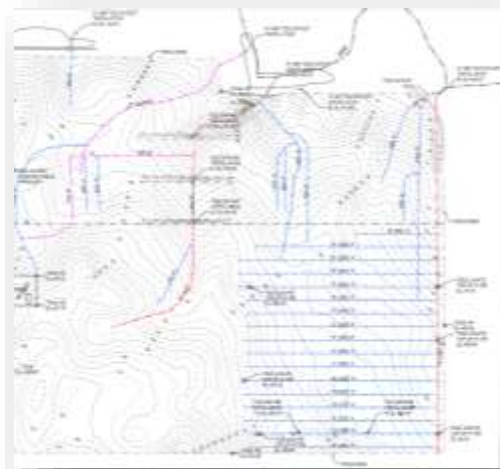




Understanding Agricultural Drainage



Gary R. Sands
Professor & Extension Engineer
grsands@umn.edu
[@UoMExtWater](https://twitter.com/UoMExtWater)

U of M Extension Drainage Design Workshop



2011 – 2014 Participants



UNIVERSITY OF MINNESOTA | EXTENSION



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NDSU EXTENSION SERVICE

WORKSHOP GOALS

- Expand knowledge
- Nail the concepts
- Build on fundamentals
- Learn new tools
- Learn new practices
- Learn from others



Learning Units for Workshop

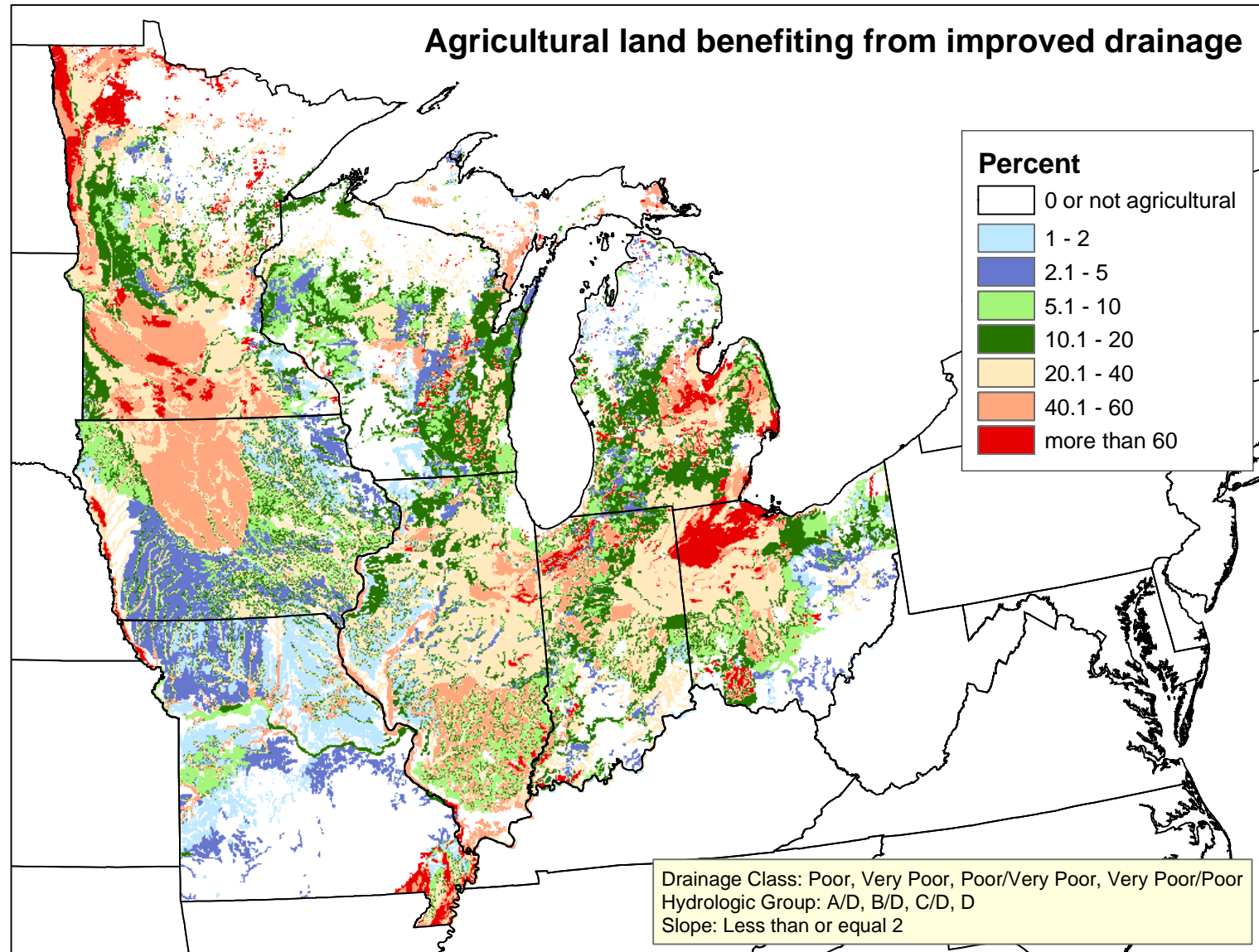
- Safety
- Design 1: Soils & principles and tools
- Design 2: Intro to drainage design
- Design 3: Whole-class design project
- Design 4: Managed drainage design
- Design 6: Team design project
- Design 7: Lift station design
- Design 8: Subirrigation design
- Conservation drainage practices
- Legal updates and perspectives
- Drainage Software



Take Home Points

- Be safe in the field (esp. trench safety)!
- Be kind to your neighbors
- Generally, state laws support drainage, but there are limits
- Drainage spacing may be the hardest and the most important decision; layout comes next
- Make your drainage systems function as uniformly as possible
- Design with conservation drainage in mind
- Drainage isn't rocket science, but there is plenty of room for excellence!
- If going to self-install, walk before you run!

Poorly Drained Soils in the Upper Midwest



Courtesy of Dan Jaynes, ARS – Ames, IA

U.S. Water Management

Arable Land
450 mil ac

World (30% land)

- 11% arable
- 18% irrigated
- ~25% drained

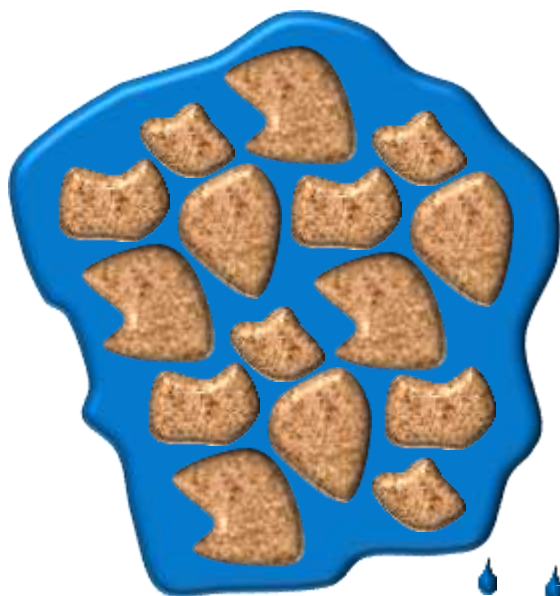
Irrigation
(13%)

Drainage
(25%)

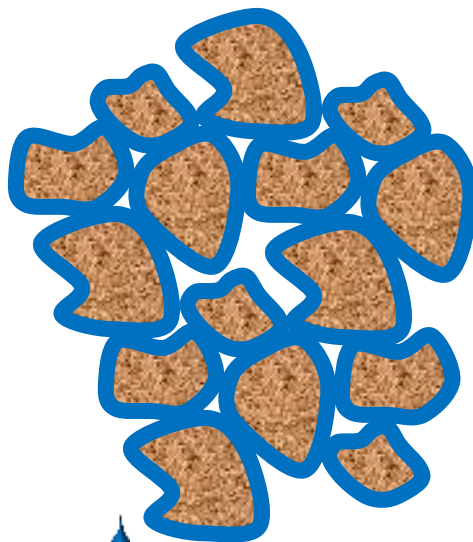
Subsurface
Drainage
(9%)

Soil Water and Drainage

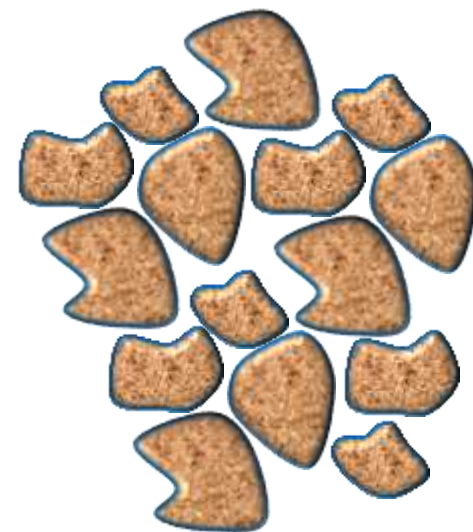
Saturation



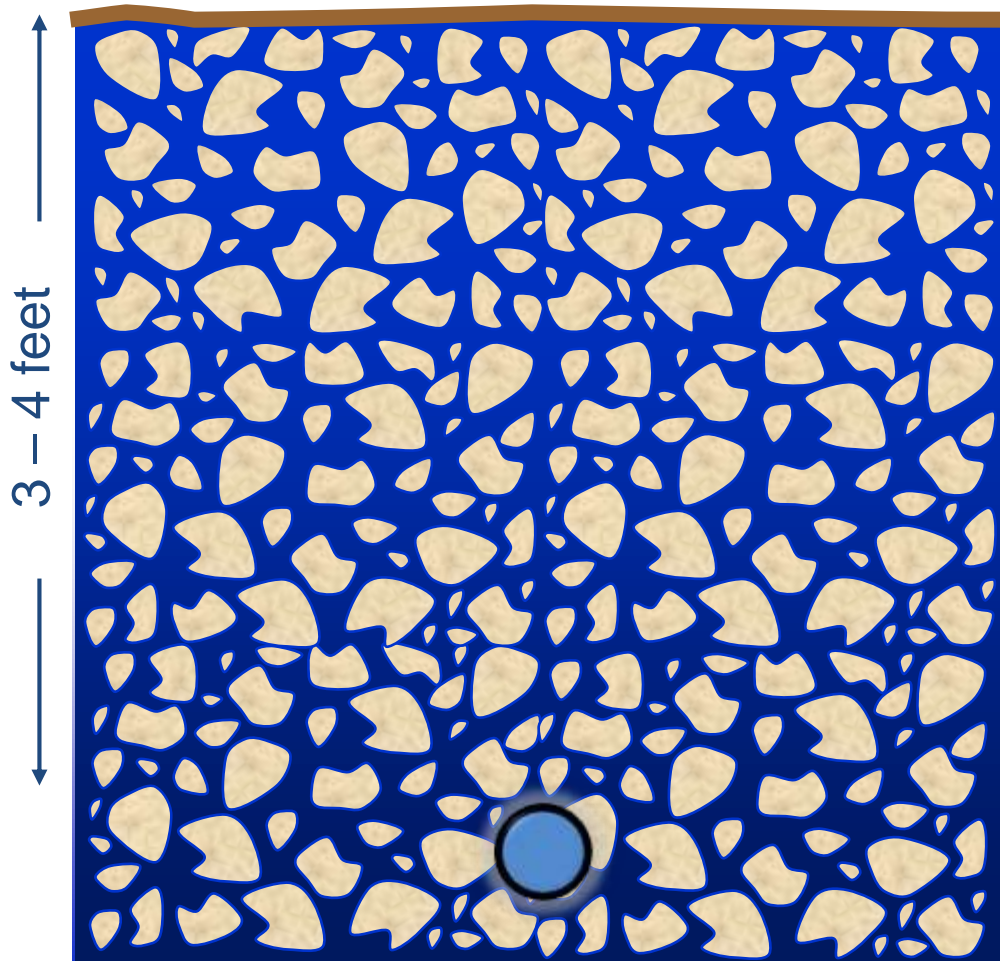
Field Capacity



Wilting Point

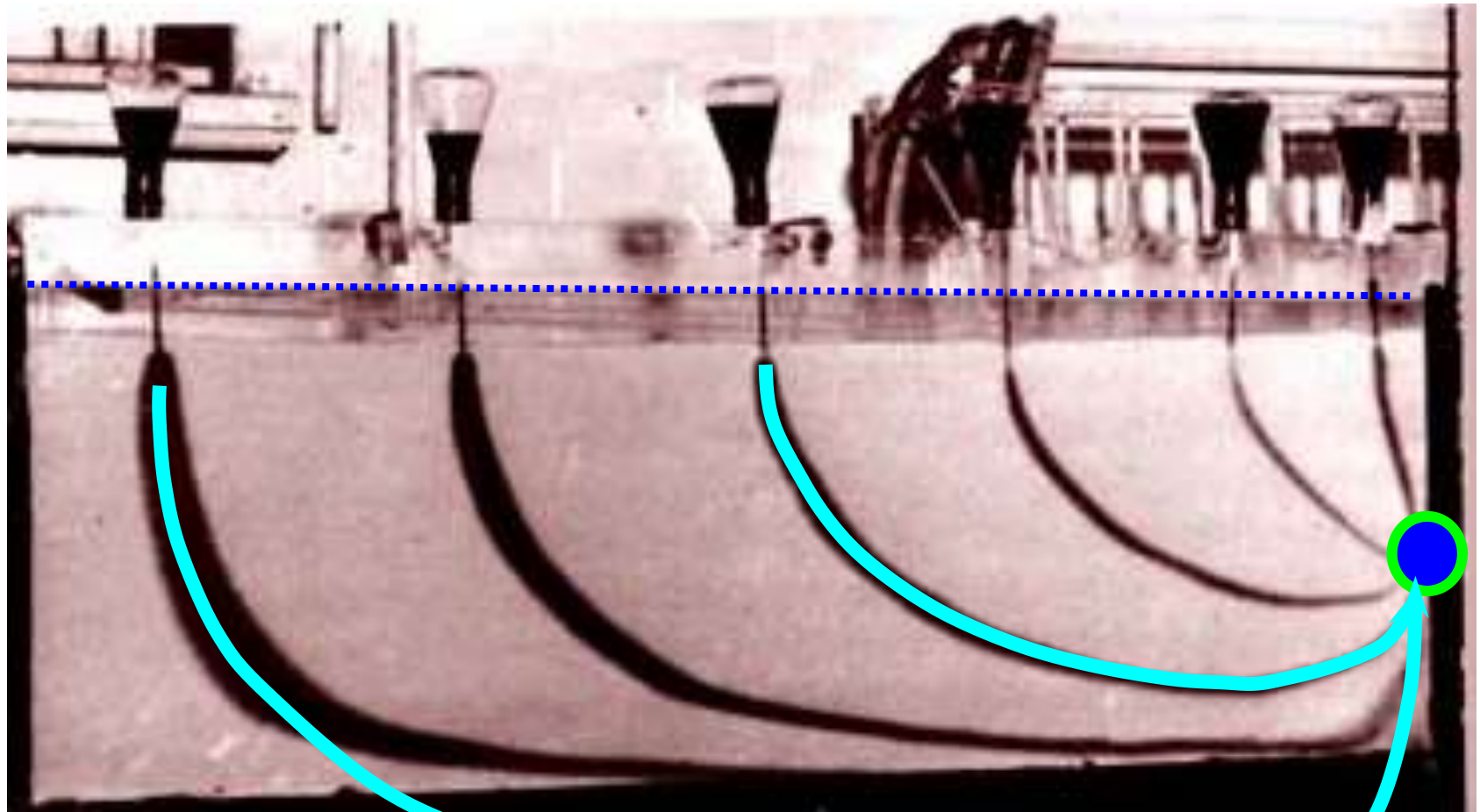


What is a Water Table?



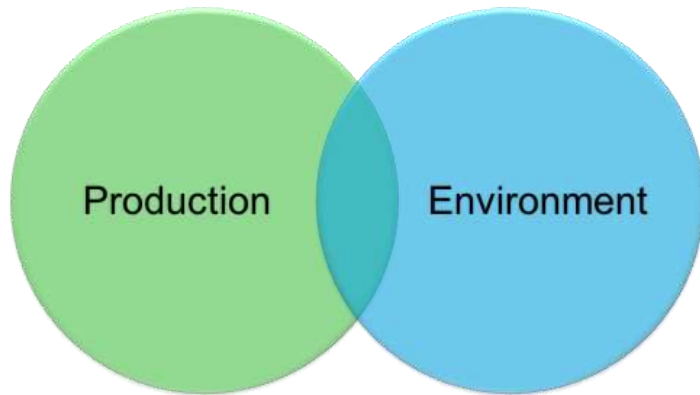
- “Gravitational” water drains from larger pores
- Water remains in smaller pores
- Water table drops over hours to days
 - *Faster at first, then more slowly*

Drainage Flow: Water Flows “Up”



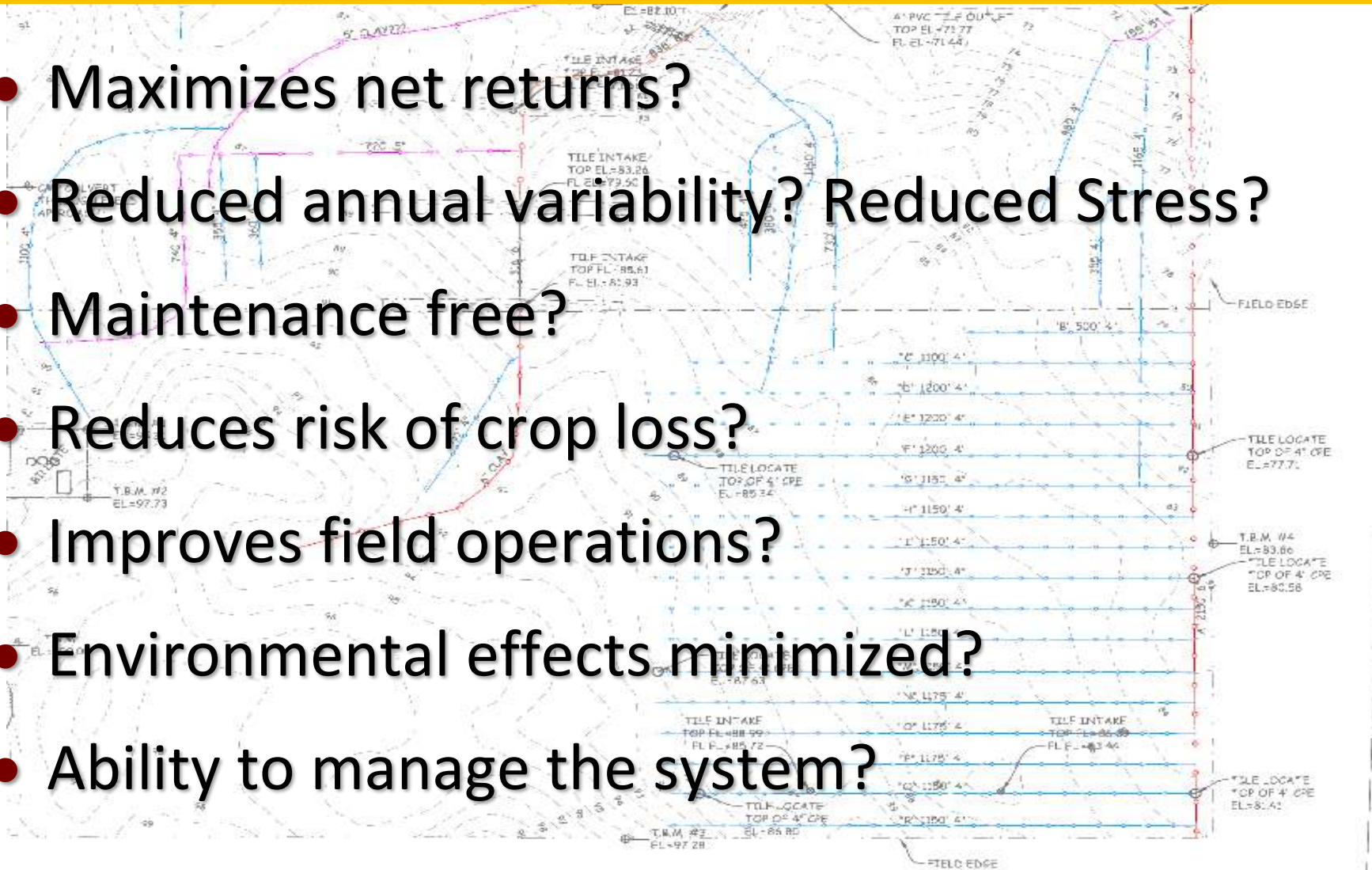
A New Age of Drainage

- Water still flows downhill, but
- Today's issues call for new approach
- **Golden Rule of Drainage**



How do you know when you've done a good job with drainage design?

- Maximizes net returns?
- Reduced annual variability? Reduced Stress?
- Maintenance free?
- Reduces risk of crop loss?
- Improves field operations?
- Environmental effects minimized?
- Ability to manage the system?



Drainage Design Choices

Design Choices

(controllable factors):

- ◆ Areas to be drained
- ◆ Drainage rates (coefficients)
 - ◆ *Drain depth*
 - ◆ *Drain spacing*
- ◆ Drain size
- ◆ ***Which choices are most important?***

Design Choices (cont.)

- ◆ Drain grades
- ◆ Drain materials
- ◆ Drainage system layout
- ◆ Outlet configuration
 - ◆ *(elev, pumped, natural)*

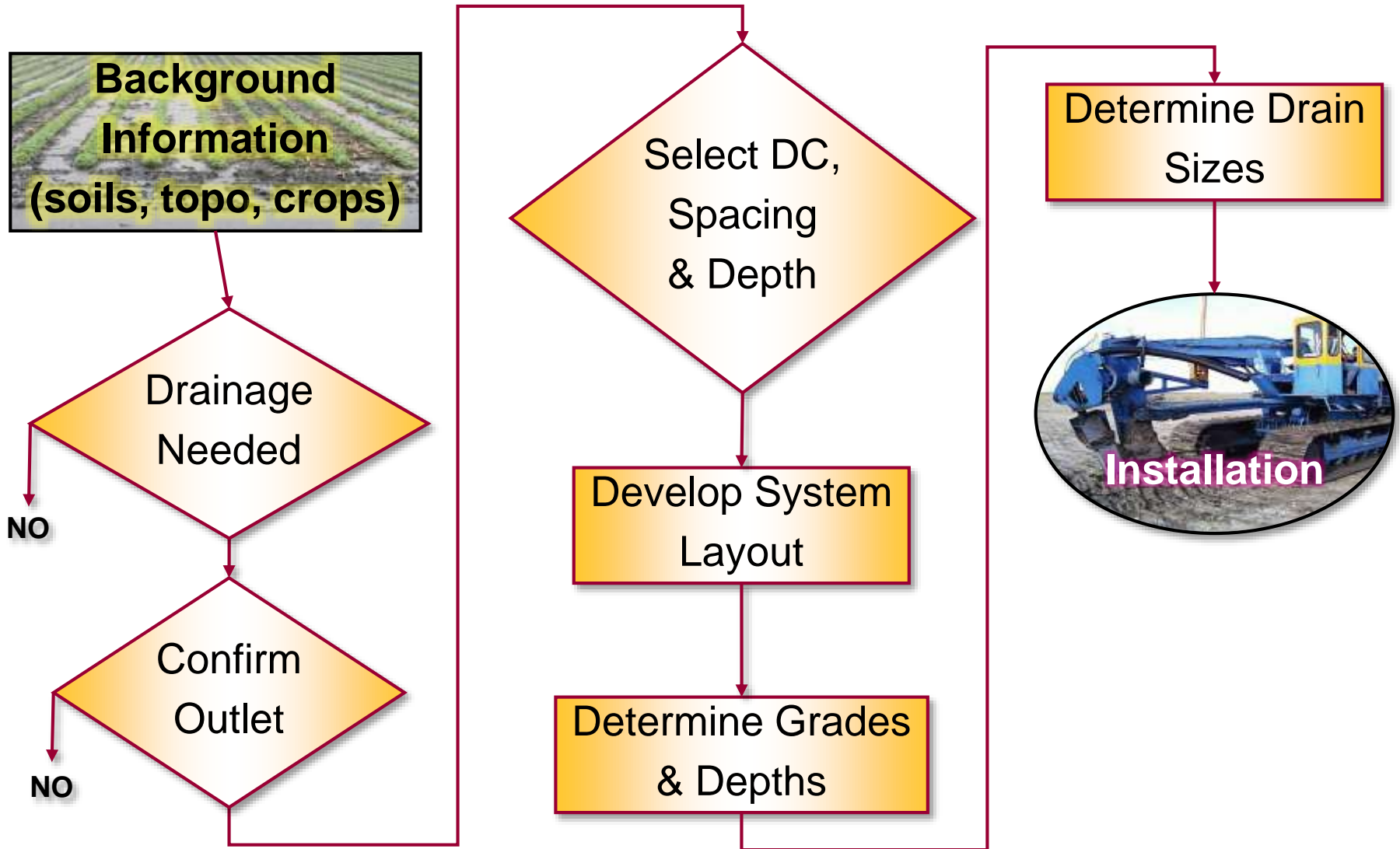


Drainage Design Conditions

- ◆ Rainfall/climate factors
- ◆ Soils
- ◆ Topography
- ◆ Outlet condition
- ◆ Legal & regulatory framework
- ◆ Client's risk aversion?
- ◆ Landowner's priorities?

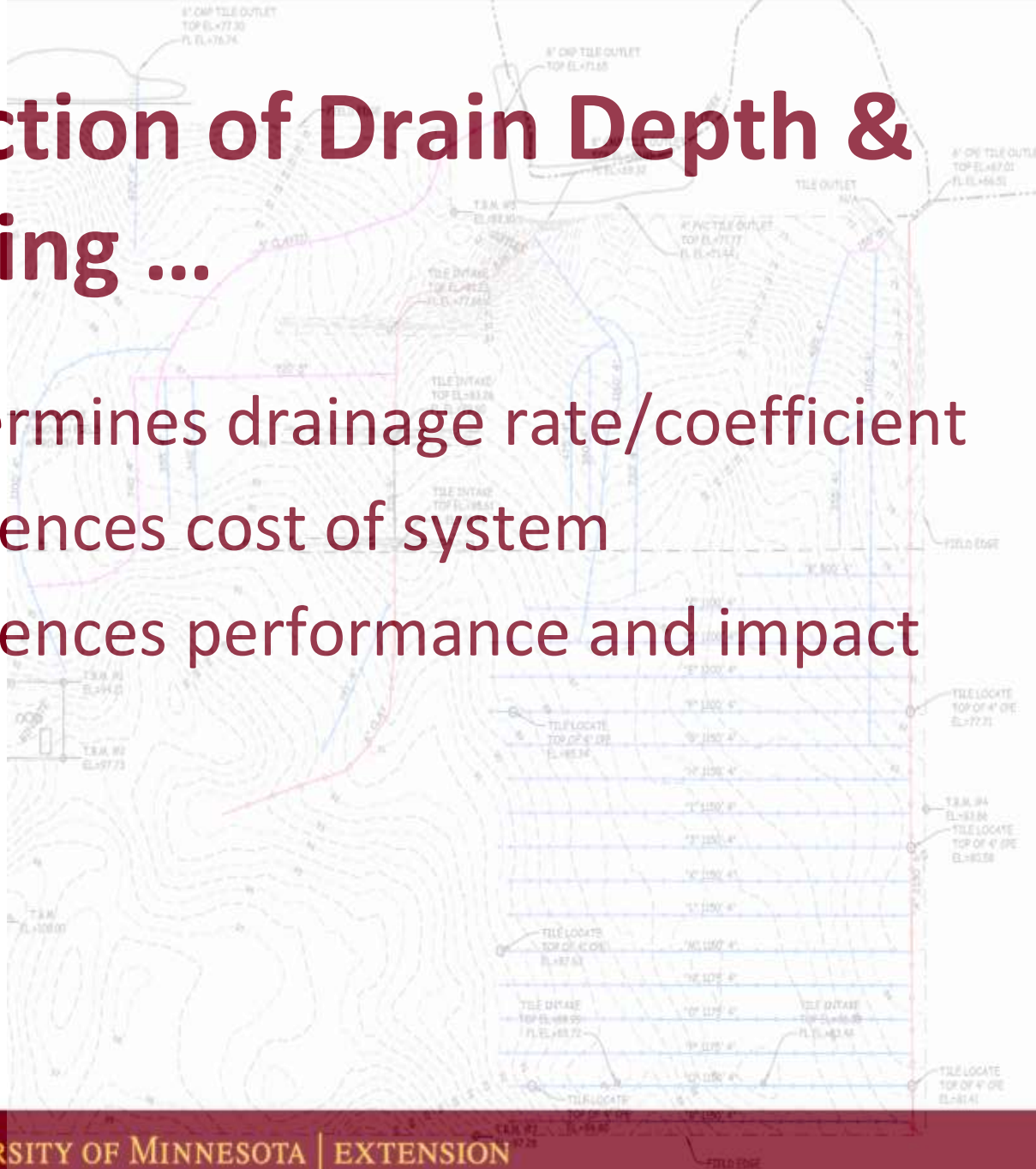


Design Process Flowchart

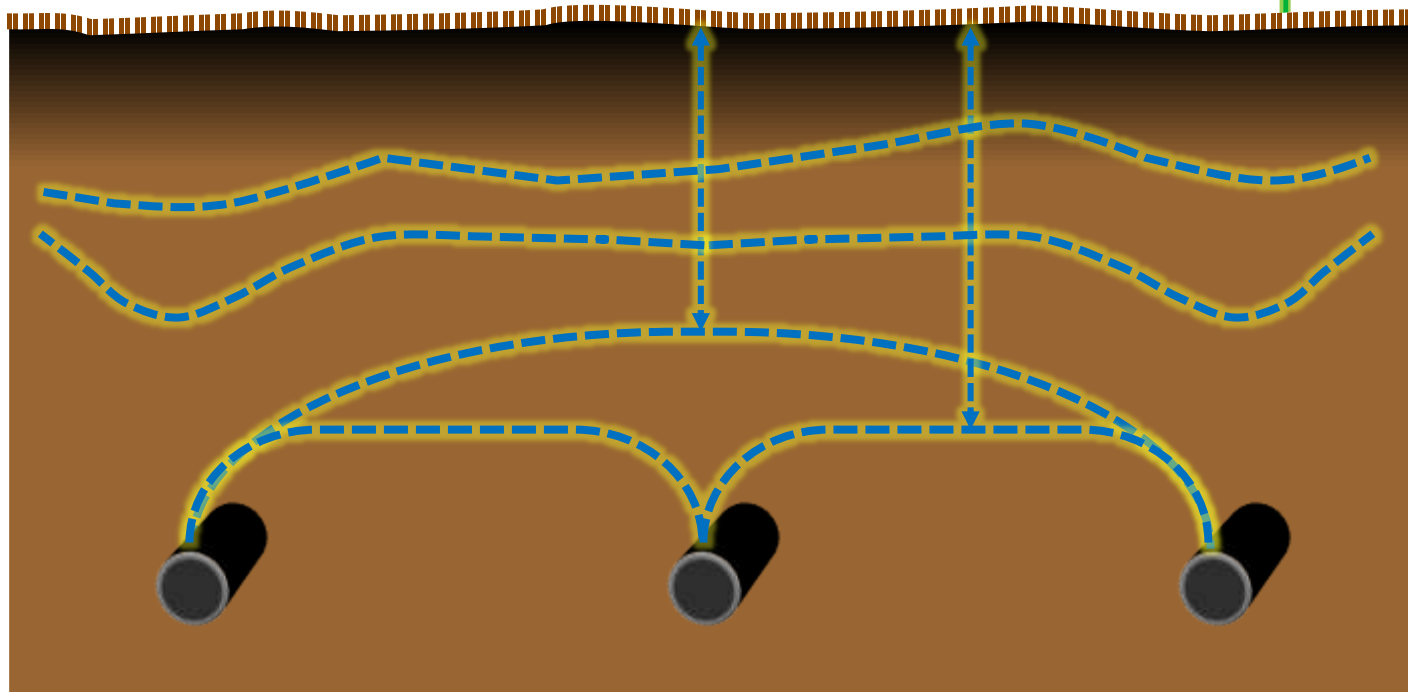


Selection of Drain Depth & Spacing ...

- Determines drainage rate/coefficient
- Influences cost of system
- Influences performance and impact

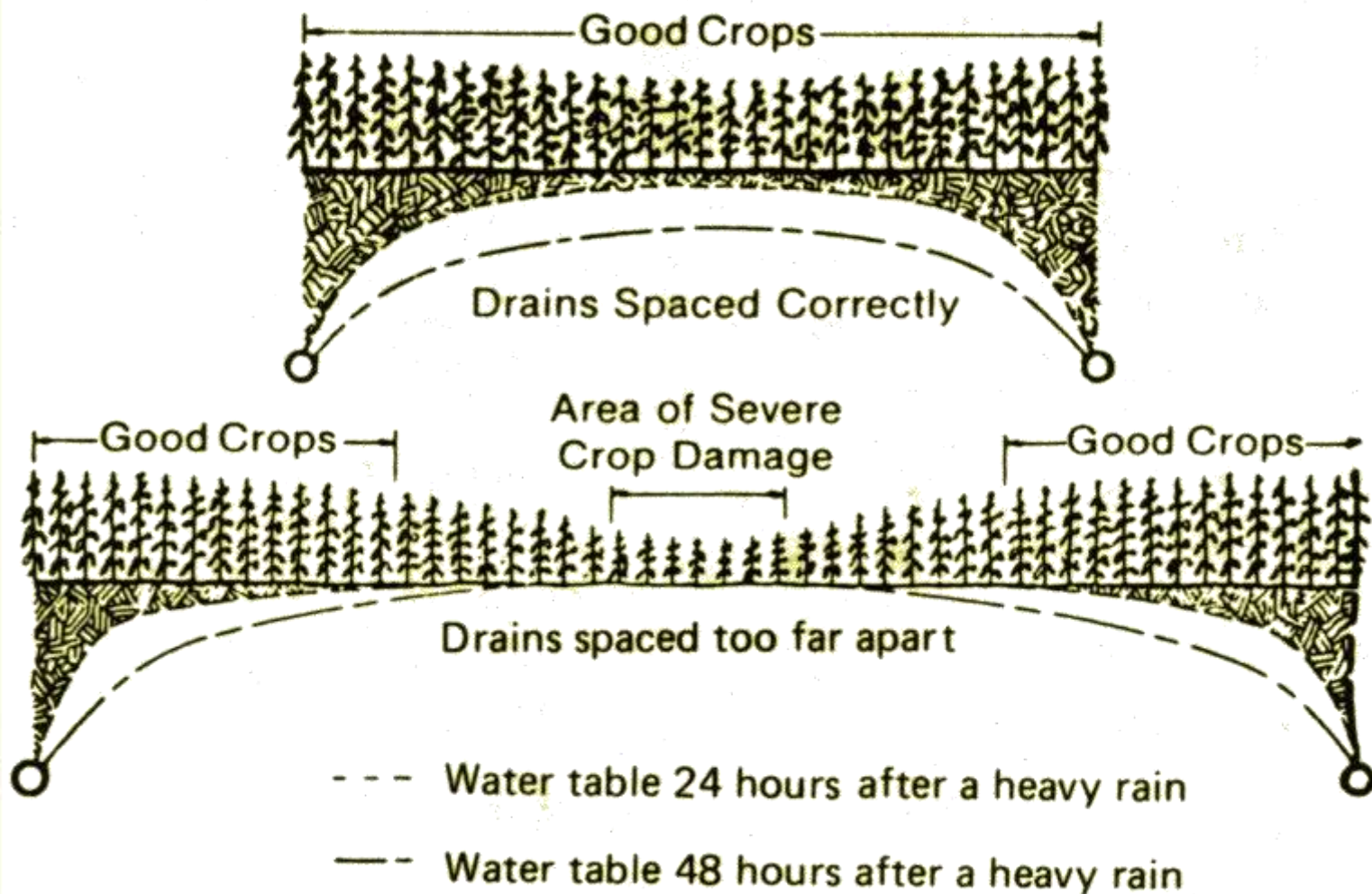


Effect of Drain Spacing

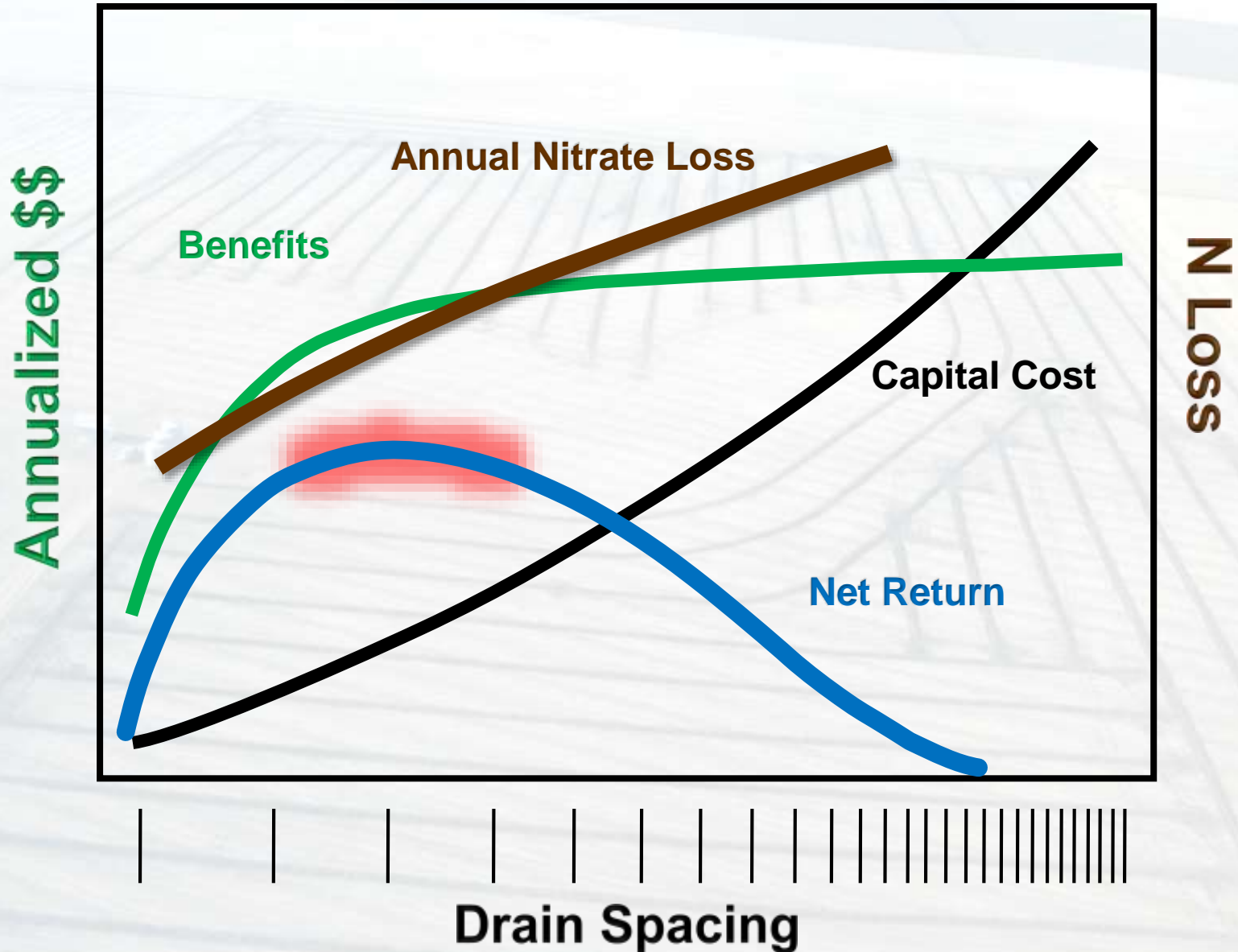


- ◆ Profitability
- ◆ Downstream or unwanted effects?

Drain Spacing: *How close is close enough?* *How close is too close?*



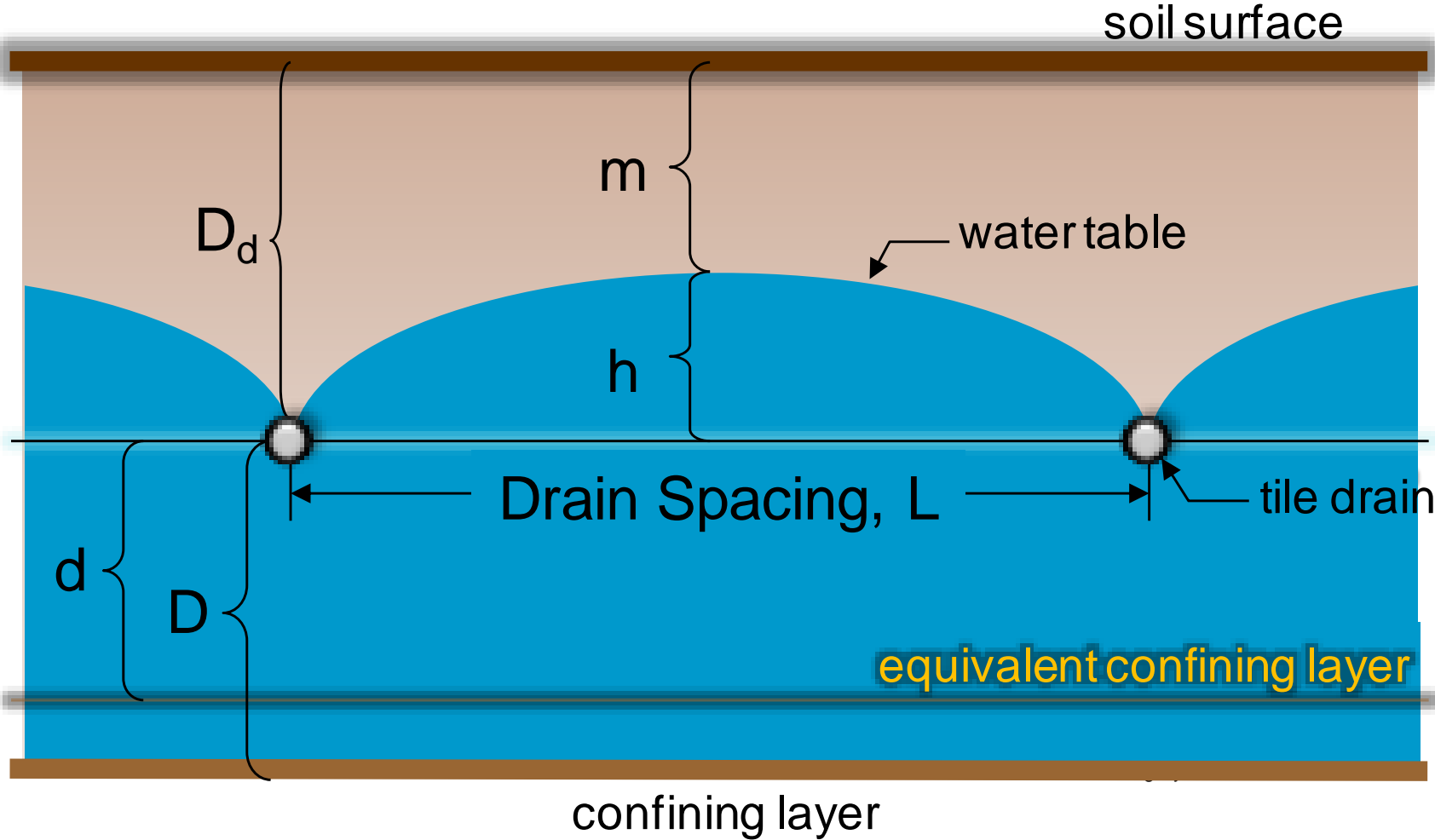
“Optimized” Drainage Design





How do you come up with drain spacing?

Drain Spacing Equation



Estimating Drain Spacing: SDSU/U of M

Drainage Calculators

igrowdrainage.org

The screenshot shows a web browser window displaying the 'iGrow Drainage Calculators' page. The page features a green header with the iGrow logo and the title 'Drainage Calculators'. Below the header, a navigation bar contains various menu items. The main content area is a grid of 18 calculator buttons. The 'Avg. Hydraulic Conductivity' button is highlighted with a blue border, the 'Drain Spacing' button is highlighted with a red border, and the 'Drainage Coefficient' button is highlighted with a green border. The footer contains a copyright notice for 2014 South Dakota Board of Regents and a link to iGrow.org.

igrowdrainage.org

18 Washoe Report 18 Vendor Report MPR Props MinRESA BiggiePacket... Dashboard Google Voice Google Scholar Google Maps Google WU

Academic Year... Courses: SSM 3... D. Karwan Hyd... Lectures - Gro... BSSEM Gridus... www.igrowdrain... 2016 Drainage...

iGrow
A Service of SDSU Extension

Drainage Calculators

Utilize these calculators to address common drainage questions. Additional information is available on iGrow

- Pipe Size -> Area Drained
- Area Drained by Pipe Sizes
- Avg. Hydraulic Conductivity**
- Drain Spacing**
- Drainage Coefficient**
- Grade -> Fall
- Fall -> Grade
- Min. Grade Needed
- Hydraulic Conductivity Converter
- Max. Lateral Length
- Length -> Lateral Sizing
- Max. Laterals on Main
- Area Drained -> Pipe Size
- Pump Size
- Subirrigation Spacing
- Sump Storage

Visit iGrow.org for the latest information from SDSU Extension. This tool was developed in collaboration with University of Minnesota Extension

© 2014 South Dakota Board of Regents

igrowdrainage.org

Saint Paul, MN (55101) Forecast | We... California Soil Resource Lab :: SoilW... SoilWeb: An Online Soil Survey Bro... www.igrowdrainage.org/#/

Pipe Size -> Area Drained

Area Drained by Pipe Sizes

Avg. Hydraulic Conductivity

Drain Spacing

Drainage Coefficient

Grade -> Fall

Fall -> Grade

Min. Grade Needed

Hydraulic Conductivity Converter

Max. Lateral Length

Length -> Lateral Sizing

Max. Laterals on Main

Area Drained -> Pipe Size

Pump Size

Subirrigation Spacing

Display a menu

DRAIN SPACING

Drainage Coefficient in./day [Calculate](#) →

Tile Diameter in

Tile Depth ft

Depth to Restrictive Layer ft

Minimum Water Table Depth ft

Hydraulic Conductivity Units

Hydraulic Conductivity Value

CALCULATE

RESULTS

Drain Spacing **63** ft

CLEAR ALL FIELDS

Resources for Soils Data

- NRCS Web Soil Survey
- Soilweb (ARS) (www, Google Earth, smartphone)
- Illinois Online Drainage Guide (U of IL)

Web Soil Survey

Home Page



The screenshot shows the Web Soil Survey Home Page in a browser window. The browser address bar shows the URL: websoilsurvey.nrcs.usda.gov/app/HomePage.htm. The page features a header with the USDA logo and the text "United States Department of Agriculture Natural Resources Conservation Service". Below the header is a navigation bar with links for "Home", "About Soils", "Help", and "Contact Us". The main content area includes a search box, a "START WSS" button, and a "Welcome to Web Soil Survey (WSS)" section. The "Welcome" section contains an image of people in a field and text describing the service. Below this is a "Three Basic Steps" section with numbered steps: "1 Define." and "2 View/Explore.". The "1 Define." step includes an "Area of Interest (AOI)" button and a screenshot of the AOI selection interface. The "2 View/Explore." step includes a "Soil Map" button and text about viewing or printing a soil map. On the right side, there are two "I Want To..." sections with lists of links, and an "Announcements/Events" section with a link to "Web Soil Survey Release History". At the bottom right, there is a "Tips & Shortcuts WSS" section with an image of hands using a soil sampling tool.

Web Soil Survey - Home

websoilsurvey.nrcs.usda.gov/app/HomePage.htm

USDA United States Department of Agriculture Natural Resources Conservation Service

Web Soil Survey

Home About Soils Help Contact Us

You are here: Web Soil Survey Home

Search

Enter Keywords

All NRCS Sites

Browse by Subject

- Soils Home
- National Cooperative Soil Survey (NCSS)
- Archived Soil Surveys
- Status Maps
- Official Soil Series Descriptions (OSD)
- Soil Series Extent Mapping Tool
- Soil Data Mart
- Geospatial Data Gateway
- eFOTG
- National Soil Characterization Data
- Soil Geochemistry Spatial Database
- Soil Quality
- Soil Geography
- Geospatial One Stop

START WSS

The simple yet powerful way to access and use soil data.

Welcome to Web Soil Survey (WSS)

Web Soil Survey (WSS) provides soil data and information produced by the National Cooperative Soil Survey. It is operated by the USDA Natural Resources Conservation Service (NRCS) and provides access to the largest natural resource information system in the world. NRCS has soil maps and data available online for more than 95 percent of the nation's counties and anticipates having 100 percent in the near future. The site is updated and maintained online as the single authoritative source of soil survey information.

Three Basic Steps

1 Define.

Area of Interest (AOI) Use the Area of Interest tab to define your area of interest.

Click to view larger image.

2 View/Explore.

Soil Map Click the Soil Map tab to view or print a soil map, or click the Soil Data Explorer tab

I Want To...

- Start Web Soil Survey (WSS)
- Know the requirements for running Web Soil Survey
- Know whether Web Soil Survey works in my web browser
- Know the Web Soil Survey hours of operation
- Find what areas of the U.S. have soil data

Announcements/Events

- Web Soil Survey Release History

I Want Help With...

- How to use Web Soil Survey
- How to use Web Soil Survey Online Help
- Known Problems and Workarounds
- Frequently Asked Questions
- Citing Web Soil Survey as a source of soils data

Tips & Shortcuts WSS



United States
Department of
Agriculture



NRCS

Natural
Resources
Conservation
Service

A product of the National
Cooperative Soil Survey,
a joint effort of the United
States Department of
Agriculture and other
Federal agencies including the
Agricultural Experiment
Stations, and local
participants

Custom Soil Resource Report for **Waseca County, Minnesota**



March 25, 2013

Soilweb:

<http://casoilresource.lawr.ucdavis.edu/soilweb-apps>

The screenshot shows the UC Davis California Soil Resource Lab website. The header includes the lab logo and a search bar. A navigation menu contains links for HOME, SOILWEB APPS, PEOPLE, PROJECTS, SOFTWARE, LINKS, and BLOG. The main content area is titled "SoilWeb Apps" and contains two columns of information.

SoilWeb

Explore soil survey areas using an interactive Google map. View detailed information about map units and their components. This app runs in your web browser and is compatible with desktop computers, tablets, and smartphones.

The SoilWeb application interface shows a satellite map with yellow lines indicating soil survey boundaries. A sidebar on the left lists soil map units with their percentages and names: 80% - Sylamore, 23% - Maria, 23% - Merrill, 23% - Tyndall, 23% - Web, and 23% - Branchwood. Each entry includes a "View Soil Data" link.

SoilWeb Earth

Soil survey data are delivered dynamically in a KML file, allowing you to view mapped areas in a 3-D display. You must have [Google Earth](#) or some other means of viewing KML files installed on your desktop computer, tablet, or smartphone.

The Google Earth interface shows a 3D view of a coastal area with a soil survey map overlaid. A pop-up window displays a soil profile with a legend and a 3D bar chart showing soil layers and their colors.

casoilresource.lawr.ucdavis.edu

Saint Paul, MN (55101) Forecast | Weather Underground

California Soil Resource Lab :: SoilWeb Apps

SoilWeb: An Online Soil Survey Browser | Californ...

Menu

SoilWeb

UCDAVIS NRCS University of California
Agriculture and Natural Resources

Display a menu

Imagery ©2016, DigitalGlobe, USDA Farm Service Agency

50 m

Terms of Use

Report a map error

Lat: 44.4110
Lon: -88.7434

casoilresource.lawr.ucdavis.edu

Saint Paul, MN (55101) Forecast | Weather Underground California Soil Resource Lab :: SoilWeb Apps SoilWeb: An Online Soil Survey Browser | Californ...

SoilWeb UCDAVIS NRCS | University of California
Agriculture and Natural Resources

< Close

Map Unit Name: **Zurich silt loam, 2 to 6 percent slopes** Symbol: **ZzB**
 Component Name: **Zurich**
 Component Key: 12089352
[Soil Data Explorer](#) | [Series Extent Explorer](#) | [Official Series Description](#)

Soil Profiles

Typical Profile >

Org. Matter Clay

Sand Ksat

pH Kr Factor

EC SAR

CaCO3 Gypsum

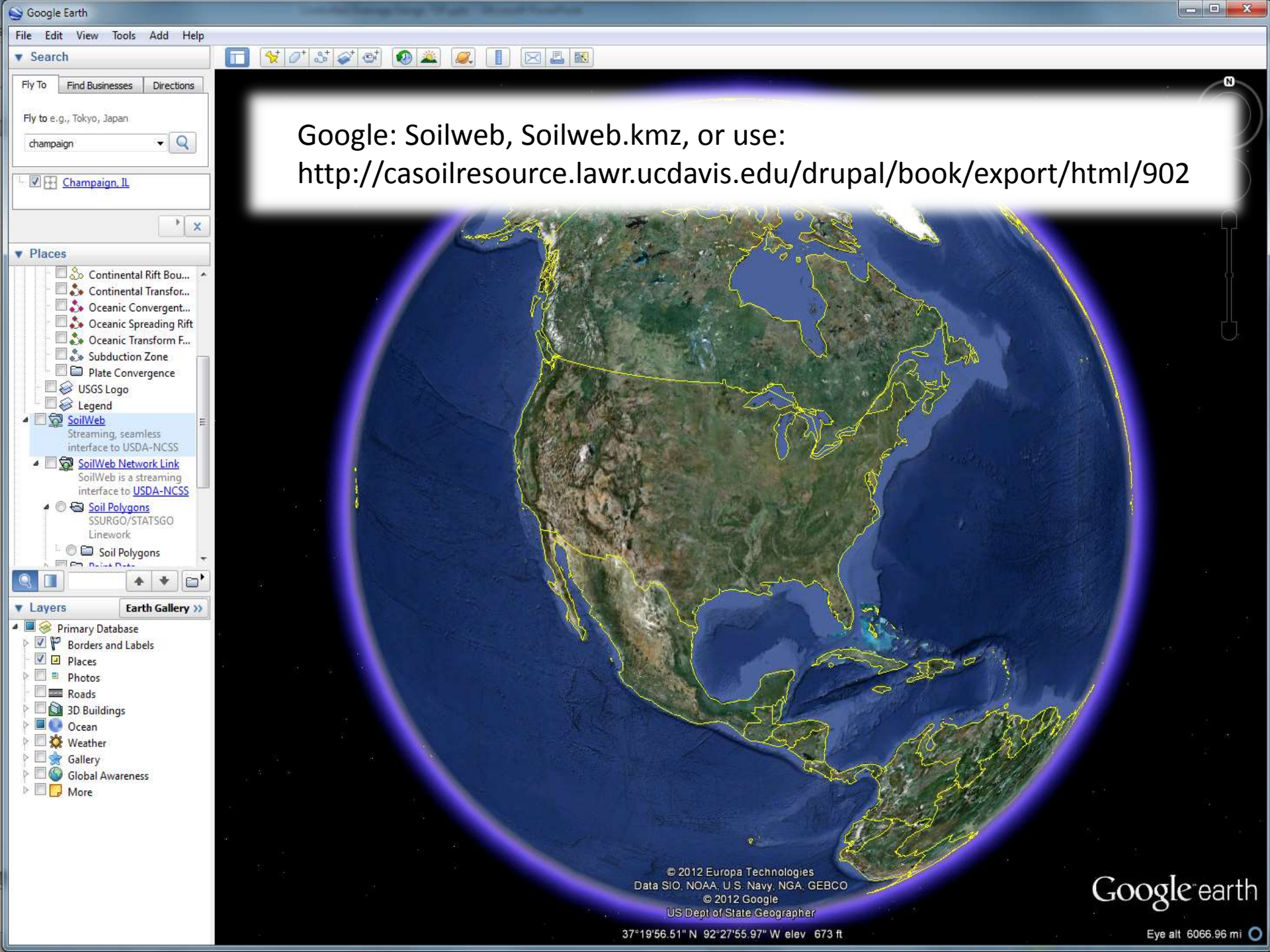
CEC @ pH7

Linear Ext.

A	0 cm
E	13 cm
BE	23 cm
Bt1	41 cm
Bt2	58 cm
2Bt3	71 cm
2BC	79 cm
2C	97 cm

Lat: 44.4096
Lon: -88.7356

Imagery ©2016, DigitalGlobe, USDA Farm Service Agency 50 m Terms of Use Report a map error



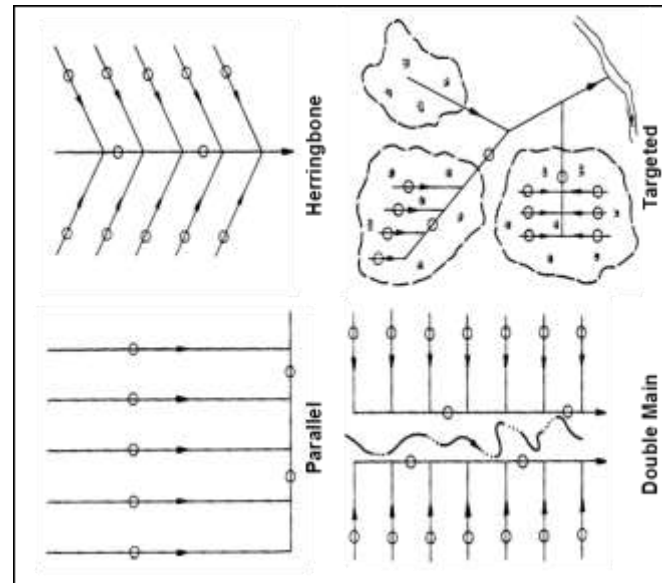
Google: Soilweb, Soilweb.kmz, or use:
<http://casoilresource.lawr.ucdavis.edu/drupal/book/export/html/902>

© 2012 Europa Technologies
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
© 2012 Google
US Dept of State Geographer

Google earth

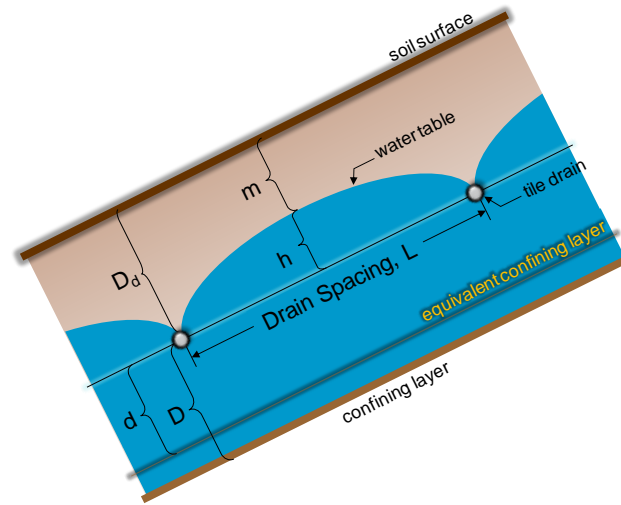
37°19'56.51" N 92°27'55.97" W elev 673 ft

Eye alt 6066.96 mi



Drainage system layout & design is about matching field topo with desired drain grades and depths so system works well and is economical!

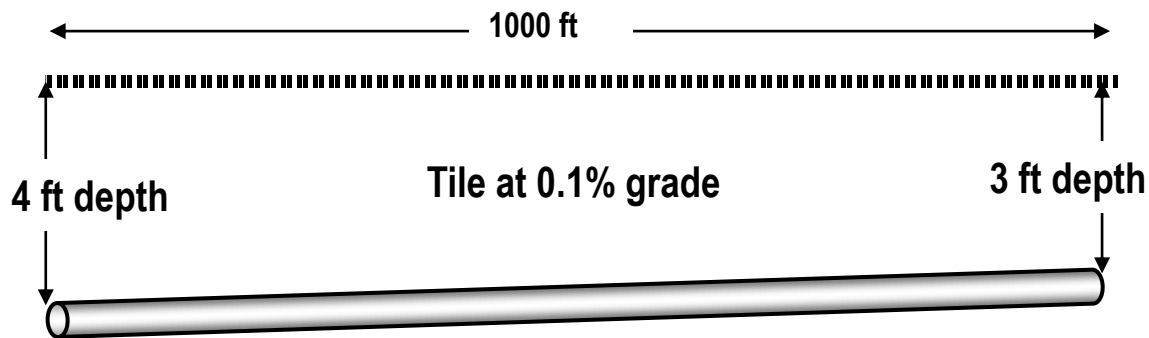
Drain Layout, Grades & Depths



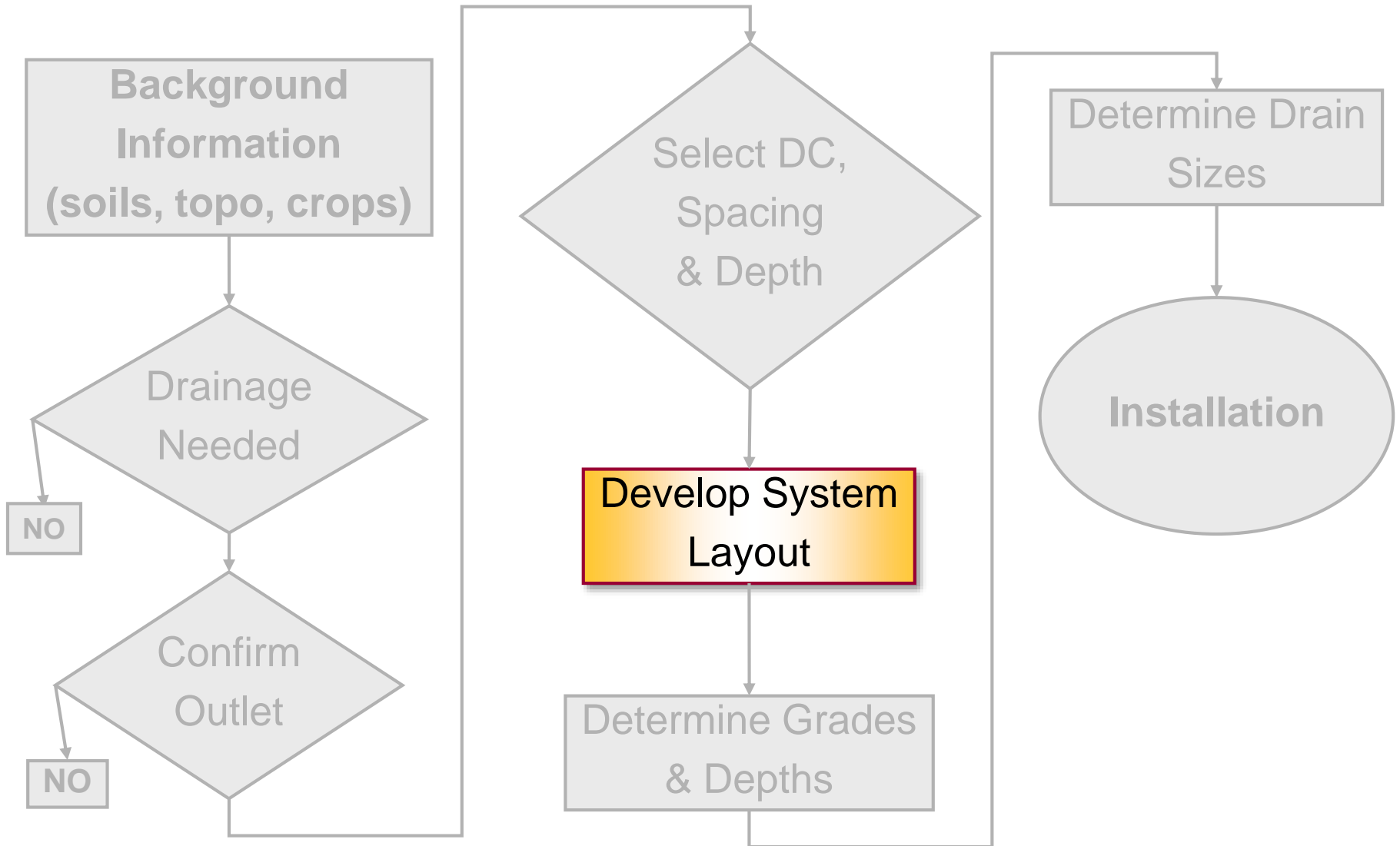
DRAINAGE DEPTH: GOING FOR UNIFORMITY

Drain Depth

- ◆ Design for uniform depth throughout system (depends on layout)
- ◆ Depth will of course vary on flat and rolling topography

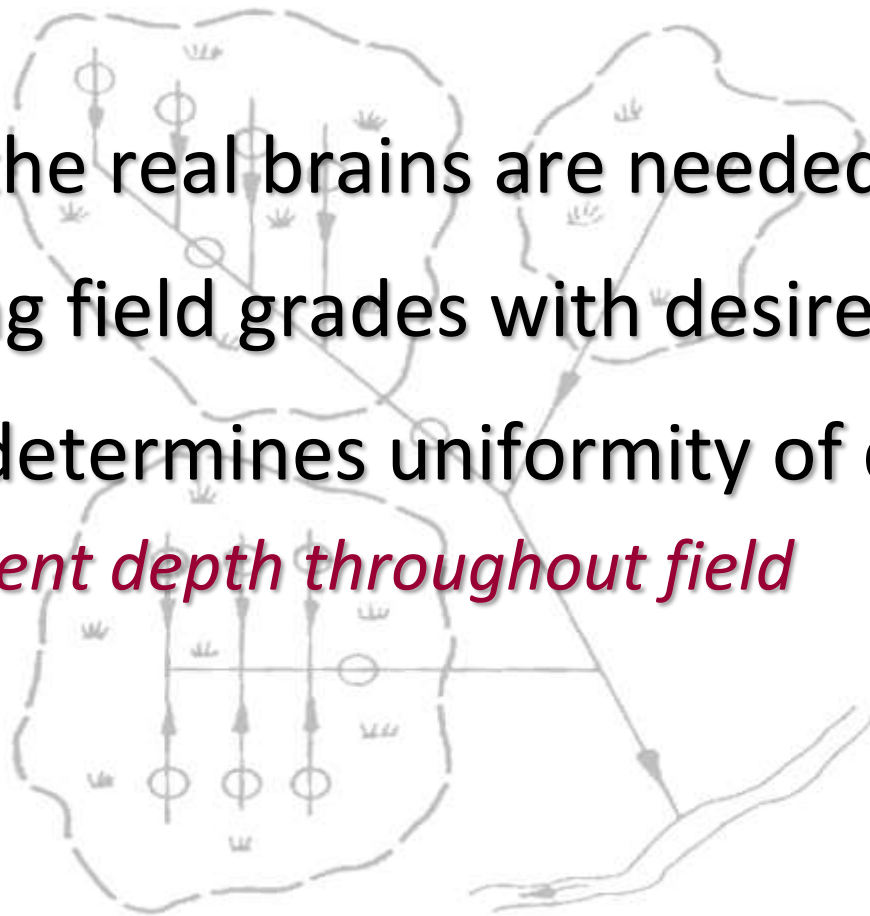


Design Process Flowchart

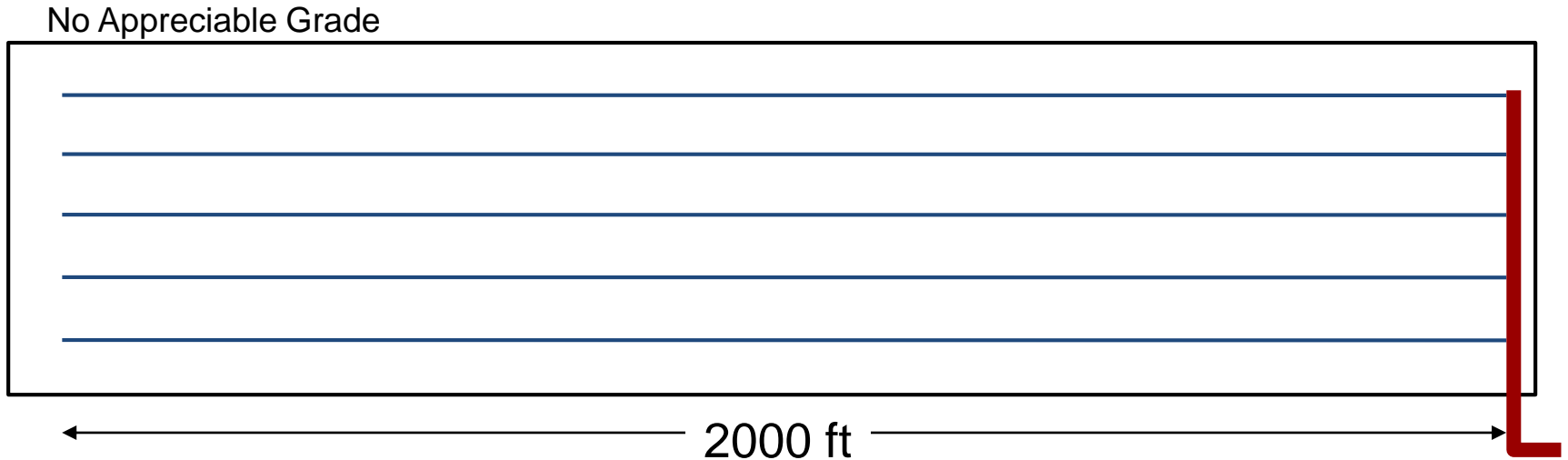


Layout

- **Most important step** (besides determining an outlet!)
- Where the real brains are needed!
- Matching field grades with desired tile grades
- Layout determines uniformity of drainage
 - *Consistent depth throughout field*

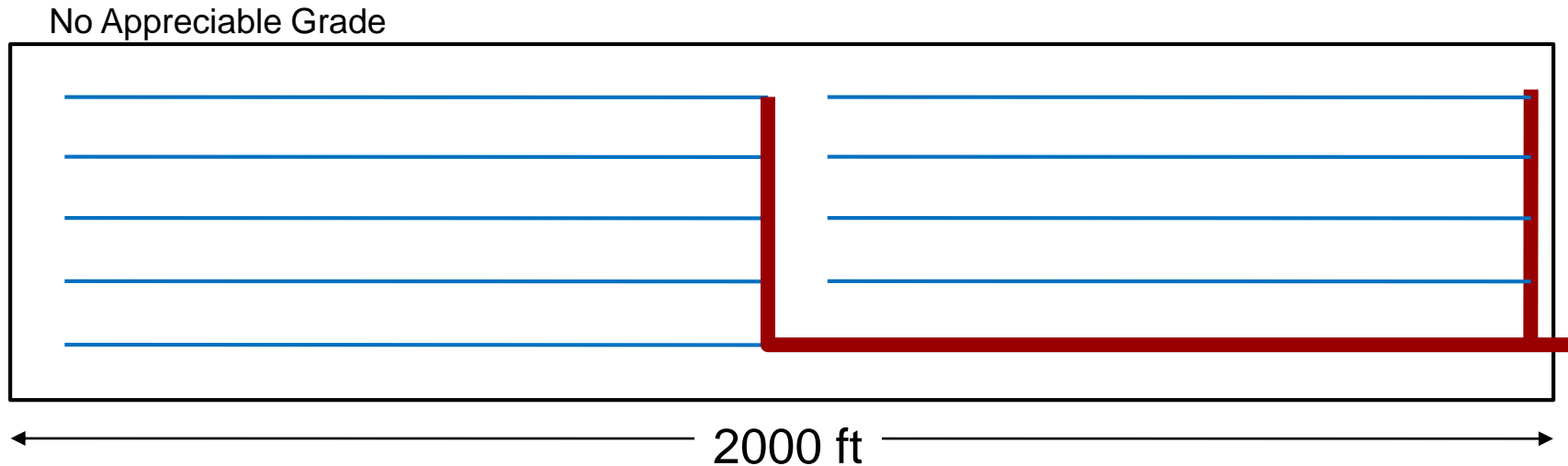


Uniform Drainage Example: Long Fields



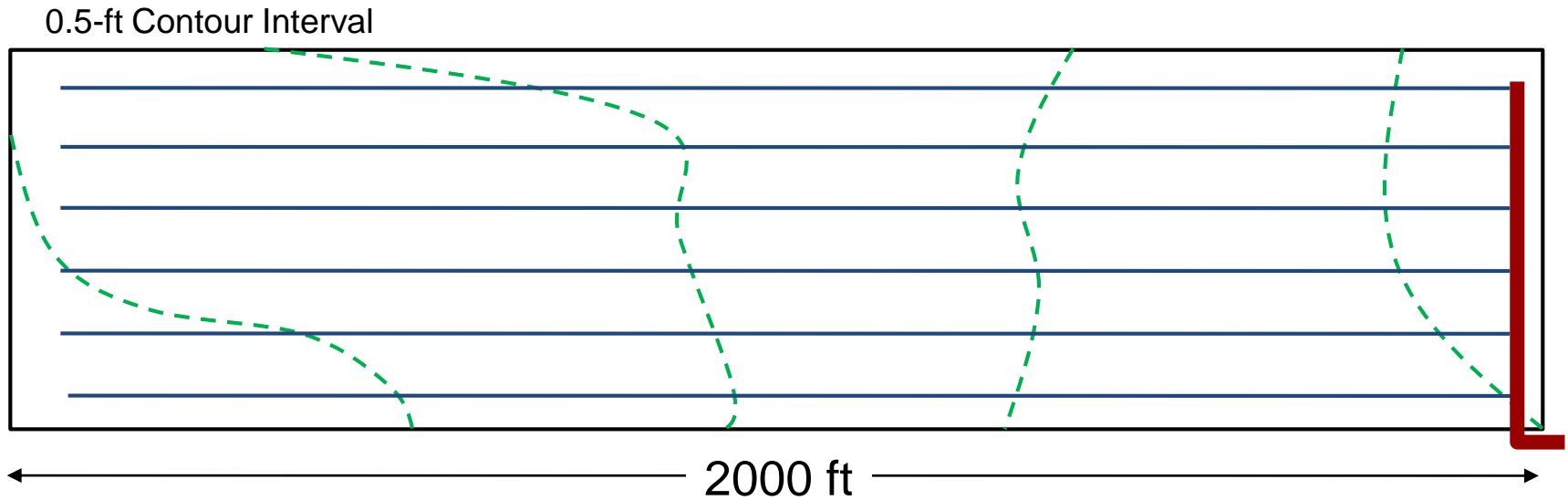
- 2000-ft laterals:
 - @ 0.08% = 1.6 ft of fall
 - @ 0.1 % = 2.0 ft of fall

Possible Solution for Long Fields



- ◆ Split the feet of fall in half
- ◆ More uniform drainage coefficient
- ◆ Yes, more connections and feet of collector (but collectors are smaller)

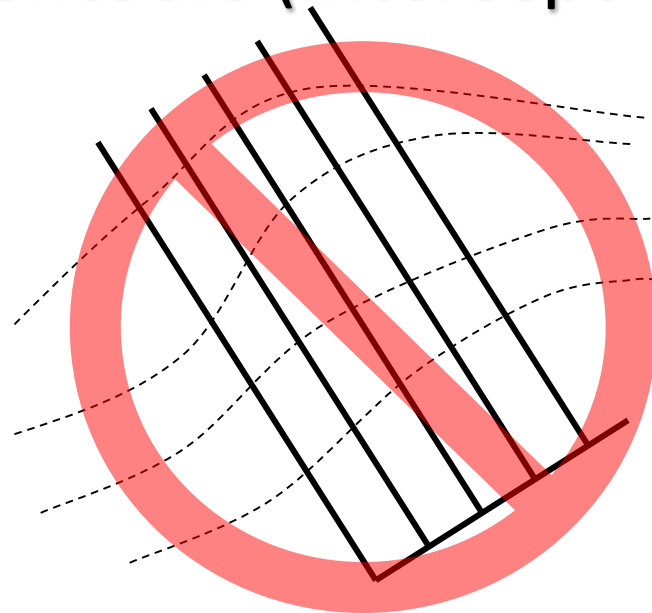
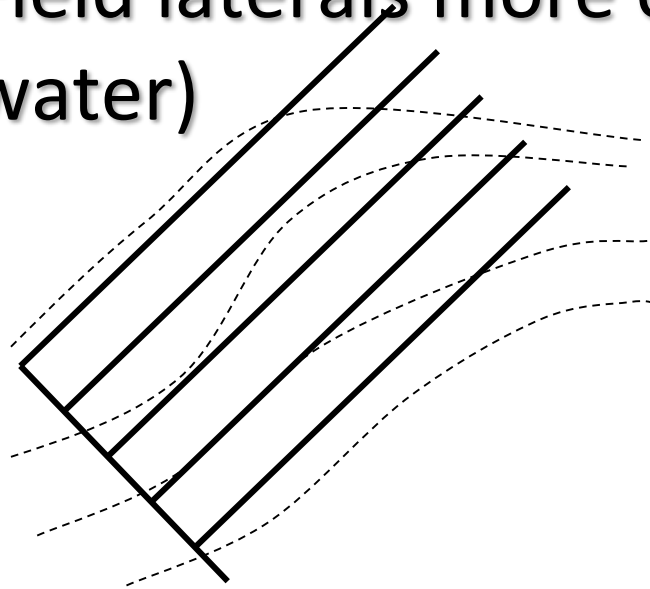
Another Example: Long Fields



- Natural field grade is $2.0 \div 2000 \times 100\% = 0.1\%$
- Easy to keep laterals at uniform depth and maintain plenty of grade

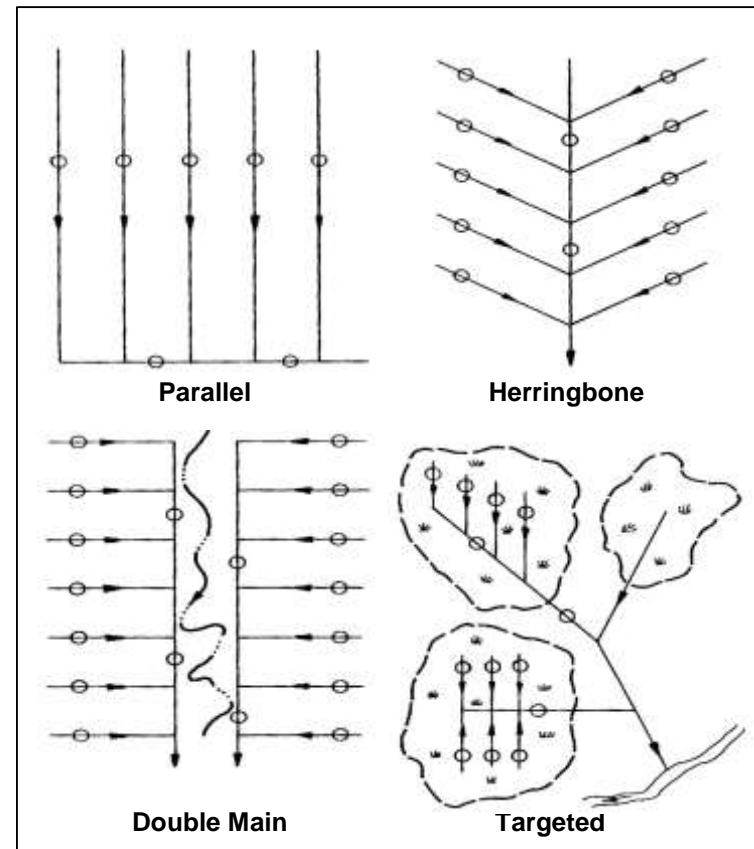
Layout

- Should start with contour (topo) map of field
 - *Only way to look at entire field at once*
- Put (sub)mains on steepest grades
- Field laterals more on contours (intercept water)

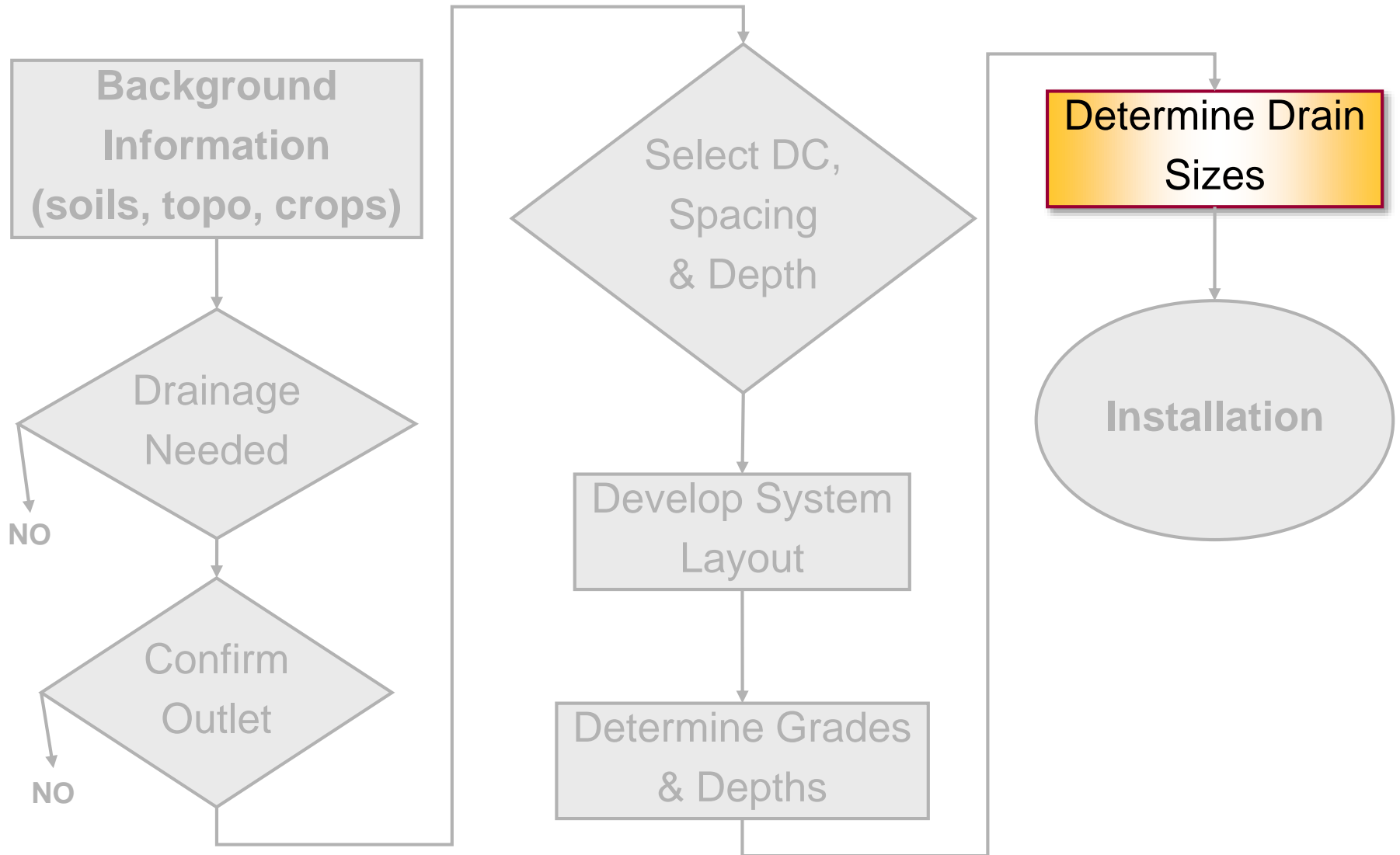


Layout

- Consider & plan for future needs
- Make maps of everything:
 - *As designed*
 - *As built*



Design Process Flowchart



Drain Sizing

To determine tile capacity, we need:

- Grade (get from layout)
- Material (we choose)
- Pipe Size (what we're after)

Design Tools



Design Tools



◆ Acres Drained

- ◆ *DC*
- ◆ *Grade*
- ◆ *Material*
- ◆ *Pipe size*



◆ Pipe Size

- ◆ *DC*
- ◆ *Grade*
- ◆ *Material*
- ◆ *Area Drained*

Design Tools

U of M Home | U of M Directories | Search U of M

UNIVERSITY OF MINNESOTA
EXTENSION

Search Extension:

Home > Agriculture > Drainage Outlet > Drainage Calculators > Online Calculators

The Drainage Outlet

Online Calculators

These calculators are based on corrugated clay pipe can be approximated by using the

- Calculate pipe diameter
- Calculate area drained
- Flowrate calculator/converter
- Prinsco Drainage Calculators

Calculate Pipe Diameter

Pipe Diameter (inches)

Use this calculator to compute the required

Smooth Interior Pipe? Yes No

Area Drained:

Acres: % Grade*

*%Grade is the feet of fall per 100 feet of

Required Pipe Diameter (inches):

Full pipe flow (cu ft/sec):

Velocity (ft/sec): **

Products

Accessories

Resources

Catalog

Product Brochu

Installation Gui

Specifications

Technical Notes

CAD Drawings

Calculators

In the News

Sales Reps

Legislative Regulatory RESOURCE CENTER

Prinsco - Mozilla Firefox

http://prinsco.com/article.cfm?ID=99

PRINSCO

Calculate by Acreage

Our drainage calculator was developed to assist you in the preliminary design and understanding of your drainage needs. We encourage you to contact your local design professional or contractor for more specific design guidance and criteria.

These calculations are based on the Manning's Roughness ASAE EP 260.3 Plastic Tubing Drainage Chart and should be used for estimating purposes only. Consult a Water Table Management Professional for design criteria information.

ⓘ = Definition

Enter the Acres to be drained:

Enter the Grade (%): ⓘ

(see below)

Acres Drained	Drainage Coefficient (in: /24 hours) ⓘ					
	1/8"	1/4"	3/8"	1/2"	3/4"	1"
Q _v flow (cu ft/sec) ⓘ	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
Velocity (ft/sec) ⓘ	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
Calculated Pipe Size (Inches) ⓘ	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
Commercial Pipe Size	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
GOLDLINE - Single Wall						
Velocity (ft/sec) ⓘ	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
Calculated Pipe Size (Inches) ⓘ	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
Commercial Pipe Size	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
GOLDFLO - Dual Wall						
Velocity (ft/sec) ⓘ	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
Calculated Pipe Size (Inches) ⓘ	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
Commercial Pipe Size	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>

Home/In the News

Driven to Discover™

Design Tools (cont.)

Illinois Drainage Guide (Online) - Windows Internet Explorer

Interactive Links are included on some of these web pages. These links are programs that were written with Visual Basic. It may be necessary to download them.

Subsurface Drainage

Illinois Drainage Guide (Online)

Department of Agricultural and Biological Engineering
University of Illinois

Navigation menu items:
 - Drainage Techniques
 - Outside for Drainage Systems
 - Surface Drainage
 - Subsurface Drainage
 - Spacing Drainage Lines
 - Layout and Materials
 - Flow Profiles in Lateral
 - Entry Specifications
 - Field Preparation Notes
 - Components
 - Design
 - Construction Drainage
 - Saturated Flow Design
 - Economics Considerations
 - History of Drainage in Illinois
 - Printable Tables and Charts

Clay or Concrete Tile

Materials:
 Plastic tubing
 Clay or concrete tile
 Smooth wall
 Other

Drainage Coefficient:
 3/8 (in/day)
 1/2 (in/day)
 3/4 (in/day)
 1 (in/day)
 Other (in/day)

Drainage Area: Tile Size: Slope: Discharge Rate: Velocity:

Tile Size and Slope
 Discharge
 Tile Size and Velocity

Tile Size (inch):
 Slope (%):

Calculate Exit

Sedimentation Depth:
 % inch

Result
 Drainage Area (acre):

Estimating Drain Spacing: SDSU/U of M

Drainage Calculators

igrowdrainage.org

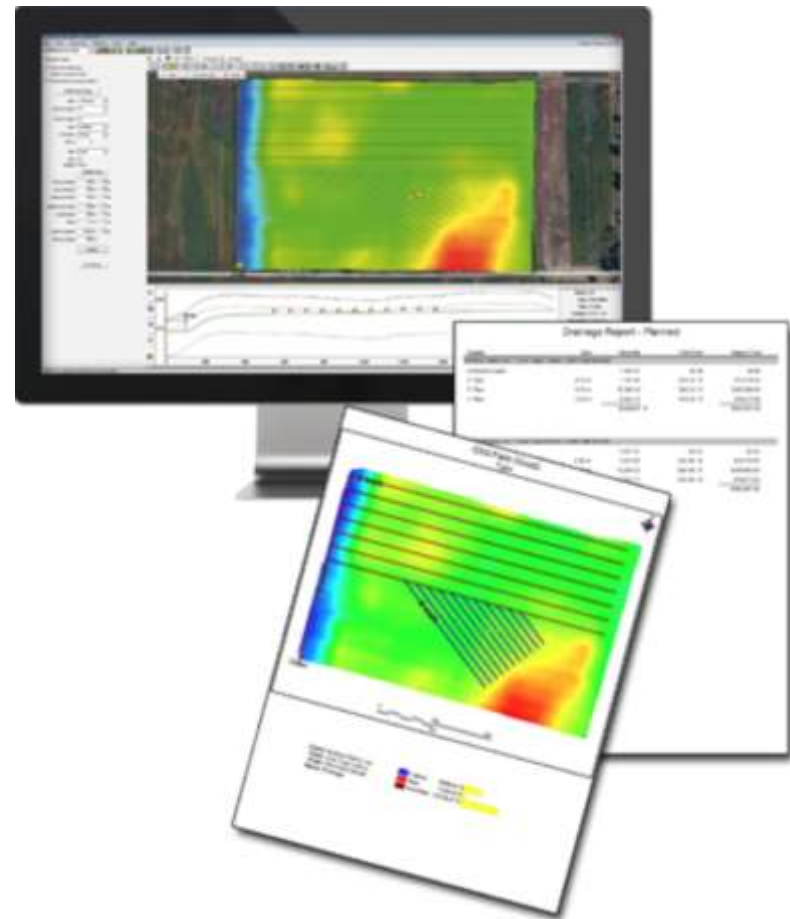
The screenshot shows a web browser window displaying the 'iGrow Drainage Calculators' page. The page has a green header with the iGrow logo and the title 'Drainage Calculators'. Below the header, there is a navigation bar with various links. The main content area features a grid of calculator buttons. Two buttons are highlighted with colored boxes: 'Pipe Size -> Area Drained' is highlighted with a blue box, and 'Area Drained -> Pipe Size' is highlighted with a red box. The footer contains a disclaimer and copyright information.

Utilize these calculators to address common drainage questions. Additional information is available on iGrow

Pipe Size -> Area Drained	Area Drained by Pipe Sizes
Avg. Hydraulic Conductivity	Drain Spacing
Drainage Coefficient	Grade -> Fall
Fall -> Grade	Min. Grade Needed
Hydraulic Conductivity Converter	Max. Lateral Length
Length -> Lateral Sizing	Max. Laterals on Main
Area Drained -> Pipe Size	Pump Size
Subirrigation Spacing	Sump Storage

Visit iGrow.org for the latest information from SDSU Extension. This tool was developed in collaboration with University of Minnesota Extension
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Computer-aided Design



Extension Drainage Publications

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The growing use of artificial subsurface drainage in Minnesota has generated much debate about its impact on hydrology and water quantity and quality. Discussions are typically focused on the local questions that have important policy implications for local and state decision makers.

- Does subsurface drainage lessen or vice versa localized flooding?
- Are catastrophic floods more frequent because of subsurface drainage?

This publication presents concepts that affect soil water and the water balance. It provides a critical system and their relationship to drainage, soil water, and hydrology are addressed and policy questions related

SUBSURFACE DRAINAGE

Artificial subsurface drainage continues to be a common practice in Minnesota, as well as in other states and countries around the world. Subsurface drainage is the practice of placing perforated pipe at a specified grade (slope) at some depth below the soil surface. Excess water from the crop root zone can enter the pipe through the perforations and travel away from the field to a ditch or other outlet. Subsurface drainage improves the productivity of poorly drained soils by lowering the water table, providing greater soil aeration, and enabling soil drying and warming in the spring. This allows fields to be planted earlier and other field operations to take place in a timely fashion. It also provides a better environment for crop emergence and growth, and can reduce soil compaction.

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WHAT IS AGRICULTURAL DRAINAGE?

Agricultural drainage is the use of subsurface permeable pipes, or both, to standstill or excess water from poorly drained soils. During the late 1800s, European settlers in the Midwest began making drainage ditches to carry water from the wet areas of the nearby streams and rivers. Later, farm drainage by installing subsurface drainage pipes generally at a depth of three to six feet. In the 1970s, most subsurface drainage pipes were short, cylindrical sections of concrete called "tile." That is why terms like tile, and tiling are still used, even though the pipe today is perforated polyethylene. A pipe installed in a subsurface drainage system either strategically placed in a field to drain an entire field. In some areas, subsurface intakes (risers) extended from underground (the surface) remove excess surface water spots in fields.



Poorly drained agricultural land

AGRICULTURAL DRAINAGE publication series

Planning an Agricultural Subsurface Drainage System

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GENERAL CONSIDERATIONS

Many soils in Minnesota and throughout the Midwest remain wet for several days after a rain event. Adequate drainage, preventing timely field operations, causing stress on growing crops. Subsurface drainage does not provide sufficient aeration for crop development, and can be an important soil conservation issue. That's why artificial drainage of poorly drained soils has become integral to maintaining a productive crop production system. Some of the most productive soils are drained, including 25% of the farmland in the United States and Canada.

Planning an effective drainage system takes time and requires consideration of a number of factors, including:

- Local, state, and federal regulations
- Soil information
- Wetland impact
- Adequacy of system outlet
- Field elevation, slope (grade), and topography assessment
- Economic feasibility
- Present and future cropping strategies
- Environmental impacts associated with drainage
- Easements and right-of-ways
- Quality of the installation

The U.S. Department of Agriculture (USDA) National Security Act and the farm bills of 1985, 1990, and 1996 created many special wetlands that all drainage projects, including tile drainage, must follow. It's also very important for the landowner, system designer, and contractor to understand other applicable federal laws, the local watershed and state laws dealing



Drainage Water Management

Questions and Answers for Managers

Jane Frankenberger, Elmer Matt Helmers, Richard

Introduction

Subsurface tile drainage management practice on farms in the Midwest. However, drainage water can lead to local and contribute to hypoxia in the Gulf of Mexico. Practices that can reduce soil erosion include growing winter cover crops, using no-till or reduced-till practices, and using drainage water management systems. Drainage water management systems are described in this fact sheet specifically to Midwest crop production systems, and not to perennials.

1. What is drainage?

- Drainage water management is a water control system that uses a lateral drain to vary the water table. The water table must rise above the drainage to occur, as indicated by the following:
- Raised after harvest to reduce the delivery of nutrients during the off-season.
- Lowered in early spring to allow the drain to flow freely such as planting or harvesting.
- Raised again after plantings to create a water table to use in midseason.

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Evaluating a Subsurface Drainage Project and Its Alternatives

Brad Carlson, Extension Educator, and Gary Sanz, Professor & Extension Engineer, University of Minnesota Extension

The use of artificial drainage for agricultural production dates back centuries. Over the last hundred years there have been several periods of increased drainage activity attributable to many factors. Most recently, improved technology for the installation of subsurface drain, coupled with the ability to evaluate yield improvements through the use of yield monitoring equipment, have significantly improved the economics of artificial drainage for many soils. Despite these improvements, drainage still represents a significant financial investment for any farm. If one considers the potential environmental impacts of agricultural drainage (changes in stream flow, nitrate loss to surface water, wildlife habitat loss), the decision is not as straightforward as one would believe. It is for these reasons that land owners should undergo a thorough and thoughtful evaluation of a drainage project before proceeding.



Advances in technology for the installation of subsurface drainage had significantly reduced its cost over the past two decades.

THE FIRST STEP

The benefits of agricultural subsurface drainage (a.k.a. "tile" drainage) include: reduced crop stress, prevention of stand loss, better utilization of inherent soil fertility because of more extensive crop roots, reduced soil compaction, and the ability to perform field activities (particularly planting) in a timely fashion due to soil trafficability. All of these benefits result in higher yields, and therefore higher income for a crop that already has a fixed input cost. Before planning a drainage project, the farmer should have an idea of what he or she thinks this improvement will mean to the bottom line. Acknowledging that each year is different with respect to climate, the farmer should consider improved profitability for wet years and dry years and consider the likelihood of each over a ten year period.

Every farmer that has done a tiling project knows what the installation cost is on a per foot basis. In addition to this basic cost, there are costs associated with outletting the water. Some of these costs may include: the installation of a new tile main, engineering and design costs, legal fees, easements and permitting, pumping and/or lift stations, and repairs and other improvements to an existing outlet. It is important that the project cost estimates include all these factors. In addition, there may be unwanted environmental costs associated with agricultural drainage, such as increased field losses of nitrate-nitrogen (which can contribute to coastal hypoxia), increased pressure on downstream drainage infrastructure, and reduction of temporary sheet water in agricultural fields (used by migratory waterfowl). Although these



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The University of Minnesota Extension agricultural drainage team brings University research to producers and industry professionals to improve water management practices.

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Two-stage drainage ditches can be a win-win

Reduce cropland nutrient losses and ditch repair costs by modifying traditional drainage ditches.



Conservation drainage in Minnesota: CNN.com article

Minnesota farmer battles Gulf 'dead zone'.



Controlling farm runoff could have multiple benefits

A new approach to farmland drainage may help reduce the Gulf of Mexico's 'dead zone.'

Contact the Agricultural Drainage Program: drainage@umn.edu

Take Home Points

- Be safe in the field (esp. trench safety)!
- Be kind to your neighbors
- Generally, state laws support drainage, but there are limits
- Drainage spacing may be the hardest and the most important decision; layout comes next
- Make your drainage systems function as uniformly as possible
- Design with conservation drainage in mind
- Drainage isn't rocket science, but there is plenty of room for excellence!
- If going to self-install, walk before you run!

Questions?

