From:	Joel Geier
To:	Coffin Butte Landfill Appeals
Subject:	LU-24-027 testimony
Date:	Tuesday, October 7, 2025 4:51:28 PM
Attachments:	Hydro Comments Joel Geier 2025-10-07.pdf

Please included the attached PDF file as testimony for the record. Thank you.

Joel Geier
clearwater@peak.org

Dear Commissioners Wyse, Malone, and Shepherd:

Thank you for this opportunity to provide testimony regarding LU-24-027. My address is 38566 Hwy 99W, Corvallis OR 97330. I ask you to uphold the careful and thoroughly considered decision of the Benton County Planning Commission, to <u>deny</u> this permit application.

My testimony here is aimed mainly at providing context for county staff as they prepare an updated Staff Report for the current appeal process. The Staff Report prepared for the previous stages of this land-use process inappropriately endorsed assertions by the applicant, even on topics for which staff and the County's consultants acknowledged a lack of technical expertise.

This was particularly true on the topics of groundwater and potential for construction of the landfill to impact rural wells. Our community was fortunate that several of the members of the Planning Commission, in particular Commissioner Lee, showed a practical understanding of how groundwater responds in fractured basalt such as we have in much of Benton County. In some respects, Commissioner Lee's understanding was at a more sophisticated level than demonstrated by the applicant's consultants, who I see are still trying to parse her statements from the final deliberations.

If county staff have yet not augmented their technical capabilities regarding these topics, then I hope that this time they'll have the wisdom to remain neutral, rather than endorse assertions by the applicant.

My testimony here is in two main parts: (1) a summary of my relevant experience on topics related to groundwater flow in fractured rock, and (2) to briefly address a few of the applicant's new claims, introduced recently in Exhibit 67. My main comments on these issues will come at a later point in this process.

1) Relevant experience regarding groundwater flow in fractured rock

I work internationally as a recognized expert with a specialization in fractured rock hydrogeology, with a Ph.D. in geology plus undergraduate degree and graduate studies in mining engineering and rock mechanics. I have 38 years of professional experience specializing in fractured rock, including methods for well test interpretation and modeling of groundwater flow and contaminant transport.

This experience has included extensive, state-of-the art field investigations in Canada, Sweden, UK, and Finland, in conjunction with their national programs for radioactive waste disposal. I was part of the original development team for FracMan (now owned and marketed by the international consulting firm WSP), which has since become an industry standard for analysis and modeling of fractured rock, with applications in hydrogeology, slope stability, seismic risk, and oil/gas reservoir engineering.

Currently I am engaged as Task Lead for an international research project focused on methods for predicting , working with research teams from Taiwan, mainland China, South Korea, Germany, Sweden, and hopefully also our own Los Alamos National Laboratory (pending issues related to the current government shutdown).

I am also currently engaged in an assignment for the International Atomic Energy Agency (IAEA), focused on the history of underground research facilities and experiments that have been conducted since the early 1960s, to gain a better understanding of fractured rock. I was recruited for the IAEA project specifically because of my recognized experience from the early Canadian and Swedish programs, which led to recognition of the pitfalls of trying to apply standard aquifer models and approaches (such as the applicant has relied in LU-24-027) in fractured bedrock environments.

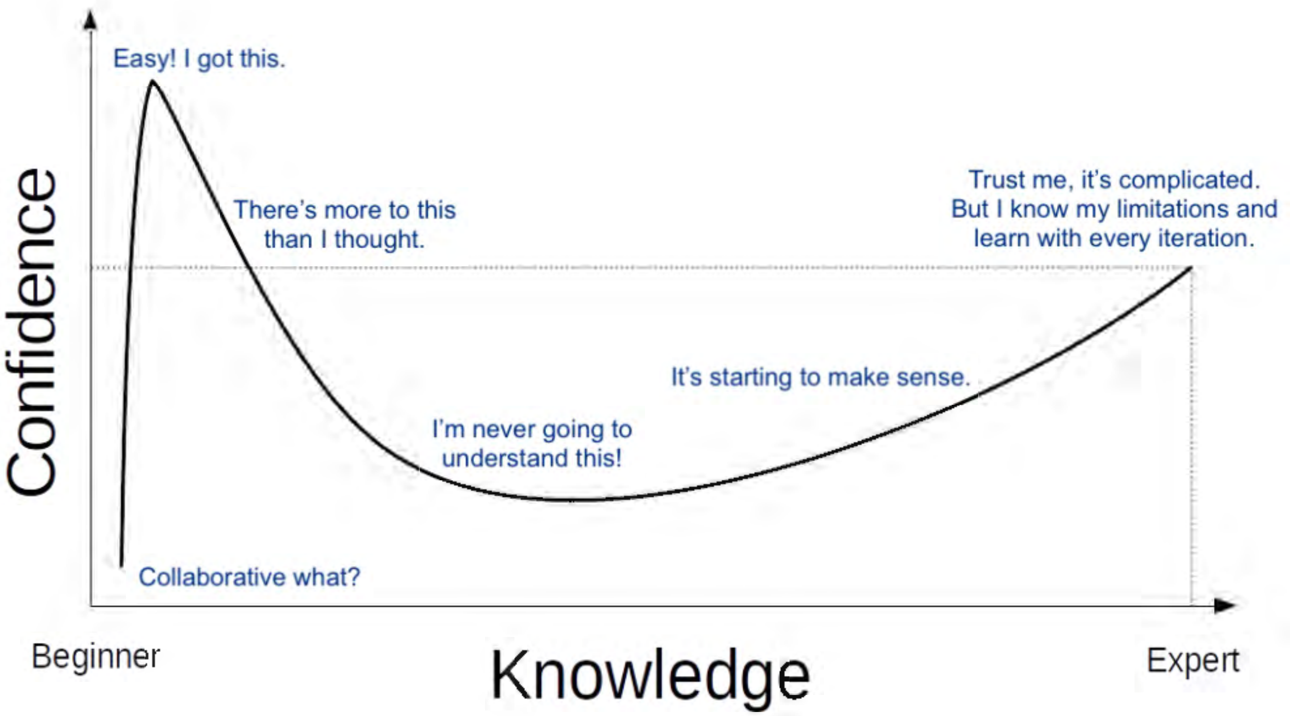
At Oregon State University, I have previously taught both the senior-level hydrogeology course and a graduate-level seminar on fractured rock hydrogeology. The first course is typically the highest level of hydrogeological instruction attained by geology majors who go on to become professional geologists. The second course served as an introduction for graduate students who were interested in improving their understanding of fractured rock hydrogeology, beyond the basic practical level expected for routine work in the field.

2) Brief comments on applicant's new claims in their Exhibit 67

My specialized experience is relevant because the applicant proposes to excavate a large volume of rock from the north end of Tampico Ridge, and then to build a landfill in that space. Most of this excavation will be in fractured bedrock.

The applicant's geologists have acknowledged that fractured bedrock is a complex environment, but their application materials thus far do not demonstrate a level of caution commensurate with their limited understanding of this environment.

Or at least, the way that their arguments about fractured bedrock have been presented by the applicant's attorneys don't show an appropriate level of caution. In the social sciences, this type of situation is sometimes referred to as the "Dunning-Kruger effect," as illustrated in the attached cartoon. In some instances, the consultants have acknowledged, in effect, "There's more to this than I thought," but the lawyers would have you believe that they're out there in the "expert" zone.



In pages 34 through 39 of Exhibit, the applicant's consultants have made an effort to refute comments that I provided to the Planning Commission, in the attached Annexes. Briefly, here are a few responses (using the same subtitles as they've used), although I do not attempt to give full responses at this time.

Annex 1, Comment 6

Applicant still has not identified any specific regulatory steps by which risks of impacts to groundwater levels in nearby wells will addressed. The regulations outlined are focused on monitoring groundwater contamination around a landfill, and do not speak to the issue of water levels being impacted by dewatering of fractured bedrock aquifers during construction.

Annex 1, Comment 9

My original comment referred to the applicant's use of the term, "seismic wave velocity." After I pointed out that this was incorrect, they have changed their wording to use the term "peak particle velocity." I agree that this is a more appropriate measure for the phenomena of concern, but this is not the term that they used in the document on which I made that comment.

Applicant's consultants have misunderstood my comments regarding the most likely way in way blasting could affect nearby wells, namely localized slip on a water-bearing fracture that forms part of a critical path for groundwater to reach a well. The major concern for this cause is reduction of well capacity rather than change in groundwater levels (which are more likely to result directly from applicant's plans for large-scale drainage/dewatering). My examples of earthquakes were meant to be illustrative, in simple terms. Changes in flowrates to underground openings have been also been documented to occur in response to blasting in nearby tunnels.

Comment 9.b. Regarding Dewatering Effects on Neighboring Wells
Here again, the applicant is responding to a comment that I made on what was previously a gap or error in their prior documentation. The information that they used a "Dupuis solution" emerged only in response to my comment.

The applicant still hasn't provided documentation of what parameter values they used in applying the Dupuit solution. Choice of parameters is key to application of any type of model.

The applicant's statement that applying this solution (derived for a radially homogeneous aquifer) is "conservative" for fractured rock is not supported by decades of evidence from research on fractured rock hydrogeology. This is a common mistake made by non-specialists who have not worked extensively in fractured rock, and should not be accepted in this context.

Comment 9c. Arsenic
Here the applicant's consultants are on very weak ground. Whether or not arsenic occurs naturally in groundwater in "large portions" of the State of Oregon is not

relevant, if those "large portions" are many tens of miles distant from the site of concern. The available data do not support applicant's prior claim that arsenic is commonly found naturally in groundwater in the area around the proposed new landfill.

The applicant's consultants continue to misunderstand, selectively dismiss and/or misconstrue results from the 1999 US Geological Survey study, in ways that will require much more lengthy testimony to elucidate. Simple presence of arsenic content in rock samples, as found in the 2013 master's thesis cited by the applicant here, does not mean that arsenic is available. Dissolution and diffusion of arsenic from rock is limited by the accessible porosity of the bedrock. This again is a complex technical topic on which there has been a large body of research. But to put it in lay terms: If you put a chunk of arsenic-bearing rock in a bucket of water, you're not going to get nearly as much arsenic into solution as if you grind up the rock and put it in the same bucket of water. The discrepancy between so-called "batch" studies and out-diffusion experiments is a well-known phenomenon for researchers working in this environment

In other comments, the applicant asserts that there is no leachate plume resulting in leaks from below the landfill. This is simply not provable, given the limited number of monitoring wells, the limited depth of those wells, the lack of proper baseline measurements prior to landfill construction, and the lack of monitoring wells beyond the eastern boundary of the landfill site.

I will give more fully developed comments on these issues at a later date in this process. At this point, I just urge you, Commissioners, and also County staff, to treat all of these claims with appropriate skepticism, and seek independent expertise as far as possible.

Yours sincerely,
Joel Geier, Ph.D.

Annex 1: Detailed information regarding groundwater issues

1. Benton County staff acknowledge that groundwater impacts "have been and continue to be a controversial topic in landfill expansion applications."

This is acknowledged directly on p. 60 of the Supplemental Staff Report, which notes that concerns about groundwater were raised not just by residents but also by the county's own Environmental and Natural Resource Advisory Committee, which was set up specifically to advise the county on environmental issues.

2. Both Benton County staff and the applicant acknowledge that access to groundwater is part of the existing residential and agricultural use of adjacent properties, and important to the character of the area.

County staff acknowledge this explicitly on p. 19 of the original Staff Report, where groundwater is listed as one of five key categories of impacts (the other four being noise, odor, traffic, and visual aesthetics). They further note that the five categories of impacts including groundwater "are typical direct impacts related to landfill uses" and furthermore "were identified by the applicant as potential off-site impacts."

VLI (according to their consultants' statement submitted by VLI as Exhibit 49) "recognizes that our neighbors rely on well water, and that springs are part of the appealing natural landscape. We will work closely with the community to monitor and address changes in local water supply wells and springs that may be affected by our operations." Further on, "VLI acknowledges the community’s concern regarding local arsenic concentrations and potential water quality changes associated with the proposed development."

3. Benton County staff acknowledge a lack of technical expertise on the topic of groundwater.

Benton County staff, in both the initial staff report and in the supplemental staff report, acknowledge that they lack expertise on groundwater issues. As stated in the Supplemental Staff Report:

> *.... the county is limited in its ability to evaluate and regulate groundwater impacts beyond the multiple levels of state and federal regulation applicable to the proposed landfill expansion. Those regulatory agencies provide a more appropriate venue to address groundwater impacts.*

The county's lack of expertise on the issue of water resources in general is further illustrated by this inaccurate statement from Benton County Public Works:

> *"Drainage for the landfill complex flows roughly from west to east. The E.E. Wilson Wildlife Area, a network of ponds and wetlands east of the subject property are the direct receiving waters for drainage from the landfill. The E.E. Wilson Wildlife Area functions as one of the headwaters of Bowers Slough, a tributary of the Willamette River."*

In fact surface drainage from the landfill complex flows both eastward and westward, because the landfill is located in a topographic saddle between Coffin Butte and Tampico Ridge. Drainage from portions of the landfill complex on the east side of the saddle does flow out onto E.E. Wilson Wildlife Area, but onto the portion that belongs to the Luckiamute River Watershed. Only a few acres of E.E. Wilson Wildlife Area, namely wetlands in the far south end adjacent to Adair Village, drain toward Bowers Slough, but those are on the other side of the surface water divide from Coffin Butte (Figure 1).

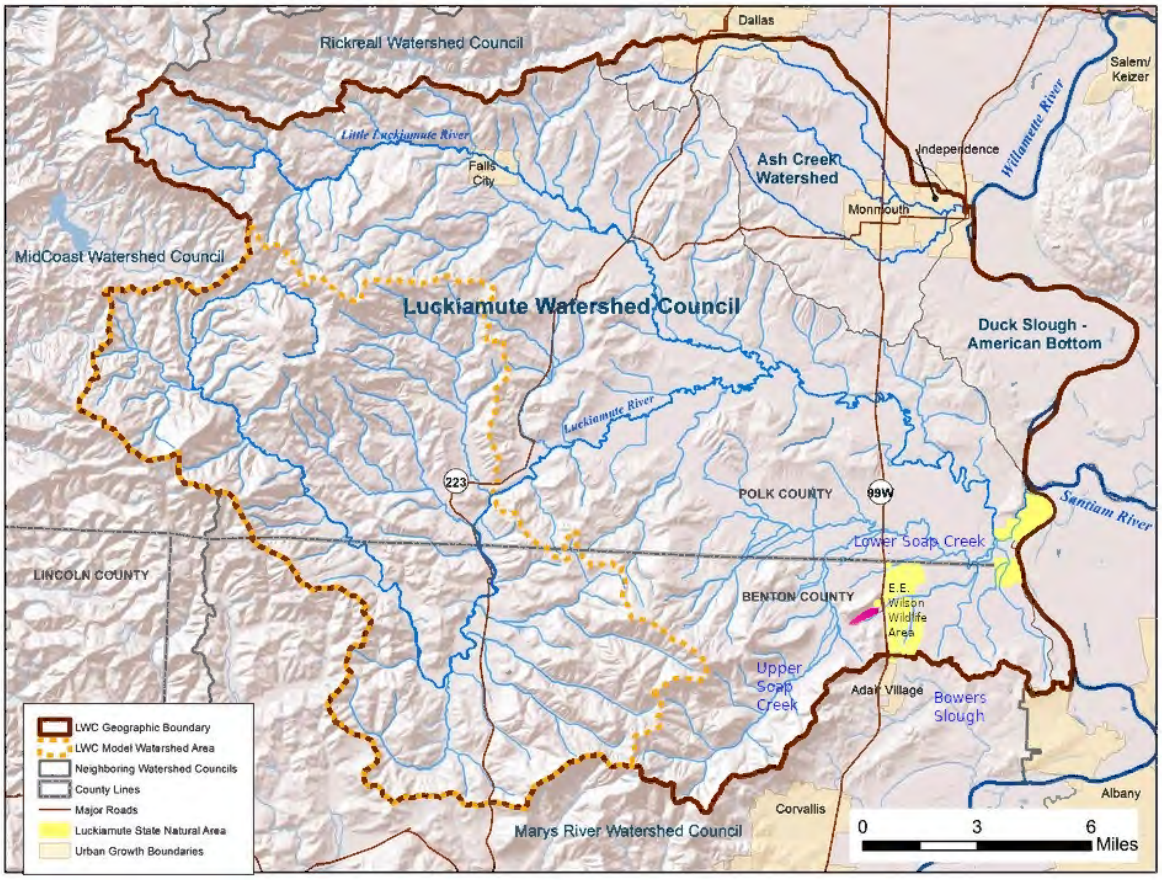


Figure 1. *Map showing landfill complex area (hot pink) and E.E. Wildlife Area (yellow, labeled) in relation to boundary between the Luckiamute Watershed (which includes the Soap Creek sub-watershed) and Bowers Slough watershed boundaries. Luckiamute State Natural Area (yellow, unlabeled) is also shown to the northeast of E.E. Wilson Wildlife Area, where Soap Creek flows into the Luckiamute River just above the confluence of the Luckiamute with the Willamette River. Map adapted from the Luckiamute Watershed Council website (www.luckiamutelwc.org). Note that the service area of LWC as mapped here also includes the Ash Creek Watershed, to the north of the Luckiamute Watershed.*

4. Despite the acknowledged relevance of groundwater issues and their own lack of expertise in the subject, County staff have neither sought nor obtained evaluation of groundwater impacts by independent experts.

Rather than dedicate resources to independent review, as they have done for other key issues raised in this land-use process, County staff frankly chose to punt on groundwater issues. They hired consultants to assess the application on issues of fire, odor and noise, but not on groundwater impacts.

This leaves you in an unfortunate position of having to decide on this application, without any technical support on an issue that everyone agrees is important.

5. Benton County staff have furthermore failed to make use of groundwater expertise that was available to them, both within the Disposal Site Advisory Committee (DSAC) and within their roster of third-party consultants.

The County's roster of third-party consultants includes Dr. Tony Sperling. Per his CV included as an annex of the Staff Report, his professional experience includes hydrogeological assessment of landfills, including an evaluation of the potential for groundwater contamination from the City of Vancouver's municipal landfill in British Columbia. However County staff have only utilized Dr. Sperling as a subcontractor for their primary contractor that was tasked with evaluation of issues related to landfill fires.

DSAC is under the direction of Community Development staff. Its membership includes David Livesay, former president of GSI Water Solutions and currently leading a DSAC subcommittee which is charged with an independent evaluation of the applicant's groundwater monitoring network at Coffin Butte. Mr. Livesay's findings would be highly relevant for your evaluation of groundwater issues related to this application. However staff have not shared his report, nor made the proceedings of that subcommittee's meetings public.

According to Benton County Code, this application should have been reviewed by Benton County's Solid Waste Advisory Council (SWAC), who would have given you their recommendation. If not for the county's ill-advised dissolution of SWAC, by statute this would have included all members of DSAC except for the landfill's representative (currently Paul Koster).

This would have given you access to the expertise of Mr. Livesay and other highly qualified current members of DSAC, independent of the landfill's representative (who was present along with Bret Davis, during the meeting when DSAC discussed whether and how to formulate input for your decision; the recording of that meeting shows that Mr. Koster abstained from the discussion but Mr. Davis did not abstain from interjecting his opinions during DSAC's deliberations).

Instead SWAC's statutory role in this process was assigned to the Environmental and Natural Resource Advisory Committee (ENRAC) by Benton County Board of Commissioners Order #D2024-048 in July of 2024. Although ENRAC members did their best to come up to speed on the issues, they acknowledged that many aspects of landfill operations were new to them. In his personal statement appended to ENRAC's recommendation to deny this application, the chair of ENRAC expressed frustration that they were also hindered by County staff. I urge you to read his statement to give you further insight into the process.

All of these factors combine to leave you with less qualified support to make your decision, than you should have had if County staff had made better use of the resources and expertise available to them, including community expertise.

6. Staff suggest that groundwater impacts will be addressed by "multiple levels of state and federal regulation" but they have not identified any specific regulatory steps in which risks of impacts on nearby wells will be assessed, nor have they even contacted the most appropriate state agency.

Of the agencies listed by Public Works (as cited in the Staff Report) no agencies with jurisdiction over groundwater resources are identified, except for Oregon Department of Environmental Quality (ODEQ) which did not respond.

County staff did not seek or obtain comments from the Oregon Water Resources Department (OWRD), which is the state-level authority responsible for assessing groundwater supply issues.

The Department of Geology and Mineral Industries (DOGAMI) were invited to comment but responded that they have no comments. Benton County staff mistakenly cite this lack of comment as evidence:

> *Additionally, DOGAMI had no comments on the proposal (see Exhibit BC2). Staff therefore concurs with the applicant's analysis and engineering comments. For purposes of county review, and in the LU-24-027 Coffin Butte Landfill CUP Supplemental Staff Report context of additional required regulatory frameworks, the proposal is unlikely to "seriously interfere" with adjacent uses concerning groundwater impacts.*

DOGAMI has no regulatory authority over groundwater resources, although they do have a role in regulating surface-water discharges from mining operations. Their lack of comment on this application has no significance for the issue with regard to which it is cited by staff.

County staff did not obtain comments from the Luckiamute Watershed Council (LWC), which has a mandate for watershed health in the watershed that contains the site of the proposed new landfill. LWC is not listed among the entities from which county staff sought comments, and it is not clear whether they were even notified.

Staff mention Oregon DEQ as an agency that may play a role in the landfill permitting process, but they do not identify any specific process in which ODEQ can be expected to evaluate risk of impacts to reliability of nearby wells.

Oregon Department of Environmental Quality does not evaluate impacts on groundwater availability or water rights in their permitting decisions, nor do they have any particular expertise in this area. Their mandate is limited to the issue water quality (whether water is safe to drink), not whether the sufficiency of water supplies for established uses will be impacted by a new development that affects groundwater.

7. Despite their acknowledged lack of expertise on groundwater issues, and failure to seek opinions from qualified independent experts, Benton County staff chose to endorse the applicant's claim that the proposal is unlikely to "seriously interfere" with the reliability of wells on neighboring properties.

As stated in the initial Staff Report:

> *Staff concurs with the applicant's analysis and engineering comments. For purposes of county review, and in the context of additional required regulatory frameworks, the proposal is unlikely to "seriously interfere" with adjacent uses with regard to any groundwater impacts.*

County staff would have been more prudent simply to state that they did not evaluate the question of whether the proposed development could impact the reliability of wells on adjacent properties.

Staff statements on this issue lack credibility, and should be disregarded unless or until they can be supported by independent experts.

8. Similarly, despite their lack of expertise and failure to utilize qualified independent expertise, Benton County staff chose to endorse the applicant's claim that the proposal is unlikely to "seriously interfere" with adjacent uses in terms of groundwater quality impacts, including potential contamination of aquifers by arsenic.

Again, County staff would have been more prudent to state simply that they did not evaluate the risk of impacts to groundwater quality, due to lack of technical expertise.

9. Information presented by the applicant on groundwater topics is misleading on numerous counts, possibly deliberately so. It is also inadequate to support the applicant's claim that groundwater resources will not be adversely affected, either in terms of quantity or quality.

9.a. Seismic disturbances from blasting

Applicant's attorney, in his cover letter for Exhibit 49, inaccurately states that the memo addresses whether blasting will impact nearby wells:

> *Groundwater Interruption. The memorandum analyzes whether the blasting and excavation on the new cell in the expansion area will impact wells on surrounding properties. The analysis concludes that these activities should not have any material impact on surrounding wells but proposes ongoing monitoring and mitigation if necessary.*

In fact the section of the memo titled "Seismic disturbances" only addresses (as its title clearly implies) whether blasting during construction of the new landfill is likely to cause seismic disturbances (such as window-rattling or foundation damage).

The memo doesn't do a very good job on that topic either. The discussion of the extent of fractures induced around a blast hole is not relevant to the question of how far and how strongly seismic waves propagate from a blast hole. Seismic waves are an elastic response of the rock, while fracturing around a borehole is anelastic. So this is really a "red herring" as raised by the applicant.

The third paragraph of this section is the only one relevant to the question of seismic wave propagation:

> *Even with the short distance of rock fragmentation from the blasting hole, as a precaution, the contractor deployed seismographs to monitor ground vibration caused by the blasting at several locations along Military and Wiles roads on the north side of Coffin Butte near existing homes, at distances of approximately 1,100 to 2,300 feet from the excavation. The seismic wave velocities at those distances were all far below the criteria used for assessing ground vibration associated with building damage.*

However the applicant has not presented the seismographic data alluded to in this paragraph (or even named the contractor), as part of the evidentiary record for this land-use proceeding.

This paragraph also contains a glaring technical error, in the last sentence, which calls into question the VLI consultants' understanding of the topic. **Seismic wave velocities** are a material property of the rock, not something that depends on the intensity of a blast (see for example this page maintained by the Society of Engineering Geophysicists: https://wiki.seg.org/wiki/Seismic_velocity
which lists typical values of seismic velocity for different rock types, and notes the fundamental relationship between seismic velocities and elastic properties of the rock). Stating that "these are all far below the criteria used for assessing ground vibration associated with building damage" is pure nonsense.

What matters for building damage (in severe cases) or lesser disturbances (such as window-rattling) is the **seismic wave amplitude**. Presumably this is what the contractor was trying to measure by deploying seismographs. Either the contractor misunderstood what they were measuring, or VLI's hydrogeological consultants misunderstood (granted they are geologists, not geophysicists).

Turning to the legitimate question of whether blasting can affect groundwater wells on neighboring properties, the applicant has not addressed whether the natural fracture system could be affected by blast-induced seismicity.

Among geoscientists it is well-known that large earthquakes can cause long-term impacts on local groundwater levels. The classic example is the 1964 Alaska Earthquake. See for example Waller (1966), which you may note is a very old paper, but still 4 years younger than the blasting reference cited by VLI (Duvall and Fogelson, 1962).

More recent research shows that groundwater systems can be influenced by much smaller seismic events. For example, Lee et al. (2024) showed that earthquakes as small as M 2.0 can influence groundwater levels.[1] The mechanism by which very small seismic events influence groundwater in fractured bedrock is generally thought to be localized slip along fractures, rather than formation of new fractures such as considered in VLI's 1962 reference.

Ongoing monitoring and mitigation in the event of impacts on nearby farms and residences is certainly a good idea, if this can be made binding.

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1 I happen to know of the Korean research from meeting one of the authors to discuss her work, while I was visiting Daejeon in 2019 to give a series of lectures on the more topic topic of fractured rock hydrogeology. But this is a very active field of research which has developed enormously since 1962. Relying on this very old Bureau of Mines document to dismiss community concerns about blasting impacts is simply not credible. As a matter of due diligence, this should not be accepted.

9.b. Dewatering effects on neighboring wells

Applicant claims (Exhibit 49) to have recently applied an "analytical solution" for calculations to estimate risk of impacts of construction on local wells. However they have presented neither the mathematical formula used, nor the results, nor the parameter values that they assumed as input for their calculation.

Taking the applicant's self-reported results at face value, this statement is cause for concern:

> *the analyses indicated that the change in water levels associated with the proposed development would be similar to changes in water levels associated with seasonal precipitation patterns.*

This could be a significant impact on existing uses, if the impacts of excavation occur during the season when groundwater levels are seasonally low, and these effects are additive. Indeed, that seems likely given statements by VLI given in oral testimony on July 8, 2025, that construction would generally occur over 6 to 8 months in the warmer/drier part of the year.

But without documentation of their calculations and independent review by competent experts, other claims of no impact cannot be accepted as evidence. The applicant describes their method only in general terms:

> *VLI's evaluation of the impacts to local water supply wells considers the relative consistency of the groundwater flow conditions to support a conservative assumption that fractured bedrock behave similarly to a porous media. Under this assumption, all fractures are interconnected, allowing the analytical solution to evaluate the most widespread effect of the proposed project.*

In such a model, normally a key parameter is the **effective hydraulic conductivity** of the fractured bedrock. The degree of drawdown of water in the bedrock, as a function of distance from the excavation, will depend on what value is assumed for this parameter. Given data on the hydraulic properties of waterconducting fractures under Tampico Ridge, and their frequency in the bedrock, a range of plausible values could be calculated. But VLI has not provided any documentation of their assumed parameter values, or their basis in terms of data from Tampico Ridge.

Applicant claims without evidence that the hydrogeological conditions under Tampico Ridge are similar to those under Coffin Butte. In fact they have neither obtained nor presented data on the bedrock hydrogeological properties, nor have they demonstrated hydrogeological understanding of the bedrock south of the proposed new landfill.

Applicant implicitly acknowledges this lack of information, by suggesting that they will undertake hydrogeological investigations if the CUP is approved. But they give no guarantee that this work will be performed beyond whatever VLI deems necessary for obtaining a permit from ODEQ.

If this investigation is limited to the areas indicated on the applicant's filings, with a few monitoring wells and "sentinel wells" located just outside the perimeter of the planed excavations, it will not be sufficient to provide an understanding of the hydrogeology of Tampico Ridge farther south. This is self-evident because without data from the area of interest, you cannot develop an understanding. It follows that risks to wells on neighboring properties will not be possible to fully assess, even after completion of the ODEQ-required investigations.

As further indication of the applicant's poor state of knowledge regarding groundwater under Tampico Ridge, note that the new Figure purporting to show groundwater directions under Tampico Ridge contradicts Figure 1 of the "Environmental and Operational Considerations" memo provided by Mr. Tuppan on February 25th. Both figures are schematic in nature and are not supported by any actual investigations of groundwater flow directions south of the proposed development area.

9.c. Arsenic

Applicant's arguments in Exhibit 49 regarding the occurrence of arsenic are misleading to the point of deceptiveness. They rely on "cherry-picking" information selectively from the USGS study by Hinkle and Polette (1999), while omitting mention of contradictory evidence. Specifically:

- They misconstrue statements about data sparseness in the mountainous portions of eastern Linn and Lane counties, as if they apply to the Willamette Valley as a whole;
- They misleadingly suggest that, because the study included specific datasets from Linn and Lane counties, that data are lacking from the vicinity of Coffin Butte;
- They misconstrue statements about "volcanic rock of rhyolitic to intermediate composition," as if they apply to volcanic rock in general.

In fact, the dataset used in the USGS study included 9 domestic wells and 1 natural spring within 5 miles of Coffin Butte Landfill, plus 40 additional wells that were within 10 miles (Figure 1). Only one of those 50 data sources showed arsenic levels above 10 µg/L (the EPA maximum contaminant limit for drinking water). One of those points is adjacent to the Springhill Golf Course in North Albany, and the other is adjacent to OSU's experimental farms near Peoria Road, both locations where arsenic-based weed-killers from past decades are a plausible source. None showed arsenic levels above 50 µg/L, in stark contrast to what has been observed at Coffin Butte.

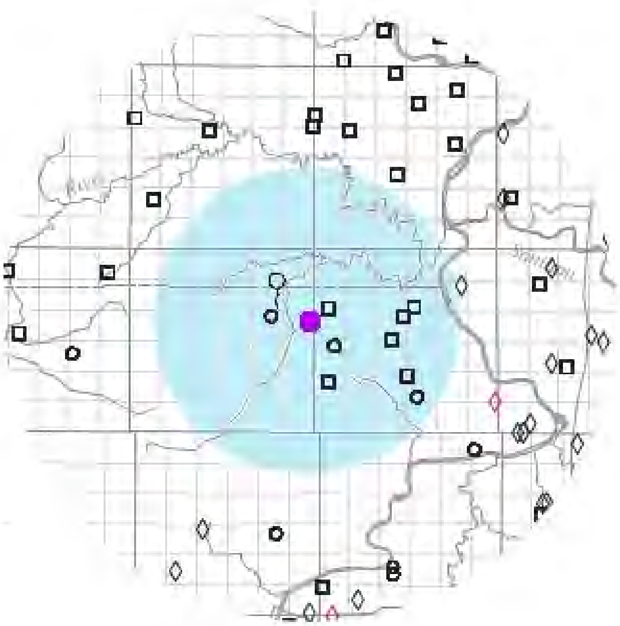

Figure 1. Detail of Plate 1 from Hinkle and Polette (1999) showing wells and springs within a 10 mile radius of the Coffin Butte Landfill site (purple dot). The blue shaded circle highlight wells and springs within 5 miles. Black symbols show sampled wells and springs where the measured arsenic concentrations were less than 10 µg/L. The two red symbols show wells where arsenic concentrations above 10 µg/L (but less than 50 µg/L) were found.

The statements by Hinkle and Polette (1999) about data sparseness referred specifically to sparsely populated part of the Willamette Basin, to whit:

> *Large portions of the area covered by the Fisher and Eugene Formations and correlative rocks, and the undifferentiated tuffaceous sedimentary rocks, tuffs, and basalt, are not represented by data collected and compiled for this report.* ***Although most of the unsampled areas underlain by these rocks are not densely populated, they are not uninhabited,*** *and the potential for impacts to human health are not insignificant.*

Their meaning is further made clear by their Plate 1, which has been submitted as part of the record. The areas lacking data are mainly in the Cascades portion of the basin, or the deeper parts of the Coast Range.

Basalt, as found at Coffin Butte (Allison, 1953), is on the opposite end of the spectrum from rhyolite, in standard classifications of volcanic rock based on silica content. This is basic information taught in introductory-level courses in geology, so VLI's geological consultants ought to know the difference.

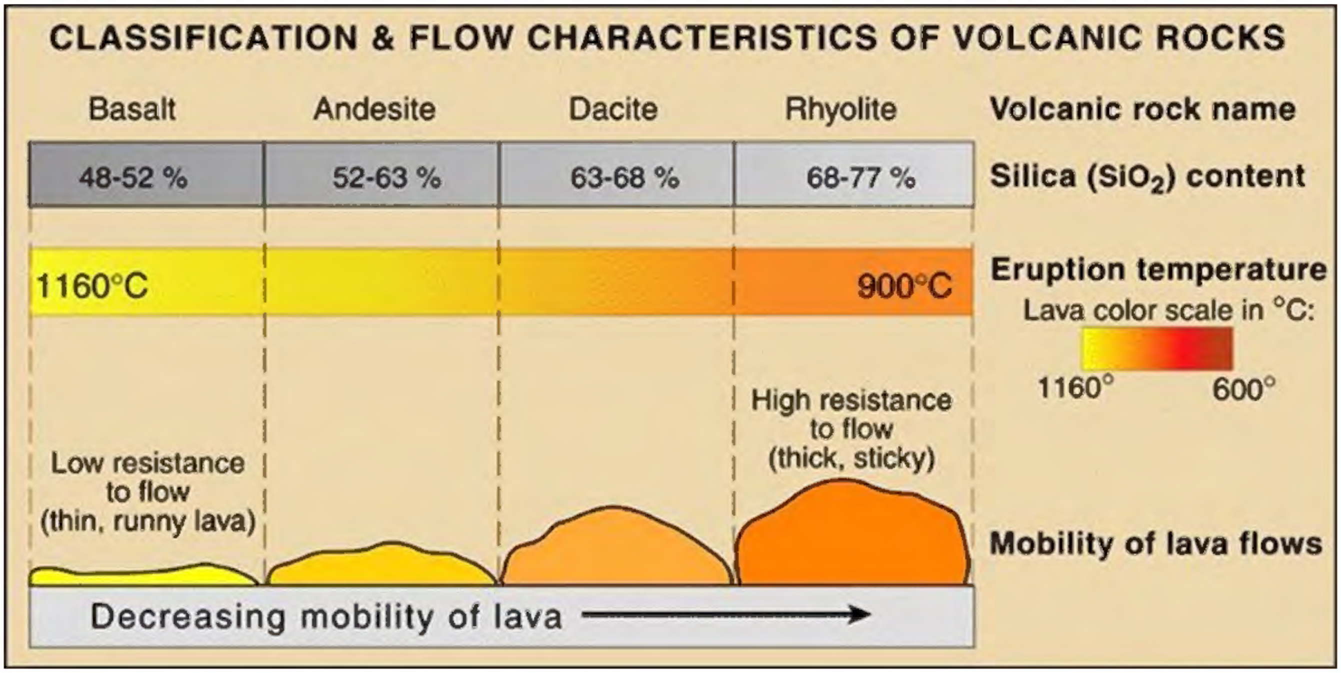

Figure 2. Volcanic rock compositions classified by silica content, ranging from basalt to rhyolite.

Hinkle and Polette (1999) state specifically:

> *High arsenic concentrations in Lane and Linn Counties appear to be associated with two regionally extensive associations of rocks, (1) the Fisher and Eugene Formations and correlative rocks, and (2) the undifferentiated tuffaceous sedimentary rocks, tuffs, and basalt. .... At land surface, these two rock associations cover 24 percent of the Willamette Basin.* ***These associations of rocks include extensive volumes of silicic (rhyolitic) volcanic rocks****, which are commonly associated with high concentrations of arsenic. ...*
>
> *Arsenic can be a component of volcanic glass in volcanic rocks of* ***rhyolitic to intermediate composition****, adsorbed to and coprecipitated with metal*

oxides (especially iron oxides), adsorbed to clay-mineral surfaces, and associated with sulfide minerals and organic carbon. ....
*[Al]though high concentrations of arsenic often occur in water within the Fisher and Eugene Formations and correlative rocks, Goldblatt and others (1963) suggest that the Fisher Formation, and not the Eugene Formation, is the source of most of the arsenic in that area. Similarly, **water within basalt flows in the undifferentiated tuffaceous sedimentary rocks, tuffs, and basalt is not a likely candidate for high concentrations of arsenic because basalt typically yields water low in arsenic (Welch and others, 1988).***

VLI's presentation of data from monitoring wells at Coffin Butte is also misleading. In presenting historical data on arsenic at Coffin Butte, they misleadingly plot data on a strangely chosen scale, with a maximum 10 times the range of the data (Figure 3). The effect is to conceal the strong fluctuations over time which are evident in a more scientifically reasonable presentation of the same data, as used in their Annual Environmental Monitoring Reports (Figure 4).

Note that the first plot in Exhibit 49 shows no arsenic measurements above 50 micrograms per liter (µg/L), but values up to 68 µg/L have been measured in a nearby well more recently. VLI's consultants are certainly aware of those recent high values.

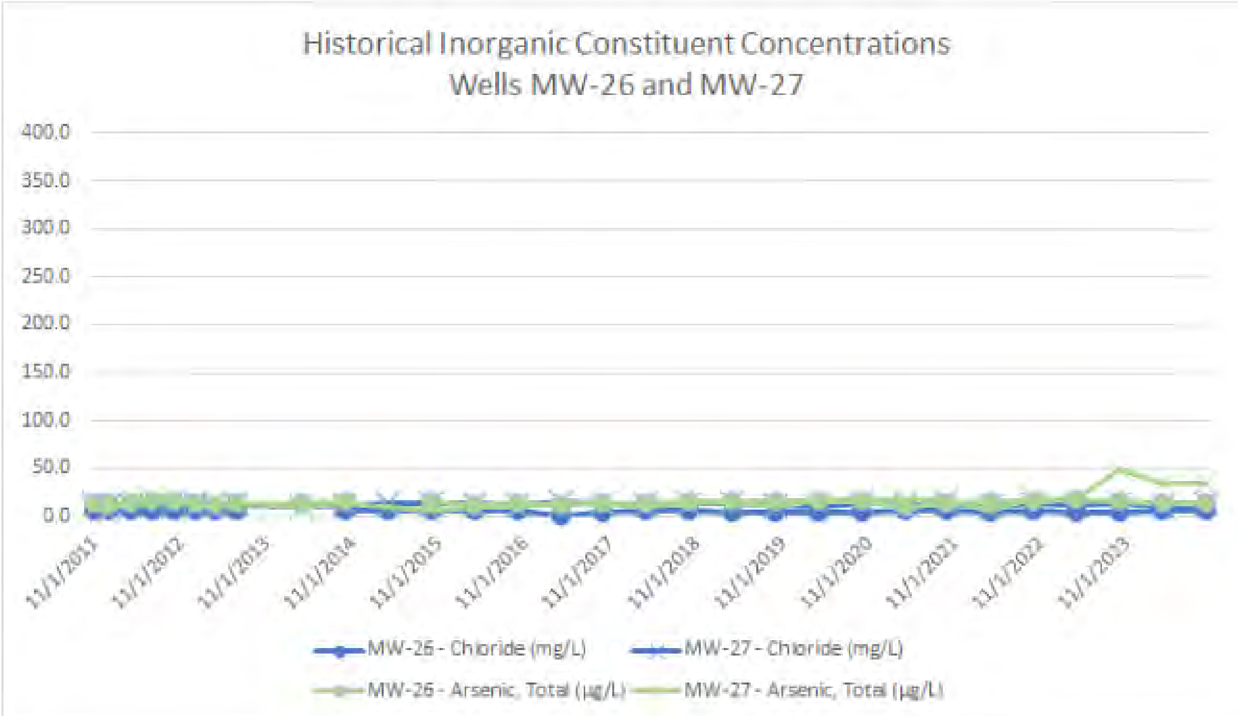

Figure 3. Arsenic and chloride levels in compliance-boundary wells MW-26 and MW-27 as plotted by VLI's consultants in Exhibit 49. Note that chloride is plotted in milligrams per liter (parts per million) while arsenic is plotted in micrograms per liter (parts per billion).

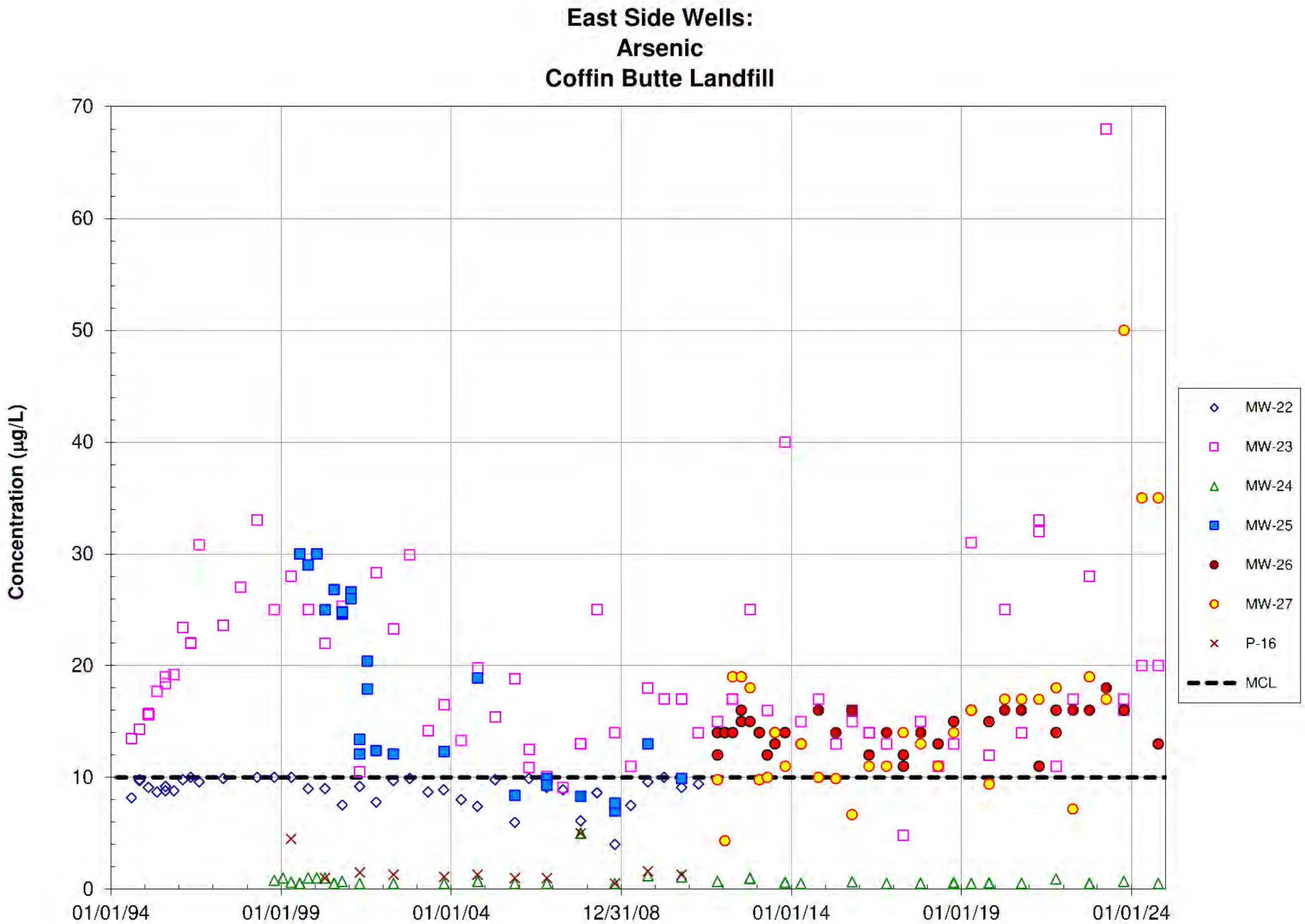

Figure 4. Arsenic concentrations in east-side monitoring wells as plotted in the 2024 Annual Environmental Monitoring Report for Coffin Butte Landfill (obtained by a public-records request from ODEQ).

Returning to Exhibit 49, in this statement VLI's consultants also carefully avoid mention of an east-side well (MW-23):

> *VLI acknowledges that since arsenic was first detected at well MW-9S, elevated arsenic concentrations have been detected in wells that monitor the east side of the facility; namely, wells MW-26, MW-27, and MW-9S; however, no monitoring results indicate that these arsenic concentrations are attributed to a leachate discharge.*

VLI has previously acknowledged (in their past AEMRs submitted to DEQ) that high arsenic in MW-23 resulted from seepage of landfill leachate. For example, this was the description given in the 2023 AEMR which was produced by one of the same two consultants who signed Exhibit 49:

> *Cell 2 – Detection Well MW-23. Early in its history, detection well MW-23 had shown increases for bicarbonate alkalinity, chloride, hardness, total dissolved solids (TDS), for five of the major dissolved metals, and for arsenic. This had been attributed to localized seepage of leachate from the south side of the landfill.*

Note that this seepage was attributed to Cell 2. **This directly contradicts VLI's statement in oral testimony on July 8th, that there has never been a seepage event from any of the lined cells at Coffin Butte.**

In the applicant's attempt to defray concerns about arsenic, they suggest that chloride is a better indicator. The second plot in Exhibit 49 (reproduced here as Figure 5) shows that the initial measurement of chloride in MW-9S was about 50 mg/L, but soon afterward the concentration jumped by nearly a factor of 6.

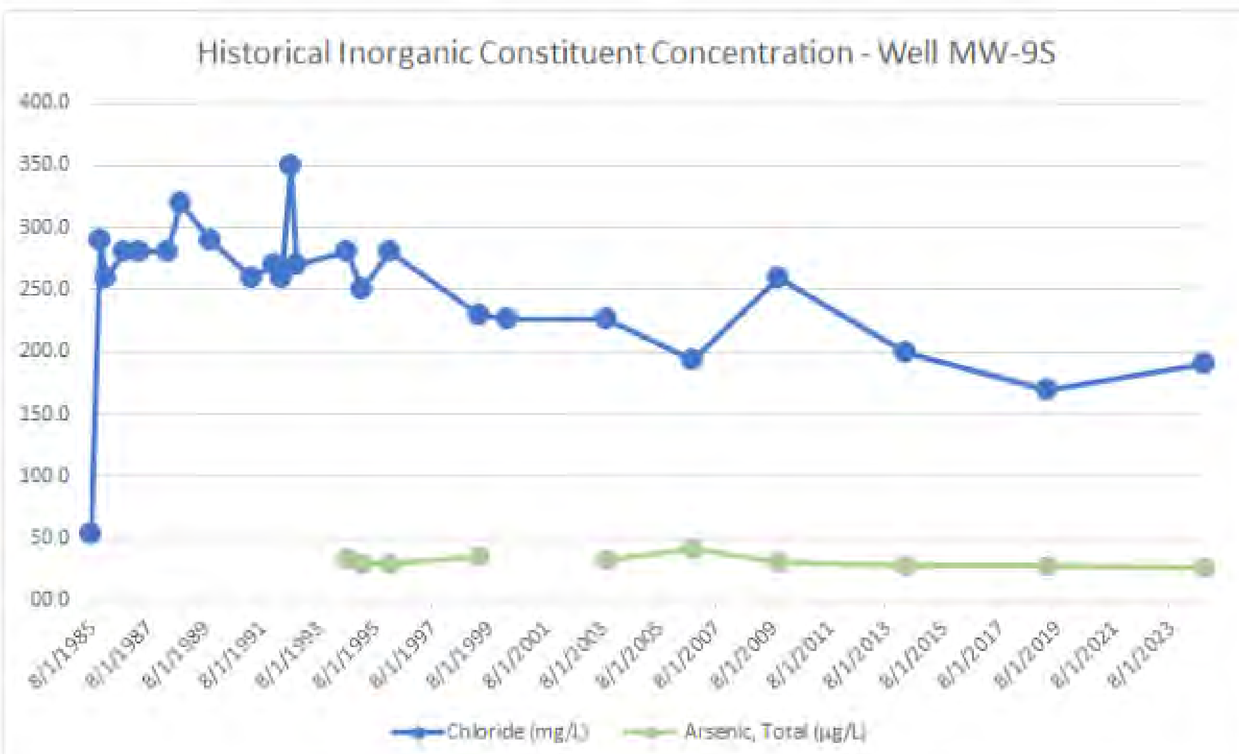

Figure 5. Arsenic and chloride levels in MW-9S as plotted by VLI's consultants in Exhibit 49.

Though this declined somewhat after the seepage problem was discovered in the mid-1990s, and corrective actions were taken, chloride in MW-9S has remained more than a factor of 3 above the initial baseline value, ever since. Far from alleviating concerns about leakage from Cell 2, this plot elevates concerns about potential for ongoing contamination of the Willamette Basin aquifer.

VLI notes that lower chloride levels are seen in the two compliance-boundary wells, MW-26 and MW-27, but this does not necessarily rule out that the high levels of arsenic observed in those wells could come from ongoing or past leaks.

As discussed by Cherry (1990), plumes from a localized leak in a landfill liner could be narrow due to weak lateral dispersion (Figure 6); Cherry noted that this problem is especially acute for monitoring wells located close to the landfill, which is currently the situation for MW-26 and MW-27. Since the conditions controlling flow from underneath a landfill may change over time as various cells are developed, the groundwater flow direction and position of the leachate plume can also shift over time.

As noted by VLI's consultants, chloride and arsenic have different mobility in the subsurface environment:

> *As groundwater migrates beyond areas of low dissolved oxygen, the iron oxide and arsenic precipitate back to the soil, reducing the concentrations in groundwater.*

This means, for example, that arsenic released by seepage from a zone of anoxic conditions below the landfill could precipitate in soil as a leachate plume emerges from under the landfill, even as chloride is carried onward by the groundwater.

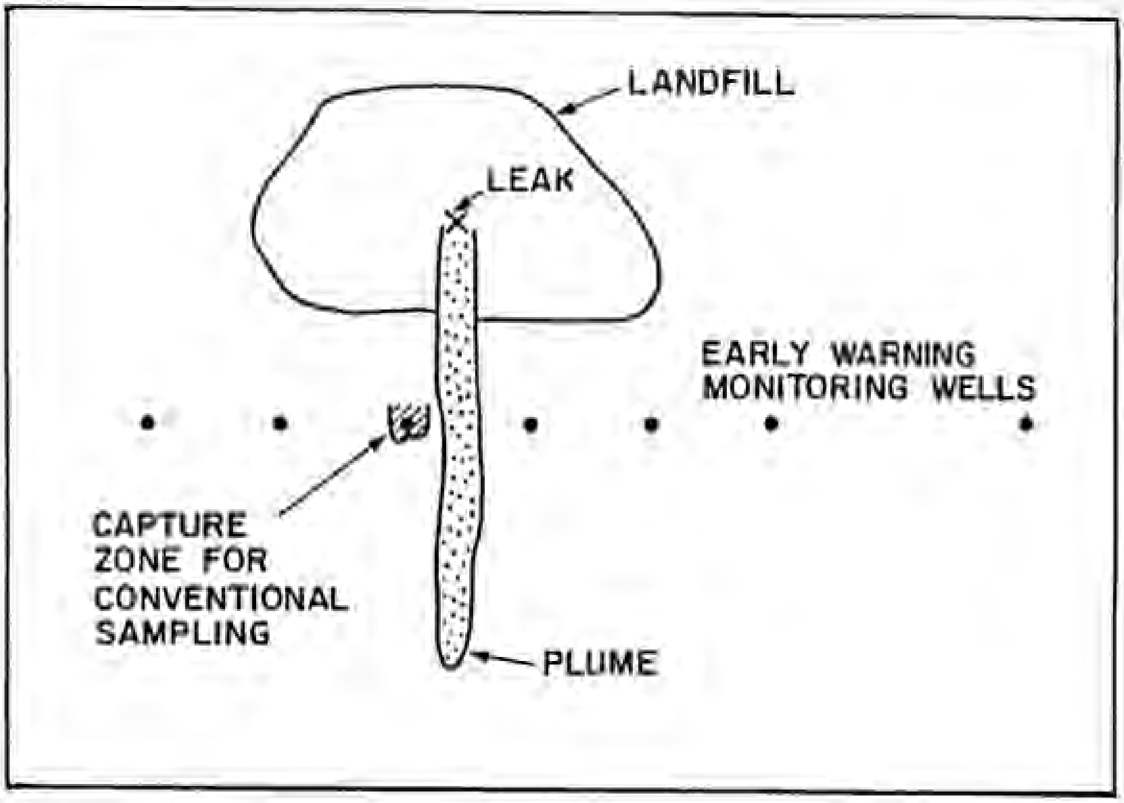

Figure 6. Schematic illustration of a narrow leachate plume originating from a liner leak, depicting how this may result in the plume bypassing monitoring wells that are located close to the landfill (Cherry, 1990).

If the position of the plume then shifts, in tight formations such as around MW-27 the accumulated arsenic could remain as a source that leaches out again depending on seasonal changes in oxygen levels, even while the main plume passes between the wells. In this scenario, a monitoring well located farther from the landfill (such as MW-9S) could have a better chance of picking up the main plume. Other contaminants have their own issues, for example the tendency of VOCs to sorb (bond) to organic matter in soils.

Other scenarios and other hypotheses could no doubt be proposed that match up with this sparse dataset. Preferably the alternatives should be tested by a combination of computer modeling and additional monitoring wells, if the existing network of wells is too sparse to discriminate between alternatives.

The AEMRs for 2020 through 2024, at least, do not present any such models, nor any examples of new monitoring wells being added to address this issue.

The last leg of VLI's argument is that "ODEQ has found this rationale sound in approving the detection monitoring program for the east side of the landfill."

The level of attention by ODEQ is questionable. When I asked ODEQ's responsible hydrogeologist about this issue in 2023, he responded (e-mail dated November 16, 2023) in part:

> You are correct that MW-23 appears to have been impacted by early releases believed to have arisen from Cell 2, prior to the construction of cell 3. Most parameters have declined to inferred background concentrations (as seen in the AEMR figures) and arsenic remains somewhat elevated at this well. If arsenic at MW-26 and 27 is a relic of past leaks as seen in MW-23 then we would not expect to see higher levels in MW-9s than in MW-26 and MW-27.
>
> For MW-26 and MW-27 which are compliance wells, we use the historic database to derive a permit specific concentration limit. If that limit is exceeded, the change in groundwater would require some explanation or investigation to assess the cause.

However it turned out that VLI's permit did not list any "permit-specific concentration limits" for arsenic in these wells.

Likewise when I requested documentation of what he described as "a comprehensive review of the data [] used to distinguish naturally occurring levels of arsenic from impacts of landfill leaching," it turned out that this just meant that DEQ had read the VLI's report and accepted it, with no record of any comments.

Data on mercury were missing from all AEMRs from 2020 through 2023, despite that these reports listed protocols for sampling for mercury (after I brought this gap to ODEQ's attention, all mention of mercury was removed from the 2024 AEMR).

County staff should have these AEMRs on file if needed for the record (they are very large documents).

10. Information presented by the applicant is not adequate to support their claim that their proposed conditions of approval are adequate to protect groundwater resources in terms of both quantity and quality.

Applicant proposes adding a handful of "sentinel wells" (also referred to as "sentry wells in some places) but provides no model results or other calculations to justify the position of these wells, or why just two or three wells just outside the landfill footprint should be sufficient.

As noted above, and discussed further by Cherry (1990), sentinel wells located close to the edge of a landfill might not be effective for detecting leachate plumes that originate from narrow liner leaks.

11. Despite their acknowledged lack of expertise and failure to utilize independent expertise regarding groundwater, Benton County staff have uncritically endorsed and adopted the conditions of approval suggested by the applicant.

Staff have not provided any coherent reasoning as to why they believe the applicant's proposed conditions of approval will be adequate for protecting groundwater and protecting adjacent land from adverse consequences.

Again, staff should just admit that they lack expertise to judge whether the applicant's proposed mitigation measures are adequate to prevent impacts on adjacent properties. It is irresponsible of them to express an opinion in support of the applicant on a topic where they admit they have no technical expertise.

12. Benton County's proposed conditions of approval regarding groundwater protection, adopted wholesale from the applicant, are stated in such terms as to not be legally binding, and hence will be ineffectual even if Benton County had a mechanism for enforcement of said conditions (which it does not).

VLI's geological consultants (notably not VLI themselves) have offered the possibility that they will do "focused hydrogeologic investigation of the proposed development," but only after VLI receives approval for the CUP. We note that one of these consultants recently retired from practice, and the other one who signed the memo was not registered to practice in Oregon, at the time of this memo. However sincere they might be in their offers to conduct such work, VLI has not given its own assurance.

County staff, in recommending these consultants' proposals as Conditions of Approval, have used language that can best be described as wishful thinking ("VLI will do ...") rather than legally binding language ("VLI shall do ...").

Staff have not identified any clear process for review of the proposed investigations (recall their lack of internal technical expertise), nor any mechanism for public involvement or reconsideration of the CUP, once granted. As such, these proposed conditions are both toothless and meaningless.

References

Cherry, J.A., 1990. Groundwater Monitoring: Some Deficiencies and Opportunities. Hazardous Waste Site Investigations; Towards Better Decisions, Lewis Publishers, B.A. Berven & R.B. Gammage, Editors. Proceedings of the 10th ORNL Life Sciences Symposium, Gatlinburg, Tennessee, May 21–24 (1990).

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Lee et al., 2024 (Gahyeon Lee, Jae Min Lee, Dongkyu Park, Dong-Hun Kim, Jaehoon Jung, and Soo-Hyoung Lee). Groundwater Level Responses due to Moderate·Small Magnitude Earthquakes Using 1Hz groundwater Data. J. Soil Groundwater Environ. Vol. 29(4), p. 32~43, 2024. https://doi.org/10.7857/JSGE.2024.29.4.032

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