

Low Cost Surface Irrigation Improvements

Improvements through Management

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THE UNIVERSITY OF ARIZONA
COLLEGE OF AGRICULTURE & LIFE SCIENCES

**Agricultural & Biosystems
Engineering**

Introduction to Surface Irrigation

- ▶ Sloped
- ▶ Modified Slope - Level End
- ▶ Dead Level



Irrigation in Arizona

- ▶ Cortaro Marana Irrigation District - Pima County



- ▶ Maricopa Stanfield Irrigation District
- ▶ Central Arizona Irrigation District

**Concerns About Future
Impacts to CAP Water
Supplies for the Districts**

- ▶ Yuma and Welton Mohawk Irrigation Districts



No New Irrigated Land in Arizona

- ▶ No funding or water for farmers to develop new land
 - ▶ Except Native Americans
- ▶ Need to make existing farmland more water efficient
 - ▶ Land leveling
 - ▶ Sprinkler and Drip irrigation
 - ▶ Management strategies

Goal of Irrigation

Apply the right amount of water as uniformly as possible to meet the crop water needs: fill the root zone; minimize runoff and deep percolation

Some Considerations

- ▶ Crop Water Use
- ▶ Soil class - water holding capacity, infiltration rate (sand, loam, clay)
- ▶ Depth of soil also relates to drainage of soil
- ▶ Soil salinity
 - ▶ Identifies limiting factors for infiltration
 - ▶ Result in increased water requirement for leaching

What Can I do as an Extension Agent

- ▶ Help Farmer review what he has:
 - ▶ Head of water (gpm)
 - ▶ Reliability of water
 - ▶ yes, everyday, OK for Drip and Sprinkler
 - ▶ No, must do surface
 - ▶ Field layout
 - ▶ Even rectangle fields
 - ▶ Uneven fields with multiple soils
 - ▶ Tools
 - ▶ NRCS Soil Survey
 - ▶ Goggle Earth - size, shape, location (wash, water source)

NRCS Web Soil Survey

Soil Survey | NRCS - NRCS Soils

soils.usda.gov/survey United States Department of Agriculture

Lists soil surveys, survey programs, soil survey technology, standards, data and references.

Soil Surveys by State - Soil Classification - Soil Geography - Soil Taxonomy

- ▶ NRCS Soils Reports
- ▶ By state - then region

Google Earth

Pull up area and measure row lengths and use elevation data to calculate slope

NOTE - this is not very accurate, but is a good starting point

The screenshot shows the NRCS Web Soil Survey homepage. At the top is the USDA logo and the text "United States Department of Agriculture Natural Resources Conservation Service". Below this is a banner with soil samples and the text "Web Soil Survey". A navigation bar includes "Home", "About Soils", "Help", and "Contact Us". A breadcrumb trail reads "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
- ▶ Geospatial Data Gateway
- ▶ eFOTG
- ▶ National Soil Characterization Data
- ▶ Soil Geochemistry Spatial Database
- ▶ Soil Quality
- ▶ Soil Geography

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.

Soil surveys can be used for general farm, local, and wider area planning. Onsite investigation is needed in some cases, such as soil quality assessments and certain conservation and engineering applications. For more detailed information, contact your local [USDA Service Center](#) or your [NRCS State Soil Scientist](#).

Four Basic Steps

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

I Want To...

- Start Web Soil Survey (WSS)
- Know the requirements for running Web Soil Survey — will Web Soil Survey work in my web browser?
- Know the Web Soil Survey hours of operation
- Find what areas of the U.S. have soil data
- Find information by topic
- Know how to hyperlink from other documents to Web Soil Survey

Announcements/Events

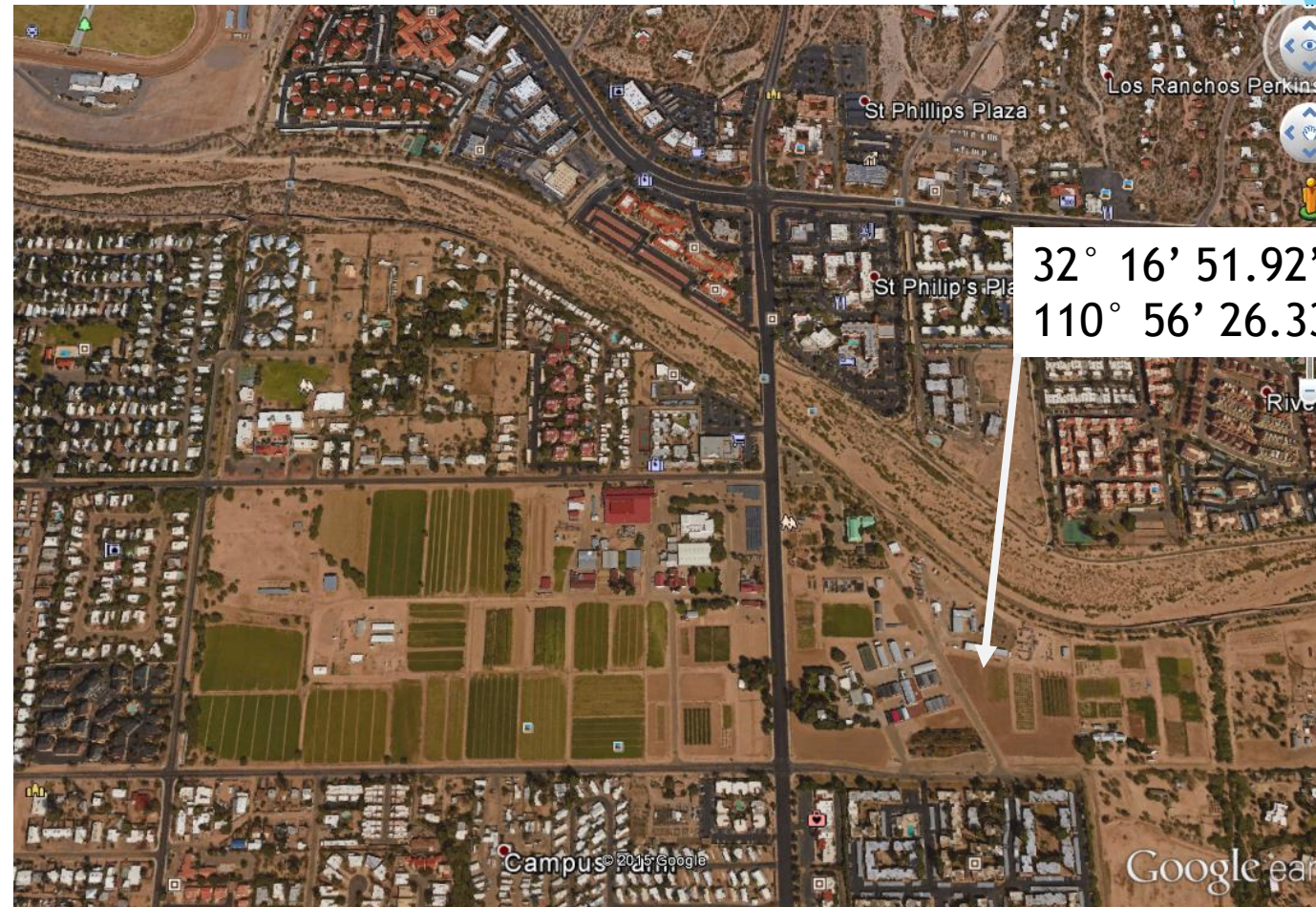
- Web Soil Survey 3.1 has been released! [View description of new features and fixes.](#)
- Web Soil Survey Release History
- Sign up for e-mail updates via GovDelivery

I Want Help With...

- Getting Started With Web Soil Survey
- 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

Google Earth

- Great Tool
- Latitude/Longitude
- Elevations
- Distances
- Site conditions
- Historic overview

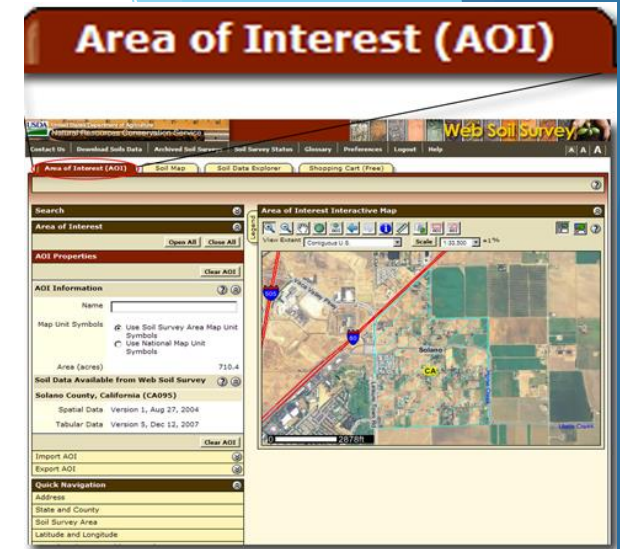


NRCS Soil Survey

▶ 4 steps

1. Area of interest (map driven by region)
 2. Soil Map - Click on the soil map tab to view a soil map
 3. Click the Soil Data Explorer tab to access soil data
 4. Use Shopping Cart tab to customize and print any reports
- ▶ Plenty of training videos just search for NRCS soil survey in YouTube

Step 1

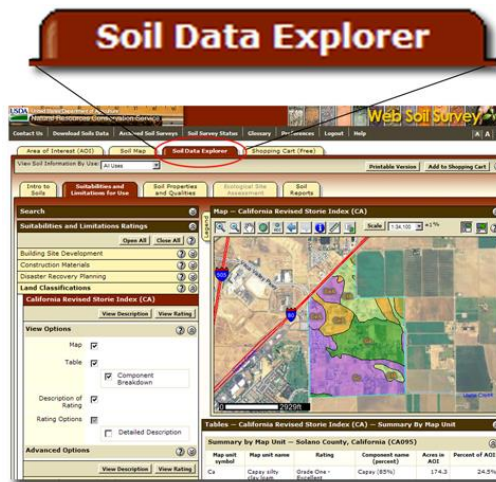


Soil Map

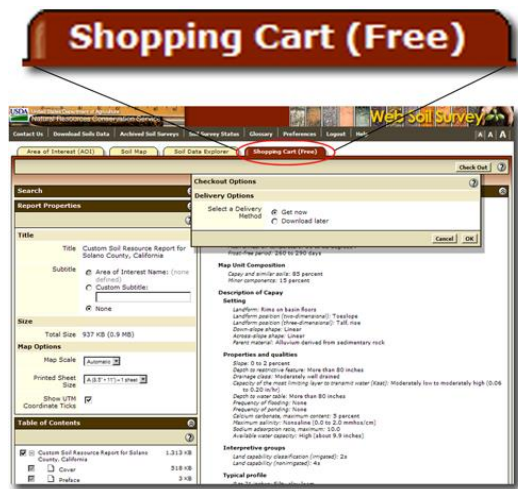
Step 2



Step 3



Step 4



Surface Irrigation - Dead Level

- ▶ 0.2% slope along furrow to keep water moving
- ▶ 0.0% side slope
- ▶ Very efficient because no runoff
- ▶ Short fields, typically 660 ft to 880 ft long
- ▶ High flow rate per furrow to get water out to end of field quickly
- ▶ Loose productivity for multiple seasons
- ▶ Expensive \$3,000 to \$8,000/ac



Surface Irrigation Design

▶ Irrigation efficiency

$$\text{▶ } Eff = 100 * \frac{F_n}{F_g} = \frac{\text{Crop requirement}}{\text{Total amount applied}}$$

▶ Total Amount Applied = crop requirement (fill root zone to desired depth) + Deep Percolated Water + Runoff

$$\text{▶ Deep Percolated} = (F_{o-l} - F_n)$$

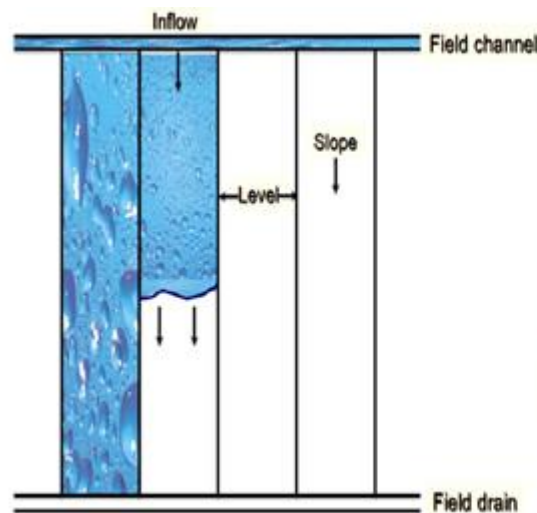
$$\text{▶ } F_{o-l} = \left[T_1 - \frac{0.0929}{f * \left(\frac{0.305 * \beta}{X} \right)} \right] * [(\beta - 1)e^\beta + 1]$$

Dang Engineer's and their equations, Just tell me what it means

- ▶ The faster you can move water down a furrow the more efficient the irrigation will be.
- ▶ But
 - ▶ Soil erosion
 - ▶ Runoff
 - ▶ Furrow roughness

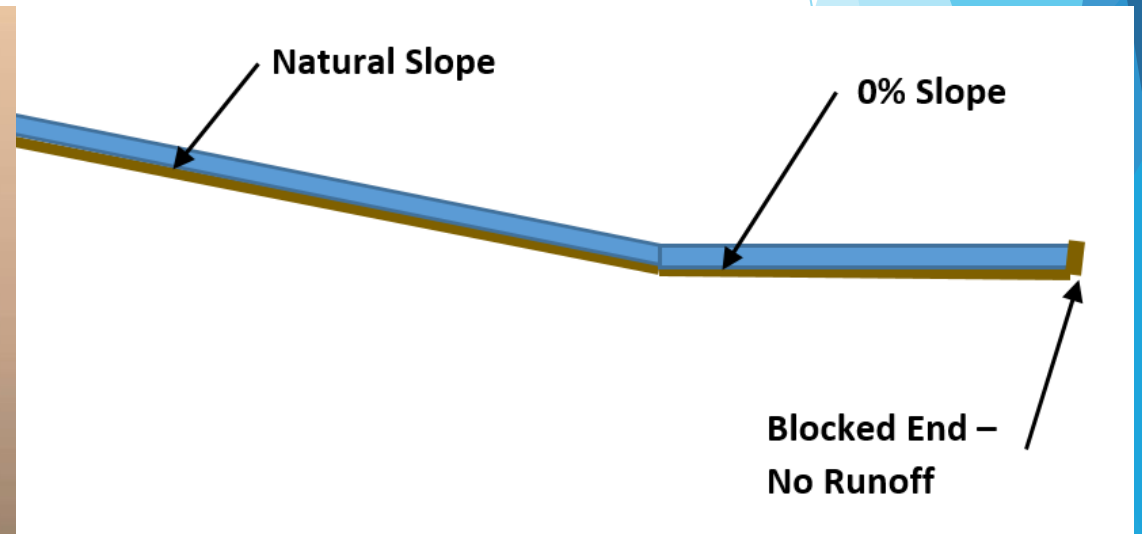
Surface Irrigation

- ▶ Most common system in Arizona
- ▶ Furrow or notched ditches for individual rows
- ▶ Some gated pipe for individual rows
- ▶ Boarder irrigation for alfalfa and wheat



Modified Slope

- ▶ Natural slope for 66% of field, then level
- ▶ Lower land leveling cost
- ▶ Do not lose top soil during land leveling process
- ▶ Lower flow rate per furrow
- ▶ Still high irrigation efficiency



Want to do Leveling

- ▶ Contact NRCS
 - ▶ EQIP \$
 - ▶ Survey field
 - ▶ Do irrigation design
 - ▶ Many no cost services, time to accomplish task depends on how busy they are
- ▶ Contact a design firm for faster service
 - ▶ Cairo Engineering, Stantec Engineering (Phoenix Office)

Factors That Influence Irrigation

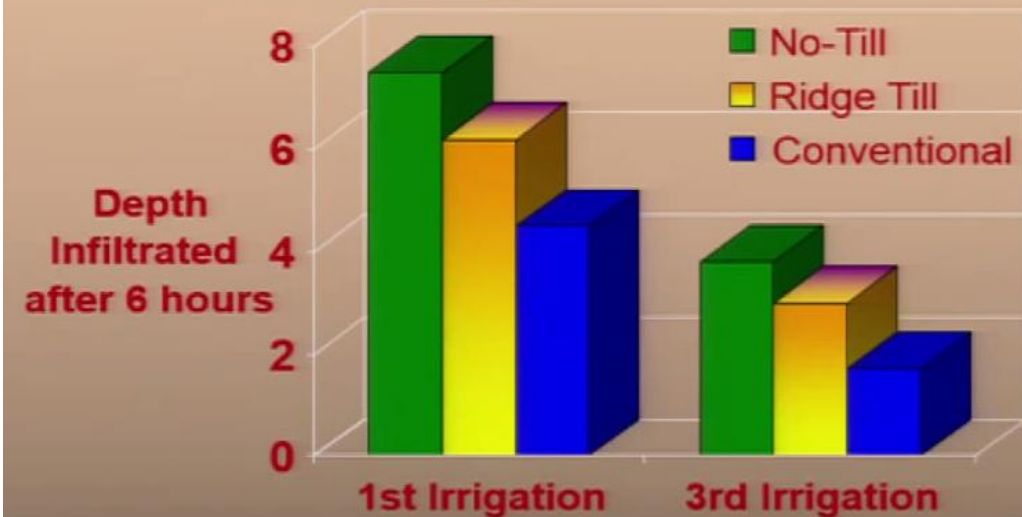
- ▶ Advance time - how fast the water runs down the furrow
- ▶ Soil texture and roughness
- ▶ Furrow slope
 - ▶ Consistency, dead level, modified sloped with level end
- ▶ Length of furrow
- ▶ Tillage

Furrow Roughness

- ▶ First irrigation is typically your pre-irrigation. High roughness will cause uneven flow of water down the furrow.
 - ▶ Decrease roughness by pulling a “bullet” down furrow
- ▶ Even with clean furrow water movement is not exactly even.



Tillage Affects on Infiltration



Management Techniques

▶ Surge Irrigation

▶ What is surge

- ▶ Wet soil with double the head of water

- ▶ Left/right/left/right...

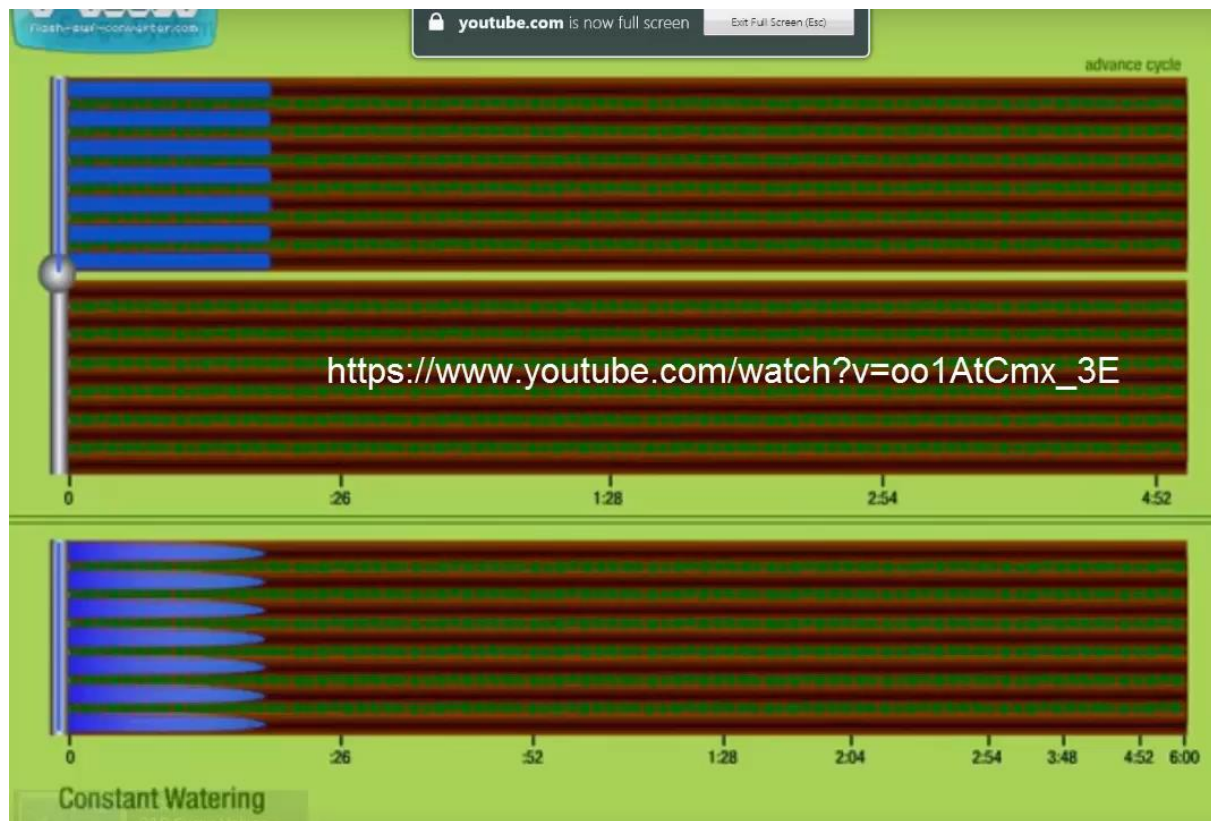
- ▶ Cycle until wetted front is 66% of way down field

- ▶ Minimize advance time because water moves faster over wetted soil

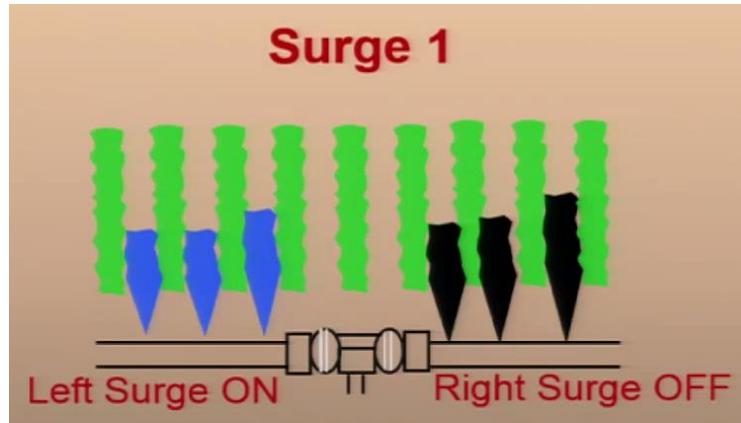
- ▶ Minimize deep percolation and runoff

- ▶ Cut back to match infiltration rate

Surge Irrigation



Surge Irrigation

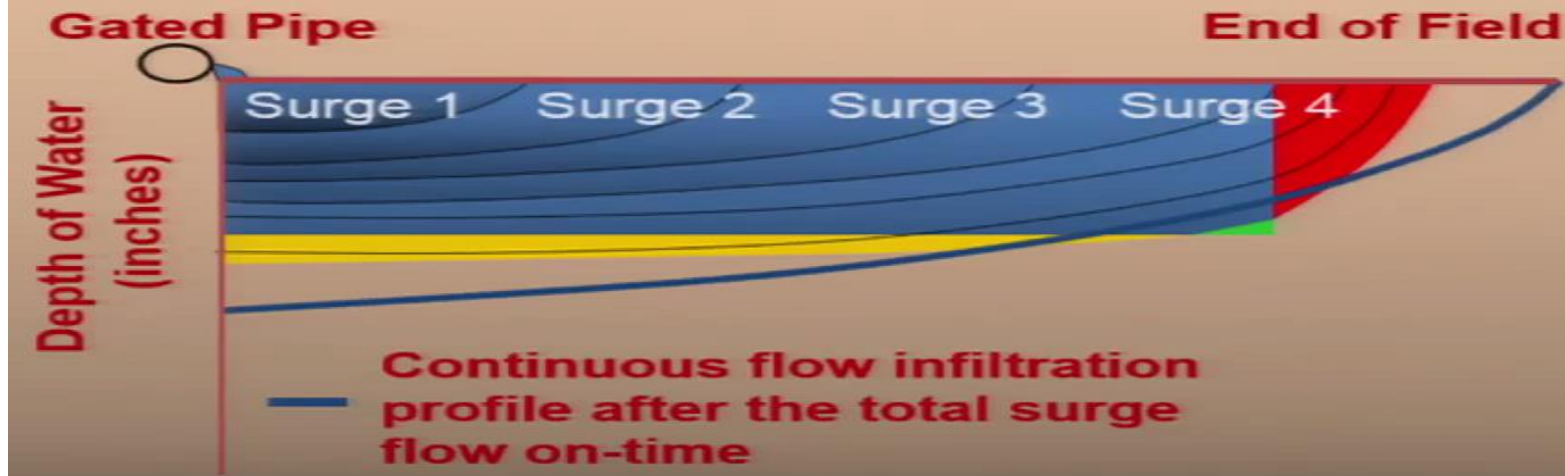


Potential Advantages of Surge Irrigation

- Advances water more quickly
- Less deep percolation
- Better runoff management
- Better uniformity
- Increased irrigation efficiency



Surge vs. Continuous



Irrigation Efficiency through Time Management

- ▶ WATCH YOUR IRRIGATION SET TIMES
 - ▶ Work with NRCS, Extension, or ABE Department to calculate the optimal time of irrigation
 - ▶ Have irrigator accurately keep track of time
 - ▶ Don't move water when convenient
 - ▶ 60 minutes per irrigation at a rate of 5 cfs over 7 irrigations wastes about 3 ac-ft of water per irrigation set.



Summary

- ▶ Goal is to minimize runoff and deep percolation
- ▶ Field Length
 - ▶ Shorter the field the higher the irrigation efficiency
 - ▶ Loose cropped land due to roads and turn rows
- ▶ Correct Stream Size
 - ▶ Match flow in furrow to
 - ▶ irrigation system
 - ▶ Soils - lighter soil \implies higher q (gpm per furrow)
 - ▶ Set Time
 - ▶ Don't waste water because you are "busy"

Saving Water In Agriculture



Irrigation training video in English and Spanish

Sponsored by ADWR, USBR, and USDA-NRCS

Available on line at:

<https://youtu.be/aFO4h8i-h6g> (English)

<https://youtu.be/3F97YRy4q4U> (Spanish)

Thank you to Bill Kranz, University of Nebraska Extension Irrigation Specialist, for exhibits used in this presentation

Irrigation Management Video

<https://youtu.be/c3DeW2Hq8WM>



**Flood Irrigation
Management**

Thank You!

Questions?

