BatemanSeidel

Carrie A. Richter
crichter@batemanseidel.com
www.batemanseidel.com
Telephone DID: 503.972.9903

September 6, 2023

VIA EMAIL

Multnomah County Hearings Officer
1600 SE 190th Ave
Portland, OR 97233
LUP-Comments@multco.us

Re: Portland Water Bureau Filtration Facility and Pipelines
County Case File T3-2022-16220

Hearings Officer Rappleyea:

As you know, this firm represents the Cottrell Community Planning Organization (hereinafter "CPO"). This letter is offered in response to materials submitted on or before August 7, 2023.

During the first open record period, the applicant submitted 46 additional documents and although many are self-explanatory responses to farm or traffic-related testimony, opponents are left to guess at the significance or relevance of a number of the documents. Engineering plans, real property legal descriptions, videos, and unrelated land use decisions are submitted without explanation, leaving opponents to guess at how they relate to the relevant criteria. Although the application has been significantly modified since its initial September 2022 submittal in response to deficiencies raised by the opposition, the applicant has not yet offered any supplemental analysis necessary to demonstrate compliance with the Community Service Conditional Use criteria set forth in MCC 39.7515.

The applicant's first acknowledgment that construction traffic was relevant emerged in early June, 2023. At that time, the applicant indicated that construction traffic would be widely dispersed throughout area roadways so as to not overwhelm any particular one area. The water treatment facility would have two access points: one to the west on Carpenter Lane and one to the south on Bluff Road through Clackamas County. In early July, Clackamas County denied the applicant's request to use Bluff Road for construction access. The result was consolidating 4-5 years' worth of construction traffic – 308,000 heavy truck trips and 700,000 work force trips - along Carpenter Lane and then dispersing throughout the network.

Hearing concerns about highly sensitive farm impacts on Carpenter Lane west of Cottrell Road, the construction traffic plan has been further constrained. Now, the applicant claims that no traffic will travel west past Cottrell Road on Carpenter Lane. The result is that all construction traffic at Cottrell Road must either travel north to Dodge Park or south to Bluff Road. Since

Exhibit J.35

Dodge Park will be riddled with months-upon-months of construction closures and detours, the applicant has produced a sensitivity determination assuming that 100% of the truck traffic will be directed from Carpenter Lane south along Cottrell Road and then to the left onto Bluff Road. [1] Ex I.86. Although this may be only a worst-case scenario, with an untested and unenforceable TDM plan, such a consolidated haul route approach would direct 308,000 heavy truck trips past the front doors and spelling disaster for the Oregon Trail Academy where congestion during am / pm pick-up hours extends on Bluff Road for several blocks.

The TDM alternatives such as bussing have not been fleshed out or analyzed for feasibility, and will have their own impacts at and around the remote parking sites. Each of the TDM alternatives has non-mitigated adverse impacts of its own. Not only is the TDM plan absolutely infeasible because it is unenforceable, the TDM plan is directed solely at meeting the peak hour congestion thresholds and not the requirements imposed by the MCC 39.7515 criteria including "consisten[cy] with the character of the area," "adversely affect natural resources," "force a significant change in or significantly increase the cost of accepted farm practices on surrounding land" and "create hazardous conditions."

These significant transportation-related changes indicate not only that the project fails to comply with the MCC 39.7515 criteria, but also evidences a need to continually and substantially alter the project because the facility siting effort lacked rigor and sufficient detail in the first place. Even as it stands now, the applicant has not provided the analysis necessary to respond to the applicable approval standards. This is critical because the applicant bears the burden of proof at all levels of the local permitting process. *Fasano v. Washington Co. Comm.*, 264 Or 574, 586, 507 P2d 23 (1973). Notwithstanding the hundreds of pages submitted by numerous highly-paid "experts" on specific subjects, the applicant has failed to meet this burden, both as a matter of law and with respect to the sufficiency of evidence. A mitigation strategy centrally focused on listening to neighbor concerns and an after-the-fact response is not evidence a reasonable person would rely on to conclude that a project of this scale will not impact the area character, surrounding farm activities or natural resources. Once future impacts are reported, they will have already occurred and the area character altered, farm practices changed, additional farm costs incurred and natural resources adversely impacted.

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[1] Under the new analysis necessary to account for the closure of Bluff Road access, the maximum allowable traffic volume has been reduced to 296 trips. Since the applicant also projects 174 peak-hour truck trips (during peak activity), this leaves only 122 additional "commuter" vehicles that can enter or exit the site during the peak hours. There are 575 commuter vehicles that are trying to enter the site during the AM and 575 leaving during the PM. This means commuter vehicles will need more than 4 hours of arrivals and departures to keep things under the limit. This converts the operation from the originally-studied idea of 2 high-volume hours (at the beginning and end of the workday) to about 9 continuous hours of truck + commuter volumes. In other words, it is essentially non-stop. Since it is unreasonable to think that the applicant is going to be able to stagger its arrivals and departures to stay below the trip cap, the only way to keep the intersections functioning will be through the TDM plan, which is undeveloped and unenforceable.

If the negative consequences resulting from the overwhelming project scale and lengthy construction duration were not enough, the surrounding area will similarly suffer as a result of the purported hard deadline that the applicant believes demands its compliance. The applicant has indicated that this project must be delivered by September, 2027, a little over 4 years from now with a project that will take at least 4-to-5 years to build.[2] Such a compressed construction schedule will not tolerate construction delays caused by good neighbor discussions or after-the-fact changes in construction methods or delivery that result in interruption at any level. Rather, meeting completion deadlines will require keeping a laser focus solely on the bottom line – an operating facility by September, 2027, at any cost.[3] Under this kind of pressure, life-transforming impacts to neighboring families and the farming community will be deemed nothing more than collateral damage.

The applicant's consultants' efforts to slice and dice the testimony in an attempt to analyze disparate issues more closely indicates that the applicant has lost sight of the forest for the trees. Taken altogether, the applicant has failed to show that this project can be constructed and operated in a way that will satisfy the Community Service use criteria and for this reason, this application must be denied.

Lengthy and Intensive Construction Impacts will Devastate the Pastoral Character

Establishing that the development will be "consistent with the character of the area" requires two things: (1) identification of the "character of the area;" and (2) an explanation of how the development will be consistent, including during the lengthy period for which it is under construction. First, the character of the area is defined not simply by categories of uses – residents, farms, schools, or the type of impact – noise, traffic, light, design, but rather the "character" of an area is an amalgam of various elements that function together to provide a collective or shared personality or significance for the area.[4] Rather than acknowledge this overall character or feeling, the applicant has only evaluated discrete impact elements rather than developing a project that is scaled so as to not alter the serene, pastoral character. As explained previously, the applicant cannot generate industrial-scale impacts to the same degree as a nearby farm and conclude that the character will not change. In this area, the law favors farming. The community must accept farm impacts as part of rural life. However, nothing in the MCC

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2 The applicant's unwillingness to disclose exactly how long it believes that construction of this facility will take from its start to operation provides the most primitive example of a failure in the proof for evaluating impacts.

3 The word "cost" is particularly apt here given that this project is currently estimated to cost the Portland rate payers $2.1 billion dollars so you can bet the City will (or at it least it should be) keenly resistant to anything that would increase the overall project cost.

4 As noted previously, the community character is articulated in the Comprehensive Plan as:

> "…quiet open spaces, vistas of productive farm and forest lands and of Mt. Hood, country road, healthy air, soils and streams and a night sky where we can clearly see the stars." Plan 1-26.

suggests that impacts from a non-farm use are, by definition, consistent with the neighborhood character, even if they are somehow commensurate with impacts from farming. More to the point, perhaps, there is absolutely no evidence to suggest that noise, light and air pollution, traffic impacts, vibration, and hazardous conditions created are anywhere within the range of impacts resulting from the most successful nearby farm operations. Semi-truck deliveries are part of the nurseryman's business but the number of farm-related trucks on a busy day are less than a dozen and do not compare to the hundreds of construction truck trips per day that are projected to occur, if this project is approved.

Regarding the consideration of how construction will impact the overall area character, the applicant's only argument is that as a general concept, construction impacts should not be considered as they are necessary to realize a use. This statement is absolutely belied by the plain language of the MCC which suggests otherwise. As staff correctly points out, the terms "use" and "development" in the MCC are synonymous. "Development" means "Any act requiring a permit stipulated by Multnomah County Ordinances as a prerequisite to the use or improvement of any land…including any ground disturbing activity." MCC 39.2000. Building this facility and installing pipelines requires construction and ground disturbance to come to fruition. Construction is part of the proposed use.

Moving beyond the plain definitions, as a practical matter, construction impacts must be considered when there is evidence that they will be so intensive as to alter the area character. Otherwise, MCC 39.7515(A) is bereft of meaning. Said differently, the character of an area may have sufficient elasticity and fortitude to overcome construction traffic from "typical development" - perhaps 6 months to a year of construction including a few days to excavate for a residential foundation or cement truck traffic to pour a slab for a new nursery greenhouse – this is typical rural-scaled construction traffic. However, the elasticity of a quiet and pastoral farming character cannot withstand 5-7 years of construction. Months-upon-months of construction activities belching exhaust, the endless grind of power tools coupled with accelerating and backing trucks, headlamp and glare from temporary construction lights, and delay / detours throughout the road system will change the area character. Residents and visitors woll no longer nature-watch, star-gaze, walk, ride horses and bicycle down the streets. The whole community of several square miles will be totally turned over to this industrial development which will set the character of the area not just the next 5-7 years but for decades to come.

Rather than offer a response that focuses on the language of the MCC, the applicant has submitted four unrelated non-farm review decisions previously issued by the County, again without analysis, presumably hoping that they will convince the Hearings Officer that the County has no practice of considering construction impacts. The Hearings Officer should reject this invitation because none of these cases considered the question and none dealt with an urban, industrial scaled use of the size, duration and impacts proposed here.

For example, Exhibit I.70 includes a decision to alter an existing PGE substation that has been in service since 1969 by an additional 200 square feet, with no evidence of prolonged construction impacts. This decision is completely dissimilar to a 30-building water filtration facility sprawling across a currently vacant 94-acre property. Exhibit I.71 considered a religious center on MUA-20 on 2.20 acres and serving the local community. This is the only decision evidencing any indication of anything more than minimal opposition. In addition to being significantly smaller and presumably nothing out of the ordinary in terms of construction impacts, there was no claim of farm impacts, which is a central issue in this case. Exhibit I.72, dealt with the expansion of the Lusted Road Water treatment facility – adding a 1,200 square foot building and 11,000 square feet of paving and some additional water treatment technology– comparatively small alterations when compared to the project proposed here and again, facing only very minimal opposition. Finally, Exhibit I.73 dealt with a 156-ft tall wireless communication facility on MUA-20. Wireless communication towers are not subject to the conditional community serve use standards of MCC 39.7000. The challenges were focused on dark sky lighting standards and cell tower siting standards that have nothing to do with this application.

None of these applications or the County's review of them indicate that the County has ever interpreted the term "use" for evaluation under the MCC 39.7515 criteria as it relates to construction. These decisions prove nothing with respect to the construction impacts that will transform the character of this area for years to come.

Compelling Farmers to Adjust its Practices Forces a Significant Change and Increases Costs

As discussed in previous testimony, there is no question that construction impacts are applicable to any evaluation of the farm impacts test. *Von Lubken v. Hood River County,* 28 Or LUBA 362, 365 (1994). In addition to evaluating specific farm practices on individual farms, the county must consider aggregate or cumulative impacts across all farm practices on a single farm unit. *Stop the Dump Coalition v. Yamhill County*, 364 Or 432, 459, 435 P3d 698 (2019). Ex I.80, the Globalwise Response to Public Comments Related to Farm Use Impacts, is defective because it fails to view the impacts to each individual farmer from a cumulative perspective. The effect is not just an occasional delay. Rather, every day and sometimes multiple times per day, a farmer will need to track and re-route for construction delay. In addition to altering employee schedules, farmers will need to communicate with other nurserymen, commercial delivery drivers, and suppliers to manage routing to a degree that is unnecessary today. Extensive road closures will lead to trespass on private farm roads demanding additional fencing and farm security. Loss of productive farmland taken to accommodate required pesticide / herbicide setbacks from construction work as well as mitigation as necessary to accommodate pipes and emergency access roads will substantially alter how farming occurs. Taken together, expending time to coordinate these operational logistics and paying employees to work additional time to make up for delays, take security precautions and incur costs that are not amortized by the loss of productive farmlands will substantially increase the cost of farming.

As noted above, whether the existing intersections will retain capacity to meet minimum level-of-service standards, assuming that everything goes as predicted, misses the point. The question is not whether the streets can accommodate the construction vehicles but rather whether the farmers will have to change their existing practices or suffer increased costs as a result of the additional traffic. *Burke v. Crook County,* 48 Or LUBA 23, 40 (2004). The applicant's traffic analysis indicates that construction will add 749 new additional daily trips, equating that to the construction of 900 new homes. Other than to respond that this calculation offers a "conservative forecast" and that most times the traffic will be up to 50% less, the applicant's traffic analysis fails to show that the additional trips – which will be more spread out due to the need to avoid the am / pm peak hours - will not significantly change farm practices or significantly increase their cost.

Make no mistake about it, this proposal will result in the temporary and permanent physical loss of surrounding lands that are currently in farm use. Reducing the productive acreage upon which to spread the cost of farming increases the overall costs necessary to farm fewer acres. In this case, the amount of that reduction is significant. According to the Globalwise report, the Ekstrom & Schmidt Nursery will permanently lose 1.8 to 1.9 acres of farmland due to new easement areas.[5] Mr. Ekstrom's testimony on Exhibit I.80 disputes this point identifying a total of four acres taken out of production as a result of the pipeline area taking, coupled with the required planting setbacks and spray buffers. Ekstrom offers that the lost profits resulting from these impacts is $250,000 to $300,000 per year. Even if the amount of the lost land is half as much, as Globalwise predicts, the lost profits would be $125,000 to $150,000 per year – a significant loss. These profits will no longer be available to invest back into the business, having the effect of increasing the cost of farming.

Similarly, the actual loss of productive agricultural land will significantly change farming practices and increase costs to the nearby Surface Nursery (Surface) as well. Among its existing farm acreage, Surface farms two properties directly to the south of the facility that are served by a private road that bifurcates these two fields and connects to Bluff Road. The applicant plans to take this road through eminent domain for use as an emergency access road to serve the treatment facility. Although this emergency access road is located within and subject to land use review in Clackamas County, the road is required by the fire code to be included as part of this facility and therefore, the resulting significant farm impacts are germane to this review as well. A detailed recitation of these impacts will not be set forth here. See the attached letter to Clackamas County. In summary, converting the farm access road to an emergency access road that will accommodate heavy vehicles will require Surface to build a farm access road parallel to

[5] The term "surrounding land" is not defined by the MCC. In *Wetherell v. Douglas County*, LUBA held that where a nonfarm dwelling is proposed on lands including a vineyard, the impacts to the vineyard located on the same property must be considered. 51 Or LUBA 699 (2006). With respect to the pipeline and emergency access road, in addition to considering impacts to the remainder of lands located outside of the easement area, the impacts analysis must consider how the underlying fee ownerships will be impacted by the temporary or permanent constraints imposed by the easements.

the emergency access road. Loss of productive farmland resulting from temporary and permanent easements, along with the land necessary to build the new farm road is estimated to total approximately 2.5 acres. The estimated loss in nursery stock revenue for every acre impacted is approximately $311,663 every three years. Contrary to the Globalwise report, converting farmland to a farm access road does not come at no cost. Further, how Surface will move equipment from the farm field to the west of the emergency road to the farm field on the east of that road is not at all clear and will significantly change Surface's farm practices.

With respect to transportation-related impacts on farming caused by construction delays, the applicant continually suggests that they will be "minimal and mitigated." This is a conclusion that lacks evidentiary support, both with respect to the credibility of the speaker as well as dearth of reliable information to support this conclusion. None of the PWB-hired consultants have ever operated a successful nursery in the Pacific Northwest, much less in East Multnomah County, so their pronouncements as to whether a delay or detour will have minimal impact on existing nursery operations is not entitled to same weight as testimony of successful farmers with a long history of nursery stock production in this area. We would note that it is not every day that farmers organize themselves; take time from their fields, warehouses and offices to drive into town to testify at a public hearing of unknown duration; or engage downtown attorneys to speak and write on their behalf. Obviously, the threat to their livelihoods posed by this application is real and profound. Consultants' highly compensated window dressing will not diminish that threat in any way.

The record reflects that Dodge Park Boulevard, one of the farmers' primary access points for moving between fields and delivering nursery stock and supplies into and out of the area, will be one-lane wide for 14 months. There is no evidence that road closures of this duration are common in this area. In fact, the poor road conditions suggest that detours and delays from road construction rarely, if ever, occur. Even if the pipeline crew moves 30 to 50 feet per day, this does not explain how long farmers or their employees or truckers might expect to remain awaiting a flagger or pilot car, which will likely add some unknown number of minutes to their journey. Further, as the video footage in the record shows, detours around Dodge Park Boulevard will be directed to the west side of Carpenter Lane,[6] directly past Hawk Haven and four nurseries – Ekstrom-Schmidt, Sunshine, Maple Farms and Don Marjama. See email "Carpenter Lane Nurseries." This is the exact stretch of road that the applicant indicates that it will not use. Directing pass-through and farm equipment traffic off of Dodge Park Boulevard and onto Carpenter Lane will cause the same significant change in equine and nursery farm practices as directing truck traffic along that route.

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6 As shown in the testimony entitled "Vehicle Routes," when Dodge Park Boulevard is closed, detour traffic will be travelling in both directions on the west side of Carpenter Lane. Traffic coming from the west will be diverted onto Altman Road and then onto Carpenter Lane. Traffic coming from the east on Dodge Park will be diverted onto Cottrell Road and then onto Carpenter Lane.

In addition to enduring what the applicant's consultant considers "minimal delays," recommended mitigation includes: requiring that farmers and their delivery drivers rely on ODOT's TripCheck system or adding employee hours on additional work days to make up for the loss. Requiring that farmers check a traffic app before travelling a farm route that they have been travelling day-in and day-out for years is not an accepted farm practice, and calculating and using a new, less direct route will change practices and increase cost. Further, in the *Stop the Dump* case, the Oregon Supreme Court held that asking a farmer to institute a mitigation measure – like work extra days or different hours to make up for road detours - can result in a significant change in farm practices. The testimony from farmers is that it is customary to shift work hours when "operationally necessary" and not when the actions from a non-farm, urban, industrial use demand such a shift. Working extra hours to make up for road detours and delays is not an accepted farm practice.

Further, under the holding in *Stop the Dump*, the burden of carrying out mitigation cannot be placed upon the farmers themselves in any respect. *See also Vincent v. Benton Co.*, 2 Or LUBA 422 (1981); *Platt v. Washington County*, 16 Or LUBA 151 (1987). Nonetheless, the record created by the applicant is rife with this sort of impermissible burden-shifting; indeed, this proposal is dependent upon it. Ever-changing traffic routes, and reliance upon TDM planning to be carried out at future points in time with no assurance of success, have created shifting sands, allowing the farmers no certainty of what to expect. Satisfying the applicant's burden of proof with regard to farm impacts requires that it provide specific routing and road and lane closure information with reasonable clarity, and identify the effects on a farm-by-farm basis with reasonable certainty. The applicant has not met this burden. It has merely been reactive, providing scattershot responses and presenting unsupportable conclusions.

The Facility will Create Hazardous Conditions and Place Excess Demands on Public Services other than Those Programmed for the Area

MCC 39.7515(E) requires a finding that the proposal will not "create hazardous conditions.' MCC 39.7515(D) requires a finding that the proposal "will not require public services other than those existing or programmed for the area." The extensive testimony from Rural Fire Protection District #10 (RFPD#10) explains that the need for procedures in the event of hazardous materials spills, fires, explosions and other incidents evidences the fact that there will be hazardous conditions created by this facility that do not exist today. The applicant's facility is akin to an industrial chemical plant requiring specialized equipment and protections for dealing with hazardous material. It does not matter how many precautions are taken, the hazardous conditions exist and therefore, violate MCC 39.7515(E). The applicant's Hazardous Materials Management Plan identifies nine "potential hazardous chemicals to be determined following construction." These undisclosed hazardous chemicals only exacerbate the concern over dangerous conditions that will be created by this facility.

With respect to the impact construction and construction traffic will have on emergency responders, RFPD#10 explains that creating or amending a traffic demand management plan in the event of an emergency will be too little, too late. In his 40 years of experience, the Fire District Chief has never heard of calling ahead to a construction site foreman during an emergency response to make sure that a road will be open and available for use. Delaying emergency responders creates a hazardous condition that will be all too common if this application is approved.

RFPD#10 explains that it lacks the necessary specialty response services required to serve the proposed facility. It is staffed and equipped to provide rural-scaled fire protection services to farms and residents. The proposed project introduces volumes and types of hazardous chemicals that should be sited in an area that has direct proximate access to fully equipped and trained emergency response facilities.

Conclusion

Although the applicant may have submitted thousands of pages worth of material, its effort lacks the details about existing conditions and project impacts necessary to satisfy the applicable approval criteria. The applicant's efforts on rebuttal fail to present a true and accurate character of the area or explain how this development, including the lengthy construction period and transmitting impacts for miles around, will not permanently change the quiet tranquility savored by local residents and that makes nursery farming so successful. This is a "mega-project" that will adversely affect natural resources, significantly change and increase the cost of existing farm practices and create hazardous conditions that are beyond the capability of RFPD#10 to serve. Conditions of approval are inappropriate in this case because the impacts identified, and mitigation offered, are so unclear and imprecise. Simply put, the applicant-identified solutions are not "feasible" allowing for a finding that compliance with the criteria is "possible, likely, and reasonably certain to succeed." *Just v. Linn County,* 32 Or LUBA 325, 330 (1997); *Rhyne v. Multnomah County,* 23 Or LUBA 442, 447-48 (1992).

For these reasons, this application must be denied.

Very truly yours,

Carrie A. Richter

Enclosures
cc: Client
lisa.m.estrin@multoco.us

Bateman Seidel

Carrie A. Richter
crichter@batemanseidel.com
www.batemanseidel.com
Telephone DID: 503.972.9903
Facsimile: 503.972.9043

August 17, 2023

VIA EMAIL

Hearings Officer Cox
Clackamas County Planning and Zoning Division
Department of Transportation and Development
Development Services Building
150 Beavercreek Road
Oregon City, OR 97045

Re: Utility Facility in EFU – County Permit No. Z0036-23

Hearings Officer Cox:

This firm represents the Appellant Surface Nursery Inc. (Appellant or Surface) as well as the Cottrell Community Planning Organization (CPO) in the above-referenced appeal. For the reasons explained in greater detail below, the applicant has not satisfied the criteria necessary to site an emergency access road on land zoned for Exclusive Farm Use (EFU). As the statement from Shawn Nerison, Vice President of Surface Nursery attests, construction and operation of this emergency road will result in significant changes to Surface Nursery's existing farming practices, increasing its costs and these impacts cannot be mitigated.

Impacts from Construction of the Emergency Access must be Considered

The Planning Director's decision concludes, based on the applicant's argument, that the impacts associated with construction are not relevant to reviewing whether a utility facility is necessary for a public service use. The decision cites *Citizens Against LNG v. Coos County,* 63 Or LUBA 162 (2011) in support of this proposition but this case has no relevance given the controlling legal framework at issue here.

First, in *Citizens Against LNG* the development was a natural gas pipeline on lands zoned for forestry where such pipelines are conditionally allowed outright and, a more significant factor to LUBA, was that ORS 772.510 expressly authorizes pipeline companies to condemn land outside of city limits for such purpose. According to LUBA, this suggests that construction impacts upon forest land were expected to occur.

In contrast, the subject property in this case is zoned EFU – a much more strict and statutorily controlled farmland protection scheme. A utility facility is permitted upon farmland only upon a finding that its location on EFU land is "necessary to provide the service" and that significant impacts and costs to surrounding farms can mitigated per ORS 215.283, OAR 660-033-0130(16)(a) and ORS 215.275.

Further, unlike the express authority for extra-territorial condemnation for natural gas pipelines at issue in *Citizens Against LNG,* there is no express authority for extra-territorial condemnation of water treatment facility emergency access roads. Rather, the City's authority for extra-jurisdictional condemnation comes from ORS 225.020(2) which allows for condemnation for municipal water works for its residents as well as for profit outside its boundaries "in the same manner as private corporations." These statutes in no way suggest that the impacts resulting from installation of a treatment facility or any associated accessory uses can be disregarded.

In fact, when LUBA has considered impacts to surrounding farm uses, it has uniformly held that the analysis must consider the totality of impacts from start to operation. In *Von Lubken v. Hood River County*, LUBA specifically held that construction impacts must be considered as part of the cumulative effects of the proposed use. 24 Or LUBA 271 (1992), *rev'd* 118 Or App 246 (1993). See also *Von Lubken v. Hood River County*, 28 Or LUBA 362, 365 (1994), *Stop the Dump Coalition v. Yamhill County*, 74 Or LUBA 1 (2016) and *Oregon Dept of Fish and Wildlife v.* Lake County, ___ Or LUBA ___ (LUBA Nos 2019-084/085/086/087/ /086/093, April 29, 2020)(failure to adopt findings explaining how shrub removal during construction will displace rodents onto farmland was error, even though the relocation might only be a temporary result of construction). The applicant must demonstrate that the cumulative impacts of the proposed emergency access road will not force a significant change in, or significantly increase the costs of, accepted farm practices on surrounding lands and in this case, the applicant has failed to make this necessary showing.

The evidence that was essential to the Planning Director's evaluation of the farm impacts test – the applicant's Soil Restoration Plan - focuses solely on how farming activities will be restored after construction but does not describe the extent of the impacts during construction. This is an error. It is also error for the applicant to fail to explain in detail how long it will take to acquire the necessary easement rights, construct this road and any evaluation of how this timing will impact the existing Surface farming operation. The applicant offers inconsistent statements about exactly how much farmland will be removed from production as a result of construction (and operation) of the emergency access road. The ways in which farm access will be changed through detours caused by construction vehicles accessing the site is similarly not discussed. Without this critical information, the County cannot conclude that the farmland and farm activities disturbed by construction of the emergency access road will not have a significant impact.

One final point that is worth noting here is that, although the applicant has remained continually cagey in its responses, documents submitted to Multnomah County for its review suggest that construction of this facility will take somewhere between four to six years to build. Presumably it will not take four to six years to build the emergency access road but the temporary easement included with the applicant's 40-day offer letter in pursuit of condemnation indicates that construction will last for five years. See attached. As the Appellant explains, occupation of Appellant's land for five years, even assuming that the land can be restored to productive use, which the Appellant disputes, will destroy the Appellant's ability to farm a significant portion of its property without any consideration of those impacts.

Disregarding construction impacts would allow the construction phase of any non-farm use, no matter how lengthy, to decimate existing farm practices with no mitigation. This would effectively cut the legs out from under the significant impact test. Construction impacts are part of the cumulative use and must be considered.

Relocating the Proposed Water Filtration Facility to Powell Butte would Eliminate the Need to Locate the Access Road on EFU Land

In evaluating whether the facility must be sited on EFU land in order to provide the service, the Planning Director takes an overly circumscribed view of the "facility" such that it looks solely at the emergency access road as the proposed use rather than the water treatment facility itself, the primary use, which creates the impetus for the roadway. The only way that the subject emergency access road can be located on EFU land is in its accessory capacity in support of the water treatment facility – a "utility facility necessary for public service" which is only conditionally permitted and not permitted as a matter of right. OAR 660-012-0065(3). It is the location of the treatment facility itself that dictates the location of the emergency access road on EFU land. Without the facility, there would be no need for the accessory road. The applicant has not considered as a viable alternative, the option of locating the facility elsewhere, thereby negating the need for an emergency access road on EFU land.

In fact, the applicant appears to concede that it is the facility itself that is "necessary" rather than the emergency road where it alleges that the facility is needed to "continue providing reliable, safe drinking water to nearly one million people." Whether or not one million people need this facility or not misses the point. The question is whether this alleged much needed facility must be located such that it demands an emergency access road that is located on EFU land. In September 2018, the applicant issued a Technical Memorandum explaining that locating the treatment facility on Powell Butte within the existing city limits would meet all of the technical specifications but was rejected due to the high likelihood of neighbor opposition. See attached. If neighborhood outcry in opposition was a recognized justification for dismissing a reasonable alternative, the very same could be said about this preferred location as well. Locating the facility on Powell Butte would eliminate the need to locate the proposed emergency access road on EFU land. This alternative was rejected for reasons not recognized under OAR 660-033-0130(16)(a)(A) and therefore, it cannot be said that the emergency access road must be sited on land zoned for EFU.

Further, the applicant has not explained why additional temporary area is necessary for construction of the emergency access road, nor has it evaluated any "reasonable alternatives" as set forth in ORS 215.275(1) and OAR 660-033-0130(16)(a) for any additional area to accommodate construction. There is no question that an emergency access must be built in order to exist but the question ORS 197.275(1) and OAR 660-033-0130(16)(a) asks is whether there might be alternatives to the extent and type of construction techniques employed that might lessen the amount of EFU land required in the first instance. According to the application pages 31-32, the permanent emergency access road will vary in width from 20 feet to 12 feet and that construction area for building this road extends from 52 feet to 22 feet. This begs the question of why a 20 foot wide emergency access is necessary in the area adjacent to active farming, but this area is reduced to 12 feet upon land occupied by non-farm uses. The applicant has not engaged in the requisite alternative analysis which is necessary. For these reasons, this application must be denied.

The Cumulative Impacts of the Emergency Access Road will Force a Significant Change and Increase the Cost of Farming

Legal Framework

ORS 215.275 provides, in relevant part:

> "(4) The owner of a utility facility approved under ORS 215.213 (1)(c)(A) or 215.283 (1)(c)(A) shall be responsible for restoring, as nearly as possible, to its former condition any agricultural land and associated improvements that are damaged or otherwise disturbed by the siting, maintenance, repair or reconstruction of the facility. Nothing in this section shall prevent the owner of the utility facility from requiring a bond or other security from a contractor or otherwise imposing on a contractor the responsibility for restoration.
>
> (5) The governing body of the county or its designee shall impose clear and objective conditions on an application for utility facility siting under ORS 215.213 (1)(c)(A) or 215.283 (1)(c)(A) to mitigate and minimize the impacts of the proposed facility, if any, on surrounding lands devoted to farm use in order to prevent a significant change in accepted farm practices or a significant increase in the cost of farm practices on the surrounding farmlands."

ORS 215.203(2)(c) defines "accepted farming practice" as "a mode of operation that is common to farms of a similar nature, necessary for the operation of such farms to obtain a profit in money, and customarily utilized in conjunction with farm use."

A "significant" change in accepted farm practices is one that is likely to have an important influence or effect on the farm practice at issue. *Stop the Dump Coalition v. Yamhill County*, 364 Or 432, 447, 435 P3d 698 (2019). A "significant" increase in the cost of a farm practice is one that represents an influential or important increase in the cost of that farm practice. *Id* The farm impacts test is applied to specific farm practices on individual farms. In addition, the applicant and county must consider aggregate or cumulative impacts across all farm practices on a single farm unit. *Id* at 459-60.

The Farm Impact Analysis is Inadequate in some Places and Contradictory in Others

In a letter dated June 15, 2023, the applicant's attorney repeats numerous times that "operation of the access road" will not force a significant change or increase cost on surrounding farmland. The central thrust of the applicant's position is that construction-related impacts, as opposed to its operation, are irrelevant because they are temporary. As explained above, that position is legally incorrect when it comes to compliance with ORS 215.275 and OAR 660-33-0130.

If construction activities are relevant, according to the applicant's representative, the Agricultural Compatibility Study (App C.1) evaluates the impacts from emergency access use as well as use of the road for construction and the Construction Traffic Impact Analysis dated June 2, 2023 evaluates the potential impacts associated with construction use of the access road and identifies best management practices to minimize and mitigate impacts. The applicant claims that locating the emergency access road along the alignment of the existing farm road minimizes the impacts. As additional mitigation for dust, the applicant agrees that vehicles speeds will not exceed 10 mph, watering the road if no measurable precipitation but not so much as to cause runoff and erosion. The staff decision imposes these recommended conditions.

This evidence is insufficient to show that the cumulative impacts on the Surface nursery practices will be mitigated so as to avoid a significant change in accepted farm practices or increase their cost. The Agricultural Compatibility Study is primarily focused on the impacts resulting from a fully functioning emergency access road assuming less than 20 trips per year. The only construction-related impact discussed in this Study relates to the bend in the road at the south end that was proposed for the facility construction access that was denied as part of the Planning Director's decision. There is no discussion in this Report of the potential damage or disturbance caused by the construction of the emergency access road. As noted above, it is not clear how long it will take to build this road or what type of dust, noise, vibration externalities could be anticipated given the type of construction machinery to be employed. Without this information, it is impossible to evaluate the impacts.

The Construction Traffic Impact Analysis is directed toward the transportation impacts associated with building a water treatment facility and associated pipelines using what is referred to as "Site Access B," the Bluff Road connection. This is no longer part of the applicant's proposal. The Analysis makes no mention of the specific transportation impacts associated with building Site Access B. No trip generation calculations were made, no analysis of where travel routes or how use of these routes will impact surrounding farming activities.

Any steps that the applicant may have taken to mitigate impacts in terms of selecting alignment or spraying the roadway for dust and not responsive to the obligation to fully and completely disclose the extent of the cumulative impacts the emergency access road will have on surrounding farmers, particularly the Appellant.

A Significant Amount of Surrounding Farmland will be Lost due to Impacts of the Emergency Access Road

Under ORS 215.275, the significant change / increased cost test looks at "surrounding lands devoted to farm use." In this case, a majority of the land that will accommodate the access road is currently in farm use. This area currently includes a 12 foot wide farm road running parallel to the eastern boundary of the Surface-owned property which provides access necessary to farm the Surface field to the west (tax lot 100) as well as tax lot 200, land to the east of the road that is leased and farmed by Surface as well. As explained in the Surface testimony, this road is routinely used and critical to moving farmworkers and equipment through these fields.

The applicant does not currently have any ownership interest in the land where the development is proposed and its ability to obtain the access and use rights necessary to occupy this land is, at this point, entirely speculative. Although there is no evidence to indicate that the right to access, construct and operate the emergency access road through condemnation is feasible, the applicant has indicated that the acquisition scope will be limited to obtaining an easement rather than fee title. The Surface held remaining interest rights require treating these development-impacted lands as "surrounding lands" for purposes of the farm impact test.

Attached to this submittal are the temporary and permanent access easement documents that were provided to the Appellant along with the 40-day demand letter. Omitting the temporary easement for the facility construction access connecting to Bluff Road, these easements identify a coterminous 40 foot wide easement running from the northern boundary of the Surface property to the south for 735 feet parallel with the eastern property line. Continuing in a southerly direction, the easement documents reflect a permanent easement of an additional 5 feet in width and a temporary easement of an additional 5 feet for a total of 10 feet. At 20 feet wide, the applicant's emergency access road will eliminate the existing farm access road and the constraints imposed by these easements will preclude Surface from enjoying the unencumbered movement of farm equipment to and through the two Surface fields. More specifically, the permanent easement provides in relevant part:

> "C. Grantor will keep the Easement Area open, accessible, and passable at all times. Grantor will erect no fence, gate or other impediment to Grantee's access to or within the Easement Area without the prior written consent of the Chief Engineer of Grantee."
>
> "E. Grantee will construct and maintain a gravel all-weather surfaced road in the Easement Area for mutual use of the Grantor and Grantee, provided however that use by farm equipment is prohibited without the prior written consent of the Chief Engineer of Grantee."

Said differently, although the Appellant can use the proposed emergency access road, it cannot block the road for any amount of time, nor may farm equipment use the road without written consent. There is no indication that the requisite consent will be granted and if so, on what terms. Prohibiting continued farm use of the existing farm road forces a significant change to existing accepted farm practices that farmers, crew members and equipment rely on for unrestricted movement to and through the Surface owned property. Even if shared, unencumbered access on the emergency access road was contemplated, according to the applicant, it will take five years to build the emergency access, leaving Surface without any access in the meantime.

The only alternative available to the Appellant is the construction of a separate and discrete farm access road running parallel to the emergency access road that will allow farming equipment to move through the Appellant's property without limitation consistent with current conditions. Building a new farm road when you already have one is not an accepted farming practice. In *Stop the Dump,* the court held that a farmer could not be forced to institute a mitigation measure, regardless of who pays for mitigation. Requiring the applicant to build a 12 foot wide farm road and then relocate it after the permanent access construction is complete, demands such inappropriate mitigation. See the Farm Impact Analysis includes cross-section drawings of the "Wide Easement Area" on p 31-32. The Surface representative explains that given the applicant's required two foot setback from the emergency road, the new farm access will need to be at least 20 feet wide to accommodate its 16 foot wide equipment that currently extends well over the existing 12 foot road width as depicted in the application.

The result is a loss of permanent farmland that far exceeds the .6 acre of permanent impact identified in the application. Taken together, the Appellant will loose approximately 51,097 sf or 1.17 acres, consisting of an essential farm access road and productive farmland, to the permanent and temporary easement for the access road.[1] Construction of the new farm access road will result in a further loss of approximately 58,500 sf or 1.34 acres that is currently planted with rows of bareroot nursery stock. Surface estimates a loss in nursery stock revenue for every acre impacted of approximately $311,663 every three years. In addition to the significant cost of constructing a new farm access road, the reduction in production value of the farm will significantly increase the cost of farming and those losses will be permanent. For comparison, in *Von Lubken supra*, LUBA held with respect to the farm impacts test that even an increased cost of just $20,000 to mitigate for dust generated during a short, 2½-month construction period could have a significant impact on farming.

Further, the location of this emergency access road essentially cuts the Surface farm operation on tax lots 100 and 200 right down the center. Farming the leased tax lot 200 land requires regularly cross the easement area with farm equipment. Under these easement terms, written consent would be required. As the Surface representative explains, construction of an all-weather road capable of handling emergency vehicles will require installing layers of gravel that could increase the finished road elevation of 20 inches or more above grade. If allowed, farm

1 This total excludes the 11,250 sf attributable to the construction access deviation near Bluff Road that was denied by the Planning Director.

equipment will not be able to safely cross with the elevated grade and if it can be accomplished, it would destroy the edges of the emergency access road. Maneuvering farm equipment from the new farm road across the emergency access road onto TL 200 is likely to require increasing the height of the new farm road as well. Constructing an elevated farm road only to accommodate passing across a non-farm emergency access road is not a customary farm practice and it is one that will substantially increase the road construction cost.

Soil Restoration Plan offers Inadequate Mitigation

The Planning Director's finding of no significant change or increased cost is premised on the restoration of farmland occurring through a Soil Restoration Plan set forth in the application. The Appellant's representative offers a detailed response on this issue and attached are a number of academic studies disputing these claims as well. Even if the soil restoration effort is successful, the loss of farmland resulting from the taking of the existing farm road and requiring the Appellant to construct a new 20 foot parallel access road will permanently occupy the identified restoration area.

For all of these reasons, the Hearings Officer must conclude that OAR 660-033-0130(16)(a)(D) and ORS 215.275 are not satisfied.

Revisions and Additional Conditions of Approval Are Necessary

If the Hearings Officer decides to authorize the emergency access road, a number of the Director-proposed conditions of approval should be revised as they are not "clear and objective," as required by OAR 660-033-0130(16)(a)(D), and given the evidence submitted to date, there is no reason to believe that compliance is "possible, likely, and reasonably certain to succeed." *Just v. Linn County*, 32 Or LUBA 325, 330 (1997) (*quoting Meyer v. City of Portland*, 67 Or App 274, 280 n 5, 678 P2d 741 (1984)).

> Condition 2: Prior to commencing any construction activities, the applicant shall provide proof of the entry of Orders of Immediate Possession for the subject property.

An order for immediate possession is available only to a public condemner under ORS 35.265. The applicant does not have authority under ORS 223.005 as a public condemner to condemn land outside of its boundaries where the property will serve a benefit to individuals outside of the City. Rather, the City's authority for extra-territorial condemnation comes from ORS 225.020(2) which allows for condemnation for municipal water works for its residents as well as for profit outside its boundaries "in the same manner as private corporations." A private condemner may obtain permission for early access only after obtaining advanced occupancy under ORS 35.275. Therefore, Condition 2 should be revised to provide:

> "Prior to commencing any construction activities, the applicant shall submit to the County copies of the entry of Orders for Advanced Occupancy for all of the property that is the subject of this application."

Condition 3: Construction activities shall not commence unless the water filtration plant in Multnomah County receives final land use approval.

The subject emergency road access is permitted only where it is accessory and in support of the water filtration plant, which is currently pending review in Multnomah County. ZDO 202 defines "accessory building or use" as:

> "A subordinate building or use, the function of which is clearly incidental to that of the main building or use on the same lot."

Under this definition, an accessory use cannot be authorized where the primary use does not already exist or is reasonably certain. The applicant has no land use approval to develop the water filtration facility to which the emergency access road is accessory. The filtration facility is a conditional use within the MUA-20 zone. In addition to obtaining discretionary conditional use approval, the application includes a request to install approximately 7.5 miles (40,500 linear feet) of new pipeline, much of which is located on EFU zoned land. At this point, there is no reason to believe that the Multnomah County application will be approved. Under the current schedule, the record in the Multnomah County land use matter will not close until September 21st with a decision presumably forthcoming in October. In the event that Multnomah County grants approval, a LUBA appeal could not only delay facility construction, reversal or remand of Multnomah County's decision may, in turn, require modification or abandonment of the accessory emergency access road that could already be under construction or in place. Said differently, in no event should use of the emergency access road precede or be used for anything other than providing emergency access to the filtration facility. Therefore, this condition should be revised to provide:

> "Construction activities shall not commence unless the water filtration plant in Multnomah County receives final land use approval that is beyond any further appeal."

Additional Condition: Limiting the Use of the Emergency Access

In some places, the applicant asserts that the road will be used solely for emergency access but in other places, indicates that the road will be used for "maintenance or other events at the filtration site when primary access on Carpenter Lane is not reasonably available." Farm Impact Analysis p 9. Elsewhere, the applicant indicates that the road will be driven once per month for inspection purposes and that the hydrants will be inspected once per year. Farm Impact Analysis p 17. The only authorization approved by the Planning Director is for emergency access. The only finding that this road is necessary in order to provide service is the emergency authorization and not for any maintenance or other purposes. Moreover, the farm impact and traffic analysis submitted with the application assumes emergency vehicle use of this road of no more than 20 trips per year. If the applicant plans on using the road for other purposes or in excess of 20 times per year, the traffic and farm impact study would need to reflect as much. Therefore, if approved, the County must impose a condition constraining use to no more than 20 emergency trips per year and only when Carpenter Lane is not available:

> "This approval authorizes use of this road for emergency access only in cases where Carpenter Lane access is not available and shall be restricted to no more than 20 trips per year."

Conclusion

For the reasons set forth above, this application fails to satisfy the exacting requirements to approve the proposed emergency access road. The cumulative impacts associated with the construction and operation of the emergency access road are not known. With respect to impacts when the road is operational, depriving Appellant from continuing to use the existing farm access road allowing for unrestricted access to its owned and leased fields and forcing alternative arrangement will result in significantly modifying its farm practices and increase the cost of farming.

Please place this letter in the record for these proceedings and provide me notice of the County's decision in this case.

Very truly yours,

Carrie A. Richter

CAR:kms
cc: Client

Attachments

Excerpt from:
Technical Memorandum
September 11, 2018
Bull Run Filtration Project
David Peters, PE, and Michelle Cheek, PE – Portland Water Bureau
Christopher Bowker – Portland Water Bureau Pierre Kwan, PE,
Aparna Garg – HDR
Dan Speicher – Jacobs
Phillippe Daniel, PE – HDR Andy McCaskill, PE – HDR
Filtration Plant Site Alternatives

5.5 Powell Butte

In 2001, the Panel recommended Powell Butte as a future treatment facility site due to its suitable elevation, location within the urban growth boundary, greater opportunities for public education and community recreation facilities, and the presence of an existing reservoir – thought to offer significant cost savings.

A facility at Powell Butte could be placed close to, or just below, the HGL, maximizing gravity flow to the facility (see Figure 7). However, pumping would be required to send water back up to retail and wholesale customers connected to the conduits between Headworks and Powell Butte, including the existing 16-inch Lusted Road Distribution Main connected to Conduits 2 and 4 at Lusted Hill. This would involve not only a pump station, but new pump mains to deliver water approximately 18-20 miles back east, at a significant cost and effort. Although Powell Butte passed the HGL criterion, it has significant drawbacks related to pumping filtered water back upstream (east) to customers.

Figure 7. Illustration showing a filtration facility located at Powell Butte relative to the HGL. Note the facility is very close to the HGL and would have gravity flow.

Powell Butte is very close to existing piping infrastructure, with additional piping estimated to be less than most of the other sites, at approximately 2,000 feet. Since Powell Butte is within two miles of the existing and future conduit ROW, it passed the proximity criterion.

Powell Butte includes multiple taxlots, four of which are quite large and total over 530 acres, and therefore is large enough for a filtration facility. Powell Butte is encircled by areas of moderate to high landslide hazard. However, low landslide susceptibility exists near where a potential treatment facility would likely be sited on the butte's interior area. Considering slopes, geologic

hazards, and existing facilities, it is estimated that the buildable area is 60 acres. Powell Butte passed the taxlot size, slopes, and geologic hazards criterion.

Powell Butte is located in Multnomah County, within the city of Portland, and is zoned as Open Space, low density residential, and multi-dwelling residential. In 2001, it was recognized that siting a facility at Powell Butte would have significant impacts on the park and surrounding neighborhoods (as the Panel was completing its work, some citizens expressed concerns about the social and environmental impacts of a facility at Powell Butte). Because of uncertainties of siting a treatment facility at Powell Butte, the Panel recommended a second site (Lusted Hill) remain under active consideration should neighborhood, environmental, or other issues render Powell Butte an inappropriate location.

More recently, Powell Butte Reservoir 2 was constructed at Powell Butte. Insight and experience from this project confirmed that neighborhood, environmental, or other difficulties would be significant if PWB were to construct a filtration facility at Powell Butte. It is also anticipated that Powell Butte would be the most difficult to secure land use approvals for development. This is because the land use process would require a Major Amendment to the Bureau's Powell Butte Conditional Use Master Plan (CUMP) and would trigger a subset of other land use reviews including conditional use, environmental, and likely an adjustment review to accommodate the impacts of development in the park and to the surrounding area. The Zoning and Land Use Review Analysis for Bull Run Water Treatment Plant Siting TM concluded that larger Powell Butte land use reviews (such as Reservoir 2 and CUMP) in the past have been appealed to LUBA by the neighborhood association and other public members, creating additional monetary costs, approval delays, and political scrutiny for the project and for PWB. These risks could significantly delay site approval, permitting, and facility construction by years. Therefore, Powell Butte did not pass the schedule criterion.

5.6 Roslyn Lake

Grantor:

Debra M. Surface, Trustee of the Revocable Living Joint Trust Agreement of the Richard M. Surface and Debra M. Surface Family Trust dated February 19, 1999
33740 SE Lusted Road
Gresham, OR 97080

After recording, return to:
Portland Water Bureau
Attn: Right-of-Way Section
1120 SW 5th Avenue, Suite 405
Portland, OR 97204

Send tax statements to:
No Change

WATER PIPELINE AND ACCESS EASEMENT

Debra M. Surface, Trustee of the Revocable Living Joint Trust Agreement of the Richard M. Surface and Debra M. Surface Family Trust dated February 19, 1999 ("Grantor"), in consideration of the sum of thirty-three thousand sixty-nine and no/100 Dollars ($33,069.00), and other good and valuable non-monetary consideration, the receipt and sufficiency of which are hereby acknowledged, hereby grants unto the City of Portland ("Grantee"), a municipal corporation of the State of Oregon, by and through its Portland Water Bureau, a perpetual, non-exclusive easement (this "Easement") for the purpose of constructing, reconstructing, accessing, operating, inspecting, monitoring, maintaining, upsizing, or replacing such above-ground or underground facilities as necessary or convenient for Grantee's water system including, but not limited to, vaults, meters, water lines, drains, hydrants, power lines and facilities, communication lines and facilities, and related appurtenances of any kind (the "Facilities"), together with the right of vehicular and pedestrian emergency and auxiliary access to Grantee's filtration facility ("Access"), through, under, over and along the following described area (the "Easement Area"):

As described on Exhibit A and depicted on Exhibit B attached and incorporated by reference.

The Easement Area contains 39,847 square feet, more or less

The terms of this Easement are as follows:

A. Grantor will neither cause nor allow any permanent or temporary surface, overhead or underground structure, facility, improvement, or activity, including but not limited to public or private utilities, buildings, sheds, garages, barns, decks, walls, garbage enclosures, mailbox structures, swimming pools, hot tubs, septic systems, stormwater infiltration basins, sumps, large vehicle storage, material storage or tree planting within the Easement Area without the prior written consent of the Chief Engineer of Grantee. All structures, facilities, improvements, or activities permitted within the Easement Area by Grantee must comply with applicable local, state, and federal laws and regulations.

B. Grantor will neither cause nor allow any change of grade within the Easement Area without the prior written consent of the Chief Engineer of Grantee.

C. Grantor will keep the Easement Area open, accessible, and passable at all times. Grantor will erect no fence, gate, or other impediment to Grantee's access to or within the Easement Area without the prior written consent of the Chief Engineer of Grantee.

D. Grantee, its agents, contractors, employees, public utility, and emergency service providers shall have the right to enter upon and use the Easement Area for the purposes described and authorized herein.

E. Grantee will construct and maintain a gravel all-weather surfaced road in the Easement Area for mutual use of the Grantor and Grantee, provided however that use by farm equipment is prohibited without the prior written consent of the Chief Engineer of Grantee.

F. Grantee will reasonably endeavor to minimize impacts to existing structures and surfaces. However, Grantee may remove any trees, shrubs, brush, paving or other materials or improvements necessary or convenient to facilitate its use of the Easement Area. Within a reasonable time after completion of any earth disturbing work undertaken by Grantee within the Easement Area, Grantee will restore the disturbed surfaces of the Easement Area to a grade and condition that, in the reasonable judgment of Grantee, are consistent with the grade and condition existing prior to Grantee's work within the Easement Area, except as to permanent changes made necessary by or authorized under this Easement. The area of restoration will not include any portions of the public right-of-way, as defined by Grantee, and will not include any structures, facilities, improvements, or activities permitted within the Easement Area under the prior written consent of the Chief Engineer of Grantee.

G. Within the Easement Area, Grantor will neither cause nor allow to be stored, used, manufactured, maintained, or disposed of, any Hazardous Substances, or any substances or materials which constitute a public health hazard, as defined by rules of the Oregon State Health Division. Grantor will neither cause nor allow any condition to exist within the Easement Area that constitutes a health hazard, as defined by rules of the Health Division. As used in this Easement, "Hazardous Substance" means: (i) any hazardous substance as defined by the Comprehensive Environmental Response, Compensation and Liability Act, as amended from time to time; or (ii) any hazardous waste defined by the Resource Conservation and Recovery Act of 1976, as amended from time to time; or (iii) any hazardous substances as defined by Oregon Revised Statute 465.200 and/or implementing regulations of the Oregon Department of Environmental Quality; or (iv) any and all material or substance defined as hazardous pursuant to any federal, state or local laws or regulations or order; or (v) any and all material or substance which is or becomes regulated by any federal, state or local governmental authority; or (vi) any and all material or substance which contains oil, gasoline, diesel fuel or other petroleum hydrocarbons and their by-products. Notwithstanding the foregoing sentences in this Section G, Grantor may use agricultural materials or substances during normal farming operations provided that such materials are approved by the Environmental Protection Agency for use in Grantor's agricultural settings and further provided that Grantor follows all Oregon Occupational Safety and Health standards, including, but not limited to, those related to hazardous communications.

H. Grantor and Grantee each agree to notify the other no less than three (3) business days prior to the commencement of any earth disturbing work within the Easement Area approved pursuant to the provisions of this Easement, provided however that in the event of emergencies no such prior notice will be required, but notice will be provided within a reasonable time after the commencement of the emergency.

I. Grantor reserves all other rights not conveyed herein but will not exercise said rights in any manner that would be inconsistent or interfere with or materially affect rights herein granted to Grantee.

J. This Easement runs with the land and binds the heirs and assigns of Grantor and will inure to the benefit of the successors in title of Grantee.

K. Grantor represents and warrants that Grantor has the authority to grant this Easement, that the person(s) executing this Easement on behalf of Grantor have the legal power, right, and actual authority to bind Grantor to the terms and conditions of this Easement.

L. Grantor agrees that the consideration recited herein is representative of fair market value for this Easement, which includes damages to the remainder property, if any, resulting from Grantee's acquisition or use of the Easement Area.

M. Grantee, by accepting this Easement, is not accepting liability for any preexisting release of Hazardous Substances onto or from the Easement Area, and Grantor is not attempting to convey any such liability.

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Grantor has duly executed this instrument on ______________________, 20_____.

____

Debra M. Surface, Trustee of the
Revocable Living Joint Trust Agreement of the
Richard M. Surface and Debra M. Surface Family
Trust dated February 19, 1999

State of OREGON

County of ________________________

This instrument was acknowledged before me on ________________________, 20______ by Debra M. Surface as Trustee of the Revocable Living Joint Trust Agreement of the Richard M. Surface and Debra M. Surface Family Trust dated February 19, 1999.

____

Notary Public – State of Oregon

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Approved and accepted pursuant to ORS 93.808 and by authority granted to the Administrator and/or Chief Engineer of the Portland Water Bureau of the City of Portland, a municipal corporation of the State of Oregon, by Ordinance No. 191094, passed on December 7, 2022 by the City Council of the City of Portland, Oregon.

By: ______________________________ Date: ______________________________

Name: Jodie Inman, PE

Title: Chief Engineer or designee,
Portland Water Bureau

Approved as to form:

____

City Attorney

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EXHIBIT A

Legal Description

For

A Permanent Water Pipeline and Access Easement

File No. W02229-02

August 15, 2022

A portion of the property conveyed to Debra M. Surface, Trustee of the Revocable Living Joint Trust Agreement of the Richard M. Surface and Debra M. Surface Family Trust as Document No. 2010-062958, recorded October 5, 2010 in Clackamas County Official Records, Clackamas County, Oregon and located in the Northeast Quarter of Section 27, Township 1 South, Range 4 East, Willamette Meridian, more particularly described as follows:

BEGINNING at the northeast corner of said Section 27, marked by a 3.25" brass cap; thence North 88°19'47" West 40.00 feet along the north line of said Section 27; thence South 01°24'46" West 735.00 feet parallel with east line of said Section 27; thence South 26°49'48" East 73.96 feet to a point 5.00 feet west, when measured at a right angle, to the east line of said Section 27; thence South 01°24'46" West 1,793.80 feet parallel with the said east line to the northerly right-of-way line of SE Bluff Road; thence South 70°00'38" East 5.28 feet along said northerly right-of-way line to the east line of said Section 27; thence North 01°24'46" East 2,595.46 feet along said east line to the said Point of Beginning.

Containing 39,847 square feet, more or less.

The basis of bearings for this description is grid north, Oregon State Plane Coordinate System, North Zone.

End of Description.

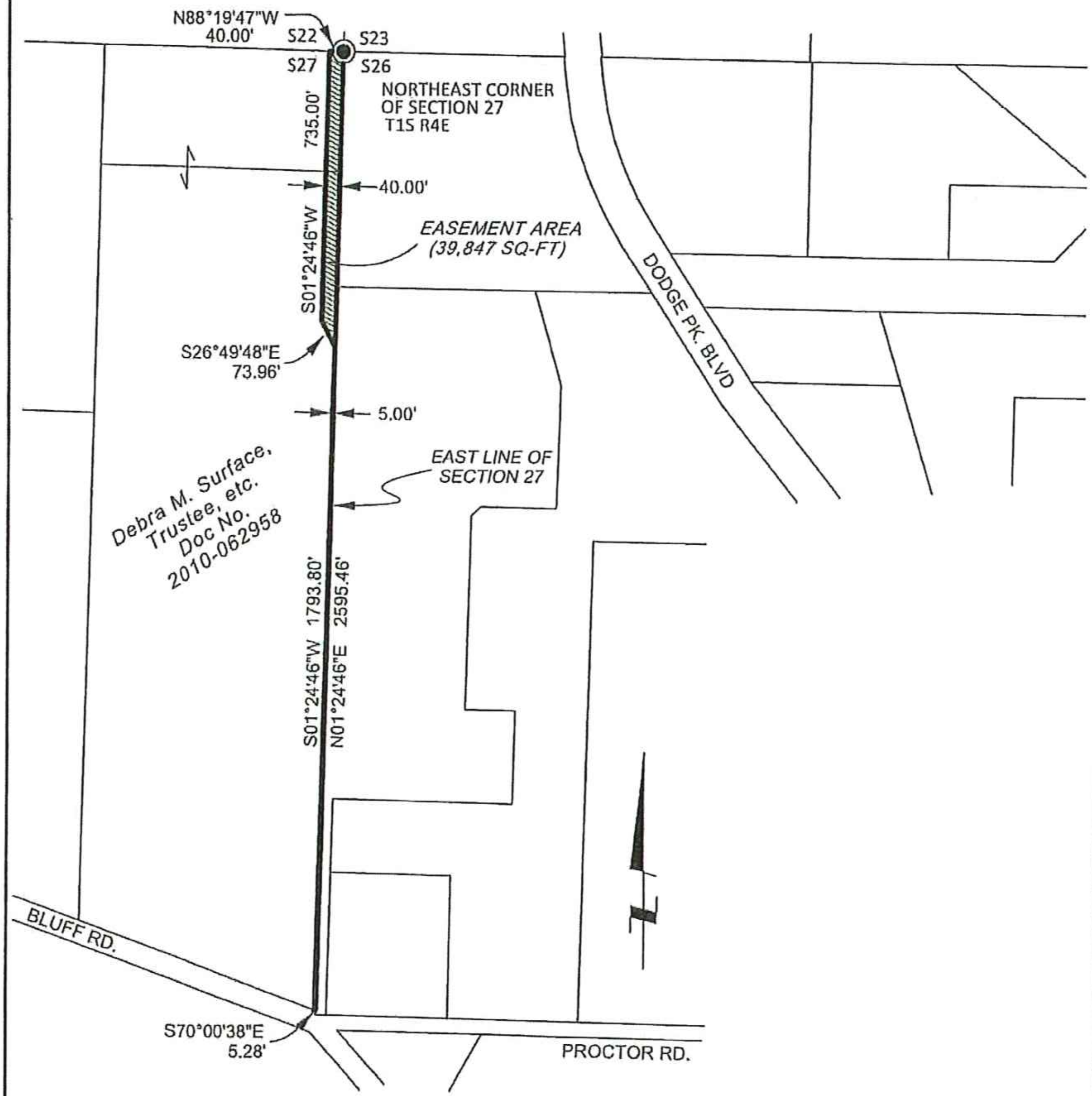
REGISTERED
PROFESSIONAL
LAND SURVEYOR

Mark Filsinger

OREGON
JULY 20, 1993
MARK D. FILSINGER
2613 LS

RENEWAL DATE: 12/31/2023

EXHIBIT B



REGISTERED
PROFESSIONAL
LAND SURVEYOR

Mark Filsinger

OREGON
JULY 20, 1993
MARK D. FILSINGER
2613 LS

RENEWAL DATE: 12/31/2023

CITY OF PORTLAND
WATER BUREAU

PERMANENT WATER PIPELINE
& ACCESS EASEMENT EXHIBIT
(FILE NO. W02229-02)

8/15/2022	T1S R4E Sec 27, NE Qtr QSEC 3966
PROJECT W02563	SCALE: 1" = 400'

Grantor:
Debra M. Surface, Trustee of the Revocable Living Joint Trust Agreement of the
Richard M. Surface and Debra M. Surface Family
Trust dated February 19, 1999
33740 SE Lusted Road
Gresham, OR 97080

After recording, return to:
Portland Water Bureau
Attn: Right of Way Section
1120 SW 5th Avenue, Suite 405
Portland Oregon 97204

Send tax statements to:
No Change

TEMPORARY CONSTRUCTION EASEMENT

Debra M. Surface, Trustee of the Revocable Living Joint Trust Agreement of the Richard M. Surface and Debra M. Surface Family Trust dated February 19, 1999 ("Grantor"), in consideration of the sum of two thousand nine hundred and thirty-one and no/100 Dollars ($2,931.00), and other good and valuable non-monetary consideration, the receipt and sufficiency of which are hereby acknowledged, hereby grants unto the City of Portland ("Grantee"), a municipal corporation of the State of Oregon, by and through its Portland Water Bureau, a temporary easement (this "Easement") for the purpose of supporting construction activities associated with the Bull Run Filtration Project W02229 (the "Project"), through, under, over and along the following described area (the "Easement Area"):

As described on Exhibit A and depicted on Exhibit B attached and incorporated by reference.

The Easement Area contains 62,310 square feet.

The terms of this Easement are as follows:

A. This Easement is temporary and granted for a term of five (5) years, commencing no earlier than August 1, 2023. The date of commencement of work shall also be the commencement of the five-year term of this Easement.

B. Grantee will notify Grantor no less than three (3) business days prior to the commencement of work under this Easement.

C. Grantee will reasonably endeavor to minimize impacts to existing structures and surfaces. However, Grantee may remove any trees, shrubs, brush, paving or other materials or improvements necessary or convenient to facilitate its use of the Easement Area. Upon

Project completion, Grantee will restore the disturbed surfaces of the Easement Area to a grade and condition that, in the reasonable judgment of Grantee, (a) is consistent with the grade and condition existing prior to Grantee's use of the Easement Area, (b) is consistent with other rights of Grantee to use some or all of the Easement Area, or (c) is consistent with Grantor's requested condition of some or all of the Easement Area upon Project completion. The area of restoration will not include any portions of the public right-of-way, as defined by Grantee.

D. Grantee, its agents, contractors, employees, public utility, and emergency service providers shall have the right to enter upon and use the Easement Area for the purposes described and authorized herein.

E. Grantor reserves all other rights not conveyed herein but will not exercise said rights in any manner that would be inconsistent or interfere with or materially affect rights herein granted to Grantee.

F. This Easement runs with the land and binds the heirs and assigns of Grantor and shall inure to the benefit of the successors in title of Grantee.

G. Grantor represents and warrants that Grantor has the authority to grant this Easement, that the person(s) executing this Easement on behalf of Grantor have the legal power, right, and actual authority to bind Grantor to the terms and conditions of this Easement.

H. Grantor agrees that the consideration recited herein is representative of fair market value for this Easement, which includes damages to the property remainder, if any, resulting from Grantee's acquisition or use of the Easement Area.

I. Grantee, by accepting this Easement, is not accepting liability for any preexisting release of hazardous substances onto or from the Easement Area, and Grantor is not attempting to convey any such liability.

THE REMAINDER OF THIS PAGE IS INTENTIONALLY LEFT BLANK.

Grantor has duly executed this instrument on ______________________, 20______.

____
Debra M. Surface, Trustee of the
Revocable Living Joint Trust Agreement of the
Richard M. Surface and Debra M. Surface Family
Trust dated February 19, 1999

State of OREGON

County of ___________________________

This instrument was acknowledged before me on _________________________, 20______ by Debra M. Surface as Trustee of the Revocable Living Joint Trust Agreement of the Richard M. Surface and Debra M. Surface Family Trust dated February 19, 1999.

____
Notary Public – State of Oregon

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Approved and accepted pursuant to ORS 93.808 and by authority granted to the Administrator and/or Chief Engineer of the Portland Water Bureau of the City of Portland, a municipal corporation of the State of Oregon, by Ordinance No. 191094, passed on December 7, 2022 by the City Council of the City of Portland, Oregon.

By: ______________________________ Date: ______________________________

Name: Jodie Inman, PE
Title: Chief Engineer or designee,
Portland Water Bureau

Approved as to form:

____

City Attorney

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EXHIBIT A

Legal Description

For

A Temporary Construction Easement

File No. W02229-02

August 15, 2022

A portion of the property conveyed to Debra M. Surface, Trustee of the Revocable Living Joint Trust Agreement of the Richard M. Surface and Debra M. Surface Family Trust as Document No. 2010-062958, recorded October 5, 2010 in Clackamas County Official Records, Clackamas County, Oregon and located in the Northeast Quarter of Section 27, Township 1 South, Range 4 East, Willamette Meridian, more particularly described as follows:

BEGINNING at the northeast corner of said Section 27, marked by a 3.25" brass cap; thence North 88°19'47" West 40.00 feet along the north line of said Section 27; thence South 01°24'46" West 735.00 feet parallel with the east line of said Section 27; thence South 23°21'24" East 71.60 feet to a point 10.00 feet west, when measured at a right angle, to the east line of said Section 27; thence South 01°24'46" West East 1349.62 feet parallel with the said east line to the beginning of a 130.00-foot radius curve concave northwesterly; thence southwesterly 117.77 feet along said curve through a central angle of 51°54'17", the chord of which bears South 27°21'55" West 113.78 feet; thence South 53°19'03" West 236.65 feet to the beginning of a 170.00-foot radius curve concave southeasterly; thence southwesterly 35.65 feet along said curve through a central angle of 12°01'00", the chord of which bears South 47°18'33" West 35.59 feet; thence South 41°18'03" West 62.11 feet to the beginning of a 42.00-foot radius curve concave northwesterly; thence southwesterly 25.39 feet along said curve through a central angle of 34°379'54", the chord of which bears South 58°37'00" West 25.00 feet to the northerly right-of-way line of S.E. Bluff Road; thence South 70°00'38" East 76.06 feet along said northerly right-of-way line to the beginning of a 42.00-foot radius non-tangent curve concave easterly, the radial bearing of which bears North 71°59'20" East; thence northerly 32.76 feet along said curve through a central angle of 44°41'22", the chord of which bears North 04°20'01" East 31.94 feet to the beginning of a 130.00-foot radius compound curve; thence northeasterly 60.44 feet along said curve through a central angle of 26°38'21", the chord of which bears North 39°59'53" East 59.90 feet; thence North 53°19'03" East 281.26 feet to the east line of said Section 27; thence North 01°24'46" East 2255.72 feet to the said Point of Beginning.

Containing 62,310 square feet, more or less.

The basis of bearings for this description is grid north, Oregon State Plane Coordinate System, North Zone.

This Temporary Construction Easement will terminate five (5) years from the beginning of the easement term stated in an executed Temporary Construction Easement agreement, or five (5) years after possession of the Subject Property Interests through eminent domain procedure, or the conclusion of the Project, whichever is earlier.

End of Description.

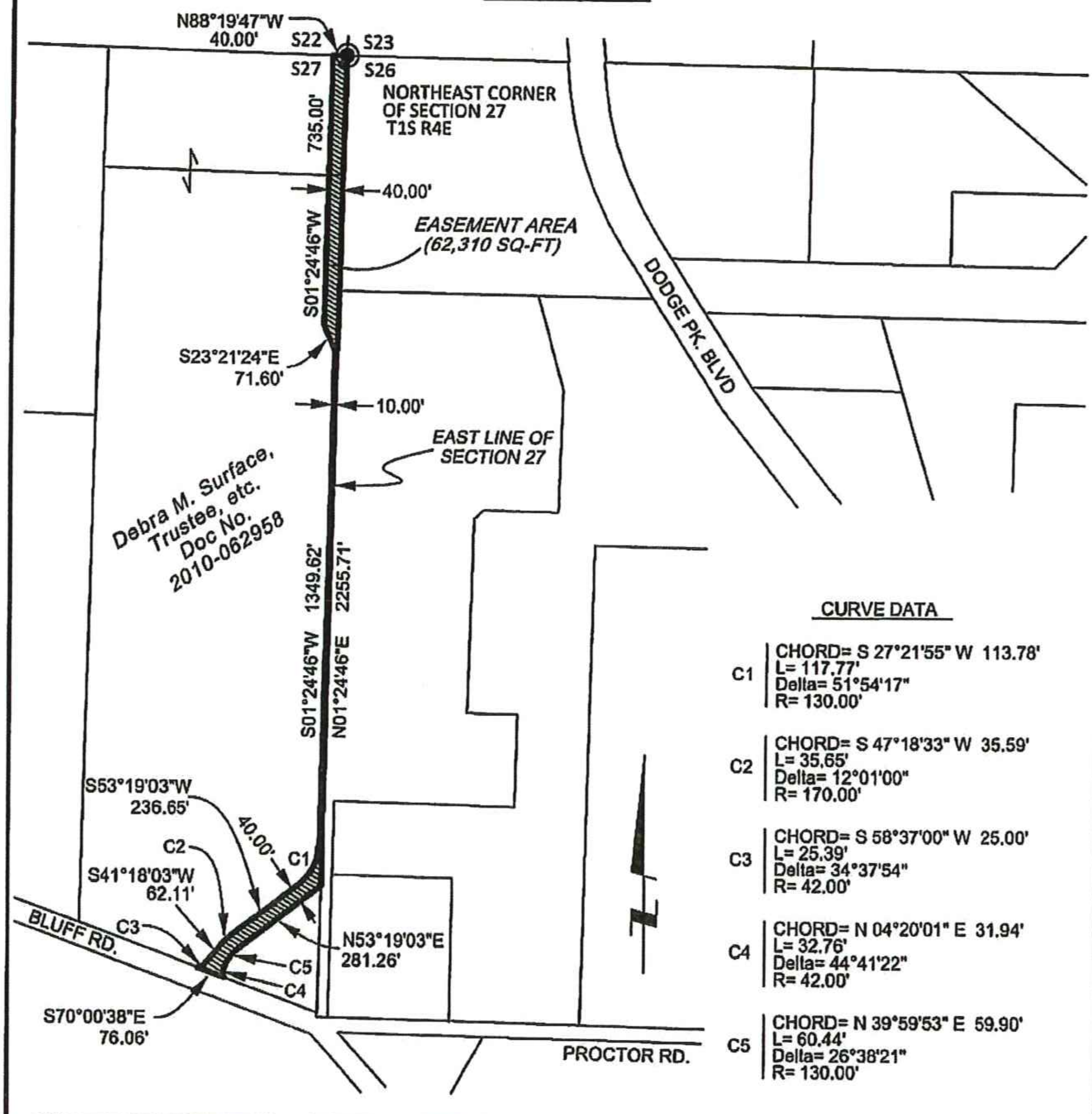
REGISTERED
PROFESSIONAL
LAND SURVEYOR

Mark Filsinger

OREGON
JULY 20, 1993
MARK D. FILSINGER
2613 LS

RENEWAL DATE: 12/31/2023

EXHIBIT B



REGISTERED
PROFESSIONAL
LAND SURVEYOR

Mark Filsinger

OREGON
JULY 20, 1993
MARK D. FILSINGER
2613 LS

RENEWAL DATE: 12/31/2023

CITY OF PORTLAND
WATER BUREAU

TEMPORARY CONSTRUCTION
EASEMENT EXHIBIT
(FILE NO. W02229-02)

8/15/2022	T1S R4E Sec 27, NE Qtr QSEC 3966
PROJECT W02563	SCALE: 1" = 400'

Received: 4 May 2022 | Accepted: 1 September 2022

DOI: 10.1002/agg2.20312

Agrosystems, Geosciences & Environment

REVIEW

Pipeline installation effects on soils and plants: A review and quantitative synthesis

Theresa Brehm | Steve Culman

College of Food, Agricultural, and Environmental Sciences, The Ohio State Univ., 1680 Madison Ave, Wooster, OH 44691, USA

Correspondence
Theresa Brehm, College of Food, Agricultural, and Environmental Sciences, The Ohio State Univ., 1680 Madison Ave., Wooster, OH 44691, USA.
Email: theresa.brehm@usda.gov

Assigned to Associate Editor Joshua McGrath.

Abstract

Oil and natural gas pipelines are essential to the transport of energy materials, but construction of these pipelines commonly causes disturbance to ecosystems. Due to variability in pipeline installation practices and environments, drawing consensus about how pipeline installations typically impact ecosystems is challenging. Here, we performed a systematic literature review to compile studies that have evaluated impacts of pipeline installation on soil and plant properties. We found 34 studies reporting pipeline impacts on agricultural and natural ecosystems from eight countries. We quantified and synthesized the magnitude of responses and found that the majority of studies found pipeline installation resulted in soil degradation via increased compaction and soil mixing, paired with decreased aggregate stability and soil carbon (C) relative to adjacent, undisturbed areas. Averaged across all studies, aggregate stability decreased 44.8%, water infiltration was reduced 85.6%, and compaction via penetration resistance increased 40.9% over pipeline areas relative to nondisturbed adjacent areas. This soil degradation led to general declines in plant productivity, with 15 out of 25 studies documenting declines in crop yields (6.2–45.6%) and six out of nine studies reporting decreased biomass from natural ecosystems (1.7–56.8%). We conclude from our quantitative synthesis that pipeline installation typically results in degraded soil and vegetation resources, and this can persist for many years following installation.

1 | INTRODUCTION

Underground pipelines are a safe and effective method for transporting oil and natural gas, with pipeline infrastructure systems now in 130 countries and on every continent (Central Intelligence Agency World Factbook Staff, 2021). Spanning over 4 million kilometers, the United States has the most extensive oil and natural gas pipeline system in the world, with roughly 486,400 km of natural gas transmission pipelines and 3,641,260 km of natural gas distribution pipelines (U.S. Bureau of Transportation Statistics Staff, 2021; U.S. PHMSA Staff, 2018).

Pipeline installation occurs within a right-of-way (ROW) or easement area, containing three major components: a trench where the pipe is laid, a work area where pipe-laying machinery traffic occurs, and a pile area where topsoil and subsoil are staged while the pipe is laid which is often adjacent to the trench. The total area of each pipeline's ROW can

Abbreviations: CEC, cation exchange capacity; EC, electrical conductivity; MBC, microbial biomass carbon; ROW, right-of-way; SIC, soil inorganic carbon; SOC, soil organic carbon; SOM, soil organic matter; TSN, total soil nitrogen.

differ per pipeline installation, pipe size, and installation depth. Historically, pipeline trenches were excavated with little to no attention paid to separating topsoil from subsoil, a practice known as a "single lift" (de Jong & Button, 1973; Harper & Kershaw, 1997; Landsburg & Cannon, 1995; Zellmer et al., 1985). Current best practices now ensure topsoil and subsoil are lifted from the trench area individually, known as a "double lift," to maintain proper separation during the installation process (Neilsen et al., 1990; Soon, Arshad, et al., 2000; Soon, Rice, et al., 2000; Tekeste et al., 2019). Double lifts are thought to decrease the rates of soil mixing between horizon layers, which often differ in texture, porosity, organic matter content, soil chemistry, and overall soil function (Desserud et al., 2010; Landsburg & Cannon, 1995; Olson & Doherty, 2012; Shi et al., 2014). Additionally, current best management practices suggest surface and deep subsoil ripping near impacted areas after pipelines have been laid to decrease long-term effects of compaction on agricultural or natural landscapes (Nexus Staff, 2022; Rover Staff, 2022).

Despite the extensive infrastructure already in place in many countries, thousands of kilometers of pipelines are still being installed globally each year (CIA World Factbook Staff, 2021). In the United States alone, pipeline mileage has increased 8.5% in the last decade (U.S. PHMSA Staff, 2020). These installations have cut through numerous ecosystems such as pastures, wetlands, forests, and agricultural fields to connect the global energy infrastructure (i.e., Jones et al., 2014; Langlois et al., 2017; McClung & Moran, 2018). The pipeline installation process causes major disturbances to these ecosystems and has the potential to fundamentally change natural soil characteristics and functioning, as well as altering the growing environment for vegetation in ROW areas compared with adjacent, undisturbed land. Through heavy machinery traffic, ineffective soil lifting via single or double lift techniques, errors in soil storage and reapplication, and inadequate site remediation after pipeline installation, areas where pipelines have been installed face potentially long-lasting deleterious effects on soil and vegetation resources (Batey, 2015; de Jong & Button, 1973; Tekeste et al., 2020).

Given the site-specific nature of pipeline installations, there is a lack of understanding and consensus on the long-term impacts on soil and vegetation resources, particularly regarding the magnitude and scope of ecosystem degradation when considering various construction, installation, and remediation practices (U.S. PHMSA Staff, 2020). To address this knowledge gap, here we present the first comprehensive, global literature review of studies documenting the effects of pipeline installations on ecosystems. The specific objectives of this study were to (a) comprehensively compile research studies reporting impacts of pipeline installation on soil and plant properties and (b) synthesize and quantify the collective mean percentage change that pipeline installations had on reported soil and plant properties in these studies.

Core Ideas

- A literature review uncovered 34 studies reporting on pipeline installation impacts to soils and plants.
- Pipelines cause sustained soil degradation for years or decades following installation.
- Soil compaction and soil horizon mixing detrimentally impact soil function.
- The 21 of 34 studies reported decreased plant biomass following installation.

2 | MATERIALS AND METHODS

Two search engines, Google Scholar and EBSCOHost, were used to find past peer-reviewed or scholarly papers about pipeline installation and effects on soil and plant yields, including journal articles, theses, dissertations, and governmental publications published prior to 15 Dec. 2020. Abstracts were required to be written in English for inclusion in this analysis. Search terms included "pipeline OR linear construction" AND "soil (characteristics OR properties OR impacts OR effects)"; "pipeline installation" AND "compaction OR erosion OR temperature"; and "pipeline installation" AND "yield OR crop yield OR producti*".

Papers were excluded if the main focus of the research was on pipeline engineering or improving installation techniques from a non-natural sciences perspective. Additionally, papers were omitted if there were no mentions of installation effects on soils or plants within the title or abstract. After an original search was conducted, these papers were also back- and front-searched to identify related studies missing from our original search, and the same exclusion processes were repeated for all back- and front-searched papers.

After examining the reported studies, our ability to conduct a meta-analysis was compromised by a (a) limited number of total studies, (b) lack of key information regarding pipeline installation processes (e.g., single vs. double lift), (c) lack of reported estimates of variability, and (d) inconsistencies across studies regarding soil and plant properties reported. As such, we opted for a quantitative synthesis which standardized responses across studies for comparative purposes. Data were compiled from all relevant papers regarding soil physical, chemical, and biological properties as well as vegetative response to pipeline installation. First, all soil and plant variables reported from each study were classified into one of three categories: increase, no significant change, or decrease. These classifications reflected what authors reported in the respective studies of how areas over pipeline ROW were impacted relative to nondisturbed adjacent areas, with statistical significance used from the original studies at $p < .05$ or

$p < .1$ levels. From each study, a percentage difference was calculated to assess the impact of pipeline installation on the reported variable. For studies that reported multiple areas over the ROW (e.g., over the trench, from work areas, etc.), all values were combined into one average "ROW" value for the study, while all measurements reported from adjacent areas were combined into one average "ADJ" value, used as a control to understand implications of pipeline installation on a study-by-study basis. Then a percentage difference for each variable within each study was calculated using Equation 1:

$$\%\ \text{difference} = \left(\frac{\text{ROW} - \text{ADJ}}{\text{ADJ}}\right) 100 \quad (1)$$

Percentage difference was used to standardize values across soil types, ecosystems, and management styles, as well as to assess the directionality and magnitude of response throughout all studies. Finally, a mean and range of percentage difference values across all studies was calculated for each soil and plant variable.

3 | RESULTS AND DISCUSSION

3.1 | Characteristics of pipelines studied

In total, 34 peer-reviewed or scholarly papers were found from eight countries (Table 1). The first pivotal study of the effects of pipeline system installation on agricultural areas was written in 1973 by de Jong and Button. However, of the 34 total studies, the majority ($n = 19$) were published within the last decade, revealing an increase in research interest in this field. Studies have reported on many ecosystems, including agricultural land, wetlands, forests, native prairies, drylands, and grasslands. Agricultural crops studied include corn (*Zea mays* L.), soybean [*Glycine max* (L.) Merr.], alfalfa (*Medicago sativa* L.), cereal grains such as sorghum [*Sorghum bicolor* (L.) Moench], wheat (*Triticum aestivum* L.), and barley (*Hordeum vulgare* L.), potato (*Solanum tuberosum* L.), raspberry (*Rubus idaeus* L.), and sunflower (*Helianthus annuus* L.).

The age of pipelines studied ranged from during the installation process to 53 yr post-installation but averaged 8.7 yr after installation. Most pipelines were studied within 10 yr of installation (25 out of 34 studies). Both single ($n = 7$) and double lift ($n = 10$) excavations were reported in the construction processes, though some studies ($n = 3$) included multiple pipelines which used different lift techniques and others ($n = 14$) did not specify the type of lift used. Studies with installations via double lifts have become more commonplace, particularly within the United States since the mid-1970s as U.S. federal regulations have attempted to standardize recommendations around separation of topsoil and subsoil in the pipeline construction process.

With research spanning five continents, differences in landscape properties have led to localized construction practices to best fit each installation site. Additionally, conditions when pipelines were installed (i.e., soil moisture conditions and time of year) also differ temporally and spatially. Studies analyzed a range of properties such as soil compaction, nutrient content, chemical data, crop yield, and plant growth, each of which will be discussed in detail below. For nearly all studies, it was typical for adjacent, undisturbed fields to be used as a control for comparative purposes. Some studies reported aggregate values from ROW areas, while others sampled separate ROW areas, differentiating between the trench, work areas, and piling areas.

3.2 | Soil physical properties

3.2.1 | Compaction

Compaction was measured via bulk density or penetration resistance. Bulk density measures the dry mass of soil including pore spaces between soil aggregates divided by a specified volume of soil collected. Higher bulk density (decreased pore space) is indicative of compacted soils. Conversely, penetration resistance is a measurement of the pressure required to reach a certain depth within a soil profile using a cone index penetrometer. Higher rates of penetration resistance are correlated with increased soil compaction.

Of the 26 studies reporting compaction via bulk density or penetration resistance, there was a mean increase of 12.6% in bulk density (ranging from −8.6 to 63.7%) and a 40.9% mean increase in penetration resistance (ranging from 1.4 to 133.3%) (Table 2, Figure 1). Culley et al. (1981) found that compaction and penetration resistance were more prevalent on fine- or medium- textured soils compared with coarse-textured soils. Additionally, bulk density and penetration resistance were consistently higher, up to a 10% increase, on pipeline ROWs compared with undisturbed fields, with work area > trench > undisturbed field (Culley et al., 1981). Naeth et al. (1987) reported 51–82% increases in bulk density in disturbed ROW, with greater subsurface compaction in the work area relative to the trench area where deeper soils had been removed and replaced.

Soon, Arshad, et al. (2000) measured bulk density in Alberta, Canada, and found that bulk density was significantly higher in the trench zone than in undisturbed fields. Additionally, penetration resistance in these fields was found to increase with disturbance, with trench = pile area > work area > undisturbed field. In a wetland study in Wisconsin, ROW soil had bulk densities 63% higher than adjacent areas

TABLE 1 Published scientific and governmental studies found evaluating the impacts of pipeline installation on soil and plant properties

Study reference no.	Country	State/province	Citation	No. of pipelines studied	Years since pipeline installed	Soil properties reported	Plant properties reported
1	Canada	Saskatoon	de Jong and Button (1973)	13	1–13	physical, chemical	grain yield
2		Ontario	Culley et al. (1981)	1	3	physical, chemical	grain yield, midsummer plant height, nutrient content
3		Ontario	Culley et al. (1982)	1	5	physical, chemical	grain yield, biomass production, plant height, cob length
4		Alberta	Naeth et al. (1987)	5	6, 15, 19, 24, 30	physical, chemical	not reported
5		Ontario	Culley and Dow (1988)	1	10	physical, chemical	grain yield, crop height
6		Alberta	Landsburg and Cannon (1989)	1	1	physical, chemical	not reported
7		Not specified	Neilsen et al. (1990)	1	2–3	physical	grain yield, emergence, seedling survival rate, plant height, silking
8		Alberta	Naeth et al. (1993)	2	12, 36	physical	not reported
9		Northwest Territories	Harper and Kershaw (1997)	1	53	physical, chemical	not reported
10		Ontario	Ivey and McBride (1999)	1	30+	physical, chemical	not reported
11		Alberta	Soon, Arshad, et al. (2000)	1	3	chemical, biological	above and belowground biomass, grain macronutrients
12		Alberta	Soon, Rice, et al. (2000)	1	3	physical, chemical	Not reported
13		Alberta	Desserud et al. (2010)	14	7–40	Physical	mean percentage cover, plant species frequency
14		Alberta	Low (2016)	1	6	not reported	species diversity, species abundance, species richness
15		British Columbia	Turner (2016)	1	2	physical, chemical	species diversity, species abundance, species richness
16	USA	Oklahoma	Zellmer et al. (1985)	1	2	physical, chemical	aboveground biomass and yield estimations
17		Kansas and Missouri	Duncan and DeJoia (2011)	1	1	physical, chemical	not reported
18		Wisconsin	Olson and Dougherty (2012)	1	8	physical	Mean percentage cover, species presence, coverage, diversity, quality, proportional species abundance

(Continues)

TABLE 1 (Continued)

Study reference no.	Country	State/province	Citation	No. of pipelines studied	Years since pipeline installed	Soil properties reported	Plant properties reported
19		New York	Schindelback and van Es (2012)	1	1	physical, chemical, biological	not reported
20		Wyoming	Gasch et al. (2016)	4	1, 5, 36, 55	physical, chemical, biological	total percentage plant coverage, plant abundance
21		Texas	Wester et al. (2019)	1	2	physical, chemical	grain yield, seedling emergence
22		Iowa	Tekeste et al. (2019)	1	0 (during installation)	physical	not reported
23		Iowa	Tekeste et al. (2020)	1	1	physical	grain yield
24	China	Xinjiang Province and Ningxia Hui Autonomous Region	Shi et al. (2014)	3	2, 6, 8	physical, chemical	not reported
25		Xinjiang Province and Ningxia Hui Autonomous Region	Xiao et al. (2014)	3	2, 6, 8	chemical	species coverage, species classification, diversity, evenness, richness, and similarity
26		Gansu and Shaanxi Provinces	Shi et al. (2015)	3	2, 6, 8	physical, chemical	plant height, stem size, corncob length and size
27		Northwest China	Xiao et al. (2017)	3	not reported		plant species classification using comparative analysis and TWINSPAN
28	Australia	Queensland	Vacher et al. (2014)	1	not reported	physical, chemical	not reported
29		Queensland	Antille et al. (2015)	1	3	physical, chemical	crop modeling using APSIM
30		Queensland	Vacher et al. (2016)	1	5+	physical	not reported
31	Argentina	Chebut	Kowaljow and Rostagno (2008)	1	3	physical, chemical	total percentage plant coverage
32	Azerbaijan	Various	Winning and Hann (2014)	1	not reported	physical	not reported
33	United Kingdom	Various	Batey (2015)	60+	studied over 40+ career years	physical, chemical	grain and harvestable yield, claims made for yield loss
34	Slovak Republic	Nitra	Halmova et al. (2017)	1	not reported	Physical	grain yield, aboveground biomass

TABLE 2 Mean and (range) of percentage change of various soil physical properties on pipeline right-of-way (ROW) areas relative to adjacent, undisturbed areas

	No. of studies				Mean percentage	
Property	**Total**	**Increase**	**No change**	**Decrease**	**change (range)**	**Citations**
Bulk density	16	10	5	1	12.6 (−8.6 to 63.7)	1, 2, 3, 4, 5, 6, 7, 11, 15, 16, 18, 20, 22, 23, 29, 33
Penetration resistance	10	7	3	0	40.9 (1.4 to 133.3)	1, 2, 3, 11, 18, 19, 22, 23, 29, 31
Soil mixing[a]	28	24	4	0	17.1 (−3.2 to 102.6)	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 24, 25, 26, 28, 29, 30, 33
Aggregate stability	12	0	0	12	−44.8 (−84.5 to −22.2)	2, 3, 10, 13, 18, 19, 21, 28, 32, 29, 15, 30
Soil temperature	5	5	0	0	38.9 (10.5 to 62.9)	8, 9, 15, 26, 34
Soil moisture	8	1	3	4	−3.9 (−25.4 to 40.4)	1, 6, 9, 11, 18, 20, 22, 34
Hydraulic conductivity	6	1	3	2	−11.2 (−38.0 to 7.1)	2, 5, 16, 17, 19, 24
Water infiltration	3	0	0	3	−85.6 (−92.7 to −78.4)	28, 29, 31
Coarse fragments/rocks	7	6	1	0	[b]	2, 4, 9, 17, 19, 24, 25

Note. Studies were classified as reporting an increase, no significant change, or decrease in the soil property in ROW relative to undisturbed areas. Positive and negative percentage changes indicate a respective increase or decrease in value over the ROW relative to the undisturbed areas. Citations refer to the study reference number listed in Table 1.

[a]Soil mixing calculated via alterations in particle size distribution and soil textural analysis.

[b]Quantitative data values rarely reported, typically observations qualitatively described in text.

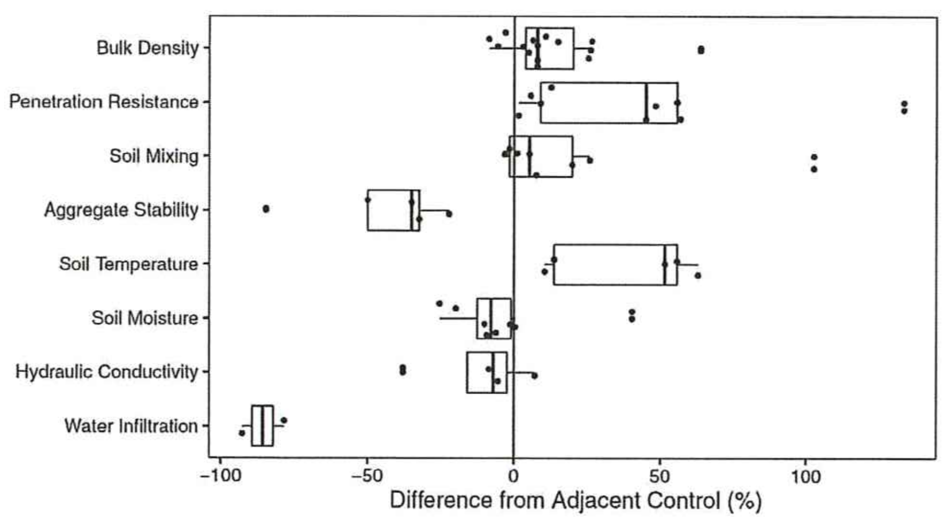


FIGURE 1 Percentage difference values for select soil physical properties between right-of-way vs. adjacent, unaffected areas. Points represent mean percentage difference of each study with boxplots representing the distribution of values. Positive and negative values indicate a respective increase or in the soil property values over the pipeline area relative to adjacent areas

(Olson & Doherty, 2012). Antille et al. (2015) found that soil compaction within lease areas increased by approximately 10% compared with undisturbed fields ($p < .05$). Additionally, surface compaction from 0 to 40 cm and subsurface compaction were significantly higher in all lease areas as well. In the United Kingdom, Batey (2015) observed that severe subsoil compaction was a factor in poor crop growth and drainage, particularly in work areas around the country. However, surface compaction in these soils was rarely detected. A similar conclusion was found by Vacher et al. (2016), where subsurface compaction increased by 15–20% in disturbed areas.

Tekeste et al. (2019) conducted compaction studies during the installation of the Dakota Access Pipeline (DAPL) in Iowa and found that ROW zones had significantly higher compaction than adjacent, undisturbed corn fields. Additionally, evidence of deep subsoil compaction, or a hardpan, was much more prevalent than surface compaction in ROW soils, with an "abrupt increase" in penetration resistance evident when instruments entered the subsoil layer.

While a majority of studies showed increases in compaction, some studies differ, including Solonetzic soils in northern Canada, where the deep ripping remediation conducted after pipeline construction increased permeability at depth and mixed soil horizons compared with adjacent areas (de Jong & Button, 1973). This ripping created an overall more favorable growing environment for vegetation by increasing porosity and hydrology of the soils, as well as elevated levels of organic matter at depth, which provided increased nutrient availability to deeper plant roots. However, within the same study, Chernozemic (mollisol) soils were also evaluated, and the opposite trends were found; soil compaction increased with depth and significant differences in wheat yields were not found.

One study by Zellmer et al. (1985) found that bulk density was significantly lower on the trench than in a control area or work area, though only by 3.0%. Schindelbeck and van Es (2012) found that decompaction efforts after pipeline installation decreased surface and subsurface hardness measured via penetration resistance by −3.0 and −11.0%, respectively, within agricultural soils, as evaluated using the Cornell Soil Health Assessment. Turner (2016) reported variable bulk densities when comparing forested and ROW soils in British Columbia, Canada, noting that high bulk density readings were found in both areas, though wetland blocks studied showed consistently higher bulk densities than forested blocks in pipeline-impacted soils.

3.2.2 | Soil mixing

Soil mixing via changes in soil texture and particle size distribution within ROW areas increased by an average of 17.1% in 28 studies, with a range of −3.2 to 102.6% (Table 2). Evidence of soil mixing can often be seen through higher clay content in surface horizons, decreased soil carbon (C), and visible changes in soil color as a result of soil churning or mixing. These effects are typically long-lasting. For example, de Jong and Button (1973) documented that soil mixed from pipeline installation 10 yr prior still had visible effects of subsoil clays on the surface. These enduring effects can fundamentally alter other soil characteristics such as water holding capacity, pH, organic matter, cation exchange capacity, and available nutrients, each of which will be discussed in greater detail in subsequent sections. Evidence of anthropogenically altered soil horizons date back to the early days of agricultural development, with Mayan and Roman agriculture and construction activities still observable on landscape scales (Dror et al., 2021; Hartshorn et al., 2006; Sandor & Homburg, 2017). However, remediation measures such as erosion control blankets, chemical amendments like humic acids, and biological amendments such as cover cropping can alleviate some detrimental effects of soil mixing in some ecological stands given proper rates of amendments (Wester et al., 2019).

3.2.3 | Aggregate stability and erodibility potential

All 12 studies that measured pipeline installation impacts on aggregate stability found significant decreases, with an average reduction of 44.8% and ranging from 22.2 to 84.5% (Table 2, Figure 1). Evidence of subsidence, or the gradual settling or sinking of soil, in ROW areas has been documented by Vacher et al. (2016), which states that depressions in disturbed fields after pipeline installation measured between 10 and 20 cm below the average slope of the adjacent study area. Introduced depressions like this can create instances of new hydric soils or vernal pools. In this study, aerial imagery was used to demonstrate alterations in elevation within the ROW, and erosion potential in these subsided areas was three to four times higher than unaffected areas. This study was conducted on vertic (vertisol) soils, which have a high shrink-swell capacity due to high clay content, paired with high water infiltration capacity, making them generally difficult to erode under normal circumstances. Ivey and McBride (1999) documented eroded areas with ROWs as well, noting that these areas contained lower percentage organic C than uneroded areas of the ROW, and similar findings were reported by Shi et al. (2014) in soils from western China and by Duncan and DeJoia (2011) in the midwestern United States. Landsburg and Cannon (1995) stated that wind erosion potential increased on pipeline areas if revegetation was not successful, particularly in soils with clayey surfaces. Additionally, Winning and Hann (2014) note that erosion potential also increased near rivers and in areas of high seismic activity. Schindelbeck and van Es (2012) found evidence of significant reduction in aggregate stability in all land types studied (agricultural areas, wetlands, and fallow lands) following pipeline installation, resulting in an average of 32% reduction in aggregate stability following construction activities. Fallow lands showed the most intensive decrease in aggregate stability (60%), while agricultural lands decreased an average of 27%.

3.2.4 | Soil temperature

Increased soil temperature was documented by five studies, with an average increase in temperature of 38.9% along ROW compared with adjacent areas, ranging from 10.5 to 62.9% higher in ROW areas compared with ADJ (Table 2). Pipelines are often internally heated to ensure proper fluidity of materials being transported, and great effort is made to reduce heat loss from pipelines into the surrounding environment. Yet, some heat can escape from pipelined areas, resulting in elevated soil temperature, decreased soil moisture, and potential alteration to soil microbial communities (Naeth et al., 1993). Halmova et al. (2017) in the Slovak Republic reported the temperature of a transported gas pipeline increased soil temperature above the pipeline 2.1–3.4 °C higher than soils farther away from the pipeline. Comparatively, Shi et al. (2015) reported a 1.0–2.0 °C increase in temperature along ROW areas in western China. However, it is essential to note that changes in albedo due to surface color change from bare soil or introduction of a new type of vegetation can also impact soil temperatures. Nonetheless, pipeline-impacted areas which do experience alterations in vegetation as well as potential pipeline-derived temperature leakages may be subject to increased soil temperatures near the pipeline trench.

3.2.5 | Soil moisture, hydraulic conductivity, and water infiltration capacity

Decreases in soil moisture were reported in half of studies (four of eight), with a mean decrease of 3.9%, ranging from −25.4 to 40.4% (Table 2). Notably, Halmova et al. (2017) attributed this decrease in gravimetric soil moisture to increases in soil temperature along the ROW but could also be due to soil mixing and subsequent changes to soil texture nearer to the surface. Natural wetland areas can be particularly disturbed by this decrease in soil moisture, where much of the native vegetation is moisture-dependent for proper growth (Olson & Doherty, 2012). Introduced, non-naturally forming vernal pools can be seen in ROW areas alongside areas of decreased moisture, which could be a result of uneven rates of soil mixing across the ROW.

Hydraulic conductivity of soils over the ROW was decreased on average of 11.2% across six studies. This is largely connected to compaction and permeability alterations in the soil, which some studies connect to remediation measures implemented at sites post-installation (Culley et al., 1982; Culley & Dow, 1988; Soon, Rice, et al., 2000). Culley et al. (1982) found that hydraulic conductivity on ROWs decreased by an average of 38% compared with undisturbed fields. In this study, total porosity decreased, but drainable porosity remained the same, and volumetric water content was similar between ROW and undisturbed fields. Soon, Rice, et al. (2000) found that hydraulic conductivity rates decreased at least 10-fold in ROW soils compared with adjacent, undisturbed areas, and water retention and release capacities were reduced by at least 40% from 0 to 12 cm in depth. Alternatively, Zellmer et al. (1985) found evidence of increased water holding capacity, which they attribute to be likely due to soil mixing and remediation measures which decreased bulk density compared with pre-installation.

Between the studies which analyzed water infiltration capacity, there was an average decrease of 85.6% across all three studies (Table 2, Figure 1). Antille et al. (2015) reported significant decreases in infiltration rates in every paired comparison. Overall, in poorly remediated soils and soil with high clay content, alterations in soil hydrology have been apparent through decreased water infiltration rates, decreased total porosity, decreased water holding capacity, and decreased total soil moisture (Antille et al., 2015; Culley et al., 1982; Culley & Dow, 1988; Landsburg & Cannon, 1989; Olson & Doherty, 2012).

3.2.6 | Exposed coarse rock fragments

Increased amounts of coarse fragments were found in six of the seven studies conducted, while one study reported no significant change between the ROW and adjacent areas (Table 2). In most studies, coarse rock fragments were not directly quantified, rather often qualitatively described. During the pipeline installation process, rocks in the subsoil can be excavated and brought to the surface, or when soils are not deep enough to allow pipelines to maintain their required depth, bedrock is often broken up via mechanical pressure and explosives to create the necessary space for placement. This commonly results in an increase in rocks in installation areas, ranging from the size of small pebbles to boulders (Batey, 2015). In the review by Landsburg and Cannon (1995), evidence of increasing stoniness was reported in 8 of 48 soils studied.

TABLE 3 Mean (range) percentage change of various soil chemical properties on pipeline right-of-way (ROW) areas relative to adjacent, undisturbed areas (ADJ)

Property	No. of studies				Mean percentage change (range)	Citations
	Total	Increase	No change	Decrease		
pH	19	9	10	0	6.81 (0.57 to 41.0)	1, 2, 3, 4, 5, 6, 9, 10, 11, 15, 16, 17, 19, 20, 21, 25, 26, 29, 31
Soil organic carbon (C)[a]	21	0	4	17	−20.8 (−49.7 to 2.4)	2, 3, 4, 5, 6, 7, 9, 10, 12, 15, 16, 17, 19, 20, 24, 25, 26, 28, 29, 31, 33
Total soil nitrogen (N)	11	2	0	9	97.3 (−49.5 to 1,166.7)	2, 3, 5, 7, 12, 15, 20, 21, 24, 26, 31
Cation exchange capacity	7	1	4	2	−1.0 (−26.8 to 42.5)	1, 3, 5, 15, 16, 17, 29
Electrical conductivity	9	7	2	0	109.4 (5.2 to 267.0)	1, 4, 6, 11, 16, 20, 21, 29, 31
Nitrate-nitrogen (NO_3–N)[b]	2	0	0	2	−56.2 (−76.7 to −35.6)	1, 19
Phosphorus (P)[c]	12	1	8	3	−13.7 (−71.3 to 39.7)	1, 2, 3, 10, 15, 16, 17, 19, 21, 24, 26, 31
Potassium (K)[c]	13	3	8	2	5.8 (−19.1 to 41.4)	1, 2, 3, 4, 5, 10, 16, 17, 19, 21, 24, 26, 29
Calcium (Ca)[c]	9	6	3	0	64.7 (−6.7 to 244.6)	4, 5, 6, 10, 11, 16, 17, 21, 29
Magnesium (Mg)[c]	9	3	4	2	88.6 (−23.5 to 410.0)	5, 6, 10, 11, 16, 17, 29, 21, 29
Sodium (Na)[c]	7	5	1	1	226.4 (−16.5 to 591.7)	4, 6, 10, 11, 16, 21, 29
Sulfur (S)[c]	5	4	0	1	479.2 (−54.2 to 1,516.7)	4, 6, 11, 15, 21

Note. Studies were classified as reporting an increase, no significant change, or decrease in the soil property in ROW relative to ADJ areas. Positive and negative percentage changes indicate a respective increase or decrease in value over the ROW relative to the undisturbed areas. Citations refer to the study reference number listed in Table 1.
[a]Soil organic carbon is calculated from both soil organic matter and soil C.
[b]NO_3–N extractants used by de Jong and Button (1973) and Schindelbeck and van Es (2012) were $CuSO_4$ and KCl, respectively.
[c]Extractable P, K, Ca, Mg, Na, S.

3.3 | Soil chemical properties

3.3.1 | pH

No significant change in soil pH following pipeline installation were found in 10 out of 19 studies (Table 3). However, nine studies, including studies conducted as early as Zellmer et al. (1985) and Naeth et al. (1987) when revegetation and soil management of ROW areas were not required by law, observed relatively uniform soil pH levels throughout the entire soil profile as a result of extreme soil mixing (Figure 2). This was commonly found in studies though rates of increase were largely determined by inherent soil pH, with an average increase in pH of 6.8% (Table 3). De Jong and Button reported surface pH generally increased 0.5 for Solonetzic soils but increased up to 1.0 in Chernozemic soils. Additionally, Landsburg and Cannon (1995) reported a general increase in surface soil pH of 0.5 to 2.0, often occurring within the top 30 cm. However, Soon, Rice, et al. (2000) found that pH was highest in the year after installation, and continuously decreased in years following; the authors did not describe instances of liming on sampled areas, which may have otherwise explained decreased pH over time within the study.

3.3.2 | Soil organic C

An average decrease of 20.8% in soil organic C, measured by a combination of soil organic matter (SOM) and soil organic carbon (SOC), occurred in ROW areas compared with ADJ, throughout 21 studies (Table 3). Increases in either organic

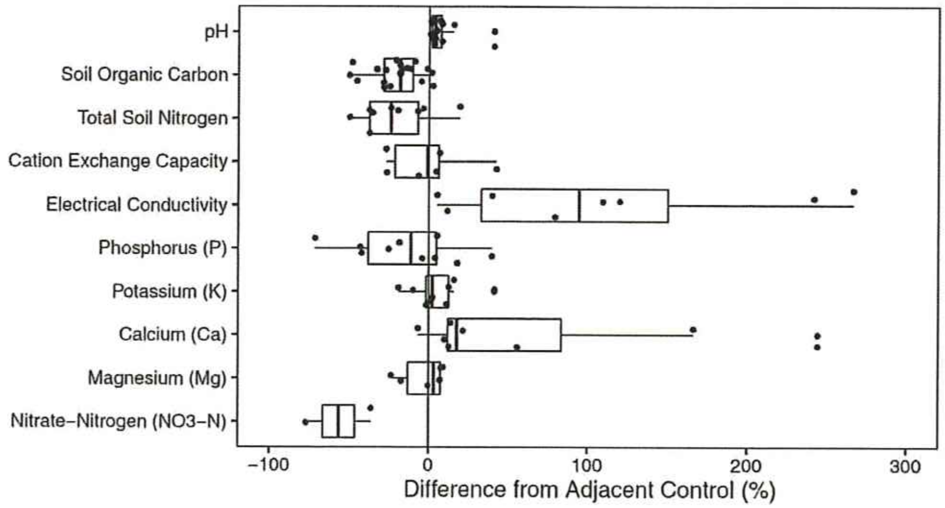


FIGURE 2 Percentage difference values for select soil chemical properties between right-of-way vs. adjacent, unaffected areas. Points represent mean percent difference of each study with boxplots representing the distribution of values. Positive and negative values indicate a respective increase or in the soil property values over the pipeline area relative to adjacent areas. Figure was truncated to improve visualization and clarity, resulting in three data points not shown for total soil N and Mg, collectively

matter or soil C were not found in any study (Figure 2). In general, most studies found the SOC levels decreased in proximity to the trench, with highest SOC levels found in undisturbed fields > work areas > trenches.

Culley et al. (1982) estimated that soil mixing and resulting topsoil dilution resulted in a 20–50% decrease in SOC from 0 to 15 cm, paired with an increase in SOC from 15 to 30 cm, compared with no changes in undisturbed fields. Likewise, Schindelbeck and van Es (2012) found a decrease of SOC by 44%, measured from 0 to 15 cm. When comparing pipelines' impacts on native grassland, Naeth et al. (1987) found that SOC concentration was between 2.5 and 6.5 times higher in undisturbed areas than ROWs and work areas had 1.1–2 times higher SOC compared with trenches. Additionally, Soon, Rice, et al. (2000) reported a SOC decrease of 12% in a work area 3 yr following pipeline installation. In a continuous study for 10 yr after a pipeline installation in Ontario, Canada, Culley and Dow (1988) reported that there were still lower SOM levels on the ROW compared with undisturbed fields. When studying a pipeline almost 50 yr after installation in the Northwest Territories of Canada, Harper and Kershaw (1997) found similarly lower SOM levels, and the authors concluded that soil development over ROW areas was slowed following pipeline installation.

However, it is not only the total SOM and SOC which is altered by pipeline installation. Ivey and McBride (1999) found that soil inorganic carbon (SIC) content increased by 1.0–3.0% while SOC decreased by 0.5–1.0% over the trench compared with a control area, with no reporting of limestone as an amendment used on this site. While disturbance in general impacts SOM and SOC levels, installation processes also create potential for more loss, particularly through period of increased precipitation accumulation and melting; however, instances of increased SOM can be found in areas with higher moisture rates, such as newly emerged vernal pools following pipeline installation. Neilsen et al. (1990) found the largest decreases in SOM occurred in soils where pipelines were installed in winter months where soil mixing was the most extreme.

3.3.3 | Nitrogen

Similar to SOC, total soil nitrogen (TSN) often decreases with disturbance. Across 11 total studies reporting TSN, there was a mean increase of 97.3%, but a median decrease of 23.9% (Table 3). Culley et al. (1981) found that TSN decreased within the 0-to-15-cm range but increased from 15 to 30 cm, and the authors estimated that organic N production was decreased by roughly 40% as a result of pipeline construction disturbance (Culley et al., 1982). After 10 yr of analysis, Culley and Dow (1988) reported ROW soils still contained 23.9% less TSN than undisturbed fields. Landsburg and Cannon (1995), Soon, Rice, et al. (2000), Kowaljow and Rostagno (2008), Shi et al. (2014), and Shi et al. (2015) reported similar decreases in TSN with pipeline installation. Schindelbeck and van Es (2012) reported a decrease of 76% in potentially mineralizable N in one soil studied following installation. Only two accounts of increases in TSN were reported, including Wester et al. (2019) which documented an increase of 1,166.7% in TSN, which the authors concluded was a result of the erosion control measures applied to the ROW compared with adjacent areas, rather than an inherent increase in TSN derived from pipeline installation.

3.3.4 | Cation exchange capacity

Cation exchange capacity (CEC) was inconsistently impacted with pipeline installations, with a mean decrease of 1.0% across seven studies (Table 3, Figure 2). Culley et al. (1982) reported a decrease in CEC within ROW agricultural soils compared with undisturbed fields following pipeline installation in Alberta, Canada. This finding is, interestingly, contradicted in a later study by Culley and Dow (1988), which found that CEC was greater in ROW relative to the undisturbed area 10 yr after pipeline installation.

3.3.5 | Electrical conductivity

In total, seven out of nine studies reported a significant increase in electrical conductivity (EC), with an average increase of 109.4% along ROW areas compared with adjacent areas across all studies, ranging from 5.2 to 267.0% (Table 3). Zellmer et al. (1985) found increasing sodium (Na) levels within the trench compared with off-ROW soils, suggesting sodium increases were due to soil horizon mixing. Similarly, Naeth et al. (1987) reported sodium adsorption rates up to five times higher in the trench compared with a control area. However, Landsburg and Cannon (1995) reported that EC levels returned to pre-disturbance levels within 5 yr of pipeline installation, beginning first at surface levels, then moving deeper as a result of leaching. De Jong and Button (1973) found that EC increased with depth, particularly in Solonetzic soils with newly installed pipelines. Similarly, Soon, Rice, et al. (2000) reported that EC levels were appreciably higher at deeper levels, from 50 to 100 cm, but the decrease after installation time Landsburg and Cannon (1995) reported was not confirmed through this study.

3.3.6 | Available nutrients

Compared with C and nitrogen (N) levels, available nutrients did not inherently decrease with proximity to pipeline and increasing rates of disturbance; rather, nutrient availability were largely dependent on soil type (Table 3). On average, alterations to phosphorus (P), potassium (K), and magnesium (Mg) nutrient levels were not significantly different from adjacent areas (Figure 2). De Jong and Button (1973) reported a decrease in P and K with depth, indicating mixing of topsoil horizons, where available nutrients are generally elevated, with subsoil, where nutrients are limited. Soon, Rice, et al. (2000) also noted that K decreased with depth in their study in Alberta, Canada.

In comparison, increases in calcium (Ca) level occurred in 67% of studies, likely derived from bedrock introduction to upper soil horizons, up to 15 cm from the soil surface, as a result of soil mixing bringing Ca-rich subsoil closer to the surface as well as remediation efforts via agricultural liming (Culley et al., 1981; Landsburg, 1989; Soon, Rice, et al., 2000; Zellmer et al., 1985). In a 10-yr study performed by Culley and Dow (1988), these findings were confirmed, stating that surface soils were increasingly calcareous compared with undisturbed fields. Additionally, Mg, Na, and S were found to increase in surface soils and with depth following pipeline installation, with mean increases of 88.6, 226.4, and 479.2%, respectively (Table 3, Landsburg, 1989; Soon, Rice, et al., 2000).

3.4 | Soil biological and biochemical properties

Little research has been conducted regarding impacts of pipelines on biological or biochemical soil properties. Soon, Arshad, et al. (2000) measured microbial biomass carbon (MBC) before and after pipeline installation, and found varying results on MBC, with no consistent effect from year to year. Overall, researchers concluded the average level of MBC was not adversely affected by pipeline installation. Gasch et al. (2016) also reported variable microbial abundance in ROW areas crossing a native sagebrush steppe in Wyoming. Conversely, Schindelbeck and van Es (2012) found significant decreases of 73% in biologically active C (permanganate oxidizable C) in pipeline areas relative to adjacent areas in New York. The authors hypothesize this is due to uncontrolled soil mixing, increasing biological activity at depth, and decreasing biological activity in surface soils. Soil health scoring of these soils saw a significant decrease of soil quality, averaging a 27% decrease in soil function, as evaluated by the Cornell Soil Health Test. Root health ratings taken during this study were not significant.

3.5 | Crop yield and plant productivity responses

Decreases in plant biomass accumulation were common among almost all species reported, with average decreases in agricultural crop yields of 10.5, 33.2, 23.6, 6.2, and 10.8% for corn grain, corn silage, soybean, alfalfa, and small grains, respectively (Table 4, Figure 3). Corn grain yields were reduced up to 50% in the first 2 yr after installation on the ROW relative to control areas (Culley et al., 1981). After 10 yr, corn yields were still suppressed, with ROW crops only yielding 77% of control area yields. In silage corn, yields were reduced by roughly 40% in the 1st year following pipeline installation (Culley et al., 1981).

TABLE 4 Mean (range) percentage change of crop yield or vegetation productivity on pipeline right-of-way (ROW) areas relative to adjacent, undisturbed areas (ADJ) across all studies

		No. of studies				Mean percentage	
Ecosystem type	Plant community	Total	Increase	No change	Decrease	change (range)	Citations
Agricultural crops	corn (grain)	5	0	1	4	−10.5 (−30.7 to 23.7)	2, 3, 5, 7, 26
	corn (silage)	2	0	0	2	−33.2 (−40.3 to −26.2)	3, 5
	soybean	3	0	0	3	−23.6 (−27.6 to −18.3)	2, 3, 5
	alfalfa	3	0	2	1	−6.2 (−22.2 to 1.91)	2, 3, 5
	small grains (barley, sorghum, wheat)	11	2	3	4	−10.8 (−67.6 to 32.0)	1, 2, 3, 5, 12, 16, 29
	raspberry	1	0	0	1	−45.6	33
	sunflower	1	1	0	0	8.1	34
Grasslands	prairie, grasses, shrubland	6	0	1	5	−56.8 (−85.7 to −24.8)	13, 14, 16, 25, 27, 31
Forests	forest	1	0	1	0	−1.7	15
Wetlands	wetland	2	0	1	1	−7.2 (−14.7 to 0.26)	14, 18

Note. Studies were classified as reporting an increase, no significant change, or decrease in the yield or productivity in ROW relative to ADJ. Positive and negative percentage changes indicate a respective increase and decrease in value over the ROW relative to the undisturbed areas. Citations refer to the study reference number listed in Table 1.

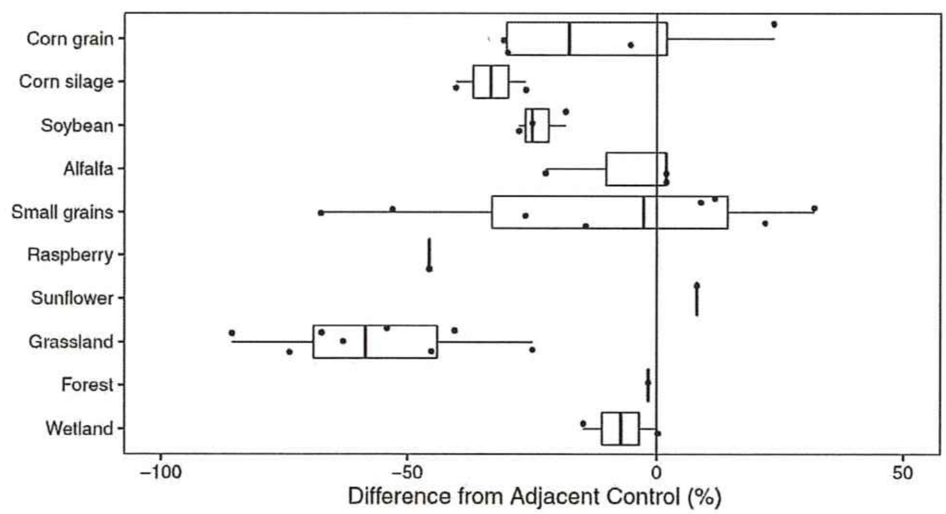


FIGURE 3 Percentage difference values for vegetative yields between right-of-way (ROW) vs. adjacent, unaffected areas (ADJ). Percentage differences were calculated with each study's paired replicate with the point representing the mean of each study's paired replicate with the point representing the mean of each study. Values on the left side of the solid line indicate a decrease in yield values when compared with adjacent values, while values on the right side indicate an increase in yield value

Neilsen et al. (1990) reported that, while corn emergence was not affected by pipeline installation, silking was delayed, corn plants were stunted, and yields were decreased on ROW. While fertilizer improved yield and accelerated silking times, the authors found that yield reductions in the ROW persisted and were greatest in areas with initially lower SOM and higher bulk density. Culley et al. (1981) and Landsburg and Cannon (1995) individually reported decreased yields in mixed soils within greenhouse studies, even when fertilized, causing both studies to conclude that fertilization alone could not fully remediate disturbed soils.

Soon, Rice, et al. (2000) reported decreased small grain yields in barley crops on ROW soils during the first harvest season after pipeline installation, but in the following 2 yr of the study, yields were comparable with that of undisturbed fields. Culley et al. (1981) found essentially no differences in small grain height within a 3-yr study period in Alberta, Canada, and only marginally different crop nutrient contents even when maturity was delayed, particularly in silage corn.

De Jong and Button (1973) found that wheat yields increased in Solonetzic soils, particularly over the trench area after remediation, which they attributed to trenching remediation measures which decreased bulk density and increased permeability and aeration. In this study, wheat yields were consistently higher over the trench, particularly for older pipelines. Zellmer et al. (1985) also found increases in wheat yields over the pipeline trench, and sorghum yields were not significantly different between ROW and adjacent areas. Similarly, Halmova et al. (2017) reported winter wheat yields increased over the trench, likely due to warmer soil conditions from pipeline temperatures. These authors reported that winter wheat yields over the trench were higher by 9.4–13.1%, and sunflower yields were higher by 8.1% compared with control areas.

Culley and Dow (1988) found that alfalfa yields increased slightly over the ROW compared with undisturbed area. Batey (2015) noted that, though claims for crop loss may not have been filed, crop loss still occurred in many areas, including with potato and raspberry. These losses could have been a result of increased moisture which contributes to increased incidence and severity of crop diseases like powdery scab in potato.

In nonagricultural soils, Kowaljow and Rostagno (2008) found that native shrubland faced difficulty in naturally revegetating disturbed areas, resulting in slow vegetation growth on-ROW compared with less disturbed areas, with lowest rates of vegetation present on the trench area. Desserud et al. (2010) found that invasive species like Kentucky bluegrass (*Poa pratensis* L.) dominated many of the native grass species in disturbed areas, while undisturbed sections had higher percentage cover by native fescue grass species. Xiao et al. (2014), Low (2016), and Xiao et al. (2017) found similar results, with invasive species thriving in disturbed areas, reducing plant diversity and resulting in difficulty of native species reestablishment after pipeline installation. Olson and Doherty (2012) found that, in naturally diverse wetland areas in Wisconsin, pipeline installation in these areas resulted in lower species richness and higher dominance of invasive species when compared with undisturbed wetland areas.

4 | CONCLUSIONS

As the number of pipeline installations around the world is projected to increase, land managers and the public would benefit from research quantifying changes in soil and plant ecosystem functions, such as analysis of soil microbial population composition and diversity following pipeline installation and the exploration of the use of remotely sensed imagery to predict vegetation changes over time and space. Specifically, managers need improved guidance on managing and improving soils post-disturbance, which could be supported by further remediation studies on pipeline-impacted areas.

Pipeline installations have occurred through the world and accordingly, research studies documenting the impacts of installation vary greatly in space and time, making drawing specific and consistent conclusions difficult. However, published research has demonstrated a general consensus that pipeline installations have resulted in lasting soil physical and chemical degradation and subsequent decreases in plant productivity. Commonly reported responses after pipeline installation includes increases in soil mixing (17.1%), compaction (bulk density: 12.6%, penetration resistance: 40.9%), increased erosion potential caused by decreased aggregate stability (−44.8%), alterations in electrical conductivity (109.4%), and decreased organic matter and organic C content (−20.8%). Additionally, pipeline installation has often been detrimental to agricultural crop yields and native vegetation in natural ecosystems, with yields averaging 6.2–33.2% lower on ROW areas compared with adjacent, undisturbed areas. However, remediation measures are major factors in the extent of disturbance and recovery potential. This literature review and quantitative synthesis provides clarity to the general degrading effect that pipeline installation has on natural resources including increased soil compaction and decreased vegetative productivity, which can often persist for decades following initial pipeline installation.

DATA AVAILABILITY STATEMENT

Data collected and used in this review were publicly available, and no new data were introduced in this report.

AUTHOR CONTRIBUTIONS

Theresa Brehm: Conceptualization; Data curation; Formal analysis; Investigation; Methodology; Validation; Visualization; Writing – original draft; Writing – review & editing. Steve Culman: Conceptualization; Formal analysis; Funding acquisition; Project administration; Resources; Software; Supervision; Validation; Visualization; Writing – review & editing.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

ORCID

Theresa Brehm https://orcid.org/0000-0001-9612-5657

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Pipelines keep robbing the land long after the bulldozers leave

A flurry of new research shows the long-term effects of pipelines on crop yields.


Sinisa Kukic / Getty Images

Jena Brooker

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Before it began digging into the earth to bury its two-and-half-foot-wide, 1,172-mile-long pipeline in the ground, Dakota Access, LLC promised to restore the land to its previous condition when construction was finished. The pipeline company signed that pledge in its contracts with landowners stretching from North Dakota to Illinois, and the project was approved by the South Dakota Public Utilities Commission under that condition. But farmers in the path of the pipeline have a different story to tell – one of broken promises and sustained damage to their land.

Now, there's data to back them up.

Researchers at Iowa State University found that in the two years following construction of the Dakota Access Pipeline corn yields in the 150-foot right-of-way declined by 15 percent. Soybean yields dropped by 25 percent.

One of the selling points that energy companies often tout is that pipeline infrastructure is seemingly invisible, buried and forgotten over the long run. The new study, published in the journal Soil Use and Management, seems to contradict that claim.

The scientists said the major issue is that soil is compacted by heavy machinery during pipeline construction, and that topsoil and subsoil are mixed together. Taken together, the damage "can discourage root growth and reduce water infiltration in the right-of-way," Robert Horton, an agronomist at Iowa State and the lead soil physicist on the project, said in a statement. He and his colleagues also found changes in available water and nutrients within the soil.

The findings are important for a number of planned pipelines across the Midwest. In one instance, the planned Midwest Carbon Express would be built on land already used for the Dakota Access pipeline, leaving farmers reeling from double impact on their crops.

It also adds to other new research on the long-term effects of pipelines on agriculture. In Ohio, using data collected from 24 different farms, researchers recently announced that corn and soybean yields were still being negatively affected three years after the construction of a series of smaller pipelines.

"Every pipeline site is going to be slightly different, but there is a general trend of degradation overall," Theresa Brehm, one of the researchers and a graduate student at Ohio State University, told Grist.

For corn, yields were down an average 23.8 percent.

"That means [farmers are] losing almost a quarter of the productivity of that land," Brehem said, adding "it's not just a 23 percent decrease from one year. There's actually a longevity impact of that."

Pipeline companies will often agree to reimburse farmers for 100 percent of crop damage in the first year after construction is complete, 75 percent for the second year, 50 percent for the third year, 25 percent for the fourth year, and 0 percent for the fifth year.

But, "by year five most people aren't getting any compensation at all," Brehm said.

Brehm told Grist that's why they looked at farms where more than three years had passed since a pipeline's construction, to see the long-term impact on farmers.

Greg Sautter owns a 100-acre farm in Wayne County, Ohio and contributed data for Brehm's research. A natural gas pipeline called the Rover

Pipeline intersects his land. Construction started in 2014 and took two years. Sautter told Grist the company's promise before the pipeline went in was that "there would be no yield loss, and the land would be put back just the way it was before."

But that's not what happened.

In the first year after the pipeline was complete Sautter planted cover crops to try and restore organic matter to the land. In the fourth year, after consulting with a soil scientist, the pipeline company paid for more than 100 loads of topsoil. The next year they were finally able to plant their usual crops. But they noticed a decline in yield.

The corn, Sautter said, "was 2 to 3 feet shorter and had very small ears."

Construction of the Rover Pipeline through Sautter's land. *Courtesy of Greg Sautter*

Sautter told Grist the impact of the pipeline's destruction on his land has been emotional. "Here's something that happened to your land that you would never think about doing yourself – taking a 150-foot swath, turning the soil

upside down, mixing it together with rocks and subsoil, and laying it back down to try to grow something," he said.
Sautter's story is not unique. In 2017, a family sued DAPL for failing to restore the land how it was before construction and failure to compensate them for damages to their 800-acre farm. In 2021, in Oklahoma, Cheniere Energy missed multiple deadlines to restore private land that was affected when they built a 200-mile natural gas pipeline. Farmers across the country have similar experiences, but often feel they don't have the money to take pipeline companies to court, leaving them suffering with the economic and emotional consequences of once-abundant farmland now scarred by a pipeline.

"They'll probably win anyway and it'll just cost you a bunch of money to try to fight it," Sautter said.

Multnomah County

LUP Comments <lup-comments@multco.us>

Response Testimony to Portland Water Bureau - T3-2022-16220

1 message

Carrie Richter <crichter@batemanseidel.com> Wed, Sep 6, 2023 at 11:07 AM
To: LUP Comments <lup-comments@multco.us>, "lup-hearings@multco.us" <lup-hearings@multco.us>
Cc: Lisa Estrin <lisa.m.estrin@multco.us>

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Good Morning:

Attached please find written testimony submitted on behalf of the Cottrell Community Planning Organization for submittal into the record in the above-referenced case.

Please confirm receipt.

Carrie Richter

Carrie Richter
Bateman◊Seidel
Bateman Seidel Miner Blomgren Chellis & Gram, P.C.
1000 SW Broadway, Suite 1910
Portland, OR 97205
(503) 972-9903 (direct phone)
(503) 972-9904 (direct fax)
crichter@batemanseidel.com

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