Dear Commissioners Wyse, Malone, and Shepherd:

This is guidance for navigating the files in this folder. These are testimonies delivered to the Planning Commission on LU-24-027, that I am entering into the Appeals record in support of my letter to you earlier today (7 October), and for Staff to use in preparation of their New Staff Report.

1416
Groundwater concerns.

1916 and 1916a
Landfill gas and effluent concerns; land use impacts from an immediate neighbor; Attachment about incompleteness of Republic application

2047, 2047a
PFAS concerns.

2056
Flaws in the odor studies.

2059
Flaws in Applicant's PFAS responses.

2063a and b
Leachate and PFAS analysis.

07082025
Odor experience; obstacles to farming.

07082025
Criteria considerations

07082025
Firefighting experience at the dump

07092025
Fire, odor, other concerns

07092025
Life and business interference; risks to livestock by an immediate neighbor

07092025
Life interference; risks to livestock by an immediate neighbor

07092025
Livelihood interference; risks to livestock by an immediate neighbor

BC7
Compilation of testimonies by adjacent neighbors

VNEQS
Odor concerns

Plume
Visual of a landfill gas plume almost 3 miles long and over a mile wide

Ken Eklund
37340 Moss Rock Drive
Corvallis, OR 97330

Joel Geier ● 38566 Hwy 99W ● Corvallis, Oregon 97330-9320

Benton County Planning Commissioners
c/o Planning Division
4500 SW Research Way
Corvallis, OR 97333

April 29, 2025

RE: LU-24-027 Conditional Use Permit Application Regarding Landfill Expansion

Dear Chair Fowler and Members of the Benton County Planning Commission:

Thank you again for the opportunity to comment on the Conditional Use Permit (CUP) application submitted by Valley Landfills Inc.

This is my third in a series of comments, and focuses on **groundwater and related geotechnical issues.**

For rural residents in north Benton County, **having your own well that you can rely on is a key part of the character of the area.** We and our neighbors rely on our wells for clean drinking water for our families, for livestock, and for irrigating our vegetable gardens and small-scale farms.

Losing access to a reliable well would seriously interfere with our use of these properties. In such cases, we and our neighbors would have to install water tanks and pay to have water trucked in, just for basic household functions. Our ability to use RR- or EFU-zoned property for activities such as raising livestock or maintaining a vegetable plot or farm, would be severely curtailed.

The burden of proof is on the applicant to supply evidence that the planned development will not interfere with these existing uses and natural features of the area.

In their application and supporting exhibits, **the Applicant has failed to demonstrate that the proposed development would not put household wells, irrigation wells and natural springs at risk.**

The **applicant has failed to consider potential impacts of blasting** during the construction phase. Excavation for the proposed new landfill will require drilling and blasting an enormous amount of the natural hillside on Tampico Ridge. **Noise and vibration set off by seismic waves from the blasting would seriously interfere with our use of our property**, for the entire construction period which could last for years.

Each of these issues is cause for denial.

Benton County staff have failed to provide their own analysis of these risks. Instead, without any justification beyond acknowledging their own lack of expertise, they state, "*Staff concurs with the applicant's analysis and engineering comments*," and go on to endorse, without reservation, the applicant's claim that the proposal *"is unlikely to 'seriously interfere' with adjacent uses with regard to any groundwater impacts."*

It would have been wiser for county staff, recognizing their own lack of expertise, either to solicit opinions from independent experts in the field of hydrogeology, or to make no statement at all on this issue.

My technical comments on these issues, as detailed in Annex 1, are intended to help you to understand the shortcomings of the applicant's arguments on these issues.

My comments are based on my relevant technical education which includes a B.Sc. in mining engineering (UC Berkeley 1985) and a Ph.D. in geology with an emphasis in hydrogeology (OSU 2005), as well as on my 37 years of professional experience in the subject of groundwater flow and contaminant transport in fractured bedrock. My work includes recent engagements as a subject-matter expert for national agencies concerned with geological disposal of radioactive waste in Finland, Sweden, South Korea, and France.

I should make clear that my consulting practice is entirely international, and I do not practice professionally in the state of Oregon. Although I have a high level of education in the subject, my comments here are stated not as a professional practicing in Oregon, but as the views of a private citizen who feels a duty to comment for the benefit of the community and the health our shared environment.

So far as possible, I have tried to frame my comments in lay terms so that you can apply your own judgment and common sense.

Thank you for considering these comments.

Yours sincerely,



Joel E. Geier, Ph.D.

Annex 1

Deficiencies in the Applicant's Analysis of Hydrogeological and Seismic Impacts of Landfill Construction and Operation

My comments in this annex focus on the following three major issues:

1. Risk that excavations for construction of the new landfill and leachate ponds could impact the dependability of nearby wells or springs.

1.1 No analysis of effects of dewatering slope above new leachate ponds.

1.2 No analysis of effects of excavation for new landfill.

1.3 No groundwater protection plan.

1.4 No baseline measurements south of proposed excavations.

1.5 Groundwater divides are not physical barriers to groundwater flow.

1.6 Misleading use of the concept of a groundwater divide.

1.7 Inadequate investigation of geology and hydrogeology of Tampico Ridge.

2. Risk of groundwater contamination during landfill operation or in the post-closure period.

2.1 Applicant misunderstands and misinterprets the meaning of "groundwater divides."

2.2 Applicant has not demonstrated an understanding of bedrock hydrogeology below Tampico Ridge.

2.3 Landfill liner systems eventually fail.

2.4 Reliance on a "state of the art" new liner system implies that long-term performance data for this system do not exist.

2.5 VLI cannot guarantee that their drainage system will function in perpetuity.

3. Blasting impacts during landfill construction

3.1 Applicant's geotechnical consultant has recommended drilling and blasting as the main method of excavation

3.2 Excavation will be as close as 250 yards from nearby residential properties

3.3. Applicant has not evaluated how noise and seismic wave propagation from blasting will impact nearby residents.

1. Risk that excavations for construction of the new landfill and leachate ponds could impact the dependability of nearby wells or springs.

The Applicant has failed to provide any analysis of of the risk that excavations for construction of the new landfill and related infrastructure (new leachate ponds) could impact the dependability of nearby wells or springs.

Both in the Burden of Proof document and the supporting documents, the Applicant and their consultants have only discussed potential impacts of groundwater use for construction and operation of the proposed new landfill. Because the landfill relies mainly on the Adair Village municipal water system for most purposes, supplemented by minor use of well water for restroom facilities in the scale house and landfill office, of course the new landfill is not expected to result in significant groundwater use.

However, considering groundwater use alone is not sufficient to evaluate the potential for groundwater impacts that will result from construction.

In simple terms, if you dig an enormous hole below the natural groundwater level, water will flow into that hole. That water has to come from somewhere. This means that groundwater levels will be lowered for some distance away from the hole.

Whether existing wells are affected by your newly dug hole depends on how far this "drawdown" of groundwater levels extends, and at what rate the effect decreases with distance.

These things are controlled by the properties of the soil and bedrock that govern how groundwater flows. The effects can be estimated by means of mathematical models, if the soil and bedrock properties are reasonably well known. Such estimates are most reliable if the mathematical models have been tested by calibration to observed water levels, including in areas where potential impacts on wells need to be assessed.

The Applicant and their consultants have not presented any such models, beyond simple contour plots of groundwater levels within the footprint of the current and proposed de-

velopment area. In particular, they have not presented any model that includes residential wells along Tampico Ridge south of the proposed new landfill.

1.1 No analysis of effects of dewatering slope above new leachate ponds

Wallace Group recommend that the slope above the proposed new leachate ponds should be dewatered to a depth of 50 feet. Applicant has neither considered nor evaluated how far the area of groundwater depression (draw-down) from these ponds will propagate on the forest conservation (FC) zoned parcel.

Besides potential impacts on wells on neighboring properties, this could cause drought stress to Douglas-firs growing on that parcel, increasing future fire risk.

Since the excavations for the proposed new leachate ponds would be mainly in soils rather than in bedrock, this should be a relatively simple situation for the Applicant to model the potential impacts on neighboring properties. However the Applicant has not provided any such analysis.

1.2 No analysis of effects of excavation for new landfill

The excavation to accommodate the new landfill will be an open pit as deep as 155 ft below the natural land surface on the north end of Tampico Ridge. Any water-bearing features (such as fractured zones of the basalt) that are intersected by this excavation will drain into the resulting pit. This water will need to be pumped out or otherwise drained from the excavation, as a practical matter to allow excavation.

Applicant has not presented any analysis of how the draining of water-bearing features will propagate through the base of Tampico Ridge. The site characterization work to date was not designed to produce the information that would be needed to inform such an analysis.

1.3 No groundwater protection plan

The applicant has not presented any plan for protecting groundwater resources, in the event that their excavations are discovered to intersect significant water-bearing features (such as fractured zones) that drain into their excavations.

The geotechnical consultant of record (Wallace Group) has presented a credible evaluation of soil properties on the site that affect constructability of the proposed new landfill. They also include a long section of recommendations for construction of an access road above the landfill, which was a feature of a previous expansion proposal that was rejected[1] but is not part of not the current proposed design. However, in general they have not investigated factors that would control potential impacts of the development on groundwater utilized on nearby residential properties.

The applicant's consultant for hydrogeological issues, Tuppan Consultants (Tuppan), though tasked with providing a memo on "Environmental and Operational Considerations," has not addressed any potential impacts of the substantial excavations that are planned as part of the proposed development.

Tuppan recognizes that securing a well with adequate flow for residential and/or agricultural use in this area can require a certain level of drilling effort, due to intrinsic limitations on predictability of occurrence of water-bearing zones. He accurately notes:

> *Water wells in this area produce primarily from fractured basalt bedrock. Predicting where and at what depth the basalt will be fractured enough to produce enough water for a supply well is problematic. This is because the lateral and vertical geometry of fractures in the bedrock basalt flows is naturally not uniform. In addition, the basalt is commonly altered to low permeability clays along fractures and in brecciated zones, thus reducing the ability of groundwater to flow within fractures. Domestic wells in this part of Benton County typically produce water from the basalt bedrock (frequently called "Blue- or Black Basalt" on the drillers' logs).*

However despite these challenges, all residential properties on Tampico Ridge have wells with adequate flow for the current residential use, and in some cases, also small-scale agricultural use. To my knowledge, none of the households on Tampico Ridge currently require water to be trucked in for household use.[2]

1 The previous design, submitted by the Applicant in 2021 and evaluated as LU-21-047, proposed to close Coffin Butte Road and replace it with a steep access road that would go up above the new disposal area, along the south edge of the development area. This plan was rejected by unanimous vote of the Benton County Planning Commission.

In other words, this is a challenge that local residents have thus far been able to surmount. The concern is that excavations for the landfill will jeopardize wells that currently provide adequate sources of water.

The applicant's consultants also fail to mention the presence of a year-round spring on the north part of Tampico Ridge, which has existed for generations. The presence of this dependable water source was likely responsible for use of this part of Tampico Ridge as a campsite by Indigenous people preparing to set out on trips through the Coast Range.[3]

An appropriate groundwater protection plan should start with a clear inventory of these existing groundwater uses and natural groundwater features, and identify methods for ensuring their protection. But the applicant has not done this.

1.4 No baseline measurements south of proposed excavations

Despite planning at least since 2020[4] to expand their landfilling operation onto Lot 1107, based on plans that included substantial excavations in the north end of Tampico Ridge, the applicant has not made use of the intervening years to develop a baseline understanding of groundwater in Tampico Ridge, anywhere to the south of the area that they propose to excavate. The applicant's parent company, Republic Services owns the adjoining land to the south, so this failure to obtain baseline data is not due to lack of access.

The applicant has not presented a compilation of data from existing household wells on Tampico Ridge, nor anywhere else around the vicinity of the landfill, except for the well for the Phillips family (whose property next door to VLI's office is "landlocked" by VLI/Republic Services holdings). Such a compilation could have been helpful to establish baseline conditions.

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2 Unlike, for example Logsdon Ridge near Lewisburg and other outliers of the Coast Range that are dominated by marine sandstone/shale sequences or tuffaceous members of the Siletz River Volcanics rather than basalt.

3 Personal communication, Rick Kipper, based on recollections of older relatives and presence of artifacts in the vicinity. Historian Bob Zybach showed Tampico Ridge as the eastern terminus of a ridge-line trail system, used by the Kalapuya and other Indigenous people, which connected all the way from here to Yaquina Bay and Siletz Bay on the coast.

4 Per December 2020 e-mails between VLI/Republic Services representative Julie Jackson and Benton County Counsel Vance Croney obtained through a public records request, which clarified that Republic Services was planning to expand operations onto this parcel, and per site development plans submitted to Oregon DEQ on July 9, 2021.

In the absence of such a compilation and lacking any baseline data of their own, the applicant's consultant is left to speculate regarding the actual hydrogeological conditions on Tampico Ridge. The groundwater elevation contours in Figure 2 of Exhibit 16, within the proposed development areas on Lot 1107 and 1200, are based on just two groundwater monitoring wells (BH-16 and BH-17) anywhere south of the current leachate-handling facility, plus apparently a natural seep or spring[5] at around 350 ft elevation, in the ravine that runs southward up the middle of Lot 1107.

The applicant's consultant (Exhibit 16) recommends adding a few wells at a later stage, mainly for groundwater quality monitoring purposes, but even these will be limited to the immediate periphery of the proposed development (emphasis added in bold):

> ***In a future phase,*** *Valley Landfills will augment the groundwater monitoring network in the south development area (for the interim, two temporary piezometers[6] were installed along the northern slope of Tampico Ridge as part of the geotechnical study). ... This will include (1) installing wells upgradient, between the landfill and properties to the south and southeast, (2) installing wells cross- and down-gradient along the perimeter of the landfill footprint to function as compliance wells, (3) decommissioning any wells that are within the planned footprint of the landfill, and (4) conducting hydraulic testing to estimate the hydraulic properties of the bedrock unit.*
>
> *...*
>
> ***installation of new groundwater monitoring wells is not proposed for this phase of site characterization*** *for several reasons. First, the locations being considered for upgradient wells are along the new access road that will be constructed south of the landfill footprint.* ***The wells can only be installed after the road is constructed because of the amount of excavation (over 100 feet vertical) from the current topography to the proposed road elevation.*** *Second, cross gradient to potentially downgradient locations will be in the way of earthwork activities if they are installed too soon—and could be destroyed. Therefore we advise to install these wells* ***after most of the landfill construction is complete****. And last, two wells that we are considering at a downgradient*

5 My conjecture based on noting that the 350 ft groundwater elevation contour coincides with the topographic elevation at this point.

6 Apparently these temporary piezometers were installed in BH-16 and BH-17 and thus are the source of data for the groundwater elevation contours mentioned above.

location (MW-8S and MW-8D) ***will hopefully be preserved*** *during landfill and infrastructure construction. During the interim, we will continue to monitor them consistent with the current monitoring program.*

From the above (noting the statements emphasized) it is clear that the applicant has no intention to develop additional baseline data for groundwater, and any new monitoring wells will be installed only after the main excavation work is completed.

Note also that the applicant's hydrogeological consultant is not even sure that the two wells MW-8S and MW-8D, located at the extreme NE corner of the proposed new landfill just off Coffin Butte Road on the adjacent FC-zoned Lot 1200 (which is not supposed to be part of the new landfill footprint), can be maintained.[7]

1.5 Groundwater divides are not physical barriers to groundwater flow

The Applicant's Burden of Proof document claims that a "groundwater divide" on Tampico Ridge will protect groundwater resources south of their proposed development. The applicant and their consultants either misunderstand or misrepresent the fundamental concept of a *groundwater divide* -- which is a phenomenon arising from groundwater flow patterns, rather than a physical feature that dictates those patterns.

Unlike a *surface-water divide*, which is directly controlled by topography, a groundwater divide need not coincide with topographic divides. Explanation of the differences between these concepts in lay terms can be found from various sources, including USGS websites.[8]

Although at very shallow depths the groundwater tends to follow topography, deeper groundwater flow can pass underneath local topographic divides. Groundwater in bedrock, in particular, may flow in different directions than flow in shallow surficial sedi-

7 There should be no rational reason for this concern by the applicant's consultant, if the applicant's plans are in fact limited to their stated goal of a "limited" expansion followed by closure of the landfill. However if their actual plan is to follow LU-24-027 with a request for the county to vacate Coffin Butte Road to allow them to implement the original plan set forth in LU-21-047, then those wells could be in the way. Perhaps, if given opportunity to ask questions of applicant's consultant, you could ask him why he was concerned about potential loss of these two monitoring wells.

8 See for example this U.S. Geological Survey website which uses the Great Lakes region of Wisconsin as an illustrative example: https://wi.water.usgs.gov/glpf/cn_nt_divides.html

ments, especially where groundwater flow through bedrock is constrained to fractures (as the applicant acknowledges is likely to be the case on Tampico Ridge).

It is also important to understand that groundwater divides are not static. As noted by the USGS website cited above[9]:

> *A second factor that controls the location of the ground-water divides is pumping from wells. Pumping can shift ground-water divides from their natural locations and even cause ground water that previously discharged to a local stream to move across surface-water divides within the basin to a regional pumping center outside the basin. Increases in pumping gradually cause the ground water divides to shift, but they have no effect on the surface-water divides.*

It follows that dewatering a slope (such as above the proposed new leachate ponds) or uncontrolled drainage to deep excavations (such as for the footprint of the proposed new landfill) could also shift groundwater divides.

A recent hydrogeological investigation by Ochoa et al. (2022)[10] of the Oak Creek watershed in Benton County, about 8 miles southwest of the proposed new landfill, shows examples of how the groundwater divides identified by actual hydrogeological investigations can differ from what might be speculated based on topographic divides. In particular is seen in Figure 6 of Ochoa et al. (2022), where the interpreted groundwater divides are distinct from the watershed boundaries following topographic divides.

As Ochoa et a. (2022) explore, this is the result of bedrock geology including the influence of the Corvallis Fault Zone. They note:

> *The low angle of the Corvallis Fault creates a wedge of Siletz Formation volcanic rocks overlying Spencer and Tyee formation sedimentary rocks which compartmentalizes vertical groundwater movement and promotes horizontal groundwater movement parallel to the fault line.*

9 ibid.

10 Ochoa, C.G.; Jarvis, W.T.; Hall, J. A hydrogeologic framework for understanding surface water and groundwater interactions in a watershed system in the Willamette Basin in western Oregon, USA. 2022, 12, 109. https://doi.org/10.3390/geosciences12030109

The Corvallis Fault also passes at a low angle below the landfill site. Although the surface trace of this fault is about 1.75 mile away from the proposed development area[11], the vertical separation between the fault and the proposed excavations may be as little as 2500 ft (less than half a mile). Hence the situation could be similar to that near Oak Creek. A comparable level of effort could be needed to demonstrate understanding of the local hydrogeology, including actual (rather than speculative) locations of groundwater divides.

1.6 Misleading use of the concept of a groundwater divide

As a guess regarding the hydrogeological situation on the rest of Tampico Ridge south of where they have any data, the applicant offers a schematic cartoon (Figure 1 of Exhibit 16). This cartoon, overlain on a topographic map, has green lines and blue arrows which, according to the legend, are supposed to be "topographic/groundwater divides" and "groundwater flow directions."

This cartoon in itself would be harmless, if taken solely as a depiction of the applicant's speculative hypothesis (or "conceptual model") regarding groundwater flow below Tampico Ridge. But as noted above, the applicant has amplified the speculative location of these "groundwater divides" into a major feature of their Burden of Proof, arguing that these will protect groundwater resources from impacts of their proposal.

The applicant has presented no data to support that that the green lines represent groundwater divides, nor that the blue arrows represent actual groundwater flow directions. The green lines do appear to coincide with topographic divides, but as established above, groundwater divides and topographic divides do not necessarily coincide.

Applicant's consultant seems to understand this where he first introduces Figure 1 on p. 5 of Exhibit 16. There he uses nuanced phrases such as "groundwater is ***generally assumed*** to flow ..." and "***presumed*** areal flow direction of groundwater" (emphasis added in bold).

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11 Wallace Group state that the closest mapped portion of the Corvallis Fault is 3 miles to the south near Adair Village, but Dr. Chris Goldfinger interpreted the surface trace, though concealed by recent surficial disturbances, to continue northeast as far as Independence Hwy just south of its intersection with Camp Adair Road. *See:* Goldfinger, C., 1990. Evolution of the Corvallis Fault and Implications for the Oregon Coast Range," M.S. thesis in geology, Oregon State University, Corvallis.

But by the next page, this nuance has been forgotten and the supposed "groundwater divide" is discussed as if it were a confirmed and absolute fact. A page later (p. 7) the consultant goes even further: "*It is this groundwater divide ... that prevents groundwater from one side of the hill to flow to the other.*"

This scientifically erroneous claim is then brought forward in the Burden of Proof:

> ***Impact on groundwater quality**. Tuppan and CEC describe a number of features and systems that protect groundwater resources, including the groundwater divide created by Tampico Ridge ....*

1.7 Inadequate investigation of geology and hydrogeology of Tampico Ridge

Applicant's presentation of information on the geology and hydrogeology of Tampico Ridge, anywhere south of the development area, is insufficient to demonstrate an understanding of how the proposed development will impact existing groundwater resources.

The evaluation of bedrock properties in particular severely circumscribed, limited to an account of at what depth bedrock not amenable to mechanical excavation was encountered. Beyond the depth at which competent bedrock (basalt) was encountered, despite that they employed core-drilling, they provide no structural geological information or interpretation, other than RQD (rock quality designation) which is a crude measure of fracture intensity.

They did not map any specific bedrock structures either in the test pits or boreholes. They made no attempt to interpolate structures between the 19 boreholes that extended into the bedrock. No pumping tests or any other types of hydraulic tests were performed to evaluate the hydraulic properties of the bedrock or the potential for lateral persistence of water-conducting zones. Only one borehole (BH-3) was located outside the footprint of

the planned development area.[12] This borehole was abandoned by filling it with bentonite, rather than using it for groundwater measurements and monitoring.[13]

Critically, there is no structural geological analysis (identification of bedrock geological structures such as local fault zones that could be significant as water-bearing features). The applicant, VLI, has also not presented any mapping of structural geological features on the exposed quarry faces at Coffin Butte, which could help to inform an analysis of risk to groundwater resources in that direction.[14]

In the Wallace Group report, the entire discussion of groundwater occurrence is limited to one paragraph in Section 4.3 (emphasis added in bold font):

> *Groundwater was encountered during the exploration at depths ranging between 4.6 and 67 feet bgs with the groundwater level generally deeper towards the northeast. We expect groundwater will be present within fractures of the weathered and competent bedrock, perched above the interface between soil and bedrock, and within alluvial soils at the lower elevation areas.* ***Fractures provide the primary transport mechanism of groundwater in the bedrock; therefore, the occurrence and amount of groundwater encountered during the excavation of the expansion cell and ponds will depend on the nature, distribution, and interconnection of the fractures.***

Despite recognizing the importance of fractures for groundwater flow in the bedrock, the drilling logs do not identify the specific locations of any such structures.

Applicant has not presented any inventory of local residential wells to identify which ones rely on water-bearing features that could potentially be drawing from fractured zones or

12 The only borehole located outside of the development area for the current proposal, BH-3, was located near the edge of the development area for the previous development plan that was rejected as LU-21-047, and thus appears to be a carry-over from that plan, rather than indication of an effort to understand the geology and hydrogeology of Tampico Ridge south of the currently proposed excavations.

13 Oregon Department of Water Resources well record BENT 56394.

14 During a landfill tour for the Benton County Talks Trash process in autumn of 2022, I asked VLI's site managers if there were any plans to map the quarry face, noting that it provided excellent exposures of fractures including possible local faults which could be valuable for risk assessment of the planned expansion into the quarry (Cell 6). They responded that Knife River wouldn't allow this due to safety issues.

networks of such zones that could be intersected by the excavation. Productive household wells on Tampico Ridge are typically screened in fractured zones in the basalt.[15]

Understanding the lateral persistence of these zones and their connections would be key to assessing the risks of excavation impacting nearby wells. However the Applicant and their consultants have neither developed nor presented any such understanding of the bedrock hydrogeology.

15 On a personal note, before we purchased our property on the east flank of Tampico Ridge in 2004, I made my own evaluation of well logs from neighboring properties on Tampico Ridge (easily obtained from the Oregon Water Resources Department database), and noted that wells capable of producing sustained water flow were generally screened in fractured zones in the basalt. We were able to find such a zone for our own well, which for the past 20 years has provided us with reliable water both for household use and for a large vegetable garden.

Issue 2: Risk of groundwater contamination during landfill operation or in the post-closure period.

Applicant argues that there is no risk of contamination from the new landfill. Their argument relies on (i) erroneous understanding of the concept of "groundwater divides," (ii) optimistic claims regarding the efficacy of an unproven liner system, and (iii) an assumption that the new landfill can be kept drained in perpetuity.

2.1 Applicant misunderstands and misinterprets the meaning of "groundwater divides

The preceding comments on Issue 1 (under subheadings 1.5 and 1.6) also apply here. The position of a groundwater divide for the bedrock aquifer system under Tampico Ridge has not been established. Since groundwater divides are not physical barriers, but depend on the flow system, the current position of any groundwater divides could shift, for example if there is an increase in groundwater pumping to the south.

2.2 Applicant has not demonstrated an understanding of bedrock hydrogeology below Tampico Ridge.

The preceding comments on Issue 1 (under subheadings 1.4 and 1.7) also apply here. The applicant has not presented neither data nor validated models for the area south of the proposed new landfill, nor adequate plans to obtain the type of data that would be needed.

2.3 Landfill liner systems eventually fail

A US Geological Survey fact sheet (Christenson and Cozzarelli, 2003)[16] summarizes the situation succinctly (emphasis added in bold):

> *Federal and state regulations were passed in the 1980s and 1990s to manage disposal of solid waste. Those regulations require that most landfills use liners and*

16 Scott C. Christenson and Isabelle M. Cozzarelli, 2003. "The Norman Landfill Environmental Research Site: What Happens to the Waste in Landfills?" USGS Fact Sheet FS-040-03, August 2003, U.S. Geological Survey, United States Department of the Interior.

leachate collection systems to minimize the seepage of leachate to ground water. Although liners and leachate collection systems minimize leakage, ***liners can fail and leachate collection systems may not collect all the leachate that escapes from a landfill.*** *Leachate collection systems require maintenance of pipes, and pipes can fail because they crack, collapse, or fill with sediment.* ***The US EPA has concluded that all landfills eventually will leak into the environment*** *(U.S. Environmental Protection Agency, 1988). Thus, the fate and transport of leachate in the environment, from both old and modern landfills, is a potentially serious environmental problem.*

The applicant's claim that risk of leakage can be avoided by use of a liner system, however advanced, amounts to asking us to ignore both common sense and the cumulative scientific evidence that landfills do eventually leak.

The applicant acknowledges (in their Exhibit 29 titled "Arsenic Memo") that their existing landfill, on the other side of Coffin Butte Road, had "a seepage event" (in other words, a leak) which VLI discovered in 1994 when groundwater sampled by a newly drilled monitoring well, MW-23, was found to have elevated levels of arsenic. Despite the applicant's claims that they resolved this issue, arsenic levels both in that well and in their compliance boundary wells continue to fluctuate. Record-high levels for the site and indeed, for the western mid-Willamette Valley, were reported in their 2023 Annual Environmental Monitoring Report.[17] I will discuss this memo at length in separate testimony, but here it bears noting that the applicant has not been able to demonstrate conclusively that their existing landfill is free from leaks.

2.4 Reliance on a "state of the art" new liner system implies that long-term performance data for this system do not exist

The argument here is very simple. If a new liner system has just recently been developed, there cannot be any data on real-world performance over time scales of decades. Man-made materials can degrade, creep, or become brittle over time.

17 The 2024 Annual Environmental Monitoring Report is still not publicly available, though a copy was supposed to be provided to Oregon DEQ earlier this year. I requested a copy from DEQ through a public records request on April 9, 2025, but as of this date I have not received it.

The history of modern technology, from the Titanic to Three Mile Island, is full of systems that were considered to be "state-of-the-art" and "fail-safe" at the time of their development.

Decades of monitoring will be needed to determine whether or not this new "state-of-the-art" liner system is as fail-safe as the applicant claims. This is not something on which we can rely in a decision on the current land-use application.

2.5 VLI cannot guarantee that their drainage system will function in perpetuity

The applicant's consultant has argued that, because the new landfill is planned to be kept in a drained condition, leachate accumulating inside the landfill couldn't rise to such a level that it would cause leachate to flow into water-bearing features in Tampico Ridge.

As noted in the US Geological Survey fact sheet referenced above (Christenson and Cozzarelli, 2003):

> *Leachate collection systems require maintenance of pipes, and pipes can fail because they crack, collapse, or fill with sediment.*

In addition, this landfill is located in a seismically active region. Besides the nearby Corvallis Fault (the activity of which is not fully understood), the Cascadia Subduction Zone is known to be capable of producing enormous earthquakes up to magnitude 9.0 or even 9.5, according to the most recent estimates.

In the event of an earthquake, even if the landfill doesn't experience slope failures that would be evident to observers assessing damage on the surface, differential movements between layers of the landfills could shear off pipes and render leachate collections systems non-functional.

A system that requires on continued maintenance also depends on the financial viability of the operator. If either VLI or its parent company go bankrupt, who will make sure that the leachate collection system keeps going?

A system that depends on indefinite maintenance of pumps and plumbing is not an intrinsically safe system. The applicant should provide an analysis of what will happen if and when the leachate collection system stops to function.

Issue 3: Blasting impacts during landfill construction.

3.1 Applicant's geotechnical consultant has recommended drilling and blasting as the main method of excavation

In reviewing the geotechnical consultant's report (Wallace Group, Exhibit 5), I noted that the geotechnical consultant has recommended drill-and-blast rather than mechanical excavation:

> *Competent basalt bedrock will likely require rock hammers or drilling and blasting to excavate. The western hillside may be excavatable mechanically; however, it will result in a ragged final slope which may be problematic over time. The eastern hillside is more competent and mechanical excavation methods will not be appropriate. We recommend that drilling and blasting is used during rock excavation. The rock excavation method should be performed in a manner that limits as much as practical blasting disturbance beyond the rock cut.*

Blasting in competent bedrock (such as basalt) is favorable to propagation of seismic waves produced by blasting, with limited attenuation.

Experience from the existing quarrying and landfill operation on Coffin Butte suggests that this is a non-negligible concern. Testimony submitted on April 16, 2025 by William J. Briskey, PE, mentions that on his family's rural residential property on the NW side of Coffin Butte, "*quarry blasting has caused structural shifts in our house, broke a window, and we now have major cracks in concrete slabs in out-buildings.*" This blasting was carried out to enable expansion of the existing Coffin Butte Landfill into a new area referred to as "Cell 6," about 200 yards from Mr. Briskey's outbuildings.

3.2 Excavation will be as close as 250 yards from nearby residential properties

The design for the proposed new Tampico Ridge landfill will require blasting within 250 yards of residences on the west side of Tampico Ridge, and within 500 yards of existing buildings on the east side of the ridge.

During blasting in the former Morse Bros. / Knife River quarry, especially during expedited excavation to make way for the ongoing landfill expansion into what the operators call "Cell 6," we and our neighbors at times experienced percussive waves that were sufficient to rattle windows. For family members who have lived in areas with frequent earthquakes (including myself), these incidents triggered an startling, alarm reaction similar to experiencing a minor, "cupboard-rattling" type of earthquake or a sonic boom.

This was when the blast face was a full mile from our house, and on a separate hillside. If this activity were to move closer to us, and on the same ridge where we live, we can anticipate that the effects will be much worse, and will be a recurring source of stress.

3.3. Applicant has not evaluated how noise and seismic wave propagation from blasting will impact nearby residents.

The Applicant has not presented any analysis of potential impacts of blasting, nor have they even recognized this as a potential impact. This is an important issue that will lead to serious interference with use of nearby residential properties. The fact that the applicant didn't even consider this impact indicates a lack of awareness or concern for how their operations impact nearby residents.

From: Bill Briskey
To: Benton Public Comment
Subject: Oppose/Deny Reference Application File Number LU-24-027
Date: Wednesday, April 16, 2025 4:15:22 PM
Attachments: KEklund Petra Schuetz letter 1-2025 methane.pdf

CAUTION: This email originated from outside of the organization. Do not click links or open attachments unless you recognize the sender and know the content is safe.

I have three primary concerns:

1. Landfill gas impact on health of my family, which includes an infant and a 5-yr-old
2. Effluent concerns since I have a well
3. Impact on how I use my land

My property shares 1580 feet of fence line with the NW corner of the landfill and the topology brings the smell right to us anytime there's a south component to the wind direction. When we bought our land 35 years ago, we were told by a Valley Landfills, Inc. representative that the original deposit location, called Cell 6, was closed so all future garbage would always be moving away from us. Since Republic moved all the refuse out of Cell 6 and Knife River blasted to remove more of the Butte at that NW corner, we've already experienced more odor and picked up more airborne garbage that blows over the fence. The quarry blasting has caused structural shifts in our house, broke a window, and we now have major cracks in concrete slabs in out-buildings. Understandably, we're very interested in the outcome of the expansion discussion.

I am becoming increasingly concerned about my family's exposure to toxic gasses every time a breeze comes from SE to SW. The gas being comprised of methane, carbon dioxide, plus other aerosols including toxic PFAS (per- and poly**fluoroalkyls**) was just last year measured by the EPA to exceed the maximum allowable emission level by 219 times. I have not seen any evidence that the ongoing problems in the existing methane collection system have been corrected since the last EPA visits, just continued gas emissions indications from satellite images and my own nose. This clearly violates BCC 53.215 (1) and makes me wonder why it doesn't get the attention it deserves by Benton County and EPA officials.

I haven't complained about the odor because, hey, I live next to a dump. But the **increase in odor** is also raising my awareness to the apparent lack of mitigation and potential long-term damage from toxicity exposure. I hosted business associates once and the stench forced me to cancel the meeting and everyone left – I haven't been able to host events since then. Before there's any expansion allowed, I'd like to see Republic get a handle on what they already have to manage. I'd also like to see evidence that they are actually solving the problem instead of dismissing complaints.

My family's well is located 500 feet from the landfill property. The migration of effluent

carrying toxic levels of arsenic to the east is alarming. When Republic starts filling Cell 6 with garbage and takes advantage of the newly exposed hillside there, I'm hoping that there won't be a westward flow of escaped effluent into the aquafer that feeds my well. Its depth is roughly 250 feet (130 ft ASL) below the bottom of the closest corner of Cell 6.

I used to have a small pond on my place, on the east side of the landfill. Water from the pond fed a small livestock tank downhill from the pond. A few years back the pond dried up. It turns out that even before Cell 6 was excavated and the quarry blasting began, the landfill decided to divert surface and shallow water flow off the Butte away from my property without discussing it with me. They did call me prior to that and offered to buy that portion of my land because they said that there was a chance that my field would experience "brighter areas" caused by runoff from the landfill. So my intended use of the pond for a livestock reservoir has been permanently curtailed.

There's no easy solution for waste, but how about accountability? It's pretty clear to me that the practice of hiding violations in the past has turned into a standard operational procedure. It's unlikely that Republic can change its practices to be transparent with the County, and the county's contract representative (legal counsel) is not negotiating on behalf of the stakeholders in our county. Ken Eklund, past Chair of the Disposal Site Advisory Committee, has been closely following the connected issues of climate damage through methane and odor impacts, both of which come from excessive leaks of landfill gas. The letter he wrote (attached) to the Planning Official and her consultant, Winterbrook Planning, does an admirable job of summarizing several areas of concern that mirror my own and highlight a lack of accountability.

I see first-hand how the landfill disregard for environmental and local land use impacts my family. I encourage our county commissioners to visit a neighborhood downwind of the landfill and think about the long-term impact when they stand there breathing in the potpourri of nasty gasses. It might be several years before science solidly connects these gasses to human health issues – even if Republic is still a viable company at that time, the expected class-action lawsuit will certainly target Benton County. The short-term financial benefits might look nice now, but the future impact will destroy Benton County and that legacy will be tied to the people making decisions today. I vote no for any expansion and would prefer that landfill operations cease. It's time for another county to carry the load.

William J. Briskey, PE
39101 Military Road
Monmouth, OR 97361

Dear Petra,

I have some notes for you, as you consider the final Application by Republic Services in order to make an official determination about its completeness as Planning Official.

1. The missing 2024 EPA Inspection Report.

> A final report from the 2024 EPA inspection is not yet available, but Applicant is aware that the inspectors found exceedances while conducting surface emissions monitoring.
>
> – Jeff Condit, Burden-of-Proof-Revised-January-15-2025.pdf, p. 102

This final report of the 2024 EPA Inspection is available, and was available prior to January 15. (I received a copy third- or fourth-hand on January 14; more about this report and its implications here). **A discussion of this report is vital to an honest narrative about methane emissions at the landfill.** A reminder that when the EPA released its inspection of the landfill in 2022, Republic similarly did not relay its report to the County, but suppressed it instead for over a year.

In the 2024 report, as in the 2022 report, the inspectors narrate a process where they find an exceedance, document it, walk a short distance (often very short), find another exceedance, and so on. They are finding another exceedance three minutes later or fifteen feet apart. In each report they cover a remarkably small proportion of the landfill surface yet find a similar high level of exceedances. The photo documentation in the 2024 report shows visually obvious problems that have been problems for some time, i.e., tears in the tarp with weeds growing out of them that are three feet high. Most notably, the 2024 report includes an instance where *a gas well was uncapped entirely*.

The 2024 report casts doubt on the Applicant's "we were upgrading the gas collection system" narrative of their 2022 report, suggesting instead a narrative where the Applicant is in a perpetual state of system "upgrade" because of deferred maintenance. The "we were upgrading the gas collection system" account does not explain why every time that an entity that is not paid by Republic has pointed a methane detector at Coffin Butte Landfill in the last two years, that entity finds excessive landfill gas emissions :

- in June 2022, the first EPA inspection uncovers 61 exceedances, including several that flamed out/approached or exceeded the lower explosive level of methane;
- in July 2023, Carbon Mapper aerially surveyed the landfill for a ten-day period and mapped multiple landfill gas plumes from multiple sources, with a combined average leak rate of approximately 3.4 metric tons of landfill gas *per hour*;

- in July 2024, the EPA's return inspection again found multiple exceedances, including one with a methane concentration over 110,000 ppmv (the EPA threshold for reporting is 100 ppmv and for remediation is 500 ppmv);

- in September 2024, Carbon Mapper surveyed the landfill from space and found the landfill was still super-emitting methane with an average leak rate of approximately 1.8 metric tons of landfill gas per hour.

In no instance did a survey fail to find dozens of leaks, including leaks with high and very high methane concentrations (EPA) or leaks that are super-emitters many times over (Carbon Mapper). The narrative that these independent sources establish is one where Coffin Butte Landfill's condition has not been maintained properly and now landfill gas emissions are burgeoning out of control of the operator.

2. DEQ's notification of investigation, August 2024.

> In August 2024, members of Oregon's congressional delegation called for the U.S. Environmental Protection Agency to complete an investigation into concerns about the landfill. Also in August 2024, DEQ issued a formal warning to Coffin Butte for not complying with new requirements to reduce methane emissions from the state's landfills.
>
> – Tracy Loew, Salem Statesman-Journal, January 10, 2025

Several DEQ officials accompanied the EPA inspectors on their 2024 inspection, and when the EPA prepared its report in August 2024, DEQ issued the formal warning highlighted above. **A discussion about this warning from DEQ is necessary for the application to be deemed complete.** The formal warning from DEQ calls into question the Applicant's narrative that it is in compliance with federal and state regulations; instead it seems that Applicant is in a recurring state of being out of compliance with regulations, and successful only at keeping one step ahead of being fined.

Side note: the Applicant's Environmental Manager, Ian Macnab, resigned in fall 2024, after the second EPA inspection, the formal warning from DEQ, the calls for the EPA to take action about the landfill's non-compliance, and the release of the Carbon Mapper quantifications of its methane emissions data.

3. The rapid decline in the efficiency of the Applicant's gas collection system.

> The US Environmental Protection Agency estimated in 2019 that Coffin Butte Landfill's methane collection system converts 57% of its methane to CO2, as compared to other Oregon landfills such as Columbia Ridge (85%) and Dry Creek (80%)[90] … Republic Services' notes that data it submitted to the EPA for inclusion in its 2021 greenhouse gas report estimates that Coffin Butte's landfill gas collection system has a collection efficiency of 91.2 percent.
>
> — The BCTT report, page 669

In the January DSAC meeting (link), methane was on the agenda, a continuation of questioning begun in DSAC's December meeting. CBL's new Environmental Manager, Paul Koster read these notes (with landfill General Manager Bret Davis chiming in):

> [begins around 1:23:22]
>
> PK: So, our last gas model was completed in 2023, and we'll be completing a new gas model spring of this year. So, looking at the gas model from '23, our efficiency was estimated about 70% for '24, and 73% in 2023. This is the total amount of methane generated 2024 – was about 3,923 to 4,100 scfm throughout the year, on average, every day, every minute. The loss in flow was largely due to – we did lose some flow between '23 and '24, was largely due to the commissioning of the new and closed flare construction project. So we had some changeover. We did lose a little bit on that.
>
> BD: Thank you for [adding]. We do a – we added wells, and so on. And so yeah, the system's not able to collect it a hundred percent. When we're adding wells or more collection.

So, to summarize, the landfill's gas collection system, which Republic reported was operating at 91.2% efficiency in 2021, by 2023 had declined to 73% and sagged further in 2024, to 70%, according to Republic's own gas modeling. **This is a critical consideration for any honest narrative about the landfill's methane emissions level**, as each decline of 1% in gas collection efficiency signifies a commensurate rise in fugitive emissions of landfill gas (by my calculations, each 1% decline in efficiency =

approximately 1.2 more metric tons of landfill gas released per day). The Applicant's representative, Paul Koster, stated this information became known to the Applicant in 2023, and was updated in 2024, and so it was well-known to the Applicant when they were preparing their application.

Note that the data is converging regarding this decline in gas collection efficiency: EPA inspectors have found it on the landfill surface, Carbon Mapper has surveyed and quantified it from the air and now from space. More data is imminently forthcoming, now that methane-detecting satellites pass over Coffin Butte Landfill several times a day. The decline in gas mitigation efforts requires a honest conversation about how low efficiency will go and what environmental impacts will be happening at that level.

4. Surging methane emissions equals surging landfill gas odors.

Methane is a pollutant and a potent greenhouse gas, and well deserves its focus in abatement efforts. The landfill gas from Coffin Butte Landfill is generally about 50% methane, 40% carbon dioxide, and 10% a mixture of many other gases, including odorifics and toxic gases such as aerosolized PFAS. So the unregulated releases of methane detected in EPA and Carbon Mapper surveys of Coffin Butte Landfill are evidence of increasing amounts of toxic and odorific gases being released by the landfill (the lead inspector for the EPA specifically mentions landfill odor in the 2024 report).

Odorific gases accompany methane, but they also occur in the pre-anaerobic phase of landfilling, and processes such as soil cover that oxidize methane do not necessarily reduce odorific gases.

The application should not be considered complete without a discussion of the relationship between the increasing amounts of landfill gas being released and the increasing number and duration of "dump day" odor events in the landfill region. As we've seen, over the past three years the Applicant has normalized a steep decline in its gas collection efficiency, so this discussion should include what measures if any the Applicant will implement to reverse the increasing odor impact upon other land uses in the region where they're occurring.

These are my first observations about the Applicant's revised application; I will likely be adding more. I'm happy to answer any questions, and hope this information will be of use to you and your consultants.

Respectfully,

Ken Eklund
37340 Moss Rock Drive
Corvallis OR
408-623-8372

From: Pamela Castle
To: Benton Public Comment
Subject: LU-24-027 comment
Date: Tuesday, July 15, 2025 6:13:10 PM
Attachments: Response to new evidence RE LU-24-027 - Pam Castle.pdf

CAUTION: This email originated from outside of the organization. Do not click links or open attachments unless you recognize the sender and know the content is safe.

RE: LU-24-027, the application to expand Coffin Butte Landfill

Dear Planning Commission Members,

I urge you to deny the application for expansion of Coffin Butte Landfill and this letter is a response to the Pawlowski letter in Section 9 "New Evidence from the July 8-9 Hearings" section in Munidocs. https://library.municode.com/or/benton_county/munidocs/munidocs?nodeId=8287987d132c0. In particular, I will address the comments about PFAS and those that recommend the county rely upon agencies to hold VLI accountable for landfill issues. I also make reference to Applicant's July 8 slide presentation also in that Munidocs section and my own written testimony regarding PFAS in leachate submitted on 6/11/2025. (https://library.municode.com/or/benton_county/munidocs/munidocs?nodeId=8135d7834e2c8).

Below I provide Mr. Pawlowski's comments in italics followed by my response to each comment.

Pawlowski comment 6, bullet point 2 – "*…Let Benton County rationally follow our nation's regulatory agency rules for guidance."*

- We know from Slide 16 of the applicant's July 8 slide show that not all the issues associated with landfills that are of environmental and human health concern are regulated by federal agencies. In the case of landfill leachate PFAS, for example, relying on agency rules and enforcement would mean there would be no oversight because, as the applicant says, "Currently there is no formal requirement to monitor PFAS in leachate or groundwater".

- Landfill leachate is known for its heavy PFAS load and large volumes of it are sent to the WWTPs of Corvallis and Salem. Somewhere around 30+ million gallons of CBL leachate is processed with municipal wastewater at municipal wastewater treatment plants (WWTPs) each year.

    - As described in my written testimony submitted into the written record on 6/11/2025, **municipal wastewater treatment plants (WWTPs) do not**

treat PFAS. PFAS mitigation requires specific processes that are not included in the WWTP process. Because of this the PFAS entering the municipal wastewater plant with leachate are not removed. They are:

- Released into the Willamette River with WWTP effluent.
- Distributed into the air as aerosolized droplets generated during aeration steps of wastewater treatment resulting in elevated PFAS levels around WWTPs.
- Spread with WWTP biosolids onto soils around the region.

- As very recently reported by The Guardian newspaper, the U.S. government has pulled $15 million in funding earmarked to study the effects of PFAS contamination of agricultural land, contamination primarily due to spreading of biosolids from WWTPs. These studies were designed to determine how PFAS move into and accumulate in crops and livestock and enter our food supply so that policy around biosolids use could be developed.
  - This is an example of why we cannot wait on agencies to police this issue. They aren't going to be able to do that for a long time because of cuts like this. Meanwhile, PFAS-laden WWTP biosolids continue to be spread onto our fields where they will persist in the environment, and emerge from the landfill in fugitive emissions and from generating plant and from flare exhaust.
  - Agencies lack the staff and funding to act fast enough to prevent lasting environmental damage, two problems which will almost undoubtedly worsen going forward. These two problems are worsening.

Pawlowski comment 6 bullet point 3 – *There has been recent concern of PFAs or other "forever" chemicals that spawn from breakdown of synthetics and plastics. Although it is argued that these chemicals are 'concentrated' at the landfill operation, these compounds are in everything we touch.*

- First, I'll touch on the idea that these are of recent concern. PFAS have been the subject of scrutiny for decades with the first EPA action on the group of chemicals coming in 2006.

- According to SL Environmental Law Group, in 1999 a lawsuit was filed against DuPont over their contamination of water with PFOS - one of the thousands of PFAS chemicals out there. DuPont settled because the facts showed they had not disclosed the known dangers of this compound.

- As early as the 1960s, scientists were documenting the dangers of PFAS exposure and the diseases they cause in lab animals.

- This is not a recent concern. It is true that it has become an increasingly alarming concern, but one that has been documented for many decades. This also points to why agencies cannot be relied upon to police landfills; they are too slow in developing regulations.

- Second, Mr. Pawlowski seems to be of the belief that our exposures to PFAS in everyday life are equivalent to chronic exposure to higher levels of PFAS via multiple routes This is, of course, not true. Dose is important here and one of the reasons we need to prevent more PFAS from concentrating in and contaminating our environment.

- Third, PFAS <u>are</u> concentrated at Coffin Butte Landfill, we have a much greater quantity of PFAS in our county than we would have if the landfill wasn't here.

  - This would not be as serious a problem if the PFAS remained in the landfill like they do in a dry environment where there is little landfill gas and leachate production. The main routes for PFAS escape from landfills are via landfill gas (even captured, flared landfill gas) and via leachate whether it leaks or is processed at WWTPs where PFAS are not treated.

Pawlowski comment 6 bullet point 4 - *PFAS are currently under research. Information on health affects are going through the scientific learning process.*

- While it is true that we are still, and will be for a long while, figuring out all of the ways that PFAS affect the health of humans and other living organisms, there are well-documented health consequences of PFAS exposure. Some of these effects are shown in a Slide 2 of my 6/11/2025 testimony.

  - That PFAS are harmful is not in question, the questions surround the types of harms and how PFAS cause these harms.

Pawlowski comment 6 bullet point 6 – *Why be in fear of what we do not know when the average human lifespans are longer than they ever have. Perhaps the invention of synthetics and plastics have benefited life more than we realize.*

- When I first read this comment, I wasn't even sure where to begin because of the unbelievable leap that was made and I still don't know what to say. It is sort of like saying that the number of Starbucks coffee shops have increased drastically during the time that human lifespans have increased, so perhaps the increase in number of locations of this franchise is responsible for that increase in human lifespan. Suffice it to say that PFAS are not lengthening lifespans.

Thank you for your time and commitment to this process. I know that it has been arduous and taxing and I do not envy you the task. Rest assured that your efforts are truly appreciated.

Thank you,

Pam Castle, M.S. Pharmacology/Toxicology

993 NW Cypress Avenue, Corvallis, OR 97330

The attachment is a PDF of this comment in the event that is preferrable.

RE: LU-24-027, the application to expand Coffin Butte Landfill

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    - As described in my written testimony submitted into the written record on 6/11/2025, **municipal wastewater treatment plants (WWTPs) do not treat PFAS**. PFAS mitigation requires specific processes that are not included in the WWTP process. Because of this the PFAS entering the municipal wastewater plant with leachate are not removed. They are:

        - Released into the Willamette River with WWTP effluent.

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Pam Castle, M.S. Pharmacology/Toxicology

993 NW Cypress Avenue, Corvallis, OR 97330

From: Ken Eklund <futureeverything@writerguy.com>
Sent: Wednesday, July 16, 2025 1:32 PM
To: Benton Public Comment
Subject: Testimony in response to Republic-County-Pawlowski written material July 8-9 on dump odor
Attachments: A1 OCA5-abridged-reduced.pdf;
A3 Odor complaint form on the Coffin Butte Landfill site Archive of Email chain.pdf;
A5 Sunshine landfill ordered to step up actions to address odors .pdf;
A6 Many say landfill emits 'invasive' odor into Harrisburg neighborhood – WSOC TV.pdf;
A7 Neighbors say landfill smell hasn't improved after state-approved action plan – WSOC TV-reduced.pdf

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RE: LU-24-027, the application to expand Coffin Butte Landfill
RECOMMENDATION: Please deny this application

Document ID: This is Part A, Odor.

Dear Chair Fowler, Vice Chair Hamann, and Planning Commissioners Biscoe, Cash, Fulford, Lee, Struthers, and Wilson:

I'm submitting this letter in response to information in four items in the in the "9. New Evidence from July 8-9 Hearings" folder on Munidocs:

1. Republic's slide deck ("25RS1067 Coffin Butte Deck_FINAL")
2. County staff's slide deck ("Staff Slides to Planning Comm LU24027 July 8")
3. Brent Pawlowski's testimony ("07092025 PAWLOWSKI_Brent")
4. Jeff Kleinman's testimony ("07092025 KLEINMAN_Jeff")

Before you begin, please note: my letter has attached evidence A1 through A7. To view these attachments using the County's **Munidocs record** system, look to the Attachments section in this email's header, and double-click to view each one.

Also: for verification of statements made, this letter refers to testimonies in the Munidocs record that relate to the information in the above four items; I've linked to them so that you can quickly and easily refer to them. (And any attachments to *those* must also be double-clicked in their header, respectively, to open.)

I intend to be as succinct as possible here, however fair warning: this letter is only Part A (Odor).

ODOR

Republic presentation, p. 8-9
Staff presentation, p. 17
Pawlowski, p. 3

also
Kleinman p. 2, 8-11, Planning Commission Findings for Denial 2021

Brent Pawlowski brings up the issue of dump odor levels and public experience and expectations about odors and smells in his letter. Republic's presentation cites its odor modeling (odor study) and proposed mitigation. The County presentation also cites the odor study and the County's proposed Conditions of Approval.

The results of the odor study are not sufficient proof that the odor impacts of an expanded landfill will not seriously impact uses adjacent to the landfill (and in its effective "adjacent" impact zone). This is due to the large number of both quantitative and qualitative flaws in the model, omissions, and the readily apparent disconnect between the odor study's theoretical results and the available real-world data. *Simply put, the odor study fails to explain what's currently happening around the landfill, much less what will happen if the landfill were to expand.*

1. **The odor study is a mishmash of snapshot inputs from 2004 (weather), 2024 (complaints) and 2023 (estimates of landfill gas emissions levels), etc., and results from such a mishmash are clearly insufficient to prove landfill odor impacts from now throughout the proposed life of the expansion.**
    a. The study uses *weather data* from 2004-5 (Munidocs **link** p. 127)
    b. Yet the study is keyed to *complaints* from its odor complaint portal, *which launched sometime after March 4, 2024* (see below), thus rendering the majority of complaints "inconclusive."
    c. The study also uses self-generated emissions estimates (see Munidocs **link** p. 127)

2. **The odor study asserts that its scientific rigor invalidates almost all community odor complaints, but it uses a cherry-picked subset of complaints, obsolete weather data, and self-determined gas emissions levels whose validity is currently being investigated by regulatory authorities, and which are contradicted by real-world data on Coffin Butte's landfill gas emissions. These shortcomings undermine its narrative of being scientifically rigorous.**
    a. Although the study purports to use "all available complaints" from 2022-2024, in fact it does not include the complaints received and compiled each year by the Benton County Disposal Site Advisory Committee in its annual Community Concerns Annual Report (CCAR), which the County then publishes to Oregon DEQ as required by state law. Republic Services has a representative on that committee, who voted on each year's CCAR. Republic's DSAC representative should have then entered those complaints into the study pool, but did not.
    The study has thus knowingly excluded from consideration several hundred community complaints about odor. Those Reports are in the record (see the attachments to p. 102 of this Munidocs **link**).
    b. Objections to the study not using CCAR complaints were made early in the public comment period, but were not acted on by Republic.
    c. As established above, the study uses weather data from 2004-5, but Oregon weather has changed significantly since then, due to climate change (see my attachment **A1**). In any case, as noted in this attachment, Oregon weather varies significantly from year to year, so using any one year as a baseline is a recipe for error.

d. The study uses Republic's reported emissions levels, but these reports are currently being audited by the EPA, after two EPA inspections revealed large-scale leaks. See my EPA timeline-explainer (the attachment to this Munidocs **link**).

e. Both Republic's presentation and the County's presentation are based on the odor study's conclusion that dump odor at the landfill property line is detectable (D/T 0.5) but does not rise above the level of nuisance (defined as D/T 7). This conclusion is called into question by actual observations of landfill gas plumes in 2023, such as one that shows a plume spilling southward and surrounding homes at concentrations of from 2,000 to 4,000 ppm-m of methane (see my attachment **A2**, a July 2023 plume image). Methane is the primary component in Coffin Butte's landfill gas (52%) and is used to track the plume; the odorifics are a host of other organic compounds which landfilling creates along with methane, and which piggyback on methane into the environment.

   i. If a 4,000 ppm concentration of methane were observed at the dump's surface, it would be 8 times the reportable level and trigger a requirement for immediate remedial action.

   ii. According to Table 1 in Republic's odor study, which is reproduced in the **County's Staff Presentation** on p. 17, the D/T value of "anaerobic digester gases" is 100,000 D/T. Anaerobic digester gas is an analogue to landfill gas, which is also largely a product of anaerobic digestion of organic matter, but landfill gas also includes odorifics that result from the breakdown of plastics, construction materials (especially gypsum wallboard), and a host of others generated by the interaction of organic and inorganic materials in the landfill. Since this data visualization shows the landfill gas emerging at somewhere over 6,000 ppm-m methane at its source, and then decreasing to concentrations of around 4,000 to 2,000 ppm-m (only decreasing 33% to 67%) before entering the property of others, we can back-of-envelope estimate that the D/T is in the neighborhood of 33,000 D/T and up when it crosses the property line. This is well above the nuisance threshold of 7, and maps well to the documented community experience, which is that the odor is powerful even miles away from the dump.

f. Both Republic's presentation and the County's presentation characterize odor with the D/T values catalogued in Table 1. This Table of Odor Index Examples is *from an entirely different industry than landfilling* (the wastewater industry).

   i. The table is useful only to wastewater treatment professionals, who may be familiar with what "primary clarifier weir cover exhaust" smells like.

   ii. The odorifics produced by wastewater treatment are only a subset of the odorifics produced by landfilling, as explained above. The quantity of odorifics such as VOCs are generally much lower in wastewater treatment, because that industry has effective odor abatement measures.

   iii. This information is old (2006). Why?

   iv. Why does this table, from another industry entirely, appear in this study, instead of a recent one that's directly relevant to landfills? The use of this table brings up questions about manipulation of the narrative of this study, such as: did the odor consultant cherry-pick this table so as to obscure the D/T of landfill gas, which may be high (higher than 100,000 D/T?)?

3. **Republic has misrepresented its complaint data for the odor study.** The presentation cites the data as coming from its "comprehensive odor management plan, 2022-2024." Ginger Richardson of Republic Services, however, informed the Benton County Board of Commissioners and staff by email on March 4, 2024, that Republic's real-time portal for

complaints (a web form) *had not yet been announced publicly*, “but would be soon” (email thread attached, see attachment **A3**). This was after Commissioner Wyse encountered landfill odor driving with her family on 99W (February 22, 2024) and sought a way to notify Republic of it, but found it notably difficult to do so (see attachment **A4**).

4. **The results of the odor study cited in Republic and County presentations are called into question by a documented real-world case where landfill odor disrupted a sale of land (a vineyard) in 2023.** That case is detailed in a local press article (see Munidocs **link**, p. 8).
5. **The results of the odor study cited in Republic and County presentations are called into question by documented cases where odor from landfills similar to Coffin Butte have caused widespread impacts over their area.** There are many examples; one such case is detailed in recent press articles from California (see Munidocs **link** and attachment **A5**) and another in news reports from North Carolina (see attachments **A6** and **A7**).
6. **The mitigation efforts listed in the Republic presentation *do not actually include any provisos for odor mitigation***. They attempt only to prolong Republic’s fiction that odors might not actually be happening at Coffin Butte Landfill.
7. **Republic has had ample opportunity to voluntarily reduce odors, but has failed to act on them.** There are well-established protocols for landfills to follow to reduce odors, but Republic has not followed any such protocol at Coffin Butte. Such actions would have been, or should have been, supplied to you as evidence – increased monitoring efforts, for example.

   In particular, Republic should have acted on the information provided to them by Carbon Mapper, the climate science nonprofit which is creating the images and data of landfill gas plumes coming off the landfill. Carbon Mapper open-sources this data *specifically so that facility operators such as Coffin Butte’s can access it and act on it*. The plume images show the origin points of the plumes, to aid facility operators in locating these mega-leaks and remediating them. Republic has not acted on these remediation aids; in fact, one mega-leak that Carbon Mapper pinpointed in July 2023 was still there in September 2024.

   If Republic did not undertake voluntary remediations in order to clean up its act and put on a good face for this expansion application, it’s exceedingly unlikely to begin once the company already has what it wants.
8. **The Conditions of Approval for odor listed in the County presentation do not actually include any provisos for controlling odor**.
   a. OP-5, limiting the height of the expanded landfill does not control odor: it is no different than the status quo.
   b. OP-7(A) and (B) also only attempt to prolong the fiction that serious odors might not be actually happening at Coffin Butte Landfill; neither contain any actual mitigation. For example, OP-7B: “Odor complaints which are verified by site personnel shall be remediated where possible” is no different from the status quo.
   c. OP-7(C) appears to be an attempt to derive a real-world operational limit from a mathematical model, which will not actually prevent any odor from occurring.
      i. A quantity of “organic waste” may be assumed in a generalized mathematical model, but there is no reliable operational way on a day-to-day basis to determine how much of incoming waste is “organic.”
      ii. OP-7(C)’s supposed annual limit of 930,000 tons of organic waste seems to be the result of mathematical misunderstanding or error by the County. Never in the dump’s history has it ever taken even half of this amount of organic waste in a year.

          A quick back-of-envelope calculation shows this: “organic” is tricky to define, but if you use the EPA guidance that a typical municipal solid waste stream is

roughly 33% ”organic,” then Coffin Butte’s current annual intake is roughly 0.36M tons of organic (33% of 1.05M tons). Allowing the annual intake of organic waste to escalate from 0.36M tons to 0.934M tons, which is what this Condition of Approval would do, is allowing a 250% increase in annual organic waste. This would lead to a corresponding sharp increase in landfill gas emissions, leading to landfill gas emissions that are 250% higher than where we are now. At no time is there any kind of “throttling” effect on landfill gas emissions as a result of OP-7(C).

iii. OP-7(C)’s so-called “limit” of 934,000 tons of organic waste annually also seems to be the result of misunderstanding or error by the County, because the County seems unaware of the drastic change that would have to have occurred for it to be triggered. As shown above, for the 934K/yr limit to come into play, the yearly waste intake would have increased 250%, which means Coffin Butte would have filled its quarry and expansion volumes much more rapidly and the landfill would be closing in the 2030–2035 timeframe.

iv. A simple use case for this Condition would be: the County discovers that Republic has exceeded its organic waste allotment (however “organic” is defined). The County has not identified any realistic mechanism by which it can enforce this Condition, i.e., how it can compel Republic to place less organic waste going forward to make up for its overage, especially since to achieve a one-ton reduction in organic waste, Republic would have to forego two additional tons of non-organic waste.

v. In terms of odor, OP-7(C) is much worse than the status quo: up to 2.5x worse.

d. OP-7(D) just furthers the narrative that the problem is detection and quantification of odors, rather than actual mitigation of them. It continues the current policy of raising procedural obstacles that must be overcome before mitigation will even be attempted, and its mitigation mandate – “Applicant shall immediately take steps to mitigate the odor” – might as well specify the use of a magic wand.

e. OP-11(A-F) – Republic is already subject to these requirements at its existing landfill. Since the County adds no monitoring or enforcement, these Conditions make no effective change to the status quo, and do not mitigate odor.

9. **Qualitative discrepancy: the odor study asserts the qualitative result of “no nuisance,” but pays no attention to how the *quality* of an odor affects its *qualitative result*.** Simply put, there are dangerous odors and non-dangerous odors, and numerous testimonies establish that Coffin Butte odor is dangerous-smelling (Munidocs **link1** **link2** **link3** **link4** etc.). “It’s OK for me to keep breathing this odor,” said no one, ever, upon encountering the smell. This is a fatal flaw in the odor study.

10. **Landfill odors DO actually signal danger.** Landfill gas is known to contain many toxics. The nose knows.

a. “Nearly 30 organic hazardous air pollutants have been identified in uncontrolled landfill gas, including benzene, toluene, ethyl benzene, and vinyl chloride. Exposure to these pollutants can lead to adverse health effects.” – EPA. As an example, Coffin Butte’s 2020 Air Toxics Emissions Inventory (the most recent I could find) shows that the landfill is calculated to have emitted over 2 tons of toluene gas that year. Toluene has a sweet or sharp odor, which is how I would describe what landfill gas smells like.

b. PFAS is a focus of current concern, because the EPA has established that these chemicals are present in landfill gas, and they are known to have a wide range of health impacts even at small concentrations, but these impacts are not yet well known,

especially for “non-legacy PFAS” (PFAS variants that are being used to replace the “legacy” PFAS types, which have been phased out due to health impacts). The science on PFAS is emerging, and that has been well documented in prior testimonies to the Planning Commission (see this Munidocs **link and its attachments**).

The current lack of clarity from the EPA about safe levels of PFAS only increases concern and avoidance. *It’s prudent to be alert to, and shield yourself and your family from, a toxic smell if you have no assurance that it’s safe to breathe.*

11. **Odor quantification does not equal proof of non-seriousness.** Republic Services and the County both admit this. According to them, a D/T of 1 means that on the average, half the people encountering it will smell it. Since approximately 8,400 people live within 5 miles of the landfill, there are 4,200 who will smell it regularly at that level.

    Let’s put “D/T” in plain language, in the experience of a person who has a reasonably good sense of smell. They will no longer be able to make use of the E.E. Wilson Wildlife Area – you have testimony to this effect. They will no longer be able to drive 99W with their windows open or the air system not on RECIRC – there’s testimony about this as well. They will no longer be able to freely visit friends or family in the area of the landfill. And if they happen to live within a certain radius of the landfill, they will need to sell and move, but of course they won’t be able to sell if buyers also have a good sense of smell. You have testimony about all this as well.

    Republic’s odor quantification of the number of people involved in this situation is suspect, given the disparity between what the numbers say and what the people say, but the *precise* number is irrelevant, because it is clearly nowhere close to zero.

    We know that **x** number of people are already suffering serious interference **i** from the odor impact of the landfill – so the harm is **x times i**. An expanded landfill would increase this impact on **x**, because as Republic admits, it would extend their time suffering the impact **i** – so, it’s now **x times (i+j)**, where **j** is that impact during that extended time. If the landfill persists for longer, it's also growing **x**, because now there’s more time for more people to suffer the impact. So an expanded landfill means we no longer have **x times i**, we have (**x+y) times (i+j)**, where **y** are the new people suffering the odor impacts. We also have an increase in odor impacts because they are a function of landfill surface area, which an expansion would increase by roughly 33%. So now, where we have **x times i** with no expansion, we have **((x+y) times (i+j)) times 1.33.** Has Republic *convinced* you that **((x+y) times (i+j)) times 1.33** is a small enough number that your criteria can safely ignore it? On the contrary, I would say: you have received no proof of that. Without proof, you cannot find that serious interference will not occur.

Conclusion. As explained in verbal testimony (see Munidocs **link**), a Burden of Proof must both produce *evidence* and create a *convincing narrative*, or it fails. Let’s look at how Republic itself characterizes its evidence, quoting the Supplemental Staff Report:

> “Staff engineering consultants have reviewed and determined the applicant’s odor study follows reasonable assumptions and modeling protocols.” (p. 8)

This is weak tea, narratively speaking. It is damning with faint praise. Any number of studies may be constructed that follow “reasonable assumptions and modeling protocols,” but which *fail to adequately and convincingly model reality*.

The numbered Arguments above create a number of narratives about odor that more than countervail the stories put forward in Republic’s presentation and by Pawlowski in his letter. Here is one such narrative, assembled from the above Arguments:

The dump has an odor problem, and has had one for many years;

Republic has been unwilling or unable to remedy it;

Republic has chosen instead to try to discount community concerns about odor;

Landfill proponents support this by characterizing complainants as NIMBYs;

Republic belatedly realized odor would be a key issue in early 2024, and created an odor complaint portal shortly before filing the expansion application;

The purpose of the portal was to collect data they could use to discount odor as an issue;

Most community members intuited this, and did not use the portal (myself included);

The data did not lend itself to the conclusion Republic wanted, and so it took approximately nine months and many attempts to engineer an odor study that could pass muster as "following reasonable assumptions and modeling protocols" and still have the conclusion that Republic wanted;

Republic knows the odor study is riddled with flaws, but is hoping the public will not be able to bring those forward;

Republic hopes to overcome the weight of hundreds of community concerns about odor by trying to assert, through the gravitas of credentialed consultants, that the action that's needed is monitoring, not mitigation.

I am not under a Burden of Proof, but I believe the evidence available to you, Commissioners, supports this narrative more than Republic's "reasonable assumptions," which is under a Burden of Proof.

I'll close with rebuttal of a point of view which Pawlowski summarizes very well:

> "Many opponents to the landfill are those that live near the landfill site… One should not expect customers of several counties to yield to the few who had the option to buy property elsewhere. The responsibility of having one's property value affected should be pushed back to those who decided to buy residential land nearby. What were they thinking?" (p. 2-3)

I think you Commissioners are aware of the shortcomings of this reasoning from a land-use perspective, so I won't belabor them. Your decision criteria focus on serious interference to other land uses and to the character of the area, not on the interests of customers or the business that serves them. What I focus on here is how this reasoning attempts to divert responsibility for environmental hazards away from the entity causing them and onto the entities suffering them – *victim blaming*, in modern parlance.

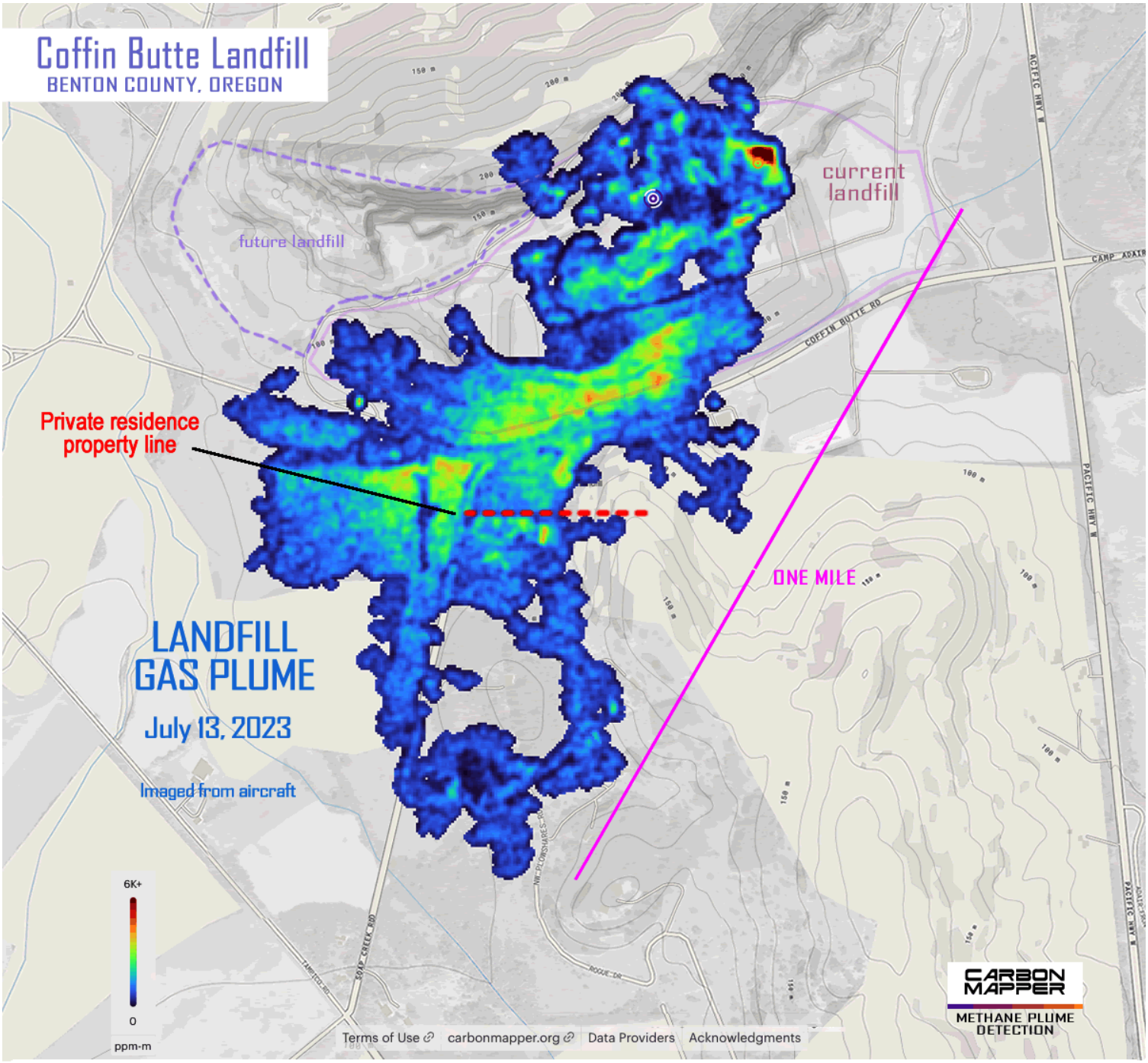
As you have heard in many testimonies, victims of dump odor did not buy, but inherited their land, or bought land when the landfill and its future were much different, or bought land many miles away from Coffin Butte Landfill, never imagining landfill stench could travel that far. Or they don't live here, they just try to visit, or pass through on Highway 99W. No matter: however they came to be where they are, your decision criteria focus on whether or not an expanded landfill will pose serious interference to their enjoyment of their land, or to the character of the area.

Pawlowski is in effect promoting the idea that the area around the landfill should become a *sacrifice zone* – or, I should say, to *continue* becoming a sacrifice zone, because that has been a dark thread in its history so far. The landfill has driven away farms and farmers with well contamination, bought up and deplatted neighborhoods-to-be, degraded wetlands and natural areas, and so on. Attorney Kleinman articulated this process and its future very well in his July 9 testimony, when he evoked an image of the landfill expanding into a new location, which blights surrounding uses, so that it has a new area to expand into, and so on, without end. –Or should I say, instead of landfill, the *Landfill Complex*, because LU-24-027 would establish a precedent of creating new landfills that no longer even physically touch the existing ones.

Every sacrifice zone has an associated *abundance zone* – somebody who profits from the sacrifice zone – and Pawlowski touches on this as well, with his opinion that the needs of Republic's customers and Republic outweigh those of the people in the sacrifice zone. Pawlowski is saying the quiet part out loud.

Commissioners, an Approve decision on this land use application would be a de facto declaration of Sacrifice Zone status, and would have a huge and irrevocable impact on the character of the area that I and many others call home.

And it may have a wider impact, as well. What we're finding in VNEQS is that many Oregonians don't want to benefit from the victimization of others. They'd vote against it, if they could. They'd object to being characterized as customers who are only concerned with low garbage rates. They may not be here to speak for themselves – many don't even know what is being proposed in their name – through no fault of their own, I may add. They're voiceless in this proceeding, but I'll speak up on their behalf, and urge you to deny the application to expand Coffin Butte Landfill. "Not in our names," is what they are saying.


Coffin Butte Landfill
BENTON COUNTY, OREGON
current landfill
future landfill
Private residence property line
ONE MILE
LANDFILL GAS PLUME
July 13, 2023
Imaged from aircraft
6K+
0
ppm-m
Terms of Use
carbonmapper.org
Data Providers
Acknowledgments
CARBON MAPPER
METHANE PLUME DETECTION

☆ **Nancy Wyse** February 28, 2024 at 8:53 PM

RE: Odor complaint form on the Coffin Butte Landfill site?

To: Ken Eklund

NW

Ken,

I don't recall if the link/online feature was ever formally shared with us (Benton County/Board of Commissioners)… it could have been, but I don't remember. I do remember seeing reports of complaints about the landfill, which included odors. Since I experienced the odors last week it made me think about that report and wonder if others were reporting. I saw your email come in and went to their website to look. It took me a few minutes to find it. I couldn't find a link. I had to do 3 or 4 searches to find it. I *think* the keyword that finally found it was "odor".

We (my family and I) were driving hwy 99W northbound on the 22nd around 5:30/5:45pm-ish. I had a respiratory infection at the time which affected my sense of smell, but just before Adair Village I noticed a "weird" smell and it got stronger right as we passed the landfill.

p.s. not to diminish the focus of your email, but I've not seen a golden eagle in Benton County before… but I'd like to! I'll keep my eyes peeled!

Benton County OREGON

Nancy V. Wyse *(She/hers)*
Commissioner
Office: 541-766-6754 | **Cell:** 541-760-6067
Email: nancy.wyse@co.benton.or.us
Address: 4500 SW Research Way, Corvallis
www.co.benton.or.us

Ken Eklund, writerguy

37340 Moss Rock Dr
Corvallis OR 97330
408.623.8372

Creator of
World Without Oil
Ed Zed Omega
FutureCoast
and other storymaking games

From: Ken Eklund
To: Benton Public Comment
Subject: Testimony in response to Republic-County-Pawlowski written material July 8-9: PFAS
Date: Wednesday, July 16, 2025 4:58:25 PM
Attachments: writerguy-cube2.png

CAUTION: This email originated from outside of the organization. Do not click links or open attachments unless you recognize the sender and know the content is safe.

RE: LU-24-027, the application to expand Coffin Butte Landfill
RECOMMENDATION: Please deny this application
ID: This is Part C: Concentrating PFAS.

Dear Chair Fowler, Vice Chair Hamann, and Planning Commissioners Biscoe, Cash, Fulford, Lee, Struthers, and Wilson:

This is testimony in response to the July 8, 2025, slide presentation made by Republic Services. It also refers to evidence and testimonies previously submitted, and provides links to articles of evidence and testimonies in the Munidocs record, to help you locate them.

CONCENTRATING PFAS
Republic (RS) presentation, p. 26
Staff presentation by reference
Pawlowski by reference

Slide 16 of the RS presentation addresses the comment "*Coffin Butte landfill leachate contains PFAS***".**

RS comment - *PFAS concentrations measured in Coffin Butte Landfill leachate samples are similar to PFAS concentrations measured in a study of landfill leachate and leachate samples collected from California MSW landfills.*

- I notice that RS carefully doesn't say what the PFAS load is – so we can't actually verify their assertion. Why is that?
- Landfill leachate is known for its PFAS load. Saying that the PFAS levels in Coffin Butte Landfill (CBL) leachate are no worse than that of other landfills is not helpful in addressing the seriousness of the concern. Other landfills are concerned too: even low levels of PFAS are of great concern.
- How leachate is treated and where those PFAS (and other toxic components) end up is critical to completing the picture. So, let's talk about that:
    - Somewhere around 35 million gallons of CBL leachate is processed with municipal wastewater at municipal wastewater treatment plants (WWTPs) every year. Currently, those are WWTPs in Corvallis and Salem.
    - As described in Pam Castle's 6/11/2025 written testimony (https://library.municode.com/or/benton_county/munidocs/munidocs?nodeId=8135d7834e2c8), **municipal wastewater treatment plants (WWTPs) do not treat PFAS**. PFAS removal requires specific processes that are not

included in WWTP process, so the PFAS entering the municipal wastewater plant with leachate are not removed during treatment. Instead, they are:

- Released into the Willamette River with WWTP effluent
- Distributed into the air as aerosolized droplets generated during aeration steps of wastewater treatment. PFAS levels are higher around WWTPs.
- Spread with biosolids onto soils in the region.

- **Aeration at WWTPs converts precursor molecules in landfill leachate into PFAS.** In other words, treatment at WWTPs makes the landfill leachate PFAS problem worse.

- A comparison of PFAS concentrations (provided by Clean Water Services) in leachate from three western Oregon landfills – Riverbend, Hillsboro and Coffin Butte – refutes the applicant's statement claiming that the PFAS concentrations in CBL leachate are similar to those of other landfills. Of the six PFAS compared in a plot of this data (submitted to the record by Dr. Joel Geier) **three were present in much higher concentrations in CBL leachate**. The PFBS concentration in CBL leachate was approximately **4 times** that of Riverbend landfill leachate and over **10 times** that of Hillsboro landfill leachate.
    - This is particularly concerning given the findings in the recently released Waterkeepers PFAS Phase II study of sites downstream from 22 U.S. WWTPs nationwide. The Rock Creek WRRF receives Hillsboro landfill leachate and releases its effluent into the Tualatin River. This waterway was in the top 6 for number of PFAS found to be elevated downstream of the effluent release. It tied for 4th place with two other landfills.
    - In addition, the increase in total PFAS concentration in the Tualatin River downstream from where the Rock Creek WRRF effluent is released was the 5th highest increase of the 22 waterways studied.

RS comment – *No PFAS have ben detected in City drinking water.*

- It is important to note that the intake for the city of Corvallis' drinking water is UPSTREAM of the City of Corvallis' WWTP effluent discharge into the Willamette River. Because of this, we would wouldn't expect the PFAS in WWTP effluent to affect the Corvallis drinking water.
    - It could, however, affect the Adair Village drinking water supply since their intake is downstream of the release of the Corvallis WWTP effluent. And it could affect other communities further downstream.
- A more appropriate measure of the effect of PFAS on the area would be the PFAS concentration in Corvallis WWTP effluent. Those PFAS are released into the Willamette River.

RS comment – *Currently there is no formal requirement to monitor PFAS in leachate or groundwater.*

- This does not lessen the concern about or the need for monitoring PFAS. Government agencies are slow to adopt and enforce rules. Waiting until CBL is forced to stop

spreading PFAS in the environment does not fit with their "good community member" descriptor.

- As very recently reported by The Guardian newspaper, the U.S. government has pulled $15 million in funding earmarked to study the effects of PFAS contamination of agricultural land, contamination primarily due to spreading of biosolids from WWTPs. These studies were designed to determine how PFAS move into and accumulate in crops and livestock and enter our food supply.
    - This is an example of why we cannot wait on agencies to police this issue. They aren't going to be able to do that for a long time. Meanwhile, PFAS-laden WWTP biosolids continue to be spread onto our fields. A good neighbor would monitor their leachate's PFAS and stop sending it to the WWTP where those PFAS go on to contaminate our environment.

RS comment – *The amount of leachate treated at the City of Corvallis' WWTP represents 0.0058% of the water treated by the WWTP.*

- This is a 100-fold underestimate. If the WWTP processed 4 billion gallons total and 23 million gallons of that was landfill leachate, the leachate accounted for 0.0058 of total. Multiply that by 100 and you get a total percentage of 0.58%, rather than the 0.0058% reported.
- Trace quantities of PFAS are of concern for human and environmental health.
- PFAS are persistent in the environment, landfill leachate has an outsized PFAS load compared to municipal wastewater, and repeated, long-term exposure to PFAS cause harm making seemingly small volumes of leachate of importance.

Please deny LU-24-027, for findings that it has not been proven not to risk the health of its neighbors and area.



Ken Eklund, writerguy

37340 Moss Rock Dr
Corvallis OR 97330
408.623.8372

Creator of
World Without Oil
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FutureCoast
and other storymaking games

Issue:

VLI has presented inaccurate information on leachate as a fraction of wastewater treated in Corvallis. The stated percentage is too low, by roughly a factor of one hundred. This gives a false impression of the significance of leachate being effectively passed through to the Willamette River, particularly in regard to the high concentrations of PFAS and heavy metals.

Statements by VLI that concentrations of these pollutants are "similar to other landfills" are cause for concern rather than cause for comfort.

In simple terms explained below, leachate shipments to Corvallis amount to roughly one and a half gallon jugs of highly contaminated water, per household per day. That shouldn't be downplayed.

New evidence:

Republic's slide deck for July 8th, slide 16 includes the following bulleted statements:

> *• PFAS concentrations measured in Coffin Butte Landfill leachate samples are similar to PFAS concentrations measured in a USEPA study of landfill leachate and in leachate samples collected from California MSW landfills.*
>
> *• Currently there is no formal requirement to monitor PFAS in leachate or groundwater.*
>
> *• The amount of leachate treated at the City of Corvallis' WWTP* ***represents 0.0058% of water treated by the WWTP****.*
>
> *• Metals concentrations in Coffin Butte leachate are similar to those at other MSW landfills, according to data published by USEPA.*

Response:

There is a major (nearly a factor of 100) error in the applicant's assertion that landfill leachate represents just 0.0058% of the wastewater treated by the City of Corvallis's wastewater treatment plant (WWTP).

> *• The amount of leachate treated at the City of Corvallis' WWTP* ***represents 0.0058% of water treated by the WWTP****.*

The City of Corvallis website (Figure 1) states that the WWTP processes "over 4 billion gallons of wastewater a year."

Table 4-11 of the 2024 Annual Environmental Monitoring Report (AEMR) for Coffin Butte, as submitted to DEQ, states that for the 12-month period from October 2023 through September 2024, VLI shipped 20,301,148 gallons of leachate to the Corvallis WWTP.

Using round numbers:

(20 million gallons leachate) / (4 billion gallons wastewater) = 0.50%

PUBLIC WORKS

Wastewater Treatment

The City of Corvallis operates one wastewater treatment plant, maintains over 200 miles of wastewater collection pipes, and treats over 4 billion gallons of wastewater a year. The sanitary sewer system is a gravity system, which uses eight pump stations to move the wastewater from lower elevation portions of the system to the treatment plant located at NE 2nd Street. The treated wastewater goes through a rigorous series of tests to assure water quality is not compromised as it is discharged back to the Willamette River. Biosolids (or sludge), a byproduct of the treatment process, are stored and recycled each summer as a soil amendment to agricultural fields. For a tour of the wastewater treatment plant, call 541-766-6934.



Figure 1: Screen shot of the City of Corvallis wastewater treatment plant web page as of July 12, 2025, documenting the amount of wastewater treated annually as "over 4 billion gallons per year."

If they shipped 23 million gallons to Corvallis last year (possibly not yet reported to DEQ) , that would be:

(23 million gallons leachate) / (4 billion gallons wastewater) = 0.58%

We suspect that the error in the applicant's slide is the result of a simple mathematical error by their consultants, or perhaps a misunderstanding of the difference between decimal fractions and percentages, rather than willful deception.

Either way, it doesn't give great confidence in the level of care that goes into their methods of handling, interpreting, and presenting data that are highly relevant for assessing risks to human health and the environment.

To put this into simple terms, a typical US household uses about 300 gallons of water per day. 0.50% of that would be 1.5 gallons of leachate per household, per day.

Imagine if, every other day, this company delivered three gallon jugs of leachate to your doorstep and asked you to kindly pour it down your toilet. That's effectively what they've been asking the City of Corvallis to do, on their behalf.

We agree with the applicant that PFAS concentrations in leachate from Coffin Butte Landfill are similar to other MSW landfills. We obtained leachate PFAS data by public records requests from the City of Corvallis and Clean Water Services (original data available in spreadsheet form on request), to compare Coffin Butte with two other landfills in western Oregon (Hillsboro and Riverbend).

For three of the six categories of regulated PFAS, Coffin Butte leachate appears to be worse than both Riverbend and Hillsboro, but lies near the middle of the range for the other three categories. All of them are far above the EPA's regulatory standards for drinking water, by factors of up to several orders of magnitude.

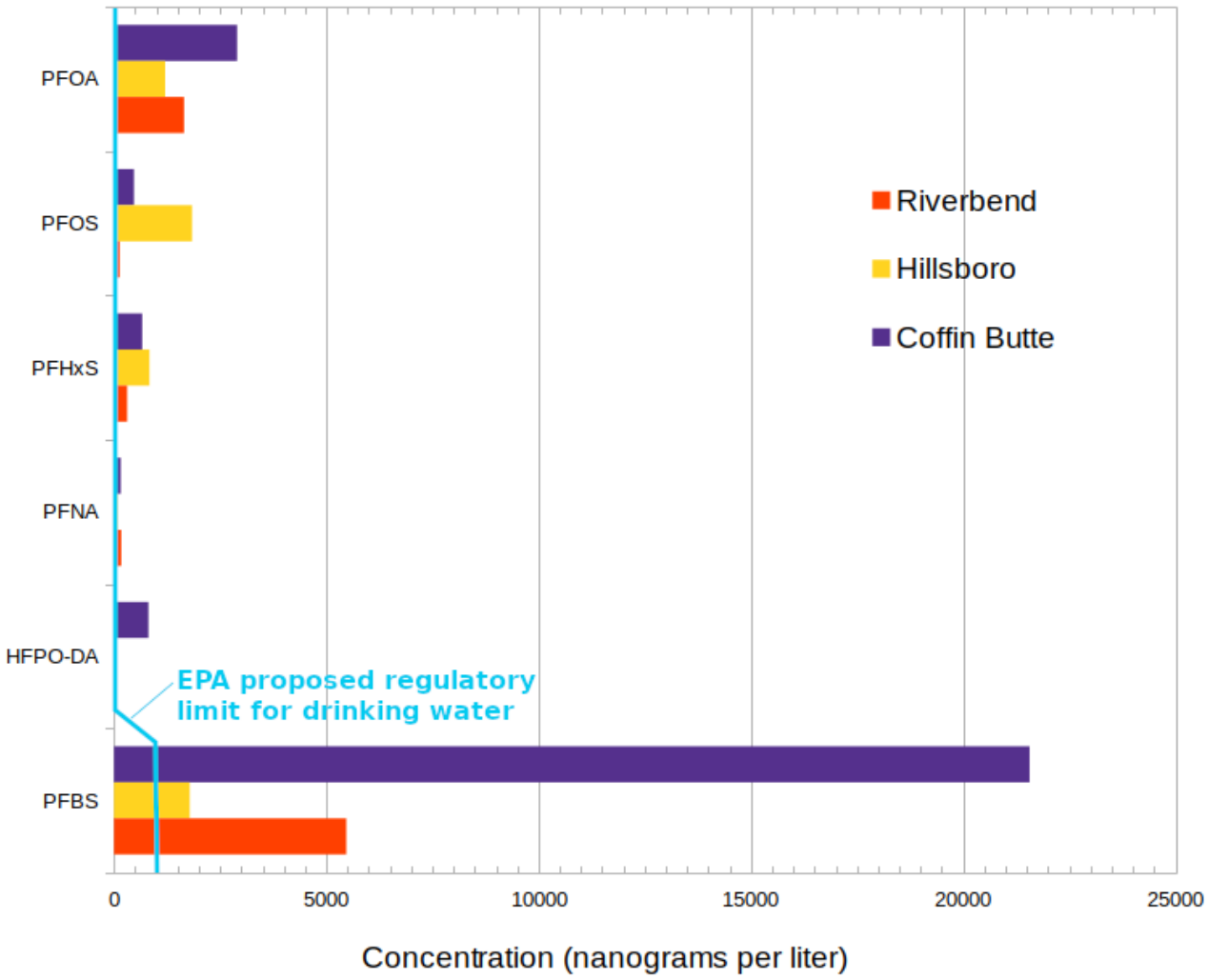


Figure 2: PFAS in leachate from three landfills in western Oregon (averages calculated over multiple samples for each of the three landfills, for the six types of PFAS now regulated by the USEPA (the "proposed" regulatory limits shown in the figure were adopted last year).

The implications of these high concentrations in leachate are just beginning to be understood. In my verbal testimony on July 9th, I included a handout from the recently released Riverkeeper report on PFAS inputs to rivers (included here as Annex 1). Data from the Tualatin River upstream and downstream of the Hillsboro WWTP show that this is a major point source of PFAS inputs to that river. At least two other WWTPs that accept landfill leachate, in other states, were found to be among the 10 worst WWTPs for PFAS pollution in the country.

No WWTPs on the Willamette River were included in that study, but it should be anticipated that the high PFAS load from Coffin Butte Landfill could affect the Willamette River below both the Corvallis WWTP and the Willow Creek WWTP in Keizer/Salem.

Similarly we agree that heavy metals concentrations in leachate from Coffin Butte are similar to other MSW landfills. That is not a favorable comparison. We also note that Coffin Butte has not presented data for mercury in leachate, at least since 2021.



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PFAS Report Phase II

UNCOVERING PFAS CONTAMINATION IN FRONTLINE COMMUNITIES



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ABOUT WATERKEEPER ALLIANCE

Waterkeeper Alliance is a global movement uniting more than 300 community-based Waterkeeper groups around the world, focusing citizen action on issues that affect our waterways, from pollution to climate change. The Waterkeeper movement patrols and protects nearly six million square miles of rivers, lakes, and coastlines in the Americas, Europe, Australia, Asia, and Africa.

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180 Maiden Lane, Suite 603, New York, N.Y. 10038

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EXECUTIVE SUMMARY



This report presents novel, targeted data from a monitoring project focused on locations near wastewater treatment plants (WWTPs) and permitted biosolids land application sites—suspected contributing sources of per- and polyfluoroalkyl substances (PFAS) to waterway contamination. The findings confirm that PFAS contamination is both widespread and persistent, reinforcing the urgent need for stronger regulations, expanded research, increased funding, and improved treatment technologies. This work adds timely, critical insight to the growing understanding of PFAS pollution, especially in frontline communities already facing disproportionate environmental and health burdens.

PFAS are a class of manufactured organic chemicals pervasive in the environment and linked to harmful public health and ecosystem impacts. Often referred to as "forever chemicals" because they do not break down or do so very slowly,[1] PFAS have been widely used in various industrial and consumer products since at least the 1950s. As a class of chemicals, there are approximately 15,000 different derivatives[2] that share similar molecular structures, environmental characteristics, and biological hazards. These toxic compounds are biopersistent, bioaccumulative, and pose serious health risks, including cancer, reproductive and developmental effects, immune system dysfunction, and hormonal disruption.[3]

Largely unregulated by EPA and many state agencies, PFAS are widely released from sources such as industrial wastewater, landfill leachate, and effluent, sewage sludge, and biosolids from wastewater treatment processes. As a result, PFAS have contaminated the environment, including both groundwater and surface water used for drinking.[4] When sewage sludge is treated to meet EPA regulatory standards and is intended to be land applied as a soil conditioner or fertilizer on agricultural, forested, and other lands, the agency typically refers to it as biosolids (Class A or B). Untreated or partially treated sewage sludge may be incinerated or disposed of in landfills—in dedicated monofills or co-disposed with municipal solid waste sites.[5] Biosolids often contain PFAS but the federal regulatory standards and treatment process are not sufficient to control these pollutants.

The pervasiveness of this contamination intensifies the potential harm to the environment and human health when facilities do not adequately contain, treat, and dispose of PFAS-contaminated wastewater and sewage sludge. These facilities[6] can receive PFAS in wastewater from residential, commercial, and industrial sources that produce, manufacture, or use products that contain PFAS.[7] As centralized collectors, WWTPs face significant challenges due to underfunding and the limitations of traditional treatment technologies. These technologies are not designed to remove or destroy compounds characterized by strong carbon-fluorine bonds and resistance to degradation. As a result, these substances are discharged into receiving surface waters through effluent or transferred through contaminated sewage sludge and biosolids. While PFAS are found in waterways across the country, their impacts are not equally distributed. Communities of color, low-income, and rural areas, which are often closer to sources of industrial pollution and have limited resources for water testing and treatment, face higher exposure risks and greater health vulnerabilities.

Despite decades of releasing PFAS into the environment, "few industrial facilities have PFAS monitoring requirements, effluent limitations,[8] or pretreatment standards[9] for wastewater discharges" because EPA has not adopted national requirements.[10]

Because industrial wastewater is not adequately regulated for PFAS, these chemicals often end up in sewage sludge, which is then processed into biosolids used on land. In 2022, EPA estimated that 56% of biosolids were land-applied for agriculture, reclamation, or other uses.[11] By 2023, that figure had risen to 60%, with 31% applied to U.S. agricultural land—an 11% increase from the previous year.[12] As a result, PFAS that are often present in biosolids have contaminated, and continue to contaminate, lands, livestock, waterways, and agricultural products across the country.[13]

The extent of PFAS contamination in U.S. surface waters was exposed in Waterkeeper Alliance's 2022 Phase I monitoring project, in which 113 Waterkeeper groups collected a total of 228 PFAS samples in waterways from 34 states and the District of Columbia (D.C.).[14] The results were striking: PFAS were present in 83% of the waterways tested, with at least one compound found in 95 out of 114 sites sampled. Of the 55 compounds analyzed, 35 were detected in 63.6% of the sites. Overall, measurable concentrations were found in waterways across 29 states and D.C., often at levels far exceeding EPA drinking water health advisory limits.[15]

Waterkeeper Alliance developed this Phase II water quality monitoring project to test surface waters for the presence of PFAS upstream and downstream from 22 WWTP sites and 10 biosolids land application fields in partnership with Hispanic Access Foundation and Waterkeeper groups in 19 states.[16] This project utilized cutting-edge SiREM PFASsive™ sampling techniques and state-of-the-art analytical methods at Eurofins Environment Testing Calscience laboratory in Sacramento, Calif. (EPA Method 1633[17]). The monitoring evaluated and quantified PFAS contamination from municipal wastewater and biosolids land application fields over time, with a focus on disproportionately impacted communities. To our knowledge, this is the first monitoring project that employed passive sampling devices at WWTP-associated sites in multiple states, producing more representative data on PFAS equilibrium concentrations.[18] By quantifying only dissolved PFAS contaminants, it provides a more accurate basis for bioavailability, toxicity, and risk assessment than conventional grab samples, which reflect total concentrations at a single timepoint. The resulting data enhances our understanding of PFAS migration pathways, bioavailability, and impacts in U.S. surface waters. It further demonstrates that treatment processes and land application methods play a critical role in the release of these contaminants into surface waters, highlighting both limitations in current practices and areas where contamination is occurring.[19]

This evaluation also helped identify sites across the country where stronger measures are needed to control source pollution from industrial dischargers as well as subsequent passthrough discharges from WWTPs and biosolids land application fields.

Our evaluation of the PFAS sampling results also makes clear that existing laws, regulations, and conventional wastewater treatment technologies are not adequately controlling, preventing, or remediating PFAS pollution in surface waters, exposing people and ecosystems to serious health risks.



PFAS are synthetic chemicals that have contaminated nearly every part of the environment and many aspects of daily life. These compounds were deliberately engineered to resist heat, water, and oil, making them extremely difficult to break down under natural conditions. As a result, they persist in the environment, bioaccumulate in humans and wildlife, and cycle through air, water, soil, and living organisms, threatening public health and ecosystems. Their widespread use and remarkable persistence have led to global contamination and an urgent need for regulatory action and cleanup.

Common household products containing PFAS.



CURRENT POLICY LANDSCAPE

The core federal law designed to control discharges of PFAS to surface waters is the Clean Water Act (CWA).[20] However, EPA has not adopted adequate regulations under the CWA to implement the law effectively and prevent this pollution.[21] For example, the agency has yet to adopt national PFAS water quality criteria to protect human health in surface waters[22] or establish Effluent Limitation Guidelines (ELGs), including pretreatment standards for industrial dischargers to wastewater treatment systems.[23] These regulations are central to placing limits on PFAS discharges through National Pollutant Discharge Elimination System (NPDES)[24] and industrial pretreatment permits.[25]

In October 2021, EPA released its PFAS Strategic Roadmap, outlining a whole-of-agency approach to addressing the toxic contaminants.[26] While progress on the development of federal PFAS actions and standards stalls, states across the country are grappling with this "contamination crisis,"[27] but state policies to address PFAS contamination are also limited and vary widely. Currently, at least 23 states have taken steps to address the problem through regulations, funding, and public health initiatives, though these measures are not yet comprehensive and vary widely in scope."[28]

In April 2024, EPA established legally enforceable Maximum Contaminant Levels (MCLs)—primary standards that apply to public water systems—for six PFAS compounds in drinking water under the Safe Drinking Water Act (SDWA).[29] In May 2024, the agency designated PFOA and PFOS as hazardous substances under CERCLA[30] (the Superfund law), enabling it to take cleanup actions and hold polluters accountable for costs.[31] The following December, EPA proposed draft human health water quality criteria (HHWQC) to limit PFOA, PFOS, and PFBS in surface waters.[32] While not yet finalized, these criteria represent concentrations which, if not exceeded, will protect the general population from adverse health effects due to ingesting water, fish, and shellfish. There is currently no proposed human health water quality criteria for other PFAS compounds.

In May 2025, EPA announced its intent to extend compliance deadlines for the PFOA and PFOS MCLs, establish a federal exemption framework, and rescind regulatory determinations for PFHxS, PFNA, HFPO-DA (GenX), as well as the Hazard Index mixture that includes PFBS.[33] These proposed changes do not have immediate legal effect and would require formal rulemaking, which could take years and likely face legal challenges.

Additionally, the agency has yet to establish numeric limits or monitoring requirements for PFAS in biosolids under Section 405(d) of the CWA,[34] despite being alerted to biosolids contamination by a major PFAS manufacturer as early as 2003.[35] Instead of taking regulatory action to address PFAS, EPA encouraged the use of biosolids as fertilizer, resulting in the widespread dispersal of the contaminants over millions of acres. The fertilizer industry estimates that farmers currently hold permits authorizing biosolid applications on approximately 70 million acres—about one-fifth of all U.S. agricultural land.[36]

Federal, state, and tribal governments must urgently monitor waterways, adopt enforceable standards to eliminate PFAS pollution sources, mitigate existing contamination, and, where authorized to regulate discharges, ensure compliance through permitting and enforcement. They must also prioritize funding for PFAS monitoring and the installation of advanced treatment technologies to protect impacted communities—especially those disproportionately affected by PFAS and other toxic pollutants. The scale of this contamination and its risks to public and environmental health demand strong and immediate regulatory action.

KEY FINDINGS

1. **The U.S. surface waters tested are widely contaminated by many different types of regulated and unregulated PFAS.**
   a. 98% of all surface water sampling sites tested upstream and downstream from WWTPs and biosolids land application fields in 19 states had one or more PFAS type detected, except for a single site downstream from a biosolids land application field in Wisconsin.
   b. More than half of the 40 PFAS chemicals that can be identified by EPA Method 1633 were detected in surface water samples upstream or downstream from WWTPs and biosolids land application fields.

2. **Wastewater treatment plants and biosolids land application field discharges can be significant contributors of multiple types of PFAS to U.S. surface waters.**
   a. The overwhelming majority of WWTPs evaluated lack enforceable PFAS limits in their CWA NPDES and other permits–both for discharges to surface waters and for biosolids applied to land application fields–underscoring the urgent need for regulatory standards to control these releases.
   b. 95% of downstream WWTPs sampling sites and 80% of downstream biosolids land application sites had elevated concentrations of multiple types of PFAS.
   c. Out of 40 types of PFAS that can be detected by EPA Method 1633, in comparison to PFAS levels detected at upstream sampling sites,[37] the sampling detected 19 types of PFAS at elevated levels downstream from WWTPs and 14 types of PFAS at elevated levels downstream from biosolids land application sites.

Elevated PFAS Levels	Detections Downstream from:	
	Wastewater Treatment Plants[38]	Biosolids Land Application Sites
PFHxA	19	6
PFOA	18	4
PFBS	17	7
PFPeA	17	6
PFHpA	14	6
PFHxS	14	3
PFOS	14	4
PFBA	12	7
PFNA	10	4

   d. Multiple types of PFAS were also frequently detected at high concentrations downstream from WWTPs located in areas with multiple indicators of environmental and health burdens on disproportionately impacted communities. For example:
      i. PFOA and PFOS were detected at the following concentrations in U.S. surface waters:

State	Waterbody	Concentration (ppt)	
		PFOA	PFOS
California	Santa Ana River	13	12
Florida	East Canal	7.1	11
Michigan	Rouge River	44	–
North Carolina	Haw River	10	23
	Cape Fear River	8.3	13
South Carolina	Pocotaligo River	28	30
Texas	Hunting Bayou	4	12

      ii. PFPeA was responsible for the greatest increases in PFAS concentrations downstream from nine WWTPs and five biosolids land application fields.
      iii. PFHxA was also responsible for the greatest increases in PFAS concentrations downstream from five WWTPs.

3. **Widespread detection of multiple PFAS types at upstream and downstream sampling sites confirms the need to regulate PFAS as a class to effectively limit exposure and address cumulative risks in U.S. surface waters.**
   a. Certain types of PFAS were frequently detected at multiple upstream and downstream sampling sites.
      i. The most commonly detected PFAS at sites associated with WWTPs were PFBA, PFPeA, PFHxA, PFHpA, PFOA, PFBS, PFHxS, and PFOS, which were all detected in 40 or more samples.
      ii. Some types of PFAS were often found to co-occur at individual sampling sites near WWTPs leading to higher overall exposures to total PFAS at those locations. For example, PFOS, PFHxA, PFOA, PFHxS, PFBS, PFHpA, PFPeA, PFBA, and PFNA were found to co-occur in 32 samples near WWTPs (and additional types of PFAS were often found at these locations as well).
      iii. Similarly, the most commonly detected PFAS at sites associated with biosolids land application fields were PFOA, PFBA, PFHxA, PFOS, PFHpA, PFBS, and PFHxS, each of which were detected in 19 or more samples.
      iv. Some types of PFAS were often found to co-occur at individual sampling sites near biosolids land application sites leading to higher overall exposures to total PFAS at those locations. For example, PFOA, PFBA, PFHxA, PFOS, PFHpA, PFBS, and PFHxA were found to co-occur in 16 samples near biosolids land application fields (additional types of PFAS were often found at these locations as well).
   b. The total downstream PFAS concentrations exceeded Environmental Working Group's (EWG) health-based criteria for protecting against human health harm caused by total concentrations of PFAS (1 ppt) at all 22 WWTP sites and at 9 of 10 biosolids land application sites.[39]
   c. The total PFAS concentration downstream from 17 WWTP sites and six biosolids land application sites increased, sometimes significantly, above total upstream PFAS concentrations. For example:
      i. In Oregon's Tualatin River, the total PFAS concentration increased from 0.97 ppt upstream to 30.02 ppt immediately downstream from the Rock Creek Water Resource Recovery Facility (WRRF)—a 2,994.85% increase.
      ii. In Washington's Dragoon Creek, the total PFAS concentration increased from 0.63 ppt upstream to 32.89 ppt immediately downstream from Spokane Riverside Park WRF's biosolids land application fields—a 5,120.63% increase.

4. **Current regulations fail to control PFAS pollution of U.S. surface waters, leaving communities at risk for toxic chemical exposure.**
   There are currently no federal surface water quality criteria or wastewater discharge limits for PFAS, and very few industrial dischargers are required to monitor or limit PFAS discharges into wastewater treatment systems—even though many industries contributing wastewater are likely handling, manufacturing, or using PFAS. At the time of sampling, PFAS concentrations downstream from WWTPs and biosolids land application fields often exceeded the current federal standards, including Safe Drinking Water Act (SDWA) MCLs, the draft HHWQC, and the EWG health-based standards referenced in this report.
      i. The elevated downstream samples were equal to or exceeded the PFOA MCLs at 12 downstream WWTP sites and two downstream biosolids land application sites.
      ii. The elevated downstream samples exceeded the PFOS MCL at nine downstream WWTP sites and two downstream biosolids land application sites.
      iii. An elevated downstream sample exceeded the PFHxS MCL at one downstream WWTP site. EPA has not developed MCLs for most PFAS.
      iv. The elevated downstream samples exceeded the draft HHWQC (Water + Organism) for PFOA at 18 downstream WWTP sites and four downstream biosolids land application sites and the draft HHWQC (Water + Organism) for PFOS at 14 downstream WWTP sites and four downstream biosolids land application sites. EPA has not developed HHWQC for most PFAS.
      v. Numerous EWG health-based criteria were exceeded in elevated samples from 29 locations downstream from WWTP sites and biosolids land application sites. PFOA, PFOS, PFHxS, and PFNA exceeded the criteria at the largest number of sites.

5. **SiREM PFASsive™ samplers provide an accurate method for conducting fresh surface water sampling for PFAS in locations that are impacted by discharges from wastewater treatment plants and biosolids land application fields.**
   These passive samples provide time-integrated data, giving a clearer picture of long-term contamination and PFAS bioavailability, toxicity, and risk–without the high cost and variability of daily or weekly grab samples. Waterkeeper groups successfully utilized the samplers across 19 states–producing results that are consistent and scientifically valid using EPA Method 1633.

WATERKEEPER ALLIANCE | PFAS REPORT PHASE II



METHODOLOGY

In April 2024, Waterkeeper Alliance, in collaboration with the Hispanic Access Foundation, initiated an extensive evaluation of selected watersheds previously sampled in the 2022 Phase I report. The goal was to identify WWTPs and biosolids land application sites that discharge near communities disproportionately impacted by environmental burdens, for more in-depth study. To determine these sites, the team utilized EPA's EJScreen—a publicly available tool that integrates demographic and environmental indicators to assess environmental justice concerns across communities nationwide.[40]

Watershed Selection

We initially identified 25 watersheds as high priority for participation in the PFAS Phase II monitoring project based on evaluations of the following criteria:

- Waterkeeper group participation in the Phase I project Reporting of a Phase I PFAS result greater than 10 ppt and reporting multiple PFAS detections greater than 3 ppt
- The presence of wastewater treatment facilities in proximity to the Phase I sampling site(s)
- The existence of a Phase I sampling site upstream or downstream from the WWTP
- The existence of approved industrial pretreatment and biosolids programs at the WWTP
- Multiple EPA EJScreen Indicators greater than the 80th percentile within 1 mile of the WWTP[41]
- The compliance history of the WWTP
- The inclusion of the WWTP in EPA's PFAS Influent Study[42]

Facility Selection

We then worked with Waterkeeper groups and Hispanic Access Foundation to finalize our selection of WWTPs and biosolids land application fields for sampling. Ultimately, we sampled 22 WWTP sites (25 WWTPs total) and 10 biosolids land application sites in 19 states. These sites were located in, or discharged upstream from, areas within the Waterkeeper group's watershed that, with limited exceptions, had multiple industrial users and where EPA EJScreen indicators were at or above the 80th percentile. The WWTP also had to discharge into a waterbody that could be sampled both upstream and downstream from publicly accessible locations or locations where access permission could be obtained. The selected biosolids land application fields were those that were associated with one of the selected WWTPs and either bordered a surface water or had ditches, streams, or other surface flow pathways to a nearby surface water that had accessible, representative upstream and downstream sampling locations.

Sampling Site Selection

Given the ubiquity of PFAS and the importance of isolating these compounds associated with the WWTP or biosolids land application field in the sample results for this project, particular attention was given to defining and locating upstream and downstream sample sites.

For the purposes of this project:

"Biosolids" are treated sewage sludge, the solid byproduct of the wastewater treatment process. They must meet EPA standards for land application or other beneficial uses, as outlined in 40 CFR Part 503. EPA classifies biosolids into two categories: Class A and Class B. Class A biosolids undergo treatment to eliminate pathogens and vector attraction, making them eligible for unrestricted land use under EPA standards, including for agriculture and landscaping. Class B biosolids are treated to reduce pathogens but may still contain detectable levels and are subject to restrictions, such as limiting public access and getting a permit to land apply. Both classes must meet requirements to address certain pollutants, including heavy metals, before being applied to land. At the time of publication, EPA has no standards or regulations for PFAS in biosolids.[43]

"Upstream" means a location on a waterbody that was above and not impacted by a pollution discharge from a targeted WWTP outfall or that was above a targeted biosolids application field. Upstream locations were generally placed at least 100 feet, but no more than one mile upstream above the outfall discharge point or biosolids application field. Waterkeeper Alliance and Waterkeeper groups conducted site-specific evaluations of sampling locations to identify representative locations and consider making modifications to the distance restrictions as necessary to ensure a sampling location was representative of conditions upstream from a WWTP or biosolids application field. Reasonable efforts were made to select accessible locations close enough to the outfall discharge point or biosolids application field to avoid as many other potential sources of PFAS pollution as possible.

"Downstream" means a location on a waterbody that was below a targeted WWTP outfall or below a targeted biosolids land application field and was designed to be representative of surface water quality downstream from the discharge, as opposed to directly capturing a sample of the WWTP effluent or biosolids application runoff. The downstream location was generally placed at least 100 feet, but no more than one mile below the outfall discharge point or biosolids application field. Waterkeeper Alliance and Waterkeeper groups conducted site-specific evaluations of sampling locations to identify representative locations and consider making modifications to the distance restrictions as necessary to ensure a sampling location was representative of conditions downstream from a WWTP or biosolids application field. Reasonable efforts were made to select accessible locations close enough to the outfall discharge point or biosolids application field to avoid as many other potential sources of PFAS pollution as possible.

The **discharge point for WWTP sampling locations** was determined based on the GPS coordinates for the location of the WWTP outfall. To select sampling site locations, Waterkeeper Alliance and Waterkeeper groups evaluated publicly available information to identify outfall discharge points to waterbodies. Using ArcGIS mapping and data analysis, field investigations, and other mapping tools, Waterkeeper Alliance and Waterkeeper groups then identified potential sampling sites on the waterbody that were located upstream and downstream of the WWTP outfall that were representative of waterbody conditions above and below the discharge.

The **discharge point for biosolids application sites** was the downstream boundary of the field or ditch, whichever was the furthest downstream, where it intersected the waterbody. To select sampling sites for biosolids application fields, Waterkeeper Alliance and Waterkeeper groups evaluated publicly available information to identify the field boundaries and any ditches, streams, or surface water flow paths on or near the field. Using ArcGIS, field investigations, and other mapping tools, Waterkeeper Alliance and Waterkeeper groups then identified potential sampling sites on the receiving waterbody that were located upstream and downstream of the biosolids application field, that were representative of waterbody conditions above and below the biosolids application field.



Sampling Method

Waterkeeper Alliance developed a Sampling and Analysis Plan for Phase II that includes a description of the project, criteria for selecting participating Waterkeepers and sampling sites, details for collecting and managing information and data, requirements for training personnel, details on project management, standards and protocols for the collection and analysis of surface water samples using SiREM PFASsive™ passive samplers, and a Quality Assurance Project Plan (QAPP) to ensure the collection of reliable and representative water quality data that meet the project's overall objectives and goals. Every effort was made to procure PFAS-free sampling equipment and supplies for the project and to avoid cross-contamination in the shipping and handling of passive sampling devices, equipment, and supplies. Waterkeeper groups also received training regarding best practices for avoiding cross-contamination while handling sampling devices, equipment, and supplies and during deployment, retrieval, transfer, and shipment of samples.

PFASsive™ passive samplers were used for quantification of the freely dissolved concentration (Cfree) of targeted PFAS analytes in sediment pore water, surface water, and stormwater. The PFASsive™ samplers are used to quantify the Cfree of dissolved PFAS in surface water via an in-situ deployment near WWTPs and biosolids land application fields. PFASsive™ samplers use a volume of laboratory-supplied clean water in a sampling device separated from water by a permeable membrane. Freely dissolved PFAS analytes in the water diffuse across the membrane until the concentration of PFAS inside equilibrates with concentrations of freely dissolved PFAS in the water. The sampling device is then removed from the deployment location. The water inside the PFASsive™ sampler is collected and analyzed like any other water sample using EPA methods.

Water Quality Data Collection

Waterkeeper Alliance conducted two training sessions for participating Waterkeeper groups in June 2024. The webinars included an overview of SiREM PFASsive™ technology, instruction on PFASsive™ sampling methodology and procedures, and equipment handling and shipping protocols. Upon completion of site selection and training, each Waterkeeper group received a box of sampling devices, equipment, and supplies from Waterkeeper Alliance via U.S. mail. Inside the box was a cooler with two or four sealed bags containing four PFASsive™ vials within each bag, two or four PFASsive™ frames, multiple

Table 1 | Sampled Watersheds and Wastewater Treatment Facility Sites

State	City or County	Waterkeeper	Facility	Receiving Waterbody	NPDES Permit No.	NPDES PFAS Effluent Limit		
AL	Hoover	Cahaba Riverkeeper	Cahaba River Water Reclamation Facility (WRF)	Cahaba River	AL0023027	None		
	Rainbow City	Coosa Riverkeeper	Rainbow City WWTP	Big Wills Creek	AL0056839	None		
CA	Los Angeles	LA Waterkeeper	LA-Glendale Water Reclamation Plant	Los Angeles River	CA0053953	None		
	Riverside	Inland Empire Waterkeeper	Riverside Regional Water Quality Control Plant	Santa Ana River	CA0105350	None		
CT	Waterbury	Long Island Soundkeeper	Waterbury Water Pollution Control Facility	Naugatuck River	CT0100625	None		
FL	Plant City	Tampa Bay Waterkeeper	Plant City WRF	East Canal	FL0026557	None		
GA	Atlanta, Smyrna	Chattahoochee Riverkeeper	City of Atlanta's R.M Clayton WRC	Chattahoochee River	GA0039012	None		
			Cobb County's R.L. Sutton WRF		GA0026140			
			West Area Water Quality Control Facility (WQCF)		GA0038644			
MD	Frederick	Potomac Riverkeeper	City of Frederick WWTP	Lower Monocacy River	MD0021610	None		
MI	Detroit	Detroit Riverkeeper	Great Lakes Water Authority Water Resource Recovery Facility	Rouge River	MI0022802	Goal	PFOS	11 ppt
							PFOA WQBEL	8,040 ppt
MS	Jackson, Richland	Pearl Riverkeeper	Jackson Publicly Owned Treatment Works (POTW), Savanna Street	Pearl River	MS0024295	None		
			West Rankin Utility Authority WWTF		MS0061743			
NY/NJ	Rockland County, Hillburn	Hackensack Riverkeeper	Western Ramapo Advanced WWTP	Ramapo River	NY0270598	None		
	Suffern		Suffern (V) Sewage Treatment Plant (STP)		NY0022748	None		
NC	Fayetteville	Cape Fear Riverkeeper	Cross Creek WRF	Cape Fear River	NC0023957	None		
	Graham	Haw Riverkeeper	Graham WWTP	Haw River	NC0021211	None		
OR	Hillsboro	Tualatin Riverkeepers	Rock Creek WRRF	Tualatin River	OR0029777	None		
RI	Cranston	Narragansett Bay Riverkeeper	Cranston WPCF	Pawtuxet River	RI0100013	None		
SC	Sumter	Black-Sampit Riverkeeper	Sumter Pocotaligo River WWTP	Pocotaligo River, East Branch	SC0027707	None		
TX	Houston	Bayou City Waterkeeper	Homestead WWTP	Hunting Bayou	TX0063029	None		
VA	Petersburg	James Riverkeeper	South Central Wastewater Treatment Facility	Appomattox River	VA0025437	None		
WA	Spokane	Spokane Riverkeeper	Spokane Riverside Park WRF	Spokane River	WA0024473	None		
WI	Waukesha	Milwaukee Riverkeeper	City Of Waukesha WWTP	Root River	WI0029971	None		
WV	Parkersburg	West Virginia Headwaters Waterkeeper	Parkersburg Utility Board	Ohio River	WV0023213	None		
	Inwood Area	Upper Potomac Riverkeeper	Berkeley County PSSD—Inwood WWTP	Opequon Creek	WV0082759	None		

Table 2 | Sampled Watersheds and Biosolids Land Application Fields

State	Waterkeeper	Facility	Biosolids Site Watershed	PFAS Limit
AL	Cahaba Riverkeeper	Cahaba River WRF (combined with Valley Creek WRF)	Cane Creek	None
	Coosa Riverkeeper	Rainbow City WWTP	Whippoorwill Creek	None
MD	Potomac Riverkeeper	Synagro Multi-WWTP Site *(inc. City of Frederick WWTP)* ◆	Monocacy River	Recommended Limits
MS	Pearl Riverkeeper	Jackson POTW, Savanna Street ◆◆	Big Creek and Pearl River	None
NC	Cape Fear Riverkeeper	Cross Creek WRF	South River	None
	Haw Riverkeeper	Graham WWTP	Haw Creek	None
VA	James Riverkeeper	Synagro Multi-WWTP Site *(inc. South Central Wastewater Authority WWTF)* ◆	Old Town Creek	None
WA	Spokane Riverkeeper	Spokane Riverside Park WRF	Dragoon Creek	None
WI	Milwaukee Riverkeeper	City of Waukesha WWTP	Spring Creek (Fox River Watershed)	None – Statewide Interim Strategy
WV	Upper Potomac Riverkeeper	Berkeley County PSSD	Back Creek	None

◆ Synagro obtains biosolids from multiple WWTPs and, as a result, land application events may contain biosolids from one or more of those facilities.
◆◆ Jackson POTW, Trahon and Big Creek WWTF also discharges to Big Creek above the confluence with Pearl River.

Eurofins 125 ml HDPE sample bottles, laboratory-provided labels, PFAS-free gloves, and PFAS-free storage bags. Waterkeeper groups designated to conduct duplicate or field blank sampling received additional vial bags and bottles. Sampling personnel conducting field blanks received two additional laboratory bottles. Sampling personnel conducting duplicates received two additional full sets of sampling supplies—vial bags, sample bottles, frames, ice packs, and other equipment.

One sampler was placed upstream of a WWTP and another was placed downstream from the same facility to evaluate discharges into the waterways.[44] In situations where the WWTP land-applied biosolids from its wastewater treatment process, and it was selected for sampling, the Waterkeeper group also placed one device upstream and another downstream from a biosolids land application field to evaluate PFAS discharged into the waterway as a result of this waste management practice.[45] Some Waterkeeper groups were also selected to collect duplicate samples or field blanks for quality control purposes. At the end of a deployment period of at least 20 days,[46] Waterkeeper groups were responsible for retrieving the device, completing field data sheets and chain of custody forms, and transferring the sample to Eurofins.

Laboratory Analysis and Equilibrium Calculations

Upon retrieval, samples, including laboratory, duplicates, and field blanks, were sent to Eurofins Sacramento for analysis using EPA Method 1633, including an M2PFOA tracer. Three sets of four vials (without frames) were also used as tracer blanks and sent directly to the analytical laboratory from SiREM for analysis. The tracer blanks are analyzed using EPA Method 1633 to confirm that the source PFASsive™ water is PFAS-free and to determine the initial tracer concentration for the samplers (required for equilibrium calculations).

Eurofins Sacramento's analytical results were reported first to SiREM Lab, which then completed equilibrium calculations prior to reporting the final results to Waterkeeper Alliance for further analysis and development of this report. Quantification of Cfree is dependent on the site-specific conditions surrounding each sampler that affect the sampling rates for each analyte. PFASsive™ uses an inert 13-C labeled PFOA (M2PFOA) tracer to evaluate the diffusion kinetics of the samplers during the exposure period. Cfree estimates of analytes that do not reach at least 10% of steady state concentrations in the sampler during deployment are reported with a qualifier. PFAS analytes were not expected to be qualified.







Data Quality

All of the data collected in this project were evaluated in accordance with a QAPP to evaluate whether the sampling produced quality data that is accurate, precise, complete, and representative, including:

1. adherence to consistent and reliable methods,
2. the analytical data meets data quality objectives (DQOs), and
3. the analytical data generated was reviewed, validated, and verified.

Although PFAS concentrations in surface water can be influenced by various factors—such as other discharges, atmospheric deposition, weather, and sampling timing—the upstream and downstream sites in this report were selected based on protocols designed to ensure representative sampling and minimize outside influences. Sites were placed near the discharge point or biosolids application area, and passive sampling over multiple days was used to reduce the impact of environmental variability. As a result, the findings are considered representative of PFAS impacts from wastewater treatment plant discharges and biosolids land application. While other influences cannot be entirely ruled out, there are no indications that they significantly affected the results given the study design. Other potential influences that we identified for a location, if any, are noted separately for each individual Waterkeeper group in the Evaluation of Facilities and Watersheds section of this report below.

As part of the review process, a Ph.D. scientist from SiREM evaluated all submitted data before modeling was performed and no abnormalities or flags reflecting on the reliability of the data were observed. The data evaluation and usability determination required by the QAPP confirmed that the data collected during this project accurately measured PFAS levels associated with the wastewater treatment facility and biosolids application field discharges identified for assessment and are suitable for use in the Project Report. The data evaluation, including any deviations from the Sampling and Analysis Plan, the assessment of Quality Control sample results, data assessment and laboratory qualifiers, and site condition impacts, is documented in the Data Evaluation and Usability Report. All Eurofins laboratory Result Qualifiers are shown in the Qualifier column next to the Results column in Appendix A; however, none of the qualifiers adversely impact the usability of the results for the purposes of this report.

Third Party Review

This report was submitted for third-party review with two experts to obtain an evaluation of the accuracy of the data and data analysis.

Table 3 | EPA Method 1633 Target Analytes

Analyte Description		CAS Number
ADONA	4,8-Dioxa-3H-perfluorononanoic acid	919005-14-4
FOSA	perfluorooctanesulfonamide	754-91-6
HFPO-DA (GenX)	Hexafluoropropylene oxide-dimer acid	13252-13-6
NEtFOSAA	N-ethyl perfluorooctane sulfonamido acetic acid	2991-50-6
NEtFOSE	N-ethyl perfluorooctane sulfonamido ethanol	1691-99-2
NEtFOSA	N-ethylperfluorooctane-1-sulfonamide	4151-50-2
NFDHA	perfluoro-3,6-dioxaheptanoic acid	151772-58-6
NMeFOSA	N-methylperfluoro-1-octanesulfonamide	31506-32-8
NMeFOSAA	N-methyl perfluorooctane sulfonamido acetic acid	2355-31-9
NMeFOSE	N-methyl perfluorooctane sulfonamido ethanol	24448-09-7
PFBA	perfluorobutanoic acid	375-22-4
PFBS	perfluorobutanesulfonic acid	375-73-5
PFDA	perfluorodecanoic acid	335-76-2
PFDoA	perfluorododecanoic acid	307-55-1
PFDoS	perfluorododecanesulfonic acid	79780-39-5
PFDS	perfluorodecanesulfonic acid	335-77-3
PFEESA	perfluoro(2-ethoxyethane)sulphonic acid	113507-82-7
PFHpA	perfluoroheptanoic acid	375-85-9
PFHpS	perfluoroheptanesulfonic acid	375-92-8
PFHxA	perfluorohexanoic acid	307-24-4
PFHxS	perfluorohexanesulfonic acid	355-46-4
PFMBA	perfluoro-4-methoxybutanoic acid	863090-89-5
PFMPA	perfluoro-3-methoxypropanoic acid	377-73-1
PFNA	perfluorononanoic acid	375-95-1
PFNS	perfluorononanesulfonic acid	68259-12-1
PFOA	perfluorooctanoic acid	335-67-1
PFOS	perfluorooctanesulfonic acid	1763-23-1
PFPeA	perfluoropentanoic acid	2706-90-3
PFPeS	perfluoropentanesulfonic acid	2706-91-4
PFTeA	perfluorotetradecanoic acid	376-06-7
PFTriA	perfluorotridecanoic acid	72629-94-8
PFUnA	perfluoroundecanoic acid	2058-94-8
9Cl-PF3ONS	9-chlorohexadecafluoro-3-oxanone-1-sulfonic acid (F-53B major)	756426-58-1
11Cl-PF3OUdS	11-chloroeicosafluoro-3-oxaundecane-1-sulfonic acid (F-53B minor)	763051-92-9
3:3 FTCA	3-perfluoropropyl propanoic acid	356-02-5
4:2 FTSA	4:2 fluorotelomer sulfonic acid	757124-72-4
5:3 FTCA	2H, 2H, 3H, 3H-perfluorooctanoic acid	914637-49-3
6:2 FTSA	6:2 fluorotelomer sulfonic acid	27619-97-2
7:3 FTCA	2H, 2H, 3H, 3H-perfluorodecanoic acid	812-70-4
8:2 FTSA	6:2 fluorotelomer sulfonic acid	39108-34-4

ANALYSIS AND FINDINGS

The Phase I PFAS monitoring project, undertaken with 113 U.S. Waterkeepers from across the country, was a first-of-its-kind nationwide survey of surface waters[47] that unequivocally demonstrated that dangerous PFAS pollution is widespread in surface waters across the country. In some locations, PFAS concentrations were thousands to hundreds of thousands times higher than what EPA experts say is safe for drinking water.

PFAS must be controlled and removed at their source in order to protect human health from these dangerous toxic chemicals, but this is not happening due to the lack of federal and state requirements for industrial dischargers and passive receivers like WWTPs and, particularly in disproportionately-impacted communities, the lack of funding to install advanced treatment systems to remove PFAS. Additionally, there are no state, tribal, and federal surface water quality or drinking water standards for most PFAS.

In 2024, EPA established legally enforceable limits for just six types of PFAS in drinking water, known as Maximum Contaminant Levels (MCLs) and proposed draft Human Health Water Quality Criteria (HHWQC) to limit three types of PFAS in surface waters.[48] At the time of publication of this report, EPA has not proposed drinking water or surface water limits for any other types of PFAS or any regulatory standards to address PFAS in biosolids.[49] Although EPA appears to have been aware of PFAS in biosolids since at least 2003, it has been reported that the agency actively encouraged the use of biosolids as fertilizer and it is estimated that farmers have obtained permits authorizing biosolids application on nearly 70 million acres of farmland, or about a fifth of all agricultural land in the U.S.[50] At the same time, states across the country are grappling with this "contamination crisis,"[51] but state policies to address PFAS contamination vary widely throughout the country.[52]

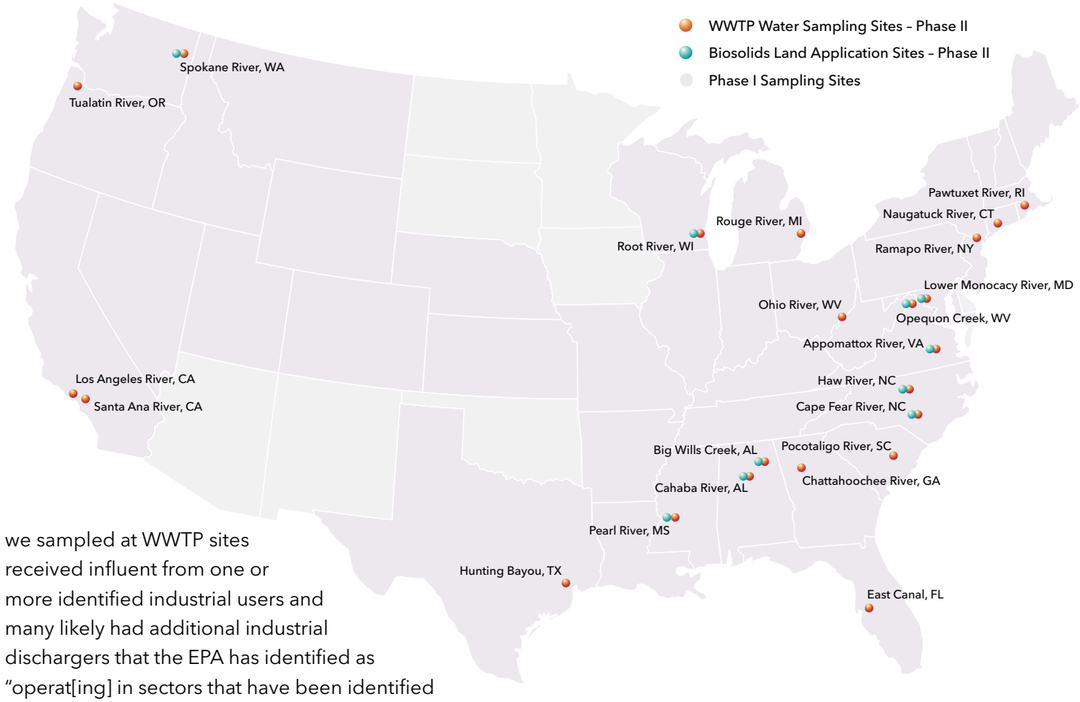
To address the urgent need for additional policy reform and scientifically sound data on PFAS sources and surface water contamination, Waterkeeper Alliance and Hispanic Access Foundation designed this Phase II PFAS monitoring project to work with U.S. Waterkeepers and partners. The project aims to evaluate and quantify PFAS contamination over time in surface waters using passive samplers placed near identified municipal wastewater treatment systems and biosolids application fields, with a focus on areas that appear to be disproportionately impacted based on the identification of EJScreen indicators above the 80th percentile. SiREM PFASsive™ samplers were selected for the project to provide an accurate representation of PFAS contamination present in the sampled surface waters and to be more reflective of bioavailability, toxicity, and risk than the data that would have been obtained through collection of a traditional single-day grab sample at each location.

Discharges from WWTPs and biosolids land application fields were indicated as a source of PFAS contamination in U.S. surface waters at nearly every downstream location we tested in 19 states, but we identified only one wastewater treatment system that has a limit on the amount of PFAS they could discharge into surface waters in their Clean Water Act NPDES permit, and we identified only seven facilities had a requirement to monitor their discharges for PFAS. *See Table 1 (p. 16)* and *Table 2 (p. 17)*. At least 22 of the 25 WWTPs where we sampled at WWTP sites received influent from one or more identified industrial users and many likely had additional industrial dischargers that the EPA has identified as "operat[ing] in sectors that have been identified as possibly handling, using, or releasing PFAS chemicals,"[53] but only one wastewater treatment system had a pretreatment program to place limits on the amount of certain PFAS that industrial users could discharge into its treatment plant.[54]

Table 4 | PFAS Types Detected at One or More Sites

	Analyte	Site Type
1	PFOS	WWTP and Biosolids
2	PFHxA	WWTP and Biosolids
3	PFHpS	Biosolids Site
4	PFOA	WWTP and Biosolids
5	PFHxS	WWTP and Biosolids
6	PFBS	WWTP and Biosolids
7	PFPeA	WWTP and Biosolids
8	PFHpA	WWTP and Biosolids
9	PFBA	WWTP and Biosolids
10	PFNA	WWTP and Biosolids
11	PFDA	WWTP and Biosolids
12	PFPeS	WWTP and Biosolids
13	6:2 FTS	WWTP
14	FOSA	WWTP and Biosolids
15	PFUnA	WWTP
16	HFPO-DA (Gen-X)	WWTP and Biosolids
17	PFMPA	WWTP
18	PFDoA	WWTP
19	8:2 FTS	WWTP
20	NMeFOSAA	WWTP
21	NEtFOSAA	WWTP
22	PFTeA	WWTP
23	PFMBA	WWTP

Figure 1 | Phase II PFAS Sampling Sites
Figure 2 | Phase I Sampling Sites



According to EPA, statewide surveys have found PFOS and PFOA in biosolids originating from industrial and non-industrial sources discharging to WWTPs across the country.[55] To the best of our knowledge, none of the WWTPs identified in this report have installed treatment technologies to remove PFAS from either their wastewater discharged to surface waters or their biosolids. Furthermore, the majority of the facilities we evaluated are not required to monitor or limit PFAS levels in biosolids prior to land application or other disposal methods for treated or untreated sewage sludge. Traditional wastewater treatment technology does not remove or destroy PFOS and PFOA, and, as a result, a portion of the PFAS will accumulate in biosolids generated during the treatment process.[56]

Controlling PFAS at the source is essential. CWA permitting authorities and industrial pretreatment programs must be utilized to require industrial dischargers to remove PFAS before releasing effluent into the environment or sending it to WWTPs.[57] The data collected in this monitoring project and discussed below provide strong evidence of the immediate need for EPA, states, and tribes to take those actions. The data also highlight the urgent need to direct federal infrastructure funding to municipal wastewater treatment systems in areas with multiple indicators of environmental and health burdens on disproportionately impacted communities, to support treatment upgrades and safe biosolids management that protect human health and the environment.

Method Evaluation

SiREM PFASsive™ samplers provide an effective method for conducting fresh surface water PFAS sampling that produce scientifically valid data in locations that are impacted by discharges from WWTPs and biosolids land application fields. With proper training provided by the SiREM PFASsive™ manufacturer, the devices were successfully deployed and retrieved by Waterkeeper groups in a wide variety of locations across the U.S.

SiREM PFASsive™ devices produced water samples that were analyzed by Eurofins Sacramento using the current approved EPA Method 1633 without any limitations attributable to the passive sampling device. A comparative analysis of the data demonstrated that SiREM PFASsive™ samplers produced reliable, consistent water quality data that was comparable between all sites despite the geographic, geomorphic, and hydrologic differences in watersheds.

The SiREM PFASsive™ passive sampling methodology captured time-integrated measurements of PFAS levels over periods of at least 20 days. Such measurements provide a more accurate representation of PFAS contamination and risk than traditional grab sample methods, which reflect PFAS concentrations that represent the entire mass of PFAS present at a single point in time and may result in an overestimation of the bioavailable PFAS exposure to human and ecological receptors. By collecting PFAS data over a longer period, understanding of PFAS migration, bioavailability, and impacts is enhanced, while also shedding light on the effectiveness of WWTP processes and land application methods in controlling or contributing to PFAS release into surface waters. The time-integrated measurements of PFAS concentrations over periods of at least 14 days is more practical and cost-effective than the alternative of collecting multiple samples on a daily or even weekly or monthly basis. This would require additional time and expenditures to collect multiple samples in the field, analyze those samples in a laboratory, and analyze multiple results for a single location.

The equilibrium concentrations generated through the use of SiREM PFASsive™ samplers provide a more accurate representation of PFAS contamination present in the sampled surface waters, and are more reflective of bioavailability, toxicity, and risk, than traditional single-day grab sample methods that may capture higher or lower values depending on the time of collection. Because PFAS are persistent, bioaccumulative, and toxic, it is critical to understand their migration pathways and bioavailability for proper delineation and risk characterization. Passive sampling in surface water is an accepted approach to assess bioavailability and risk.[58] The SiREM PFASsive™ passive sampler "is a diffusion-based equilibrium passive sampler that was developed and validated for relevant PFAS (EPA 537, EPA 1633) in porewater and surface water."[59] After retrieving the SiREM PFASsive™ device, the water collected in the sampler is treated like any other water sample allowing the PFAS to be concentrated and measured using EPA analysis methods "without the additional extraction steps required for sorbents" and the "results are presented as concentrations in nanograms per liter (ng/L)."[60] A reverse tracer in the devices also "allows the extent of equilibrium to be determined during deployment and used to estimate the freely dissolved equilibrium concentration in the environment. The freely dissolved equilibrium concentration has been shown to relate better to bioavailability, toxicity, and risk assessment models than concentrations measured from conventional grab samples."[61]

ELEVATED DOWNSTREAM WWTP SITE RESULTS as shown in Table 5 *(p. 23)*:

PFOA DETECTION
- 44 ppt Rouge River, MI
- 28 ppt Pocotaligo River, SC
- 13 ppt Santa Ana River, CA
- 10 ppt Haw River, NC

PFPeA DETECTION
- 43 ppt Santa Ana River, CA
- 38 ppt Pocotaligo River, SC
- 36 ppt Haw River, NC
- 22 ppt Monocacy River, MD
- 20 ppt Los Angeles River, CA
- 18 ppt Root River, WI

PFHxA DETECTION
- 49 ppt Pocotaligo River, SC
- 27 ppt Santa Ana River, CA
- 27 ppt Haw River, NC
- 20 ppt Los Angeles River, CA

PFOS DETECTION
- 30 ppt Pocotaligo River, SC
- 23 ppt Haw River, NC
- 13 ppt Cape Fear River, NC
- 12 ppt Santa Ana River, CA
- 12 ppt Hunting Bayou, TX
- 11 ppt East Canal, FL

Table 5 | Elevated Sample Values Downstream from WWTPs (ppt)

State	Waterkeeper/ Waterbody	Wastewater Treatment Plant		PFAS Analyte (ppt)																		
				PFOA	PFHxA	PFBS	PFPeA	PFHpA	PFHxS	PFOS	PFBA	PFNA	PFDA	PFPeS	FOSA	PFUnA	PFDoA	6:2 FTS	PFMPA	PFTeA	NMeFOSAA	PFMBA
AL	**Cahaba Riverkeeper** Cahaba River	Cahaba River WRF		4.9	6.4	6.4	10.0	1.9	1.5													
	Coosa Riverkeeper Big Wills Creek	Rainbow City WWTP		2.2					0.6		1.9				1.6							
CA	**Inland Empire Waterkeeper** Santa Ana River	Riverside RWQCP	Nov.		27.0		43.0															
			Aug. ▾	13.0	20.0	21.0	24.0	3.6		12.0		2.1										6.1
	LA Waterkeeper Los Angeles River	LA-Glendale WRP			20.0		20.0	3.3			9.8		2.1									
CT	**Long Island Soundkeeper** Naugatuck River	Waterbury WPCF			8.9	3.1	8.1	2.6	1.7	8.3	4.8											
FL	**Tampa Bay Waterkeeper** East Canal	Plant City WRF ▾		7.1	6.3	6.0	9.9	3.7	3.9	11.0	9.0	1.3		0.71								
GA	**Chattahoochee Riverkeeper** Chattahoochee River	Clayton, Sutton, West Area ◆		2.8	4.6	4.3	6.1	1.5			2.1						1.2		2.1	4.1		
MD	**Potomac Riverkeeper** Monocacy River	City of Frederick WWTP		6.8	13.0	5.0	22.0	2.5	2.5		4.4				0.62							
MI	**Detroit Riverkeeper** Rouge River	Great Lakes Water Authority Water Resource Recovery Facility (GLWA WRRF)		44.0	9.2				16.0	3.1			5.0									
MS	**Pearl Riverkeeper** Pearl River	Jackson POTW, Savanna Street / West Rankin Utility Authority WWTF ▾		2.9	4.4	3.0		1.3	1.3	3.5	3.6	0.71										
NC	**Cape Fear Riverkeeper** Cape Fear River	Cross Creek WRF		8.3	6.7	4.7	8.6	3.7	5.3	13.0	5.4			0.94								
	Haw Riverkeeper Haw River	Graham WWTP		10.0	27.0	17.0	36.0	8.8	4.5	23.0	9.2	2.2	2.6			0.87	0.59	1.1	0.88			
NJ	**Hackensack Riverkeeper** Ramapo River	Western Ramapo Advanced WWTP / Suffern (V) STP	Nov.	6.7	10.0	2.5			3.5	4.7												
OR	**Tualatin Riverkeepers** Tualatin River	Rock Creek WRRF		3.3	7.1	3.5	4.4	1.7	0.73	2.5	6.2	0.59										
RI	**Narragansett Bay Riverkeeper** Pawtuxet River	Cranston WPCF ©					5.7	4.9	2.3			2.1										
SC	**Black-Sampit Riverkeeper** Pocotaligo River	Sumter Pocotaligo River WWTP		28.0	49.0	5.5	38.0	21.0		30.0	12.0	2.3	2.1		1.7	0.79		22.0			1.1	
TX	**Bayou City Waterkeeper** Hunting Bayou	Homestead WWTP		4.0	11.0	11.0	9.3			12.0		1.3	0.64									
VA	**James Riverkeeper** Appomattox River	South Central Wastewater Authority WWTF		2.6		2.3	4.4			2.6		0.75										
WA	**Spokane Riverkeeper** Spokane River	Spokane Riverside Park WRF		1.1	2.0				0.8	2.1												
WI	**Milwaukee Riverkeeper** Root River	City of Waukesha WWTP ©		8.0	7.6	4.8	18.0	1.9	2.1	5.0	6.5	1.3	0.83									
WV	**Upper Potomac Riverkeeper** Opequon Creek	Berkeley County PSSD – Inwood WWTP		4.1	7.2	9.3	9.3															
	West Virginia Headwaters Waterkeeper Ohio River	Parkersburg Utility Board				1.6																

Includes all downstream sample results where the downstream value exceeded the upstream value except where as noted with an ▾ did not have upstream samples.
© **Combined:** The result represents the highest concentration in either the primary or duplicate sample.
◆ City of Atlanta's R.M Clayton WRC, Cobb County's R.L. Sutton WRF, and West Area Water Quality Control Facility (WQCF)

Overview of Results for WWTPs and Biosolids Land Application Fields

The sampling data collected through this project confirmed, consistent with the results of our Phase I sampling, that U.S. surface waters are widely contaminated by many different types of PFAS. Although we sampled fewer waterways in this project than in the previous monitoring project, we found that one or more PFAS were detected at all surface water sampling sites tested both upstream and downstream from WWTPs and biosolids land application fields in 19 states, with the exception of a single site downstream from a biosolids land application field in Wisconsin. See Appendix A.

The sampling results also indicated the widespread presence of multiple types of PFAS in U.S. surface waters. Out of 40 types of PFAS detected by EPA Method 1633, 23 types of PFAS were detected in upstream or downstream surface water sampling sites.

PFAS Surface Water Contamination from WWTPs and Biosolids Land Application Fields

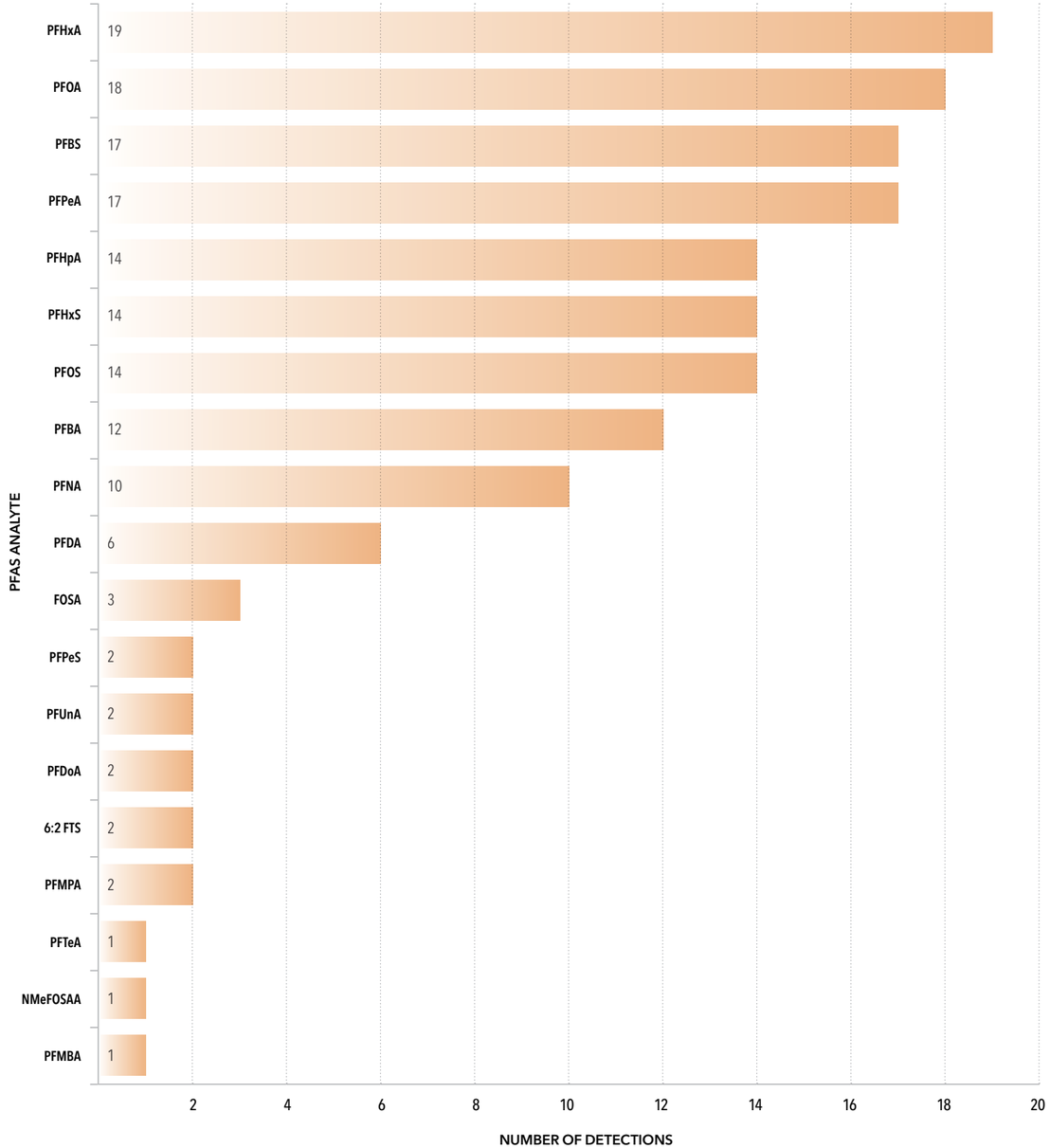
The sampling data collected in the project clearly demonstrate that discharges of PFAS from multiple WWTPs and biosolids land application fields that we evaluated are contributing multiple types of PFAS to U.S. surface waters. By comparing upstream and downstream results, we determined that elevated concentrations of multiple types of PFAS were detected at 21 of 22 downstream WWTP sampling sites[62] and at 8 of the 10 downstream biosolids land application sampling sites. *See Table 5*[63] *(p. 23) and Table 6 (below).* Pearl River biosolids site sampling results reported and analyzed below include any PFAS contributed by Jackson POTW's biosolids land application fields and the Trahon and Big Creek WWTF to Big Creek above its confluence with the Pearl River.

Table 6 | Elevated Sample Values Downstream from Biosolids Land Application Fields[64]

State	Waterbody	PFAS Analyte (ppt)													
		PFBA	PFBS	PFPeA	PFHxA	PFHpA	PFOA	PFNA	PFOS	PFHxS	PFDA	FOSA	PFPeS	PFHpS	HFPO-DA (GenX)
AL	Cane Creek ©	11.00	2.70	11.00	4.20	1.70	4.10	0.68	5.80						
MD	Monocacy River	6.20	3.90		4.90	2.20		0.77							
MS	Pearl River ◆			13.00					3.60		0.73				
NC	Haw Creek	3.90	5.30					1.90			0.81		2.20	1.30	
	South River ©	6.70	5.50	4.80	3.20	2.80	5.80	1.40	7.50	2.40		0.86			0.94
VA	Old Town Creek ▼	1.30	1.30	1.70	1.70	0.81	3.90		3.10	1.50					
WA	Dragoon Creek	3.10	5.80	12.00	7.40	1.50	1.50			0.71		0.88			
WV	Back Creek ©	2.50	2.50	1.40	3.10	1.00									

Includes all downstream sample results where the downstream value exceeded the upstream value except where as noted with an ▼ did not have upstream samples.
© **Combined:** The result represents the highest concentration in either the primary or duplicate sample.
◆ Jackson POTW, Trahon, and Big Creek WWTF also discharges to the sampled waterway through Big Creek and could have contributed PFAS to the downstream sample results.

Figure 3 | Number of Elevated Downstream PFAS Detections at WWTP Sites, by Analyte



Wastewater Treatment Plants

Out of 40 types of PFAS detected by EPA Method 1633, 19 types of PFAS at elevated levels were detected downstream from WWTPs. The most frequently detected PFAS at elevated levels downstream from wastewater treatment plants include PFHxA (19 detections), PFOA (18 detections), PFBS and PFPeA (17 detections), PFHpA, PFHxS, and PFOS (14 detections), PFBA (12 detections), and PFNA (10 detections). *See Figure 3 (p. 25).*

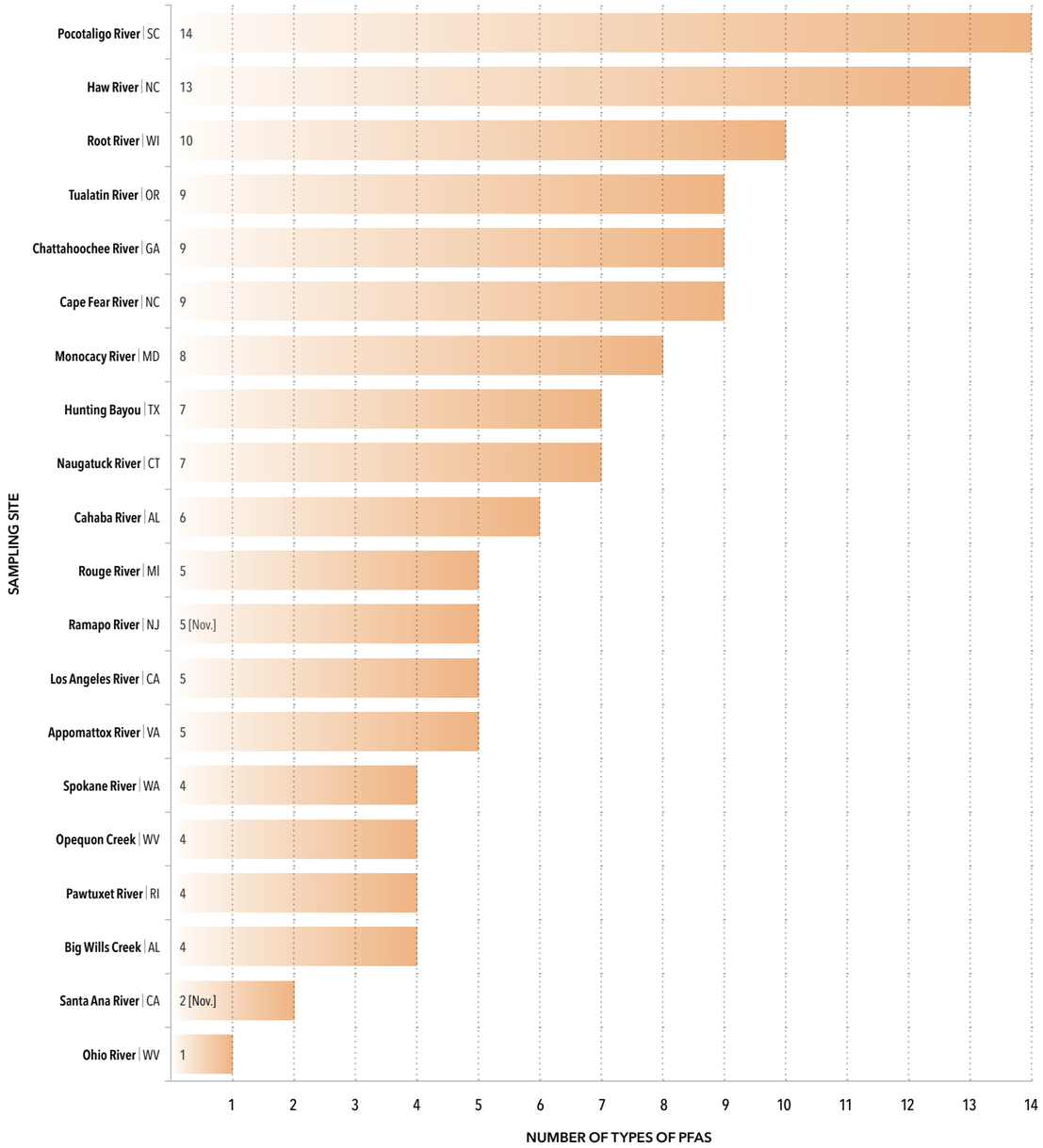
The highest elevated concentration of PFAS downstream from a WWTP was PFHxA at 49 ppt in the Pocotaligo River below the Sumter Pocotaligo River WWTP in South Carolina. PFHxA was detected in 19 samples downstream from WWTPs and the mean concentration of all values combined was 13.02 ppt. PFOA was also detected in 18 samples taken downstream from WWTPs, with a mean concentration of 8.88 ppt for all sites and the highest elevated concentration, 44 ppt, was found in the Rouge River below the GLWA WRRF in Michigan. *See Table 7 (below).*

Multiple types of PFAS were also frequently detected, often at high concentrations, at elevated levels at a single sampling site downstream from each WWTP, presenting unacceptable, cumulative risks to communities with multiple EJScreen Indexes that exceed the 80th percentile. For example, 14 types of PFAS were detected at the sampling site in the Haw River downstream from a Graham WWTP outfall in North Carolina, 13 types of PFAS were detected at the sampling site in the Pocotaligo River downstream from a Sumter Pocotaligo River WWTP outfall in South Carolina, and 10 types of PFAS were detected at the sampling site in the Root River downstream from a Waukesha WWTP outfall in Wisconsin. *See Figure 4 (p. 27).*

Table 7 | PFAS Concentrations and Watersheds with Highest Detection for Each Analyte Downstream from WWTPs
Maximum, Minimum, and Mean

Analyte	Watershed with Highest Elevated Detection	Elevated Downstream Detection (ppt)			
		Number of Detections	Mean	Minimum	Maximum
PFHxA	Pocotaligo River	19	13.02	2	49
PFOA	Rouge River	18	8.88	1.1	44
PFPeA	Santa Ana River	17	16.28	4.4	43
PFOS	Pocotaligo River	14	9.49	2.1	30
6:2 FTS	Pocotaligo River	2	11.55	1.1	22
PFBS	Santa Ana River	17	6.53	1.6	21
PFHpA	Pocotaligo River	14	4.46	1.3	21
PFHxS	Rouge River	14	0.64	0.64	16
PFBA	Pocotaligo River	12	6.24	1.9	12
PFMBA	Santa Ana River	1	6.1	6.1	6.1
PFDA	Rouge River	6	2.21	0.64	5
PFTeA	Chattahoochee River	1	4.1	4.1	4.1
PFNA	Pocotaligo River	10	1.47	0.59	2.3
PFMPA	Chattahoochee River	2	1.49	0.88	2.1
FOSA	Pocotaligo River	3	1.31	0.62	1.7
PFDoA	Chattahoochee River	2	0.9	0.59	1.2
PFPeS	Cape Fear River	2	0.83	0.71	0.94
NMeFOSAA	Pocotaligo River	1	1.1	1.1	1.1
PFUnA	Haw River	2	0.83	0.79	0.87

Figure 4 | Number of Different PFAS Types Elevated Downstream from WWTPs
Comparing Upstream/Downstream Sample Results



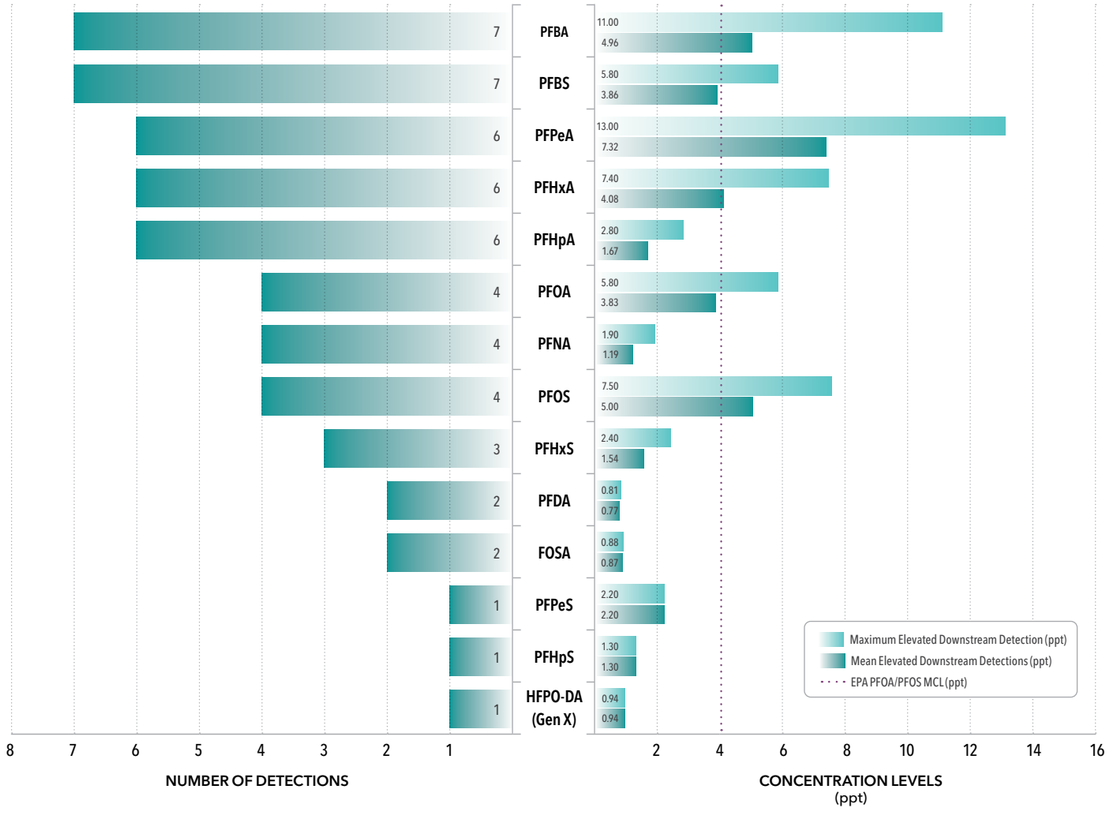
Biosolids Land Application Fields

Out of 40 types of PFAS detected by EPA Method 1633, in comparison to PFAS levels detected at upstream sampling sites, the sampling detected 14 types of PFAS at elevated levels downstream from biosolids land application sites. The most frequently detected PFAS at elevated levels downstream from biosolids land application sites include PFBA and PFBS (7 detections), PFPeA, PFHxA, and PFHpA (6 detections), and PFOA, PFNA, and PFOS (4 detections). *See Figure 5 (below).*

PFPeA was detected at elevated levels at six of the 10 biosolids land application sites, with a mean concentration of 7.32 ppt for all sites. PFBA was detected at elevated levels downstream from seven biosolids land application sites with a mean concentration of 4.96 ppt for all sites and the highest elevated concentration, 11 ppt, was found in Cane Creek below the Beltona Mine Land Reclamation Site in Alabama. *See Figure 6 (below).*

Figure 5 | Number of Elevated Downstream PFAS Detections at Biosolid Sampling Sites by Analyte

Figure 6 | Biosolids Application Fields
Maximum and Mean Concentrations of Elevated PFAS Downstream from All Sites



Specific PFAS Types

As shown in Figure 7 [WWTP Sites] and Figure 8 [Biosolids Sites], PFPeA was responsible for the greatest increases in PFAS concentrations downstream from nine WWTPs and five biosolids land application fields. PFHxA was responsible for the greatest increases in PFAS concentrations downstream from five WWTPs. Notably, these types of PFAS are neither regulated by EPA nor included in the draft HHWQC.[65] These two compounds are also not regulated as hazardous substances under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)[66] or the SDWA.[67] As for the other PFAS responsible for the greatest increases at other WWTPs, EPA has only established MCLs for PFOA, PFOS, and PFHxS and a Hazard Index value for a mixture containing two or more of PFHxS, PFNA, HFPO-DA, and PFBS. EPA has also proposed draft HHWQC for PFOA, PFOS, and PFBS.[68]

Figure 7 | PFAS Analytes with Greatest Downstream Concentration Increase by Number of Watersheds
Upstream and Downstream Comparison at Wastewater Treatment Plants

Figure 8 | PFAS Analytes with Greatest Downstream Increase in Concentration by Number of Watersheds
Upstream and Downstream Comparison at Biosolids Land Application Fields

Table 8 | PFAS Analytes with Greatest Concentration Increase in Downstream WWTP Site Samples

State	Waterbody	Waterkeeper	PFAS Analyte with Greatest Increase	Amount of Increase (ppt)	Total # of PFAS Analytes Elevated
AL	Cahaba River	Cahaba Riverkeeper	PFPeA	2.7	6
	Big Wills Creek	Coosa Riverkeeper	FOSA	1.6	4
CA	Santa Ana River [Nov.]	Inland Empire Waterkeeper	PFPeA	31	2
	Los Angeles River	LA Waterkeeper	PFPeA	8	5
CT	Naugatuck River	Long Island Soundkeeper	PFHxA	1.8	7
FL	East Canal	Tampa Bay Waterkeeper	No Upstream Sample		
GA	Chattahoochee River	Chattahoochee Riverkeeper	PFTeA	4.1	9
MD	Monocacy River	Potomac Riverkeeper	PFPeA	17.8	8
MI	Rouge River	Detroit Riverkeeper	PFOA	40.2	5
MS	Pearl River	Pearl Riverkeeper	No Upstream Sample		
NC	Cape Fear River	Cape Fear Riverkeeper	PFOS	2	9
	Haw River	Haw Riverkeeper	PFPeA	22	14
NJ	Ramapo River [Nov.]	Hackensack Riverkeeper	PFHxS	3.5	5
OR	Tualatin River	Tualatin Riverkeepers	PFHxA	7.1	9
RI	Pawtuxet River ©	Narragansett Bay Riverkeeper	PFPeA	0.2	4
SC	Pocotaligo River	Black-Sampit Riverkeeper	PFHxA	39.4	13
TX	Hunting Bayou	Bayou City Waterkeeper	PFHxA	4.2	7
VA	Appomattox River	James Riverkeeper	PFPeA	0.9	5
WA	Spokane River	Spokane Riverkeeper	PFHxA	1.46	4
WI	Root River ©	Milwaukee Riverkeeper	PFPeA	12.3	10
WV	Opequon Creek	Upper Potomac Riverkeeper	PFPeA	1.4	4
	Ohio River	West Virginia Headwaters Waterkeeper	PFBS	0.1	1

© **Combined:** The result represents the highest concentration in either the primary or duplicate sample.

As shown in Table 8 *(above)*, downstream from WWTPs:

CALIFORNIA

In Inland Empire Waterkeeper's watershed, PFPeA increased by 31 ppt in the Santa Ana River below the Riverside RWQCP's outfall in California.

NORTH CAROLINA

In Haw Riverkeeper's watershed, PFPeA increased by 22 ppt in the Haw River below the City of Graham WWTP's outfall in North Carolina.

SOUTH CAROLINA

In Black-Sampit Riverkeeper's watershed, PFHxA increased by 39.4 ppt in the Pocotaligo River below the Sumter Pocotaligo River Plant outfall in South Carolina.

Table 9 | PFAS Analytes with Greatest Concentration Increase in Downstream Biosolids Site Samples

State	Waterbody	Waterkeeper	PFAS Analyte wth Greatest Increase	Amount of Increase (ppt)
AL	Cane Creek ©	Cahaba Riverkeeper and Black Warrior Riverkeeper	PFPeA	11
	Whippoorwill Creek	Coosa Riverkeeper	No Increase	
MD	Monocacy River	Potomac Riverkeeper	PFNA	0.77
MS	Pearl River	Pearl Riverkeeper	PFPeA	1
NC	South River ©	Cape Fear Riverkeeper	PFPeA	4.8
	Haw Creek	Haw Riverkeeper	PFBS	5.3
VA	Old Town Creek ▼	James Riverkeeper	PFOA	3.9
WA	Dragoon Creek	Spokane Riverkeeper	PFPeA	12
WI	Spring Creek	Milwaukee Riverkeeper	No Increase	
WV	Back Creek ©	Upper Potomac Riverkeeper	PFPeA	1.4

© **Combined:** The result represents the highest concentration in either the primary or duplicate sample.
▼ James Riverkeeper location has no upstream site.

As shown in Table 9 *(left)*, downstream from biosolids land application fields:

ALABAMA

In Black Warrior Riverkeeper's watershed, PFPeA increased by 11 ppt in the Cane Creek below the Jefferson County Commission WWTPs' biosolids application site in Alabama.

WASHINGTON

In Spokane Riverkeeper's watershed, PFPeA increased by 12 ppt in the Dragoon Creek below the Spokane Riverside Park WRF's biosolids application fields in Washington.

Total PFAS Concentrations

The data collected in this project demonstrates that it is imperative for PFAS to be regulated as a class, as opposed to solely as individual chemicals, in order to effectively control widespread exposure and address the risks posed by combined exposures to multiple PFAS chemicals in U.S. surface waters.[69] Regulating PFAS on a compound-by-compound basis has left thousands of PFAS chemicals completely unregulated. As our data demonstrate, multiple types of PFAS often co-occur at a single location and unregulated PFAS are often present at high concentrations. The presence of multiple types of PFAS heightens human exposure risk since PFAS mixtures may have additive and synergistic effects."[70] Moreover, the harmful effects of PFAS exposure may be "more related to total PFAS levels, rather than individual PFAS compounds."[71]

In this project, the most frequently detected PFAS in upstream and downstream samples tended to co-occur at multiple locations leading to high overall exposure to total PFAS at those locations. For example, as shown in Figure 9 *(p. 32),* PFBA, PFPeA, PFHxA, PFHpA, PFOA, PFBS, PFHxS, and PFOS were detected in 40 or more samples near WWTPs. In 32 samples, the sampling detected PFOS, PFHxA, PFOA, PFHxS, PFBS, PFPeA, PFHpA, PFBA, and PFNA (often as well as other PFAS) at that single location. See Appendix A.

Figure 9 | PFAS Types Detected Upstream and Downstream from WWTPs

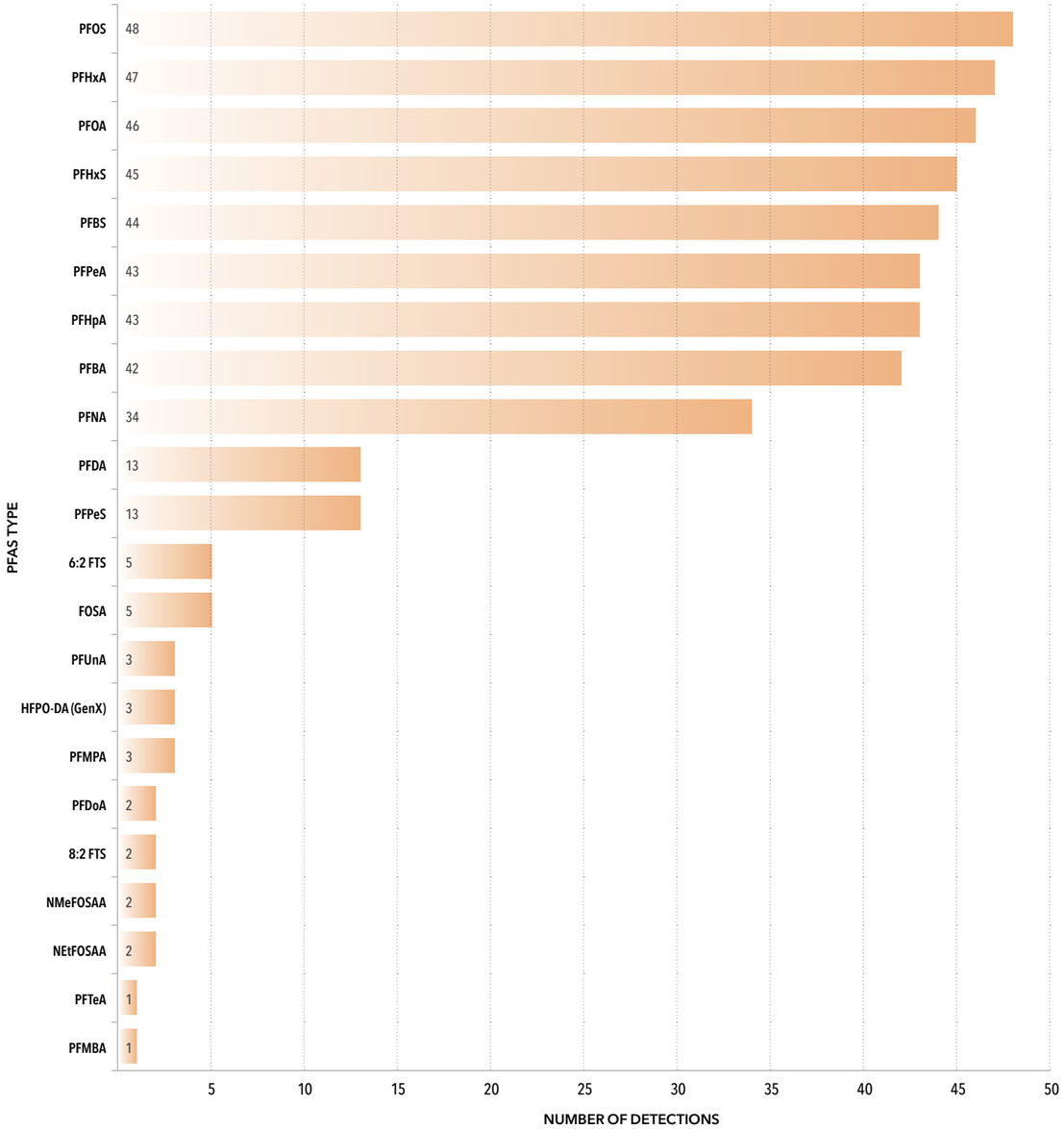
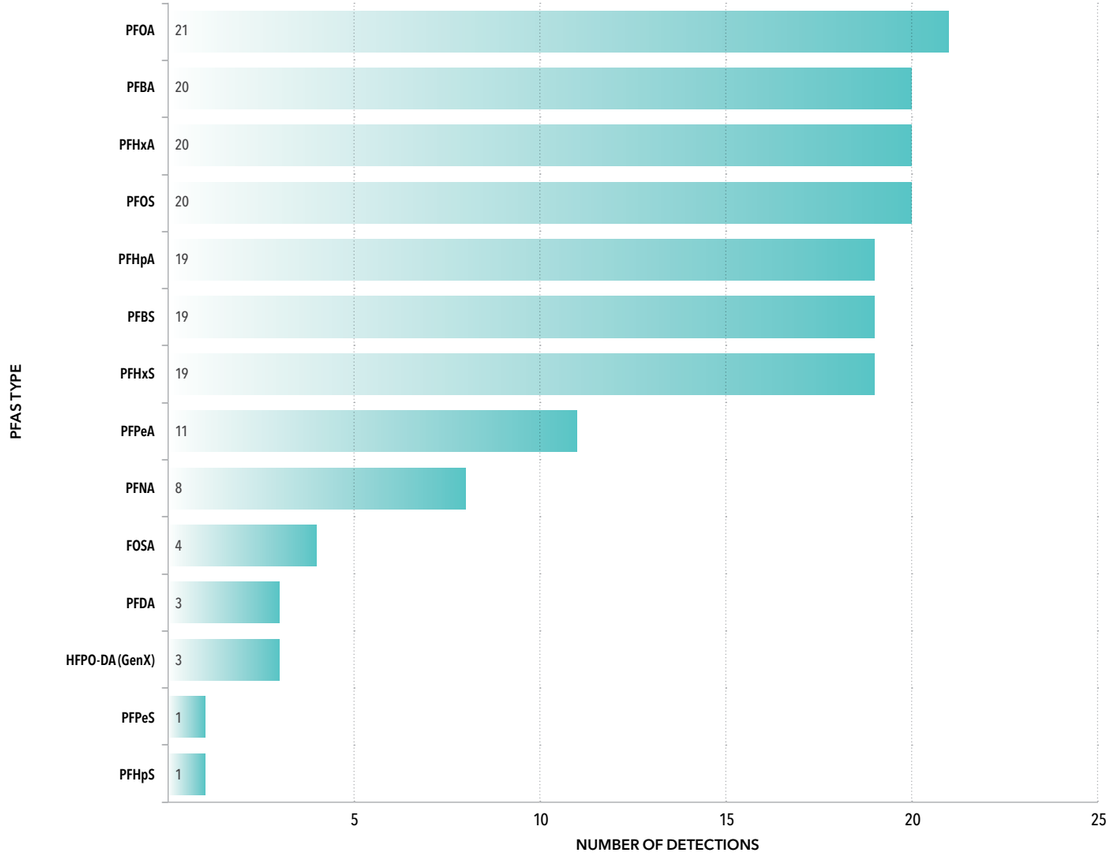


Figure 10 | PFAS Types Detected Upstream and Downstream from Biosolids Land Application Fields



Similarly, near biosolids land application sites, as shown in Figure 10 *(above)*, the most frequently detected PFAS include PFOA, PFBA, PFHxA, PFOS, PFHpA, PFBS, and PFHxS, occurring in 19 or more samples. In 16 samples, the sampling detected PFOA, PFBA, PFHxA, PFOS, PFHpA, PFBS, and PFHxS (often as well as other PFAS) at that single location. See Appendix A.

By contrast, PFUnA, PFDoA, PFTeA, 8:2 FTS, NMeFOSAA, NEtFOSAA, HFPO-DA (Gen-X), PFMBA, and PFMPA were detected at 3 or fewer sampling sites near WWTPs, and PFDA, PFPeS, PFHpS, and HFPO-DA (Gen-X) were detected in 3 or fewer samples near biosolids land application sites.

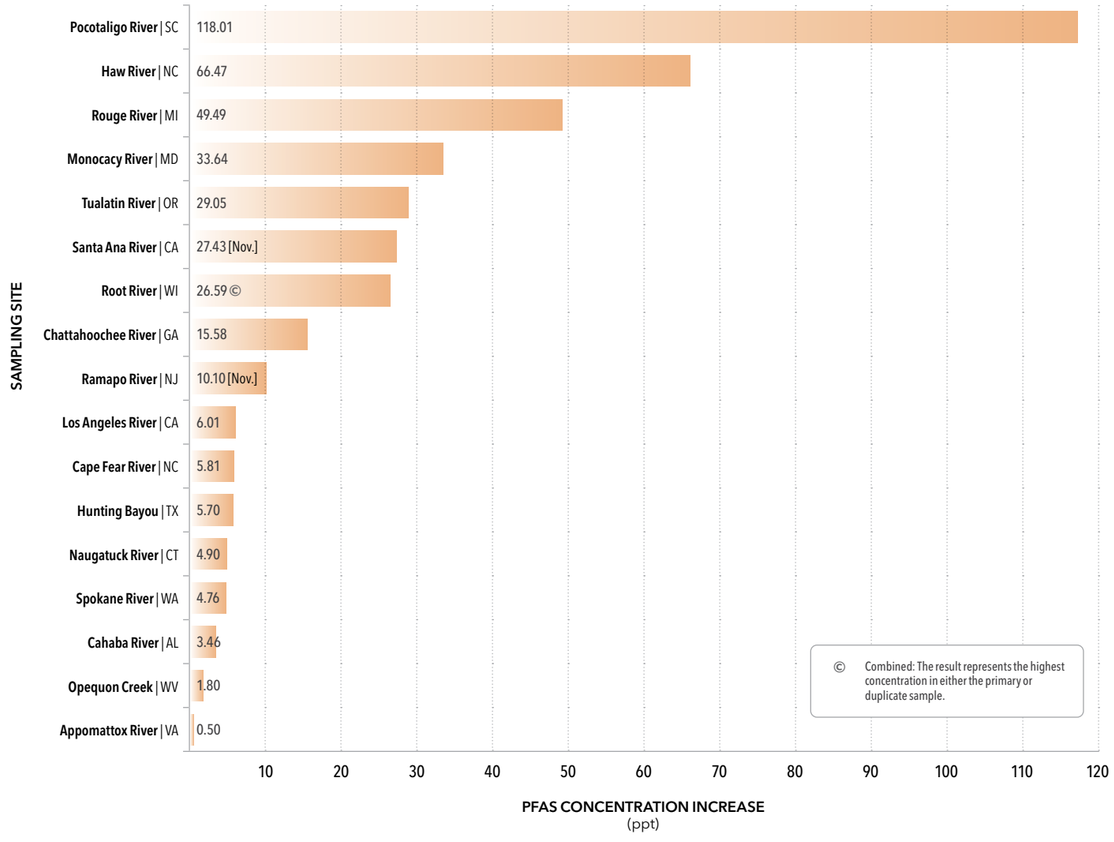
Additionally, as shown in Tables 10 *(p. 34)* and Table 11 *(p. 36)*, as a result of the presence of multiple PFAS chemicals, the total PFAS concentration downstream from 17 WWTPs and six biosolids land application sites increased, sometimes very significantly, above total upstream PFAS concentrations. Significant total PFAS concentrations were also detected at the downstream sites for two WWTPs and one biosolids land application field that did not have upstream sampling sites.

Table 10 | Total PFAS Concentrations Upstream and Downstream from WWTPs

State	Waterbody	Waterkeeper	Total PFAS (ppt)		Increase or Decrease (ppt)	Percent Increase or Decrease
			Upstream	Downstream		
AL	Cahaba River	Cahaba Riverkeeper	38.07	41.53	3.46	9.09%
	Big Wills Creek	Coosa Riverkeeper	15.04	12.71	-2.33	-15.49%
CA	Santa Ana River [Nov.]	Inland Empire Waterkeeper	89.70	117.13	27.43	30.58%
	Los Angeles River	LA Waterkeeper	69.79	75.80	6.01	8.61%
CT	Naugatuck River	Long Island Soundkeeper	41.60	46.50	4.90	11.78%
FL	East Canal	Tampa Bay Waterkeeper	No Sample	58.91		
GA	Chattahoochee River	Chattahoochee Riverkeeper	17.52	33.10	15.58	88.93%
MD	Monocacy River	Potomac Riverkeeper	26.28	59.92	33.64	128.01%
MI	Rouge River	Detroit Riverkeeper	33.71	83.20	49.49	146.81%
MS	Pearl River	Pearl Riverkeeper	No Sample	20.71		
NC	Haw River	Haw Riverkeeper	78.07	144.54	66.47	85.14%
	Cape Fear River	Cape Fear Riverkeeper	51.93	57.74	5.81	11.19%
NY/NJ	Ramapo River [Nov.]	Hackensack Riverkeeper	22.10	32.20	10.10	45.70%
OR	Tualatin River	Tualatin Riverkeepers	0.97	30.02	29.05	2994.85%
RI	Pawtuxet River ©	Narragansett Bay Riverkeeper	39.40	39.00	-0.40	-1.02%
SC	Pocotaligo River	Black-Sampit Riverkeeper	110.38	228.39	118.01	106.91%
TX	Hunting Bayou	Bayou City Waterkeeper	57.77	63.47	5.70	9.87%
VA	Appomattox River	James Riverkeeper	21.11	21.61	0.50	2.37%
WA	Spokane River	Spokane Riverkeeper	1.24	6.00	4.76	383.87%
WI	Root River ©	Milwaukee Riverkeeper	29.44	56.03	26.59	90.32%
WV	Opequon Creek	Upper Potomac Riverkeeper	45.10	46.90	1.80	3.99%
	Ohio River	West Virginia Headwaters Waterkeeper	21.95	18.86	-3.09	-14.08%

© **Combined:** The result represents the highest concentration in either the primary or duplicate sample.

Figure 11 | Amount of Total PFAS Increase Downstream from WWTPs



As shown in Table 10 *(p. 34)* and Figure 11 *(above)*, at WWTPs:

MICHIGAN

The Rouge River's total PFAS concentration increased from 33.71 ppt upstream to 83.20 ppt downstream from the GLWA WRRF—an increase of 49.49 ppt or 146.81%.

OREGON

The Tualatin River's total PFAS concentration increased from 0.97 ppt upstream to 30.02 ppt immediately downstream from the Rock Creek WRRF—an increase of 29.05 ppt or 2,994.85%.

SOUTH CAROLINA

The Pocotaligo River's total PFAS concentration increased from 110.38 ppt upstream to 228.39 ppt downstream from the Sumter Pocotalio River Plant—an increase of 118.01 ppt or 106.91%.

NORTH CAROLINA

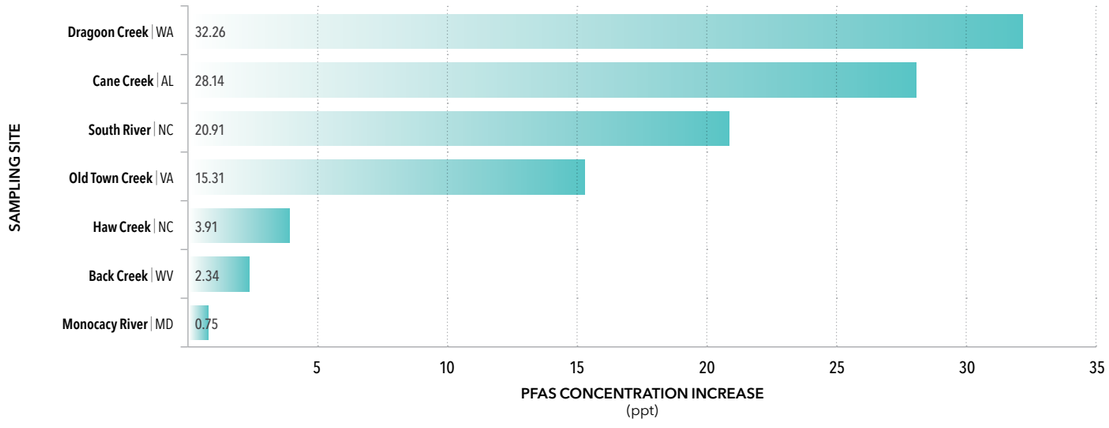
The Haw River's total PFAS concentration increased from 78.07 ppt upstream to 144.54 ppt downstream from the Graham WWTP—an increase of 66.47 ppt or 85.14%.

Table 11 | Total PFAS Concentrations Upstream and Downstream from Biosolids Land Application Fields

State	Waterbody	Waterkeeper	Total PFAS (ppt)		Increase or Decrease (ppt)	Percent Increase or Decrease
			Upstream	Downstream		
AL	Cane Creek ©	Cahaba Riverkeeper	15.04	43.18	28.14	187.10%
	Whippoorwill Creek	Coosa Riverkeeper	14.02	2.27	-11.75	-83.81%
MD	Monocacy River	Potomac Riverkeeper	27.27	28.02	0.75	2.75%
MS	Pearl River	Pearl Riverkeeper	32.67	30.78	-1.89	-5.79%
NC	South River ©	Cape Fear Riverkeeper	20.99	41.90	20.91	99.62%
	Haw Creek	Haw Riverkeeper	102.60	106.51	3.91	3.81%
VA	Old Town Creek	James Riverkeeper	No Sample	15.31		
WA	Dragoon Creek	Spokane Riverkeeper	0.63	32.89	32.26	5120.63%
WI	Spring Creek	Milwaukee Riverkeeper	1.10	0	-1.10	-100.00%
WV	Back Creek ©	Upper Potomac Riverkeeper	15.26	17.60	2.34	15.33%

© **Combined:** The result represents the highest concentration in either the primary or duplicate sample.

Figure 12 | Amount of Total PFAS Increase Downstream from Biosolids Land Application Fields



As shown in Table 11 and Figure 12 *(above)*, downstream from biosolids land application sites:

ALABAMA

Cane Creek's total PFAS concentration increased from 15.04 ppt upstream to 43.18 ppt downstream from Jefferson County Commission WWTPs' biosolids application site—an increase of 28.14 ppt or 187.10%.

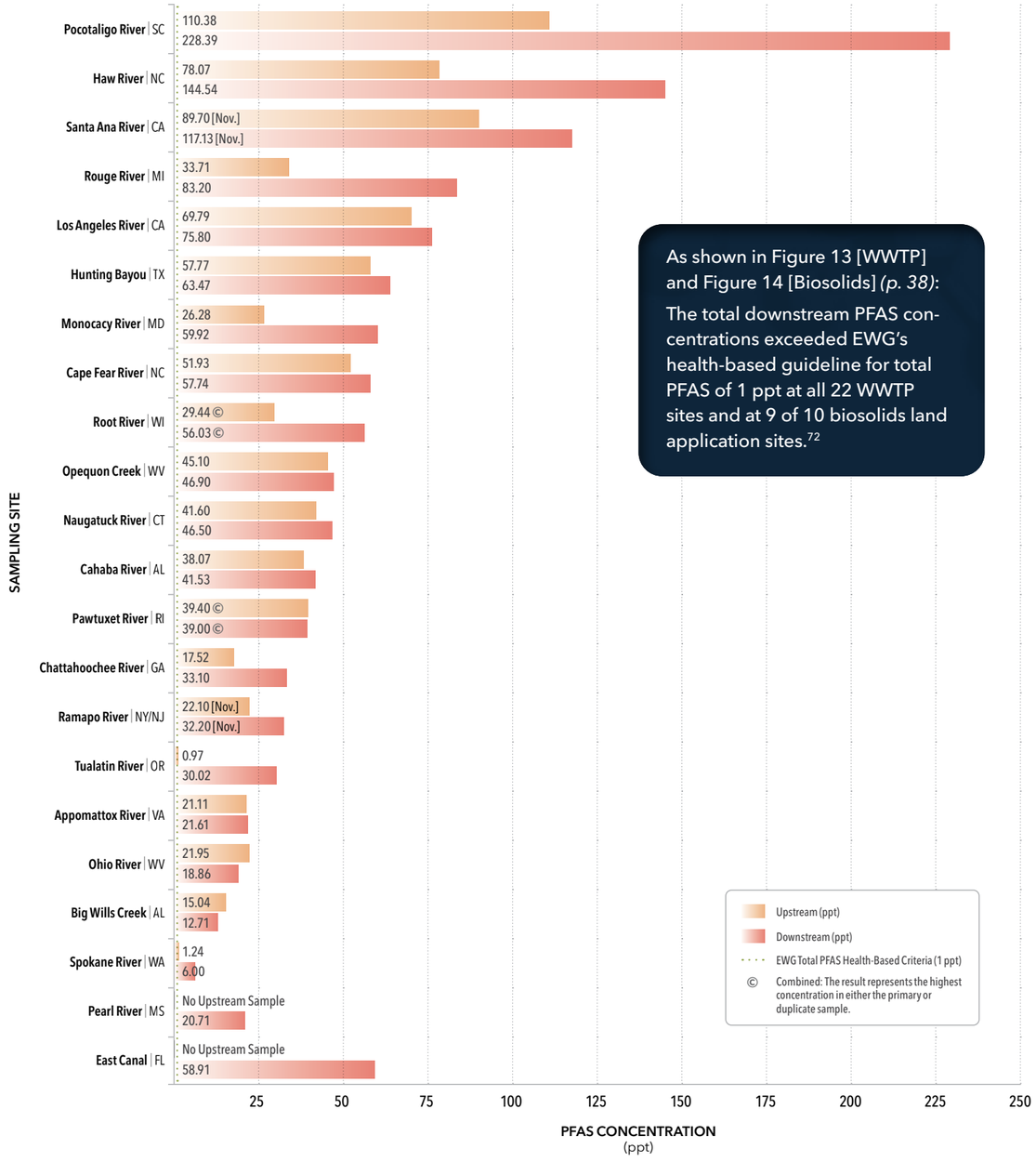
NORTH CAROLINA

South River's total PFAS concentration increased from 20.99 ppt upstream to 41.9 ppt downstream from Fayetteville Cross Creek WRF's biosolids application fields—an increase of 20.91 ppt or 99.62%.

WASHINGTON

Dragoon Creek's total PFAS concentration increased from 0.63 ppt upstream to 32.89 ppt immediately downstream from Spokane Riverside Park WRF's biosolids land application fields—an increase of 32.26 ppt or 5,120.63%.

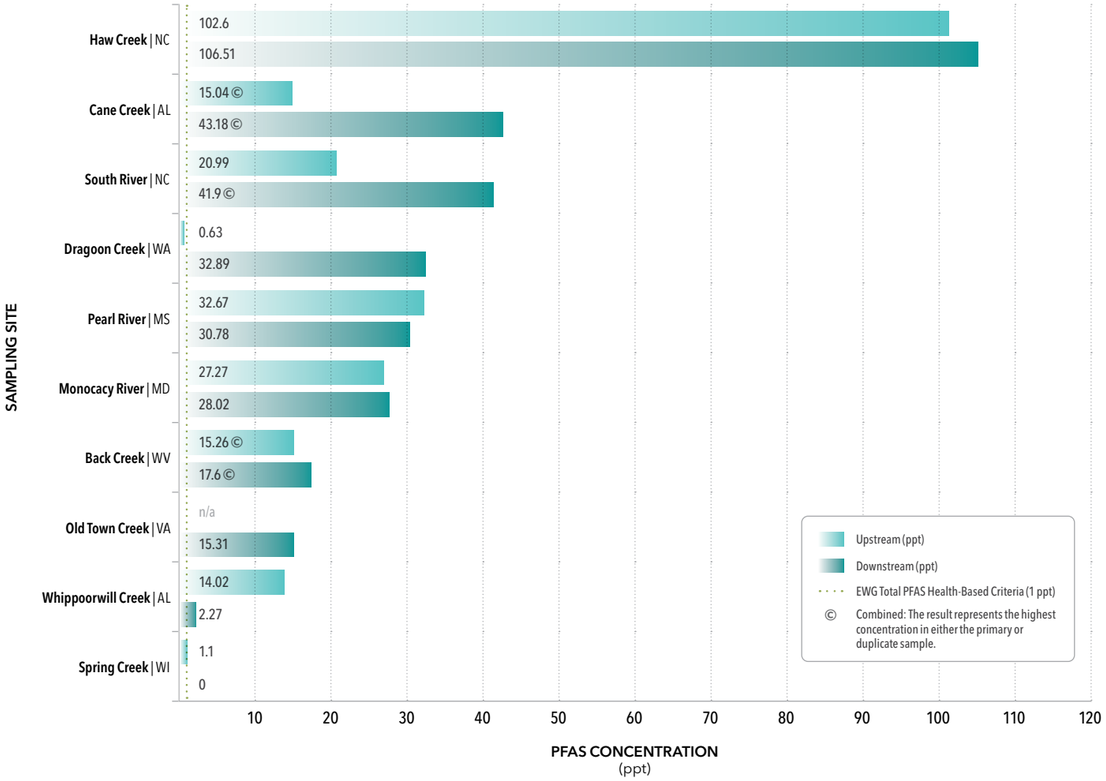
Figure 13 | Total PFAS Concentrations Upstream and Downstream from WWTPs



As shown in Figure 13 [WWTP] and Figure 14 [Biosolids] *(p. 38)*:

The total downstream PFAS concentrations exceeded EWG's health-based guideline for total PFAS of 1 ppt at all 22 WWTP sites and at 9 of 10 biosolids land application sites.[72]

Figure 14 | Total PFAS Upstream and Downstream from Biosolids Application Sites



PFAS Criteria

While there is no safe level of PFAS in drinking water, there are a limited number of state and/or federal health-based criteria applicable to water for some PFAS. EWG has developed health-based criteria applicable to water for most PFAS[73] that can also be utilized to evaluate the levels of PFAS we detected in this sampling project. *See Table 12 (p. 39).*

EPA has finalized MCLs under the federal SDWA[74] for only five PFAS–PFOA, PFOS, PFNA, PFHxS, and HFPO-DA (Gen-X)–and a Hazard Index for mixtures containing two or more of PFHxS, PFNA, HFPO-DA, and PFBS.[75] EPA has also published draft HHWQC under the Clean Water Act for PFOA, PFOS, and PFBS that apply to surface waters and "reflect the latest available scientific information including final human health toxicity values, draft bioaccumulation factors, draft relative source contributions, and updated drinking water ingestion rates."[76] Additionally, some states have adopted criteria for certain types of PFAS in surface waters. *See Table 12 (p. 39).*

The sampling data we collected detected elevated PFAS concentrations downstream from the WWTPs and biosolids land application sites that often exceeded SDWA MCLs for PFOA, PFOS, and/or PFHxS, and draft HHWQC (Water + Organism) for PFOA and PFOS and/or EWG's guidelines for multiple PFAS. *See Tables 13–15 (pp. 42–44).*

Table 12 | State, Federal, and EWG PFAS Criteria Applicable to Sampled Watersheds[77]

PFAS Analyte	Value (ppt)	Source[78]	Type	Note[79]
PFBA	1000	EWG	Health Guideline	
	1800	CT	DW Action Level	
PFPeA	1000	EWG	Health Guideline	
	70	RI	SW Quality Action Level	=> Sum of 8 PFAS
PFHxA	1000	EWG	Health Guideline	
	240	CT	DW Action Level	
	400,000	MI	MCL	
	70	RI	SW Quality Action Level	=> Sum of 8 PFAS
PFHpA	1000	EWG	Health Guideline	
	70	RI	SW Quality Action Level	=> Sum of 8 PFAS
PFOA	0.09	EWG	Health Guideline	
	4	EPA	MCL	
	0.0009	EPA	SW HH Water + Organism	
	0.007	CA	Public Health Goal	
	16	CT	DW Action Level	
	500	FL	HH SW Screening Level	
	8	MI	MCL	
	66	MI	SW Noncancer (DW)	
	10	NY	MCL	
	6.7	NY	Ambient WQ for HH (DW)	
	30	OR	DW Health Advisory Level	=> Sum of 4 PFAS
	70	RI	SW Quality Action Level	=> Sum of 8 PFAS
	20	RI	MCL	
	10	WA	DW Action Level	
	70	WI	MCL	Alone or +PFOS
	20	WI	SW Quality (DW)	
PFNA	0.006	EWG	Health Guideline	
	10	EPA	MCL	
	n/a	EPA	Hazard Index of 1 (unitless)	PFHxS, PFNA, HFPO-DA, and PFBS
	12	CT	DW Action Level	
	6	MI	MCL	
	30	OR	DW Health Advisory Level	=> Sum of 4 PFAS
	70	RI	SW Quality Action Level	=> Sum of 8 PFAS
	9	WA	DW Action Level	
PFDA	0.006	EWG	Health Guideline	
	70	RI	SW Quality Action Level	=> Sum of 8 PFAS
PFUnA	0.006	EWG	Health Guideline	
PFDoA	0.006	EWG	Health Guideline	
PFTrDA	0.006	EWG	Health Guideline	
PFTeA	0.006	EWG	Health Guideline	

Table 12 | State, Federal, and EWG PFAS Criteria Applicable to Sampled Watersheds[77]

PFAS Analyte	Value (ppt)	Source[78]	Type	Note[79]
PFBS	2000	EWG	Health Guideline	
	n/a	EPA	Hazard Index of 1 (unitless)	PFHxS, PFNA, HFPO-DA, and PFBS
	400	EPA	SW HH Water + Organism	
	500	CA	Health Notification Level	
	760	CT	DW Action Level	
	420	MI	MCL	
	345	WA	DW Action Level	
PFPeS	1	EWG	Health Guideline	
PFHxS	0.001	EWG	Health Guideline	
	10	EPA	MCL	
	n/a	EPA	Hazard Index of 1 (unitless)	PFHxS, PFNA, HFPO-DA, and PFBS
	3	CA	Health Notification Level	
	49	CT	DW Action Level	
	140	MD	DW Health Advisory Level	
	51	MI	MCL	
	59	MI	SW Noncancer (DW)	
	30	OR	DW Health Advisory Level	=> Sum of 4 PFAS
	1	RI	SW Quality Action Level	=> Sum of 8 PFAS
	20	RI	MCL	
	65	WA	DW Action Level	
PFHpS	0.001	EWG	Health Guideline	
PFOS	0.3	EWG	Health Guideline	
	4	EPA	MCL	
	0.06	EPA	SW HH Water + Organism	
	1	CA	Public Health Goal	
	10	CT	DW Action Level	
	10	FL	HH SW Screening Level	
	16	MI	MCL	
	11	MI	SW Noncancer (DW)	
	10	NY	MCL	
	2.7	NY	Ambient WQ for HH (DW)	
	30	OR	DW Level	=> Sum of 4 PFAS
	70	RI	SW Quality Action Level	=> Sum of 8 PFAS
	20	RI	MCL	
	15	WA	DW Action Level	
	70	WI	MCL	Alone or +PFOS
	8	WI	SW Quality (All Waters)	

Table 12 | State, Federal, and EWG PFAS Criteria Applicable to Sampled Watersheds[77]

PFAS Analyte	Value (ppt)	Source[78]	Type	Note[79]
PFNS	1	EWG	Health Guideline	
PFDS	0.001	EWG	Health Guideline	
PFDoS	1	EWG	Health Guideline	
FOSA	0.3	EWG	Health Guideline	
NMeFOSAA	1	EWG	Health Guideline	
NEtFOSAA	1	EWG	Health Guideline	
4:2 FTS	1	EWG	Health Guideline	
6:2 FTS	1	EWG	Health Guideline	
8:2 FTS	1	EWG	Health Guideline	
NEtFOSA	1	EWG	Health Guideline	
NMeFOSA	1	EWG	Health Guideline	
NMeFOSE	1	EWG	Health Guideline	
NEtFOSE	1	EWG	Health Guideline	
9Cl-PF3ONS	1	EWG	Health Guideline	
	2	CT	DW Action Level	
GenX	9	EWG	Health Guideline	
	10	EPA	MCL	
	n/a	EPA	Hazard Index of 1 (unitless)	PFHxS, PFNA, HFPO-DA, and PFBS
	19	CT	DW Action Level	
	370	MI	MCL	
11Cl-PF3OUdS	1	EWG	Health Guideline	
	5	CT	DW Action Level	
ADONA	1	EWG	Health Guideline	
3:3 FTCA				
5:3 FTCA				
7:3 FTCA				
NFDHA				
PFMBA	1	EWG	Health Guideline	
PFMPA	1	EWG	Health Guideline	
PFEESA		EWG	Health Guideline	

Table 13 | Exceedances of MCLs in Elevated Samples Downstream from WWTPs and Biosolids Land Application Sites

State	Waterbody	Waterkeeper	Analyte Amounts(ppt)			EPA MCL		
			PFOA	PFOS	PFHxS	PFOA	PFOS	PFHxS
Wastewater Treatment Sites								
AL	Cahaba River	Cahaba Riverkeeper	4.90			4	4	10
CA	Santa Ana River [Aug.] ▾	Inland Empire Waterkeeper	13.00	12.00		4	4	10
CT	Naugatuck River	Long Island Soundkeeper		8.30		4	4	10
FL	East Canal ▾	Tampa Bay Waterkeeper	7.10	11.00		4	4	10
MD	Monocacy River	Potomac Riverkeeper	6.80			4	4	10
MI	Rouge River	Detroit Riverkeeper	44.00		16.00	4	4	10
NC	Cape Fear River	Cape Fear Riverkeeper	8.30	13.00		4	4	10
	Haw River	Haw Riverkeeper	10.00	23.00		4	4	10
NJ	Ramapo River [Nov.]	Hackensack Riverkeeper	6.70	4.70		4	4	10
SC	Pocotaligo River	Black-Sampit Riverkeeper	28.00	30.00		4	4	10
TX	Hunting Bayou	Bayou City Waterkeeper	4.00	12.00		4	4	10
WI	Root River ©	Milwaukee Riverkeeper	8.00	5.00		4	4	10
WV	Opequon Creek	Upper Potomac Riverkeeper	4.10			4	4	10
Biosolids Application Sites								
AL	Cane Creek ©	Cahaba Riverkeeper Black Warrior Riverkeeper	4.10	5.80		4	4	10
NC	South River ©	Cape Fear Riverkeeper	5.80	7.50		4	4	10

Note: Only includes values that were elevated in comparison to upstream sites, except where as noted with an ▾ there was no upstream site.
© **Combined:** The result represents the highest concentration in either the primary or duplicate sample.

Samples upstream from WWTPs and biosolids land application fields also frequently exceeded these criteria. For example, the concentration of PFOS (11 ppt) and PFHxS (15 ppt) exceeded the MCL upstream from the Riverside RWQCP in the Santa Ana River (CA) [Nov.] and the concentration of PFOA (32 ppt) and PFOS (36 ppt) exceeded the MCL upstream from the Graham WWTP biosolids land application site in Haw Creek (NC). See Appendix A.

However, except where otherwise noted, the evaluation in Table 13 *(above)* and Table 14 *(p. 43)* only assesses downstream results where the downstream concentration exceeded the upstream concentration. These results are particularly concerning given the fact that the values are equilibrium concentrations that are more reflective of bioavailability, toxicity, and risk.

Table 14 | Exceedances of EPA HHWQC (Water + Organism) in Elevated Samples Downstream from WWTP and Biosolids Sites

State	Waterbody	Waterkeeper	PFOA Amounts (ppt)			PFOS Amounts (ppt)		
			Sample Results	EPA Criteria	Excess Amount	Sample Results	EPA Criteria	Excess Amount
Wastewater Treatment Sites								
AL	Cahaba River	Cahaba Riverkeeper	4.90	0.0009	4.8991			
	Big Wills Creek	Coosa Riverkeeper	2.20	0.0009	2.1991			
CA	Santa Ana River [Aug.] ▾	Inland Empire Waterkeeper	13.00	0.0009	12.9991	12.00	0.06	11.94
CT	Naugatuck River	Long Island Soundkeeper				8.30	0.06	8.24
FL	East Canal ▾	Tampa Bay Waterkeeper	7.10	0.0009	7.0991	11.00	0.06	10.94
GA	Chattahoochee River	Chattahoochee Riverkeeper	2.80	0.0009	2.7991			
MD	Monocacy River	Potomac Riverkeeper	6.80	0.0009	6.7991			
MI	Rouge River	Detroit Riverkeeper	44.00	0.0009	43.9991	3.10	0.06	3.04
MS	Pearl River ▾	Pearl Riverkeeper	2.90	0.0009	2.8991	3.50	0.06	3.44
NC	Cape Fear River	Cape Fear Riverkeeper	8.30	0.0009	8.2991	13.00	0.06	12.94
	Haw River	Haw Riverkeeper	10.00	0.0009	9.9991	23.00	0.06	22.94
NJ	Ramapo River [Nov.]	Hackensack Riverkeeper	6.70	0.0009	6.6991	4.70	0.06	4.64
OR	Tualatin River	Tualatin Riverkeepers	3.30	0.0009	3.2991	2.50	0.06	2.44
SC	Pocotaligo River	Black-Sampit Riverkeeper	28.00	0.0009	27.9991	30.00	0.06	29.94
TX	Hunting Bayou	Bayou City Waterkeeper	4.00	0.0009	3.9991	12.00	0.06	11.94
VA	Appomattox River	James Riverkeeper	2.60	0.0009	2.5991	2.60	0.06	2.54
WA	Spokane River	Spokane Riverkeeper	1.10	0.0009	1.0991	2.10	0.06	2.04
WI	Root River ©	Milwaukee Riverkeeper	8.00	0.0009	7.9991	5.00	0.06	4.94
WV	Opequon Creek	Upper Potomac Riverkeeper	4.10	0.0009	4.0991			
Biosolids Application Sites								
AL	Cane Creek ©	Cahaba Riverkeeper/ Black Warrior Riverkeeper	4.10	0.0009	4.0991	5.80	0.06	5.74
MS	Pearl River	Pearl Riverkeeper				3.60	0.06	3.54
NC	South River ©	Cape Fear Riverkeeper	5.80	0.0009	5.7991	7.50	0.06	7.44
VA	Old Town Creek ▾	James Riverkeeper	3.90	0.0009	3.8991	3.10	0.06	3.04
WA	Dragoon Creek	Spokane Riverkeeper	1.50	0.0009	1.4991			

Note: Only includes values that were elevated in comparison to upstream sites, except where as noted with an ▾ there was no upstream site.
© **Combined:** The result represents the highest concentration in either the primary or duplicate sample.

Table 15 | Exceedances of EWG Criteria in Elevated Samples Downstream from WWTPs and Biosolids Land Application Sites

State	Waterbody	Amounts by Analyte (ppt)														
		PFOA	PFOS	PFHxS	PFNA	PFDA	FOSA	PFDoA	6:2 FTS	PFUnA	PFTeA	PFTeS	NMeFOSAA	PFMPA	PFMBA	PFHpS
EWG Criteria Amount		0.09	0.3	0.001	0.006	0.006	0.3	0.006	1.00	0.006	0.006	1.00	1.00	1.00	1.00	0.001
Wastewater Treatment Sites																
AL	Cahaba River	4.90		1.50												
	Big Wills Creek	2.20		0.64			1.60									
CA	Santa Ana River [Aug.] ▾	13.00	12.00		2.10										6.10	
	Los Angeles River					2.10										
CT	Naugatuck River		8.30	1.70												
FL	East Canal ▾	7.10	11.00	3.90	1.30											
GA	Chattahoochee River	2.80						1.20			4.10			2.10		
MD	Monocacy River	6.80		2.50			0.62									
MI	Rouge River	44.00	3.10	16.00		5.00										
MS	Pearl River ▾	2.90	3.50	1.30	0.71											
NC	Haw River	10.00	23.00	4.50	2.20	2.60		0.59	1.10	0.87						
	Cape Fear River	8.30	13.00	5.30												
NJ	Ramapo River [Nov.]	6.70	4.70	3.50												
OR	Tualatin River	3.30	2.50	0.73	0.59											
RI	Pawtuxet River ©			2.30	2.10											
SC	Pocotaligo River	28.00	30.00		2.30	2.10	1.70		22.00	0.79			1.10			
TX	Hunting Bayou	4.00	12.00		1.30	0.64										
VA	Appomattox River	2.60	2.60		0.75											
WA	Spokane River	1.10	2.10	0.80												
WI	Root River ©	8.00	5.00	2.10	1.30	0.83										
WV	Opequon Creek	4.10														
	Ohio River															
Biosolids Application Sites																
AL	Cane Creek ©	4.10	5.80		0.68											
NC	Haw Creek				1.90	0.81						2.20				1.30
	South River ©	5.80	7.50	2.40	1.40		0.86									
MD	Monocacy River				0.77											
MS	Pearl River		3.60			0.73										
VA	Old Town Creek ▾	3.90	3.10	1.50												
WA	Dragoon Creek	1.50		0.71			0.88									

Note: Only includes values that were elevated in comparison to upstream sites, except where as noted with an ▾ there was no upstream site.
© **Combined:** The result represents the highest concentration in either the primary or duplicate sample.

As shown in Table 13 *(p. 42)* and Figure 15 [WWTPs] *(p. 46)*:

1. The MCL for PFOA was exceeded at 12 downstream WWTP sites and two downstream biosolids land application sites.
   - ↳ In the Pocotaligo River downstream from the Sumter Pocotaligo River Plant in South Carolina, PFOA exceeded the MCL of 4 ppt by 24 ppt.
   - ↳ In the Rouge River downstream from the GLWA WRRF in Michigan, PFOA exceeded the MCL of 4 ppt by 40 ppt.
   - ↳ In the Santa Ana River [Aug.] downstream from the Riverside RWQCP in California, PFOA exceeded the MCL of 4 ppt by 9 ppt.

2. The MCL for PFOS was exceeded at nine downstream WWTP sites and two downstream biosolids land application sites.
   - ↳ In the Pocotaligo River downstream from the Sumter Pocotaligo River Plant in South Carolina, PFOS exceeded the MCL of 4 ppt by 26 ppt.
   - ↳ In the Haw River downstream from the Graham WWTP in North Carolina, PFOS exceeded the MCL of 4 ppt by 19 ppt.
   - ↳ In the Cape Fear River downstream from the Fayetteville Cross Creek WRF, PFOS exceeded the MCL of 4 ppt by 9 ppt.

3. The MCL for PFHxS was exceeded at one downstream WWTP site.
   - ↳ In the Rouge River downstream from the GLWA WRRF in Michigan, PFHxS exceeded the MCL of 10 ppt by 6 ppt.

As shown in Table 14 *(p. 43)* and Figure 16 [WWTPs] *(p. 47)*:

1. The draft HHWQC (Water + Organism) for PFOA was exceeded at 18 downstream WWTP sites and 4 downstream biosolids land application sites.
   - ↳ In the Pocotaligo River downstream from the Sumter Pocotaligo River Plant in South Carolina, PFOA exceeded the draft HHWQC of 0.0009 ppt by 27.9991 ppt.
   - ↳ In the Rouge River downstream from the GLWA WRRF in Michigan, PFOA exceeded the draft HHWQC of 0.0009 ppt by 43.9991 ppt.
   - ↳ In the South River downstream from Fayetteville Cross Creek's biosolids land application fields in North Carolina, PFOA exceeded the draft HHWQC of 0.0009 ppt by 5.7991 ppt.

2. The draft HHWQC (Water + Organism) for PFOS was exceeded at 14 downstream WWTP sites and 4 downstream biosolids land application sites.
   - ↳ In the Pocotaligo River downstream from the Sumter Pocotaligo River Plant in South Carolina, PFOS exceeded the draft HHWQC of 0.06 by 29.94 ppt.
   - ↳ In the Haw River downstream from the Graham WWTP in North Carolina, PFOS exceeded the draft HHWQC of 0.06 by 22.94 ppt.
   - ↳ In the South River downstream from Fayetteville Cross Creek's biosolids land application fields in North Carolina, PFOS exceeded the draft HHWQC of 0.06 by 7.44 ppt.

Figure 15 | Exceedances of EPA PFAS MCLs Downstream from WWTP Outfalls
Includes Only Sites Where Downstream PFAS Concentrations Exceeded Upstream PFAS Concentrations ⬩

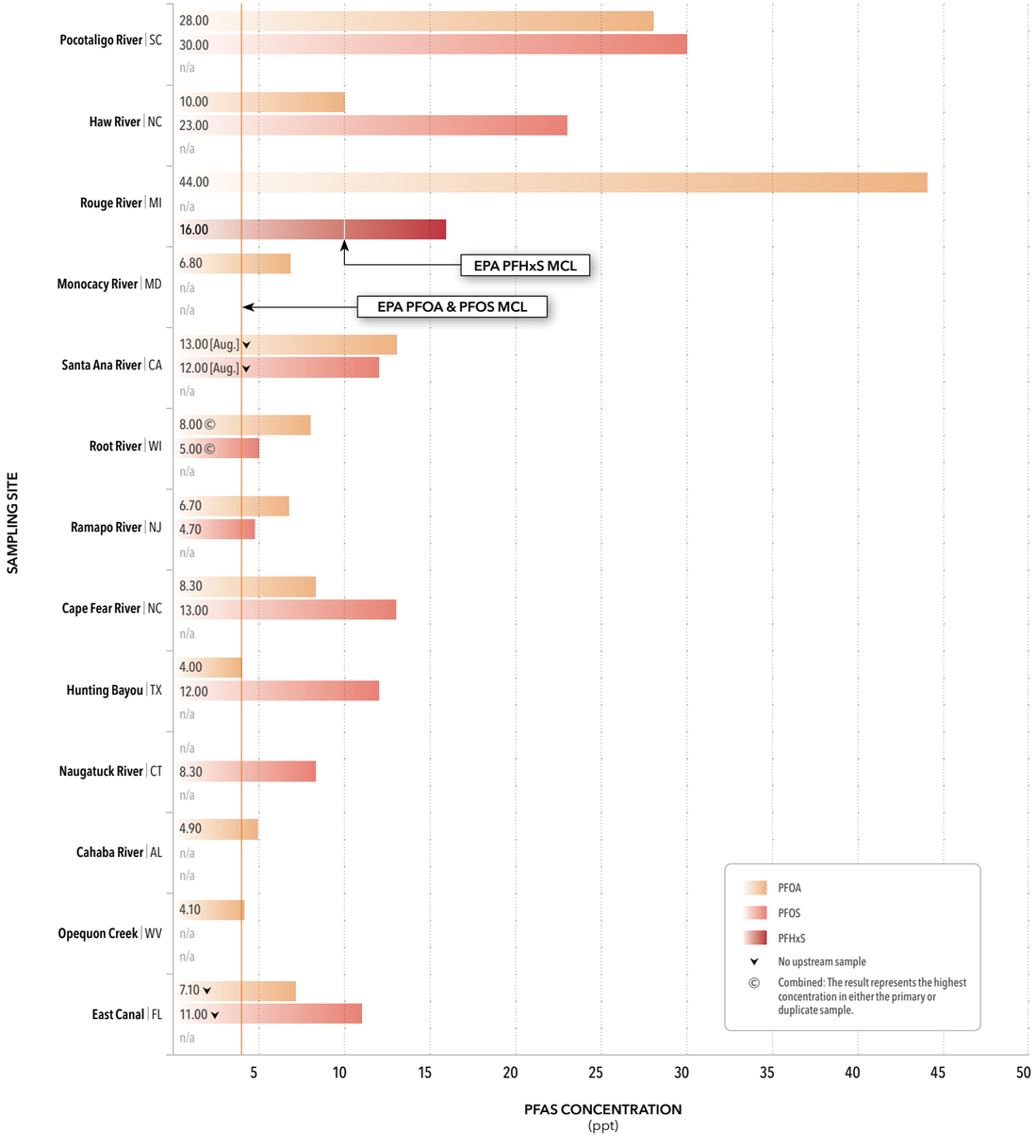
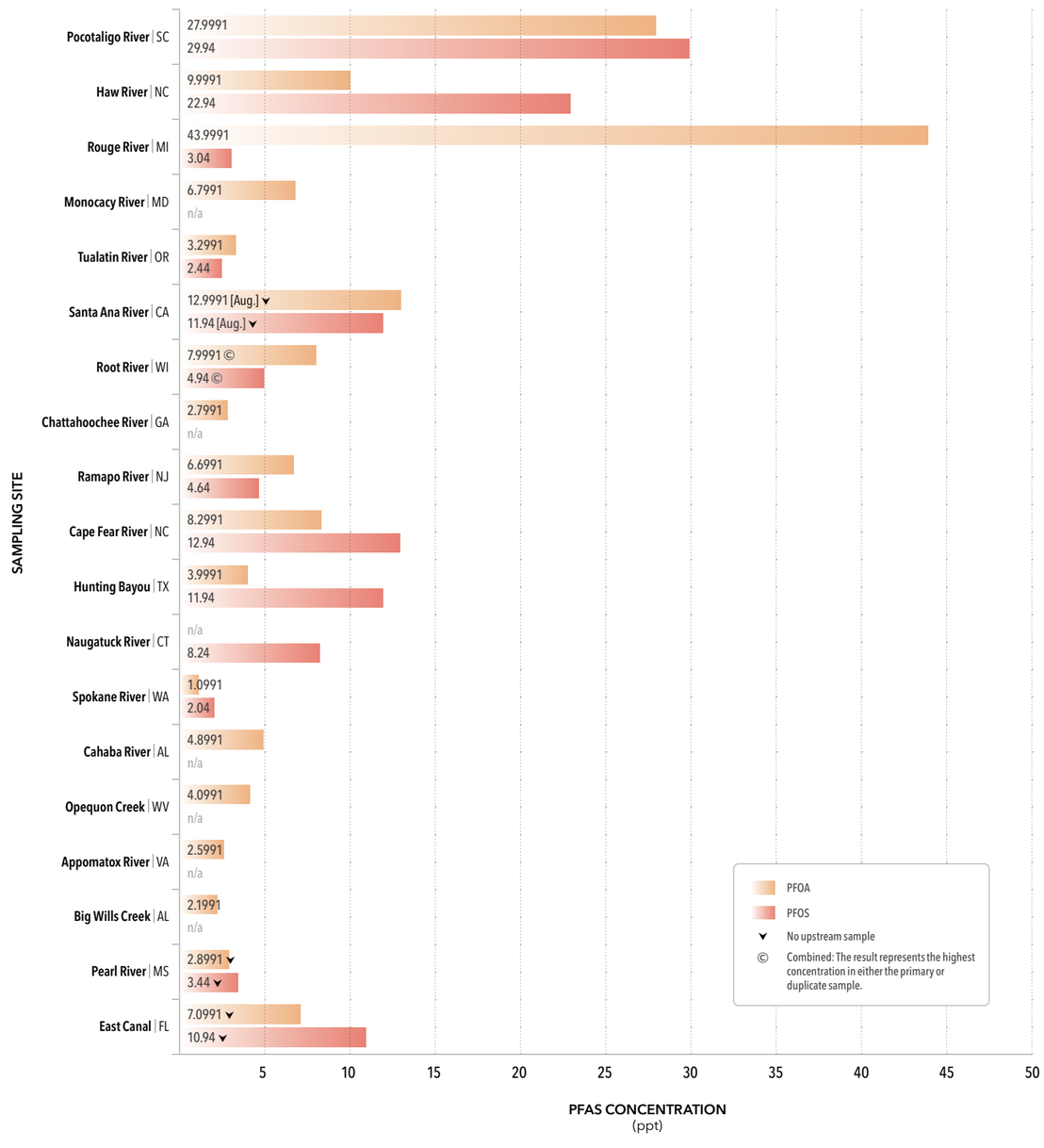


Figure 16 | Exceedances of Draft HHWQC (Water + Organism) Downstream from WWTPs
Includes Only Sites Where Downstream Concentrations Exceeded Upstream PFAS Concentrations

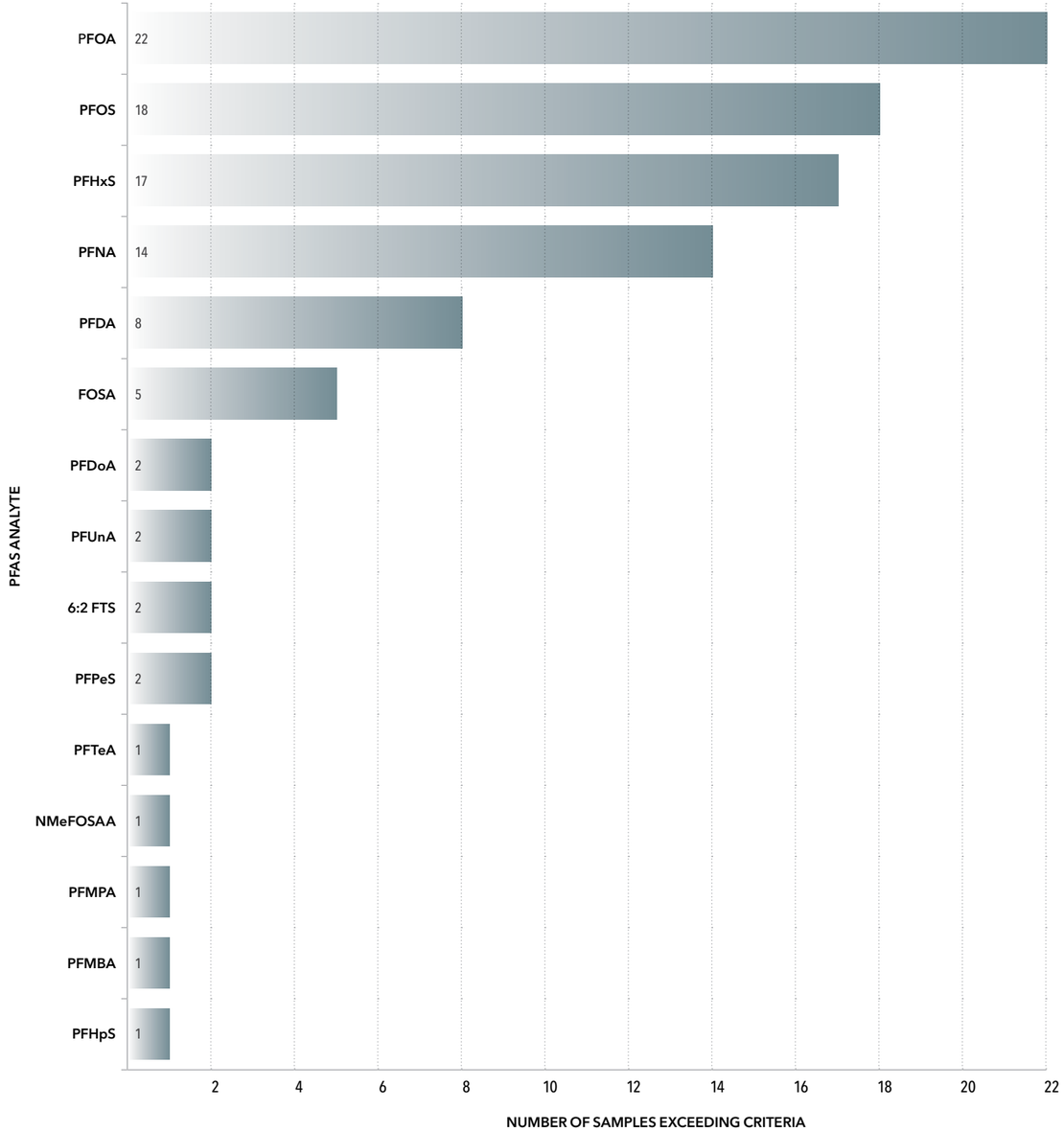


As shown in Table *15 (p. 44)* and *Figure 17 [WWTPs and Biosolids] (p. 49)*, EWG's health-based criteria were exceeded at 29 locations downstream from WWTP sites and biosolids land application sites. The PFAS types that most frequently exceeded EWG's criteria at the greatest number of elevated downstream sites were:

- PFOA (22 sites)
- PFOS (18 sites)
- PFHxS (17 sites)
- PFNA (14 sites)

1. There are no federal standards for PFDA, which is a "[b]reakdown product of stain- and grease-proof coatings on food packaging, couches, carpets."[80] It was detected at higher concentrations in sampling sites downstream from six WWTPs and two biosolids land application fields at levels that exceed EWG's health-based criteria. Based on "EPA's toxicity value published in the Integrated Risk Information System's toxicological review," the EWG criteria for PFDA is 0.006 ppt to protect against developmental and immune harm in humans.[81]
   - ↳ In the Rouge River downstream from the GLWA WRRF in Michigan, the PFDA concentration was 5 ppt.
   - ↳ In the Haw River downstream from the Graham WWTP in North Carolina, the PFDA concentration was 2.6 ppt.
   - ↳ In the Los Angeles River downstream from the LA-Glendale WRP in California, the PFDA concentration was 2.1 ppt.
   - ↳ In Haw Creek downstream from the Graham WWTP biosolids land application field in North Carolina, the PFDA concentration was 0.81 ppt.
2. There are no federal standards for FOSA, which is widely used in industrial processes.[82] It was detected at higher concentrations in sampling sites downstream from three WWTPs and two biosolids land application fields at levels that exceed EWG's health-based criteria. Based on "EPA's final toxicity value for PFOS from the Office of Water's Final Human Health Toxicity Assessment," the EWG criteria for FOSA is 0.3 ppt to protect against cardiovascular harm and harm to fetal growth in humans.[83]
   - ↳ In the Pocotaligo River downstream from the Sumter Pocotaligo River Plant in South Carolina, the FOSA concentration was 1.7 ppt.
   - ↳ In Big Wills Creek downstream from the Rainbow City WWTP in Alabama, the FOSA concentration was 1.6 ppt.
   - ↳ In the Monocacy River downstream from the City of Frederick WWTP in Maryland, the FOSA concentration was 0.62 ppt.
   - ↳ In Dragoon Creek downstream from the Spokane Riverside Park WRF's biosolids land application fields in Washington, the FOSA concentration was 0.88 ppt.
   - ↳ In the South River downstream from Fayetteville Cross Creek's biosolids land application fields in North Carolina, the FOSA concentration was 0.86 ppt.

Figure 17 | Number of Elevated Downstream Samples Exceeding EWG Criteria
Downstream from Wastewater Treatment Plants and Biosolids Land Application Sites



Note: Santa Ana, CA [Aug.] and East Canal, FL did not obtain upstream samples.

3. There are no federal standards for 6:2 FTS, which is used as a replacement for PFOS in aqueous film-forming foam and in the chromium electroplating industry.[84] It was detected at higher concentrations in sampling sites downstream from two WWTPs at levels that exceed EWG's health-based criteria. "[B]ased on studies by Phillipe Grandjean of Harvard University and many other independent researchers," the EWG criteria for 6:2 FTS is 1 ppt to protect against adverse human health effects.[85]
   - ↳ In the Pocotaligo River downstream from the Sumter Pocotaligo River Plant in South Carolina, the 6:2 FTS concentration was 22 ppt.[86]
   - ↳ In the Haw River downstream from the Graham WWTP in North Carolina, the 6:2 FTS concentration was 1.1 ppt.

4. There are no federal standards for PFTeA, which is used in a wide variety of consumer products.[87] It was detected at higher concentrations in sampling sites downstream from one WWTP at levels that exceed EWG's health-based criteria. "[B]ased on EPA's recommended application of the toxicity value for PFDA published in the Integrated Risk Information System's toxicological review," the EWG criteria for PFTeA is 0.006 ppt to protect against harm to the immune system and harm to fetal growth and child development.[88]
   - ↳ In the Chattahoochee River downstream from the City of Atlanta's R.M. Clayton WRC, Cobb County's R.L. Sutton WRF, and the West Area WQCF in Georgia, the PFTeA concentration was 4.1 ppt.

5. There are no federal standards for PFHpS, which is used in many consumer products. It was detected at higher concentrations in sampling sites downstream from one biosolids land application site at levels that exceed EWG's health-based criteria. Based on "EPA's recommended application of the PFHxS toxicity value published in the Integrated Risk Information System's toxicological review," the EWG criteria for PFHpS is 0.001 ppt to protect against cancer, endocrine disruption, accelerated puberty, liver and immune system damage, and thyroid changes.[89]
   - ↳ In Haw Creek downstream from the Graham WWTP biosolids land application field in North Carolina, the PFHpS concentration was 1.3 ppt.

6. There are no federal standards for PFMBA, which is used in many consumer products. It was detected at higher concentrations in sampling sites downstream from one WWTP at levels that exceed EWG's health-based criteria. "[B]ased on studies by Phillipe Grandjean of Harvard University and many other independent researchers," the EWG criteria for PFMBA is 1 ppt to protect against adverse human health effects.[90]
   - ↳ In the Santa Ana River [Aug.] downstream from the Riverside RWQCP in California, the concentration of PFMBA was 6.1 ppt.

EVALUATION OF FACILITIES AND WATERSHEDS

To further evaluate the contribution of PFAS to the sampled watersheds, we conducted a comparative analysis of upstream and downstream results for each of the WWTPs and biosolids land application fields, and we assessed the results in relation to the available criteria for evaluating human health risks. Additionally, we reviewed information about the facilities from publicly available sources and EJScreen data to better understand the potential sources and environmental justice implications of PFAS contamination. This information was obtained from state agencies, EPA, the facilities' webpages, public information requests, and other online resources. Statements made herein about the facilities and industrial users rely on the accuracy and completeness of these sources. While we undertook a thorough review of available, but often limited information, we make no independent representation of these facts. The results of our evaluation are set forth below. EPA EJScreen Enforcement and Compliance History Online (ECHO) and Community Reports discussed for each facility can be found in Appendix B.

Nearly all of the WWTPs evaluated in this project accept discharges into their treatment systems from industrial users. Yet, based on our review of public records, it appears the overwhelming majority of the WWTPs do not place any PFAS limits on these users. This is concerning given the fact that a significant number of these industrial users operate in sectors known for producing and/or utilizing PFAS. Based on information taken from EPA's PFAS Analytic Tools, which is a publicly available online repository of PFAS data collected by the agency, we determined that most WWTPs are likely receiving discharges from at least one permitted industrial user that is "operat[ing] in sectors that have been identified as possibly handling, using, or releasing PFAS chemicals." Frequently, the data indicates that there may be additional unpermitted industrial users of these systems that have been identified in the database.

To effectively stem the tide of PFAS contamination in U.S. waterways, federal and state governments must prioritize regulation of the industrial sources from which it originates. Industry, which profits from the use of these toxic chemicals, must also be required to share the financial burden of cleaning up its PFAS pollution. Otherwise, WWTPs, and the communities that rely on them, will be forced to shoulder that burden alone. This is not only a matter of fairness; it also makes financial sense given that controlling PFAS at the source is significantly less costly than trying to remove it at the wastewater or drinking water utility level.[91]

EPA's own investigations have confirmed both the extent of PFAS contamination in industrial wastewater and the need for pretreatment solutions to sufficiently address the problem. In 2021, EPA studied industrial discharges of PFAS from five industrial categories, including: Organic Chemicals, Plastics, and Synthetic Fibers Manufacturing; Metal Finishing; Pulp, Paper and Paperboard Manufacturing; Textile Mills; and Commercial Airports. The Agency found that "[f]ew facilities in these industries currently have monitoring requirements, effluent limitations, or pretreatment standards for PFAS in their wastewater discharge permits."[92] It then "identified available wastewater treatment technologies, such as activated carbon, ion exchange, and membrane filtration, that may reduce PFAS in wastewater discharges from facilities in these industrial point source categories."[93] Pretreatment technologies such as these currently exist and have been found to be both cost-effective and successful in reducing concentrations of PFOA and PFOS.[94] Given the apparent extent of industry's contribution to PFAS pollution in WWTPs, it is imperative that federal and state governments incorporate pretreatment technologies into their strategies to protect public health in their communities.

WATERSHEDS WITH THE GREATEST DOWNSTREAM TOTAL PFAS CONCENTRATION INCREASES

We generated more detailed evaluations for watersheds where the WWTPs and biosolids land application fields had the greatest increases in total PFAS concentrations between upstream and downstream sampling sites. These evaluations are presented below by Waterkeeper group watershed.

Black-Sampit Riverkeeper, Pocotaligo River, South Carolina

Wastewater Treatment Plant Site

According to its 2017 NPDES permit application, the Sumter Pocotaligo River WWTP is a municipal wastewater treatment system that is owned and operated by the City of Sumter's Wastewater Division of the Utilities Department and serves 51,000 people. In addition, the facility handles wastewater from numerous industrial dischargers, including four permitted Significant Industrial Users and 20 permitted Categorical Industrial Users. The WWTP discharges treated wastewater into the East Branch of the Pocotaligo River at an average design flow of 15 MGD. The Pocotaligo River Watershed makes up 171,780 acres of the Upper Coastal Plain region of South Carolina. According to ECHO, Sumter is located in an area with four State EJ Indexes and six Federal EJ Indexes greater than the state's 80th percentile within one mile of the facility, including wastewater discharges at 87 (State).[95] According to the EPA EJScreen, of people living within one mile of Sumter WWTP, 65% are people of color and 42% are low income.[96]

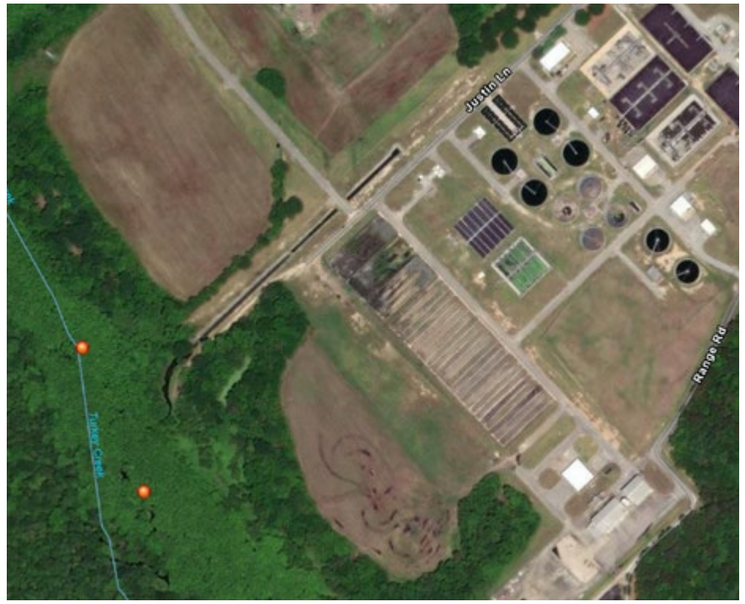
The NPDES permit for Sumter WWTP does not include any limits on the amount of PFAS the facility discharges into the Pocotaligo River and there are no pretreatment limits to control PFAS discharges to the WWTP by industrial dischargers. Of the 24 permitted industrial users discharging wastewater to Sumter Pocotaligo River WWTP, EPA's PFAS Analytic Tools[97] lists the following 11 as facilities "operat[ing] in sectors that have been identified as possibly handling, using, or releasing PFAS chemicals":

- Apex Tools (Metal Coating)
- Armoloy Southeast (Metal Coating)
- Continental Tire (Consumer Products)
- EMS – chemie (Plastics and Resins)
- Enersys – Sumter Metals (Metal Machinery Mfg.)
- GRR (Waste Management)
- Interlake Mecalux (Metal Machinery Mfg.)
- Metal Finishing Services, Inc. (Metal Coating)
- Metokote Corporation (Metal Coating)
- Phibro – Tech, Inc. (Chemical Mfg.)
- Santee Print Works (Textiles and Leather)

There are likely additional unpermitted industrial dischargers contributing PFAS to the WWTP given that EPA's PFAS Analytic Tools identifies 40 facilities located within the City of Sumter that operate in PFAS-related sectors, including:

- Airports
- Chemical Mfg.
- Consumer Products
- Electronics Industry
- Glass Products
- Metal Coating
- Metal Machinery Mfg.
- National Defense
- Paints and Coatings
- Plastics and Resins
- Textiles and Leathers
- Waste Management

Sumter Pocotaligo WWTP | Pocotaligo River



PFAS Phase II Sampling Site

From 2022 to 2023, as part of the state's Ambient Surface Water PFAS Project,[98] the South Carolina Department of Environmental Services tested for a series of 26 PFAS or precursor compounds in ambient surface water at locations upstream and downstream from Sumter Pocotaligo River WWTP's outfall. The results show significant increases in the average concentrations of multiple types of PFAS between the upstream monitoring location and the closest downstream monitoring location, for example:

- PFOS (12.1 ppt to 62.93 ppt)
- PFHxA (5.69 ppt to 84.67 ppt)
- PFPeA (5.29 ppt to 69.03 ppt)
- 6:2 FTS (N.D. to 53.95 ppt)

Sampling conducted by Black-Sampit Riverkeeper in December 2023 also detected significant increases in PFAS downstream from the Sumter Pocotaligo River WWTP's outfall, particularly PFPeA (<1 ppt to 110.9 ppt) and PFHxA (2 ppt to 194.7 ppt).

For Phase II, Black-Sampit Riverkeeper deployed PFASsive™ passive sampling devices upstream and downstream from the WWTP's outfall to the East Branch of the Pocotaligo River from August 23, 2024 to September 25, 2024. Both upstream and downstream sampling sites detected multiple types of regulated and unregulated PFAS.[99] However, the concentrations of multiple types of PFAS increased significantly at the downstream site, resulting in a total PFAS concentration of 228.39 ppt. With an increase of 118.01 ppt (106.91%), this site became the most contaminated location detected in this monitoring project.

For example, the concentration of PFHxA increased from 9.6 ppt to 49 ppt (410.42%), the concentration of PFPeA increased from 9.7 ppt to 38 ppt (291.75%), and the concentration of PFHpA increased from 4 ppt to 21 ppt (425%). Multiple other types of PFAS increased in downstream samples at levels ranging from 21.74% to 144.9%, including 6:2 FTS, which increased from non-detect to 22 ppt. These results are consistent with the findings of previous sampling, and indicate that the Sumter Pocotaligo River WWTP's outfall is likely a significant source of PFAS in the Pocotaligo River.

Downstream concentrations of PFAS demonstrate that the surface water at this location is unsafe for drinking without advanced treatment. For example, the concentration of PFOA at the downstream location was 28 ppt, which is 24 ppt greater than the MCL of 4 ppt, and the concentration of PFOS was 30 ppt, which is 26 ppt greater than the MCL of 4 ppt.

The concentrations of PFOA and PFOS in the downstream samples were also greater than the draft HHWQC (Water + Organism). Specifically, PFOA exceeded the criteria of 0.0009 ppt by 27.9991 ppt, and PFOS exceeded the 0.06 criteria by 29.94 ppt.

Table 16 | Pocotaligo River Upstream and Downstream from Sumter WWTP

Analyte	Sample (ppt)				MCL (ppt)		EPA (ppt)		EWG (ppt)	
	▲ Upstream	▼ Downstream	Change	% Change	Criteria	Downstream Exceedance	Criteria	Downstream Exceedance	Criteria	Downstream Exceedance
PFHxA	9.60	49.00	39.40	410.42%					1000	
PFPeA	9.70	38.00	28.30	291.75%					1000	
6:2 FTS	0.00	22.00	22.00	n/a					1	21.000
PFHpA	4.00	21.00	17.00	425.00%					1000	
PFOS	22.00	30.00	8.00	36.36%	4	26.00	0.06	29.94	0.3	29.700
PFBA	4.90	12.00	7.10	144.90%					1000	
PFOA	23.00	28.00	5.00	21.74%	4	24.00	0.0009	27.9991	0.09	27.910
PFBS	3.10	5.50	2.40	77.42%			400		2000	
PFDA	0.00	2.10	2.10	n/a					0.006	2.094
FOSA	0.00	1.70	1.70	n/a					0.3	1.400
PFNA	1.50	2.30	0.80	53.33%	10				0.006	2.294
PFUnA	0.00	0.79	0.79	n/a					0.006	0.784
NMeFOSAA	0.66	1.10	0.44	66.67%					1	0.100
PFPeS	1.20	1.10	-0.10	-8.33%					1	0.100
NEtFOSAA	0.72	0.00	-0.72	-100.00%					1	
PFHxS	14.00	6.60	-7.40	-52.86%	10				0.001	6.599
HFPO-DA (GenX)	16.00	7.20	-8.80	-55.00%	10				9	
Total PFAS	110.38	228.39	118.01	106.91%						

Non-detect recorded as 0 Downstream Increase Exceed criteria levels

There are no national or state Clean Water Act ambient surface water quality criteria for most PFAS detected at elevated levels, such as PFHxA, PFPeA, 6:2 FTS, PFHpA, PFBA, FOSA, PFNA, and PFUnA. However, several PFAS without federal or state standards, including PFDA, PFUnA, PFPeS, 6:2 FTS, FOSA, and NMeFOSAA, exceeded EWG's health-based criteria, as did PFNA. *See Table 16 (above).*

This evaluation indicates that Sumter Pocotaligo River WWTP is contributing a significant amount of PFAS to the Pocotaligo River and that multiple industrial dischargers are likely contributing to the WWTP's discharge of PFAS to the river. This pollution will likely continue to pose significant risks to human health until pretreatment limits are imposed on industrial sources discharging into the WWTP, and a PFAS limit is included in the Sumter Pocotaligo River WWTP's NPDES permit. Implementing these measures will require the installation of advanced treatment technology and a plan to safely manage the contaminants removed during treatment.

Haw Riverkeeper, Haw River and Haw Creek, North Carolina

Wastewater Treatment Plant and Biosolids Sites

The Graham WWTP is a municipal wastewater treatment system that is owned and operated by the City of Graham that serves a population of close to 17,000 residents.[100] In addition, the facility handles wastewater from multiple industrial dischargers, including five permitted Significant Industrial Users, of which three are categorical. The WWTP discharges treated wastewater into the Haw River at an average design flow of 3.5 MGD. The Haw River, which flows 110 miles south to the Cape Fear River and joins the Jordan Lake Reservoir, spans a 1,700-square-mile watershed. The Haw River and its watershed provide drinking water to nearly one million people and supports diverse wildlife, including the endangered Cape Fear shiner.

According to ECHO, Graham WWTP is located in an area with eight State Supplemental EJ Indexes and seven Federal Supplemental EJ Indexes greater than the 80th percentile within one mile of the facility, including wastewater discharges at 97 (State).[101] According to the EPA EJScreen, of people living within one mile of Graham WWTP, 35% are people of color and 27% are low income.[102] Although Graham WWTP's NPDES permit[103] requires that the facility monitor for PFAS chemicals listed in Table 1 of EPA Method 1633 twice a year, the permit does not include any limits on the amount of PFAS the facility discharges.

EPA's PFAS Analytic Tools[104] identifies seven facilities in the City of Graham that are "operat[ing] in sectors that have been identified as possibly handling, using, or releasing PFAS chemicals." Specifically, those industry sectors include Chemical Mfg., Clean Product Mfg., Metal Coating, Paper Mills and Products, Plastics and Resins, and Waste Management. EPA's list of facilities does not include any of those that are permitted to discharge into Graham WWTP.

In 2019, North Carolina's Department of Environmental Quality (DEQ) determined that the Graham WWTP's influent was contaminated with PFAS. DEQ's sampling[105] detected the presence of 13 PFAS; three of which were detected at concentrations greater than 10 ppt: PFHxA (max. 11.8 ppt), PFPeA (max. 65.6 ppt), and PFOS (max. 12.8 ppt). That same year, Haw Riverkeeper tested water samples collected upstream and downstream of WWTPs along the Haw, including the Graham WWTP. Water samples taken from upstream and downstream of the facility outfall detected total PFAS concentrations of 33.14 ppt (upstream) and 44.75 ppt (downstream).

For this project, Haw Riverkeeper deployed PFASsive™ passive sampling devices immediately upstream and downstream from a Graham WWTP's outfall to the Haw River from August 12, 2024 to September 20, 2024. Both upstream and downstream sampling sites detected multiple types of PFAS. However, total PFAS concentrations increased significantly at the downstream site, rising by 66.47 ppt or 85.14%. For example, the concentration of PFPeA increased from 14 ppt to 36 ppt (157.14%), the concentration of PFDA increased from 1.2 ppt to 2.6 ppt

Graham WWTP | Haw River



PFAS Phase II Sampling Site

(116.67%), and the concentration of PFHxA increased from 13 ppt to 27 ppt (107.69%). Multiple other types of PFAS increased in downstream samples at levels ranging from 7.14% to 91.01%, including PFBS which increased from 8.9 ppt to 17 ppt. These results are consistent with the findings of previous sampling and indicate that the Graham WWTP's outfall is likely a significant source of PFAS in the Haw River.

Downstream concentrations of PFAS demonstrate that the surface water is unsafe for drinking without advanced treatment. For example, the concentration of PFOA at the downstream location was 10 ppt, which is 6 ppt greater than the MCL of 4 ppt, and the concentration of PFOS was 23 ppt, which is 19 ppt greater than the MCL of 4 ppt.

The concentrations of PFOA and PFOS in the downstream samples were also greater than the draft HHWQC (Water + Organism). Specifically, PFOA exceeded the criteria of 0.0009 ppt by 9.9991 ppt, and PFOS exceeded the 0.06 ppt criteria by 22.94 ppt. There are no national or state CWA surface water quality criteria for the protection of human health that apply to the majority of PFAS that were detected at elevated levels, including PFPeA, PFHxA, PFBA, PFHpA, PFDA, 6:2 FTS, PFMPA, PFUnA, PFNA, PFDoA, and PFHxS.

Additionally, numerous PFAS that do not have any federal or state regulatory standards significantly exceeded EWG's health-based criteria, including PFDA (also detected in 2019 NCDEQ Influent Sampling), PFUnA, PFDoA (also detected in 2019 NCDEQ Influent Sampling), and 6:2 FTS (also detected in 2019 NCDEQ Influent Sampling). PFNA and PFHxS also significantly exceeded EWG's health-based criteria. *See Table 17 (below).*

Table 17 | Haw River Upstream and Downstream from Graham WWTP

Analyte	Sample (ppt)				MCL (ppt)		EPA (ppt)		EWG (ppt)	
	▲ Upstream	▼ Downstream	Change	% Change	Criteria	Downstream Exceedance	Criteria	Downstream Exceedance	Criteria	Downstream Exceedance
PFPeA	14.00	36.00	22.00	157.14%					1000	
PFHxA	13.00	27.00	14.00	107.69%					1000	
PFBS	8.90	17.00	8.10	91.01%			400		2000	
PFOS	17.00	23.00	6.00	35.29%	4	19.00	0.06	22.94	0.3	22.700
PFBA	5.10	9.20	4.10	80.39%					1000	
PFHpA	5.20	8.80	3.60	69.23%					1000	
PFOA	7.10	10.00	2.90	40.85%	4	6.00	0.0009	9.9991	0.09	9.910
PFDA	1.20	2.60	1.40	116.67%					0.006	2.594
6:2 FTS	0.00	1.10	1.10	n/a					1	0.100
PFMPA	0.00	0.88	0.88	n/a					1	
PFUnA	0.00	0.87	0.87	n/a					0.006	0.864
PFNA	1.50	2.20	0.70	46.67%	10				0.006	2.194
PFDoA	0.00	0.59	0.59	n/a					0.006	0.584
PFHxS	4.20	4.50	0.30	7.14%	10				0.001	4.499
PFPeS	0.87	0.80	-0.07	-8.05%					1	
Total PFAS	78.07	144.54	66.47	85.14%						

Non-detect recorded as 0 Downstream Increase Exceed criteria levels

Graham WWTP Biosolids Fields | Haw Creek



PFAS Phase II Sampling Site Biosolids Land Application Sites

In addition to directly discharging wastewater into the Haw River, Graham WWTP is permitted[106] to operate a Residuals Land Application Program to land apply biosolids at nine fields owned by the City of Graham, all of which are located in the Haw River watershed. Graham WWTP produces Class B biosolids, and in 2023, Graham WWTP generated and land-applied 151.296 dry tons of its biosolids to six of the nine land application fields—a total of 51.6 acres.[107] In 2024, Graham WWTP land-applied 217.703 dry tons of its biosolids.[108]

For this project, Haw Riverkeeper also deployed PFASsive™ passive sampling devices in the Haw Creek immediately upstream and downstream from land application sites receiving biosolids from Graham WWTP. Those sampling devices were deployed from August 12, 2024 to September 20, 2024. Both upstream and downstream sampling sites detected multiple types of regulated and unregulated PFAS. It is notable that the upstream location had very high concentrations of certain types of PFAS, including PFOA and PFOS, as well as elevated concentrations of other PFAS. The concentration of total PFAS increased at the downstream site by 3.91 ppt—an increase of 3.81%. For example, the concentration of PFBS increased from a non-detect to 5.3 ppt, and PFBA increased from a non-detect to 3.9 ppt.

Like the samples taken downstream from Graham WWTP's outfall, the PFAS concentrations downstream from Graham's land application site demonstrate that the surface water is unsafe for drinking without advanced treatment. For example, the concentration of PFOA at the downstream location was 29 ppt, which is 25 ppt greater than the MCL of 4 ppt, and the concentration of PFOS was 34 ppt, which is 30 ppt greater than the MCL of 4 ppt. The concentrations of PFOA and PFOS in the downstream samples also greatly exceeded draft HHWQC (Water + Organism), indicating that concentrations exceeded the levels EPA has identified as being necessary to protect the general population from adverse health effects due to ingesting water, fish, and shellfish from the waterbody. In the downstream sample, PFOA exceeded the draft HHWQC (Water + Organism) of 0.0009 ppt by 28.9991 ppt, and PFOS exceeded the

Table 18 | Haw Creek Upstream and Downstream from Biosolids Site

Analyte	Sample (ppt)				MCL (ppt)		EPA (ppt)		EWG (ppt)	
	▲ Upstream	▼ Downstream	Change	% Change	Criteria	Downstream Exceedance	Criteria	Downstream Exceedance	Criteria	Downstream Exceedance
PFBS	0	5.3	5.3	n/a			400		2000	
PFBA	0	3.9	3.9	n/a					1000	
PFPeS	0	2.2	2.2	n/a					1	1.2
PFNA	0	1.9	1.9	n/a	10				0.006	1.894
PFHpS	0	1.3	1.3	n/a					0.001	1.299
PFDA	0	0.81	0.81	n/a					0.006	0.804
PFPeA	6.5	6.1	-0.4	-6.15%					1000	
PFHxA	9.5	8.8	-0.7	-7.37%					1000	
PFOS	36	34	-2	-5.56%	4	30	0.06	33.94	0.3	33.7
PFHxS	7.6	5.5	-2.1	-27.63%	10				0.001	5.499
PFOA	32	29	-3	-9.38%	4	25	0.0009	28.9991	0.09	28.91
PFHpA	11	7.7	-3.3	-30.00%					1000	
Total PFAS	102.6	106.51	3.91	3.81%						

Non-detect recorded as 0 Downstream Increase Exceed criteria levels

0.06 ppt criteria by 33.94 ppt. There are no national or state Clean Water Act surface water quality criteria for the protection of human health that apply to the majority of PFAS that were detected at elevated levels, including PFBA, PFPeS, PFNA, PFHpS, and PFDA.

Additionally, numerous PFAS that do not have any federal or state regulatory standards significantly exceeded EWG's health-based criteria, including PFDA, PFPeS, and PFHpS. Elevated levels of PFNA also significantly exceeded EWG's health-based criteria. *See Table 18 (above).*

This evaluation indicates that Graham WWTP and its biosolids land application site in Haw Creek are contributing PFAS to the Haw River and that multiple industrial dischargers are likely contributing to the WWTP's discharge of PFAS to the river. This pollution will likely continue to create significant risks to human health until PFAS pretreatment limits are placed on industrial sources of PFAS discharging into the WWTP and PFAS limits are placed in the Graham WWTP's NPDES permit, which will require installation of PFAS treatment technology, limits on biosolids land application, and a plan to safely manage PFAS removed during the treatment process.

Detroit Riverkeeper, Rouge River, Michigan
Wastewater Treatment Plant Site

The Great Lakes Water Authority Water Resource Recovery Facility (GLWA WRRF) is a municipal wastewater treatment system that is owned and operated by the City of Detroit Board of Water Commissioners. This facility serves a population of approximately 2.8 million residents and is considered "the largest single-site treatment facility in North America."[109] GLWA WRFF accepts discharges from 234 permitted industrial users. GLWA WRRF discharges wastewater into the Rouge River and other locations.[110] The Rouge River is a tributary to the Detroit River and contributes to the Great Lakes Basin, one of the largest freshwater ecosystems, and the watershed is home to 1.35 million people in Oakland, Washtenaw, and Wayne counties.

The GLWA Wastewater Master Plan states that "[t]he permitted peak primary treatment capacity is 1,700 MGD (the largest in the nation) and the peak secondary treatment capacity is 930 MGD."[111] According to ECHO, GLWA WRRF is located in an area with 13 State Supplemental EJ Indexes and 13 Federal Supplement EJ Indexes greater than the 80th percentile within one mile of the facility, including wastewater discharges at 99 (State).[112] According to the EPA EJScreen, of people living within one mile of GLWA WRRF, 59% are people of color and 65% are low income.[113]

The NPDES permit for GLWA WRRF requires quarterly monitoring and reporting of PFAS in the facility's effluent. The permit also requires that GLWA WRRF submit a Pollutant Minimization and Source Evaluation Program for Perfluorooctane Sulfonate (PFOS) and/or Perfluorooctanoic Acid (PFOA) that will "identify and address sources of [PFOS] and/or [PFOA] and to reduce and maintain the effluent concentrations of PFOS and/or PFOA at or below the water quality standards (WQS) and/or the Water Quality-Based Effluent limit (WQBEL)."[114] The 2019 permit includes a goal of meeting the water quality standard for PFOS of 11 ppt and a WQBEL for PFOA of 8,040 ppt. For comparison, the EPA and MI MCLs are 4 ppt and 8 ppt respectively for PFOA and the National Recommended Ambient Water Quality Criteria for the Protection of Human Health includes a EPA Water + Organism Human Health Criteria of 0.0009 ppt for PFOA. Beyond these requirements, however, the permit does not include any limits on the amount of PFAS the facility discharges. In terms of the facilities' industrial dischargers, GLWA WRRF has adopted a Local Limit for PFOS of 65 ppt (Daily Maximum).[115]

GLWA WRRF conducted PFAS sampling of the influent from these industrial users as part of its Pollutant Minimization and Source Evaluation Program.[116] Based on its sampling, GLWA WRRF classified 48 of these facilities as "Significant Sources" and five as "Potential Sources" of PFOS and/or PFOA.[117]

There are likely additional unpermitted industrial dischargers contributing PFAS to the WRRF given that EPA's PFAS Analytic Tools[118] identifies 217 facilities located within the City of Detroit that are "operat[ing] in sectors that have been identified as possibly handling, using, or releasing PFAS chemicals," including:

- Airports
- Cement Mfg.
- Chemical Mfg.
- Cleaning Product Mfg.
- Consumer Products
- Fire Training
- Glass Products
- Industrial Gas
- Metal Coating
- Metal Machinery Mfg.
- Oil and Gas
- Paints and Coatings
- Paper Mills and Products
- Petroleum
- Plastics and Resins
- Printing
- Waste Management

Michigan's Department of Environment, Great Lakes, and Energy (EGLE) conducted PFAS sampling of GLWA WRRF's influent and effluent from 2018 to 2020. The results showed significant concentrations of PFOA (6.4 ppt to 12 ppt) and PFOS (5.7 ppt to 30 ppt) in the facility's effluent, and equally high concentrations in the facility's influent, including PFOA concentrations ranging from 4.64 ppt to 9.10 ppt and PFOS concentrations ranging from 7.54 ppt to 15.60 ppt.[119] Further, as part of its Pollutant Minimization and Source Evaluation Program, GLWA WRRF collected quarterly samples of its discharges during 2023 and tested

them for 28 PFAS chemicals. The results showed annual average concentrations of PFOA at 8.5 ppt (max. 11.5 ppt) and PFOS at 13.8 ppt (max. 26.5 ppt).[120] The testing also detected other PFAS chemicals in the facility's effluent, including:

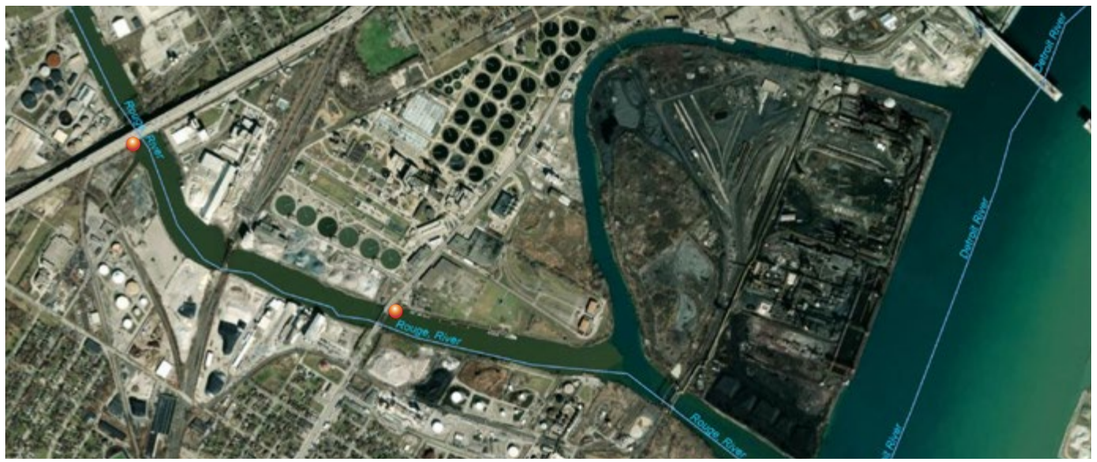
- PFBA (max. 19 ppt)
- PFPeA (max. 13 ppt)
- PFHxA (max. 23 ppt)
- PFBS (max. 26 ppt)
- PFHpA (max. 4.6 ppt)
- 6:2 FTSA (max. 8.5 ppt)
- PFHxS (max. 8.2 ppt)[121]

For this project, Detroit Riverkeeper deployed PFASsive™ passive sampling devices upstream and downstream from one of the GLWA WRRF's outfalls (Outfall 050) and the Oakwood Combined Sewer Overflow Retention Basin channel from August 8, 2024 to September 8, 2024.[122] Both upstream and downstream sampling sites detected multiple types of PFAS. However, the concentrations of multiple types of PFAS increased significantly at the downstream site resulting in a total PFAS concentration increase of 49.49 ppt—an increase of 146.81%. For example, the concentration of PFOA increased from 3.8 ppt to 44 ppt (1,057.89%) and the concentration of PFHxS increased from 1.8 ppt to 16 ppt (788.89%). Other types of PFAS increased in downstream samples at levels ranging from 19.23% to 48.39%, including PFHxA which increased from 6.2 ppt to 9.2 ppt. These results are consistent with the findings of previous sampling and indicate that the GLWA WRRF is likely a significant source of PFAS in the Rouge River.

Downstream concentrations of PFAS demonstrate that the surface water as this location is likely unsafe for drinking without advanced treatment. For example, the concentration of PFOA at the downstream location was 44 ppt, which is 40 ppt greater than the MCL of 4 ppt, and the concentration of PFHxS was 16 ppt, which is 6 ppt greater than the MCL of 10 ppt. PFOA also exceeded Michigan's MCL (16 ppt) by 36 ppt.[123]

The concentrations of PFOA and PFOS in the downstream samples also greatly exceeded the draft HHWQC (Water + Organism), indicating the concentrations exceeded the levels EPA has identified as being necessary to protect the general population from adverse health effects due to ingesting water, fish, and shellfish from the waterbody. In the downstream sample, PFOA exceeded the draft HHWQC (Water + Organism) of 0.0009 ppt by 43.9991 ppt, and PFOS exceeded the 0.06 ppt criteria

GLWA WRRF | Rouge River



PFAS Phase II Sampling Site

Table 19—Rouge River Upstream and Downstream from GLWA WRRF

Analyte	Sample (ppt)				MCL (ppt)		EPA (ppt)		EWG (ppt)		MI MCL (ppt)	
	▲ Upstream	▼ Downstream	Change	% Change	Criteria	Downstream Exceedance	Criteria	Downstream Exceedance	Criteria	Downstream Exceedance	Criteria	Downstream Exceedance
PFOA	3.80	44.00	40.20	1057.89%	4	40.00	0.0009	43.9991	0.09	43.910	8	36
PFHxS	1.80	16.00	14.20	788.89%	10	6.00			0.001	15.999	51	
PFDA	0.00	5.00	5.00	n/a					0.006	4.994		
PFHxA	6.20	9.20	3.00	48.39%					1000		400,000	
PFOS	2.60	3.10	0.50	19.23%	4		0.06	3.04	0.3	2.800	16	
PFHpA	1.60	1.60	0.00	0.00%					1000			
6:2 FTS	1.50	1.30	-0.20	-13.33%					1	0.300		
PFNA	0.61	0.00	-0.61	-100.00%	10				0.006		6	
FOSA	1.30	0.00	-1.30	-100.00%					0.3			
PFPeA	4.30	1.70	-2.60	-60.47%					1000			
PFBS	4.50	1.30	-3.20	-71.11%			400.00		2000		420	
PFBA	5.50	0.00	-5.50	-100.00%					1000			
Total PFAS	33.71	83.20	49.49	146.81%								

Non-detect recorded as 0 Downstream Increase Exceed criteria levels

by 3.04 ppt. There are no national or state Clean Water Act surface water quality criteria for the protection of human health that apply to the majority of PFAS that were detected at elevated levels, including PFHxS, PFDA, and PFHxA.

Other PFAS that do not have any federal or state regulatory standards exceeded EWG's health-based criteria, including PFDA and 6:2 FTS. PFOA, PFHxS, and PFOS also exceeded EWG's health-based criteria. *See Table 19 (above).*

This evaluation indicates that GLWA WRRF appears to be contributing a significant amount of PFAS to the Rouge River and that multiple industrial dischargers are likely contributing to the WRRF's discharge of PFAS to the river. This pollution will likely continue to create significant risks to human health until additional PFAS pretreatment limits are placed on industrial sources of PFAS discharging into the WRRF and more protective, mandatory permit limits are placed in the GLWA WRRF's NPDES permit, which will require installation of PFAS treatment technology and a plan to safely manage PFAS removed during the treatment process. Assessment of the two outlets contributions of PFAS to the Rouge River is also warranted and may result in the need for additional controls in those areas.

Potomac Riverkeeper, Monocacy River, Maryland
Wastewater Treatment Plant and Biosolids Sites

The City of Frederick WWTP (Frederick WWTP) is a municipal wastewater treatment system that is owned and operated by the City of Frederick and serves a population of 73,000 residents.[124] In addition, the facility handles wastewater from two permitted Significant Industrial Users.[125] The Frederick WWTP discharges wastewater into the Lower Monocacy River at an average design flow of 8 MGD.[126] The Lower Monocacy Watershed covers 194,790 acres and is home to 7,626 residents. According to the EJScreen Community Report for this facility, Frederick WWTP is located in an area with two State Supplemental EJ Indexes greater than the 80th percentile within one mile of the facility, including wastewater discharges at 80 (State). According to the EPA EJScreen, of people living within one mile of Frederick WWTP, 37% are people of color and 15% are low income.[127]

The NPDES permit for Frederick WWTP does not include any limits on the amount of PFAS the facility discharges into the Monocacy River and there are no pretreatment limits to control PFAS discharges to the WWTP by industrial dischargers.[128] Neither of Frederick WWTPs permitted industrial users are included in EPA's PFAS Analytic Tools[129] as facilities "operat[ing] in sectors that have been identified as possibly handling, using, or releasing PFAS chemicals." There are likely additional unpermitted industrial dischargers contributing PFAS to the WWTP given that EPA's PFAS Analytic Tools identifies 40 facilities located within the City of Frederick that operate in related sectors, including:

- Airports
- Cement Mfg.
- Chemical Mfg.
- Cleaning Product Mfg.
- Electronics Industry
- Furniture and Carpet
- Metal Coating
- Metal Machinery Mfg.
- Mining and Refining
- National Defense
- Paints and Coatings
- Petroleum
- Printing
- Textiles and Leather
- Waste Management

City of Frederick WWTP | Monocacy River



PFAS Phase II Sampling Site

For this project, Potomac Riverkeeper deployed PFASsive™ passive sampling devices immediately upstream and downstream from a Frederick WWTP outfall to the Monocacy River from August 13, 2024 to September 6, 2024. Both upstream and downstream sampling sites detected multiple types of PFAS. However, the concentrations of eight types of PFAS increased at the downstream site resulting in a total PFAS concentration increase of 33.64 ppt–an increase of 128.01%. For example, the concentration of PFPeA increased from 4.2 ppt to 22 ppt (423.81%), the concentration of PFHxA increased from 3.4 ppt to 13 ppt (282.35%), and the concentration of PFHxS increased from 1.1 ppt to 2.5 ppt (127.27%). Multiple other types of PFAS increased in downstream samples at levels ranging from 18.92% to 83.78%, including PFOA which increased from 3.7 ppt to 6.8 ppt. These results indicate that the Frederick WWTP's outfall is likely a significant source of PFAS in the Monocacy River.

Downstream concentrations of PFAS demonstrate that the surface water is unsafe at this location for drinking without advanced treatment. For example, the concentration of PFOA at the downstream location was 6.8 ppt, which is 2.8 ppt greater than the MCL of 4 ppt.

The concentrations of PFOA and PFOS in the downstream sample also exceeded the draft HHWQC (Water + Organism), indicating the concentrations exceeded the levels EPA has identified as being necessary to protect the general population from adverse health effects due to ingesting water, fish, and shellfish from the waterbody. In the downstream sample, PFOA exceeded the draft HHWQC (Water + Organism) of 0.0009 ppt by 6.7991 ppt, and PFOS exceeded the 0.06 ppt criteria by 3.04 ppt. There are no national or state Clean Water Act surface water quality criteria for the protection of human health that apply to the majority of PFAS that were detected at elevated levels, including PFPeA, PFHxA, PFHxS, PFHpA, PFBA, and FOSA.

FOSA does not have any federal or state regulatory standards but exceeded EWG's health-based criteria. PFOA, PFHxS, and PFOS also significantly exceeded EWG's health-based criteria. *See Table 20 (below).*

Frederick WWTP contracts with Synagro Central, LLC to haul and land apply the facility's biosolids. Potomac Riverkeeper conducted PFAS sampling upstream and downstream from the biosolids land application site at the Baumgartner & Zack Property, one of Synagro's land application sites, which is located in the Monocacy River watershed that is approved for biosolids application from the Frederick WWTP and other WWTPs.[130]

Samples of the Monocacy River upstream and downstream from the biosolids land application site contained PFAS.[131] However, the concentrations of multiple types of PFAS increased at the downstream site resulting in a total PFAS concentration increase of 0.75 ppt–an increase of 2.75%. For example, the concentration of PFBS increased from 3.5 ppt to 3.9 ppt (11.43%), and PFNA increased

Table 20 | Monocacy River Upstream and Downstream from Frederick WWTP

Analyte	Sample (ppt)				MCL (ppt)		EPA (ppt)		EWG (ppt)	
	▲ Upstream	▼ Downstream	Change	% Change	Criteria	Downstream Exceedance	Criteria	Downstream Exceedance	Criteria	Downstream Exceedance
PFPeA	4.20	22.00	17.80	423.81%					1000	
PFHxA	3.40	13.00	9.60	282.35%					1000	
PFOA	3.70	6.80	3.10	83.78%	4	2.80	0.0009	6.7991	0.09	6.710
PFBS	3.60	5.00	1.40	38.89%			400		2000	
PFHxS	1.10	2.50	1.40	127.27%	10				0.001	2.499
PFHpA	1.70	2.50	0.80	47.06%					1000	
PFBA	3.70	4.40	0.70	18.92%					1000	
FOSA	0.00	0.62	0.62	n/a					0.3	0.320
PFNA	0.68	0.00	-0.68	-100.00%	10				0.006	
PFOS	4.20	3.10	-1.10	-26.19%	4		0.06	3.0400	0.3	2.800
Total PFAS	26.28	59.92	33.64	128.01%						

Non-detect recorded as 0 Downstream Increase Exceed criteria levels

Table 21 | Monocacy River Upstream and Downstream from Biosolids Land Application Fields

Analyte	Sample (ppt)				MCL (ppt)		EPA (ppt)		EWG (ppt)		MD DW (ppt)	
	▲ Upstream	▼ Downstream	Change	% Change	Criteria	Downstream Exceedance	Criteria	Downstream Exceedance	Criteria	Downstream Exceedance	Criteria	Downstream Exceedance
PFBA	5.9	6.2	0.30	5.08%					1000			
PFHxA	4.4	4.9	0.50	11.36%					1000			
PFHpA	2.0	2.2	0.20	10.00%					1000			
PFOA	4.6	3.7	-0.90	-19.57%	4		0.0009	3.6991	0.09	3.61		
PFNA	0.00	0.77	0.77	n/a	10				0.006	0.764		
PFBS	3.5	3.9	0.40	11.43%			400		2000			
PFHxS	0.87	0.85	-0.02	-2.30%	10				0.001	0.849	140	
PFOS	6.0	5.5	-0.50	-8.33%	4	1.50	0.06	5.44	0.3	5.20		
Total PFAS	27.27	28.02	0.75	2.75%								

Non-detect recorded as 0 Downstream Increase Exceed criteria levels

from a non-detect to 0.77 ppt. Other types of PFAS increased in downstream samples at levels ranging from 5.08% to 11.36%.

The concentration of PFOS at the downstream location was 5.5 ppt, which is 1.5 ppt greater than the MCL of 4 ppt, rendering the surface water at this location unsafe for drinking without advanced treatment. PFOA and PFOS concentrations also exceeded the draft HHWQC (Water + Organism), indicating the concentrations exceeded the levels EPA has identified as being necessary to protect the general population from adverse health effects due to ingesting water, fish, and shellfish from the waterbody. PFOA exceeded the draft HHWQC (Water + Organism) of 0.0009 ppt by 3.6991 ppt, and PFOS exceeded the draft HHWQC (Water + Organism) of 0.06 ppt by 5.44 ppt. PFOA, PFNA, PFHxS, and PFOS also exceeded the EWG health-based criteria. *See Table 21 (above).*

Synagro Central, LLC Biosolids Application Field | Monocacy River



Biosolids Application Field

This evaluation indicates that Frederick WWTP is contributing PFAS to the Monocacy River and that multiple industrial dischargers to the WWTP are likely contributing to the discharge of PFAS to the river. This pollution will likely continue to create significant risks to human health until PFAS pretreatment limits are placed on industrial sources of PFAS discharging into the WWTP and a PFAS limit is placed in the Frederick WWTP's NPDES permit, which will require installation of PFAS treatment technology and a plan to safely manage PFAS removed during the treatment process.

Tualatin Riverkeepers, Tualatin River, Oregon
Wastewater Treatment Plant Site

The Tualatin River Watershed spans 712 square miles and is home to over 600,000 Oregon residents. The Tualatin River flows approximately 83 miles from the Coast Mountain Range to the Willamette River. Fed by more than 900 miles of tributary streams, the river serves as a drinking water source for 400,000 people. The Rock Creek WRRF, which discharges into the Tualatin River, is a municipal wastewater treatment system that is owned and operated by Clean Water Services (CWS) and serves a population of approximately 326,488 residents.[132] In addition, the facility handles wastewater from numerous industrial dischargers, including five permitted Significant Industrial Users (SIUs) and 15 permitted Categorical Industrial Users (CIUs).

Clean Water Services also owns and operates three other water resource recovery facilities that receive discharges from an additional seven SIUs and 12 CIUs. Rock Creek WRRF "is designed to treat an average dry season flow of 52.7 MGD (projected for 2025 conditions and with no discharge from the Hillsboro and Forest Grove WRRFs) and a daily maximum wet weather flow of 126 MGD."[133] According to ECHO, Rock Creek WRRF is located in an area with 11 State Supplemental EJ Indexes and 11 Federal Supplemental EJ Indexes greater than the 80th percentile within one mile of the facility, including wastewater discharges at 99 (State).[134] According to the EPA EJScreen, of people living within one mile of Rock Creek WRRF, 45% are people of color and 17% are low income.[135]

Clean Water Services' 2022 Annual Report states that CWS monitors for PFAS at its STPs.[136] However, its NPDES permit[137] does not include any limits on the amount of PFAS the Rock Creek WRRF discharges into the Tualatin River, and there are no pretreatment limits to control PFAS discharges to the facility by industrial dischargers. Of Clean Water Services' 39 permitted industrial users, EPA's PFAS Analytic Tools[138] lists the following 11 as facilities "operat[ing] in sectors that have been identified as possibly handling, using, or releasing PFAS chemicals":

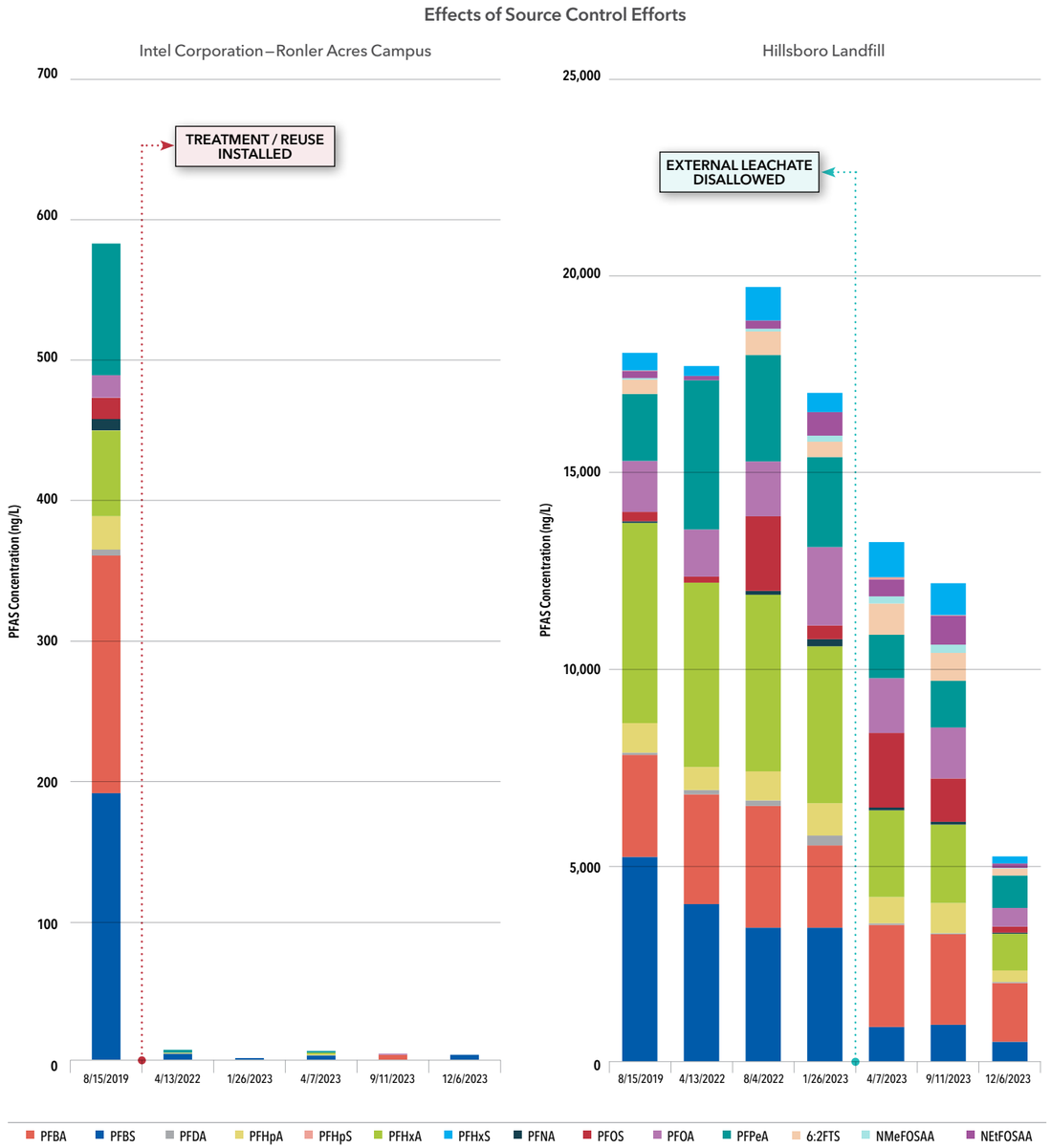
- Linde Inc. (Industrial Gas)
- TOK America (Chemical Mfg.)
- Analog Devices (formerly Maxim Integrated Products) (Electronics Industry)
- BASF Corporation (Chemical Mfg.)
- Hillsboro Landfill, Inc. (Waste Management)
- Intel Corporation – Ronler Acres Campus (Electronics Industry)
- Jireh Semiconductor, Inc. (Electronics Industry)
- KoMiCo Hillsboro, LLC (Metal Coating)
- Qorvo U.S. Inc. (Electronics Industry)
- QuantumClean (Metal Coating)
- Sumitomo Electric Semiconductor Materials, Inc. (Electronics Industry

There are likely additional unpermitted industrial dischargers contributing PFAS to the Rock Creek WRRF given that EPA's PFAS Analytic Tools identifies 51 facilities located within the City of Hillsboro that operate in related sectors, including:

- Airports
- Chemical Mfg.
- Electronics Industry
- Industrial Gas
- Metal Coating
- Metal Machinery Mfg.
- Plastics and Resins
- Printing
- Waste Management

Of the 20 permitted industrial users discharging wastewater specifically to Rock Creek WRRF, Clean Water Services has identified Intel Corporation – Ronler Acres Campus and Hillsboro Landfill as being the major industrial sources of PFAS to Rock Creek WRRF.[139] The majority of Intel Corporation's contribution appears to have significantly decreased after 2019, while Hillsboro Landfill continues to contribute significant concentrations of multiple types of PFAS from landfill leachate to Rock Creek WRRF.

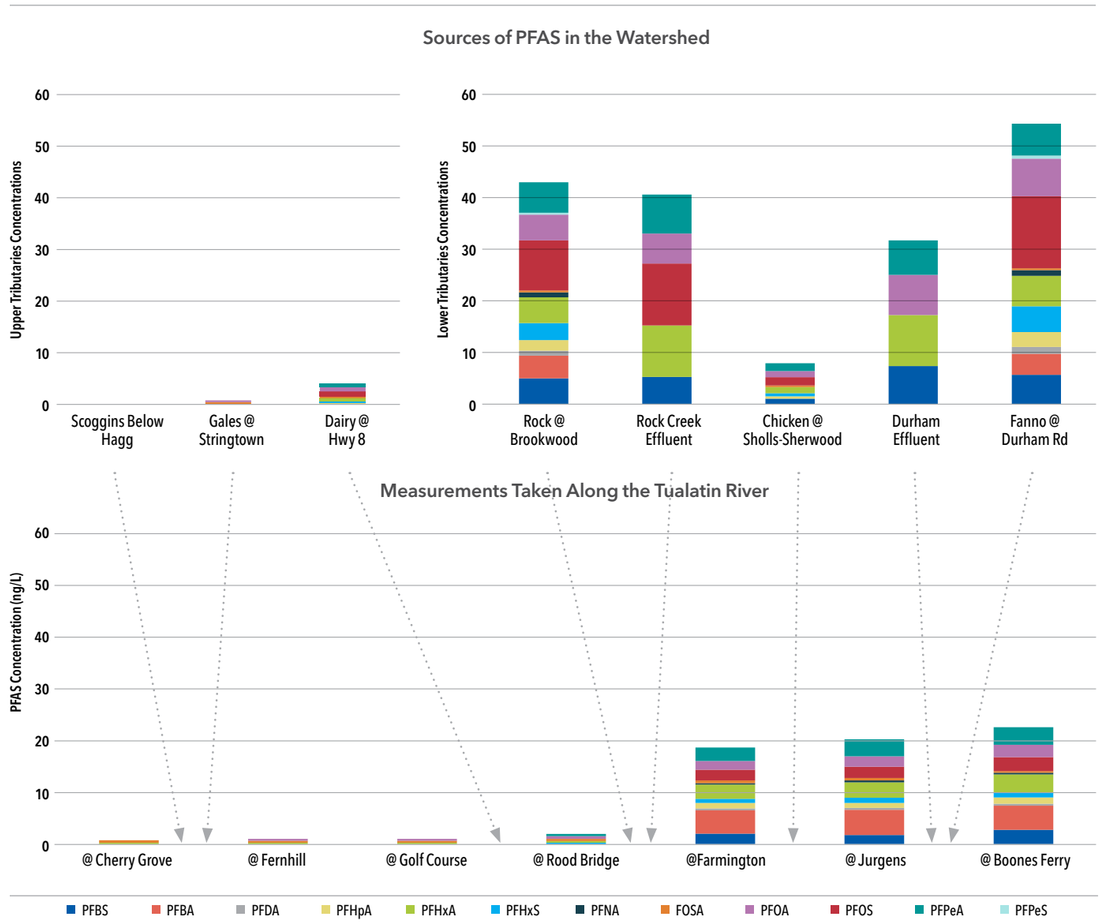
Figure 18 | Clean Water Services Advisory Commission 2024 Meeting[140]



Other than these two facilities, it is unclear how many of EPA's other listed facilities discharge into Rock Creek WRRF, rather than one of CWS' other three facilities. However, according to Clean Water Services' NPDES permit renewal application, Rock Creek WRRF may receive and treat flows from Hillsboro and Forest Grove depending on the season and whether the flows exceed the facilities' capacities.[141] Thus, Rock Creek is likely receiving, either directly or indirectly, discharges from at least some of these industrial users operating in PFAS-related sectors.

Clean Water Services has identified Rock Creek WRRF's summer discharges as a dominant source of PFAS pollution in the Tualatin River.[142] In particular, Clean Water Services has reported that Rock Creek WRRF's effluent contributes PFBS, PFHxA, PFOS, PFOA, and PFPeA to the river.

Figure 19 | Clean Water Services Advisory Commission 2024 Meeting[143]



For this project, Tualatin Riverkeepers deployed PFASsive™ passive sampling devices upstream and downstream from two Rock Creek WRRF outfalls from August 9, 2024 to September 19, 2024. The downstream sampling site detected multiple types of PFAS. However, the upstream sample only showed trace levels of PFOS at 0.97 ppt. The concentrations of multiple types of PFAS increased significantly at the downstream site resulting in a total PFAS concentration increase of 29.05 ppt–an increase of 2,994.85%. For example, the concentration of PFHxA increased from a non-detect to 7.1 ppt, the concentration of PFBA increased from a non-detect to 6.2 ppt, and the concentration of PFOS increased from 0.97 ppt to 2.5 ppt (157.73%). These results are consistent with the findings of previous sampling and indicate that the Rock Creek WRRF's outfall is likely a significant source of PFAS in the Tualatin River.

The concentrations of PFOA and PFOS in the downstream samples greatly exceeded the draft HHWQC (Water + Organism), indicating the concentrations exceeded the levels EPA has identified as being necessary to protect the general population from adverse health effects due to ingesting water, fish, and shellfish from the waterbody. In the downstream sample, PFOA exceeded the draft HHWQC (Water + Organism) of 0.0009 ppt by 3.2991 ppt, and PFOS exceeded the 0.06 ppt criteria by 2.44 ppt. There are no national or state Clean Water Act surface water quality criteria for the protection of human health that apply to the majority of PFAS that were detected at elevated levels, including PFHxA, PFBA,

Rock Creek WRRF | Tualatin River



PFAS Phase II Sampling Site

PFPeA, PFHpA, PFHxS, and PFNA. Additionally, PFOA, PFOS, PFNA and PFHxS exceeded EWG's health guidelines. *See Table 22 (below).*

This evaluation indicates that Rock Creek WRRF is contributing PFAS to the Tualatin River and that multiple industrial dischargers are likely contributing to the WRRF's discharge of PFAS to the river. This pollution will likely continue to create significant risks to human health until PFAS pretreatment limits are placed on industrial sources of PFAS discharging into the STP and a PFAS limit is placed in the Rock Creek WRRF's NPDES permit, which will require installation of PFAS treatment technology and a plan to safely manage PFAS removed during the treatment process.

Table 22 | Tualatin River Upstream and Downstream from Rock Creek WRRF

Analyte	Sample (ppt)				MCL (ppt)		EPA (ppt)		EWG (ppt)	
	▲ Upstream	▼ Downstream	Change	% Change	Criteria	Downstream Exceedance	Criteria	Downstream Exceedance	Criteria	Downstream Exceedance
PFHxA	0.00	7.10	7.10	N/A					1000	
PFBA	0.00	6.20	6.20	N/A					1000	
PFPeA	0.00	4.40	4.40	N/A					1000	
PFBS	0.00	3.50	3.50	N/A			400		2000	
PFOA	0.00	3.30	3.30	N/A	4		0.0009	3.2991	0.09	3.210
PFHpA	0.00	1.70	1.70	N/A					1000	
PFOS	0.97	2.50	1.53	157.73%	4		0.06	2.4400	0.3	2.200
PFHxS	0.00	0.73	0.73	N/A	10				0.001	0.729
PFNA	0.00	0.59	0.59	N/A	10				0.006	0.584
Total PFAS	0.97	30.02	29.05	2994.85%						

Non-detect recorded as 0 Downstream Increase Exceed criteria levels

Inland Empire Waterkeeper, Santa Ana River, California
Wastewater Treatment Plant Site

The Riverside RWQCP is a municipal wastewater treatment system that is owned and operated by the City of Riverside's Department of Public Works and serves a population of more than 300,000.[144] In addition, the facility handles wastewater from numerous industrial dischargers, including 10 permitted Class I, Significant Industrial Users and two permitted Categorical Industrial Users. Riverside RWQCP discharges wastewater into the Santa Ana River at an average design flow of 46 MGD. The Santa Ana River Watershed covers 2,630 square miles across San Bernardino, Riverside, Orange, and Los Angeles Counties. According to ECHO, Riverside RWQCP is located in an area with 11 State Supplemental EJ Indexes and 13 Federal Supplement EJ Indexes greater than the 80th percentile within one mile of the facility, including wastewater discharges at 97 (Federal).[145] According to the EPA EJScreen, of people living within one mile of Riverside RWQCP, 80% are people of color and 34% are low income.[146]

The NPDES permit[147] for Riverside RWQCP does not include any limits on the amount of PFAS the facility discharges into the Santa Ana River and there are no pretreatment limits to control PFAS discharges to the RWQCP by industrial dischargers. Of the 12 permitted industrial users discharging wastewater to Riverside RWQCP, EPA's PFAS Analytic Tools[148] lists one facility as "operat[ing] in sectors that have been identified as possibly handling, using, or releasing PFAS chemicals": Von Zabern Surgical (Waste Management). There are likely additional unpermitted industrial dischargers contributing PFAS to the RWQCP given that EPA's PFAS Analytic Tools identifies 61 active facilities located within the City of Riverside that operate in PFAS-related sectors, including:

- Airports
- Cement Mfg.
- Chemical Mfg.
- Cleaning Product Mfg.
- Electronics
- Fire Protection
- Industrial Gas
- Metal Coating
- Metal Machinery Mfg.
- Mining and Refining
- National Defense
- Paints and coatings
- Petroleum
- Plastics and Resins
- Printing
- Textiles and Leather
- Waste Management

Based on 2021 sampling data collected by Riverside RWQCP, the facility's influent,[149] effluent,[150] and biosolids[151] contain significant concentrations of PFAS. The PFAS detected at the highest concentrations in the facility's influent, effluent, and biosolids were PFPeS (46 ppt), PFPeA (63 ppt), and 5:3 FTCA (140 ug/kg), respectively.

For this project, Inland Empire Waterkeeper conducted two rounds of sampling. It first deployed PFASsive™ passive sampling devices immediately downstream from a Riverside RWQCP's outfall to the Santa Ana River from

Riverside RWQCP | Santa Ana River



PFAS Phase II Sampling Site

August 14, 2024 to September 11, 2024. Two months later, Inland Empire Waterkeeper conducted its second round of sampling by deploying sampling devices downstream as well as upstream of a facility outfall to the Santa Ana River from November 11, 2024 to December 18, 2024. Both upstream and downstream sampling sites detected multiple types of PFAS.[152] However, the sampling devices deployed in November detected two PFAS that increased in concentration significantly at the downstream site resulting in a total PFAS concentration increase of 27.43 ppt—an increase of 30.58%. Specifically, the concentration of PFHxA increased from 11 ppt to 27 ppt (145.45%) and the concentration of PFPeA increased from 12 ppt to 43 ppt (258.33%).

Downstream concentrations of PFAS demonstrate that the surface water at this location is unsafe for drinking without advanced treatment. For example, the concentration of PFOA at the downstream location in November and August was 10 ppt and 13 ppt, respectively, which are 6 ppt and 9 ppt greater than the MCL, and the concentration of PFOS was 6.8 ppt and 12 ppt, respectively, which are 2.8 ppt and 8 ppt greater than the MCL.

The concentrations of PFOA and PFOS in the downstream samples also greatly exceeded the draft HHWQC, indicating the concentrations exceeded the levels EPA has identified as being necessary to protect the general population from adverse health effects due to ingesting water, fish, and shellfish from the waterbody. In the November downstream sample, PFOA exceeded the draft HHWQC (Water + Organism) by 0.0009 ppt by 9.9991 ppt, and PFOS exceeded the 0.06 ppt criteria by 6.74 ppt. In the August downstream sample, PFOA exceeded the draft HHWQC (Water + Organism) by 12.9991 ppt, and PFOS exceeded the criteria by 11.94 ppt. There are no national or state Clean Water Act surface water quality criteria for the protection of human health that apply to certain PFAS that were detected at elevated levels, including PFPeA and PFHxA.

Additionally, PFOA and PFOS exceeded California's Public Health Goal of 0.007 ppt (PFOA) and 1 ppt (PFOS).[153] The November downstream sample detected PFOA and PFOS concentrations that exceeded the Public Health Goal by 9.993 ppt and 5.8 ppt, respectively, and the August downstream sample detected PFOA and PFOS concentrations that exceeded the Public Health Goal by 12.993 ppt and 11 ppt, respectively. Further, both the November and August downstream samples exceeded California's Notification Level of 3 ppt for PFHxS by 4.7 ppt.[154] Finally, numerous PFAS significantly exceeded EWG's health-based criteria, including PFDA (Aug.), PFPeS (Nov. and Aug.), and PFMBA (Aug.). PFOA (Nov. and Aug.), PFOS (Nov. and Aug.), PFNA (Nov. and Aug.) and PFHxS (Nov. and Aug.) also exceeded EWG's health-based criteria. *See Table 23 (p. 71).*

This evaluation indicates that Riverside RWQCP is contributing PFAS to the Santa Ana River and that multiple industrial dischargers to the RWQCP are likely contributing to the RWQCP's discharge of PFAS to the river. This pollution will likely continue to create significant risks to human health until PFAS pretreatment limits are placed on industrial sources of PFAS discharging into the RWQCP and a PFAS limit is placed in the Riverside RWQCP's NPDES permit, which will require installation of PFAS treatment technology and a plan to safely manage PFAS removed during the treatment process.

WATERKEEPER ALLIANCE | PFAS REPORT PHASE II
ANALYSIS AND FINDINGS

Table 23 | Santa Ana River Upstream and Downstream from Riverside RWQCP

Analyte	Sample (ppt)				MCL (ppt)		EPA (ppt)		EWG (ppt)		CA Public Health Goal (ppt)		CA Notification Level (ppt)	
	▲ Upstream	▼ Downstream	Change	% Change	Criteria	Downstream Exceedance	Criteria	Downstream Exceedance	Criteria	Downstream Exceedance	Criteria	Downstream Exceedance	Criteria	Downstream Exceedance
November														
PFPeA	12.00	43.00	31.00	258.33%										
PFHxA	11.00	27.00	16.00	145.45%					1000					
PFDA	0.00	0.00	0.00	0.00%					0.006					
PFMBA	0.00	0.00	0.00	0.00%					1					
PFNA	1.00	0.73	-0.27	-27.00%	10				0.006	0.724				
PFHpA	3.50	2.70	-0.80	-22.86%					1000					
PFOA	11.00	10.00	-1.00	-9.09%	4	6.00	0.0009	9.9991	0.09	9.910	0.007	9.993		
PFPeS	2.90	1.50	-1.40	-48.28%					1	0.500				
PFBA	13.00	11.00	-2.00	-15.38%					1000					
PFBS	9.30	6.70	-2.60	-27.96%			400		2000				500	
PFOS	11.00	6.80	-4.20	-38.18%	4	2.80	0.06	6.7400	0.3	6.500	1	5.800		
PFHxS	15.00	7.70	-7.30	-48.67%	10				0.001	7.699			3	4.70
Total PFAS	89.70	117.13	27.43	30.58%										
August (no upstream sampling)														
PFPeA	n/a	24.00	n/a	n/a					1000					
PFHxA	n/a	20.00	n/a	n/a					1000					
PFDA	n/a	2.20	n/a	n/a					0.006	2.194				
PFMBA	n/a	6.10	n/a	n/a					1	5.100				
PFNA	n/a	2.10	n/a	n/a	10				0.006	2.094				
PFHpA	n/a	3.60	n/a	n/a					1000					
PFOA	n/a	13.00	n/a	n/a	4	9	0.0009	12.9991	0.09	12.910	0.007	12.993		
PFPeS	n/a	1.20	n/a	n/a					1	0.200				
PFBA	n/a	12.00	n/a	n/a					1000					
PFBS	n/a	21.00	n/a	n/a			400		2000				500	
PFOS	n/a	12.00	n/a	n/a	4	8	0.06	11.9400	0.3	11.700	1	11.000		
PFHxS	n/a	7.70	n/a	n/a	10				0.001	7.699			3	4.7
Total PFAS	–	124.90	–	–										

Non-detect recorded as 0 Downstream Increase Exceed criteria levels

Milwaukee Riverkeeper, Root River and Spring Creek, Wisconsin
Wastewater Treatment Plant and Biosolids Sites

The Waukesha WWTP is a municipal wastewater treatment system that is owned and operated by the City of Waukesha that serves a population of 73,000 people.[155] In addition, the facility handles wastewater from 30 permitted industrial dischargers, including six Significant Industrial Users and 18 Categorical Industrial Users. Waukesha WWTP's permit was issued in 2019, at that time, Waukesha WWTP was discharging solely to the Fox River at an annual average design flow of 14 MGD. The permit, however, incorporates Waukesha WWTP's plans to start discharging most of its effluent to the Root River sometime "[d]uring the 5-year permit term."[156] This new discharge is based on approval of the first proposed Great Lakes diversion (for a community in a straddling county) under the Great Lakes Compact. In 2023, the upgrades necessary to transfer the majority of its discharges to the Root River were completed.[157] According to the permit, these discharges are allowed an annual average design flow of 9.3 MGD.

The Root River Watershed covers 198 square miles across parts of Waukesha, Milwaukee, and Racine counties in Wisconsin. It includes 117 miles of rivers and streams, including the Root River, which originates in southern Milwaukee County, and flows southeast into Lake Michigan. According to ECHO, Waukesha WWTP is located in an area with 13 State Supplemental EJ Indexes and 10 Federal Supplemental EJ Indexes greater than the 80th percentile within one mile of the facility, including wastewater discharges at 98 (State).[158] According to the EPA EJScreen, of people living within one mile of Waukesha WWTP, 28% are people of color and 28% are low income.[159]

The NPDES permit[160] for Waukesha WWTP does not include any limits on the amount of PFAS the facility discharges into the Root River and there are no pretreatment limits to control PFAS discharges to the WWTP by industrial dischargers. Of the 30 permitted industrial users discharging wastewater to Waukesha WWTP, EPA's PFAS Analytic Tools[161] lists the following five as facilities "operat[ing] in sectors that have been identified as possibly handling, using, or releasing PFAS chemicals": Gascoigne Co. (Metal Coating), GE Medical Systems, LLC (Electronics Industry), H.O. Bostrom Co. (Metal Coating), Profile Finishing Systems, LLC (Metal Coating), and Waukesha Memorial Hospital Inc. (Airports). There are likely additional unpermitted industrial dischargers contributing PFAS to the WWTP given that EPA's PFAS Analytic Tools identifies 40 facilities located within the City of Waukesha that operate in related sectors, including:

- Airports
- Chemical Mfg.
- Clean Product Mfg.
- Electronics Industry
- Industrial Gas
- Metal Coating
- Metal Machinery Mfg.
- Paints and Coatings
- Printing
- Textiles and Leather
- Waste Management

For this project, Milwaukee Riverkeeper deployed PFASsive™ passive sampling devices and duplicate devices immediately upstream and downstream from the Waukesha WWTP's outfall to the Root River from August 14, 2024 to September 18, 2024. Both upstream and downstream sampling sites detected multiple types of PFAS. However, the concentrations of nine types of PFAS increased at the downstream site, in both the primary and duplicate samples, resulting in a total PFAS concentration increase of 25.76 ppt—an increase of 90.26%—in the primary downstream sample, and 25.63 ppt (91.21% increase) in the duplicate downstream sample.

For example, in the primary and duplicate downstream samples, the concentration of PFPeA increased from 5.7 ppt to 18 ppt (215.79%) and 5.6 ppt to 18 ppt (221.43%), respectively. The concentration of PFOA increased in the primary and duplicate downstream samples from 4.2 ppt to 8 ppt (90.48%) and 3.9 ppt to 6.4 ppt (64.10%), respectively. Multiple other types of PFAS increased in downstream samples at levels ranging from 25% to 74.07% in the primary samples and 10.53% to 100% in the duplicate samples. These results indicate that the Waukesha WWTP's outfall is likely a significant source of PFAS in the Root River.

WATERKEEPER ALLIANCE | PFAS REPORT PHASE II
ANALYSIS AND FINDINGS

Downstream concentrations of PFAS demonstrate that the surface water at this location is unsafe for drinking without advanced treatment. For example, the concentration of PFOA at the primary downstream location was 8 ppt, which is 4 ppt greater than the MCL, and the concentration of PFOS was 4.4 ppt, which is 0.4 ppt greater than the MCL.

The concentrations of PFOA and PFOS in the downstream samples also exceeded the draft HHWQC (Water + Organism), indicating the concentrations exceeded the levels EPA has identified as being necessary to protect the general population from adverse health effects due to ingesting water, fish, and shellfish from the waterbody. In the primary downstream sample, PFOA exceeded the draft HHWQC (Water + Organism) Human Health Criteria of 0.0009 ppt by 7.9991 ppt, and PFOS exceeded the 0.06 ppt criteria by 4.34 ppt. There are no national or state Clean Water Act surface water quality criteria for the protection of human health that apply to certain PFAS that were detected at elevated levels, including PFPeA, PFHxA, PFBA, PFHpA, PFHxS, and PFNA.

Waukesha WWTP Outfall | Root River



PFAS Phase II Sampling Site

Additionally, PFDA (duplicate sample) does not have any federal or state regulatory standards but exceeded EWG's health-based criteria. PFOA, PFOS, PFNA and PFHxS (primary sample) also exceeded EWG's health-based criteria. *See Table 24 (below).*

In addition to directly discharging wastewater into the Root River, Waukesha WWTP is permitted[162] to operate a Land Application Program to land apply its wastewater treatment biosolids. In its 2017 permit application,[163] Waukesha WWTP estimated that it would generate and

Table 24 | Root River Upstream and Downstream from Waukesha WWTP

Analyte	Sample (ppt)				Duplicate Sample (ppt)				MCL (ppt)		EPA (ppt)		EWG (ppt)	
	▲ Upstream	▼ Downstream	Change	% Change	▲ Upstream	▼ Downstream	Change	% Change	Criteria	Downstream Exceedance	Criteria	Downstream Exceedance	Criteria	Downstream Exceedance
PFPeA	5.70	18.00	12.30	215.79%	5.60	18.00	12.40	221.43%					1000	
PFOA	4.20	8.00	3.80	90.48%	3.90	6.40	2.50	64.10%	4	4.00	0.0009	7.9991	0.09	7.910
PFHxA	4.50	7.60	3.10	68.89%	4.70	7.10	2.40	51.06%					1000	
PFBS	2.70	4.70	2.00	74.07%	2.80	4.80	2.00	71.43%			400		2000	
PFOS	2.70	4.40	1.70	62.96%	2.50	5.00	2.50	100.00%	4	0.40	0.06	4.3400	0.3	4.100
PFBA	5.20	6.50	1.30	25.00%	5.70	6.30	0.60	10.53%					1000	
PFHpA	1.30	1.90	0.60	46.15%	1.40	1.90	0.50	35.71%					1000	
PFHxS	1.60	2.10	0.50	31.25%	1.50	2.10	0.60	40.00%	10				0.001	2.099
PFNA	0.64	1.10	0.46	71.88%	0.00	1.30	1.30	n/a	10				0.006	1.094
PFDA	0.00	0.00	0.00	0.00%	0.00	0.83	0.83	n/a					0.006	0.824
Total PFAS	28.54	54.30	25.76	90.26%	28.10	53.73	25.63	91.21%						

Non-detect recorded as 0 Downstream Increase Exceed criteria levels

Table 25 | Spring Creek Upstream and Downstream from Biosolids Land Application Site

Analyte	Sample (ppt)				MCL (ppt)		EPA (ppt)		EWG (ppt)		WI MCL (ppt)		WI SW Quality–DW (ppt)		WI SW Quality–All Waters (ppt)	
	▲ Upstream	▼ Downstream	Change	%Change	Criteria	Downstream Exceedance	Criteria	Downstream Exceedance	Criteria	Downstream Exceedance	Criteria	Downstream Exceedance	Criteria	Downstream Exceedance	Criteria	Downstream Exceedance
PFBA	1.10	0.00	-1.10	-100.00%					1000							
PFPeA	0.00	0.00	0.00	0.00%					1000							
PFHxA	0.00	0.00	0.00	0.00%					1000							
PFHpA	0.00	0.00	0.00	0.00%					1000							
PFOA	0.00	0.00	0.00	0.00%	4		0.0009		0.09		70		20			
PFNA	0.00	0.00	0.00	0.00%	10				0.006							
PFDA	0.00	0.00	0.00	0.00%					0.006							
PFBS	0.00	0.00	0.00	0.00%			400		2000							
PFPeS	0.00	0.00	0.00	0.00%					1							
PFHxS	0.00	0.00	0.00	0.00%	10				0.001							
PFHpS	0.00	0.00	0.00	0.00%					0.001							
PFOS	0.00	0.00	0.00	0.00%	4		0.06		0.3		70				8	
FOSA	0.00	0.00	0.00	0.00%					0.3							
HFPO-DA (GenX)	0.00	0.00	0.00	0.00%					9							
Total PFAS	1.1	0	-1.1	-100.00%												

Non-detect recorded as 0

land apply a total of 1,352 dry tons of Class B, anaerobically digested biosolids annually.

Milwaukee Riverkeeper conducted PFAS sampling in Spring Creek upstream and downstream from multiple land application sites near East Troy, Wisconsin, in the Fox River watershed. In 2024, these fields received roughly 374 metric tons of Waukesha WWTP's biosolids. The only PFAS detected at the sampling sites was PFBA, and it was only detected upstream of the biosolids land application fields at a concentration of 1.1 ppt. The concentration of PFBA decreased to a non-detect–a 100% decrease–at the downstream site. *See Table 25 (above).*

This evaluation indicates that Waukesha WWTP is contributing PFAS to the Root River and that multiple industrial dischargers are likely contributing to the WWTP's discharge of PFAS to the river. This pollution will likely continue to create significant risks to human health until PFAS pretreatment limits are placed on industrial sources of PFAS discharging into the WWTP and a PFAS limit is placed in the Waukesha WWTP's NPDES permit, which will require installation of PFAS treatment technology and a plan to safely manage PFAS removed during the treatment process.

Spokane Riverkeeper, Spokane River and Dragoon Creek, Washington

Wastewater Treatment Plant and Biosolids Sites

The Spokane Riverside Park WRF is a municipal wastewater treatment system that is owned and operated by the City of Spokane that serves a population of approximately 255,000 residents.[164] In addition, the facility handles wastewater from numerous industrial dischargers, including six permitted Categorical Industrial Users and eight permitted Significant Industrial Users. Spokane Riverside Park WRF discharges wastewater into the Spokane River at a Maximum Month Average Design Flow of 68.1 MGD during the months of March to October, and 56.4 MGD from November to February.

The Spokane River flows 111 miles west from Lake Coeur d'Alene in Idaho into Washington State, where it empties into the Franklin D. Roosevelt Lake impoundment of the Columbia River. The Spokane Valley-Rathdrum Prairie aquifer, which sits below the watershed, is a primary source of drinking water. According to ECHO, Spokane Riverside Park WRF is located in an area with 10 State EJ Supplemental Indexes and eight Federal Supplemental Indexes greater than the 80th percentile within one mile of the facility, including wastewater discharges at 95 (State).[165] According to the EPA EJScreen, of people living within one mile of Spokane Riverside Park WRF, 14% are people of color and 20% are low income.[166]

The NPDES permit[167] for Spokane Riverside Park WRF does not include any limits on the amount of PFAS the facility discharges into the Spokane River and there are no pretreatment limits to control PFAS discharges to the WRF by industrial dischargers. Of the 14 permitted industrial users discharging wastewater to Spokane Riverside Park WRF, EPA's PFAS Analytic Tools[168] lists two as facilities "operat[ing] in sectors that have been identified as possibly handling, using, or releasing PFAS chemicals.": Spokane Metal Finishing (Metal Coating) and Fairchild Airforce Base (National Defense). The federal government has identified Fairchild Airforce Base (AFB) as one of the facilities that used aqueous film forming foam (AFFF) containing PFAS for firefighter training.[169] There are likely additional unpermitted industrial dischargers contributing PFAS to the WRF given that EPA's PFAS Analytic Tools identifies 100 facilities located within the City of Spokane that operate in related sectors, including:

- Airports
- Chemical Mfg.
- Electronics Industry
- Fire Training
- Furniture and Carpet
- Industrial Gas
- Metal Coating
- Metal Machinery Mfg.
- Mining and Refining
- National Defense
- Paints and Coatings
- Paper Mills and Products
- Petroleum
- Plastics and Resins
- Printing
- Textiles and Leathers
- Waste Management

Washington Department of Ecology's 2016 sampling study of Spokane Riverside Park WRF's effluent revealed significant concentrations of PFAS. Specifically, the Department's study detected concentration levels of total Perfluoroalkyl acids of 91.8 ppt in the spring samples and 71.4 ppt in the fall samples.[170]

For this project, Spokane Riverkeeper deployed PFASsive™ passive sampling devices immediately upstream and downstream from Spokane Riverside Park WRF's outfall from August 7, 2024 to September 11, 2024. Samples of the Spokane River upstream and downstream from a Spokane Riverside Park WRF outfall contained multiple types of PFAS. However, the concentrations of four types of PFAS increased at the downstream site resulting in a total PFAS concentration increase of 4.76 ppt or 383.87%. For example, the concentration of PFHxA increased from 0.54 ppt to 2 ppt (270.37% increase).

Additional PFAS were also detected downstream at increased levels, including PFOA (1.1 ppt), PFOS (2.1 ppt), and PFHxS (0.8 ppt). PFOA and PFOS exceeded the draft HHWQC (Water + Organism), indicating the concentrations exceeded the levels EPA has identified as being necessary to protect the general population from adverse health effects due to ingesting water, fish, and shellfish from the waterbody. PFOA, PFHxS, and PFOS also exceeded the EWG health-based criteria. *See Table 26 (p. 76).*

Spokane Riverside Park WRF Biosolids Fields | Dragoon Creek



PFAS Phase II Sampling Site Biosolids Land Application Fields

Spokane Riverside Park WRF land applies biosolids at various locations in the Spokane River watershed. According to Spokane Riverside Park WRF's 2023 Biosolids Facility Report, the facility produced 7,168 dry tons of Class B biosolids, all of which were land-applied in-state at eight agricultural sites in amounts ranging from 1.69 tons/acre to 4.07 tons/acre. The total measured acreage of these sites was 2,613.[171]

For this project, Spokane Riverkeeper deployed PFASsive™ passive sampling devices immediately upstream and downstream from multiple Spokane Riverside Park WRF land application sites—Eichmeyer Fields 3 and 5, Ingwaldson Fields 1 and 2, and Eckhart Fields 17 and 18—all of which are located along Dragoon Creek. The devices were deployed on August 7, 2024, and retrieved on September 11, 2024. The downstream sampling site detected multiple types of PFAS. However, the upstream location only detected one type of PFAS, FOSA at 0.63 ppt.

At the downstream location, the concentrations of multiple types of PFAS increased significantly resulting in a total PFAS concentration increase of 32.26 ppt—an increase of 5,120.63%. For example, the concentration of PFPeA increased from a non-detect to 12 ppt, and the concentration of PFHxA increased from a non-detect to 7.4 ppt. These results indicate that the Spokane Riverside Park WRF's biosolids land application fields are likely a significant source of PFAS in Dragoon Creek, a tributary to the Little Spokane River.

Additionally, the concentration of PFOA in the downstream sample exceeded the draft HHWQC (Water + Organism), indicating the concentration exceeded the levels EPA has identified as being necessary to protect the general population from adverse health effects due to ingesting water, fish, and shellfish from the waterbody. Specifically, in the downstream sample, PFOA exceeded the draft HHWQC (Water + Organism) of 0.0009 ppt by 1.4991 ppt. There are no national or state Clean Water Act surface water quality criteria for the protection of human health that apply to certain PFAS that were detected at elevated levels, including PFPeA, PFHxA, PFBS, PFBA, PFHpA, and PFHxS.

FOSA—a type of PFAS that does not have any federal or state regulatory standards—exceeded EWG's health-based criteria by 0.58 ppt. PFOA and PFHxS also exceeded EWG's health-based criteria. *See Table 27 (below).*

This evaluation indicates that Spokane Riverside Park WRF biosolids sites are likely contributing a significant amount of PFAS to Dragoon Creek and that multiple industrial dischargers are likely contributing to the WRF's discharge of PFAS to the waterway. This pollution will likely continue to create significant risks to human health until PFAS pretreatment limits are placed on industrial sources of PFAS discharging into the WRF and PFAS limits are placed in Spokane Riverside Park WRFF's NPDES permit, which will require installation of PFAS treatment technology, limits on biosolids land application, and a plan to safely manage PFAS removed during the treatment process.

Table 26 | Spokane River Upstream and Downstream from Spokane Riverside Park WRF

Analyte	Sample (ppt)				MCL (ppt)		EPA (ppt)		EWG (ppt)		WA DW Action Level (ppt)	
	▲ Upstream	▼ Downstream	Change	% Change	Criteria	Downstream Exceedance	Criteria	Downstream Exceedance	Criteria	Downstream Exceedance	Criteria	Downstream Exceedance
PFHxA	0.54	2.00	1.46	270.37%					1000			
PFOA	0.00	1.10	1.10	n/a	4		0.0009	1.0991	0.09	1.01	10	
PFHxS	0.00	0.80	0.80	n/a	10				0.001	0.799	65	
PFOS	0.70	2.10	1.40	200.00%	4		0.06	2.04	0.3	1.80	15	
Total PFAS	1.24	6.00	4.76	383.87%								

Non-detect recorded as 0 Downstream Increase Exceed criteria levels

Table 27 | Dragoon Creek Upstream and Downstream from Biosolids Sites

Analyte	Sample (ppt)				MCL (ppt)		EPA (ppt)		EWG (ppt)	
	▲ Upstream	▼ Downstream	Change	% Change	Criteria	Downstream Exceedance	Criteria	Downstream Exceedance	Criteria	Downstream Exceedance
PFPeA	0	12	12.00	n/a					1000	
PFHxA	0	7.4	7.40	n/a					1000	
PFBS	0	5.8	5.80	n/a			400		2000	
PFBA	0	3.1	3.10	n/a					1000	
PFHpA	0	1.5	1.50	n/a					1000	
PFOA	0	1.5	1.50	n/a	4		0.0009	1.4991	0.09	1.41
PFHxS	0	0.71	0.71	n/a	10				0.001	0.709
FOSA	0.63	0.88	0.25	39.68%					0.3	0.58
Total PFAS	0.63	32.89	32.26	5120.63%						

Non-detect recorded as 0 Downstream Increase Exceed criteria levels

Cape Fear Riverkeeper, Cape Fear and South Rivers, North Carolina

Wastewater Treatment Plant and Biosolids Sites

The Cross Creek WRF is a municipal wastewater treatment system that is owned and operated by the Fayetteville Public Works Commission and serves a population of approximately 100,500 residents.[172] In addition, the facility handles wastewater from numerous industrial dischargers, including eight permitted Significant Industrial Users, two of which are Categorical Industrial Users.[173] Cross Creek WRF discharges wastewater into the Cape Fear River at a monthly average design flow of 25 MGD.

The Cape Fear River Basin, the largest in North Carolina, spans approximately 9,164 square miles, or about 16.5% of the state's total land area. Nearly one-third of North Carolina's population resides in the basin. According to ECHO, Cross Creek WRF is located in an area with 12 State Supplemental EJ Indexes and 12 Federal Supplemental EJ Indexes greater than the 80th percentile within one mile of the facility, including wastewater discharges at 99 (State and Federal).[174] According to the EPA EJScreen, of people living within one mile of Cross Creek WRF, 89% are people of color, 77% are low income, and 9.78% of households are on public assistance.[175]

The NPDES permit[176] for Cross Creek WRF does not include any limits on the amount of PFAS the facility discharges into the Cape Fear River and no pretreatment limits to limit PFAS discharges to the WRF by industrial dischargers. Of the permitted industrial users discharging wastewater to Cross Creek WRF, EPA's PFAS Analytic Tools[177] lists the following three as facilities "operat[ing] in sectors that have been identified as possibly handling, using, or releasing PFAS chemicals":

- Hexion Inc.—Fayetteville Facility (Plastics and Resins)
- Goodyear Tire and Rubber Co. (Consumer Products)
- Cumberland County Landfill (Waste Management)

There are likely additional unpermitted industrial dischargers contributing PFAS to the WRF given that EPA's PFAS Analytic Tools identifies 31 facilities located within the City of Fayetteville that operate in PFAS-related sectors including:

- Airports
- Chemical Mfg.
- Consumer Products
- Industrial Gas
- Metal Coating
- National Defense
- Petroleum
- Plastics and Resins
- Waste Management

In 2019, DEQ sampled Cross Creek WRF's influent for PFAS. The sampling results showed the presence of 13 PFAS; five of which were detected at concentrations greater than 20 ppt: PFBA (max. 21.3 ppt), PFHxS (max. 20.4 ppt), PFHxA (max. 35.5 ppt), PFPeA (max. 30 ppt), and PFOS (max. 28.3 ppt).[178]

For this project, Cape Fear Riverkeeper deployed PFASsive™ passive sampling devices immediately upstream and downstream from Cross Creek WRF's outfall from September 5, 2024 to November 8, 2024. Samples of the Cape Fear River upstream and downstream from Cross Creek WRF were contaminated with ten types of PFAS, and nine types of PFAS were detected at increased levels at the downstream site.[179] PFAS were detected downstream at increased levels, including PFOA, PFBS, PFHxS, and PFOS. PFOA (8.3 ppt) and PFOS (13 ppt) exceeded the MCL, rendering the surface water unsafe for drinking without advanced treatment, and exceeded the draft HHWQC (Water + Organism), indicating the concentrations exceeded the levels EPA has identified as being necessary to protect the general population from adverse health effects due to ingesting water, fish, and shellfish from the waterbody. PFOA, PFOS, PFNA, and PFHxS also exceeded the EWG health-based criteria. *See Table 28 (p. 79).*

In addition to directly discharging wastewater into the Cape Fear River, the Fayetteville Public Works Commission is permitted to operate a Residuals Land Application Program to land apply wastewater treatment Class B residuals at various locations in the Cape Fear and Lumber River Basins.[180] According to its 2023 Annual Report, which includes annual land application data from Cross Creek and Rockfish Creek WWTPs, Fayetteville land-applied 3,651.02 dry tons of Class B residuals on 58 fields totalling 1,443.93 acres during 2023.[181] The permits for these facilities do not contain any monitoring or limits on the amount of PFAS that can be present in the land-applied residuals.

Fayetteville's 2023 Annual Report[182] also identifies the locations where the city land-applied these 3,651.02 dry tons of residuals—of which 1,940.35 dry tons were generated by Cross Creek WRF. Several of Fayetteville's sites with the greatest volumes of land application (exceeding three tons/acre) in 2023[183] are located directly adjacent to the South River, a tributary to the Cape Fear River, near Autryville, North Carolina. These fields are traversed by ditches that channel runoff, shallow groundwater, and any pollutants directly into the South River.

For this project, Cape Fear Riverkeeper deployed PFASsive™ passive sampling devices immediately upstream and downstream of Cross Creek WRF's land application sites along the South River. These fields received 672.66 tons of residuals from Cross Creek WRF in 2023 in amounts ranging from 1.10 tons/acre to 5.07 tons/acre. The devices were deployed on August 27, 2024. The downstream device was retrieved on November 8, 2024, and the upstream device was retrieved on January 10, 2025. Cape Fear Riverkeeper also deployed a duplicate sampling device downstream of the land application site from August 27, 2024 to November 8, 2024.

Both upstream and downstream sampling sites detected multiple types of PFAS. However, the concentrations of all detected PFAS increased at the downstream site resulting in a total PFAS concentration increase of 20.21 ppt (96.28%). For example, the concentration of PFBS increased from 2.7 ppt to 5.5 ppt (103.7%). Multiple other types of PFAS increased in downstream samples at levels ranging from 31.58% to 86.67%. These results indicate that the Cross Creek WRF's residuals land application fields in the South River watershed are likely a significant source of PFAS in the South River.

Downstream concentrations of PFAS demonstrate that the surface water at this location is unsafe for drinking without advanced treatment. For example, the concentration of PFOA at the downstream location was 5.8 ppt, which is 1.8 ppt greater than the MCL of 4 ppt, and the concentration of PFOS was 7.5 ppt, which is 3.5 ppt greater than the MCL of 4 ppt.

The concentrations of PFOA and PFOS in the downstream sample also exceeded the draft HHWQC (Water +

Table 28 | Cape Fear River Upstream and Downstream from Fayetteville Cross Creek WRF

Analyte	Sample (ppt)				MCL (ppt)		EPA (ppt)		EWG (ppt)	
	▲ Upstream	▼ Downstream	Change	% Change	Criteria	Downstream Exceedance	Criteria	Downstream Exceedance	Criteria	Downstream Exceedance
PFBA	5.00	5.40	0.40	7.41%					1000	
PFPeA	7.30	8.60	1.30	15.12%					1000	
PFHxA	5.70	6.70	1.00	14.93%					1000	
PFHpA	3.50	3.70	0.20	5.41%					1000	
PFOA	8.10	8.30	0.20	2.41%	4	4.30	0.0009	8.2991	0.09	8.21
PFNA	1.10	1.10	0.00	0.00	10				0.006	1.094
PFBS	4.20	4.70	0.50	10.64%			400		2000	
PFPeS	0.93	0.94	0.01	1.06%					1	
PFHxS	5.10	5.30	0.20	3.77%	10				0.001	5.299
PFOS	11.00	13.00	2.00	15.38%	4	9.00	0.06	12.94	0.3	12.70
Total PFAS	51.93	57.74	5.81	10.06%						

Non-detect recorded as 0 Downstream Increase Exceed criteria levels

Fayetteville Cross Creek Biosolids Fields | South River



PFAS Phase II Sampling Site Biosolids Land Application Fields

Organism), indicating that concentrations exceeded the levels EPA has identified as being necessary to protect the general population from adverse health effects due to ingesting water, fish, and shellfish from the waterbody. In the downstream sample, PFOA exceeded the draft HHWQC (Water + Organism) of 0.0009 ppt by 5.7991 ppt, and PFOS exceeded the 0.06 ppt criteria by 7.44 ppt. There are no national or state Clean Water Act surface water quality criteria for the protection of human health that apply to certain PFAS that were detected at elevated levels, including PFPeA, PFBA, PFHxS, PFHpA, PFHxA, FOSA, PFNA, and HFPO-DA (Gen-X).

Additionally, FOSA—a type of PFAS that does not have any federal or state regulatory standards—exceeded EWG's health-based criteria by 0.56 ppt. PFOA, PFOS, PFNA, and PFHxS also exceeded EWG's health-based criteria. *See Table 29 (below).*

This evaluation indicates that Cross Creek WRF's land application sites are likely contributing a significant amount of PFAS to the South River and that multiple industrial dischargers are likely contributing to the WWTP's discharge of PFAS to the waterway. This pollution will likely continue to create significant risks to human health until PFAS pretreatment limits are placed on industrial sources of PFAS discharging into the WWTP and PFAS limits are placed in the Cross Creek WRF's NPDES permit, which will require installation of advanced treatment technology, limits on residuals land application, and a plan to safely manage PFAS removed during the treatment process.

Table 29 | South River Upstream and Downstream from Biosolids Site

Analyte	Sample (ppt)					MCL (ppt)		EPA (ppt)		EWG (ppt)	
	▲ Upstream	▼ Downstream	Downstream Duplicate	Change	% Change	Criteria	Downstream Exceedance	Criteria	Downstream Exceedance	Criteria	Downstream Exceedance
PFPeA	0	4.2	4.8	4.20	n/a					1000	
PFBA	3.9	6.7	6.2	2.80	71.79%					1000	
PFBS	2.7	5.5	5.1	2.80	103.70%			400		2000	
PFOA	3.3	5.8	5.8	2.50	75.76%	4	1.8	0.0009	5.7991	0.09	5.71
PFHxS	0	2.4	2.2	2.40	n/a	10				0.001	2.399
PFOS	5.7	7.5	6.7	1.80	31.58%	4	3.5	0.06	7.44	0.3	7.2
PFHpA	1.5	2.8	2.8	1.30	86.67%					1000	
PFHxA	2.2	3.1	3.2	0.90	40.91%					1000	
FOSA	0	0.86	0.62	0.86	n/a					0.3	0.56
PFNA	1	1.4	1.3	0.40	40.00%	10				0.006	1.394
HFPO-DA (GenX)	0.69	0.94	0.84	0.25	36.23%	10				9	
Total PFAS	20.99	41.2	39.56	20.21	96.28%						

Non-detect recorded as 0 Downstream Increase Exceed criteria levels

Cahaba Riverkeeper and Black Warrior Riverkeeper, Cahaba River and Cane Creek, Alabama

Wastewater Treatment Plant and Biosolids Sites

The Cahaba River WWTP is a municipal wastewater treatment system that is owned and operated by the Jefferson County Commission Environmental Services Department. This facility serves a population of 95,000 people[184] and discharges wastewater into the Cahaba River at an average design flow of 12 MGD.[185] According to ECHO, Cahaba River WWTP is located in an area with 10 State Supplemental EJ Indexes and nine Federal Supplement EJ Indexes greater than the state's 80th percentile within one mile of the facility.[186] According to the EPA EJScreen, of people living within one mile of Cahaba WRF, 65% are people of color and 34% are low income.[187]

The Jefferson County Environmental Services Department is authorized to receive discharges from numerous industrial dischargers pursuant to its Industrial Pretreatment Program, including 53 industrial facilities, of which 25 are permitted under the State Indirect Discharge (SID) program, and nine landfills.[188] Because Jefferson County Environmental Services Department's wastewater treatment and collection system consists of nine wastewater treatment plants, including Cahaba River WWTP, it is unclear whether the facility receives discharges from any of these industrial users and, if so, to what extent. Although Cahaba River WWTP's 2017 NPDES renewal application states that it is subject to an approved pretreatment program, the facility also states that it receives discharges from zero industrial users.[189]

The NPDES permit[190] for Cahaba River WWTP does not include any limits on the amount of PFAS the facility discharges into the Cahaba River, and there are no pretreatment limits to control PFAS discharges to the facility by industrial users. Of the 25 permitted industrial users discharging wastewater to the Jefferson County Environmental Services Department facilities, EPA's PFAS Analytic Tools[191] identifies the following 11 facilities as "operat[ing] in sectors that have been identified as possibly handling, using, or releasing PFAS chemicals":

- Amerex Corporation (Metal Coating and Chemical Mfg.)
- Chevron Bulk Terminal Birmingham (Petroleum)
- CRB (Plastics and Resins, and Textiles and Leather)
- Hanna Steel (Metal Coating)
- Kaiser Industries (Airports)
- Kent Corporation (Metal Machinery Mfg.)
- Max Coating (Metal Coating)
- Nutec Metal Finishing, LLC (Metal Coating)
- Precoat Metals (Metal Coating)
- Progressive Metal Finishers, Inc. (Metal Coating)
- Scholar Craft Products, Inc. (Metal Coating)

EPA also identifies these landfills (Waste Management) as handling, using, or releasing PFAS, including:

- Cedar Hill
- Big Sky Solid Waste Facility
- Eastern Area Landfill
- Green Mountain
- New Georgia Landfill
- Pine View Landfill
- Star Ridge
- Willow Ridge Landfill

In addition, 11 facilities (8 of which have separate NPDES permits) located in the Cities of Hoover, Irondale, and Vestavia Hills, areas serviced by Cahaba River WWTP, are also included on EPA's list as potential PFAS-discharging facilities including:

- TV Alabama (Airport)
- City of Hoover (Waste Management)
- Scholar Craft Products, Inc. (Metal Coating)
- United Chair Irondale Plant (Metal Coating)
- International Oil Corp. (Paints and Coatings)
- Creative Polymer Solutions, LLC (Plastics and Resins)
- Eastwood Mobile Home Village (Waste Management)
- EWTN WWTP (Waste Management)
- Irondale WWTF (Waste Management)
- Liberty Park WRRF (Waste Management)
- Cahaba River WRF (Waste Management), the facility sampled for purposes of this report

For this project, Cahaba Riverkeeper deployed PFASsive™ passive sampling devices immediately upstream and downstream from Cahaba River WWTP's outfall from August 22, 2024 to September 18, 2024. Samples taken upstream and downstream from Cahaba

Table 30 | Cahaba River Upstream and Downstream from Cahaba River WWTP

Analyte	Sample (ppt)				MCL (ppt)		EPA (ppt)		EWG (ppt)	
	▲ Upstream	▼ Downstream	Change	% Change	Criteria	Downstream Exceedance	Criteria	Downstream Exceedance	Criteria	Downstream Exceedance
PFBA	5.20	5.20	0.00	0.00					1000	
PFPeA	7.30	10.00	2.70	36.99%					1000	
PFHxA	5.40	6.40	1.00	18.52%					1000	
PFHpA	1.70	1.90	0.20	11.76%					1000	
PFOA	4.60	4.90	0.30	6.52%	4	0.90	0.0009	4.8991	0.09	4.81
PFNA	0.85	0.73	-0.12	0.14%	10				0.006	0.724
PFDA	0.52	0.00	-0.52	-100.00%					0.006	
PFBS	6.00	6.40	0.40	6.67%			400		2000	
PFHxS	1.30	1.50	0.20	15.38%	10				0.001	1.499
PFOS	5.20	4.50	-0.70	-13.46%	4	0.50	0.06	4.44	0.3	4.20
Total PFAS	38.07	41.53	3.46	9.09%						

Non-detect recorded as 0 Downstream Increase Exceed criteria levels

River WWTP outfalls were contaminated with multiple types of PFAS, and six types of PFAS were detected at increased concentrations at the downstream site.[192] PFPeA increased most significantly at the downstream site from 7.3 ppt to 10 ppt (36.99%). The total PFAS concentration increased by 3.46 ppt or 9.09%. At the downstream site, PFOA (4.9 ppt) exceeded the MCL, rendering the surface water unsafe for drinking water without advanced treatment. PFOA and PFOS also exceeded the draft HHWQC (Water + Organism) at the downstream site, indicating the concentration exceeded the level EPA has identified as being necessary to protect the general population from adverse health effects due to ingesting water, fish, and shellfish from the waterbody. Additionally, numerous PFAS significantly exceeded EWG's health-based criteria, including PFOA, PFNA, PFHxS, and PFOS. *See Table 30 (above).*

In 2024, Cahaba River WWTP generated 4,664 dry tons of biosolids. However, the facility has not produced biosolids for land application since October 2020.[193] Its current process for disposing of biosolids is to pump them, as waste activated biosolids, to the Al Seier Pump Station, where they are mixed with wastewater and sent to the Valley Creek WRF for full treatment. From Valley Creek,[194] the biosolids are authorized to be land-applied at a 241-acre mine reclamation site, called the Flat Top Land Application Site, as well as a 1,000-acre agricultural land application site, called the Beltona Land Reclamation Site. The Beltona Land Reclamation Site, which is located in the Cane Creek watershed (in Black Warrior Riverkeeper's watershed), is used to grow bermuda grass for erosion control.

For this project, Cahaba Riverkeeper and Black Warrior Riverkeeper deployed PFASsive™ passive sampling devices and duplicate sampling devices immediately upstream and downstream of the Beltona Land Reclamation Site in Cane Creek to determine its contribution of PFAS contamination to that waterway. The devices were deployed from August 20, 2024 to September 17, 2024. Both upstream and downstream sampling sites detected multiple types of PFAS. However, the concentrations of eight types of PFAS increased at the downstream sites, resulting in a total PFAS concentration increase of 28.54 ppt—an increase of 201.84%—in the primary samples,[195] and an increase of 18.12 ppt (140.47%) in the duplicate samples. PFPeA and PFBA were detected at the highest concentrations—both 11 ppt.

In the primary and duplicate samples, the concentration of PFHpA increased from 0.54 ppt to 1.7 ppt (214.81%) and a non-detect to 1.4 ppt, respectively. The concentration of PFHxA in the primary and duplicate samples increased from 1.2 ppt to 4.2 ppt (250%) and 1 ppt to 3.1 ppt (210%). Also, the concentration of PFBA in the primary and duplicate samples increased from 3.8 ppt to 11 ppt (189.47%) and 2.7 ppt to 6.4 ppt (137.04%). Multiple other types of

Beltona Land Reclamation Site | Cane Creek



PFAS Phase II Sampling Site Biosolids Land Application Fields

PFAS increased in downstream samples at levels ranging from 52.63% to 127.78% in the primary sample and 34.15% to 126.67% in the duplicate samples. These results indicate that the Cahaba River/Valley Creek WWTPs' biosolids land application site is likely a significant source of PFAS in Cane Creek, a tributary to the Locust Fork, which is a tributary to the Black Warrior River.

The concentration of regulated PFAS increased downstream from the biosolids land application field, including PFOS, PFOA, and PFNA. Downstream concentrations of PFAS demonstrate that the surface water at this location is unsafe for drinking without advanced treatment. For example, the downstream concentration of PFOA was 4.1 ppt, which is 0.1 ppt greater than the MCL, and the concentration of PFOS was 5.8 ppt, which is 1.8 ppt greater than the MCL.

The concentrations of PFOA and PFOS in the downstream sample also exceeded the draft HHWQC (Water + Organism), indicating the concentrations exceeded the levels EPA has identified as being necessary to protect the general population from adverse health effects due to ingesting water, fish, and shellfish from the waterbody. In the downstream sample, PFOA exceeded the draft HHWQC (Water + Organism) of 0.0009 ppt by 4.0991 ppt, and PFOS exceeded the 0.06 ppt criteria by 5.74 ppt. There are no national or state Clean Water Act surface water quality criteria for the protection of human health that apply to certain PFAS that were detected at elevated levels, including PFPeA, PFBA, PFHxA, PFHpA, and PFNA. However, PFOA, PFOS, PFNA, and PFHxS exceeded EWG's health-based criteria. *See Table 31 (below).*

This evaluation indicates that Cahaba River WWTP's land application site is likely contributing a significant amount of PFAS to Cane Creek and that multiple industrial dischargers to the facility are likely contributing to the WWTP's discharge of PFAS to the waterway. This pollution will likely continue to create significant risks to human health until PFAS pretreatment limits are placed on industrial sources of PFAS discharging into the facility and PFAS limits are placed in the Cahaba River WWTP's NPDES permit, which will require installation of PFAS treatment technology, limits on biosolids land application, and a plan to safely manage PFAS removed during the treatment process.

Table 31 | Cane Creek Upstream and Downstream from Biosolids Site

Analyte	Sample (ppt)				Duplicate Sample (ppt)				MCL (ppt)		EPA (ppt)		EWG (ppt)	
	▲ Upstream	▼ Downstream	Change	% Change	▲ Upstream	▼ Downstream	Change	% Change	Criteria	Downstream Exceedance	Criteria	Downstream Exceedance	Criteria	Downstream Exceedance
PFPeA	0	11	11	n/a	0	6.1	6.1	n/a					1000	
PFBA	3.8	11	7.2	189.47%	2.7	6.4	3.7	137.04%					1000	
PFHxA	1.2	4.2	3	250.00%	1	3.1	2.1	210.00%					1000	
PFOA	1.8	4.1	2.3	127.78%	1.5	3.4	1.9	126.67%	4	0.1	0.0009	4.0991	0.09	4.01
PFOS	3.8	5.8	2	52.63%	4.1	5.5	1.4	34.15%	4	1.8	0.06	5.74	0.3	5.5
PFBS	1.4	2.7	1.3	92.86%	1.4	2.5	1.1	78.57%			400		2000	
PFHpA	0.54	1.7	1.16	214.81%	0	1.4	1.4	n/a					1000	
PFNA	0	0.68	0.68	n/a	0	0.62	0.62	n/a	10				0.006	0.674
PFHxS	1.6	1.5	-0.1	-6.25%	2.2	2	-0.2	-9.09%	10				0.001	1.499
Total PFAS	14.14	42.68	28.54	201.84%	12.9	31.02	18.12	140.47%						

Non-detect recorded as 0 Downstream Increase Exceed criteria levels

SAMPLING RESULTS BY WATERKEEPER GROUP WATERSHED[196]

Bayou City Waterkeeper, Hunting Bayou, Texas
Wastewater Treatment Plant Site

The Hunting Bayou watershed spans the city limits of Houston, Galena Park, and Jacinto City, with an estimated population of 75,627. The Homestead WWTP, a municipal wastewater treatment facility, serves 7,961 people and discharges treated wastewater to Hunting Bayou.[197] Within one mile of the facility, 97% of residents are people of color, and 68% are low-income. EPA has identified approximately 1,405 potential PFAS-discharging facilities within Houston.[198]

Samples taken upstream and downstream from a WWTP outfall on Hunting Bayou were contaminated with multiple types of PFAS, and seven types of PFAS were detected at increased concentrations at the downstream site. Regulated PFAS were detected downstream from the WWTP, including PFOA, PFNA, PFHxS, and PFOS.[199] While PFAS levels increased downstream from the WWTP, the difference between upstream and downstream concentrations was not significant for most PFAS with the exception of PFHxA, which increased by 4.2 ppt (61.76%). However, the total PFAS concentration increased by 5.7 ppt (9.87%).

The PFAS contamination, both upstream and downstream, has rendered the surface water unsafe for drinking without advanced treatment, with PFOS (4 ppt) at the level of the MCL and PFOS exceeding the MCL by 8 ppt. PFOS and PFOA also exceeded the draft HHWQC (Water + Organism), indicating the concentrations exceeded the levels EPA has identified as being necessary to protect the general population from adverse health effects due to ingesting water, fish, and shellfish from the waterbody. Multiple PFAS exceeded EWG's health-based criteria. *See Table 32 (below).*

Table 32 | Hunting Bayou Upstream and Downstream from Homestead WWTP

Analyte	Sample (ppt)				MCL (ppt)		EPA (ppt)		EWG (ppt)	
	▲ Upstream	▼ Downstream	Change	% Change	Criteria	Downstream Exceedance	Criteria	Downstream Exceedance	Criteria	Downstream Exceedance
PFBA	6.30	6.20	-0.10	-1.59%					1000	
PFPeA	8.70	9.30	0.60	6.90%					1000	
PFHxA	6.80	11.00	4.20	61.76%					1000	
PFHpA	3.70	3.40	-0.30	-8.11%					1000	
PFOA	3.70	4.00	0.30	8.11%	4		0.0009	3.9991	0.09	3.91
PFNA	1.20	1.30	0.10	8.33%	10				0.006	1.29
PFDA	0.55	0.64	0.09	16.36%					0.006	0.63
PFBS	9.40	11.00	1.60	17.02%			400		2000	
PFPeS	0.72	0.63	-0.09	-12.50%					1	
PFHxS	4.70	4.00	-0.70	-14.89%	10				0.001	4.00
PFOS	11.00	12.00	1.00	9.09%	4	8.00	0.06	11.94	0.3	11.70
6:2 FTS	1.00	0.00	-1.00	-100.00%					1	
Total PFAS	57.77	63.47	5.70	9.87%						

Non-detect recorded as 0 Downstream Increase Exceed criteria levels

Chattahoochee Riverkeeper, Chattahoochee River, Georgia
Wastewater Treatment Plant Site

The Chattahoochee River Basin, also known as the Apalachicola-Chattahoochee-Flint basin, covers an area of 8,770 square miles. The Chattahoochee River flows southwest for 434 miles, starting in the southern Appalachian Mountains, passing through the Atlanta metropolitan area, and ending at Lake Seminole. The river provides 70 percent of Atlanta's drinking water. The City of Atlanta's R.M. Clayton WRC, Cobb County's R.L. Sutton WRF, and the West Area WQCF discharge treated wastewater into the Chattahoochee River.[200] Of the people living within one mile of these facilities, 42% are people of color and 17% are low-income. EPA has identified approximately 290 potential PFAS-discharging facilities within the City of Atlanta, which is served by multiple wastewater treatment plants.[201]

Samples taken upstream and downstream from the facilities' outfalls to the Chattahoochee River were contaminated with multiple types of PFAS. Nine types of PFAS were detected at elevated levels downstream from the discharge points, including PFPeA at 6.1 ppt (74.29% increase) and PFTeA at 4.1 ppt (upstream sample was non-detect). The total PFAS concentration increased by 15.58 ppt (88.93%). Federally regulated PFAS were detected downstream at increased levels, including PFBS and PFOA. PFOA and PFOS exceeded the draft HHWQC (Water + Organism), indicating the concentrations exceeded the levels EPA has identified as being necessary to protect the general population from adverse health effects due to ingesting water, fish, and shellfish from the waterbody. PFOA, PFDoA, PFTeA, PFHxS, PFOS, and PFMPA also exceeded the EWG health-based criteria. *See Table 33 (below).*

Table 33 | Chattahoochee River Upstream and Downstream from The City of Atlanta's R.M Clayton WRC, Cobb County's R.L. Sutton WRF, and the West Area WQCF

Analyte	Sample (ppt)				MCL (ppt)		EPA (ppt)		EWG (ppt)	
	▲ Upstream	▼ Downstream	Change	% Change	Criteria	Downstream Exceedance	Criteria	Downstream Exceedance	Criteria	Downstream Exceedance
PFBA	1.6	2.1	0.5	31.25%					1000	
PFPeA	3.50	6.10	2.60	74.29%					1000	
PFHxA	3.20	4.60	1.40	43.75%					1000	
PFHpA	0.82	1.50	0.68	82.93%					1000	
PFOA	2.70	2.80	0.10	3.70%	4		0.0009	2.7991	0.09	2.71
PFDoA	0.00	1.20	1.20	n/a					0.006	1.194
PFTeA	0.00	4.10	4.10	n/a					0.006	4.094
PFBS	1.30	4.30	3.00	230.77%			400		2000	
PFHxS	1.80	1.70	-0.10	-5.56%	10				0.001	1.699
PFOS	2.60	2.60	0.00	0.00%	4		0.06	2.54	0.3	2.30
PFMPA	0.00	2.10	2.10	n/a					1	1.10
Total PFAS	17.52	33.10	15.58	88.93%						

Non-detect recorded as 0 Downstream Increase Exceed criteria levels

Coosa Riverkeeper, Big Wills Creek and Whippoorwill Creek, Alabama

Wastewater Treatment Plant and Biosolids Sites

The Coosa River Basin spans more than 10,000 square miles and flows over 280 miles from northwestern Georgia to central Alabama. The Lower Coosa River Basin is home to up to 46 federally protected species, and is considered one of the most biodiverse ecosystems in the world. Big Wills Creek is a tributary to the Coosa River and Whippoorwill Creek is a tributary to the Locust Fork River in the Black Warrior River watershed. The Rainbow City WWTP is a municipal facility that discharges treated wastewater to Big Wills Creek.[202] The facility does not receive discharges from significant industrial users. Of the people living within one mile of the Rainbow City WWTP, 24% are people of color and 38% are low-income.

The Rainbow City WWTP is a municipal facility that produces approximately 1,400 lbs/day of Class B biosolids, which is stored in a biosolids lagoon. Since 2023, the plant has contracted with Denali Water Systems to transport biosolids to the Dennis Burton Farm in Altoona, Alabama, where it is land-applied as fertilizer for growing crops in the Whippoorwill Creek watershed.[203] According to Denali's nutrient management plan, about 125 acres of land receive the plant's biosolids each year.

Samples of Big Wills Creek upstream and downstream from a Rainbow City WWTP outfall contained multiple types of PFAS.[204] No significant increases were observed between upstream and downstream samples, with the exception of FOSA (non-detect to 1.6 ppt increase). Numerous PFAS decreased in the downstream sample, as did the total PFAS concentration by 2.33 ppt (15.49%). These results could have been influenced by factors such as backflow from the Coosa River, season, precipitation, discharge schedules, and leachate contributions. At the downstream site, PFOA and PFOS exceeded the draft HHWQC (Water + Organism), indicating the concentrations exceeded the levels EPA has identified as being necessary to protect the general population from adverse health effects due to ingesting water, fish, and shellfish from the waterbody. PFOA, PFNA, PFHxS, PFOS, and FOSA also exceeded the EWG health-based criteria. *See Table 34 (below).*

Table 34 | Big Wills Creek Upstream and Downstream from Rainbow City WWTP

Analyte	Sample (ppt)				MCL (ppt)		EPA (ppt)		EWG (ppt)	
	▲ Upstream	▼ Downstream	Change	% Change	Criteria	Downstream Exceedance	Criteria	Downstream Exceedance	Criteria	Downstream Exceedance
PFBA	1.80	1.90	0.10	5.56%					1000	
PFPeA	2.70	0.00	-2.70	-100.00%						
PFHxA	2.70	2.60	-0.10	-3.70%					1000	
PFHpA	0.96	0.95	-0.01	-1.04%					1000	
PFOA	2.00	2.20	0.20	10.00%	4		0.0009	2.1991	0.09	2.11
PFNA	0.58	0.54	-0.04	-6.90%	10				0.006	0.534
PFDA	0.65	0.00	-0.65	-100.00%					0.006	
PFBS	0.82	0.58	-0.24	-29.27%			400		2000	
PFHxS	0.63	0.64	0.01	1.59%	10				0.001	0.639
PFOS	2.20	1.70	-0.50	-22.73%	4		0.06	1.64	0.3	1.40
FOSA	0.00	1.60	1.60	n/a					0.3	1.30
Total PFAS	15.04	12.71	-2.33	-15.49%						

Non-detect recorded as 0 Downstream Increase Exceed criteria levels

The designated upstream and downstream sampling sites in Whippoorwill Creek near the Rainbow City WWTP's biosolids land application site, which is located in the Black Warrior River watershed, also contained PFAS. Due to sampling location constraints, the upstream sampling site was adjacent to one of the biosolids application fields. PFAS decreased significantly between upstream and downstream samples, with many downstream samples showing non-detect for multiple PFAS. The total PFAS concentration also decreased by 11.75 ppt (83.81%). At the upstream site, PFOS (5.6 ppt), exceeded the MCL, rendering the surface water at this location unsafe for drinking without advanced treatment. At the upstream and downstream sites, PFOA and PFOS exceeded the draft HHWQC (Water + Organism), indicating the concentrations exceeded the levels EPA has identified as being necessary to protect the general population from adverse health effects due to ingesting water, fish, and shellfish from the waterbody. PFOA and PFOS also exceeded the EWG health-based criteria at the downstream site. *See Table 35 (below).*

Table 35 | Whippoorwill Creek Upstream and Downstream from Biosolids Land Application Sites

Analyte	Sample (ppt)				MCL (ppt)		EPA (ppt)		EWG (ppt)	
	▲ Upstream	▼ Downstream	Change	% Change	Criteria	Downstream Exceedance	Criteria	Downstream Exceedance	Criteria	Downstream Exceedance
PFBA	1.8	0.00	-1.80	-100.00%					1000	
PFHxA	0.86	0.00	-0.86	-100.00%					1000	
PFHpA	0.72	0.00	-0.72	-100.00%					1000	
PFOA	2.4	0.77	-1.63	-67.92%	4		0.0009	0.7691	0.09	0.68
PFBS	1.7	0.00	-1.70	-100.00%			400		2000	
PFHxS	0.94	0.00	-0.94	-100.00%	10				0.001	
PFOS	5.6	1.5	-4.10	-73.21%	4		0.06	1.44	0.3	1.20
Total PFAS	14.02	2.27	-11.75	-83.81%						

Non-detect recorded as 0 Downstream Increase Exceed criteria levels

Hackensack Riverkeeper, Ramapo River, New York/New Jersey
Wastewater Treatment Plant Site

The Ramapo River Basin, located in southeastern New York State and northeastern New Jersey, covers approximately 935 square miles and is a major tributary of the Passaic River. Sampling was conducted on the Ramapo River upstream and downstream from two municipal WWTPs that discharge to the Ramapo River: the Suffern (V) STP and the Western Ramapo WWTP.[205] The Suffern (V) STP serves a population of 13,000 people. Within one mile of the Western Ramapo WWTP, 56% of residents are people of color and 27% are low-income. New York State has also designated this area as a Disadvantaged Community.[206] The EPA has identified eight potential PFAS-discharging facilities within the Cities of Suffern and Hillburn.[207]

Samples of the Ramapo River upstream and downstream from the WWTPs' outfalls contained multiple types of PFAS.[208] At the downstream site in Mahwah, New Jersey just across the border from Suffern, New York, five types of PFAS were detected at elevated levels, including PFHxA at 10 ppt (2.5 ppt increase), PFHxS at 3.5 ppt (non-detect at upstream site), and PFBS at 2.5 ppt (non-detect at upstream site). The total PFAS concentration increased by 10.10 ppt (45.7%). Federally regulated PFAS were detected downstream at increased levels, including PFOA (6.7 ppt), PFBS, PFOS (4.7 ppt), and PFHxS. PFOA and PFOS exceeded the MCLs at the downstream site, rendering the surface water at this location unsafe for drinking without advanced treatment. PFOA and PFOS also exceeded the draft HHWQC (Water + Organism), indicating the concentrations exceeded the levels EPA has identified as being necessary to protect the general population from adverse health effects due to ingesting water, fish, and shellfish from the waterbody. The PFOS concentration in the downstream sample exceeded New York's water quality guidance values for protection of human health in raw source water[209] and PFOA, PFOS, and PFHxS also exceeded the EWG health-based criteria. *See Table 36 (below).*

Table 36 | Ramapo River Upstream and Downstream from WWTP and STP

Analyte	Sample (ppt)					MCL (ppt)		EPA (ppt)		EWG (ppt)		NY MCL (ppt)		State Ambient WQ for HH (DW) (ppt)	
	▲ Upstream	▼ Downstream	Change	% Change	Upstream (August)	Criteria	Downstream Exceedance	Criteria	Downstream Exceedance	Criteria	Downstream Exceedance	Criteria	Downstream Exceedance	Criteria	Downstream Exceedance
PFBA	0.00	0.00	0.00	0.00%	3.30					1000					
PFPeA	5.40	4.80	-0.60	-11.11%	9.10					1000					
PFHxA	7.50	10.00	2.50	33.33%	5.90					1000					
PFHpA	0.00	0.00	0.00	0.00%	2.20					1000					
PFOA	6.10	6.70	0.60	9.84%	5.20	4	2.70	0.0009	6.6991	0.09	6.61	10		6.7	
PFNA	0.00	0.00	0.00	0.00%	1.60	10				0.006					
PFUnA	0.00	0.00	0.00	0.00%	0.97					0.006					
PFBS	0.00	2.50	2.50	n/a	1.30			400		2000					
PFHxS	0.00	3.50	3.50	n/a	1.00	10				0.001	3.50				
PFOS	3.10	4.70	1.60	51.61%	3.90	4	0.70	0.06	4.64	0.3	4.40	10		2.7	2.00
FOSA	0.00	0.00	0.00	0.00%	0.56					0.3					
Total PFAS	22.10	32.20	10.10	45.70%	35.03										

Non-detect recorded as 0 Downstream Increase Exceed criteria levels

James Riverkeeper, Appomattox River and Old Town Creek, Virginia
Wastewater Treatment Plant and Biosolids Sites

The James River, Virginia's largest river, flows 340 miles and connects to 25,000 miles of tributaries, including the Appomattox River. Its watershed spans approximately 10,000 square miles, making up nearly a quarter of the state. About one-third of Virginians live within this watershed. Within one mile of the South Central WWTP,[210] a wastewater treatment system serving five localities and discharging effluent to the Appomattox River, 56% are people of color and 33% are low income. EPA has identified 29 potential PFAS-discharging facilities in Petersburg.[211]

Samples of the Appomattox River upstream and downstream from a South Central WWTP outfall contained multiple types of PFAS. However, the concentrations of several of PFAS increased slightly at the downstream site resulting in a total PFAS concentration increase of 0.5 ppt–an increase of 2.37%. PFOA (2.6 ppt) and PFOS (2.6 ppt) were detected in downstream samples at levels that exceeded the draft HHWQC (Water + Organism), indicating the concentrations exceeded the levels EPA has identified as being necessary to protect the general population from adverse health effects due to ingesting water, fish, and shellfish from the waterbody. PFOA, PFOS, PFNA, and PFHxS also exceeded the EWG health-based criteria. *See Table 37 (below).*

South Central WWTP's method for disposing of its biosolids is through land application.[212] The facility produces Class B biosolids, which it prepares for land application through dewatering followed by lime stabilization. According to South Central WWTP's Biosolids Facility Report,[213] the facility produced and land applied 3,426 dry metric tons of biosolids in 2023, however, the land application is handled by Synagro Central, LLC, which sources biosolids for land application from multiple WWTPs.[214] For purposes of this project, James Riverkeeper conducted PFAS sampling downstream from a Synagro biosolids land application field, VA-CH-00004-0-0010, located in the Old Town Creek watershed.[215]

Table 37 | Appomattox River Upstream and Downstream from South Central WWTP

Analyte	Sample (ppt)				MCL (ppt)		EPA (ppt)		EWG (ppt)	
	▲ Upstream	▼ Downstream	Change	% Change	Criteria	Downstream Exceedance	Criteria	Downstream Exceedance	Criteria	Downstream Exceedance
PFBA	5.80	4.50	-1.30	-22.41%					1000	
PFPeA	3.50	4.40	0.90	25.71%					1000	
PFHxA	2.90	2.80	-0.10	-3.45%					1000	
PFHpA	1.20	1.10	-0.10	-8.33%					1000	
PFOA	2.40	2.60	0.20	8.33%	4		0.0009	2.5991	0.09	2.51
PFNA	0.00	0.75	0.75	n/a	10				0.006	0.744
PFBS	2.10	2.30	0.20	9.52%			400		2000	
PFHxS	0.57	0.56	-0.01	-1.75%	10				0.001	0.559
PFOS	2.10	2.60	0.50	23.81%	4		0.06	2.54	0.3	2.30
PFMPA	0.54	0.00	-0.54	-100.00%					1	
Total PFAS	21.11	21.61	0.50	2.37%						

Non-detect recorded as 0 Downstream Increase Exceed criteria levels

Samples of Old Town Creek taken downstream from the biosolids land application site detected multiple types of PFAS. The PFAS detected at the highest concentrations were PFOA (3.9 ppt) and PFOS (3.1 ppt). The concentrations of PFOA and PFOS in the sample taken downstream from the land application site also exceeded the draft HHWQC (Water + Organism), indicating the concentrations exceeded the levels EPA has identified as being necessary to protect the general population from adverse health effects due to ingesting water, fish, and shellfish from the waterbody. In the downstream sample, PFOA exceeded the draft HHWQC (Water + Organism) of 0.0009 ppt by 3.8991 ppt, and PFOS exceeded the 0.06 ppt criteria by 3.04 ppt. Additionally, PFHxS, PFOA, and PFOS exceeded EWG's health-based criteria. *See Table 38 (below).*

Table 38 | Old Town Creek Downstream from Biosolids Land Application Field

Analyte	Sample (ppt)	MCL (ppt)		EPA (ppt)		EWG (ppt)	
	Downstream	Criteria	Downstream Exceedance	Criteria	Downstream Exceedance	Criteria	Downstream Exceedance
PFBA	1.3					1000	
PFPeA	1.7					1000	
PFHxA	1.7					1000	
PFHpA	0.81					1000	
PFOA	3.9	4		0.0009	3.8991	0.09	3.81
PFBS	1.3			400		2000	
PFHxS	1.5	10				0.001	1.499
PFOS	3.1	4		0.06	3.04	0.3	2.80
Total PFAS	15.31						

Non-detect recorded as 0 | Exceed criteria levels

Long Island Soundkeeper, Naugatuck River, Connecticut
Wastewater Treatment Plant Site

The Naugatuck River Watershed spans 311 square miles and drains into the Naugatuck River, the only major river entirely within Connecticut and the largest tributary of the Housatonic River. Waterbury WPCF is a wastewater treatment system that serves approximately 125,000 residents of Waterbury and three other communities and handles wastewater from industrial dischargers.[216] Within one mile of the Waterbury WPCF, 44% of residents are people of color and 29% are low-income. The WWTP discharges treated wastewater to the Naugatuck River. EPA has identified 38 active PFAS-discharging facilities within the City of Waterbury.[217]

Samples of the Naugatuck River upstream and downstream from Waterbury WPCF outfalls contained multiple types of PFAS. However, the concentrations of seven types of PFAS increased at the downstream site resulting in a total PFAS concentration increase of 4.9 ppt—an increase of 11.78%. For example, the concentration of PFHxA increased from 7.1 ppt to 8.9 ppt (25.35%).

Federally regulated PFAS were also detected downstream at increased levels, including PFOS (8.3 ppt), PFBS (3.1 ppt), and PFHxS (1.7 ppt). However, the concentration of PFOA decreased slightly from 8.1 ppt to 7.8 ppt (3.7% decrease). PFOA exceeded the MCL by 3.8 ppt and PFOS exceeded the MCL by 4.3 ppt, rendering the surface water at this location unsafe for drinking without advanced treatment. PFOA and PFOS also exceeded the draft HHWQC (Water + Organism), indicating the concentrations exceeded the levels EPA has identified as being necessary to protect the general population from adverse health effects due to ingesting water, fish, and shellfish from the waterbody. PFOA, PFNA, PFHxS, and PFOS also exceeded the EWG health-based criteria. *See Table 39 (below).*

Table 39 | Naugatuck River Upstream and Downstream from Waterbury WPCF

Analyte	Sample (ppt)				MCL (ppt)		EPA (ppt)		EWG (ppt)		State DW Action Level (ppt)	
	Upstream	Downstream	Change	% Change	Criteria	Downstream Exceedance	Criteria	Downstream Exceedance	Criteria	Downstream Exceedance	Criteria	Downstream Exceedance
PFBA	3.60	4.80	1.20	33.33%					1000		1800	
PFPeA	6.90	8.10	1.20	17.39%					1000			
PFHxA	7.10	8.90	1.80	25.35%					1000		240	
PFHpA	2.50	2.60	0.10	4.00%					1000			
PFOA	8.10	7.80	-0.30	-3.70%	4	3.80	0.0009	7.7991	0.09	7.71	16	
PFNA	1.50	1.20	-0.30	-20.00%	10				0.006	1.194	12	
PFBS	2.70	3.10	0.40	14.81%			400		2000		760	
PFHxS	1.60	1.70	0.10	6.25%	10				0.001	1.699	49	
PFOS	7.60	8.30	0.70	9.21%	4	4.30	0.06	8.24	0.3	8.00	10	
Total PFAS	41.60	46.50	4.90	11.78%								

Non-detect recorded as 0 | Downstream Increase | Exceed criteria levels

Los Angeles Waterkeeper, Los Angeles River, California
Wastewater Treatment Plant Site

The Los Angeles (LA) River Watershed spans 834 square miles, with the river stretching 51 miles from its headwaters in the Angeles National Forest to the Pacific Ocean in Long Beach. The LA-Glendale WRP is a municipal wastewater treatment system that is co-owned by the Cities of Los Angeles and Glendale, and operated by LA Sanitation, that serves a population of approximately 434,000 residents and handles wastewater from multiple industrial dischargers.[218] Within one mile of the LA River, there are 17 cities, 23 City of LA neighborhoods, and four unincorporated communities, and nearly 1,000,000 residents.[219] Within one mile of the LA-Glendale WRF, 54% of the population are people of color and 39% are low-income. Data for industrial discharges from the LA-Glendale WRF are aggregated with those from three other reclamation plants. In 2021, these four facilities received discharges from 166 permitted industrial users. EPA has identified 23 facilities in the City of Glendale alone as potential sources of PFAS discharges.[220]

Samples of the LA River upstream and downstream from the LA-Glendale WRF outfall contained multiple types of PFAS. However, the concentrations of five types of PFAS increased at the downstream site resulting in a total PFAS concentration increase of 6.01 ppt—an increase of 8.61%. For example, the concentration of PFPeA increased from 12 ppt to 20 ppt (66.67% increase) and the concentration of PFBA increased from 7.8 ppt to 9.8 ppt (25.64% increase).

Federally regulated PFAS were also detected downstream but at decreased concentrations, including PFOA (1.04% decrease) and PFOS (13.24% decrease). However, in the downstream sample, PFOA (9.5 ppt) exceeded the MCL by 5.5 ppt and PFOS (5.9 ppt) exceeded the MCL by 1.9 ppt, indicating the surface water at this location is unsafe for drinking without advanced treatment. Additionally, PFOA exceeded the California Public Health Goal of 0.007 ppt by 9.493 ppt and PFOS exceeded the California Public Health Goal of 1 ppt by 4.9 ppt.[221] PFOA and PFOS also exceeded the draft HHWQC (Water + Organism), indicating the concentrations exceeded the levels EPA has identified as being necessary to protect the general population from adverse health effects due to ingesting water, fish, and shellfish from the waterbody, and PFOA, PFOS, PFDA, and PFHxS exceeded the EWG health-based criteria. *See Table 40 (below).*

Table 40 | Los Angeles River Upstream and Downstream from LA-Glendale WRF

Analyte	Sample (ppt)				MCL (ppt)		EPA (ppt)		EWG (ppt)		CA Public Health Goal (ppt)		CA Notification Level (ppt)	
	▲ Upstream	▼ Downstream	Change	% Change	Criteria	Downstream Exceedance	Criteria	Downstream Exceedance	Criteria	Downstream Exceedance	Criteria	Downstream Exceedance	Criteria	Downstream Exceedance
PFBA	7.80	9.80	2.00	25.64%					1000					
PFPeA	12.00	20.00	8.00	66.67%					1000					
PFHxA	19.00	20.00	1.00	5.26%					1000					
PFHpA	3.10	3.30	0.20	6.45%					1000					
PFOA	9.60	9.50	-0.10	-1.04%	4	5.50	0.0009	9.4991	0.09	9.41	0.007	9.493		
PFNA	1.10	0.00	-1.10	-100.00%	10				0.006					
PFDA	2.00	2.10	0.10	5.00%					0.006	2.094				
PFBS	3.70	2.50	-1.20	-32.43%			400		2000				500	
PFPeS	0.57	0.00	-0.57	-100.00%					1					
PFHxS	3.50	2.70	-0.80	-22.86%	10				0.001	2.699			3	
PFOS	6.80	5.90	-0.90	-13.24%	4	1.90	0.06	5.84	0.3	5.60	1	4.90		
NEtFOSAA	0.62	0.00	-0.62	-100.00%					1					
Total PFAS	69.79	75.80	6.01	8.61%										

Non-detect recorded as 0 Downstream Increase Exceed criteria levels

Narragansett Bay Riverkeeper, Pawtuxet River, Rhode Island
Wastewater Treatment Plant Site

The Pawtuxet River Watershed is the second largest watershed in Rhode Island, covering 231 square miles and it is home to approximately 235,000 residents. The Cranston WPCF is a municipal wastewater treatment system serving around 73,200 residents.[222] Within one mile of the Cranston WPCF, 25% of residents are people of color and 18% are low-income. The facility discharges treated wastewater to the Pawtuxet River. EPA has identified 42 potential PFAS-discharging facilities within Cranston.[223]

Samples of the Pawtuxet River upstream and downstream from WPCF outfalls contained multiple types of PFAS. The concentrations of five types of PFAS slightly increased at the downstream site. However, there was not a significant difference between the two sites, with the downstream site showing a total PFAS concentration increase of 0.6 ppt—an increase of 1.57%. The PFOS concentration decreased slightly by 0.2 ppt.

Federally regulated PFAS were detected downstream, including PFOA (7.7 ppt), PFBS (1.5 ppt), PFOS (4.3 ppt), PFNA (2.1 ppt), and PFHxS (2.3 ppt). PFOA exceeded the MCL by 3.7 ppt and PFOS exceeded the MCL 0.3 ppt, rendering the surface water at this location unsafe for drinking without advanced treatment. However, the PFOA concentration decreased in the downstream duplicate sample and the upstream duplicate concentration was also higher than the downstream primary sample concentration by 0.1 ppt. PFOA and PFOS also exceeded the draft HHWQC (Water + Organism), indicating the concentrations exceeded the levels EPA has identified as being necessary to protect the general population from adverse health effects due to ingesting water, fish, and shellfish from the waterbody, and PFOA, PFNA, PFHxS, and PFOS exceeded the EWG health-based criteria. *See Table 41 (below).*

Table 41 | Pawtuxet River Upstream and Downstream from Cranston WPCF

Analyte	Sample (ppt)				Duplicate Sample (ppt)				MCL (ppt)		EPA (ppt)		EWG (ppt)		RI MCL (ppt)		RI SWQ Action Level (ppt)	
	▲ Upstream	▼ Downstream	Change	% Change	▲ Upstream	▼ Downstream	Change	% Change	Criteria	Downstream Exceedance	Criteria	Downstream Exceedance	Criteria	Downstream Exceedance	Criteria	Downstream Exceedance	Criteria	Downstream Exceedance
PFBA	3.20	3.10	-0.10	-3.13%	3.30	3.20	-0.10	-3.03%					1000				Sum of 8 => 70 ppt	
PFPeA	5.50	5.70	0.20	3.64%	5.40	5.30	-0.10	-1.85%					1000					
PFHxA	7.40	7.20	-0.20	-2.70%	6.70	7.30	0.60	8.96%					1000					
PFHpA	4.80	4.90	0.10	2.08%	4.60	4.90	0.30	6.52%					1000					
PFOA	7.10	7.70	0.60	8.45%	7.80	7.50	-0.30	-3.85%	4	3.70	0.0009	7.6991	0.09	7.61				
PFNA	2.00	2.10	0.10	5.00%	2.00	1.90	-0.10	-5.00%	10				0.006	2.094				
PFBS	1.50	1.50	0.00	0.00%	1.70	1.50	-0.20	-11.76%			400		2000					
PFHxS	2.20	2.30	0.10	4.55%	2.20	2.30	0.10	4.55%	10				0.001	2.299				
PFOS	4.50	4.30	-0.20	-4.44%	4.70	4.30	-0.40	-8.51%	4	0.30	0.06	4.24	0.3	4.00				
Total PFAS	38.20	38.80	0.60	1.57%	38.40	38.20	-0.20	-0.52%										

Non-detect recorded as 0 Downstream Increase Exceed criteria levels

Pearl Riverkeeper, Pearl River, Mississippi
Wastewater Treatment Plant and Biosolids Sites

The Pearl River Basin spans 8,760 square miles in Central and Southern Mississippi and three Louisiana parishes, eventually draining in the Mississippi Sound, Lake Borgne, and the Gulf of Mexico. It is home to nearly one million people, more than one-third of Mississippi's population. There are three WWTPs located near one or more of the locations selected for sampling by Pearl Riverkeeper—Jackson POTW, Savannah Street, West Rankin Utility Authority WWTF, and Jackson POTW, Trahon and Big Creek.[224] Within one mile of the Jackson POTW, Savanna Street, 80% of residents are people of color and 60% are low-income. The EPA has identified 50 potential PFAS-discharging facilities within the City of Jackson.[225]

Pearl Riverkeeper sampled upstream and downstream from two separate outfalls into the Pearl River from Jackson POTW, Savannah Street and West Rankin Utility Authority WWTF. These two outfalls are approximately 1.6 river miles apart. A tributary stream also flows into the Pearl River between the upstream and downstream sampling locations. The upstream sampler was not recovered so no results are available for that location. The sample from the downstream location contained eight types of PFAS. Overall, the total PFAS concentration at the downstream location was 20.71 ppt. PFHxA (4.4 ppt) and PFBA (3.6 ppt) were detected at the highest concentrations. The federally regulated PFAS detected downstream included PFOA (2.9 ppt), PFBS (3 ppt), PFOS (3.5 ppt), PFNA (0.71 ppt), and PFHxS (1.3 ppt). PFOA and PFOS exceeded the draft HHWQC (Water + Organism), indicating the concentrations exceeded the levels EPA has identified as being necessary to protect the general population from adverse health effects due to ingesting water, fish, and shellfish from the waterbody, and PFOA, PFNA, PFHxS, and PFOS exceeded the EWG health-based criteria. *See Table 42 (below)*

Pearl Riverkeeper also collected additional samples at two locations further downstream. One sampling site was located upstream and the other sampling site was

Table 42 | Pearl River Downstream from Jackson POTW, Savanna Street and West Rankin WWTF

Analyte	Sample (ppt)	MCL (ppt)		EPA (ppt)		EWG (ppt)	
	▼ Downstream	Criteria	Downstream Exceedance	Criteria	Downstream Exceedance	Criteria	Downstream Exceedance
PFBA	3.60					1000	
PFHxA	4.40					1000	
PFHpA	1.30					1000	
PFOA	2.90	4		0.0009	2.8991	0.09	2.81
PFNA	0.71					0.006	0.704
PFBS	3.00			400		2000	
PFHxS	1.30	10				0.001	1.299
PFOS	3.50	4		0.06	3.44	0.3	3.20
Total PFAS	20.71						

Non-detect recorded as 0 | Exceed criteria levels

located downstream from where Big Creek enters the Pearl River. One or more of Jackson POTW's biosolids application fields are located in the Big Creek watershed roughly 1.5–2.0 miles from the confluence of Big Creek and the Pearl River. Jackson POTW, Trahon and Big Creek also discharges into Big Creek above the confluence of Big Creek and the Pearl River. Samples of the Pearl River upstream and downstream from the Big Creek confluence contained multiple types of PFAS. The concentrations total PFAS decreased at the downstream site to 30.78 ppt, resulting in a total PFAS concentration decrease of 1.89 ppt (5.79%). However, three types of PFAS increased slightly at the downstream site, including PFPeA at 13 ppt (8.33% increase), PFDA at 0.73 ppt (4.29% increase), and PFOS at 3.6 ppt (9.09% increase).

PFOS (3.6 ppt) was the only federally regulated PFAS detected downstream at a slightly increased concentration. However, PFOA and PFOS both exceeded the draft HHWQC (Water + Organism), indicating the concentrations exceeded the levels EPA has identified as being necessary to protect the general population from adverse health effects due to ingesting water, fish, and shellfish from the waterbody. PFOA, PFDA, PFHxS, and PFOS also exceeded the EWG health-based criteria. *See Table 43 (below).*

Table 43 | Pearl River Upstream and Downstream from the Big Creek Confluence

Analyte	Sample (ppt)				MCL (ppt)		EPA (ppt)		EWG (ppt)	
	▲ Upstream	▼ Downstream	Change	% Change	Criteria	Downstream Exceedance	Criteria	Downstream Exceedance	Criteria	Downstream Exceedance
PFBA	4.2	3.8	-0.40	-9.52%					1000	
PFPeA	12	13	1.00	8.33%					1000	
PFHxA	3.2	3.2	0.00	0.00%					1000	
PFHpA	1.2	1.0	-0.20	-16.67%					1000	
PFOA	3.3	2.8	-0.50	-15.15%	4		0.0009	2.7991	0.09	2.71
PFNA	0.67	0.00	-0.67	-100.00%	10				0.006	
PFDA	0.70	0.73	0.03	4.29%					0.006	0.724
PFBS	3.1	1.7	-1.40	-45.16%	400				2000	
PFHxS	1.0	0.95	-0.05	-5.00%	10				0.001	0.949
PFOS	3.3	3.6	0.30	9.09%	4		0.06	3.54	0.3	3.30
Total PFAS	32.67	30.78	-1.89	-5.79%						

Non-detect recorded as 0 | Downstream Increase | Exceed criteria levels

Tampa Bay Waterkeeper, East Canal, Florida
Wastewater Treatment Plant Site

The Hillsborough River Watershed covers more than 675 square miles, including the City of Tampa. East Canal is a tributary to Itchepackesassa Creek, which flows into the Hillsborough River and, ultimately, into Hillsborough Bay. Plant City WRF, a municipal wastewater treatment system, owned and operated by the City of Plant City, serves a population of approximately 40,000 residents and discharges into the East Canal.[226] EPA has identified 27 potential PFAS-discharging facilities within Plant City.[227] Within one mile of the Plant City WRF, 58% of residents are people of color and 50% are low-income.

Samples of the East Canal taken downstream from a Plant City WRF outfall detected ten types of PFAS. PFBA (9 ppt), PFPeA (9.9 ppt), and PFOS (11 ppt) were detected at the highest concentrations. The downstream site had a total PFAS concentration of 58.91 ppt. Upstream samples were not collected. Federally regulated PFAS were detected at the downstream sampling site, including PFOA, PFNA, PFHxS, PFBS, and PFOS. PFOA (7.1 ppt) exceeded the MCL by 3.1 ppt, and PFOS exceeded the MCL by 7 ppt, rendering the surface water at this location unsafe for drinking without advanced treatment. PFOA and PFOS exceeded the draft HHWQC (Water + Organism), indicating the concentrations exceeded the levels EPA has identified as being necessary to protect the general population from adverse health effects due to ingesting water, fish, and shellfish from the waterbody. PFOA, PFNA, PFHxS, and PFOS also exceeded the EWG health-based criteria. *See Table 44 (below).*

Table 44 | East Canal Downstream from Plant City WRF

Analyte	Sample (ppt)	MCL (ppt)		EPA (ppt)		EWG (ppt)		State Surface WQ HH Screening (ppt)	
	▼ Downstream	Criteria	Downstream Exceedance	Criteria	Downstream Exceedance	Criteria	Downstream Exceedance	Criteria	Downstream Exceedance
PFBA	9.00					1000			
PFPeA	9.90					1000			
PFHxA	6.30					1000			
PFHpA	3.70					1000			
PFOA	7.10	4	3.10	0.0009	7.0991	0.09	7.01	500	
PFNA	1.30	10				0.006	1.294		
PFBS	6.00			400		2000			
PFPeS	0.71					1			
PFHxS	3.90	10				0.001	3.899		
PFOS	11.00	4	7.00	0.06	10.94	0.3	10.70	10	1.00
Total PFAS	58.91								

Non-detect recorded as 0 | Exceed criteria levels

Upper Potomac Riverkeeper, Opequon Creek and Back Creek, West Virginia
Wastewater Treatment Plant and Biosolids Sites

The Opequon Creek Watershed spans approximately 341 square miles across West Virginia and Virginia, with more than half of its area located in West Virginia. Opequon Creek flows into the Potomac River near Martinsburg, West Virginia. The Back Creek Watershed covers 374 square miles in Virginia and West Virginia, before flowing into the Potomac River near Allensville., West Virginia. Berkeley County operates four sewage treatment and collection systems pursuant to NPDES Permit WV0082759. One of those systems, Berkeley County PSSD – Inwood WWTP (Outlet 002) serves a population of 17,500 residents and discharges to Opequon Creek.[228] Of those living within one mile of Inwood WWTP, 13% are people of color and 20% are low income. EPA has identified 2 potential PFAS-discharging facilities within Inwood involving Chemical Manufacturing, Paints and Coatings, and Cleaning Products Manufacturing industries, however, its appears from the NPDES permit that these facilities discharge into a different Berkeley County PSSD facility.[229]

Samples of Opequon Creek upstream and downstream from an Inwood WWTP outfall contained multiple types of PFAS. While PFPeA, PFHxA, PFOA, and PFBS increased slightly downstream from the WWTP, PFOS slightly decreased, resulting in a total PFAS concentration increase of 1.8 ppt—an increase of 3.99%. Only PFPeA and PFBS increased by more than 1 ppt.

Regulated PFAS were detected in the downstream samples, including PFOA (4.1 ppt), PFHxS (3 ppt), PFBS (9.3 ppt), and PFOS (4.9 ppt). PFOA exceeded the MCL by 0.1 ppt and PFOS exceeded the MCL by 0.9 ppt, rendering the surface water at this location unsafe for drinking without advanced treatment. PFOA and PFOS also exceeded the draft HHWQC (Water + Organism), indicating the concentrations exceeded the levels EPA has identified as being necessary to protect the general population from adverse health effects due to ingesting water, fish, and shellfish from the waterbody. PFOA, PFHxS, PFOS, and 8:2 FTS also exceeded the EWG health-based criteria. *See Table 45 (below).*

Table 45 | Opequon Creek Upstream and Downstream from Berkeley County PSSD – Inwood WWTP

Analyte	Sample (ppt)				MCL (ppt)		EPA (ppt)		EWG (ppt)	
	▲ Upstream	▼ Downstream	Change	% Change	Criteria	Downstream Exceedance	Criteria	Downstream Exceedance	Criteria	Downstream Exceedance
PFBA	3.50	3.40	-0.10	-2.86%					1000	
PFPeA	7.90	9.30	1.40	17.72%					1000	
PFHxA	6.50	7.20	0.70	10.77%					1000	
PFHpA	1.60	1.40	-0.20	-12.50%					1000	
PFOA	3.50	4.10	0.60	17.14%	4	0.10	0.0009	4.0991	0.09	4.01
PFBS	8.00	9.30	1.30	16.25%			400		2000	
PFHxS	3.30	3.00	-0.30	-9.09%	10				0.001	2.999
PFOS	5.30	4.90	-0.40	-7.55%	4	0.90	0.06	4.84	0.3	4.60
8:2 FTS	5.50	4.30	-1.20	-21.82%					1	3.30
Total PFAS	45.10	46.90	1.80	3.99%						

Non-detect recorded as 0 | Downstream Increase | Exceed criteria levels

Berkeley County PSSD is permitted to land-apply biosolids produced at its sewage collection and treatment systems.[230] Specifically, it is permitted to apply biosolids on fields at 11 agricultural sites at a maximum annual loading rate of 1.5 tons/acre. PFAS sampling was conducted upstream and downstream from the Dehaven Farm, one of Berkeley County PSSD's land application sites, located in the Back Creek watershed.

Samples of Back Creek upstream and downstream from the Dehaven biosolids land application site contained multiple types of PFAS. However, the concentrations of four types of PFAS increased slightly at the downstream site resulting in a total PFAS concentration increase of 0.61 ppt–an increase of 4.74%. For example, the concentration of PFPeA increased from a non-detect to 1.4 ppt.

Federally regulated PFAS were also detected in downstream samples, including PFOA (2 ppt), PFBS (1.7 ppt), PFHxS (1.8 ppt), and PFOS (2.1 ppt). PFOS and PFBS concentrations decreased slightly at the downstream site. PFOA and PFOS exceeded the draft HHWQC (Water + Organism), indicating the concentrations exceeded the levels EPA has identified as being necessary to protect the general population from adverse health effects due to ingesting water, fish, and shellfish from the waterbody. PFOA, PFHxS, and PFOS also exceeded the EWG health-based criteria. *See Table 46 (below).*

Table 46 | Back Creek Upstream and Downstream from Biosolids Land Application Fields

Analyte	Sample (ppt)				Duplicate Sample (ppt)				MCL (ppt)		EPA (ppt)		EWG (ppt)	
	▲ Upstream	▼ Downstream	Change	% Change	▲ Upstream	▼ Downstream	Change	% Change	Criteria	Downstream Exceedance	Criteria	Downstream Exceedance	Criteria	Downstream Exceedance
PFBA	2.3	1.9	-0.40	-17.39%	1.9	2.5	0.60	31.58%					1000	
PFPeA	0.00	1.4	1.40	n/a	0.00	0.00	0.00	0.00%					1000	
PFHxA	1.8	1.7	-0.10	-5.56%	1.5	3.1	1.60	106.67%					1000	
PFHpA	0.86	0.87	0.01	1.16%	0.83	1.0	0.17	20.48%					1000	
PFOA	1.9	2.0	0.10	5.26%	2.3	2.2	-0.10	-4.35%	4		0.0009	1.9991	0.09	1.91
PFBS	2.3	1.7	-0.60	-26.09%	2.0	2.5	0.50	25.00%			400		2000	
PFHxS	1.4	1.8	0.40	28.57%	2.5	2.2	-0.30	-12.00%	10				0.001	1.799
PFOS	2.3	2.1	-0.20	-8.70%	3.2	2.7	-0.50	-15.63%	4		0.06	2.04	0.3	1.80
Total PFAS	12.86	13.47	0.61	4.74%	14.23	16.2	1.97	13.84%						

Non-detect recorded as 0 Downstream Increase Exceed criteria levels

West Virginia Headwaters Waterkeeper, Ohio River, West Virginia
Wastewater Treatment Plant Site

The Ohio River's drainage basin covers 204,000 square miles, including most of West Virginia. The river flows 981 miles, providing drinking water to over five million people and handles wastewater from several industrial dischargers. The Parkersburg Utility Board WWTP serves approximately 100,000 residents.[231] Within one mile of the Parkersburg WWTP, 8% of residents are people of color and 56% are low-income. The facility discharges treated wastewater to the Ohio River. The EPA has identified 22 potential PFAS-discharging facilities within Parkersburg.[232]

Samples of the Ohio River upstream and downstream from a Parkersburg WWTP outfall contained multiple types of PFAS. However, only the concentration of PFBS increased slightly in the downstream sample. Federally regulated PFAS were detected downstream, including PFOA (3.4 ppt), PFNA (0.67 ppt), PFBS (1.6 ppt), PFHxS (0.99 ppt), and PFOS (3.1 ppt). PFOA and PFOS exceeded the draft HHWQC (Water + Organism), indicating the concentrations exceeded the levels EPA has identified as being necessary to protect the general population from adverse health effects due to ingesting water, fish, and shellfish from the waterbody. PFOA, PFNA, PFHxS, and PFOS also exceeded the EWG health-based criteria. *See Table 47 (below).*

Table 47 | Ohio River Upstream and Downstream from Parkersburg WWTP

Analyte	Sample (ppt)				MCL (ppt)		EPA (ppt)		EWG (ppt)	
	▲ Upstream	▼ Downstream	Change	% Change	Criteria	Downstream Exceedance	Criteria	Downstream Exceedance	Criteria	Downstream Exceedance
PFBA	3.10	3.00	-0.10	-3.23%					1000	
PFPeA	2.70	2.60	-0.10	-3.70%					1000	
PFHxA	2.60	2.40	-0.20	-7.69%					1000	
PFHpA	1.10	1.10	0.00	0.00%					1000	
PFOA	4.10	3.40	-0.70	-17.07%	4		0.0009	3.3991	0.09	3.31
PFNA	0.85	0.67	-0.18	-21.18%	10				0.006	0.664
PFDA	0.55	0.00	-0.55	-100.00%					0.006	
PFBS	1.50	1.60	0.10	6.67%			400		2000	
PFHxS	1.10	0.99	-0.11	-10.00%	10				0.001	0.989
PFOS	3.90	3.10	-0.80	-20.51%	4		0.06	3.04	0.3	2.80
HFPO-DA (GenX)	0.45	0.00	-0.45	-100.00%	10				9	
Total PFAS	21.95	18.86	-3.09	-14.08%						

Non-detect recorded as 0 Downstream Increase Exceed criteria levels

POLICY RECOMMENDATIONS

PFAS pose significant societal risks, including health issues, environmental contamination, and economic costs, particularly affecting disadvantaged communities. It is essential that PFAS is addressed by the government at both the federal, state, and tribal government levels. The following recommendations propose reforms that policymakers can adopt to prevent or mitigate PFAS pollution.

Federal Administrative Policy Reforms

Absent comprehensive reform, industry accountability, and substantial investment of federal funds to support affected communities, the short- and long-term harms of PFAS pollution will continue to grow. In May 2025, despite the urgent need for federal action, EPA announced plans to weaken existing national drinking water standards for PFAS. Specifically, the agency proposed rescinding standards for PFHxS, PFNA, and GenX (HFPO-DA), as well as the hazard index that includes those chemicals and PFBS. It also signaled delays in compliance deadlines and new industry loopholes for PFOA and PFOS.

Rather than weakening protections, EPA must finalize, adopt, and enforce pending reforms—including the draft HHWQC—to help stem the accumulation of PFAS in the nation's waterways.

Given the well-documented health risks, environmental persistence, and widespread presence of PFAS in surface waters, EPA must regulate these substances as a class rather than individually. This will prevent industries from shifting to unregulated but equally harmful alternatives. Production and use of PFAS should be phased out entirely. The federal government should also ban the land application of biosolids containing PFAS to stop their spread into the food chain.

At a minimum, EPA should lead a coordinated federal response to help state, tribal, and local governments address the public health emergency posed by PFAS. This must include the adoption of effluent limitation guidelines and pretreatment standards for industrial dischargers; enforceable drinking water limits for all PFAS under the SDWA; and national water quality criteria to protect both people and aquatic life under the CWA.

Where effluent guidelines are not yet in place, technology-based discharge limits must be developed using best professional judgment. Funding for wastewater treatment must increase to keep PFAS from being released into surface waters that are used for private and public drinking water, recreation, and fish/shellfish consumption.

Finally, the federal government must expand monitoring of PFAS in surface water, groundwater, and drinking water; strengthen health surveillance; advance scientific research; restore essential monitoring programs; and provide direct assistance to impacted communities—especially in rural areas with high levels of contamination.

Congressional Policy Reforms

Congress must take action to lessen PFAS' current impact on the public and adopt policies that will create a lasting difference. Several measures focused on funding, research, or regulatory oversight have already been introduced in Congress that, if passed, would improve public health outcomes related to PFAS.

Congress must provide increased funding for wastewater treatment facilities to update their systems to prevent PFAS from returning to the water supply. Congress also needs to provide funding for communities and individuals directly impacted by the failure to protect them from PFAS. As one example, H.R.1517, the Relief for Farmers Hit with PFAS Act, directs the Department of Agriculture to create a grant program to support financial assistance for farmers impacted by PFAS.[233] Farmers are especially impacted by the land application of biosolids to their fields.

Measures focused on regulatory improvements would lead to a more comprehensive governmental approach to PFAS. This includes reintroduction of the bipartisan, bicameral Clean Water Standards for PFAS Act, which requires EPA to develop water criteria for PFAS under the Clean Water Act, provides the agency with an achievable roadmap to establish ELGs and standards for eight priority industry categories for all measurable PFAS or classes of PFAS within three years, and includes significant federal support to assist communities in upgrading their municipal water infrastructure in order to safeguard public health and protect ratepayers.[234] S.820, the Protecting Consumers from PFAS Act, which would add the Consumer Product Safety Commission to the list of agencies required to be represented on the PFAS interagency working group, or H.R.5356, the PFAS Act, which would require the Secretary of Transportation to establish a PFAS replacement program at certain airports.

Congress must also fund and implement more strategic and coordinated monitoring of surface waters, groundwater, and drinking water supplies. H.R.5259, the PFAS Exposure Assessment and Documentation Act, shows how the government can invest in testing for PFAS in humans and working with individuals and healthcare systems to educate them and monitor for future risks. More funding is needed for all communities for this kind of health care.

State Policy Reforms

In 2023, at least 23 states passed 50 bills related to PFAS and, in 2024, at least 17 states passed more than 40 bills related to PFAS.[235] Sixteen states have started phasing out or restricting PFAS in various products, including apparel, carpets, cleaning products, cookware, dental floss, fire-fighting foam, food packaging, menstrual products, and personal care items.[236] Maine has enacted legislation to phase out the sale of products containing PFAS, and offers financial support to impacted farmers. Minnesota passed a measure prohibiting the use of PFAS in certain consumer products and food packaging. Michigan and New Jersey have established grants to provide financial assistance for addressing PFAS contamination in drinking water systems, and in 2020, New Jersey set drinking water standards for PFOA and PFOS. Additionally, California has banned the use of PFAS in food packaging and products intended for infants and children. In 2020, New Jersey set drinking water standards for PFOA and PFOS.

Several states have recently adopted prohibitions, strategies, or standards for biosolids testing and/or land application, including, relevant to this report, Connecticut, Maryland, Michigan, New York, and Wisconsin.[237] Numerous states have also adopted regulatory standards to control PFAS in surface waters. *See Table 12 (p. 39).* For example, California has established Public Health Goals (PHGs) for certain classes of PFAS that are more stringent than EPA's MCLs. While PHGs are nonregulatory, the State Water Resources Control Board uses them as a reference when determining the state's primary drinking water standards and MCLs.[238] New Jersey is conducting a study to assess the feasibility of establishing standards, such as MCLs, for the entire class or specific subclasses or mixtures of PFAS in drinking water, rather than for each substance individually.[239]

States should not wait for the federal government to act on PFAS; they can draw on existing solutions and take swift, decisive action on this critical issue.

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6 This project is focused on WWTPs that collect and treat wastewater from domestic sewage, commercial businesses, and industries. See *Municipal Wastewater*, EPA www.epa.gov/npdes/municipal-wastewater (Apr. 19, 2024). These facilities are commonly referred to as municipal WWTPs (WWTPs), Sewage Treatment Plants (STPs), water resource recovery facilities (WRRF), publicly owned treatment works (POTWs), and similar names.

7 EPA, Information Collection Request 2799.01, Supporting Statement B, Publicly Owned Treatment Works (POTW) Influent Per- and Polyfluoroalkyl Substances (PFAS) Study and National Sewage Sludge Survey (NSSS) 1-2 ("[t]here are over 50 industrial categories regulated by Effluent Limitations Guidelines and Standards (ELGs) that do not have any PFAS requirements and additional industries that the EPA has determined historically or currently use PFAS but for which insufficient PFAS monitoring data has been identified.") (2024) www.epa.gov/system/files/documents/2024-10/pfas_potw-icr-supporting-statement-b.pdf.

8 In National Pollutant Discharge Elimination System (NPDES) permits under the Clean Water Act, 33 U.S.C. §§ 1251 *et seq.*, "[e]ffluent limitations serve as the primary mechanism… for controlling discharges of pollutants to receiving waters. When developing effluent limitations for an NPDES permit, a permit writer must consider limits based on both the technology available to control the pollutants (i.e., technology-based effluent limits) and limits that are protective of the water quality standards of the receiving water (i.e., water quality-based effluent limits)." *NPDES Permit Limits*, EPA, www.epa.gov/npdes/npdes-permit-limits (Sept. 16, 2024).

9 Under the Clean Water Act, "[p]retreatment standards are pollutant discharge limits which apply to industrial users [that discharge into municipal WWTPs]… [and] can be expressed as numeric limits, narrative prohibitions, and best management practices (BMPs)." *Pretreatment Standards and Requirements-Applicability*, EPA, www.epa.gov/npdes/pretreatment-standards-and-requirements-applicability (Sept. 16, 2024).

10 EPA, Information Collection Request 2799.01, Supporting Statement A, POTW Influent Per- and Polyfluoroalkyl Substances (PFAS) Study and National Sewage Sludge Survey (NSSS) 2 (2024) www.epa.gov/system/files/documents/2024-10/pfas_potw-icr-supporting-statement-a.pdf. ("The EPA has not established national technology-based numeric standards for PFAS in wastewater discharges and few states have developed water quality standards for PFAS. Therefore, few industrial facilities have PFAS monitoring requirements, effluent limitations, or pretreatment standards for wastewater discharges.")

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13 See, *e.g.*, EPA, Draft Sewage Sludge Risk Assessment for Perfluorooctanoic Acid (PFOA) CASRN 335-67-1 and Perfluorooctane Sulfonic Acid (PFOS) CASRN 1763-23-1, at 4 (2025), www.epa.gov/system/files/documents/2025-01/draft-sewage-sludge-risk-assessment-pfoa-pfos.pdf.

14 Kelly Hunter Foster & Daniel E. Estrin, Waterkeeper Alliance, Invisible Unbreakable Unnatural: PFAS Contamination of U.S. Surface Waters 7 (2022), waterkeeper.org/wp-content/uploads/2022/10/Waterkeeper-Alliance-PFAS-Report-FINAL-10.14.22.pdf.

15 *Id.* at 9.

16 We were able to obtain samples upstream and downstream from 20 WWTPs and 9 sludge land application fields. At two WWTPs and one sludge land application field, we were only able to obtain downstream samples.

17 EPA, Method 1633, Revision A, Analysis of Per- and Polyfluoroalkyl Substances (PFAS) in Aqueous, Solid, Biosolids, and Tissue Samples by LC-MS/MS (2024), www.epa.gov/system/files/documents/2024-12/method-1633a-december-5-2024-508-compliant.pdf (items previously posted in an errata table are addressed in the December 2024 version of EPA Method 1633A).

18 An equilibrium concentration reflects the point where the amount of PFAS in the sampled medium (here, it is surface water) and the sampler are in balance. See Blessing Medon et. al., *A Field-Validated Equilibrium Passive Sampler for the Monitoring of Per- and Polyfluoroalkyl Substances (PFAS) in Sediment Pore Water and Surface Water*, 25 Env't Sci.: Processes & Impacts 980, 981 (2023) pubs.rsc.org/en/content/articlepdf/2023/em/d2em00483f ("In passive sampling, the amount of analyte accumulated in the sampler increases with time until a dynamic equilibrium is established between the receiving phase and the sampled environment.… [T]he concentration of the analyte in the sampled medium is calculated based on the equilibrium partitioning of the analyte between the receiving phase and the sampled medium."); *see also PFASsive*™, Eurofins, www.eurofinsus.com/environment-testing/pfas-testing/services/passive-sampling/ (last visited Mar. 27, 2025) ("PFASsive™ can be used to provide critical data for fate and risk assessments, toxicity identification and remediation design and/or monitoring that is more representative than conventional grab samples as it quantifies contaminants only in the dissolved form.").

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20 33 U.S.C. §§ 1251 et seq.

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35 Hiroko Tabuchi, The EPA Promotes Toxic Fertilizer. 3M told It of Risks Years Ago., N.Y. Times www.nytimes.com/2024/12/27/climate/epa-pfas-fertilizer-3m-forever-chemicals.html?unlocked_article_code=1.104.iE0j.fBMcId1eDgGp&smid=nytcore-ios-share&referringSource=articleShare (Jan. 2, 2025).

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37 One sludge land application site, Virginia's Old Town Creek, did not have an upstream sample but significant concentrations were detected in the downstream sample. Two WWTP sites did not have upstream samples, Florida's East Canal and Mississippi's Pearl River, but significant concentrations were detected in both of the downstream samples.

38 See "Table 3: U.S. EPA Method 1633 Target Analytes" *(p. 19)*, for the unabbreviated scientific name for each type of PFAS discussed in this report.

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44 Devices upstream from the WWTPs located on Florida's East Canal and Mississippi's Pearl River were not retrieved.

45 An upstream device was not placed above one sludge land application site located on Virginia's Old Town Creek.

46 The deployment period extended over 20 or more days for all samplers. The method requires a deployment date of at least 14 days to reach equilibrium. See *supra* note 18.

47 See *Invisible Unbreakable Unnatural*, Waterkeeper All., waterkeeper.org/pfas/ (last visited Mar. 28, 2025).

48 See *Per- and Polyfluoroalkyl Substances (PFAS)*, *supra* note 29; Human Health Water Quality Criteria for PFAS, *supra* note 32.

49 See *Gatz*, *supra* note 21.

50 See *Tabuchi*, *supra* note 35.

51 See *Mapping the PFAS Contamination Crisis, supra* note 27.

52 See *State Legislation and Federal Action*, *supra* note 28.

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63 Where a duplicate sample was obtained, the highest value for each analyte is reported.

64 Includes all downstream sample results where the downstream value exceeded the upstream value. No upstream sample was taken on Old Town Creek. Where a duplicate sample was obtained, the highest value for each analyte is reported.

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66 See *Designation of PFOA and PFOS as Hazardous Substances, supra* note 30

67 See *Per- and Polyfluoroalkyl Substances (PFAS), supra note 29*

68 *Id.*

69 Anna Reade, *The Scientific Basis for Managing PFAS as a Chemical Class*, Nat. Res. Def. Council (June 30, 2020), www.nrdc.org/bio/anna-reade/scientific-basis-managing-pfas-chemical-class; *see generally* Kwiatkowski, *supra* note 1.

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103 See *generally* N.C. Dep't of Env't Quality, Final NPDES Permit Renewal, Graham WWTP (2022), edocs.deq.nc.gov/WaterResources/DocView.aspx?id=2229270&dbid=0&repo=WaterResources&searchid=9ad699aa-ee4a-4ae7-8bef-2aa5458fd591.

104 See *PFAS Analytic Tools*, *supra* note 53.

105 *Emerging Compound Facility Sampling*, N.C. Dep't of Env't Quality, ncdenr.maps.arcgis.com/apps/instant/attachmentviewer/index.html?appid=ed308373c97e4a23a29210fa53a3d404 (last visited Nov. 19, 2024).

106 See *generally* City of Graham, City of Graham Land Application 2023 Annual Report (2023) edocs.deq.nc.gov/WaterResources/DocView.aspx?id=3175263&dbid=0&repo=WaterResources&searchid=68b0599d-be54-455f-82c7-0190f3f48ec0.

107 *Id.* at § 1, at 1.

108 *Biosolids Facility Report: City Of Graham*, EPA ECHO, echo.epa.gov/biosolids-facility-report?id=NCL021211 (last visited Jan. 3, 2025).

109 See *Our Wastewater System*, Great Lakes Water Auth., www.glwater.org/our-system/wastewater-system (last visited Nov. 15, 2024).

110 GLWA WRRFdischarges from three outfalls, only one of which discharges to Rouge River (Outfall 050). According to the facility's NPDES permit, GLWA WRRF may not discharge from Outfall 050 "unless hydraulically or structurally necessary." Mich. Dep't of Env't, Great Lakes, and Energy, NPDES Permit No. MI0022802, at 10 (2019), jeffersonchalmerswaterproject.org/323_m_NPDES%20Permit%20-%20FINAL-GLWA%20WRRF.pdf.

111 Great Lakes Water Auth., Wastewater Master Plan 7-1 (2020), glwa.wpenginepowered.com/wp-content/uploads/2020/12/Full_WWMP_Report_Final_June-2020.pdf.

112 *Detailed Facility Report: GLWA Water Resource Recovery Facility*, EPA ECHO, echo.epa.gov/detailed-facility-report?fid=110000555435&ej_type=sup&ej_compare=US (last visited Jan. 3, 2025).

113 *Id.* ECHO statistics last reviewed January 3, 2025.

114 Mich. Dep't of Env't, Great Lakes, and Energy, NPDES PERMIT NO. MI0022802, at 44 (2019), jeffersonchalmerswaterproject.org/323_m_NPDES%20Permit%20-%20FINAL-GLWA%20WRRF.pdf. As of 2024, the State of Michigan has set a WQS for PFOS at 11 ppt and a WQBEL for PFOA at 8,040 ppt. See Great Lakes Water Auth., Status Report—Pollutant Minimization and Source Evaluation Program for PFOS and PFOA 2 (2024), glwa.wpenginepowered.com/wp-content/uploads/2024/09/PFOA_PFOS-Minimization-Program-May-2024.pdf.

115 Great Lakes Water Auth., IPP Rules_2024, *supra* note 54 at 16

116 See *generally* Great Lakes Water Auth., Status Report—Pollutant Minimization and Source Evaluation Program for PFOS and PFOA, *supra* note 114

117 *Id.* at attach. 1. GLWA WRRF defines a "Significant Source" as one where "PFAS-based compounds were identified or used in their processes, or PFOS and/or PFOA concentrations exceed EGLE's Water Quality Standards (WQS) of 11 [ppt] (PFOS) or 420 [ppt] (PFOA) from one or more sampling events." *Id.* at 5. The facility classifies a facility as a "Potential Source" "where at least one sample result exceeds EGLE's Water Quality Standards." *Id.* at 6.

118 See *PFAS Analytic Tools*, *supra* note 53.

119 Evaluation of PFAS in Influent, Effluent, and Residuals of Wastewater Treatment Plants (WWTPs) in Michigan, EGLE, Project Number: 60588767 (Apr. 2021), https://www.michigan.gov/egle/-/media/Project/Websites/egle/Documents/Programs/WRD/IPP/pfas-initiatives-statewide-full-report.pdf?rev=90923004ae6448c9a17f0e1f4b3d90de&hash=AB84F5CFA197AC923AC4F51717F75085.

120 See *Status Report—Pollutant Minimization and Source Evaluation Program*, *supra* note 114, at 7.

121 See *id.* at attach. 2.

122 A cement plant with an average facility flow of 0.0031 MGD in 2024 (St. Marys Cement - Permit No. MI0004243) and a Combined Sewer Overflow outlet with no reported overflow events in 2024 (Wayne Country Rouge River CSO RTB - Permit No. MI0028819) also discharge to this part of the Rouge River. See Pollutant Loading Report (DMR), St. Marys Cement, EPA ECHO, https://echo.epa.gov/trends/loading-tool/reports/dmr-pollutant-loading?permit_id=MI0004243&year=2024 (last visited June 14, 2025); MiEnviro Portal CSO/SSO List, Mich. Env., Great Lakes, and Energy, https://mienviro.michigan.gov/ncore/external/overflow/list (last visited June 14, 2025).

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125 *Id.*

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127 *Detailed Facility Report: Frederick WWTP*, EPA ECHO, https://echo.epa.gov/detailed-facility-report?fid=110000557166 (last visited June 14, 2025). ECHO statistics last reviewed June 14, 2025.

128 Industrial Pretreatment Ordinance (Amended by Ordinance G-15-08), City of Frederick, MD, https://www.cityoffrederickmd.gov/DocumentCenter/View/4901/G-15-08-Concerning-Industrial-Pretreatment?bidId= (last visited June 14, 2025).

129 See *PFAS Analytic Tools*, *supra* note 53.

130 Map of Land Application Permits for Biosolids in Maryland, Potomac Riverkeeper Network, https://www.potomacriverkeepernetwork.org/md-biosolids-permit-app-map/ (last visited June 17, 2025); Nutrient Management Plan Update, CA 37: Baungartner & Zack Property, Synagro Permit No. 2017-SAG-5979 (Sept. 17, 2021), https://mdedataviewer.mde.state.md.us/OpenDataDocuments?ID=2216012.

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132 Or. Dep't of Env't Quality, NPDES Permit Renewal Fact Sheet Clean Water Services 10 (2022), ormswd2.synergydcs.com/HPRMWebDrawer/RecordView/6369437.

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135 *Id.* ECHO statistics last reviewed January 16, 2025.

136 Clean Water Servs., 2022 Annual Report 2, 3 (2022), cleanwaterservices.org/wp-content/uploads/2023/05/2022-NPDES-Annual-Report-Pretreatment-Program.pdf.

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141 See *NPDES Permit Renewal Fact Sheet Clean Water Services*, *supra* note 132, at 10.

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146 *Id.* ECHO statistics last reviewed January 3, 2025.

147 See *generally* Cal. Reg'l Water Quality Control Bd., Renewal of Waste Discharge and Producer/User Reclamation Requirements for the Riverside RWQCP (2013), https://www.waterboards.ca.gov/santaana/board_decisions/adopted_orders/orders/2013_orders.html

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154 *Notification Level Issuance,* Cal. Water Bds., www.waterboards.ca.gov/drinking_water/programs/documents/PFHxS-issuance.pdf (last visited April 7, 2025).

155 City of Waukesha, Permit Fact Sheet 1 (2019), dnr.wisconsin.gov/sites/default/files/topic/WaterUse/Waukesha/WaukeshaWPDESPermitFactsheet.pdf.

156 Wis. Dep't of Nat. Res., WPDES Permit 14 (2019), dnr.wisconsin.gov/sites/default/files/topic/WaterUse/Waukesha/WaukeshaWPDESPermit.pdf.

157 City of Waukesha, Description of Process 2 (2023), webfile.waukesha-wi.gov/waukesha/Document_Center/Government/Clean%20Water/Description%20of%20Water%20Treatment%20Process%20(PDF).pdf.

158 *Detailed Facility Report: Waukesha WWTP*, EPA ECHO, https://echo.epa.gov/detailed-facility-report?fid=110000555097 (last visited Jan. 3, 2025).

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160 *See generally WPDES Permit*, *supra* note 155 and 156.

161 See *PFAS Analytic Tools*, *supra* note 53.

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164 City of Spokane Pub. Works, Application for Renewal of NPDES Municipal Wastewater Discharge Permit 2 (2021), apps.ecology.wa.gov/paris/DownloadDocument.aspx?Id=357285. *Note: This is a Direct Download Link*

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169 See *PFAS Exposure Assessment: Spokane County, Washington*, Agency for Toxic Substances and Disease Registry (Nov. 12, 2024), https://www.atsdr.cdc.gov/pfas/exposure-assessments/spokane-county-washington.html

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179 For purposes of analysis, "regulated" in the section references federal regulations, and does not address the range of state regulations of PFAS.

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187 *Id.* ECHO statistics last reviewed January 3, 2025.

188 See Jefferson Cnty. Comm'n, *Pretreatment Program Final*, *in* Jefferson County Environmental Services Department Capacity, Management, Operations and Maintenance (CMOM) Program 2 (2022), www.jccal.org/Sites/Jefferson_County/Documents/Environmental%20Services/2022%20CMOM%20Program%20Plan%20Combined-09152023.pdf.

189 See *generally* Jefferson Cnty. Comm'n, NPDES Permit Application (2017), *supra* note 184.

190 See *generally* Final Permit Modification, *supra* note 185; *see also* Ala. Dep't of Env't Mgmt., Draft Permit, Valley Creek WRF (2023), lf.adem.alabama.gov/WebLink/DocView.aspx?id=105000175&dbid=0&cr=1.

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193 See Jefferson Cnty. Comm'n, 2021 Beneficial Use of By-Product Material, Annual Reporting and Applications 2 (2022), lf.adem.alabama.gov/WebLink/DocView.aspx?id=104822881&dbid=0.

194 See *Ala. Dep't of Env't Mgmt.*, *Final Permit Modification*, *supra* note 185; Draft Permit, Valley Creek WRF (2023), *supra* note 190.

195 Upon retrieval, the primary downstream sampling device was found to be buried below roughly 4 inches of sediment. The duplicate sample was not buried in sediment at the time of retrieval. This likely accounts for the differences in analytical results between the primary and duplicate downstream samples.

196 Demographic information in this section is sourced from data obtained through EPA EJScreen, see EJScreen *supra* note 40.

197 Detailed Facility Report: Homestead WWTP, EPA ECHO, https://echo.epa.gov/detailed-facility-report?fid=110033926278 (last visited June 17, 2025).

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200 Detailed Facility Report: R.M. Clayton WRC, EPA, ECHO, https://echo.epa.gov/detailed-facility-report?fid=110011331022&ej_type=sup&ej_compare=US (last visited June 17, 2025).; Detailed Facility Report: City of Atlanta CSO West Area, https://echo.epa.gov/detailed-facility-report?fid=110020834533 (last visited June 17, 2025); Detailed Facility Report: R.L. Sutton WRF, https://echo.epa.gov/detailed-facility-report?fid=110009358015 (last visited June 17, 2025). The sampling sites were also upstream and downstream from two industrial stormwater outfalls associated with an asphalt plant.

201 See *PFAS Analytic Tools*, *supra* note 53.

202 Detailed Facility Report: Rainbow City WWTP, https://echo.epa.gov/detailed-facility-report?fid=110055974147 (last visited June 17, 2025).

203 Nutrient Managment Plan for the Land Application of Municipal Biosolids From: Utilities Board of Rainbow City, AL, Denali Water Solutions, (Aug. 2023), https://lf.adem.alabama.gov/WebLink/DocView.aspx?id=105181103&dbid=0&cr=1

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205 Detailed Facility Report: Suffern (V) STP, EPA ECHO, https://echo.epa.gov/detailed-facility-report?fid=110006621496 (last visited June 17, 2025); Detailed Facility Report: Western Ramapo Advanced WWTP, EPA ECHO, https://echo.epa.gov/detailed-facility-report?fid=110020151253 (last visited June 17, 2025).

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207 *See PFAS Analytic Tools, supra* note 53.

208 Ramapo Valley Well Field, Permit No. NY0248258, also discharges untreated groundwater to augment river flow seasonally as needed. Env. Notice Bulletin, Ramapo Valley Well Field Discharge, N.Y. Dep't of Env't Conservation, https://dec.ny.gov/news/environmental-notice-bulletin/2023-03-01/completed-application/ramapo-valley-well-field-discharge (last visited June 14, 2025).

209 *Emerging Contaminants in N.Y.'s Waters*, N.Y. Dep't of Env't Conservation, dec.ny.gov/environmental-protection/water/emerging-contaminants (last visited April 7, 2025).

210 South Central Financial Statements, Year Ended June 30, 2024, scwwa.org/wp-content/uploads/2024/11/South-Central-Wastewater-Authority-2024.pdf; Detailed Facility Report: South Central Wastewater Authority WWTF, https://echo.epa.gov/detailed-facility-report?fid=110008192918 (last visited June 17, 2025).

211 See *PFAS Analytic Tools*, *supra* note 53.

212 See *generally* South Central Wastewater Authority, Request For Proposal, RFP #24-0812 – Biosolids Disposal (2024), govtribe.com/file/government-file/24-0812-scwwa-biosolids-rfp-dot-pdf.

213 *Biosolids Facility Report: Petersburg STP*, EPA ECHO, echo.epa.gov/biosolids-facility-report?id=VAL025437 (last visited Dec. 9, 2024).

214 See, e.g, Petersburg Virgina, Sludge Management, http://www.petersburg-va.org/562/Public-Private-Education-Facilities (last visited June 11, 2025); Letter from Carolanne M. Whiteside, Synagro Technical Service Coordinator to Virginia Dept. of Env. Quality, (Mar. 14, 2023), https://www.goochlandva.us/DocumentCenter/View/9390/Synagro---March-14-2023 (last visited June 11, 2025).

215 See Permit No. VPA00836, VA Dept. of Env. Quality, https://www.deq.virginia.gov/permits/public-notices/water/land-application-virginia-pollution-abatement-vpa (last visited June 11, 2025).

216 Detailed Facility Report: Waterbury WPCF, EPA ECHO, https://echo.epa.gov/detailed-facility-report?fid=110035779789 (last accessed June 17, 2025).

217 See *PFAS Analytic Tools*, *supra* note 53.

218 LA Sanitation City of Los Angeles, Los Angeles-Glendale Water Reclamation Plant, https://sanitation.lacity.gov/san/faces/home/portal/s-lsh-wwd/s-lsh-wwd-cw/s-lsh-wwd-cw-p?_adf.ctrl-state=vdlc0vvep_10&_afrLoop=1540858680529765#! (last visited June 11, 2025); Detailed Facility Report: LA-Glendale WRP, https://echo.epa.gov/detailed-facility-report?fid=110035779789 (last accessed June 17, 2025).

219 See, LA River Master Plan, Existing Conditions Summary, https://larivermasterplan.org/about/existing-conditions-summary/ and Background, https://larivermasterplan.org/about/background/ (last visited June 11, 2025).

220 See *PFAS Analytic Tools*, *supra* note 53.

221 See *Perfluorooctanoic Acid (PFOA) and Perfluorooctane Sulfonic Acid (PFOS) in Drinking Water*, *supra* note 153.

222 Detailed Facility Report: Cranston WPCF, EPA ECHO, https://echo.epa.gov/detailed-facility-report?fid=110000735713&ej_type=sup&ej_compare=US (last visited June 17, 2025).

223 See *PFAS Analytic Tools*, *supra* note 53.

224 Detailed Facility Report: Jackson POTW, Savanna Street, EPA ECHO, https://echo.epa.gov/detailed-facility-report?fid=110000727394&ej_type=sup&ej_compare=US (last visited June 17, 2025); Detailed Facility Report: West Rankin Utility Authority WWTF, EPA ECHO, https://echo.epa.gov/detailed-facility-report?fid=110064616535 (last visited June 17, 2025); Detailed Facility Report: Jackson POTW, Trahon and Big Creek WWTF, EPA ECHO, https://echo.epa.gov/detailed-facility-report?fid=110055990726 (last visited June 17, 2025).

225 See *PFAS Analytic Tools*, *supra* note 53.

226 Detailed Facility Report: Plant City WRF, EPA ECHO, https://echo.epa.gov/detailed-facility-report?fid=110035612539 (last visited June 17, 2025).

227 See *PFAS Analytic Tools*, *supra* note 53.

228 Berkeley Country PSSD - OH/ INW/ BH/ NE 001-004 (Inwood), EPA ECHO, https://echo.epa.gov/detailed-facility-report?fid=110015983328 (last visited June 17, 2025).

229 See *PFAS Analytic Tools*, *supra* note 53.

230 Permit No.WV 0082759, West VA Dept. of Env. Protection, at 76, https://documents.dep.wv.gov/AppXtender/datasources/DEPAX16/applications/38/document/863955?lqid=-1&lqrid=%7B4a55c8f5-63c0-4f64-a610-2d03bfefdc40%7D&lqaid=38&qrid=%7B4a55c8f5-63c0-4f64-a610-2d03bfefdc40%7D&qridx=0 (last visited June 17, 2025).

231 Detailed Facility Report: Parkersburg Utility Board, https://echo.epa.gov/detailed-facility-report?fid=110010868016&ej_type=sup&ej_compare=US (last visited June 17, 2025).

232 See *PFAS Analytic Tools*, *supra* note 53.

233 All bill numbers refer to introductions in the 118th Congress.

234 *Pappas, Gillibrand, Fitzpatrick, Kildee Introduce Bipartisan Legislation to Address PFAS Contamination and Hold Polluters Accountable*, Congressman Chris Pappas (Apr. 18, 2024), pappas.house.gov/media/press-releases/pappas-gillibrand-fitzpatrick-kildee-introduce-bipartisan-legislation-to-address-pfas-contamination-and-hold-polluters-accountable.

235 See *State Legislation and Federal Action*, *supra* note 28.

236 *Our Priorities: PFAS "Forever Chemicals"*, Safer States, www.saferstates.org/priorities/pfas/ (last visited Mar. 7, 2025).

237 See PFAS Land Application Regulations, Most Policy Initiative, https://mostpolicyinitiative.org/science-note/pfas-land-application-regulations/#:~:text=PFAS%20builds%20up%20in%20biosolids%20used%20in%20land%20application.&text=A%20biosolid%20is%20a%20treated,or%20fertilizer%20(EPA%202025). (last visited June 15, 2025).

238 See *Perfluorooctanoic Acid (PFOA) and Perfluorooctane Sulfonic Acid (PFOS) in Drinking Water*, *supra* note 153.

239 *Gov. Murphy Signs Nation-Leading PFAs Bill Into Law, More Needed for Strongest Protections*, Sierra Club, NJ Chapter (Jan. 22, 2024), www.sierraclub.org/new-jersey/blog/2024/01/gov-murphy-signs-nation-leading-pfas-bill-law-more-needed-strongest.

DATE RECEIVED: 7/8/25
FROM: Tremaine + Gail Arkley
PHONE OR EMAIL:

Benton County Planning Commission
c/o Community Development Dept.
4500 SW Research Way
Corvallis, OR 9733

July 6, 2025

Re: LU-24-027 application to expand the Coffin Butte Landfill

Dear Chair Fowler, Vice-chair Hamann and members of the Benton County Planning Commission,

My wife Gail and I live on 24 acres in Polk County. 15 of those acres are a fruit and vegetable farm, Arkley Farm, and we have owned this property since 1975. My farmland is zoned EFU, and has Class 1 soil, i.e. the best (and to keep it that way I have always farmed organically; no chemical inputs, no sprays).

My farm is in Independence - about 2 miles north of the Buena Vista Ferry, if you know where that is. If you don't: we're a little over 7.5 miles *as the crow flies* from Republic Service's Coffin Butte Landfill (over 10 miles by road).

I keep hearing that Republic Services' odor consultant claims it is highly unlikely that anyone would smell the dump from such a distance.

Well I am writing to tell you for a fact I can smell the stench from here, over 7 miles away. And I know it is dump stench I am smelling, because I know what the dump smells like up close whenever I drive by it - and that is definitely what I smell here on my farm at times. There is a dairy a few miles Southwest of us that we sometimes smell too, but there is no comparison. A dairy just smells like cows and manure... whereas the dump stench is indescribably bad.

We used to smell it only intermittently, but lately we have been smelling it more often.

At times, the stench is very strong at our farm. It's so strong at times that we are afraid to go out and plant vegetables in our raised beds, or do our harvesting, or go out and mow, for fear of what's in that stench mixed with the air we are breathing. How many toxins are we absorbing through our skin? The smell even gets into our clothing and hair. What is coating our fruits and vegetables? We don't know, but the more we learn about what all is in the landfill gas that leaks out of the Coffin Butte dump, the greater is our fear. We are concerned on behalf of the people who work for us too. They should not be subject to these unknowns either.

This is an undue burden and definitely interferes with our farming operation. It is a problem that is bad enough with the dump as it exists already, but it will only get worse if you allow this landfill to expand. Please do not let that happen.

Please deny LU-24-027.

Sincerely,

Tremaine and Gail Arkley
9775 Hultman Rd
Independence, OR 97351

DATE RECEIVED: 7/8/25
FROM: Mason Leavitt
PHONE OR EMAIL:

BEYOND TOXICS

Benton County Planning Commission
4500 SW Research Way
Corvallis, OR 97333

Submitted in person on July 8th, 2025

Subject: Public Comment for LU-24-027

To the Benton County Planning Commission,

Beyond Toxics, an environmental justice organization that works to address air quality concerns throughout the state of Oregon, and one that has been long involved in the community concerns surrounding the Coffin Butte landfill, strongly urges you to deny the proposed expansion of the landfill. This Planning Commission is tasked with ensuring that this landfill does not seriously interfere with uses of adjacent property to the site. Based on this County's findings, evidence in the record, and strong community input, an approval of this expansion would not meet that task.

The expansion project should be denied because it does not comply with the Benton County Code. The expansion development area extends to lots zoned Landfill Site (LS) and Forest Conservation (FC). The expansion was first proposed in 2021, and was denied by the Benton County Planning Commission.[1] Landfill expansions are conditional uses in the LS zone and the FC zone.[2] The proposed uses must meet both the general conditional use criteria under BCC 53.215 and the additional criteria for each respective zone. It fails to do so for the reasons included below, and those provided by other commenters.

Please include this comment in the record for this application and please provide Beyond Toxics with notice of any further hearings or processes related to this application.

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[1] LU-21-047 Planning Commission Findings, Benton County Community Development Department, December 7, 2021.

[2] BCC 77.305 (Any proposal to expand the area approved for a landfill within the Landfill Site Zone is allowed by conditional use permit. . .); BCC 60.215(11) (Conditional uses include disposal site for solid waste approved by the Benton County Board of Commissioners and the Oregon Department of Environmental Quality together with equipment, facilities, or buildings necessary for its operation).

A. BCC 53.215: Conditional Use Criteria

The approval of a conditional use permit must be based on findings that (1) the proposed use does not seriously interfere with uses on adjacent property, with the character of the area, or with the purpose of the zone; (2) the proposed use does not impose an undue burden on any public improvements, facilities, utilities, or services available to the area; and (3) the proposed use complies with any additional criteria which may be required for the specific use by the code.

The County's findings and the evidence in the record do not support that the proposed use will not seriously interfere with uses on adjacent property, the character of the area, or the purpose of the zone. As the record shows and as other commenters have highlighted and provided evidence in support of, the expansion of the landfill, which also extends the life of the landfill, seriously interferes with uses on adjacent property and the character of the area.[3] As discussed in greater detail below, Beyond Toxics is deeply concerned about noise, odor, traffic, soil/water quality and air quality impacts, in addition to climate and public health concerns, from the proposed use.

The evidence in the record also does not support that the proposed use does not impose undue burden on public improvements, facilities, utilities, and other services available to the area. As the record shows and as other commenters have highlighted and provided evidence in support of, the expansion of the landfill, which also extends the life of the landfill, imposed an undue burden in conflict with BCC 53.215(2).[4] Beyond Toxics is particularly concerned about recreation, traffic, and fire risk.

Finally, as discussed below, the proposed use does not comply with the additional criteria required for the use FC zone. Because the proposed use does not comply with the BCC's criteria for conditional uses, it should be denied.

B. BCC 60.220: Forest Conservation Zone Conditional Use Criteria

The findings and evidence in the record do not support that the proposed use meets the conditional use criteria for the FC zone.

- 60.215(11) Conditional Uses: Disposal site for solid waste approved by the Benton County Board of Commissioners and the Oregon Department of Environmental Quality together with equipment, facilities, or buildings necessary for its operation.

It is not clear based on the record that this threshold criterion has been met. It is not clear whether the expansion has been or needs to be approved by DEQ based on the supplemental staff

[3] See, e.g., VNEQS comment (BC8.2).
[4] See, e.g., VNEQS comment (BC8.2).

report or the BOP and its exhibits.[5] DEQ Permit #306 expressly requires approval of a work plan for any expansion beyond the current footprint of the landfill.[6] Exhibits 24 and 25 indicate that the Applicant received DEQ approval of a work plan in 2021 related to a potential expansion, but it is not clear that subsequent DEQ approval of the site characterization was received.[7] The Applicant appears to suggest that whether or not the expansion requires additional DEQ approval is not relevant to this section of the code because "Whether serving the existing or proposed disposal site, the proposed Project elements on the FC-zoned land fall into the category of equipment, facilities, or buildings necessary" for the operation of either the existing or proposed site. But the Applicant has not supported that displacing the current buildings and leachate ponds, or building the maintenance area onto FC-zoned land would be necessary but for the expansion of the landfill site. Therefore, the County should ensure that all required DEQ approval has been obtained before approving the expansion.

- 60.220: A use allowed under 60.215 may be approved only upon finding that the use: (a) will not force a significant change in, or significantly increase the cost of, accepted farming or forest practices on agriculture or forest lands;

The proposed use involves building an 1,800-square-foot employee building and parking, modifying access roads, relocating leachate ponds and infrastructure, cut activities, and a shop/maintenance area (at least 10,000 square feet).[8] The staff report also does not consider or describe in detail the size of the parking lot or road modifications. The Applicant has not supported how these developments, which involve cut activities and displacement of buildings, parking, and leachate management infrastructure towards the perimeters of the development area,[9] will not seriously interfere with the purpose of the zone or force a significant change in accepted farming or forest practices. Evidence in the record supports the contrary conclusion that these developments, particularly the replacement of leachate ponds further towards the south, will significantly affect surrounding agricultural and forest uses.[10]

- (b) will not significantly increase fire hazard or significantly increase fire suppression costs or significantly increase risks to fire suppression personnel; and

The findings and evidence in the record do not support that the proposed use will not significantly increase fire hazard or fire suppression costs and risks.[11] The findings do not

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[5] Supplemental Staff Report at 101.
[6] Exhibit 23 at 16.
[7] Exhibit 23 at 16.
[8] Supplemental Staff Report at 104 indicates that Applicant clarified the proposal includes a 10,000 square-foot maintenance building and a 400-gallon septic tank, but the BOP at Exhibit 2 notates a 28,000 square-foot area.
[9] Supplemental Staff Report at 104.
[10] See, e.g., Supplemental Staff Report at 102-103.
[11] Supplemental Staff Report at 104-105.

sufficiently address the Adair Rural Fire Protection District's recommendation to deny the application, including because the proposal may increase traffic and associated emergency response demands and present elevated fire risk, burdening the volunteer-based fire department.[12] Exhibit 20 is primarily based on landfill staff interviews, not a systematic review or record of fire events at the landfill site. Even so, the report indicates that the frequency of both landfill face and grass fires has increased in the past several years. Additionally, the assessment does not appear to provide an analysis of how the expansion project itself (i.e., its new location to the south of Coffin Butte Road, and the new position of the leachate system and buildings adjacent to, rather than across the road from, the working face) has changed the fire risk of the use.[13]

- (c) complies with criteria set forth in BCC 53.215 and 53.220.

The proposed use does not comply with the code's general conditional use criteria as discussed above. Most significantly, the record supports that the proposed use will seriously interfere with the purpose of the FC zone in violation of BCC 53.215(1). BCC 60.005(1) states that "[t]he purpose of the zone is to The Forest Conservation Zone shall conserve forest lands, promote the management and growing of trees, support the harvesting of trees and primary processing of wood products, and protect the air, water, and wildlife resources in the zone." The development of built infrastructure and the placement of leachate ponds and systems, and a 400 gallon septic tank on FC land seriously interferes with and conflicts with the conservation purpose of the zone.

Based on the County's findings and the evidence in the record, the expansion project does not comply with the County Code's requirements for conditional uses and should be denied.

Beyond the project's conflicts with the County's land use code, Coffin Butte is a site with a long history of mismanagement and environmental concerns. This site has been emitting dangerously high levels of methane for years, with the United States EPA concluding after two recent compliance inspections that the landfill has "wide spread shortcomings" in the site's monitoring practices. Landfills, which produce methane as bacteria decompose waste, are the third largest source of human-related methane emissions in the United States. Methane plumes created at landfills also release health-harming pollutants that are present in the trash as it breaks down over time.[14] These toxins, such as nitrogen oxides, sulfur dioxide, hydrogen sulfide, toluene and PFAS, or "forever chemicals,"escape with the methane. Some estimates indicate that volatile organic compound (VOC) emissions from landfills account for 10% of total VOC emissions in

[12] Supplemental Staff Report at 18, 70-71, 104.
[13] See Exhibit 20 (historic review).
[14] https://rmi.org/methane-a-threat-to-people-and-planet/#:~:text=Methane%20is%20a%20risk%20to,shortens%20lives%20in%20affected%20regions

the United States.[15] These compounds are associated with many negative public health impacts to workers and neighboring residents, including smog formation and release of particulate matter and carcinogens. Additionally, methane emissions, and the additional toxins they contain, are still understudied and often go undetected.

Recent studies by federal agencies such as the EPA and NASA have shown that landfill methane emissions far exceed previous estimates, in some places by as much as 100 times the regulatory limit. EPA inspections have uncovered these kinds of methane exceedances at Oregon landfills, including "explosive" levels at Benton County's Coffin Butte landfill.[16]

Furthermore, Coffin Butte's excessive methane emissions is also a significant climate change driver for the area. Methane is a powerful greenhouse gas that is 80 times more potent than carbon dioxide in short-term climate warming. Landfills, which produce methane as bacteria decompose waste, are the third largest source of human-related methane emissions in the United States. In 2022 alone, Oregon landfills emitted methane equal to an estimated 2 million metric tons of carbon dioxide. That is the same as 466,000 cars on the road for one-year.

It would be extremely irresponsible to approve the expansion of a landfill that is already struggling to keep up with its environmental requirements. Community members already experience these impacts, smelling gases that they have no knowledge of the contents or the short and long term effects on their health. This Commission must consider the current, ongoing impacts of the site before allowing these issues to only be further exacerbated by an expansion.

Sincerely,

Mason Leavitt GIS Analyst & Programs Coordinator
Beyond Toxics
120 Shelton McMurphy Blvd Suite 280
Eugene, OR 97403

15 https://www.sciencedirect.com/science/article/abs/pii/S0957582018307572#:~:text=It%20is%20estimated%20that%20VOC,et%20al.%2C%202009

16 https://www.documentcloud.org/documents/24040319-coffin-butte-epa-inspection-06-23-22/

I am Speaker #10

Two people ceded their time to me

Marge Popp #13 and Josh Dodson #25

Intro.....



I am reading a letter from my husband, Kevin Higgins. Kevin is a retired fire captain. He served over 20 years at the Adair Rural Fire Dept., retiring in 2022.
He also is the former Emergency Manager for Benton County. He moved on to become the Special Services Manager for the Sheriffs Office and due to a schedule conflict he is unable to be in person tonight. Kevin was asked to share his experiences with fires at the dump. The following letter is from Kevin.

When I first started at Adair Fire, we were still having routine fires at the dump, some of them very big, multiple alarm, and many agencies needed to fight.
One particular fire was big enough to make the Associated Press as National news in 1999. Some of those fires took all night to get out since the fire would be deep into the trash and would often require us to bring a dozer in to move the trash around to get to the fire.

These fires used a HUGE amount of water to fight. The landfill folks always hated it when we started dumping thousands of gallons of water on the fire because it would throw off the leachate.

I know the fuel load in the landfill is huge, and that is why a fire there requires so many resources. Fighting a fire there is one of the worst locations to fight a fire due to all the unknown substances burning. It is so toxic that you basically have to fight the fire on air the whole time. You're wearing a SCBA pack and on air for hours, but if you don't go on air, you usually cough and feel sick for days afterwards. Who knows what that has done to each of us that have fought those fires while not being on air. I have often wondered what kind of toxins were released into the air that not only we were breathing but may have affected the environment also.

My son Levi and I both wanted to communicate to you the physical effects of fighting the fire on the dump. We both experienced that our eyes got sticky and goopy and we both had burning in our lungs if we didn't stay on the SCBA air. Our lungs would burn for days after and we would feel lethargic and sick. Levi also experienced the explosions under the tarp and said that it was terrifying watching the fire hitting so many hazardous materials and seeing the fire color changes as it hit car parts, plastic and even petroleum products. The smoke was thick, black and heavy .

I imagine a scenario where we had a large wildland fire that included the dump here. We would have a toxic mess on our hands. A typical wildland crew wouldn't have the equipment to fight the fire at the dump. The structure firefighters would prioritize working exposure protection of homes and buildings. That doesn't leave many resources to fight the fire in the dump with all of it's toxins.

Over the years, they started doing something different, because the fires started to decrease in frequency. The last few I went to started in equipment operating at the dump but then would spread to the noxious trash so we had and equipment fire and a trash fire to deal with at the same time. This often required mutual aid from Corvallis Fire, Albany Fire and Polk County Fire to assist.

In the early days of tarping, I can personally remember fires that were under the tarp and feeling the methane explosions under my feet. Back then, I had to personally make large cuts in the tarps themselves to release the methane buildup so it didn't explode on our crew. I have heard representatives from the dump say that never happened. I can tell you that I was there. I did cut the tarps, and our crew felt the explosions!! It most definitely happened. It was an eerie sensation to feel the weight of the dump exploding under your feet.

I have heard testimony from supposed experts that say that since 1999 there have only been a very few fires at the dump. I am also reporting that is not true. I don't remember seeing those experts up there and I have no idea where they are getting their information. We had no less than two fires per year for many years, and every fire is dangerous because you have no idea what is burning and what is going to be burning next. Now granted, there were fires that were in the equipment that didn't spread to the trash in the dump itself. That was mostly because we were able to be timely in our response and quickly contain the fire to the equipment.

The Higgins family moved to the Soap Creek Valley in the early 70's. This is where I was raised and I have memories of going to the dump as a kid looking for treasures. I was a young inventor, and the dump looked a lot different then. My wife and I decided to move back to the Soap Creek Valley in the late 90's to raise our family. Our son and his wife are considering this as well. That would be 4 generations and so for our family, the stakes are high. We want to protect and preserve the beauty and health of the Soap Creek Valley and of Benton County.

The whole landfill issue is frustrating, and the expansion is all about greed.

I hope the commissioners are smart enough to fulfill the commitment made by previous commissioners to wind down the landfill, not expand it...yet again,. What a disaster it would be for them to overrule basically 100% opposition to the landfill, with only 3 supportive voices, and those three are all money driven the Republic Services, and the county itself, and trash hauling company in an outside county . NOBODY else was in support.

In closing, two things. To be clear, I am 100% opposed to any expansion of the dump. And second, I looked online for Benton Counties commitment to the environment, this is what I found. It should help in your decision making process:

"Benton County, Oregon, demonstrates a strong commitment to environmental sustainability through various initiatives and plans. The county aims to reduce greenhouse gas emissions, protect natural resources, and promote sustainable practices in areas like waste management and land use. "

BEYOND TOXICS

DATE RECEIVED: 9/9/25
FROM: Mason Leavitt
PHONE OR EMAIL:

120 Shelton McMurphy Blvd Suite 280
Eugene Oregon 97403
Mason Leavitt, GIS Analyst & Programs Coordinator

Chair Fowler, Vice Chair Haiman and Members of the Planning Commission,

Thank you for making time for members of the community to speak here again and we all appreciate your continued service through this thoroughly complex application. My name is Mason Leavitt and I am a GIS analyst and programs coordinator for Beyond Toxics an environmental justice organization that works to address air, water, and soil quality concerns throughout the state of Oregon. We have worked with the residents of Soap Creek Valley and Adair Village for 3 years now regarding the operations of the applicant.

I would like to speak to two items generally this evening. First, I wish to briefly raise novel concerns over the applicants ability to meet CUP criteria for Forest Conservation zones. Second, I wish to respond to Republic Services supplement odor study and some of the discussion points raised last night as well as the related conditions of approval.

Benton County code 60.220 B states that a CUP must be found that it "will not significantly increase fire hazard or significantly increase fire suppression costs or significantly increase risks to fire suppression personnel"

The findings and evidence in the record do not support that the proposed use will not significantly increase fire hazard or fire suppression costs and risks. The findings do not sufficiently address the Adair Rural Fire Protection District's recommendation to deny the application, including because the proposal may increase traffic and associated emergency response demands and present elevated fire risk, burdening the volunteer-based fire department. As discussed in detail last evening, exhibit 20 is primarily based on landfill staff interviews, not a systematic review or record of fire events at the landfill site. The applicant's consultant stated last night that the landfill operators do not and have not kept a record of site incidents related to fire. While the COAs related to fire would not require them to do so, this is allowing the applicant to build the plane as they fly it. Benton County code clearly states that they must show the new operations would not increase a fire risk, and the applicant has stated they have failed to construct an accurate, complete, and representative database of fire incidents at the landfill.

In May I began my testimony on odor with the quote "All models are wrong, but some are useful" but today I will begin with two quotes from the applicant's odor consultants. "Models are not great at modeling surfaces that have complex topography" They also stated "Models like this - in reference to AERMOD- are not such that they track perfectly what we measure". All three of these quotes nail a fundamental limitation of models- they do not reflect reality. Hence why the saying all models are wrong is important to remember tonight.

Last night both county staff and the applicant's consultant suggested their revised model is a substantial improvement from the first study since it now demonstrates levels of hydrogen sulfide that would constitute a nuisance at the fenceline of the applicant's property. I agree with their assessment that this is an improvement, but I would assert here tonight that the model still does not reflect what hundreds of residents in the soap, Creek Valley and Adair Village experience. You have seen and heard numerous testimonies that clearly demonstrate folks smell levels of landfill gas that constitutes a nuisance much farther away than just the fence line at the facility. This means that the applicant's model is still not an adequate reflection of reality and does not meet the burden of proof to demonstrate that a significant burden is not occurring on adjacent properties. Remember, it is their burden of proof, and if they cannot prove that then the application should be rejected.

Recall, the applicant's model is based on weather inputs, an assumed input of 930,000 tons of organic waste, and a fugitive emissions rate of 25%. Based on third party satellite data and an ongoing investigation from the EPA, it is more than likely Coffin Butte has a fugitive emissions rate higher than 25%. In a hearing in late May on Coffin Butte's Title V air permit conducted by ODEQ, DEQ outright stated they do not have the expertise or staff capacity to evaluate if that 25% assumption is valid or invalid. The expertise to validate this assumption does not exist in the state of Oregon, and we have many reasons to doubt that assumption that the applicant has not responded to.

Next, I would like to address the input rate of 930,000 tons of organic waste. Last night consultants hired by the Benton county planning staff stated that annual reports submitted to Oregon DEQ corroborate the applicant assumption of 930,000 tons of organic waste. I have submitted to the record tonight one of those annual reports. They do not distinguish between inorganic and organic waste intake. Instead, they distinguish between municipal solid waste and construction and demolition waste. Based on the statements from planning staff and the applicant, it appears that there is an equation of municipal solid waste and organic waste. However, the conditions of approval put forth by county staff and the applicant state there ought to be a limit of 930,000 tons of organic waste as a COA. I want to note that there was no clear definition put forth by the applicant of what constituted organic waste, and that seemed to differ from the earlier discussion of what went in the model input.

Second, in the same hearing for a title five air contamination discharge permit with Oregon department of environmental quality I mentioned earlier and in the planning documents submitted to Benton County, the applicant stated they estimate they will have an intake of 1,.5 million tons per year. Note this contradicts what we heard in may when the applicant stated they

did not plan to increase waste intake beyond the current 1.1 million ton limit. The applicant has offered no clarity on how they plan to document organic versus in organic waste, they have offered no explanation on how the 930,000 ton input for the model is corroborated by annual reports submitted to Benton County, and there was a complete conflation of these terms during last night's hearing. The lack of clarity obfuscates the parameters of the odor model and how they plan to comply with conditions of approval.

Finally, I want to observe again that the applicant has chosen not to deploy air monitoring as a technique for corroborating the findings of their odor study. The applicant has even submitted other outer studies done at landfills experiencing similar problems, but they have declined to do so for this landfill. SCS engineers, one of the consultants hired by the applicant, even strongly suggests using air monitors and drones as an assured method to prevent odor nuisances.[1]

Ironically, one of the conditions of approval requires that the applicant deploy a hydrogen sulfide monitor as part of their operations. Additionally, as discussed last night, SB 726 might require the use of drones depending on how DEQ structures the rules, but this would only start in 2027. This seems to be placing the cart before the horse. Instead of the applicant clearly demonstrating that they are keeping hydrogen sulfide levels at adequate concentrations to prevent odor nuisances, they are allowed to expand their operations and then do so. Additionally, the applicant and county staff made it very clear last evening that these conditions of approval are only related to the new landfill. How will we know if the hydrogen sulfide measured on these air monitors comes from the old landfill versus the new landfill? Beyond Toxics has decades of experience with this exact conundrum, and I can tell you, it is next to impossible to meet an evidentiary standard a multi billion corporation wouldn't be able to have dismissed.

This means the applicant will have the ability to blame high levels of hydrogen sulfide on the old landfill and claim they are still operating within conditions of approval. This conundrum makes many of these conditions unenforceable, and this problem extends beyond odor. Additionally, the other conditions related to odor are based on someone smelling the air and then smelling a high concentration of hydrogen sulfide before making a subjective determination if the air constitutes a nuisance. This means we will be stuck in a he smells/ She smells conundrum constantly. Even if the county chose to invest in COA enforcement, meeting the evidentiary standard of definitive proof that the new landfill is the source of these odor problems would be next to impossible.

As one last note on odor, I want to remind the planning committee that testimony has shown the applicant is failing to use best practices to prevent odor issues. Multiple satellite images have demonstrated a failure of the applicant to fully cover their working face with soil or tarps, one of their alternative daily covers. The applicant has also stated in a rebuttal to my

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1 https://www.scsengineers.com/the-who-what-when-where-and-why-of-measuring-and-controlling-landfill-odors-and-h2s/

testimony that tarps are not intended to prevent landfill gas from escaping, which raised the question of why they are using it for daily cover. Additionally, the EPA has found the applicant's intermediate cover to be inflated with methane gas, which means holes in that intermediate cover would seem to likely be belching gas.

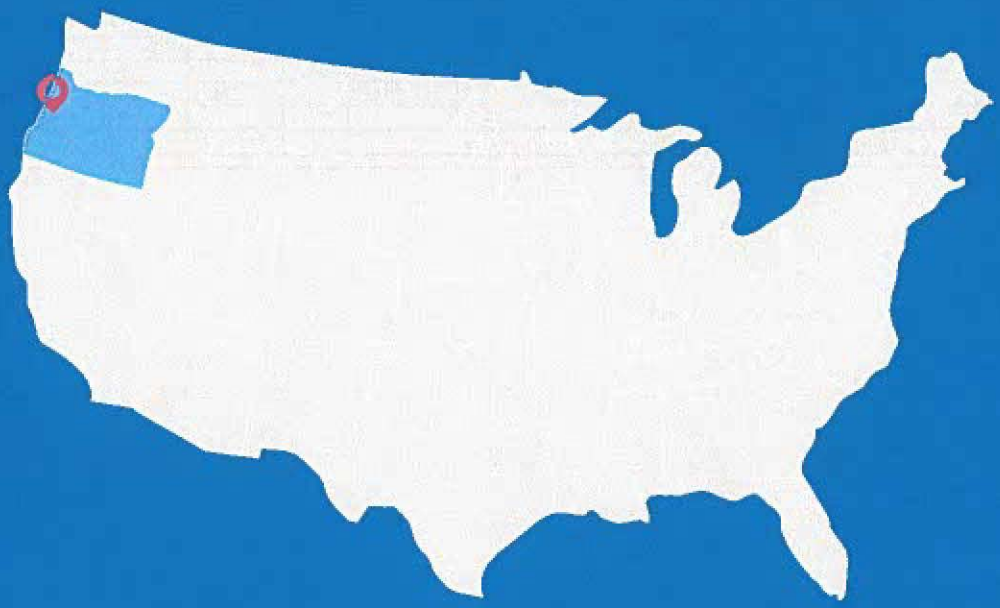
The planning commission has two different sets of data in front of them that lead to different conclusions on the issue of odor. On one hand, the applicant has proposed an odor model, whose underlying parameters are in serious question. On the other hand, there are hundreds of public testimonies pointing to odor as an existing serious interference that will be exacerbated both through an increase in waste and an extended duration of landfill operations. The applicant has dismissed these experiences as anecdotal, but they are also trying to use them to validate their model. Benton County code clearly states the planning commission can approve or deny an application at their discretionary interpretation. It is up to your discretion, which set of data you find to be more valid as you make your decision.

REPUBLIC SERVICES

Sustainability in Action

Coffin Butte Landfill and Pacific Region Compost Annual Report

Benton County
2023



Summary of Landfill Users

(By County of Origin)

SUMMARY OF LANDFILL USERS BY COUNTY OF ORIGIN

Coffin Butte Landfill Tonnage by Type and County - Total for Year 2023

		Commercial							Public			Alternate Daily Cover				Compost	
County	Vehicles	MSW	C&D	Asbestos	Agricultural Waste	Industrial Waste	Sludge	Totals	MSW	Other	Totals	Contaminated Soil	Covanta Ash	Shaker Fines	Totals	Yard Waste Received	Compost Sales (Yds)
Benton	33,210	50,791.66	7,672.54	122.90	2.21	18,025.69	-	76,617.00	9,432.29	-	9,432.29	16,024.73	-	-	16,024.73	2,686.70	715.30
Linn	31,644	79,294.20	4,209.07	159.41	95.77	32,139.44	12,504.38	128,402.27	6,021.67	-	6,021.67	5,179.93	-	-	5,179.93	923.15	50.00
Polk	16,626	40,333.34	1,667.19	122.61	892.71	2,402.03	6,218.74	51,591.62	3,367.85	-	3,367.85	2,236.30	-	-	2,236.30	250.00	68.25
Marion	12,094	213,992.44	519.86	276.56	108.43	5,616.35	40.66	220,554.30	973.46	-	973.46	6,445.39	25,199.96	-	31,645.35	78.90	12.00
Lane	2,207	4,184.63	150.20	3.50	-	23,781.64	-	28,119.97	50.56	-	50.56	16,343.03	-	-	16,343.03	0.56	4.00
Tillamook	1,609	29,873.43	-	0.02	1,695.73	727.94	7,335.06	39,132.23	71.14	-	71.14	-	-	-	-	-	-
Yamhill	4,518	95,502.05	259.41	20.87	1,251.94	416.28	-	97,450.55	474.37	-	474.37	25.07	-	-	25.07	3.12	-
Lincoln	5,264	44,661.45	111.82	67.04	-	42,381.61	63,932.31	151,157.23	30.03	-	30.03	719.39	-	-	719.39	1.81	-
Coos	7	-	-	-	-	-	4.57	4.57	-	-	-	43.96	-	-	43.96	-	-
Pierce, WA	21	1.11	-	-	314.81	17.31	-	333.23	-	-	-	-	-	-	-	-	-
Washington	6,956	178,437.10	0.47	45.82	171.72	281.70	-	178,936.81	1.26	-	1.26	-	-	2,783.72	2,783.72	-	-
Jackson	5	0.62	-	-	-	0.07	-	0.69	-	-	-	5.11	-	-	5.11	-	-
Multnomah	221	2,856.81	-	52.75	-	394.60	-	3,004.16	-	-	-	414.95	-	-	414.95	-	-
Douglas	396	10,969.37	-	5.17	-	1.90	-	10,976.44	4.74	-	4.74	149.99	-	-	149.99	-	-
Clackamas	1,053	13,503.89	2.78	175.59	1,656.56	2,382.62	2,245.84	19,967.28	5.97	-	5.97	3.54	-	-	3.54	-	-
Columbia	1	-	-	6.73	-	-	-	6.73	-	-	-	-	-	-	-	-	-
Curry	1	-	-	-	-	-	-	-	-	-	-	9.11	-	-	9.11	-	-
Jefferson	1	-	-	-	1.42	-	-	1.42	-	-	-	-	-	-	-	-	-
Clatsop	21	0.05	-	-	-	598.00	-	598.05	-	-	-	0.20	-	-	0.20	-	-
Lake	5	0.57	-	-	-	-	-	0.57	-	-	-	-	-	-	-	-	-
Cowlitz, WA	11	-	-	-	-	281.14	-	281.14	-	-	-	-	-	-	-	-	-
Deschutes	7	0.80	-	15.43	-	-	-	16.23	-	-	-	1.01	-	-	1.01	-	-
Baker	269	3.92	-	412.39	-	1,781.63	2.50	2,200.44	-	-	-	1,101.17	-	-	1,101.17	1.70	-
Malheur	2	1.19	-	-	-	-	-	1.19	-	-	-	-	-	-	-	-	-
Josephine	2	0.26	-	-	-	-	-	0.26	-	-	-	5.33	-	-	5.33	-	-
Misc. County	20	-	-	-	-	0.27	-	0.27	576.39	-	576.39	0.15	-	-	0.15	-	-
Clark, WA	135	0.10	-	-	-	1,794.64	-	1,794.74	-	-	-	-	-	-	-	-	-
Totals	126,306							1,011,154.39			21,059.73				76,753.49		

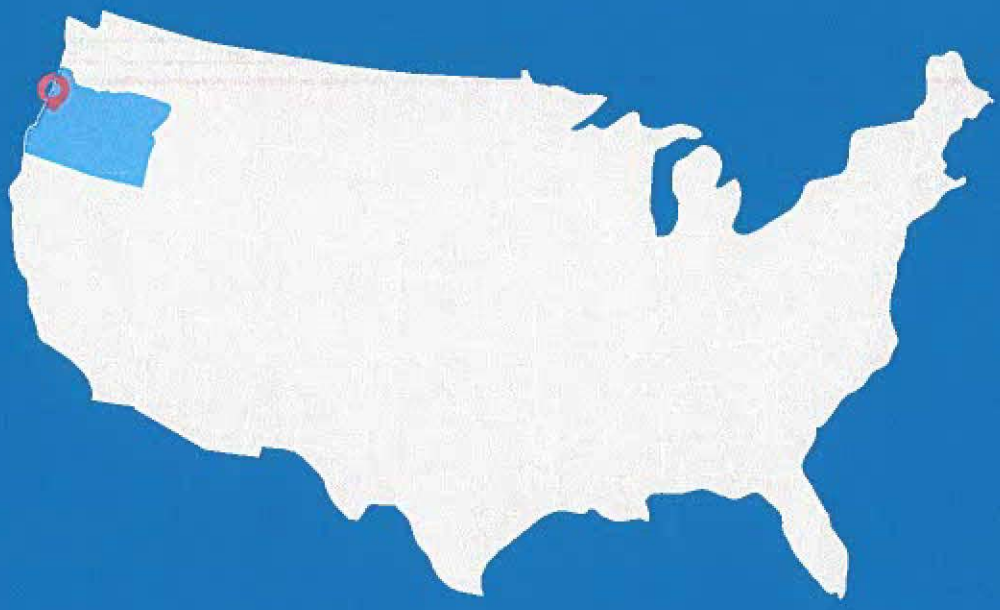
REPUBLIC SERVICES

Sustainability in Action

Coffin Butte Landfill and Pacific Region Compost Annual Report

Benton County

2022



Summary of Landfill Users

(By County of Origin)

Coffin Butte Landfill Tonnage by Type and County - Total for Year 2022

		Commercial							Public			Alternate Daily Cover				Compost	
County	Vehicles	MSW	C&D	Asbestos	Agricultural Waste	Industrial Waste	Sludge	Totals	MSW	Other	Totals	Contaminated Soil	Covanta Ash	Shaker Fines	Totals	Yard Waste Received	Compost Sales (Yds)
Benton	41,707	86,457.92	13,498.17	556.11	15.40	14,580.15	-	75,124.55	10,629.73	-	10,629.73	2,318.43	-	-	2,318.43	2,272.60	845.65
Linn	33,575	78,122.51	6,190.54	302.50	110.17	32,561.15	14,234.64	137,521.51	6,107.35	-	6,107.35	1,608.37	-	-	1,608.37	949.37	50.00
Polk	17,461	42,585.09	2,458.01	24.07	1,021.98	2,068.44	175.11	48,332.70	4,436.31	-	4,436.31	877.37	-	-	877.37	550.76	38.00
Marion	111,848	197,190.04	3,683.28	467.84	1.63	4,299.31	-	204,642.10	1,463.95	-	1,463.95	1,602.42	29,289.81	-	32,892.23	8.80	2.90
Lane	2,136	4,855.30	51.16	347.55	46.69	34,180.81	-	39,481.51	42.57	-	42.57	3,423.28	-	-	3,423.28	8.01	-
Tillamook	1,848	30,199.46	5.88	0.10	2,074.10	969.14	5,944.89	39,193.57	81.52	-	81.52	-	-	-	-	-	-
Yamhill	4,499	65,060.47	3,045.04	40.36	356.62	896.53	-	99,399.02	264.07	-	264.07	945.02	-	-	945.02	0.38	-
Lincoln	5,927	44,744.79	148.07	42.26	-	122,018.32	4,480.33	171,434.67	87.66	-	87.66	338.97	-	-	338.97	1.27	-
Coos	54	0.10	-	544.83	-	-	-	544.93	-	-	-	394.61	-	-	394.61	0.48	-
Pierce, WA	12	-	-	-	193.28	0.34	-	193.62	-	-	-	-	-	-	-	-	-
Washington	7,510	192,964.48	0.29	-	197.24	197.31	-	193,362.32	18.00	-	18.00	8.54	-	2,943.77	2,952.29	-	-
Jackson	8	-	-	-	-	-	-	-	-	-	-	7.92	-	-	7.92	-	-
Multnomah	79	868.91	3.69	65.20	-	42.01	-	979.81	-	-	-	44.11	-	-	44.11	-	-
Douglas	394	10,426.86	-	0.33	-	207.43	-	10,634.62	-	-	-	399.69	-	-	399.69	-	-
Clackamas	1,035	15,815.12	199.56	54.48	235.51	3,135.39	1,899.28	21,327.34	19.82	-	19.82	48.58	-	-	48.58	8.01	-
Columbia	4	0.32	1.20	-	-	-	-	1.52	0.43	-	0.43	-	-	-	-	-	-
Umatilla	1	0.20	-	-	-	-	-	0.20	-	-	-	-	-	-	-	-	-
Jefferson	2	-	-	-	-	-	-	-	-	-	-	0.95	-	-	0.95	-	-
Clatsop	43	-	4.98	-	-	581.64	-	586.62	2.82	-	2.82	13.31	-	-	13.31	-	-
Klamath	3	0.51	-	-	-	-	-	0.51	-	-	-	79.47	-	-	79.47	-	-
Crook	2	0.10	-	-	-	-	-	0.10	-	-	-	-	-	-	-	-	-
Deschutes	2	0.16	-	8.89	-	-	-	9.05	-	-	-	-	-	-	-	-	-
Baker	26	9.04	17.51	-	-	-	-	26.55	-	-	-	2.10	-	-	2.10	0.04	-
Malheur	3	11.97	0.76	-	-	-	-	12.73	-	-	-	-	-	-	-	0.21	-
Josephine	4	-	-	-	-	0.37	-	0.37	-	-	-	1.08	-	-	1.08	-	-
Misc. County	21	-	6.64	5.90	-	0.04	-	11.98	12.16	330.94	343.10	30.54	-	-	30.54	-	0.96
Clark, WA	22	2.40	-	-	-	291.92	-	294.32	-	-	-	10.95	-	-	10.95	-	-
Totals	128,045							1,043,154.55			23,597.93				48,389.29		

BEYOND TOXICS

Mason Leavitt <mleavitt@beyondtoxics.org>

Fwd: Coffin Butte Title V Air Quality Permit

3 messages

N Whitcombe <nwhitcombe@gmail.com> Wed, Jul 9, 2025 at 4:00 PM
To: Mason Leavitt <mleavitt@beyondtoxics.org>

All I have is this email from Mike

---------- Forwarded message ---------
From: **EISELE Michael * DEQ** <Michael.EISELE@deq.oregon.gov>
Date: Mon, Jun 30, 2025 at 1:37 PM
Subject: RE: Coffin Butte Title V Air Quality Permit
To: N Whitcombe <nwhitcombe@gmail.com>

In their permit application they requested to be permitted at a rate of 1,500,000 tons/yr.

Mike

From: N Whitcombe <nwhitcombe@gmail.com>
Sent: Monday, June 30, 2025 1:10 PM
To: EISELE Michael * DEQ <Michael.EISELE@deq.oregon.gov>
Subject: Re: Coffin Butte Title V Air Quality Permit

Have they made any future projections of waste acceptance rates for 2026 onward?

On Mon, Jun 30, 2025 at 12:44 PM EISELE Michael * DEQ <Michael.EISELE@deq.oregon.gov> wrote:

> Yes. Hopefully the attached waste in place report is not too big for your system.
>
> Mike
>
> ---
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> Did Republic/VLI submit annual waste amounts to DEQ as a part of its Title V permit?
>
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BEYOND TOXICS

Mason Leavitt <mleavitt@beyondtoxics.org>

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COFFIN BUTTE LANDFILL & PACIFIC REGION COMPOST

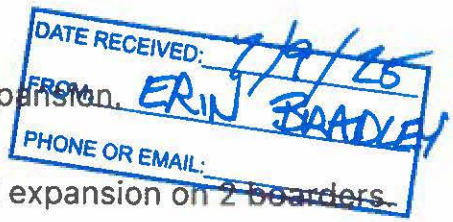
Annual Report
2021

REPUBLIC SERVICES

SUMMARY OF LANDFILL USERS BY COUNTY OF ORIGIN

Coffin Butte Landfill Vehicles by Class and Tons Disposed - Total for Year 2021					
	Commercial Vehicles Intercompany Franchised & Third Party Franchised		Private Vehicles	Total Vehicles	Total Tons
	MSW	C&D	(Includes Special Waste, Asbestos, & Public)		
County	Tons	Tons	Tons		
Benton	42,452.83	12,900.97	59,398.96	41,843	114,752.76
Linn	76,778.56	5,425.95	60,576.27	35,053	142,780.78
Polk	42,377.41	2,399.56	28,032.97	20,107	72,809.94
Marion	171,226.30	1,418.02	153,079.05	17,478	325,723.37
Lane	5,037.03	100.83	32,866.18	1,903	38,004.04
Tillamook	30,061.68	0.57	8,897.47	1,662	38,959.72
Yamhill	49,328.85	1,570.74	1,225.23	2,304	52,124.82
Lincoln	50,310.49	499.92	63,775.99	4,396	114,586.40
Coos	5.85	2.58	495.46	41	503.89
Pierce, WA	0.76	1.12	0.00	3	1.88
Washington	35,315.78	219.51	570.56	1,466	36,105.85
Jackson	0.00	0.00	6.19	7	6.19
Multnomah	0.08	0.00	20.21	7	20.29
Douglas	4,264.52	0.83	106.21	170	4,371.56
Clackamas	13,173.34	5.31	2,294.90	707	15,473.55
Columbia	6,015.42	1.62	0.00	212	6,017.04
Clatstop	0.21	0.00	560.32	41	560.53
Klamath	1.78	0.00	5.55	6	7.33
Deschutes	1.11	0.00	39.76	7	40.87
Baker	24.23	9.59	4.07	120	37.89
Josephine	0.00	0.00	94.06	17	94.06
Misc. County	2.02	2.13	11.85	18	16.00
M-Clackamas	0.20	0.00	4,903.62	290	4,903.82
M-Multnomah	0.00	0.00	597.40	34	597.40
M-Washington	76,526.58	0.00	1,040.40	3,468	77,566.98
Totals	**602,905.03**	**24,559.25**	**418,602.68**	**131,360**	**1,046,066.96**

Erin Bradley



38578 Hwy 99w Corvallis 97330 I am in opposition of the proposed expansion.

Our farm is one of the closest neighbors to republic Services proposed expansion on 2 boarders.

Since we last gathered here there is a few things I think you should be aware of.
mc Caulim rock drilling called on May 28th at 10:49 am from an unknown and blocked number to let us know of the blast that would would occur on the May 29 th between 12 and 4 . If we had any questions or concerns please call Republic Services. We were not given a number to call if we had questions or and issues. I was very surprised as I thought the blasting was done.

I was unable to find a phone number online where someone would answer. I left a voicemail at Valley Landfills and hoped for the best.

The following am I had to drive around at 8 am and go to office to get someone to return my call. I received a call back from the environmental staff member. he did answer my questions about location and why. . He said that we would most likely not feel or hear the blast. I explained what we did and the stress it could cause on the animals and clients. I requested to change the blast days to Fridays as they are more flexible for us. He said he would ask. He offered to follow up the following day to see how everything was. I did not hear back from from him the following day or even the following week.

On June 10th at 9:20 in the am I received a voicemail from Emily at Mccolum Rock drilling . The voicemail said they would be blasting that day between 12pm and 5pm. She mentioned that she had tried to reach out the day before. I called her back and let her know I did not receive a call and there was no record of the call on the caller ID. She nicely apologized and said there may have been issues on their end. I asked for the blasting day to be changed to Fridays. She checked and then said they could do Fridays but it was up to Republic Services.

I then called Republic Services and left a vm. He did return my call promptly and apologized for not following back up with me. I let him know we did not receive a 24 hr notice call and we definitely felt and heard the blast on May 29th and June 4th. The blast cause stress on our animals, startled clients and scared a volunteer. I mentioned the drilling company could change to Fridays. He said he would ask his people again. The blasts were never changed to Fridays.

I did manage to record a blast on June 10th in the Nw Corner of my property. I have printed it out for you to see. The first slide is a semi truck going south on 99w and passing in front of our property .The second is the blast . Quite a noticeable difference in decibels. The first blast on May 29th was much bigger than this.

Republic Services has increasingly affected the use of my land. Placed stress on my livestock, volunteers,clients and has affected a service to the community. Last testimony I mentioned the groups we serve. I failed to mention we are a provider for the State of Oregon DHS Child Services. We are

Service! Farm-Service- and an adjacent property on two boarders.

The proposed facility can not be operated without noise and odor that will affect our business and other agricultural activities. There are no conditions of approval or other mitigation measures that will resolve these issues. The proposed landfill is a massive industrial complex that can not be mitigated and must not be approved.

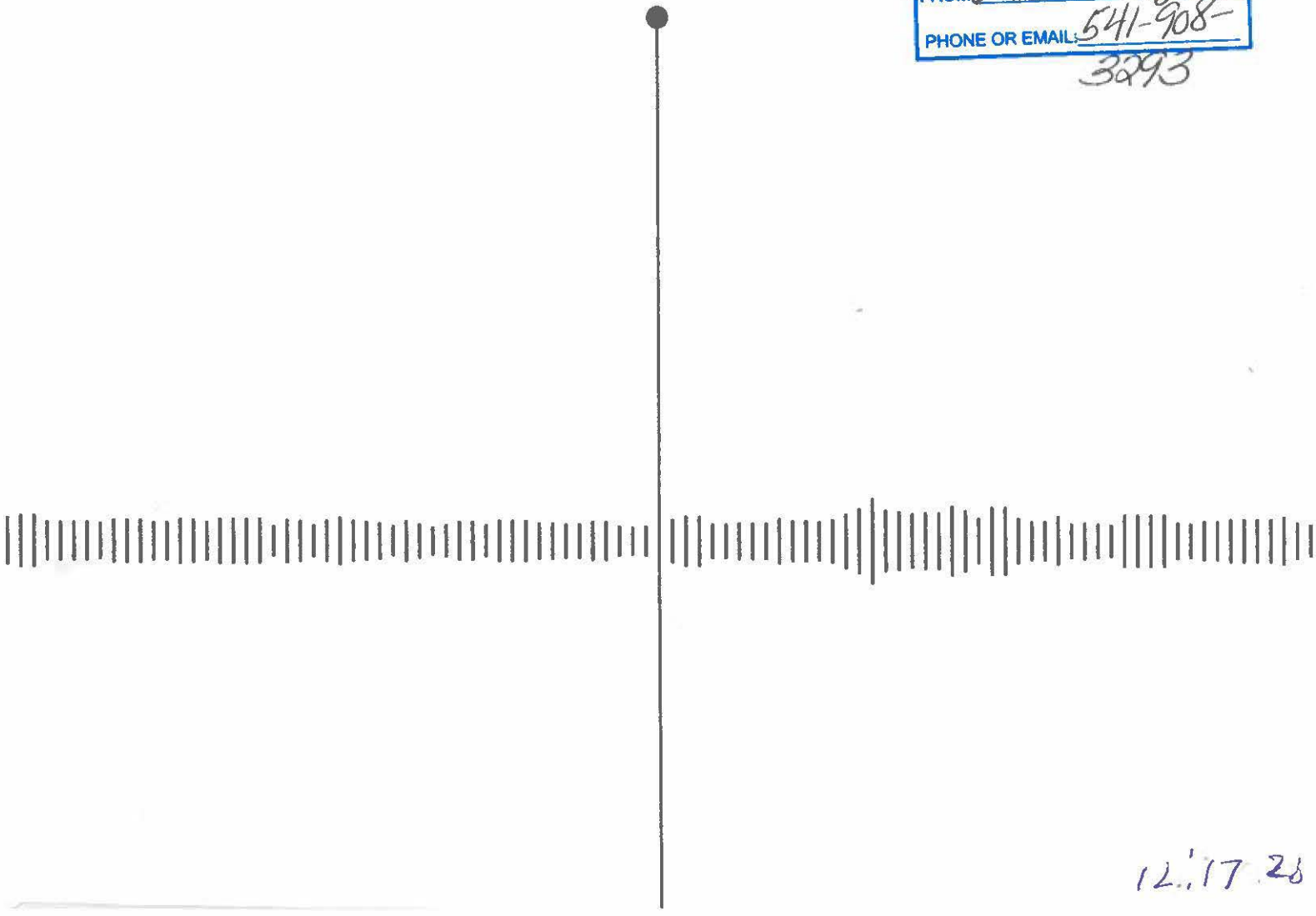
If approved we may loose our ability to operate entirely. The land would become uninhabitable ,for our programs and our animals. After seeing the last staff report and the recommendations for approval with conditions, I talked to a real estate broker .She said due to everything we are currently experiencing and location it would be a hard sell. We looked at properties comparable to what we had and none were affordable. We request that you reject LU-24-027 to ensure our continued service to the community. The proposed expansion would seriously interfere with uses on our adjacent property and Violates section 53.215(1)

6/10/2025

New Recording 5

1:21 PM 39:26

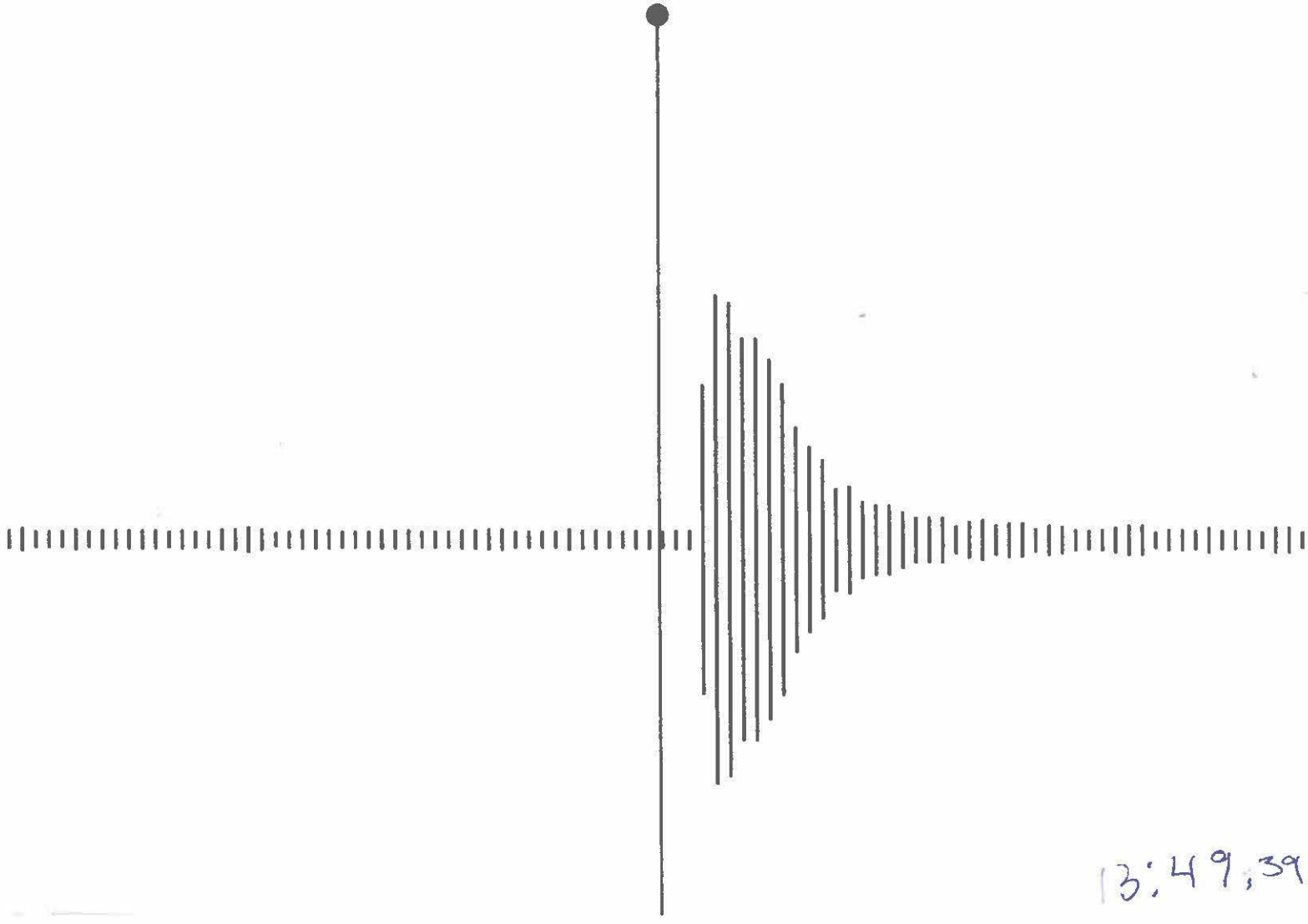
DATE RECEIVED:
FROM Erin Bradley
PHONE OR EMAIL: 541-908-3293



12.17.26

New Recording 5

1:21PM 39:26



13:49,39

DATE RECEIVED: 9/9/2025
FROM: McKenna Bradley
PHONE OR EMAIL:

My name is Mckenna Bradley and I live at 38578 Hwy 99w Corvallis 97330 and I oppose the land use application Lu-24-026

My home is south of Coffin Butte Road and it shares two borders with the proposed expansion.

I am 17 years old and a senior at Crescent Valley High School, I am also entering my freshman year at LBCC to complete college credits during high school.

I'm also highly involved in 4-h and am in 3 different 4h clubs as well as the president of two of those clubs for the second year in a row. I also host 2 practice pre fairs for my club at my house.

I competitively high dollar show cattle at the state and Regional level. I have a cow Potato that has won multiple Supreme Championships when she was a heifer. Her calf paisley that I bred and raised is now 11 months old and beginning her jackpot career. On top of all that I breed and show Nigerian Dwarf goats and show and care for my horses.

I want to share with you my lived experience of living by the land fill for 17 years of my life. and present you with bags of trash collected from our property. This trash doesn't belong to us but it still ends up scattered along my fields! This trash belongs to Republic landfill. This trash has been gathered after falling down from the sky, onto my property or flying into my pastures from republic trucks. On the back is labeled contents and what the items can do to my livestock. Our land is currently polluted every single day the landfill is open. It's not just the trucks polluting, it's also trash blowing over the trees onto our property.

From years of this trash accumulating It's now imbedded below the grass and a hazard when the roots are pulled up by my grazing livestock. No matter how hard I try I just can't get rid of it. For years I have walked my pastures picking up these pieces, but they never stop coming...

Did you know it doesn't take a whole plastic bag to kill a horse, cow or goat? Did you know plastic can affect the reproduction of livestock and their fertility rates? If not then I will provide three different studies that are peer reviewed. I wanted to provide these studies because studies without peer review are often false information.

My cattle have been purchased all by myself from profits earned by my hard work of raising and selling my livestock. The feed and medical bills are paid for by myself. I put in over 3,000 hours into raising my livestock each year let that sink in.

I can't use my pastures anymore to put my livestock out to roam right now because I can't risk my animals dying. Because of this I have to hand-walk cattle daily instead of letting them roam happily outside. This also increases the cost of my hay bill and has my fields having to be manually cut which increases fire risks in the summer.

Another reason I can't put out my livestock is If I lose my livestock or they remain un-bred due to fertility problems caused by this affects my funds set away for college.

I plan to join the LBCC nationally ranked livestock judging team next year after I graduate high school. I also plan to go onto a 4 year university and get my degree and ultimately receive my masters and PHD in Animal nutrition. If I miss one piece of the debris similar to what is in those bags I may lose an animal. This would be a big loss for my schooling fund and a loss of a friend.

The cattle have also been stressed With the current blasting

All and all the Lu-24-027 land use application needs to be denied entirely not just on conditions. Not just for the future safety of my animals but for the next generation of kids that will inherit this land near the landfill from their families just like myself.

DATE RECEIVED: 7-9-25
FROM: McKenna Bradley
PHONE OR EMAIL: 541-998-8490

animals

MDPI

Review

Impact of Microplastics and Nanoplastics on Livestock Health: An Emerging Risk for Reproductive Efficiency

Susy Urli [1], Francesca Corte Pause [1], Martina Crociati [2,3,*], Anja Baufeld [4], Maurizio Monaci [2,3] and Giuseppe Stradaioli [1,*]

1 Department of Agricultural, Food, Environmental and Animal Sciences, University of Udine, Via Delle Scienze 206, 33100 Udine, Italy; susy.urli@uniud.it (S.U.); francesca.cortepause@uniud.it (F.C.P.)
2 Department of Veterinary Medicine, University of Perugia, Via S. Costanzo 4, 06126 Perugia, Italy; maurizio.monaci@unipg.it
3 Centre for Perinatal and Reproductive Medicine, University of Perugia, 06129 Perugia, Italy
4 Research Institute for Farm Animal Biology (FBN), Wilhelm-Stahl-Allee 2, 18196 Dummerstorf, Germany; baufeld@fbn-dummerstorf.de
* Correspondence: martina.crociati@unipg.it (M.C.); giuseppe.stradaioli@uniud.it (G.S.); Tel.: +39-075-5857620 (M.C.); +39-0432-558580 (G.S.)

Simple Summary: Due to its multiple properties, such as stability, hardness and economic prices, the application of plastics has gradually increased, becoming essential in every industry. Since 1950, the worldwide plastic distribution has progressively created a serious pollution issue caused by difficulties in proper recycling, which has led to the presence of plastic fragments, called microplastics and nanoplastics (MPs/NPs), in the environment. The majority of the research has focused on the aquatic pollution, while studies regarding soil contamination are still poor, with the necessity to better understand how MPs/NPs can enter the food chain and reach humans passing through both crops and animals. Therefore, there is a need for evaluation, and the present work will provide an overview of the sources and distribution of MPs/NPs in farms; different mammalian exposure (digestion, inhalation and dermal contact) and associated risks and health problems caused by these fragments. In particular, this review aims to provide information on the effects, mainly from additives (such as Bisphenol A-BPA), on livestock reproduction and fertility.

Abstract: Pollution due to microplastics and nanoplastics is one of the major environmental issues of the last decade and represents a growing threat to human and animal health. In aquatic species, there is a large amount of information regarding the perturbation of marine organisms; instead, there are only a few studies focusing on the pathophysiological consequences of an acute and chronic exposure to micro- and nanoplastics in mammalian systems, especially on the reproductive system. There are several studies that have described the damage caused by plastic particles, including oxidative stress, apoptosis, inflammatory response, dysregulation of the endocrine system and accumulation in various organs. In addition to this, microplastics have recently been found to influence the evolution of microbial communities and increase the gene exchange, including antibiotic and metal resistance genes. Special attention must be paid to farm animals, because they produce food such as milk, eggs and meat, with the consequent risk of biological amplification along the food chain. The results of several studies indicate that there is an accumulation of microplastics and nanoplastics in human and animal tissues, with several negative effects, but all the effects in the body have not been ascertained, especially considering the long-term consequences. This review provides an overview of the possible adverse effects of the exposure of livestock to micro- and nanoplastics and assesses the potential risks for the disruption of reproductive physiological functions.

Keywords: microplastics; nanoplastics; reproductive system; health; bovine; cow; cattle; BPA; granulosa cells; steroid hormone

check for updates

Citation: Urli, S.; Corte Pause, F.; Crociati, M.; Baufeld, A.; Monaci, M.; Stradaioli, G. Impact of Microplastics and Nanoplastics on Livestock Health: An Emerging Risk for Reproductive Efficiency. *Animals* 2023, *13*, 1132. https://doi.org/10.3390/ani13071132

Academic Editors: Filippo Giarratana and Luca Nalbone

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DATE RECEIVED: 7-4-25
FROM: McKenna Bradley
PHONE OR EMAIL: 541-990-8490

ELSEVIER

Small Ruminant Research 30 (1998) 77–83

Small Ruminant Research

Pathology of the rumen in goats caused by plastic foreign bodies with reference to its prevalence in Jordan

N. Hailat[a,*], A. Al-Darraji[a], S. Lafi[b], S.A. Barakat[c], F. Al-Ani[b], H. El-Magrhaby[b], K. Al-Qudah[b], S. Gharaibeh[b], M. Rousan[b], M. Al-Smadi[a]

[a] *Pathology Laboratory, Department of Clinical Veterinary Sciences, Faculty of Veterinary Medicine, Jordan University of Science Technology, Irbid, PO Box 3030, Jordan*

[b] *Department of Clinical Veterinary Sciences, Faculty of Veterinary Medicine, Jordan University of Science Technology, Irbid, PO Box 3030, Jordan*

[c] *Department of Chemistry, Faculty of Science, Jordan University of Science and Technology, Irbid, PO Box 3030, Jordan*

Accepted 27 December 1997

Abstract

The lesions in rumens of goats with soft foreign bodies (SFB), namely plastics, and its prevalence in Jordan are investigated. In cases where hard masses of plastics were seen, congestion, erosions, focally denuded areas and focal thickening of nodular- and proliferative-type were seen in the mucosal wall of the rumen. Shortening and stunting of the papillae with irregular distribution, and in some cases thinning of the walls were also observed. Histopathologic examination revealed the presence of rumenitis and prolonged rete pegs with a papillary or frond-like downward growths. This hyperplastic growth also took the shape of numerous epithelial islands of variable thickness, approaching the muscularis mucosae. These revealed differentiated stratified squamous epithelium with intercellular bridges, keratin formation and with several mitotic figures as seen under a high-power field (40×). In cases where floating plastic was found, the changes were less prominent. These findings suggest that plastics play an important role in the pathogenesis of rumenitis and ruminal hyperplasia. This could be the consequence of partial degradation and/or chronic irritation of plastics. Out of 347 rumens examined in the summer of 1996, 39 (11%); 10/136 (7%) rumens at Ajloun and 29/311 (7%) at Irbid slaughterhouses contained plastics. Out of the 888 goats brought to the Veterinary Health Centre (VHC) from January 1993 to September 1997 for treatment of different conditions, 32 (3.6%) had plastic impaction and were treated by rumenotomy of which 32/722 (4.5%) were older than one year. Out of 28 goats brought dead to VHC for routine necropsy examinations, three goats had plastic impaction. No significant differences were found in the prevalence of plastic among Shami, local and mixed-breed goats. These results suggest that subclinical cases exceed clinical ones. The prevalence, although when compared with our previous results in sheep, is low, yet it is still considered quite high and public awareness and anti-littering laws and a clean-up of the environment would substantially reduce this problem in Jordan. © 1998 Elsevier Science B.V. All rights reserved.

Keywords: Goats; Plastics; Rumen; Hyperplasia; Prevalence

*Corresponding author. Tel.: 009622295111 Ext. 2037; fax: 00 962 2 295123.

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PHONE OR EMAIL: 541-990-8490

RESEARCH ARTICLE

PLASTIC BAGS - THREAT TO ENVIRONMENT AND CATTLE HEALTH: A RETROSPECTIVE STUDY FROM GONDAR CITY OF ETHIOPIA

Velappagoundar Ramaswamy[1†] and Hardeep Rai Sharma[2*]

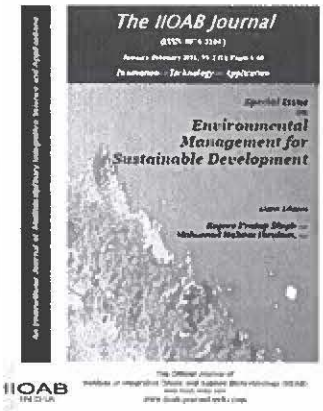
[1] *Associate Professor, Unit of Clinical Studies, Faculty of Veterinary Medicine, University of Gondar, P. O. Box No. 196, Gondar, ETHIOPIA*

[2] *Associate Professor, Department of Environmental and Occupational Health and Safety, College of Medicine and Health Sciences, University of Gondar, P. O. Box No. 1319, Gondar, ETHIOPIA*

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***Corresponding author:** Email:* kalindi99@rediffmail.com; †vetsurgeonerode@yahoo.co.in Tel: +251-918775622; Fax: +251-581111479

ABSTRACT



A retrospective study was conducted in Gondar city of Ethiopia for six years (2004/05 to 2009/10) to observe the impact of plastic bags usage on environment and cattle health. Paper packaging is vanishing slowly in the city and limited to small shops only. Open dumping of plastic bags containing wastes is observed commonly near road side, open plots, river side, in drains and public places however, it is prohibited under Ethiopian law. Winds carry bags to distant areas sometimes found entangled on the trees and shrubs create nuisance. During rainy season, the blockage of drains and overflowing of water was observed in some areas of the city. During study period, out of 711 rumenotomies done, in 111 (15.61%) and 600 (84.39%) animals, emergency rumenotomy and elective rumenotomy was performed, respectively. The quantity of the foreign bodies (FB's) collected from the rumen was ranging from 0.75 to 2.0 kg in 28 animals (3.94%); 2.0 to 5.0 kg in 116 animals (16.32%); 5.0 to 9.0 kg in 217 animals (30.52%) and above 9.0 kg in 350 animals (49.23%). Due to absence of plastic recycling unit in the Gondar city or in nearby areas, there is no practice of collecting and selling these products to junk dealers. Use of reusable bags made of cloths, jute and other natural fibers must be encouraged. In order to save the life of animals, residents should not pack and throw the food items in plastic bags. The cattle owners may be advised not to allow their cattle to freely wander in streets especially in the cities. They should see that the grazing lands are not polluted with the polythene and other wastes. Awareness may be created on careless disposal of plastic bags and as well as the periodical cleaning of these wastes in the grazing area.

Keywords: *plastic bags; cattle health; environmental effects; rumenotomy; reuse; Gondar*

[1] INTRODUCTION

Every year trillions of polythene bags are used in the World. They persist on this earth to haunt us and our generations for centuries. Polythene chokes the drains and the water bodies, pollutes the land and poisons us slowly but surely. Even mowed grass cannot escape the polythene menace [1]. Polythene has been recovered from the rumen of countless cattle and is a major threat to animals also. Polythene pollution is an epidemic now. Polythene is indestructible. One particle of polythene is further made of many particles. If we continue to use polythene, the earth would become polluted on an alarming rate [2].

The word plastic has its origin from the Greek word "plastikos", which means 'able to be molded into different shapes' [3]. They are made up of long chain polymeric molecules [4] and basic materials used for their manufacturing is extracted from oil, coal and natural gas [5]. Plastic or polythene bags commonly known as festal in Amharic language are in common use as shopping

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bags for packaging food, and other items in Gondar city as well as other parts of Ethiopia. In addition to polythene bags, plastics are used in bottling of mineral water, cold drinks and liquid soap, which become part of waste after use. Majority of the residents collect their household wastes in plastic sacks and place them roadside on every Friday until it is carried away by private waste collectors in the city. Their better physical and chemical properties of being strong, light in weight, resistance to water and most water-borne microorganisms make them preferable choice over paper and reusable cloth and jute bags. Plastic consumption is growing at a rate of approximately 5% annually, and the global production reaching about 150 million tons per year [6].

After their entry to environment, plastics resist biodegradation and pollute for decades and centuries [7], and pose risk to human health and environment [8]. They are resistant to moisture, travel long distances because of their light weight, block drains during rains, and may also trap birds. Plastics cause "visible pollution" as they contribute to large volume of total municipal solid wastes and are major threat to air [9], oceans [10], soil [11], livestock [12,13], wildlife [14] and marine life [15]. Approximately, 95% of urban stray cattle in India are suffering from various ailments due to hazardous materials, mostly plastic bags inside their abdomen [13]. These plastics reduce the rain water percolation, affecting the ground water recharge and level. Soil fertility and seed germination is also affected when these plastic bags become part of manure and reaches agricultural fields. Presently there is no recycling unit of plastic bags in Gondar city so most of these plastics become part of municipal waste. As per literature survey limited work is done on this aspect in Ethiopia [16], so this study was designed to assess the impacts of plastic usage on environment and cattle health and to put forward some alternatives about plastic bags usage. The data obtained would be a baseline for the further research.

[II] MATERIALS AND METHODS

2.1. Study area

Gondar city, the capital of North Gondar zone in Amhara regional state, is located 750km North-west of capital city of Addis Ababa [Figure-1]. It is situated between 12°36'N and 33°28'E at an altitude of about 2300 m above mean sea level with an average temperature of 20°C and an average annual rainfall of 1800 mm. Being a highland area, the city is spread on different mountains, slopes and in valleys and has three small rivers, many streams and a lake. The city with a population of 186,077 [17], has 21 kebeles (wards), one hospital, three health stations, two health centers, one university, three veterinary clinics, four colleges, six secondary schools, one preparatory school (Senior Secondary School), one technical and vocational school, 27 primary schools, 13 kindergartens and an airport. The city has historical importance of being the capital of Ethiopia from 1635 to 1855 G.C. and has many medieval castles and churches.

2.2. Methodology

The retrospective study period was six years (2004/05 to 2009/10) and the data was collected by:
1. Personal observation.
2. Case study analysis i.e. by observation of cases registered under three veterinary clinics.
3. Key informant interview i.e. by conducting interviews of animal health assistants working in veterinary health service and private veterinary practitioners of Gondar city.
4. Transect walk observation.

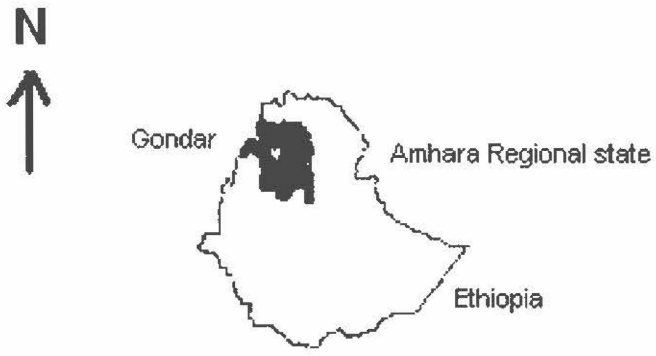


Fig: 1. Map of the study area

[III] RESULTS AND DISCUSSION

3.1. Increasing trend of plastic bags use

During the study period, authors observed an increasing trend of using plastic bags among Gondar city residents. A developing trend of "use and throw-away" towards these polythene bags is the main cause of the problem. During 2004-2008, shopkeepers sell these bags and provide the bags to those customers purchasing more items. The trend changed slowly and up to 2009, these plastic bags were given free of charge to shoppers. In some years residents of the city will be accustomed to plastic bags use that they find it difficult to change their habits. Paper packaging is vanishing slowly in the city and limited to small shops only. Locally made bags from big empty plastic sacks are in use on Saturday market day in the city but they are also losing their charm in the race of modernization. These plastic bags do not contribute much in terms of volume and weight to municipal solid waste (MSW), but the main problem is the disposal of these bags after use. Presence of used bags causes aesthetic disturbance of the city's hilly landscape.

3.2. Current practices of plastic bags use and their environmental impacts

Open dumping of residential wastes including plastic is observed commonly in almost all wards of the city. Dumping is commonly observed near road side, open plots, river side, in drains and public places however, it is prohibited under Ethiopian law [18]. Residents used commonly plastic sacks and polythene bags for storing their wastes, which ultimately become part of MSW. From the temporary and final waste disposal sites, the stray and other domestic animals like cattle and donkeys engulf these

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plastic bags containing food materials inside. Sometimes the street boys were also found to sort large size and good quality bags for their use. Winds carry away these bags to distant areas which were sometimes found entangled on the trees and shrubs and creates nuisance. During rainy season, the blockage of drains and overflowing of water was also observed in some areas of the city. Sometimes residents pack and throw the food items in the plastic bags. The stray and other animals were unable to open these bags and were found to consume whole plastic bags. In due course of time, the amount of plastic bags got accumulated in the stomach of these animals and create health problem for these animals. Intentional open burning of waste along with plastic bags is also a commonly observed practice in the city leading to problem of local air pollution with harmful gases.

As per the section 8 of Ethiopian Government Proclamation, passed in February 2007, any unlabeled plastic bag will be treated as unlawful and also bans the manufacture and import of plastic bags less than 0.03 mm in thickness [18]. Authors observed different colors of unlabelled plastic bags available and provided commonly in Gondar city, which are against the government law and need to be controlled.

3.3. Effects on cattle health

The plastic bags along with other foreign bodies in cattle affect the health and cause economic loss to the owner. The cattle have three non-glandular fore-stomach compartments - the rumen, reticulum and omasum. These are the sites for fermentative digestion. The fourth glandular compartment, the abomasum is the "true stomach" which is responsible for the next phase of enzymatic digestion. The indiscriminate eating habits and mineral deficiency make them susceptible to inadvertent ingestion of foreign materials [19, 20]. The various pathological conditions that are encountered due to ingestion of plastic and polythene materials in animals are indigestion, impaction, tympany, polybezoars, and immunosuppression [13]. The most common symptoms observed in the affected animal were bloat and were exhibited by the abnormal bulging of the paralumbar fossa on the left side of the abdominal wall. The other clinical symptoms were depression, complete or partial anorexia followed by loss of weight, ruminal impaction, reduction of milk yield, and suspended rumination. Milk and weight reduction in the affected animals was variable according to the stage of lactation, quantities of foreign bodies ingested and severity of the bloat. However accurate data in this regard was not maintained properly by the respective clinics. Acute bloat causes more pressure over the diaphragm and ribs which limits the respiratory movements, leading to hypoventilation and decreased venous return to the heart [19]. Lack of emergency and timely treatment of acute bloat may lead to cattle mortality. When the conservative line of treatment fails to correct these ailments of rumen, the only alternative is rumenotomy, which is surgically opening the rumen for treating its various ailments and to remove a variety of foreign bodies. A total of 711 rumenotomies were performed in the Gondar city area during the study period [Table– 1].

The bloat or tympanites may occur in different forms like acute, chronic recurrent, simple or frothy bloat. Out of the 711 rumenotomies done, in 111 (15.61%) and 600 (84.39%) animals, emergency rumenotomy and elective rumenotomy were performed, respectively. The ruminal tympany occurs during obstruction due to foreign bodies occluding the passage of eructing gases [26]. Farmers who could not arrange timely treatment used to lose their animals. The acute bloat was due to the complete obstruction of the rumino-reticular orifice and the ingesta could not be moved to the next compartment and the stasis resulted in accumulation of the fermented gas in the rumen.

In the cases of recurrent bloat the distension of the rumen reduced subsequent to conservative line of treatment. In these cases the obstructing foreign bodies were shifted to other parts of rumen resulting in temporary relief of bloat which recurred after few days. Ruminal impaction is due to the obstruction caused to the movement of the ingesta to the next compartment and it was noticed in 148 (20.83%) animals. It has been observed that cows with polythene materials in their stomach suffer from immunosuppression that leads to increased sensitivity to various infections [13].

Table: 1. Details of rumenotomies performed in the Gondar city during 2004-2010

Sl. No.	Place of surgery	Number of cattle operated
1.	Gondar university veterinary clinic	85
2.	Gondar woreda veterinary clinic	99
3.	Animal health assistants (private practice)	502
4.	Private veterinary clinic, Gondar	25
Total		711

Table: 2. The details of quantity of the foreign bodies (FB's) collected during rumenotomy

Sl. No	Quantities of FB's recovered (Kg)	No of animals	%
1.	0.75 - 2.0	28	3.94
2.	2.0 - 5.0	116	16.31
3.	5.0 - 9.0	217	30.52
4.	> 9.0	350	49.23
Total		711	100

The foreign bodies recovered by transruminal exploration during rumenotomy are broadly classified into penetrating (nails, wires) and non- penetrating foreign bodies (polythene bags, plastic materials, rubber articles, leather pieces, and cloths) as found in the cattle [Figure– 2 and – 3]. Other workers in different part of World encountered metallic objects [21], cloths [22] and

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polythene bags [23] in the gastrointestinal tract of ruminants, causing ruminal obstruction and occlusion. The foreign bodies were mostly dark black in color and their shapes modified into ball-like and other shapes and their texture was also altered to be tougher than original. The above changes in foreign bodies were



Fig: 2. Large quantity of foreign bodies recovered after rumenotomy.

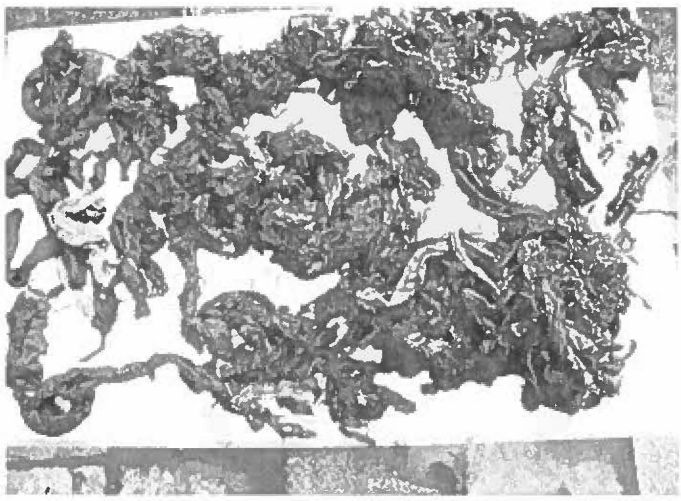


Fig: 3. Varieties of foreign bodies removed from a cow

due to churning action by the contraction of the rumen and reticulum and also by the action of the micro flora population inside. These large tight balls inside the rumen cause impaction. In some animals the churned up masses get fused together and make it difficult to remove through the rumenotomy opening and have to be cut into pieces and removed. The quantity of the foreign bodies collected from the rumen were ranging from 0.75 to 2.0 kg in 28 animals (3.94%); 2.0 to 5.0 kg in 116 animals (16.31%); 5.0 to 9.0 kg in 217 animals (30.52%) and > 9.0 kg in 350 animals (49.23%) [Table-2]. The items rarely recovered were a small boy's trouser, belt and screw driver. In some unusual cases about 70% of the rumen was impacted with the foreign bodies. On exploratory rumenotomy twenty-two hair balls were recovered from the rumen and reticulum of a goat [24]. In an unusual case of rumenotomy in a cow revealed a large empty cement bag with its part embedded in the reticulo-omasal orifice obstructing the ingesta [25].

In all the cases the animals showed symptoms of pain exhibited by depression, arched back and grunting. Apart from this there was sudden drop in milk yield and 75% reduction was noticed incurring a heavy economic loss to the farmer. Losses or costs of several kinds occur like losses by death and by culling of bloat prone animals, losses of production from animals which suffer from bloat and survive, losses due to the disruption of normal farm work and management programs, losses due to the use of less productive but safer pastures, and the cost of preventive measures and treatment. Not measurable in monetary terms is the mental and physical strain on the farmer and his family when an outbreak occurs. Other costs those of research and extension services must be added [27].

3.4. Reuse and recycling

It's very difficult to impose complete ban on plastic bags use and plastic packing until there is fully equitable alternative available. The four R's as feasible options for achieving reduced material use and waste generation are Reduction, Reuse, Recycling and Recovery. Presently only reduce and reuse option are feasible in Gondar. As there are no recycling units for plastics in the Gondar city or in nearby areas, there is no practice of collecting and selling these products to junk dealers. However, the residents were found to reuse good quality of big size plastic bags. The reuse of these bags was observed among small shopkeepers and rural people, who sell vegetable in Saturday market. The residents had a good practice of reusing mineral water and cold drinks plastic bottles for pouring milk, oil, and "tella", a local beverage therefore contributing in reducing the amount of waste. In our previous study, the respondents were agreed to participate in segregating and storing the wastes provided there is some recycling unit which can buy their segregated wastes [28].

3.5. Options

Reusable bags made of cloths, jute and other natural fibers are durable, having long life span, biodegradable and above all environment friendly. Further reusable bags are washable, easy to carry and handle, will not break under the weight of heavy shopping items, reduce use of plastic bags, and do not pose a threat to environment and wildlife. Such types of bags are already in use in Addis Ababa, the capital city of Ethiopia and also seen occasionally in Gondar. Even plastic bags can be reused again and again so that threat to environment and life can be reduced. If possible we can refuse unnecessary packing of

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purchased item in plastics. In order to save the life of cattle, residents should not pack and throw the food items in plastic bags. The cattle owners may be advised not to allow their cattle to freely wander in streets especially in the cities. They should see that the grazing lands are not polluted with the polythene and other wastes. Awareness may be created on careless disposal of plastic bags and as well as the periodical cleaning of these wastes in the grazing area. Creating awareness among city residents regarding indiscriminate use and disposal of plastic bags will be a good option to overcome the problem in future. The non-governmental organization named "SOS Addis Tefetron Bemalimat Bikletin Masweged Mahiber" in Addis Ababa is engaged in generating awareness among Addis Ababa residents [29]; however such types of activities are needed in other parts of Ethiopia.

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ABOUT AUTHORS



Dr. Velappagoundar Ramaswamy *is an Associate Professor of Surgery in Faculty of Veterinary Medicine, University of Gondar, Ethiopia. He is a veterinary surgeon, academician, researcher and consultant. He served at different positions in Department of Veterinary Surgery and Radiology, Veterinary College and Research Institute Namakkal; Veterinary University Training and Research Center, Erode, Tamil Nadu, India. He has authored and coauthored about 15 publications in his field.*



Dr. Hardeep Rai Sharma *is an Associate Professor of Environmental Science in Department of Environmental and Occupational Health and Safety in University of Gondar, Ethiopia. He has taught various courses at university and college level in India and Bhutan. He has authored and coauthored about 20 publications in the areas of water quality, heavy metals and pesticide residues in different environmental components, municipal waste management and religion and environment. He is a life member of Ethiopian Red Cross Society, Ethiopian Public Health Association, Occupational Safety and Health Professionals-Ethiopia, Indian Water Works Association, and a member of Editorial board of Ethiopian Journal of Health and Biomedical Sciences and reviewed papers for national and international journals. He is Honorary Associate Editor of "Environment & We: An International Journal of Science & Technology".*

July 7, 2025

DATE RECEIVED: 7/9/25
FROM: Angela Krueger
PHONE OR EMAIL:

Angela Krueger
Ryan Wilson
28903 Tampico Road
Corvallis, Oregon 97330

To: Benton County Planning Commission

RE: Opposition to LU-24-027 Land Use Application

Dear Commissioners,

We respectfully urge you to deny the proposed landfill expansion application LU-24-027. Our family lives on and operates a cattle ranch (dba Krueger West Cattle Company LLC). We graze cows on Exclusive Farm Use (EFU) land at 28903 Tampico Road, just south of the proposed landfill expansion site.

Currently, the existing landfill operation north of Coffin Butte Road seriously interferes with the use of our property and threatens the health of our livestock and the viability of our business, primarily due to trash blowing onto our grazing land, and through the frequent and persistent odors from the dump. The threat of groundwater becoming contaminated through leaks from the landfill is ever present. We water our cows almost exclusively from an under-ground spring and contamination could be extremely detrimental to our livestock's health.

The proposed expansion parcel will bring both these impacts much closer to our farm operation and therefore the proposed expansion cannot meet the conditional use review criteria. The proposed landfill expansion will seriously interfere with uses on our adjacent property (BCC 53.215(1).

Cattle have been a part of my (Angela) life since I was in the third grade. As I was growing up showing cows in 4-H I decided that I wanted to have my own beef herd. Raising cattle on a property such as the one we live on now is literally a dream come true.

On our property we are continuously working to return the land back to its historic state by eradicating non-native vegetation, and encouraging the growth of oak trees and native plants. We use cattle to rotationally graze the pastures year-round. Since moving here, we have increased our herd to just shy of 30 cows. Our herd consists of mainly Purebred Herefords with some crossbred calves and two dairy heifers. Some

of the cattle we own now have genetic ties to my very first Hereford cow. These cows are not just cows to us this is a legacy we are creating.

Our steers and heifers raised for meat are born to mother cows on our land. They are raised their entire life on our pastures. We mainly sell beef in quarters, halves, and wholes to families in Benton and surrounding counties. In recent years we have started selling calves as 4-H steers and replacement heifers to other Oregon farmers.

Raising a beef herd is more than just an investment of money it is an investment of time and a lifestyle many would not be willing to participate in. We have spent the last 8 years building this herd from the ground up. Endless hours spent working for free and footing the bill for the business when it was not making a profit because the inputs like hay and grain were so expensive. Finally, we have found a groove that works. What scares us the most is the possibility of losing cattle because they consumed trash that has blown over from the landfill. If we have just one cow death it would put us financially in the red. How may years could we really continue if we started losing more cows because of this terrifying circumstance? The trash is not only harmful to our cow's welfare but also to the livelihood of our business. It would be heartbreaking to have to walk away from everything we have worked for because of the landfill expansion.

We are attaching a series of photos taken on our property over the past couple years and as recently as last week that document the trash being blown into our grazing pastures. There have been two instances where we have had to pull plastic out of the mouths of our calves to prevent them from eating it. It is nothing but sheer luck that we were in the right place at the right time. It is impossible to watch the herd constantly to prevent them from eating plastic blown in from the landfill. This cannot be allowed to continue and moving the landfill operation closer will only make the problem worse.

We ask you to reject LU-24-027 outright. There are no enforceable mitigation measures or conditions of approval that can be implemented to eliminate or reduce these impacts sufficiently to protect the uses on our property.

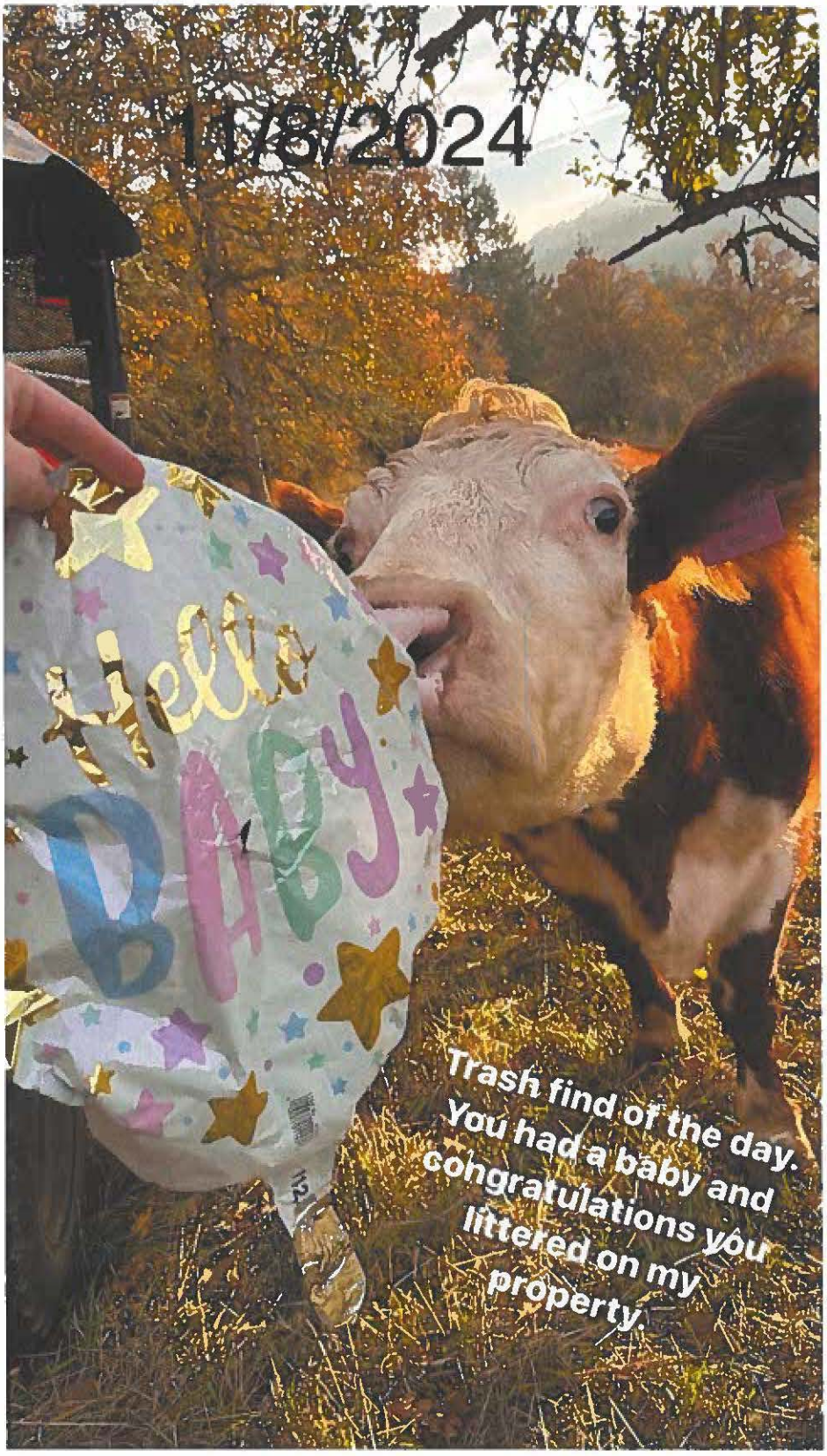
Sincerely,

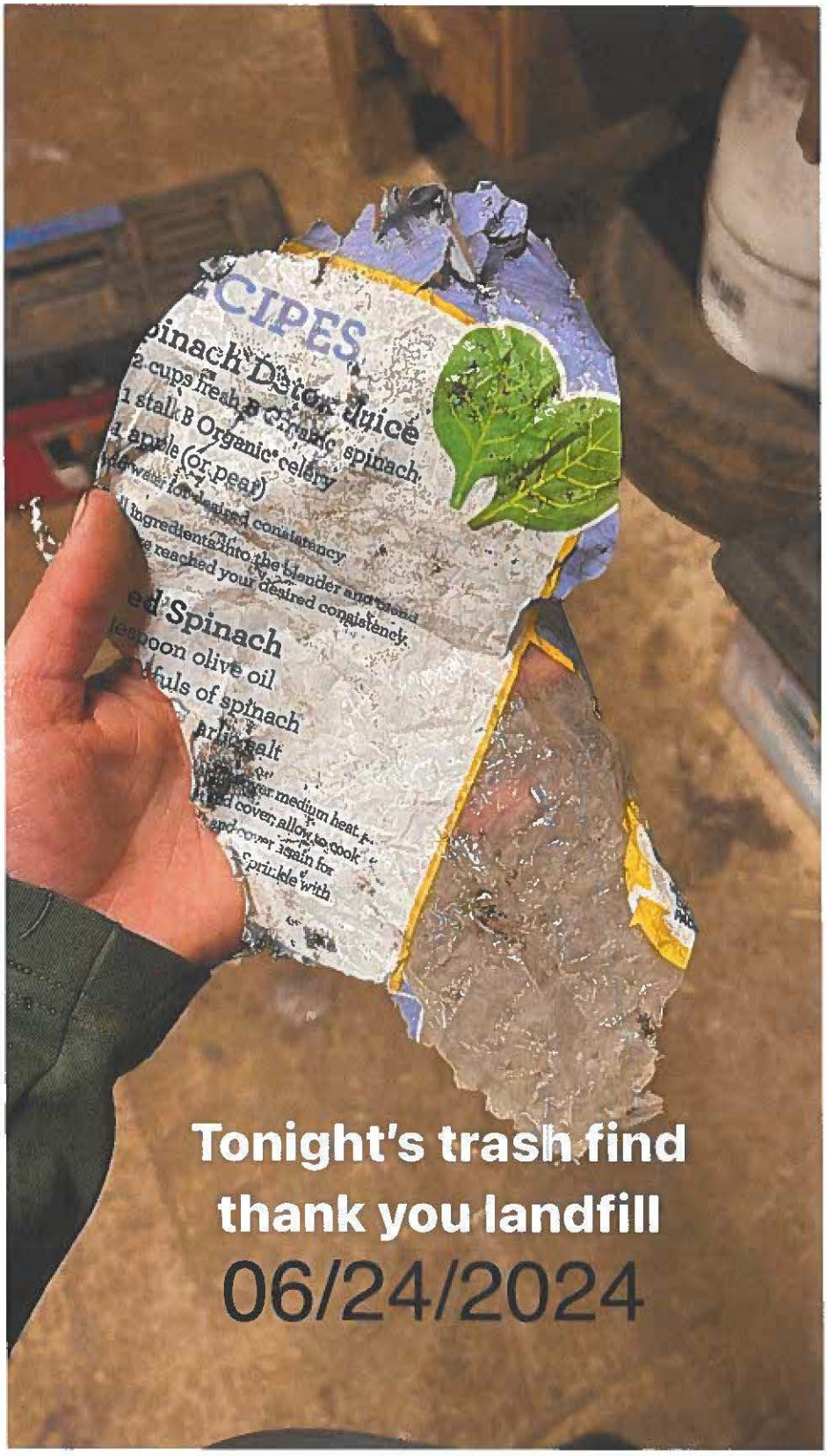
Angela Krueger
Ryan Wilson
28903 Tampico Road
Corvallis, Oregon 97330


Gifts from the landfill
05/19/2024


11/26/2024
Would it be a trip out to the pasture to check cows without finding dump trash?


PROTEIN BAR
CHOCOLATE CHIP COOKIE DOUGH
Trash find of the day. The problem with living too close to the Corvallis landfill.... 😢
09/18/23

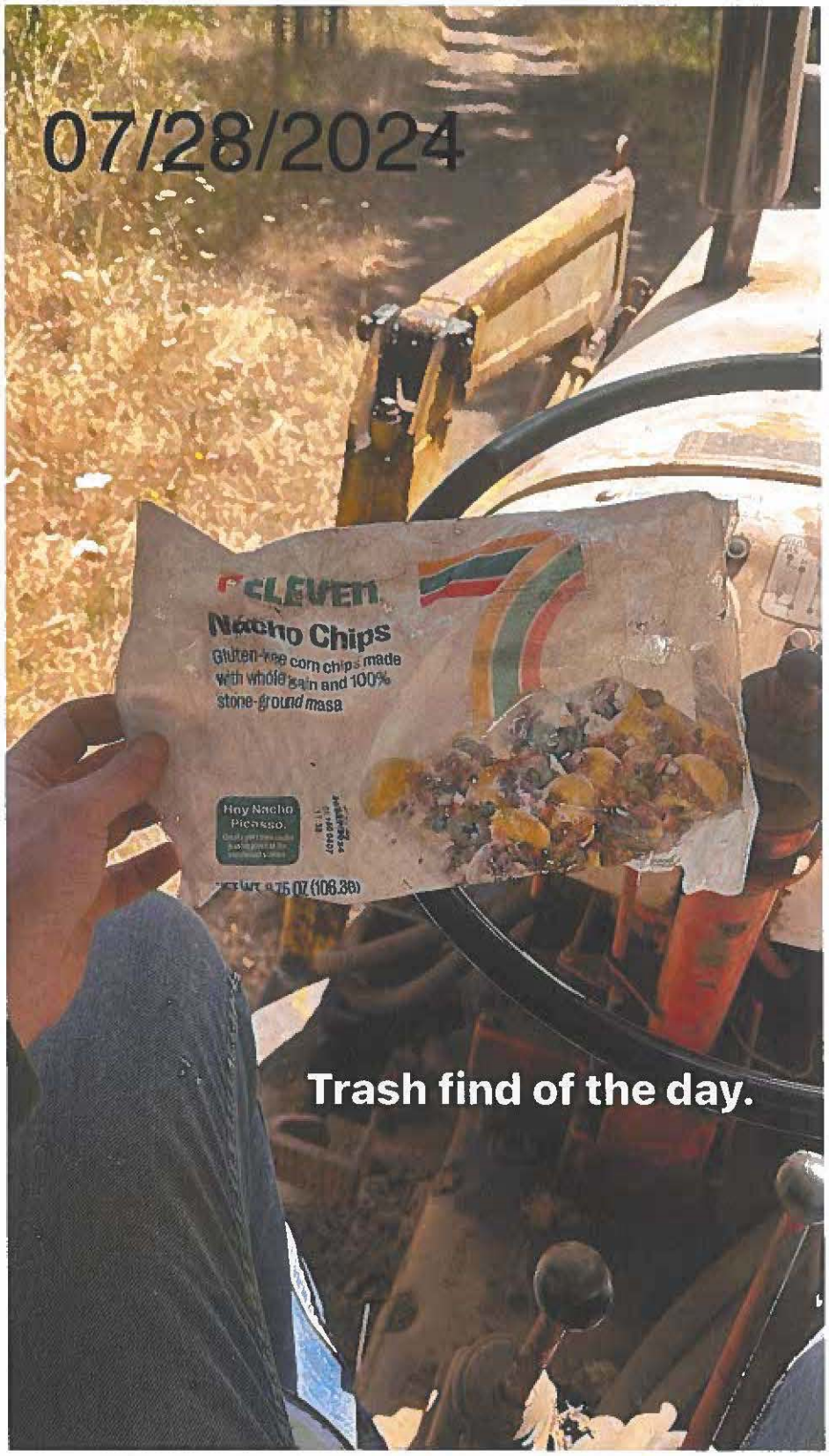

11/8/2024
Hello
BABY
Trash find of the day.
You had a baby and
congratulations you
littered on my
property.

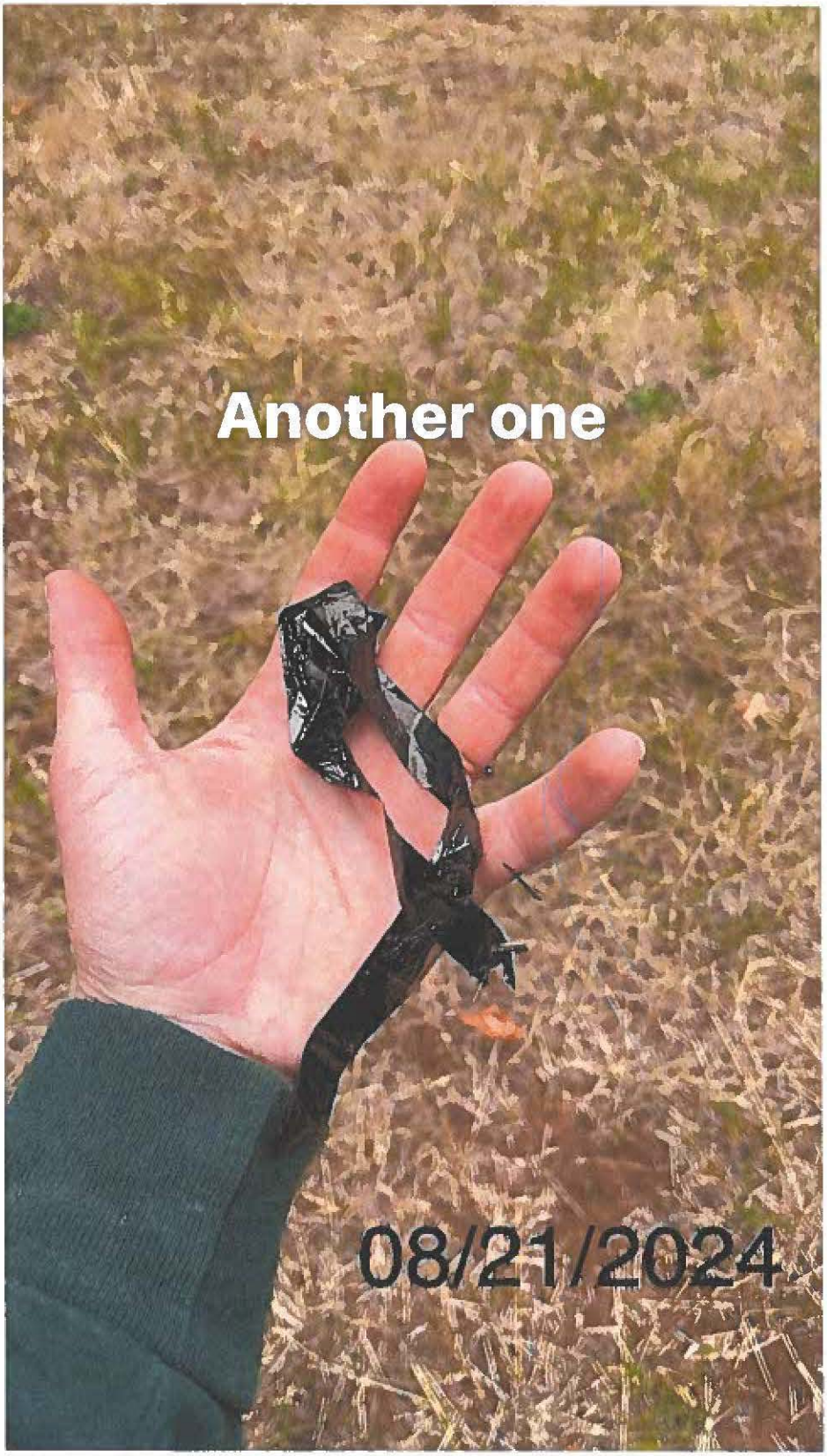

CIPES
pinach Detox Juice
2 cups fresh organic spinach
1 stalk B Organic celery
1 apple (or pear)
ed Spinach
spoon olive oil
fuls of spinach
Tonight's trash find
thank you landfill
06/24/2024


Would it be trip out to feed the cows without finding dump trash that's floated over?
02/08/2024


Another trash find.
Thank you landfill
07/02/2024

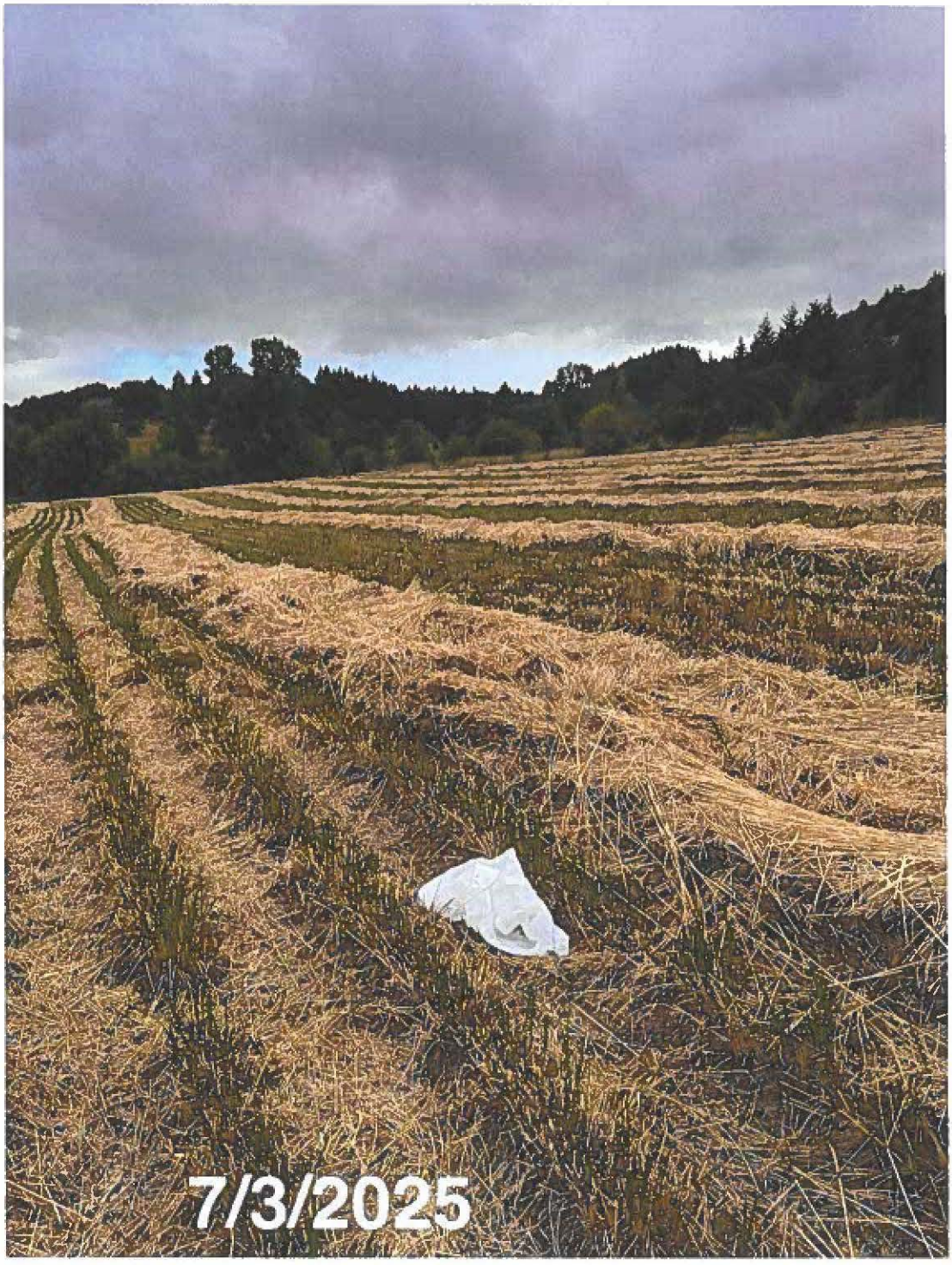

08/20/2024
Always trash, thanks
Coffin Butte Landfill
Synthetic
Biogel PI Indicator
Underglove


07/28/2024
7-ELEVEN
Nacho Chips
Gluten-free corn chips made with whole grain and 100% stone-ground masa
Hey Nacho Picasso.
Trash find of the day.


Another one
08/21/2024


Nutrition Facts
NATURE'S BAKERY
FIG BAR
7/1/2025

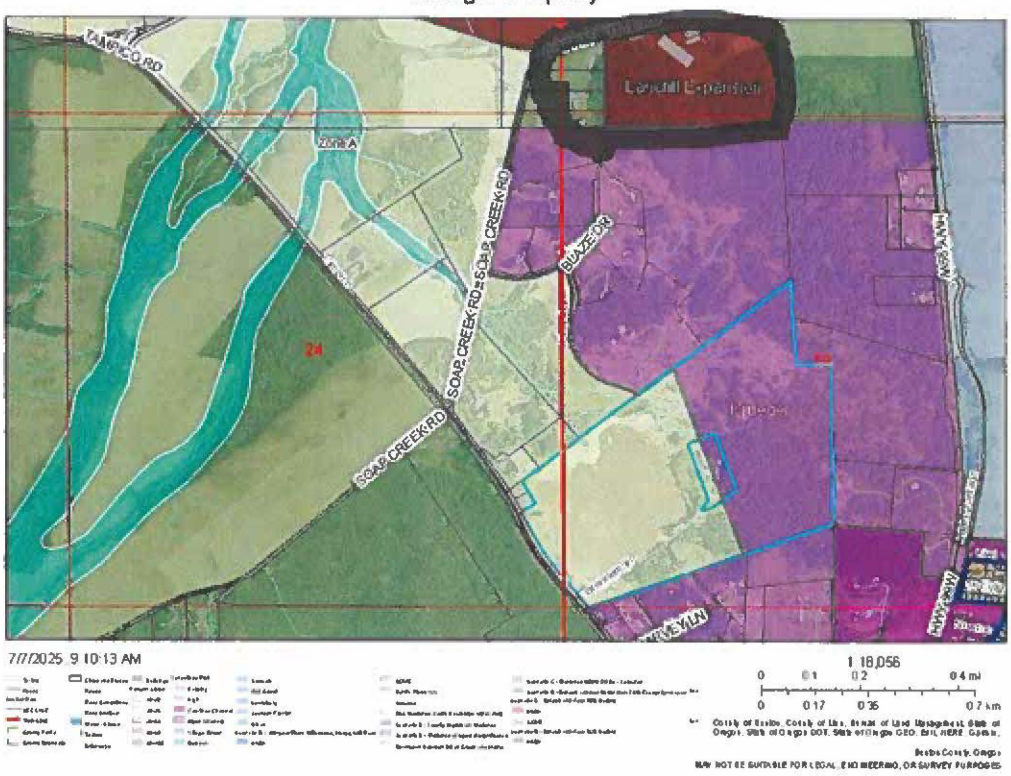

3/11/2025
Thank you Coffin Butte Landfill


7/3/2025


7/3/2025


7/5/2025

Krueger Property





LU-24-027 Supplemental Staff Report to Benton County Planning Commission

Benton County Exhibit 7 (BC7)
Compiled Testimony from Adjacent Property Owners/Residents

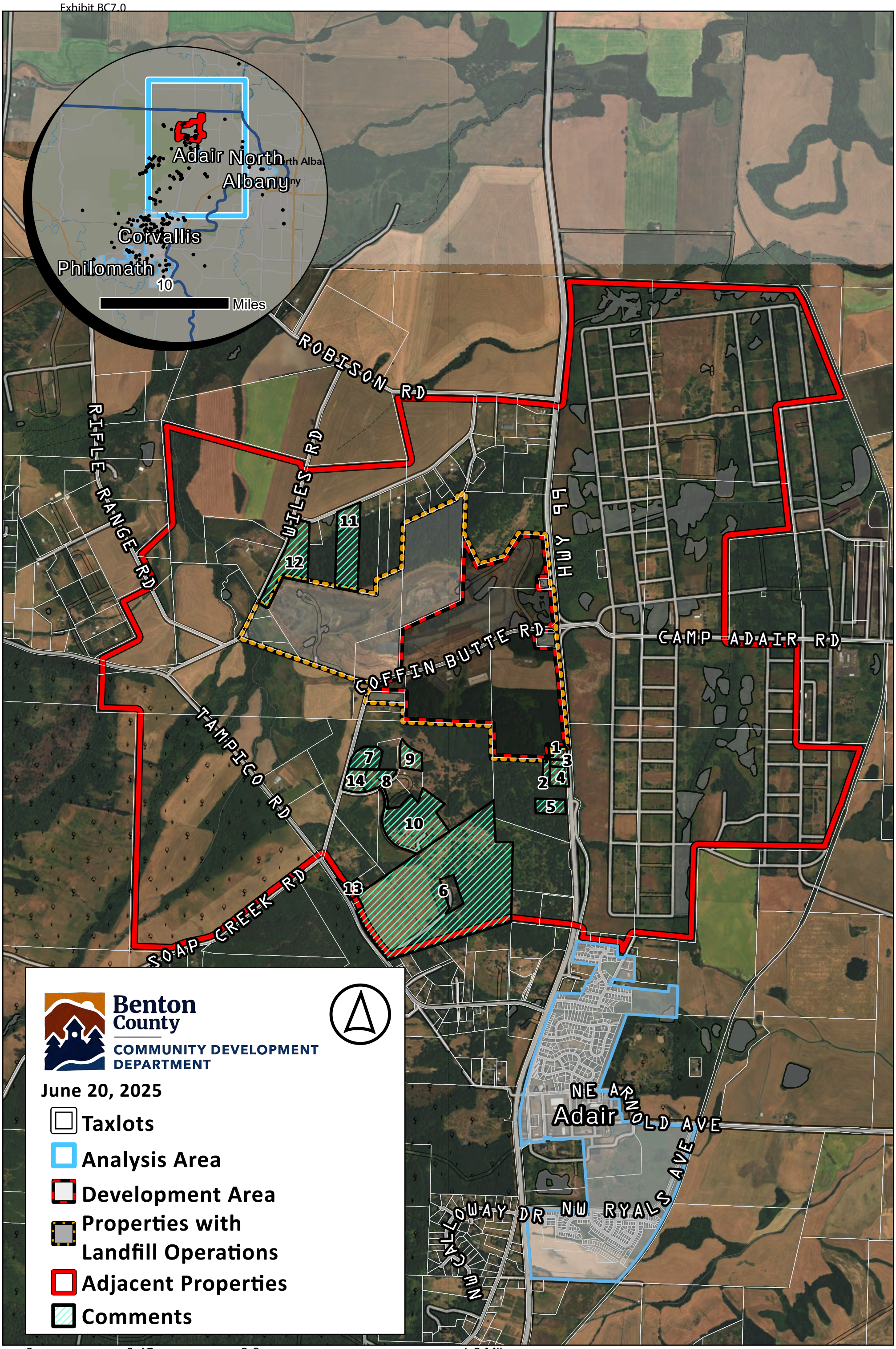
Contents:

BC7.0	Map of Testimony from Adjacent Properties
BC7.1	E. and L. Bradley
BC7.2	J. Searls
BC7.3	J. Geier
BC7.4	C. and P. Merrill
BC7.5	J. and P. Morrell
BC7.6	R. Wilson
BC7.7	G. Carlin
BC7.8	L. A. Davis
BC7.9	I. Finn
BC7.10	A., C., R. Holdorf
BC7.11	D. Hackleman
BC7.12	B. Briskey
BC7.13	D. and N. Johnson
BC7.14	G. Lind Flak

Benton County Exhibit 7 (BC7)

BC7.0	Map of Testimony from Adjacent Properties

Exhibit BC7.0



County of Benton, Oregon State Parks, State of Oregon GEO, Esri, TomTom, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, US Census Bureau, USDA, USFWS, County of Benton, Oregon State Parks, State of Oregon GEO, Esri, TomTom, Garmin, SafeGraph, FAO, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, USFWS, Maxar

Benton County Exhibit 7 (BC7)

BC7.1	E. and L. Bradley

From: Erin Bradley
To: Benton Public Comment
Subject: Oppose LU-24-027
Date: Tuesday, April 22, 2025 7:25:43 AM

CAUTION: This email originated from outside of the organization. Do not click links or open attachments unless you recognize the sender and know the content is safe.

Erin and Lowell Bradley
38578 Hwy 99W
Oppose Lu-24-027

Benton County Planning Commissioners,

I respectfully request the Benton County Planning Commissioners to deny LU-24-027. This proposed expansion would move the landfill even closer to our property line. We are one of the closest southern neighbors. The buffer land is no longer sufficient due to the growing pile of debris. This proposal seriously interferes with the use of our property. Republic Services is currently in violation of County code 53.12. The last few years we have suffered through noise outside business hours, plastic bags blowing from the landfill, over the trees, onto our property, along with strange plumes of dust like material. Some days the odor is unbearable. The proposed expansion does nothing to align with Benton County's 2040 Thriving Communities Act.

Sincerely,
Erin and Lowell Bradley
38578 Hwy 99W Corvallis, Oregon 97330

From: Erin Bradley
To: Benton Public Comment
Subject: Oppose LU-24-027
Date: Tuesday, April 22, 2025 7:30:02 AM

CAUTION: This email originated from outside of the organization. Do not click links or open attachments unless you recognize the sender and know the content is safe.

Benton County Planning Commissioners,

July 24th, 2024, at approximately 7:30 pm Republic Services had a fire directly behind their building with the burn off stack. After hearing the Adair Village siren, I turned on the public scanner. To my horror I leaned not only of the fire, but that the fireman could not get in the gate or reach anyone to unlock it. In addition, the fire was right next to the propane storage. I am so grateful for our public responders who extinguished the 1/4-acre fire quickly. If they had not, the unmaintained Republic Services forest that boarders our land would have caught fire. I can throw a stone from my property line onto their forest land. At the time I had 18 head of livestock. I do have 2 livestock trailers but that is not sufficient for an emergency evacuation with NO warning.

May 18th, 2024, two hydraulic lifts caught fire on equipment. Two people driving by called it in. With the amount of methane in the trash pile you would think you would think Republic Services would have staff monitoring 24 hours a day?

There have been many fire alarms due to the burn off stack in the last two years. This made dispatchers question if calls were valid. Our counties resources have been wasted by false alarms. We have lived on edge due to the lack of diligence on Republic Services part. Our property is one of the closest to the proposed expansion. We respectfully request that the Benton County Planning Commissioners Deny LU-24-027

Erin and Lowell Bradley
38578 Hwy 99W Corvallis

From: Erin Bradley
To: Benton Public Comment
Subject: Deny LU-24-027
Date: Wednesday, April 23, 2025 8:45:50 PM

CAUTION: This email originated from outside of the organization. Do not click links or open attachments unless you recognize the sender and know the content is safe.

Benton County Planning Commissioners,

Our property is just south of the proposed expansion, and we share two land boarders. We have a barn with 13 head of livestock. On an average temperature day, the animals consume or use approximately 200 gallons of water. On hot days it is significantly higher, close to double. This estimate does not include our family of four daily usage. I am very concerned that drainage to these huge excavations could affect our well. This would be in violation of Benton County Code 53.215 (1) as it would place an undue burden on us being an adjacent property owner. I respectfully request you Deny LU-24-027.

Erin and Lowell Bradley
38578 Hwy 99W
Corvallis Oregon 97330

From: Erin Bradley
To: Benton Public Comment
Subject: Deny LU-24-027
Date: Tuesday, May 6, 2025 9:59:49 AM

CAUTION: This email originated from outside of the organization. Do not click links or open attachments unless you recognize the sender and know the content is safe.

Good Morning County Planning Commissioners,

My name is Erin Bradley. I live at 38578 OR-99W, Corvallis OR 97330.

I would like to mention a possible error in the map at the presentation last week and in the conditional land use application. The property north of us is listed as a 10 acres parcel and is shaded purple. The property is Republics Forrest Land owned by Valley Landfills and should be shaded green. I believe the map paints an inaccurate picture. It appears there is a 10 acre buffer between my property and the forest land.

Please see the attached photos of the maps presented, a current photo of the forrest looking north in my property, and Benton County's information.

I would also like to add photos to the record of the July 24th 2024 fire next to this forrest.This demonstrates the almost need to evacuate on our part. This fire could have spread to the forrest, or to the landfill.

Please deny LU-24-027 as it is affecting the enjoyment and use of our land.

Erin Bradley

Erin Bradley
Bit By Bit
541-908-3293
bitbybitadaptiveriding.org


BIT
BY BIT
ADAPTIVE RIDING

9:17 5Gw

English

005888 - Property Detail

FOR ASSESSMENT AND TAX PURPOSES ONLY

Account Information

Account Information

Account #:	005888
Map Taxlot:	10418000 1200
Acreage:	82.7
Property Class:	400
Tax Code Area:	0916
Situs Address:	29160 COFFIN BUTTE RD CORVALLIS, OR 97330

Last Certified Values

Market Land:	$526,080.0
	0

Print Close

essment.bentoncountyor.gov

12:58
11 of 76
library/functions.azurewebsites.us



Exhibit BC7.1











Benton County Exhibit 7 (BC7)

BC7.2	J. Searls

From: James Searls
To: Benton Public Comment
Subject: Oppose/Deny LU-24-027
Date: Thursday, April 24, 2025 10:08:52 PM

CAUTION: This email originated from outside of the organization. Do not click links or open attachments unless you recognize the sender and know the content is safe.

My name is James Searls.

I own Smile Farm LLC (www.smilefarm.us) which is located at 38538 Hwy 99W, Corvallis, OR, 97330. My land is south and adjacent to the proposed Coffin Butte Landfill expansion. Ground zero.

I strongly oppose the expansion of the dump. Please do not approve the application LU-24-027 to expand the Coffin Butte Landfill. I have concerns about how this will negatively impact my property and farm.

It is our goal to provide perennial and annual crops for our community each year from our land- as well as provide farm services throughout the valley. Our motto is- "We grow smiles one plant at a time." It makes us feel good to grow specialty crops, give eggs, donate fruits and veggies and regenerate healthy soil and ecosystems. An expansion of the landfill could harm our soil and air quality making it harder to produce crops.

It is hard to smile at our farm sometimes when noxious odors from the Coffin Butte Landfill infiltrate our property. These odors/gases already cause problems and they are out of control. An expansion of the landfill will bring the piles of garbage (future dump cells) physically closer to my farm which will create a bigger odor problem.

Decline the proposal to expand the dump. Help save Smile Farm.

Thank you for your time and consideration.

Best,

James Searls

319 331 9885

james@smilefarm.us

From: James Searls
To: Benton Public Comment
Subject: Oppose/Deny LU-24-027
Date: Thursday, April 24, 2025 10:12:28 PM

CAUTION: This email originated from outside of the organization. Do not click links or open attachments unless you recognize the sender and know the content is safe.

Dear Benton County Planning Commissioners,

My name is James Searls.
I live at 38538 Hwy 99W, Corvallis, OR, 97330. This is directly south of the Coffin Butte Landfill. I live here with my son, Burton.

We have a giant farm dog, Leroy, who helps protect our chickens. The chickens and Leroy roam the grounds of our property regularly drinking water from puddles, seasonal streams and water from our well. My son and I drink from the well too.

I am concerned about the hydrological impacts related to the proposed expansion of the Coffin Butte Landfill. How will this affect the quality of our future water? How will this impact our soil? We need reliable, safe water and soil to sustain our home, our farm, our animals and loved ones.

An expansion of the landfill- moving closer to and upstream from my property will threaten my water resources and could contaminate our soil.

Please decline the application LU-24-027 to expand the landfill. I strongly object to this proposal as it threatens our livelihood for the future.

Thank you for your time and consideration.

Sincerely,
James Searls

From: James Searls
To: Benton Public Comment
Subject: Oppose/deny application LU-24-027
Date: Thursday, April 24, 2025 10:25:19 PM

CAUTION: This email originated from outside of the organization. Do not click links or open attachments unless you recognize the sender and know the content is safe.

Dear Benton County Planning Commissioners,

My name is James Searls and my son's name is Burton. We live next door to the Coffin Butte Landfill at 38538 Hwy 99W, Corvallis, OR, 97330. We are located to the south of the proposed expansion site.

I am writing because I strongly oppose Republic Services' Conditional Use Permit application LU-24-027 to expand the Coffin Butte landfill. I urge the Planning Commission to deny this application.

The proposed expansion would seriously interfere with the character of the surrounding area and impose an undue burden on public resources, in violation of Benton County Code 53.215 (1) and (2). Specifically, this expansion raises major concerns about:

- Air and water pollution threaten our local ecosystems and community health
- Traffic increases that pose safety risks on nearby roads and pathways
- Odor and noise issues that degrade quality of life for residents and visitors
- Negative impacts on wildlife, recreation, and property values
- Long-term climate and environmental consequences for future generations

The proposed expansion does nothing to align with *Benton County's 2040 Thriving Communities Initiative*. This expansion undermines our shared goals for responsible environmental stewardship, prioritizing public health, and sustainable waste management.

I believe Benton County should invest in waste reduction, recycling, and circular economy solutions, not expanding landfills that perpetuate pollution and place a long-term burden on local communities!

Please reject LU-24-027. Thank you for your consideration and for protecting the health and future of Benton County.

Sincerely,

James Searls

3193319885

From: James Searls
To: Benton Public Comment
Subject: Oppose/deny LU-24-027
Date: Thursday, April 24, 2025 10:38:37 PM

CAUTION: This email originated from outside of the organization. Do not click links or open attachments unless you recognize the sender and know the content is safe.

Dear Benton County Commissioners

My name is James Searls. I own one of the south neighboring properties of the Coffin Butte Landfill. 38538 Hwy 99W, Corvallis, Oregon, 97330 is the address.

I strongly oppose the expansion of the landfill. Application LU-24-027 should be declined.

I believe an expansion will negatively impact the value of my property, farm and home. An expansion will bring more traffic and machinery closer to my home and family. The dump is already a nuisance for us. We can already smell the horrible odors that bleed out Coffin Butte Landfill. We already hear big machinery and trucks operating during quiet hours of the night/morning. We already have daily litter along Highway 99. I am concerned that an expansion will exacerbate these problems.

I also worry that our wonderful (million dollar) views of Mt Hood, Mt Jefferson, Three-fingered Jack will be tainted by the mountain of trash. Currently, we cannot see the landfill from our home. Sometimes I go out on our deck to enjoy the views and our land only to be hit with a noxious odor caused by the landfill. It is disgusting and worrisome and ruins the moment. The odors cause me to go back inside. IT ISN'T FAIR.

Growing the landfill will allow Republic Services to operate for more years which will prolong our struggles. It will trash the value of our property for more years to come.

Again, I oppose the proposal to expand the landfill. Please deny application LU-24-027.

Thanks for your time and consideration.

Sincerely,

James Searls

3193319885

james@smilefarm.us

Corvallis, OR, 97330

From: James Searls
To: Benton Public Comment
Subject: Deny/oppose LU-24-027
Date: Thursday, April 24, 2025 10:50:58 PM

CAUTION: This email originated from outside of the organization. Do not click links or open attachments unless you recognize the sender and know the content is safe.

Dear Benton County Planning Commissioners,

My name is James Searls. My son and I live at 38538 Hwy 99W, Corvallis, Oregon, 97330.

I am concerned about the proposal to expand the landfill. Specifically, how it will change habitat for Oregon's creatures and wildlife. The fauna that grazes upon our property are wonderful. Natures food chain is fully present here ranging from insects and birds, to elk and mountain lions. This is one of the main reasons I bought this property. I love watching and living among the wildlife here. Expanding the landfill will threaten our property and the surrounding wildlife.

Please do not approve the application LU-24-027 to expand the Coffin Butte Landfill. Help preserve the habitat for our wildlife. I oppose the proposal.

Thank you for your time and attention.

Sincerely,

James Searls

3193319885

james@smilefarm.us

Corvallis, OR, 97330

Benton County Exhibit 7 (BC7)

BC7.3	J. Geier

From: Joel Geier
To: Benton Public Comment
Subject: Deny LU-24-027: First set of comments (pertaining to heron nesting colony disturbance)
Date: Monday, April 21, 2025 4:33:40 PM
Attachments: LU-24-027 comments - heron rookery.pdf
Coffin Butte-Camp Adair Herons 2000-2025-04-20.pdf

CAUTION: This email originated from outside of the organization. Do not click links or open attachments unless you recognize the sender and know the content is safe.

Dear Development Department Staff:

Please provide my attached letter (first attachment), together with a report giving supporting details (second attachment) to the Planning Commission for their consideration.

You may note, this is just the first of several sets of comments that I intend to send. For some of the other comments, I'm still awaiting responses from Oregon DEQ.

Thank you for your efforts, and please let me know if you have any questions about this part of my testimony.

Yours sincerely,

Joel Geier
North Benton County resident

From: Joel Geier
To: Benton Public Comment
Subject: Re: Deny LU-24-027: Second set of comments (pertaining to rubbish in farm fields)
Date: Monday, April 21, 2025 4:59:39 PM
Attachments: LU-24-027 comments - rubbish in fields.pdf

CAUTION: This email originated from outside of the organization. Do not click links or open attachments unless you recognize the sender and know the content is safe.

Dear Development Department Staff:

Please provide my attached letter to the Planning Commission for their consideration.

Thank you for your efforts, and please let me know if you have any questions about this part of my testimony.

Yours sincerely,

Joel Geier
North Benton County resident

Joel Geier
38566 Hwy 99W
Corvallis, Oregon 97330-9320
(541) 745-5821
joel.geier@peak.org

Benton County Planning Commissioners
c/o Planning Division
4500 SW Research Way
Corvallis, OR 97333

April 21, 2025

RE: LU-24-027 Conditional Use Permit Application Regarding Landfill Expansion

Dear Nicholas Fowler, Chair, and Members of the Benton County Planning Commission:

Thank you for the opportunity to comment on the Conditional Use Permit (CUP) application submitted by Valley Landfills Inc., which corporation proposes to construct a new landfill on the north end of Tampico Ridge, south of Coffin Butte Road.

I'll be submitting a series of comments on different problems raised by this application, each of which give grounds for denial. This is my first set of comments in the series, focusing on the status of a Great Blue Heron nesting colony (or "rookery") which has been continuously active at this site since the spring of 2000.

The key points are these:

1. Applicant has not provided you with full information regarding the status of the heron nesting colony, which still persists at the site although the locus of nesting activity has shifted approximately 250 yards to the east since an apparent disturbance event in 2022.

2. The currently active nesting area is less than 1/4 mile from where applicant proposes major excavation work to build new leachate ponds on Forest Conservation land (Lot 1200), in place of the existing ponds which are within the footprint of the proposed new landfill.

3. Satellite images of the proposed development show that the applicant has failed to avoid disturbance to the previously documented heron rookery areas, during 2022, 2023, and 2024, and this pattern of disturbance continues into the current year.

Taken as a whole, these points indicate that approval of this CUP application would lead to further disturbance of this heron nesting colony, in contradiction to **Benton County Goal 5.9 Wildlife Habitat: To conserve and protect wildlife habitats and to promote habitat management that maintains wildlife diversity.** The applicant's record of recent and ongoing adverse activity, on the same lots where they propose to develop a new landfill and leachate ponds, makes it clear that the most likely outcome will be exactly the opposite of what Goal 5.9 espouses.

I elaborate on each of these points below (Further documentation is given in the attached report, which is an updated version of a report that I provided to ODFW and ODF on March 15, 2025).

1. Applicant has not provided you with full information regarding the status of the heron nesting colony, which still persists at the site although the locus of nesting activity has shifted approximately 250 yards to the east since an apparent disturbance event in 2022.

From reading the information provided by the applicant and their wildlife consultant (Turnstone), in their Burden of Proof statement and supporting exhibits, you might easily get the idea that herons simply gave up on the area, after an apparent mass failure of the nesting colony sometime between April and June of 2022. This is far from the truth.

In fact, community observations, as summarized in a report that I'm submitting together with this comment, establish that the herons have continued to nest in ash trees within 220 yards of Turnstone's observation point OP2, beginning in March 2023 and continuing in both subsequent years, up to the date of this comment. Several of the nests are in a direct line of sight from OP2. Adult herons flying to and from nests in the ash trees should have been visible from that point.

This is not to say that the information provided by the applicant or their consultant is false, just that it doesn't provide a full account of heron nesting activity in the immediate vicinity.

One possibility is that the applicant's consultant simply failed to notice heron activity a short distance east of the old nests that they were focused on. This is possible but seems improbable, for skilled field biologists.

A second possibility could be that the consultants may have seen this heron activity nearby, but they adhered to a very narrow interpretation of the protocol which required them only to report if they saw herons in or around the nests in the older nesting area, and not necessarily to report herons nearby.

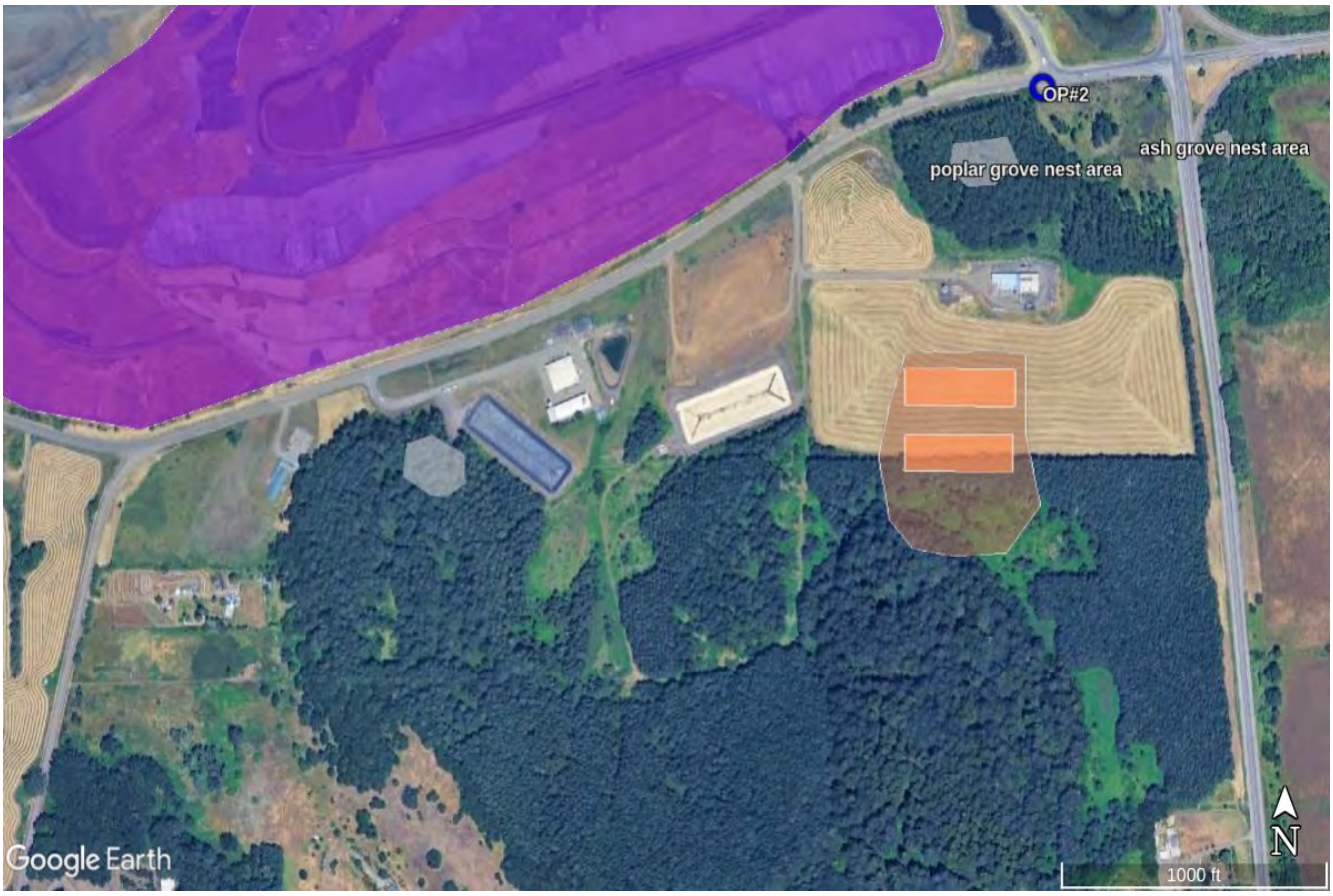
Regardless of whether the omission is due to careful parsing of observations or simply failure to notice, it's clear from independent observations that herons do continue to nest immediately proximal to the area of the proposed development, which has consequences for the proposed development.

2. The currently active nesting area is less than 1/4 mile from where applicant proposes major excavation work to build new leachate ponds on Forest Conservation land (Lot 1200), in place of the existing ponds which are within the footprint of the proposed new landfill.

The image below shows the proximity of the currently active heron nest area ("ash grove nest area") to the area proposed for development of new leachate ponds on Forest Conservation land. I've sketched in the proposed location of the new ponds (solid orange), and the approximate footprint of the required excavations (tinted orange).

From length scale included in the image, you can see that this construction activity would be within roughly 1000 ft (330 yards). Under the Oregon Forest Practices Act heron rookeries are protected, and Oregon Department of Forestry rules require avoidance of forest land operations (including truck traffic) between February 15th and July 31st, within a 1/4-mile (440 yard) radius.

The applicant has not provided any plan for protecting the ash-grove nesting area, within their current site development plans which acknowledge only a need to protect the older nesting areas, and those only if their consultants happened to notice heron nesting activity during 2023 through 2025.



3. Satellite images of the proposed development show that the applicant has failed to avoid disturbance to the previously documented heron rookery areas, during 2022, 2023, and 2024, and this pattern of disturbance continues into the current year.

Ever since the applicant learned in late 2021 that the herons nesting in the poplars could be an impediment to their development plans, in each successive nesting season (2022, 2023, 2024 and 2025) they have operated heavy equipment (excavators and gravel trucks) in an area that had previously been left undisturbed from 2017 to 2021 (during which period the herons established their nesting area in the poplar grove).

A timeline of this activity, based on evidence provided by historical satellite images, is given in the report included with this set of comments.

Whether this activity was inadvertent or otherwise, it could well have caused the apparent abandonment of nests during 2022, and the reluctance of herons to return to the area in subsequent years.

At the very least, conducting this activity so close to the known nesting areas, during nesting season, demonstrates insufficient diligence regarding the disturbance issue.

Given the applicant's poor track record on this issue, better outcomes cannot be expected in the event that they gain approval for the proposed development.

Thank you for considering these comments. I reserve the right to provide further written and oral testimony according to the time frame allowed by statute.

Yours sincerely,



Joel E. Geier, Ph.D.

Great Blue Heron Monitoring

Community observations of heron nests
Coffin Butte and vicinity, north Benton County, Oregon
2000 through present

March 15, 2025
Amended to include observations through April 20, 2025
Joel Geier

Executive Summary

A heron nesting colony is known to have been present in the area just south of Coffin Butte for more than 25 years, starting in 2000 and continuing into the current year, 2025. Although initially the colony seemed to be stable, making use of a stand of mature conifers from the early 2000s through at least 2018, within the past 6 years it has shifted nesting locations twice.

A mass incident of nest abandonment and colony failure occurred in the poplar grove ("eastern rookery") sometime during in mid- to late May 2022. The cause is not known with certainty, but excavation equipment and trucks were documented as operating as close as 600 ft to the nesting area around the time of the abandonment, much closer than the 1/4 mile buffer zone that was recommended to the operators to avoid disturbance. Bald eagles were seen scavenging the nests, but not until at least a week after the adults had abandoned the nests.

In subsequent years, herons have continued to visit the poplars during nesting season, but have not been documented as re-occupying nests in that area. Continuing disturbance by equipment operating within the recommended buffer zone during 2023, 2024, and again in 2025 may be a factor in discouraging them from reoccupying nests in that area. Instead the main locus of nesting activity since 2022 has been in an ash grove just east of the poplars. Nesting there was successful in 2023 and probably also in 2024.

That nesting area is occupied again in 2025, with herons incubating on nests as of the date of the report. This new nesting area is very close to a busy highway intersection, which poses a potential risk for the long-term success of the colony. Although the herons appear to be acclimated to the normal flow of vehicular traffic, nesting could be disturbed by pedestrians walking along the highway and/or vehicle operators who exit their vehicles during roadside stops. Such an incident was observed on April 19, 2025 when a sheriff's inmate crew picking up roadside litter near the landfill entrance came within 30 yards of the nests.

Introduction

Great Blue Heron (*Ardea herodias*) is one of Oregon's most well-known bird species, frequently noticed, recognized, and beloved by many members of the public.

This is also one of very few bird species to be specifically protected under Oregon state law (OAR 629-665-0120), which is focused on protecting and preventing disturbance to colonial nesting sites known as "heronries" or "heron rookeries."

Although perceived as a "common" bird species due to its high visibility, the status of Great Blue Heron as a nesting species in the Willamette Valley is poorly understood, both in terms of numbers of breeding birds, and the stability of existing colonies.[1]

This report summarizes community observations of herons nesting in the vicinity of the Coffin Butte landfill from the year 2000 through early 2025.

Data sources

Observations of herons nesting were not systematic over most of the 25-year period from 2000 to 2025. For years prior to 2022, a record of incidental observations has been gleaned from resources including *The Chat* (newsletter published monthly by the Mid-Willamette Bird Alliance[2]) and the electronic archives of two e-mail lists:

- Oregon Birders Online (OBOL), https://www.freelists.org/archive/obol/
- Mid-Valley Nature https://groups.google.com/g/mid-valley-nature

From 2022 onward, observations have been maintained systematically in Excel spreadsheets which are reproduced here in tabular form.

1 (Ann Eissinger, personal communication, 2021)

2 The Mid-Willamette Bird Alliance is the current name of the organization formerly known as Audubon Society of Corvallis. Newsletters prior to 2024 were published under the former name of the organization.

Locations referenced

The following locations (Figure 1) are referred to frequently in this report:

Coffin Butte is a natural landform in the shape of a ridge elongated in ENE-WSW direction, about one mile long with a peak elevation of 737 ft, which is the last in a series of ridges and hills extending northward from Vineyard Mountain near Lewisburg.

Tampico Ridge is the first main ridge to the south of Coffin Butte, elongated in the S-N direction, also about one mile long. Tampico Ridge has multiple four main summits. The highest summit, toward the south, rises to 613 ft. The next summit to the north, sometimes labeled as Poison Oak Hill, is just slightly lower at 612 ft. At its north end, Tampico Ridge splits into two ridges, with summits locally known as Schulmerich Hill (532 ft) at the north end of the main ridge line, and Beals Hill (512 ft) on the ridge line branching toward the NW.

Tampico Ridge is separated from Coffin Butte by a topographic saddle which is traversed by Coffin Butte Road, with its highest point just north of Beals Hill.



Figure 1. Satellite view of the landscape around Coffin Butte showing locations referenced by name in this report including Toketie Marsh, conifer grove nesting area ("western rookery"), poplar grove nesting area (eastern rookery"), and ash grove nesting area.

Coffin Butte Landfill is located on the south face of Coffin Butte, north of Coffin Butte Road, and is operated by Valley Landfills Inc. (VLI), a wholly owned subsidiary of Republic Services Inc.

Toketie Marsh is the name given by VLI to a remedial wetland that was constructed in early 1994[3], on the NW side of the junction of Coffin Butte Road with State Highway 99W, as partial mitigation to compensate for the destruction of two ponds higher up on the SE flank of Coffin Butte.

A **conifer grove** (mainly Douglas-firs, covering about 16 acres) on the north end of Beals Hill, between the landfill office and a facility for handling landfill leachate, has been one of the locations where herons have nested during the past 25 years. The heron nesting area in this conifer grove is referred to as "the western rookery" in some VLI documents.

A **poplar grove** (hybrid poplars covering about 9 acres) due south of Toketie Marsh and the landfill entrance (scale house road) has developed from hybrid poplars that were planted around 1994, as part of the same mitigation project. On site development maps this area is referred to as the "south cloverleaf mitigation area." The heron nesting area in this poplar grove is referred to as "the eastern rookery" in some VLI documents.

An **ash grove** (predominantly Oregon-ash, covering about 7 acres) is located on state land just east of the poplar grove, on the east side of Highway 99W. This ash grove together with the poplar grove form a nearly continuous arc of closed-canopy forest, separated only by the highway right-of-way (about 30 m wide). Herons have been observed nesting in the ash grove since 2023 after an apparent mass failure in the poplar grove in 2022.

Rays prairie is an informal name[4] for a 70-acre prairie restoration area on state land (part of E.E. Wilson Wildlife Area), adjacent to the ash grove on its east side and extending south for about 3/4 mile. Herons can frequently be seen hunting both upland areas and around the edges of two constructed wetlands during nesting season.

A **stockpile** area for fill dirt periodically used as cover material on the landfill is located to the west of the poplar grove. The east edge of this stockpile area is 0.12 mile from the heron nesting area in the poplar grove. Satellite images show that this area was managed as an

3 Per historical images on Google Earth, and confirmed by former manager Brian May, personal communication November 27, 2023.

4 Named for a former manager of E.E. Wilson Wildlife Area who initiated the restoration effort in the early 2000s. The lower of two constructed wetlands in the prairie area is known as Laguna del Ray (https://ebird.org/hotspot/L14643022). The upper wetland is informally known as Playa del Ray. Baseline point counts for this area during the early stages of prairie restoration are on file with ODFW.

agricultural field through 2006, then left fallow until 2016 when it was farmed again. In 2017 fill dirt was stockpiled on this area to form a small hill which was left undisturbed for the next several years, and was noticeably vegetated by 2020 (Figure 2).



Figure 3. Satellite view of the fill-dirt stockpile from August 13, 2020, showing the fill-dirt stockpile in an undisturbed, vegetated state at that time, with no excavating equipment present. Note that the track leading out from the east side of the stockpile is faint and does not connect to the access road for the generating plant, with a closed gate at that point, indicating that it was in a state of disuse.

Historical observations 2000 through 2020

Great Blue Herons were first documented nesting near Coffin Butte in 2000, with the following description as recorded in the summer field notes column in the *The Chat*:

> *An improbable choice of nesting site by Great Blue Herons at Toketie Marsh, at the entrance to Coffin Butte Landfill along Highway 99W north of Corvallis, gave area birders a unique chance to observe these birds through the summer. On 7-1, Carolyn Paynter watched an adult feeding 3 young in a very crowded nest. By 7-16 the juveniles could be seen hunting inexpertly around the edges of the marsh.*

As this new colony increased, the herons began to nest in the conifer grove south of the growing landfill, in the area between VLI's office building and a leachate storage facility. The field notes from the April 2018 issue of *The Chat* gave this update, noting the impact of rising Bald Eagle numbers on heronries:

> *On 10 Mar more than 20 Great Blue Herons flew in to perch in conifers where they've nested in recent years on the south side of Coffin Butte Regional Landfill. As Bald Eagle numbers continue to recover, herons seem to have abandoned some relatively exposed nesting locations along the main rivers, in favor of conifer groves that offer more protection from avian predators.*

The heron nesting area in the conifer grove, now referred to by VLI's consultants as the "western rookery" for this site, was documented by the Oregon Department of Forestry in a Notification of Operations (NOAP) under NOAP ID: 2019-551-05885. This documentation reportedly occurred when VLI sought clearance from ODF to log in that area, and were informed that this work could not proceed while that rookery remained active.

By the next year, 2020, herons were noticed to be nesting in the hybrid poplar plantation (now referred to as the "eastern rookery"). Whether this shift was due to disturbance in the former location, or due to the improved suitability of the poplars as they had grown taller with a closed canopy, or due to some other factor, is unknown.

Heron nesting activity in 2021

Community nesting observations during the 2021 nesting season are summarized in Table 1. At least 12 pairs nested in the poplar grove (east rookery) and possibly upward of 15.[5] By June local observers began to notice young birds foraging alongside adults in the local fields and pastures of Soap Creek Valley, indicating that at least some of these nests were successful.

Table 1. Heron observations during 2021.

Date	Number of herons	Location	Observer	Notes
1/28/21	0	poplar grove, conifer grove, and vicinity	Joel Geier [Mid-Valley Nature]	"I haven't seen much activity so far in the heron nesting colony at Coffin Butte Landfill. Still many hundreds of gulls around ..."
2/23/21	18	Toketie Marsh	Joel Geier [Mid-Valley Nature]	Two Bald Eagles (one adult, one immature) were keeping the gull flock stirred up above the Coffin Butte Regional Landfill, and also briefly put 18 Great Blue Herons to flight off of the remedial wetland ("Toketie Marsh").
4/07/21	12+ active nests	poplar grove	Joel Geier [Mid-Valley Nature]	"Now is still a good time to watch Great Blue Herons nesting in the poplar plantation just south of Coffin Butte Regional Landfill. At least 12 nests were active as of yesterday, and they're easy to see from the road as the poplars have just started to leaf out.
7/07/21	several	poplar grove	Joel Geier [Mid-Valley Nature]	"Great Blue Heron chicks in the poplars outside Coffin Butte Regional Landfill are now in "Stage 1" [beg from the tree as adults flt back and forth] from recently harvested fields full of voles both dead and alive. Some of the heron chicks may have already left the nest, but some were in good view when I stopped by there this morning. .... The chicks that remain are mainly standing up in the nests now, mostly motionless and pretending to be invisible until mom or dad returns with a cropful of fresh carrion."

An October 25, 2021 report by Stephanie James of Turnstone Environmental Consultants, submitted by the landfill operators in support of a proposed expansion of the Coffin Butte

5 Per comments by wildlife biologist Dave Vesely.

Landfill, based on a single site visit on October 8, 2021, stated the following regarding the conifer grove nesting area ("western rookery"):

> *James was able to observe the rookery from the access road but was not able to investigate under the trees up close due to fencing and high coverage of poison oak. James observed 12 stick nests in 8 active nest trees in the western rookery. The nests were approximately 18 to 36 inches in width, 70 to 100 feet in height, and did not appear active this year (2021) with no visible whitewash. The nests appeared to be intact and were likely were built upon in the last 2 to 3 years.*

Regarding the poplar grove nesting area ("eastern rookery"), the same report stated:

> *The eastern rookery is in a forested stand with 12- to 20-inch hybrid poplar trees approximately 90 to 110 feet in height. This forest lost many branches in recent wind and ice events, as noted by downed limbs and broken branches. The eastern rookery was likely active this year as evidenced by copious whitewash under the nests (Figure 1). This rookery contained six nests approximately 12 to 30 inches in width, 60 to 80 feet in height, in four poplar trees.*

Independent photos from Nov 7, 2021 documented that 13 heron nests were still present in the poplars as of that date, even after fall wind and ice events. Note that this was more than twice as many nests as reported by the landfill's consultant.

After local conservationists expressed concerns about impacts on herons, ODFW commented, recommending three years of professional surveys, as well as restriction of landfill activities within 1/4 mile of the active nesting areas during the critical breeding period from February through June.

Heron nesting activity and nesting failure in 2022

Community nesting observations during the 2022 nesting season are summarized in Table 2. All observations of nesting activity in this year were from the poplar grove. Although this nesting area was occupied with as many as 14 active nests, these all appear to have failed sometime between May 14 and May 25.

At least 10 nests were occupied by March 5. Incubation started sometime between March 22 and April 12, by which date herons were incubating at least 12 nests. Based on a 28-day incubation period, the earliest expected hatch date (if incubation began on March 23) would have been April 20. The latest expected hatch date (if incubation began on April 12) would have been May 10.

In a brief visit on April 20, the adult herons were observed to be perched near the nests, but not incubating. The nesting area continued to be active with adult herons present through May 14, but by May 25 it was abandoned.

Juvenile Bald Eagles were observed visiting the abandoned nests on June 1, but this was a full week after the heronry was already noted to be abandoned by community observers. The most likely explanation of the observed eagle activity on that date is that they were scavenging already-dead heron chicks from the nests.

A carcass draped over a utility wire, noted on May 25 and still hanging there for some weeks afterward, suggests the possibility of a disturbance resulting in a panic flight in conditions of dim light or darkness (i.e., when herons might not be able to see and avoid such a wire) sometime between May 14 and May 25.

Several hypotheses for this nesting colony mass failure during May of 2022 can be considered.

Hypothesis 1: Failure caused by adverse weather

Weather during April 2022, and into the first weeks of May, was notably cool and rainy for the season. These conditions could have been adverse for survival of heron chicks, particularly if they had hatched and reached the stage of growth where both parents would be away from the nest for extended periods, leaving them exposed to the weather. However the observational bounds on incubation period, together with behavioral observations from the period after hatchlings would have been expected, do not support this hypothesis.

Table 2. Heron observations during 2022. Community observations are in black font. Additional observations by Turnstone Environmental Consultants (on behalf of VLI) that help to inform the timeline up to and shortly after the time of mass nesting failure are included in blue font.

Date	Number of herons	Location	Observer	Notes
2/17/22	1	poplar grove	Stephanie James	Adults observed standing in one nest.
3/05/22	10+	poplar grove	Priya Thakkar	"Saturday evening I saw a heron standing up in each of the nests! There were at least 10 that I could see, and only one of the nests off to the side didn't have a heron in it."
3/22/22	17	poplar grove	Stephanie James	Adults observed standing in or near 11 active nests.
4/12/22	12+	poplar grove	Joel Geier	At least 12 nests were occupied with adults incubating or brooding on the nest.
4/20/22	18+	poplar grove	Joel Geier	Adult herons were perched near the nests, but not on them, in brief visit.
4/28/22	17	poplar grove	Stephanie James	Adults observed standing in or near 14 nests, all active. One observed possibly turning an egg in the nest.
5/14/22	several	poplar grove	Joy Shreyer	Several adult herons perched around the nests.
5/25/22	0	poplar grove	Joel Geier	Heronry abandoned. Decomposed / desiccated carcass, apparently of a heron, hanging from utility wire along the south side of Coffin Butte Road, due north of the west end of the poplar grove nesting area.
5/26/22	0	poplar grove	Joel Geier	Posted inquiry to OBOL and Mid-Valley Nature list, noting abandonment of heronry, and requesting any observations not already reported.
6/01/22	0	poplar grove	Stephanie James	No herons present. Juvenile bald eagles moving from nest to nest in groups of 2 to 4.

Hypothesis 2: Predation by eagles

The nearby landfill is well known to host large numbers of bald eagles, both adult and juvenile, which scavenge from the waste. With such concentrations of eagles nearby, predation on heronries is a plausible risk, as has been observed in the Puget Sound region (Eissinger, 2007).

The observations by VLI's consultant on June 1, 2022 document that eagles visited the heronry on that date. However this was a full week after failure of the heronry was noticed by community observers.

If the failure of the heronry was due to eagle predation, we should expect that most predation would have occurred on or within days after the date that adults abandoned the heronry. The fact that eagles were observed going from nest to nest at least a full week post-failure is counter-indicative of this hypothesis, suggesting instead that the eagles had just recently discovered this source of carrion.

Hypothesis 3: Disturbance by landfill operations

Heavy equipment operations in a fill-dirt stockpile just west of the poplar grove was a possible source of disturbance, during the period in which nesting failure occurred.

Satellite images from June 2022 (Figure 3) show excavation equipment operating within 0.16 mile of the heron nesting area. In comparison with satellite images of the same area from August 2020 (Figure 2), the 2022 images show indications of recent truck traffic along the access road leading out from the east side of the stockpile even closer to the nest sites.



Figure 3. Satellite view of the fill-dirt stockpile from June 24, 2022, showing excavating equipment working in a recently excavated area southwest of the poplar grove nesting area. Note that the road leading out from the east side of the stockpile shows signs of recent use. The area of recent excavations, as measured from this image, was approximately 2.6 acres.

Concerns about this issue as a possible cause of the nesting colony failure were raised during a Benton County Disposal Site Advisory Committee on July 27, 2024. Notes on the minutes for that meeting provided to Benton County staff state[6]:

> *Last year ODFW's biologists recommended that there should be no major construction within 1/4 mile of the rookery, from February 15 through July 31, apart from the usual traffic on Coffin Butte Road and Hwy 99W.*[7]
>
> *During March of 2022, local observers noted that heavy equipment was being used to mine away the stockpile of fill dirt adjacent to the Forest Conservation zone. Initially this activity was on the far side of the stockpile, where it seemed unlikely to impact the herons. However that activity seems to have shifted much closer to the rookery during May, around the time that the herons disappeared.*
>
> *Two questions for Republic staff:*
>
> *1) Did Republic Services carry out any monitoring of this nesting colony this year? And if so, have those observations been reported to ODFW?*
>
> *2) Also, is there any log of activities that were carried out within or near the Forest Conservation zone? Of particular concern would be if and when trucks hauling fill dirt started to use the gate onto Coffin Butte to the east of the stockpile, or if there were any personnel entries into the rookery area itself.*
>
> *Ian [Macnab] (Republic Services) responded that these are normal operations and there has been no other change in that area for quite some time. A biologist has been monitoring the eastern and western rookeries starting this year. Results will not be reported by the biologist until the end of a three-year period, and no data is available at this time.*

No further information has been provided by VLI or Republic Services regarding the timing of these operations.

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6 Comments transmitted by e-mail to Community Development Department staff Linda Ray and Daniel Redick on September 3, 2022.

7 A Condition of Approval proposed by CDD staff for LU-21-047, based on input from ODFW, was stated as follows: "During the critical nesting period for the Great blue heron, which is from February 15 through July 31, neither construction to prepare the ground or build the leachate ponds, employee building, road bed, or landfill cell shall occur within a quarter mile of the boundary of the rookery."

However the company has asserted a right to conduct landfill-related operations outside of the posted operating hours:[8]

> *"..internal operations, which include the arrival of field personnel on-site, begins at 4:30 a.m., Monday through Friday, and at 7:30 a.m. on Saturday. Additional operations not governed by the conditional use permit include work by third party contractors on landfill infrastructure, and commercial customers, who have 24-hour access to the Landfill.*

Such activities have been observed to occur pre-dawn, making use of bright artificial lights. During a landfill tour, the landfill environmental manager confirmed that portable lights to support operations on the landfill typically come on at 4:45 a.m.[9] During the period from May 14 to May 25 in which nesting failure apparently occurred, local sunrise ranges from 5:45 a.m. to 5:35 a.m.

The satellite evidence shows that operations in the stockpile area were in fact unusual, so this remains as a plausible cause for nesting colony disturbance and abandonment. If heavy equipment and/or artificial lights powered up in the stockpile area before sunrise, this would have been an unaccustomed disturbance and could conceivably caused a panic flight.

8 Benton County Talks Trash Solid Waste Process Workgroup Report, 2023, p. 830.
9 Benton County Talks Trash Solid Waste Process Workgroup Report, 2023, p. 935.

Heron nesting activity in 2023

Community nesting observations during the 2023 nesting season are summarized in Table 3.

There were two observations during March in which herons either perched in the poplar grove or flew toward it with a stick. Satellite images (Figure 4) show that excavation activity occurred in the stockpile area, during the early part of the nesting season. This recurring disturbance might have inhibited herons from occupying utilizing the nests in the poplars, despite some indications of interest.

Table 3. Heron observations during 2023.

Date	Time of day	Number of herons	Location	Observer	Notes
1/12/23	afternoon	0	poplar grove	Joel Geier	At least 15 stick nests
3/17/23	17:35	1	poplar grove	Joel Geier	roosting in the hybrid poplars, not in one of the trees with one of the nests that were occupied last spring
3/24/23		0	poplar grove	Jim Fairchild	Quick look at the hybrid poplar heron nests (~16, no visible occupants)
3/26/23	12:00	2	Ray's Prairie (Laguna del Ray)	Joel Geier	Flew up from ground south of pond.
3/26/23	14:30	5	Ray's Prairie	Rebecca Geier	South of ash grove
3/26/23	14:45	1	Soap Creek Ranch pasture north of entrance road	Joel Geier	hunting in pasture
3/26/23		2	ash grove / poplar grove	Jim & Karan Fairchild	2 herons just east of 99W in the ash grove next to the highway. One repeatedly circled over 99W towards the [poplars], carrying a stick. Last we saw it had stopped in the top of the ash grove.
3/27/23	15:30	6	ash grove	Joel Geier	6 herons perched in the ash grove ... including two pairs and two "single" birds, each on partly-constructed nests (several of them just a few sticks laid cross-wise). We saw one heron drop down into the understory and come back up with a stick, which its mate then added to the growing nest.
3/29/23	10:00	2	Soap Creek Ranch pasture north of entrance road	Joel Geier	hunting in pasture
5/15/23	10:30	1+	ash grove	Joel Geier	adult standing in nest, hard to see due to foliage
6/18/23	10:45	6+	ash grove	Joel Geier	multiple nests with noisy nestlings, 3 in one nest, total of at least 6 nestlings. Look nearly ready to fledge.

All other observations of nesting activity were from the ash grove. Numbers of herons were decreased from the previous year, with a maximum of 6 adults recorded early in the nesting season. Six nestlings, nearly ready to fledge, were observed in nests in the ash grove on June 18.

Based on these observations, the nests in the ash grove appeared to be successful, but no nesting was observed in the poplar grove. eBird records from nearby E.E. Wilson Wildlife Area confirm that herons were regularly present throughout the nesting season, including in June and July.



Figure 4. Satellite view of the fill-dirt stockpile from April 29, 2023, showing continuation of excavation activity southwest of the poplar grove nesting area, during the early part of the heron nesting season. Note that the road leading out from the east side of the stockpile continues to show signs of recent use. The excavated area has grown to 3.0 acres.

Heron nesting activity in 2024

Community nesting observations during the 2024 nesting season are summarized in Table 4.

Early in the nesting season, around February 12, one heron was observed standing in one of the old nests in the poplar grove. All other observations of nesting activity were from the ash grove.

Satellite images (Figure 5) show that excavation activity occurred in the stockpile area, and agricultural equipment activity (presumably field spraying) even closer to the nesting area occurred during the early part of the nesting season. This recurring disturbance might again have inhibited herons from occupying utilizing the nests in the poplars.

Nests in the ash grove began to be occupied by mid-February. Incubating birds on at least 6 active nests were noted by March 31. Subsequent observations were limited due to dense foliage and other time commitments by volunteer observers. However eBird records from nearby E.E. Wilson Wildlife Area indicate that herons were regularly present throughout the nesting season, including in June and July.

Table 4. Heron observations during 2024.

Date	Time of day	Number of herons	Location	Observer	Notes
2/12/24 (approx)		1	poplar grove	Dave Vesely	1 standing on old nest in poplars (noted in e-mail Feb 14, 2024 as “a couple days ago”)
2/13/24	13:30	1	ash grove	Joel Geier	Standing on one of last year’s nests
2/14/24	13:30	6	ash grove / Ray's prairie	Joel Geier	3 in trees around last year’s nests, 3 hunting out in Ray’s Prairie
3/10/24		6	ash grove	Joel Geier	6 in ash trees around last year’s nests, all toward north end
3/17/24	10:00	6	ash grove	Joel Geier	About 6 standing on nests (brief drive-by)
3/31/24	09:35	6	ash grove	Joel Geier	At least 6 incubating on nests. 3 additional nests seen but could not tell if occupied.



Figure 5. Satellite view of the fill-dirt stockpile from April 19, 2024, showing continuation of excavation activity southwest of the poplar grove nesting area, during the early part of the heron nesting season. Note that the road leading out from the east side of the stockpile continues to show signs of recent use. Tracks in the adjacent grass field, approaching within 250 ft of the heron nests, are presumably from operation of spray buggies during early spring.

Heron nesting activity in 2025 (to date)

Community nesting observations during the 2025 nesting season through the date of this report (March 14, 2025) are summarized in Table 5.

Thus far there have been two observations during March in which herons flew into and/or perched in the poplar grove. However the main locus of nesting activity continues to be in the ash grove.

Disturbance within the recommended 1/4 mile buffer zone is again ongoing and has intensified as of the date of this report (Figure 6).

Table 5. Heron observations during 2025.

Date	Time of day	Number of herons	Location	Observer	Effective transect width (m)
2/09/25	10:00	5	ash grove	Joel Geier	Standing in and near nests, flew off to north
2/21/25	13:30	10	ash grove	Joel Geier	Standing in and near nests
2/28/25	10:00	8	ash grove	Joel Geier	Standing in and near nests
3/06/25		1	poplar grove	Karan & Jim Fairchild	we did see a heron fly low into the hybrid poplar stand, but lost where it went.
3/06/25		1	ash grove	Karan Fairchild	one heron standing on a nest in the thick ash tops immediately east of 99W. I could count at least 12 nest accumulations in the hybrid poplar stand, but saw no herons on nests.
3/11/25	11:55	1	poplar grove	Joel Geier	Heron called while flying north from area of ash grove, looped back over Toketie Marsh and landed to perch in edge of poplars, south of Coffin Butte Road near OP2 (2nd utility pole west of highway). Viewed from north of archery range.
3/11/25	12:05	2	prairie restoration just e. of trailhead.	Joel Geier	Two adult herons hunting in prairie.
3/14/25	13:30	8+	ash grove	Joel Geier	Two herons incubating on nests, others standing in or near nests. Very brief stop. Excavation activity noted adjacent to poplar grove.
3/38/25	12:00	10+	ash grove	Joel Geier	7+ incubating on nests, 2 standing in nests, 1 building new nest.
4/08/25	09:35	10	ash grove	Joel Geier	9 incubating, 1 standing in nest. Small nests up high now occupied with incubating birds.
4/19/25	11:00	3+	ash grove	Joel Geier	Litter crew walking/working on both sides of highway. Herons standing up in nests.
4/20/25	15:30	3+	ash grove	Joel Geier	Brief check following disturbance. 3 herons standing in nests. Heard "cluck" calls indicating birds still in agitated state.



Figure 6. Photograph from March 14, 2025 of excavation activity underway on, below the previous natural grade of the stockpile. Dump trucks observed entering and leaving site via the road to the east, passing within 600 feet of the nesting area in the poplars.

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Joel Geier
38566 Hwy 99W
Corvallis, Oregon 97330-9320
(541) 745-5821
joel.geier@peak.org

Benton County Planning Commissioners
c/o Planning Division
4500 SW Research Way
Corvallis, OR 97333

April 21, 2025

RE: LU-24-027 Conditional Use Permit Application Regarding Landfill Expansion

Dear Nicholas Fowler, Chair, and Members of the Benton County Planning Commission:

Thank you again for the opportunity to comment on the Conditional Use Permit (CUP) application submitted by Valley Landfills Inc., which corporation proposes to construct a new landfill on the north end of Tampico Ridge, south of Coffin Butte Road.

This is my second in a series of comments, and it will be brief.

Today while returning from bird surveys near Airlie, I noticed windblown plastic trash far out in this agricultural field. This is another consequence of the landfill operation. The impacts extends far into Polk County, at least as far as Rickreall.

I'm sharing a few snapshots on the following. This particular land belongs to Green Spring Farms, which specializes in regenerative agriculture. Their office is located in Suver, about 2 miles from the landfill.

A suggested question for you to ask of Staff:

Did Green Springs Farms receive a notice of opportunity to comment on LU-24-027? What about other farms in the landfill-impacted area, which for this issue extends at least as far north as Rickreall?

Thank you for considering these comments. I reserve the right to provide further written and oral testimony according to the time frame allowed by statute.

Yours sincerely,



Joel E. Geier, Ph.D.





From: Joel Geier
To: Benton Public Comment
Subject: Oppose/Deny LU-24-027: Arsenic issues
Date: Tuesday, April 29, 2025 4:48:15 PM

CAUTION: This email originated from outside of the organization. Do not click links or open attachments unless you recognize the sender and know the content is safe.

Dear Community Development Department staff:

I'm attaching my fourth set of comments for the Planning Commission. Please include these comments in the information packet for their deliberations.

Thank you,
Joel Geier
North Benton County resident

Joel Geier ● 38566 Hwy 99W ● Corvallis, Oregon 97330-9320

Benton County Planning Commissioners c/o Planning Division
4500 SW Research Way, Corvallis, OR 97333

April 29, 2025

RE: LU-24-027 Conditional Use Permit Application Regarding Landfill Expansion: Arsenic

Dear Chair Fowler and Members of the Benton County Planning Commission:

Thank you again for the opportunity to comment on the Conditional Use Permit (CUP) application submitted by Valley Landfills Inc., which proposes to start what amounts to a new landfill on the north end of Tampico Ridge, south of Coffin Butte Road.

This is my fourth in a series of comments, and focuses on the **anomalously high and fluctuating levels of arsenic** that have been found in groundwater monitoring wells around the east side of the existing landfill, ever since 1994 when the applicant first began to test for arsenic in this area.

Five monitoring wells in this part of the landfill site have frequently exceeded 15 micrograms per liter, which is 50% in excess of the US EPA's maximum contaminant level (MCL) for drinking water.

These arsenic levels on the landfill site are higher than have been found in any other well, anywhere within the applicant's 90 square mile Analysis Area. Yet remarkably the applicant asks you, in Exhibit 29 of their application, to believe that these are "natural" arsenic levels for the area.

"Why are is the applicant raising this issue as part of this application?" you might well ask. Exhibit 29 pertains to the existing landfill north of Coffin Butte Road, rather than the proposed new landfill to the south.

But regardless of their reasons, this exhibit does serve as a useful example of how the applicant handles legitimate environmental concerns that have been raised by local residents.

Rather than installing new monitoring wells to gain a better understanding of the issue, the applicant instead has tried to "argue the problem away."

As I detail in an annex to this statement, the applicant's arguments are shaky at best. The fact that they have included this dubious memo as part of their application casts doubt on the entire application, and **gives you further grounds to deny**.

Yours sincerely,



Joel E. Geier, Ph.D.

Annex 1
Comments on Arsenic Memo and Addendum

The applicant has raised the arsenic issue in a memorandum included as Exhibit 29 of their Burden of Proof statement, supplemented by an addendum on January 15, 2025. My comments here highlight the following problems with these documents:

1. Arsenic levels observed at the Coffin Butte Landfill site are highly unusual
2. Aggregation of data from wide regions is misleading
3. Claims of "steady" readings are questionable
4. Choice of baseline is questionable

These are elaborated in sequence below.

1. Arsenic levels observed at the Coffin Butte Landfill site are highly unusual for the western mid-Willamette Valley

The applicant asserts:

> *"There is no data to suggest that the existing arsenic levels are anything other than what is naturally occurring in the soil, or that leachate is impacting the environment or public health."*

This statement has two parts. The second part cannot be evaluated because neither the applicant nor Oregon DEQ nor Benton County have tested for potential impacts of leachate on the environment, anywhere outside of the site boundary. This despite that two of the compliance boundary wells (MW-26 and MW-27) have registered arsenic concentrations above the US EPA's maximum contaminant level (MCL) regularly for the past 14 years (Figure 1).

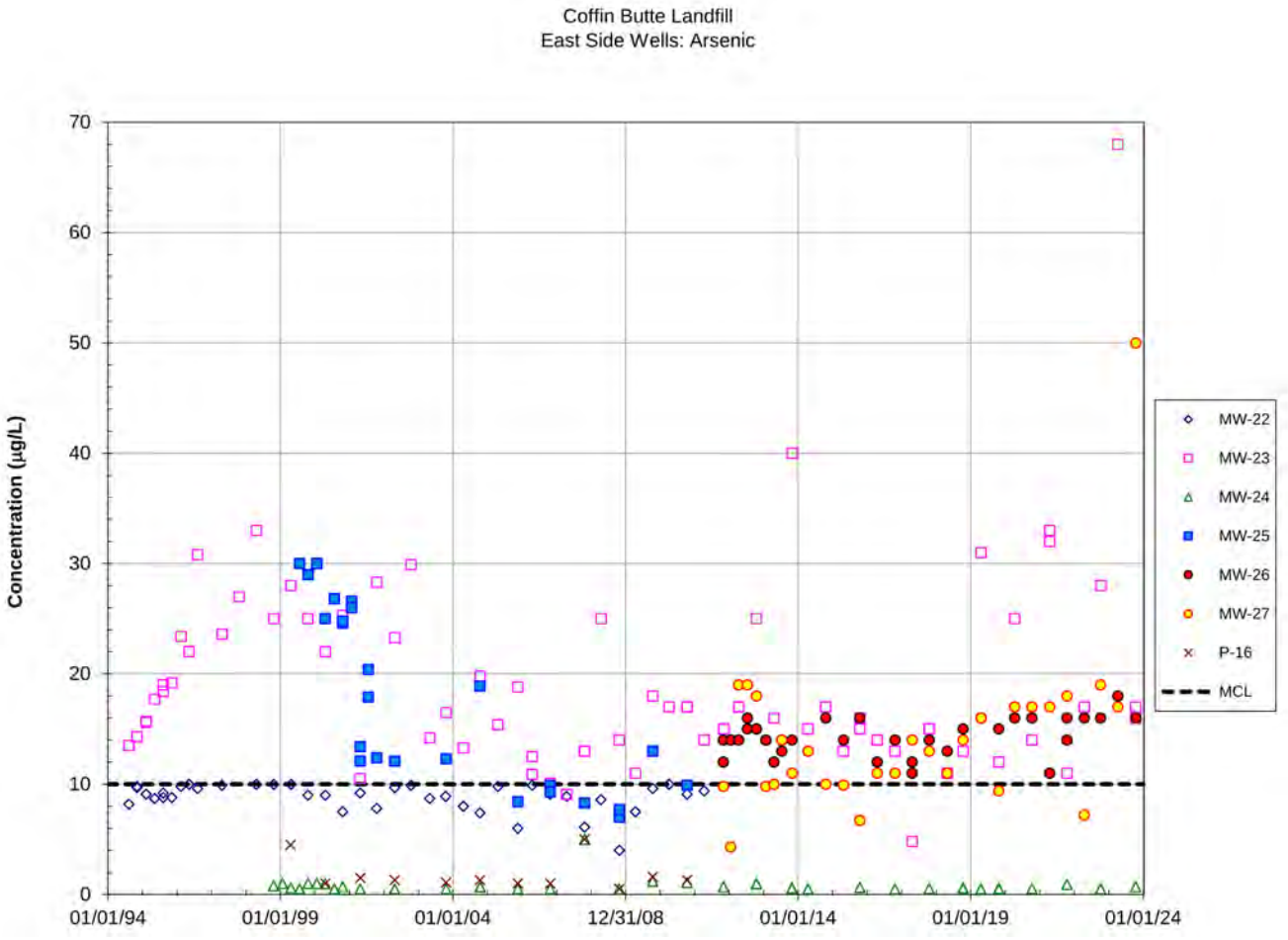


Figure 1. Arsenic concentrations in wells on the east side of Coffin Butte Landfill (from p. 245 of the 2023 Annual Environmental Monitoring Report submitted to Oregon DEQ).

Regarding the first part of the statement, the applicant has not developed any data regarding what arsenic levels are "naturally occurring" in the area of concern, since nearly all of their measurements in that area come from after a known leachate seepage incident (to be discussed in more detail below).

However a regional study data by US Geological Survey scientists, published in 1999,[1] shows clearly that the values observed at Coffin Butte are highly unusual for northwestern Benton County and adjoining areas of Polk County (see Figure 2).

1 Hinkle and Pollette, 1999, Arsenic in Ground Water of the Willamette Valley, US Geological Survey Water Resources Investigations Report 98-4205.

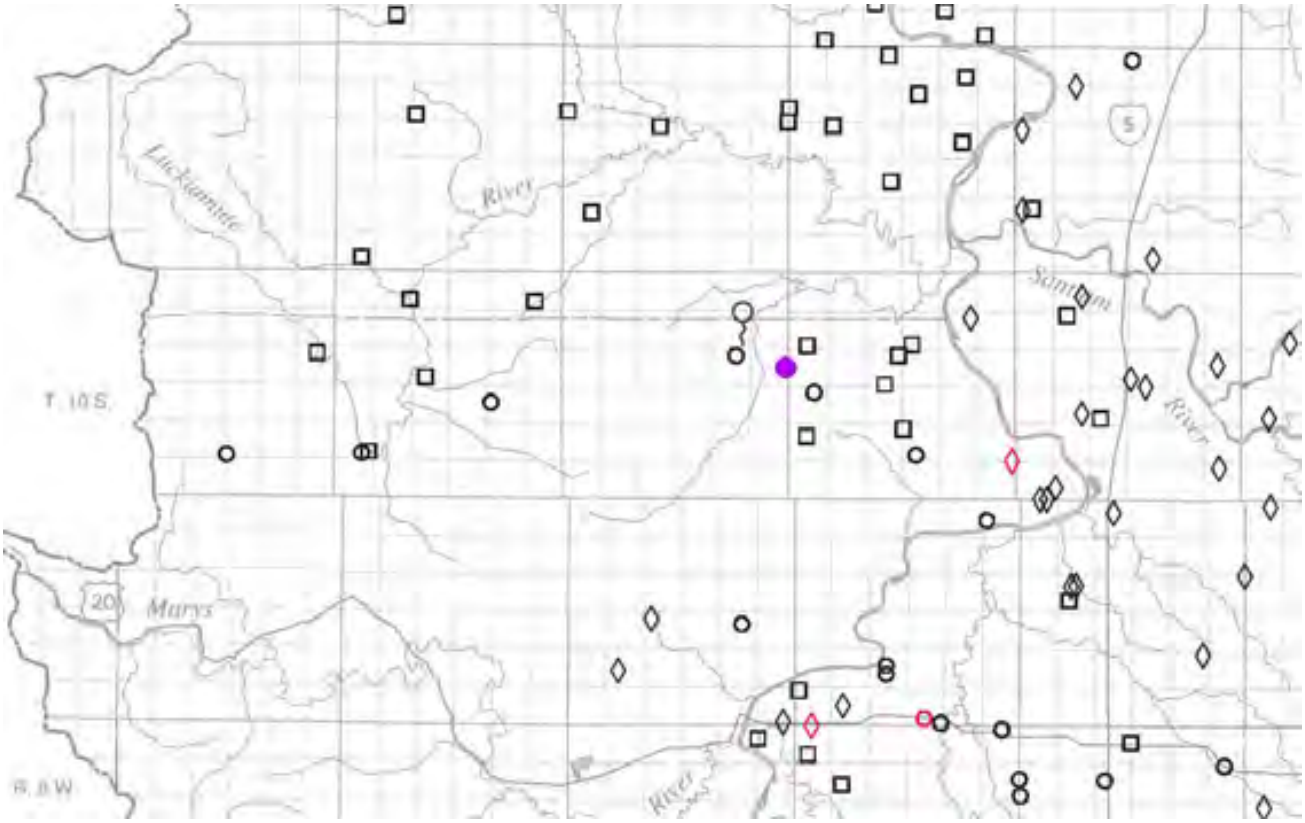


Figure 2. Detail of Plate 1 from Hinkle and Pollette (1999) showing arsenic concentrations in wells in the western mid-Willamette Valley region. The purple dot has been added for reference to show the location of Coffin Butte Landfill (not sampled by Hinkle and Pollette). Black symbols are wells and springs for which the measured arsenic concentration was 10 micrograms per liter or less. Red symbols show wells where arsenic concentrations were in the range 11 to 50 micrograms per liter. No wells in this area were found to have arsenic concentrations above 50 micrograms per liter. The square grid shows section lines (typically 1 mile on a side) for scale.

Values higher than the US EPA's maximum contaminant level (MCL) of 10 micrograms per liter are rare (just 3 wells out of more than 80 in the area of this detail, none of them within the applicant's Analysis Area). None of the wells evaluated by Hinkle and Pollette (1999) were found to have arsenic concentrations above 50 micrograms per liter. In contrast, arsenic concentrations in two wells at the Coffin Butte Landfill site have recently risen to 50 micrograms per liter and 68 micrograms per liter, respectively.[2]

Additional data aggregated by census tracts by the Oregon Health Authority (Table 1) indicate that just 1 of 146 wells in any census tract within 25 miles of Coffin Butte landfill

2 2023 Annual Environmental Monitoring Report for Coffin Butte Landfill

which registered an arsenic concentration higher than the MCL, and that well only had a concentration of 14 micrograms per liter. The average arsenic concentration over this sample is only 0.37 µg/L.

So clearly naturally elevated arsenic is extremely uncommon anywhere in the vicinity of Coffin Butte Landfill. Applicant has presented no data to support their suggestion that the observed arsenic levels are naturally occurring in the soil.

On the contrary, both in the Burden of Proof and in this memo, the applicant acknowledges that when these high levels were first noticed in MW-23 in 1994, the cause was found to be seepage of leachate from the south side of the landfill.

While the Burden of Proof suggests that this seepage event only happened in 1994, from statements in past AEMRs it appears that the applicant does not know exactly when the seepage began or how long it went on before it was detected fortuitously by sampling of MW-23. A more reasonable and parsimonious interpretation is that if seepage happened once and resulted in high arsenic levels, it could happen again and may even be ongoing.

Table 1. Arsenic levels in domestic wells as aggregated by the Oregon Health Authority for census tracts in Benton and Polk counties.

Census Tract	County	Geology (see key)	Approx. mean distance from Coffin Butte (miles)	Maximum distance from Coffin Butte (miles)	Number of samples N	Mean concentration (µg/L)	Maximum concentration (µg/L)	Number of tests over 10 ppb
41003010100	Benton	Tt, Qs	5	9	5	0.58	2.9	0
41003000500	Benton	Tcs, Qs	5	8	18	0.17	2	0
41053020302	Polk	Qs, Teo	6	12	3	0.73	2.2	0
41003000600	Benton	Qs	7	9	16	0	0	0
41003000400	Benton	Tcs, Qs	8	9	2	0	0	0
41003000900	Benton	Tcs	9	10	12	0	0	0
41003010900	Benton	Tcs, Qs	11	14	19	0.05	1	0
41003000202	Benton	Qs	12	13	13	0.15	1	0
41003000100	Benton	Qs	12	14	3	1.33	2	0
41003010200	Benton	Tt, Tcs, Qs	13	21	11	1.66	**14**	1
41053020303	Polk	Qs	13	14	1	0	0	0
41003010800	Benton	Tcs	13	14	3	0	0	0
41053020204	Polk	Teo	14	17	3	0	0	0
41053020202	Polk	Qs, Teo	16	13	1	0	0	0
41053020400	Polk	Tcs, Teo, Tmi	21	37	2	0	0	0
41053005300	Polk	Tmb, Teo, Qs	21	28	6	0	0	0
41053020500	Polk	Teo, Qs	22	23	1	0	0	0
41003010400	Benton	Qs, Tt, Tmi	23	32	27	0.78	7	0
Total	**Polk/Benton**		**<25**	**<35**	**146**	**0.37**	**14**	**1**

Key to abbreviations for geological formations, in order from oldest to youngest:
Tcs: Siletz River Volcanics (Paleocene to Eocene basaltic and related rocks of the Siletzia terrane).
Tt: Tyee Formation (Eocene marine sandstones/shale sequence, provenance possibly the Idaho Batholith)
Teo: Yamhill/Nestucca formations (Eocene to Oligocene marine volcanic-rich sedimentary and volcanic rocks)
Tmb: Columbia River Basalts (Middle Miocene basalts and minor tuffaceous sedimentary rocks)
Tmi: Mafic intrusions (Miocene mafic intrusions on Coast Range peaks including Marys Peak)
Qs: Quaternary sediments (late Pleistocene flood deposits and minor younger sediments on Willamette Valley floor)

2. Aggregation of data from wide regions is misleading

The 2/15/24 memorandum states:

> *In the Portland Basin, the background concentration is 8.8 milligrams per kilogram; in the Cascade Range it is 19 milligrams per kilogram; and in the South Willamette Valley (where Coffin Butte is located) it is 18 milligrams per kilogram.*

The units are surely incorrect, as 18 milligrams per kilogram of water (i.e., per liter) equates to 18,000 micrograms per liter, or nearly 2000 times the US EPA's maximum contaminant limit (MCL) for drinking water.

Even if the units were fixed, mention of concentrations in the Portland Basin and Cascade Range is meaningless for this application. The local geology in the area of the landfill (Siletz River Volcanics) differs from the geology that prevails in either of those regions.

Citing an average value over the Southern Willamette Valley is deceptive. It is well-known that the southernmost part of the Willamette Valley, from Eugene (Spencer Butte area) south to Creswell and Cottage Grove, is an area where high arsenic in water wells is a common problem. From Plate 1 in Hinkle and Pollette (1999), it can readily be seen that close to half of wells south of State Hwy 126 exceed the MCL, and many exceed 50 micrograms per liter. This situation has led to drinking water advisories for those areas. However from Fern Ridge Reservoir north, arsenic problems are rare.

3. Claims of "steady" readings are questionable

The Burden of Proof states that, after high levels of arsenic were detected in 1994 and were attributed to a seepage problem:

> *VLI took various and appropriate corrective measures to correct the issue. Readings taken from compliance wells installed in 2011 have been stable with averages consistent with the background concentrations of arsenic in the Willamette Valley.*

These steady readings indicate that there have been no leachate releases or impacts on groundwater.

From Figure 1 it can be seen that, after a few years of decline following measures to address the seepage problem, arsenic levels in MW-23 (see Figure 3 for well locations) have continued to fluctuate over a wide range, spiking several times to levels above 30 micrograms per liter.

The compliance boundary wells (MW-26 and MW-27) have exceeded the US EPA's MCL for arsenic in most measurements since they were installed. Most arsenic measurements in both of these compliance-boundary wells are also higher than in any wells not on the landfill site, within the Analysis Area chosen by the applicant.

From 2014 to 2019, only two or three of the 10 arsenic measurements were above 15 micrograms per liter in these two wells. Since then, all but three measurements have been above that threshold. In late 2023, the arsenic concentration in MW-27 spiked up to 50 micrograms per liter. That doesn't meet any common definition of "stable." Note that this measurement predated the 2/15/2024 memorandum included in the application.

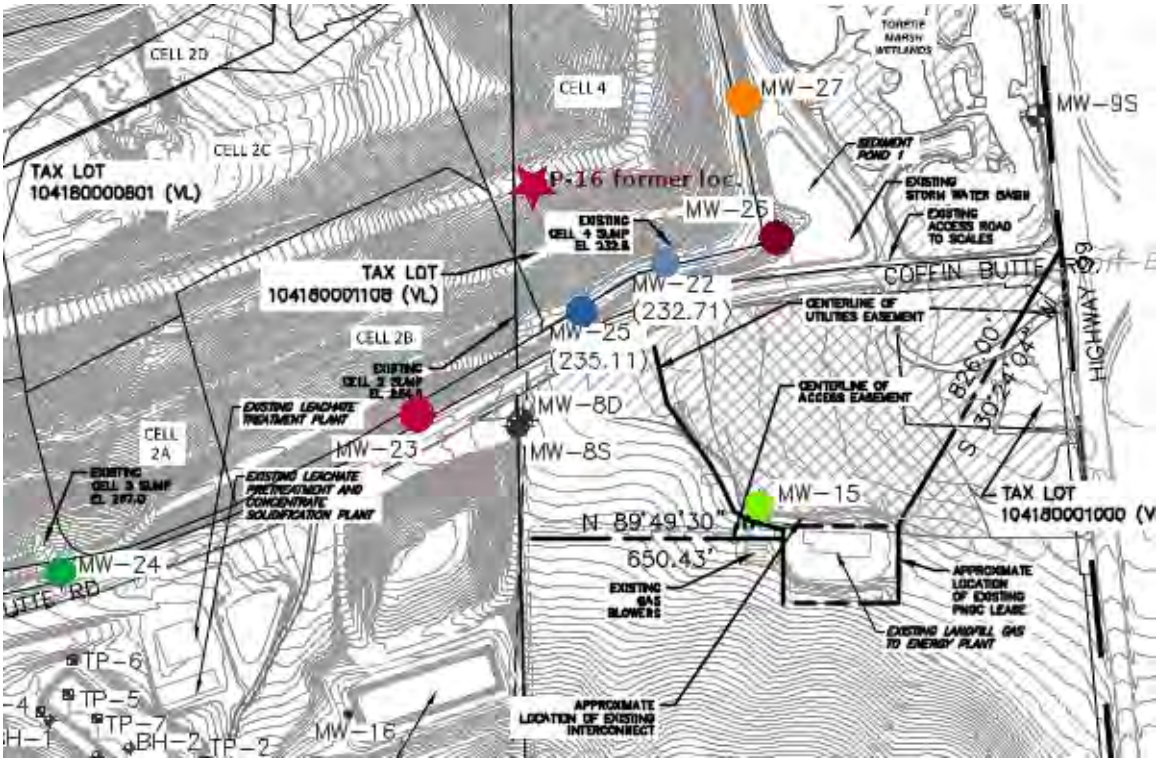


Figure 3. Location of monitoring wells in the area of concern.

4. Choice of baseline is questionable

The memo inaccurately suggests that the applicant started testing east-side wells for arsenic in 1991.

> *Arsenic testing at Coffin Butte initially began in April 1991, in well MW-S9* [corrected to MW-9S in the addendum] *on the landfill's northeast side.*

MW-9S was drilled on August 2, 1985, but there is no record of it having been tested for arsenic until February 8, 1995.[3]

The first reported arsenic measurements at Coffin Butte were in late 1988, mainly on the west side of the landfill.

The only pre-1994 measurement reported from the east side was apparently in MW-8S, in 1988.[4] That sample yielded a non-detection (ND) for an analysis threshold of 2 micrograms per liter in MW-8S. MW-8S is just across the road from the existing landfill, and about 90 yards downhill from MW-23, in the same direction as the interpreted hydraulic gradient.

The fact that arsenic was not detected in well MW-8S when it was sampled in 1988 may be a better indicator of baseline conditions, than wells that were sampled only after the acknowledged seepage problem that was discovered in 1994.

Applicant has instead claimed that MW-9S provides baseline data:

> *However, it is important to note that the initial sampling at this well – which established baseline arsenic levels in background concentrations - occurred prior to the completion of Cell 2 construction or any landfilling on the east side of Coffin Butte.*

3 Based on data provided in the AEMRs including a digital appendix of the 2023 AEMR, Appendix_F_-_2023_Historical_Database.xlsx. The latter shows that in 1991 MW-9S was sampled for alkalinity, chemical oxygen demand, chloride, hardness, nitrogen (various measures), total dissolved solids, suspended solids, sulfate, and total organic carbon, but not arsenic or other metals.

4 This measurement is missing from the database provided as digital appendix F, but shown as a plotted value in the 2023 AEMR, p. C-114 as well as in AEMRs from previous years.

As discussed above, there appears to be no record of sampling MW-9S prior to the early-1990s seepage incident.

According to the 2021 AEMR, this well drilled in 1985 is only 35 feet deep. The site map shows that this well is located right at the edge of State Hwy 99W, under what was part of the "half cloverleaf" interchange that was constructed for Camp Adair in the 1940s, using aggregate and fill rock from various sources. It is also right alongside the creek that was channelized to create what was called "the canal" during the Camp Adair period. This well is also immediately adjacent to a remedial wetland ("Toketie Marsh") that was constructed during the same time as the seepage occurred. Historical satellite images from Google Earth (Figure 4) show the condition of the area around MW-9S at that time.

The applicant has claimed:

> *Because this well is more than 1,800 feet away from MW-23, and because sampling occurred prior to the construction of Cell 2, it is implausible for the readings at this location to have been impacted by leachate.*

This ignores that there was a very simple way for leachate from the south side of the landfill to reach MW-9S.

This seepage would have drained into the ditch on the north side of Coffin Butte Road, flowed down through the ditch into the sediment pond, and into the newly created wetland as it was filling with water. Contaminated water in the wetland then would simply need to seep down through the disturbed sediments in which MW-9S was drilled.



Figure 4. View of east side of existing landfill development area from satellite images taken in May of 1944 (available on Google Earth). The recently constructed wetland on the east side of the scale-house road ("Toketie Marsh") is still in an unvegetated state though filling with water (indicated by shimmer). The sedimentation pond that flows into Toketie Marsh, receiving water from the ditch that runs past MW-23, also appears to be water-filled in this image. MW-9S is located at the edge of Toketie Marsh on the west side of Hwy 99W, next to the area where part of the former cloverleaf ramp has been bulldozed away.

Indeed, the available data from MW-9S (Figure 4) show that measurements shortly after the seepage problem was discovered in 1994 were higher (35 to 42 micrograms per liter) than the values seen since 2014 (in the range 27 to 29 micrograms per liter). This is consistent with the idea that this well could have initially been contaminated by leachate (which has arsenic concentrations above 100 micrograms per liter) arriving relatively directly via surface drainage, but since has declined to levels more consistent with a groundwater plume.

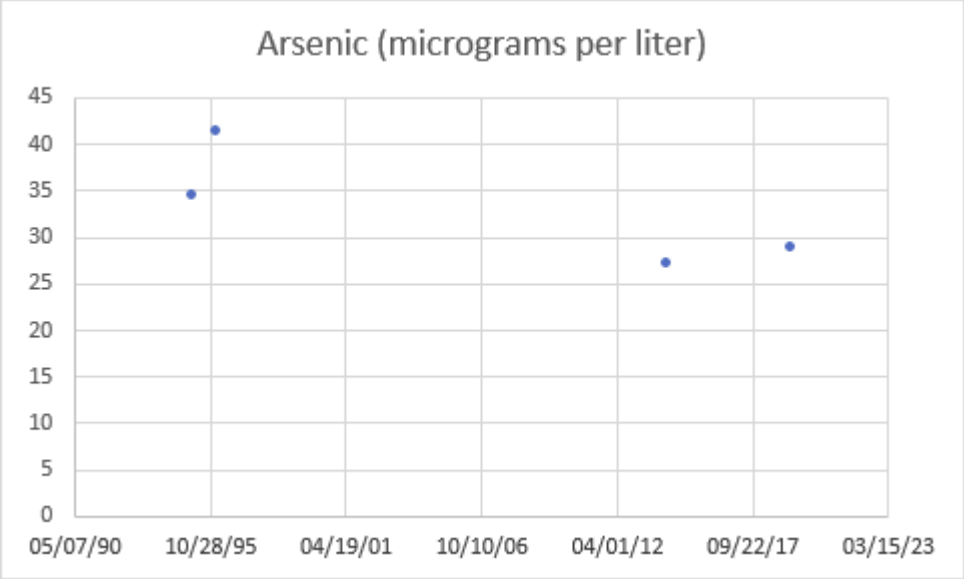


Figure 4. Arsenic concentrations measured in MW-9S from 1990 to 2023. Note that, although the applicant states that "this well has been subject to a quintennial sampling schedule (every five years) since 1991," the earliest reported are from 1995, and there appears to have been an 18-year gap in arsenic testing from February 1996 to April 2014. According to the applicant's arsenic addendum this well was again tested for arsenic in October 2024, with a reported concentration of 27 micrograms per liter.

In any case, concentrations observed in MW-23 and the compliance-boundary well MW-27 in 2023 exceeded the highest concentrations ever measured in MW-9S.

So even if we accept the applicant's questionable claim that MW-9S represents "baseline," recent measurements have exceeded the supposed baseline values.

From: Joel Geier
To: Benton Public Comment
Subject: LU-24-027: Information to add to the record regarding groundwater
Date: Saturday, May 3, 2025 6:48:59 PM

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Dear members of the Planning Commission and Community Development Department staff:

Please enter the attached document:

> Ochoa, C.G.; Jarvis, W.T.; Hall, J.
> A Hydrogeologic Framework for Understanding Surface Water and Groundwater Interactions in a Watershed System in the Willamette Basin in Western Oregon, USA.
> *Geosciences* **2022**, *12*, 109. https://doi.org/10.3390/geosciences12030109

into the record for LU-24-027. This is a peer-reviewed, open-access article distributed under the terms and conditions of the Creative Commons Attribution license (https://creativecommons.org/licenses/by/4.0/).

The article contains scientific information that is highly relevant to understanding the flaws in the Applicant's claims that construction of the proposed new landfill will not impact groundwater access and groundwater quality on adjacent properties.

The article describes findings from a scientific investigation of groundwater and its relationship to surface water flow in the Oak Creek watershed, on the west side of Corvallis and also in Benton County.

The Oak Creek watershed is less than 10 miles south of the proposed new landfill, bordering on the Soap Creek watershed in its upper reaches. It is similar to the proposed development in terms of:

- bedrock geology,
- climate including seasonal precipitation,
- topographic relief,
- proximity to the Corvallis Fault.

I've cited this article in my own previously submitted testimony on groundwater issues. The second author, Dr. William (Todd) Jarvis, an Engineering Geologist registered in Oregon, kindly reviewed my testimony on that topic before I sent it to you, and confirmed that my representations of the technical findings in this article were accurate.

In particular, I cited this document as an example of how:

- Groundwater divides do not necessarily coincide with topographic divides

(contrary to the applicant's claims).
- Groundwater directions in fractured bedrock (similar to that under Tampico Ridge) cannot be fully predicted from topography and shallow investigations.
- Bedrock structures such as the Corvallis Fault (which also angles down under the proposed development site) can influence groundwater flow directions.

This study also serves as an example of what the Applicant could have done, if they were genuinely interested to develop an understanding of groundwater in the area around the proposed new landfill. Such an investigation could provide a well-founded analysis of the risks for groundwater resources on adjacent properties.

But the Applicant has not undertaken such an investigation. Instead they're expecting you to accept arguments based almost entirely on the very limited data that they've collected on their own site. They know that this leaves major gaps, which they've tried to fill by conjecture and "arm-waving."

I hope that you will see that **arm-waving in the absence of relevant data is not an acceptable way to dismiss the legitimate concerns of nearby residents**, for whom loss of access of to safe and reliable well water would **seriously interfere with use of their property (Benton County Code 53.215)**.

Thank you for taking this information into consideration for your deliberations.

Yours sincerely,
Joel Geier, Ph.D.
38566 Hwy 99W
Corvallis, OR 97330-9320

From: Joel Geier
To: Benton Public Comment
Subject: LU-24-027: Information to add to the record regarding arsenic
Date: Saturday, May 3, 2025 6:11:57 AM

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Dear Community Development Department staff and members of the Planning Commission:

Please enter the attached document:

> Arsenic in Ground Water of the Willamette Basin, Oregon
> by Stephen R. Hinkle and Danial J. Polette
> Water-Resources Investigations Report 98–4205

into the record for LU-24-027.

This is a publicly available document produced by the United States Geological Survey.

It contains scientific information that is highly relevant to the Applicant's claims that the high levels of arsenic discovered in groundwater at the landfill site are "typical" for this part of the Willamette Valley.

I've cited this document in my own previously submitted testimony on the arsenic issue (in which, I notice now, I misspelled the name of the second author as "Pollette").

This document is technical in nature, so some details may require a scientific background to understand. But here's one simple thing to note:

If you run text search on this document, you'll find that the names of the two counties closest to Coffin Butte Landfill, Benton and Polk, occur just four times in total. Two of those instances are as labels on maps. The other two are for a single document in the list of references. Nowhere in this document is there any mention of arsenic as being a naturally occurring problem in either Benton or Polk County.

In contrast, Linn and Lane counties are mentioned frequently (a total of about 75 time). Linn and Lane are the counties in the southern Willamette Valley where arsenic in groundwater is recognized to be a common problem, not Benton or Polk.

In other words, the "character of the area," in areas of Benton and Polk counties all around the landfill, has been an area where rural residents haven't had to worry about arsenic in their wells, at least up until now.

Thank you for taking this information into consideration for your deliberations.

Yours sincerely,
Joel Geier, Ph.D.
38566 Hwy 99W
Corvallis, OR 97330-9320

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A Hydrogeologic Framework for Understanding Surface Water and Groundwater Interactions in a Watershed System in the Willamette Basin in Western Oregon, USA

Article *in* Geosciences · February 2022

DOI: 10.3390/geosciences12030109

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Article

A Hydrogeologic Framework for Understanding Surface Water and Groundwater Interactions in a Watershed System in the Willamette Basin in Western Oregon, USA

Carlos G. Ochoa [1,*], William Todd Jarvis [2] and Jesse Hall [3]

[1] Ecohydrology Lab, College of Agricultural Sciences, Oregon State University, Corvallis, OR 97331, USA
[2] Institute for Water and Watersheds, Oregon State University, Corvallis, OR 97331, USA; todd.jarvis@oregonstate.edu
[3] Water Resources Graduate Program, Oregon State University, Corvallis, OR 97331, USA; jhall80@gmail.com
* Correspondence: carlos.ochoa@oregonstate.edu; Tel.: +1-541-737-0933

Abstract: A broad understanding of local geology and hydrologic processes is important for effective water resources management. The objectives of this project were to characterize the hydrogeologic framework of the Oak Creek Watershed (OCW) geographical area and examine the connections between surface water and groundwater at selected locations along the main stem of Oak Creek. The OCW area comprises the Siletz River Volcanic (SRV) Formation in the upper portion of the watershed and sedimentary rock formations in the valley. Past hydrologic and geologic studies and our field measurement data were synthesized to create a hydrogeologic framework of the watershed, including a geologic interpretation and a conceptual model of shallow, deep, and lateral groundwater flow throughout the OCW. The highly permeable geology of the SRV formation juxtaposed against the Willamette Basin's sedimentary geology creates areas of opposing groundwater flow characteristics (e.g., hydraulic conductivity) in the watershed. The Corvallis Fault is the primary interface between these two zones and generally acts as a hydraulic barrier, deflecting groundwater flow just upstream of the fault interface. The extreme angle of the Corvallis Fault and adjacent less permeable sedimentary geology might facilitate subsurface bulk water storage in selected locations. The stream-aquifer relationships investigated showed gaining conditions are prominent in the upper watershed's northern volcanic region and transition into neutral and losing conditions in the downstream southern sedimentary region in the valley. Agriculture irrigation seepage in the valley appeared to contribute to streamflow gaining conditions. Results from this case study contribute critical information toward enhancing understanding of local hydrogeologic features and potential for improved SW-GW resources management in areas near coastal ranges such as those found in the Pacific Northwest, USA.

Keywords: hydrology; geology; surface water-groundwater interactions; fault permeability; gaining stream; losing stream

Citation: Ochoa, C.G.; Jarvis, W.T.; Hall, J. A Hydrogeologic Framework for Understanding Surface Water and Groundwater Interactions in a Watershed System in the Willamette Basin in Western Oregon, USA. **2022**, *12*, 109. https://doi.org/10.3390/geosciences12030109

Academic Editors: Helder I. Chaminé and Jesus Martinez-Frias

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1. Introduction

Understanding the interactions between surface water and groundwater (SW-GW) is critical for improved water resources management [1,2]. Surface water and groundwater cannot be seen as isolated components [3] and the role of geology in their spatial and temporal variability throughout the landscape needs to be better understood. The replenishment of groundwater from surface water sources such as irrigation and precipitation can be influenced by geologic characteristics, such as the presence of fractured bedrock or basalt [4], and the timing and quantity of precipitation [5,6] or irrigation [7,8]. A common expression of SW-GW relationships occurs at the stream and aquifer intersection. Geology has long been considered a primary driver of watershed hydraulic characteristics [9–11]

such as streambed permeability and the rate of surface water infiltration into the aquifer [12]. A variable SW-GW flow exchange can influence the streamflow volume between any two points along the stream and can create gaining conditions where groundwater inputs contribute to streamflow, or losing conditions where streamflow is lost through the permeable substrate [13–15]. Groundwater inputs can constitute a significant portion of the overall streamflow volume of a gaining reach or stream, especially during low-flow conditions [16]. The SW-GW connections are highly dependent on the geological features responsible for water transport and distribution throughout the landscape [4,17–19].

Geologic faults are another feature that significantly influences SW-GW relationships, particularly the dynamics of groundwater flow. Faulting impacts groundwater hydrology by altering flow vectors near the fault core zone [20]. Fault gouge, coupled with separation, creates a broad spectrum of hydraulic barriers, conduits, or a combination of these [4,17,20,21]. Impermeable areas within fault zones can sever the hydraulic continuity of aquifers, producing incongruent groundwater tables and isolated groundwater compartments. Active faults can have irregular fault core thickness and a degree of damage to surrounding rock along their profile length [21]. Varying degrees of damage and fault gouge create significant contrasts in permeability along with the fault profile, and as a result, a single fault can be both a barrier and a conduit for groundwater flow [21,22].

A common resource management integration of SW-GW relationships is by using groundwater replenishment tools such as managed aquifer recharge (MAR). In a 60-year retrospective of global MAR, Dillon et al. [23] indicated that "*MAR is a management tool to consider with and complement new efficiency measures in irrigation, switching to low water use crops, conjunctive use of surface water and groundwater resources including substituting use of recycled water for groundwater, and foregoing extraction*". The drivers for considering MAR in various forms include limited surface reservoir sites, increased costs associated with surface water treatment for harmful algal blooms, decreasing barriers to fish passage, and increased costs to purchase water from regional water suppliers. Over the past 50 years, the storage of managed aquifer recharge in the US has increased nearly 10-fold from approximately 300 Mm^3 $year^{-1}$ in 1965 to 2570 Mm^3 $year^{-1}$ in 2015 [23].

According to the Oregon Water Resources Department (OWRD), managed recharge and related aquifer storage and recovery (ASR) projects have been operating in Oregon since 1996, with more than 7.5 Mm^3 per year stored annually. Potential aquifer storage identified by Woody [24] approaches Oregon's annual public water supply in the year 2000, or 500 Mm^3. Oregon currently has approximately 15 state-authorized and planned ASR test sites servicing municipalities and agriculture. Most of these sites store water in volcanic rock aquifers, including the Siletz River Volcanics [24]. The use of small-scale managed recharge utilizing rainwater or spring water for domestic well storage is increasingly considered in mountainous areas underlain by low permeability volcanic rocks and siltstone [25,26]. Likewise, a market for aquifer storage space is gaining momentum as the concept of Aquifer Recharge Units (ARU) is being developed [27].

Characterizing hydrogeology's role in SW-GW interactions is critical for understanding the potential for integrated water resources management, including stream-aquifer interactions and groundwater recharge. This project examined hydrogeological features influencing SW-GW interactions in the southern portion of the Willamette Basin region in western Oregon, USA. The objectives of this case study were to: (1) characterize the hydrogeological framework of the watershed geographical area, and (2) examine stream-aquifer relationships along the main stem of the creek.

2. Materials and Methods

2.1. Study Site

The study was conducted in the Oak Creek Watershed (OCW) within the Willamette Basin region. The OCW (44.57° latitude; −123.30° longitude) encompasses 3360 hectares, and it is adjacent (west) to the City of Corvallis, Oregon, USA. The main stem of Oak Creek

flows 11 km from its source and highest point (650 m above sea level, MASL) in the McDonald-Dunn Forest to its lowest point (64 MASL) at the confluence with Marys River. The climate in the region is a Mediterranean type, with a warm and dry season in the summer and a mild and wet winter season. Most precipitation occurs as rainfall between November and April. Mean annual precipitation within the basin ranges from 2500 mm at higher elevations to 1000 mm at lower elevations [28]. The monthly-averaged lowest temperature occurs in January (0.67 °C), while the highest occurs in August (27.4 °C). The lowest and highest total monthly precipitation occurring in July (9.1 mm) and December (181.4 mm), respectively [29]. Oak Creek is a fourth-order headwater stream with discharge volumes generally ranging between 0.01 $m^3 s^{-1}$ and 0.25 $m^3 s^{-1}$, and peak discharge reaching up to 6 $m^3 s^{-1}$ in the winter. Upland overstory vegetation at the OCW is dominated by Douglas-Fir (*Pseudotsuga menziesii*), western hemlock (*Tsuga heterophylla*), and western red cedar (*Thuja plicata*). At lower elevation sites, White oak (*Quercus alba*), red alder (*Alnus rubra*), Oregon ash (*Fraxinus latifolia*), and bigleaf maple (*Acer macrophyllum*) dominate the landscape.

Land cover in OCW encompasses forest (70%), agriculture (12%), urban (12%), and undeveloped (6%). Land use categories at OCW include forestry in the uplands, agriculture in mid to lower elevation sites, and urban including Oregon State University (OSU)'s main campus at the bottom of the watershed. Much of the area of the OCW is a mixture of publicly and privately-owned forest maintained for uses such as timber harvest, protected water drinking water-supply source areas, recreation, and forestry and agricultural research stations associated with the Colleges of Agricultural Sciences and College of Forestry at OSU. Approximately 20 hectares of OSU's pasture fields in the lower valley are irrigated with water diverted from Oak Creek during the summer. Water pumped from the creek is run through underground pipes that feed individual irrigation lines with multiple sprinkler pods at different fields. The rest of the agricultural activity in OCW depends mostly on the soil moisture accumulated during the wet precipitation season in the winter. No deep groundwater extraction for agriculture irrigation currently exists at the OCW. The Siletz River Volcanic (SRV) rock formation underlying much of OCW has become increasingly important for municipal and domestic water supplies in the last 30 years [30]. Over the past 20 years, significant residential growth near the cities of Corvallis and Philomath, Oregon, USA has been occurring [30,31].

The generalized hydrostratigraphy of the rocks underlying OCW has been summarized by [20,30,32,33] based on water well logs available from the OWRD, oil exploration wells available from the Oregon Department of Geology and Mineral Industries (ODGMI), field examination of rock quarries, outcrop examination, and hydrogeologic mapping (Table 1).

Table 1. Lithology, permeability, and hydrologic features of the various geologic formations at OCW.

Formation Name	Generalized Lithology	Permeability Architecture	Hydrologic Properties
Alluvium	Sand, gravel, cobbles thin, 10 m thick	Porous media.	Prolific yield for irrigation near Willamette River.
Spencer/Tyee/Yamhill, undifferentiated	Shale, siltstone, interbedded sandstone, up to 3000 m thick	Microfractures in siltstones and shale, porous media in sandstones.	Low yield for domestic wells. Some saline water and artesian flow in deep sandstones.
Siletz River Volcanics	Basalts with interbedded claystone and sandstone, up to 1000 m thick	Fractures, conduit flow in interflows. Stratigraphic and structural groundwater compartments common.	Moderate yield for domestic and municipal wells.

2.2. Hydrogeologic Framework

2.2.1. Site Geologic Conditions Map and Hydrogeologic Cross-Sections

Information from several sources including previous geophysical research conducted in the OCW [20], oil and gas exploration well logs maintained by the ODGMI, United Stated Geologic Survey (USGS) geological maps, OWRD water well logs, and our field-based data were used to create a Site Geologic Conditions Map along with cross-sections of site geologic and hydrogeologic conditions (Figure 1).

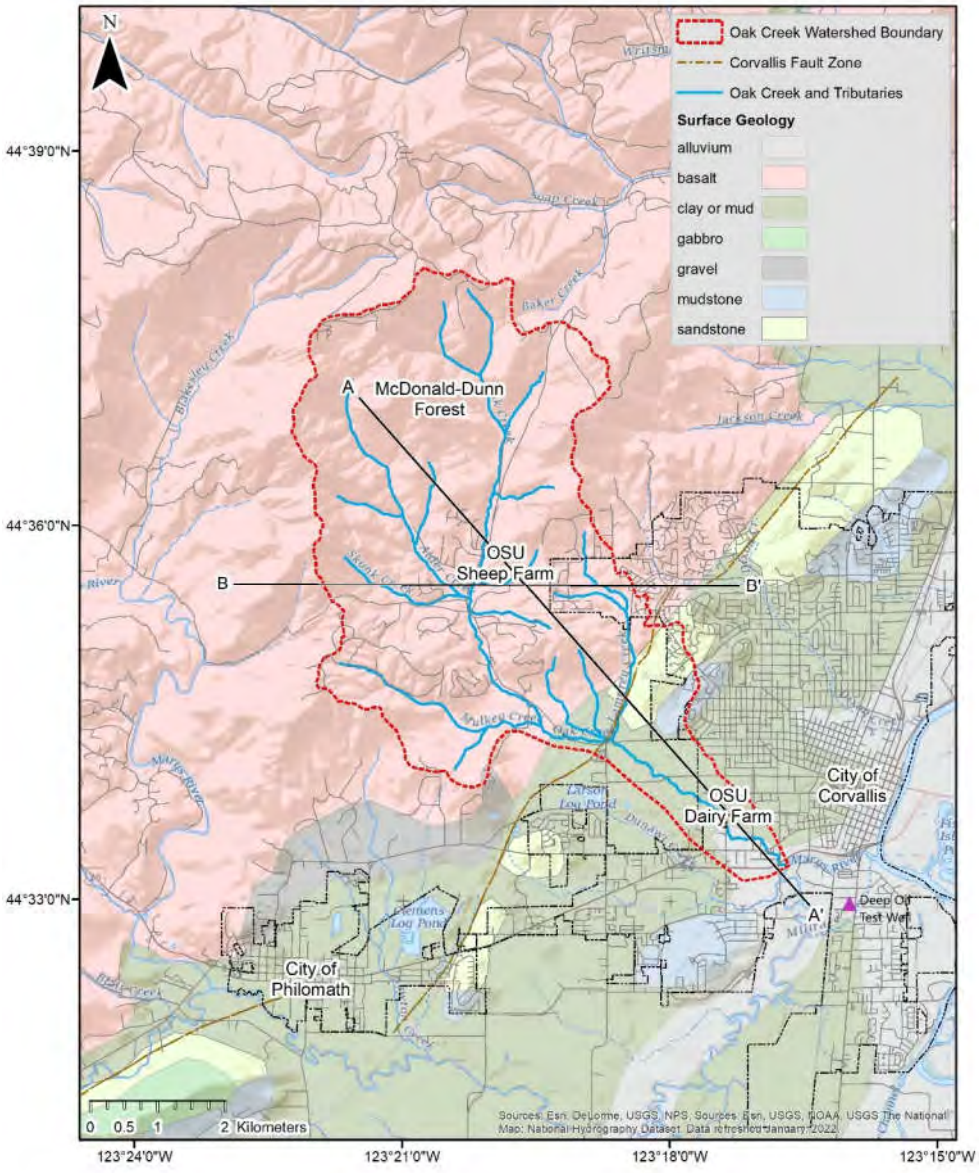


Figure 1. Surface geology map showing geologic cross-section locations and the main geologic features in the Oak Creek Watershed (OCW) and the surrounding region including Corvallis, Philomath, and Oregon State University (OSU).

Well logs of particular interest included those of a 655 m deep well completed in 1934 by the Willamette Petroleum Syndicate (WPS) located in south Corvallis near the outlet of the watershed (see Figure 1), and a 2581 m deep well completed in 1964 by the Gulf Oil Corporation of California (GOC) located approximately 18 km to the southeast near

Halsey, Oregon, USA (location not shown on Figure 1). The GOC well penetrates surficial alluvial deposits of soil, clay, sand, and gravel before encountering the Eugene Formation, the Spencer Formation, the Yamhill Formation, the Tyee Formation, and finally, the SRV Formation at 2160 m below ground surface. The WPS well records are relatively complete to a depth of 655 m, other than a missing section between 412 and 475 m depth, which was likely omitted due to a high-pressure water flow event occurring when the borehole was deepened with a cable tool. The well log annotation substantiated that the drillers required a water shut-off valve when they reached approximately 450 m. This interval is likely a confined aquifer and is stratigraphically located in a volcano-clastic conglomerate mentioned in the GOC well log. If the missing zone and the volcano-clastic zone are stratigraphically equivalent, this zone's apparent thickness likely decreases from nearly 450 to 60 m thick from east to west.

Seismic reflection data and deep exploratory well logs throughout the Willamette Valley reveal the bottom SRV unit extends from beneath the continental shelf in the west [34,35] to as far east as the Cascade Range [20]. Geophysical evidence shows the thickness of the SRV formation to be approximately 8 to 18 km [36–38], with about 4.5 km exposed west of the Corvallis Fault [20].

The Corvallis Fault, which bisects the watershed, is a low-angle reverse-thrust fault [20] uplifting the watershed's northern volcanic region over the southern sedimentary region and pushing it to the southwest. The position of the fault creates two distinct geologic areas with opposing hydrogeologic conditions. Portions of the study site north of the Corvallis Fault overlie the SRV Formation, which consists of a mélange of permeable Paleocene to Eocene submarine basaltic pillow lavas interbedded with less permeable tuffaceous marine sediments which dip approximately 20 degrees to the west. The fault-cutting alignment perpendicular across the watershed creates an abrupt interface between the northern high conductivity volcanic geology and the southern low conductivity sedimentary geology. Additionally, numerous dikes of gabbro, diorite, and aplite rock cut through the fault zone and act as hydraulic barriers, completely severing the hydraulic connection at the fault interface and redirecting groundwater in these areas [20]. The low angle of the Corvallis Fault creates a wedge of Siletz Formation volcanic rocks overlying Spencer and Tyee formation sedimentary rocks [20] which compartmentalizes vertical groundwater movement and promotes horizontal groundwater movement parallel to the fault line.

South of the Corvallis Fault, geology abruptly transitions into thick repetitious sequences of bedded units of graded sandstones, siltstones, and shales [39]. Fractured marine basalt found north of the Corvallis Fault interface is highly permeable due to large conduits (fractures) cutting through the formation; however, the rock itself is nearly nonporous. Conversely, the sedimentary formations found south of the fault are more porous but less permeable.

These two regions' opposing hydrological characteristics influence where and how groundwater flows and how late into the dry summer season water remains in these formations to supply surface water streams (baseflow). The Tyee and Spencer formations, sandstones and siltstones with high porosity (14% to 49%) but low permeability (1×10^{-11} to 6×10^{-6} m s^{-1}), can sustain baseflow into surface water streams later into the dry season when compared to the less porous (3% to 35%) and more permeable (4×10^{-7} to 2×10^{-2} m s^{-1}) basalts of the SRV Formation [40,41].

To better understand the geologic structure of the OCW, we constructed two hydrogeologic cross-sections (A-A' and B-B'), the locations of which are shown on the surface geology map (see Figure 1). Cross-section A-A' runs from the McDonald-Dunn Forest in the northern region of the watershed in a southeast direction through Oak Creek and the Corvallis Fault. Cross-section B-B' runs from west to east, approximately perpendicular to Oak Creek at the OSU Sheep Center.

Subsurface geology and static water level information represented on the geologic cross-sections were obtained through the analysis of over 600 OWRD well logs, two deep

exploration drill logs (WPS and GOC), geology maps, previous research reports [20,30,32,42], and our stream and shallow groundwater well level information. Geologic and hydrologic data of wells within 250 m of each side of the cross-section line were projected onto the cross-section transect to create a vertical hydrogeologic profile (n = 620). Additionally, well log stratigraphy from the nearby WPS and GOC deep exploration wells were projected to the cross-section profile (n = 2). Together, the cross-sections provide a three-dimensional representation of the hydrogeologic framework of the OCW site and an indication of how the Corvallis Fault affects OCW groundwater dynamics.

2.2.2. Stream-Aquifer Interactions

We used shallow groundwater and stream levels data to assess stream-aquifer interactions at one site (OSU Sheep Center; 118 MASL) in the northern volcanic portion of the watershed and one site (OSU Dairy Center; 80 MASL) in the southern basin-sediment infills. Data from previously installed monitoring wells (<6 m depth; 50 mm diameter) were used to characterize water table fluctuations at these two sites [33]. Two wells (sw-1 and sw-2) were in the riparian area at the OSU Sheep Center, and three wells (dw-1 to dw-3) were located in the riparian zone at the OSU Dairy Center. A laser level was used to measure onsite soil surface, stream, and water table elevation to develop cross-section profiles at each location. Data from two other wells in a 2-ha irrigated pasture grass field and one well in its adjacent riparian area, near the stream gauge, were used to characterize irrigation percolation contributions to the shallow aquifer and potential return flow to the stream. All wells were equipped with water level loggers (Model HOBO U20-001-01, Onset Computer, Corp., Bourne, MA, USA) and programmed to record data every hour. A water level meter (Model 101, Solinist Canada Ltd., Georgetown, ON, Canada) was used to collect depth to water table during selected dates. These data were used for verification or calibration of the water level loggers. A water level logger (Model HOBO MX2001, Onset Computer, Corp., Bourne, MA, USA) was installed in each location (OSU Sheep Center and OSU Dairy Center) to measure stream water level fluctuations.

In addition to the monitoring of stream and groundwater levels to assess stream-aquifer interactions, we also monitored hydrostatic pressure differential at selected locations in the streambed during summer groundwater baseflow conditions. We built a hydraulic potentiometric manometer (potentiomanometer) [33] to collect hydrostatic pressure data from 20 different locations along the creek, from its headwaters to its mid and lower reaches. Three measurements at each location were taken at 1 m depth in areas where streambed conditions permitted an adequate seal between the potentiomanometer and surrounding sediment. Locations with large rocks, highly compacted sediments, or sand and gravel bottoms did not provide adequate conditions for manometer readings. A 'vertical gradient' (positive or negative) was obtained for each location based on the potentiomanometer readings. Hydrostatic pressure values of zero or between −1 and 1 mm were considered to be neutral [33].

2.2.3. Potentiometric Surface Map

We developed a potentiometric surface map based on a previous study on springs and losing reaches of the upper watershed [30], static water level data obtained from OWRD well logs, surface water levels of surrounding rivers and streams, and data obtained from our observation wells. Potentiometric contour lines were created by first generating an Excel® spreadsheet detailing the position of wells, surface water observation locations, and the respective static water level of our observation wells at each location. Static water level (meters below ground surface) was then subtracted from the ground surface elevation to obtain hydrostatic head in meters at each location. The OWRD water level measurements span approximately 65 years and at different times of the year, as summarized in their well-log database. We acknowledge there could be much uncertainty; consequently, all the wells' data are referenced as a generalized summary of water level measurements. Long-term data from observation wells at or near OCW are scarce.

Data from a well near the OCW showed seasonal static water level variations of about 4 to 25 m during the period or record 1994 to 2014 (Figure A1). This is within the contour interval of 25 m we used in generating the potentiometric surface map.

Given static water levels in individual wells represent a snapshot in time, synoptic contour lines were generated using the spatial analyst extension of ArcMap® (Version: 10.4.1, ESRI, Redland, CA, USA) to create a digital elevation model (DEM) of the water table surrounding the OCW. Spatial analyst does not consider the influence of the Corvallis Fault when using water elevation data to generate the DEM. Thus, specific contour lines were manually edited to show the elevation of groundwater more accurately as it crosses the geologic interface at the Corvallis Fault. These maps were compared to and shown to be consistent with past hydrologic research in the area (see for example [32]).

Potential lines were edited where there were conflicting or limited data. For example, the potential lines were not shown in areas with a limited potentiometric low associated with pumping from clusters of domestic wells. Likewise, the potential lines were adjusted where our field observations of the potentiomanometer readings suggested gaining or losing reaches that conflicted with direct field observations such as a spring occurrence or detailed water level measurements in dedicated observation wells.

3. Results

3.1. Hydrogeologic Framework

3.1.1. Hydrogeologic Cross-Sections

Figure 2a,b shows the cross-sectional representation of the three distinct geologic formations found at the OCW study site: the fractured and highly permeable SRV Formation to the north of the Corvallis Fault, the low permeability Tyee and Spencer Formations to the south of the fault, and the fault zone itself. The water table in the sedimentary basin region is laterally continuous compared to stratigraphically compartmentalized water-bearing zones found in the Siletz Formation [30]. Depths to water in the OCW site ranged from nearly ground-surface (<1 to 3 m) in the upper region of the watershed near the McDonald-Dunn Forest to nearly 100 m below ground surface in the central portion of the watershed near the OSU Sheep Center (see Figure 1).

Figure 2a (cross-section A-A') shows the multilayered aquifer system of the SRV formation, as well as the shallow and deep aquifer zones of the basin region east of the fault. Data from the WPS and GOC deep exploration wells showed that the water table in the basin east of the fault was generally within 3 to 5 m below the ground surface, with slight fluctuation throughout the year. The GOC drill logs showed a 400+ m thick layer of a water-bearing zone of volcano-clastic conglomerate extending as far west as the Corvallis Fault. Dip estimations suggest the volcano-clastic layer shallows to the west from the GOC well and could be located 10 to 60 m below the OSU Horse Center (Figure 2a). Previous field observations by Goldfinger [20] near the City of Philomath, OR, noted this volcano-clastic layer outcropping in a gravel pit within Spencer Formation siltstones on the Corvallis Fault interface. The volcano-clastic layer at the Philomath Gravel Pit supports the notion that this layer is contiguous east to the GOC exploration well location, dipping between 1 and 3 degrees to the north striking to the southwest.

Figure 2b (cross-section B-B') illustrates the Siletz River Volcanics region of the watershed. Data from nearby well logs showed unconfined, confined, perched, and compartmentalized aquifer systems within the SRV formation near the OSU Sheep Farm. Depth to water table data was more erratic as the distance from Oak Creek increased, with static water levels adjacent to the creek found near the ground surface. Static water levels decreased in elevation as the distance from the creek increased. Additionally, artesian wells near the west end of the profile (data not shown) indicated confined aquifers within the SRVs near the OSU Sheep Center and McDonald-Dunn Forest. During the dry season, the central water-bearing unit in this region appeared to be individual isolated pockets of sandstone within the SRVs.

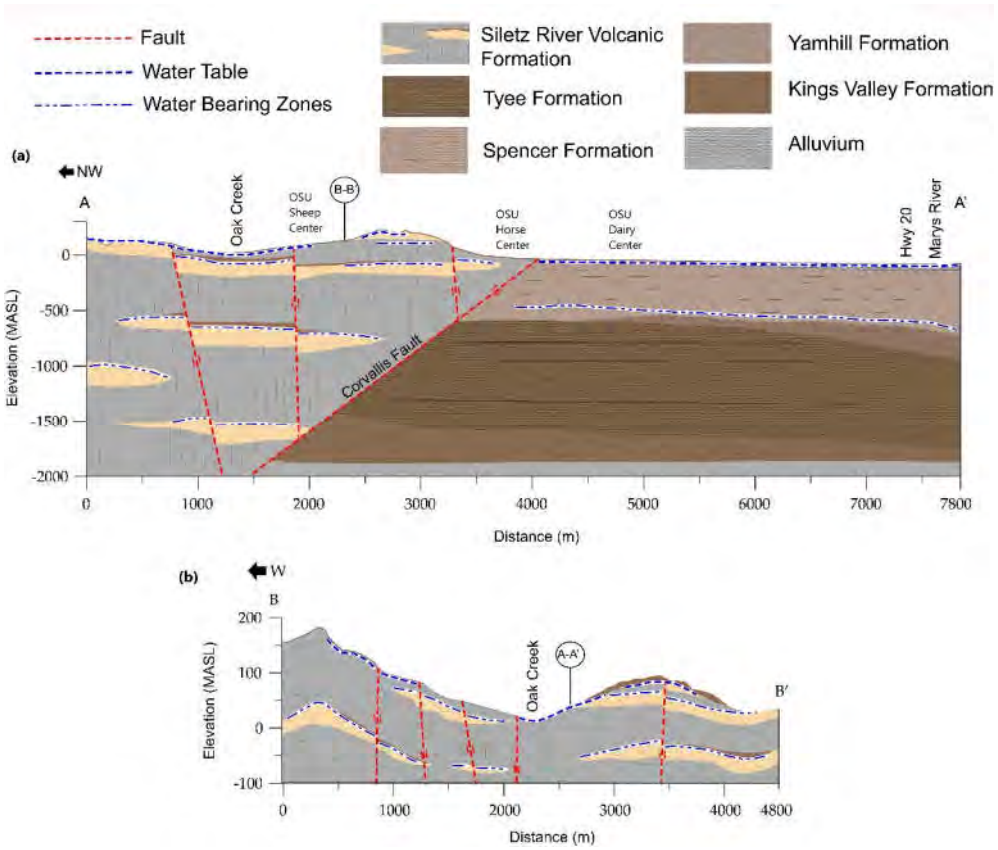


Figure 2. Geologic cross-sections of the Oak Creek Watershed. (**a**) Cross-section A-A′ (drawn to scale) runs from the headwaters of Oak Creek in McDonald-Dunn Forest, southeast to the confluence with Marys River. (**b**) Cross-section B-B′ (drawn 5× vertical exaggeration) runs from the headwaters of Oak Creek in the McDonald-Dunn Forest southeast to its confluence with Marys River.

3.1.2. Stream-Aquifer Relationships

Figure 3 shows three years (2019–2021) of seasonal water level fluctuations in the stream, the monitoring well in the riparian zone, and a well in a non-irrigated crop field at the OSU Dairy Center, in the sedimentary rock formations (see Figure 1). The well in the riparian area is 6 m north of the stream, the well in the irrigated field is 160 m north of the stream, and the well in the non-irrigated agricultural field is 90 m south of the stream. Relatively rapid rises and declines in stream level in response to rainfall events during winter and spring were observed. Groundwater levels in all wells began rising with the onset of winter precipitation, which reached its peak in January. Following the end of the rain season in the spring, groundwater levels started a steady decline, which in the non-irrigated field continued until baseflow conditions were reached in the fall. In the irrigated field, groundwater levels started rising soon after the onset of the irrigation season (July to September) and remained relatively high during the summer and fall. A slight groundwater level rise during the irrigation season was also observed in the riparian area well, located 6 m north of Oak Creek and 40 m south of the irrigated field's edge. Marginal to no summer precipitation was observed during the three years evaluated; therefore, the groundwater level rises observed in the wells in the irrigated field and riparian area were attributed to irrigation seepage and return flow to the stream, respectively. All irrigation applications were from water diverted from Oak Creek. Total water applied (irrigation depth) for the pasture field depicted in Figure 3 was 510 mm in 2020 and 670 mm in 2021. No records are available for 2019. Annual total precipitation was 871, 1004, and 1043 mm in 2019, 2020, and 2021, respectively.

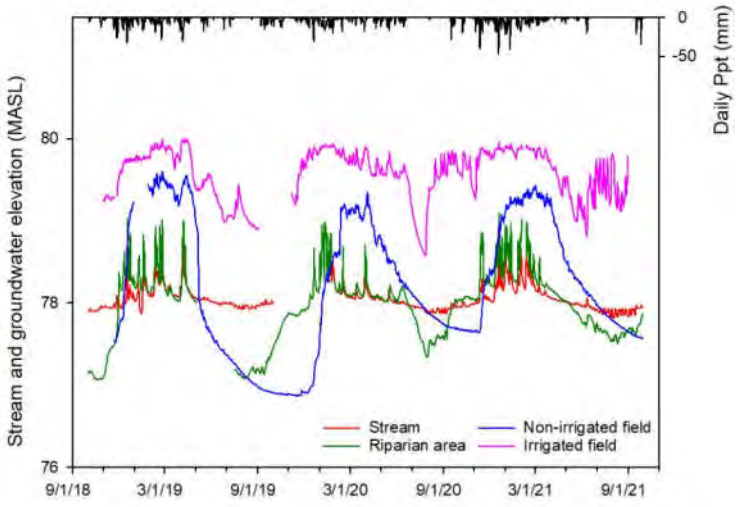


Figure 3. Seasonal surface water and shallow groundwater response to precipitation (Ppt) in three water years (2019 to 2021) at in-stream and various monitoring well locations at variable distance from Oak Creek's mainstem near the OSU Dairy Center: a well in the riparian area 6 m north of the stream, a well in an irrigated field 160 m north of the stream, and a well in a non-irrigated agricultural field 90 m south of the stream. Irrigation season is typically July to September every year. Daily Ppt records obtained from https://agsci.oregonstate.edu/hyslop-weather-station (accessed on 30 January 2022).

A closer look at stream and groundwater levels variability in the wells in irrigated, non-irrigated, and riparian areas during the 2020 irrigation season (27 July to 12 September) is shown in Figure 4. A downward groundwater level trend, typical of the transition to baseflow conditions in the summer, can be observed in all wells before the start of irrigation. While a steady decline in groundwater level occurred in the non-irrigated field during the rest of the season, the well in the irrigated field first, followed by the well in the riparian area, showed a rise in groundwater level of up to 1.18 m a few days after irrigation started. Several peak and slow decline events observed in the irrigated field well corresponded to irrigation applications. Groundwater levels for both the riparian and irrigated field wells continued higher than the non-irrigated field during the remainder of the irrigation season.

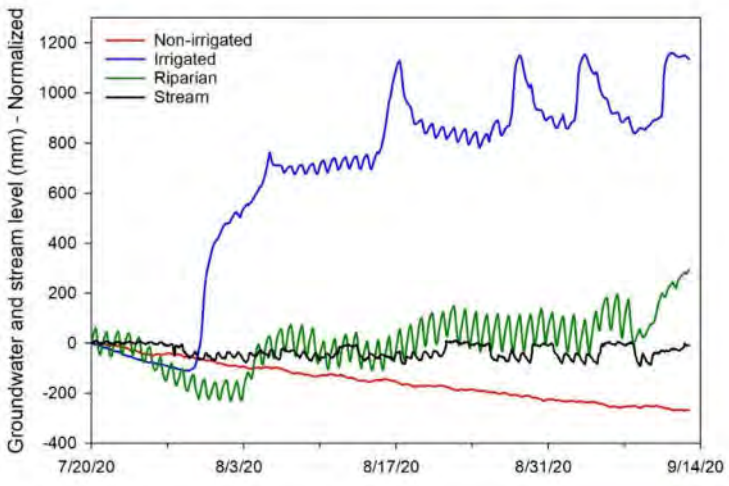


Figure 4. Stream and shallow groundwater level variability in wells at riparian, irrigated, and non-irrigated field locations during the 2020 irrigation season (27 July to 12 September).

Variable seasonal stream-aquifer interactions along non-irrigated fields in both the SRV and Sediments formations were observed. Figure 5a shows groundwater and Oak Creek levels at an upstream cross-section at the OSU Sheep Center, in the SRV rocks-dominated area of the OCW in 2021 (See Figure 1). The steep gradient between groundwater and stream levels for peak flow in the winter and baseflow in the summer indicated 'gaining' streamflow conditions. Figure 5b shows groundwater and Oak Creek levels at a downstream cross-section at the OSU Dairy Center, in the Sediments portion of the OCW. At this reach, groundwater and stream levels showed 'losing' streamflow conditions during the summer (baseflow) and 'gaining conditions' during the winter precipitation season.

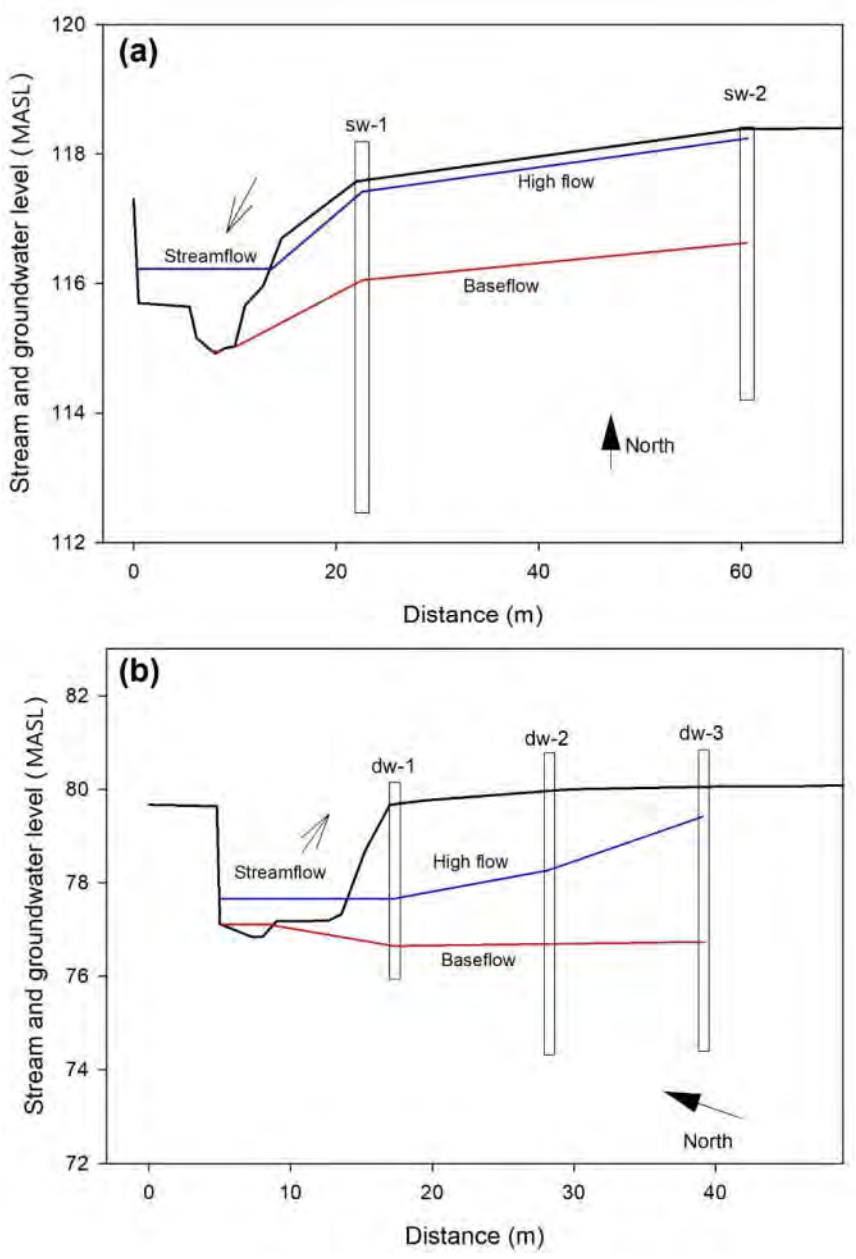


Figure 5. Surface water and groundwater levels (MASL) at baseflow (summer) and high streamflow (winter) conditions in (**a**) the Siletz River Volcanics formation at the OSU Sheep Center and (**b**) the alluvium in the Spencer formation at the OSU Dairy Center.

Data from the potentiomanometer test conducted under baseflow conditions in the summer showed that the Oak Creek streambed is losing water to the aquifer at locations upstream from the confluence with Alder Creek (see Figure 1), in the permeable fractured volcanic geology, as indicated by the negative pressure values obtained. The negative vertical hydraulic gradient gradually decreased until it reversed at approximately 3 km upstream of the Corvallis Fault, where multiple readings showed a positive slope immediately upstream of the fault. Once Oak Creek crossed the Corvallis Fault, hydraulic gradients became much less variable and maintained neutral or positive pressure conditions, as reported in [33].

3.1.3. Potentiometric Surface Map

The potentiometric surface map (Figure 6) generated from shallow static water level and surface water level data showed that the region's water table generally followed surface topography across the study area. Most of the groundwater within the OCW originated in higher elevations in the McDonald-Dunn Forest and flowed down-gradient to the south towards Oak Creek and Marys River's confluence. Water table elevation levels are 1 to 3 m higher on the northern side of the fault line and then drop significantly immediately past the fault. Once past the fault plane, water table elevations and gradients had much less variance than those of the volcanic region. In the southern region, surface topography affected water table elevations in places, but groundwater generally flows at a consistent gradient toward either the Marys River or the Willamette River.

The watershed's northern volcanic portion was characterized by downward vertical gradients that flowed from several aquicludes and aquitards, resulting in a multilayered aquifer system (see Figure 2a: Cross-Section A-A'). Water table levels in the southern sedimentary region of the watershed generally remained much more consistent, only fluctuating between 1 to 5 m throughout the year.

The Corvallis Fault lies at the boundary between the Siletz Formation and the Tyee and Spencer Formations and acts as the interface between these two opposing hydrologic zones. Potentiometric contour lines generated from OWRD well log data indicated that the fault zone acts as both a barrier and a conduit for groundwater flow through the fault interface. Impermeable zones within the fault deflect groundwater, while large fractures and truncations allow groundwater to pass. Additionally, the abrupt change in permeability between the two formations impacts groundwater paths and velocities, as fluid transfer through geologic material is much more efficient in the watershed's northern volcanic region.

Hydraulic gradients within the OCW generally mimic the topography, with groundwater circulating from higher elevations towards lower elevations in the creek channel or to the south in the basin. This is generally true down to the Corvallis Fault, where the fault's impermeable nature causes groundwater to flow parallel to the fault plane until it either finds a conduit or flows through the terminus of the fault damage zone.

Potentiometric contour lines adjacent to the fault have been altered by the change in permeability architectures and the less-permeable fault zone, which has caused them to become fragmented in places. Additionally, water table elevations in the Oak Creek basin within 1 to 2 km northwest of the fault-line have been elevated, as indicated by the area's diminutive groundwater flow gradient.

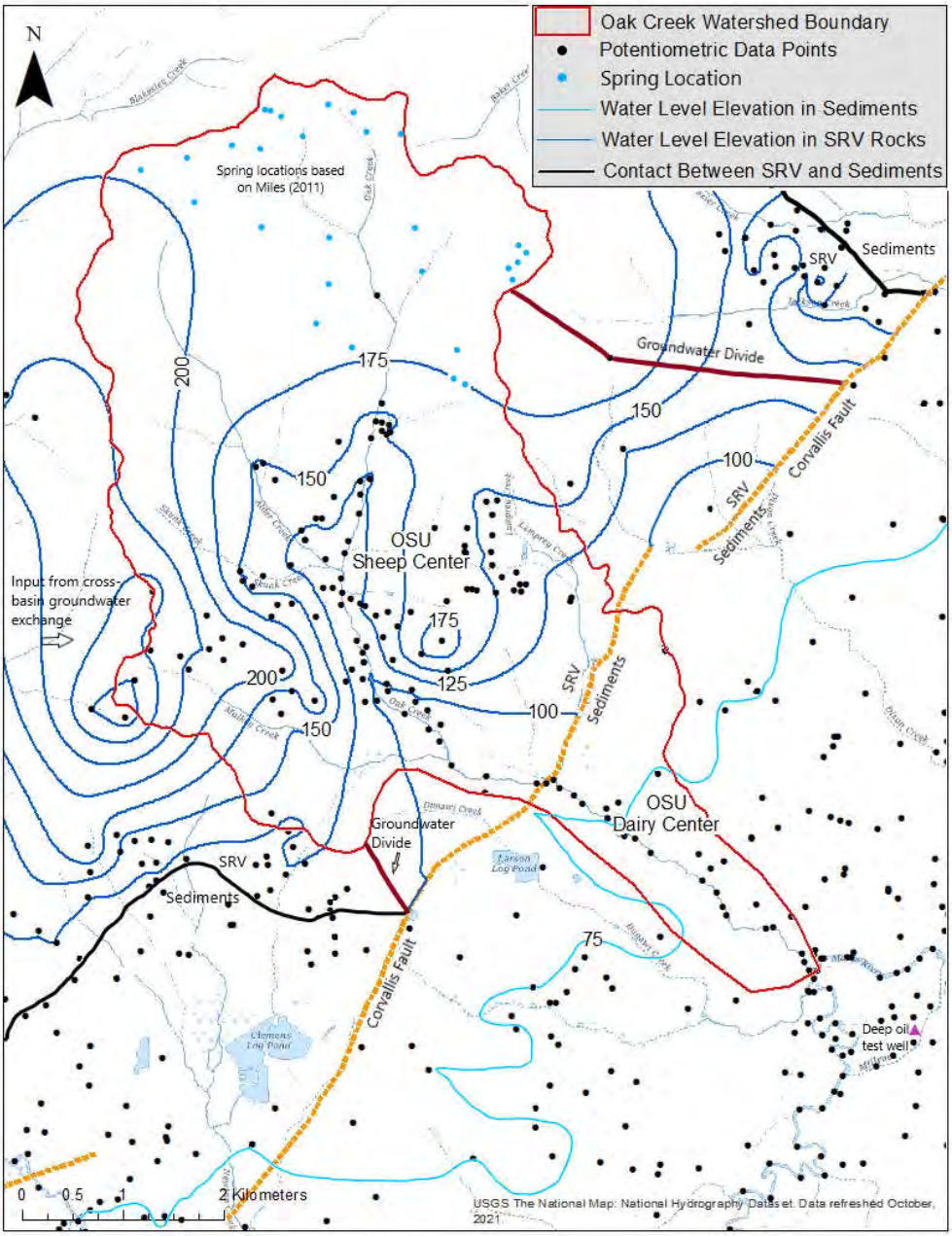


Figure 6. Potentiometric surface map of the Oak Creek Watershed and the surrounding region.

3.1.4. Conceptual Model

A conceptual (block) model, including the neighboring hydrogeologic conditions, was created to gain a three-dimensional representation of the OCW and surrounding region's hydrogeologic framework. The model developed is a synthesis of available topographic, geologic, and hydrologic data. Location, depth, and representation of geologic formations and structures were based on geologic descriptions from well logs and maps described by Goldfinger [20]. The nearby WPS and GOC deep exploration wells drilled southeast of the OCW provided data on subsurface geology structure, including lithology, potential water-bearing zones, dip and strike of geological layers, and water quality. The dip angle and distance from the exploration wells to the study area were considered when interpreting hydrogeological structure and conditions.

The Oak Creek Watershed conceptual model (Figure 7) shows that watershed hydrologic characteristics are dominated by surface topography and geology. The highly contrasting permeability architecture of the opposing geologic formations and the fault between the northern volcanic and the southern sedimentary regions influence groundwater flow through the fault interface. This groundwater compartmentalization model is consistent with other studies completed in fractured volcanic aquifers in Oregon [4,43]. Past drilling and other research data [20,30] in the OCW have indicated numerous intrusions of very low permeability volcanics throughout the region, especially along faults. The contrasting permeabilities of the northern and southern regions paired with impermeable intrusives along the fault interface have produced a zone of decreased permeability along the fault plane. As groundwater circulates hydraulically down-gradient and encounters this zone, velocities decrease, and flow is deflected along the fault strike. Groundwater gradients within the two regions of the study site are highly contrasting, with higher grades in the northern volcanic region compared to a lower grade in the southern sedimentary region. The fracture permeability, coupled with the higher surface slope in the Siletz Formation, results in a discontinuous water table with numerous perched and confined systems. In contrast, low permeability, and low gradients in the Tyee and Spencer formations of the southern region create a shallow water table circulating towards the Willamette River, which serves as a regional hydraulic sink (Figure 7).

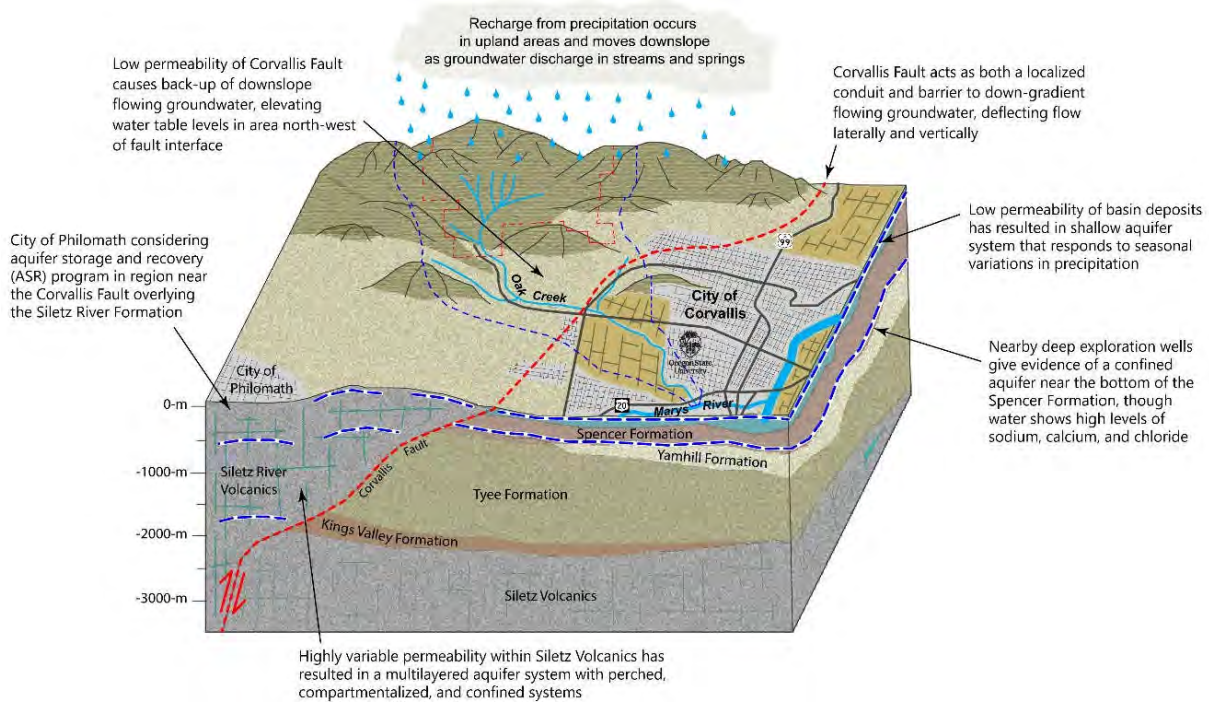


Figure 7. Conceptual model of the groundwater system of the Oak Creek Watershed and surrounding region based on a synthesis of topographic features and data from hydrologic and geologic investigations.

4. Discussion

4.1. Interaction of Geology and Hydrology

Previous sections discussed the geology and hydrology using a synthesis approach building upon rather than duplicating previous studies. Most of the physical hydrology studies summarized in this study focused on low flow conditions, given this is a time of year with competition for water use between agricultural facilities, fisheries, and rural residential land use rather than exploring the interaction of geology, direct runoff, and

baseflow. Seasonal SW-GW connections are variable and can be contrasting within short distances. Gaining conditions are prominent in the watershed's northern volcanic region and transition into neutral and losing conditions in the southern sedimentary region. As depicted in Figure 8, the upper part of the watershed is a springs basin where the SRV is composed of low permeability rock mixed with higher permeability breccia and interflow zones, similar to conditions commonly found in rock quarries. Based on areal analysis, the rocks and interflow zones dip westward due to uplift along the Corvallis Fault. Losing reaches of the incised streams are more common where the topography becomes less steep. Whether the noted stream losses can be directly attributed to a function of changes in permeability architecture is uncertain and its study goes beyond the purpose of this synthesis paper.

The middle section of the watershed constitutes a generally gaining reach of the mainstem of Oak Creek. Drainage from the overlying perched aquifer to springs discharging along the stream bank can be observed downgradient of the OSU animal research facilities. Ground-truthing through observations of water levels in shallow wells confirmed the hydraulic separation of the perched aquifer from the deeper volcanic rock aquifer. Stable isotope analyses of stream water, coupled with general water chemistry analyses, indicate mixing of surface water and groundwater in the OCW exists [44]. Reconnaissance-level stream gauging using a potentiomanometer identified isolated losing reaches [33]. Whether the losing reaches are a function of an apparent increase in intercalated low permeability sedimentary rocks or volcanic rock permeability architecture or stream capture of clusters of permit-exempt wells servicing the rural residences remains unknown without further investigations.

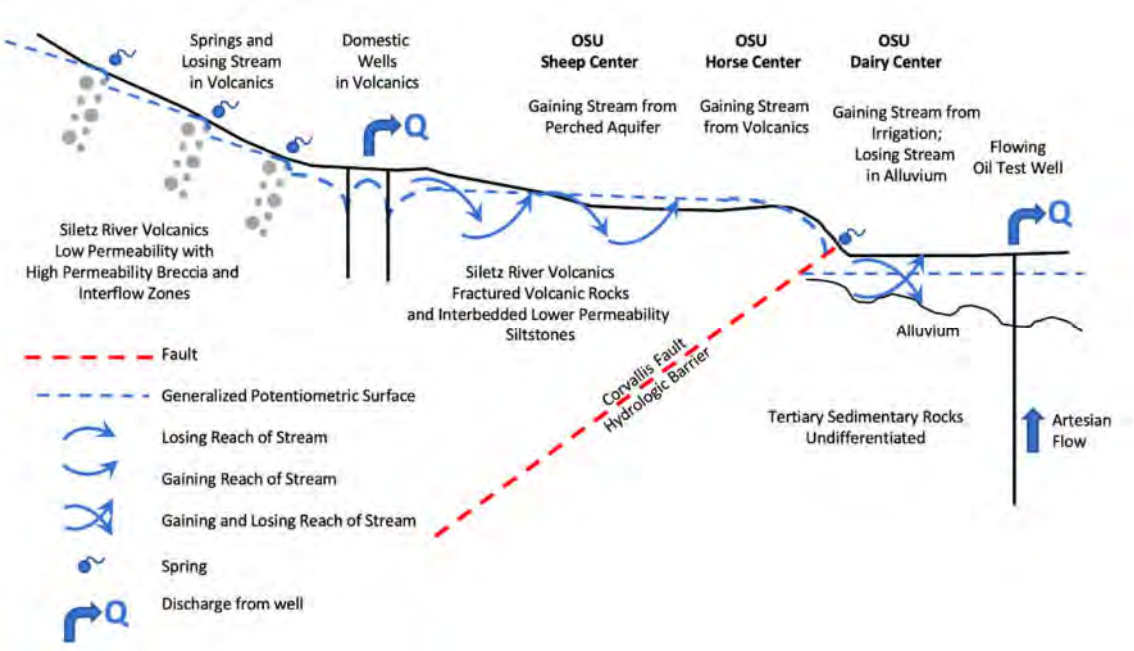


Figure 8. Summary sketch of hydrogeologic observations and interpretations. Not to scale. Generalized orientation of the section coincides with section A-A′ on Figure 1.

Study results showed that the hydrogeology of the OCW is characterized by two regions of contrasting hydrologic properties: the highly fractured and permeable Siltez Volcanic rocks in the northern region of the watershed and the low permeability sediments of the Spencer, Yamhill, and Tyee formations in the southern region. The interface between these two regions is the Corvallis Fault that serves as a hydraulic barrier to groundwater flowing downgradient from the Coastal Range to the Marys River basin to the south

and the Willamette River to the east. The Corvallis Fault severs the hydraulic continuity of the volcanic rock aquifer by juxtaposing the lower permeability sedimentary rocks to the east against the higher permeability rocks on the hanging wall of the reverse fault. The hydrologic barrier interpretation of the Corvallis Fault is corroborated by previous work that mapped the Benton County area's well function, including wells located within the OCW and SRV, Tyee, and Spencer Formations. Transmissivity, specific capacity, and total yield all increased in the Oak Creek Basin area near the Corvallis Fault [30]. These findings are consistent with the hydrogeologic framework presented in this article. As groundwater encounters the less-permeable interface of the Corvallis Fault, it backs up, increasing the amount of groundwater available for withdrawal. This results in groundwater mounding in the SRV north of the fault that contributes to the compartmentalization of the volcanic rock aquifer.

Higher variability of groundwater level exists within the Siletz Formation compared to the Tyee and Spencer formations. The potentiometric surface map developed in this study provides evidence of the northern and southern regions' opposing permeability architectures and hydraulic conductivities. Water contours in the northern region generally have a higher gradient than those in the southern region due to the volcanic rock's greater effective porosity (permeability) and hydraulic conductivity. Water moves more freely through the northern portion of the watershed, and as a result, the hydraulic gradient is steeper in the northern region compared to the southern region. The potentiometric surface map developed in this project is consistent with a groundwater map completed in the Corvallis area that stopped just east of the OCW [32]. While no wells penetrate the Corvallis Fault to confirm the hydraulic separation from west to east, the decrease in hydraulic gradient in wells tapping the sedimentary rocks to the east, coupled with the reported artesian flow from a nearby oil and gas exploration well provides first order approximations of the lack of direct hydraulic continuity across the Corvallis Fault. Irrigation of fields along the lower reach of the OCW also complicate the confident assessment of gaining and losing reaches as some of the return flows from irrigation occur along the north bank of the stream. Yet, water levels measured in shallow wells located on the south bank of the stream are unchanged during the irrigation season.

4.2. Groundwater Compartmentalization

The Corvallis Fault, coupled with complex inter-layering of sedimentary rocks and volcanic rocks and groundwater mounding, has created a groundwater compartment in the OCW. Groundwater compartments have demonstrated the suitability of Columbia River Basalts for the storage of water and gas. Mansfield [45] described a compartmentalized aquifer in northwestern Oregon for aquifer storage and recovery as an affordable alternative to above-ground storage. The Mist Gas Field, located along the Oregon coast near Astoria, Oregon, has been used since the 1980s to store natural gas in compartmentalized volcanic rocks similar to the compartment described by Mansfield, precluding the need for expensive above-ground storage facilities [46]. Harpham [43] designed an Aquifer Storage and Recovery project to repurpose a dam site in the Deschutes Basin near Tumalo, Oregon, USA where a surface water reservoir constructed on the footwall of a fault in the volcanic rocks has never held water since construction in 1915. Ringrose and Meckel [47] cite the role of fault architecture as a critical element for storage site characterization elsewhere in the world, citing a global petroleum assessment where 71% of the known hydrocarbon reserves occurred in structural (i.e., faulted) traps, as opposed to stratigraphic or other traps.

Beyond the trace of the Corvallis Fault, the outline of the OCW groundwater compartment closely coincides with watershed boundary. As depicted in Figure 6, the northern boundary is defined hydraulically by the groundwater mounding or "divide" just beyond the watershed boundary. Likewise, the aquifer compartment's southern boundary closely coincides with the watershed boundary, which is hydraulically defined by groundwater mounding or divide.

4.3. Land and Watershed Management Practices

An isotope and geochemical investigation by Johnson [44] identified a connection between agricultural land use in the middle reaches of the OCW. The preponderance of forest and agricultural use within the OCW, coupled with the related rural residences served by individual permit-exempt water wells, underscores the importance of protecting drinking water supplies, especially given that permit-exempt water wells are typically paired with onsite wastewater systems that are well known for contributing nitrates and phosphorus to groundwater [48]. While the Agricultural Improvement Act (Farm Bill) of 2018 primarily focuses on building partnerships between water utilities and agricultural producers in watersheds to limit nutrient and sediment runoff, the Conservation Partnership Programs rarely address groundwater and much less groundwater supplying drinking water derived from private wells [49].

This paradox is not unique to the Farm Bill of 2018. The Wellhead Protection and Source Water Protection Programs associated with the Safe Drinking Water Act, as amended in 1986, served as the impetus behind states to develop programs to protect groundwater supplying public water systems. However, the Wellhead Protection and Source Water Protection Programs continued to overlook protection for areas serviced by private wells. The Sole Source Aquifer program authorized by the Safe Drinking Water Act of 1974 allowed citizens to petition the Environmental Protection Agency for Sole Source Aquifer Designation when an aquifer supplies at least 50% of the drinking water for a "service area" and if there are no reasonably available alternative drinking water sources should the aquifer become contaminated. This study provides an example of the type of information needed to develop a Source Water Protection program in mixed agriculture, forestry, and rural residential land use through the Sole Source Aquifer petition process.

4.4. Framework Adds to Role of Geology and Potential Groundwater Supplies

One of the ancillary goals of the study was to evaluate the substitution for surface water supplies used by research farms that require temporary dams on Oak Creek which inhibit fish passage. The OCW study offers an unusual alignment of supplemental water needs, hydrogeologic framework that contributes to water supply options, current favorable land use for water quality protection, and aquifer compartmentalization for subsurface storage. The nearby communities of Philomath and Dallas, Oregon, USA are experiencing growth and desire to develop new groundwater supplies and underground water storage options in the same aquifers underlying the OCW. The findings of our study contribute options to supplement these and other local municipal water supplies [50] and can inform proposed aquifer storage and recovery (ASR) projects in the surrounding region. ASR is a proven technology used by many municipalities where water is injected and stored in subsurface aquifers for future extraction. Use of ASR may be possible within the volcanic rocks underlying the OSU agricultural research facilities. Comparable hydrogeologic compartmentalization of the volcanic rocks in the OCW were proven to be instrumental in ASR in the volcanic rocks underlying Warren, Oregon, USA as described by Mansfield [44].

While proximity does not guarantee viability, the OCW is located near other ASR projects utilizing the volcanic rocks for subsurface storage. Aquifer storage and recovery techniques have been shown to be successful within the volcanic rocks serving as water supplies for the City of Dallas, Oregon, USA. The Dallas ASR system is unique in Oregon because the naturally brackish groundwater found in the volcanic rocks mixes with the injected water. However, recovery of injected water has been sufficient to supplement municipal water supplies during periods of water scarcity.

The neighboring City of Philomath is also pursuing ASR for supplementing municipal drinking water supplies and has generated plans to develop two existing drinking water wells. Philomath water managers expect the ASR project to reduce water demands

on the nearby Marys River, which has experienced record low flows during the summer months. Preliminary pump tests and other performance analyses conducted on the City's wells have shown promising results.

The minimal overburden overlying the SRV in the OCW contribute to the viability of managed recharge. Likewise, constructed wetlands could be used to treat water before infiltration. The general lack of land development, except for small agricultural research facilities, research forest, and the few rural residences, make the OCW a valuable location for managed aquifer recharge.

Hydrogeological information in the OCW region is limited as deep drilling in the area has been sparse. The 650-m deep oil exploration well drilled east of the OCW encountered a sufficient water flow that well casing was installed to shut off the flow. The old well records do not report whether the water was fresh or saline, or any estimated flow rates. However, the available deep well data from nearby oil and gas exploration wells suggests that a well approaching 500 m in depth located east of the Corvallis Fault may encounter fine-grained sandstones capable of yielding sufficient water quantities to facilities located in the lower portion of the OCW, though the produced water quality remains unknown. Further investigation, including the drilling of a small diameter test hole followed by geophysical logging, would provide information on the number and thickness of the interbedded sandstones encountered in the test hole. Geophysical logging would also provide a first-order approximation of the salinity of water stored in the sandstones.

5. Conclusions

This case study contributes critical information toward enhancing understanding of local hydrogeologic features and improved groundwater resources management in areas near coastal ranges such as those found in the Pacific Northwest, USA. While this study's goal was to characterize the hydrogeologic framework within and near the Oak Creek Watershed (OCW) and enhance base knowledge of groundwater flow and aquifer fluid dynamics in the region, we were able to link this information for current and future water uses. First, the interaction of geology and hydrology are assessed with particular focus on the hydrologic role of the Corvallis Fault. The hydraulic barrier-conduit role of the fault contributes to the compartmentalization of the volcanic rock aquifer, creating two hydraulically separated groundwater compartments. The complex intrinsic and secondary permeability architecture of the volcanic rock aquifers imposed through flows and later structural geologic history link two adjacent watersheds through inter-basin groundwater flow. These findings provide an opportunity for proactive land and watershed management practices given the OCW and nearby mountainous regions are used, or are anticipated to be used, for residential and municipal drinking water supplies, either through direct capture through wells or secondary capture through managed aquifer recharge storage and recovery. Deep drilling frontiers for underutilized groundwater and aquifer storage exist, as shown by the limited hydrogeologic data reported for a smattering of past oil and gas exploration wells near the OCW.

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Appendix A

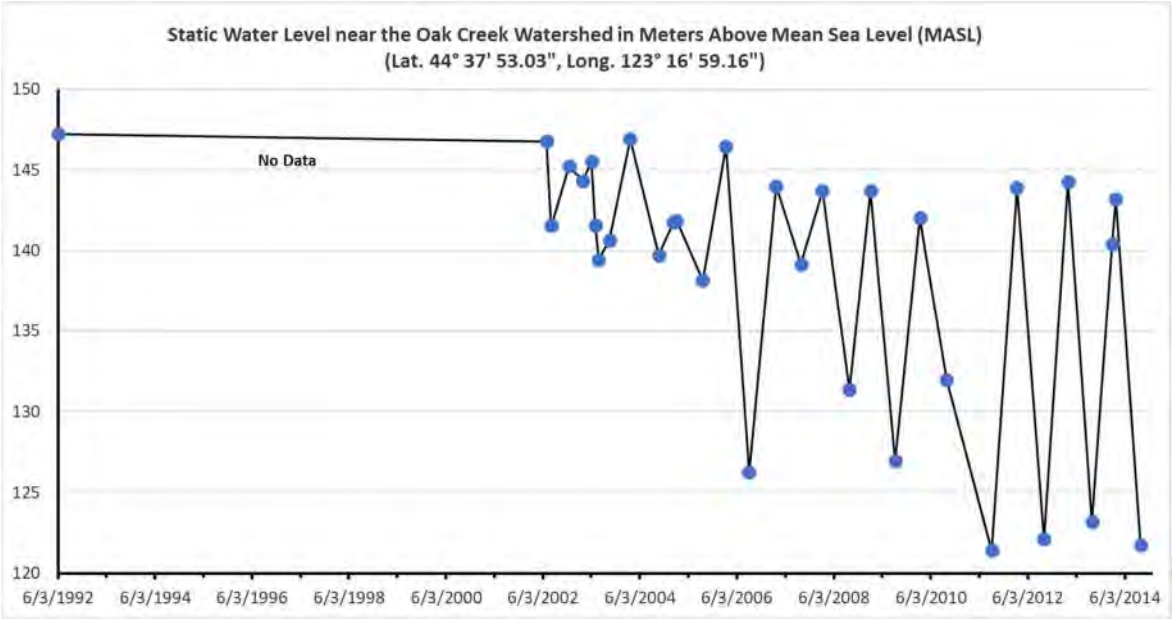


Figure A1. Example of Static Water Level Measurements at Observation Well near the Oak Creek Watershed (OCW), Corvallis, Orgon, USA. Data source (https://www.oregon.gov/owrd (accessed on 30 January 2022)).

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Arsenic in Ground Water of the Willamette Basin, Oregon

By Stephen R. Hinkle *and* Danial J. Polette

SUMMARY AND CONCLUSIONS

Arsenic concentrations exceeding the U.S. Environmental Protection Agency (USEPA) current Maximum Contaminant Level (MCL) of 50 µg/L (micrograms per liter) are widespread in ground water in the Willamette Basin. The Oregon Water Resources Department and the U.S. Geological Survey began a cooperative study in the Willamette Basin in 1996. One goal of this study is to characterize the regional distribution of naturally occurring poor-quality ground water, such as ground water with high concentrations of arsenic. Characterization of the regional distribution of arsenic concentrations in the Willamette Basin will be useful to public health officials, water-resource managers, the medical community, and those using ground water for drinking and cooking.

The spatial distribution of arsenic concentrations in ground water of the Willamette Basin was assessed by combining historical data from 597 sites with data from 131 sites collected for this study. A total of 728 spatially distinct samples thus were available. Additional data also were collected to evaluate temporal variability of arsenic concentrations on a seasonal timescale. Samples were collected quarterly from 17 sites for 1 year for this purpose. Temporal variability was addressed for two reasons: First, characterization of temporal variability allowed evaluation of the acceptability of combining arsenic-concentration data collected during different seasons for determining the spatial distribution of arsenic concentrations. Second, knowledge of temporal variability will benefit well owners and water managers who require guidance on timing for sampling.

During the course of quarterly sampling, arsenic concentrations in water from many wells remained essentially constant, but variations of up to almost a factor of three were observed in other wells. No obvious correlation with season was apparent. Analytical accuracy, as determined from 11 standard reference samples submitted during the course of project work, generally was within ±10 percent, and always ±20 percent. Thus, analytical variability can only explain some of the observed temporal variability. One possible explanation for observed temporal variability in arsenic concentrations is that differences in the amount of pumpage prior to sampling may lead to variations in the amounts of water pumped from different sources (different aquifers or parts of aquifers), and thus, differences in water chemistry.

For a regional assessment of arsenic concentrations in ground water, where arsenic concentrations may vary in space by several orders of magnitude, the relatively smaller temporal variations such as those observed in the quarterly samples are not a significant limitation, and the aggregation of data collected at different times is justified. However, this conclusion may not necessarily apply to all investigations of arsenic concentrations in ground water. For some purposes, site-specific characterization may require characterization of temporal variability. Such characterization may require evaluation over a range of well uses and seasons.

Concentrations of arsenic in the 728 spatially distributed samples ranged from less than 1 to 2,000 µg/L. Concentrations in 58 (8.0 percent) of the samples exceeded the USEPA current MCL.

Regionally, the distribution of arsenic concentrations in ground water of the Willamette Basin appears to be primarily related to aquifer geology. High arsenic concentrations (concentrations exceeding the USEPA current MCL) are widespread in bedrock areas in south-central and eastern Lane County, and Linn County. High concentrations of arsenic also are present in some ground water in the Tualatin Basin (a subbasin in the northwestern part of the Willamette Basin). 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. (These rock associations are defined by Walker and MacLeod, 1991. The undifferentiated tuffaceous sedimentary rocks, tuffs, and basalt are approximately equivalent to the Little Butte Volcanic Series of Peck and others, 1964.) 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. High concentrations in the Tualatin Basin are associated with alluvial deposits. At a regional scale, well depth does not appear to be a useful predictor of arsenic concentration in the Willamette Basin. However, depth may be an important parameter on a local scale, particularly where wells of different depth tap aquifers in different geologic units.

Ground waters in bedrock areas in south-central and eastern Lane County, bedrock areas in Linn County, and alluvial areas in the Tualatin Basin may be more likely to yield water high in arsenic than ground water elsewhere in the basin. However, it cannot be assumed that these areas are the only areas in the basin that contain ground water with high concentrations of arsenic. Little or no data exist for many parts of the basin. Even in areas that have been sampled, geohydrologic heterogeneity makes it difficult to formulate meaningful generalizations regarding the likelihood of finding high-arsenic ground water. There is no substitute for actual sampling.

Available information, in combination with an understanding of processes known to promote arsenic mobilization, is sufficient to formulate hypotheses that explain arsenic sources and mobilization in the Willamette Basin. However, available geochemical data and interpretations are sparse. Thus, these hypotheses are preliminary, serving mainly to help direct future geochemical investigation in the Willamette Basin.

Anthropogenic sources of arsenic can be significant in some settings. Arsenical pesticides such as lead arsenate have been used in the basin, and arsenic can be released into the environment from industrial sources. However, regional patterns of arsenic occurrence in Willamette Basin ground water are not consistent with either industrial or agricultural sources of arsenic.

Naturally occurring arsenic commonly is found in a variety of solid phases. 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. Examination of these potential arsenic sources for arsenic availability in the Willamette Basin apparently has never been done.

Two categories of processes largely control arsenic mobility in aquifers: (1) adsorption and desorption reactions and (2) solid-phase precipitation and dissolution reactions. Arsenic adsorption and desorption reactions are influenced by changes in pH, occurrence of redox (reduction/oxidation) reactions, presence of competing anions, and solid-phase structural changes at the atomic level. Solid-phase precipitation and dissolution reactions are controlled by solution chemistry, including pH, redox state, and chemical composition.

Several species of arsenic occur in nature, but arsenate (arsenic V) and arsenite (arsenic III) are the two forms commonly found in ground water. For this study, samples from five domestic wells were analyzed for arsenic species. Two additional analyses for arsenic species in ground water from the Willamette Basin were available in the literature. Arsenite was the predominant species of arsenic in six of these seven samples. The predominance of arsenite has both geochemical and toxicological implications. From a geochemical standpoint, mobility of arsenite differs from that of arsenate. From a public-health perspective, arsenite is more toxic than arsenate, and arsenite also is more difficult to remove from drinking-water supplies than is arsenate. Seven samples do not characterize regional arsenic speciation patterns. However, if the predominance of arsenite in Willamette Basin samples is substantiated by additional speciation work, public health officials and water managers may need to evaluate the scope of the arsenic problem with regard not only to arsenic concentrations, but also to arsenic speciation.

Existing data, including the speciation data, and published interpretations were used to establish preliminary hypotheses for the evolution of high-arsenic ground water in the Willamette Basin. For ground water in bedrock areas of Lane and Linn Counties, existing information suggests that at least some of the following controlling factors likely are important in adsorption and desorption reactions that often control arsenic mobility: (1) high pH, (2) presence of competing anions, and (3) occurrence of reducing conditions. Existing information did not allow for evaluation of the potential importance of adsorption and desorption reactions related to solid-phase structural changes at the atomic level, or solid-phase precipitation and dissolution reactions.

For alluvial ground water of the Tualatin Basin, presence of competing anions and occurrence of reducing conditions may be important controlling factors in arsenic adsorption and desorption reactions. These two factors might be more important than pH controls over arsenic adsorption and desorption. Reducing conditions and high concentrations of dissolved iron also suggest that dissolution of iron oxides, with subsequent release of adsorbed and (or) coprecipitated arsenic, may play a role in arsenic mobility in the Tualatin Basin.

Although the regional distribution of arsenic concentrations in ground water of the Willamette Basin has been evaluated by this study, an understanding of how ground water in parts of the basin evolved to contain high concentrations of arsenic has not yet been developed. Limited geochemical data have allowed establishment of preliminary hypotheses to explain the evolution of high-arsenic ground water. Developing an understanding of arsenic sources and processes responsible for evolution of high concentrations of arsenic, though, will require additional geochemical investigation. In particular, thermodynamic evaluation of ground water chemistry and study of solid phases present in aquifers would facilitate development of an understanding of adsorption and desorption and precipitation and dissolution reactions controlling arsenic mobility in the Willamette Basin. A key benefit of detailed geochemical study of arsenic in ground water of the Willamette Basin would be increased predictability of areas likely to yield ground water with high arsenic concentrations. Such increased predictability would be likely to have transfer value beyond the Willamette Basin.

INTRODUCTION

In response to increasing demands on ground-water resources in the Willamette Basin, Oregon (fig. 1), the Oregon Water Resources Department (OWRD) and the U.S. Geological Survey (USGS) began a cooperative study of the basin's ground-water resources in 1996. This study was designed to increase the current understanding of the ground-water resource, and to better characterize the distribution of naturally occurring poor-

Figure 1



Figure 1. Location of the Willamette Basin, Oregon.

quality ground water in the basin. Essential components of the study of the physical ground-water resource are the development of a quantitative understanding of regional ground-water availability and flow, and of ground-water/surface-water interactions. Of paramount interest in the characterization of naturally occurring poor-quality ground water in the Willamette Basin is the distribution of arsenic in ground water, the subject of this report.

Arsenic contaminates many regional aquifer systems worldwide (Cantor, 1996; Thornton, 1996), and arsenic commonly is detected in ground water of the Willamette Basin at concentrations exceeding the U.S. Environmental Protection Agency (USEPA) current drinking water Maximum Contaminant Level (MCL) of 50 µg/L (micrograms per liter) (U.S. Environmental Protection Agency, 1996). Arsenic is associated with a number of adverse effects on human health. The USEPA considers arsenic to be a human carcinogen (U.S. Environmental Protection Agency, 1996). Examples of other adverse health effects attributed to consumption of arsenic range from weakness and abdominal pain to neurological and cardiovascular problems. A review of health effects associated with consumption of arsenic is given in a report by World Health Organization (1996).

Purpose and Scope

The primary purpose of this report is to describe the spatial distribution of arsenic concentrations in ground water of the Willamette Basin. Both historical data and data collected for this study (henceforth, "project data") were used for this purpose. Project data also were used to evaluate temporal variability of arsenic concentrations. It is useful to have an understanding of temporal variability before arsenic-concentration data, collected at different times, is used to evaluate spatial distributions. Evaluation of temporal variability may also benefit well owners and water managers, who may require guidance on timing for sampling.

A secondary purpose of this report is to briefly summarize current knowledge of the geochemistry of arsenic in the Willamette Basin. Relevant geochemical data are few, so this discussion is inherently general, serving mainly to outline future research needs. Possible sources of arsenic are evaluated, and geochemical processes that may control arsenic mobilization are briefly discussed.

Location and Description of the Willamette Basin

The Willamette Basin is an approximately 12,000-square-mile basin in northwestern Oregon. Primary drainage is by the Willamette River, but for the purposes of the study, the basin is defined to also include the region drained by the Sandy River; both rivers are tributary to the Columbia River. The Willamette Basin was home to 69 percent of the State's population in 1990 (Broad and Collins, 1996).

The crests of two north-south trending mountain ranges, the Coast and the Cascade Ranges, respectively define the western and eastern edges of the Willamette Basin. The Willamette Valley, an elongated, structural and erosional lowland, lies between these mountain ranges. The Coast Range is composed of marine sedimentary rocks and associated volcanic rocks. The Cascade Range is composed of lava flows and pyroclastic and epiclastic rocks. The Willamette Valley is filled with clastic basin-fill sediments of primarily alluvial origin; these alluvial sediments form the most important aquifers in the Willamette Basin. The geologic framework of the basin is described by Gannett and Caldwell (in press), and a regional representation of the surficial geology of the Willamette Basin is given on the geologic map of Oregon compiled by Walker and MacLeod (1991). Usage of geologic names in this report is consistent with that of Walker and MacLeod (1991).

STUDY DESIGN AND METHODS

The overall approach used to collect, assemble, and analyze data for this report is described in this section. First, a description of the sources of historical data is given, followed by a description of the sampling design for project data. Approaches used to define the quality of both historical and project data are discussed, as are collection and analytical methods used for project data. Finally, benchmarks for comparison of arsenic-concentration data, and methods for identification of well locations, are described.

Historical Data

Analysis of historical data (arsenic concentrations and site locations, and in most cases, well depths) from regional ground-water investigations was the starting point for evaluation of distribution of arsenic in the Willamette Basin. Some wells were sampled more than once; in these cases, the first-in-time sample was selected. Four sets of historical data used in this report are described below.

Historical data from the USGS National Water Information System (NWIS) database (Maddy and others, 1990) (271 wells). These data were collected between 1971 and 1997 as parts of various USGS projects. Many of these projects were regional in scope, and thus these data cover large areas in the Willamette Basin. In addition to arsenic concentrations, depth data also were retrieved. Data from both unfiltered and filtered samples were found in NWIS. Some of these NWIS data are discussed in the following reports: Frank and Collins, 1978; Gonthier, 1983; Leonard and Collins, 1983; Hinkle, 1997. Project data, although stored in NWIS, are discussed separately (see section "Sampling Design for Project Data").

Data from four USGS studies (Frank, 1973, 1974, 1976; Helm and Leonard, 1977), not entered into NWIS (89 wells). These data, also from regional-scale projects, encompass large areas in the southern part of the basin. The data were collected between 1964 and 1973 by USGS personnel. Well depths were obtained from tables in the reports. Techniques used to process these samples (in particular, filtering or a lack thereof) are not known.

Data from a USGS study in Lane County, not entered into NWIS (171 wells; 1 nonthermal spring). These data were collected during 1962–63, and summarized by Goldblatt and others (1963). Many of these wells withdraw water from the arsenic-rich Fisher Formation (Goldblatt and others, 1963). Arsenic concentrations and well depths were compiled from original project notes from USGS files. Samples were collected and analyzed as unfiltered samples (A.S. Van Denburgh, U.S. Geological Survey, oral commun., 1997).

Data from Linn County Department of Health Services, Environmental Health Program (65 wells). More than 100 wells were sampled for arsenic by the Environmental Health Program in 1987. Most of these wells were located near Sweet Home, an area that received little coverage in the three regional data sets listed above. Drillers' logs were on file with the Environmental Health Program for many of these wells. In 1996, USGS personnel were able to locate 65 homes corresponding to addresses from well drillers' logs for sampled wells. Arsenic concentrations from Environmental Health Program files and well depths from well drillers' logs were matched with the home locations to create a data coverage. Samples were probably collected and analyzed as unfiltered samples.

Sampling Design for Project Data

Project data were collected for several purposes. Ground-water samples were collected to fill gaps in the spatial distribution of the historical data and to illustrate the magnitude of temporal variability in arsenic concentrations. In addition, five ground-water samples were analyzed for arsenic species. Quality-control (QC) data were collected to evaluate the quality of project data, evaluate the quality of historical data (by resampling selected historical sites), and compare results obtained by different processing and analytical methods.

Samples from 125 wells and 6 nonthermal springs were collected during 1996 and 1997 to complement the spatial distribution of historical data. The wells and springs sampled were distributed throughout the lower elevation areas of the Willamette Basin, which are areas of greatest ground-water use. These sites had not previously been sampled for arsenic by the USGS. Some wells were sampled more than once during the course of this project; in these cases, the first-in-time samples were used to define the spatial distribution of arsenic.

To evaluate temporal variability of arsenic concentrations, samples were collected quarterly for 1 year from each of 17 sites. These samples also were collected during 1996 and 1997. A subset (5) of these 17 sites were sampled for arsenic species.

QC samples were used to evaluate the quality of techniques used to collect and analyze project samples. Twelve field equipment blanks, 6 sets of triplicate split samples, and 11 standard reference samples (SRSs) were analyzed over the course of the project. Field equipment blanks allow evaluation of the extent of any sample contamination

resulting from sample collection, processing, and analysis. Replicate samples allow evaluation of the reproducibility (precision) of analyses. SRSs facilitate evaluation of analytical accuracy. The USGS SRS program, an interlaboratory testing program, is described in a report by Long and Farrar (1995). Preparation, description, and most probable values (MPVs) of constituents of individual SRSs used in this study are described by U.S. Geological Survey (1990) and Long and Farrar (1991, 1993, 1995). An MPV for an analyte is the median of the concentrations determined by the participating laboratories. Analytical results are reported as percentages of SRS-program MPVs.

Additional quality assurance included resampling 11 historical sites. Comparison between historical arsenic concentrations and concentrations determined upon resampling offers a measure of the reliability of historical data.

Comparisons between filtered and unfiltered samples, and between USGS and USEPA analytical methods, also were made. Characterization of differences in arsenic concentrations among unfiltered and filtered samples helps quantify the effect of sample filtering, and increases the transfer value of the data and interpretations presented in this report. Data from comparison of USGS and USEPA analytical methods facilitate comparison of arsenic concentrations determined by USGS methods with USEPA water-quality criteria.

Project Sample Collection Methods

Project samples from wells and springs used for evaluation of spatial distribution of arsenic were not filtered. Unfiltered samples, in addition to being more economical to collect than samples filtered through 0.45-µm (micrometer) filters, also have the advantage of being more representative of the water being consumed by most well owners. Another justification for collection of unfiltered samples is that many of the historical data, with which project data were combined, were from analyses of unfiltered samples. Furthermore, USEPA and World Health Organization (WHO) guidelines for water quality (see section “Comparisons with Water-Quality Criteria“) apply to “finished water.” For most project wells, which were primarily domestic wells, “finished water” generally is equivalent to unfiltered water. However, because unfiltered samples may contain more colloids and (or) more sediment entrained during pumping, unfiltered samples are less representative of water actually moving through an aquifer than are 0.45-µm-filtered samples. Thus, the use of unfiltered samples in characterization of ground-water quality represents an approximation. Additional, quantitative discussion on this topic is presented in the section, “Comparison of Processing and Analytical Methods.”

Of the 125 project wells used for evaluation of spatial distribution of arsenic, 116 were actively used domestic wells. The remaining 9 wells included 3 public-water-supply wells, 3 industrial wells, 2 irrigation wells, and 1 livestock well. Of these nine wells, those that were not actively used were purged a minimum of three casing volumes prior to sampling to remove standing water from the well. Samples from actively used wells were collected following a minimum purge time of 1 minute. Longer purge times, characteristic of most USGS ground-water-quality work, were deemed unnecessary for actively used wells in this project because these wells experienced a degree of regular purging from the frequent use of the wells. A resulting limitation, however, is that samples from these wells may lose arsenic by way of adsorption to iron casing or precipitation as ground water undergoes geochemical changes while residing in a well bore or casing. Thus, arsenic concentrations in samples from these wells may be biased toward low arsenic concentrations relative to water actually moving through the aquifer. The extent of this possible bias has not been quantified, but because these wells were actively used, this potential bias is likely to be small.

Project samples collected from springs were collected from flowing springs. Fine sediment was present along with the water in several of the springs, so spring samples were filtered through 0.45-µm nominal-pore-size filters.

Project wells sampled for evaluation of temporal variability in arsenic concentrations were actively used wells, sampled using the same methods as for project wells sampled for evaluation of spatial distribution of arsenic.

Project wells sampled for arsenic speciation also were actively used wells. Samples were collected as unfiltered samples following a minimum well purge time of 1 minute. Samples were col-

lected without headspace in brown glass vials, wrapped in aluminum foil (to prevent photooxidation), and shipped on ice to the laboratory.

Eleven wells represented in the historical data set were resampled. All were actively used wells and were sampled using the same methods as for project wells sampled for evaluation of spatial distribution of arsenic.

Samples for comparison between filtered and unfiltered samples, and comparison of USGS and USEPA methods, were collected from a subset of the wells sampled for temporal variability. Each 10-liter sample was split in the field by mechanical agitation into four subsamples. One subsample was filtered through a 0.10-µm nominal-pore-size 47-mm-diameter filter. One subsample was filtered through a 0.45-µm nominal-pore-size 142-mm-diameter filter. Two subsamples were collected as unfiltered samples. For each set of the four subsamples, both of the filtered samples and one of the unfiltered samples were analyzed by USGS methods (see section "Project Analytical Methods"). The other unfiltered sample was analyzed by USEPA methods (see section "Project Analytical Methods").

All arsenic samples, except samples collected for analysis of arsenic species, were field-acidified to below pH 2 with nitric acid. Samples for analysis of arsenic species were not acidified.

Project Analytical Methods

Arsenic analyses were done at the USGS National Water Quality Laboratory (NWQL) in Arvada, Colorado. Most arsenic determinations were done by hydride atomic absorption with a 3-minute sulfuric acid and potassium persulfate digestion (Fishman and Friedman, 1989). This is the standard USGS method, and it is referred to as the "USGS method" in this report. Ten analyses were done by graphite furnace atomic absorption with a 2-hour hydrochloric acid and nitric acid digestion (U.S. Environmental Protection Agency, 1994). This method is referred to as the "USEPA method" in this report. The analytical minimum reporting level (MRL) was 1 µg/L for both methods.

Samples for arsenic speciation were analyzed by the USGS Methods Research and Development Program at the USGS NWQL. Samples were analyzed for two inorganic species, arsenite (arsenic III) and arsenate (arsenic V), and two organic species, monosodium methylarsonate (CH_3AsO_3HNa) and sodium dimethylarsinate ($(CH_3)_2AsO_2Na$). Analyses were done by direct injection high-performance liquid chromatography/hydride generation/inductively coupled plasma-mass spectrometry. Method detection limits (MDLs) were 0.2 µg/L (expressed as mass of arsenic per liter). Samples were analyzed within 48 hours of collection.

Comparisons with Water-Quality Criteria

To provide benchmarks against which arsenic-concentration data can be compared, arsenic-concentration data are compared with USEPA and WHO drinking-water standards. Concentrations of arsenic are compared to the USEPA current drinking water MCL for arsenic of 50 µg/L (U.S. Environmental Protection Agency, 1996). The USEPA current MCL is the maximum concentration of a contaminant allowed in a public water system. This MCL is under review (U.S. Environmental Protection Agency, 1996). Bagla and Kaiser (1996) report that the USEPA is considering reducing the current MCL by 90 percent. However, until any such reduction in the MCL occurs, the current MCL remains a logical benchmark for comparison. As an alternative benchmark, concentrations of arsenic also are compared to the WHO provisional guideline of 10 µg/L (World Health Organization, 1996).

Water with an arsenic concentration below the USEPA current MCL or WHO provisional guideline is not necessarily free from health risks. For example, arsenic concentrations may be below the USEPA current MCL and WHO provisional guideline, but still be greater than the USEPA drinking-water Risk-Specific-Dose Health Advisory (RSDHA) of 2 µg/L (U.S. Environmental Protection Agency, 1996). (The RSDHA is defined as the concentration of a contaminant in drinking water that is expected to result in a specified increased risk of cancer. The USEPA RSDHA for arsenic is calculated at the 1-in-10,000 cancer risk level. Consumption of water containing a contaminant at the RSDHA 1-in-10,000 risk level is expected to be associated with the following risk: a 70-kg adult drinking 2 L of such water per day for 70 years faces an increased risk of cancer of

approximately 1 in 10,000.) Furthermore, effects of arsenic consumption on human health are not uniform among different people, and no single threshold can be defined as the dividing line between "safe" and "unsafe." Comparison of arsenic data to the USEPA current MCL and WHO provisional guideline are done solely for illustrative purposes; no implication of "safety" or lack thereof is implied.

Methods of Identifying Wells

All wells discussed in this report were assigned well location names corresponding to well locations. Well locations generally were determined when the wells were first visited. Well locations were identified using the Township, Range, and Section method of land subdivision. Two methods are shown on figure 2. Most wells were identified with a system that uses nested groups of the letters A, B, C, and D for section subdivision. Prior to about 1967, wells were identified with an alternative system, using letters A through R (excluding I and O) for section subdivision. To preserve linkage to historical data sources, all wells discussed in this report are referred to by the well location names originally assigned to them. It should be noted, however, that in some cases, the original well location names do not accurately describe the true locations of the wells. To provide accurate locational and identifying information for wells discussed in this report, corrected well locations, and additional identifying information (USGS site identification number and OWRD well log identification number), are listed along with original well locations in the

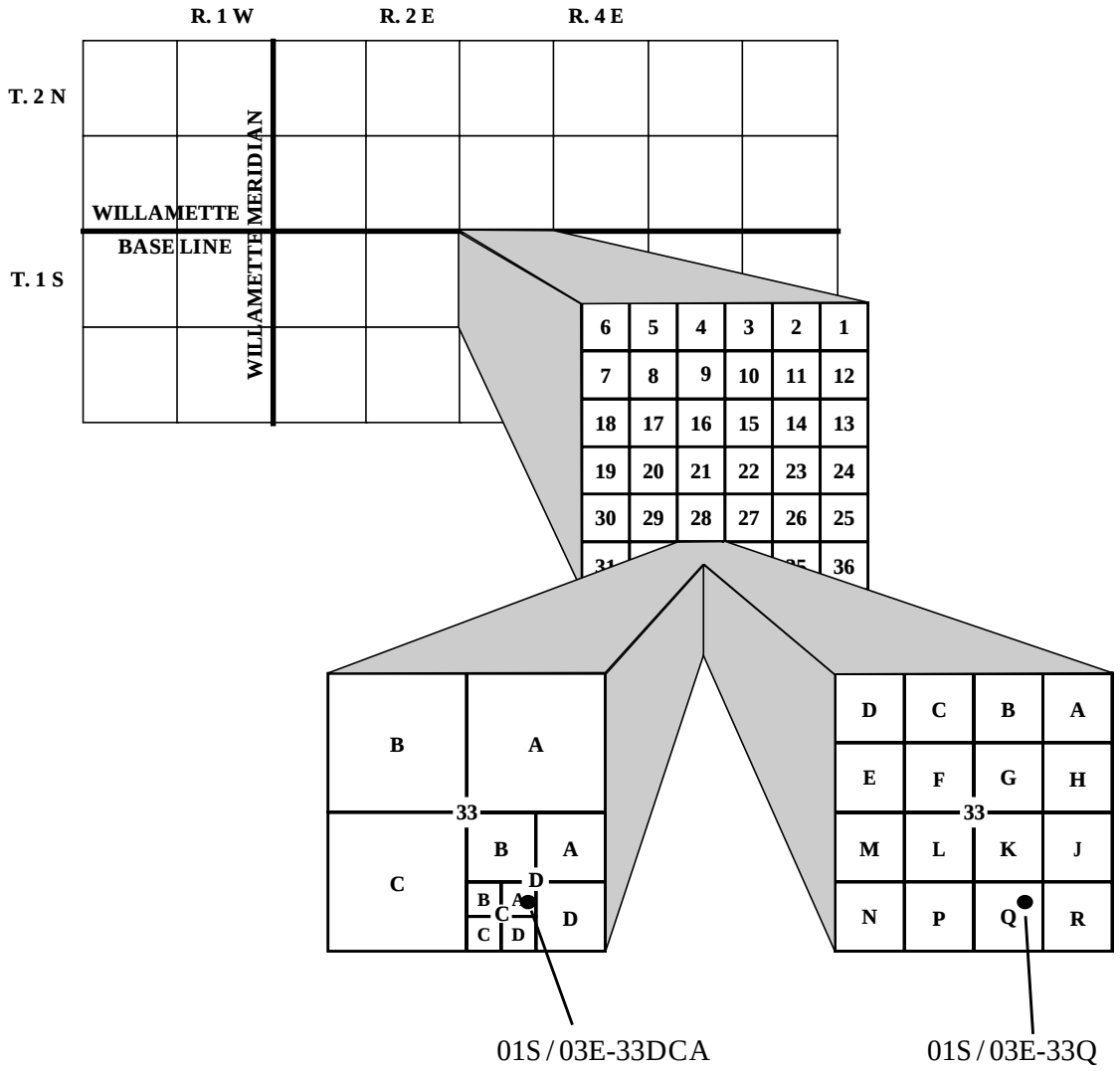


Figure 2. Well-location system.

Appendix. Note that in the project data report (Orzol and others, in press), wells are listed by corrected well location names.

DATA QUALITY: SAMPLING AND ANALYTICAL VARIABILITY VERSUS ENVIRONMENTAL VARIABILITY

In this section, project QC data are evaluated to characterize sampling and analytical variability. Sampling and analytical variability must be evaluated before environmental variability can be addressed. Three sets of QC data were collected as part of project data-collection activities. First, sampling and analytical variability of project data are evaluated. Second, the quality of historical data is discussed. Evaluation of historical data is difficult because few historical quality-control data are available. However, resampling of historically sampled sites provides insight into the quality of the historical data. Third, a comparison of sample processing and analytical methods is presented; these data illustrate the magnitude of the differences that can arise from use of various sample processing and analytical methods.

Quality of Project Data

All 12 project field equipment blanks yielded arsenic concentrations below the MRL of 1 µg/L. These results indicate that field and laboratory methods were noncontaminating.

The coefficient of variation (CV) (standard deviation divided by mean, expressed in percent) for each of the six sets of project triplicate split samples ranged from 0.0 to 14 percent. The median CV was 6.0 percent.

Analytical accuracy of project data was quantified with data from 11 SRSs. Analytical accuracy ranged from 92 to 110 percent for nine of the SRSs, but was 82 and 120 percent for the other two SRSs. In other words, reported concentrations were in error by up to about ±20 percent.

Contamination-free sampling and analysis, and reasonable analytical precision and accuracy, indicate that project data were adequate for definition of patterns of regional arsenic occurrence. However, because analytical accuracy was observed to range up to about ±20 percent, definitive characterization of temporal variability at individual sites is compromised where temporal variability also is on the order of ±20 percent or less.

Quality of Historical Data

The quality of project data is well characterized, so comparison of project and historical arsenic concentrations yields a measure of the quality of the historical data. Evaluation of the analytical accuracy of historical data is particularly desirable. However, arsenic concentrations determined in original studies and determined again during this study may differ for a variety of reasons unrelated to differences in data quality. Notably, differences between historical arsenic concentrations and arsenic concentrations determined from sampling during this project may reflect changes in the source of water being sampled at different times. Changes in the source of water being sampled can arise for a number of reasons. Ground-water flowpaths in aquifers can change over seasonal or longer time scales. Also, water often flows into wells from more than one permeable zone, and the relative contributions from different zones can change as pumping stresses change. Thus, changes in type of well use (for example, change from domestic use to lawn-watering use) or differences in the history of well use prior to sampling can result in changes in the source of water being withdrawn from wells. Finally, changes in well construction or well characteristics (for example, well cave-in over time) can result in changes in source water for wells. (Note, however, that none of the 11 wells were known to have been deepened between the time of historical sampling and the time of project resampling.) In addition to changes in source water to wells, variability in arsenic concentrations can arise from differences in sample processing prior to analysis, or, especially in the case of unfiltered samples, differences in the amount of colloid- or sediment-bound arsenic. Therefore, an absence of strong correlation between historical and project arsenic concentrations is not necessarily cause for rejection of the historical data. Because differences between historical and project data can arise from a number of factors in addition to differences in data quality, the central purpose for which the resampling data were collected was to determine if the magnitudes of the historical data are adequate

for definition of patterns of regional arsenic occurrence.

Data from the 11 sites with historical data that were resampled are presented in table 1. Differences between historical and project data are variable. For example, a difference of less than 10 percent was observed for well 19S/03W-31E1, whereas an order-of-magnitude difference was observed for well 22S/03W-17N. However, historical and project arsenic concentrations were in agreement when interpreted relative to exceedances of the USEPA current MCL. Sites at which historical arsenic concentrations exceeded the USEPA current MCL also yielded water exceeding the USEPA current MCL upon sampling during this project, and sites at which historical arsenic concentrations were less than the USEPA current MCL also yielded water below the USEPA current MCL upon sampling during this project. The historical data therefore indicate a similar pattern of spatial variability of arsenic concentrations as the project data.

Closer examination of these data indicates that data from the early 1960s generally correlate poorly with project data, whereas later data demonstrate reasonably good correlation. This pattern may reflect improvements in analytical techniques since the early 1960s.

Because two historical samples dating from the mid- to late-1960s (wells 12S/01W-29N1 and 18S/04W-14ACB) had both arsenic and chloride data, these sites were sampled for chloride as well as arsenic during project sampling (table 1). For well 12S/01W-29N1, both the arsenic and chloride concentrations were slightly lower upon project sampling: the arsenic concentration upon project sampling was 86 percent of the historical concentration, and the chloride concentration, 88 percent of the historical concentration. For well 18S/04W-14ACB, both the arsenic and the chloride concentrations were considerably lower upon project sampling: the arsenic concentration upon project sampling was 60 percent of the historical concentration, and the chloride concentration, 33 percent of the historical concentration. Historical chloride concentrations would be expected to be reliable, and would have been negligibly affected by sample processing or the presence of colloids and sediment. Thus, the changes in chloride concentrations suggest that changes in the source of water being pumped by these two wells have occurred over time. If historical chloride concentrations had been similar to project chloride concentrations, then the historical arsenic analyses might be suspect. However, differences in chloride concentrations between historical and project sampling suggest that differences in arsenic concentrations between historical and project sampling were a result, at least in part, of changes in the source of water being pumped by these wells.

Comparison of historical arsenic concentrations and arsenic concentrations determined upon project sampling indicate that historical arsenic concentrations will not necessarily reflect current arsenic concentrations. Use of historical data in process-oriented geochemical studies could be problematic. However, the comparison does

Table 1. Comparison of historical arsenic concentrations with arsenic concentrations measured during this project
[Well location as recorded in original data source; arsenic concentrations in micrograms per liter; "--", unknown]

		Historical data		Project resampling	
Source for historical data	Well location	Date	Arsenic concentration	Date	Arsenic concentration
USGS files; Goldblatt and others, 1963	18S/04W-22B	10/04/62	160	08/20/97	820
USGS files; Goldblatt and others, 1963	18S/04W-10D	10/17/62	120	08/20/97	520
USGS files; Goldblatt and others, 1963	22S/03W-17N	10/25/62	32	09/05/96	3
USGS files; Goldblatt and others, 1963	19S/03W-11E2	01/08/63	420	11/13/96	700
USGS files; Goldblatt and others, 1963	19S/03W-31E1	03/29/63	120	11/13/96	130
Frank, F.J., 1973	18S/04W-14ACB	06/12/69	500[a]	09/06/96	300[b]
Helm and Leonard, 1977	12S/01W-29N1	06/24/65	70[c]	08/29/96	60[d]
Linn County Dept. of Health Services	13S/01E-33	--/--/87	10	09/06/96	4
Linn County Dept. of Health Services	14S/01E-05	--/--/87	74	09/06/96	89
Linn County Dept. of Health Services	13S/01E-33AC	04/09/87	900	09/06/96	790
Linn County Dept. of Health Services	13S/01E-35	07/06/87	<5	09/06/96	3

[a]Chloride concentration 43 milligrams per liter.
[b]Chloride concentration 14 milligrams per liter.
[c]Chloride concentration 26 milligrams per liter.
[d]Chloride concentration 23 milligrams per liter.

suggest that the historical data are adequate for definition of patterns of regional arsenic occurrence.

Comparison of Processing and Analytical Methods

Hydrologists employ a variety of sample processing and analytical methods in geochemical and water-quality studies. Samples may be collected as unfiltered or as filtered samples. Filtering may be done using any of a variety of pore sizes, but 0.10-µm and 0.45-µm pore sizes are most commonly used. Analysis of arsenic usually is done using either hydride atomic absorption (commonly used by the USGS) or by graphite furnace atomic absorption (commonly used by the USEPA).

When combining data collected by a number of investigators using a variety of sample processing and analytical methods, questions about the comparability of data arise. Furthermore, comparison of analyses performed using non-USEPA analytical methods against USEPA water-quality criteria raises questions about comparability of analytical techniques. Information on comparability of different sample processing and analytical methods is given in this section. Data from split samples that were (1) filtered through 0.10-µm nominal-pore-size filters and analyzed by hydride atomic absorption, (2) filtered through 0.45-µm nominal-pore-size filters and analyzed by hydride atomic absorption, (3) analyzed as unfiltered samples using hydride atomic absorption, and (4) analyzed as unfiltered samples using graphite furnace atomic absorption are shown in table 2 and on figure 3.

Differences in reported arsenic concentrations between unfiltered and filtered samples generally were small. However, one set of samples (from well 21S/03E-08CBD2) demonstrated that concentrations of arsenic in unfiltered samples can be considerably greater (factor of three) than those in filtered samples. Differences between unfiltered and filtered samples may result from differences in the amount of colloid- or sediment-associated arsenic in the samples. Concentrations in both the unfiltered and the filtered samples from this site were greater than the USEPA current MCL, so interpretation was not affected significantly. However, interpretation of data from other sites could conceivably be affected by such differences between unfiltered and filtered samples and investigators will need to bear such potential differences in mind. Overall, however, combining filtered and unfiltered samples appears to be acceptable for definition of patterns of regional arsenic occurrence.

Differences in reported arsenic concentrations between the two analytical methods were small. Arsenic concentrations reported for samples analyzed by the USEPA method were slightly higher than those analyzed by the USGS method. These differences could be a result of differences in analytical methods. The longer digestion associated with the USEPA method could result in differences in reported arsenic concentrations. Different reagents used in sample digestion in the two methods also could result in differences in reported arsenic concentrations. However, the observed differences also could simply represent analytical variability.

Table 2. Comparison of arsenic concentrations for various processing and analytical methods

[USGS, U.S. Geological Survey; USEPA, U.S. Environmental Protection Agency; arsenic concentrations in micrograms per liter; processing and analytical methods described in text]

Well location	Filtered, 0.10-micrometer filter	Filtered, 0.45-micrometer filter	Unfiltered (USGS method)	Unfiltered (USEPA method)
01N/03W-04CCC	54	57	53	64
01N/03W-07CCD1	17	17	16	22
01N/03W-15ADB1	47	47	53	60
01S/03W-10BCA1	55	57	59	64
02S/02W-11CCD1	16	16	20	24
15S/01W-23CCA	18	18	18	21
17S/01W-24DCA	70	75	70	82
19S/01W-03ADB	41	43	40	46
21S/03E-08CBD2	62	64	180	180
18S/04W-14BBA	1,100	1,100	1,100	1,200

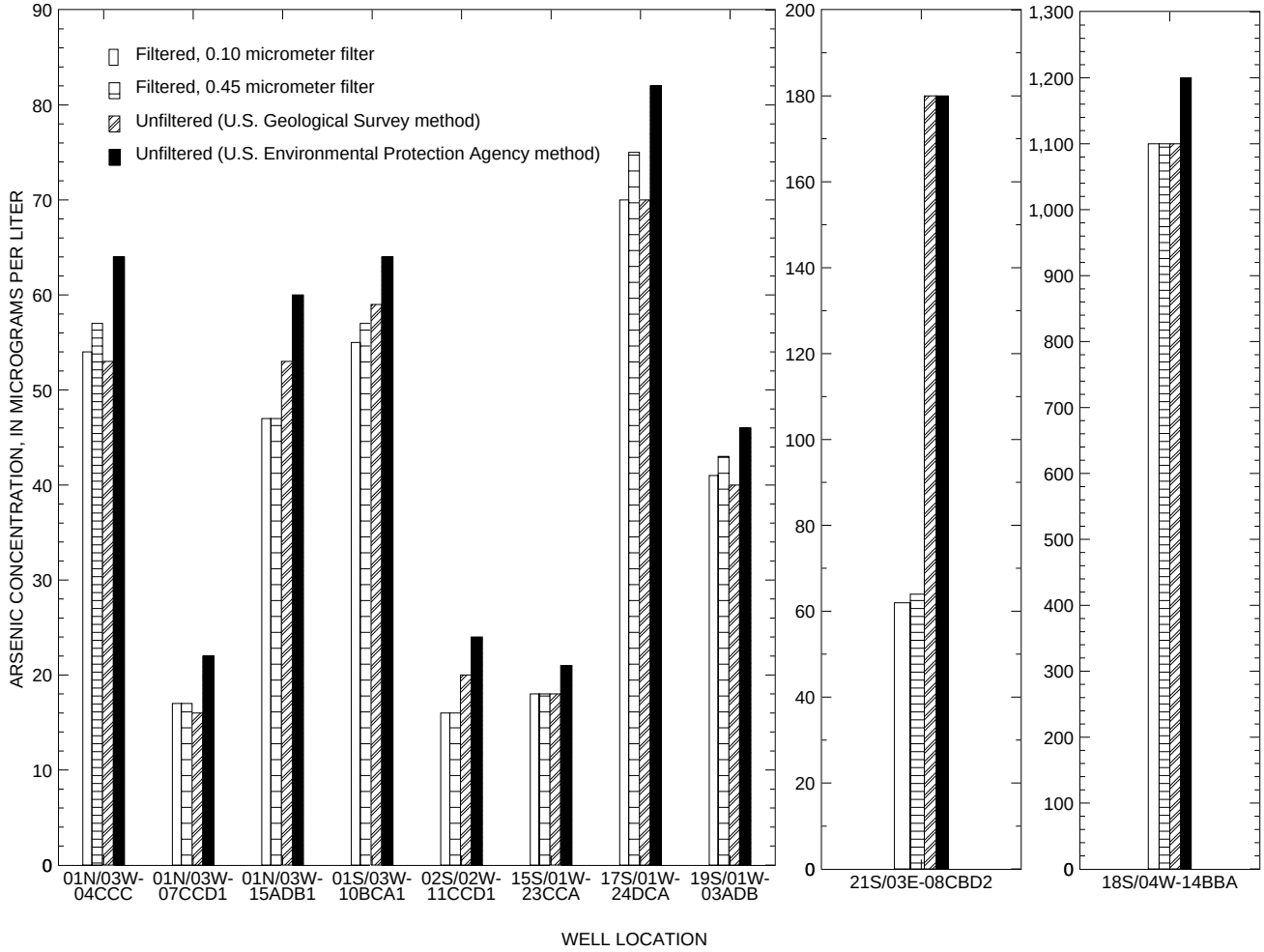


Figure 3. Comparison of arsenic concentrations determined by various processing and analytical methods.

DISTRIBUTION OF ARSENIC

The distribution of arsenic in ground water of the Willamette Basin is discussed in terms of temporal and spatial variability. First, project data are used to assess temporal variability. It is useful to assess temporal variability before arsenic-concentration data collected at different times is used to evaluate spatial distribution. Also, assessment of temporal variability should benefit well owners and water managers who desire guidance on when to sample for arsenic. Second, historical and project data are used to define spatial variability of arsenic concentrations in ground water in the Willamette Basin.

Temporal Variability

Project data were used to evaluate temporal variability of arsenic concentrations in ground water during a 1-year period. These data help characterize variability resulting from seasonal and other short- to medium-term factors. Characterization of temporal variability in arsenic concentrations over longer periods of time was not explicitly done, but long-term variability was discussed qualitatively in a previous section of this report, “Quality of Historical Data.”

Arsenic concentrations measured quarterly over a period of 1 year at 17 sites are given in table 3 and shown on figure 4. Field-measured specific conductance, a surrogate for dissolved solids, also is given in table 3. Arsenic concentrations did exhibit temporal variability. Although arsenic concentrations in water from many wells remained essentially constant over the course of sampling, concentrations at some sites varied by up to almost ±50 percent from mean concentrations, and arsenic concentrations in samples from well 19S/01W-

Table 3. Temporal variations in arsenic concentrations and specific conductance

["As", arsenic concentration in µg/L (micrograms per liter); "SC", field-measured specific conductance in µS/cm (microsiemens per centimeter) at 25 degrees Celsius; "--", not measured]

Well location	Date	As	SC	Date	As	SC	Date	As	SC	Date	As	SC	Date	As	SC
01N/03W-04CCC	11/21/96	53	587	02/20/97	52	585	05/15/97	82	496	08/19/97	97	522	12/05/97	72	616
01N/03W-07CCD1	11/19/96	16	345	02/20/97	17	357	05/15/97	19	345	08/19/97	26	314	12/05/97	18	345
01N/03W-15ADB1	11/21/96	53	1,220	02/20/97	47	1,300	05/15/97	64	1,390	08/19/97	63	1,500	12/05/97	52	1,450
01S/02W-29DBD	11/12/96	33	--	02/20/97	28	194	05/15/97	35	193	08/19/97	41	195	12/05/97	29	192
01S/02W-33BBA	11/12/96	12	--	02/20/97	10	274	05/15/97	12	272	08/19/97	13	275	12/05/97	12	274
01S/03W-10BCA1	11/19/96	59	341	02/20/97	52	340	05/15/97	62	339	08/19/97	56	339	12/05/97	56	341
02S/02W-11CCD1	11/19/96	20	335	02/20/97	16	335	05/15/97	18	334	08/19/97	19	336	12/05/97	18	336
15S/01W-23CCA	08/14/96	19	268	11/15/96	18	263	02/18/97	19	261	05/13/97	17	262	08/20/97	19	262
15S/01W-23CCC2	08/14/96	11	164	11/15/96	11	167	02/18/97	10	163	05/13/97	9	161	08/20/97	12	164
17S/01W-24DCA	09/06/96	85	194	11/15/96	70	198	02/19/97	74	195	05/13/97	84	191	08/21/97	69	193
18S/04W-14ACA	09/05/96	9	319	11/14/96	6	293	02/18/97	5	253	05/14/97	6	250	08/21/97	10	320
18S/04W-14BBA	09/04/96	830	1,040	11/15/96	1,100	1,070	02/20/97	640	797	[a]	[a]	[a]	08/20/97	1,100	1,060
19S/01W-03ADB	09/04/96	15	188	11/14/96	40	329	02/18/97	23	193	05/13/97	33	237	08/21/97	28	205
19S/03W-11E2	11/13/96	700	389	02/19/97	710	393	05/14/97	740	396	08/20/97	850	391	12/04/97	800	390
19S/03W-31E1	11/13/96	130	295	02/19/97	130	295	05/14/97	140	291	08/20/97	130	285	12/04/97	130	292
21S/03E-08CBD2	09/05/96	140	1,590	11/14/96	180	1,460	02/18/97	130	1,120	05/13/97	100	1090	09/04/97	69	1,450
22S/03W-17N	09/05/96	3	298	11/13/96	3	292	02/19/97	4	276	05/14/97	4	295	09/04/97	4	381

[a]Four samples within 37 hours:
05/13/97 at 7 p.m., As, 1100 µg/L; SC, 1090 µS/cm
05/14/97 at 10 a.m., As, 810 µg/L; SC, 952 µS/cm
05/14/97 at 8 p.m., As, 880 µg/L; SC, 809 µS/cm
05/15/97 at 8 a.m., As, 600 µg/L; SC, 877 µS/cm.

03ADB varied by a factor of 2.7 between the lowest and highest concentrations. The data as a whole demonstrate no obvious correlation with seasons. Analytical variability may be responsible for some of the observed variability, but can only explain up to about ±20-percent variation among samples. Differences in arsenic concentrations also could be due, in part, to temporally varying amounts of colloid- or sediment-bound arsenic. However, 10 of the 17 wells used for quarterly sampling also were used in the comparison of unfiltered and filtered samples. The resulting data showed little colloid- or sediment-bound arsenic present in samples from those wells at that time, except for well 21S/03E-08CBD2. Clearly, other factors are responsible for some of the observed temporal variability in arsenic concentrations.

It is likely that temporal variability in project data reflects variation in contributing sources of water to wells, and in the absence of seasonal patterns in temporal data, variation in contributing sources to wells is probably largely due to short-term (hour-to-hour or day-to-day) variations in well use prior to sampling. Relatively heavy well use can temporarily deplete water from parts of an aquifer adjacent to the well, and thus the well can yield water of different chemical quality than when sampled after a period of relatively light use. Two pieces of evidence suggest that some of the 17 wells sampled for temporal variability yield water from different sources at different times, although a relation between differences in contributing sources to wells and differences in well use remains only a hypothesis. One piece of evidence for changing water sources to wells lies in the specific conductance data. Specific conductance generally was less variable in samples where arsenic concentrations were less variable (table 3). Furthermore, specific conductance had the greatest relative temporal variability for water from well 19S/01W-03ADB; the same site also had the greatest relative temporal variability in arsenic concentrations (table 3). Because large changes in the chemistry of individual bodies of ground water generally take place over a period of years, it is difficult to explain large seasonal changes in specific conductance of well water by processes other than changing water sources to wells. A second piece of evidence suggesting changing water sources to wells is derived from examination of data from well 18S/04W-14BBA. Maximum and minimum arsenic concentrations in samples from this site varied by nearly a factor of two over the course of a year. At this site, some additional temporal sampling was conducted. Four samples were collected over one 37-hour period. The observed variability during a

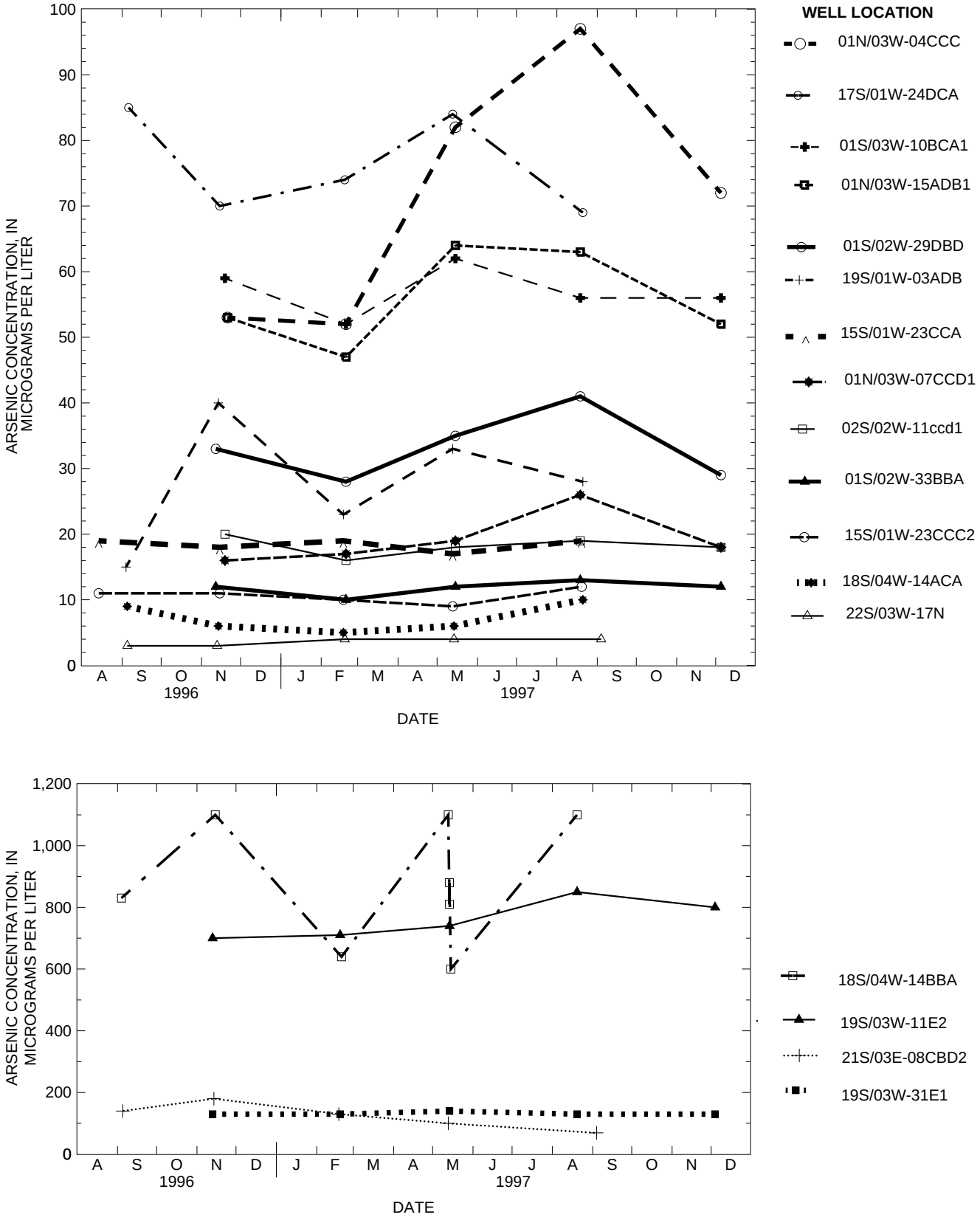


Figure 4. Temporal variations in arsenic concentrations.

37-hour period was as great as the variability observed during the course of a year (table 3, fig. 4). Such variability over the course of 37 hours cannot be ascribed to seasonal factors.

Certainly, a relationship between arsenic concentrations and well use prior to sampling remains only a hypothesis. But regardless of the processes resulting in the observed temporal variability, the data demonstrate that short-term variability in arsenic concentrations can be similar in magnitude to variability observed during the course of quarterly sampling.

The temporal variability of the project data (less than a factor of three) contrasts greatly with temporal variability in arsenic concentrations reported by Nadakavukaren and others (1984) for some wells in Lane County in the southern part of the Willamette Basin. Nadakavukaren and others (1984) reported temporal variability of up to about three orders of magnitude over the course of a year for some of the 14 wells sampled. Such variability is intriguing, because temporal variability of this magnitude in ground-water chemistry at individual sites is unusual.

Nadakavukaren and others (1984) noted that arsenic concentrations often were low (relative to mean concentrations) during the winter (rainy) season. However, they also reported that equally low concentrations were observed during other seasons, including the summer (dry) season, at several sites. Thus, although they observed temporal variability in arsenic concentrations, Nadakavukaren and others (1984) reported that they were unable to relate temporal variability to environmental factors. Unfortunately, sample-collection procedures were not defined in the paper. One aspect of the data not discussed in the original paper, but that may have significant bearing on interpretation of temporal variability, is that most of the wells sampled were irrigation wells. Irrigation wells tend to be unused during the rainy season, and frequently remain idle for long periods during other parts of the year. Recall that it was proposed that temporal variability of project data was related, at least in part, to well use prior to sampling, and recall, also, that project wells either were actively used domestic wells or were sampled after purging three well-bore volumes. It is possible that the extreme variability in arsenic concentrations reported by Nadakavukaren and others (1984) could be related to previous well use (or lack of well use), especially if the wells were not purged prior to sampling. Certainly, the use of irrigation wells for most of the work presented by Nadakavukaren and others (1984), and the absence of documentation of well-purging criteria, make interpretation of their temporal data difficult. Data of Nadakavukaren and others (1984) suggest that caution be applied when using historical data for which both well-use and well-purging information are unavailable.

The absence of seasonal trends in project data suggests that data collected at different times in the Willamette Basin can be combined for use in definition of spatial variability in arsenic concentrations. However, data of Nadakavukaren and others (1984), although difficult to interpret, suggest that historical data for which the history of well use and well purging are unknown may not always be sufficient for site-specific characterization. Thus, although temporal variability is not likely to be a significant problem for a regional evaluation of ground-water arsenic concentrations, the quality of historical data should be evaluated. Most of the historical data compiled for use in this report were from samples collected by USGS personnel. The remainder of the data (from Linn County Department of Health Services, Environmental Health Program) were collected from domestic wells, which presumably were actively used wells. USGS protocols have long required (at least as far back as 1960; Rainwater and Thatcher, 1960) that groundwater samples be collected from purged or actively used wells. Thus, from a standpoint of well use/well purging, the historical data used in this report are believed to be of adequate quality for a regional assessment of arsenic concentrations in ground water. Resampling of selected wells represented in the historical data supports this assumption, as was shown in the section “Quality of Historical Data.”

Spatial Distribution

Historical and project data were combined and used to evaluate the spatial distribution of arsenic concentrations in ground water of the Willamette Basin. A total of 728 spatially distinct samples thus were available—597 historical and 131 project samples. Of these 728 samples, 721 were from wells, and 7 were from nonthermal springs. These data are available in digital format

(CD-ROM) in a separate data report (Orzol and others, in press).

Concentrations of arsenic in the 728 samples ranged from < 1 to 2,000 µg/L. A histogram of these data is shown on figure 5. Concentrations in 58 samples (8.0 percent) exceeded the USEPA current MCL (50 µg/L), and 158 (21.7 percent) exceeded the WHO provisional guideline (10 µg/L). The 728 samples were not randomly distributed throughout the basin, so it does not follow that 8 percent of all wells in the basin will exceed the USEPA current MCL. Furthermore, because some of the data (in particular, data of Goldblatt and others, 1963, and data from Linn County Department of Health Services) were collected to address suspected arsenic problems, the cumulative data set contains a bias towards high arsenic concentrations (exceeding the USEPA current MCL). The data do, however, indicate the existence of extensive bodies of high-arsenic ground water in the basin.

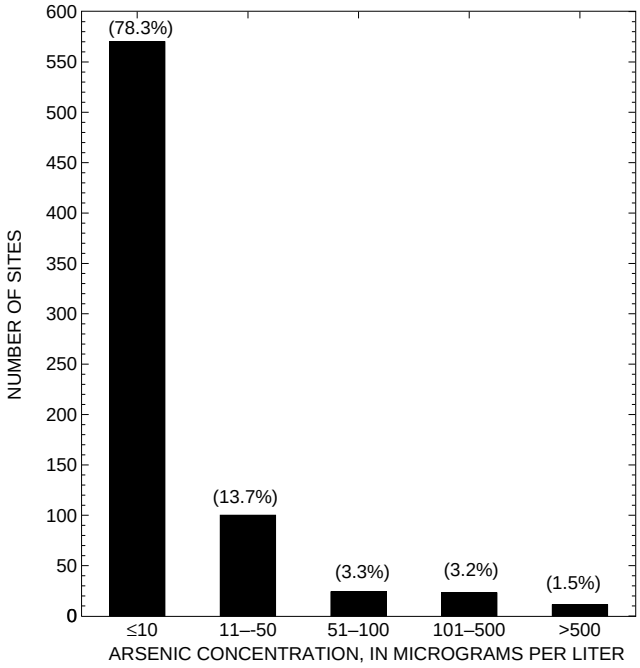


Figure 5. Arsenic concentrations for sites sampled in the Willamette Basin, Oregon. (Number in parentheses is percentage of the total number of sites.)

Depth data were available for 651 of the 728 sites. The relation of arsenic concentration to depth is shown on figure 6. Data from springs were included on this figure; springs were assigned a "well depth" of zero. (For plotting purposes, censored data [concentrations below reporting levels] were arbitrarily plotted at one-half of the reporting

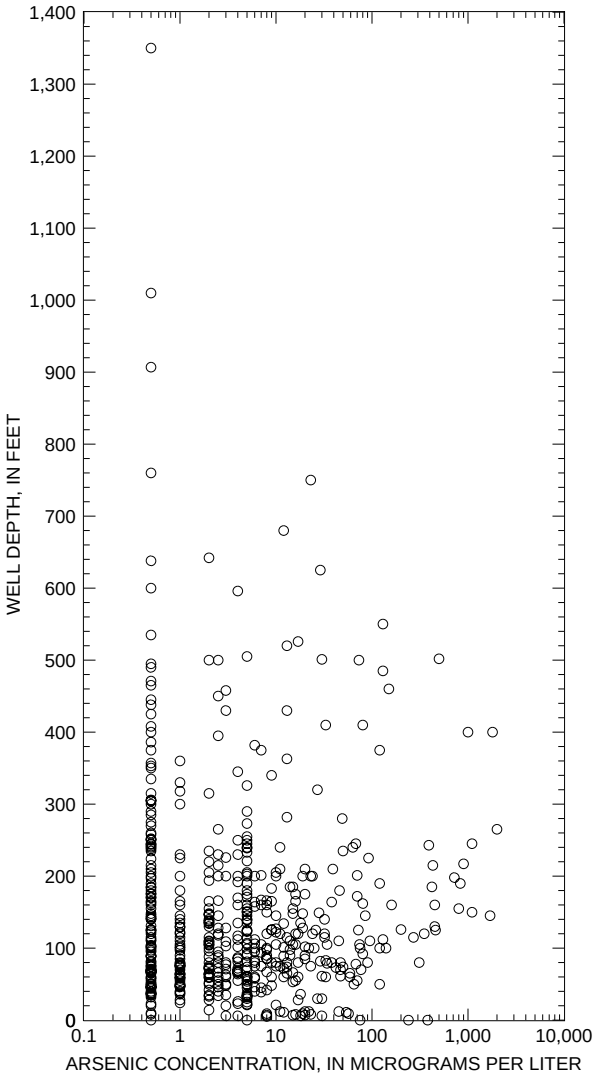


Figure 6. Relation of arsenic concentration to well depth. (Data from six springs also are included; "well depth" is set to zero for springs.)

levels. Censoring occurred at three concentration levels: 1, 5, and 10 µg/L.) No obvious relation of arsenic concentration to well depth was observed. On a regional scale, depth does not appear to be a useful parameter for predicting arsenic concentrations. However, depth may be an important parameter on a local scale.

The spatial distribution of arsenic concentrations is shown on plate 1. Patterns of arsenic occurrence are apparent. Most (53) of the 58 samples with high concentrations of arsenic came from wells and springs in bedrock areas (areas where bedrock is exposed at land surface or is covered by thin layers of alluvium) in south-central and eastern Lane County, and Linn County (pl. 1). The remain-

ing 5 (of the 58) samples came from wells near the center of the Tualatin Basin in Washington County (northwestern part of the Willamette Basin) (pl. 1). These five wells produce water from alluvial deposits. Not only were most of the 58 occurrences of high arsenic concentrations in Lane and Linn Counties, but the highest concentrations also were found there. Arsenic concentrations ranged up to 2,000 µg/L in Lane and Linn Counties, and six samples contained ≥1,000 µg/L. In contrast, the maximum concentration of arsenic in the Tualatin Basin, 77 µg/L, was substantially smaller than many of the concentrations found in Lane and Linn Counties, although still a concentration of considerable concern.

All five exceedances of the USEPA current MCL in the Tualatin Basin were from filtered samples. Many of the exceedances of the USEPA current MCL in Lane and Linn Counties were from unfiltered samples, but concentrations in filtered samples from that part of the Willamette Basin have been observed to exceed 1,000 µg/L. Because filtered samples generally contain primarily dissolved constituents, the presence of high concentrations of arsenic in filtered samples suggests that geochemical conditions can be favorable for development of high dissolved-arsenic concentrations both in the Tualatin Basin and in bedrock areas of Lane and Linn Counties.

Intermediate arsenic concentrations (>10 µg/L and ≤ 50 µg/L) were widespread in the Willamette Basin (pl. 1). As might be expected, many of the occurrences of intermediate arsenic concentrations were located in the same regions where high arsenic concentrations were found. However, intermediate arsenic concentrations were found in many other areas as well, and in a variety of geologic materials.

Occurrence of high concentrations of arsenic in bedrock areas of Lane and Linn Counties appears to be related to the areal extent of two associations of older volcanic rocks: (1) the Fisher and Eugene Formations and correlative rocks (Oligocene and upper Eocene epochs), and (2) undifferentiated tuffaceous sedimentary rocks, tuffs, and basalt (Miocene and Oligocene epochs). (The undifferentiated tuffaceous sedimentary rocks, tuffs, and basalt are approximately equivalent to the Little Butte Volcanic Series of Peck and others [1964].) The surficial extent of these two rock associations is shown on plate 1. At land surface, the two rock associations cover 24 percent of the Willamette Basin. All detections of high concentrations of arsenic in Lane and Linn Counties occur in or very close to places where these volcanic rocks crop out, or in areas where thin layers of alluvial materials cover the rocks. These rocks include extensive volumes of silicic (rhyolitic) volcanic rocks. Ground water high in naturally occurring arsenic commonly is associated with volcanic rocks silicic to intermediate in composition (Welch and others, 1988). Thus, the apparent relationship between high concentrations of arsenic and geologic unit is not unexpected.

Interpretation of relationships between high concentrations of arsenic in ground water and geologic units could be improved upon at a local scale by use of more detailed (local) geologic maps. For example, although 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). The regional nature of the work presented in this report, with the requisite use of regional-scale rock associations, did not allow for finer-scale interpretation of the occurrence of high concentrations of arsenic relative to geologic characteristics. However, investigators involved in local-scale ground-water assessments should be able to make use of more detailed geologic mapping to help guide sampling.

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. The surface exposure of these rocks alone represents 24 percent of the area of the Willamette Basin, and their full extent is greater. Additional sampling of wells completed in these arsenic-containing rocks would better define

the spatial distribution of high-arsenic water in areas not sampled during this study. Further, the presence of high arsenic concentrations in other aquifers in the Willamette Basin (pl. 1) suggests that additional sampling might reveal still more problem areas.

GEOCHEMISTRY OF ARSENIC

An understanding of factors controlling the distribution of arsenic in ground water requires a knowledge of arsenic sources and of processes controlling arsenic mobility. To that end, possible sources of arsenic in Willamette Basin ground water are discussed in this section. Processes that have been shown to control arsenic mobility in other natural systems are discussed next. Then, arsenic speciation data collected as part of this project, along with some historical speciation data, are presented. Finally, geochemical data (including the speciation data) and information from existing interpretive reports are used to construct preliminary hypotheses regarding possible geochemical controls over mobilization of arsenic in the Willamette Basin. An understanding of arsenic sources and geochemistry in the basin could help guide future monitoring efforts both in the basin and elsewhere. However, rigorous geochemical investigation of reasonable hypotheses will be required before an adequate understanding of arsenic geochemistry in the Willamette Basin can be said to exist. Thus, this discussion may serve future research.

Sources of Arsenic

Arsenic can be introduced into ground water from anthropogenic and natural sources. Anthropogenic sources may be important in some settings. Because industrial activity tends to be localized, it would be difficult to explain regional patterns of arsenic occurrence in the Willamette Basin by introduction from industrial sources. However, arsenical pesticides such as lead arsenate were historically used in large quantities in agricultural areas of the Willamette Basin (Rinehold and Jenkins, 1993). High-arsenic ground water in bedrock areas of Lane and Linn County tends to occur in nonagricultural areas, so it is unlikely that the observed high concentrations of arsenic in ground water in those areas can be attributed to historical use of arsenical pesticides. However, in contrast to land-use patterns in the bedrock areas of Lane and Linn Counties, land use in alluvial portions of the Tualatin Basin includes a variety of agricultural land uses, and high-arsenic ground water in alluvium in the Tualatin Basin does generally coincide with occurrence of agricultural areas. Closer inspection of the data, however, shows that detections of high concentrations of arsenic in Tualatin Basin ground water generally are near rivers and streams (pl. 1). Ground water near these rivers and streams likely represents ground water near the end of ground-water flowpaths. Occurrence of high concentrations of arsenic in downgradient parts of ground-water flowpaths could result from transport of arsenic from upgradient areas where arsenical pesticides historically had been applied, or from mobilization of naturally occurring arsenic during geochemical evolution as ground water moves along flowpaths. Arsenic is nearly immobile in topsoils, and arsenic in arsenical-pesticide-contaminated topsoil leaches on timescales of decades or more (Aten and others, 1980). Thus, occurrence of high concentrations of arsenic primarily in downgradient areas, and not more uniformly distributed in the Tualatin Basin, is more consistent with a natural source than an anthropogenic source. However, no rigorous ground-water flowpath analysis has been done for arsenic transport in the Tualatin Basin, and instances of leaching of arsenic from sites of historical arsenical use into ground water of the Tualatin Basin cannot be ruled out. Nonetheless, regional patterns of arsenic concentrations in ground water of the Willamette Basin as a whole probably reflect primarily natural sources.

Naturally occurring arsenic commonly is found in 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 (Welch and others, 1988). Sulfide minerals can contain arsenic either as a dominant mineral-forming element or as an impurity; sulfide minerals are found locally in the Western Cascades (U.S. Geological Survey, 1969). Metal oxides and clay minerals are ubiquitous in the Willamette Basin. Organic carbon is widespread in many parts

of the Willamette Basin, especially in alluvial deposits. Volcanic glass, commonly a major component of volcanic rocks, also is widely found in Willamette Basin aquifers, although much of the original glass in older volcanic rocks has been devitrified (Peck and others, 1964). Thus, arsenic originally associated with such volcanic glass either will have become associated with devitrification alteration products such as clays and metal oxides, or will have been released into solution and subsequently adsorbed or precipitated elsewhere or flushed from the aquifer. However, volcanic glass is still abundant in the Willamette Basin, and thus may constitute a current source of arsenic. At a minimum, the apparent relationship between rock associations containing silicic volcanic rocks and the occurrence of high concentrations of arsenic in ground water in Lane and Linn Counties described earlier in this report suggests that considerable amounts of arsenic might ultimately have come from volcanic glass. Thus, several sources of naturally occurring arsenic dispersed in aquifer materials can reasonably be postulated. However, examination of these various potential arsenic sources for arsenic availability in the Willamette Basin apparently has never been done.

Review of Geochemical Processes Controlling Arsenic Mobility

Two categories of processes largely control arsenic mobility in aquifers: (1) adsorption and desorption reactions and (2) solid-phase precipitation and dissolution reactions. Attachment of arsenic to an iron oxide surface is an example of an adsorption reaction. The reverse of this reaction, arsenic becoming detached from such a surface, is an example of desorption. Solid-phase precipitation is the formation of a solid phase from components present in aqueous solution. Precipitation of the mineral calcite, from calcium and carbonate present in ground water, is an example of solid-phase precipitation. Dissolution of volcanic glass within an aquifer is an example of solid-phase dissolution.

Arsenic adsorption and desorption reactions are influenced by changes in pH, occurrence of redox (reduction/oxidation) reactions, presence of competing anions, and solid-phase structural changes at the atomic level. Solid-phase precipitation and dissolution reactions are controlled by solution chemistry, including pH, redox state, and chemical composition.

Adsorption and Desorption Processes

Arsenic is a redox-sensitive element. This means that arsenic may gain or lose electrons in redox reactions. As a result, arsenic may be present in a variety of redox states. Arsenate and arsenite are the two forms of arsenic commonly found in ground water (Masscheleyn and others, 1991). Arsenate generally predominates under oxidizing conditions. Arsenite predominates when conditions become sufficiently reducing. Under the pH conditions of most ground water, arsenate is present as the negatively charged oxyanions $H_2AsO_4^-$ or $HAsO_4^{2-}$, whereas arsenite is present as the uncharged species $H_3AsO_3^0$ (Hem, 1985). The strength of adsorption and desorption reactions between these different arsenic species and solid-phase surfaces in aquifers varies, in part, because of these differences in charge. Differences in species charge affect the character of electrostatic interactions between species and surfaces.

Arsenate and arsenite adsorb to surfaces of a variety of aquifer materials, including iron oxides, aluminum oxides, and clay minerals. Adsorption and desorption reactions between arsenate and iron-oxide surfaces are particularly important controlling reactions because iron oxides are widespread in the hydrogeologic environment as coatings on other solids, and because arsenate adsorbs strongly to iron-oxide surfaces in acidic and near-neutral-pH water (Dzombak and Morel, 1990; Waychunas and others, 1993). However, desorption of arsenate from iron-oxide surfaces becomes favored as pH values become alkaline (Fuller and Davis, 1989; Dzombak and Morel, 1990). The pH-dependence of arsenate adsorption to iron-oxide surfaces appears to be related to the change in iron-oxide net surface charge from positive to negative as pH increases above the zero-point-of-charge (pH at which the net surface charge is equal to zero) of about 7.7 for goethite (crystalline iron oxide) (Stumm and Morgan, 1996) or 8.0 for ferrihydrite (amorphous iron oxide) (Dzombak and Morel, 1990). Where pH values are above about 8, the negative net surface charge of

iron oxide can repel negatively charged ions such as arsenate.

Iron-oxide surfaces also adsorb arsenite, and both arsenate and arsenite adsorb to aluminum oxides and clay-mineral surfaces. However, these adsorption reactions appear generally to be weaker than is the case for arsenate adsorption to iron-oxide surfaces under typical environmental pH conditions (Manning and Goldberg, 1997). Nevertheless, pH-dependent adsorption and desorption reactions other than those between arsenate and iron-oxide surfaces may be important controls over arsenic mobility in some settings. As is the case for adsorption of arsenate to iron-oxide surfaces, adsorption of arsenite to iron-oxide surfaces tends to decrease as pH increases, at least between the range from pH 6 to pH 9 (Dzombak and Morel, 1990). Unfortunately, arsenate and arsenite adsorption and desorption reactions with other common surfaces are less well characterized, and apparently more complex than is the case for adsorption and desorption reactions with iron-oxide surfaces (Manning and Goldberg, 1997).

As a result of the pH dependence of arsenic adsorption, changes in ground-water pH can promote adsorption or desorption of arsenic. Because solid-phase diagenesis (water-rock interaction) typically consumes H^+ (Stumm and Morgan, 1996), the pH of ground water tends to increase with residence time, which, in turn, increases along ground-water flowpaths. Because iron-oxide surfaces can hold large amounts of adsorbed arsenate, geochemical evolution of ground water to high (alkaline) pH can induce desorption of arsenic sufficient to result in exceedances of the USEPA current MCL in some environments (see, for example, Robertson, 1989).

Similarly, redox reactions can control aqueous arsenic concentrations by their effects on arsenic speciation, and hence, arsenic adsorption and desorption. For example, reduction of arsenate to arsenite can promote arsenic mobility because arsenite is generally less strongly adsorbed than is arsenate. Redox reactions involving either aqueous or adsorbed arsenic can affect arsenic mobility (Manning and Goldberg, 1997).

Arsenic adsorption also can be affected by the presence of competing ions. In particular, phosphate and arsenate have similar geochemical behavior, and as such, both compete for sorption sites (Hingston and others, 1971; Livesey and Huang, 1981; Manning and Goldberg, 1996). Oxyanions in addition to phosphate also may compete for sorption sites. For example, Robertson (1989) suggested that correlation of arsenate with oxyanions of molybdenum, selenium, and vanadium in ground water of the Southwestern United States may be evidence for competitive adsorption among those oxyanions.

Finally, structural changes in solid phases at the atomic level also affect arsenic adsorption and desorption. For example, conversion of ferrihydrite to goethite or to other crystalline iron-oxide phases may occur gradually over time (Dzombak and Morel, 1990). Fuller and others (1993) demonstrated that as ferrihydrite crystallizes into goethite, the density of arsenic adsorption sites decreases. This decrease in density of adsorption sites can result in desorption of adsorbed arsenic. Structural changes in other solid phases may possibly affect arsenic mobility, too. The role of such solid-phase structural changes on ground-water arsenic concentrations has, however, received little attention to date.

Precipitation and Dissolution Processes

The various solid phases (minerals, amorphous oxides, volcanic glass, organic carbon) of which aquifers are composed exist in a variety of thermodynamic states. At any given time, some aquifer solid phases will be undergoing dissolution, whereas others will be precipitating from solution. Arsenic contained within solid phases, either as a primary structural component of or an impurity in any of a variety of solid phases, is released to ground water when those solid phases dissolve. Similarly, arsenic is removed from ground water when solid phases containing arsenic precipitate from aqueous solution. As an example, because arsenic often coprecipitates with iron oxide (Waychunas and others, 1993), iron oxide may act as an arsenic source (case of dissolution) or a sink (case of precipitation) for ground water. Furthermore, solid-phase dissolution will contribute not only arsenic contained within that phase, but also any arsenic adsorbed to the solid-phase surface. The process of release of adsorbed arsenic as a result of solid-phase dissolution is distinct from the process of desorption from stable solid phases.

The interplay of redox reactions and solid-phase precipitation and dissolution may be particularly important with regard to aqueous arsenic and solid-phase iron oxides and sulfide minerals. High concentrations of arsenic often are associated with iron oxides and sulfide minerals (Thornton, 1996). Iron oxides frequently dissolve under reducing conditions, but often precipitate under oxidizing conditions. Sulfide minerals generally are unstable under oxidizing conditions, but may precipitate under reducing conditions. Thus, as a result of the redox-sensitive nature of iron oxides and sulfide minerals, transfer of large amounts of arsenic between these solid phases and neighboring water may result from redox-facilitated precipitation and dissolution reactions.

Arsenic Speciation in the Willamette Basin

Three samples from alluvial wells in the Tualatin Basin and two from bedrock wells in Lane County were analyzed for four common species of arsenic. Concentrations of the two organic species of arsenic analyzed (monosodium methylarsonate, or CH_3AsO_3HNa, and sodium dimethylarsinate, or $(CH_3)_2AsO_2Na$) were below MDLs, so only the data for the two inorganic species are tabulated. These speciation data are given in table 4.

Two additional analyses for arsenic species in ground water from the Willamette Basin were available in the literature. Welch and others (1988) reported arsenite and arsenate concentrations for water from two wells in Lane County. Arsenite represented 7 percent and 62 percent of the total arsenic in these samples (total arsenic concentrations being 25 and 45 µg/L, respectively).

The most striking feature of the data from the two studies is the predominance of arsenite. The predominance of arsenite has both geochemical and toxicological implications. From a geochemical standpoint, the speciation data are of interest because mobility of arsenite differs from that of arsenate (see section “Review of Geochemical Processes Controlling Arsenic Mobility”). From a public-health perspective, the speciation data are interesting because arsenite is more toxic than arsenate in at least some of its effects. In human acute toxicity studies, arsenite has been shown to be more potent than arsenate (U.S. Environmental Protection Agency, 1988). With regard to human chromosome breakage, arsenite is about an order of magnitude more potent than arsenate (U.S. Environmental Protection Agency, 1988). Morrison and others (1989) report that arsenite is 50 times as toxic as arsenate, but do not report the organisms studied. Also, arsenite is more difficult to remove from drinking-water supplies than is arsenate (Gupta and Chen, 1978; Schneiter and Middlebrooks, 1983). However, it would be premature to make generalizations regarding arsenic toxicity in the Willamette Basin based upon such limited speciation data (seven samples). Complicating the matter, in the benchmarks against which drinking water arsenic concentration data commonly are compared—the USEPA current MCL and the WHO provisional guideline—no differen- tiation is made between arsenite and arsenate. But if the apparent predominance of arsenite in Willamette Basin ground water is confirmed by additional speciation work, public health officials and water managers may need to evaluate the scope of the arsenic problem with regard not only to arsenic concentrations, but also to arsenic speciation.

Table 4. Speciation of arsenic

[Total arsenic concentration is from a separate analysis of a separate sample, and differs from the total of arsenite-plus-arsenate because of sampling and (or) analytical variability. Recovery, total of arsenite-plus-arsenate divided by total arsenic; µg/L, micrograms per liter]

Well location	Date	Arsenite (percent of total of arsenite-plus-arsenate)	Arsenate (percent of total of arsenite-plus-arsenate)	Arsenite (µg/L)	Arsenate (µg/L)	Total of arsenite-plus-arsenate (µg/L)	Total arsenic concentration (µg/L)	Recovery (percent)
01N/03W-04CCC	08/19/97	76	24	61.1	18.9	80.0	97	82
01S/03W-10BCA1	08/19/97	96	4	58.8	2.3	61.1	56	110
02S/02W-11CCD1	08/19/97	94	6	15.3	.9	16.2	19	85
18S/04W-14BBA	08/20/97	>99	<1	1,200	6.1	1,210	1,100	110
19S/03W-31E1	08/20/97	68	32	61.5	29.4	90.9	130	70

Geochemistry of Arsenic in the Willamette Basin

Few routine chemical analyses (of major ions and field parameters) are available for high-arsenic ground water from bedrock areas of Lane and Linn Counties. Goldblatt and others (1963) noted that high-arsenic ground water tended to have high pH (>8.0) and high orthophosphate concentrations, although only two routine chemical analyses for high-arsenic ground water were published. Reliable measures of redox conditions were not collected. However, the observation was made during site visits that water from many of the wells in bedrock areas of Lane and Linn Counties that yielded high-arsenic ground water during project sampling also had sulfide odors. The presence of sulfide in water indicates chemically reducing conditions. The observation of sulfide, along with the detection of arsenite (the more reduced of the two major arsenic species) in some ground-water samples, indicates the presence of reducing conditions in some ground water in these areas.

Together, these data suggest that for ground water in bedrock areas of Lane and Linn Counties, one or more of the following controlling factors likely are important in adsorption and desorption reactions that in turn often control arsenic mobility: (1) high pH, (2) presence of competing anions, and (3) occurrence of reducing conditions. The sparse available data do not allow even for speculation about adsorption and desorption reactions related to solid-phase structural changes at the atomic level in ground water of bedrock areas of Lane and Linn Counties. Similarly, evidence is lacking to even begin to develop hypotheses about solid-phase precipitation and dissolution reactions.

Previous investigations of the quality of Tualatin Basin ground water provide some preliminary insight into arsenic geochemistry there. Rounds and others (1994) reported that high phosphorus concentrations (up to 2.9 mg/L [milligrams per liter]) are common in Tualatin Basin ground water. In an analysis of 47 filtered ground-water samples from the Tualatin Basin, Hinkle (1997) reported that the median arsenic concentration in low-dissolved-oxygen samples (dissolved oxygen concentrations < 1.0 mg/L) was greater than the median arsenic concentration in well-oxygenated samples. The difference was statistically significant. Of the 47 samples, the 4 that exceeded the USEPA current MCL not only had low dissolved-oxygen concentrations, but also had high concentrations of orthophosphate (0.36 to 2.0 mg/L) and iron (160 to 1,900 µg/L). However, pH was not unusually high; pH of three of the four high-arsenic samples ranged from 7.5 to 7.6, and was 8.1 for the fourth sample.

These data suggest that for alluvial ground water in the Tualatin Basin, presence of competing anions and occurrence of reducing conditions may be important controlling factors in arsenic adsorption and desorption reactions. These two factors might be more important than pH controls over arsenic adsorption and desorption. Reducing conditions and high concentrations of dissolved iron also suggest that dissolution of iron oxides, with subsequent release of adsorbed or coprecipitated arsenic, may play a role in arsenic mobility in the Tualatin Basin.

Hypotheses about factors affecting arsenic adsorption and desorption reactions should account for arsenic speciation. Limited geochemical data suggest that desorption of arsenic from solid phases may be an important process in ground water both in bedrock areas of Lane and Linn Counties and in alluvium in the Tualatin Basin. Desorption of arsenate from iron oxides commonly results from high pH or the presence of competing ions. Such processes, of course, require the presence of arsenate on solid-phase surfaces. Because redox reactions often are slow and frequently far from equilibrium, it would not be unexpected to find arsenate adsorbed to solid-phase surfaces in chemically reducing environments. It might appear, though, that the predominance of arsenite relative to arsenate in aqueous speciation samples would be inconsistent with a hypothesis of desorption of arsenate from iron-oxide surfaces. However, it may be that arsenate is desorbed from aquifer surfaces and subsequently reduced to arsenite.

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APPENDIX

APPENDIX

Table 1. Wells discussed in report text, tables, and figures, listed by well location name from original source, and cross-referenced by recalculated well location and by U.S. Geological Survey site identification number and Oregon Water Resources Department well log identification number
["--", identical to "Well location (original source)"; N/A, none or not determined].

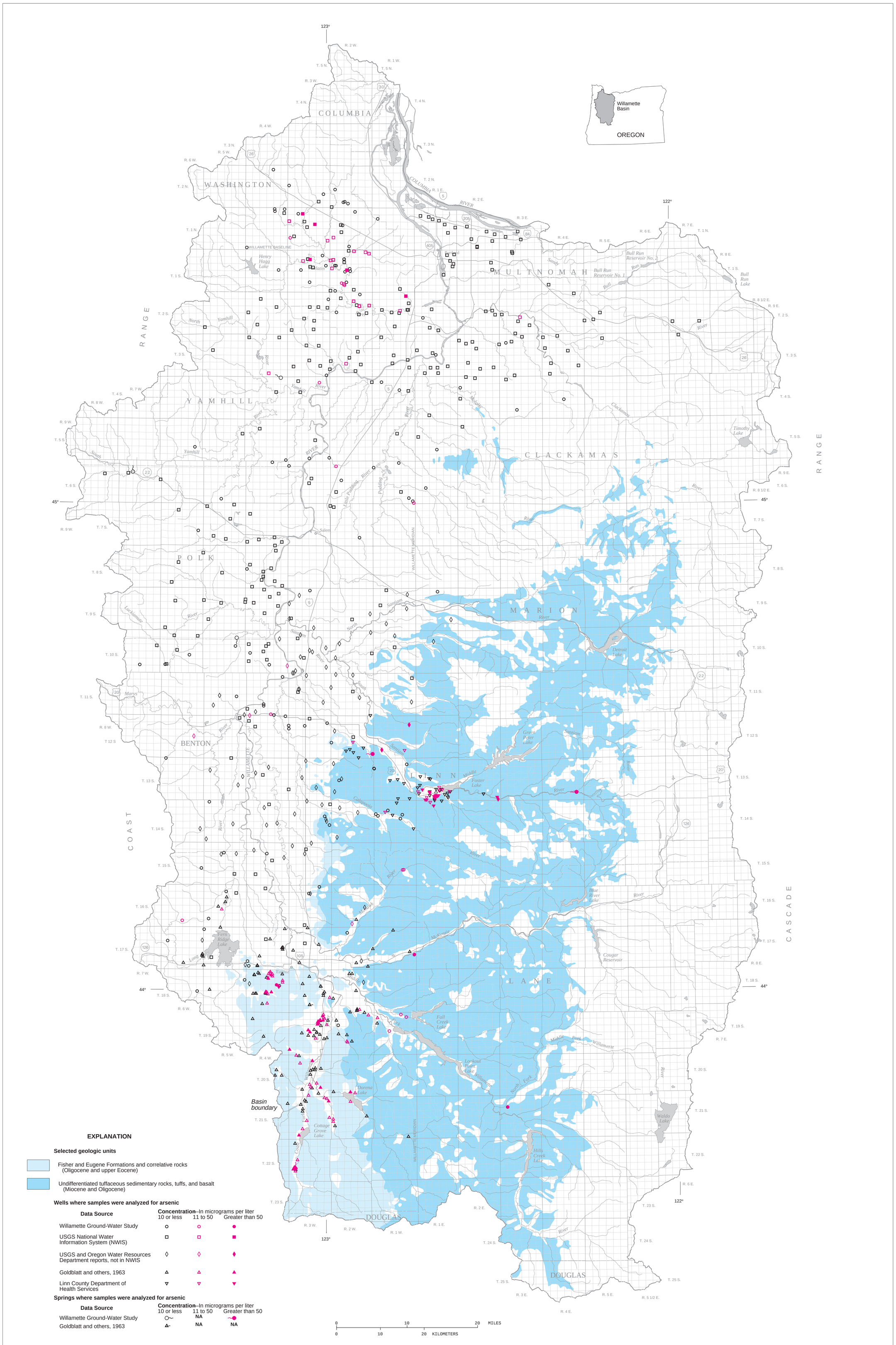
Well location (original source)	Well location (recalculated)	U.S. Geological Survey site identification number	Oregon Water Resources Department well log identification number
01N/03W-04CCC	--	453540123041101	WASH 5967
01N/03W-07CCD1	--	453445123063201	WASH 6037
01N/03W-15ADB1	--	453422123020201	N/A
01S/02W-29DBD	--	452707122572201	WASH 10406
01S/02W-33BBA	--	452651122565001	WASH 10475
01S/03W-10BCA1	--	453002123025301	WASH 143
02S/02W-11CCD1	--	452416122541601	WASH 12572
12S/01W-29N1	12S/01W-29CCA	442934122502801	LINN 9588
13S/01E-33	13S/01E-33DB1	442332122412701	LINN 12832
13S/01E-33AC	--	442348122412301	LINN 12776
13S/01E-35	13S/01E-35BD1	442347122391001	LINN 12914
14S/01E-05	13S/01E-32CD1	442323122424801	LINN 10997
15S/01W-23CCA	--	441447122464501	LANE 50736
15S/01W-23CCC2	--	441446122465701	LANE 5873
17S/01W-24DCA	--	440420122445701	LANE 2085
18S/04W-10D	18S/04W-10BB1	440125123095901	N/A
18S/04W-14ACA	--	440029123080301	LANE 17048
18S/04W-14ACB	--	440024123080901	LANE 17052
18S/04W-14BBA	--	440036123083201	LANE 16780
18S/04W-22B	18S/04W-22BA1	435942123092501	N/A
19S/01W-03ADB	--	435656122471801	LANE 19429
19S/03W-11E2	19S/03W-11BC3	435606123012501	N/A
19S/03W-31E1	19S/03W-31BB1	435237123061801	N/A
21S/03E-08CBD2	--	434528122290901	LANE 23527
22S/03W-17N	22S/03W-17CC1	433859123045601	N/A

U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

Prepared in cooperation with
OREGON WATER RESOURCES DEPARTMENT

WATER-RESOURCES INVESTIGATIONS REPORT 98-4205
Arsenic concentrations in ground water, and selected geologic units—PLATE 1

Hinkle, S.R. and Polette, D.J.
Arsenic in Ground Water of the Willamette Basin, Oregon



EXPLANATION

Selected geologic units

- Fisher and Eugene Formations and correlative rocks (Oligocene and upper Eocene)
- Undifferentiated tuffaceous sedimentary rocks, tuffs, and basalt (Miocene and Oligocene)

Wells where samples were analyzed for arsenic

Data Source	Concentration—In micrograms per liter: 10 or less	11 to 50	Greater than 50
Willamette Ground-Water Study	○	○	●
USGS National Water Information System (NWIS)	□	□	■
USGS and Oregon Water Resources Department reports, not in NWIS	◊	◊	♦
Goldblatt and others, 1963	△	△	▲
Linn County Department of Health Services	▽	▽	▼

Springs where samples were analyzed for arsenic

Data Source	Concentration—In micrograms per liter: 10 or less	11 to 50	Greater than 50
Willamette Ground-Water Study	○~	NA	~●
Goldblatt and others, 1963	△-	NA	NA

Base modified from U.S. Geological Survey Digital base from
U.S. Geological Survey Digital Line Graphs published at 1:100,000, 1987;
U.S. Bureau of the Census, TIGER/Line(R), published at 1:100,000, 1990;
U.S. Geological Survey Digital Line Graphs published at 1:100,000, 1988
and modified by the State of Oregon. 1994;
U.S. Geological Survey quadrangle maps published at 1:24,000
as digitized by Oregon Department of Transportation;
Universal Transverse Mercator projection, Zone 10
1927 North American Datum

Geology from Walker and MacLeod, U.S. Geological Survey Digital Line G
published at 1:500,000, 1991 and modified by the State of Oregon, 199

DISTRIBUTION OF ARSENIC CONCENTRATIONS IN GROUND WATER, AND SELECTED GEOLOGIC UNITS OF THE WILLAMETTE BASIN, OREGON

By
Danial J. Polette and Stephen R. Hinkle

From: Joel Geier
To: Benton Public Comment
Subject: LU-24-027: Leachate and arsenic issues
Date: Monday, May 5, 2025 7:36:23 PM

CAUTION: This email originated from outside of the organization. Do not click links or open attachments unless you recognize the sender and know the content is safe.

Dear Planning Department staff and members of the Planning Commission:

Please enter the attached presentation into the record for this land-use decisions.

This is a presentation that I developed for local United States Geological Survey (USGS) water quality scientists, for a meeting in January of 2025. Unfortunately due to current disruptions in funding for federal agencies, which have impacted the USGS office in Corvallis, we haven't been able to follow up on this discussion.

Please note Slide 16, "Shifting explanations." These were compiled from past minutes of Benton County's Solid Waste Advisory Committee (SWAC) and from the applicant's "Annual Environmental Monitoring Report."

SWAC volunteers expressed concern about the observed high arsenic levels more than 20 years ago. In response, the landfill's representatives gave them a shifting set of explanations, none of which have stood up to the test of time.

In the applicant's testimony last Thursday, their consultant Jeff Shepherd raised yet another hypothesis for the observed high levels of arsenic in groundwater at the landfill site.

As a scientist, I see hypotheses as a good thing. But hypotheses need to be tested, in order to see if they hold water.

Despite 30 years of anomalously high arsenic levels at this landfill site, the applicant has yet to present a scientific plan to test any of their various arm-waving explanations for the observed high levels of arsenic. That includes their most recent attempt at an explanation, as presented to you last Thursday.

Yours sincerely,

Joel Geier, Ph.D.
38566 Hwy 99W
Corvallis, OR 97330-9320

Water contamination concerns arising from landfills in Oregon

Joel Geier
Mark Yeager
(with contributions from Mason Leavitt)



Main Topics

Contaminants from landfill leachate passed through wastewater treatment plants into Oregon rivers

Sewage sludge (“biosolids”) from same wastewater treatment plants

Arsenic plume apparently forming from Coffin Butte landfill

What's in landfill leachate?

Dissolved metals (major):

Calcium	160 mg/L	
Iron	0.91 mg/L	– exceeds MCL for drinking water
Manganese	1 mg/L	– exceeds MCL for drinking water
Magnesium	160 mg/L	
Silicon	37 mg/L	

Dissolved metals (trace):

Antimony	16 µg/L	– exceeds MCL for drinking water
Arsenic	120 µg/L	– exceeds MCL for drinking water
Barium	570 µg/L	
Chromium	180 µg/L	– exceeds MCL for drinking water
Cobalt	38 µg/L	
Copper	5.3 µg/L	
Lead	1.2 µg/L	– goal for drinking water is zero
Mercury	???	– data missing from reports for Coffin Butte
Nickel	140 µg/L	
Selenium	1.6 µg/L	
Silver	0.1 µg/L	
Thallium	0.1 µg/L	
Vanadium	140 µg/L	
Zinc	37 µg/L	

What's in landfill leachate?

Organic chemicals above detectable limits in 2021 at Coffin Butte:

Acetone	460 µg/L
Benzene	3.8 µg/L
2-Butanone	490 µg/L
Carbon Disulfide	3.7 µg/L
1,4 Dichlorobenzene	2.1 µg/L
Ethylbenzene	5.2 µg/L
p-Isopropyl toluene	1.8 µg/L
Naphtalene	5.2 µg/L
Toluene	37 µg/L
1,2,4-Trimethylbenzene	1.7 µg/L
m,p-Xylene	7 µg/L
o-Xylene	4.3 µg/L

Past years:
cis-1,2-Cichloroethene
Isopropyl benzene
4-Methyl-2-Pentatone

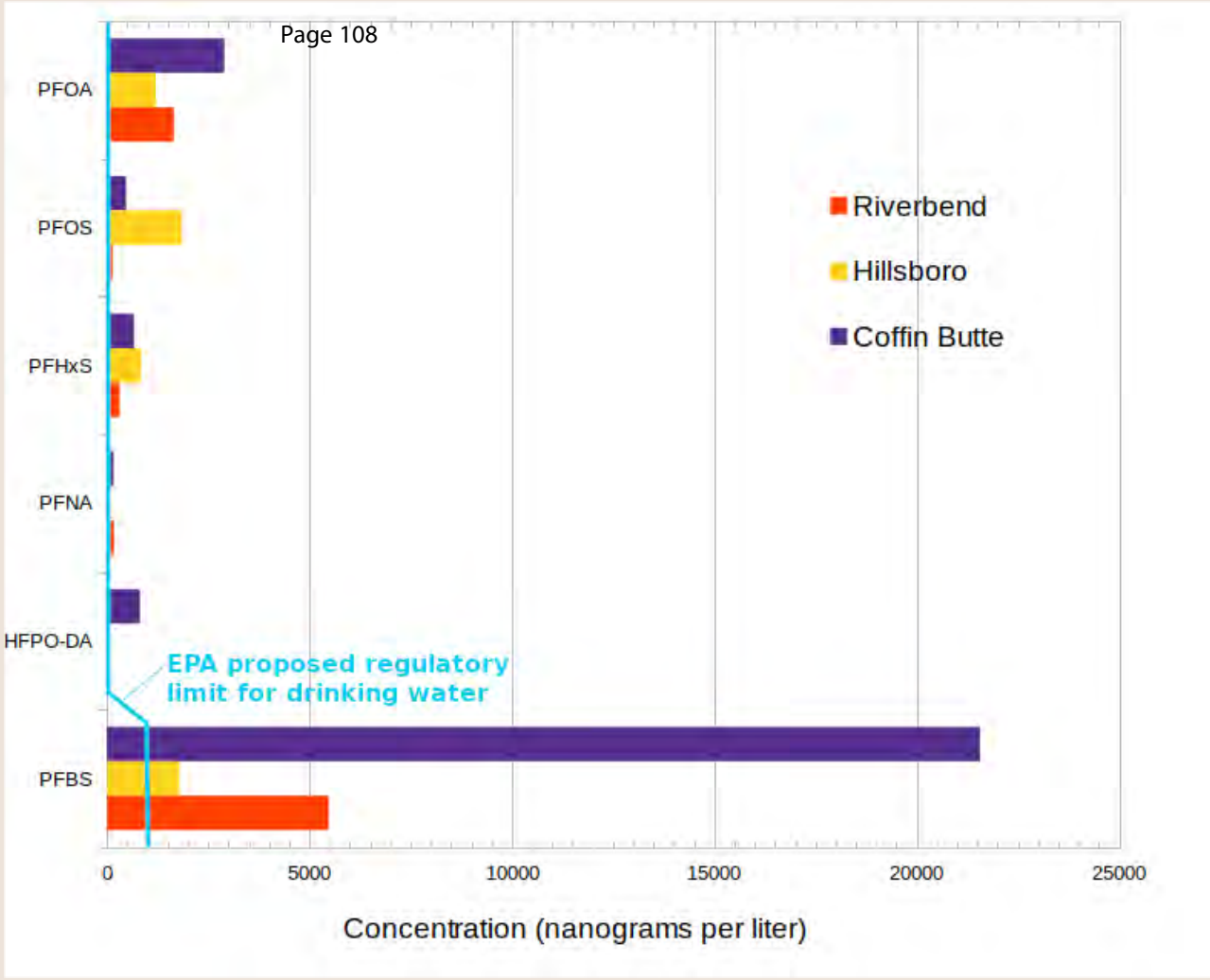
Substances still found in local fields that were "irrigated" with leachate before 1998:
tetrachloroethylene (PCE)
trichloroethylene (TCE)
1,1-dichloroethylene

Only recently tested for: **Per- and polyfluorakyl substances (PFAS)**

PFAS in landfill leachate:

Data for six types now regulated by US EPA as human carcinogens.

Differences among landfills may reflect different average age of waste, as well as different materials accepted (such as incinerator ash)



Municipal wastewater plants not effective for removing PFAS

Concentrations in municipal wastewater expected to decline as regulatory changes reduce PFAS in consumer products.

Landfills will continue to produce indefinitely from “legacy” waste.

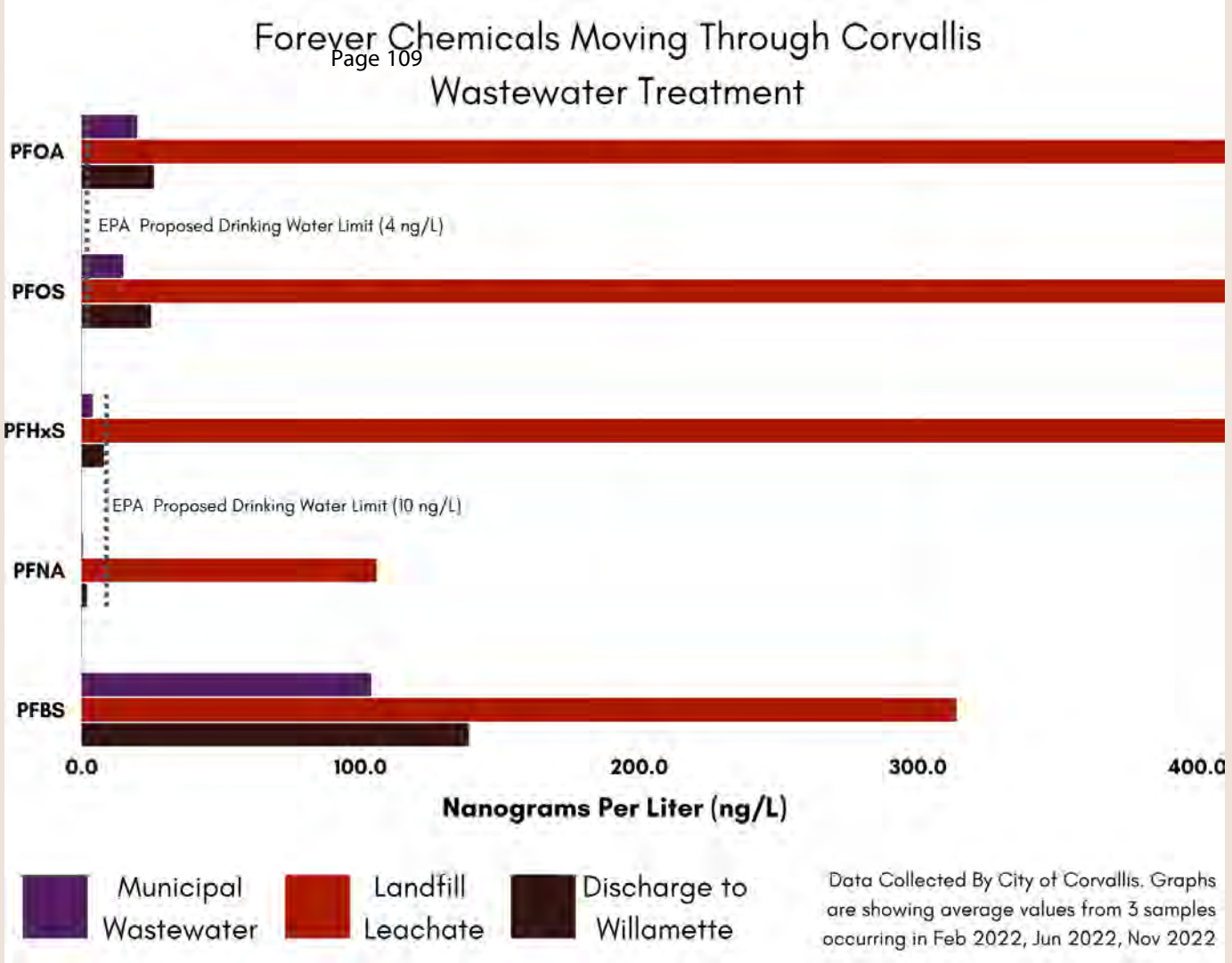
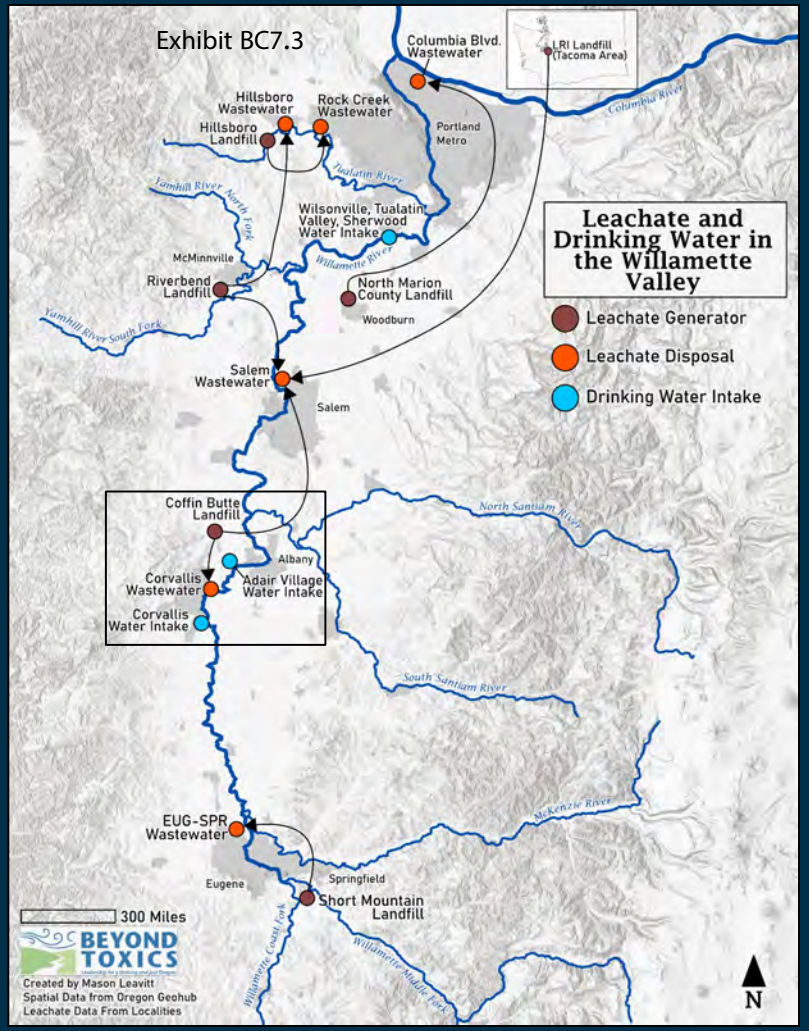
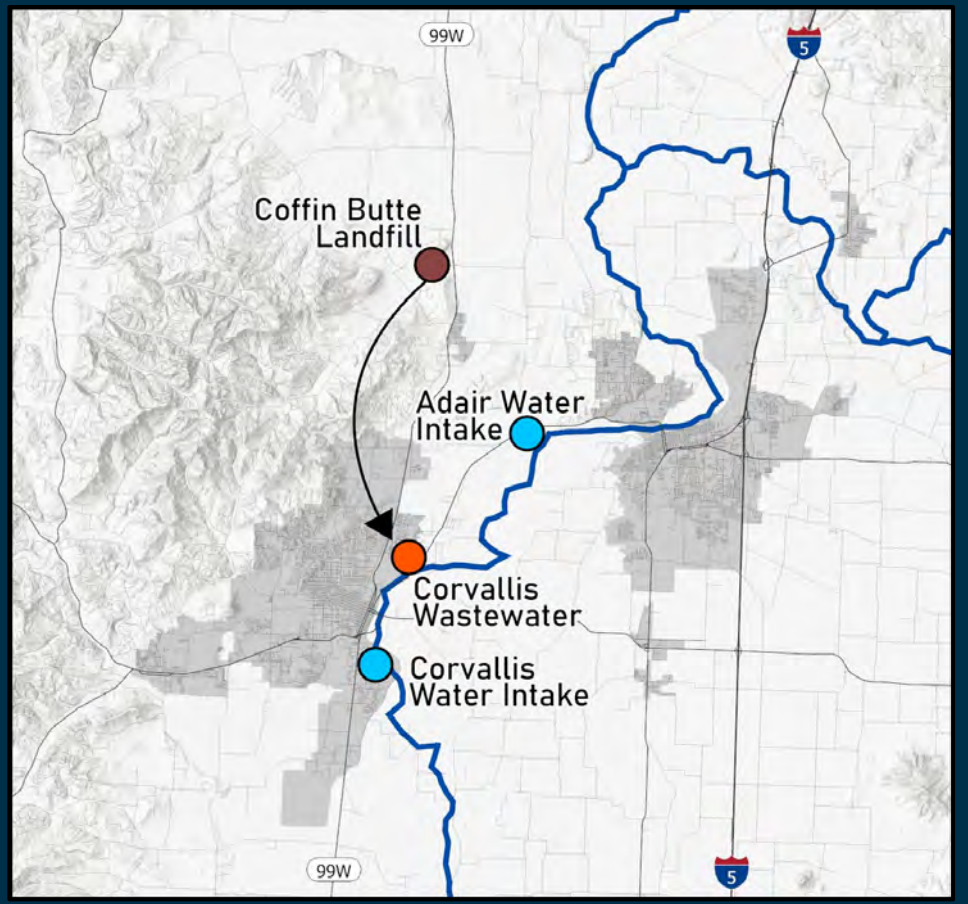


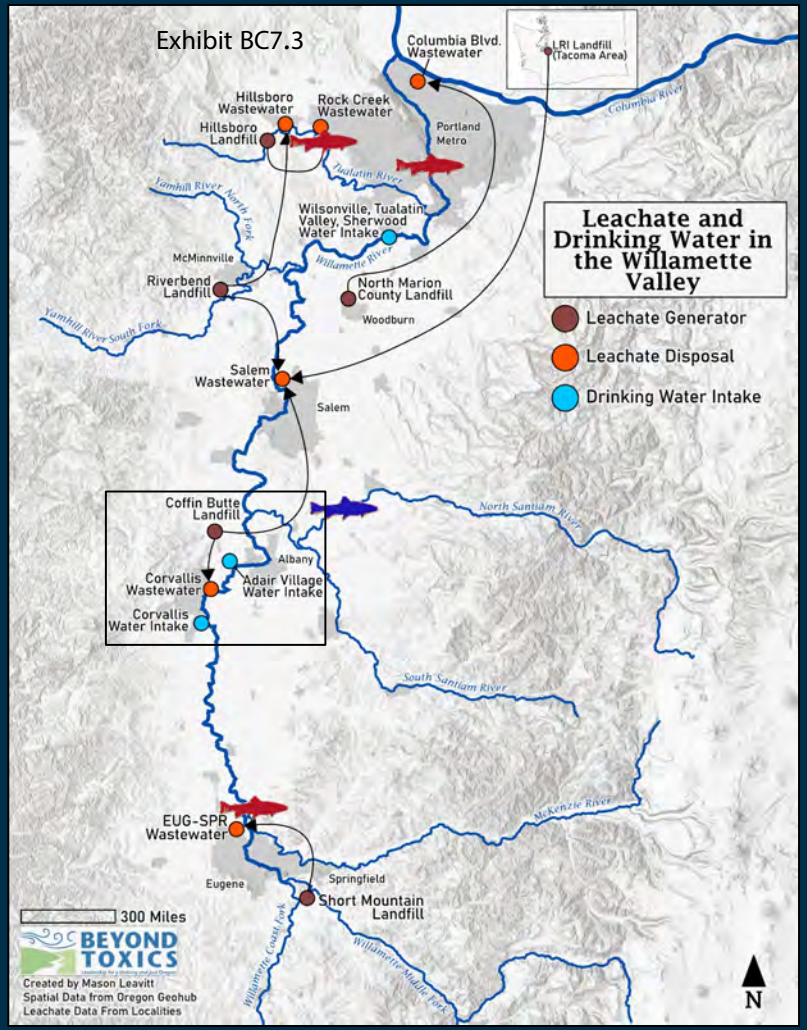
Exhibit BC7.3

Leachate Inputs to Willamette





Evidence of bioaccumulation

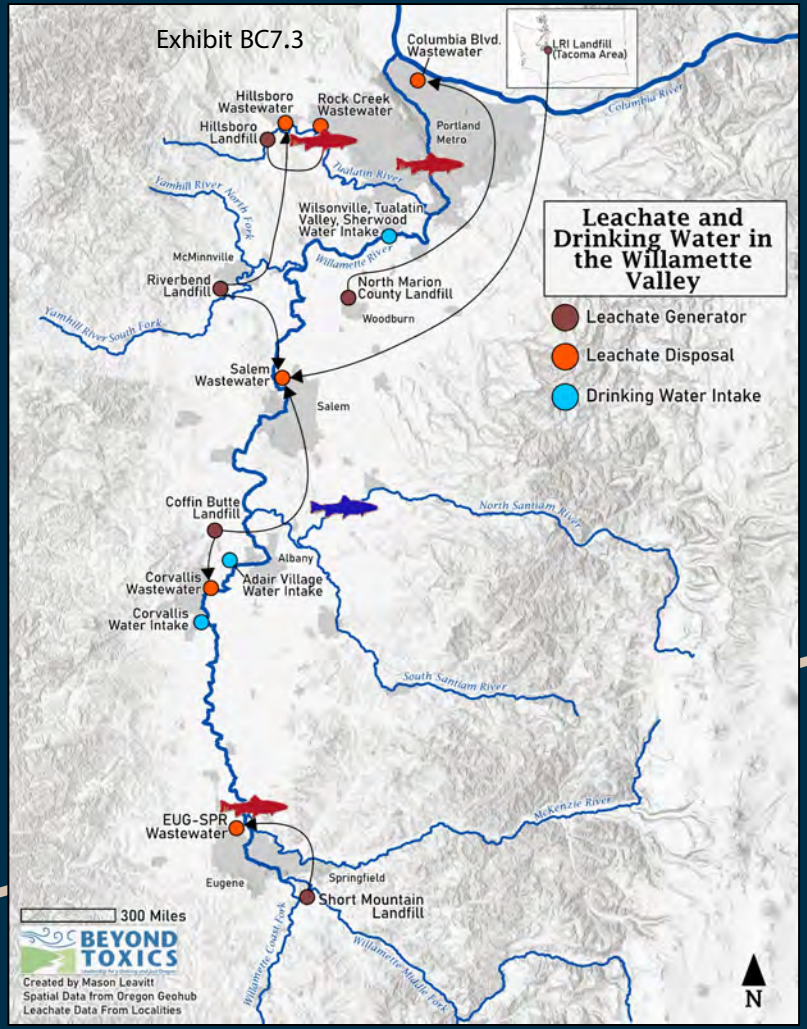


2008 NRSA fish tissue study: PFAS found at detectable levels in fish in all Willamette Valley locations sampled downstream of WWTPs accepting landfill leachate.

Also found in Rogue River fish sampled below White City WWTP where leachate is piped directly from Dry Creek landfill.

Only “clean” sample was from North Santiam River below Stayton WWTP (which processes municipal wastewater but no landfill leachate).

Fish species: Northern pikeminnow (Eugene), mountain whitefish (Stayton), carp (Oregon City and Hillsboro), cutthroat trout (Rogue Valley)



Discussion?

Any recent efforts to sample PFAS in Oregon rivers?

Any new information about accumulation in biota, river sediments or hyporheic zone?

How much PFAS and heavy metals end up in sludge (“biosolids”)?

Any efforts to understand fate & transport of contaminants from sludge in the environment?

Arsenic issue: Anomalously high concentrations in monitoring wells on south/east side of landfill, fluctuating over time



First noted in mid-1990s after acknowledged seepage event.

Arsenic Concentrations East-side wells 1994-2021

Data from 2021 Annual Environmental Monitoring Report

Compliance boundary wells MW-26 and -27 have regularly exceeded MCL of 10 µg/L since installed in 2013.

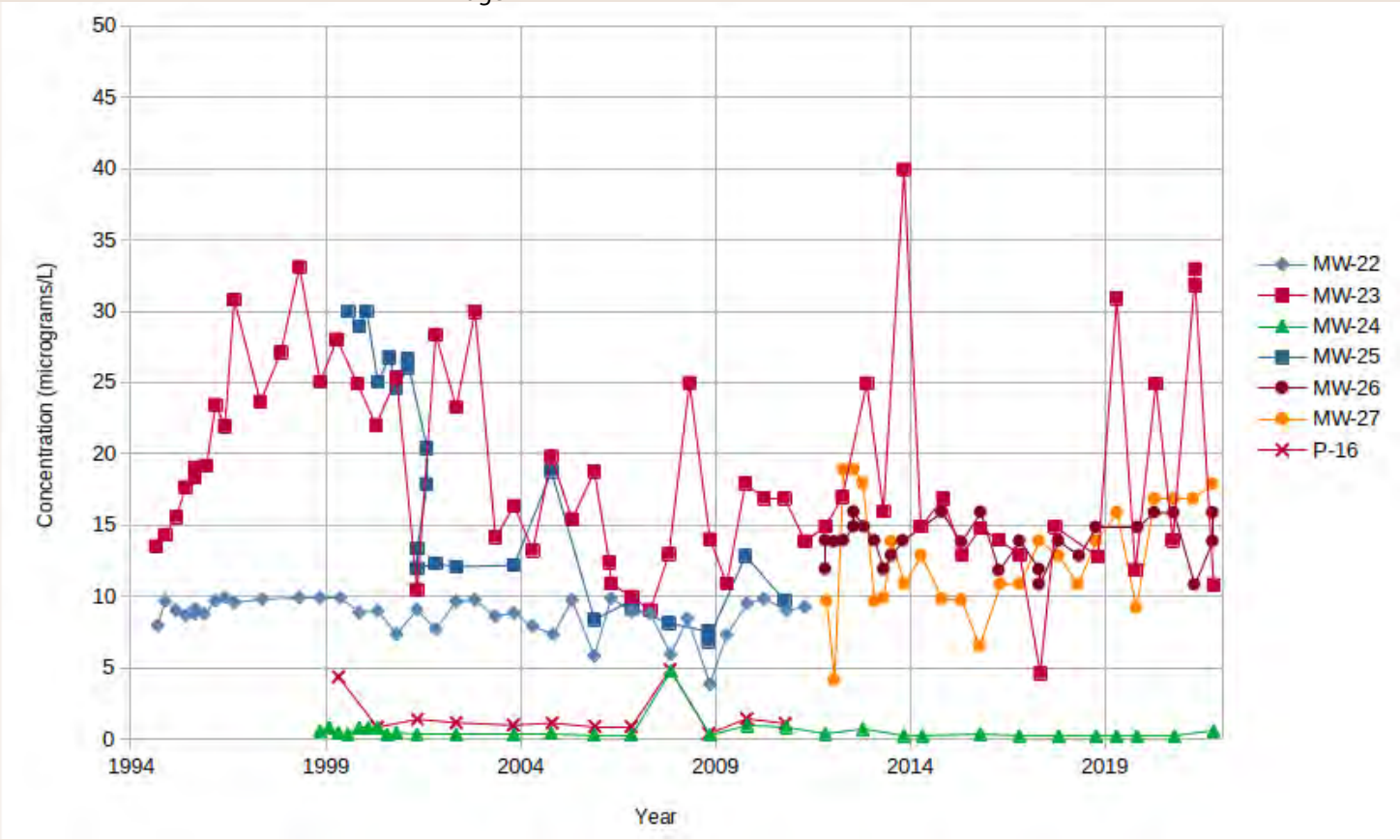
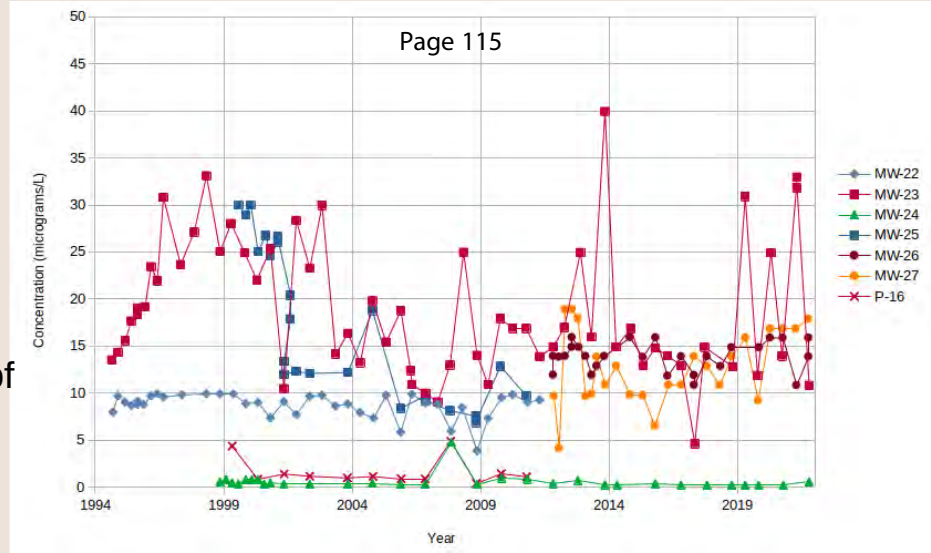
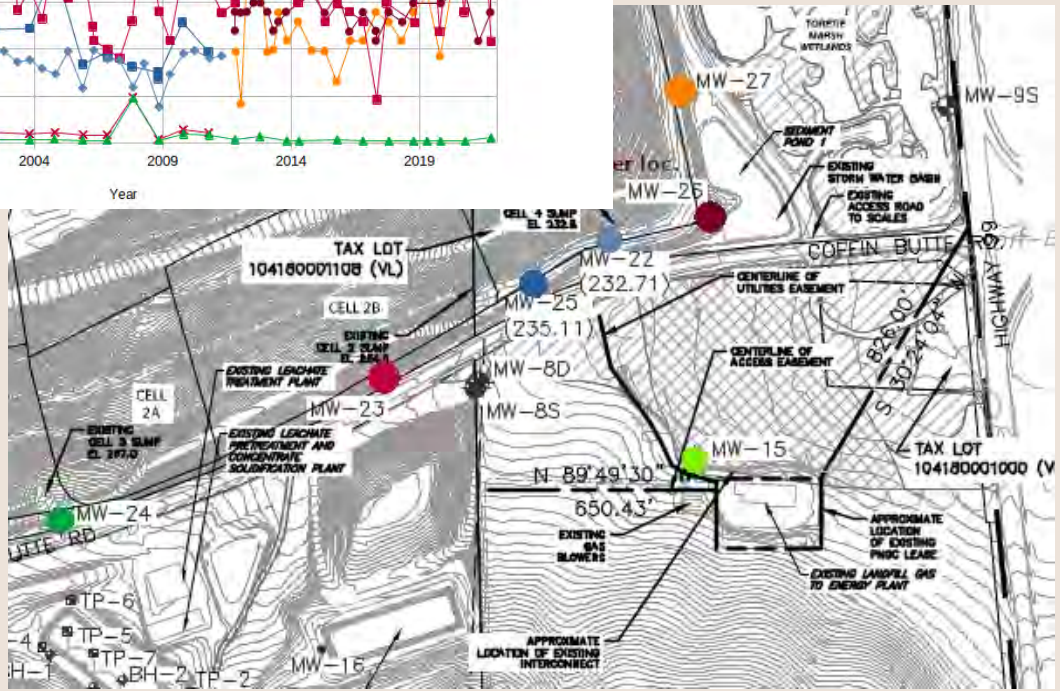


Exhibit BC7.3



High arsenic in MW-23 and all wells down-gradient of early/mid 1990s seepage incident.

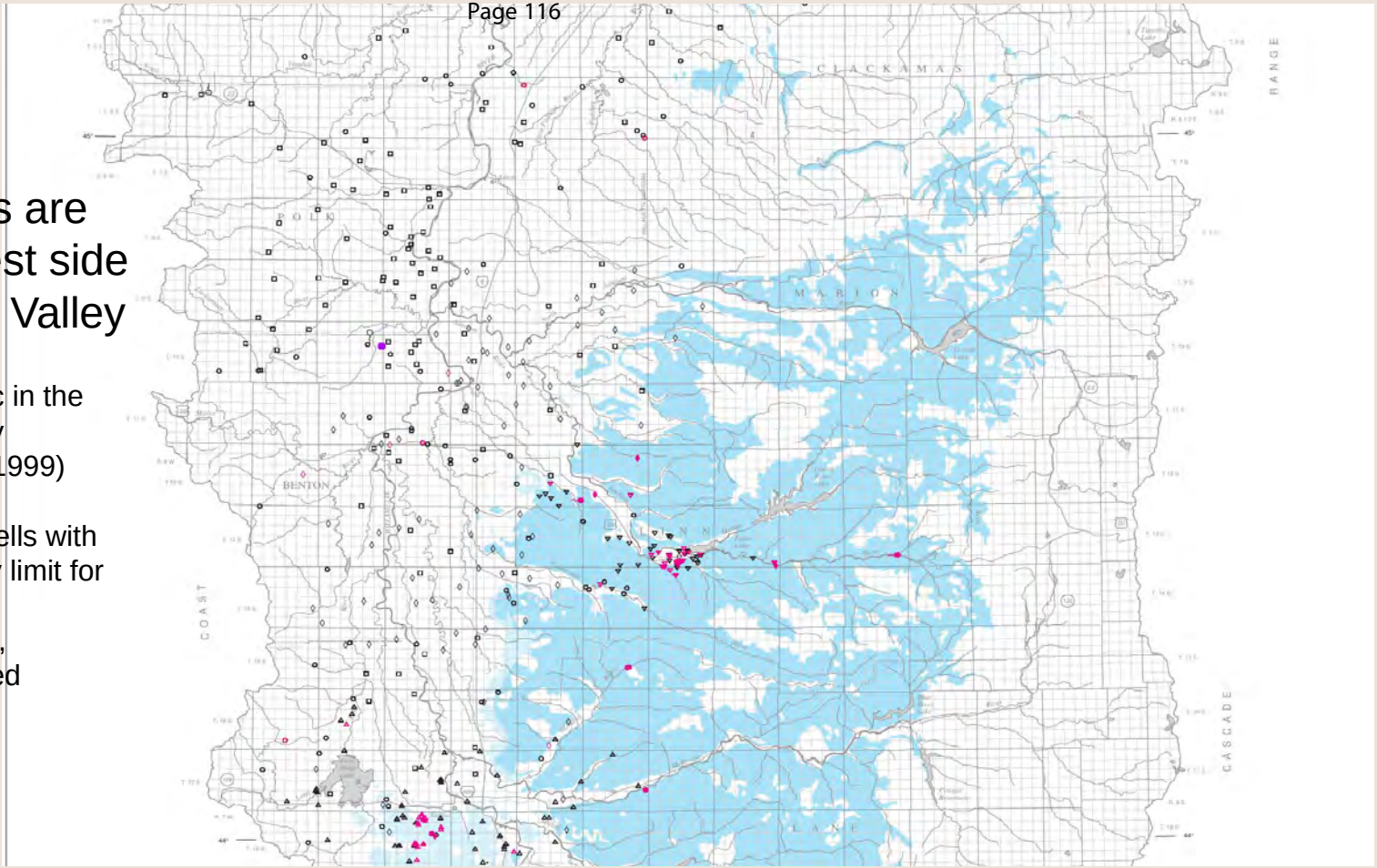
No problems in:
MW-24 (higher up drainage)
MW-15 (across gradient)
P-16 (across gradient)



Observed levels are anomalous for west side of mid-Willamette Valley

USGS Study of Arsenic in the Willamette Valley
(Hinkle and Pollette, 1999)

Red markers indicate wells with arsenic above regulatory limit for drinking water:
>10 µg/L if hollow,
>50 µg/L if solid red

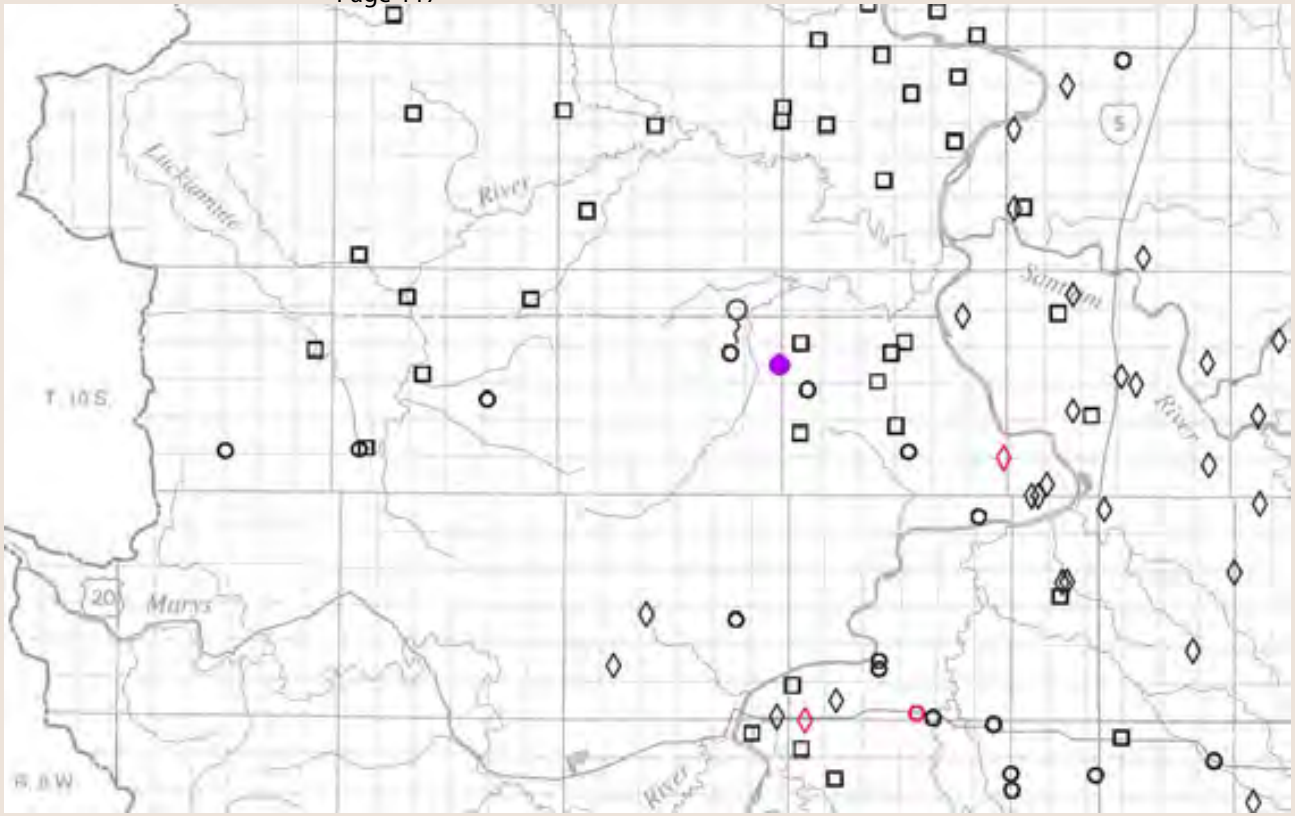


Observed levels are anomalous for west side of mid-Willamette Valley

USGS Study of Arsenic in the Willamette Valley
(Hinkle and Pollette, 1999)

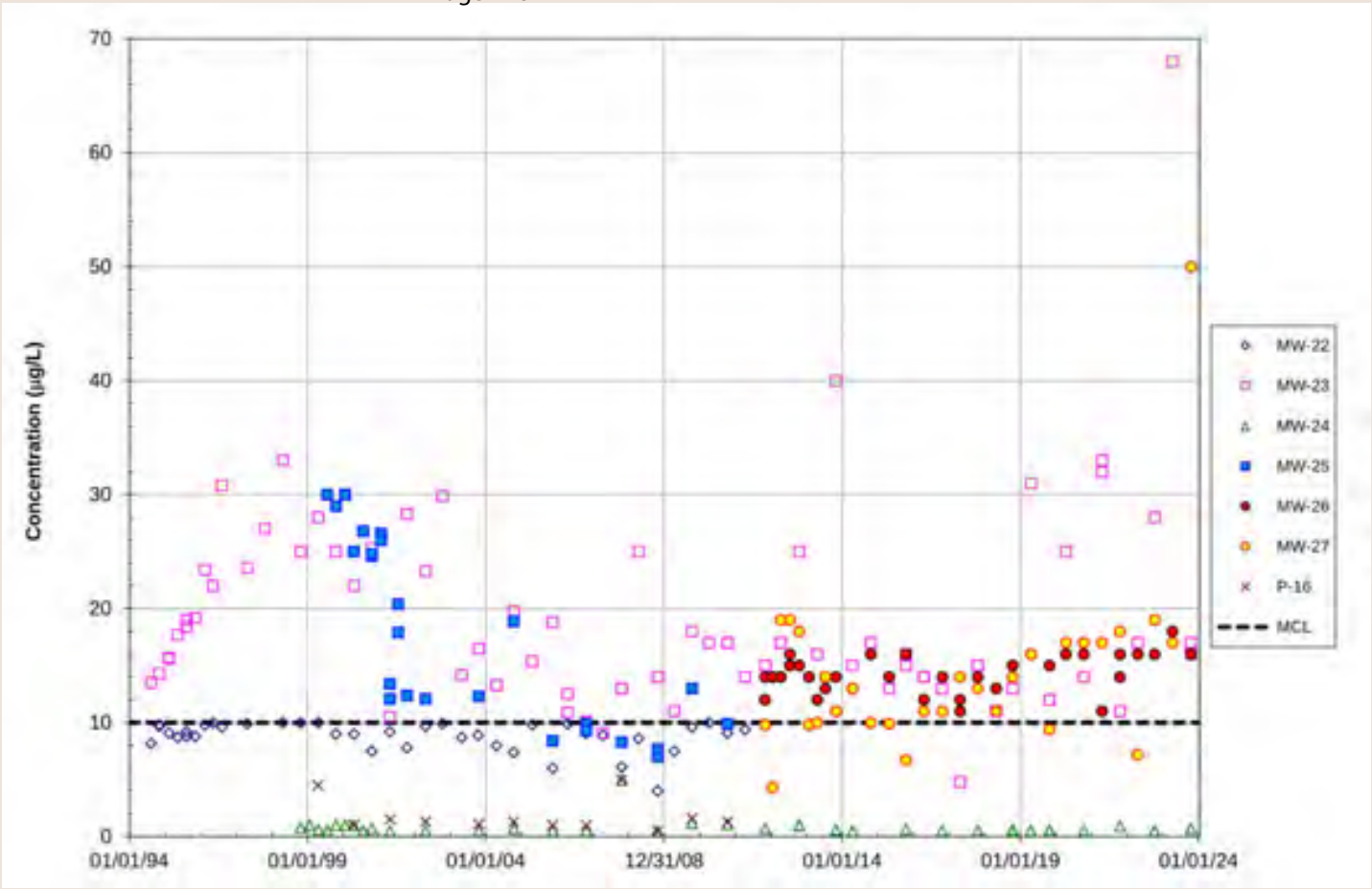
Red markers indicate wells with arsenic above regulatory limit for drinking water (10 µg/L but less than 50 µg/L).

Purple dot shows location of Coffin Butte Landfill.



Most recent data: Arsenic Concentrations East-side wells 1994-**2023**

Data from 2023 Annual Environmental Monitoring Report



Shifting explanations

“These are background levels of arsenic, typical for that part of the site.”
Problem: Values are anomalous for this part of Willamette Valley, and also fluctuate with time.

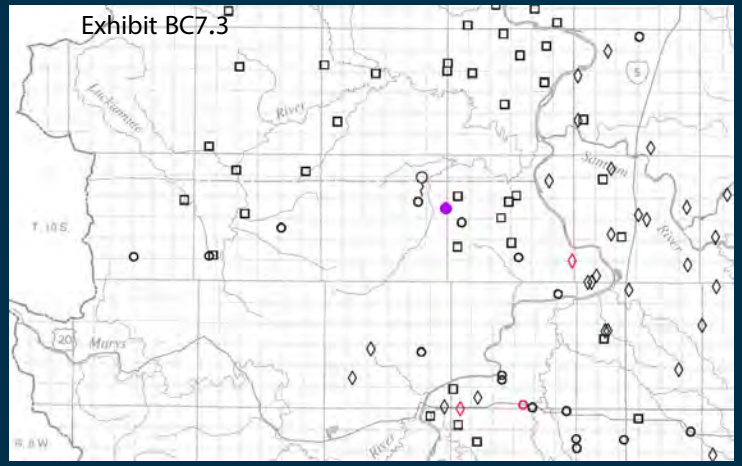
“Arsenic doesn’t normally come out of landfills.”
Problem: Leachate from this landfill has measured As concentrations ~120 µg/L

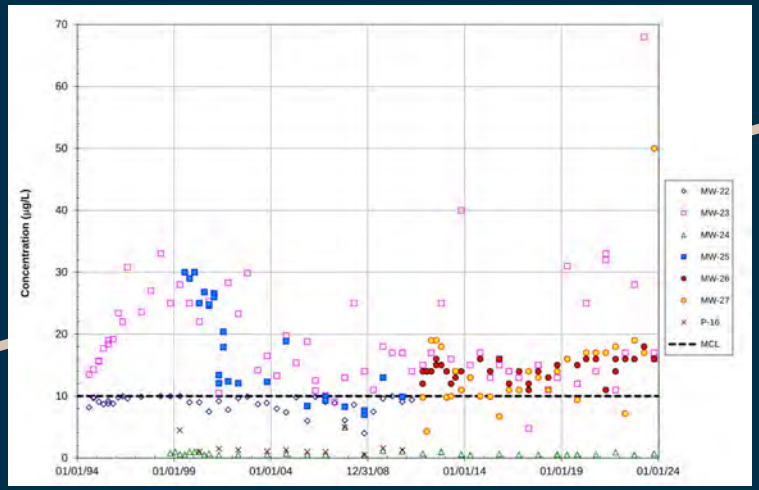
”Higher concentrations are observed in MW-9S near highway”
Problem: MW-9S is in disturbed location (drilled into a former cloverleaf intersection ramp from 1940s), at edge of an artificial wetland that was bulldozed out during the early 1990s seepage event, and filled with runoff from the acknowledged seepage area. So MW-9S was compromised before it was ever sampled for arsenic.
Also new data approaching 70 µg/L in MW-23 exceed highest levels ever measured in MW-9S.

”MW-27 is difficult to sample because it’s screened in a low-permeability layer.”
Problem: This doesn’t explain upward trend in recent years. Might be a good argument for adding another compliance-boundary well.

”Other indicators of leachate (Fe, Mn, and TDS) do not show similar trends.”
Problem: Both Fe and Mn have been trending upward in recent years, and have exceeded the site-specific action limits.

”These are typical values for the southern Willamette Valley”
Problem: Coffin Butte is in the mid-Willamette Valley.





Closing discussion

Alternative hypotheses for high arsenic – direct leakage or mobilization?

Possibilities for off-site measurements?

Precautionary well testing for down-gradient households?

Anything else?

From: Joel Geier
To: Benton Public Comment
Subject: Oppose/Deny LU-24-027: Resubmittal of 2021 testimony on heron impact
Date: Thursday, May 8, 2025 12:43:14 PM

CAUTION: This email originated from outside of the organization. Do not click links or open attachments unless you recognize the sender and know the content is safe.

Dear Chair Fowler and Members of the Planning Commission:

As additional testimony on the issue of sensitive Great Blue Heron rookeries (Development Code Sections 87.200 through 87.230), I'm herewith resubmitting my testimony from a very similar application by the same applicant in 2021 (LU-21-047). I am also attaching related testimony by Debbie and Norm Johnson for that same proposal, which includes facts that are still relevant regarding heron rookeries and the applicable state forestry rules and county development code.

My 2021 testimony applies in its entirely to the current application, except regarding the details of the changes in topography.

The main difference is that LU-21-047 proposed a 270 ft tall ridge constructed of waste that would completely block the existing flyway through existing, broad topographic saddle between Coffin Butte and Tampico Ridge. In 2021 I noted that this would cut off access to one or more foraging areas that are used by the herons during nesting season.

The current proposal, if taken at face value, would not entirely block this flyway, but it would severely constrict it by building another huge hill of garbage out from the north end of Tampico Ridge. Only a narrow "valley" would be left along the road running between the new and old landfills. Herons using that valley to fly to foraging areas to the west and then to carry food back to their nests would be vulnerable to harassment by Bald Eagles which (as the applicant has documented) congregate around the dump site.

Again, **that's only if the current proposal is taken at face value.**

As noted by the VNEQS attorney, Jeffrey Kleinman, during his oral testimony on May 6th, if you approve LU-24-027, there is no real impediment to the applicant reverting to the original plan set forth in LU-21-047. All that would be needed is a vacation of the section of Coffin Butte Road between the new and old landfills, which would not require approval of the Planning Commission. Indeed, the Applicant's submissions to Oregon Department of Environmental Quality (DEQ) for the current application are essentially unchanged from their submissions for LU-21-047. In particular these two exhibits in the Applicant's Burden of Proof are the same as were submitted to Oregon DEQ for LU-21-047:

Exhibit 24. Oregon DEQ Permit Work Plan.
Exhibit 25. Oregon DEQ Approval of Work Plan

The field investigations described in Exhibit 5 (geotechnical engineering explorations

of the Development Site) were all carried out under the same 2021 work plan. Thus the Applicant would not need to change any of its filings with DEQ, to go ahead with the original plan.

If the Applicant reverts to their original 2021 design after securing your assent to LU-24-027, then the impacts on the herons in their current nesting location, just east of Lot 1200, will be the same as for the original design put forward in LU-21-047.

Please note this applies to all aspects of LU-24-027. Denial of LU-24-027 is your only way to assure that the Applicant doesn't implement by stealth what you rejected unanimously in 2021.

Yours sincerely,
Joel Geier, Ph.D.
38566 Hwy 99W
Corvallis OR 97330

Joel Geier
38566 Hwy 99W
Corvallis, Oregon 97330-9320
(541) 745-5821
joel.geier@peak.org

Benton County Planning Commissioners
c/o Planning Division
360 SW Avery Avenue
Corvallis, Oregon 97333-1139
Phone: 541-766-6819
FAX: 541-766-6891

November 1, 2021

RE: LU-21-047 Coffin Butte Conditional Use Permit

Dear Ken Kenaston, Chair, and Members of the Benton County Planning Commission:

Thank you for this opportunity to comment on this Conditional Use Permit (CUP) application. I am submitting additional comments based on documents from county staff and others that were not made available to the public until after my previous comments on October 22nd. My supplemental comments here are to note the insufficiency of county staff recommendations regarding a specific topic:

Great Blue Heron rookeries in the path of this development will be disturbed (BCDC Sections 87.200 through 87.230)

Summary: The conditions of approval recommended by staff are insufficient to prevent disturbance and likely permanent loss of at least one significant rookery known to be active in 2021:

- The recommended conditions of approval only address disruptions by preliminary construction activities at ground level.
- They do not address impacts of constructing a high ridge that will obstruct flyways between the rookery and important feeding areas.
- They do not address impacts of future garbage tipping activity including heavy equipment, noise, and bright lights on an adjacent slope above the trees that host the rookery.
- There is no provision for independent monitoring and assessment of disturbance.
- There is no provision for mitigation in the likely event that this landfill expansion causes the rookery to be abandoned.

In the absence of a plan to ensure that disturbance can be avoided and in the absence of a mitigation plan to compensate if and when the rookeries are abandoned, **Section 87.230 requires you to reject this application.**

Background: Two Great Blue Heron rookeries active within the past decade are known to exist in the immediate vicinity, one just east and one on the west edge of the proposed new landfill disposal area (Figure 1). The **eastern rookery**, in hybrid poplars south of Coffin Butte Road, was still active during the 2021 nesting season, with counts of up to 24 occupied nests. The **western rookery**, in dense

conifers west of the existing leachate pond, may still be active but is difficult to observe from the public right-of-way along Coffin Butte Road. Applicant acknowledges that their staff have seen herons using both areas.

The western rookery site will mostly be *buried under* the proposed new disposal area. Portions on an adjacent lot to the west are directly in the path of the proposed new haul road for quarry and landfill traffic. Applicant has already bulldozed a route through this area (observable from Soap Creek Road), apparently without waiting for biologist surveys to check for evidence of recent use.

The eastern rookery is on a lot zoned as FC (Forest Conservation, Lot 1200). The proposed new haul road will run close the the west edge of the poplars that host the eastern rookery. Applicant also proposes to excavate the hillside to the south, to build two large new leachate ponds.

Thus future landfill operations will be on three sides of the rookery, rather than mainly just the northern side. With a state highway and truck merging lanes to the east, there will be disturbance to this rookery from all four sides.

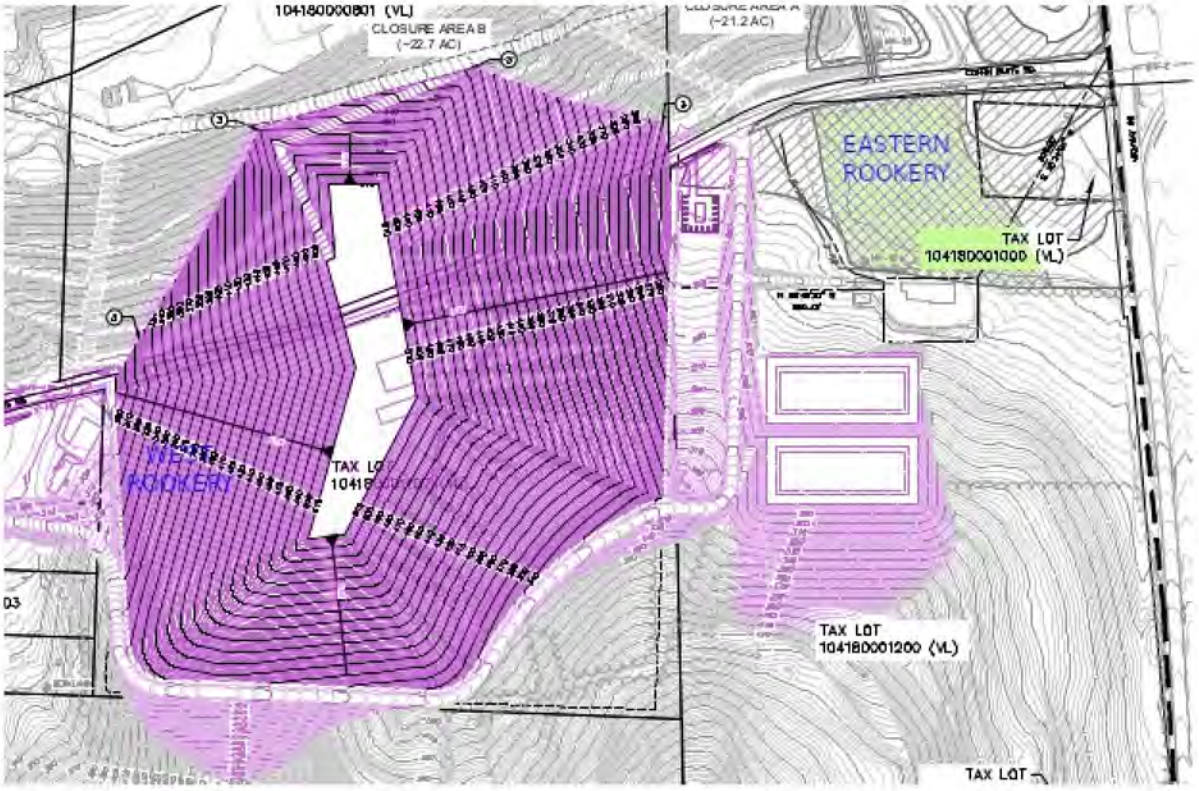


Figure 1. Location of eastern and western Great Blue Heron rookeries in relation to proposed new landfill disposal area and related roads and leachate ponds. Purple shading shows the extent of areas that are directly impacted by construction plans, including a new haul road, new employee building, new ponds, and areas to be regraded. The new ridge line to be created by garbage disposal is shaded in darker purple. Numbered contours are at 10-ft intervals.

Applicant proposes to build the new disposal cell to a height 270 ft above the east end of Coffin Butte Rd. This means that active tipping areas will be on a slope high above the tops of the nesting trees, increasing exposure of the colony to predators such as ravens and eagles.

Persistence and reproductive success of Great Blue Heron rookeries depend on multiple factors. From personal communication with wildlife biologist and noted heron expert Ann Eissinger, key factors include:

- Proximity to multiple nearby foraging areas as food sources;
- Undisturbed flyways between the rookery and foraging areas;
- Buffers around nesting trees to protect from disturbance by human activity including pedestrian access, equipment noise and bright lights.

While some heron rookeries may tolerate some degree of disturbance by acclimation to regular human activity nearby, increases in the level of disturbance, the proximity, or types of disturbance could lead to colony abandonment.

The conservation status and population trends for the Willamette Valley nesting population are not understood, due in part to a chronic dearth of resources for non-game species monitoring by the responsible state wildlife agency, ODFW. Thus the consequences of disrupting a rookery of this size (20+ pairs) for the regional population are unknown.

Site-specific conditions and impacts:

Observations of this particular nesting site by skilled local observers, over the past two decades, indicate that herons nesting here utilize foraging areas both to the east (prairie restorations and wetlands on E.E. Wilson Wildlife Area) and west (pastures in the Soap Creek Valley), as well as fields to the north near Wiles Rd. and Robison Rd. Thus there are multiple nearby foraging areas, all of which may be necessary for reproductive success of this rookery.

The natural, gentle topographical saddle between Coffin Butte to the north and Tampico Ridge to the south currently provides flyways for herons to travel easily to all of these foraging areas, either by flying west through the saddle and then north or south along Soap Creek, or flying east toward E.E. Wilson Wildlife Area.

If the development proceeds as proposed, a 270 ft tall ridge constructed of waste will completely block the existing flyway through this saddle, cutting off access to one or more foraging areas.

Heavy equipment operating on this rising mountain of garbage will, within just a few years (based on the disposal rates implied by Applicant's projected capacity of just 12 years) be operating at tree-top level or higher, relative to the adjacent rookeries. This will be a *new type and new direction* of disturbance, different from what has not existed for these rookeries in the past.

Code requirements: Benton County, in Development Code Sections 87.200 through 87.230, has recognized the sensitivity of heron rookeries. ODFW biologists have submitted comments noting that this development has a significant chance of impact. Section 87.230 specifically states:

> *(i) The County shall impose conditions on the proposed use in order to* ***ensure that it will not destroy the sensitive habitat or result in abandonment of the area.***

> *(ii) The County **shall deny the application if such impacts of the proposed use can not be mitigated** and that the development **may** lead to destruction or abandonment of the sensitive habitat.*

The conditions of approval suggested in the Benton County staff report **do not ensure** that the proposed use will not result in abandonment of the area. They only provide for guidelines to reduce disruptions during preliminary construction activities at ground level, and then subsequent monitoring to see if the herons stay or abandon the site.

These conditions **do not address** impacts of constructing a 270 ft high ridge that will obstruct flyways between the rookery and important feeding areas.

They **do not address** impacts of future garbage tipping, trash compaction, daily cover application, and other activities that will result in heavy equipment activity, noise, and bright lights on an adjacent slope above the trees that host the rookery.

The conditions call only for monitoring by a biologist under contract to the Applicant. Applicant has very strong financial motivation for this multi-million dollar expansion to proceed without impediment, and no financial incentive to ensure that the heron rookeries persist. **Independent monitoring is needed to avoid this clear conflict of interest**.

The mitigation measures suggested by county staff are very weak, suggesting only that "*the applicant's biologist shall consult with ODFW on improvements that can be made to the site, and the applicant shall incorporate those improvements, that will enhance nesting productivity, mitigate disturbance, and enhance nearby foraging habitat.*"

Note that these proposed conditions contain **no provision nor requirement** for off-site mitigation or enhancements. The applicant's land does not contain enough open foraging habitat to sustain this rookery. Open foraging habitat on Applicant's land could only be expanded by logging of trees on adjoining parcels, which are required to buffer neighboring residences, and furthermore restricted by FC zoning.

The proposed conditions make no requirement for Applicant to fund or post bond for habitat mitigation on nearby lands not owned by Applicant, in the very likely event that this landfill expansion causes the rookery to be abandoned.

Thus the proposed conditions are not adequate, as required by Section 87.230, to ensure that the proposed use will not result in abandonment of the area. The development may – and very likely *will* – lead to abandonment of the sensitive habitat.

In these circumstances, Section 87.230 of the Benton County Development Code clearly states that the County **shall deny the application**.

Thank you for considering these comments. I reserve the right to give further written and oral testimony on this and other issues according to the time frame allowed by statute.

Yours sincerely,

Joel E. Geier, Ph.D.

cc: Ann Eissinger
cc: Audubon Society of Corvallis, Portland Audubon Society, Salem Audubon Society, and Lane County Audubon, Defenders of Wildlife – Northwest Region

From: Joel Geier
To: Benton Public Comment
Cc: REED; Dave Mellinger; AnneMary Myers; Shawn Woods
Subject: Fwd: Great Blue Heron monitoring at the Coffin Butte landfill site and adjacent areas of E.E. Wilson, 2000-2025
Date: Friday, May 9, 2025 5:48:33 AM

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Dear Chair Fowler and Members of the Planning Commission,

I noted in last night's hearing that Commissioner Biscoe in particular seemed interested in establishing the record regarding the nesting area currently in use by the herons adjacent to the proposed development site.

Here's an acknowledgement that I received from the Oregon Department of Forestry (ODF) when I shared my report with them as well as Oregon Department of Fish & Wildlife (ODFW) on March 14, 2025.

I did not receive any acknowledgement from ODFW at that time, but I'm cc:ing ODFW's District Biologist Greg Reed here, in the hope that he can confirm receipt of that report.

I have not yet sent the nest tree GPS coordinates referenced in the e-mails below. Those coordinates are sensitive information due to the risk of yet further disturbance to these herons during nesting season, so I won't place them in the public record, but I will be making them available to Mr. Reed and refuge manager Shawn Woods via a separate communication.

Yours sincerely,
Joel Geier

From: "Jennifer Weikel" <jennifer.weikel@odf.oregon.gov>
To: "Joel Geier" <clearwater@peak.org>
Sent: Friday, March 14, 2025 4:08:15 PM
Subject: RE: Great Blue Heron monitoring at the Coffin Butte landfill site and adjacent areas of E.E. Wilson, 2000-2015

Thank you Joel. I received your email. I am not working as the wildlife biologist right now, but I passed on your information to the person who is in that roll right now.

Appreciate the detailed report.

Jennifer Weikel
Oregon Department of Forestry
(503) 931-9521

From: Joel Geier <clearwater@peak.org>
Sent: Friday, March 14, 2025 3:55 PM
To: REED Gregory C * ODFW <Gregory.C.REED@odfw.oregon.gov>
Cc: AnneMary Myers <AnneMary.Myers@state.or.us>; WEIKEL Jennifer * ODF <jennifer.weikel@odf.oregon.gov>; WOODS Shawn K * ODFW <Shawn.K.WOODS@odfw.oregon.gov>; Jim Fairchild <jim@alderspring.net>; Jayshaun Talbert <talberja@oregonstate.edu>
Subject: Great Blue Heron monitoring at the Coffin Butte landfill site and adjacent areas of E.E. Wilson, 2000-2015

You don't often get email from clearwater@peak.org. Learn why this is important

Hi Greg,

Hope all's well as you look forward to field season, despite what I suppose could be complications for any programs relying on federal funds this year.

As I mentioned to you last year, I've been keeping track of community observations of the Great Blue Heron nesting colony at the Coffin Butte site, including my own observations as well as those of volunteers affiliated with the Mid-Willamette Bird Alliance (formerly known as Audubon Society of Corvallis).

Here's a report that summarizes nesting-season observations both of heron nesting activity and potential causes of disturbance, from 2000 through the current year (right up to today, in fact). I hope this will help to inform you in your own assessment of the status of this heron nesting colony, and how it might best be protected for future seasons. Please feel free to give me a call if you have any questions!

A bit of data still missing from this report: Back in mid-January, I went into the ash grove area and mapped the trees with nests remaining from the 2024 nesting season. I have GPS coordinates for those trees as well as notes and sketches of the nest configurations. There are five nest trees (most of them with multiple trunks) holding a total of 13 "full-sized" stick nests, plus three smaller/partial nests that don't appear to have been completed.

I can get those nest-tree data to you at a later date, and will also share those with Shawn Woods (cc:d here) in case it's helpful for his management decisions in that area.

As a side note, I found a couple more elk/deer carcasses in there (pretty far decomposed) which I'll add into ODFW's roadkill project on iNaturalist (I'm up to about 8 now).

I'm also cc:ing Anne Mary Meyers and Jen Weikel here to keep them in the loop, as well as Jim Fairchild and Jayshaun Talbert on behalf of MVBA.

All the best,
Joel

--
Joel Geier
38566 Hwy 99W
Corvallis Oregon 97330-9320
tel +1 541 745-5821
clearwater@peak.org

Benton County Exhibit 7 (BC7)

BC7.4	C. and P. Merrill

From: Cressey Merrill
To: Benton Public Comment
Subject: Oppose/deny LI-24-027
Date: Tuesday, April 29, 2025 6:12:26 PM

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Dear Benton County Planning Commissioners,

My name is Cressey Merrill and I live at 38544 hwy 99 w, Corvallis, Oregon 97330.

I am writing because I strongly oppose Republic Services' Conditional Use Permit application LU-24-027 to expand the Coffin Butte landfill. I urge the Planning Commission to deny this application.

The proposed expansion would seriously interfere with the character of the surrounding area and impose an undue burden on public resources, in violation of Benton County Code 53.215 (1) and (2). Specifically, this expansion raises major concerns about:

- Air and water pollution threaten our local ecosystems and community health many times the odor is so strong that people will not come over to visit, and I can not be outside and enjoy my property.
- Traffic increases that pose safety risks on nearby roads and pathways. The increased traffic has started creating sinking of the roadway.
- Odor and noise issues that degrade quality of life for residents and visitors. The blasting noise is excessive sometimes, and will shake my house and rattle my windows.
- Negative impacts on wildlife, recreation, and property values. My property value is going down and the poor wildlife is being displaced.
- Long-term climate and environmental consequences for future generations

The proposed expansion does nothing to align with Benton County's 2040 Thriving Communities Initiative. This expansion undermines our shared goals for responsible environmental stewardship, prioritizing public health, and sustainable waste management.

I believe Benton County should invest in waste reduction, recycling, and circular economy solutions, not expanding landfills that perpetuate pollution and place a long-term burden on local communities!

Please reject LU-24-027. Thank you for your consideration and for protecting the health and future of Benton County.

Sincerely,
Cressey Merrill
38544 hwy 99 w, Corvallis, Oregon 97330

Cressey Merrill

Bottom Dwellers Inc
541-231-7186

From: CRESS MERRILL
To: Benton Public Comment
Subject: Deny LU-24-027
Date: Tuesday, April 29, 2025 7:27:59 PM

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My name is Paulette Merrill and my husband and I own the property at 38544 Hwy 99W Corvallis, Or. 97330.
I am writing to urge the denial of the expansion of the Coffin Butte Landfill. As many of my neighbors have already communicated, this proposal is against many of the standards of living that the residents of Corvallis hold dear. I will mention specifically water quality--most of the neighbors of the present landfill have private or shared wells. I understand rock blasting will be required for this project. Blasting can disrupt the established water ways.
Traffic using the landfill is already excessive. A few years ago there was an accident in my neighbors frontage. More traffic means more potential for accidents.
I won't even bother to devote the time and space needed to go on about quality of life issues. We are certainly living in trying times and need all the peace and tranquility we can get. I don't see expanding the landfill as doing anything to promote peace or tranquility.
I urge you to deny LU-24-027.
Paulette Merrill
38544 Hwy 99W
Corvallis, Or. 97330
16390 Hiram
Oregon City, Or 97045
503-656-4629

Benton County Exhibit 7 (BC7)

BC7.5	J. and P. Morrell

From: Morrell, Tisha
To: Benton Public Comment
Subject: Comment on Republic application for Coffin Butte Expansion
Date: Saturday, April 19, 2025 9:17:04 PM
Attachments: Landfill response.docx

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To whom it may concern:
Attached please find my comments on the application by Republic to expand Coffin Butte Landfill,
Thank you,
Patricia Morrell

Patricia D. Morrell
Professor Emeritus, University of Portland, School of Education
Professor Emeritus, The University of Queensland, School of Education

19 April 2025

I am submitting these comments in response to the Republic Services proposed landfill expansion. With my husband, I own a home and property south of the landfill and close to the proposed expansion site: (38464 Highway 99W).

I am hoping that the expansion proposal will be denied for a variety of reasons. Some of the more pressing concerns are bulleted below:

- Current methane emission levels are unsafe. Methane levels have been linked to health concerns as well as adding to exacerbating conditions for climate change, increased concern with landfill fires, among others. While Republic is "working on" the issue, they have not yet remedied the current methane emissions and Increasing the size of the landfill will only add to the problems. Additionally, emission of other landfill gases, along with dirt and particulate matter (e.g., fiberglass dust) raises other health concerns.
- Odors from the landfill have obviously increased as the amount of waste they receive has increased. Unfortunately, since reporting the odors doesn't result in any real action by the State and certainly not the landfill. As a result, we don't bother to complain. I can't imagine how many more days I'll need to keep my house windows closed if the size of the landfill increases.
- Reports of unsafe practices (e.g, truck washing, questions of proper ash disposal, proper maintenance of equipment, malfunctioning systems, to name a few) have been witnessed and reported.
- Currently less than 10% (perhaps closer to 6%) of the waste in the landfill originates in Benton County, yet it is Benton County, its population, and its community that are being impacted negatively by the increased waste acceptance.
- Questions about ground water leachate without proper state and federal regulating capabilities make it unwise to risk the problems that would likely arise with an expansion into another groundwater system (i.e. different hill).
- There have been concerns raised with what would happen to the intake cap if the expansion is approved. We have already been told that the current cap has been ignored.
- The "meteorological, geologic, and population density are not conducive to a larger landfill tonnage" as described in a Benton County government issued document dating back two years prior to these latest two requests (see https://cd.bentoncountyor.gov/wp-content/uploads/2023/12/history_doc_-_updated_3-27-23.pdf)

The landfill is a for-profit operation, is not a good neighbor, and has dragged its feet in addressing issues, doing as little as possible to maximise profits. It does, however, provide the County with a financial incentive to keep it growing, but at what cost to our community? Remember, the landfill needs to be managed long after it reaches capacity. And the landfill was originally approved with a set capacity in mind. Given past behavior, it is also of concern that Republic will be emboldened by an approved expansion and continue to ask to expand further.

The current landfill would not have been built where it is given our present-day knowledge of appropriate sites. Coffin Butte landfill should be permitted to reach its current preset life span and then be closed. It is time to move to better ways of managing our waste.

Respectfully submitted,
Patricia D. Morrell
morrell@up.edu

To: Benton County Planning Commission
From: Jeffrey Morrell
38464 Highway 99W
Corvallis, OR 97330
Re: LU24-027 Coffin Butte Landfill Expansion Proposal

I am writing this comment in regard to Republic's proposed expansion of the Coffin Butte Landfill.

By way of background, we have owned our house at 38464 Highway 99W for over 40 years. Our property is approximately 1 km south of the landfill and the proposed expansion will be just over the hill from our house. I have also served on the Solid Waste Advisory Committee (SWAC) and the Disposal Site Advisory Committee (DSAC) for over 16 years and am very familiar with the current operation as well as how it has changed. Most recently, I served briefly on the revived DSAC but had to resign as I took a five year position in South Australia; however, our son now lives in our house, and we continue to be registered voters in Benton County.

At the start, I will state that I have no problem with the position of the current landfill site. It was there before we purchased our house and will be there in one form or another long after we pass from the earth. However, for the entire time I served on the SWAC and DSAC, we were continually told that the landfill had decades of capacity and had no intention to cross the road. We were also told that the land to the south was purchased as buffer, not destined to be active landfill.

When the landfill was owned by Valley Landfills, we were impressed with their forward thinking in terms of methane generation through the co-generation facility and, temporarily, through their attempt at reverse osmosis to treat their leachate water to keep all of the leachate on site. These illustrated a company that while working to be profitable, was embedded in the community. Although many of the people who worked with Valley remain, the approach has changed dramatically since Republic has assumed ownership with markedly increased fill rates and, as we notice it, more odor issues. We have never reported these because we have accepted the reality of our location.

I have read through the documents provided by Republic in their application and have the following comments

Traffic: This proposal differs from the previous plan in that it no longer proposes immediately closing Coffin Butte Road to markedly increase landfill capacity; however, it would be disingenuous for the Planning Commission and the County Commissioners to consider this proposal in isolation and ignore the previous proposal for a much larger expansion with the associated closure of Coffin Butte Road.

The logistics of having a public highway running between landfill cells will be daunting and will ultimately lead to a request to close the road to the public. This proposal really sets the stage for the inevitable increasing landfill footprint, leading to the eventual road closure that Republic desires.

Closure of Coffin Butte Road will eliminate the one well-constructed access to Highway 99W from the Soap Creek Valley. This is critical in inclement weather because residents will be forced to use either Sulphur Springs Road or Tampico Road, both of which are narrow and difficult to drive under winter conditions. This will slow emergency response time, potentially creating life threatening situations.

Alternatively, drivers could take Tampico Road heading north around Coffin Butte to exit on either Robison or Airlie Roads. All of this is currently on unimproved dirt track. Multiple tests driving from the junction of Tampico and Sulphur Springs Roads showed that this detour resulted in an increased driving time of 15 minutes to reach Highway 99W. This delay could be lethal for emergency responses.

The current proposal only offers to improve Coffin Butte Road in the areas directly impacted by the expansion but makes no provision for further improvements, leaving these costs to the county and local residents.

It is hard to examine this proposal as a single submission without considering how it will support continued expansion to the south of Coffin Butte Road nor is it hard to imagine that County would not want to continue receiving the millions of dollars in unencumbered funds it receives annually from dramatically increased landfill activities.

Odor Issues: Odors are a reality at any landfill, although we do appreciate Republic's attempts to minimise this issue through landfill gas collection, tarping and daily cover. However, moving the landfill further south will inevitably result in increased odor complaints. As noted earlier, we have noted many more days when we can detect the landfill, but normally do not complain as we see little purpose, especially when we learned that most of these complaints go to the State who then talks to the landfill operators and dismisses them. Residents will be forced to deal with increasing odors. The smell alone is an issue, but recent reports from flyovers suggest that methane levels are often far in excess of minimum effects levels. Expansion will further increase local methane exposure regardless of attempts to capture some of the releases. This has the potential to impact the health of local residents.

Future Capacity: It is a reality that all landfills eventually reach their designed capacity and close. We have already seen this in several other Willamette Valley facilities. Furthermore, most regions are seeking alternative disposal strategies that place landfills as the last option for dealing with municipal solid waste. Alternatively, landfills are being sited in more remote areas with lower rainfall to reduce some of the environmental impacts (e.g Arlington, Oregon).

Many of the emerging technologies are less financially attractive, but they create opportunities for reuse in the circular economy. Corvallis and Benton County have both been leaders in identifying local, environmentally appropriate strategies for dealing with waste. Expanding the landfill to permit continued decades of disposal goes against this overall strategy.

In summary, the proposed expansion of the Coffin Butte facility will result in increased traffic, more odor issues, potential health issues and a general approach that will readily facilitate continued expansion at the expense of the adjoining properties. We respectively ask that the Planning Commission carefully consider and deny this proposal as it does little to benefit the local community and has the potential to do greater harm to the surrounding area.

Sincerely

Jeffrey Morrell

38464 Highway 99W

Benton County Exhibit 7 (BC7)

BC7.6	R. Wilson

From: ryan.wilson1768@gmail.com
To: Benton Public Comment
Cc: angela.krueger.94@gmail.com
Subject: Oppose/Deny LU-24-027
Date: Monday, April 28, 2025 9:26:00 AM

CAUTION: This email originated from outside of the organization. Do not click links or open attachments unless you recognize the sender and know the content is safe.

Hello,

Ryan Wilson 28903 Tampico Road Corvallis Oregon 97330
Hello, I am writing to testify against the expansion of coffin butte landfill.

Aside from the obvious reason to stop the landfill expansion such as private companies unfairly profiting off of the local resources of the area, pollutions contaminates and the fact that Benton County should not be the primary dumping ground for all of Oregon. My primary concern is for the safety of farming in the area. Due to our proximity to the landfill where we grass a herd of cattle for local food production, we have been finding a staggering increase of air blown trash coming from the dump. We get styrofoam, plastic bags, and metallic chip bag that become air born from the landfill and litter the pastures we use to raise livestock. This poses a significant risk to the animals. If a cow or calf were to eat a plastic bag or styrofoam this would certainly mean their death. With an expansion to the landfill it can only be expected to intake more trash that will lead to more airborne plastics reaching susceptible animals, both wildlife and nearby associated livestock. We feel it is imperative that Republic Services is responsible for the care the material they take into the landfill and should use methods to prevent airborne debris from leaving their site.

Some of these trash finds can be found under Pastur teaur story
https://www.instagram.com/stories/highlights/17938813898405124/

Ryan Wilson, LEED Green Assoc.
OSU Alumni - CEM, MBA
Cell:5037793488
Email: ryan.wilson1768@gmail.com

Benton County Exhibit 7 (BC7)

BC7.7	G. Carlin

From: Grant Carlin
To: Benton Public Comment
Subject: Landfill testimony "Oppose"
Date: Sunday, April 27, 2025 10:39:28 PM
Attachments: Testimony against landfill expansion April "25.docx

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Virus-free.www.avast.com

Email to: publiccomment@bentoncountyor.gov.

Benton County Planning Commission Testimony

Regarding Application 3 LU-24-027

"Oppose LU-24-027

4/27/2025

My name is Grant Carlin; my address is 38581 Soap Creek Rd. Corvallis, OR 97330. I am writing in opposition to Republic Services' proposed Coffin Butte landfill expansion.

Noise Pollution:

My wife and I live nearly adjacent to and just west of Republic's proposed cell site's location south of Coffin Butte Rd. We and our neighbors, will be directly and adversely impacted if Republic Services' application to expand is approved.

I will address the issues most concerning us ranging from personally experienced and periodically on-going, to those likely to arise given Republic's history with it landfill neighbor nationally.

NOISE LEVELS:

In its the initial CUP, Republic's hired sound consultant cavalierly dismissed our concerns stating that even though the new cell would be a half mile closer, "Noise emissions for the on-site operations are unlikely to increase…" That is total hogwash, to put it politely. Facts prove otherwise. On several days since the initial application was withdrawn, Republic has engaged in operations directly east of their current office location, in the area of the proposed expansion. These operations have included placing and later removing a huge pile of fill dirt that was stored there as excavations were being done on top of Coffin Butte. Among the equipment used were countless trucks clanging doors, braking loudly and sounding horns, loud pile drivers and large front-end loaders with back-up horns that can be heard for two miles. When Republic has been operating temporarily in this proposed expansion site it is so noisy that my dogs are too frightened to go outside. When I called Republic to inquire what was going on, the site manager politely apologized

for the racket and said it would be done in a few more days. This is a direct refutation of the company's hired sound consultant's preposterous claim.

I ask each of the Commissioners, would you be satisfied living under those circumstances on a daily basis for many years to come? If Republic's application is approved, that is what you will be asking my family and our neighbors to do. Not only would it create an untenable situation for us, but it would also render our property worthless, as no one in their right mind would want to live where we do under a constant 5:30 AM to 6PM loud din.

GROUNDWATER POLLUTION:

Groundwater pollution is another issue: Republic Has a long history of groundwater pollution violations; in May of 2021 it agreed to a nearly ½ million dollar stipulated settlement with the San Francisco Regional Water Board of California for civil liability claims including possible water pollution from leakage at the bottom of its landfill in Richland, CA; instead of reporting within the mandatory 5 days, Republic took 145 days. The Board also noted that Republic had prior violations at its OX Mtn. landfill within the previous five years.

Recently, "On Monday, April 2, 2025 a court ruled in Lower Susquehanna Riverkeeper Association's favor that Republic Services' Modern Landfill violated the federal Clean Water Act 419 times from July 2019 through April 2023. The landfill, located in York County, PA, generates approximately 200,000 gallons per day of leachate wastewater. The landfill is subject to a permit under the Clean Water Act that authorizes pollutants to be discharged into Kreutz Creek, a tributary of the Susquehanna River. Those discharges must strictly adhere to the pollution limitations of the permit, however, and the court found Republic Services violated those terms, subjecting it to strict liability under federal law."https://www.publicjustice.net/republic-services-modern-landfill-clean-water-act-violations/

At Coffin Butte's proposed cell, even if best practices are followed, there is no guarantee that ground water won't be polluted, or that timely reporting will be done.

Once neighborhood well water is polluted, the only recourses left neighbors are litigation and then relocation.

POSSIBILITY OF RADIOACTIVE WASTE BEING BROUGHT TO THE SITE:

There is no guarantee of what Republic Services would like to bring into its expanded site if its application is approved. A good example of this is a site owned by Republic Services in Wayne County, Michigan. It was set to receive radioactive waste from New York in the fall of 2024, before towns sued the company, seeking to halt the disposal plan.
https://www.wastedive.com/news/wayne-disposal-hazardous-waste-lawsuit-michigan-republic-services/728268/

Some projects, even with the most stringent of imposed conditions, are just not conducive to acceptable outcomes. I believe that this proposed landfill expansion is one such project. In summary, all of the above will dramatically and adversely impact the character of the entire area as well as devalue our property and that of our neighbors. Area residents will pay dearly for many years into the future, just so Republic can squeeze out only a few more years of profit. Legally, approval of this permit will thus be in direct violation of Benton County's Ordinance 53.215 Section 1.

Accordingly, I urge the Commission to do what's right for the public, not what's good for Republic's bottom line, … and thus deny the Conditional Use Permit.

Grant Carlin

541-745-3968

Benton County Exhibit 7 (BC7)

BC7.8	L. A. Davis

From: Lue Ann Davis
To: Benton Public Comment
Subject: Oppose/Deny LU-24-027
Date: Monday, April 21, 2025 9:40:37 AM

CAUTION: This email originated from outside of the organization. Do not click links or open attachments unless you recognize the sender and know the content is safe.

Dear Benton County Planning Commissioners,

We are writing because we stongly oppose Republic Services Conditional Use Permit application LU-24-027 and urge the Planning Commission to deny this application, as it is in direct violation of Benton County Code 53.215 (1) and (2).

We live at 28925 Blaze Drive, which is located on the backside of the proposed expansion. We get our water from the well that is located on the north end of our property. We not only use the water for daily household use but we also have a small hazelnut orchard and garden that relies on regular irrigation throughout the summer months.

We are worried about the sustainability of the well and the serious impact the expansion could have. There is a very real possibility of groundwater contamination that could do irreparable damage to our home and our financial well being. I also don't have a lot of faith about the landfill's site preparation phase that might affect groundwater levels and cause our well to go dry during the summer months. That would severely interfere with our orchard and plants and cost a lot of money.

The smell is so bad at times I have to stay inside, which interferes with the numerous chores that have to be done. It not only affects my property, but I was at Adair Park with my dog the other day and had to immediately return home due to the horrendous methane stench. It's a lovely park that should be shared by all, but it's not possible if you can't breathe and your eyes start watering.

The operational noise is already so loud and obnoxious, with the rattling of windows as the sounds of the semi tractor trailers downshift and grind along, it would only increase with the expansion. Since there would be no cap on how much garbage could be brought in, the traffic and noise would only increase, disturbing the rural community atmosphere and turning it into a heavily industrialized area.

We understand Republic Services' main goal is to make as much money as possible, regardless of the harmful consequences that may occur. You need only to look at the numerous unanswered code violations for this site and their other operations to know they are not acting in good faith.

The consequences of your decision will have long term ramifications for the surrounding community for generations to come.

Please follow the recommendations of the Environmental and Natural Resources Advisory Committee (ENRAC) and deny/oppose LU-24-027.

Sincerely,

Steve Frazier and Lue Ann Davis
28925 Blaze Drive
Corvallis, OR

Benton County Exhibit 7 (BC7)

BC7.9	I. Finn

From: Ian Finn
To: Benton Public Comment
Cc: Mark Yeager; Barb Fick
Subject: Testimony in Opposition to LU-24-027
Date: Tuesday, April 29, 2025 12:46:34 PM

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Chair Nicholas Fowler and Planning Commission Members

RE: Testimony in Opposition to LU-24-027

Via: publiccomment@bentoncountyor,gov

My name is Ian Finn, and I was born, raised, and now live at 28984 Blaze Drive, Corvallis, 97330.
My home is the closest residential property to the proposed landfill expansion, located due south of the expansion property.
I have several concerns about the proposed development and its direct effect upon my property. The impacts that affect my ability to use and manage my properties include noise, odor, groundwater contamination and dewatering, blowing trash, fires, and property values.
Moving the landfill to the south side of Coffin Butte Road will bring the entire operation more than 2,000 feet closer to my home and will now be within 800 feet of where I live.
The **current operation on the north side of Coffin Butte Road seriously interferes with the use of my property** due to never-ending odor intrusions, constant noise from trucks and diesel engines, banging metal doors when trash trucks dump, backup alarms, flying paper and plastic, lights at night, fireworks used to deter scavenger birds, to name a few. The massive increase in the volume of trash coming to the existing dump in the last 8 years has been overwhelming. And if this expansion is approved, the annual trash tonnage limit will be removed thereby opening the door to yet more trash coming in every day. **Moving the proposed operation 2,000 feet closer to my home will exacerbate these impacts**!
Noise from the operation regularly begins at 4 a.m. in the summer and often continues until 8 or 9 pm six days a week. It is impossible to take advantage of my landscaped property during the best time of the year due to the noise and constant odors. And I understand that they now want to begin operations 7 days a week. Truly no peace from the constant noise. **The proposed expansion will seriously interfere with the uses on my property**.
The odors from the existing facility seriously interfere with the use of my property. When the odors occur, you must stay indoors and close your windows. We know the landfill is leaking large amounts of methane, but with the methane come lots of other toxic landfill gases that are likely endangering our health. **Being essentially right next door to my house, the proposed expansion will seriously interfere with my use of my property**.
Groundwater contamination of my domestic drinking water well is a constant concern. All landfills leak leachate and other pollutants into the groundwater. Two landfill cells on the north side of Coffin Butte Road are unlined and were closed in the 1970s. The landfill operators are capturing 2 million gallons of leachate from those cells every year, but this is no estimate of how much pollution is going into the groundwater that is the source of my drinking water.
And while the new landfill will have a liner, those liners will eventually leak after being punctured by millions of pounds of trash that are compacted on top of the liner system. My drinking water supply is under further threat by the location of the new landfill.
The proposed excavation of 3.5 million cubic yards of material just to the north of my property to create the hole to put trash into threatens to disrupt the groundwater system and potentially dewater my well. This massive excavation will create a low spot in the vicinity of my property and may impact the availability of water from my well. If my well is impacted by the excavation, it will seriously interfere with the use of my property. The applicant and the County have done nothing to evaluate the threat from this proposed excavation.
When I was born in 1994, the amount trash coming to the dump was about 200,000 tons per year. Today, there are over 1 million tons of trash being dumped into this landfill from around the state and neighboring states, and the impacts from this massive industrial operation will undoubtedly affect my ability to sell my property in the future.
Given all the documented impacts of landfill operations, the proposed expansion will seriously interfere with the use

of my property in violation of BCC 53.215(1), and therefore I urge the Planning Commission to deny this application for a conditional use permit.

Respectfully submitted,

Barbara Fick

Ian Finn

ianfinn40@gmail.com
541-231-1132
Mechanical Engineering
Oregon State University

Benton County Exhibit 7 (BC7)

BC7.10	A., C., R. Holdorf

From: Rose Holdorf
To: Benton Public Comment
Cc: Debbie Palmer; Cathy Holdorf; Andrew Child; Adam Hyla E. Holdorf; Willow Holdorf; Chrystal Young; ben bliss
Subject: Please oppose/Deny LU-24-027
Date: Monday, April 21, 2025 7:14:56 AM

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Dear Benton County Planning Commissioners,

My name is Rose Holdorf and I live at 38483 Plowshares Road–one of the landfill's closest neighbors. My parents purchased the land and built our family home the year I was born, 1989. We reside on tax lot 10419B001500 and share a property line with Republic Services.

I am writing because I strongly oppose Republic Services' Conditional Use Permit application LU-24-027 to expand the Coffin Butte landfill. I urge the Planning Commission to deny this application.

It is horrifying to consider what might come if Republic Services is allowed to expand a landfill site onto Tampico Ridge, the same ridge that shares a forest, foundation, and water table as my home and the homes of my neighbors. In the past five years as Republic has ramped up business, the existing landfill has drastically changed the character of my neighborhood. It is a more prominent eyesore on my drive home, I have to pick up more fly away garbage from our property, it smells worse and more frequently than I ever remember in my 36 years of calling this place my home, and for the first time in my life I can actually see the landfill from my living room. The lights from the top of the landfill glare through the trees and the truck motors and beeping backup noises echo through my window early in the morning.

The proposed expansion could devastate the assets my family has cultivated on this land. Building a new landfill cell on the opposite side of Coffin Butte Road keeps me up at night. After 36 years, will we be forced to move? Will we lose all property value? Will our well water become contaminated and undrinkable, or dry up? Will living even closer to a landfill cell give us cancer or make us sick? How will the excavation of the cell, digging deep into our shared hillside, affect the literal foundation from which my family's life in the Soap Creek Valley was built?

The proposed expansion would seriously interfere with the character of the surrounding area and impose an undue burden on public resources, in violation of Benton County Code 53.215 (1) and (2).

In my adult years, every choice I have made–which jobs I choose, how I spend my

free time, how I envision my life ahead of me–has come down to a central question: how can I continue to steward and thrive in the place where I am from? I love where I live and feel so lucky to reside in a house and tend to the land that my family has nourished for my whole life. I feel I live in the most beautiful place in the world. I look forward to taking care of this place and making it even better for the generations to come. I hope Benton County will do its part and envision a future for our community that is sustained by clean air, drinkable water, and solutions to our waste that prioritizes its residents health and wellbeing.

Please reject LU-24-027. Thank you for your consideration and for protecting the health and future of Benton County and my lifelong home.

Sincerely,

Rose Holdorf
38483 Plowshares Road
Corvallis, OR 97330

From: Cathy Holdorf
To: Benton Public Comment
Cc: Holdorf Rose; Debbie Palmer
Subject: Landfill permit app #LU-24-027
Date: Monday, April 21, 2025 12:53:45 PM

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To the Benton County Planning Commissioners,

I am writing to testify in opposition to the landfill expansion - Republic Service's permit application #LU-24-027.

Our house and 60 acres is at 38483 Plowshares Rd. We share part of our northern boundary with the landfill.
My husband (deceased) and I designed and built our 3900 sq ft house 36 years ago with the intention of having a multi-generational property that could be carried on by our family after we were gone. We sit on 30 acres zoned R10 and 30 acres EFU.

We felt we'd done our due diligence in researching the future and impact of the landfill. It was relatively small at the time and not very noticeable from our property, nor from Hwy 99. It was well-kept by the Bunn Bros, with the installation of the wildlife area near the highway, and timely covering of garbage. They even planted wildflowers and clover in the covering soil. And we were told that the landfill would "sunset" in 30 or so years.

Well, things have certainly changed. Now we have a true mountain of garbage, much of which is visibly uncovered and in plain sight from Hwy 99, Tampico, and Soap Creek Roads. Even when areas are covered with plastic, it takes a long time before being covered with soil. There is an endless stream of trucks and noise, and an almost constant stench at all times of day and night.

Republic Services does not seem to show any regard for it's impact on neighboring properties - only on how much garbage they can pack in.

I am very concerned that if Republic is allowed to start a new landfill on the south side of Coffin Butte Rd, our property value would plummet and our well water would be at risk for contamination - or perhaps dry up altogether. This, in addition to the certainty of more noise, worse odors, and likely carcinogenic contaminants in the air. (Already, we are witnessing terrible dust clouds from some of the dumping vehicles.)

And aside from the issues of those of us along the ridge… what about all of those new Adair Village houses? That is a fast-growing community very close by.

This landfill is already a health hazard and has a big negative impact to the community at large - as an eyesore, from the stench and from the garbage along the roads and in fields & yards, and from the endless trucks that bring garbage from so many counties far away. And what of the leachate from all of that toxic garbage? What is that contaminating?

There is so much bad that will come if this landfill is allowed to get bigger. A landfill this size should be far away from a residential area. Please do not allow it to grow.
PLEASE deny this application!

Respectfully, Catherine Holdorf

From: Adam Holdorf
To: Benton Public Comment
Subject: Please oppose/Deny LU-24-027
Date: Sunday, April 27, 2025 4:50:36 PM

CAUTION: This email originated from outside of the organization. Do not click links or open attachments unless you recognize the sender and know the content is safe.

Dear Benton County Planning Commissioners,

I am writing in opposition to Conditional Use Permit application LU-24-027, to expand the Coffin Butte landfill. I urge the Planning Commission to deny this application.

My sister, her partner, and my stepmother reside on tax lot 10419B001500 and share a property line with Republic Services. This lot has been our family's home since 1989. Our well is within 1,000 feet of the crest of Tampico Ridge.

In denying the initial Conditional Use Application a few years ago, members of the Planning Commission expressed the need for a comprehensive solid waste management strategy. Such an approach would balance the case for this landfill's expansion with a consideration of alternatives.

Evidently, no such action has taken place. Benton County, with just 2 percent of the population of Oregon, takes the waste of 20 percent of all state residents. My family, our neighbors, and other residents of Benton County bear a disproportionate burden for the state's failure to justly plan for solid waste disposal.

We pay in the stronger-than-ever smell of the landfill on the frequent—more frequent than ever—mornings when its nuisance gases seep through the still air.

We pay in fear: What should we do if our well water is already contaminated? How would we know?

And within a few years, we will face a morbid reckoning as a mountain of trash overtakes the highest point of Coffin Butte.

Humans—innately vigilant for threat and opportunity—have always looked to the horizon. Shortsighted planning by county officials will soon mean that for miles around, for tens of thousands of county residents, a new

landmark will mar our vision. North of Coffin Butte Road, when the sky bends toward the earth it will touch only garbage.

The proposed expansion would seriously interfere with the character of the surrounding area and impose an undue burden on public resources, in violation of Benton County Code 53.215 (1) and (2).

My family has lived on this land for more than 35 years, with a hope to continue our stewardship, and with an understanding that the landfill's owners would continue to use its buffer property to the south of Coffin Butte as just that: a buffer. We have lived uneasily in the shadow of our neighbor, watching its operations grow, but we have determined to live and made meaningful investments in our property. My family has the same right as every one of your constituents to breathe clean air and drink clean water at the place we call home.

Sincerely,

Adam Holdorf
2434 SW Holden St., Apt A
Seattle WA 98106-3487

Benton County Exhibit 7 (BC7)

BC7.11	D. Hackleman

From: David Hackleman
To: Benton Public Comment
Subject: LU-24-027
Date: Thursday, April 17, 2025 10:24:47 AM
Attachments: Adjacent Landowner Comments DH 4 17 2025.pdf

CAUTION: This email originated from outside of the organization. Do not click links or open attachments unless you recognize the sender and know the content is safe.

Attached are my written testimony as an adjacent landowner. I have also mailed a physical copy with my signature to Benton County Community Development Department, 4500 SW Research Way, Corvallis, OR 97333 today.

Sorry I will be unable to attend in person, I am out of the country from 18 April through 3 May.

Sincerely, David Hackleman
39125 Military Road
Monmouth OR 97361

16 April 2025
David Hackleman (503.569.2504)
39125 Military Road
Monmouth, OR 97361

To:
Benton County Planning Comission
Benton County Community Development Department
4500 SW Research Way
Corvallis, OR 97333

Re: File Number LU-24-027
Comments regarding Conditional Use permit proposal to expand the Coffin Butte Landfill,

From my perspective, it is not in the best interest of Benton County nor my adjacent property to support the expansion proposal. The impact of the landfill on adjacent property uses and the overall character of the area has become more and more significant since the site was changed from local to regional. Dramatically increasing the annual intake of refuse is not the answer. In addition, an increasing burden is being imposed upon the local infrastructure, primarily regarding state and county roads and emergency services, but also including habitability of the local region for humans and wildlife. An expansion of the landfill will only exacerbate this situation.

My commentary in no way is to be construed as an affront to the talents and work performed by the operators of the landfill. They perform their work in a very professional manner. It is not their fault that this landfill is in an inappropriate location for expansion and actually should be capped and terminated. Having a major landfill in an area with significant rainfall - immediately upstream and adjacent to a wetland wildlife refuge for aquatic flora and fauna is not in the best interest of future generations. We can do far better!

The vastly increased intake of refuse has already negatively impacted the value of my property. Refuse is apparent on Hwy99W in increasing amounts from improperly secured transport vehicles. Odors that were uncommon for decades are on the increase and noise from the vehicular operations is heard more as the landfill height increases. In addition, the observation by passing motorists on Hwy99W is now one of sheets of plastic instead of grassy green slopes.

There is a great deal of inertia regarding refuse disposal. Work is underway to move us in the direction of less need for landfills, but at a minimum one could locate landfills in regions far superior to one which is adjacent to a wetland and has a moderate to high level of rainfall. Long ago, Oregon commenced development of a means to utilize a landfill located in an arid region of our State for refuse including the use of public funds to build transfer stations on railway systems. It is time we utilize this form of conveyance and also take steps to further encourage compost operations and reclaim. By not supporting an expansion of the existing landfill, the movement toward such a future would be encouraged.

Observations:

1. The air quality at my residence and all the others on the North side of the Butte seems to be increasingly affected by odors believed to be emanating from the landfill as it is now growing at a far greater rate than it was in prior years. It is suspected that this is due to the increased elevation and change of the location of the dumping sites, but may also be impacted by covering practices. This last year, I have noticed many days in which an odor is present, however I have been remiss in reporting each day of an odor event as they are so frequent. Once I am indoors, the filtering in my HVAC system reduces the intensity. I do not measure the composition of the emissions detected. These odors are those of decaying organic matter.

2. Airborne debris are being deposited on my property from the landfill at a rate that has been increasing during the last few years. I can supply photos of such material should these be necessary. The majority are plastic films such as bags and wrappers commonly discarded in refuse streams.

3. The view from the apex of the Butte is now being occluded by portions of the landfill. The ramifications are a lack of the ability to view Hwy99W at this time. The horizon view has not been occluded to date, however in the event the landfill and any structures reach a height approximately 50 feet below the location of the telecommunications systems, their presence will negatively impact the site viability for such operations.

4. In addition, the ambient audio noise at the hilltop due to the vehicular and equipment operations at the landfill during operating hours is significantly greater than it was when fewer vehicles were traversing the area and when the landfill dump site was not as elevated. This does reduce the quality of the conditions at the geodesic dome.

5. The noise floor (a technical term related to telecommunications) has increased from S1 as measured by radio apparatus in 1990 to S6 as measured this year. This represents an increase in the local electronic noise from radio sources of approximately 30dB, or a factor of 1000. This increase has reduced the quality of the site for telecommunications operations. It is unclear as to the source of this radio noise, it is under investigation. The noise floor at my residence on the North Side of the Butte has remained at S1 and not increased.

6. Property value estimations (Zillo) have been declining over the last few years. While uncertain of the precise reasons for such declines, the net result is that the absolute value of the property I and others on the North Side of the Butte own may be further at risk if expansion is supported.

Recommendations:

1. Monitoring and reporting of the air quality including both Greenhouse gas emissions (Carbon Monoxide, Carbon Dioxide, Methane, etc.) and known odor compounds (such as Sulfides and Non-methane organic compounds) with alert notifications to the public and any personnel that can take actions toward abatement if levels exceed either emission standards for public areas or significant odor detection levels. Monitors should be placed at the periphery of the landfill properties. A minimum of four such monitors downwind from the landfill in the top four prevailing wind directions.

2. A means to eliminate the airborne debris.

3. Public dissemination of the water quality of all test wells on a website that is easily accessible with appropriate comparison to similar regions beyond the local landfill area.

4. Testing and reporting of the water quality for all local residential drinking water wells performed at a minimum annually with comparison to Oregon standards for Drinking water.

5. Covering of all areas of the landfill deemed "filled" with an appropriate layer of local fill dirt and nurturing of appropriate grasses on this fill that will not penetrate the polymer layers below and provide a more pleasing view to motorists passing the landfill along Hwy99W. It is important not to import fill dirt that may contain invasive species seeds from remote locations.

Following are some details of the impacts I have experienced, many of which are increasingly interfering with my intended uses and can be construed as becoming a burden for the public as well.

I have owned and resided on 40 Acres of land on the north side of Coffin Butte since 1980. My property extends from Military Road Southward and over the crest of Coffin Butte and contains the summit. A portion of my property extends on the south face of Coffin Butte and adjoins the landfill properties. I chose this property based on its qualities for residence, agriculture, forestry and radio telecommunications. These uses have been identified in the legal documents I prepared regarding my land use. I have supplemented the forest through planting and maintained its integrity to the present day. I had a road constructed that reaches the top of the Butte. Along that road, there are several test wells. Water samples are drawn from these wells by Republic or its representatives on a periodic bases. Reports of the water quality have not been received by me so I am uncertain of even my own water well quality.

Radio Telecommunications:

The apex of Coffin Butte is one of the best sites for radio telecommunications in the local area. This is one of the primary reasons I selected the property. I have made significant capital improvements to the hilltop to enable the telecommunications:

- a 35-Foot geodesic dome
- three 50-foot self supporting towers
- two smaller self supporting towers
- a self-supporting 50 foot rotating mast
- Solar panels to harvest electric energy
- Storage batteries
- Radio Telecommunications electronic hardware
- Antennas for communications
- Remotely operated amateur radio communications equipment
- There is a well situated on the hill crest

Soap Creek valley is the secluded valley immediately West of Hwy99W and South of the Landfill area. My property is the site of an amateur radio emergency services radio relay (repeater) station for that valley as it is the ideal location for such a communications gateway. The repeater is powered via solar panels with battery storage and is fire hardened as it is buried below its antenna tower. It is in place to facilitate emergency communications to and within the Soap Creek valley. This emergency communications system is an adjunct of the Benton County Emergency Services network. It is owned

and maintained by the Soap Creek valley Amateur Radio community, a volunteer group composed of local citizens within the valley. They have also connected non-amateur radio citizens in the valley through the use of FRS (Family Radio Service) communications tools.

I am an amateur radio operator, having been first licensed in 1966 and continually hence. I am a member of the Amateur Radio Relay League and president of the Oregon Chapter 108 of the Quarter Century Wireless Association. While these are not professional employment activities (amateur radio operators and communications are stipulated by law to be non-commercial), they enable me to aid my fellow citizens in times of natural and other disasters when other forms of communication are not available or unreliable. I have been a Benton County Emergency Services volunteer since 1980.

The Quarter Century Wireless Association Oregon Chapter has installed a remote amateur radio transceiver system within the dome I own on the hilltop. It is powered by solar panels with battery storage. There is a wireless communications control link to this system to one of the Amateur Radio operators in Soap Creek Valley. These types of communications links operate in the 3 to 5 GHz region of the radio frequency spectrum and are considered “line of sight”. This means if something blocks the path, communications are not possible.

As long as the landfill surface stays at a minimum 50 feet below my lower property line, it should not deleteriously affect signal transmissions to the site. At the present time, increased radio and audio interference is present for signal reception. At this point is it more of a nuisance than a major issue, however it does reduce my ability to utilize my property in the manner I have been using it since 1980. The earlier local (not regional) landfill was not increasing in size at a rate that would significantly alter my use for radio communications for the foreseeable future, but with the increase from 40KTons to 1MTons annual input, the time to potential interference was reduced by a factor of 25 to roughly 6 years instead of 150 years.

Forestry:
The property was purchased with timber remaining in 1980. Harvesting was performed prior to my purchase, but probably no later than in the 1940's. Trees spanning up to 40 – 50 years age were on the property. To improve the forest, I have planted hundreds of tree starts on the North side of the Butte. The trees on the North side now range in age up to at least 100 years and many exceed 100 feet in height. This year I am in the process of improving the forest further through the removal of invasive species and possibly some selective thinning. The trees do not seem to be affected by the proximity to the landfill, however significant quantities of plastic film-like materials have been found throughout the property. These were not present when I acquired the property in 1980 and are likely the result of a modest amount of material being lofted by wind from the landfill. As the height of the landfill operation level increases, more such material will be lofted and deposited on the North side of the hill. This type of deposit is primarily a nuisance. It does degrade the quality of the property from my perspective and for anyone that might be considering acquisition of it after me.

Agriculture:
The property at the top of the hill and at the bottom on the north side are suitable for pasture use. The land quality is adequate for fruit trees and berry bushes, but not very suitable for row crops. Currently, the hilltop has not been employed as pasture for livestock in part due to its remote location. Odors from the landfill will probably not affect use of this nature unless there are toxic elements to the emissions. It is unknown if toxic or otherwise dangerous emissions exist from the landfill as no monitoring of the emissions is evidently taking place. The odors detected by personal observation seem to be from the landfill, but the composition of these is unknown for the above mentioned reason.

Since some odors may stem from sulfides that could be toxic, it would be appreciated if monitoring were in place. Whether or not an expansion takes place, it is likely emissions will increase as the landfill active area is elevated and hence such monitoring is increasingly important to ensure safety both for personnel living near and utilizing or working at the landfill.

Residence:
I have resided at 39125 Military road the majority of the time since 1980. While the landfill was a small county facility, I had a close and friendly relationship with Mr. Weber and his operations. I was well aware of the landfill and was of the understanding that it was to focus on local refuse. The rate of landfill deposition was far lower until the change to a regional landfill. While I am a local landholder, I was not aware of any opportunity to comment regarding the change to a regional landfill. That change has affected my quality of life, property use, and the character of the region. In spite of this, my relationship with Valley Landfills and Republic has been friendly. I have happily cooperated with access to the monitoring wells and other items. It is not them that are creating the issue, it is the location and geology of the site.

Odors and audio emissions from the landfill have been on the increase over the last several years. While odors have been present frequently, I have not sent in very many notes regarding odors or audio emissions. At this time, odors are present frequently, and do detract from the ambiance of my residence. Odors are present even during periods in which the landfill is closed. Noises (back-up beepers, etc.) are heard more often lately during the operations, disturbing the ambiance as well.

As the landfill increases in extent, the market potential for my property diminishes. Should the landfill be completed and closed, my property value will likely stop diminishing, odors and emissions will reduce and the view from the apex of the butte would be of green grass instead of black plastic. Due to our climate, rainfall permeates the landfill and enables materials to migrate through runoff beyond the confines of the landfill, either as surface water or even possibly penetrating and entering the aquifer.

No matter what takes place, I shall remain committed to my term of participation in the Benton County Disposal Site Advisory Committee. We have recently worked as a team and developed a plan towards increasing the preparedness of the site in the event of a wildfire entering or emerging during the fire season. Thanks go to Republic and the Adair Rural Fire Department on this matter!

Sincerely, Dr. David Hackleman

Benton County Exhibit 7 (BC7)

BC7.12	B. Briskey

From: Bill Briskey
To: Benton Public Comment
Subject: Oppose/Deny Reference Application File Number LU-24-027
Date: Wednesday, April 16, 2025 4:15:22 PM
Attachments: KEklund Petra Schuetz letter 1-2025 methane.pdf

CAUTION: This email originated from outside of the organization. Do not click links or open attachments unless you recognize the sender and know the content is safe.

I have three primary concerns:

1. Landfill gas impact on health of my family, which includes an infant and a 5-yr-old
2. Effluent concerns since I have a well
3. Impact on how I use my land

My property shares 1580 feet of fence line with the NW corner of the landfill and the topology brings the smell right to us anytime there's a south component to the wind direction. When we bought our land 35 years ago, we were told by a Valley Landfills, Inc. representative that the original deposit location, called Cell 6, was closed so all future garbage would always be moving away from us. Since Republic moved all the refuse out of Cell 6 and Knife River blasted to remove more of the Butte at that NW corner, we've already experienced more odor and picked up more airborne garbage that blows over the fence. The quarry blasting has caused structural shifts in our house, broke a window, and we now have major cracks in concrete slabs in out-buildings. Understandably, we're very interested in the outcome of the expansion discussion.

I am becoming increasingly concerned about my family's exposure to toxic gasses every time a breeze comes from SE to SW. The gas being comprised of methane, carbon dioxide, plus other aerosols including toxic PFAS (per- and poly**fluoroalkyls**) was just last year measured by the EPA to exceed the maximum allowable emission level by 219 times. I have not seen any evidence that the ongoing problems in the existing methane collection system have been corrected since the last EPA visits, just continued gas emissions indications from satellite images and my own nose. This clearly violates BCC 53.215 (1) and makes me wonder why it doesn't get the attention it deserves by Benton County and EPA officials.

I haven't complained about the odor because, hey, I live next to a dump. But the **increase in odor** is also raising my awareness to the apparent lack of mitigation and potential long-term damage from toxicity exposure. I hosted business associates once and the stench forced me to cancel the meeting and everyone left – I haven't been able to host events since then. Before there's any expansion allowed, I'd like to see Republic get a handle on what they already have to manage. I'd also like to see evidence that they are actually solving the problem instead of dismissing complaints.

My family's well is located 500 feet from the landfill property. The migration of effluent

carrying toxic levels of arsenic to the east is alarming. When Republic starts filling Cell 6 with garbage and takes advantage of the newly exposed hillside there, I'm hoping that there won't be a westward flow of escaped effluent into the aquafer that feeds my well. Its depth is roughly 250 feet (130 ft ASL) below the bottom of the closest corner of Cell 6.

I used to have a small pond on my place, on the east side of the landfill. Water from the pond fed a small livestock tank downhill from the pond. A few years back the pond dried up. It turns out that even before Cell 6 was excavated and the quarry blasting began, the landfill decided to divert surface and shallow water flow off the Butte away from my property without discussing it with me. They did call me prior to that and offered to buy that portion of my land because they said that there was a chance that my field would experience "brighter areas" caused by runoff from the landfill. So my intended use of the pond for a livestock reservoir has been permanently curtailed.

There's no easy solution for waste, but how about accountability? It's pretty clear to me that the practice of hiding violations in the past has turned into a standard operational procedure. It's unlikely that Republic can change its practices to be transparent with the County, and the county's contract representative (legal counsel) is not negotiating on behalf of the stakeholders in our county. Ken Eklund, past Chair of the Disposal Site Advisory Committee, has been closely following the connected issues of climate damage through methane and odor impacts, both of which come from excessive leaks of landfill gas. The letter he wrote (attached) to the Planning Official and her consultant, Winterbrook Planning, does an admirable job of summarizing several areas of concern that mirror my own and highlight a lack of accountability.

I see first-hand how the landfill disregard for environmental and local land use impacts my family. I encourage our county commissioners to visit a neighborhood downwind of the landfill and think about the long-term impact when they stand there breathing in the potpourri of nasty gasses. It might be several years before science solidly connects these gasses to human health issues – even if Republic is still a viable company at that time, the expected class-action lawsuit will certainly target Benton County. The short-term financial benefits might look nice now, but the future impact will destroy Benton County and that legacy will be tied to the people making decisions today. I vote no for any expansion and would prefer that landfill operations cease. It's time for another county to carry the load.

William J. Briskey, PE
39101 Military Road
Monmouth, OR 97361

Dear Petra,

I have some notes for you, as you consider the final Application by Republic Services in order to make an official determination about its completeness as Planning Official.

1. The missing 2024 EPA Inspection Report.

> A final report from the 2024 EPA inspection is not yet available, but Applicant is aware that the inspectors found exceedances while conducting surface emissions monitoring.
>
> – Jeff Condit, Burden-of-Proof-Revised-January-15-2025.pdf, p. 102

This final report of the 2024 EPA Inspection is available, and was available prior to January 15. (I received a copy third- or fourth-hand on January 14; more about this report and its implications here). **A discussion of this report is vital to an honest narrative about methane emissions at the landfill.** A reminder that when the EPA released its inspection of the landfill in 2022, Republic similarly did not relay its report to the County, but suppressed it instead for over a year.

In the 2024 report, as in the 2022 report, the inspectors narrate a process where they find an exceedance, document it, walk a short distance (often very short), find another exceedance, and so on. They are finding another exceedance three minutes later or fifteen feet apart. In each report they cover a remarkably small proportion of the landfill surface yet find a similar high level of exceedances. The photo documentation in the 2024 report shows visually obvious problems that have been problems for some time, i.e., tears in the tarp with weeds growing out of them that are three feet high. Most notably, the 2024 report includes an instance where *a gas well was uncapped entirely*.

The 2024 report casts doubt on the Applicant's "we were upgrading the gas collection system" narrative of their 2022 report, suggesting instead a narrative where the Applicant is in a perpetual state of system "upgrade" because of deferred maintenance. The "we were upgrading the gas collection system" account does not explain why every time that an entity that is not paid by Republic has pointed a methane detector at Coffin Butte Landfill in the last two years, that entity finds excessive landfill gas emissions :

- in June 2022, the first EPA inspection uncovers 61 exceedances, including several that flamed out/approached or exceeded the lower explosive level of methane;
- in July 2023, Carbon Mapper aerially surveyed the landfill for a ten-day period and mapped multiple landfill gas plumes from multiple sources, with a combined average leak rate of approximately 3.4 metric tons of landfill gas *per hour*;

- in July 2024, the EPA's return inspection again found multiple exceedances, including one with a methane concentration over 110,000 ppmv (the EPA threshold for reporting is 100 ppmv and for remediation is 500 ppmv);
- in September 2024, Carbon Mapper surveyed the landfill from space and found the landfill was still super-emitting methane with an average leak rate of approximately 1.8 metric tons of landfill gas per hour.

In no instance did a survey fail to find dozens of leaks, including leaks with high and very high methane concentrations (EPA) or leaks that are super-emitters many times over (Carbon Mapper). The narrative that these independent sources establish is one where Coffin Butte Landfill's condition has not been maintained properly and now landfill gas emissions are burgeoning out of control of the operator.

2. DEQ's notification of investigation, August 2024.

> In August 2024, members of Oregon's congressional delegation called for the U.S. Environmental Protection Agency to complete an investigation into concerns about the landfill. Also in August 2024, DEQ issued a formal warning to Coffin Butte for not complying with new requirements to reduce methane emissions from the state's landfills.
>
> – Tracy Loew, Salem Statesman-Journal, January 10, 2025

Several DEQ officials accompanied the EPA inspectors on their 2024 inspection, and when the EPA prepared its report in August 2024, DEQ issued the formal warning highlighted above. **A discussion about this warning from DEQ is necessary for the application to be deemed complete.** The formal warning from DEQ calls into question the Applicant's narrative that it is in compliance with federal and state regulations; instead it seems that Applicant is in a recurring state of being out of compliance with regulations, and successful only at keeping one step ahead of being fined.

Side note: the Applicant's Environmental Manager, Ian Macnab, resigned in fall 2024, after the second EPA inspection, the formal warning from DEQ, the calls for the EPA to take action about the landfill's non-compliance, and the release of the Carbon Mapper quantifications of its methane emissions data.

3. The rapid decline in the efficiency of the Applicant's gas collection system.

> The US Environmental Protection Agency estimated in 2019 that Coffin Butte Landfill's methane collection system converts 57% of its methane to CO2, as compared to other Oregon landfills such as Columbia Ridge (85%) and Dry Creek (80%)[90] … Republic Services' notes that data it submitted to the EPA for inclusion in its 2021 greenhouse gas report estimates that Coffin Butte's landfill gas collection system has a collection efficiency of 91.2 percent.
>
> — The BCTT report, page 669

In the January DSAC meeting (link), methane was on the agenda, a continuation of questioning begun in DSAC's December meeting. CBL's new Environmental Manager, Paul Koster read these notes (with landfill General Manager Bret Davis chiming in):

> [begins around 1:23:22]
>
> PK: So, our last gas model was completed in 2023, and we'll be completing a new gas model spring of this year. So, looking at the gas model from '23, our efficiency was estimated about 70% for '24, and 73% in 2023. This is the total amount of methane generated 2024 – was about 3,923 to 4,100 scfm throughout the year, on average, every day, every minute. The loss in flow was largely due to – we did lose some flow between '23 and '24, was largely due to the commissioning of the new and closed flare construction project. So we had some changeover. We did lose a little bit on that.
>
> BD: Thank you for [adding]. We do a – we added wells, and so on. And so yeah, the system's not able to collect it a hundred percent. When we're adding wells or more collection.

So, to summarize, the landfill's gas collection system, which Republic reported was operating at 91.2% efficiency in 2021, by 2023 had declined to 73% and sagged further in 2024, to 70%, according to Republic's own gas modeling. **This is a critical consideration for any honest narrative about the landfill's methane emissions level**, as each decline of 1% in gas collection efficiency signifies a commensurate rise in fugitive emissions of landfill gas (by my calculations, each 1% decline in efficiency =

approximately 1.2 more metric tons of landfill gas released per day). The Applicant's representative, Paul Koster, stated this information became known to the Applicant in 2023, and was updated in 2024, and so it was well-known to the Applicant when they were preparing their application.

Note that the data is converging regarding this decline in gas collection efficiency: EPA inspectors have found it on the landfill surface, Carbon Mapper has surveyed and quantified it from the air and now from space. More data is imminently forthcoming, now that methane-detecting satellites pass over Coffin Butte Landfill several times a day. The decline in gas mitigation efforts requires a honest conversation about how low efficiency will go and what environmental impacts will be happening at that level.

4. Surging methane emissions equals surging landfill gas odors.

Methane is a pollutant and a potent greenhouse gas, and well deserves its focus in abatement efforts. The landfill gas from Coffin Butte Landfill is generally about 50% methane, 40% carbon dioxide, and 10% a mixture of many other gases, including odorifics and toxic gases such as aerosolized PFAS. So the unregulated releases of methane detected in EPA and Carbon Mapper surveys of Coffin Butte Landfill are evidence of increasing amounts of toxic and odorific gases being released by the landfill (the lead inspector for the EPA specifically mentions landfill odor in the 2024 report).

Odorific gases accompany methane, but they also occur in the pre-anaerobic phase of landfilling, and processes such as soil cover that oxidize methane do not necessarily reduce odorific gases.

The application should not be considered complete without a discussion of the relationship between the increasing amounts of landfill gas being released and the increasing number and duration of "dump day" odor events in the landfill region. As we've seen, over the past three years the Applicant has normalized a steep decline in its gas collection efficiency, so this discussion should include what measures if any the Applicant will implement to reverse the increasing odor impact upon other land uses in the region where they're occurring.

These are my first observations about the Applicant's revised application; I will likely be adding more. I'm happy to answer any questions, and hope this information will be of use to you and your consultants.

Respectfully,

Ken Eklund
37340 Moss Rock Drive
Corvallis OR
408-623-8372

Benton County Exhibit 7 (BC7)

BC7.13	D. and N. Johnson

File Number LU-21-047

Comments on the application for a Conditional Use Permit for the Coffin Butte Landfill to place a new disposal cell south of Coffin Butte Road, relocate the leachate ponds south of Coffin Butte Road, vacate Coffin Butte [presumably this means Coffin Butte Road] and relocate the roadway around the area of the new disposal cell.

Debbie and Norm Johnson
28831 Tampico Road
Corvallis, OR 97330

We oppose this conditional use permit for the following reasons:

1. **Habitat for the Great-blue Heron Rookery Must be Protected and Enhanced**
   The project location hosts a great-blue heron rookery which was documented by the Oregon Department of Forestry in a Notification of Operations (NOAP) under NOAP ID: 2019-551-05885. Great-blue herons are colonial nesters, and as many as 20 heron nests have been observed in the rookery. Under the Oregon Forest Practices Act heron rookeries are protected. Between February 15th and July 31st no forest operations (including truck traffic) are allowed within one-quarter mile of active nest trees and trees cannot be harvested within 300 feet of heron nests.

   Heron rookeries are also protected under the Benton County Development Code as a "Goal 5" resource. According to 87.210 (Sensitive fish and Wildlife Habitat Overlay) a 600-foot area around the great-blue heron rookery must be protected and a site-specific management plan is needed to ensure that "proposed uses and activities will not destroy or result in the abandonment of these areas. [Ord 91-0080, Ord 93-0098]"

   Although anecdotal information suggests that the rookery, or portions of the rookery have moved since the 2019 ODF NOAP was filed, a site-specific management plan is needed before the Coffin Butte conditional use permit can be considered. The management plan should evaluate the quality of heron nesting habitat at the location documented in the ODF NOAP as well as any other locations that are currently in use or have been used in the past. If a previous heron rookery location offers better nest tree structure, then that location should be preserved so that the rookery has an opportunity to move back (Figure 1).

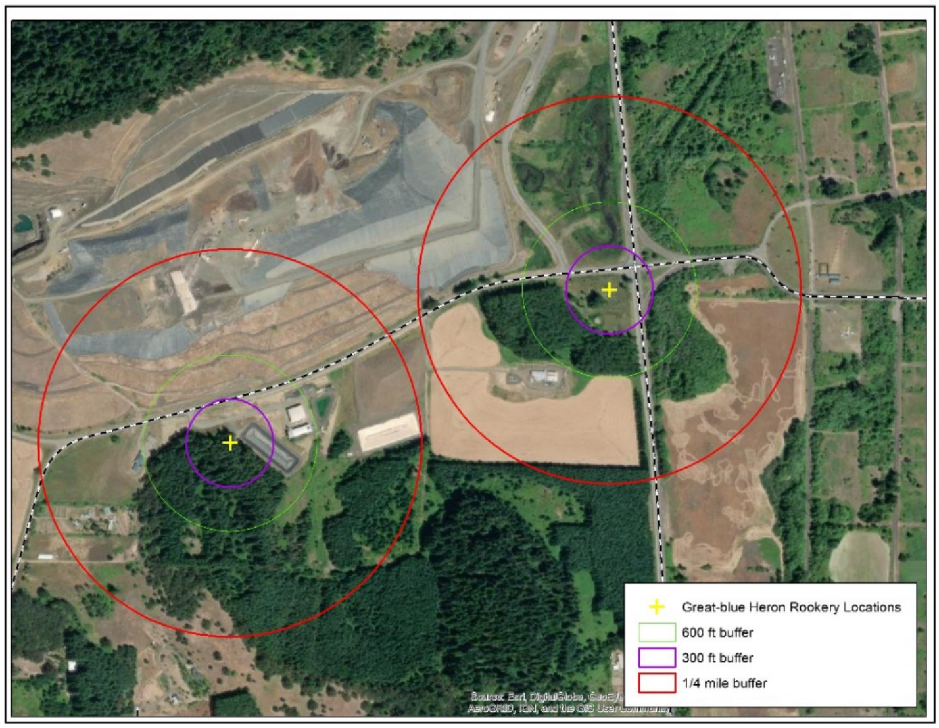


Figure1. Location of known great-blue heron rookeries and buffers associated with the Oregon Forest Practices Act and the Benton County Development Code.

Benton County Exhibit 7 (BC7)

BC7.14	G. Lind Flak

From: Community Development, Benton County, Oregon
To: Benton Public Comment
Subject: LU-24-027 Coffin Butte Proposed Expansion Written Feedback
Date: Tuesday, April 29, 2025 8:12:44 PM

Subject of Testimony: LU-24-027 Conditional Use Permit Application Regarding Landfill Expansion

Full Name: GINA LIND FLAK

Email: gflakmn@gmail.com

Street Address: 28891 BLAZE DR, CORVALLIS OR 97330

Written Testimony:

Dear Benton County Planning Commission:

I am writing to comment on the Conditional Use Permit (CUP) application submitted by Valley Landfills Inc. I am vehemently opposed to any expansion of the Coffin Butte landfill.

My husband and I live near the landfill. We have animals on our land and a well and septic system. I am already concerned about the quality of our water, and I believe that any expansion of the landfill will put our health and the health of the animals on our land at risk.

Losing access to the water in our well would seriously interfere with the use of our property. We do not currently have a water tank so we would need to buy one at great expenses and pay to have water trucked in. We would no longer be able to lease our farm-zoned property for livestock as we do now as it wouldn't be economically feasible.

We have not seen any evidence presented by Republic or Vallery Landfills to show that their plans will not interfere with our existing land use, or well water, or the beauty of the area, which is why we purchased our home here 9 years ago.

I'm also concerned about the blasting that would take place since we already experience noise – often beginning as early as 5:30 am when trucks begin arriving, and the dust and odor emanating from the landfill and all of the traffic.

Each morning, I drive on Coffin Butte Road, cross Hwy 99 and continue on Camp Adair Road on my way to work in Albany. Camp Adair Road is littered with trash as far as Independence Highway and even onto Hwy 20. Last summer, I followed a trail of pink insulation in the ditches and hanging from bushes and trees along the road, all the way from Hwy 20 to the Coffin Butte landfill in my neighborhood. There were bright pink pieces of insulation on Hwy 20 heading toward Corvallis, Independence Highway, Camp Adair Road, Hwy 99, and Coffin Butte Road up to the landfill entrance. A year later and I still see pieces of that pink insulation. It's disgusting we allow this to happen.

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Submitter's IP Address: 98.97.35.195

From: kiko denzer <kiko@handprintpress.com>
Subject: **[VNEQS/Dumpsters] Re: deny LU-24-027**
Date: October 7, 2025 at 9:49:55 AM PDT
To: landfillappeals@bentoncountyor.gov

TO: Commissioners Shepherd, Wyse, and Malone, of Benton County Oregon
FROM: Kiko Denzer, Philomath Oregon
DATE: 10/7/2025
RE: Further concerns regarding Republic Service's application to expand Coffin Butte Dump.

In their long and heavily appended response to the planning commission decision, the applicant addresses only a few issues where they have quantities of hard-to-understand data. It's a common and often effective tactic. Pages and pages of numbers from people with letters behind their names — "it must be right!"

Right? And who has the time and staff to verify, much less challenge, all that data?

In fact, however, the impacts addressed by the applicant (groundwater, fire, odor, and traffic sound) are the least of the public health concerns facing Benton County.

The applicant does not address PFAS (both in leachate as well as in groundwater and air), methane generation and its effect on climate, impact on wildlife, visual blight, economic impact (owners unable to sell their properties, developers avoiding dump sites, loss of recreational and agritourism revenues, etc.), impact on emergency escape routes in the event of a major fire, and other public health matters.

All of these pose significant burdens, and not only on our community, but on all the adjacent communities. And all have been extensively addressed by a large and growing group of

citizens, including VNEQS, many of whose members are professionals with experience and standing in related fields.

The applicant's responses to statements from the planning commission rely on the applicant's own "expert" data. However, as Commissioner Lee suggested on the first page of the applicant's response, what if the applicant's data is wrong?

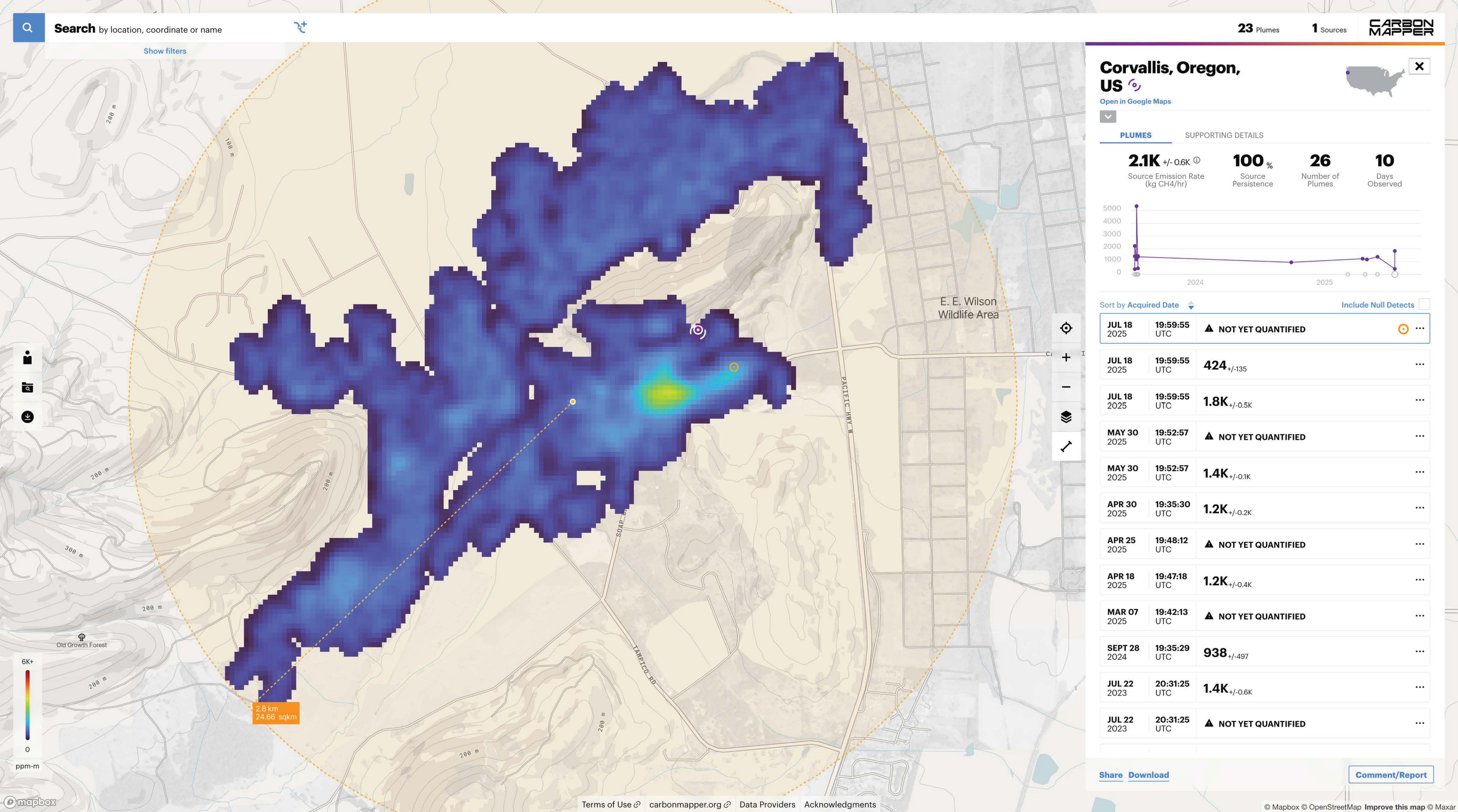
The county's obligation to the citizenry requires caution and care. If the county can't verify the applicant's data, and if citizen research and testimony not only challenge that data but extend into areas that the applicant has not addressed, the logical, moral, and legal course for the county is to err on the side of caution.

I respectfully request that the commissioners look at the big picture, and consider that the applicant's desire to expand the dump is inadequate motive for a decision with this much potential impact.

Concern for the health and well-being of the citizens of the county is not part of their application. They make this very clear when they say that Commissioner Lee's concern about high cancer rates "is entirely unsupported by any evidence in the record…" vague, and based on "conjecture or generalized fears."

The public record — locally, nationally, and internationally — is rife with well-documented examples of communities being poisoned by proximity to toxic disposal sites and/or toxic industries. To label as "conjecture" local knowledge of cancer cases and related concerns about known sources of known toxins is a clear dismissal of the very idea of "public health." For residents to feel insulted and angry in response would not be surprising.

The county has an obligation, as well as the power and authority, to re-frame the negotiation. If the county makes the health of the public their first priority, they can deny the application and work with Republic to address all the concerns and improve the management of waste — not only in Benton County, but statewide, and perhaps nationally.



Corvallis, Oregon, US

Open in Google Maps

PLUMES | SUPPORTING DETAILS

2.1K +/- 0.6K	100 %	26	10
Source Emission Rate (kg CH4/hr)	Source Persistence	Number of Plumes	Days Observed

5000
4000
3000
2000
1000
0
2024
2025

Sort by Acquired Date

Include Null Detects

JUL 18 2025	19:59:55 UTC	⚠ NOT YET QUANTIFIED
JUL 18 2025	19:59:55 UTC	424 +/-135
JUL 18 2025	19:59:55 UTC	1.8K +/-0.5K
MAY 30 2025	19:52:57 UTC	⚠ NOT YET QUANTIFIED
MAY 30 2025	19:52:57 UTC	1.4K +/-0.1K
APR 30 2025	19:35:30 UTC	1.2K +/-0.2K
APR 25 2025	19:48:12 UTC	⚠ NOT YET QUANTIFIED
APR 18 2025	19:47:18 UTC	1.2K +/-0.4K
MAR 07 2025	19:42:13 UTC	⚠ NOT YET QUANTIFIED
SEPT 28 2024	19:35:29 UTC	938 +/-497
JUL 22 2023	20:31:25 UTC	1.4K +/-0.6K
JUL 22 2023	20:31:25 UTC	⚠ NOT YET QUANTIFIED

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