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Fairfax County Board of Supervisors  
12000 Government Center Parkway  
Fairfax, VA 22035

Re: ZMOD Draft Ordinance

Dear Members of the Board of Supervisors:

This letter is intended to help provide clarification to some of the difficult technical complexities regarding water quality that face the Board as you review the Draft ZMod Ordinance. These are not easy issues, and a detailed understanding of the science of water quality is critical for the effective stewardship of our watersheds and the safety of our drinking water. Hopefully this will help you make quality, technically-defensible decisions on issues that affect the future health, safety, and economic well-being of the citizens of Fairfax County.

As you know, I spent most of my 40-year career as a technical expert dealing with mapping the transport pathways and attempting to treat some of the worst groundwater contamination challenges in the US and internationally. I also chaired and was the lead instructor for the Site Assessment and Remediation Program at the University of California, Davis for 14 years. I am very concerned that some of the proposed ZMod changes, particularly regarding ALUs and HBBs on septic, and issues regarding flood plains are not prudent and may in fact prove to be dangerous. Below I discuss how a septic system works, limitations of ALUs and HBBs, the USGS report on nitrates in Difficult Run, the CEC PFAS and the Occoquan, public involvement in neighborhood projects, and overland relief/flood plain issues.

### **Septic Systems**

The mechanics and limitations of a septic system are important to understand before allowing additional volume or waste types. A septic system is a collection of living organisms in a biological reactor that do a remarkably effective job of treating normal household waste, as long as they are not mistreated. The system has several parts: the tank, pipes and distribution box(es), and the leach field. As waste flows into a septic tank, the heavier solids settle to the bottom. The scum layer rises to the top, where it is blocked from moving into the leach field by baffles. Anaerobic bacteria, which do not tolerate oxygen, digest (obtain energy from) the organic material in the middle liquid level, as well as some of the solids, before the liquid flows under the baffle to the leach field. The undigestible solids build up on the bottom, and are required to be pumped every five years.

The partially treated liquid waste flows out of the tank into the leach field and surrounding soils, where aerobic bacteria, which require oxygen, further treat and filter the wastes. One of the elements that is not actually “treated” but whose oxidation state is changed in the leach field is nitrogen (N). The urea in human waste has two “reduced” (no oxygen)  $\text{NH}_2$  groups stuck to a carbon atom. The  $\text{NH}_2$  is not significantly changed by the anaerobic bacteria in the septic tank. However, the aerobic (oxygen using) bacteria in the leach field convert it into the highly oxygenated nitrate ( $\text{NO}_3$ ). Nitrate is not further treated or attenuated in the septic systems, and it is fairly mobile in groundwater. It can act as an indicator compound illustrating contaminant transport. Nitrate has an advantage in that it is relatively cheap to measure.

As you know, a septic system is designed based on the number of bedrooms in a single family residence with an assumed number of persons and gallons per day of discharge. This provides the bacteria with

sufficient “residence time” to adequately treat the waste from the occupants. If this flow is exceeded, the system becomes flooded, and undigested anaerobic waste may flow out into the leach field, possibly preventing the aerobic bacteria in the field from doing their job. This may result in a clogged system. The result would essentially be the disposal of raw, potentially disease-carrying sewage directly to the soil, aquifer, and surface water.

Many older septic systems in the County are in stressed condition. Thousands are not pumped on a regular basis and few have any capacity to handle additional waste load. Many have only a single leach field, rather than the modern requirement for two fields that are alternated every year to give each field a rest. Many have trees or landscaping that encroach on the leach field. Many homeowners misuse their garbage disposals, adding a heavy load of indigestible solid material. None is designed to handle chemicals or additional loading. Even household bleach, ammonia, and excessive use of anti-bacterial soap are not recommended in household systems beyond occasional and low dose amounts. It is not recommended to wash back-to-back bleached loads; front-end washers may be an issue, as there is not enough water to dilute the bleach.

### **USGS, EPA, and USDA study on NO<sub>3</sub> from septic systems found in Difficult Run**

A 2016 study done by USGS, EPA, and USDA ( <http://dx.doi.org/10.3133/sir20165093>) included the Difficult Run watershed as one of their four study areas. Their key conclusions include (*italics mine*):

- “elevated nitrate levels present in Difficult Run are positively correlated to the density of septic tanks”
- “total nitrogen load is estimated to be 140,000 pounds per year, and is strongly affected by base flow (*groundwater discharge*) export of nitrogen from the basin.”
- “Due to continued development and urbanization of the Difficult Run watershed, the percent of stream flow due to base flow, or groundwater discharge, has decreased from 58% to 50% in the last 20 years.” (*This means the corresponding stormwater runoff component has increased from 42% to 50% over the same time*).
- “The total phosphorus load was 14,000 pounds per year, with the majority of the load contributed during stormflow periods.”
- “relatively low nitrogen concentrations are located in areas that are served by city sewer lines.”

In my opinion, these study conclusions are very significant for Fairfax County. This study proves that leachate from a large number of septic tanks is causing elevated nitrate levels in surface water; therefore a complex series of contaminant transport pathways from individual septic tanks to ground and surface waters must exist. And, if a contaminant transport pathway is proven to exist for nitrates, than it also likely exists for untreated toxic chemicals and pathogens.

This study clearly illustrates the incredible complexity and seriousness of the relationship between the:

- increased frequency of high-intensity storm events due to climate change;
- effect of incremental increases in impervious surfaces, which have increased the percentage of stormwater runoff by 8% in the last 20 years. This has overwhelmed our under-designed and inadequate infrastructure and threatens significant economic damage and loss of life; and
- limitations on the effectiveness of existing septic systems and the potential for leaching of harmful and toxic chemicals and pathogens to the surface water.

### **ALUs and HBBs on Septic Systems**

Permitting Assisted Living Units (ALUs) and Home-Based Businesses (HBBs) on property with septic systems have two very problematic issues - the additional volume of waste added to the system, and the

presence of toxic chemicals that may inhibit or poison the system bacteria or flow through untreated into groundwater.

The additional inhabitants in an ALU and/or business employees and customers in a HBB may significantly add to the total volume of wastes flowing to septic – exceeding the design capacity and inundating a system of potential marginal capacity, even if no chemicals are disposed.

Even worse, the frequent discharge of waste materials associated with HBBs will certainly be detrimental to the health of the bacteria in the septic tank. Many of the waste chemicals from these businesses would be toxic to those sensitive bacteria; they don't tolerate oxygen or oxidizers, and anti-bacterial solutions and toxic chemicals kill them or reduce their effectiveness.

Beauty salons and barber shops may have several chemicals or substances that create adverse effects. The “bleach” used for hair lightening is a fairly strong oxidizer and the salon professionals wear rubber gloves when using it. The bacteria have no such PPE. Hair and surfactants from soaps and conditioners may clog the septic tank and leach field; hair dyes and straighteners may be toxic, as are sanitizers and bleach used to disinfect surfaces between customers. Art studios and repair shops (and although not permitted, nail salons and small engine repair advertisements as seen on Nextdoor web sites), etc. all may use toxic solvents, paints, cleaners, oils, or chlorinated degreasers.

If the concentration of these chemicals or the rate of use is too frequent, these toxins can quickly poison and kill the entire colony of bacteria that break down human waste. Excess volume of water from repeated hair washings can overwhelm the designed septic volume. Most governmental jurisdictions that permit some of these uses on septic require dedicated sinks with separate holding tanks (not attached to septic) to receive these chemicals; these tanks must be pumped regularly. They also may require the installation of an additional septic tank to handle excessive water flow.

If the tank bacteria are impaired, undigested anaerobic waste will flow out into the leach field, preventing the aerobic bacteria in the field from doing their job - resulting in a clogged system. Then, raw, potentially disease-carrying sewage (yes Covid) and toxic chemicals will be disposed directly to the soil, aquifer, and surface water.

In addition to the health of the system bacteria, the transport of disposed chemicals migrating untreated through the septic tank and leach field to the aquifer are of significant concern. Many County residents on septic also get their water from private wells. Therefore, the disposal of wastes from a home business may threaten the quality of their own and their neighbors' drinking water.

The migration of toxic chemicals or untreated pathogens are not as easy to track as nitrates. **There is no easy test for the presence of these chemicals, or their adverse effects.** The septic system and leach field is not easy to access or test. The business practices are almost impossible to enforce. The best solution is to not dispose wastes or extra liquid volume into a system that is not designed to handle them.

### **CEC's - Environmental Working Group – PFAS in Fairfax drinking water – Occuquan Reservoir**

In my 40 years' experience developing groundwater treatment strategies and designing multi-million dollar treatment systems, I have had to address numerous Contaminants of Emerging Concern (CEC's), sometimes as an emergency, after they have become a “Big” concern – often because they were not taken seriously or were dismissed early on when something could have been done.

CECs have been in the recent news in the Fairfax area as the respected Environmental Working Group just released the results of a survey showing that PFAS (Per/poly FluoroAlkyl Substances) have been found at

high levels in the drinking water at 19 Northern Virginia locations. The samples near the Occoquan Reservoir were found to have PFAS at higher levels.

PFAS are a large group (a couple thousand) of complex chemicals that have been used in fire-fighting foam, stain resistant carpet, water-repellent clothing, non-stick cookware, and Teflon for decades. Some of these chemicals are still being used; others have been discontinued. Unfortunately, they have been linked to a number of very serious health problems. They are referred to as “forever chemicals” because they do not readily break down, and they accumulate in our bodies.

U.S. EPA does not formally regulate PFAS, but they do have a non-enforceable health advisory of 70 parts-per-trillion (ppt). Many advisory groups recommend that this number be in the single digits. For reference, a ppt is essentially one second in 31,000 years! As with all CECs, the toxicology and regulatory enforcement are still evolving. Even the approved analytical methodologies and number of chemicals analyzed are not well established. Water purveyors, DOD, and EPA measure a different number of different compounds. I spoke with the Lab Manager of one of the few labs in the country that are accredited to run these methods. They maintain a clean room, using Liquid Chromatography/Tandem Mass Spectroscopy to get ppt levels. The analytic method is even more complex than it sounds, and costs in excess of \$235 per sample, depending on which methodology is used and the number of PFAS being sampled for. Extensive quality control is required.

The issue of PFAS in drinking water is an extremely complex situation, similar to many that I have addressed in my career. It will be very difficult and expensive to determine the likely source of contamination, and address the problem. (There was a fire-fighting foam spill at the Manassas airport on February 7, 2020, but no relationship to County drinking water has been established). However, what is important to the Board is that the Occoquan Reservoir provides approximately 40% of the County’s drinking water. If the reservoir is expected to continue as a safe and reliable water supply, the surrounding groundwater recharge areas and surface waters must be carefully protected; the Water Supply Overlay District must be considered sacrosanct.

### **Public Input and Enforcement**

Citizen involvement and public hearings on neighborhood development issues are critical. As an example, in 2019 a developer proposed an 86-bed assisted living facility on Hunter Mill Road. The Applicants’ consultant submitted a plan to reduce the Resource Protection Area (RPA) - necessary to gain additional area for their proposed septic system. LDS staff rely on the accuracy of the submittals certified by registered surveyors, wetlands professionals, and attorneys and do not have the time or resources to visit each site. Based on the Applicants submittal, LDS approved the modification. However, as citizens discovered, the stamped survey for the project was not accurate or consistent with two previous developer surveys; a flowing spring and 150-foot (probably perennial) creek had been removed from the topo map, which significantly reduced the RPA area.

Curiously, an orphan rectangle remained on one of the Applicant submittals that modified a GIS layer from a previous developer’s survey – the bridge over the missing creek! Citizens also provided detailed history of neighboring septic systems that were relocated due to flooding, nearby drinking water wells, and a history of using the adjacent property in the winter for ice skating due to high perched water tables (that likely created the missing spring). Citizens also pointed out severe issues with the applicants proposed alternative onsite sewage system (AOSS), especially vendor limitations for medical wastes on septic that the Division of Environmental Health did not address. Shortly after the citizens testified about the above inaccuracies before the Planning Commission, the Applicant withdrew their application. LDS and Stormwater Management staff prepared a detailed memo illustrating the discrepancies. This year, after

citizen request, the inaccurate RPA approval is being revoked. This clearly illustrates the value of citizen involvement.

This is not an isolated example (and it also applies to construction projects). When I chaired the Chesapeake Bay Protection Ordinance Exemption Review Committee, there were several examples of applicant representatives certifying and submitting inaccurate or intentionally incomplete applications. There is no risk to the applicant, as there are no consequences for their actions, and the competent, though overworked staff at LDS may or may not catch the problems. Some of the repeat offenders actually serve on County task forces that make policy recommendations.

I have held registered professional engineer and General Engineering Contractor licenses in 11 different states, and there are competency and ethical requirements in each. In Virginia they are managed by the Department of Professional and Occupational Regulation and the Virginia State Bar. I would expect if I were caught stamping and submitting seriously inaccurate documents to a regulatory body (as in the Hunter Mill example) than I would be referred to these agencies for investigation – and likely have my license to practice engineering revoked. I once helped manage an enforcement group in the California Toxics program in the early 1980's. The program initially was a disorganized mess of unenforced violators. After taking action against three of the most egregious offenders, much of the problem went away – the others significantly cleaned up their act. I believe that if similar enforcement action were taken by the County, the workload and stress on LDS and other review staff would be greatly diminished, as they wouldn't be forced to question and prepare lengthy detailed comments on inadequate submittals. Marginal development projects would not be pursued.

### **Overland Relief and Floodplains**

One of the most important issues facing the County, exacerbated by climate change, is flooding, with the resultant property damage and loss of life. ZMod does not address this critical issue. When County floodplain regulations were first needed years ago, they were put in the zoning ordinance for convenience. They do not belong there. The floodplain regulations should be in a stand-alone ordinance, which is the norm in other jurisdictions. The existing review process involves three review divisions (Zoning, LDS [both site review and building plan review], and stormwater planning). This is unnecessarily cumbersome, is at risk for missing important issues, and is very expensive without adding value.

The current County regulations (which encompass some, but not all of the required federal regulations) permit LDS technical staff to review and approve limited uses or changes to the floodplains; other submittals require an expensive, lengthy review process starting in Zoning, who request assistance from LDS technical staff, who in turn reach out to stormwater planning. A Zoning Special Exception staff report request and a LDS technical staff report are written and the case is heard by the Board. This is not appropriate, as these are very complex engineering problems that deal with life and death issues, and have severe economic consequences; Zoning does not have staff with the technical expertise to address them.

All floodplain references should be taken out of the Zoning Ordinance, and stand-alone floodplain regulations should be adopted just as with the Chesapeake Bay Preservation Ordinance and the Stormwater Management Ordinance. The review authority should be transferred to Land Development Services where the appropriate expertise exists. In order to fix the current system, experienced engineers in LDS should work with their colleagues in SWPD to prepare a separate ordinance that integrates County floodplain issues with FEMA requirements (the County administers the NFIP regulations on behalf of FEMA and is a Community Rating System which allow lower insurance rates) and addresses essential overland relief issues. Over 80% of flooding occurs outside the FEMA regulated floodplains. This structure is how most

other jurisdictions address this issue with increasing risk for property damage and loss of life. This would streamline the process, and possibly allow areas such as Little Pimmit Run to be safely redeveloped.

SWPD has numerous dedicated, competent staff, but they have an extremely challenging task. Not only do development pressures (which they have no control over) increase the density of impervious surfaces and create higher contributions of storm water runoff to stream flow (see USGS report conclusions above), but climate change exacerbates damage with more frequent torrential rainstorms (July 8 and August 14, 2019) that produce catastrophic results. It is critical for the physical and economic survival of the County that new development in floodplains is severely restricted and the extensive development that already exists in floodplains is redeveloped in a way that keeps people and property out of harm's way.

### **Recommendations**

- ALUs and HBBs (other than paper-based offices) should not be allowed on septic systems;
- The Occoquan Reservoir drinking water supply must be protected through a well-enforced Occoquan Overlay District;
- Floodplain issues should be removed from the Zoning Ordinance and addressed by LDS in coordination with Stormwater Planning, factoring in FEMA requirements and the need for adequate overland relief;
- Public hearings to give neighbors an opportunity to provide input must be retained. Each property is unique, and the specific circumstances must be considered. Neighbors are often aware of critical information; and
- An active and effective enforcement system is critical for insuring compliance with County, state and federal law and ordinances.

There are no easy tests or quick checks that can resolve any of these issues. They are very complex technical problems. Good policy and hard work are required. Please take action that will keep us all safe. Thank you again for the opportunity to provide input.

I'd be glad to answer any question you may have..

Sincerely

Chris Koerner

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