"This Policy Does Not Have The Force of Law"
ADOPTED

SUBJECT:	Solid Waste Policy: Definition for Aquifer System. [OAC Rule 3745-27-01(B)(4)]	Number: DDAGW-02-05-100 Issue: 07/29/97 Revised: Page 1 of 6

PURPOSE: To provide policy on the meaning of "aquifer system" as defined in the solid waste regulations.

BACKGROUND: OAC Rule 3745-27-01(B)(4) as it applies to municipal, industrial and residual waste landfills defines the term "aquifer system" as "one or more geologic unit(s) or formation(s) that is/are wholly or partly saturated with water and is/are able to store, transmit, and yield significant amounts of water to wells or springs."

There has been much discussion on the interpretation of this definition. It is in response to these discussions that this policy has been prepared.

This guidance discusses interpretations of various parts of this definition including:

a) "one or more geologic unit(s) or formation(s)";

b) "wholly or partly saturated"; and

c) "is/are able to store, transmit, and yield significant amounts of water."

POLICY: A) Geologic Medium

The phrase "one or more geologic unit(s) or formation(s)" refers to the medium in which the aquifer system exists and that this medium can encompass a part of a geologic formation, an entire geologic formation or several geologic formations. A formation is a unique lithologic unit that can be mapped but does not include units composed of material that has been physically altered, transformed or used during a manufacturing process. It does include mine spoil. An aquifer system exists only in formations, parts of formations or groups of formations that sustain a significant yield of water to a well.

Article 6 of the Code of Stratigraphic Nomenclature (1970) defines a "rock-stratigraphic formation" as "the fundamental unit in rock-stratigraphic classification that is a body of rock characterized by lithologic homogeneity; it is prevailingly but not necessarily tabular and is mappable at the earth's surface or traceable in the subsurface."

By the above definition, in order to qualify as a formation, a lithologic unit must possess some distinctive lithologic features (i.e. rock type, bedding, etc) and must be mappable. This criterion for a "formation" also applies to unconsolidated soil-stratigraphic units under Article 18 of the Code of Stratigraphic Nomenclature.

The cause of deposition is not a criterion for defining a geologic formation, but rather that the unit has some unique features when compared to surrounding units and that it is mappable. It has been suggested that mine spoil does not qualify as a formation because it is man-made. However, most mine spoil in the State of Ohio is unique when compared to underlying lithologic units and generally is extensive enough to be mapped; therefore, mine spoil can be considered a formation. For purposes of this policy, material (blast furnace slag, foundry sand, fly ash, bottom ash, etc.) that has been physically altered, transformed or used during a manufacturing process (i.e., melted or burned) shall be considered a waste material and not a geologic formation.

The phrase "one more geologic unit(s) or formation(s)" also speaks to the presence of upper and lower boundaries for the aquifer system. It must be kept in mind that an aquifer system does <u>not</u> necessarily encompass an entire formation. It may be present only in one section of a formation. An aquifer system is limited to those parts of formations or a group of formations that are capable of a significant yield. General examples of this are shown in Figures 1 and 2.

The sandstone formation in Figure 1 is 100 feet thick. This sandstone is massive and well cemented, except for a ten foot thick area in the center of the formation. This ten foot thick zone is fractured and friable. Monitoring wells installed above and below this zone in the unfractured sandstone can be easily bailed dry and take several weeks to recover. Monitoring wells in the fractured unit can sustain a yield of three gallons per minute (gpm). Therefore, this example shows the aquifer system is present only within the fractured zone of this sandstone formation. The rest of the formation is an aquiclude.

Figure 2 shows a sand seam in a till formation overlying a bedrock aquifer system demonstrated, by a series of aquifer pumping tests, to be interconnected to the bedrock aquifer. The sand seam will sustain a yield of only 0.1 gallon per minute while the bedrock aquifer system will sustain a yield of twenry gallons per minute. Even though these two formations are interconnected hydraulically, the interconnection is not great enough for the sand seam to have a significant yield, hence, it is not part of the bedrock aquifer system. Thus, the upper boundary of the aquifer system is the bedrock till interface and the sand seam is considered a significant zone of saturation under the non-hazardous solid waste rules. ["A zone of saturation that may act as a preferential pathway of migration.. .," OAC Rules 3745-27-01B(39)]. If the sand seam had a significant yield, when compared to the regional aquifer, then the two units could be considered to have enough interconnection to constitute a single aquifer system.

In summary, a formation is the medium in which an aquifer system exists. A formation is a unique lithologic unit that can be mapped but does not include units composed of material that has been physically altered, transformed or used during a manufacturing process. It does include mine spoil. An aquifer system exists only in formations, parts of formations or groups of formations that sustain a significant yield.

B) <u>Saturation of Media</u>

The phase "wholly or partly saturated" mandates, in situations of water table aquifer systems, that the vadose zone of the permeable formation or group or formations be included as part of the aquifer system. This concept was developed for-two reasons. Since the vadose zone of a water table aquifer system is usually as permeable as the saturated portion, the time required for a contaminant to migrate through this zone is usually very short. Also, it is not unusual for the water table to fluctuate within the aquifer system and for portions of the aquifer system that are above the water table one day, to be below it the next. Accordingly the phrase "wholly or partly saturated" was included in the definition for aquifer system so the entire permeable zone could be included in the siting evaluation of a facility.

The classic example of this concept is that of a sand and gravel water table aquifer system (Figure 3). In this case, the sand and gravel formation is 100 feet thick, but it is saturated only in the lower seventy feet of the formation.

The aquifer system encompasses the entire 100 feet of the formation because the permeability and hydraulic properties of me formation above the water table are similar to those below. Again this applies only to non-hazardous facilities.

As in the discussion on aquifer media, it is important to identify the upper boundary of the aquifer system accurately. The upper boundary can be represented by the ground surface (Figure 3) or the lower surface of an impermeable formation (Figure 4).

For fractured bedrock, it is important to consider changes in the overall permeability of the formation when determining the boundaries of the water table aquifer system. Figure 4 represents the water table aquifer system within a fractured sandstone formation. Above the sandstone is a fractured shale.

Even though the two formations exist within the same fracture system, the differences in matrix properties cause the overall permeabilities of the two formations to be different. Boring logs and tests performed on the two formations indicate that the fractures in the shale are not as wide nor as extensive as those fractures in the sandstone. In addition, weathering along the fractures has deposited a significant amount of clay material into the fractures of the shale. Predictably, hydraulic conductivity testing demonstrates that the permeability of the shale was several orders of magnitude less that the sandstone. In this case, the upper boundary of the aquifer system would be established at the top of the sandstone formation since it is probable that even if the shale became saturated it would not yield a significant amount of water and would constitute an aquiclude.

In summary, the phase “wholly or partly saturated” includes the permeable vadose zone that may exist above a water table aquifer system. Definition of the upper boundary of an aquifer system is necessary in order for the siting of a proposed facility to be ‘evaluated.

C) <u>Yield</u>

There is a considerable debate about how to interpret the phrase “is/are able to store, transmit, and yield significant amounts of water.” The primary issue of this controversy concerns interpretation of the phrase “yield significant amounts of water.”

The phrase “yield significant amounts of water” means any yield greater than one-tenth (0.1) of a gallon per minute measured as a time weighted average over a twenty-four (24) hour period except where the yield of the unit being examined is less than three (3) gallons per minute but greater than one-tenth (0.1) of a gallon per minute, in which case the significant yield is equal to or greater than fifty (50%) percent of the yield of another zone of saturation under the property, which is the likely source of water-used for potable purposes within one mile of the facility.

Figure 5 provides an example of how the above criteria and information should be used in practice. Here we have a bedrock regional aquifer used for potable purposes with an average yield of 5 gallons per minute based on the well logs reported for the area. Above this bedrock aquifer system is ninety feet of till with a two foot saturated sand zone located within the till about twenty feet above the bedrock. Hydraulic testing of the sand zone indicates that it will sustain a yield of 0.9 gallons per minute and there are no connections between it and the bedrock aquifer system. According to records, the sand seam has not been used as a source of water and the bedrock is the source of water for residences within one mile of the site. Based on the above information, the sand zone does not possess a significant yield and is not an aquifer system. While the sand zone has a yield above 0.1 gallons per minute, the sand zone's yield is less than 3 gallons per minute and less than 50% of the yield of the bedrock aquifer system.

Conclusion:

This policy is intended to explain Ohio EPA's interpretation of several parts of the definition of "aquifer system" as contained in OAC Rule 3745-27-01(B)(4). These parts are those relating to media, media saturation, and media yield.

The phrase "one or more geologic unit(s) or formation(s)" refers to the medium in which the aquifer system exists and that this medium can encompass a part of a geologic formation, an entire geologic formation or several geologic formations. A formation is a unique lithologic unit that can be mapped but does not include units composed of material that has been physically altered, transformed or used during a manufacturing process. It does include mine spoil. An aquifer system exists only in formations, parts of formations or groups of formations that sustain a significant yield.

The term "wholly or partly saturated" includes the vadose zone as part of a water table aquifer system. The vadose zone of a water table' aquifer system ends when its hydrogeologic properties change such that it is no longer reasonable to expect it to yield a significant amount of water if it became saturated.

The phrase "yield significant amounts of water" means any yield greater than one-tenth (0.1) of a gallon per minute measured as a time weighted average over a twenty-four (24) hour period except where the yield of the unit being examined is less than three (3) gallons per minute but greater than one-tenth (0.1) of a gallon per minute, in which case the significant yield is equal to or greater than fifty (50%) percent of the yield of another zone of saturation under the property, which is the likely source of water used for potable purposes within one mile of the facility.

Figure 1
Case Where Aquifer/Aquifer System Exists Only Within Part of a Formation

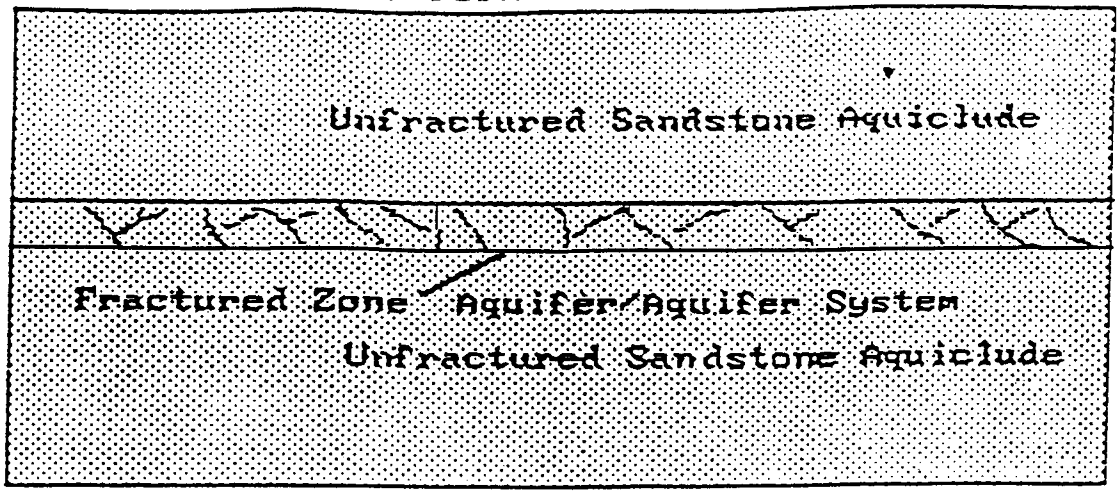

Figure 2
ase Where Interconnection Between Formations Determines
quifer/Aquifer System Boundary

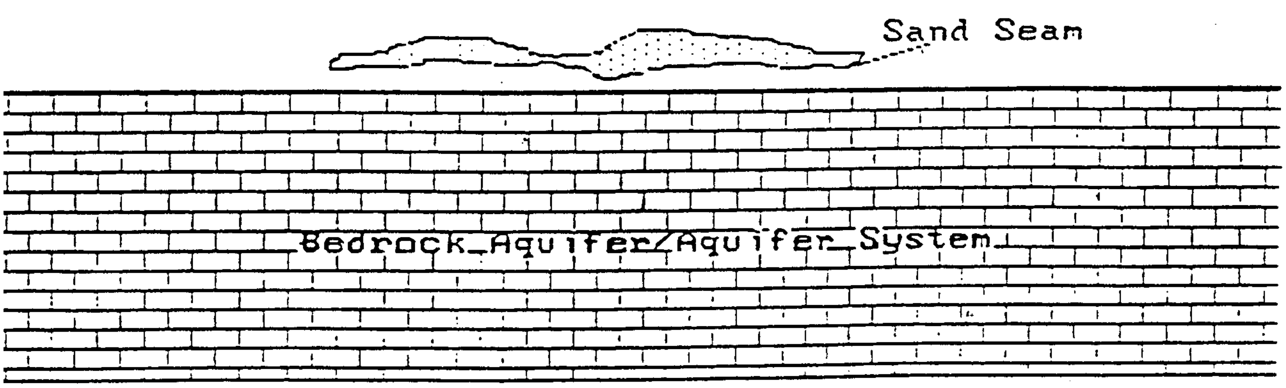

Figure 3
Unconfined Aquifer/Aquifer System Where The Vadose Zone Is A Part Of The Aquifer/Aquifer System

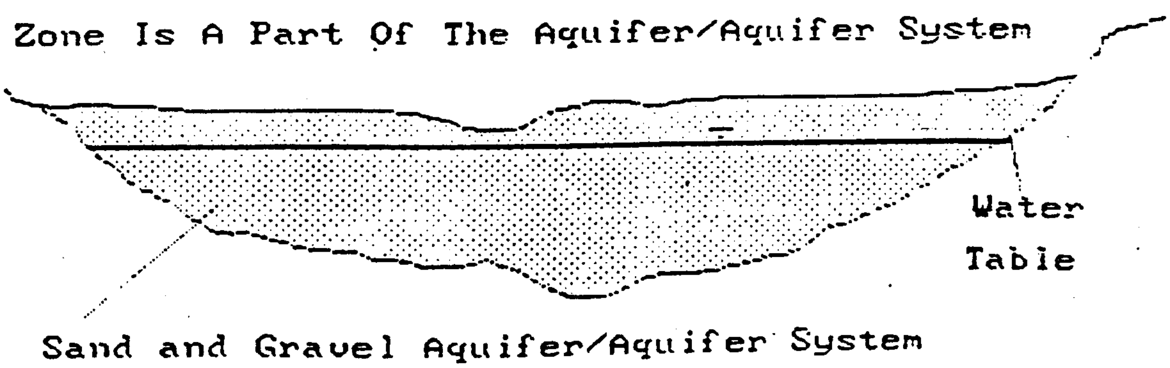

Figure 4
Boundary Determinations Involving Unconfined Aquifer/Aquifer System

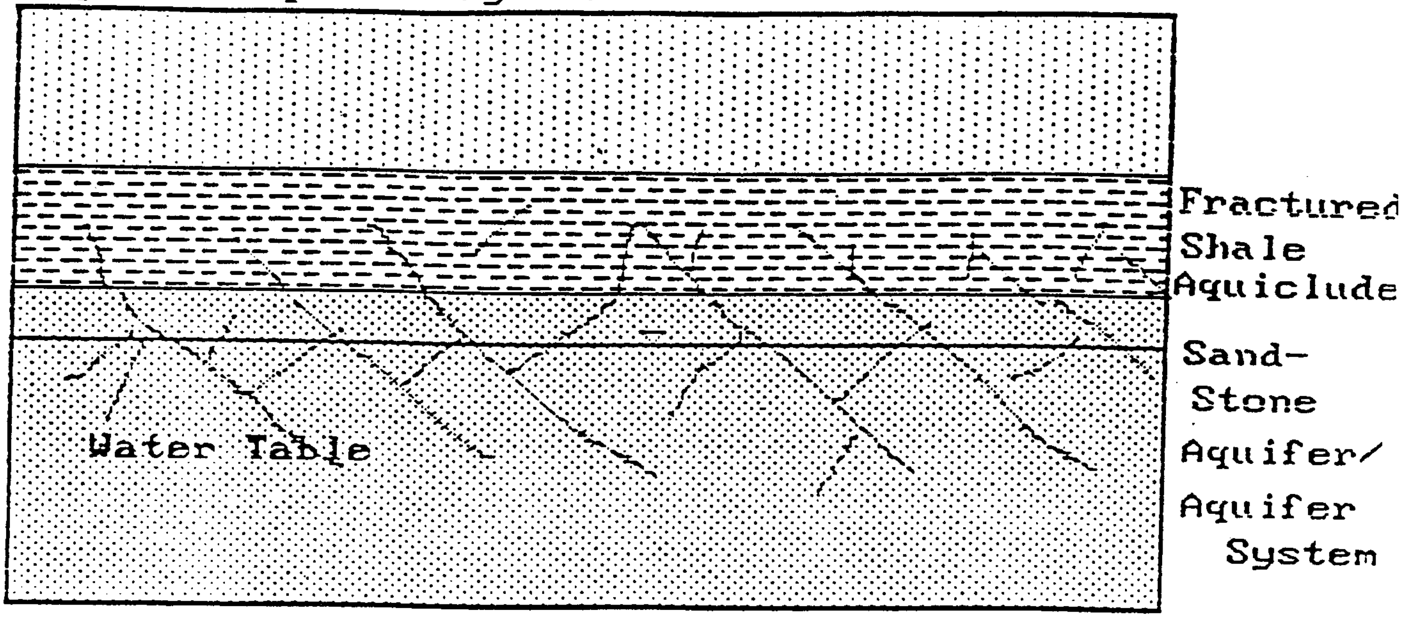

Figure 5
Significant Yield Example