CP Training
Ground Water

Part I

Introduction
By now, you have heard that ground water is part of the VAP process. The key for any Certified Professional is to determine how ground water figures into a particular project. The way that each Certified Professional approaches the VAP Phase II Property Assessment process is unique. In my experience, I have found that the most logical and cost effective approach is to conduct a thorough evaluation of soils within the identified areas on your property long before one considers installing the first ground water monitoring well. This process may be slightly more time consuming – and we do not always have the luxury of time – but the VAP is not a process for those in a tremendous rush.

My talk is organized to first discuss the investigation of soils and the potential impact of constituents of concern in soil to ground water. This is followed by a discussion of the obligations to protect ground water determined or assumed to be "clean" and the implications of these obligations. From that point, we will move on to the issues of ground water classification and ground water response requirements. I have included several examples and lessons learned from my own personal experience to try and make this entire process make sense.

Soil Investigation
One goal of the site investigation process is to collect soil analytical data within the direct-contact point of compliance interval at your particular site. Make no mistake: virtually every property has a soil direct-contact point of compliance based upon the intended future land use. However, a property might have multiple soil points of compliance that are based upon exposure pathways other that direct contact. These exposure pathways for soil include future construction and excavation activities, the soil to indoor air pathway, or some soil point of compliance to protect an important ecological resource.

As part of the VAP Phase II process, it is necessary to sample and evaluate soils from within the direct-contact point of compliance interval. However, it is also necessary to evaluate the interval situated below the direct-contact point of compliance interval and above the first saturated zone underlying the property. One reason for testing soils both within and below the point of compliance interval is to determine whether constituents of concern are present at concentrations that could potentially leach to ground water.

Evaluation of Soil Leaching to Ground Water
Assume we have a population of soil analytical data from the Phase II process. There are several means by which a Certified Professional may evaluate whether a detected concentration of a constituent of concern could potentially leach to ground water at a concentration which would exceed a VAP unrestricted potable use standard.

Perhaps the easiest way is to use the Ohio EPA Technical Guidance document for the development and use of leach-based soil values. This document is very useful, and contains

look-up tables that provide generic leach-based soil concentrations for several of the more common constituents of concern found in soil at VAP sites.

When dealing with organic constituents – such as these shown in the slide - it is important to apply the correct soil type at your property. There is a discussion in the guidance document as to how a Certified Professional goes about determining whether he or she is dealing with Type I, Type II, or Type III soils. You are all intelligent people, and the guidance document is clear on how one determines one's soil type at a property, so I will not belabor this issue here. The narrative in the guidance document lists the criteria that must be met for these look-up values to be used at a particular property. This guidance document is useful, but only to the extent that the Certified Professional exercises care in determining whether their particular property meets the criteria to use these values.

The technical guidance document also discusses the use of what are referred to as dilution/attenuation factors that may be applied to these generic leaching values. Dilution/attenuation factors are essentially multipliers which can be applied to Ohio EPA derived leach-based soil values. For metals, multipliers of 10 or 20 may be applied, which are dependent upon the size of the potential source area. And, of course, you will know the area of your potential source areas, because you have done a good job during the soil characterization process in your Phase II.

For organic constituents, dilution/attenuation factors are essentially multipliers, which are applied based upon the characteristics of the ground water zone that may be affected by soil leaching. You can see from this slide that the dilution factor for organic constituents is one (no dilution) if the uppermost saturated zone has a hydraulic conductivity of less than or equal to 1 times ten to the minus third centimeters per second. The guidance document is clear on how to calculate a dilution factor that may be applied to the look-up values for organic constituents in the guidance document. A word of caution: misapplication of dilution factors is closely watched in the review of NFA Letters. Make sure you tread carefully in this area, and document what you have done if you intend to apply a dilution factor.

So, use of these so-called generic leaching values is one way to evaluate potential leaching of constituents of concern to ground water. A second way is the performance of site-specific soil partitioning calculations to evaluate leaching potential. Typically, I calculate soil partitioning values for those constituents detected in soil for which there is no corresponding look-up value in the Ohio EPA Technical Guidance document. And to do so, one may use the following equation.

There is nothing stopping a Certified Professional from performing soil partitioning calculations for those compounds for which the agency has already calculated a leach-based value in the Ohio EPA Technical Guidance document. However, my experience is that this is akin to beating your head against a wall. When I have done it, I have often come up with values that are **lower** than those listed in the Technical Guidance document, or values that are very comparable.

This equation is a modification of the equation in VAP T~~D~~GC 07.~~05.004~~09.031. I would also refer you to T~~D~~GC 07.~~05.005~~09.032 which discusses the Soil Attenuation Model, or "SAM",

and the Risk-Based Corrective Action, or "RBCA", Tool Kit. Both the RBCA Tool Kit and SAM models have equations that are useful in evaluating the concentration of a chemical of concern that can be left in soil above the first ground water zone that would be protective of Unrestricted Potable Use Standards, or UPUS.

Soil partitioning equations and models are intended under the VAP as screening tools for fast assessment of the potential for a constituent of concern, or COC, to leach to ground water. I would emphasize that there is no one right way to derive prospective leaching concentrations for soils. One always has the alternative of having the Ohio EPA calculate values for you through Technical Assistance.

If you are like me, your eyes glaze over when presented with a mathematical equation. But I have found this one particularly useful under the VAP. I would urge you to get very cozy with this equation or some other screening equation. Create a spreadsheet so that you can plug in a very few variables so that this equation will generate a screening value which – in some circumstances – may turn out to be an applicable standard at your property.

Discussion of Parameters for Soil Partitioning Equation

Let's run through this equation briefly. What you are trying to determine is Cs, which is your site-specific leach based soil value. To calculate this, you must first know the target concentration for your COC in ground water in milligrams per liter, which is Cw. This value may either be a published Generic Unrestricted Potable Use Standard or a Risk-Derived Unrestricted Potable Use Standard which are printed in look up tables in Rule 08. If your COC has neither a published Generic nor a Risk-Derived UPUS, contact the Ohio EPA VAP staff, and discuss the situation. You may not be the first CP who needed a value in ground water calculated for your COC for which there is no published standard. The agency may be able to provide you with a value to use. Just make sure you document where you got the value you used, and that you include this documentation in your final VAP Phase II report. Or, you may derive a target concentration for your COC in ground water as part of a property-specific risk assessment.

The next site-specific parameter in our equation is the organic carbon partitioning coefficient, or Koc. The Ohio EPA has complied lists of Koc values that may be used for COCs on VAP projects. Another approach would be to suggest a Koc value and the basis for its use to Ohio EPA and then seek concurrence from Ohio EPA under Technical Assistance.

The last parameter is fraction of organic carbon, or foc. One can use a default value – the agency has generally accepted a default value of 0.2%, or 0.002 – or one can obtain a site-specific value through the collection of undisturbed geotechnical samples at your site. If you opt for the site-specific approach, geotechnical information related to foc needs to be collected in areas that are not affected by COCs, in other words, areas on-site that are quote clean unquote. You will not know where these areas are on the first day of your field investigation. Typically, geotechnical information is collected after you have a complete characterization of soils on-site, and you know where the bad stuff is and you can bias your geotechnical sample collection to areas and soil horizons known to be unaffected by COCs.

Before we leave this point and go back to our equation here, I would point out that the Ohio EPA has a T~~D~~GC regarding how to sample and analyze soils for fraction of organic carbon. This is T~~D~~GC 07.~~03.019~~09.024. READ THIS DOCUMENT. UNDERSTAND THIS DOCUMENT. Because, failure to sample and analyze foc appropriately in the Phase II process can make the whole NFA submittal unravel. This makes for unhappy clients, unhappy Certified Professionals, and unhappy people all the way around.

So, with this information, one can calculate a soil partitioning value for organic constituents of concern. And, as discussed when using generic Ohio EPA-derived leach based soil values, dilution/attenuation factors may be applied to these site-specific soil partitioning values, as appropriate.

Partitioning Equation for Metals

There is a somewhat similar equation to derive site-specific soil partitioning coefficients for inorganic constituents in the event that the Ohio EPA has not published a generic look up value, or you want to calculate your own site-specific soil partitioning value for metals. I have found this useful in the case of cadmium and arsenic in certain cases. The Ohio EPA does permit use of a blend of generic leach-based soil values and site-specific values in NFA submittals.

As can be seen, some of our old friends are in this equation: Cs, the concentration in soil that we are looking for; Cw, the target concentration in ground water, with three new expressions. The soil/water partitioning coefficient, or Kd; water-filled soil porosity, or theta sub w; and soil bulk density, or rho sub b. As with Koc, the Ohio EPA has recommended values of Kd that have been previously provided to Certified Professionals. If a Kd does not exist for your particular metal, an internet search will generally yield a range of values that can be applied. It is probably advisable to be conservative in your selection of an inorganic Kd value, since there is variation in the literature. While you could use a site-specific value for water-filled soil porosity, Ohio EPA has in the past applied a default value of 0.26. Finally, we enter a value – in kilograms per liter – for dry weight soil bulk density. A word of caution, watch your units, because most geotechnical laboratories will report bulk density in pounds per cubic foot, or grams per cubic centimeter.

Geotechnical Testing

From this it is apparent that unless you are going to use Ohio EPA derived leach-based soil values or rely on default inputs to leaching equations or models, the collection of certain geotechnical data is necessary. To be able to evaluate site-specific soil partitioning, analysis of soils for fraction of organic carbon and bulk density is often the minimum one should obtain. Many Certified Professionals also evaluate geotechnical samples for porosity, in situ permeability, cation exchange capacity, and other variables. Since the VAP does not certify laboratories for the analysis of geotechnical parameters, Certified Professionals are advised to use established, reputable geotech labs, and to make the laboratory selected aware of the provisions of various VAP T~~D~~GCs relative to the analysis of samples for fraction of organic carbon and dry weight evaluation of soil bulk density.

In addition to generic leach-based values and calculated soil partitioning values, there are models which may estimate the potential of a particular constituent of concern to leach to ground water. These include VLEACH and SESOIL. These models are available commercially, and have been

used successfully in making demonstrations of potential leaching to ground water as part of the VAP. Properly applied, the use of modeling is an acceptable approach to develop screening levels for constituents of concern and their potential to leach to ground water.

One other option available to the Certified Professional is the use of a weight-of-evidence demonstration to make a case that COCs do – or do not – have the potential to leach to ground water in excess of UPUS. A weight-of-evidence demonstration can include a variety of factors, among them:

- Whether or not ground water is even present beneath a property
- The separation distance between the constituents in soil and the uppermost occurrence of ground water
- Site-specific geological factors that would inhibit the migration of COCs to ground water
- The residence time that a particular COC has been in soil and yet not impacted ground water.

There are obviously other factors that can be used in a weight-of-evidence demonstration, many of which are specific to the particular geologic or geochemical make-up of your site.

Assessing the Need to Protect Ground Water

All this previous discussion is tied back to the various ways in which we may derive values to determine whether concentrations of COCs in soil have the potential to leach to ground water. The easiest way may be the use of the generic values in the Ohio EPA Technical Guidance document. However, site-specific leach-based soil values may be calculated for your site either by choice or by necessity. Or, one could use a model to simulate leaching potential, or make a weight-of-evidence demonstration based upon your specific site.

At this point you may be asking, what does all this has to do with ground water? Simply this: the VAP requires that each property be evaluated to determine whether ground water on the property meets or exceeds UPUS. Sampling ground water is always an option to determine this, but VAP rules do allow a Certified Professional to use a weight-of-evidence demonstration to assume that the ground water below a property is “clean”.

A comparison of concentrations of COCs in soil to leach-based soil values could be used as one of the pieces of information in a weight-of-evidence demonstration to evaluate whether it is appropriate to make the assumption ground water is “clean”. A few cautionary notes related to making this assumption must be stated. To make this assumption VAP rules require an understanding of the nature and type of the release, that is the site release history. Further, the CP must understand the physical characteristics of the vadose zone and the overall site geology, as well as any other factors important to determining whether ground water could be impacted even when a leaching evaluation suggests no leaching potential. Migration routes, such as releases directly to ground water from USTs or other mechanisms must be considered. Off-property sources impacting ground water on the property also need to be considered. So, the leaching potential is only part of the weight-of-evidence demonstration.

A quantitative evaluation of leaching is not a required component of a weight-of-evidence demonstration. There may be certain circumstances that justify an assumption that ground water will not be impacted even when leaching calculations might suggest otherwise. For instance, an

old release of a traditionally immobile substance such as certain metals to shallow soils with a large separation distance to ground water is one such example. In this example, it is important to obtain soil data at depth to demonstrate that any contamination indeed remains at a shallow interval and has not migrated even though leaching calculations might suggest otherwise. Therefore, although a leaching evaluation of soils is often a good first step in determining whether or not to investigate ground water, other considerations may or may not lead to a decision to sink wells.

POGWMUPUS

As I stated early on in this presentation, there may be certain sites where you as the Certified Professional believe that the release history, site-specific subsurface conditions, the areal and vertical distribution of COCs in soil, and the absence of potential off-site sources of ground water contamination support a conclusion that there is a limited probability that ground water beneath your property has been impacted in excess of UPUS. In these cases, the Certified Professional may **assume** that ground water meets UPUS. Where the weight-of-evidence supports this assumption, a Certified Professional is not obligated to test, characterize or otherwise evaluate ground water conditions. This has the potential – if all the stars are aligned at your particular site - to be a big time and money saver for your client.

This is the entire basis for this discussion about whether or not the weight-of-evidence supports a conclusion that concentrations of COCs are not a leaching concern. Whether ground water is demonstrated to meet UPUS through sampling, or is assumed to meet UPUS, Ohio law indicates that ground water which is not already contaminated may not become contaminated in the future either through the action or inaction of a Volunteer. This is referred to as the Protection of Ground Water Meeting Unrestricted Potable Use Standards, which has the rather attractive acronym under the VAP of POGWMUPUS. A POGWMUPUS demonstration is made when a Certified Professional concludes – and the Ohio EPA concurs – that, based upon the evidence, ground water beneath a site is not contaminated, and that the concentrations of COCs in soil support a determination that ground water will not become contaminated in the future. **It is important to note here that the VAP does not permit a Certified Professional to ever assume or otherwise conclude – without testing or other hard evidence – that ground water beneath a site *is* contaminated.**

If ground water beneath your property is not already contaminated and you conclude that leaching of COCs may cause ground water to become contaminated at some point in the future, your leach-based soil values – not the soil direct-contact standards that everyone is so fond of – may actually end up being your soil applicable standard, driving remediation at a particular property.

In an oversimplified example, let's say you as the Certified Professional have a site with Type III soils, ground water that meets UPUS, and you only have one COC in soil at the site – carbon tetrachloride. Your direct-contact soil standard under a commercial/industrial land use scenario is 16 parts per million. That's your clean-up standard, your applicable standard, right? No. Since ground water meets UPUS, your applicable soil clean-up standard – in accordance with the provisions of POGWMUPUS – may be the generic leach-based soil value for carbon tetrachloride for Type III soils, or 0.28 parts per million. This reduction in your soil clean-up

standard by a factor of 57 is due to the requirement to protect ground water. Unless the nature of the saturated zone beneath your property allows the application of a dilution/attenuation factor of 57, you may be stuck with a clean-up standard of 0.28 parts per million. There are more extreme examples, which you may discover as you work through the process for yourself.

The concept of the need to protect ground water that meets UPUS can be difficult to grasp initially, and has been the basis for the denial of more than one NFA Letter. However, if the weight-of-evidence at your site supports a POGWMUPUS demonstration, this can be a way for your Volunteer to save some time and effort, and avoid turning over the ground water card at all. So, the moral of the story here is, assemble your soil data population carefully, particularly at sites where there has been no previous investigation of ground water. Bear in mind that if your soil data indicates achievement of generic or derived leach-based standards and the site release history supports it, there may be an intelligent way to exit the VAP freeway without having to travel through the big city of ground water at all.

This is a critical point, and one that cannot be emphasized enough under the VAP: comparison to direct-contact soil standards is only a start. It is critical to understand that if ground water beneath a site is clean, or may be assumed to be clean based upon the release history and other lines of evidence, the leach-based soil values may substitute themselves for your soil clean-up values. Therefore, it is always important to know as you begin investigation of a site all background information regarding previous investigations of ground water, all background information related to the concentrations of COCs in soil - all background information in general - so that you can devise your sampling strategy with regard to site evaluation appropriately.

Now, with this discussion complete we can move forward into our discussion of the investigation and determination of our ground water response requirements, as outlined in Rules 07 and 10 of the VAP. Any questions to this point?

Evaluation of Ground Water Zones Exceeding UPUS

Let's say we have gone through our soil sampling exercise at our VAP property, and we have determined that concentrations of COCs are present in soil at concentrations that could leach to ground water. Or, let's assume that we have previous reports or existing ground water data that indicate that ground water beneath a property may already contain COCs in excess of UPUS. This commits the Certified Professional to evaluate the ground water situation beneath the property. From a logic standpoint, the clearest way to proceed with our investigation of ground water beneath a site is from the top-down, rather than from the bottom-up. This is somewhat intuitive, although there have been instances where a CP has assessed a deeper saturated unit while ignoring ground water conditions in shallower units.

An example is in southern Cuyahoga County or northern Summit County, where the Certified Professional may be faced with up to four saturated units: a shallow unconsolidated unit; the underlying Sharon Sandstone; which is in turn underlain by the Mississippian Cuyahoga Formation, which is in turn underlain by the Berea Sandstone. Conducting one's initial assessment of the Berea Sandstone because it is being exploited by local private water wells is very costly, time consuming, and potentially irrelevant from the standpoint of the VAP. Assessing ground water at a VAP property should be looked at like unpeeling an onion. The

uppermost layer is evaluated first, and then subsequent layers evaluated if warranted based upon the investigation of the first layer.

Determining Whether there is Ground Water

The first thing that a Certified Professional should seek to do is to determine whether ground water as defined under the VAP is actually present in the uppermost unit. A unit is defined as containing ground water under the VAP if the *in situ* hydraulic conductivity is greater than or equal to five times E to the minus 6th centimeters per second, or the unit is capable of yielding to a properly constructed well greater than 1.5 gallons of water over an eight hour period. I would stress that this is an "either – or" situation: a unit needs to meet only one of these criteria for the water in the unit to not be considered ground water; it does not have to meet both. Further, there is a second point I want to stress here: a Certified Professional may always assume that a saturated unit contains ground water if – based upon his or her professional judgment – the evidence seems obvious in their particular case. For example, your previous experience may indicate pretty quickly whether or not it is obvious that a saturated zone will yield an excess of 1.5 gallons over an eight hour period.

An evaluation as to whether a unit contains ground water as defined under the VAP should be reserved for those "marginal" saturated zones, such as a perched non-contiguous unit beneath an urban site. There are VAP T~~D~~GCs on this issue – 07.~~03.008~~09.014 and 07.~~03.009~~09.015 – should you ever find yourself in one of these "marginal" positions. If you aren't sure, consult these T~~D~~GCs and proceed accordingly. I have made one successful demonstration that a shallow unit did not contain ground water as defined under the VAP. However, in that case, it made a big difference in the final outcome of the project.

If one determines that your uppermost unit – or any unit beneath the property, for that matter – does not contain ground water as defined under the VAP, a note contained in Rule 10 indicates that the CP may treat any COCs detected in the quote unquote water within this unit as soil. In other words, the concentrations of COCs reported for this unit may be compared to leaching to ground water standards, or direct-contact standards for construction and excavation activities, if the unit is shallow enough to be encountered during these activities.

Evaluating Ground Water Contamination

From this point forward, we are going to assume that you have determined that the uppermost saturated unit beneath your property contains ground water as defined under the VAP. At this point, it is necessary to take stock of what you know. Do you have previous reports which indicate that ground water within any saturated unit beneath your property contains concentrations of COCs in excess of UPUS? If not, it is now up to you as the CP to make this determination.

VAP rules discourage placement of ground water monitoring wells through soil source areas unless absolutely necessary. As an example, I had a site that had 75,000 cubic yards of foundry sand that had been placed directly on top of the Berea Sandstone. Over the years, a saturated zone had become established within the foundry sand fill. The only way that I could evaluate ground water quality in the underlying Berea Sandstone was to install double-cased monitoring wells through the foundry sand fill (i.e., my source area). But the point I am trying to make is

that conducting a thorough evaluation of soil conditions on-site is critical before one begins the ground water assessment phase of investigation. Monitoring wells should be placed immediately down-gradient of source areas to make a determination of whether or not ground water within the saturated zone being evaluated has been affected by concentrations of COCs in excess of UPUS. A common mistake is to rush out and install monitoring wells before knowing where source areas are on the property in question. This is typically ill-advised until one knows first whether one even has source areas, and secondly where these potential source areas are relative to where one can (or wants to) put monitoring wells.

Proper Placement of Ground Water Monitoring Wells

Knowing where the source areas are, it is the Certified Professional's obligation under the VAP to install an appropriate number of properly constructed and correctly sized ground water monitoring wells down-gradient of source areas to characterize whether or not COCs are present in ground water in excess of UPUS. The words "appropriate number" are somewhat open to interpretation, and are at the discretion of the Certified Professional. Those of us with a RCRA background typically think in terms of one well up-gradient and three wells down-gradient as being appropriate, and depending upon the soil source area size, that may well be the case. However, I have seen cases where one well down-gradient of a small source area was appropriate, and I have seen circumstances where nine wells down-gradient of a source area was appropriate, primarily depending upon the size of the source area, and the nature and concentration of the COCs present in the source area.

Obviously, once the wells are in place, it is important to survey their location and the top of casing elevation of each well, so that a practical determination of ground water flow direction may be made within our ground water unit. It is at this point that we may receive a surprise. What you thought was down-gradient of that source area actually turns out – following determination of ground water flow direction – to be side gradient, or otherwise not positioned correctly to determine if COCs are present in ground water in excess of UPUS. Usually, there is no way to correct this except to install additional wells. But the point is made that one needs to evaluate all previous information, and still use best professional judgment when attempting to install wells down-gradient of source areas.

Proper Well Development and Filtration Issues

Now, we have our wells in place, they are down-gradient of our source area or areas, and we are ready to sample, right? Not quite. Proper development of a monitoring well is crucial. Concentrations of VOCs and metals in ground water can be skewed – downward in the case of VOCs, and upward in the case of metals – if a well is not properly developed. The Ohio EPA's Division of Drinking and Ground Waters has a published Technical Guidance Document. I would urge all CPs and their ground water sampling staffs to review this document to determine when field filtering of ground water samples is appropriate in the context of any ground water investigation. My experience is that – except in extreme cases, which are spelled out in a VAP TDGC – the agency prefers the collection of unfiltered samples. The use of low-flow or micro-purging techniques is acceptable, in accordance with Ohio EPA's Technical Guidance Manual for hydrogeologic investigations. However, a properly developed well not only yields better quality data – regardless of whether or not you use low flow/micro-purge techniques – but is also

a requirement of any investigation of ground water being conducted in accordance with the Division of Drinking and Ground Water's Technical Guidance Document.

Ground Water Sampling to Evaluate Meeting UPUS

So, after development, we are now ready to collect our ground water quality data. Sampling methods and the frequency at which samples are collected to accommodate the evaluation of temporal and spatial variations in ground water geochemistry were discussed as part of the Phase II Property Assessment segment. In a previous version of the VAP rules, a CP could only conclude that ground water beneath a property exceeded UPUS if two samples collected from the same monitoring well within a specified time period of each other were analyzed by a Certified Laboratory and both exceeded UPUS. However, this requirement was eliminated as part of the 2002 rule review process. Now, VAP rules are silent on how many samples must be collected from a well to conclude that ground water within a zone meets or exceeds UPUS. This leaves the determination to the CP's best professional judgment. I have had cases where the first sample collected from a well exceeded UPUS, while a second sample from the same well did not. In these cases – and with the concurrence of Ohio EPA VAP personnel – I collected a "tie-breaker" sample. But generally speaking, a Certified Professional must exercise best professional judgment before he or she concludes that ground water within a particular saturated zone beneath a property exceeds UPUS. Elements that may enter into a CP's judgment include:

- Did the first sample collected from a properly developed well contain a concentration of a COC that exceeded a potable use standard by an order of magnitude?
- Is there historic ground water data that indicates an exceedance of UPUS, and does your first sample from the same well or area confirm this exceedance?

But, a word to the wise: when in doubt, budget for and plan to collect two rounds of samples from your wells. This is an area where you do not want to be penny wise and pound foolish, and get surprised when you receive comments on your NFA Letter.

VAP rules also indicate an evaluation of temporal and spatial variations of ground water quality is an essential part of the evaluation process. Temporal variations tend to be most intense, as ground water levels fluctuate in the spring and fall. I have seen cases of the same monitoring well meeting UPUS in the fall when water levels are depleted, and exceeding UPUS in the spring when ground water levels are up.

Evaluating Protection of Lower Ground Water Zones

So, let us conclude that our uppermost saturated unit – our uppermost layer of the onion, if you will – contains concentrations of COCs in excess of UPUS. The requirement to protect ground water no longer applies, correct? I mean, I stated earlier, that if our uppermost ground water unit was contaminated, this situation meant that the provisions of POGWMUPUS no longer applied, right? Well, this is true so far as the uppermost ground water zone is concerned relative to soil leaching. But, the provisions of POGWMUPUS apply to each lower ground water unit, in turn. In other words, if your uppermost ground water zone is contaminated, it is incumbent upon the Certified Professional to first determine whether there are confining units present beneath a property that separate lower saturated units from this contaminated unit, and secondly to demonstrate, either through physical sampling or presentation of a weight-of-evidence that any

lower saturated units are uncontaminated and will remain so following your submittal of the NFA Letter.

Please note that a common mistake is to assume that the next lower ground water zone that requires protection is a deeper regional aquifer. This may not be true. VAP rules require any ground water zone beneath a property be protected if this zone meets UPUS. Therefore, a low-yielding ground water zone between your shallow contaminated zone and the regional aquifer may end up being the zone you have to demonstrate is protected. Often the existence of these zones is not known except by site-specific characterization of the hydrogeology. This is the reason why research and investigation of the complete hydrogeologic site conceptual model is so essential at a VAP property.

This demonstration of POGWMUPUS for deeper saturated units when you have a shallow unit that is contaminated is an iterative, highly site-specific, and potentially time-consuming process. Many CPs seek agency Technical Assistance if the geologic setting is particularly complex. Some sites are simple, particularly in central Ohio.

One has a saturated, perched unit over dolomite bedrock, and one has the saturated zone within the bedrock itself. It is a relatively linear process: evaluate the shallow perched zone, and, if contaminated, evaluate the saturated zone within the bedrock. If the bedrock unit is not contaminated, make a demonstration to the Ohio EPA that the bedrock unit will not become contaminated, either through actions that the Volunteer will undertake, or based on geologic and hydrogeologic conditions that are specific to your particular site. If you cannot make such a demonstration, then remediation of the shallow saturated unit may be required, even if it will not migrate beyond your lateral VAP point of compliance, for no other reason than satisfying the provisions of POGWMUPUS – that which is not already contaminated, we may not allow to become contaminated.

Evaluating On vs. Off-Property Sources That Have Impacted Ground Water On Property
Now, all the foregoing discussion – including our discussion of soil sampling – presupposes that we are dealing with a site where the source areas are exclusively on-property. While this is typically the case at VAP properties that I have worked on, it is important to note here that certain sites – particularly those in heavily industrialized areas – may have impacts to ground water that originate from areas that are off-property. The important task for the Certified Professional is to conduct your Phase II Property Assessment activities in such a way that both on- and off-property source areas are evaluated for their potential impact to ground water zones. Perhaps the best way to illustrate this is through an example of a VAP site that I am working on in central Ohio. Our property had a history of the past use of TCE, particularly in the southern portion of the site. A VAP Phase I Property Assessment was performed, and on-site identified areas noted. In addition, two off-property potential source areas were also listed as identified areas.

The Phase II Property Assessment did – in fact – indicate releases of TCE from previous on-property operations to soil and ground water. However, in the course of the Phase II Property Assessment one of the two off-site potential source areas was also identified as having impacting

ground water quality on the VAP property. The complicating factor was that the constituent of concern emanating from this adjacent property onto our property was also TCE.

Through coordination with the Ohio EPA Northwest District VAP staff, we obtained concurrence from the agency that our TCE ground water impacts were due to both on- and off-property source areas. Given this set of circumstances, our obligation during the assessment phase was to evaluate and delineate ground water impacts relative to our on-property source areas, and to determine whether deeper ground water zones would be protected as a result of ***on***-property releases. Through the installation of deeper nested well sets, it was determined that deeper ground water zones would be protected following remedial activities to be undertaken by the Volunteer.

Off-property impacts were determined through our Phase II Property Assessment efforts to be as extensive – if not more so – than the on-property impacts related to the Volunteer's historic activities. The agency indicated that in accordance with VAP rules the Volunteer was not obliged to evaluate whether deeper ground water zones were protected relative to ***off***-property impacts. And, while the rules indicate that the Volunteer is not obligated to remediate ground water relative to ***off***-property impacts (except to the extent to prevent exposures on-site, regardless of the pathway), in this case – due a variety of complicated political and legal factors, the Volunteer intends to remediate the entire ground water situation.

End of Rule 7 and Beginning of Rule 10

Our discussion has now moved into the meat of the VAP so-called "Ground water Rule", in other words, Chapter 3745-300-10 of the Ohio Administrative Code. And the meat of the Ground water Rule is really best laid out in three words – **classification**, and **response requirements**.

Requirement to Classify Ground Water

Going back to our onion analogy, we need to determine the VAP classification of our uppermost saturated unit, and each subsequent zone underlying this saturated unit that we believe is "in our VAP project". By "in our VAP project", I mean that you do not have to classify ground water to the center of the earth. You only need concern yourself with the classification of those units that have been impacted by COCs in excess of UPUS. It is important to note here that only ground water zones that exceed UPUS need to be classified. Ground water zones that meet UPUS – and even those units that could potentially be impacted by COCs in excess of UPUS – do not need to be classified. This is a common misunderstanding.

In the simplest situation, this involves classification of only the uppermost saturated unit which exceeds UPUS. The next lowest saturated unit, which meets UPUS, you will have to make a demonstration that it will remain uncontaminated. In more complicated situations, you may have three, four, or perhaps more saturated units that require classification, based upon the subsurface stratigraphy of your site and the depth of ground water contamination. Failing to have an understanding of the use, probable yield and probable quality of units deeper than your uppermost saturated unit puts the Certified Professional in a bind from two directions. First, you may have an unclear picture as to your response requirements even for your uppermost saturated zone, and second, you could be setting yourself up for a particularly rough time during the NFA

review process because you have not attempted to understand the general nature of ground water zones beneath your shallowest contaminated unit on-site.

Review of Ground Water Classification

Let's review ground water classification under the VAP. Ground water classification is discussed in paragraph (~~C~~B) of Rule 10.

There is a handy flow chart in ~~the rule~~TGC document VA30010.09.001 that walks the Certified Professional through the process. Essentially, under the VAP, ground water is classified either as Critical Resource Ground Water, Class A Ground Water, or Class B Ground Water.

Critical Resource Ground Water

If the ground water zone that has been impacted by COCs in excess of UPUS meets one or more of the following criteria, it is classified as Critical Resource Ground Water:

- First, is ground water from that zone being used by a public water system, and is the zone located in a ground water source protection area for that public water system?
- Second, is the ground water zone part of an unconsolidated unit that is capable of yielding – based upon a time weighted average over a 24-hour period – greater than 100 gallons per minute as determined by a pump test conducted in accordance with the Phase II Property Assessment rule?
- Third, is the ground water zone part of a consolidated zone that is part of a sole source aquifer?

If your ground water zone meets any of these three criteria, congratulations. Your contaminated ground water zone is classified as Critical Resource Ground Water, which, of course, has the most intensive response requirements. However, if none of these criteria are met, the Certified Professional may conclude that the ground water zone containing concentrations of COCs in excess of UPUS is not Critical Resource Ground Water.

Ohio Department of Natural Resources ground water resources maps may be useful in evaluating whether or not a zone contains Critical Resource Ground Water. This is particularly true in the case of the unit being an unconsolidated zone capable of yielding in excess of 100 gallons per minute. These maps can be used in lieu of performing a pump test. However, watch out for the criteria listed in paragraph (~~C~~B)(1)(a) of Rule 10. I am familiar with one VAP project where an unconsolidated contaminated ground water zone beneath a property is being used down-gradient – in part – by a municipal water supply, and the site is situated within the ground water source protection area for that municipal supply. Therefore, in accordance with paragraph (~~C~~B)(1)(a), the contaminated ground water zone has been determined by the Ohio EPA to contain Critical Resource Ground Water even though the time-weighted average yield of the unit is less than 100 gallons per minute.

The mere fact that this contaminated ground water zone is situated within a source protection area and is being used – in part – by a public water supply is the basis for determining that the provisions of paragraph (~~C)~~B(1)(a) apply. Over-reliance upon or looking solely at the ODNR ground water resources map would not have told the Certified Professional this fact. Further, ground water source protection areas are not shown on ODNR ground water resources maps.

Finally, as an aside, some municipal water suppliers may not readily publicize their source protection areas, citing concerns related to security issues. In the past 12 months, I have been turned away from three municipalities when I requested a copy of their source area protection maps, all three of which cited the USA Patriot Act. If resistance of this nature is encountered on the local level, a CP should contact Ohio EPA to obtain a copy of the source area protection maps. These maps are public information and Ohio EPA has copies of all official maps, and it is only these official maps that need to be used for ground water classification purposes. Unofficial maps not on file with Ohio EPA, if they exist, do not impact classification.

So, the moral of the story here is: look carefully at the provisions of paragraph (~~C~~B)(1)(a) through (~~C~~B)(1)(c). Do your research as to the location of sole source aquifers in the area (there are only a few of these in the State of Ohio, and they are published on the Ohio EPA's web page). Also, research whether a public water supplier may be using ground water from a particular zone that is present beneath your property. Three "ifs" here: if ground water in this zone contains COCs in excess of UPUS, and if ground water from that zone is being used as part of a public water supply, and if that zone is situated within a ground water source protection area, you have Critical Resource Ground Water. Correct interpretation of paragraph (~~C~~B)(1) of Rule 10 is an essential element if you have a highly productive ground water zone beneath your property that has been impacted by COCs in excess of UPUS, regardless of whether the source areas are located on or off your particular property. Many times, the key to whether you have Critical Resource Ground Water or Class A Ground Water is whether or not your property is located in a ground water source protection zone.

Class A Ground Water

A contaminated ground water zone that does not meet any of the criteria for Critical Resource Ground Water, but meets any of the following criteria is classified as Class A Ground Water:

- First, the zone that you are evaluating is being used on property as a source of potable water, or by anyone within a one-half mile radius of your property. By anyone, the rules mean anyone – a public water supplier, twenty people, or one little old man who refuses to switch over to a public supply because of the Communist plot behind fluoride in drinking water. Note here the distinction we drew above: if a public water supply is using the same ground water zone that is contaminated on your property within one-half mile but you are NOT within a ground water source protection area, an argument could be made that the ground water in that zone is Class A and not Critical Resource. This is particularly true if the contaminated unit is part of an unconsolidated zone that yields less than 100 gallons per minute, and the unit is not part of a consolidated sole source aquifer. This is a fine point, but one worth pointing out. So, ground water within the contaminated zone is Class A if it does not meet any of the criteria for Critical Resource Ground Water but it is being used for potable purposes either on property or within a one-half mile radius of the property boundary.
- The second criteria for Class A ground water is whether the contaminated zone is capable of yielding greater than one tenth of a gallon per minute as determined by a yield evaluation conducted in accordance with the Phase II rule, and the ambient ground water quality in the zone (in other words, minus any contaminants your site may have contributed) is less than 3,000 milligrams per liter of total dissolved solids.

These criteria are taken directly from Rule 10, although there are a couple of subtleties that should be pointed out. Determining potential use of ground water from your contaminated zone within a one-half mile radius of the property boundary as part of paragraph (~~D~~B)(2)(a) is pretty straight-forward through the use of ODNR water well logs or other local authorities, such as the county health department. Or, you can use your own knowledge of the area and the property. With regard to the yield requirement in paragraph (~~D~~B)(2)(b), ODNR ground water resources maps are – again – a good starting point. Further, while yield testing is always an option under the Rule, a Certified Professional has the option to by-pass yield testing and assume that ground water within a contaminated zone is Class A, provided that he or she has evaluated and determined that the criteria for Critical Resource Ground Water do not apply to the ground water zone in question. Assuming that a contaminated ground water zone is Class A is often done when it is obvious based upon the Certified Professional's knowledge of the site and regional hydrogeology and best professional judgment. Such an assumption can eliminate the time and effort required to make a Class B Ground Water determination.

With regard to the total dissolved solids content provision of paragraph (~~D~~B)(2)(b), it should be clarified that testing to show that TDS content is below 3,000 milligrams per liter is not a rule requirement. This can also be assumed. Testing for TDS content is only required to demonstrate that the concentration is greater than 3,000 milligrams per liter as part of a Class B Ground Water classification demonstration. And I would like to point out as an aside that I worked in Florida for a number of years. Many communities extracted ground water for their public supply from the Floridan Aquifer, which was widely known to contain an ambient TDS concentration in excess of 3,000 milligrams per liter. However, the Floridan was highly productive, yielding in excess of 300 gallons per minute on average. It was economical in water starved Florida to employ expensive techniques such as reverse osmosis to treat the raw water from the Floridan Aquifer to reduce the TDS content to below 400 milligrams per liter. My point is, while this is not happening anywhere in Ohio (yet), one could envision a circumstance where the ambient TDS of a ground water zone was greater than 3,000 milligrams per liter (on its face, Class B ground water) yet the ground water zone was highly productive, and being exploited as a raw water supply for a community water system (on its face, Critical Resource, therefore trumping the Class B classification). So, the 3,000 milligram per liter TDS criteria discussed in paragraph (~~C~~B)(2) of Rule 10 should, like many other things in the VAP, be used as part of a weight-of-evidence demonstration, rather than relying upon this criterion solely.

Class B Ground Water

Paragraph (~~D~~B)(3) of Rule 10 indicates that ground water that does not meet any of the criteria for either Critical Resource or Class A Ground water may be considered Class B ground water. However, there are two criteria listed in paragraph (D)(2)(c) of Rule 10 that can turn otherwise Class A Ground Water into Class B Ground Water. So, let's review these:

- A ground water zone may be classified as Class B if the zone being classified contains less than 3,000 milligrams per liter of TDS AND is capable of yielding greater than one tenth of a gallon per minute but less than three gallons per minute as determined by a yield evaluation conducted in accordance with the Phase II rule, AND there is another ground water zone beneath the property that is a likely source of raw water for potable purposes both beneath the property and within a one half mile radius of the property; AND this other ground water zone yields greater than three gallons per minute, AND this

other ground water zone yields ground water at a rate that is at least twice that of the ground water zone we are attempting to classify. All five of these criteria must be met. We will go through an example of how this demonstration was made at a property that I worked on later in this presentation, but it is important to note that there is an awful lot of yield testing going on to make this demonstration. Yield testing in accordance with the Phase II rule is a very technical and time-consuming exercise, and therefore expensive. Further, yield testing is highly sensitive to temporal variations and heterogeneity of the subsurface stratigraphy. A strong word of caution. Do not embark upon this path unless there is – based upon your best professional judgment – ample benefit that will be derived from making a successful Class B demonstration at your particular property, and the benefits and risks have been thoroughly reviewed by the Volunteer.

- A ground water zone may be classified as Class B if the zone being classified contains less than 3,000 milligrams per liter of TDS and is capable of yielding greater than one tenth of a gallon per minute but less than three gallons per minute as determined by a yield evaluation conducted in accordance with the Phase II rule, AND all parts of the ground water zone are wholly contained within 15 feet of the ground surface, AND the ground water zone is in a unconsolidated unit. Demonstrating the fact that the unit is wholly situated within 15 feet of the ground surface will require a fair amount of documentation and exploration on the CP's part – namely drilling holes and installing wells, including wells that are not down-gradient of documented source areas - all in an attempt to demonstrate that the ground water zone in question is wholly contained within 15 feet of the ground surface.

So, by rule, any ground water zone that does not meet the definition of Critical Resource or Class A Ground Water is Class B Ground Water. However, several things to reiterate in conclusion before we wrap up our discussion of what Rule 10 says about classification:

- The ODNR has multiple resources (potable water well logs, oil and gas well logs, ground water resources maps) that are important screening tools to assist the CP in the classification process; however, these documents cannot be relied upon solely to make a classification of a ground water zone.
- Pay close attention to the provisions of paragraphs (~~C~~B)(1)(a) and (~~C~~B)(1)(c); a ground water zone does not have to have a minimum yield of 100 gallons per minute to be considered Critical Resource Ground Water.
- Once one has determined that he or she is not dealing with Critical Resource Ground Water, the Certified Professional may always assume that a ground water zone contains Class A Ground Water without yield testing, or an evaluation of TDS content.
- Yield testing in accordance with the Phase II rule is always required to make a Class B determination based on yield for a contaminated ground water zone.
- There is no requirement to evaluate ambient ground water quality for TDS content to demonstrate the concentration is below 3,000 milligrams per liter. However, such an assessment may be required as part of a weight-of-evidence demonstration that a particular saturated zone contains Class B ground water. I have made Class B classifications without ever evaluating TDS content, relying upon the other provisions of paragraph (~~C~~B) of Rule 10.

Part II

Advice/Examples of Ground Water Classification
Before we broke for lunch, we discussed the ground water classification scheme under the VAP. We will now move onto a couple of examples related to ground water classification. The first of these two demonstrations is relatively straight forward, while the second was somewhat more complicated. I have made both demonstrations on NFA projects that I have worked on. Both happen to involve the Berea Sandstone Formation in southern Cuyahoga County.

First Classification Example
During the 1960s, a farmer stripped all the overburden from above the underlying Berea Sandstone to provide fill for the construction of Interstate 71. He stripped everything over a 10 acre area to a depth of between 25 and 28 feet deep, such that in the end, trucks were able to drive on the upper surface of the Berea Sandstone on his property. More fill was required for Interstate 71, so the farmer petitioned the local community to blast the Berea Sandstone with dynamite. But this request was denied. By this time he had made everyone in the area who relied upon the Berea Sandstone for drinking water mad by disrupting their flow, affecting their quality, etc. So, with a 10-acre hole on his property, 25-28 feet deep, our farmer did the cheapest thing possible and turned the hole into a pond. The pond remained on-site for about 10 years, until our farmer was approached by a trucking company, who asked if they could dispose of spent fired foundry sand from a local casting plant into the pond. They offered to pay our farmer, and so, he told them to go ahead.

In 2000 when we approached the property to perform a voluntary action, the stratigraphy of the property consisted of 25-28 feet of spent foundry sand directly overlying the Berea Sandstone. A perched ground water zone had become established in the foundry sand fill, and this zone was clearly contaminated based upon previous investigations and our own sampling. Concentrations of lead, benzene, phenols, and other compounds were present in ground water in excess of UPUS in the foundry sand saturated zone. This made us reluctant to perform yield testing due to the cost and expense of getting rid of contaminated water extracted during the pump test.

We stopped to take stock of what we knew. The unit was not wholly situated within 15 feet of the ground surface (thanks to our farmer), and the ambient total dissolved solids content in the perched unit was in the range of 1500 – 1800 milligrams per liter. So, an initial, first blush back of the envelope classification of the ground water zone within the foundry sand was that the unit might be Class A Ground Water, unless we moved forward with yield testing of the foundry sand ground water zone.

We convinced the Volunteer of the need to perform yield testing, and proceeded to evaluate yield at two down-gradient wells that we believed would be biased toward the location of highest yield. We conducted our yield testing during the spring which we felt would bias the results to that temporal period of highest potential yield. Yield testing was thus conducted at the time and locations which were biased toward the highest potential yield. Pump tests were conducted in accordance with the provisions of the Phase II rule, with all contaminated water generated during yield testing transferred to 55-gallon drums, and characterized for off-site disposal.

The results of these yield tests indicated the time-weighted twenty-four hour average for both wells was around 0.9 gallons per minute. We compared this yield of the foundry sand fill unit to that of the underlying Berea Sandstone Formation, which was between 10 and 15 gallons per minute based upon ODNR well logs for wells within a one-half mile radius of the property. Based upon this comparison, we concluded that the ground water within the foundry sand was Class B, and the Ohio EPA concurred.

An initial ground water sample from the underlying Berea Sandstone Formation indicated COCs were present in excess of UPUS. However, a second sample was collected based upon the VAP rules in effect at that time. This sample indicated that ground water quality within the Berea met UPUS. It was at this point that we approached the Ohio EPA, who suggested that we collect a "tie-breaker" sample from the Berea. This third sample again indicated that ground water quality within the Berea met UPUS. However, given the initial exceedance, and the fact that local water well logs indicated an average yield for the Berea Sandstone of between 10 and 15 gallons per minute, the Berea Sandstone ground water zone was determined to be Class A ground water. A VAP Operations & Maintenance Plan was implemented as part of the NFA Letter to assure continued compliance with VAP applicable standards in the Berea Sandstone at the property boundary**.**

Second Classification Example

The second classification example was a little more complex, and involved a perched saturated unit contaminated with chlorinated solvent COCs in excess of UPUS. This unit had a yield (depending upon the well in question) of between 0.4 and 1.2 gallons per minute, and extended to a depth of up to 24 feet beneath the property. Finally, this unit had a baseline total dissolved solids content of approximately 700 milligrams per liter. Beneath this unit was the Cuyahoga Formation which historically had been exploited for potable use purposes in a very few wells within a one-half mile radius of the property boundary. Our monitoring wells into the Cuyahoga Formation indicated that the upper portion of this unit was contaminated as well. Our wells into the Cuyahoga Formation had yields of 0.9 – 2.4 gallons per minute, although admittedly none of our wells fully penetrated the Cuyahoga Formation. And beneath the Cuyahoga Formation is the Berea Sandstone.

The entire area around our property was now connected to a municipal water supply. However, prior to 1960, private water wells were used on many properties within one-half mile of our particular property. A review of ODNR water well logs revealed the presence of 106 former private water wells within one-half mile of our site. Of these 106 wells, 99 (or over 90%) exploited the Berea Sandstone for their source of potable water. Published yields on the well logs for wells completed into the Berea were between 2 and 20 gallons per minute, with the average of the 99 wells being between 7 and 8 gallons per minute.

Of the seven wells not completed into the Berea Sandstone, one was completed into a shallow sand unit that was not present on our property, while the other six were completed into the Cuyahoga Formation. The six Cuyahoga Shale formation private wells yielded between one and five gallons per minute, with an average – albeit not statistically significant – of 2.5 gallons per minute. And, again, in this case I am using past tense – yielded – because the entire area is now connected to a public water supply. Without going door-to-door and asking the residents at the

locations where private wells were indicated – "Are you still using a private water well on your property?" – I ***assumed*** that most if not all of these private water wells were no longer in service. This assumption was backed up by my – me, the CP - driving past most of the 106 locations referenced and conducting a windshield survey to determine if there was evidence of continued private water well use on these properties.

So, to once again set up the situation: we have a perched zone with a yield of 0.4 – 1.2 gallons per minute, contaminated with COCs in excess of UPUS that was not being exploited for community or private potable use within one-half mile of our property. Below this was what we referred to as the upper portion of the Cuyahoga Shale Formation which was also contaminated with concentrations of COCs in excess of UPUS, and had a yield of between 0.9 and 2.4 gallons per minute. Further, there was evidence of prior private potable use within one half mile of our property. Deeper monitoring wells installed into the Cuyahoga Shale Formation as part of our VAP activities were clean, and also exhibited yields of up to 2.4 gallons per minute. And, beneath the Cuyahoga Formation, we had the Berea Sandstone, which we did not physically investigate as part of our VAP activities. However, research of ODNR well logs indicated the Berea Sandstone was present some 80-90 feet below our property and had an average yield of between 7 and 8 gallons per minute based upon a statistically significant average of the 99 private water supply wells completed into this unit within one half mile of our property.

My initial conclusion was that the perched saturated zone was Class B, not based upon it being entirely within 15 feet of ground surface (because it extended to 24 feet deep in places), and not based on total dissolved solids content (700 milligrams per liter), and not based upon a yield of less than 0.1 gallons per minute (because our documented yield was between 0.4 and 1.2 gallons per minute. Rather, we concluded that the Berea Sandstone Formation was a more likely source of potable water since over 90% of well logs for former private wells in the area exploited this unit, and that our maximum yield for the perched unit – 1.2 gallons per minute – was less than half the reported average yield of the Berea Sandstone – 7 to 8 gallons per minute. The agency concurred with the Class B classification of the shallow perched unit.

Where I got greedy was when I attempted to classify the Cuyahoga Formation as containing Class B Ground water. I argued that it met the criteria. Pump test results and average published yields were less than 2.5 gallons per minute, while the average and statistically significant yield of the underlying Berea Sandstone was between 7 and 8 gallons per minute. The Cuyahoga Formation's yield was less than half of that of the Berea Sandstone, and I argued that over 90% of the former wells installed in the area exploited the Berea Sandstone, not the Cuyahoga Formation. Therefore the Berea Sandstone must be considered a **more** likely source of potable water than the Cuyahoga Formation, since over 9 out of 10 well drillers chose to exploit the Berea rather than the Cuyahoga. I thought it was a great demonstration that ground water within the Cuyahoga Formation was Class B.

My error was in assuming that no one within one-half mile of our property was continuing to exploit the Cuyahoga Formation for potable purposes. ***Past*** potable use – especially if assumed – is nowhere to be found in the classification language of paragraph (~~C~~B) of Rule 10. The issue here was that we did not address whether there were continued potable users of ground water in the Cuyahoga Formation within one-half mile of our property. The agency – correctly – did not

concur with my assessment, and busted me on the most basic definitional criteria for Class A Ground Water – that ground water within the Cuyahoga Formation might still be exploited as a potable water source within one-half mile of our property. I begged the Volunteer to allow me to do a door-to-door survey of the owners of the six wells completed into the Cuyahoga Formation to verify that they were no longer using their wells as a source of potable water. My client – more accurately, my client's attorney – did not want me to undertake this survey.

I next attempted to split the Cuyahoga Formation into an upper weathered zone – which was contaminated above UPUS – and a lower coherent zone – which was clean. I classified the upper weathered zone as Class B, and the lower coherent zone as Class A – although this was unnecessary on my part, because – repeat after me – if a ground water zone meets UPUS, the zone is not classified under the VAP. This was a nice try on my part, but in the end the agency urged me to drop this approach and classify the entire Cuyahoga Formation as Class A, again for the most basic of VAP definitional reasons – I had not verified that the Cuyahoga Formation was no longer being used as a source of potable water within one-half mile of the property. In other words, the agency essentially asked me, what part of paragraph (~~C~~B)(2)(a) are you having a problem with? I had begged my client to let me do the door-to-door thing, to demonstrate that the six wells that were documented as having been installed into the Cuyahoga Formation had been abandoned. The Client refused, and the Ohio EPA finally let the last air out of that balloon and told me that even if I verified that those six wells were no longer in service, that ODNR well logs are not perfect, and that there might be other "undocumented" wells in the area that exploited the Cuyahoga Formation. So, my final classification of ground water at this site was: contaminated perched unit, Class B. The Cuyahoga Formation, which was contaminated only in its upper weathered portion, was determined to be Class A. The lower coherent portion of the Cuyahoga Formation was determined to be clean, and this provided me with a weight-of-evidence demonstration that the provisions of POGWMUPUS to the lower Berea Sandstone Formation were met. And, as stated, since there was no evidence of potential impacts to the Berea Sandstone Formation, there was no obligation on my part under the rules to classify ground water within this zone.

Beginning of Ground Water Response Requirements Discussion

So, why all this discussion of classification? What's the point? Quite simply, ground water classification determines your point of compliance, and drives your response action obligations with respect to ground water under the VAP. There is a flow chart in ~~Chapter 3745-300-10(F)~~ TGC document VA30010.09.001 which is reproduced here which emphasizes the point. Everything that we have talked about up to this point has led us to this slide. The first box asks us the simple question: does the water in the zone meet the definition of ground water, which we discussed earlier? If not, this table does not apply, and the "water" in such a zone may be treated as soil.

The next box asks us does the ground water within the saturated unit – be it the uppermost saturated unit, or some deeper unit – contain concentrations of COCs in excess of UPUS? If the answer to this question is no, particularly for the uppermost saturated unit, your response requirements – assuming that you can not make a weight-of-evidence demonstration to the contrary – may have just became several degrees more stringent, because the provisions of POGWMUPUS apply, and your soil clean-up values may have just become the leach-based soil

values. These can be orders of magnitude lower than the soil direct-contact values in Rule 08. But it is important to note that even if your uppermost saturated unit meets the definition of ground water and contains COCs in excess of UPUS, the provisions of POGWMUPUS apply to each successive saturated unit below your uppermost saturated unit. So, again, the classification of ground water in your uppermost – and successively deeper – saturated units is critical to your determining your response requirements, bearing in mind that any unit which does not contain COCs in excess of UPUS does not require classification under the VAP.

Beginning of USD Discussion

A Certified Professional's response requirements for Critical Resource Ground Water and Class A Ground Water are dependent upon whether or not the property you are working on has what is referred to as an Urban Setting Designation. So, a word here about Urban Setting Designations.

The VAP rules relating to obtaining an Urban Setting Designation are found in Chapter 3745-300-10, paragraph ~~D~~C. An Urban Setting Designation essentially is a way to verify that ground water is not being used for potable purposes near a property, as is the case in most urban areas in the State of Ohio. An Urban Setting Designation may only be used for the purposes of eliminating the potable use pathway off-property. The most common misconception about what an Urban Setting Designation does for a property is that, if my property has an Urban Setting Designation, I don't have to clean-up ground water. I have heard this from Volunteers, elected officials, even CPs. This is not the case, at all, period. What an Urban Setting Designation does is eliminate the potable use pathway off-property. It does not change response requirements on property, and it does not change off-property response requirements related to non-potable uses of the ground water. You will still need to restrict ground water uses on property, and – if ground water on Property meets UPUS, the requirements to protect ground water meeting UPUS are unchanged by an Urban Setting Designation.

Another way to think about the impact an Urban Setting Designation has on response requirements is that it can change the ground water point of compliance down-gradient of the property. But, its impact on response requirements does vary with the classification of the ground water zone. This is – in essence – what an Urban Setting Designation does.

USD Threshold Criteria Discussion

How does a property receive an Urban Setting Designation? First of all, Paragraph (~~D~~C) of Rule 10 indicates that only you as the Certified Professional may request an Urban Setting Designation. There are threshold criteria that must be met in making an application to the Director for an Urban Setting Designation. Paragraph (~~D~~C) of Rule 10 lists the threshold criteria that must be evaluated and met for a Certified Professional to submit a designation request to the Director for approval. These criteria are like the eligibility requirements outlined in Rule 02 – these are mandatory criteria that must be met for a Certified Professional to request an Urban Setting Designation. There is really nothing that can be done to work around these threshold criteria.

Without going through the threshold criteria in paragraph (~~D~~C) of the rule line by line, let's briefly review the threshold criteria. The property for which the Urban Setting Designation is sought must be located entirely within the corporate boundaries of a city or a township with a

population of 20,000 or more residents. The city or township in question must be served by a public water system, where the CP can demonstrate that 90 percent of the parcels within a one-mile radius of the proposed Urban Setting Designation area are connected or capable of being connected to the public water supply. There is a TDGC (10.09.004) that provides guidance on how to demonstrate achievement of this threshold criterion.

Other threshold criteria are that the community water system is capable of meeting the future needs of the community, and that the property for which the Urban Setting Designation is being sought cannot be located in a ground water source water protection area for a public water system. Another threshold criterion is that there are no wells installed or used for potable purposes within one-half mile of the property for which the Urban Setting Designation is being sought. There is also a TDGC (10.09.005) which provides guidance on this issue.

Another threshold criterion is that there is not a reasonable expectation that new potable wells will be installed within one-half mile of our property in the future. In some cases, this can be easy, such as in the case of the City of Cleveland, where there are enforceable restrictions against the installation of potable water supply wells within the city limits. There are other provisions outlined of paragraph (D)(1)(g) that should be evaluated as threshold criteria by the Certified Professional, and I would refer you to the rule to review these provisions for yourself.

Making a USD Request to the Director

Once a Certified Professional has satisfied these threshold criteria, it is time to make your request for an Urban Setting Designation. The request is prepared by a Certified Professional, and submitted to the Director of the Ohio EPA, who is the only person authorized to grant an Urban Setting Designation request. It is important to note that the granting of the Urban Setting Designation request is not automatic based upon the satisfaction of the threshold criteria outlined in paragraph (D)(1) of Rule 10. The Director may deny the Urban Setting Designation request based on a variety of considerations. The items which a Certified Professional must include in an Urban Setting Designation request are outlined in paragraph (D)(2) of Rule 10. We will not go into them in detail here, and I would refer you to the rule.

Agency Consideration of USD Request

After receipt of a complete Urban Setting Designation request, the Director of the Ohio EPA may request additional information from the CP, and may conduct direct consultation with the affected legislative authorities. This consultation may include the holding of a public meeting to air the Urban Setting Designation request with residents that may be affected by the Urban Setting Designation. Following this consultation phase, the Director may approve or deny the Urban Setting Designation request. The Volunteer – your client – is responsible for bearing all Ohio EPA costs associated with evaluating the Urban Setting Designation request – even if the request is ultimately denied.

The point of this discussion is to emphasize that whether or not a property has an Urban Setting Designation directly affects response requirements, and a ground water zone's point of compliance. Behind all this, the Certified Professional must bear in mind that the Urban Setting Designation serves only to eliminate the potable use pathway to off-property receptors. We will discuss this next. However, I would urge all Certified Professionals to realize that an Urban

Setting Designation – once granted by the Director – is not an on-going get out of jail free card. If a Certified Professional intends to use an Urban Setting Designation in support of a No Further Action Letter, the Certified Professional must verify the validity of the USD prior to relying on it in the NFA Letter. The criteria a CP must use to evaluate the validity of the USD are outlined in paragraph (~~D~~C)(3) of Rule 10. Read this paragraph if you intend to use an Urban Setting Designation in support of a No Further Action Letter. Further, all Certified Professionals should understand that once an Urban Setting Designation request has been granted, the USD is not "forever". USD boundaries are subject to periodic review. Paragraph (~~D~~C)(4) of Rule 10 indicates that the Director of the Ohio EPA may – and, for all intents and purposes, has already established – a program by which the protectiveness of any Urban Setting Designation is verified by the agency.

Area wide USDs (those USDs covering large tracks of properties) are reviewed on their 5-year anniversary and every 5 years after that to verify their validity. Upon review, the agency may eliminate or reduce the boundaries of a USD. Any changes to a USD will be public noticed and all CPs will be notified of the changes. Changes to the boundary of a USD will not impact the validity of a CNS for properties that have already relied on the USD, but it could impact whether other properties can take advantage of the USD for future NFA Letters. So, bear these two components in mind – a CP must first review the provisions of paragraph (~~D~~C)(3) if he or she intends to use an Urban Setting Designation in support of a No Further Action Letter. Secondly, no Urban Setting Designation is forever. A program is in place to periodically verify the protectiveness of the Urban Setting Designation for the potable use pathway off-property.

Response Requirements

As stated, there is a flow chart in ~~paragraph (F) of Rule 10~~ the guidance documents that will guide you through the ground water response requirements depending upon ground water classification, whether or not the site has an Urban Setting Designation, and whether the source of ground water contamination is due entirely, partially, or not at all to source areas located on your property. Paragraph (~~F~~E) goes through, in step-by-step detail, these response requirements based upon your particular situation.

One point to emphasize - regardless of the classification of ground water in a contaminated zone beneath your property, and regardless of whether or not there is an Urban Setting Designation for your property – if the contamination is due to source areas NOT located on your property, the response requirements are pretty much as follows: you must implement institutional controls to prevent ingestion of contaminated ground water on property, and assure that all other **on property** pathways for human health – such as volatilization to indoor air, construction/excavation worker exposure, etc. – are controlled within the confines of VAP applicable standards. Finally, the Volunteer must evaluate and control complete ecological exposure pathways on property. The Volunteer is not responsible for evaluating or protecting off-property receptors when the source of the contamination originates off-property.

We will be evaluating response requirements in a reverse order than that presented in paragraph (~~F~~E) of Rule 10. The basis for this is that each set of response requirements layers itself onto the next lowest classification of ground water. That is to say, all Class B response requirements are also included in Class A and Critical Resource response requirements, and all Class A response

requirements are included in Critical Resource response requirements. In this analysis, we will assume that ground water contamination within a particular zone or zones beneath your property are due entirely to on property source areas. So, to begin we will evaluate the response requirements for Class B Ground Water, which are found in paragraph (~~F~~E)(6).

Class B Ground Water

Response requirements for Class B ground water are:

- Implementation of institutional or engineering controls that prevent human exposure on the property to ground water containing concentrations of COCs in excess of UPUS, or restoration of ground water to meet UPUS.
- Ensuring the protection of human health and important ecological resources both ON and OFF property from exposure to COCs in ground water. The pathways that need to be evaluated – both on property and at the nearest down-gradient non-potable receptor – include, but are not limited to: use of contaminated ground water down-gradient of your property for lawn watering, the volatilization to indoor air pathway, ground water emanating to surface water, or shallow ground water seeping into subsurface utility tunnels or sewers.

In essence, a Class B Ground Water classification – assuming that you have eliminated on-site potable and non-potable exposure pathways related to the contaminated Class B ground water zone - establishes your point of compliance to the nearest down-gradient non-potable receptor.

Class A with an Urban Setting Designation

The response requirements for Class A ground water with an Urban Setting Designation are found in paragraph (~~F~~E)(5) of Rule 10. In essence, the response requirements for Class A ground water with an Urban Setting Designation are the same as Class B ground water. The point of compliance – assuming that you have eliminated on-property potable and non-potable exposure pathways related to the contaminated Class A ground water zone – is, again, the nearest down-gradient non-potable receptor. As above, the Volunteer must:

- Implementation of institutional or engineering controls that prevent human exposure on the property to ground water containing concentrations of COCs in excess of UPUS, or restoration of ground water to meet UPUS.
- Ensuring the protection of human health and important ecological resources ON and OFF property from exposure to COCs in the ground water at the point of compliance. As above, the non-potable pathways that need to be evaluated include use of contaminated ground water down-gradient of your property for lawn watering, the volatilization to indoor air pathway, ground water emanating to surface water, or shallow ground water seeping into subsurface utility tunnels or sewers, etc.

It is assumed, of course, that the Urban Setting Designation has eliminated the potable use pathway off-property.

Class A without a USD

The response requirements for Class A Ground Water without an Urban Setting Designation are found in paragraph (~~F~~E)(4) of Rule 10. In essence, for Class A Ground Water without an Urban Setting Designation, your point of compliance is your property boundary. There are some exceptions, such as if the Class A Ground Water is discharging directly to surface water that is on or adjacent to the property. In lieu of remediating ground water so it meets UPUS, the CP and Volunteer usually put in place institutional controls that prevent the ingestion of contaminated ground water for potable purposes on-site. But ground water must be remediated to the extent that it will not migrate off-site in excess of UPUS. This could be done through active remediation, engineering controls, or other means that meet applicable standards in accordance with Rule 15, the VAP remedy rule. If ground water has already migrated off-site in excess of UPUS and is expected to affect off-site wells used for potable purposes, the Volunteer must do one of the following: 1) remediate off-site ground water contamination so that it meets UPUS, or 2) provide an alternative supply or treatment of ground water until such time as concentrations of COCs no longer exceed UPUS.

Critical Resource Ground Water with a USD

The response requirements for Critical Resource Ground Water with an Urban Setting Designation are found in paragraph (~~F~~E)(3) of Rule 10, and are – in most ways - identical to those of Critical Resource Ground Water without an Urban Setting Designation except in one critical element, that being the point of compliance related to the potable use of ground water. Instead of the property boundary being the point of compliance, a distance of one-half mile from the boundary of the VAP property or the USD boundary, which ever is greater, becomes your point of compliance. But bear in mind that this only applies to the potable use exposure pathway. Other pathways that exist off-site – non-potable exposures related to lawn watering, volatilization to indoor air, ground water emanating to surface water, exposure in utility trenches or underground utilities, etc. – may still require remediation of contaminated Critical Resource Ground Water, even if an Urban Setting Designation has been issued for the property.

Critical Resource Ground Water without a USD

The response requirements for Critical Resource Ground Water without an Urban Setting Designation are found in paragraph (~~F~~E)(2) of Rule 10. If we have Critical Resource Ground Water that contains COCs in excess of UPUS, and the source of the COCs is entirely attributable to source areas on our property, your point of compliance is the property boundary. There are some exceptions, such as if the Critical Resource Ground Water is discharging directly to surface water that is on or adjacent to the property, and I would refer you to paragraph (~~F~~E)(2)(a)(ii) of Rule 10. The Volunteer must implement institutional controls to prevent the on-going or future use of ground water on-site, and remediate on-site ground water so that it will not migrate off-site in excess of UPUS. If ground water contamination has already migrated off-site, the Volunteer must implement **one or more** of the following activities to ensure that any potential users of ground water for potable purposes have a continuing supply of potable water that does not contain COCs in excess of UPUS: 1) complete remediation of the contaminated ground water, both on- and off-property; and/or 2) provide a reliable alternative potable water supply to affected down-gradient users of ground water. An O&M plan must be put in place to implement response requirements that visually verify and research well log records to document the continued non-use of ground water in areas down-gradient of the VAP property. The Volunteer

must send certified mail written notifications to all owners of properties where ground water either has or is reasonably anticipated to exceed UPUS. In essence, contaminated Critical Resource Ground Water on a property without an Urban Setting Designation has the potential to be bad juju. Should a Covenant Not to Sue be issued, there are re-opener provisions that must be included in an O&M Plan, in the event that off-property folks want to start using the ground water for potable purposes in areas where concentrations of COCs exceed UPUS as a result of source areas on the VAP property. This re-opener applies whether there is a USD or not.

It should be noted here in our discussion of ground water response requirements we have assumed that ground water source areas are situated solely upon the VAP property. Rule 10 goes through in detail what the response actions are if the source of concentrations of COCs in excess of UPUS on a VAP property are a blend of off- and on-property source areas, or are entirely attributable to off-property source areas. Should you find yourself in one of these situations, I would urge you to carefully review Rule 10, because there isn't time enough to go through all the possible permutations of response requirements in these blended or off-property situations.

Lessons Learned about Response Requirements

Response requirements begin and end with the correct classification of each saturated unit. An incorrectly classified unit will have an incorrect response requirement. Particularly if we are dealing with Critical Resource Ground Water, early agency coordination often results in a smoother review of the NFA letter and avoids "messy" comments from the agency. With Critical Resource Ground Water, it may not always be obvious whether source areas are all on-property or not, particularly if you are dealing with an adjacent property owner that does not want to cooperate with you. Obtaining Ohio EPA concurrence with what you are doing is critical, so that you do not end up doing something that is either less than or goes beyond what the agency might require. Under the VAP, be like Goldilocks: some things were too big, others were too small, but one was just right.

Too often Certified Professionals get bound up in the concept that the only exposure pathway for ground water is ingestion. In other words, no one is drinking the water; therefore I have no issues associated with exposure pathways to ground water. This is a common misconception. There are several pathways that involve non-consumption of ground water that could still result in the need for active remediation or some form of engineering control.

Importance of Non-potable Pathways

Obviously, if you have Critical Resource Ground Water contaminated due to releases on your property, and these releases are going to impact a community water supply well, you have an obligation to do remediation in that circumstance, or get the municipality to move their wells so that you are no longer posing a risk. That is, in essence, what the regulations state. However, in the circumstance of contaminated Class A Ground Water that is predicted through modeling or another mechanism to not affect a potable well, one could say that your point of compliance may be related to future construction activities that encounter ground water, such as deep trenches for utilities or foundations. Nonetheless, bear this in mind: Class A Ground Water or Critical Resource Ground Water without an Urban Setting Designation has the same point of compliance, the property boundary. Down-gradient non-potable receptors cannot be impacted by COCs in excess of UPUS if the ground water is classified as Class A or Critical Resource without an

Urban Setting Designation. The VAP has indicated that incidental ingestion of contaminated ground water during construction activities is an insignificant risk that does not need to be evaluated. So that ingestion pathway – the construction worker taking in some amount of ground water through the mouth – is not evaluated. Dermal and inhalation exposure to contaminated ground water in a construction/excavation setting is a difficult exposure pathway to quantify, but is still one that needs to be evaluated. Where a property-specific risk assessment has indicated that exposure to a COC poses a risk to a hypothetical construction worker based upon the duration that is reasonably anticipated for that person to be exposed during construction, the Volunteer may be required to implement some form of construction worker institutional control, or remediate ground water.

Indoor Air Assessment as a Response Requirement

One non-potable pathway that is really starting to come into focus is the volatilization of compounds from soil or ground water to indoor air. In the case of Class A ground water with an Urban Setting Designation, your point of compliance is no longer your property line, but your nearest down-gradient non-potable receptor. In the old days, when I was a little CP, we interpreted that to mean the nearest stream or surface water body down-gradient of your site. For example, in the City of Cleveland, if your site was one-half mile from Lake Erie, we might have considered the nearest down-gradient non-potable receptor to have been Lake Erie, or some tributary to Lake Erie. It is possible that some utility trench down-gradient of our site may have been our point of compliance. However, since ingestion of contaminated ground water is eliminated as a pathway for construction workers and short term exposures during construction are such that vapors would not pose that great of a risk, down-gradient construction and excavation activities in utility trenches could in most cases be discounted.

All this has been changed for volatile organic compounds, such that your nearest down-gradient non-potable receptor – in other words, your point of compliance - may be the nearest building. If your modeling indicates that contaminated ground water is, has or will migrate to an area underneath that building, thereby creating the potential for the volatilization of these compounds to indoor air, you have a response requirement. This is not some academic exercise. A lot of us in the environmental consulting community are familiar with the example of a bank or some other commercial establishment located next door to a gas station, which experiences gasoline vapors in the interior of their building due to the migration of contaminated ground water. Under the VAP the risk associated with this pathway must be quantified. In other words, it must be assigned a numeric risk factor that is added to your soil direct-contact multiple chemical adjustments. So, determining your ground water point of compliance is a critical factor, and one that is not always obvious. But it is essential for determining your response requirements. We are dealing with a situation in the City of Cleveland, where we have Class A Ground Water with an Urban Setting Designation for our property. Therefore, our point of compliance was not the property boundary, but the nearest down-gradient non-potable receptor. Across the street from us is a school, with a basement. That school immediately became our point of compliance, because we had volatile organic compounds in ground water, and our predictive modeling indicated that our contaminated ground water would eventually encounter the foundation wall of the school's basement. The concentrations in ground water predicted by our model would volatilize into the building at concentrations in excess of VAP applicable standards. This

necessitated a response requirement where none was obvious prior to predictive indoor air modeling for an off-property non-potable receptor.

So ground water response requirements must look at all exposure pathways: ingestion, inhalation of volatiles from soil/ground water to indoor air, discharge of contaminated ground water to surface water, and the protection of important ecological receptors. Fortunately, this is rapidly streaming toward the requirements for use of generic numeric standards or performance of a property-specific risk assessment, which is beyond my area of discussion. But I wish to conclude my remarks by wishing you well as a CP.