatment systems should only be conducted under controlled conditions. This includes using a known, representative flow pattern, a properly designed sampling port and a flow-proportional composite sampler. It also must be conducted over sufficient time for the system to reach steady state conditions.

SUMMARY

"It is an old axiom that the result of any testing method can be no better than the sample on which it is performed."[1] Even state-of-the-art laboratories, with the use of calibrated equipment by certified laboratory analysts, cannot provide accurate data on treatment system performance if the effluent sample was collected in a non-representative manner. Proper sampling is the foundation on which laboratory analysis and data evaluation is built. Improper sampling means laboratory analysis and data evaluation is a total waste of time, money and resources. The biggest problem is, once the sample is submitted, it is then too late for anyone to determine if proper methods were used during sample collection.

To represent the effluent flow stream over a specific time, effluent samples must be flow-proportional composite samples, collected over the same time from a properly designed sampling port. This port must be properly located and maintained to insure the sample submitted for laboratory analysis is representative of the effluent flow stream. Only then will a defensible sample be analyzed and evaluated.

REFERENCES

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