DRAINAGE RECORDS MODERNIZATION GUIDELINES

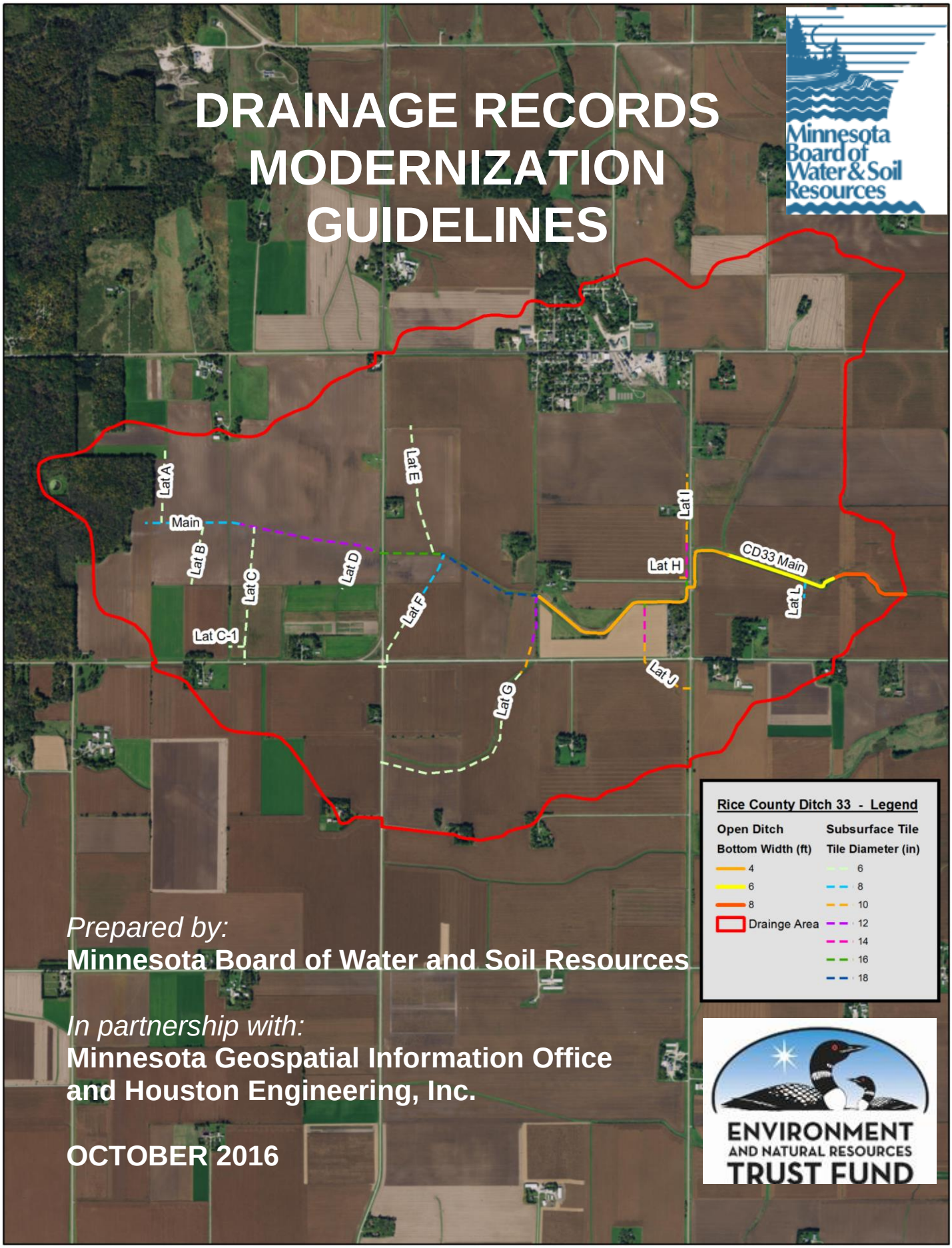

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TABLE OF CONTENTS

LIST OF FIGURES

1. PROJECT BACKGROUND AND ACKNOWLEDGEMENTS

These guidelines were prepared using grant funding in fiscal year 2014 from the Minnesota Environment and Natural Resources Trust Fund (ENRTF) to the Board of Water and Soil Resources (BWSR). The project included the following components:

- Develop a drainage records GIS database template with consistent data standards and formatting for download and use by Minnesota Statutes Chapter 103E drainage authorities;
- Include public access to Chapter 103E drainage system hydrographic data from users of the template via the Minnesota Geospatial Commons web-based data portal; and
- Update the *Drainage Records Modernization Guidelines, September 2008*.

Pertinent information about Chapter 103E drainage authorities and drainage records modernization is included the following sections.

BWSR contracted with the Minnesota Geographic Information Office (MnGeo) to implement the project. MnGeo subcontracted with Houston Engineering, Inc. for database and guidelines development portions of the project. The project sought input from stakeholders, first by conducting a survey and using focus group meetings around the state to obtain information to guide the development of the template and updated *Drainage Records Modernization Guidelines*. The project team also formed a project advisory committee involving drainage authority, drainage manager, drainage inspector, state agency and private industry representatives to help guide the project and test the database template. All who participated in the project development are gratefully acknowledged. See acknowledgements in Appendix B.

2. INTRODUCTION

Minnesota Statutes Chapter 103E *Drainage* (https://www.revisor.mn.gov/statutes/?id=103E) is also referred to as Minnesota public drainage law or the drainage code. Chapter 103E *Drainage* and Chapter 103D *Watershed Districts* (https://www.revisor.mn.gov/statutes/?id=103D) vest authority and responsibility for administration of Chapter 103E drainage systems, including open ditch and subsurface tile systems, in Minnesota counties and watershed districts. This includes joint county drainage authorities for drainage systems that cross county boundaries and are not administered by a watershed district. These public drainage authorities are responsible for all aspects of administration of Chapter 103E drainage systems, which are co-owned by the assessed, benefited landowners. As of 2016, there were 75 counties and 21 watershed districts that serve as Chapter 103E drainage authorities. The responsibilities of these drainage authorities include maintenance of all associated drainage system records, in accordance with the requirements of Section 103E.101 *Drainage Proceeding and Construction Records.*

Based on the Buffer Protection Maps developed for the Minnesota Buffer Law in 2016, there are approximately 20,000 miles of Chapter 103E public drainage ditches in Minnesota. The total miles of Chapter 103E subsurface drainage tile in Minnesota has not been compiled to date, but is extensive in the south-central, southwest, and central portions the predominately agricultural area of Minnesota. The number and miles of Chapter 103E drainage ditch and/or subsurface tile systems administered by a county

or watershed district drainage authority varies greatly with the size of the jurisdiction and the intensity of agricultural drainage within the jurisdiction. Many Chapter 103E drainage systems were established in the late 19th and early 20th centuries.

With the increasing availability of electronic scanning equipment, as well as database, GIS, and other computer software, new methods have emerged to create, store, use, and otherwise manage drainage system records. Involved staff are also being trained and enabled with these technologies and methods in various daily work duties. Some drainage authorities have begun implementing some or all of these technologies and methods. Implementation of one or more of these methods is considered "drainage records modernization." These methods also serve the purpose of drainage records preservation, which is increasingly important as drainage system records continue to age. Some drainage system records are more than 100 years old. Historically, drainage system records were created on commonly available materials such as paper and Mylar, using methods such as typewriters with carbon paper and blue line processes that are subject to deterioration over time even when documents are carefully stored.

In the mid-1990s, the Board of Water and Soil Resources (BWSR) began to provide state cost-share for Chapter 103E drainage system inventories and drainage records modernization through what was called the Local Water Management Challenge Grant Program. The objective was to support Comprehensive Local Water Management Plan priorities for improved management of water quantity and quality through enhanced management of Chapter 103E drainage systems. In fiscal year 2008, BWSR was appropriated funding to prepare the first Drainage Records Modernization Guidelines. In fiscal years 2009 and 2011, BWSR was appropriated specific funding for drainage records modernization cost-share. The associated work of drainage authorities and their consultants led to the development of some of the first drainage records databases using GIS.

In 2006, the stakeholder Drainage Work Group clarified the purposes for drainage records modernization and associated guidelines, including:

- Consolidate, document, and share the experience of drainage authorities that have modernized their Chapter 103E drainage system records, to increase the efficiency and reduce the costs for drainage records modernization by other drainage authorities.
- Promote drainage records preservation through modernization.
- Promote more consistent drainage records modernization statewide.
- Enable more efficient and effective administration of Chapter 103E drainage systems for enhanced management of water quantity and quality.

These updated guidelines and the associated drainage records GIS database template were developed to help fulfill the above purposes, building upon prior experience to date.

3. PERTINENT DEFINITIONS

- ***Domains –*** A mechanism for enforcing data integrity. Attribute domains define what values are allowed in a field, in a feature class, or nonspatial attribute table. An example of a domain would be a pick list for type of drainage system like open ditch or subsurface tile.

- ***Drainage Records Modernization*** – In the context of this document, drainage records modernization is the process of taking drainage system records, such as hard copy plans, profiles, drainage authority orders, and other drainage system documents and data, and creating digital versions usable via computers or mobile devices. Modernization involves scanning, digitizing, database creation, and otherwise organizing electronic versions of these drainage system records. These digital versions can then be used with database and mapping software to map, query, and analyze data for various drainage system administration purposes.

- ***Esri and ArcGIS*** – Commercial GIS company (http://www.esri.com/) and software (http://www.esri.com/software/arcgis).

- ***Feature Class –*** In a file geodatabase, a collection of geographic features with the same geometry type (such as point, line, or polygon), the same attributes, and the same spatial reference. Feature classes can be stored in geodatabases, shapefiles, coverages, or other data formats. Feature classes allow homogeneous features to be grouped into a single unit for data storage purposes. For example, highways, primary roads, and secondary roads can be grouped into a line feature class named "roads." In a geodatabase, feature classes can also store annotation and dimensions.

- ***Feature Dataset*** – Any collection of related data, usually grouped or stored together within a file geodatabase.

- ***File Geodatabase*** – ESRI and ArcGIS proprietary file structure used primarily to store, query, and manipulate spatial data. Geodatabases store geometry, a spatial reference system, attributes, and behavioral rules for data.

- ***Geographic Information System (GIS)*** – A geographic information system (GIS) integrates hardware, software, and data for capturing, managing, analyzing, and displaying all forms of geographically referenced information. In the strictest sense, it is any information system capable of integrating, storing, editing, analyzing, sharing, and displaying geographically referenced information. In a more generic sense, GIS applications include tools that allow users to create interactive queries (user created searches), analyze spatial information, edit data and maps, and present the results of these operations.

- ***Georeferencing*** – The process of aligning an image file such as an historical map, satellite image, or aerial photograph to known reference points. To georeference an image, one first needs to choose the coordinate system and other projection parameters, establish control points, and input

the known geographic coordinates of those control points. Georeferencing eliminates the need for a digitizing table, when maps have already been scanned into a digital format. In this case, the process of digitizing occurs on the computer screen and not on the digitizing table. Please refer to the "Fundamentals of Georeferencing a Raster Dataset" for further information on the process (http://desktop.arcgis.com/en/arcmap/latest/manage-data/raster-and-images/fundamentals-for-georeferencing-a-raster-dataset.htm).

- ***Global Positioning System (GPS)*** – A satellite-based navigation and surveying system that enables 3-dimensional location of points and objects. GPS satellites circle the earth twice a day in a very precise orbit and transmit signal information to earth. GPS receivers use these satellite signals and triangulation to calculate an exact location. Applicable vertical and horizontal control data enable definition of locations relative to a given coordinate system.

- ***Metadata*** – Data about data. Metadata describes the attributes and contents of an original document or work, and can relieve potential data users of having to have full advance knowledge of the existence and characteristics of a data set in order to appropriately use the data.

- ***Relationship Class*** – An item in the geodatabase that stores information about a relationship. A relationship class is visible as an item in the ArcCatalog tree or contents view.

- ***Scanning and Digitizing*** – Scanning is the process of taking a hard copy version of a document and sending it through a scanner that will take an image and save it into a format that can be read on a computer, normally as a picture (e.g. JPG or PDF format). Digitizing is the process of converting a map or other document into points, lines, or polygons in a format that can be used electronically, including creation of data layers. These electronic documents can then be manipulated further into other image formats, including formats that can be read by mapping software.

- ***Table*** – A set of data elements arranged in rows and columns. Each row represents a single record. Each column represents a field of the record. Rows and columns intersect to form cells, which contain a specific value for one field in a record.

4. BENEFITS OF DRAINAGE RECORDS MODERNIZATION

4.1 DRAINAGE RECORDS PRESERVATION

- The conversion of paper, Mylar, and other types of hard copy documents and maps to digital format greatly reduces the need of handling what might be fragile originals, and potentially the need to retain them.
- The digitization of drainage records provides an archived copy of all original documents and maps, preventing the loss of these historical legal documents (with proper electronic backup). Many drainage authority IT departments have formal record retention and disaster recovery policies in place when information is in a digital format.

4.2 IMPROVED ACCESS TO DRAINAGE SYSTEM RECORDS

- Modernized records provide the ability to share greater amounts of information more readily and efficiently with landowners, auditors, attorneys, engineers, viewers, inspectors and others involved in drainage system administration, as well as with watershed modelers and planners.
- With drainage records being electronic, staff time needed to handle landowner inquiries can be substantially reduced, as well as the associated "counter time" of landowners seeking drainage system information. The information can also be provided in a more accurate and timely method.
- The accessibility and ease of sharing and printing electronic documents enables more efficient information sharing among the county and/or watershed district staff and other advisors involved in drainage system administration.
- Electronic records provide enhanced ability to standardize and use digitized drainage system information across county and/or watershed district boundaries.
- Digitized drainage system information can increase the accuracy and reduce the time and costs for redetermination of benefits and damages for drainage systems.
- Readily available digital records and maps can reduce engineering costs for drainage system repair or improvement projects by quickly providing available information about the drainage system.
- A digital, organized and indexed library of historical documents can reduce review time and costs from legal and engineering professions during repair, improvements, and redetermination of benefits and damages proceedings.
- Modern technologies such as mobile devices and web applications can provide accessibility of the information in the field saving drainage inspectors time in obtaining records and reviewing pertinent drainage system information.
- Storing drainage system information in GIS allows for improved access to visualize the information spatially for planning and other needs.

4.3 ENHANCED DRAINAGE SYSTEM MANAGEMENT, ORGANIZATION AND STANDARDIZATION

- When paper drainage system map information is converted to digital format, other types of data layers can be overlaid electronically, substantially improving drainage management potential. Storing the information in a GIS allows for advanced analysis used in redetermination of benefits and damages, improvement and repair projects.
- Topographic data overlaid on drainage system maps can help define drainage management options, which in turn can help guide managing of water quantity and quality issues within a drainage system, subwatershed, and associated watershed.
- Storing drainage records in a GIS can help provide interactive maps to educate the public about water resource issues surrounding drainage and drainage management.

- Drainage authorities and their partners have used digital drainage system maps and overlays to determine buffer areas, feedlot setbacks, and locations for temporary or permanent detention areas for water quantity and quality control purposes.
- Modern drainage records, along with appropriate software can facilitate data entry on web and mobile devices for management of the system using standardized management methods. These activities may include conducting inspections, reporting violations and managing maintenance projects.
- Modern drainage records combined with software solutions can facilitate data standardization while increasing an organizations capability to share information via the web.
- Centrally storing drainage records in a modern database and software application can improve communication across departments and advisors of a drainage authority.
- Standardizing drainage records to a common template can facilitate more efficient data aggregation at a watershed, regional or state scale.
- Modern drainage records are a critical component of reestablishing an incomplete public drainage system record as described under Minnesota Statute 103E.101 Subd. 4a (https://www.revisor.mn.gov/statutes/?id=103E.101). More information regarding this process can be found in the *Minnesota Public Drainage Manual*, Chapter 3, Section XII (http://drainage.pca.state.mn.us/index.php/B._Re-Establishment_of_Public_Drainage_Records).

5. LESSONS LEARNED AND RECOMMENDATIONS IN RECORDS MODERNIZATION

Prior to studying the details, methods, and procedures for modernizing particular elements of drainage records, it is important to recognize some general lessons learned and recommendations from previous projects. These lessons are drawn from the 2008 guidelines, more recent focus group meetings, and professional experience of the project team.

5.1 START SMALL – COMPLETE A TEST SET

- The drainage system administration staff interviewed frequently suggested that it is best to start small (e.g. a single drainage system) and gradually work up to full records modernization.
- Drainage authorities that tried to do too much too fast, often became overwhelmed and frustrated when they needed to go back and make changes to their modernization procedure.
- Starting on a small pilot project is extremely important if the staff performing the work is not familiar with public drainage system records.
- Starting small provides opportunities to estimate resources needed, timelines and allows for adjustments to be made that are practical for the uses of the information.

5.2 CONSIDER THE BENEFITS OF USING THE DRAINAGE RECORDS GIS DATABASE TEMPLATE

- The drainage records GIS database template was developed based on experience to date of drainage authority advisors and consultants to provide an efficient and effective method, with sound data standards, to store, manage and use Chapter 103E drainage system records.
- The template enables data accessibility and better communication for drainage authority staff and advisors, as well as with landowners and others.
- One of the challenges today for data management is the number of options available. Use of the template and standards based on prior experience provides opportunity for collaboration across drainage authorities and statewide.
- The database template is documented with metadata saving drainage authority staff time not having to create documentation.

5.3 SCANNING AND DIGITIZING DRAINAGE SYSTEM RECORDS

- Nearly all of those interviewed noted that scanning and digitizing drainage system records is an important early step in the modernization process. Scanned historical documents provide the fundamental information that will be put into digital databases and GIS's.
- Each document should be scanned as a unique electronic file. Filing and/or naming these electronic files in an organized manner during the scanning process will save substantial time during other phases of the modernization process.
- Review the history of the drainage system before proceeding with other elements of records modernization. This allows for key missing documents to be identified ahead of time.

5.4 SUGGESTED DIGITAL DRAINAGE RECORDS COMPONENTS

- A set of scanned and indexed historical documents.
- A GIS centerline representing the alignment of open ditch and tile segments that make up a public drainage system with key attributes.

5.5 CONSIDER A TEAM APPROACH TO MODERNIZATION

- To save money and staff time, team up with neighboring county(ies) or watershed district(s) and work together to modernize records.
- Several modernization projects have utilized a joint contract with engineering /consulting firms that can at a minimum provide expertise on the proper conversion protocol to follow, or potentially perform, the entire conversion process.
- Some jurisdictions have modernized records "in-house" as time, funding, and staffing allow. However, most drainage authorities lack sufficient expertise or available time to complete the modernization project without outside help.

5.6 STORE DRAINAGE RECORDS USING MODERN TECHNOLOGIES SUCH AS GIS DATABASES AND WEB APPLICATIONS

Database applications facilitates:

- Accessibility options for better communication among staff and across departments.
- More efficient methods of sharing information with landowners and other parties.

6. TYPES AND USES OF DRAINAGE RECORDS PRODUCED BY DRAINAGE AUTHORITIES

Prior to beginning a drainage records modernization project, it is important to understand why different types of information are produced. Drainage authorities produce a variety of data for drainage systems over time because of state statutes and associated administration and management activities. This information is typically produced for:

- ***Legal Proceedings*** – Chapter 103E drainage proceedings produce documents such as petitions, orders, and reports that are critical to understanding the design and history of a drainage system. Engineering report documents contain charts, graphs, large sheet plans, and profiles, along with viewer's reports, contain most of the detailed data. These items are routinely used in the maintenance and management of a drainage system. In the 20th century most of these documents were created as paper records. Only recently has some of this data been created as CAD drawings, GIS databases, spreadsheets, or other electronic documents.

- ***Management and Maintenance*** – These records are an outcome of actions occurring long after a system has been established and built. The drainage authority has a responsibility to inspect, manage and maintain the system. Over time, maintenance needs arise due to weather events, sedimentation, land use changes, and other factors. Drainage authorities manage and pay for the maintenance with assessments to the parcels and land owners. Both management and maintenance generate information that can be stored in modern formats such as GIS and databases.

Drainage authorities also encounter numerous business needs that may benefit from drainage records being in an accessible electronic format. Listed below are some of the business needs that a drainage records database can serve:

- ***Efficiently Managing Legal Proceedings*** – Depending on the type of legal proceeding, this can produce data such as new alignments and benefitted land owner lists. This data can be directly stored in a GIS database;
- ***Record Retention*** – Minnesota statute 103E.101 outlines that a drainage authority is responsible for record retention;

- ***Conducting Inspections*** – A drainage authority has a statutory obligation to conduct inspections on each system. Drainage record modernization can help organize this information and store it for use in planning routine or major repairs and associated drainage proceedings;
- ***Maintenance*** – Maintenance, such as ditch cleanouts and tile repairs, create a documentation need to store the details of these activities;
- ***Inquiries*** – There are often inquiries from land owners or other organizations about history or maintenance of a system. Modernized records can provide much easier and timelier access to the information.

These are few examples of the types of information and uses of data created for Chapter 103E drainage systems. More needs for data creation are documented in Chapter 103E and a companion associated guidance document titled the "Minnesota Public Drainage Manual" (http://drainage.pca.state.mn.us/index.php/Main_Page).

7. APPROACHES AND TECHNOLOGIES USED IN DRAINAGE RECORDS MODERNIZATION

Drainage records modernization can take the form of differing approaches and technologies. While scanning drainage documents into an electronic form and storing them in a simple database is a critical first step in preserving and protecting drainage records, the documents can become even more accessible and useful by converting the historical documents into a GIS format and/or entering them into web-based databases. Drainage authorities may choose to implement any or all of these approaches depending upon technological and staff resources they have available. At minimum a drainage authority should scan, store, and organize their historical documents. Without preserving the historical public drainage system documents, it would be very costly and difficult to modernize some information such as alignments and profiles. It would also be challenging to recreate the history of the drainage system for future reference and drainage system activities.

Specific technologies, resources, and guidelines for drainage records modernization are discussed in the following three sections:

Section 8 discusses historical records. Historical records are a mandatory component of any records modernization effort. This data is typically stored in network folders, document management systems, or software solutions. Accessibility of the historical documents typically range from file folders to software applications to websites.

Section 9 discusses hydrographic or engineering data. This information has many uses for drainage system administration, as well as for watershed modeling and planning, if aggregated into a statewide database accessible to others. This information is often used to answer the "what" and "where" questions about a drainage systems. It primarily consists of a list of drainage systems in a drainage authority, the alignments, and some engineering characteristics. While this information is not mandatory to have in a modern

format and is ultimately derived from the historical documents or field survey, modernizing this data should be considered a high priority and can save a lot of time in answering inquiries. Typically, this data is entered and stored in GIS databases and accessed with software applications. BWSR and partners have also created a GIS database template to assist drainage authorities with storing this type of information in a standardized data model.

Finally, **Section 10** discusses information that is created from management and maintenance activities of a system, such as repairs, inspections, violations, and redetermination of benefits and damages. Though maintaining this information is important, it should be the later enhancements in a drainage records modernization project. Typically, this data is stored in spreadsheets, GIS or Web-based databases, and accessed with software applications.

8. GATHERING AND PRESERVING HISTORICAL RECORDS

In Minnesota, land information is collected and maintained locally by county offices, including the Recorder (formerly Registrar of Deeds), Tax Payer Services, Auditor, Treasurer, Assessor, Surveyor, Land Management, Planning and Zoning, Engineer, Public Works, GIS Departments, and by watershed districts. The process of gathering and preserving land information, specifically drainage system records, is important for every county and watershed district that administers public drainage systems as a drainage authority under Chapter 103E. While some drainage authorities utilize significant digital technology, others rely solely on hard copies of records.

As many drainage authorities indicated during past interviews and surveys, many (if not most) drainage system establishment maps are more than 100 years old and are deteriorating. The material they were printed on include paper, vellum, and parchment, all of which can crack and break after many years of being rolled up and stored. Converting these maps to a digital format is the first step in the process of preserving these documents and making them accessible. This process is typically done through scanning. Once in a digital form, these documents can be easily shared between departments, governmental units, and other drainage authority advisors. They can also be converted into digital data for use in mapping and analysis.

When gathering drainage system history, it is important to look at each system separately and determine all the key components and actions that define the drainage system, such as when it was established, when there were improvements to the system, if/when a system was divided to create separate systems, and when repairs and other maintenance were completed. The associated engineering and administrative documents are key records. During review, if any of these documents are missing, the absence should be noted and more investigation completed to determine if these documents are stored in another location or even exist.

Drainage system inspectors or other drainage authority staff may have much of this information available in notes or reports that they have submitted to the county commissioners or watershed district managers for a regular or periodic update on the system. If the gathering of drainage records has not been

undertaken to date, doing so can prove very valuable to the drainage authority because it generates a comprehensive history of each of the drainage systems under its jurisdiction and identify areas that need further research.

It is recommended that a person with public drainage experience is reviewing the documents. The project team has observed numerous instances where documents have been scanned by an inexperienced person who did not understand what was being scanned, named the file in a way that was not useful in accessing the documents, and did not recognize that key documents were missing.

Below are recommended steps that can be followed when working through this process.

Step 1) *Identify the Staff that is Most Appropriate to Accurately Review, Scan, and Organize the Historical Documents.*

Some drainage authorities choose to hire an intern that works closely with a drainage inspector or auditor who has a good understanding of drainage proceedings. Coupling these staff together allows for review by experienced staff while utilizing cheaper labor for some of the work. Other drainage authorities choose to hire a consultant with drainage experience or use a consultant to serve as the experienced reviewer. The most important part of this step is to ensure whomever works on this task have adequate experience and supervision. Section 8.1 discusses some best practices and lessons learned in scanning documents.

Step 2) *Find or Create a List of Public Drainage Systems that the Drainage Authority Administers.*

This list can usually be found as a spreadsheet or a typed list of systems that have been assessed by the drainage authority for drainage system work. The list should include a status of the system, i.e. whether it is active, abandoned or transferred. Such a list will help guide the designated staff to appropriately scan, organize and store things as they are related to the same drainage system. It should be noted that this list may be confusing for inexperienced staff, without providing them an understanding of the basic processes that alter the management and scope of a drainage system. For example, it is not uncommon to have drainage systems combined, be transferred to a watershed or city, portions abandoned, a new lateral established, or an improvement defined.

Step 3) *Create a File Naming Convention and Document Index.*

Numerous drainage authorities have developed file naming conventions and indexes for the purposes of finding and accessing their drainage records. While there is no right or wrong way to name a file, Section 8.2 below describes in detail a naming convention developed from the Rice Creek Watershed District's drainage records modernization project that is applicable to document categorization for most types of drainage authorities.

Step 4) *Perform a Cursory Review of the Found Documents.*

Historic documents for each system should, at a minimum, include a petition and an order to establish the system, engineering reports and drawings of the system, and a viewer's report for the original determination of benefits. If these documents are not available, staff research to understand why they are missing before proceeding further. Evidence of improvements, repairs, or redeterminations of benefits should be accompanied by documents supporting these proceedings. The cursory review of documents can be a time consuming task if there are multiple versions of engineering drawings for preliminary, final, and as-builts. A system that has had improvements or partial abandonments can also make this task challenging. Removing duplicate copies of documents and other non-pertinent documents prior to scanning will assist greatly in streamlining the process.

Step 5) *Plan for File Storage and Organization.*

Drainage authorities may have a variety of options for file storage and organization available to them depending on software that has already been implemented. Typically, one of three storage methods have been used: 1) simple computer network folders; 2) document management systems such as Application Extender (http://www.emc.com/enterprise-content-management/applicationxtender/index.htm), Laserfiche (https://www.laserfiche.com/) and M-Files (https://www.m-files.com/); and 3) software solutions such as DrainageDB (http://www.heigeo.com/drainagedb/). This step should identify the preferred storage for the scanned documents. If software is being used to store the documents, the organization is limited to the software capabilities. Many of these software packages can also facilitate searching and accessibility.

Step 6) *Plan for the Scanning.*

Scanning documents has many considerations that should be reviewed prior to scanning. These include specific scanner hardware settings and file formats, as well as some best practices. Another consideration is to group a set of documents that are related to each other into a single scan. For example, a redetermination of benefits and damages proceeding may include numerous documents and some drainage authorities have chosen to group all of the documents into one scanned file to make it more accessible to review the history. Grouping documents has both pros and cons. The pro is there are less documents to review at the system level. The con is it can be difficult to find an individual document inside a group. In the example given it may be more challenging to find the notice of public hearing document if there are a large number of documents that were grouped together. Grouping documents should be thought threw and use with caution on an as needed case to reduce the number of total files. One thing we do not recommend doing is grouping all documents for a system into a single file. The grouping consideration comes down to an organization's preference. Section 8.3 provides some recommendations for scanner settings and file formats.

Step 7) *Scan the Documents.*

This is the most laborious step in the procedure. In modernizing drainage system records, a key goal typically should be to preserve all records pertaining to each system. Because there can be many documents that pertain to each system, priorities for scanning are important as are methods to organize and consolidate information. Some drainage authorities have chosen to scan all documents system by system, while others have chosen to scan only key documents initially and scan the remaining documents at a later date. Your method will depend on what other components of records modernization are being completed and your timeline. Follow these sub steps when scanning:

- Step 7a) Scan the document with appropriate settings.
- Step 7b) Name the file with the naming convention chosen in Step 3.
- Step 7c) Open the file to ensure it scanned correctly and the quality is acceptable.
- Step 7d) Add the file to the document index listing or storage software.
- Step 7e) Repeat for all documents.

Step 8) *Backup the Documents.*

Scanning, naming, and indexing the documents is a large investment of time and resources. The drainage authority should do a backup of the scans to ensure there is redundancy in the electronic documents. Drainage authorities may approach backups in a variety of ways depending upon what type of policies or technologies in are in place. Backups could be as simple as copying the scanned files to DVDs or external hard drives. Backups may also already be occurring at the server level. Document management systems or other software solutions may also serve as a backup to the files stored on a computer network. There should also be consideration for the storage of the backup offsite.

8.1 BEST PRACTICES IN SCANNING OF HISTORICAL RECORDS

Scanning and digitizing historical documents protects them from loss due to deterioration and enables many efficiencies of drainage system management. Counties and watershed district(s) that have completed this process have provided some suggestions for consideration. It is hoped these will help to minimize road blocks while increasing usefulness in the process of scanning.

- When scanning deteriorating documents, use large pieces of clear plastic and sandwich the document between them. Then feed the sandwiched document through the scanner. The scanner will read the information on the map or document through the clear plastic. Another suggestion is to tape the document to an existing large sheet of paper. This will add tape to the already deteriorating document, but the sheet can become a permanent backing to the old document. Documents can also be laminated to preserve the document for later use and handling.
- Maps that are wider than the scanner present unique challenges. Ask neighboring drainage authorities if they have a larger scanner that can be borrowed for scanning some documents or

outsource the large format scanning to a professional scanning company. Scanning equipment is commonly found in most counties, especially within highway departments.

- Another suggestion provided by multiple drainage authorities is focused on the types of drawings that are being stored. Not all updated versions of an engineer's drawings make it back to the drainage authority. Drawings can be "As-Built" (or "As-Constructed"), or might include later notations of changes. Major repairs and improvements that modify the drainage system may have been implemented, so check the legend of each drawing for this type of information. When preparing the documents for scanning, be aware of this and reflect it in the naming of the documents.

8.2 FILE NAMING CONVENTION

After scanning each document, the scanning system will ask the user to name the file. Taking the time to name the document correctly will improve the efficiency of locating a document, as well as incorporate it into an index of all the documents.

The recommended **Naming Convention** for scanned documents is as follows:

- DD##_TYPE_DATE_UniqueValue
- An example of this: CD01_RPT-E_19200305_1.tif

The following data description shows each component of the filename. For the ## or ### component, determine if your drainage authority drainage system numbers include greater than 100 or less than 100 and then use the appropriate format. This will aid in sorting of the drainage systems in a file tree. If you have 132 drainage systems, then system 78 should be as 078. Any system below 10 should be written with a zero in front so that the names wills sort correctly.

- DD = Drainage System Type
  - CD = County Ditch or Tile
  - JD = Judicial or Joint Ditch or Tile
  - PD = Public Ditch or Tile
  - SD = State Ditch
- ## - 2 Digit Drainage System Number – If numbers are less than 100.
- ### - 3 Digit Drainage System Number – If numbers are greater than 100.
- Document Type – this is likely not a complete list of the types of documents you may encounter while scanning. Additional abbreviations for document types can be added as needed.
  - *LEGAL*: Legal documents (e.g., appeals)
  - *VR*: Viewers report / benefit redetermination
  - A-P: Commissioner preliminary advisory report
  - A-F: Commissioner final advisory report
  - BM: Benefitted parcels (i.e., auditors tabular assessment)
  - P-A: Petition - abandonment

- P-E: Petition – establishment
- P-RE: Petition – repair
- P-M: Petition / request – maintenance
- P-I: Petition - improvement
- P-X: Petition – extension
- P-L: Petition – laterals
- P-RA: Petition - realignment
- *OD-E*: Order – establishment
- *OD-RE*: Order – repair
- *OD*-I: Order - improvement
- *OD-A*: Order – abandonment and partial abandonment
- *OD-C*: Order – court / legal proceedings
- OD-X: Order – extension
- OD-L: Order – laterals
- OD-D: Order – diversion and impoundments
- *OD-O:* – Other Order (e.g., outlet) (could use additional categories)
- RPT-I: Report – inspection
- RPT–E: Report – engineers (preliminary and final)
- RPT-S: Report – survey (preliminary and final)
- RPT-V: Report - viewers
- RES: Resolution (adopting repair / official profile)
- PLANS-E-MAP: Plans / drawing – establishment – location maps/plan view
- PLANS-E-CS: Plans / drawing – establishment – cut sheets
- PLANS-E-XS: Plans / drawing – establishment – cross section
- PLANS-E-P: Plans / drawing – establishment – profile
- PLANS-E-O: Plans / drawing – establishment – other
- PLANS-I: Plans/ drawing – improvement
- PLANS-R: Plans / drawing – repair
- PLANS-M: Plans / drawing – maintenance
- BID-DOC: Bid documents / specifications
- C: Contracts (with contractor)
- MT: Memos and Transmittals
- N: Notifications
- B: Bonds
- OTHER: Other document types

- Date – Date or Year the document was published or completed. You may encounter documents that have no dates. In this case replace the date with undated.
- Unique Value – Some types of documents may have more than one sheet or document pertaining to the activity. You may frequently find multiple engineering profiles sheets for a system.

8.3 DOCUMENT INDEX

A recommendation from many of the drainage authorities interviewed is to create a master document index. This helps locate the documents needed by referencing the list, looking at the date of the document, and then determining what data is contained within that document from the description field. Figure 1 is an example from McLeod County used in the 2008 Drainage Records Modernization Guidelines. Figure 2 is an example from the Rice Creek Watershed District. Figure 3 is an example from Nicollet County developed to import into the DrainageDB software system.

COUNTY DITCH 28			
FILENAME	*DATE*	*TITLE / DESCRIPTION*	*REF. NO.*
CD28Mc002	July, 1916	Exhibit 1, Map of, CD 28, McLeod Co, Minn	145.
CD28Mc010	Mar, 1953	CD 28, Install 12" Drain Tile on Br 9, ** *Dismissed 1963-4 improvement maps call this Br 1***	--
CD28Mc011	Nov, 1963	Sheet 1, Plans, Improvement of, CD 28, McLeod Co, MN, Index	152.
CD28Mc015	1969	Sheet 2, CD 28, McLeod Co, Profile of Main, BRs 2, 2A, 3, 4, 5, 6 and 7	–
CD28Mc016	1971	Dwg 1, CD 28, Mc, Improvement, RECORD DRAWINGS, CONSTRUCTED 1970	–
CD28Mc402	Nov, 1916	"Sale of Ditch Jobs", Description by stake number	
CD28Mc404	Mar, 1921	Pages 1of3, Order to construct (Br 8 ~ Sta 0 to 51+3)	
CD28Mc410	Apr, 1953	Proposal that was approved	
CD28Mc417	Oct, 1964	Notice of final hearing, Improvement of CD 28	
CD28Mc424	Jun, 1986	Letter to replace segment of tile to a different size	
	Geo-referenced Map(s)		
BOLD	Legal description used in determining linework.		

Figure 1: McLeod County Example of a Master Document Index

Historic Document and Summary Listing

RCWD
RICE CREEK WATERSHED DISTRICT

Washington Judicial Ditch 6

(Click blue text to open scanned image.)
(* denotes large file size, greater than 3mb)

1920

- Petition. May 29th
- Engineers Report. August 23rd*
- Proposed Alignment. October 15th
- Viewers Report. November 29th

1921

- Court File. July 11th
- Engineers Report with Maps. July 11th
- Court File. August 24th
- Court File. September 12th
- Viewers Report. September 12th
- Order Confirming Establishment. September 12th

1922

- Court File. December 4th
- Court File. December 22nd

1973

- Court File. February 8th

1974

- Order Transferring Drainage System to RCWD. March 18th

1987

- Location Maps from Hickok. May

2015

- Historical Review Memo. January 8th
- Resolution 2015-06, Reestablish and Correct Drainage System Record for WJD6. February 25th

Various

- Various Legal Items and Reports from 1973-2002.

1 Rice Creek Watershed Historic Document and Summary Listing – WJD 6

Figure 2: Rice Creek Watershed District's Example of a Historical Document and Summary Listing

Ditch Name	Document Title	Type	Document Date	Document Year	File Name	Notes
CD70	Microfiche note	Other	0-0	0	CD70_OTH_00000000_1.pdf	
CD70	Establishment lien	Benefitted parcels	1-Jul	1920	CD70_ATA-E_19200701_1.pdf	
CD70	Bid	Bid Documents - Specifications	28-May	1920	CD70_BD-S_19200528_1.pdf	
CD70	Bond of Petitioners	Bonds	30-Jan	1920	CD70_BOND_19200130_1.pdf	
CD70	Oath of Engineer	Bonds	16-Feb	1920	CD70_BOND_19200216_1.pdf	
CD70	Oath of Viewers	Bonds	24-Mar	1920	CD70_BOND_19200324_1.pdf	
CD70	Oath of Viewers	Bonds	29-Mar	1920	CD70_BOND_19200329_1.pdf	
CD70	Bond of Contractor	Bonds	4-Jun	1920	CD70_BOND_19200604_1.pdf	
CD70	Proposal for Contract	Contracts	28-May	1920	CD70_C_19200528_1.pdf	
CD70	Establishment Public Notice	Notifications	16-Feb	1920	CD70_NOTIF_19200216_1.pdf	
CD70	Auditor's notice	Notifications	26-Mar	1920	CD70_NOTIF_19200326_1.pdf	
CD70	Order Establishing	Order - Establishment	3-May	1920	CD70_O-E_19200503_1.pdf	
CD70	Order finding ditch practical	Order - Establishment	24-Mar	1920	CD70_O-E_19200324_1.pdf	
CD70	Petition to Establish	Petition - Establishment	22-Jan	1920	CD70_P-E_19200122_1.pdf	
CD70	Standard Headwall Design	Plans - Drawing - Establishment - Cross	9-Mar	1920	CD70_PLANS-E-XS_19200309_1.pdf	
CD70	Affidavit of mailing	Notifications	12-Mar	1920	CD70_PN_19200312_1.pdf	
CD70	Affidavit of mailing	Notifications	1-Apr	1920	CD70_PN_19200401_1.pdf	
CD70	Affidavit of mailing	Notifications	12-May	1920	CD70_PN_19200512_1.pdf	
CD70	Engineer's Preliminary Report	Report - Engineers	9-Mar	1920	CD70_RPT-E_19200309_1.pdf	
CD70	Engineer's Final Report	Report - Engineers	25-Mar	1920	CD70_RPT-E_19200325_1.pdf	
CD70	Engineer's contract payments	Report - Engineers	28-Jul	1920	CD70_RPT-E_19200728_1.pdf	
CD70	Engineer's completion of contra	Report - Engineers	8-Nov	1920	CD70_RPT-E_19201108_1.pdf	
CD70	Viewer acceptance	Viewers report - benefit redeterminati	26-Mar	1920	CD70_VR-E_19200326_1.pdf	
CD70	Appoint new Viewer	Viewers report - benefit redeterminati	29-Mar	1920	CD70_VR-E_19200329_1.pdf	
CD70	Viewer's Report	Viewers report - benefit redeterminati	1-Apr	1920	CD70_VR-E_19200401_1.pdf	
CD70	Bond of Contractor	Bonds	11-Aug	1921	CD70_BOND_19210811_1.pdf	
CD70	Expense	Other	19-Sep	1938	CD70_OTH_19380919_1.pdf	
CD70	Repair lien	Benefitted parcels	1-Sep	1955	CD70_ATA-R_19550900_1.pdf	

Figure 3: Nicollet County Example of a Document Index used to Import into DrainageDB software.

8.4 SCANNER SETTINGS AND FILE FORMATS

The types of documents that a scanner produces can vary greatly depending on which scanner is used. However, all scanners can produce a Tagged Image File Format (TIFF), which is the format suggested by those interviewed. TIFF is a file format for storing images, including photographs and line art. TIFF format is standard in document imaging and document management systems. It is important to scan engineering drawings, maps, plans and profile sheets, or other large size documents that may need to be georeferenced in the future as TIFF files. When scanning other documents types such as reports, notifications, petitions, and orders documents, Portable Document Format (PDF) can be considered to reduce file sizes without losing resolution. It is suggested by those interviewed to scan documents at 400 dots per inch (DPI). To help determine if the resolution and scanner settings are appropriate for the document, it is a good practice to check the quality of the scan by opening it on a computer and reviewing before saving the file.

Image and file sizes can always be reduced by decreasing resolution, but can never be increased. Since this is the only time these documents will be scanned, it is advisable to scan documents at a higher resolution to retain more data. Storage space is becoming increasingly less costly and thus can accommodate the

larger file sizes. If your documents are in color, it is best to scan them using a color profile. Color documents can always be converted to black and white, but the same cannot be said of turning a black and white document into color. When documents are dark background with white lines, first scan the document normally and then create an inverse of the file to make a white background and black lines (shown in Figure 4). The software that accompanies these scanners will normally have this feature available. Otherwise, this can be achieved in any photo processing software.

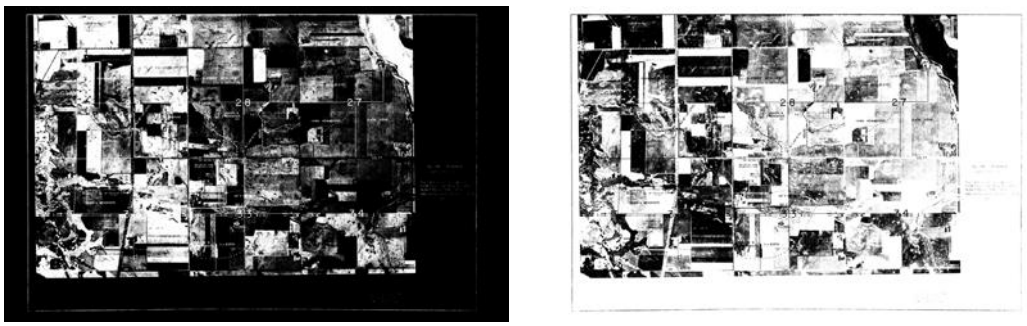

Figure 4: File scanned with dark areas and then converted to an inverse.

TIFFs can easily be converted to many different formats after they are created. A popular format, PDF, can be easily created from TIFFs at a later date for ease of use. PDFs are very portable and work well to share via websites or applications. Some drainage authorities choose to keep the original TIFF scans but use the PDFs for sharing and accessing in software systems. Certain types of document imaging systems can do the conversion directly from the program when needed.

9. HYDROGRAPHIC AND ENGINEERING DATA

Hydrographic and engineering data is created when a drainage system is designed and built. Historically, this data was contained in engineering reports, plans, drawings, and profiles that were hand drawn because a majority of these systems were constructed prior to the age of electronic records. For this reason, it can be very time consuming to use the data in this format. That has led some drainage authorities to transfer data from the historical documents into a modernized, electronic format. Recently, this format conversion has ranged from CAD drawings to various GIS formats. Based on interviews, surveys, and work with drainage authorities it is evident there is no standardized format conversion, structure, or process used by all drainage authorities. This is likely due to the fact that software has evolved over the years and staff skills using GIS and CAD has varied greatly. Some drainage authorities have also supplemented historic information with field surveys where the constructed system doesn't match what was designed or data gaps exist in the historical documents.

An advantage of migrating this information to GIS is that users can layer different types of data to see relationships, patterns, and trends through spatial analysis. Figure 5 shows a visual of a GIS with pertinent

data layers, as well as examples of spatial analysis that can be conducted with various data layers.

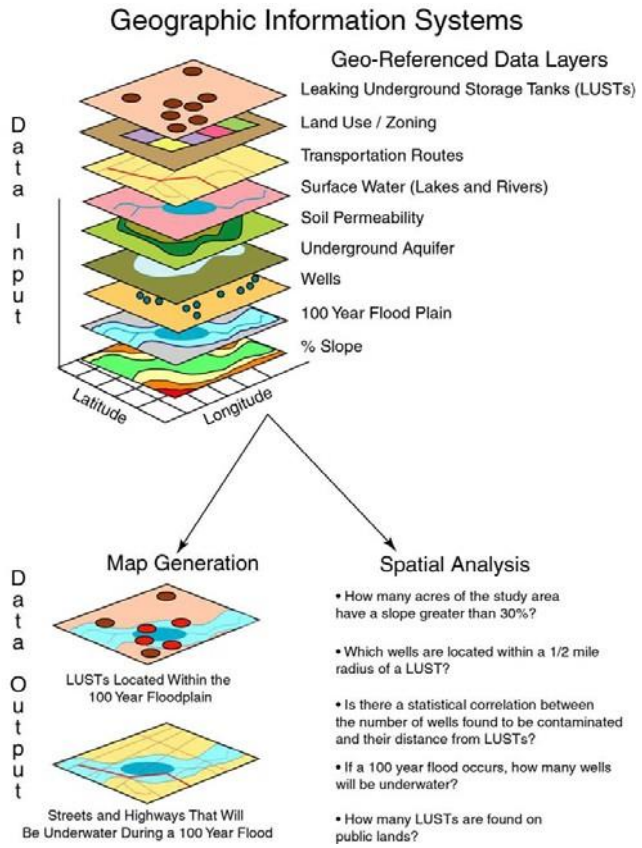

Figure 5: Example GIS Data Layers, Map Generation and Spatial Analysis

9.1 DRAINAGE RECORDS MODERNIZATION GIS DATABASE TEMPLATE

In 2016, a GIS database template was developed as part of the drainage records modernization database project (see *Introduction* above). One of the goals for the drainage records modernization (DRM) database template is to standardized GIS information for maintaining, sharing, and exchanging related data pertaining to MN State Statute 103E public drainage systems. The template was developed with input from a project advisory committee and tested with a few drainage authorities. The template is available from BWSR via a Template Request Form which is available on the Minnesota Geospatial Commons (https://gisdata.mn.gov/dataset/public_drainage_records_template) for download. By using the template a drainage authority agrees to provide a subset of hydrographic information back to the Geospatial Commons (https://gisdata.mn.gov/) for sharing with other interested parties, such as watershed modelers and planners.

An ESRI File Geodatabase (version 10.4+) was selected as the template structure to develop upon. File

Geodatabase will be referred to as “FGDB” from this point forward and is an industry standard for storing GIS data. The geodatabase template is a standardized set of tables and fields that can store different elements of information suited for public drainage systems. The template schema is not restricted and any user can add additional elements as needed by their organization. BWSR would appreciate it if a user adds an element that may be useful for others to share this element with the template maintainers. One of the end goals is to have and maintain a standardized database template that can be used to aggregate data.

Figure 6 shows the subset of hydrographic data that a template user is required to share (where information is available) with the Geospatial Commons including drainage authorities, systems, ditchshed, drainage system centerlines, profile points, and structures.

The template contains the components depicted in the diagram below. The feature classes are organized into two feature datasets – Hydrographic and Management. A description and structure breakdown of each feature class and systems table are explained in Section 9.2 below. BWSR recognizes there will be data gaps or resource limitations that prevent some drainage authorities from providing a complete subset of data, but the expectation on using the template is sharing what hydrographic data they have.

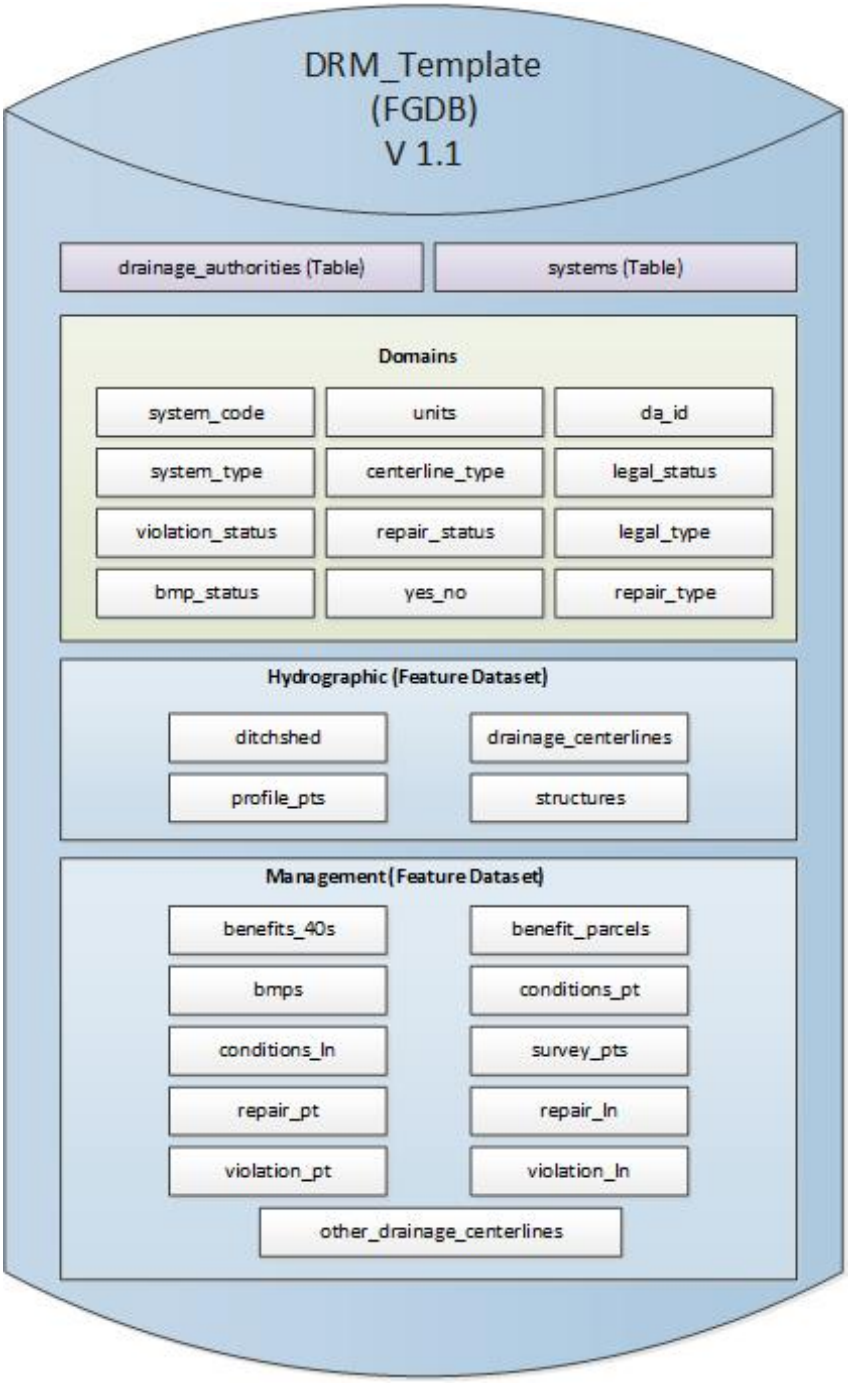

Figure 6. DRM Database Template

The next Sections 9.2 and 9.3 describe the structure of each table and feature class. Those attributes described as "required" should be populated by drainage authorities to ensure consistent and complete data for appropriate use by others. If a required attribute is unknown it should be populated with "unknown." The database template also contains fields for unique IDs that can be used to "relate" or

"join" tables together. No permanent "joins" or "relates" are stored in the database template at this time, but users can add these as needed.

9.2 MODERNIZATION STEPS FOR DATA CREATION

While other approaches can be used to store and modernize this type of information, the remainder of Section 9 will focus on using the DRM template. The next steps explain how to populate the "drainage_authorities" and "systems" standalone tables as well as the "Hydrographic" feature dataset of the file geodatabase.

Step 1) Obtain a blank DRM geodatabase template from BWSR by filling out the request form (https://gisdata.mn.gov/dataset/public_drainage_records_template) available through the Geospatial Commons. The current version of the geodatabase template at the time this guidelines document was created is version 1.1. Please follow the geospatial commons website and refer to the metadata for any future updates. Agree to the conditions of use and submit back to BWSR who will send you the template once you are authorized.

Step 2) Rename the file geodatabase to something relative to your organization. An example is "RiceCounty_DRM.gdb."

Step 3) Populate the "drainage_authorities" table. The purpose of populating this table is to identify the drainage authority contact information. It may also be used if individual geodatabases are aggregated in the future. This table should only contain one record for your organization. The table structure is shown below.

drainage_authorities Table (Alias: Drainage Authorities)

Field Name	Alias	Type	Domain	Required	Description
OBJECTID	OBJECTID	Object ID	NA	Yes	Internal ID generated and used by ArcGIS software
da_id	Drainage Authority ID	Short Integer	NA (see coded values list in Appendix A)	Yes	Unique ID provided to each drainage authority. This id is used to relate the system table to the drainage centerline feature class. See appendix A for list of codes.
da_org	Drainage Authority Organization	Text (50)	NA	Yes	Organization name of drainage authority
da_contact_title	Drainage Authority Contact Title	Text (50)	NA	Yes	Job title of the position that serves as the primary contact for the drainage authority. For example County Auditor, Ditch Inspector or Watershed District Administrator
da_website	Drainage Authority Website	Text (100)	NA	Yes	Public website for drainage authority information.

Below is a sample record for the drainage_authorities table:

- ObjectID = 1

- Drainage Authority ID = 1
- Drainage Authority Organization = Rice County
- Drainage Authority Contact = County Auditor
- Drainage Authority Website = http://www.co.rice.mn.us/node/2211

Step 4) Gather the scanned historical records for reference. The scanned documents will be referred to and used often in the next steps. This step should have already been completed using guidelines in section 8.

Step 5) Populate the "systems" table. This table will store a complete list of 103E drainage systems for the drainage authority. It includes fields to store commonly used information about each public drainage system. This information is typically derived from the historic documents. The drainage authority may already have portions of this information in spreadsheets or other software applications, such as DrainageDB. It is also important to note that if your drainage authority uses software like DrainageDB the information could be entered into that system first and then exported to a table to put into the template. Figure 7 shows an example of the information populated inside of the DrainageDB software.

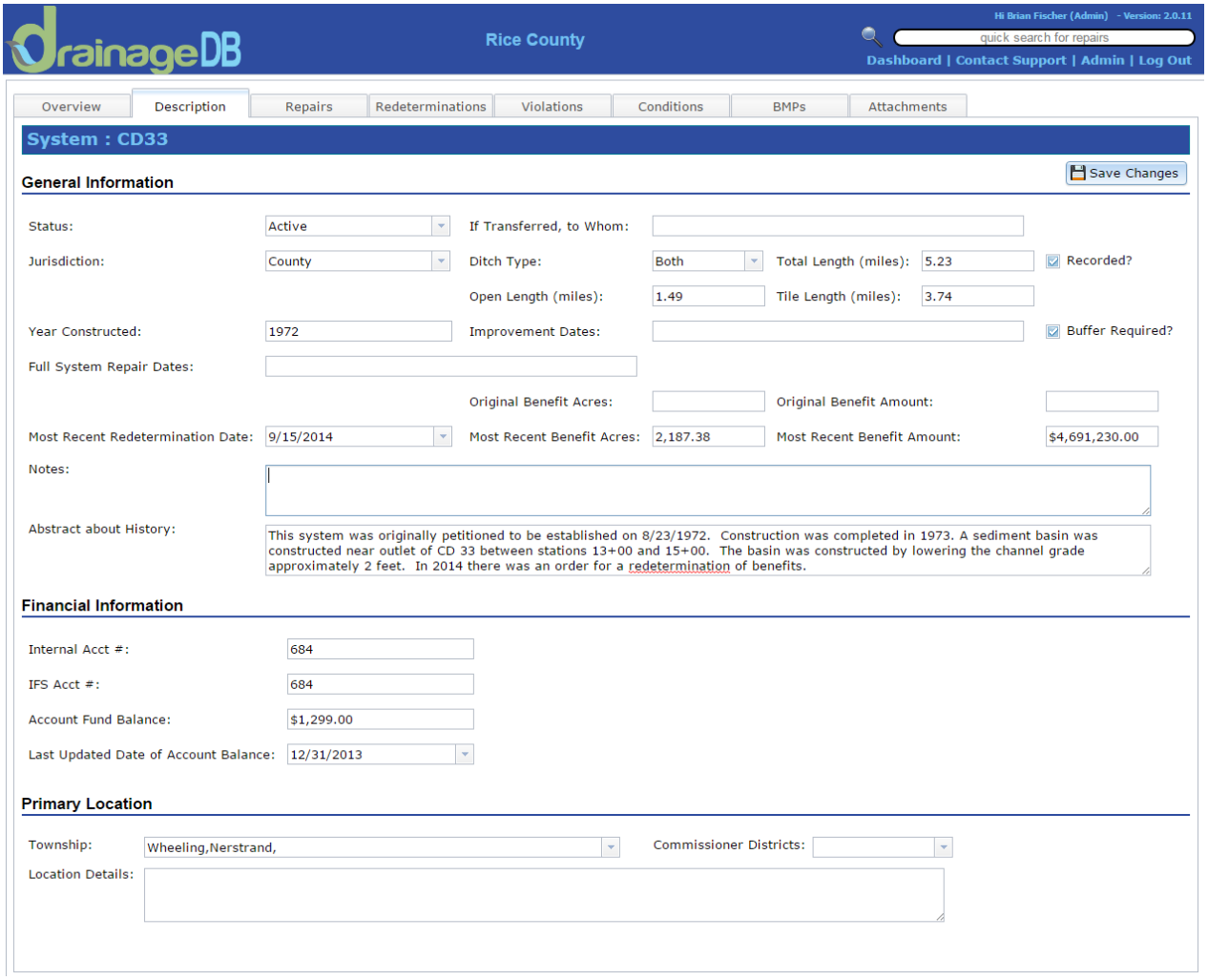

Figure 7. Example of system information populated in DrainageDB software.

There are a couple approaches to proceeding with this step from here. One approach is to fill out all of the drainage systems information in this table before proceeding to the next step. Another approach is to fill out one drainage system's information at a time and then proceed to step 6 on the same system. The table structure for Systems is shown below.

Systems Table (Alias: 103E Public Drainage Systems)					
Field Name	**Alias**	**Type**	**Domain**	**Required**	**Description**
OBJECTID	OBJECTID	Object ID	NA	Yes	Internal ID generated and used by ArcGIS software
system_name	System Name	Text (50)	NA	Yes	Full legal drainage system name used by the drainage authority. In the case where a project number or name has been also assigned to a group of systems please

Systems Table (Alias: 103E Public Drainage Systems)					
Field Name	**Alias**	**Type**	**Domain**	**Required**	**Description**
					include the project name. Ex.) County Ditch 10 or Project 17 – County Ditch 25
system_code	System Code	Text (25)	NA	Yes	System code or abbreviation used by the drainage authority. Ex.) CD 10
da_id	Drainage Authority ID	Short Integer	Yes (see coded values in Fig 1)	Yes	Unique ID provided to each drainage authority. This id is used to relate the system table to the drainage centerline feature class.
legal_type	Legal Type	Text (20)	Legal_type (Joint, Judicial, County, State, Other, Unknown)	Yes	Legal type of drainage system. Used to differentiate drainage systems that cross jurisdictional boundaries
county	County	Text (50)	NA	Yes	Comma separated list of counties the system is located within
da_primary	Primary Drainage Authority	Text (3)	(Yes_No)	Yes	Is the Drainage authority that is listed in the organization table and that populated this database the primary drainage authority for this system? Primary is typically defined has having a majority of the system within their jurisdictional boundary. Most applicable on Joint or Judicial systems where the system spans multiple counties.
ds_type	System Type	Text (20)	Type (Open Ditch, Tile, Both)	Yes	Does the system consist of open ditch, tile or both?
status	Legal Status	Text (20)	Legal Status (Active, Abandoned, Transferred, Never Built, Other, Unknown)	Yes	Legal status of the drainage system (active, abandoned, transferred, never built, other or unknown)
built_date	Built Date	Date	NA	Yes	Date of legal order establishing the system or date/year the system was built. If full date is not known estimate to the year.

Systems Table (Alias: 103E Public Drainage Systems)					
Field Name	**Alias**	**Type**	**Domain**	**Required**	**Description**
built_date_desc	Built Date Description	Text (100)	NA	Yes	Describe what the date is entered into the built_date field. For example is the date the year built, date of establishment order, date of engineer's plans or other?
re_determination_date	Redetermination Date	Date	NA	No	Date the system was originally determined for benefits or last redetermination of benefits proceeding
determination_date_desc	Determination Date Description	Text (100)	NA	No	Describe what the date is entered into the re_determination_date field. For example is this the date of the petition, viewer's report or some other?
system_ben_am	Total System Benefits Amount	Text (50)	NA	No	Total system benefit amount in dollars for the originally determined benefits or last redetermination of benefits and damages proceeding
system_ben_acres	Total System Benefitted Acres	Text (50)	NA	No	Total system benefitted acres for the originally determined benefits or last redetermination of benefits and damages proceeding
system_outlet_fees	Total System Outlet Fees	Text (50)	NA	No	Total system outlet fees for the originally determined benefits and damages or last redetermination of benefits and damages proceeding
buffer_required	Buffer Required	Text (3)	Yes_No	Yes	Is a buffer strip required on any part of the open ditch as defined by 103E.021 statute?
open_ditch_mi	Open Ditch Miles	Double	NA	Yes	Miles of open ditch within the drainage system. This field value should match the sum of the open ditch centerline lengths within the drainage system.
tile_mi	Tile Miles	Double	NA	Yes	Miles of tile and stormsewer within the drainage system. This field value should match the sum of the tile and stormsewer centerline

Systems Table (Alias: 103E Public Drainage Systems)					
Field Name	**Alias**	**Type**	**Domain**	**Required**	**Description**
					lengths within the drainage system.
notes	Notes	Text (500)	NA	No	General notes about the drainage system. Useful for noting any significant history items or out of the ordinary things with the system
document_index	Document Index	Text (255)	NA	No	File name or URL to a scanned document summary index or listing

Below is a sample record for the systems table:

- ObjectID = 1
- System Name = County Ditch 33
- System Code = CD33
- Drainage Authority ID = 27131
- Legal Type = County
- County (could be multiple) = Rice
- Primary Drainage Authority = Yes
- System Type (Open, Tile, Both) = Both
- Legal Status (Active, Dismissed, Abandoned, Transferred) = Active
- Built Date = 08/23/1972
- Built Date Description = Date shown on the original engineer's plan and profile files.
- Date of Last Redetermination = 9/15/2014
- Determination Date Description = Date of most recent viewer's report for redetermination of benefits and damages proceeding.
- Total System Benefits Amount = $4,691,230
- Total System Benefitted Acres = 2,187.38
- Total System Outlet Fees = Not Applicable
- Buffer_required = Yes
- Open_ditch_miles = 1.49
- Tile_mi = 3.74
- Notes = This system was originally petitioned to be established on 8/23/1972. Construction was completed in 1973. A sediment basin was constructed near outlet of CD 33 between stations 13+00 and 15+00.
- Document_index = https://rice.drainagedb.net/portal/

Step 6) Populate the "drainage_centerlines" feature class's geometry (i.e. polylines or spatial features). Inside the file geodatabase there is a feature dataset called hydrographic. That feature dataset

contains a feature class called “drainage_centerlines.” This is a polyline feature class that is intended to store the “as-built” or “as current” centerline alignment for each active public drainage system. Figure 8 provides an example of the DRM geodatabase. This can be a time consuming step depending on the sources of information to work from. This step will further be broken down into sub steps.

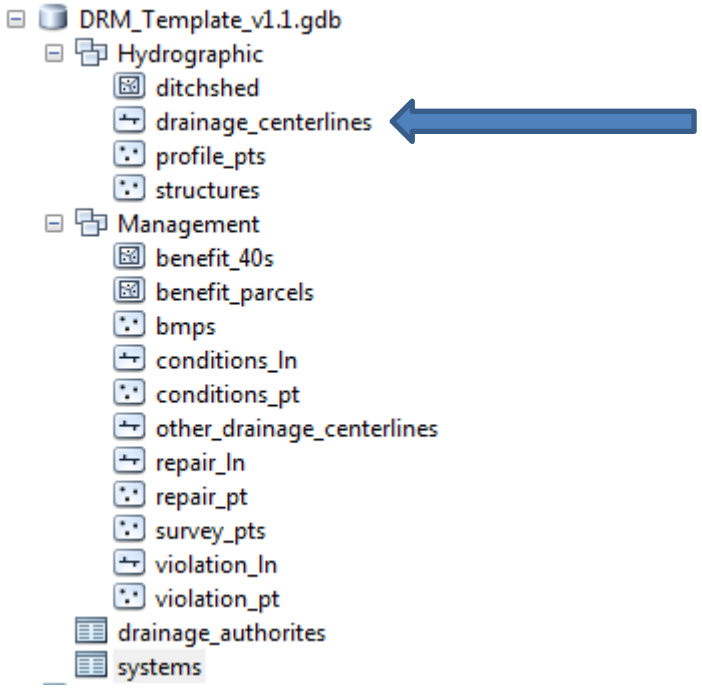

Figure 8. DRM ESRI File Geodatabase Structure

Step 6a) Evaluate how the alignment centerlines for each drainage system will be drawn in GIS. For some drainage authorities there may have already been work completed that contains the alignments in a GIS or CAD format. In this case, the lines can be imported into the feature class, then the information can be quality checked against the historic plans, and more information can be entered as desired. In the case where there is no existing GIS information, the data must be created from historical documents or field surveys. There are a couple of different approaches that can be used. One approach is to use the original plat or plan engineering drawing and georeference it to known coordinates. More detail about georeferencing is provided in the *Definitions* section. Once the map is georeferenced a user can digitize the alignments off of the plat or plan map.

Another approach that can be used specifically with open ditches is to digitize the centerlines using aerial photography or LiDAR. Often it can be beneficial to use both sources for digitizing. In this case you will still want to reference the historical documents to see the legal start and end points of the ditch. It is also useful to use base map reference layers, such as public land survey system lines, parcel lines, and roads. These features are often referenced

in the historical documents. Using multiple years of aerial photos is preferred over using a single source. Depending on the time of the year and resolution of the aerial photos, certain features may stand out better. Digitizing tile lines is often more challenging because the features are subsurface and tend to not be visible on aerial photos. However, indicators of the tile may be present if it was just installed prior to the photo, or it is shallow enough to affect vegetation growth. This can sometimes be seen in early 1990s USGS digital orthophoto quarter quads (DOQQs). Often when trying to reconstruct the tile alignments, users have to revert back to the original historical documents.

One other consideration when using heads up digitizing methods is to recognize the accuracy of the source data being used. For example, many counties have developed survey accurate PLSS and parcel datasets that will be much more accurate than State or Federal datasets, such as USGS 7.5' topographic quad maps. The user drawing in the lines should also consider using best practices in GIS by creating topology between features and snapping end points. Digitizing should also be done at a scale that is appropriate to the source of the data. This task should recognize the need for a person that has appropriate GIS skills with data creation and GIS software such as ESRI's ArcGIS for Desktop.

Other methods for creating the centerline alignments are to use legal descriptions and draw the lines using coordination geometry (COGO) tools within GIS or CAD software. This method is not used as frequently because it is very labor intensive and the underlying legal descriptions typically do not exist on the historical documents. Another method is to field survey the alignments with GPS equipment. This also is typically not done because of costs and resources although potentially provides the most spatially accurate information.

Note that these methods are not exclusively independent of each other. Past experiences have reported these methods are often combined based on what is practical for a drainage authority's resources, completeness of the historical documents, and precision needs. Often greater precision can be obtained from legal descriptions, field surveys, and digitizing off of aerial photos, than by georeferencing historical scanned maps.

Finally, in this step there are a few other considerations to take into account.

- Consider the coordinate system used to digitize or GPS data. The template is setup in UTM 15 NAD83 coordinate system. If your drainage authority has standards for creating data in County Coordinates to minimize error and distortion, create the data in that coordinate system and convert into UTM for the template.
- Consider digitizing the centerline to fit future needs. In creating stationing points of the ditch profile it may be beneficial to digitize in the direction of stationing.
- Initially create a new feature for the line work at any change in line type or name. In later steps these lines will further be split to represent other attribute differences such as tile size or open ditch characteristics.

- Often, there are historical documents that show alignments for "as planned" or "as designed" versus "as-built" or "as current". Creating centerline alignments for each one can be very time consuming. We recommend focusing on the "as-built" or "as-current" condition of the drainage system. Typically, the "as planned" alignments can be referenced when needed in the historical documents.
- Be aware that there can be improvements made to the system that can add or change alignments of the original system. Partial abandonments may remove or realign parts of the system. As a user, you will need to decide the significance of retaining historic alignments. The template supports flagging the status of a line segment or moving the line into the "other_drainage_centerlines" feature class (indicating that it is no longer part of the public drainage system). Review the historical documents ahead of time to be aware of these modifications.

Step 6b) Populate a subset of attributes in the "drainage_centerlines" feature class. The drainage authority should first review the optional attributes and then decide which ones are important based on the resources and historical documents available. The reminder of these guidelines will assume all the attributes are to be populated and information is available regardless of whether it is a required or optional attribute. In this sub step start by populating the "system_code", "type", "segment_name", "map_label", and "source." These attributes should be straight forward and easy to designate. They make up a majority of what should be considered required attributes in this feature class. The table structure is shown below.

drainage_centerlines Feature Class (Alias: Drainage Centerlines)					
Field Name	Alias	Type	Domain	Required	Description
OBJECTID	OBJECTID	Object ID	NA	Yes	Internal ID generated and used by ArcGIS software
SHAPE	SHAPE	Geometry	NA	Yes	Auto-created and Reserved field to store feature geometries by the software
SHAPE_Length	SHAPE_Length	Double	NA	Yes	Auto-created and reserved field used to store feature lengths by the software (in units of coordinate system)
system_code	System Code	Text (25)	NA	Yes	System code or abbreviation used by the drainage authority. Ex.) CD 10
type	Drainage Line Type	Text (25)	centerline_ type (Open, Shallow Ditch with Pipe, Storm Sewer, Tile, Other)	Yes	Line type of the drainage segment. Used for symbolizing in the map or queries. Open represents an open channel ditch, Shallow Ditch with Pipe represents a segment of a ditch that is a pipe/tile but has a shallow open channel on top of

drainage_centerlines Feature Class (Alias: Drainage Centerlines)					
Field Name	Alias	Type	Domain	Required	Description
					the tile (most commonly found at outlets of systems). Storm Sewer are segments that have been urbanized and are part of a city's storm sewer system. Tile represents underground segments.
segment_name	Segment Name	Text (50)	NA	Yes	Name given to segment that is not the drainage name. Examples could include Main trunk, Branch 2
map_label	Map Label	Text (50)	NA	No	Desired label used on the map. Useful for abbreviating labels. Ex: CD24 Br. 2 or just Br. 2)
bottom_width	Bottom Width (ft)	Double	NA	Yes	Bottom width of the open channel ditch segment in feet. Enter -9999 if unknown and -9998 if not applicable.
tile_dim	Tile Dimension (in)	Short Integer	NA	Yes	Tile dimension of subsurface tile in inches. Enter -9999 if unknown and -9998 if not applicable.
tile_material	Tile Material	Text (25)	NA	No	Tile material such as concrete, clay or plastic. Enter Unknown or Not Applicable where appropriate.
source	Source	Text (100)	NA	Yes	Source of line segment. Example could be plans, aerial, photos, GPS, legal description?
side_slope	Side Slope (H:V)	Text (10)	NA	Yes	Side slope of open ditch banks represented as a ratio. Represented as horizontal to vertical. Example 3:1 Enter Unknown or Not Applicable where appropriate.
grade	Percent Grade	Double	NA	No	Percent grade of line segment. Enter -9999 if unknown and -9998 if not applicable.
buffer_right	Buffer Right side	Text (3)	Yes or No	Yes	Is a buffer required on the right side of the open ditch looking upstream? Enter Unknown or Not Applicable where appropriate.
buffer_left	Buffer Left side	Text (3)	Yes or No	No	Is a buffer required on the left side of the open ditch looking downstream? Enter Unknown or Not Applicable where appropriate.

drainage_centerlines Feature Class (Alias: Drainage Centerlines)					
Field Name	Alias	Type	Domain	Required	Description
buffer_req_date	Buffer Date	Date	NA	No	What date was a buffer required to be established on this segment of open ditch?
easement	Easement	Text (10)	Yes, No, Unknown	No	Does the segment have a recorded easement with the County Recorder?
easement_width_ right	Easement Width Right Side	Double	NA	No	Easement width right side of ditch looking upstream. Enter -9999 if unknown and -9998 if not applicable.
easement_width_ left	Easement Width Left Side	Double	NA	No	Easement width left side of ditch looking upstream. Enter -9999 if unknown and -9998 if not applicable.
construction_ easement	Construction Easement	Text (10)	Yes, No, Unknown	No	Does the segment have a construction easement?
construction_ easement_width_ right	Construction Easement Width Right Side	Double	NA	No	Construction easement width on right side of ditch looking upstream. Enter -9999 if unknown and -9998 if not applicable.
construction_ easement_width_ left	Construction Easement Width Left Side	Double	NA	No	Construction easement width left side of ditch looking upstream. Enter -9999 if unknown and -9998 if not applicable.
notes	Notes	Text (255)	NA	No	General notes about the line segment. Useful for noting anything significant about the segment.

Step 6c) At this sub step you will need to decide if you want to complete this alignment information for each system and repeat steps 6a and 6b now or continue on to step 7 with the existing drainage system you are working on.

Step 7) Create a profile spreadsheet. Based on past project experience, there are challenges with populating some of the "drainage_centerlines" layer attributes, because there can be data gaps or information that doesn't exist in the historical documents. Typically attributes such as tile size, grades, open channel bottom width, and open channel side slopes are not shown on the plan sheets where information is digitized from. Figure 9 shows an example of a plan sheet.

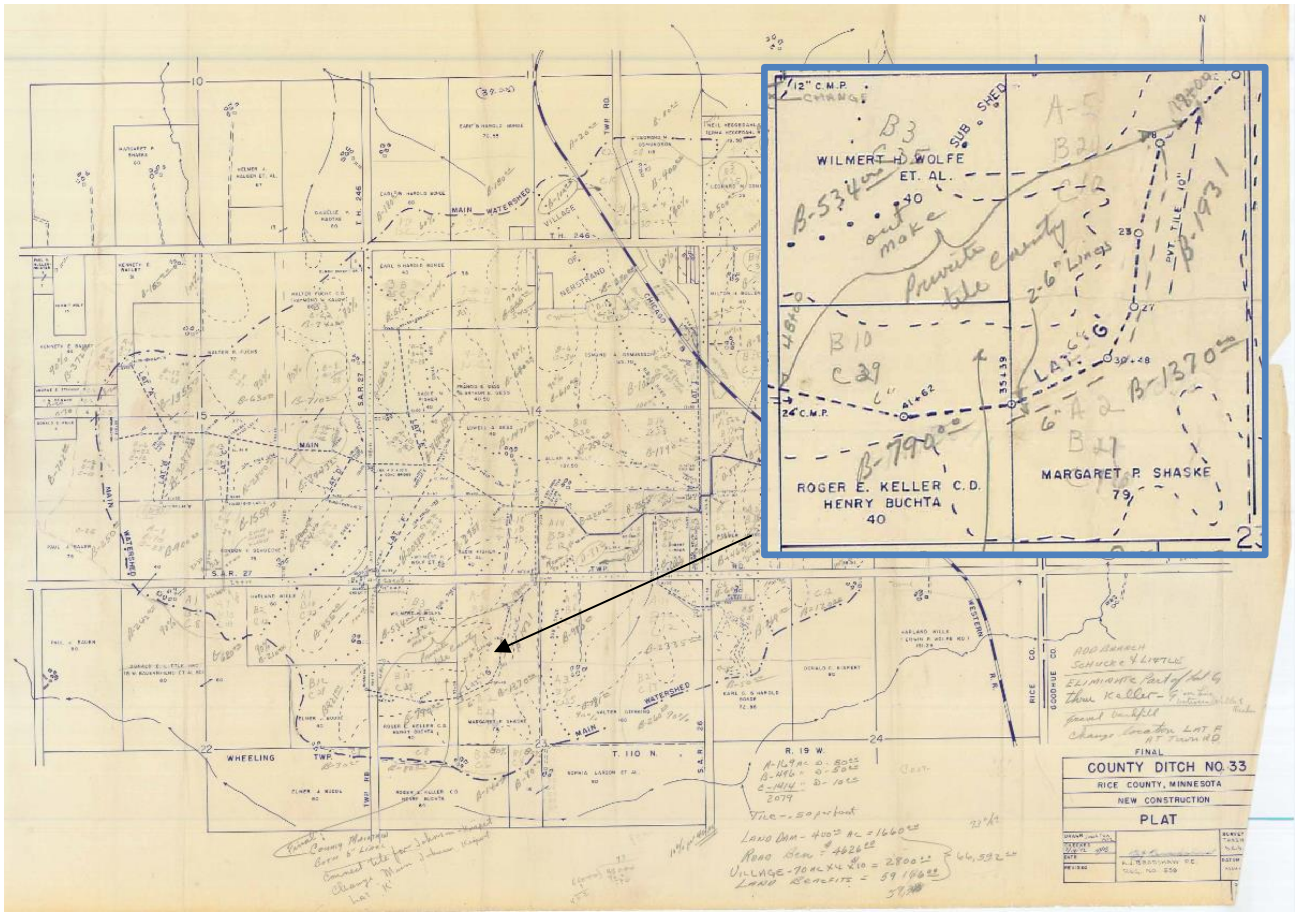

Figure 9. Example plat from Rice County Ditch 33 with a blown up area of Lateral G.

Breaks in these attributes are more accurately shown by stations on profile sheets. Figures 10 and 11 show an example of a profile sheet.

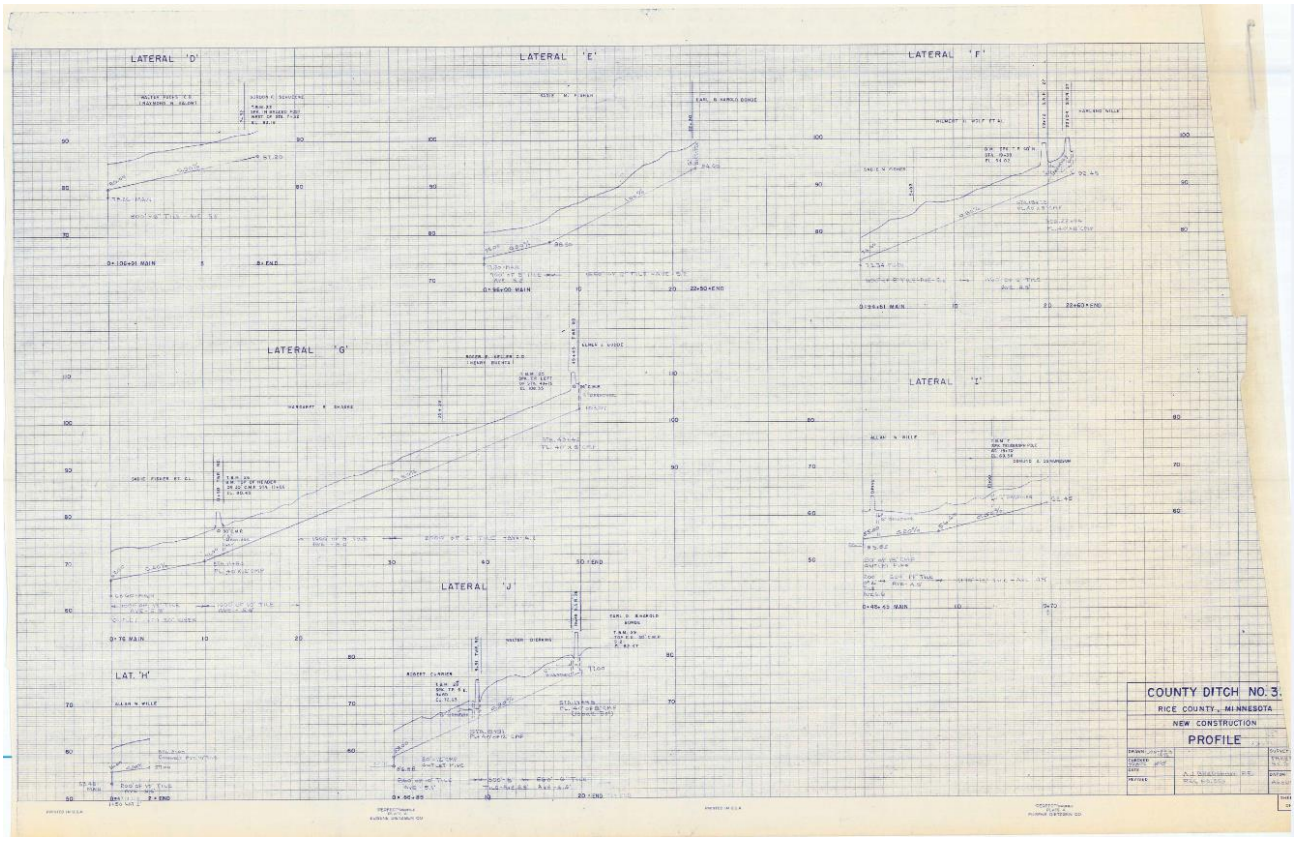

Figure 10. Example Profile sheet form Rice County Ditch 33.

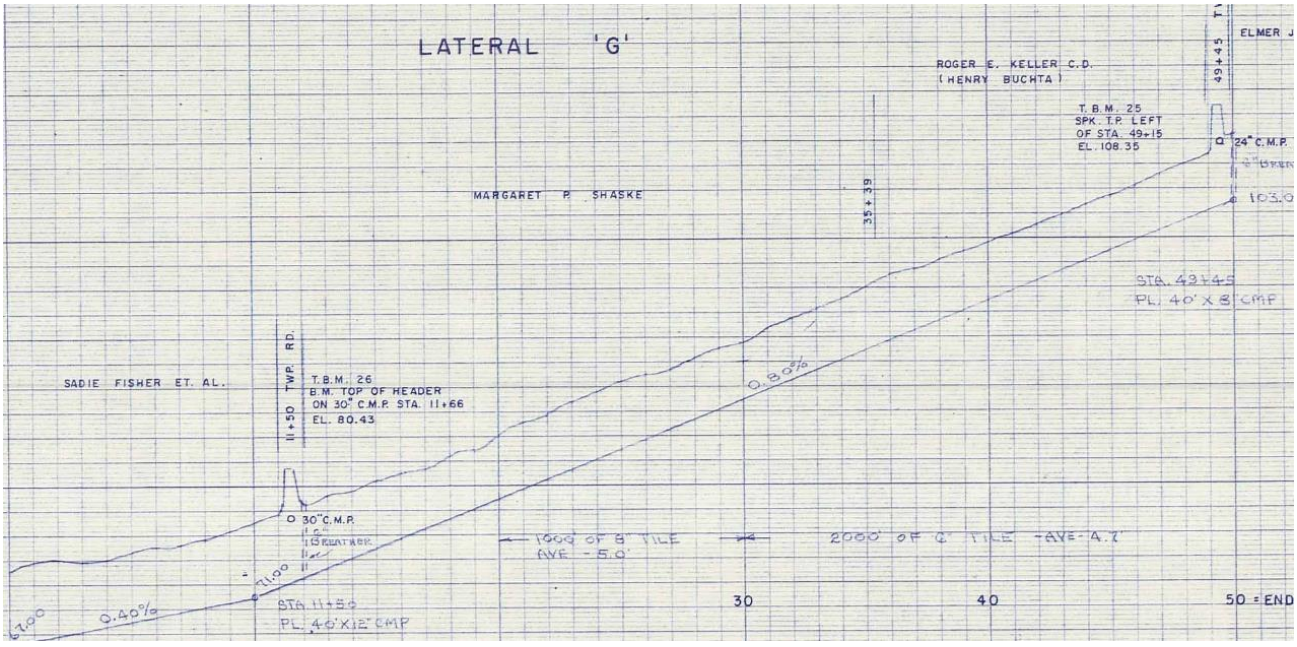

Figure 11. Blown up area on County Ditch 33, Lateral G Profile Sheet.

To help identify these values from the profile sheets and transfer them as attributes to the drainage systems centerline feature class, follow the instructions below to create a stationing spreadsheet.

1. Obtain the applicable scans or hardcopies of the most up to date profile of record.
    a. This is most likely the design profile, but could be an updated profile based on an as-built survey or subsequent improvements (As-Constructed and Subsequently Improved Condition, ACSIC).
    b. Obtain a scan or hardcopy of the Engineer's report associated with the profile if the document exists. Engineer's reports can often provide important ancillary information about the design of a system.

2. Open Microsoft Excel and create a spreadsheet with the following columns:
    a. system_code – Code name of the drainage System Ex. CD43
    b. type – Ditch type. Options are Open, Tile, Storm Sewer, Other
    c. reach – Descriptor for a stretch of drainage that typically combines branch and type, i.e. Main Trunk Open Channel, Branch 1 Open Channel, Branch 1 Tile, etc.
    d. station – Marker point along alignment. Each noted station is an Excel record. The following station points should be noted:
        i. Beginning of alignment
        ii. End of alignment
        iii. PVIs – change in grade
        iv. Stationing intervals typically every 100 feet
        v. Points of interest – change in channel size, change in geometry, sediment trap, etc.
    e. reachID – Concatenation of reach and station to be used to join to a feature class in step 8.
    f. hist_elev – Historical elevation of profile at the specified station
    g. hist_datum – Historical datum of profile at the specified station
    h. hist_grade – Historical profile slope upstream of the specified station. This is a % value.
    i. hist_bottom_width – Historical width of the channel bottom in feet upstream of the specified station
    j. hist_side_slope– Historical Side Slope, ratio H:V upstream of the specified station where the input is the Horizontal number, i.e. a value of 2 would correspond to a 2:1 side slope
    k. hist_tile_dim – Historical dimension of tile in inches upstream of the specified station
    l. hist_tile_material – Historical material of tile upstream of the specified station
    m. elev – Historical elevation of profile at the specified station
    n. datum – current datum of profile at the specified station
    o. grade – Profile slope upstream of the specified station. This is a % value.
    p. bottom_width – Width of the channel bottom in feet upstream of the specified station
    q. side_slope – Side Slope, ratio H:V upstream of the specified station
    r. tile_dim – Dimension of tile in inches upstream of the specified station
    s. tile_material – Material of tile upstream of the specified station

t. (Optional) notes – text to help describe features at specified station

u. (Optional) other columns as desired

3. Populate the columns specified above based on the most up-to-date profile on record as well as the historical profile information in appropriate columns if available. Additional data may be available in the Engineer's Report associated with each profile, (i.e. bottom widths, side slopes, tile size and material, and tile lengths). The user may need assistance from an engineer to help read the profiles if the user is unfamiliar with these type of drawings. An example of a populated Drainage System Profile spreadsheet is shown below:

system_code	type	reach	station	reachID	hist_elev	hist_datum	hist_grade	hist_bottom_width	hist_sid
CD43	Open	Main Trunk Open Channel	20300.00	Main Trunk Open Channel_20300	0.00	Unknown	0.000000	0.00	
CD43	Open	Main Trunk Open Channel	20400.00	Main Trunk Open Channel_20400	0.00	Unknown	0.000000	0.00	
CD43	Open	Main Trunk Open Channel	22800.00	Main Trunk Open Channel_22800	76.95	Unknown	0.000000	0.00	
CD43	Open	Main Trunk Open Channel	22900.00	Main Trunk Open Channel_22900	76.95	Unknown	0.000000	12.00	
CD43	Open	Main Trunk Open Channel	23000.00	Main Trunk Open Channel_23000	76.95	Unknown	0.000000	12.00	
CD43	Open	Main Trunk Open Channel	23100.00	Main Trunk Open Channel_23100	76.95	Unknown	0.000000	12.00	
CD43	Open	Main Trunk Open Channel	23200.00	Main Trunk Open Channel_23200	76.95	Unknown	0.005300	0.00	
CD43	Open	Main Trunk Open Channel	23300.00	Main Trunk Open Channel_23300	76.42	Unknown	0.005300	0.00	
CD43	Open	Main Trunk Open Channel	23400.00	Main Trunk Open Channel_23400	75.89	Unknown	0.005300	0.00	
CD43	Open	Main Trunk Open Channel	23500.00	Main Trunk Open Channel_23500	73.82	Unknown	0.005300	0.00	
CD43	Open	Main Trunk Open Channel	23600.00	Main Trunk Open Channel_23600	73.75	Unknown	0.005300	0.00	
CD43	Open	Main Trunk Open Channel	23700.00	Main Trunk Open Channel_23700	73.75	Unknown	0.000000	0.00	
CD43	Open	Branch 1 Open Channel	0.00	Branch 1 Open Channel_0	0.00		0.000000	0.00	
CD43	Open	Branch 1 Open Channel	100.00	Branch 1 Open Channel_100	0.00		0.000000	0.00	
CD43	Open	Branch 1 Open Channel	200.00	Branch 1 Open Channel_200	0.00		0.000000	0.00	
CD43	Open	Branch 1 Open Channel	300.00	Branch 1 Open Channel_300	0.00		0.000000	0.00	
CD43	Open	Branch 1 Open Channel	400.00	Branch 1 Open Channel_400	0.00		0.000000	0.00	
CD43	Open	Branch 1 Open Channel	500.00	Branch 1 Open Channel_500	0.00		0.000000	0.00	
CD43	Open	Branch 1 Open Channel	600.00	Branch 1 Open Channel_600	0.00		0.000000	0.00	
CD43	Open	Branch 1 Open Channel	700.00	Branch 1 Open Channel_700	0.00		0.000000	0.00	
CD43	Open	Branch 1 Open Channel	800.00	Branch 1 Open Channel_800	0.00		0.000000	0.00	
CD43	Open	Branch 1 Open Channel	900.00	Branch 1 Open Channel_900	0.00		0.000000	0.00	
CD43	Open	Branch 1 Open Channel	1000.00	Branch 1 Open Channel_1000	0.00		0.000000	0.00	

Step 8) Add and attribute station points using the "profile_pts" template feature class. This layer will be used to help verify the accuracy of the drainage centerline alignments (segmentation) and determine where to split lines based on changes in attributes in Step 9. It is also a very handy layer to reference locations on a drainage system. The table structure is shown below.

profile_pts Feature Class (Alias: Profile Points)					
Field Name	**Alias**	**Type**	**Domain**	**Required**	**Description**
OBJECTID	OBJECTID	Object ID	NA	Yes	Internal ID generated and used by ArcGIS software
SHAPE	SHAPE	Geometry	NA	Yes	Auto-created and Reserved field to store feature geometries by the software
system_code	System Code	Text (25)	NA	No	System code used by the drainage authority. Most commonly the abbreviation of the system.
station	Station	Text (50)	NA	Yes	Distance in feet at specific location of the alignment. Most commonly this is referenced from the downstream end of the system or intersection of a branch of the system. Example stationing is 0+00 or 100.
hist_elev	Historic Elevation	Double	NA	Yes	Historic Elevation in feet at the station point. This is typically taken from engineering profile sheets. Enter -9999 if unknown and -9998 if not applicable.
hist_datum	Historic Vertical Datum	text	NA	Yes	Vertical Datum for historic elevations if known. Older profile sheets are typically on an assumed datum and not tied to a Mean Sea Level datum.
elev	Elevation	Double	NA	No	As-Constructed and Subsequently Improved Condition (ACSIC). This is typically based on surveyed elevations or the historic elevation converted to a Mean Sea Level Datum. Elevation in feet at the station point. Enter -9999 if unknown and -9998 if not applicable.
vertical_datum	Vertical Datum	text	NA	No	Vertical Datum for ACSIC elevation values (preferably NAVD 88)

The following steps are for adding and populating station points to the "profile_pts" feature class using ArcGIS for Desktop software.

1. Open the spreadsheet created in Step 7.
    a. Be sure you have elevations (historic and /or ACSIC) at every stationing interval typically every 100 feet.
    b. Verify all fields are attributed as completely as possible while ensuring that following fields are populated at minimum:
        i. system_code – Code name of the drainage System Ex. CD43
        ii. station – marker point along an alignment
        iii. hist_elev - design or as-built elevation from historical documents.
        iv. hist_datum - vertical datum of the design or as-built elevations. Frequently these are on an assumed datum or other non-sea level datum. If the datum is unknown enter "Unknown" or "Assumed."
        v. elev - should be the ACSIC profile or other profile of record. If the ACSIC has not been determined and converted to a sea-level datum, this field should be left null.
        vi. datum - the vertical datum of the "elev" field. These should be in a sea level datum (e.g. NGVD 29 or NAVD 88). If the datum is unknown enter "Unknown" or "Assumed."
2. Create a temporary file geodatabase called "working"
3. Open ArcMap and add the drainage_centerlines feature class to the map. Re-project the layer into a compatible foot-based projection (Ex. Minnesota State Plane South Feet). Put the output of the newly projected layer in the "working" file geodatabase and name it drainage_centerlines_working
4. Add the drainage_centerlines_working feature class to your map. Be sure your Coordinate System is in "feet," this is important for geoprocessing.
5. Open the attribute table for the drainage_centerlines_working layer and verify that each segment/record accurately corresponds to the related information in the profile spreadsheet. If not, make it so.
6. Verify that the start of the drainage_centerlines_working alignment features (line segments) is at the downstream end of each branch/lateral (if the historic stationing goes from upstream to downstream), or at the upstream end of each branch/lateral (if the historic stationing goes from downstream to upstream)
    a. If the drainage_centerlines_working alignment feature starts do not correspond to the stationing starts, then you need to flip the direction of each
    b. Make sure that the stationing direction is consistent throughout (either upstream or downstream)
7. Add a field to the drainage_centerlines_working feature class with a type "Double" and name it "length."

8. Right click on the new field “length” and select “Calculate Geometry.”
    a. Calculate the length of the features in feet and append unit to field name.
9. Compare the length of each alignment (line segment) to the cumulative total of corresponding reach length records in the drainage system profile spreadsheet referenced in step 1. Ex. A 1000 foot segment in the drainage_centerlines_working layer named “Branch 1” should match the 1000 foot cumulative total of all associated spreadsheet records named “Branch 1 Open Channel”.
10. If the alignment (segments in the drainage_centerlines_working layer) lengths don’t match the corresponding cumulative total reach lengths in the spreadsheet, adjust the drainage_centerlines_working alignments and/or drainage system profile spreadsheet as necessary until an accurate match is reached. Each should be a true representation of the real-world drainage system geometry thus the corresponding lengths should match.
11. Once the drainage_centerlines_working feature class lengths match those in the drainage system profile spreadsheet table, execute a split on the polyline
    a. Split at the stationing interval distance (typically every 100 feet)
    b. Check the box to start ‘From Start Point of Line’.
12. Use the measure tool to make sure the newly created line segments are 100 feet. (i.e., if they measure to be 328 feet long, change your data frame coordinate system to one with feet—not metric—and redo the split.)
13. Complete additional splits at points of interest where other stations have been created (non-stationing interval locations) in the drainage system profile spreadsheet. For example these could be at culverts or beginning of lakes.
14. Open the profile_pts feature class and reproject it into the same foot based system you used for the drainage_centerline_working layer. Put the output in the same “working” file geodatabase and name it “profile_pts_working”
15. Open the profile_pts_working layer and create points starting at the downstream end of each branch/lateral and moving upstream at each split point.
    a. Be sure to use “snapping” at endpoints

    Optionally, if one has the appropriate ArcMap licensing, he/she could execute intersect functionality using the profile_pts_working layer and the drainage_centerlines_working layer to create points at the vertex ends of each line segment then manually add a point to the beginning of the start segment.
16. Enter each station value from the spreadsheet into the corresponding point station field for each point in the profile_pts_working layer. Check to ensure the station value is accurate based on the distance each point is away from the start of the alignment.
17. Add a field named linkID to the profile_pts_working layer. Make it a text field with a 100 length.
18. If you haven’t already done so, open up the profile spreadsheet and ensure you have populated each reachID cell with a reach field and station concatenation value (ex: Main Trunk Open Channel_1000)

19. In the profile_pts_working layer, populate the linkID field for each point with the corresponding reachID value from the spreadsheet. Ensure these values are entered exactly as they are in the spreadsheet.
20. Execute a "Join" based on the linkID field in the profile_pts_working layer and the reachID field in the drainage system profile spreadsheet table referenced in Step 1.
21. Populate like fields during the join using the GIS "Field Calculator"
22. Save all edits. Remove all "Joins."
23. Delete the linkID field from the profile_pts_working layer.
24. Complete a review of the newly attributed points.
25. If the profile_pts_working feature class is without issue, it can be reprojected back into UTM 15 NAD83, named profile_pts, and put back into the DRM template as the new master feature class. Note: the drainage_centerlines_working feature class could also be reprojected, renamed, and added back into the template as the master. However, more frequently than not this feature class with all the station interval splits would be harder to work with than the alignment layer imported into the DRM template drainage_centerlines feature class previously.

Step 9) Split and populate the "drainage_centerline" feature class using the newly created profile_pts layer created during Steps 7 and 8 as a reference layer. The primary attributes you will populate include tile size, tile material, grade, channel bottom width, and side slopes if available. This is a time consuming task and may involve manual data entry, so be conscious of errors. Other attributes left in the feature class include documenting of required buffers. The requirement for buffers on open ditch systems under M.S. 103E are triggered by a redetermination of benefits or improvement. A review of the historical documents should identify these requirements. The last fields in this feature class are known easements. If easements exist, these are typically noted in engineer reports. If easements have not been identified or the drainage authority has chosen not to populate those fields, the fields should be populated with "unknown" or not populated.

Step 10) Populate the "ditchshed" Feature Class.

This is a polygon feature class representing the drainage area of the drainage system to its outlet, also referred to as a "watershed". This data does not always exist for every system. Sometimes the information is included in a viewer's report or engineer's report. In other instances, the watersheds have been delineated from topographic data. If the data does not already exist, it can take considerable time to develop this layer.

ditchshed Feature Class (Alias: Ditchshed)

Field Name	Alias	Type	Domain	Required	Description
OBJECTID	OBJECTID	Object ID	NA	Yes	Internal ID generated and used by ArcGIS software

ditchshed Feature Class (Alias: Ditchshed)					
Field Name	**Alias**	**Type**	**Domain**	**Required**	**Description**
SHAPE	SHAPE	Geometry	NA	Yes	Auto-created and Reserved field to store feature geometries by the software
SHAPE_Length	SHAPE_Length	Double	NA	Yes	Auto-created and reserved field that stores feature lengths
SHAPE_Area	SHAPE_Area	Double	NA	Yes	Auto-created and reserved field that stores feature area size
system_code	System Code	Text (25)	NA	No	System code used by the drainage authority
source	Source	Text (100)	NA	Yes	Source of watershed delineation
create_date	Date Created	Date	NA	Yes	Creation date of ditchshed

Step 11) Populate the "structures" feature class.

A structure is typically a culvert, crossing, bridge, or some other in-channel water control feature on the drainage system. If this data does not already exist it can take considerable resources to develop because it usually is created through field survey. This information can be used to determine locations where water could pond within Chapter 103E drainage ditches, due to the bottom elevation of the culvert or bridge being higher than the established elevation of the drainage ditch bottom. The data is also useful for converting historic profile elevations on an assumed datum to a known mean sea level datum. For the field "roadname," include the county/state highway designation and/or the street name. "Driveway" and "field road" are also acceptable entries for this field.

structures Feature Class (Alias: Structures)					
Field Name	**Alias**	**Type**	**Domain**	**Required**	**Description**
OBJECTID	OBJECTID	Object ID	NA	Yes	Internal ID generated and used by ArcGIS software
SHAPE	SHAPE	Geometry	NA	Yes	Auto-created and Reserved field to store feature geometries by the software
system_code	System Code	Text (25)	NA	No	System code used by the drainage authority
type	Type	Text (50)	NA	Yes	Type of Structure (e.g. culvert, box culvert, weir, bridge, dam, manhole)
material	Material	Text (50)	NA	Yes	Material of structure (e.g. concrete, clay, CSP, HDPE)

structures Feature Class (Alias: Structures)					
Field Name	**Alias**	**Type**	**Domain**	**Required**	**Description**
size_in	Size Inches	Text (50)	NA	Yes	Size in inches of the opening of the structure. If structure has multiple sizes for span and rise enter both in.
owner	Owner	Text (50)	NA	No	Owner of structure
length	Length	Text (25)	NA	No	Length of structure in feet
end_treatment	End Treatment	Text (50)	NA	No	End treatment type of structure. Examples would be apron, cut to slope, end wall, spigot end, bell end. If end treatment type is different for each side of structure, enter both in.
inv_up	Invert Up	Double	NA	No	Upstream invert elevation
Inv_dn	Invert Down	Double	NA	No	Downstream invert elevation
roadname	Roadname	Text(100)	NA	No	Name of road intersecting at the structure
notes	Notes	Text (255)	NA	No	Description of structure
source	Source	Text (100)	NA	Yes	Source of structure point
survey_date	Survey Date	Date	NA	Yes	Date structure points was surveyed
vert_datum	Vertical Datum	Text (100)	NA	No	Vertical datum of invert elevations

9.3 METADATA

Metadata (http://www.mngeo.state.mn.us/committee/standards/mgmg/metadata.htm) is sometimes called "data about data." It describes the content, quality, condition, availability, and other characteristics of data, which is particularly important for digital, geospatial data. It is through the evaluation of metadata that a user can determine if the data meets their needs.

Metadata is mandatory for data that is published in the Minnesota Geospatial Commons (https://gisdata.mn.gov/content/?q=help/become_publisher). To obtain the template package from BWSR the Drainage Authority user is required to fill out a template request form (https://gisdata.mn.gov/dataset/public_drainage_records_template) whereby they agree to share the hydrographic portion of their data on the Geospatial Commons.

To help with this, the metadata that comes with the template package has been seeded (pre-populated) with information that should be common to all users such as item names and field descriptions. The user only has to fill out those portions of metadata that are unique to them such as how their data was processed and contact information. The template package includes instructions on how to complete the metadata as well as how to publish it and its respective hydrographic data on the Geospatial Commons.

9.4 HYDROGRAPHIC AND ENGINEERING DATA SUMMARY

The steps and guidelines outlined in Section 9 will lead to populating the hydrographic data portion of the template. As noted in certain steps, there may be portions that still remain empty because of historical data gaps or insufficient drainage authority resources to collect the data. This is acceptable but should be noted in metadata. At this point, the hydrographic data may be published, per the signed template request form with BWSR, to the Geospatial Commons. For more information please see the template request form resource page (https://gisdata.mn.gov/dataset/public_drainage_records_template) on the Geospatial Commons.

The results of this step will allow users to overlay map, share the data on websites or interactive maps, aggregate data on a regional or statewide level, and produce maps such as the one shown in Figure 12.

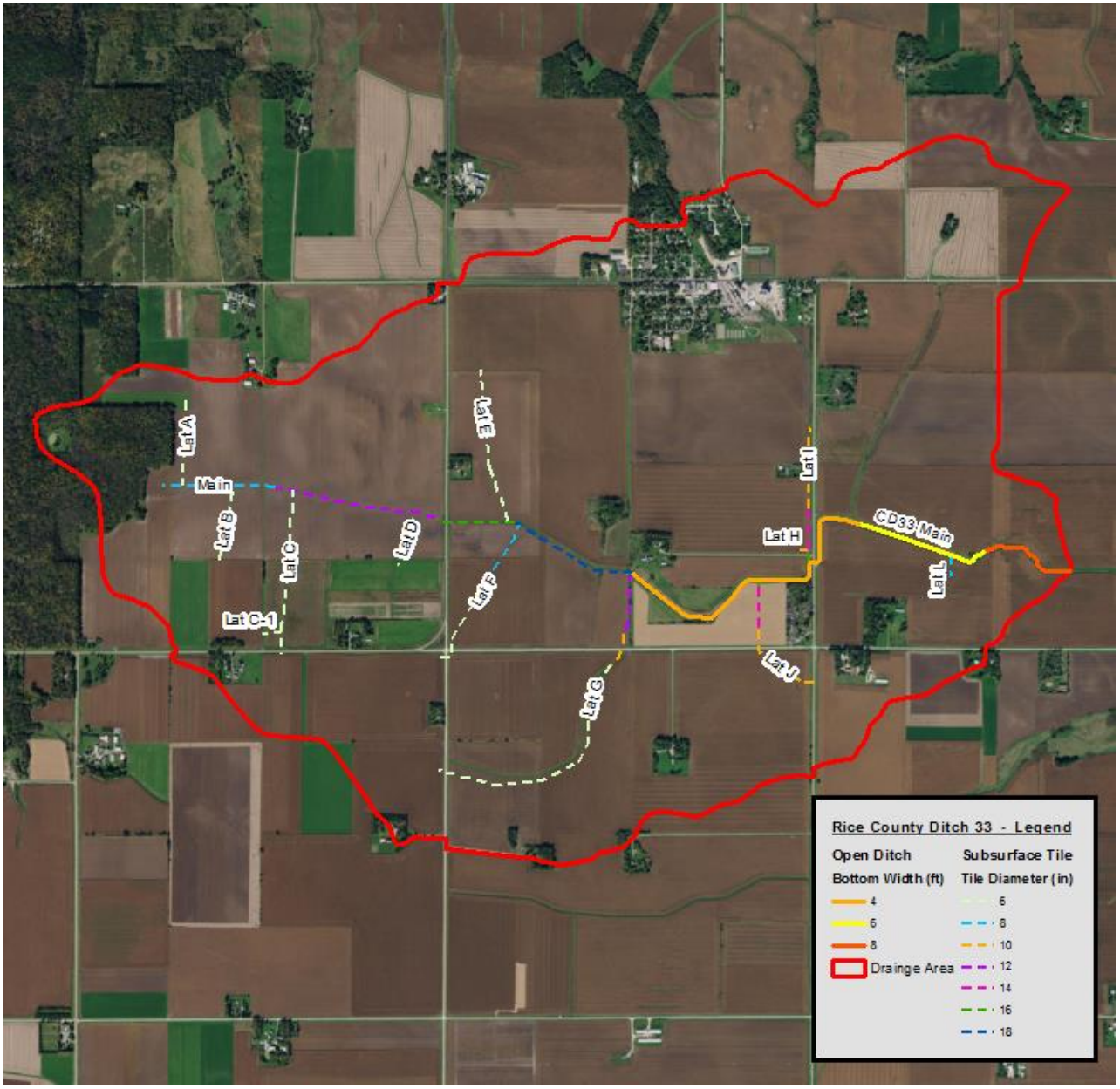

Figure 12. Example Drainage System Map produced from DRM Template.

10. MANAGEMENT AND MAINTENANCE DATA

This category of information is typically produced in support of administration or maintenance activities on a drainage system. For example, a redetermination of benefits and damages produces a new list of benefitted land owners with amounts and acres used to assess the cost of maintenance and management of the system. Through interviews, surveys and prior work, we have identified numerous approaches on how drainage authorities manage this information. Some drainage authorities used basic tools such as spreadsheets and text documents, others store portions of this information in GIS files, while over a dozen

said they use the software product DrainageDB to manage this type of information.

In developing the DRM template, it was acknowledged that this type of information is typically not shared with other agencies or the public. There will also continue to be a variety of tools and methods used to enter, store, and organize this type of information. With these considerations the DRM template developed feature classes to store many practical information pieces, but acknowledge this is a non-required component of the database template. The sections below provide an explanation and limited instructions on how these components could be populated by a drainage authority.

10.1 BENEFITTED LAND

Benefitted land owners are determined through a legal process in the statute called viewing. During the viewing process viewers (independent third party) are hired to determine the value of drainage provided by the ditch for each 40 acre parcel that, in part, is drained by the public drainage system. The factors used to determine benefits and damages include soils, proximity to the ditch, topography, and crop values. Minnesota Statute Chapter 103E *Drainage* says that the benefits to be summarized and reported by 40-acre parcel. This was traditionally the only way benefitted assessment rolls were listed. However, today most viewers provide a list by county parcel ID and land owner.

The benefitted lands information can be managed by a drainage authority using a variety of methods. Typically, the county auditors who manage public drainage system assessments store this information in a tax system or simply in spreadsheets. The information represents a spatial location so it allows the drainage authority to manage the information in GIS. To help facilitate storing information in GIS, the template has included two optional feature classes. The feature classes and attributes are described below.

10.1.1 BENEFITTED FORTIES

"Benefitted Forties" is a polygon feature class, and is a spatial representation of the forty acre grid in a public land survey system (PLSS). A legal proceeding makes a determination of how the drainage system benefits and damages the forties drained by the system, and is defined in a viewer's report. Note: where government lots exist, viewers assign the benefits to the government lot rather than by the quarter/quarter section. For polygons which are government lots, do not populate the "forty" field. For polygons which are not government lots, do not populate the "govt_lot" field.

Benefit_40s Feature Class (Alias: Benefitted Forties)					
Field Name	**Alias**	**Type**	**Domain**	**Required**	**Description**
OBJECTID	OBJECTID	Object ID	NA	Yes	Internal ID generated and used by ArcGIS software
SHAPE	SHAPE	Geometry	NA	Yes	Auto-created and Reserved field to store feature geometries by the software
system_code	System Code	Text (25)	NA	No	System code used by the drainage authority

Benefit_40s Feature Class (Alias: Benefitted Forties)					
Field Name	**Alias**	**Type**	**Domain**	**Required**	**Description**
tract_ac	Tract Acres	Double	NA	Yes	Acres of tract land representing the forty
benefit_am	Benefit Amount	Double	NA	Yes	Benefit amount from viewers report for that forty
benefit_ac	Benefit Acres	Double	NA	Yes	Benefit acres from viewers report for that forty
notes	Notes	Text (255)			Notes
SHAPE_Length	SHAPE_Length	Double	NA	Yes	Auto-created and reserved field that stores feature lengths
SHAPE_Area	SHAPE_Area	Double	NA	Yes	Auto-created and reserved field that stores feature area size
township	Township	Text (25)	NA	Yes	Township
range	Range	Text (25)	NA	Yes	Range
section	Section	Text (25)	NA	Yes	Section
forty	Forty Description	Text (25)	NA	Yes	Forty Description Example; NENE (northeast quarter of the northeast quarter)
govt_lot	Government Lot	Text (25)	NA	Yes	Government Lot Description

11.1.2 BENEFITTED PARCELS

"Benefitted Parcels" is a polygon feature class and is a spatial representation of individual land parcels that benefit a drainage system. These benefits may have been determined through a legal proceeding based upon a more recent viewer's report, or it may from the drainage authority's and/or county auditor's reassignment of historic "forty" (quarter/quarter) benefits to individual parcels.

benefit_parcels Feature Class (Alias: Benefitted Parcels)					
Field Name	**Alias**	**Type**	**Domain**	**Required**	**Description**
OBJECTID	OBJECTID	Object ID	NA	Yes	Internal ID generated and used by ArcGIS software
SHAPE	SHAPE	Geometry	NA	Yes	Auto-created and Reserved field to store feature geometries by the software
system_code	System Code	Text (25)	NA	Yes	System code used by the drainage authority
parcel_id	Parcel ID	Text (25)	NA	Yes	County Parcel identification number
landowner_name	Owner Name	Text (50)	NA	No	Landowner of the parcel
benefit_ac	Benefit Acres	Double	NA	Yes	Benefit acres from viewers report
benefit_am	Benefit Amount	Double	NA	Yes	Benefit amount from viewers report
benefit_perc	Percent of Total Benefits	Double	NA	No	Percent of total dollar benefits this parcel has of the total system dollar benefits. Value represents percentage. Enter -9999 for unknown.
deed_acres	Deed Acres	Double	NA	No	Acres for the parcel that are shown in the County tax or deed records
SHAPE_Length	SHAPE_Length	Double	NA	Yes	Auto-created and reserved field that stores feature lengths
SHAPE_Area	SHAPE_Area	Double	NA	Yes	Auto-created and reserved field that stores feature area size

10.2 BMPS

Best management practices (BMPs) are structural features that may be constructed by the drainage authority to control flooding, reduce system maintenance, and improve water quality, including but not limited to, side inlet controls, water ways, water and sediment control basins, and woodchip bioreactors, and saturated buffers. This point feature class is a spatial representation of BMPs that are under the management of the drainage authority.

bmps Feature Class (Alias: BMPs)					
Field Name	**Alias**	**Type**	**Domain**	**Required**	**Description**
OBJECTID	OBJECTID	Object ID	NA	Yes	Internal ID generated and used by ArcGIS software
SHAPE	SHAPE	Geometry	NA	Yes	Auto-created and Reserved field to store feature geometries by the software
system_code	System Code	Text (25)	NA	No	System code used by the drainage authority
create_date	Date Created	Date	NA	Yes	Date best management practice was created in GIS
status	Status	Text (25)	bmp_status (Existing, Recommended)	Yes	Is the BMP existing or recommended?
bmp_type	BMP Type	Text (50)	NA	Yes	Type of Best management practice
landowner_name	Landowner Name	Text (50)	NA	No	Name of land owner of parcel the BMP is located on
parcel_id	Parcel ID	Text (25)	NA	No	County Parcel identification number BMP is located on
notes	Notes	Text (255)	NA	No	Detailed description of best management practice

10.3 CONDITIONS LINES AND POINTS

Minnesota Statue Chapter 103E *Drainage* requires that drainage authorities inspect each drainage system at least once every five years. For the purposes of this template, we are referring to these types of inspections as condition reports. The primary use of these feature classes is to spatially document the condition of the systems. Both a point and a line feature class have been provided in the template, with identical attributes, to allow flexibility in how the observed condition is geolocated.

conditions_ln and conditions_pt Feature Classes (Alias: Condition Lines and Condition Points)					
Field Name	**Alias**	**Type**	**Domain**	**Required**	**Description**
OBJECTID	OBJECTID	Object ID	NA	Yes	Internal ID generated and used by ArcGIS software
SHAPE	SHAPE	Geometry	NA	Yes	Auto-created and Reserved field to store feature geometries by the software

conditions_ln and conditions_pt Feature Classes (Alias: Condition Lines and Condition Points)					
Field Name	**Alias**	**Type**	**Domain**	**Required**	**Description**
SHAPE_Length	SHAPE_Length	Double	NA	Yes	Auto-created and reserved field that stores feature lengths
system_code	System Code	Text (25)	NA	No	System code used by the drainage authority
notes	Notes	Text (255)	NA	Yes	Notes about the condition report
picture_link	Picture Link	Text (255)	NA	No	File name or URL link to condition photos
monitor	Monitor	Text (3)	Yes,No	Yes	Should this location continue to be monitored for future maintenance needs?
parcel_id	Parcel ID	Text (25)	NA	No	Primary County parcel identification number the condition location report is located on
landowner_name	Landowner Name	Text (50)	NA	No	Primary landowner name for the parcel the condition location report is located on
create_date	Date Created	Date	NA	Yes	Date of the condition report

10.4 REPAIR LINES AND POINTS

According to Chapter 103E, a drainage authority shall maintain the drainage system … to make the drainage system efficient. “Repair” within the context of this feature class includes any work completed by the drainage authority to restore the function of the drainage system. This work ranges from routine maintenance completed annually along a system to system-wide repairs to the as-constructed and subsequently improved condition. Typical maintenance or repairs could include, but be limited to, replacing culverts, cleaning out sediment in an open ditch, and replacing subsurface tile. These line and point feature classes are a spatial representation of maintenance repair locations within a drainage system.

repair_ln and repair_pt Feature Classes (Alias: Repair Lines and Repair Points)					
Field Name	**Alias**	**Type**	**Domain**	**Required**	**Description**
OBJECTID	OBJECTID	Object ID	NA	Yes	Internal ID generated and used by ArcGIS software
SHAPE	SHAPE	Geometry	NA	Yes	Auto-created and Reserved field to store feature geometries by the software

repair_ln and repair_pt Feature Classes (Alias: Repair Lines and Repair Points)					
Field Name	**Alias**	**Type**	**Domain**	**Required**	**Description**
SHAPE_Length	SHAPE_Length	Double	NA	Yes	Auto-created and reserved field that stores feature lengths
system_code	System Code	Text (25)	NA	Yes	System code used by the drainage authority
create_date	Date Created	Date	NA	Yes	Date repair need was reported
close_date	Date Closed	Date	NA	Yes	Date repair was closed or fixed
repair_id	Repair ID	Text (6)	NA	No	Repair Identification number. Useful for uniquely referencing each repair. An example numbering system could be a two digit year followed by a unique number for that year. Example given is 16-001
landowner_name	Landowner Name	Text (50)	NA	No	Name of Landowner for the parcel the repair was located on
parcel_id	Parcel ID	Text (25)	NA	No	County Parcel ID value for which the repair was located on
repair_type	Repair Type	Text (25)	repair_type (beaver/beaver dam, clean out, culvert/crossing, slough, tile blowout, tile replacement, surface intake, tile outlet, tree removal, vegetation removal, other)	Yes	Type of Repair
proposed_work	Proposed Work	Text (255)	NA	Yes	Description of proposed work
picture_link	Picture Link	Text (255)	NA	No	File name or URL to picture of repair
status	Status	Text (6)	repair_status (InReview, InProgress, Completed)	Yes	Status of repair

10.5 SURVEY POINTS

Drainage authorities survey drainage systems for various reasons. The survey information is typically collected with high-accuracy GPS equipment. This feature class is set up to store those survey points in a central location. They may include survey shots for the bottom of a ditch, cross sections, culverts, tile inlets and tile outlets. This point feature class is a spatial representation of survey shots that were collected for projects or studies within the drainage system.

survey_pts Feature Class (Alias: Survey Points)					
Field Name	**Alias**	**Type**	**Domain**	**Required**	**Description**
OBJECTID	OBJECTID	Object ID	NA	Yes	Internal ID generated and used by ArcGIS software
SHAPE	SHAPE	Geometry	NA	Yes	Auto-created and Reserved field to store feature geometries by the software
system_code	System Code	Text (25)	NA	No	System code used by the drainage authority
description	Description	Text (50)	NA	No	Description of the survey shot
project_name	Project Name	Text (50)	NA	No	Project Name for the survey shot. Useful for grouping the points.
point_ID	Point ID	Long Integer	NA	No	Point ID of the survey shot. Typically created from the GPS collector
feature_code	Feature Code	Text (25)	NA	Yes	Feature code of the survey shot typically entered during the survey on the GPS collector
elevation	Elevation	Double	NA	No	Elevation of survey shot
vert_datum	Vertical Datum	Text (25)	NA	Yes	Vertical Datum of survey shot.
survey_date	Survey Date	Date	NA	Yes	Date of survey shot
survey_units	Survey Units	Text (25)	Units	Yes	Unit used for elevation of survey shot

10.6 VIOLATION LINES AND POINTS

The MS 103E references possible violation types that drainage authorities are responsible to report, document, and remedy. This line and point feature class is a spatial representation of a reported violation location along a public drainage system.

violation_ln and violation_pt Feature Classes (Alias: Violation Lines and Points)					
Field Name	**Alias**	**Type**	**Domain**	**Required**	**Description**
OBJECTID	OBJECTID	Object ID	NA	Yes	Internal ID generated and used by ArcGIS software

violation_ln and violation_pt Feature Classes (Alias: Violation Lines and Points)					
Field Name	**Alias**	**Type**	**Domain**	**Required**	**Description**
SHAPE	SHAPE	Geometry	NA	Yes	Auto-created and Reserved field to store feature geometries by the software
system_code	System Code	Text (25)	NA	Yes	System code used by the drainage authority
source_date	Source Date	Date	NA	Yes	Date of violation report
close_date	Date Closed	Date	NA	Yes	Date violation was closed or resolved
violation_id	Violation ID	Text (6)	NA	Yes	Unique violation id used for referencing
notification_source	Notification Source	Text (25)	NA	Yes	What was the source of the violation notification?
landowner_name	Landowner Name	Text (50)	NA	Yes	Landowner name
parcel_id	Parcel ID	Text (50)	NA	No	County parcel number
violation_type	Violation Type	Text (25)	NA	Yes	Type of violation
enforce_action 1	Enforcement Action 1	Text (3)	Yes_no	No	Enforcement action taken under Section 103E.705, Subdivision s 1. And 2.
enforce_action 2	Enforcement Action 2	Text (3)	Yes_no	No	Enforcement action taken under Section 103E.021, Subdivision 4.
enforce_action 3	Enforcement Action 3	Text (3)	Yes_no	No	Enforcement action taken under Section 103E.728, Subdivision 2.
notes	Notes	Text (255)	NA	No	Notes
picture_link	Picture Link	Text (255)	NA	No	File path or URL to pictures
status	Status	Text (6)	Violation_status (Open, Closed)	Yes	Is the violation still open or closed per the statute requirements?
SHAPE_Length	SHAPE_Length	Double	NA	Yes	Auto-created and reserved field that stores feature lengths (in meters)

10.7 OTHER MANAGEMENT AND MAINTENANCE LAYERS

Although not included in the DRM database template at this point in time with the exception of section 10.7.3, the project team is aware that drainage authorities may create other GIS layers to support their administration efforts. The following section outlines three examples of these layers.

10.7.1 RIPARIAN BUFFERS/BUFFER STRIP INVENTORY

A requirement for grass strips along certain public drainage system open channels is contained in Minnesota Statutes, Section 103E.021 “Ditches Must be planted with Permanent Grass.” Drainage

proceedings that necessitate the appointment of viewers, which triggers the buffer strip requirement, include establishments, improvements, petitioned repairs, and redetermination of benefits. In 2007, the Legislature added Section 103E.067 Ditch Buffer Strip Annual Reporting. In 2015, M.S. 103F.48 added buffer requirements for all public drainage system open channels. The drainage authority may or may not elect to enforce and report on buffer strips under this provision, but is responsible nonetheless for complying with M.S. 103E.021 and 103E.067. Documenting a buffer strip requirement and presence can currently be done under attributes in the "drainage_centerline" feature class.

An alternative to the basic attribute documentation could be to have a separate GIS data layer, similar to the one shown in Figure 13, to define the locations and dimensions of these buffers. Creating buffers as a polygon would take more effort because the information would have to be digitized from aerial photos or GPS in the field.

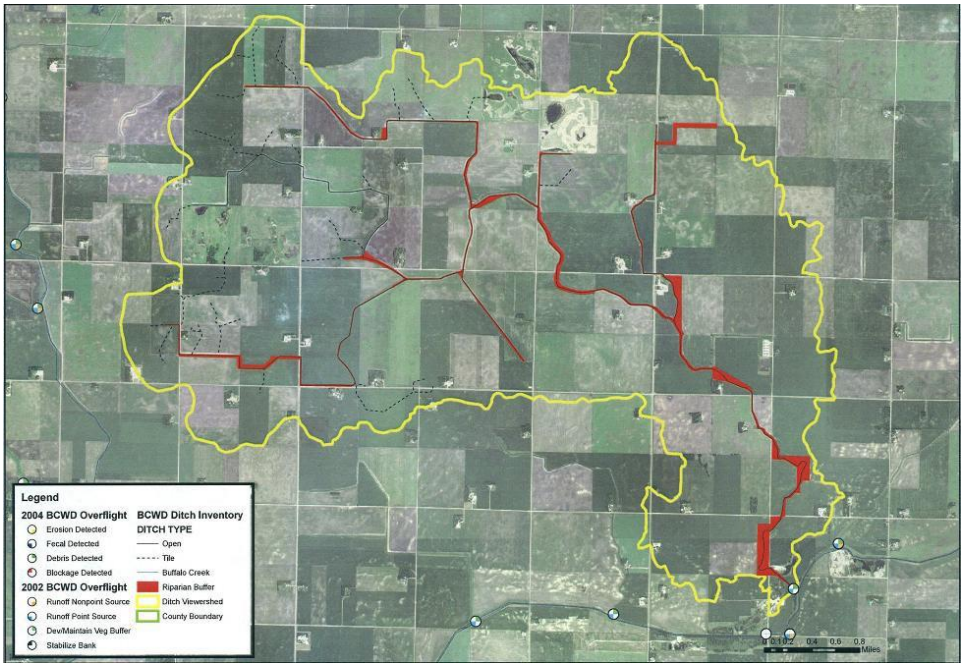

Figure 13: Example Map Showing Ditch Buffer Data

10.7.2 SIDE INLETS/TILE OUTLETS AND FIELD TILE INLETS

Determining the locations of all side inlets on ditches and tile outlets into ditch systems can enable enhanced management of drainage systems. This information can also help determine and track which inlets/outlets are part of the public drainage system and which are private, including tracking any required permits. While a significant amount of work is required, it is recommended that the location, size, and elevation, if possible, of side inlets/tile outlets and field tile inlets be acquired to establish a complete inventory. Examples of side inlets and surface risers are shown in Figure 14.

Figure 14: Tile Outlet into Drainage Ditch (left photo) and Perforated Tile Riser Inlet (right photo)

10.7.3 PRIVATE DITCH AND TILE ALIGNMENTS

Some drainage authorities interviewed have pursued mapping of private drainage systems (ditch and/or tile) that drain into to public Chapter 103E systems they administrate as it becomes available. The purpose of a new private ditch and tile alignments GIS layer is to distinguish the private drainage system from the public and to manage the public systems, including approval for outlets into public drainage systems. Collecting information on the private systems allows the drainage authority to incorporate this information into the GIS database and to communicate more effectively with landowners about drainage system administration. This information can be challenging to map because a majority of private systems are subsurface tile. Occasionally, private tiles are identified on historic plan or plan maps. Caution has to be taken when assuming these private tiles still exist since historical documents can be more than 75 years old. Under certain conditions subsurface tile can also be seen on aerial photography. The challenge with this type of data collection is that it can be very time consuming and difficult to verify exact location and tile size. Figure 15 below is a historical plat map, where it shows Lateral HH is part of the public drainage system, while the dashed lines connected to it are private tile.

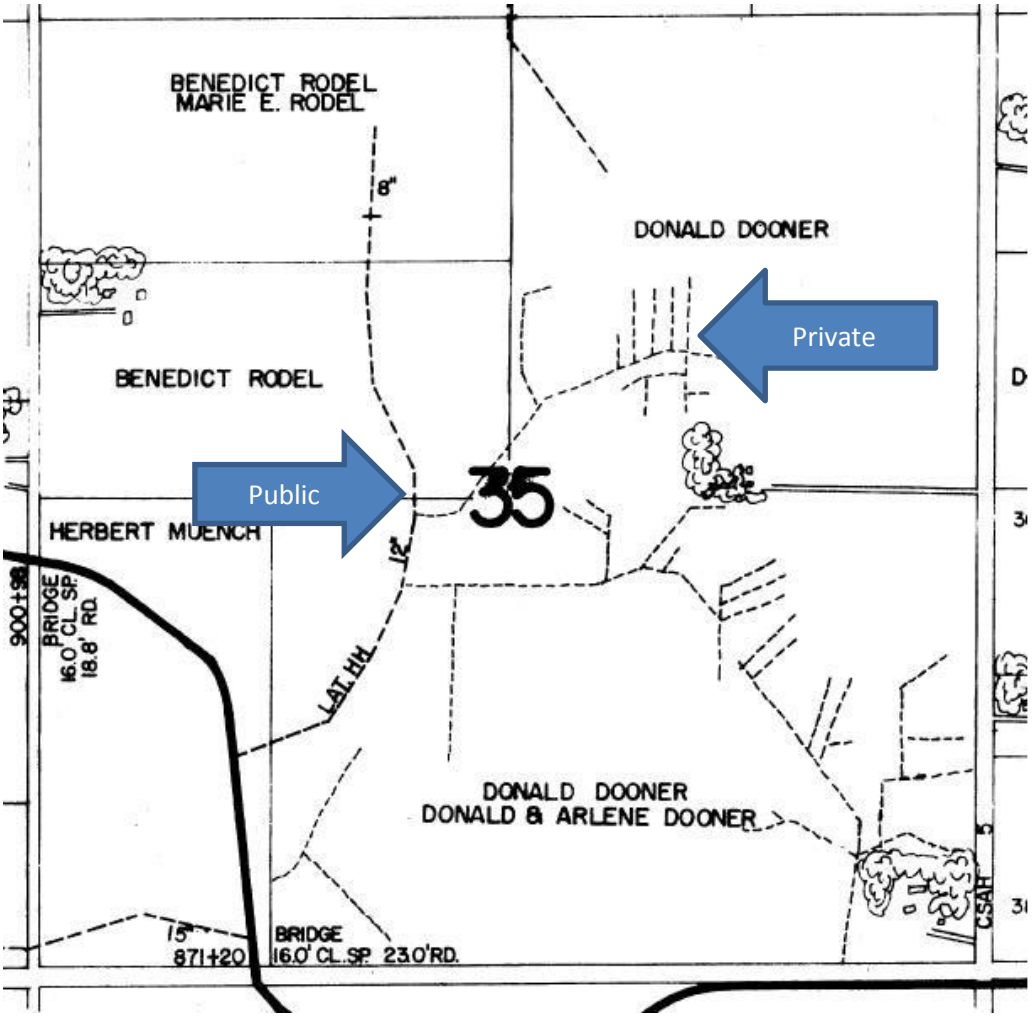

Figure 15: Public and Private Drainage System Components

This line feature class is a spatial representation of other drainage lines that drainage authorities may want to store for management purpose. Most commonly this will be used to store segments of drainage systems that have been abandoned or transferred.

other_drainage_centerlines Feature Classes (Alias: Other Drainage Centerlines)					
Field Name	**Alias**	**Type**	**Domain**	**Required**	**Description**
OBJECTID	OBJECTID	Object ID	NA	Yes	Internal ID generated and used by ArcGIS software
SHAPE	SHAPE	Geometry	NA	Yes	Auto-created and Reserved field to store feature geometries by the software
type	Drainage Line Type	Text (25)	centerline_type (Open, Tile, Storm Sewer, Other)	Yes	Describes the type of drainage line the segment represents.

other_drainage_centerlines Feature Classes (Alias: Other Drainage Centerlines)					
Field Name	**Alias**	**Type**	**Domain**	**Required**	**Description**
system_name	System Name	Text (50)	NA	Yes	Name of the drainage system the segment use to be part of or drains to.
map_label	Map Label	Text (50)	NA	No	Desired label used on the map. Useful for abbreviating labels. Ex: CD24 Br. 2 or just Br. 2)
status	Status	Text (100)	NA	Yes	Describe the status of the segment. Ex: Abandoned, Transferred, Public Water, Private
tile_dim	Tile Dimension (in)	Short Integer	NA	No	Tile dimension of subsurface tile in inches. Enter -9999 if unknown and -9998 if not applicable.
notes	Notes	Text (255)	NA	No	General notes about the line segment. Useful for noting anything significant about the segment.

11. ACCESSIBILITY TO MODERNIZED DRAINAGE RECORDS

Some drainage authorities have chosen to make their drainage records available to other departments within their county, as well as to the public. Based on interviews and past work, there have been numerous examples of sharing data both internally and externally. Below are a few examples ranging from basic to more advance.

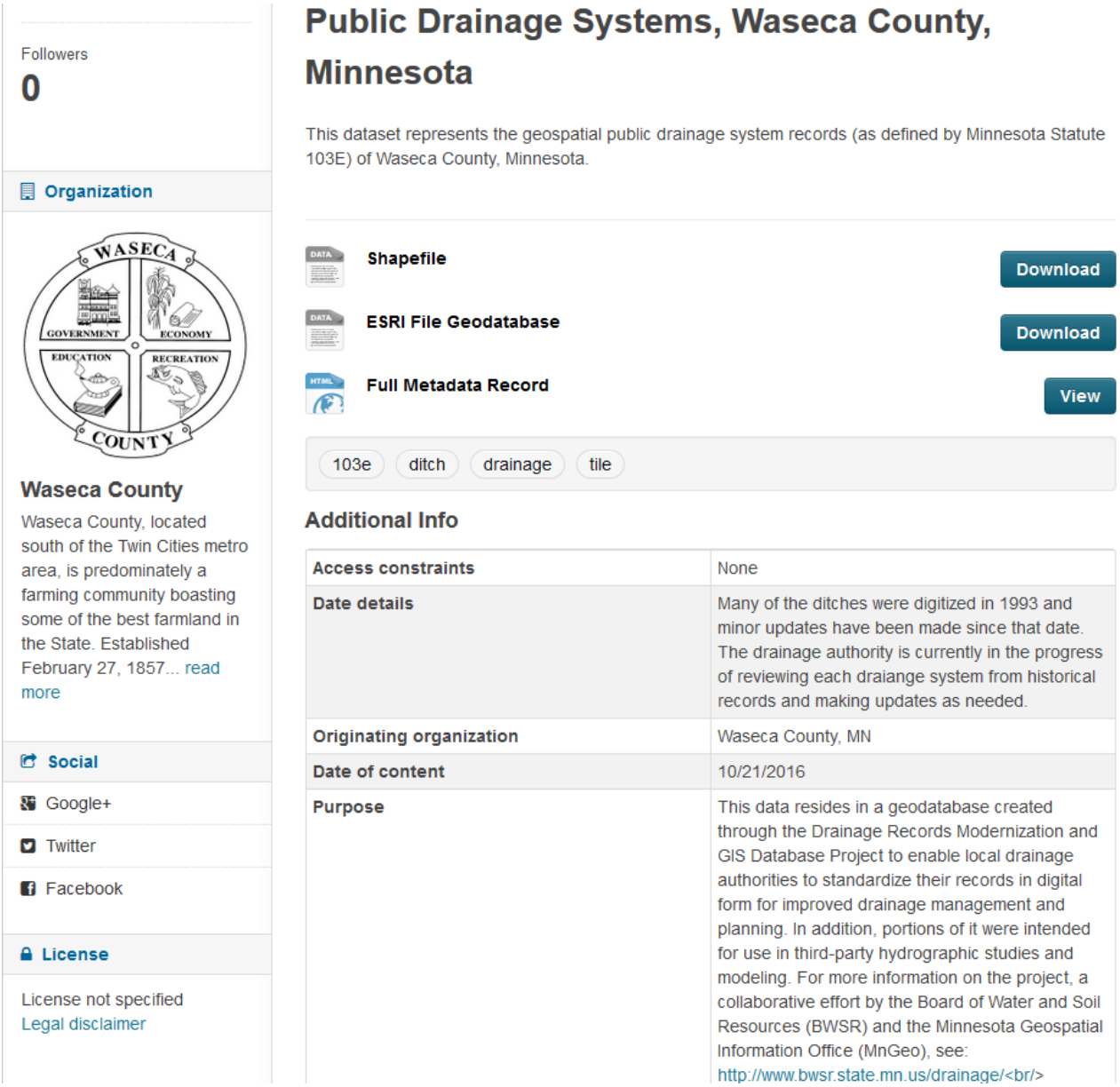

Figure 16: Example County Public Drainage System Resource Page on Geospatial Commons
(https://gisdata.mn.gov/dataset/us-mn-co-waseca-water-public-drainage-systems)

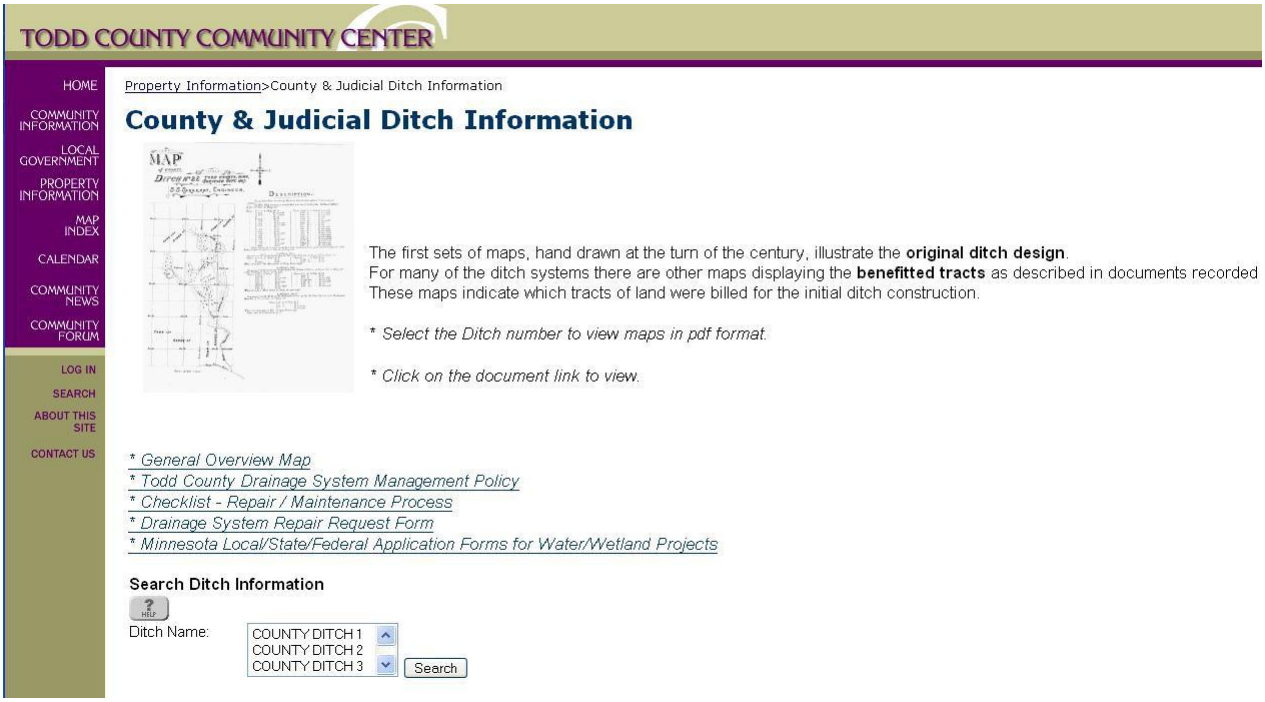

Figure 17: Example County Web Page for Drainage System Information
(http://interactive.mytoddcounty.com/propertyinfo2941.asp)

RCWD Drainage System Information Portal

Background
In 2009 the Rice Creek Watershed District received a grant from the Board of Soil and Water Resource to aid in the completion of a drainage records modernization project. The project involved three primary components. 1) To scan and inventory the available historic records for each drainage system 2) To create GIS layers from the information 3) To make the information accessible through a website. The RCWD has completed 27 drainage systems and the results are accessible through this portal.

GIS Data Viewing and Access
Part of this project consisted of developing an interactive mapping application to view the GIS data related to the drainage systems. Click on the link to open the interactive map in a new window. Start DitchViewer

To download the GIS data for use in ArcGIS software, click here.

Document Summary Listing and Access
NOTE: The document summary listings are best viewed with Internet Explorer 9+. If you are using Google Chrome or Firefox, please be aware these browsers have changed the way they view PDF files by default. The default viewers in those browsers to do not display hyperlink paths correctly in the PDF files. If you need to use Chrome or Firefox please disable the default PDF viewers. Instructions for Google Chrome are here. Instructions for Firefox is here.

- Anoka County Ditch 10-22-32
- Anoka County Ditch 15
- Anoka County Ditch 25
- Anoka County Ditch 31
- Anoka County Ditch 33 (Abandoned)
- Anoka County Ditch 46
- Anoka County Ditch 47 (Abandoned)
- Anoka County Ditch 55
- Anoka County Ditch 53-62
- Anoka County Ditch 72
- Anoka-Washington Judicial Ditch 2
- Anoka-Washington Judicial Ditch 3
- Anoka-Ramsey Judicial Ditch 1
- Judicial Ditch 4
- Ramsey-Washington Judicial Ditch 1
- Washington Judicial Ditch 5
- Washington Judicial Ditch 6
- Washington Judicial Ditch 7
- Ramsey County Ditch 1
- Ramsey County Ditch 2
- Ramsey County Ditch 3
- Ramsey County Ditch 4
- Ramsey County Ditch 5
- Ramsey County Ditch 8
- Ramsey County Ditch 11
- Ramsey County Ditch 12 (Abandoned)

Click on a drainage system on the map to open the document summary listing.

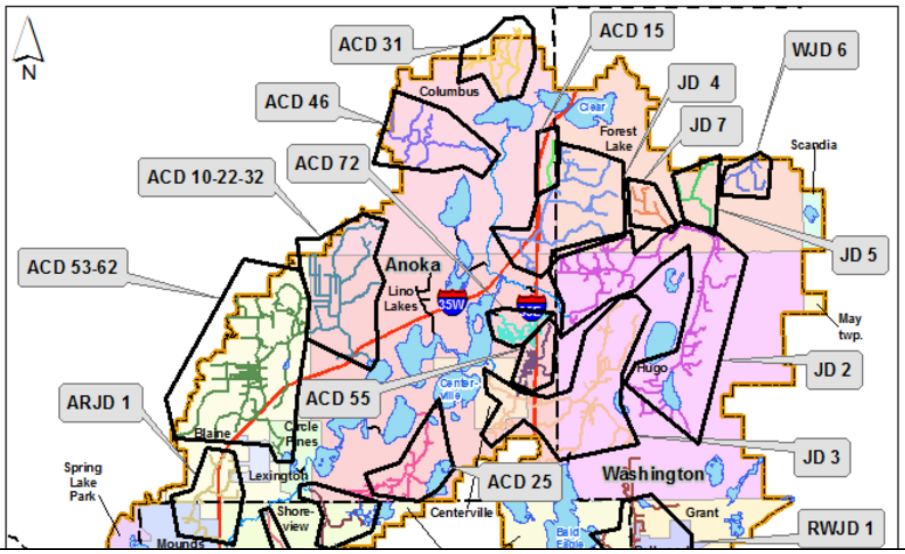

Figure 18: Example Watershed District Web Page for Drainage System Information
(http://rcwd.houstoneng.net/ditchportal/drainagesystemportal.html)

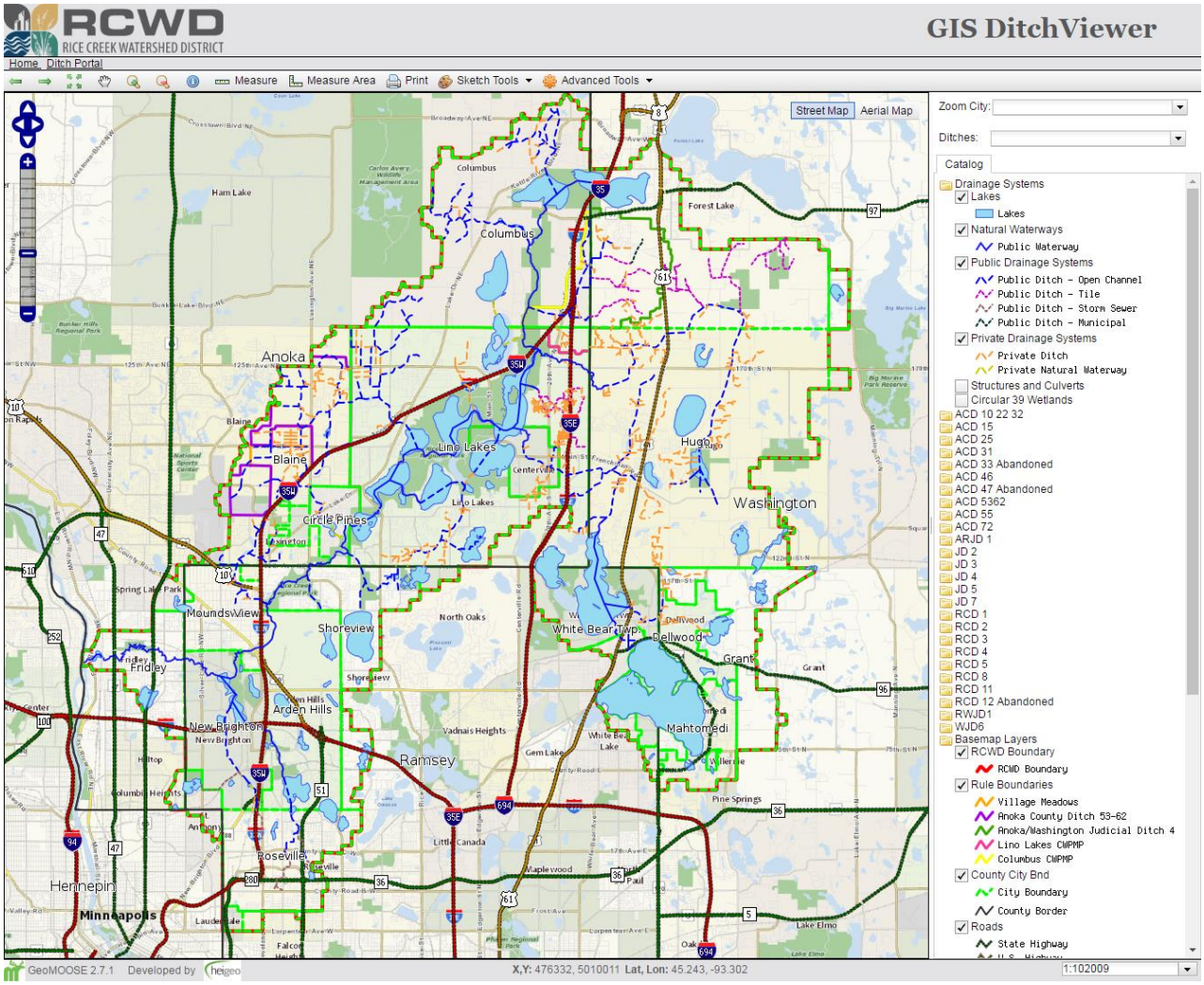

Figure 19: Example Watershed District Interactive GIS Viewer
(http://rcwd.houstoneng.net/ditchviewer_public.php)

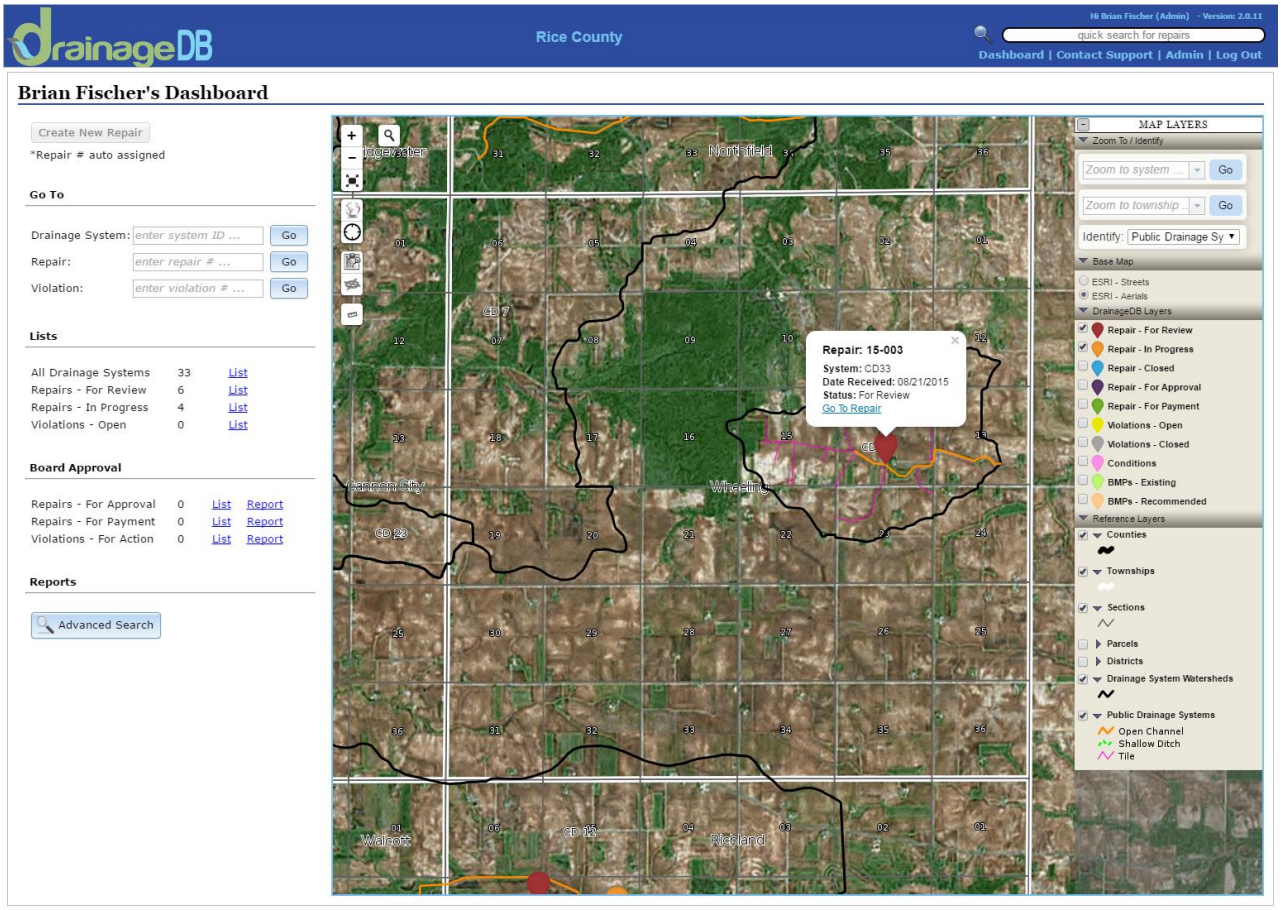

Figure 20: Example DrainageDB Software Used at Rice County for Internal Data Sharing

APPENDIX A. DOMAIN DESCRIPTIONS AND VALUES FOR DRAINAGE AUTHORITY IDS

Aitkin	27001
Anoka	27003
Becker	27005
Beltrami	27007
Benton	27009
Big Stone	27011
Blue Earth	27013
Brown	27015
Carlton	27017
Carver	27019
Cass	27021
Chippewa	27023
Chisago	27025
Clay	27027
Clearwater	27029
Cook	27031
Cottonwood	27033
Crow Wing	27035
Dakota	27037
Dodge	27039
Douglas	27041
Faribault	27043
Fillmore	27045
Freeborn	27047
Goodhue	27049
Grant	27051
Hennepin	27053
Houston	27055
Hubbard	27057
Isanti	27059
Itasca	27061
Jackson	27063
Kanabec	27065
Kandiyohi	27067
Kittson	27069
Koochiching	27071
Lac qui Parle	27073
Lake	27075
Lake of the Woods	27077

Le Sueur	27079
Lincoln	27081
Lyon	27083
McLeod	27085
Mahnomen	27087
Marshall	27089
Meeker	27093
Mille Lacs	27095
Morrison	27097
Mower	27099
Murray	27101
Nicollet	27103
Martin	27091
Nobles	27105
Norman	27107
Olmsted	27109
Otter Tail	27111
Pennington	27113
Pine	27115
Pipestone	27117
Polk	27119
Pope	27121
Ramsey	27123
Red Lake	27125
Redwood	27127
Renville	27129
Rice	27131
Rock	27133
Roseau	27135
Saint Louis	27137
Scott	27139
Sherburne	27141
Sibley	27143
Stearns	27145
Steele	27147
Stevens	27149
Swift	27151
Todd	27153
Traverse	27155
Wabasha	27157
Wadena	27159
Waseca	27161

Washington	27163
Watonwan	27165
Wilkin	27167
Winona	27169
Wright	27171
Yellow Medicine	27173
Bois de Sioux WD	27201
Buffalo Creek WD	27211
Buffalo Red River WD	27221
Clearwater River WD	27231
Coon Creek WD	27241
High Island WD	27251
Lac qui Parle Yellow Bank WD	27261
Middle Snake Tamarac River WD	27271
Minnehaha Creek WD	27281
Nine Mile Creek WD	27291
North Fork Crow River WD	27301
Pelican River WD	27311
Red Lake WD	27321
Rice Creek WD	27331
Roseau River WD	27341
Sand Hill River WD	27351
Sauk River WD	27361
Turtle Creek WD	27371
Two Rivers WD	27381
Wild Rice WD	27391
Yellow Medicine River WD	27401

APPENDIX B. ACKNOWLEDGEMENTS

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