PO Box 44
1124 Willis Ave
Perry, IA 50220

Annexation Report

Drainage District No. 10

Worth County, Iowa
2025

PROFESSIONAL ENGINEER
JACOB L.
HAGAN
25738
IOWA

I hereby certify that this engineering document was prepared by me or under my direct personal supervision and that I am a duly licensed Professional Engineer under the laws of the State of Iowa.

1/5/26

Jacob L. Hagan, P.E. (date)
License No. 25738
My license renewal date is December 31, 2026.
Pages or sheets covered by this seal:
All

Project No. 2529-98

Executive Summary

Introduction

This report recommends the annexation of additional lands into Drainage District No. 10. The objective is to align the district's legal boundaries with the full extent of the lands that materially benefit from its infrastructure, ensuring the system is effective and that maintenance costs are shared equitably among all beneficiaries.

Justification for Annexation

The basis for this annexation is the significant evolution in agricultural practices since the district's formation. A system originally designed to support farming operations with 3-ton equipment and 40-bushel-per-acre yields is now tasked with supporting 50-ton equipment and 200+ bushel-per-acre yields. The hydraulic load placed on the district's drainage facilities has increased substantially. This annexation is a necessary modernization to align the district's legal and financial structure with its current operational reality.

Material Benefits

Annexation requires tangible, material benefits such as increased property value and agricultural productivity. The primary economic benefit is a direct increase in crop yields, as the district's deep, maintained facilities provides a superior outlet that is essential for the effective function of private subsurface tile drainage. This leads to improved soil health and more timely fieldwork. Additional benefits include the protection of non-agricultural property through improved water management, which helps keep basements dry and prevents soil saturation on lawns and driveways. Furthermore, inclusion grants landowner's significant legal rights under Iowa Code, including the right to petition for repairs, the right to object to assessments, and the right of remonstrance to stop a proposed project.

Methodology for Determining Annexation

The parcels recommended for annexation were identified through an objective, data-driven engineering analysis. Every acre was evaluated against five key criteria to determine material benefit. A parcel was identified as benefited if the district provides an improved outlet where the natural slope is insufficient for effective drainage, or if the district provides significantly closer and more efficient access to a drainage outlet than what existed naturally. Additionally, official USDA soil data was used to identify lands with inherent limitations, such as a poor natural drainage class, low soil permeability, or a high-water table, that are overcome by the artificial drainage the district enables. This scientific process ensures that only lands receiving a true, material benefit are recommended for inclusion.

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Introduction

Overview

The Worth County Board of Supervisors, serving as Trustees for Drainage District No. 10 (DD 10), has identified additional lands that appear to benefit from the district's drainage infrastructure but are not currently included within the district's boundaries. As authorized by Iowa Code §468.119, the Board appointed AgriVia to serve as the engineer for a potential annexation.

This report examines these additional lands to determine if they receive a material benefit from DD 10. It has been prepared to provide a thorough, transparent, and legally sound basis for the Board and affected landowners to evaluate the proposed annexation. Our investigation includes a review of the lands' elevation, historical and current drainage conditions, and their relationship to the established district facilities.

Location

Drainage District No. 10 (DD 10) serves approximately 7,214 acres including lands in Sections 4-9, and 17 of Danville Township, Sections 19-21, and 27-34 of Brookfield Township, and Sections 24-25, and 36 of Bristol Township in Worth County, Iowa. A Map of the DD 10 benefitted area in included in Appendix A.

Material Benefits of Drainage

Crop Yield Response

A 1983 ISU study found that poor drainage can reduce yields by up to 32%, but installing tile in these areas often provides strong economic returns. A table showing yield increases from that study is provided below:

	Poor Drainage (Less than ¼" Drainage Coefficient)		High Drainage (1/2" Drainage Coefficient)		Percent Increase	
Soil Drainage Class	**Corn Yield (bu/acre)**	**Soybeans Yield (bu/acre)**	**Corn Yield (bu/acre)**	**Soybeans Yield (bu/acre)**	**Corn Yield**	**Soybeans Yield**
Very Poorly Drained	28	12	123	48	339%	300%
Poorly Drained	80	31	121	47	51%	52%
Somewhat Poorly Drained	90	34	124	48	38%	41%

According to Iowa State University Extension's Understanding the Economics of Tile Drainage (2023), tile drainage can increase corn yields by 10–20 bushels per acre and soybean yields by 4–8 bushels per acre, depending on soil and weather.

Using ISU's Excel-based calculator, we prepared a map of the drainage district showing estimated corn yield increases for tile drainage based on soil drainage class. This calculator is available at: extension.iastate.edu/agdm/wholefarm/xls/c2-90tilinganalysis.xlsx. The soil drain class map is included in Appendix H.

Long-term research from Ohio State University found similar benefits. Their data showed that tiled fields produced 24–39% more corn and 12–45% more soybeans compared to untiled ground. Benefit-cost ratios ranged from 1.7:1 up to 4:1, meaning a return of $3–$4 for every $1 invested in tile.

For more detail, we have included a summary of drainage benefits from Ohio State in Appendix B.

Non-Crop Benefits

Drainage districts do not just serve farmland. Acreages, conservation areas, and other rural homes depend on district infrastructure to lower the water table, keep basements dry, and manage stormwater that would otherwise pool in yards and create muddy driveways for example. These properties benefit from better growing conditions for trees, lawns, and gardens, similar to how urban properties benefit from storm sewer systems.

Public roads, driveways, and paths are another example. Modern roadways, especially paved ones, shed water quickly. That runoff often enters the drainage system through roadside intakes. Drier roads and driveways are more durable, easier to maintain, and less prone to erosion or frost damage. Iowa Code 468.43 allows for assessing roads because they directly benefit from district facilities.

There are also public health benefits. In the early days, before drainage districts existed, wetlands across Iowa were breeding grounds for mosquitoes and disease. The law (Iowa Code 468.2) recognizes drainage as a tool to improve public health, safety, and overall welfare.

Existing Infrastructure

Facilities

Drainage District No. 10 includes a main open ditch, four lateral ditches and twelve tile laterals totaling approximately 6.4 miles of open ditches and 4.7 miles of lateral tiles. The district facilities are listed below:

Drainage District No. 10 Existing Ditches and Tiles
Main Open Ditch
Lateral 1 Open Ditch
Lateral 1-A Tile
Lateral 1-A-1 Tile
Lateral 1-B Tile
Lateral 1-B-1 Tile
Lateral 1-B-1-A Tile
Lateral 6 Tile
Lateral 6-A Tile
Lateral 6-B Tile
Lateral 7 Open Ditch
Lateral 7 Tile
Lateral 7-A Tile
Lateral 8 Open Ditch
Lateral 8 Tile
Lateral 9 Open Ditch
Lateral 9 Tile
Lateral 9-A Tile

Landscape Considerations

District Landscape

To better understand the watershed, we used publicly available LiDAR (Light Detection and Ranging) technology to map the district's surface topography. LiDAR uses laser pulses from aircraft to produce highly accurate elevation data, allowing us to identify natural drainage patterns and areas of water accumulation. Based on this analysis, we determined that 7,214 acres drain to the district's facilities. An elevation map is included in Appendix D, and a water flow paths map is included in Appendix E.

Soils

Drainage classes vary across the district as shown below: The soils in this drainage district are primarily silts and clays. Common soil types include Clarion, Webster, Nicolett, Okoboji, Canisteo, and Agnus with slopes ranging from flat to moderately steep. Drainage classes vary across the district as shown below:

Soil Drainage Class			
As Noted on Schedule	**Drain Class**	**Acres**	**Percentage of Watershed**
7	Very Poorly Drained	1,003	13.9%
6	Poorly Drained	2,794	38.7%
5	Somewhat Poorly Drained	1,346	18.6%
4	Moderately Well Drained	1,078	14.9%
3	Well Drained	766	10.6%
2	Somewhat Excessively Drained	0	0.0%
1	Excessively Drained	71	1.0%
0	Disturbed Soils (Interstate 35)	134	1.9%

Private Drainage

The primary purpose of a drainage district is to provide a legal and reliable outlet for surface and subsurface drainage, allowing coordinated water management across multiple properties. While the district maintains shared infrastructure, such as main tile lines and open ditches, individual landowners are responsible for installing and maintaining private tile systems on their land to connect to and benefit from the district system.

Water Flow Behavior

Subsurface drainage systems collect excess water using perforated pipes or clay tiles installed below ground. As the soil becomes saturated, water moves through the soil's pores and enters the tile system through small openings. The water is then carried away to the district main. This process lowers the water table, improves soil aeration, and reduces surface runoff.

A key soil property in drainage design is saturated hydraulic conductivity (Ksat), which measures how quickly water moves through saturated soil. Sandy soils have high Ksat values and drain quickly, while clay soils, such as those common in this district, have lower Ksat values and drain more slowly. Most soils in the district are classified as loams and clay loams, with moderate to low Ksat values. These values are used to determine appropriate drainage coefficients and to guide decisions on tile spacing and depth for an effective and efficient drainage system.

Land Use

Landowners are free to manage their land as they choose, regardless of how much benefit they receive from the drainage system. The lands already included in the district since its establishment include some acres not being currently farmed. The current district includes wetlands, grassland, woods, and other non-cropped areas. The proposed annexed lands are mostly cropland.

Whether a property is currently tile drained has no bearing on its inclusion or benefit from a drainage district. District facilities are designed to provide an outlet to all lands within their watershed, regardless of private land use or drainage improvements. The Classification Commission determines relative benefit and assigns corresponding cost shares through its report, ensuring fair distribution. Every drainage district in Iowa includes acres that are not presently tile drained, including this one. Having private tile is not a prerequisite for materially benefiting from a district facility. The law presumes benefit for all included lands; it is up to each landowner to decide how and when to make use of that benefit. The district's role is to provide and maintain the outlet, not to monitor or influence individual property management decisions.

The current classification schedule has been in place for over one hundred years, and in that time, land use on many parcels may have changed. However, the drainage district is focused on providing a drainage outlet, not on how or whether each parcel takes advantage of the outlet. That decision rests entirely with the landowner.

Legal Framework

Statutory Requirements
The annexation of land into a drainage district is governed by Iowa Code Chapter 468. Specifically, §468.119 requires an engineer's report that makes a "survey and plat thereof showing their **relation, elevation, and condition of drainage**" and must "specify the character of the benefits received". Iowa Code §468.120 further requires the Board of Supervisors to be satisfied that the lands are "materially benefited" by the district and that annexation is feasible, expedient, and for the public good before proceeding.

The "Material Benefit" Standard
Iowa courts have established a clear and strict standard for what constitutes a "material benefit." This report was prepared with these legal precedents at its core.

- **More Than Just an Outlet**: It is not enough for a drainage district to simply provide an outlet for surface water that would naturally drain off a property anyway. The Iowa Supreme Court has stated that a landowner "may freely avail himself of the topography of his land, and may discharge his surface waters wherever gravitation naturally carries them, without further concern (Thompson v. Bd. of Sup'rs, 1925).

- **A Demonstrable Improvement**: To be "material," benefit must increase the land's value, "either by relieving it of some burden, or by making it adapted for a different purpose, or better adapted for the purpose for which it is used".

- **Specific, Not Conclusory**: An engineer's report cannot simply state that lands are benefitted. The courts require a specific explanation of how they are benefitted. For instance, Lindflott v. Drainage District No. 23 (2017), a material benefit was found because the district's deep ditch enabled the landowner to deepen their own private ditch, an improvement that would have otherwise been impossible.

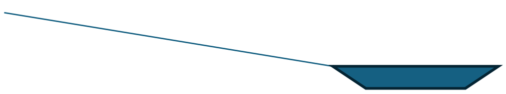
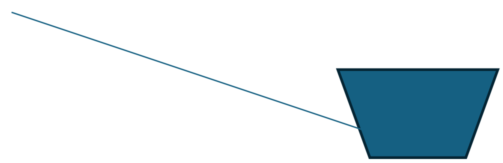
Methodology

Relation of Annexed Lands to District
We analyzed how the proposed annexed lands physically connect to the DD 10 facilities. Using GIS mapping, we traced the water flow paths from every acre of the subject properties to the district's infrastructure. Our analysis shows that the DD 10 system provides a deeper and more stable outlet than what existed in the natural landscape prior to its construction. The original engineer included the excavation quantity removed indicating the ditch is larger than what previously existed. The original engineer's report, plans and profiles are on file in the Auditor's Office as public record.

This artificial lowering of the drainage outlet is the key relationship; it creates the opportunity for landowners to install deeper, more effective private subsurface tile systems, a direct and demonstrable benefit that would not exist otherwise. An example is provided below showing how an improved ditch is not only deeper but can carry far more water providing a more reliable and deeper outlet.

Cross Section Before Improvement Example	Cross Section After Improvement Example
	

Elevation and Topography Analysis
Using LiDAR elevation data, we created a detailed topographic model. While it is obvious that water naturally flows from higher to lower elevations, this alone does not mean higher lands do not receive material benefit from a drainage district.

Slope Before Improvement Example	Slope After Improvement Example
	

As illustrated above; by deepening the outlet, a drainage district effectively increases the available "fall" or slope for a private tile system. This allows a landowner to drain otherwise flat or depressional areas and enables them to use smaller, less expensive tile to achieve the same drainage capacity, a direct economic benefit.

Condition of Drainage
We compared the landscape's historical condition, using the 1850's General Land office maps, 1875 Andres Atlas, soil maps, historical plats, and aerial photography with its current state.

The best available information of the condition of drainage prior to the district establishment is soil maps. The soil maps can tell us what the natural drainage of the soil is without artificial drainage, what landscape it sat in, and what formed the soils. For example, high organic matter would indicate the area was peat, and thus very poorly drained and unsuitable for agriculture before artificial drainage.

- Before DD 10: Historically, some of the area proposed for annexation, particularly parcels with poorly drained soils, high water tables, and low Ksat values were limited in their agricultural use. These areas were often saturated, suitable for pasture or hay, and planting was frequently delayed.

- After DD 10: The construction and maintenance of the DD 10 facilities provided an outlet nearer and deep enough to make comprehensive subsurface tiling feasible. This transformed the land's potential, allowing for its conversion into productive row crop agriculture. This change in the land's utility and productivity is a clear and direct material benefit resulting from the existence of DD 10.

Specification of Benefits Received
Based on our analysis, the lands proposed for annexation receive the following material benefits, as required by Iowa Code and defined by case law:

- **Improved Agricultural Productivity**
  The largest economic benefit of the district is its direct increase in agricultural productivity. By providing an improved and reliable outlet for drainage, DD 10 enables landowners to:

  - Lower the water table, which improves soil aeration and creates a healthier root environment.
  - Achieve more timely fieldwork, as soils warm up faster and support equipment sooner in the spring.
  - Increase crop yields. Research from the 1983 Iowa State University study shows that effective tile drainage can boost corn yields by over 50% on poorly drained soils, a substantial increase in value directly attributable to the drainage outlet.

- **Enabling Surface Drainage**
  The DD 10 facilities provide a direct conveyance for surface overflow waters to escape the district. Landowners can legally install tile surface intakes in upland depressions and construct surface drains along the ditch to remove large volumes of excess water that would otherwise remain trapped in those depressions. Without the facilities, the available grade for private tile lines designed to carry surface water would be significantly reduced or in some cases, nonexistent. Reduced grade requires larger tile sizes to maintain capacity, which substantially increases installation costs. This represents a clear and direct material benefit of the drainage district facility.

  The included map in Appendix F, based on USDA Soil Survey data, illustrates the ratings for Surface Water Management Systems, which evaluate how well soils can naturally handle and move excess water across the land through features like ditches, grassy channels, terraces, or diversions. These ratings consider key soil traits in their untouched state, such as depth to bedrock or hard layers, water flow speed through soil, slope, flood or ponding risks, rock or salt content, erosion potential, and gypsum levels, without factoring in current land uses. Every parcel recommended to be annexed is considered either not limited or somewhat limited, indicating improved surface water management systems are possible.

  In addition, there would be many cases where draining these areas would be legally impossible without a drainage district outlet. Iowa Code §468.621 prohibits a landowner from increasing the quantity or altering the manner of water discharge onto a downstream neighbor without that neighbor's consent. This means an upland landowner cannot install intakes or surface drains in their depressions and discharge that water onto their neighbor. The presence of a lawful drainage district facility provides a collectively maintained and authorized outlet for such discharges. This allows these depressional areas to be farmed and to achieve much higher crop yields, a direct and measurable material benefit that would not exist without the district facility.

- **Enabling Subsurface Drainage**
  The "Iowa Drainage Guide" published by Iowa State Extension states a subsurface (tile) drainage system will only function as well as its outlet. Without the DD 10 facilities, landowners would be limited to the shallow, and in many cases ineffective, natural drainage paths that existed prior to the district's construction. In numerous areas, there would be no feasible subsurface drainage outlet at all. Without the district facilities, the available grade for private tile lines designed to carry subsurface water would be significantly reduced or in some cases, nonexistent. Reduced grade requires larger tile sizes to maintain capacity, which substantially increases installation costs. This represents a clear and direct material benefit of the drainage district facilities.

  Installing a private tile system without an established drainage district outlet could also create legal complications, as Iowa Code §468.621 prohibits a landowner from increasing the quantity or altering the manner of water discharged onto a downstream property without the downstream owner's consent. An upland landowner cannot legally pattern-tile their field and simply discharge water directly across the property line onto their lower neighbor. In addition, landowners are prohibited from tile draining their fields across watershed lines into another creek. The district facilities provide a lawful, more effective, and collectively maintained outlet, granting all landowners within its benefitted area the right to connect private drainage systems. This relieves them of both the legal exposure and physical limitations that would otherwise prevent adequate drainage.

The included map in Appendix G, based on USDA Soil Survey data, illustrates the ratings for Subsurface Water Management Systems, which assess how effectively soils can be drained underground to remove excess water. These ratings consider key soil traits in their natural state, such as depth to the water table, salt levels, flooding risks, sodicity, sand content, soil acidity or alkalinity, water flow rate, density, gypsum content, and potential for subsidence, without accounting for current land uses. Every parcel recommended to be annexed is considered either not limited or somewhat limited, indicating improved surface water management systems are possible.

- **Increased Land Value and Utility**
  The ability to convert land from marginal pasture or wetland to productive cropland directly and materially increases its value. The historical and soil records show that the landscape has been altered for agricultural purposes because of the opportunities created by DD 10. This is not merely an acceleration of natural flow; it is a fundamental change in the land's character and economic potential by making it better adapted for cropland and other uses.

  The private landowner ultimately makes the decision of what to do with their land, for some they have chosen to create wildlife habitat, hunting areas, or construct homes. These landowners may argue they do not receive a benefit from the drainage district, because they do not see cropland yield increases, but they benefit from drier basements, improved access paths, upland plant and wildlife population, and less surface ponding. These are a tangible economic benefit, a home with a dry basement has less maintenance and more usable floor space than a home with a wet basement.

  Land use can change at any time, and it is not within the district's purview to dictate or evaluate how individual landowners use their property. The district respects each landowner's right to choose their own land use, and those choices are irrelevant to their rights and obligations within the district. State law is clear that all landowners within a drainage district share equal rights to use and benefit from the drainage system.

  A property currently in woodland, pasture, or other non-cropland use could be converted to row-crop production and pattern-tiled at any time. The district should not be required to fund additional annexation or reclassification proceedings each time such a change occurs. The system must remain stable and equitable for all members, regardless of individual land use decisions.

  Having access to a functioning drainage facility provides landowners with flexibility to change how their land is used in the future. A parcel that currently serves as woodland or pasture retains the option to be converted to cropland because the necessary outlet already exists. This flexibility carries inherent value. Even if a current owner does not intend to change their land use, the ability to do so increases the property's market value. A prospective buyer who wishes to convert the land to cropland will recognize the benefit of an established drainage outlet and be willing to pay more for a property that can support such a transition. In this way, access to a drainage system not only enhances agricultural productivity but also strengthens long-term land value and marketability.

Most of Iowa's popular game animals, including deer, pheasants, quail, rabbits, turkeys, and coyotes, strongly favor upland habitats over consistently wet or swampy areas because uplands provide better cover, forage, nesting sites, and accessibility. Prolonged saturation reduces habitat quality, limits movement, and increases disease risk for both wildlife and native upland vegetation. Many common Iowa trees and plants such as maples, oaks, hickories, and prairie grasses cannot tolerate extended flooding, quickly dying from root suffocation or oxygen loss. By improving drainage, lands become better suited for upland wildlife, timber production, and recreation such as hunting and bird watching. Ultimately, the district's drainage facilities provide a tangible benefit by giving landowners the flexibility to maintain or enhance their property for the uses they value most.

- **Shared Rights and Benefits**
  Landowners included in a drainage district share important rights that ensure access, fairness, and control. They can use the district's drainage system, request repairs or improvements, and take part in public hearings and decisions that affect how the system is managed. Included landowners also have the right to object to unfair costs or oppose major projects they do not support. Together, these rights provide both access to the infrastructure and a voice in how it is maintained and improved, protections not available to landowners outside the district.

- **Right to Petition for Repairs §468.126**
  Iowa Code §468.126 grants landowners within a drainage district the right to petition for repairs or improvements to the district's facilities. This includes restoring the system to its original capacity or upgrading it to meet evolving drainage needs. These rights ensure that any landowner within the district, regardless of current land use, can initiate action to benefit their property. For woodland owners or those not presently utilizing the facility, inclusion preserves the legal right to request repairs or improvements if land use changes, drainage issues emerge, or neighboring development alters runoff patterns.

  Landowners outside the district do not have this right: they cannot petition for repairs, cannot compel trustee action, and may be left unprotected if the system deteriorates or access is denied when drainage becomes necessary. Inclusion under §468.126 guarantees agency, protection, and access.

- **Rights of Participation in Public Hearings §468.14–§468.22**
  Iowa Code §468.14–§468.22 establishes the procedural rights of landowners during the establishment or improvement of a drainage district, ensuring due process through notice, hearing, objection, and review. These provisions guarantee that every landowner within the district has a formal opportunity to be heard before any classification, assessment, or construction proceeds. Landowners receive written notice of proposed actions, may appear at public hearings to support or oppose the plans, and can contest benefit classifications or cost allocations. This framework safeguards against unilateral decisions and promotes transparency, fairness, and accountability in district governance.

  In contrast, landowners whose water drains toward the district but who are not formally included do not receive notice, cannot object, and lack standing to influence decisions, even when district actions may affect downstream conditions or future access. Inclusion ensures not only the right to use the facility, but also the right to participate in its planning and oversight.

- **Rights of Use §468.2 and Case Law**
  Iowa Code §468.2 establishes the foundational principle that all lands within a drainage district are presumed to be benefited and entitled to the use of the district's improvements. This includes the right to tile into a district facility, a critical benefit for landowners, even if their property is not currently tiled or under cultivation. Inclusion in the district automatically secures this right, without requiring a separate

petition, or legal proceeding. Landowners may connect private tile systems to district mains, laterals, or outlets as needed.

In contrast, landowners whose water drains toward the district but who are not formally included do not possess this automatic right. They must request permission, negotiate access, or face potential denial or special assessments. Inclusion ensures that drainage infrastructure is available when needed, without delay or uncertainty, and that landowners retain full legal standing to use, maintain, and benefit from the system. This right becomes especially valuable as land use changes, such as when woodland is converted to cropland, or when drainage needs evolve due to shifting soil, weather, or development conditions.

- **Right of Objection §468.83, §468.84**
  Sections 468.83 and 468.84 of the Iowa Code grant landowners within a drainage district the right to formally object to assessments and classifications they believe are unfair and to appeal those decisions through the courts. Landowners outside the district, whose water may drain into it but who are not formally included, do not have these rights. They cannot object to assessments, or influence district decisions, even though their land may depend on or affect the system.

- **Right of Remonstrance §468.28**
  Iowa Code §468.28 grants landowners within a drainage district the right to file a remonstrance, a formal objection that can prevent the establishment or improvement of a drainage facility if signed by at least 50% of the landowners representing at least 70% of the affected land area. It represents a distinct benefit of district inclusion: only included landowners have standing to exercise this right. Those whose land drains into the district but who are not formally included cannot participate in a remonstrance, cannot vote on improvements, and cannot influence district decisions, even if the outcomes affect their property.

Procedure

Data Collection and Preparation
To establish a fair and measurable system for identifying lands that benefit from the drainage district facilities, a comprehensive analysis was conducted on the entire potential area. This process is designed to be objective, relying on established scientific data and engineering principles.

The entire area was divided into a grid of one-acre squares. For each square, we compiled data from trusted and publicly available sources. Elevation and slope data were derived from high-precision LiDAR (Light Detection and Ranging) datasets provided by Iowa State University. Soil characteristics, including drainage class, depth to the water table, and Saturated Hydraulic Conductivity (Ksat), were obtained from official USDA-NRCS (Natural Resources Conservation Service) soil surveys. Finally, we performed spatial measurements within GIS to define each acre's physical relationship to the existing drainage district infrastructure.

Evaluation Criteria
Each parcel was evaluated across three main categories: Elevation, Relation to District Facilities, and Natural Condition of Drainage. On the assessment schedule, values highlighted in red indicate that a specific criterion for benefit has been met. The five criteria are detailed below.

Elevation

- Slope: Effective subsurface drainage depends on having sufficient grade for pipe flow capacity. To quantify the improvement in grade provided by the district facility, the average ground slope from each acre to the district outlet was calculated by tracing the natural flow path. Using that slope, we then determined the drainage coefficient achievable with a standard 4-inch subsurface drain. The 1983 Iowa State University study found that increases in drainage coefficient up 1.0 inches per day resulted in meaningful corn and soybean yield increases. Where the natural slope was insufficient to achieve a drainage coefficient of at least 1.0 inches per day, the land is materially benefitting from the increased depth and outlet capacity provided by the district facility.

Relation to District Facilities

- Improved Outlet Access: The district facility provides a shorter and more direct path to a usable drainage outlet than existed under the previous natural conditions. To quantify this improvement, we calculated the reduction in flow distance from each parcel to its nearest viable outlet. Any parcel for which the district facility reduced that distance (thereby bringing a usable outlet closer) has been materially benefitted by the facility. For example, under pre-district conditions, a parcel's nearest outlet of sufficient depth for subsurface drainage may have been 5,000 feet away. Following construction of the district facility, that outlet distance may now be only 1,000 feet. This reduction in length needed and subsequent cost of tile is a clear, direct, and material benefit to the landowner.

Natural Condition of Drainage

- Drainage Class: Using USDA soil classifications, we identified the drainage condition of each 1-acre square within every parcel. Based on guidance from the Ag Decision Maker of Iowa State University Extension, soils classified as very poorly drained, poorly drained, somewhat poorly drained, or moderately well drained show a notable crop yield increase when artificially drained. Therefore, any parcel containing these soils will receive a material benefit from artificial drainage.

- Saturated Hydraulic Conductivity (Ksat): Ksat (saturated hydraulic conductivity) measures how quickly water moves through saturated soil. Ksat values (less than approximately 115 inches per day) indicate soils with poor permeability and a strong need for artificial drainage. In such soils, effective drainage generally requires tile spacings of about 120 feet using standard 4-inch diameter tile installed at a depth of four feet. This configuration is designed to lower the water table to at least two feet below the surface, assuming a restrictive layer at 8 feet and a drainage coefficient of 0.5 inches per day. A spacing of 120 feet represents the practical upper limit for most private pattern-tile systems. Areas identified as suitable for or requiring pattern tile drainage require a legal and functional outlet such as the one provided by the drainage district facility.

- Water Table Depth: For optimal crop production, Iowa State University research recommends maintaining a water table depth of at least twenty-four inches during the growing season. Any acre with a naturally occurring average water table depth of less than 24 benefits from artificial drainage, as its natural condition is not ideal for modern agricultural yields.

Conclusion for Annexation

A parcel does not need to meet all five criteria to be considered for annexation, as the benefits vary from one property to another. Every parcel proposed for annexation meets at least three of the metrics defined above, and several met all five criteria.

This data-driven system ensures that the determination of benefit is both repeatable, scientific, and equitable. For a detailed assessment of the benefit allocated to each individual parcel (both existing and newly annexed), please consult the official Reclassification Report filed with this Annexation Report.

Landowner Considerations

Public Hearing on Report

A public hearing will be scheduled to review this annexation report. Per Iowa Code § 468.14, all affected landowners will be notified by mail, and notice will also be published in a local newspaper. At the hearing, we will present our findings, proposed annexation, and will be available to answer questions and address concerns.

The Board of Trustees will conduct the hearing and may continue it to a later date if more discussion or information is needed. No decision can be made until the hearing is held and all landowner input is considered. This report may be amended as needed in response to feedback received during the hearing.

Objections
Landowners who have concerns about the proposed annexation are encouraged to submit written objections either before or during the public hearing. These written objections will be included in the official record and are necessary to preserve the right to appeal the Board's final decision.

Landowners who wish to object to their assessment are strongly encouraged to provide any relevant information, such as tile maps, permanent wetland easements, or other documentation not available to us, that could assist in refining the schedule if necessary.

Recommendations

Annexation Schedule
We find that the parcels included in the Annexation Schedule are materially benefitted by the facilities of Drainage District No. 10. The benefits derived, specifically the provision of a sufficiently deep and legal outlet enabling the conversion of land to more productive agricultural use, and supporting modern subsurface drainage systems, are substantial and extend far beyond the mere conveyance of natural surface flow. Historical data demonstrates that the landscape within the district has been fundamentally improved and transformed into a significantly more economically productive area.

Our parcel-level analyses confirm that each tract possesses measurable potential to benefit from the district facilities, regardless of the current land use decisions of individual owners. We have provided our five criteria for determining material benefit from the district facility. These were based on physical and soil factors including improved available slope, closer proximity to outlets, and natural condition of drainage (soil drainage class, saturated hydraulic conductivity (Ksat), and water table depth). Together, these criteria quantify each parcel's improved capacity for effective drainage and demonstrate how the district facility provides that improvement and material benefit.

Recommendations
We recommend that the Board accept the filing of this report and schedule a public hearing to formally present the findings and proposed annexation schedule to all affected landowners. At the closing of the hearing, we further recommend that the Board proceed with adopting the annexation as presented.

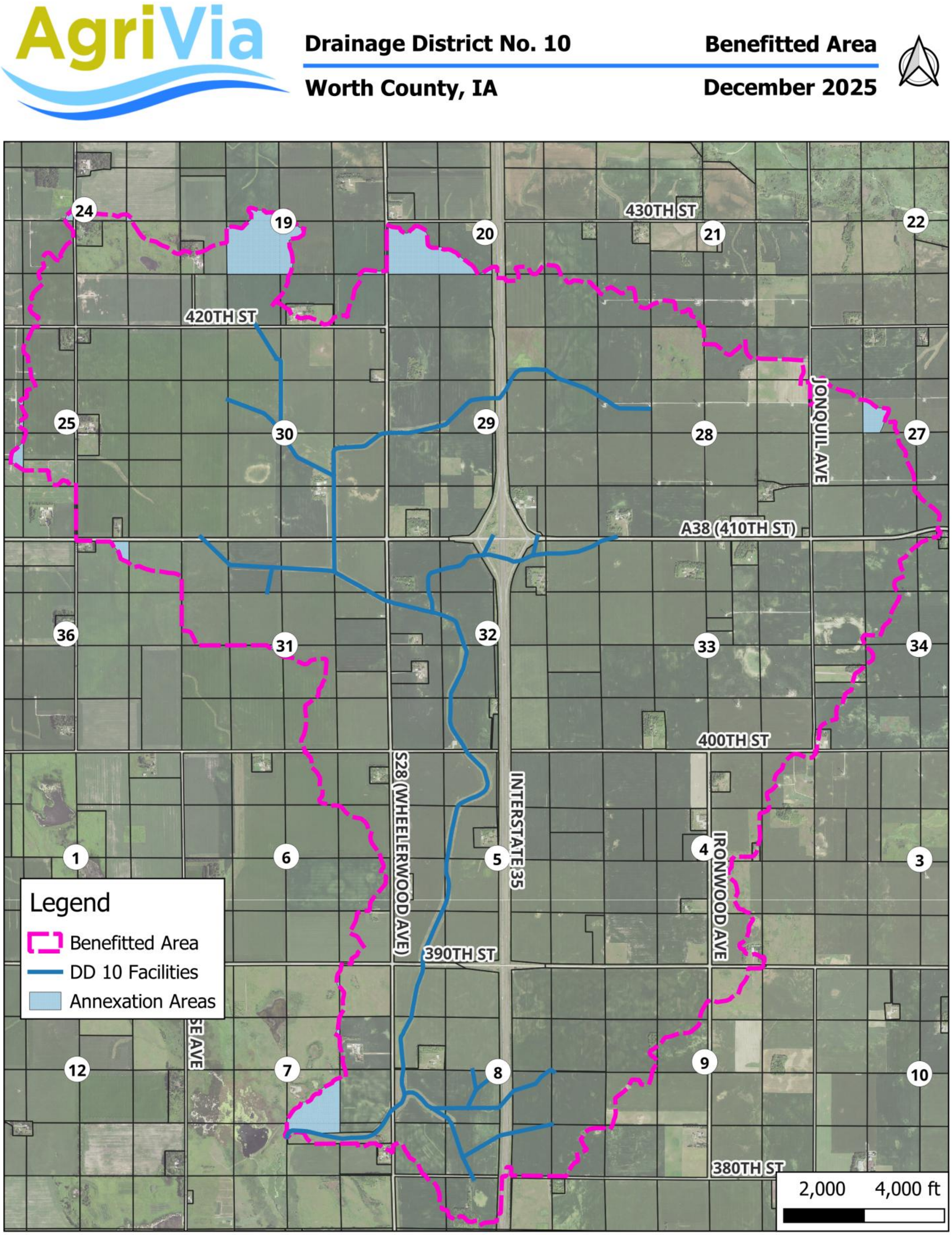
If the Board of Trustees or landowners have any questions or concerns, please contact AgriVia at the phone number or email listed.

Sincerely,

Jacob Hagan

Jacob Hagan, P.E.
AgriVia
712-250-4318
jacob.agrivia@gmail.com

Appendix A – Benefitted Area



Appendix B- "Twenty Benefits of Drainage"- Ohio State Extension

AGRICULTURAL ENGINEERING Serves Ohio

Cooperative Extension Service
The Ohio State University

Agricultural Engineering
2073 Neil Avenue
Columbus, Ohio 43210

SOIL AND WATER NO. 31

JULY 1982

TWENTY BENEFITS OF DRAINAGE

Many of the best soils in the United States and throughout the world have drainage problems that need to be solved before efficient agricultural production can be achieved. This discussion of drainage benefits is based on an earlier paper by the author entitled "Ten Benefits of Drainage" and several reports from other agricultural engineers in the United States, Canada, and England. Some of these drainage benefits are difficult to measure precisely, and many are interrelated, but their combined effect has been observed in numerous drainage studies.

1. Better soil aeration results from good drainage (surface water and free water in the root zone removed within 24 hours after heavy rainfall). This permits more extensive root development and a more favorable environment for beneficial soil microorganisms and earthworms. When soil aeration is reduced, the severity of soil-borne root diseases is increased.

2. Better soil moisture conditions with good drainage permit more efficient operation of tillage, planting, and harvesting equipment.

3. Better soil structure can be developed and maintained with good drainage, since there is less chance of destroying soil tilth due to compaction when working soil that is too wet.

4. Soils warm up more quickly in the spring when free water is removed by a drainage system. This results in better seed germination and an increased rate of plant growth.

5. An increased supply of nitrogen can be obtained from the soil when drainage lowers the water table in the root zone. Denitrification often occurs in soils with poor drainage.

6. Longer growing seasons can be achieved with good drainage due to earlier possible planting dates. This also permits the use of higher-yielding crop varities or extended grazing periods for livestock.

7. Certain toxic substances and disease organisms are removed from the soil due to better drainage and soil aeration. In wet soil, roots can be injured by toxic substances produced in the reduction of iron and manganese salts and the reduction of nitrates to nitrites.

8. Winds are less liable to uproot plants growing in soils that have been properly drained, since root systems are deeper.

9. Soil erosion and sediment loss can be reduced by subsurface drainage, since drained soils have a greater capacity to absorb rainfall and the soil filters out suspended sediment.

10. Good drainage saves fuel that would be used in working around wet areas in fields

(over)

College of Agriculture and Home Economics of The Ohio State University and The United States Department of Agriculture Cooperating

that are not properly drained. Also, since drained land is easier to work, there is less need for dual wheels or four-wheel drive tractors.

11. Good drainage reduces winter crop damage such as frost heaving of alfalfa and smothering of wheat under patches of ice.

12. Good drainage promotes earlier crop maturity and earlier fall harvests when climatic conditions are better for natural drying of grain in the field, thereby saving artificial drying costs.

13. A greater variety of crops can be grown on a farm that has good drainage. Alfalfa and sweet corn are examples of those that a farmer may choose.

14. Weed control is easier with good drainage since shallow-rooted weeds and undesirable grasses often thrive in wet soil, crowding out the planted crop.

15. Well-drained grazing land supports more livestock, with less compaction damage to vegetation and soil from animal traffic.

16. Good drainage reduces diseases that thrive on wet land. These include foot rot and liver fluke that infect livestock, and diseases carried by mosquitoes to both livestock and people.

17. Valuable livestock water supplies can be obtained by draining hillside seeps and piping the water to stock water tanks.

18. Plants are better able to withstand summer droughts with good drainage, since lower water tables in the spring permit deeper root development for extraction of soil moisture and nutrients.

19. Drainage is essential for salinity control in drier regions where irrigation is needed for permanent agricultural production.

20. Overall, good drainage results in higher crop yields, improved crop quality, and reduced risk of crop loss due to waterlogged soil. Also, fewer acres are required ro produce our needed food supplies.

Several years of drainage research in Ohio has compared corn and soybean yields from undrained, surface drained only, tile drained only, and combined tile plus surface drained plots. Annual benefit/cost ratios were also calculated for these alternative drainage systems. It was shown that the average annual return per $100 invested in drainage ranged from $120 to $210 for soybeans, and from $170 to $220 for corn. Further details on this research are reported in Soil and Water No. 23 (DRAINAGE--What is it Worth on CORN Land?" and Soil and Water No. 24 (DRAINAGE--What is it Worth for SOYBEAN Land?"). These leaflets are available from Extension Agricultural Engineers, 2073 Neil Avenue, Columbus, OH 43210.

Actual returns on a drainage investment for a particular farm will vary with factors such as soil type, weather conditions, cost of the drainage system, crops grown, and management. Drainage improvements may involve surface drainage, subsurface drainage, outlet ditches, or a combination of practices. Changes in soil and crop management techniques may also be desirable to improve soil structure and water movement in the soil. Almost 60 percent of Ohio's cropland and 25 percent of all U. S. cropland is in need of drainage.

Melville L. Palmer

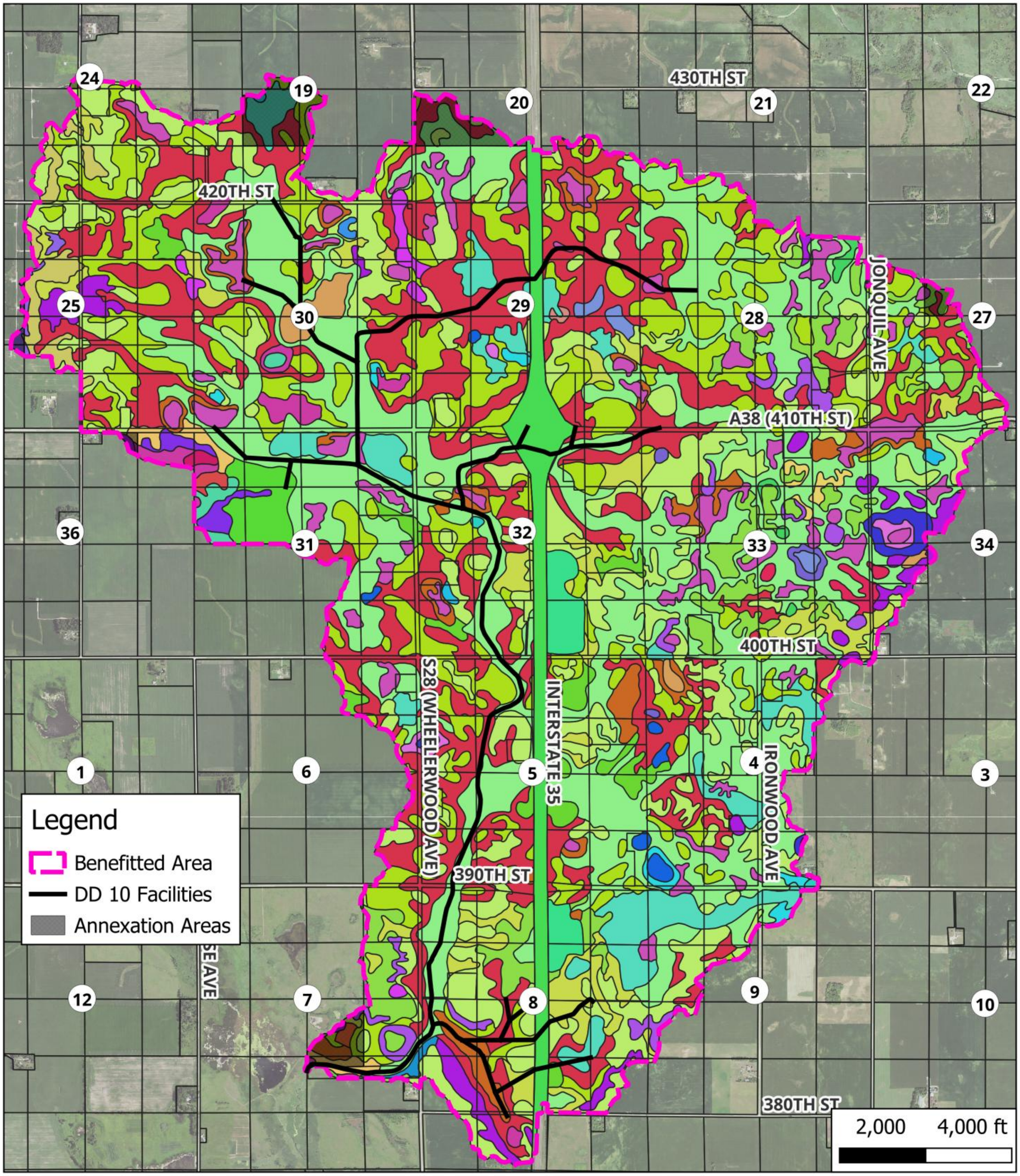
Melville L. Palmer
Extension Agricultural Engineer

Appendix C – Soil Map

AgriVia

Drainage District No. 10 **Soil Types**

Worth County, IA **December 2025**



Drainage District No. 10 — Soil Types

Worth County, IA — **December 2025**

Legend

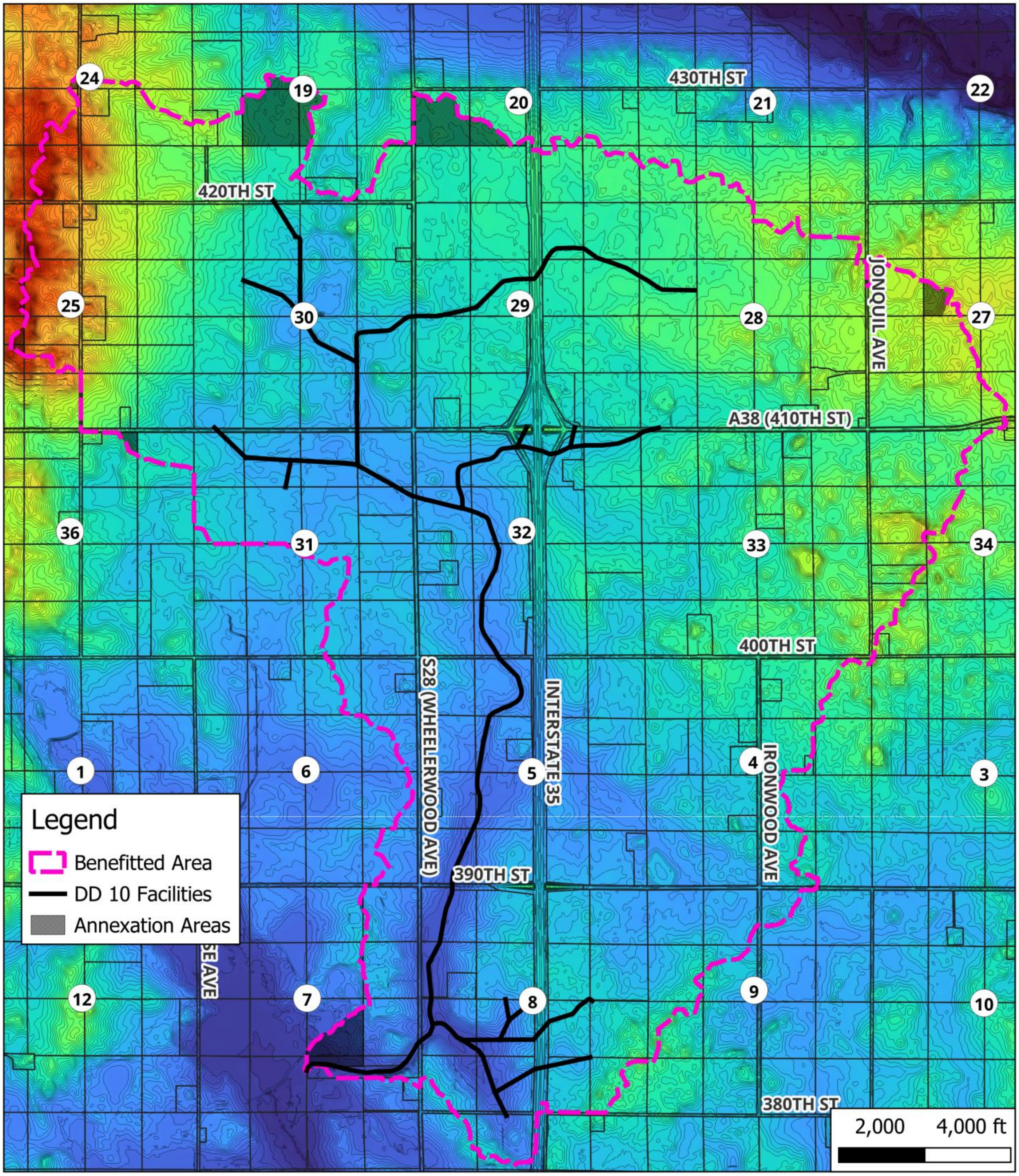
Soil Types

- Angus loam, 2 to 5 percent slopes, moderately eroded
- Angus loam, 2 to 6 percent slopes
- Angus loam, 5 to 9 percent slopes, moderately eroded
- Angus loam, 6 to 10 percent slopes
- Anthroportic Udorthents, 2 to 9 percent slopes
- Bolan loam, 0 to 2 percent slopes
- Bolan loam, 2 to 5 percent slopes
- Canisteo clay loam, 0 to 2 percent slopes
- Clarion loam, 2 to 6 percent slopes
- Clarion loam, 6 to 10 percent slopes, moderately eroded
- Clarion-Storden complex, 6 to 10 percent slopes, moderately eroded
- Clarion-Swanlake complex, 2 to 6 percent slopes
- Dickinson fine sandy loam, 0 to 2 percent slopes
- Dickinson fine sandy loam, 2 to 5 percent slopes
- Dickinson fine sandy loam, 5 to 9 percent slopes
- Flagler sandy loam, 0 to 5 percent slopes
- Flagler sandy loam, 0 to 5 percent slopes, rarely flooded
- Harcot loam, 0 to 2 percent slopes, rarely flooded
- Harps clay loam, 0 to 2 percent slopes
- Harps-Okoboji complex, 0 to 2 percent slopes
- Hawick sandy loam, 2 to 9 percent slopes, moderately eroded
- Hawick sandy loam, 9 to 14 percent slopes, moderately eroded
- Klossner muck, 0 to 1 percent slopes
- Lawler loam, 0 to 2 percent slopes, rarely flooded
- Le Sueur loam, 1 to 3 percent slopes
- Lester loam, 10 to 16 percent slopes, moderately eroded
- Marshan clay loam, 0 to 2 percent slopes, rarely flooded
- Nicollet clay loam, 1 to 3 percent slopes
- Nicollet-Clarion complex, 1 to 3 percent slopes
- Okoboji silty clay loam, 0 to 1 percent slopes
- Saude loam, 0 to 2 percent slopes
- Saude loam, 2 to 5 percent slopes
- Shandep clay loam, 0 to 1 percent slopes, occasionally flooded
- Shandep clay loam, 0 to 2 percent slopes, ponded, occasionally flooded
- Sparta loamy sand, 2 to 5 percent slopes
- Sparta loamy sand, 5 to 9 percent slopes
- Talcot clay loam, 0 to 2 percent slopes, rarely flooded
- Udorthents-Highway complex, 0 to 5 percent slopes
- Waukee loam, 0 to 2 percent slopes
- Waukee loam, 0 to 2 percent slopes, rarely flooded
- Webster clay loam, 0 to 2 percent slopes
- Webster-Nicollet complex, 0 to 3 percent slopes

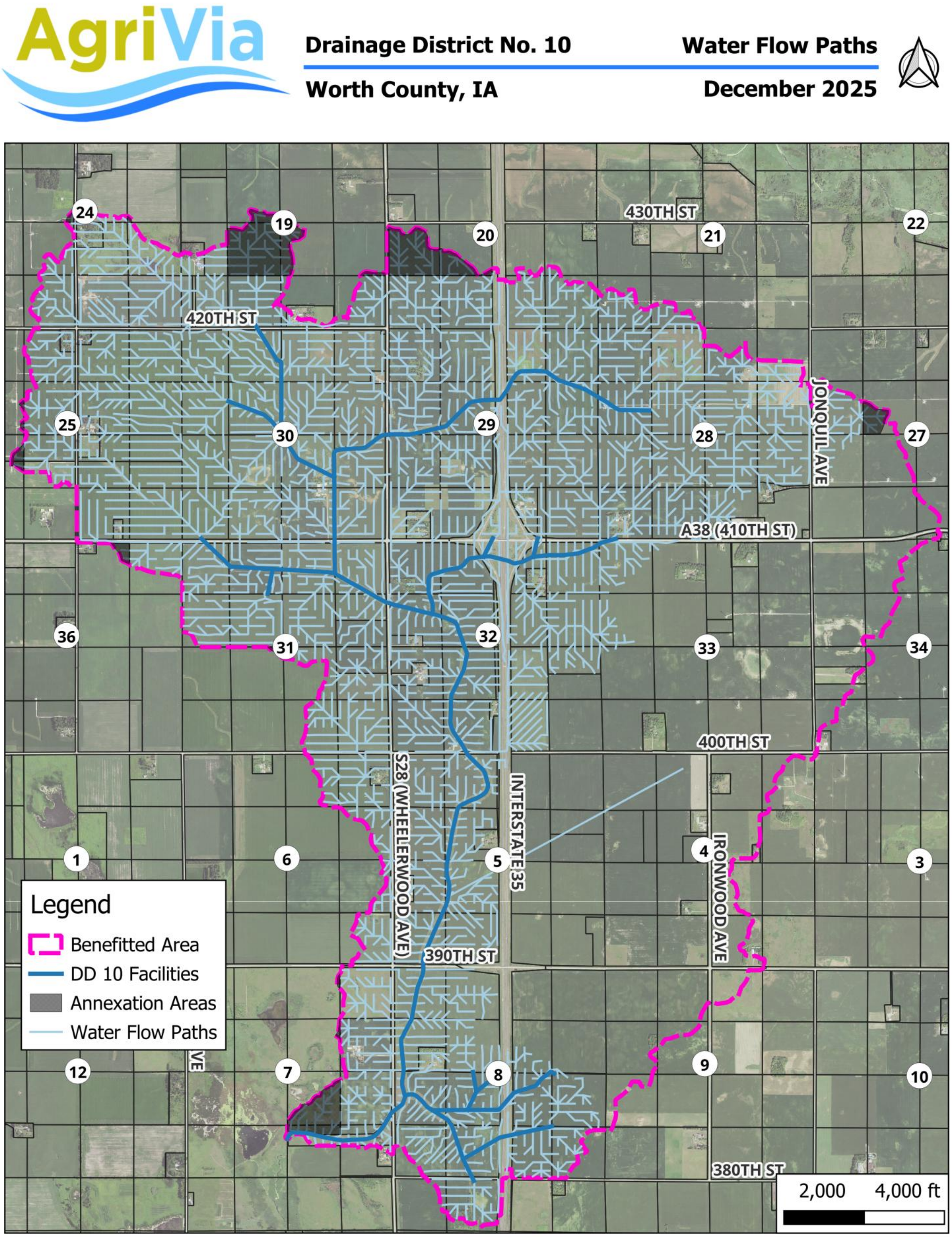
Appendix D – Elevation Map

Drainage District No. 10 | **Elevation Map**

Worth County, IA | **December 2025**



Appendix E - Water Flow Paths Map



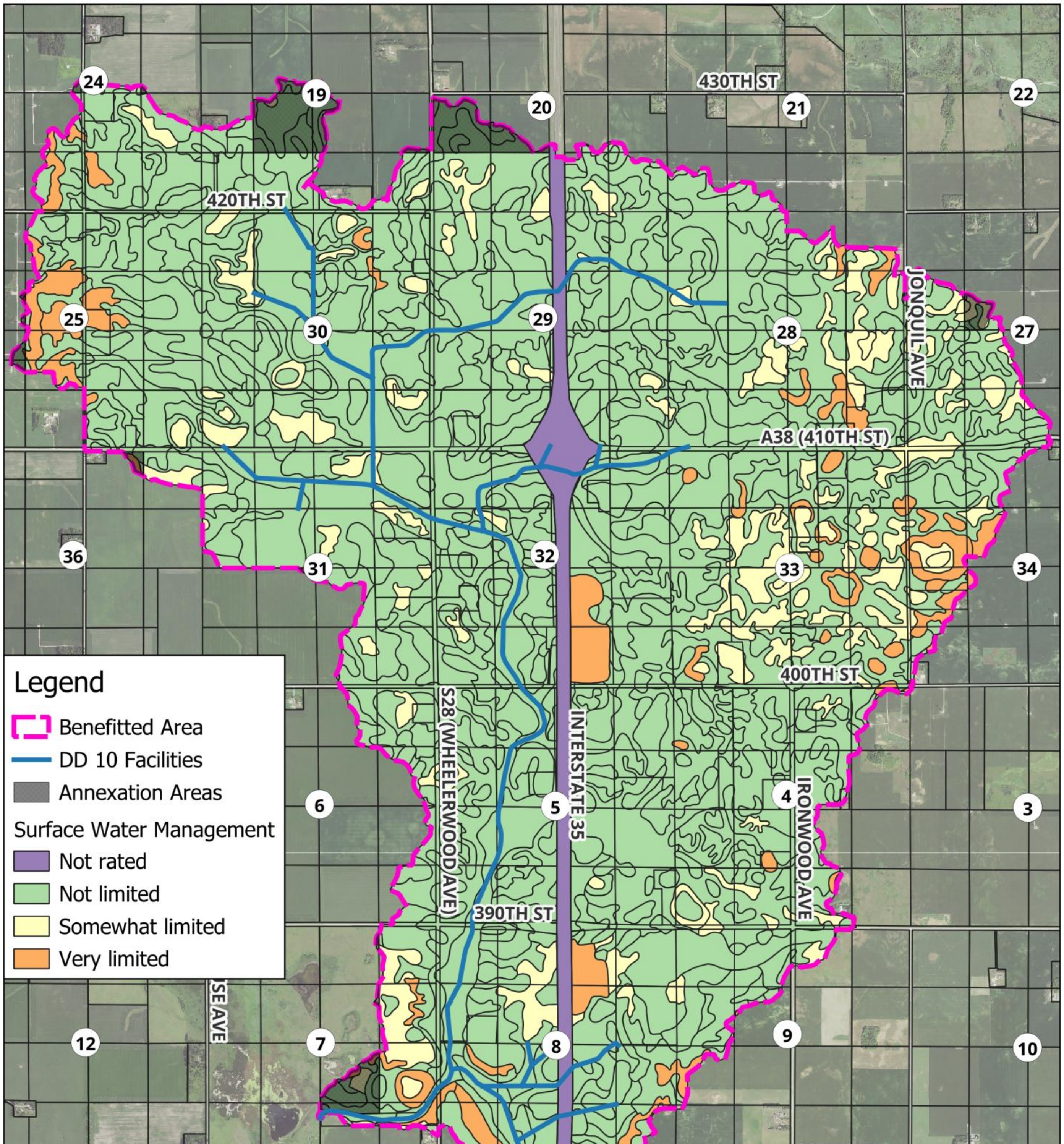
Appendix F- Surface Water Management Map

Drainage District No. 10

Worth County, IA

Surface Water Management

December 2025



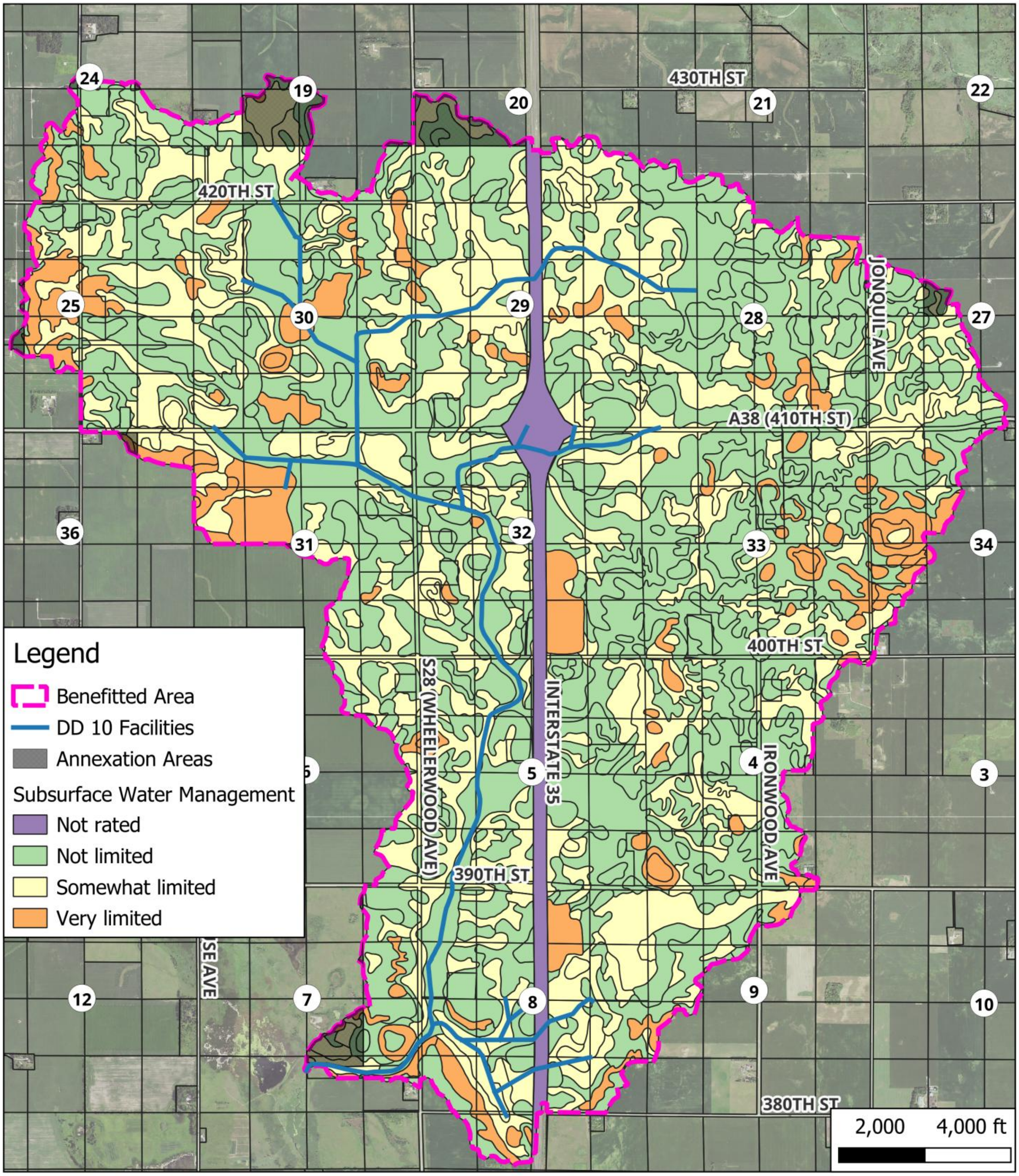
Appendix G - Subsurface (Tile) Water Management Map

Drainage District No. 10

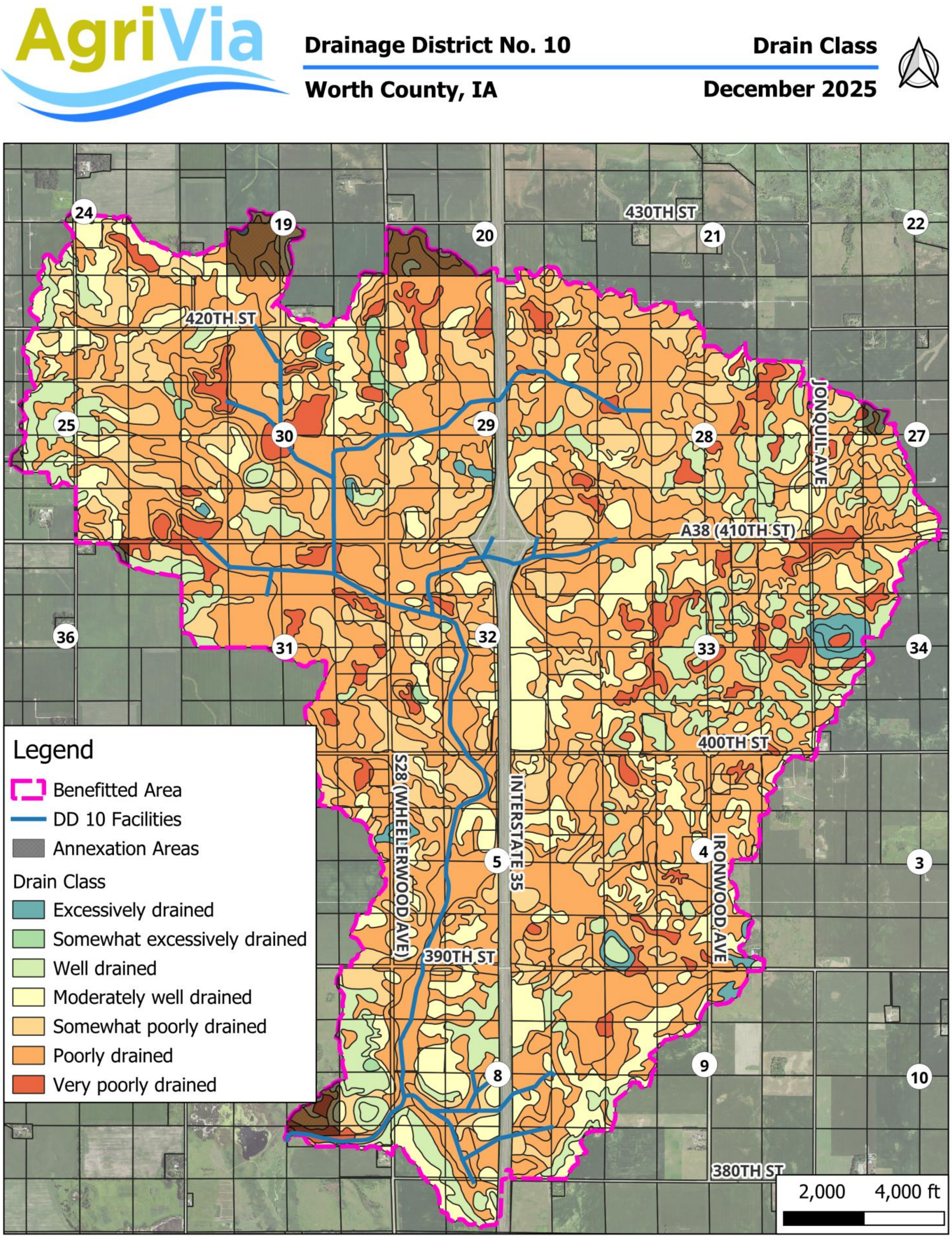
Worth County, IA

Subsurface Water Management

December 2025



Appendix H – Soil Drainage Class



PIN	Deedholder	S-T-R	Legal Description	Area (Acres)	Elevation		Relation to Facility		Condition of Drainage		
					Elevation (ft)	Slope (%)	Outlet Closer (%)	Proximity (ft)	Drain Class	Ksat (in/day)	Water Table Depth (in)
0631300002	BRAKKE, JEFFREY A	31-99-21	31-99-21 NE SW	1.3	1235.5	-0.06	88.7	2507.9	7	8.7	0.0
0525300002	BRUNSVOLD, RALPH TRUST	25-99-22	25 99 22 S 1/2 NW SW	1.1	1328.1	0.17	80.3	5751.2	4	40.9	35.0
1007400008	DJUREN, DAVE ALLEN & CAROL MARIE	07-98-21	7-98-21 SW SE EX PAR	7	1209.5	-2.62	100.0	0.0	7	56.6	0.0
0525100003	EVANS, ELIOT	25-99-22	25 99 22 SW NW	0.8	1340.8	0.61	81.4	5791.8	4	71.8	35.0
0525300001	EVANS, ELIOT	25-99-22	25 99 22 N 1/2 NW SW	2	1328.1	0.07	80.5	5682.2	4	63.7	35.0
0627100001	HELGESON, DAVID J TRUST & GLORIA J TRUST	27-99-21	SECTION:27 TOWNSHIP:99 RANGE:21 NW NW BROOKFIELD	0.1	1284.7	0.02	71.2	9391.4	5	38.9	12.5
0627100004	HELGESON, DAVID J TRUST & GLORIA J TRUST	27-99-21	SECTION:27 TOWNSHIP:99 RANGE:21 SE NW BROOKFIELD	8.7	1281.8	0.01	70.5	9704.5	6	15.7	3.6
0619100005	IMLAU, WILLIAM A	19-99-21	SECTION:19 TOWNSHIP:99 RANGE:21 SE NW BROOKFIELD	4.2	1255.6	0.00	90.9	2677.4	6	17.8	0.2
0524200004	KINGLAND FARMS LC	24-99-22	24 99 22 SE NE	0.3	1286.6	0.22	85.1	4671.8	5	40.3	25.3
0536200006	MMH IOWA ENTERPRISES LLC	36-99-22	36-99-22 NW NE EX PAR	3.3	1249.9	0.01	92.5	1878.4	6	53.9	0.0
0524100004	NELSON FAMILY FARM	24-99-22	SECTION:24 TOWNSHIP:99 RANGE:22 SE NW BRISTOL	0.8	1309.9	0.28	82.2	5769.1	6	73.5	5.2
0620300001	SAWIN, STEVEN LIVING TRUST	20-99-21	SECTION:20 TOWNSHIP:99 RANGE:21 NW SW BROOKFIELD	29.7	1254.6	0.03	84.7	4475.4	6	9.6	0.0
0620300002	SAWIN, STEVEN LIVING TRUST	20-99-21	SECTION:20 TOWNSHIP:99 RANGE:21 NE SW BROOKFIELD	10.2	1255.2	0.00	83.5	4892.8	6	6.6	0.0
0619200003	TENOLD FARM LLC	19-99-21	SECTION:19 TOWNSHIP:99 RANGE:21 SW NE BROOKFIELD	1.3	1258.2	0.03	89.4	3181.2	6	31.3	0.2
0619400001	TENOLD FARM LLC	19-99-21	SECTION:19 TOWNSHIP:99 RANGE:21 NW SE BROOKFIELD	10.7	1256.5	0.05	93.7	1786.0	6	10.2	0.2
1007200001	UNITED STATES OF AMERICA	07-98-21	SECTION:07 TOWNSHIP:98 RANGE:21 NW NE DANVILLE	0.4	1233.3	0.00	73.5	1819.4	4	48.0	29.5
1007200003	UNITED STATES OF AMERICA	07-98-21	SECTION:07 TOWNSHIP:98 RANGE:21 SW NE DANVILLE	0.5	1235.4	0.00	78.8	1353.9	6	26.1	2.4
1007400001	UNITED STATES OF AMERICA	07-98-21	SECTION:07 TOWNSHIP:98 RANGE:21 NW SE DANVILLE	20.4	1209.4	-1.45	83.0	126.9	7	17.5	0.0

PIN	Deedholder	S-T-R	Legal Description	Area (Acres)	Elevation		Relation to Facility		Condition of Drainage		
					Elevation (ft)	Slope (%)	Outlet Closer (%)	Proximity (ft)	Drain Class	Ksat (in/day)	Water Table Depth (in)
0619300002	WELCH, LA VONNE M & JOHN F	19-99-21	SECTION:19 TOWNSHIP:99 RANGE:21 NE SW BROOKFIELD	38.4	1254.6	0.00	95.5	1252.2	6	12.5	0.0
0619400002	WELCH, LA VONNE M & JOHN F	19-99-21	SECTION:19 TOWNSHIP:99 RANGE:21 NE SE BROOKFIELD	1.2	1257.4	0.05	82.5	5238.9	6	17.4	3.9
			Total Acres	**142.4**							

AgriVia

PO Box 44
1124 Willis Ave
Perry, IA 50220

Technical Appendix

Drainage District No. 10 Annexation Report

Worth County, Iowa
2025

Project No. 2529-98

Table of Contents

Introduction

Introduction
This document provides a summary of the detailed legal and technical appendices filed in support of the annexation report. These appendices collectively establish a comprehensive, data-driven, and legally sound justification for the inclusion of the proposed lands. The core finding of this engineering analysis is that every parcel within the defined watershed boundary receives a direct, material, and special benefit from the Drainage District's infrastructure.

Summary of the Legal and Technical Case for Annexation
The engineering recommendation for annexation is built upon three foundational pillars: a correct interpretation of Iowa drainage law, a rigorous application of modern engineering science, and a realistic assessment of the demands of 21st-century agriculture.

A Legally Sound Definition of "Benefit":
A thorough analysis of over a century of Iowa case law confirms that a "material benefit" is not limited to the direct draining of a swamp. The courts consistently recognize the provision of a better and more efficient outlet as a tangible, assessable benefit. The district's infrastructure provides all tributary lands, including uplands, with the legal right and physical ability to more effectively drain their own property—an opportunity that is legally restricted and physically impractical without the district.

A Scientifically Irrefutable Engineering Analysis:
This report is the result of a modern, multi-layered engineering survey that is legally compliant and technically superior to historical methods. By integrating USDA Soil Survey data, high-resolution LiDAR elevation data, and established hydraulic modeling, this analysis moves beyond subjective opinion to a quantifiable, objective conclusion. This data-driven approach is used to systematically refute common fallacies, proving through the laws of physics that higher-elevation lands are entirely dependent on the downstream outlet and that the watershed is the only scientifically logical boundary for this engineered system.

The "Evolving Standard of Benefit":
The central argument of this report is that the definition of drainage "benefit" must be viewed through a modern lens. A system designed for the 40-bushel-per-acre yields and 3-ton tractors of the 1920s is fundamentally inadequate for the 200+ bushel yields, 50-ton equipment, and high-intensity rainfall events of the 2020s. The demands placed on the system have increased by an order of magnitude. Annexation is therefore not a correction of a historical error, but an essential modernization to align the district's legal and financial structure with its current hydraulic and economic reality.

Legal Case for Annexation

Overview of "Material Benefit" as defined by Iowa Courts
Iowa courts have consistently held that for a parcel of land to be either included in a new drainage district or annexed into an existing one, it must receive a material or special benefit from the improvement. This benefit cannot be speculative or trivial. It must be a tangible advantage that increases the land's value, makes it better suited for its intended use, or relieves it of a burden, such as inadequate drainage. Over more than a century of case law, the courts have clarified that simply being located in the same watershed is not, by itself, a material benefit. A landowner has the right to let surface water flow naturally from their property and is not obligated to pay for its journey downstream. The benefit must be more direct, such as providing a better outlet than nature affords, improving the quality of the soil through better drainage, or enabling a landowner to make their own drainage more effective.

This appendix provides a summary and technical analysis of key Iowa court cases governing the establishment and annexation of lands into a drainage district. Each analysis explains the case's precedent and its specific applicability to the engineering findings and recommendations contained in this report.

Zinser v. Bd. of Sup'rs of Buena Vista County, 114 N.W. 51 (Iowa 1907)

Case Summary:

The Iowa Supreme Court established the foundational principles for including land in a drainage district. The engineer in this case had improperly included all lands within the watershed, stating he "simply returned all lands within the watershed" because he felt incompetent to pass on whether a substantial advantage would accrue to each parcel. The Court rejected this approach, holding that inclusion cannot be based merely on being within a watershed. It ruled that a prerequisite for inclusion is that the land "will in all reasonable probability derive some special benefit from the improvement". The Court defined this benefit as something that must "increase its value, either by relieving it of some burden, or by making it adapted for a different purpose, or better adapted for the purpose for which it is used".

Applicability to This Annexation:

This case is the most critical precedent, as this report recommends annexing the entire watershed. However, unlike the engineer in Zinser, this recommendation is not based on a simplistic assumption. It is based on a specific, universal finding of a shared material benefit that applies to every parcel within the watershed boundary.

- A Shared Burden and a Universal Benefit: The engineer in Zinser failed because he offered no reason for inclusion beyond geography. In contrast, my analysis has identified a single, pervasive "burden" that affects every parcel within this watershed: the entire watershed funnels to a single, high, and inefficient natural outlet. This shared topographic bottleneck creates an insufficient hydraulic gradient for all tributary lands, impeding both surface and subsurface drainage across the entire area. The district's facilities, by cutting through this bottleneck and establishing a lower control elevation, provides a direct, special, and universal benefit to every parcel that drains to it.
- The Watershed Boundary Defines the Benefited Area: In this specific case, the watershed boundary is not an arbitrary line; it is the precise boundary of the area physically constrained by the inadequate natural outlet. Every parcel within this boundary is hydraulically tributary to the problem point and is therefore directly benefited by its solution. Lands outside this watershed do not share this burden and are not included. Thus, the annexation of the entire watershed is justified by a specific, shared engineering problem and a universal solution, not by a mere assumption.

Technical Analysis:

The technical failure in Zinser was the lack of analysis. The recommendation was an assumption, not a conclusion. My recommendation is a conclusion derived from a comprehensive hydraulic and topographic analysis of the entire watershed. This analysis demonstrates that the pre-district hydraulic grade line (HGL) for the entire basin was artificially elevated by the high elevation of the natural outlet. This condition suppresses drainage potential universally. The district's deep drainage facilities effectively lowered the tailwater elevation for the entire system, thereby steepening the potential HGL for every tributary parcel. This increased potential gradient is a direct, quantifiable engineering benefit that allows for deeper and more effective tile systems and faster surface water removal throughout the entire watershed. This is the specific "special benefit" that the engineer in Zinser failed to identify.

Thompson v. Bd. of Sup'rs of Buena Vista County, 206 N.W. 624 (Iowa 1925)

Case Summary:

The court rejected the annexation of 102,000 acres of upstream land that was part of other functional drainage districts with their own adequate outlets. The Board's only justification for annexing these distant, high-elevation lands was that their water eventually flowed into the downstream creek being improved. The court famously ruled that a landowner has no "continuing obligation to 'pay the freight' upon his own surface waters after they have left his lands".

Applicability to This Annexation:
This case is applicable as a crucial point of distinction. The principle in Thompson applies to remote lands that do not need the downstream improvement to drain. It prevents districts from assessing lands far upstream that already have their own working outlets. Our case is the opposite. The benefit identified in this report is not a remote, downstream improvement. It is a direct and local benefit provided by the district's outlet, which is necessary for the proper drainage of the subject parcels. The annexed lands do not have other "adequate outlets"; the district's facility is their outlet.

Technical Analysis:
The lands in Thompson were hydraulically independent of the lower district's improvements. In our case, the parcels proposed for annexation are hydraulically dependent on the district's drainage facilities. The controlling elevation for the entire annexed area is the artificially lowered elevation of the district's outlet. This is not a matter of "paying the freight" for water already gone; it is a matter of paying for the creation of an essential outlet that allows water to leave in the first place.

Lindflott v. Drainage District No. 23, No. 16-1579 (Iowa Ct. App. 2017)
Case Summary:
The Court of Appeals affirmed an annexation where the material benefit was the district's excavation of a downstream channel, which in turn enabled the landowner to effectively deepen the channel on his own property. This private improvement, the court reasoned, "would have been impossible without the district". The landowner's choice to take advantage of the opportunity created by the district was seen as an "implicit acknowledgement" of the benefit.

Applicability to This Annexation:
This case is highly supportive of our core argument that benefit equals opportunity. It directly refutes the notion that a benefit must be a finished, passive improvement.

- Benefit as Opportunity: The ruling confirms that providing the ability for a landowner to improve their own drainage is a material benefit. Our report is based on this exact premise: the district provides landowners the opportunity to install effective tile systems where it was previously futile.
- Irrelevance of Current Use: The benefit in Lindflott existed the moment the district's ditch was dug, regardless of whether the landowner ever chose to act. This powerfully refutes the anticipated objection that land in CRP or woodland receives no benefit until it is actively farmed. The opportunity to convert it to a higher use is the benefit.

Technical Analysis:
The engineering principle is identical to our case. A downstream excavation (the district's ditch) lowered the hydraulic control point. This increased the potential hydraulic gradient available to all upstream properties within the watershed. This increased gradient is what makes deeper, more effective drainage on the annexed parcels possible. That a landowner must still invest in private laterals to realize the full economic value of this potential does not negate the material benefit of the district providing the essential outlet that makes such an investment viable.

Hatcher v. Bd. of Sup'rs of Greene Cnty., 145 N.W. 12 (Iowa 1914)
Case Summary:
The court affirmed an assessment of benefits against a landowner whose property contained a large, useless pond covering 80-90 acres. The new drainage system ran through the pond and made the land productive. The court held that reclaiming swampy or overflow lands for agriculture is a valid public purpose. It also noted that a

drainage plan is not expected to provide complete drainage for every individual, and that "private drains and laterals must often supplement the system for the highest results".

Applicability to This Annexation:
This case provides strong support for the purpose of the annexation and refutes objections based on current land use. The court's recognition that landowners must supplement the main system supports our argument that the district's responsibility is to provide the main outlet. The landowner is then responsible for taking advantage of it. A landowner cannot refuse to connect their private drains and then claim the district provides no benefit.

Technical Analysis:
The technical benefit in Hatcher was the draining of a large depressional area, or "pothole." Many of the subject parcels in our case exhibit similar characteristics, albeit perhaps on a smaller scale. By providing a deep outlet, the district allows these depressional areas, which currently hold water due to a lack of a natural surface outlet, to be tapped and drained via subsurface tile. This transforms them from a liability into a productive asset, a clear material benefit.

Prichard v. Bd. of Sup'rs of Woodbury Cnty., 129 N.W. 970 (Iowa 1911)
Case Summary:
The court affirmed the establishment of a district and addressed the issue of lands receiving varying degrees of benefit. It ruled that such differences are not grounds for excluding land from the district. The court stated, "Doubtless some will be benefited much more in proportion than others... but all those things are subject to adjustment, when the board shall come finally to pass upon the classification of the land and the assessment of the cost of the improvement".

Applicability to This Annexation:
This precedent is essential for properly framing the debate over land use including CRP, acreages, and woodland. An argument that a wooded parcel benefits less than a cornfield is not a defense against annexation. As long as the wooded parcel receives some special benefit (the new opportunity for drainage), it is properly included.

Technical Analysis:
Technically, the potential for improved drainage exists for both tilled and wooded parcels because the hydraulic gradient has been improved for the entire watershed. The cost to realize this benefit (e.g., land clearing) and the immediate economic return will vary by parcel. These do not negate the underlying engineering benefit that justifies inclusion in the district.

Monson v. Board of Sup'rs of Boone and Story Counties, 149 N.W. 624 (Iowa 1914)
Case Summary:
The court held it was proper to consider a land's pre-existing condition when assessing benefits. Land that had already achieved partial drainage through natural means was entitled to a reduced assessment compared to land that was completely unimproved. The court also analyzed a hypothetical where a main drain was built to a "shallower depth" that was "insufficient to furnish complete drainage" to the lowest lands. It concluded that this would still confer a "lessened benefit" that would be properly assessable.

Applicability to This Annexation:
This case provides two key points. First, the inverse of its main holding is powerful: if partial natural drainage warrants a lower assessment, then a complete lack of natural drainage warrants a finding of a high degree of benefit. Second, it establishes that an outlet does not have to be perfect to be a benefit. The fact that a system provides a "lessened benefit" or is "insufficient to furnish complete drainage" does not mean there is no benefit at all. It means the benefit exists and should be assessed proportionally. This counters any potential argument that because the district does not solve every conceivable water problem, it provides no benefit.

Technical Analysis:
The Monson case supports a nuanced engineering view. A drainage system provides a spectrum of benefits. My analysis confirms the district provides a substantial benefit by creating an effective outlet. Even if this outlet is not infinitely deep, it is a vast improvement over the natural condition and provides a real, assessable benefit to all tributary lands by making their drainage possible.

Kelley v. Drainage District No. 60 In Greene County, 138 N.W. 841 (Iowa 1912)
Case Summary:
The court affirmed the creation of a new district over an existing one that had proven insufficient. It held that the purpose of such a project could be to supply a "better outlet" or an "additional outlet". The court found that providing a better outlet "was of some benefit to all the lands tributary thereto". The case also made the critical procedural point that a landowner's failure to appeal the establishment order constitutes a waiver of objections and the order becomes "conclusive and final that all prior proceedings were regular and according to law".

Applicability to This Annexation:
This case confirms that improving an existing drainage path constitutes a material benefit. It is not necessary that the land be an untamed swamp. If the district provides a better, deeper, or more efficient outlet than what nature provides, it is conferring a benefit upon all tributary lands. This directly applies to our watershed, where the district channel is a significant improvement over the inefficient natural outlet.

Technical Analysis:
The engineering principle here is efficiency. The natural outlet of the watershed may have functioned, but at a low capacity, causing water to back up and fields to remain saturated. The district's ditch, with its engineered size, depth, and grade, provides a high-capacity outlet. This increased conveyance capacity is a direct technical benefit to all lands that drain to it, as it lowers the water surface elevation during runoff events and allows private tile systems to function more effectively.

Ray W. Ohrtman Revocable Trust v. Palo Alto Cnty. Bd. of Sup'rs, No. 07-1921 (Iowa Ct. App. 2008)
Case Summary:
The Court of Appeals reversed an annexation, finding the landowners would not receive a material benefit. The key fact was that the annexed lands already drained into Cylinder Creek, a natural watercourse that served as an adequate outlet. The plaintiff's expert successfully argued that work done downstream on the district's main ditch would not benefit the upstream landowners whose drainage was controlled by the natural creek channel, which included a "bottleneck" that restricted flow naturally.

Applicability to This Annexation:
This case serves as a clear factual counter-example and highlights the strength of our position. The annexation in Ohrtman failed because the landowners already had a functional, albeit natural, outlet. The district's work was downstream of their controlling feature. In our case, the district's work is the outlet. It created the outlet by cutting through the watershed's natural "bottleneck." Therefore, unlike in Ohrtman, the benefit is direct and essential, not remote and speculative.

Technical Analysis:
The hydraulic control for the Ohrtman properties was the natural Cylinder Creek channel. The district's work was downstream of this control and thus provided no hydraulic benefit upstream. In our watershed, the hydraulic control for the entire annexed area was the high natural outlet. The district's drainage facility excavated this control point to a lower elevation, directly and materially benefiting every acre upstream of it.

Blue Verbrugge Family Farms, LLC v. Hamilton Cnty. Bd. of Supervisors, No. 22-1797 (Iowa Ct. App. 2024)
Case Summary:

In another recent decision reversing an annexation, the Court of Appeals reiterated the established principles. It found the engineer's report insufficient because it relied on the watershed concept without specifying the material benefit to the annexed lands. Citing Lindflott, the court stated, "when the topography of land would ensure surface waters drained off the landowner's property naturally, a landowner must receive some benefit other than an outlet for surface waters to have a material benefit".

Applicability to This Annexation:
Like Ohrtman, this case is a valuable point of distinction. The annexation failed because of a perceived lack of benefit stated in the report beyond what nature already provided. Our report, in contrast, is based on the specific finding that the topography of the watershed does not ensure that surface and subsurface waters drain off naturally and effectively. Our entire premise is that the district provides a benefit precisely because natural drainage is inadequate.

Technical Analysis:
The court in Blue Verbrugge was not presented with evidence in the engineer's report of a universal, shared hydraulic impediment like the one present in our watershed. The conclusion that "water would drain naturally without the improvement" was accepted by that court. My analysis of our watershed shows the opposite. While water would eventually find its way out, it would do so slowly and inefficiently, keeping the water table high and preventing optimal land use. The district's improvement creates an efficient, low-elevation pathway that makes modern, productive agriculture possible.

Roewe v. Pavik, 70 N.W.2d 845 (Iowa 1955)
Case Summary:
The court affirmed the annexation of lands that had been considered but excluded during the district's original formation. The landowners argued this was "res judicata" (a thing decided). The court held that the annexation statute "contemplates the correction of errors, unintentional or otherwise, in not including certain lands" and that a prior omission is not a permanent bar to later annexation.

Applicability to This Annexation:
This case is procedurally important. It grants the Board the authority to ensure that all lands that are materially benefited by the district are included and contribute to its costs. It affirms that the Board's duty is ongoing. If any of the subject parcels were considered but excluded in the past, Roewe confirms the Board's authority to reconsider them based on the new, detailed analysis provided in this report.

Technical Analysis:
Drainage science and land management goals evolve. An area not considered "wet" enough for inclusion in 1920 may, by modern agricultural standards, be significantly burdened by a high-water table that the district now relieves. This case allows the Board to apply modern engineering analysis and agricultural standards to correct historical boundaries and ensure equitable contribution from all benefited parties.

Statutory and Technical Methodology of Engineering Required

Introduction and Purpose
The purpose of this section is to provide a detailed explanation of the statutory authority and the modern engineering methodology employed to survey the lands within the proposed annexation area and determine the benefits accruing to each parcel. This document will establish that the procedures undertaken are in full compliance with the Iowa Code, represent the current standard of care for the professional practice of engineering, and yield an objective, data-driven, and equitable result.

This analysis is presented to preemptively address potential challenges regarding the definition of "survey" as used in drainage law and to demonstrate that a physical, "boots-on-the-ground" topographical survey of each individual parcel is neither required by law nor is it the most accurate or comprehensive method available today for a watershed-scale benefit analysis. The methods used herein are scientifically rigorous, legally sound, and technically superior to historical practices.

Statutory Interpretation: Defining "Survey" and the Role of the Engineer

The duties and qualifications of the engineer in a drainage matter are outlined in Iowa Code Chapter 468, "Drainage." A correct interpretation of this language is critical to understanding the legal and technical foundation of this report.

An "Engineering Survey" vs. "Land Surveying"

Iowa Code §468.11 directs the appointed engineer to "examine the lands... and survey and locate such drains... as may be necessary for the drainage of the lands." This term must be understood as an engineering survey, a comprehensive investigation and analysis, not solely as a land survey, which is primarily concerned with property boundaries. Iowa Code Chapter 542B, which governs professional licensure, makes a clear distinction:

- Practice of Engineering (§542B.2): Defined as "any service or creative work, the adequate performance of which requires engineering education, training, and experience in the application of special knowledge of the mathematical, physical, and engineering sciences to such services or creative work as... consultation, investigation, evaluation, planning... and design of... public or private utilities, structures, machines, processes, works, or projects."
- Practice of Land Surveying (§542B.2): Defined as "surveying of areas for their correct determination and description and for conveyancing, or for the establishment or reestablishment of land boundaries and the platting of lands and subdivisions..."

The tasks required by Chapter 468—evaluating drainage needs, investigating watershed hydrology, planning drain locations, and determining benefits—fall squarely and unambiguously under the statutory definition of the "Practice of Engineering." The work is an investigation and evaluation of a public work. Therefore, the "survey" mandated is an engineering investigation that employs all necessary tools and techniques to fulfill its purpose.

The Professional Engineer as a Disinterested Expert

The Iowa Code is prescriptive in requiring a qualified, professional engineer for this process. Specifically, §468.11 mandates the appointment of a "disinterested and competent engineer." This requirement is a foundational safeguard of the entire process. Landowners, by nature, have a direct financial incentive to resist annexation or minimize their assessment. The law requires the appointment of a licensed professional engineer to serve as an objective, unbiased expert whose duty is to the scientific and mathematical facts of the analysis, not to the financial interests of any single party.

The engineer functions as an impartial "number cruncher," bound by a professional code of ethics and the laws of the State of Iowa. The role is to ensure that the complex calculations of hydrology, benefit, and cost are performed uniformly and equitably across all parcels, based on verifiable data and established engineering principles. This provides the Board of Supervisors with a technical recommendation free from personal or financial bias.

The Modern Engineering Survey: A Multi-Layered, Data-Driven Investigation

To claim that a 1904-era methodology is required to interpret a 1904-era law is to ignore a century of scientific and technological progress. Our engineering survey employed a multi-layered data analysis approach that is more accurate, comprehensive, and objective than any method available in the past. This approach does not require physical entry onto every parcel of land to develop a complete and precise understanding of the watershed. The results of this investigation are presented in the plats, profiles, and schedules included with this report.

The following data sets were integrated and analyzed to produce the benefit determination:

Foundational Data Layer: USDA-NRCS Soil Survey

- Description: A comprehensive, scientifically vetted inventory of soil resources.
- Purpose & Function: The soil type of a given parcel is a direct physical record of its long-term, inherent drainage characteristics. We utilized this data to objectively identify lands with limitations that demonstrate a need for drainage. Key data points were analyzed for each soil type on every acre of the watershed.
- Significance: This data is an objective, pre-existing scientific baseline that is not subject to interpretation or opinion. It establishes the need for improved drainage on a parcel-by-parcel basis.

Topographic Data Layer: LiDAR (Light Detection and Ranging)

- Description: High-resolution elevation data collected by aircraft using laser pulses, resulting in a digital elevation model (DEM) of the entire land surface with vertical accuracy measured in inches.
- Purpose & Function: LiDAR provides a complete and continuous topographic map of the entire annexation area. This data was used to:
    - Precisely delineate watershed and sub-watershed boundaries.
    - Trace the exact flow paths of surface water.
    - Identify all depressions, ridges, and slopes that control the movement of water.
    - Calculate the acreage of land tributary to specific points in the drainage system.
- Significance: LiDAR allows for a complete, system-wide understanding of how all parcels are hydrologically connected, making the entire watershed visible and analyzable as a single, integrated system.

Observational & Analytical Layers: Visual Survey, Aerial Photos.

- Description: This phase combines professional observation with advanced computer modeling.
- Purpose & Function:
    - Visual Survey: We conducted a visual survey by visiting and driving through the area to observe general land use, verify locations of key infrastructure, and confirm that conditions on the ground were consistent with the data. This is a verification step, not a data collection step.
    - Aerial Photography: Modern, high-resolution and historical aerial imagery was analyzed to identify signatures of poor drainage, providing further corroboration of the soil and LiDAR data.
- Significance: This final layer transforms the raw data into an objective determination of benefit. The benefit is no longer a subjective opinion but a calculated, quantifiable improvement in the land's ability to shed excess water.

Integration with the Public Record and Right to Amend

This engineering report should not be viewed in a vacuum. It is the latest entry in the comprehensive, ongoing public record of this Drainage District.

Consultation of Existing Records:

In preparing this report, a thorough review of all reasonably available public records pertaining to the district was conducted. This includes, but is not limited to, the original engineer's report, all subsequent repair reports, previous reclassification reports, and minutes of official proceedings. The historical context and technical data contained in these documents inform the analysis and recommendations herein.

Public Access:

These historical documents are public records on file with the County Auditor and are available for public inspection. The information contained within them is considered part of the total body of knowledge regarding the district and is incorporated by reference into this report.

Right to Amend:
In accordance with standard professional engineering practice, the engineer reserves the right to amend or supplement this report in light of new and material information that may be presented or discovered prior to final action by the Board of Supervisors.

Conclusion: A Legally Compliant, Technically Superior, and Objective Process
The determination of benefits for the lands within the annexation area was the result of a rigorous engineering survey, fully compliant with the intent and letter of Iowa Code Chapter 468 and the professional standards of Iowa Code Chapter 542B.

The assertion that a "survey" requires individual property entry and traditional measurement is legally unfounded and technically obsolete. The modern, multi-layered approach detailed herein provides a more complete, more accurate, and more objective understanding of the entire drainage system.

The resulting recommendation is not subjective. It is the conclusion of a scientific process, conducted by a disinterested professional engineer as required by law, that uses standardized data and accepted engineering calculations to determine which lands contribute water to the system and which lands derive a benefit from the system's ability to provide a stable, efficient, and legally accessible outlet.

Historical Drainage of the Landscape

Introduction and Purpose
The purpose of this section is to provide a detailed explanation for the primary use of the United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) Soil Survey data in determining the historical landscape and drainage characteristics of the land proposed for annexation. The critical period for this analysis is the time immediately preceding the establishment of the drainage district. Due to the limited and often anecdotal information available from that specific era, a methodology based on the most robust, scientific, and temporally stable evidence is required.

This document will demonstrate that while historical records such as General Land Office (GLO) surveys, county atlases, and early aerial photography provide valuable context, they possess significant limitations in scope, purpose, and accuracy for delineating historical wetlands and drainage patterns. In contrast, modern soil survey data provides a direct, physical record of long-term hydrological conditions that predated the artificial drainage systems of the 20th century. It is an impartial, scientific baseline that remains legible on the landscape today.

The Scientific Foundation of Soil Survey Data as a Historical Record
Soil is not a static medium; it is a product of its environment, developing over centuries and millennia through a process called pedogenesis. The physical and chemical properties of a soil profile serve as a long-term, integrated record of the conditions under which it formed, particularly its relationship with water.

Key Principles:

- Formation of Hydric Soils: Soils that are saturated or ponded for long periods during the growing season develop unique characteristics known as hydric soil indicators. The prolonged absence of oxygen (anaerobic conditions) triggers chemical reactions, primarily the reduction of iron and manganese compounds.
- Redoximorphic Features: These reactions create visible, persistent features in the soil profile.
- Gleying: In consistently saturated soils, iron is stripped away, leaving dull gray, blue, or green colors. This is a clear indicator of long-term waterlogging.

- Mottling: In soils with fluctuating water tables, iron is reduced and moved, then re-oxidized and concentrated in patches of red or orange when the water level drops. These "mottles" are a distinct signature of a seasonally high-water table.
- Temporal Stability: These hydric features form over hundreds of years. Critically, they do not disappear once a field is artificially drained with tiles or ditches. While the hydrology is altered, the soil's physical and chemical profile remains as a "memory" of its pre-drainage state. An artificially drained field with hydric soil indicators is definitive proof that the area was historically a wetland or poorly drained upland.

The USDA-NRCS Soil Survey is a comprehensive inventory of these soil resources, mapped through extensive fieldwork including soil pits, auger borings, and laboratory analysis. The resulting maps and data, found in the Soil Survey Geographic (SSURGO) database, represent the most detailed and scientifically-defensible record of the inherent properties of the land, reflecting conditions that existed long before the district.

Analysis and Limitations of Alternative Historical Sources

While appealing for their age, historical maps and photos were created for purposes other than detailed hydrological analysis. Their utility in this context is limited by their intent, scale, and the technology of their time.

1850s General Land Office (GLO) Survey Maps

The GLO surveys were the first systematic documentation of the region. However, their primary purpose was legal, not ecological: to establish a grid system (the Public Land Survey System) for the orderly sale and transfer of land.

Limitations:

- Purpose-Driven Inaccuracy: Surveyors were tasked with marking section lines and corners. They noted features that intersected their straight survey lines but did not explore and map the full extent of features between these lines. A large wetland complex located entirely within a section could be missed or misrepresented.
- Qualitative & Non-Specific Data: Features were often described with simple, non-standardized terms like "swamp," "marsh," or "low wet prairie." These terms lacked precise definitions and the maps used simplistic symbology that did not differentiate between permanently inundated swamps and seasonally saturated prairies.
- Temporal Gap: These surveys were conducted approximately 70 years before the drainage district's formation. While a useful starting point, they do not account for any land-use changes or smaller, private drainage efforts that may have occurred in that half-century.

1875 Andreas Atlas and Later County Plat Atlases

These atlases are invaluable for genealogical and property research, but they are not scientific documents of the natural landscape.

Limitations:

- Commercial, Not Scientific, Intent: The primary goal of these atlases was to document land ownership. Landowners often paid to have their plots, and sometimes their homesteads, illustrated. The focus was on property lines, owner names, roads, schools, and other cultural features.
- Generalized Natural Features: Natural features like streams and wetlands were typically secondary. Their depiction was often stylized, simplified, or derived from older GLO maps without new, systematic field verification. The accuracy of their boundaries is highly questionable and was not the cartographer's main concern.
- Data by Subscription: The level of detail could be influenced by which landowners sponsored the atlas, potentially leading to omissions or inaccuracies in less-populated or less-affluent areas.

Aerial Photography (1930s and later)

Aerial photography provides a powerful, top-down view of the landscape. However, for determining pre-district conditions, it has one critical, disqualifying flaw.

Limitations:

- Incorrect Time Period: The earliest comprehensive aerial surveys of this region date to the 1930s. These photographs were taken years after the drainage district was established and operational. They do not show the landscape before drainage; they show the landscape as a result of widespread, systematic artificial drainage. Any historically wet areas that were successfully drained by 1930 would likely appear as productive cropland in these photos.
- Transient Conditions: A photograph captures a single moment. The appearance of wetness is highly dependent on the season, recent precipitation, and specific farming practices at the time the photo was taken. It cannot distinguish between a temporarily flooded area and a persistent, historically saturated landscape.

Comparative Summary and Conclusion

The following table summarizes the utility of each data source for determining the 1919 landscape conditions:

Data Source	Primary Purpose	Relevant Strengths	Critical Limitations for Early Drainage Analysis
USDA Soil Survey	Scientific inventory of soil resources	Direct physical evidence of long-term hydrology; unaffected by post-drainage; high scientific rigor and standardization.	None. It is the most reliable baseline.
1850s GLO Maps	Legal survey for land sale	First systematic documentation; notes major features on section lines.	Incorrect purpose (legal, not ecological); qualitative, non-specific data; 100-year temporal gap; incomplete mapping between lines.
1875+ County Atlases	Document land ownership	Shows property lines and cultural features.	Commercial purpose, not scientific; natural features are secondary and generalized; accuracy is not verifiable.
1930s+ Aerial Photos	Landscape documentation	Provides a visual snapshot of the land.	Shows landscape after years of artificial drainage; cannot represent pre-drainage conditions Depicts transient, not historical, wetness.

Conclusion:

While historical maps and photographs offer context about land ownership and settlement, they are fundamentally unsuited for the precise, scientific task of reconstructing the drainage landscape pre-drainage district. Their purposes were different, their methods were qualitative, and in the case of aerial photography, their timing is incorrect.

The USDA Soil Survey data, in contrast, is grounded in the direct, physical evidence of the soil itself. The hydric indicators recorded in the soil profile are a durable, scientific ledger of the historical hydrological regime, formed over centuries and persisting despite the installation of artificial drainage. Therefore, the soil survey provides the most accurate, defensible, and legally sound basis for identifying those lands that were historically poorly drained and would have benefited from the formation of the drainage district.

The Evolving Standard of Benefit and Modern Reality

Introduction: Annexation as Modernization, Not Historical Correction
The purpose of this annexation report is not to claim the original engineers made a "mistake." On the contrary, they designed a system that was appropriate for the agriculture, technology, and economic realities of their time. However, to suggest that their assessment should be the final word on drainage benefit is to ignore a century of agricultural revolution and engineering advancement.

Opponents to annexation have cited legal precedents such as Zinser v. Board of Supervisors (1907) and Thompson v. Board of Supervisors (1925). These cases, while foundational, are over a century old. Relying on their specific application to define "benefit" today is a profound error.

This re-evaluation is mandated by a fundamental shift in the definition of "drainage" itself. What was once considered adequate is now functionally obsolete. Annexation, therefore, is not about correcting the past; it is about aligning the legal and financial structure of the district with the current hydraulic and economic reality of the watershed.

A Revolution in the Fields: The Quantifiable Transformation of Iowa Agriculture
The agriculture of 100 years ago is starkly different than today. The changes are not merely incremental; they are exponential and have completely redefined the demands placed on the land and the water management systems beneath it.

The productivity demands:

- 1925: The average Iowa corn yield was approximately 40 bushels per acre. Land that couldn't reliably produce this was relegated to pasture.
- 2025: The average Iowa corn yield is now over 200 bushels per acre, a 500% increase. Modern crop genetics, developed through university research and private innovation, demand an optimized soil environment. They are bred for high performance in ideal conditions and are exceptionally vulnerable to yield loss from the anaerobic conditions caused by poor drainage.

The Weight of Modernity:

- 1925: A fully loaded tractor and implement might weigh 3-4 tons. Soil compaction was a minor concern.
- 2025: A fully loaded combine can weigh over 30 tons, and a grain cart can exceed 50 tons. This immense weight requires firm, well-drained soil to operate without causing deep, yield-robbing compaction. The "benefit" of drainage is no longer just about crop health; it's about the fundamental ability to get equipment into the field.

The Economics of Water:

- 1925: With low input costs and low yields, a wet spot in a field was a nuisance. The economic loss was minimal.
- 2025: With corn at over $5.00/bushel, a single acre yielding 220 bushels is worth $1,100. An acre lost to ponding is not a nuisance; it is a significant financial blow.

The New Hydraulic Reality: A Changing Climate
The weather patterns of 100 years ago are not the weather patterns of 2025. The rainfall that drainage systems must manage has fundamentally changed, rendering old design standards inadequate.

- Increased Precipitation Load: According to the Iowa Climate Statement, statewide annual precipitation has increased by roughly 8% over the last century. This means the total volume of water the system must handle is greater.

- The Rise of Extreme Events: Far more critical is the change in rainfall intensity. Data from the Iowa Department of Natural Resources and NOAA shows that the frequency of heavy precipitation events (e.g., more than 3 inches in 24 hours) has increased by over 30% in the last 50 years.

A drainage system designed 100 years ago for slow, multi-day melts and gentle rains is now being asked to handle high-intensity rains that drop a month's worth of rain in a day. The system's ability to evacuate this water quickly is a benefit of a different magnitude than was ever conceived by the original engineers.

The Engineering Revolution: From Art and Observation to Science and Simulation
The toolkit and knowledge base of the modern engineer bear little resemblance to that of their earlier counterpart.

The Evolution of Knowledge:

- Manning's Equation (1889), Bernoulli's Principle (1738), Darcy's Law (1856): The foundational equations are not new. What is new is our ability to apply them with unprecedented precision. The original engineer applied these principles using hand calculations for a few discrete points. Now, we can make excel spreadsheets to calculate a 1,000 data points in a moment.
- Modern University-Backed Research: Post-WWII, land-grant universities like Iowa State University created the modern science of agricultural drainage. They developed the drainage coefficient standards, the Hooghoudt and Kirkham equations for subsurface flow, and the design manuals (e.g., the Iowa Drainage Guide) that are now the industry standard.

The Power of Modern Tools:

- Past: The engineer used a transit, a level, and a notebook. They could take dozens, perhaps hundreds, of elevation shots in a day. Their understanding of the landscape was an interpolation between these sparse points.
- 2025: The engineer uses LiDAR, which provides billions of high-accuracy elevation points, creating a flawless digital twin of the landscape. We use GIS to run complex hydrologic models that simulate precisely how water will move across every foot of the watershed under different storm conditions. We can prove benefit with a level of computational certainty that would have been indistinguishable from magic for an early engineer.

The most telling evidence of this evolution lies in the engineering standard used to design drainage systems: the drainage coefficient. This is the rate at which water is to be removed from a soil profile, typically measured in inches per 24 hours.

- The 1900s Standard: Basic Land Reclamation. The original goal was to drain potholes and swamps to make land merely tillable. The prevailing philosophy was to farm the highlands and pasture the lowlands. Engineers designed systems to a drainage coefficient of approximately 1/10th of an inch. This was sufficient to remove surface water over several days. Tiling, if done at all, was random, targeting only the wettest spots.
- The Modern Standard: Agronomic Optimization. Today's goal is not mere reclamation; it is the optimization of the soil environment for maximum economic yield. The philosophy is to farm every acre intensively. Modern high-yield hybrids are intolerant of excess moisture, and multi-ton equipment requires firm soil. Consequently, engineers now design systems to a drainage coefficient of a 1/2 an inch or more. This is a 400-500% increase in the expected drainage capacity. This capacity is achieved through intensive, systematic pattern tiling, with lines spaced as tightly as 20 feet apart.

This is not a minor adjustment. It is a paradigm shift. The demand placed on the drainage outlet by a modern, pattern-tiled farm is an order of magnitude greater than what the original system was designed to handle.

The Inequity of the Status Quo
Without annexation, a dysfunctional and inequitable scenario exists:

- Existing members pay 100% of the costs for maintaining a system.
- Unassessed lands benefit from and consume a significant portion of the system's capacity, increasing the wear and tear and necessitating more frequent and costly maintenance.
- When the system becomes overloaded and requires upgrades to handle the modern load, the existing members would be forced to pay for improvements necessitated by the unassessed lands.

This is an unsustainable model. Annexation remedies this by aligning the financial responsibility with the hydraulic reality. It ensures that all lands that benefit from and place a load on the system contribute their fair share to its upkeep and eventual modernization.

Conclusion: The Unavoidable Mandate to Modernize
To hold a 21st-century drainage system hostage to a 1904 legal and technical standard is an indefensible position.

- The agricultural purpose has changed: from subsistence to high-production optimization.
- The physical load has changed: from lightweight machines to massive equipment.
- The economic reality has changed: from minimal losses to thousands of dollars per acre.
- The climatic input has changed: from gentle rains to high-intensity storm events.
- The engineering analysis has changed: from sparse observation to total-system simulation.

Given this complete transformation, the definition of "benefit" must also be transformed. The lands proposed for annexation are undeniably benefiting under the modern, quantifiable, and scientifically-proven standards of 2025. To fail to annex them is to ignore a century of progress and to force the district to operate under an obsolete and inequitable framework.

Benefits Beyond the Swamp

Introduction: The Principle of Differential Benefit
The purpose of this section is to provide a detailed technical and legal rationale for the assessment of all lands within the proposed annexation area, including those at higher elevations (hereafter "uplands") as well as those in depressions and former wetlands (hereafter "lowlands"). The reclassification and assessment schedule filed with this report is predicated on the well-established principle of differential benefit. This principle recognizes that while all lands tributary to a common drainage outlet benefits from its improvement, the nature and degree of that benefit vary with topography, soil characteristics, and proximity to the main conduit.

This analysis will demonstrate conclusively that the benefits afforded to the upland tracts, while different in nature from the direct dewatering of the lowland tracts, are substantial, quantifiable, and legally recognized as assessable. The narrative that the district improvements only serve the lowlands at the expense of the uplands is a fundamental misunderstanding of watershed hydrology and established drainage law. The district provides a comprehensive, system-wide benefit by furnishing a stable, efficient, and legally protected outlet that all landowners can utilize to improve their own properties.

The Legal Framework: The Right to an Outlet and the Limitations of Natural Drainage
Under Iowa common law, a dominant (upland) estate has a natural easement to cast surface water onto the servient (lowland) estate. However, this right is not absolute. The "natural servitude" rule is constrained, meaning an upland owner may not materially increase the volume or velocity of water, nor concentrate its flow and discharge it upon the servient estate in a manner different from natural drainage without incurring liability for damages.

This legal constraint is the foundational reason why upland properties derive a profound benefit from the district. Without the District's improvements, an upland landowner is legally prohibited from implementing comprehensive drainage improvements (e.g., extensive tile systems) if such actions would overburden the natural drainage course and harm downstream neighbors.

The establishment of a drainage district provides the legal and physical mechanism to overcome this restriction. It grants every landowner within its boundaries, upland and lowland alike, the right to use the common, engineered outlet. This grants the upland owner the ability to more fully and aggressively drain their own property, thereby increasing its productivity and value, in a way they legally could not before. This conveyance of a legal right is, in itself, a significant and assessable benefit.

This principle is affirmed by the Supreme Court of Iowa in Kelley v. Drainage District No. 60 In Greene County, 158 Iowa 735 (1912), which states:

"The new drains did relieve the main drain in the system as previously constructed by furnishing an additional outlet, and in this respect was of some benefit to all the lands tributary thereto, even though not as near to some of them as the existing main. Nor was the circumstance that it did not touch such lands a valid objection to the assessments..."

This precedent confirms that providing an improved outlet constitutes a benefit to all tributary lands, regardless of their direct proximity to the new improvement.

The Scientific Evidence: Upland Soils Demonstrate a Clear Need for Improved Drainage
An objective analysis of the USDA-NRCS Soil Survey data for the upland parcels within the annexation area reveals that these tracts are not naturally well-drained and require artificial drainage to achieve optimal agricultural productivity. The soil's physical properties serve as a permanent record of its inherent drainage limitations.

- Soil Drainage Class: The schedule includes the soil drainage class for each parcel. These classifications are scientific determinations that the soils are subject to seasonal waterlogging that can inhibit root development and delay field operations.
- Saturated Hydraulic Conductivity (Ksat): Ksat values for these soils are often in a range that indicates slow water percolation through the soil profile. During periods of high precipitation, this leads to prolonged saturation in the crop root zone, reducing oxygen and stressing the crop, thereby limiting yield potential.
- Depth to Seasonal High-Water Table: Soil survey data documents a seasonal high-water table within 1 to 3 feet of the surface for many of these upland soils. This saturation directly interferes with agricultural production.
- Suitability for Drainage: Critically, the USDA Soil Survey explicitly lists these same soil types as being suitable for and responsive to artificial drainage, whether by subsurface tile or surface modifications. This confirms two essential facts: (1) the land needs drainage to be fully productive, and (2) the land is capable of taking advantage of the outlet provided by the district.

The Hydrologic & Engineering Benefit: The Superiority of the District Outlet
The benefit to the uplands is most clearly illustrated by comparing the pre-district outlet with the engineered district drainage facility.

The Pre-District Outlet: A High-Resistance Natural System
Prior to the District's improvements, the natural outlet for the uplands was the adjacent lowland swamp. This system is characterized by:

- High Hydraulic Resistance: Dense vegetation, shallow depth, and meandering flow paths create significant friction, slowing the flow of water.

- High Water Level: The water level in the swamp is, by definition, at or near the ground surface. Any tile line from an upland farm outletting into this system would be frequently submerged ("drowned outlet"), rendering it ineffective and preventing the tile from draining the upland soil profile.
- Limited and Variable Capacity: The capacity of the swamp to convey water is small and fluctuates wildly with rainfall, offering no reliable outlet for upland drainage.

The District Outlet: A Low-Resistance Engineered System
The district's facility provides a vastly superior outlet defined by:

- Lower Invert Elevation: The bottom of the district facility is engineered to be significantly deeper than the natural swamp ground. This creates a much steeper hydraulic gradient (slope), which is the primary driver of water flow.
- Accelerated Drainage of Upland Soils: The direct engineering consequence of this superior outlet is that water can exit upland tile systems freely and rapidly. This lowers the water table in the upland soil profile much faster after a precipitation event—clearing the root zone in hours instead of days. This reduction in the duration of soil saturation is a direct, tangible agronomic benefit that directly translates to increased crop yields and land value.

Conclusion: An Equitable Assessment for System-Wide Benefits
The narrative of an upland-lowland conflict is a false dichotomy. The drainage of a watershed is an interconnected system. The reclassification and assessment schedule accurately reflects the physical and legal realities of this system.

Lowland tracts receive a high-percentage benefit through the direct removal of surface water and the lowering of the water table, making previously unproductive land farmable.

Upland tracts receive a different, but no less critical, benefit: the provision of a legally protected and hydrologically efficient outlet. This outlet unlocks the full productive potential of their land by enabling them to install or improve their own drainage systems in a manner that would otherwise be legally and physically impractical.

The assessments are not a subsidy from the "good" uplands to the "bad" lowlands. They are an equitable distribution of costs for a comprehensive, system-wide improvement project where every parcel receives a distinct, measurable, and legally recognized benefit. The differing assessment rates are a direct and fair reflection of the differing types and degrees of these benefits.

A Technical Refutation of the "Higher Elevation" Fallacy

The Fallacy Defined: A Misapplication of First Principles
The argument presented is that land at a higher elevation cannot benefit from a drainage facility at a lower elevation. This position is a gross oversimplification that reduces the complex science of hydrology to a single variable, resulting in a conclusion that is physically impossible and illogical.

All open-channel flow is governed by the conversion of potential energy to kinetic energy, driven by gravity. The potential energy (PE) of a mass of water (m) is given by:

$$PE = mgh$$

Where g is the acceleration due to gravity and h is the elevation head. For flow to occur between two points, there must be a difference in potential energy, meaning $h_1 > h_2$. The argument that higher elevation land does not benefit is therefore a paradox: it is a statement that the fundamental condition required for drainage to exist is simultaneously proof that it does not provide benefit.

The relevant engineering analysis is not if the land is higher, but rather how the drainage district's infrastructure optimizes the rate and efficiency of the energy conversion that constitutes drainage for the contributing area.

The Governing Physics: The Energy Equation

The movement of water in a drainage system is defined by the Energy Equation, an extension of Bernoulli's principle. Considering two points, point 1 on a parcel in the watershed and point 2 in the district facility, the equation is:

$$\frac{p_1}{\gamma} + z_1 + \frac{\alpha_1 V_1^2}{2g} = \frac{p_2}{\gamma} + z_2 + \frac{\alpha_2 V_2^2}{2g} + h_L$$

Where:

- p_2/γ = Pressure head
- z = Elevation head
- $\alpha V^2/2g$= Velocity head (where α is the kinetic energy correction factor)
- h_L = Head loss due to friction between points 1 and 2

The "higher elevation" argument nearsightedly considers only the term $z_1 > z_2$. This is a scientifically illiterate interpretation. The total driving force for drainage is the difference in the Total Energy Head between the two points.

The drainage district's function is to manipulate the right side of this equation to the benefit of the left side. By constructing and maintaining a deep, clean channel, the district:

- Minimizes Downstream Energy Head: It ensures the water surface elevation ($z_2 + p_2/\gamma$) is as low as possible.
- Minimizes Head Loss (h_L): It reduces channel friction (Manning's n) and removes obstructions.

By minimizing these downstream energy terms, the district maximizes the total energy gradient across the entire system. This steeper gradient is the force that "pulls" water from the higher-elevation parcels at a much greater rate than would occur under degraded, natural conditions.

The Backwater Effect: A Mathematical Certainty

The most critical benefit provided to higher-elevation lands is the mitigation of the backwater effect. This is not a theoretical concept; it is a calculable phenomenon governed by the differential equation for Gradually Varied Flow (GVF):

$$\frac{dy}{dx} = \frac{S_0 - S_f}{1 - Fr^2} \text{ where } Fr = \frac{V}{\sqrt{gy}}$$

Where:

- dy/dx = The change in water depth with respect to distance along the channel
- S_0 = The slope of the channel bottom
- S_f = The friction slope (energy loss)
- Fr = The Froude number, indicating the state of flow (subcritical if $Fr < 1$)

When a district drainage facility becomes clogged with sediment or vegetation, its conveyance is reduced. This is mathematically equivalent to placing a dam at the downstream end. This obstruction forces the flow into a subcritical state ($Fr < 1$) and initiates an M1 Backwater Curve. Under this profile, the water depth y increases as one moves upstream (dy/dx is positive), even as the channel bottom (S_0) may be dropping.

This is the engineering proof: A downstream restriction causes a quantifiable rise in the water surface elevation that can extend for miles upstream. This elevated water surface drowns the outlets of private tiles and tributary swales originating from higher-elevation lands, rendering them partially or wholly ineffective. The district's maintenance directly prevents the formation of these M1 profiles, thereby guaranteeing a free-flowing outlet for the entire watershed.

On-Farm Impact: The Collapse of the Subsurface Drainage Gradient

The effectiveness of a subsurface tile drains on any parcel, regardless of elevation, is governed by the physics of flow in porous media, often approximated by the Hooghoudt or Kirkham equations. A simplified representation is Darcy's Law:

$$Q = -KA\frac{\Delta h}{L}$$

Where:

- Q = Flow rate into the tile
- K = Hydraulic conductivity of the soil
- A = Cross-sectional area of flow
- $\Delta h/L$ = The hydraulic gradient (the driving force)

The hydraulic gradient is the difference between the water table height in the field and the water level at the tile drain. When a district facility is functioning properly, the tile has a free outlet, and the water level at the drain is low, creating a steep gradient and high flow (Q).

When the backwater effect from a poorly maintained facility submerges the tile outlet, the water level at the drain rises significantly. This flattens the hydraulic gradient ($\Delta h/L \rightarrow 0$). Consequently, flow into the tile slows to a trickle or stops completely, leading to saturated soils and crop damage on the "higher elevation" parcel. The benefit is not theoretical; it is the preservation of the physical gradient necessary for tile drainage to function.

Conclusion: An Argument Devoid of Scientific Merit

The assertion that higher elevation land does not benefit from a drainage system is not a valid technical argument; it is a statement made in defiance of the fundamental laws of physics and hydraulic engineering. It ignores the Energy Equation, the mathematical certainty of the backwater effect, and the principles of subsurface flow.

The relationship is one of complete systemic interdependence. To suggest otherwise is to argue that water flows uphill or that a clogged drain has no effect on the sink above it. This report, and the body of engineering science it is based upon, rejects this fallacy in the strongest possible terms.

“The Watershed Fallacy”

The Guiding Principle: Hydrologic Unity

In drainage engineering, the watershed is the fundamental unit of analysis. A watershed is an area of land where all surface and subsurface water drains to a single, common outlet. This is not an arbitrary line on a map; it is a physical boundary dictated by topography and the laws of gravity.

For a typical agricultural drainage district, which functions as a closed, engineered system, the watershed boundary is the most logical, scientifically defensible, and equitable boundary for the district itself. Every parcel within that watershed contributes runoff and hydraulic load to the district's infrastructure. Every parcel, therefore, is an integral component of the system, and its relationship to the system must be evaluated.

Contextualizing the "Watershed Fallacy": A Legal Doctrine of Specificity, Not Exclusion

Opponents of annexation often invoke the "watershed fallacy" as if it were an absolute prohibition against using a watershed as a district boundary. This is a profound misreading of legal precedent. The "watershed fallacy" court cases did not rule that a watershed is an improper boundary. They ruled against a failure of proof by the petitioning engineers in specific, dissimilar circumstances.

The key cases where this fallacy was cited involved critical distinctions from the present case:

- Massive Scale and Natural Rivers: These cases typically involved vast, multi-county watersheds of natural rivers. The "improvements" were often limited to channel straightening along a small portion of a massive, pre-existing waterway. It is absurd to suggest that a farm 50 miles upstream in a 1,000-square-mile river basin receives a material benefit from an improvement far downstream. The scale is completely different.
- Improving a Natural Creek vs. Creating a New Ditch: Many of these cases dealt with improvements to existing creeks that already provided a significant degree of natural drainage. The argument for "benefit" was therefore weaker, as it was a marginal improvement, not the creation of the outlet itself. This is fundamentally different from a district that installed an artificial ditch and tile system where only a marshy slough existed before. In such a system, the district's infrastructure provides the only functional outlet.
- The Engineer's Failure of Proof: Most importantly, the engineers in those cases made a conclusory argument. They simply drew the massive watershed line and asserted that all lands within it must benefit, without providing the parcel-by-parcel analysis of hydraulic and hydrologic connection. The court rejected this lack of specific evidence. The "fallacy" was not the boundary; it was the assumption that inclusion within the boundary automatically equaled benefit without doing the work to prove it.

This report does the exact opposite. It uses the watershed as the correct area of study and then proceeds to prove the material benefit to each parcel within it through a specific, data-driven analysis.

The Correct Application: The Watershed as the Boundary in Engineered Systems

In my professional engineering experience, spanning the analysis of over 50 agricultural drainage districts annexations, establishments, and reclassifications in Iowa, I have recommended the watershed boundary as the district boundary in all but two instances. This is not a coincidence; it is the logical outcome of how these systems function.

When a district constructs a ditch or a main tile, it becomes the artificial outlet for its entire watershed. Every drop of water that falls on a parcel within that watershed, that is not lost to evaporation or deep seepage, has only one place to go: the district's infrastructure.

- Every acre contributes runoff, adding to the load and the need for maintenance.
- Every private tile system relies on the district's main to provide a free-flowing outlet.
- The hydraulic performance of every parcel is inextricably linked to the performance of the common outlet.

To arbitrarily draw the district line somewhere inside the watershed boundary is to ignore this physical reality. It creates a system where some beneficiaries pay for the maintenance of an outlet that is being used, and burdened, by other non-paying beneficiaries. This is the definition of an inequitable system.

Conclusion: A Fallacy of Misapplication

Invoking the "watershed fallacy" in the context of this agricultural drainage district is a red herring. It is an attempt to apply a narrow legal finding from factually dissimilar cases involving massive river basins to a small, closed, and fully engineered system.

The watershed is the scientifically correct and legally defensible boundary for this district because every parcel within it is hydrologically connected and contributes to the system's load. This report has provided the specific, parcel-by-parcel evidence of material benefit that was absent in the cases where the "watershed fallacy" was correctly identified. The boundary of the district should reflect the physical reality of the watershed it serves.