

bank filtration. In these cases, the performance of the bank filtration process in reducing *Cryptosporidium* levels will be reflected in the monitoring results and bin classification.

Systems using bank filtered water without additional filtration typically must collect source water samples in the surface water (*i.e.*, prior to bank filtration) to determine bin classification. This applies to systems using bank filtration to meet the *Cryptosporidium* removal requirements of the IESWTR or LT1ESWTR under the provisions for alternative filtration demonstration in 40 CFR 141.173(b) or 141.552(a). Note that the proposed bank filtration criteria for *Cryptosporidium* removal credit under the LT2ESWTR do not apply to existing State actions to provide alternative filtration *Cryptosporidium* removal credit for IESWTR or LT1ESWTR compliance.

In the case of systems that use GWUDI sources without additional filtration and that meet all the criteria for avoiding filtration in 40 CFR 141.71, samples must be collected from the ground water (*e.g.*, the well). Further, such systems must comply with the requirements of the LT2ESWTR that apply to unfiltered systems, as described in section IV.B.

b. *How was this proposal developed?* This section describes the bank filtration treatment process, provides more detail on the aquifer types and ground water collection devices that are eligible for bank filtration credit, and describes the data supporting the proposed requirements.

Bank filtration is a water treatment process that makes use of surface water that has naturally infiltrated into ground water via the river bed or bank(s) and is recovered via a pumping well. Stream-bed infiltration is typically enhanced by the pumping action of near-stream wells (*e.g.*, water supply, irrigation). Bank filtrate is water drawn into a pumping well from a nearby surface water source which has traveled through the subsurface, either vertically, horizontally or both, mixing to some degree with other ground water. Through bank filtration, microorganisms and other particles are removed by contact with the aquifer materials.

The bank filtration removal process performs most efficiently when the aquifer is comprised of granular materials with open pore-space for water flow around the grains. In these granular porous aquifers, the flow path is meandering, thereby providing ample opportunity for the organism to come into contact with and attach to a grain surface. Although detachment can occur, it typically occurs at a very slow

rate so that organisms remain attached to a grain for long periods. When ground water travel times from source water to well are long or when little or no detachment occurs, most organisms will become inactivated before they can enter a well. Thus, bank filtration relies on removal, but also, in some cases, on inactivation to protect wells from pathogen contamination.

Only Wells Located in Unconsolidated, Predominantly Sandy Aquifers Are Eligible

Only granular aquifers are eligible for bank filtration credit. Granular aquifers are those comprised of sand, clay, silt, rock fragments, pebbles or larger particles and minor cement. The aquifer material is required to be unconsolidated, with subsurface samples friable upon touch. Uncemented granular aquifers are typically formed by alluvial or glacial processes. Such aquifers are usually identified on a detailed geologic map (*e.g.*, labeled as Quaternary alluvium).

Under today's proposal, a system seeking *Cryptosporidium* removal credit must characterize the aquifer at the well site to determine aquifer properties. At a minimum, the aquifer characterization must include the collection of relatively undisturbed, continuous, core samples from the surface to a depth equal to the bottom of the well screen. The proposed site must have substantial core recovery during drilling operations; specifically, the recovered core length must be at least 90% of the total projected depth to the well screen.

Samples of the recovered core must be submitted to a laboratory for sieve analysis to determine grain size distribution over the entire recovered core length. Each sieve sample must be acquired at regular intervals over the length of the recovered core, with one sample representing a composite of each two feet of recovered core. A two-foot sampling interval reflects the necessity to sample the core frequently without imposing an undue burden. Because it is anticipated that wells will range from 50 to 100 foot in depth, a two-foot sampling interval will result in about 25 to 50 samples for analysis. Each sampled interval must be examined to determine if more than ten percent of the grains in that interval are less than 1.0 mm in diameter (#18 sieve size). In the U.S. Department of Agriculture soil classification system, the #18 sieve separates very coarse sands from coarse sands. The length of core (based on the samples from two-foot intervals) with more than ten percent of the grains less than 1.0 mm in diameter must be summed to determine the overall core

length with sufficient fine-grained material so as to provide adequate removal. An aquifer is eligible for removal credit if at least 90% of the sampled core length contains sufficient fine-grained material as defined in this section.

Cryptosporidium oocysts have a natural affinity for attaching to fine-grained material. A study of oocyst removal in sand columns shows greater oocyst removal in finer-grained sands than in coarser-grained sands (Harter *et al.* 2000). The core sampling procedure described in this section is designed to measure the proportion of fine-grained sands (grains less than 1.0 mm in diameter) so as to ensure that a potential bank filtration site is capable of retarding transport (or removing) oocysts during ground water flow from the source surface water to the water supply well. The value of 1.0 mm for the bounding size of the sand grains was determined based on calculations performed by Harter using data from Harter *et al.* (2000). Harter showed that, for ground water velocities typical of a bank filtration site (1.5 to 15 m/day), a typical bank filtration site composed of grains with a diameter of 1.0 mm would achieve at least 1.0 log removal over a 50 foot transport distance. Larger-sized grains would achieve less removal, all other factors being equal.

Alluvial and glacial aquifers are complex mixtures of sand, gravel and other sized particles. Particles of similar size are often grouped together in the subsurface, due to sorting by flowing water that carries and then deposits the particles. Where there exists significant thickness of coarse-grained particles, such as gravels, with few finer materials, there is limited opportunity for oocyst removal. When the total gravel thickness, as measured in a core, exceeds 10%, it is more likely (based on analysis of ground water flow within mixtures containing differing-sized grains) that the gravel-rich intervals are interconnected. Interconnected gravel can form a continuous, preferential flow path from the source surface water to the water supply well. Where such preferential flow paths exist, a preponderance of the total ground water flow occurs within the preferential flow path, ground water velocity is higher, and natural filtration is minimal. A proposed bank filtration site is acceptable if at least 90% of the core length contains grains with sufficient fine-grained material (diameter less than 1.0 mm); that is, it is acceptable if the core contains less than 10% gravel-rich intervals.

Aquifer materials with significant fracturing are capable of transmitting