Optimization of On-Farm Practices in Response to Urbanization Pressures on Water Rights

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Colorado, USA

https://www.regenmg.com

Presentation:

- Regenesis MG, the research team, and the cooperation.
- Background on western water rights under prior appropriation.
- Consideration of alternative farming practices.
- Implementation strategies.
- Proof of concept projects.
- Discussion / questions.

Who we are:

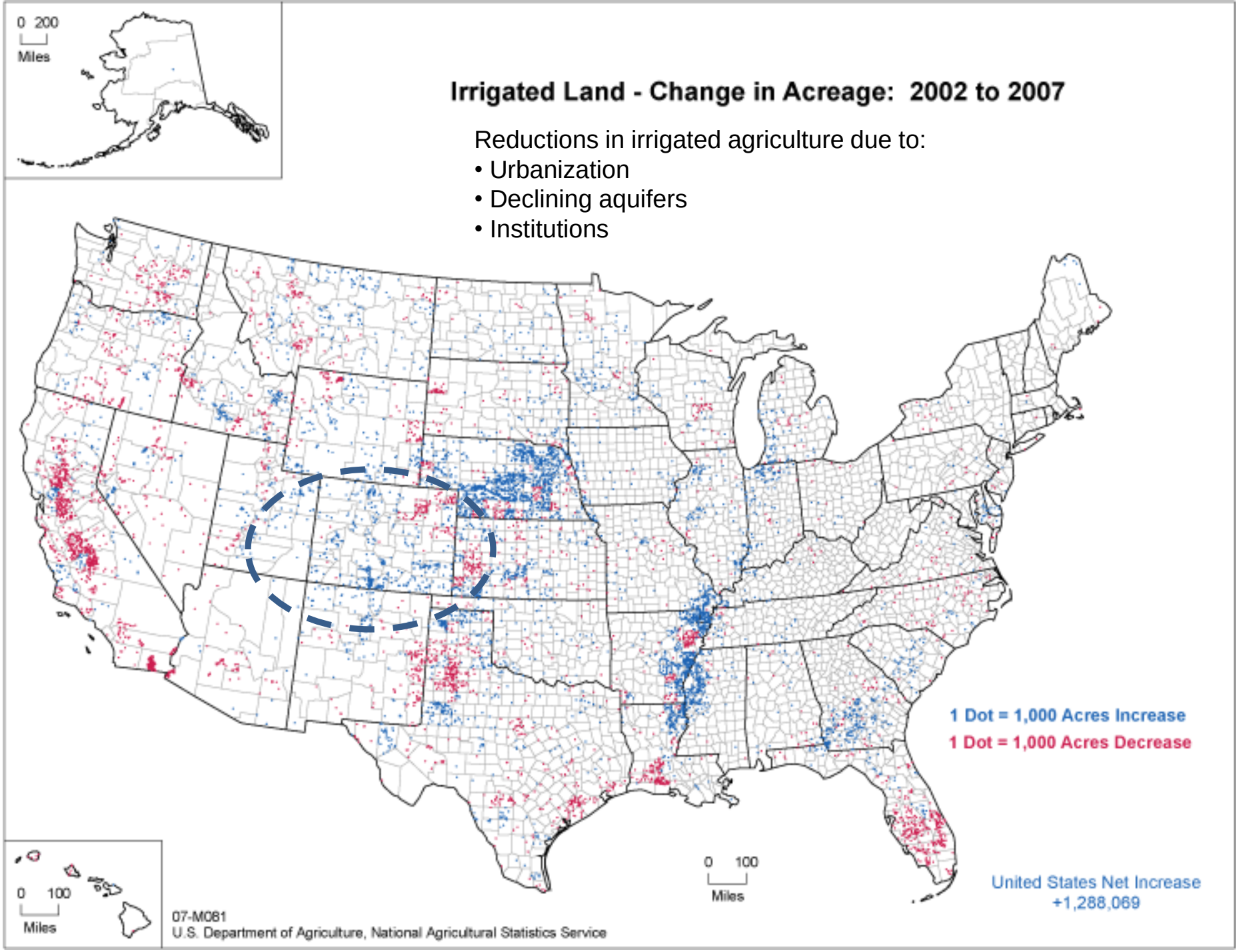
Underpinned by researchers:

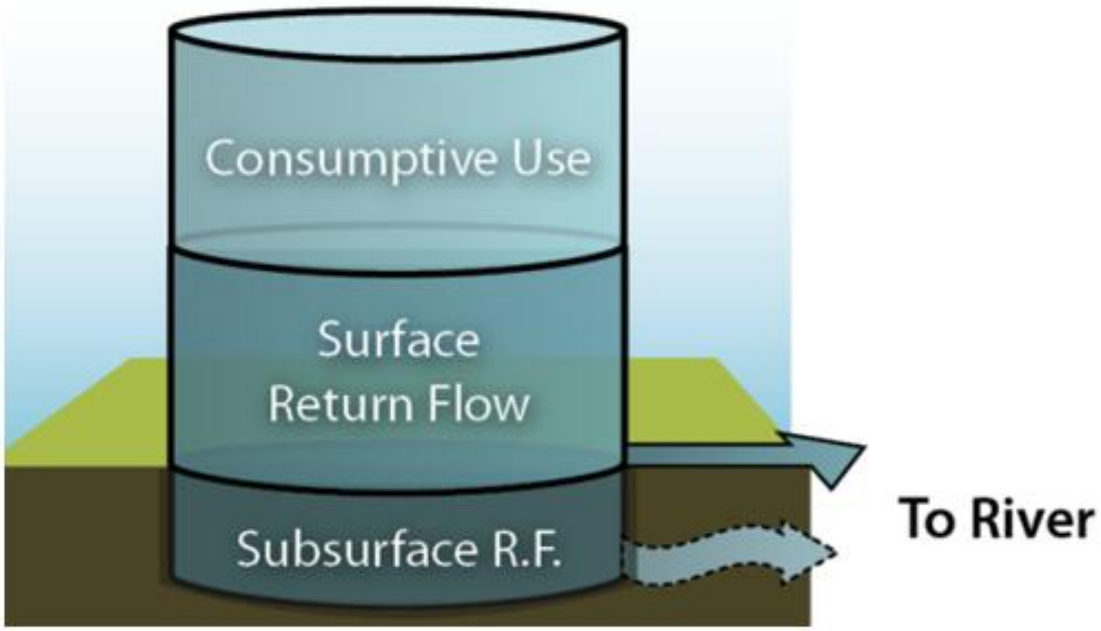
With USDA ARS, we work together under a CRADA – a cooperative research and development agreement – a private / government partnership to develop and deploy intellectual property.

Dr. Tom Trout is our research leader and he is here at the conference – speaking tomorrow.

Ag to urban water transfers:

- Driven by western U.S. population growth and municipal interests in developing a safe yield with their water supplies.
- Too often transfers are accomplished with "buy and dry" (permanent dry up of the farm) strategies.
- Question: can we avoid "buy and dry"?
- With SWIIM, some farmers will evaluate their future operations as a consumptive use (CU) water budget and ask themselves if they wish to adopt a package of changed practices in order to see a new and relatively low risk revenue stream added into their existing operations.


0 200
Miles
Irrigated Land - Change in Acreage: 2002 to 2007
Reductions in irrigated agriculture due to:
• Urbanization
• Declining aquifers
• Institutions
1 Dot = 1,000 Acres Increase
1 Dot = 1,000 Acres Decrease
0 100
Miles
United States Net Increase
+1,288,069
0 100
Miles
07-M081
U.S. Department of Agriculture, National Agricultural Statistics Service

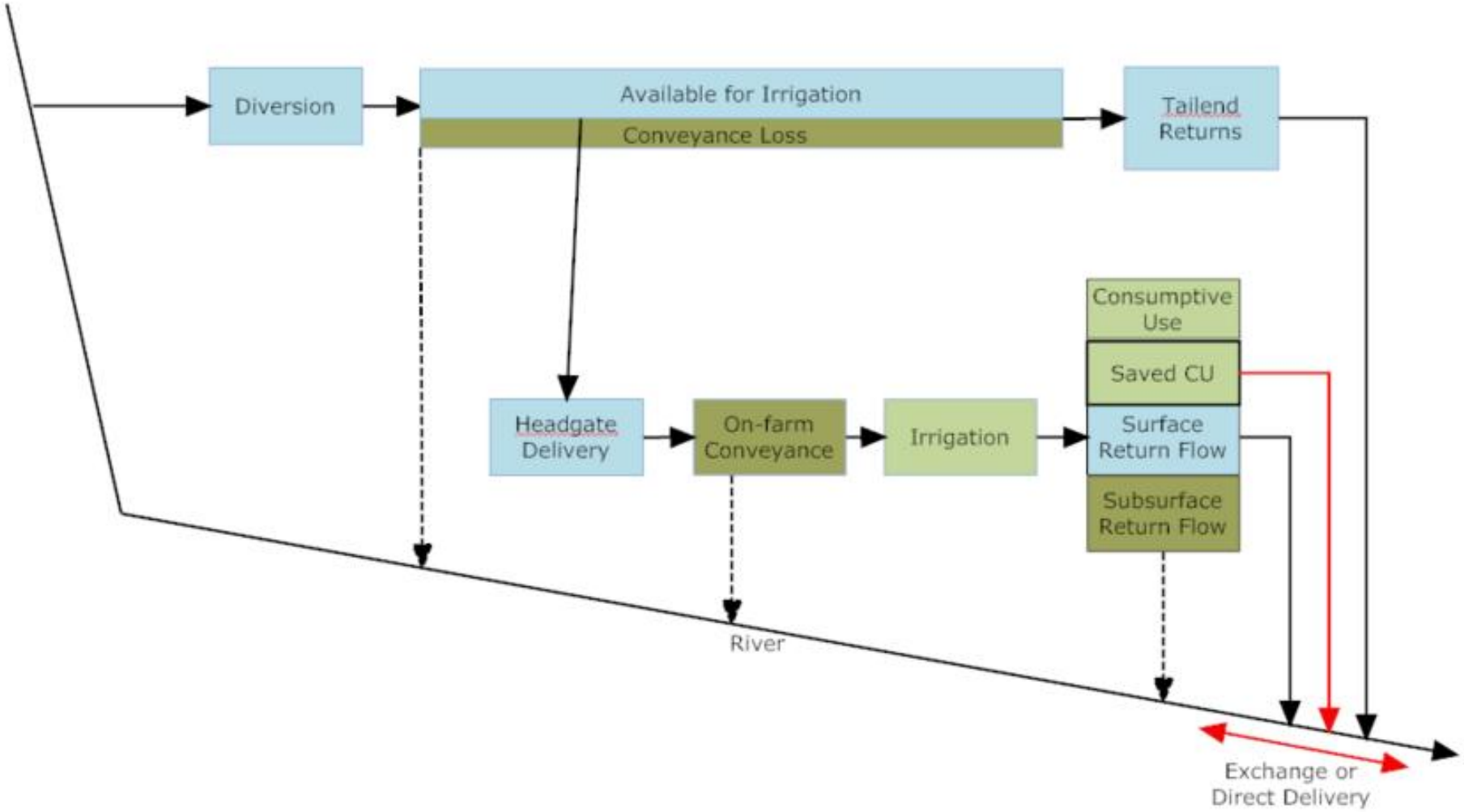


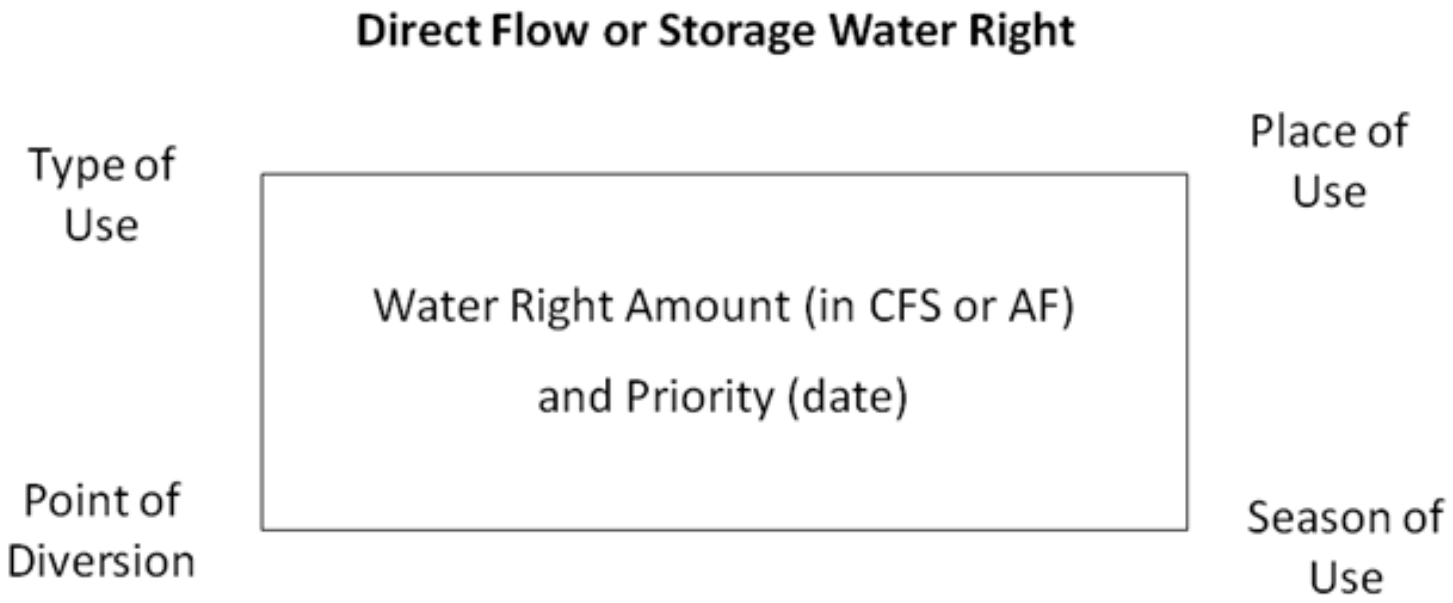
Quantification of Historic Consumptive Use (CU) Water

Key points:

Return flows are obligated to the river in the historic pattern of time, place, flow, and volume. Return flows are some else's water right.

A farmer cannot increase their irrigation efficiency and then consumptively use more water because that "saved water" belongs to someone else on the river.


Diversion
Available for Irrigation
Conveyance Loss
Tailend Returns
Consumptive Use
Saved CU
Surface Return Flow
Subsurface Return Flow
Headgate Delivery
On-farm Conveyance
Irrigation
River
Exchange or Direct Delivery



Decreed Water Rights under Prior Appropriation

Sustainable Water and Innovative Irrigation Management®

SWIIM is a patent-pending technology package:

- A mathematical optimization.
- GIS mapping of the farm.
- SCADA-based monitoring.
- Wireless communications.
- Internet, server-based delivery of software.
- Instrumentation:
  - Water measurement.
  - Soil moisture measurement.
  - Remote sensing.

SWIIM must be:

- Practical.
- Affordable.
- Functional.
- Transparent (to other water users and the State regulators).

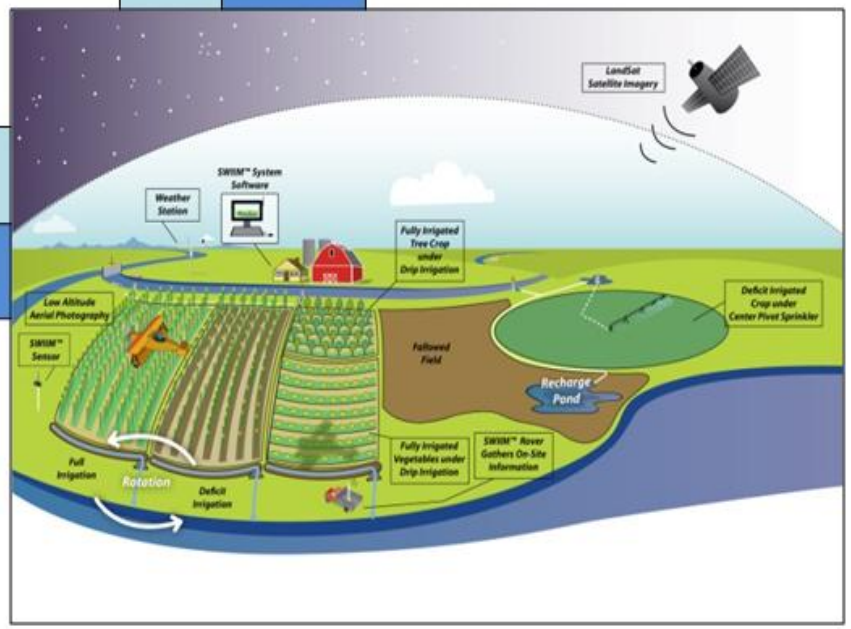
SWIIM™ System

SWIIM Planner

- GIS farm data entry
- Historic net returns
- Acceptable practices
- Mathematical optimization

SWIIM Manager

- SCADA Monitoring
- Water balance reporting
- Soil moisture sensing
- Remote sensing



Operational simulation:

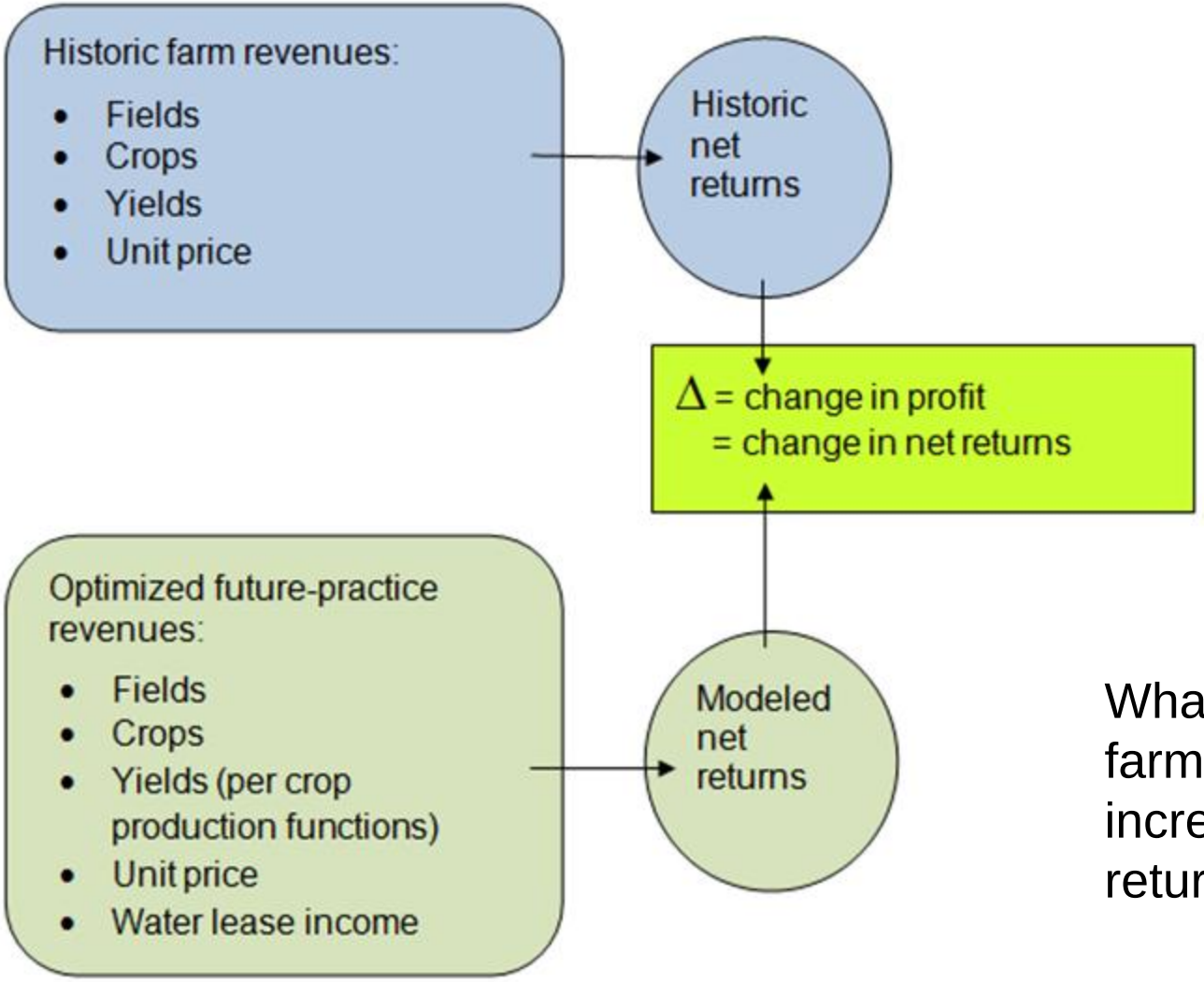
- Fields (GIS interface).
- Crops.
- Farming practices.
- Input costs.
- Crop prices.

http://www.nass.usda.gov/

Mathematical optimization:

- Objective function.
- Constraints.
- Decision variables.
- Parameters.

The objective function maximizes the net return to the farming operation given the constraints, decision variables, and parameters.



What might the farmer do with the increased net returns?

Farm improvements? EQIP?

Potential for changed farming practices:

- Deficit irrigation of selected crops.
- Crop rotations.
- Introduction of new crops including perennial crops.
- Permanent fallowing or rotational fallowing.
- Introduction of dryland crops.
- Continued full irrigation of selected crops.
- Combinations of the above.

What is
deficit irrigation?

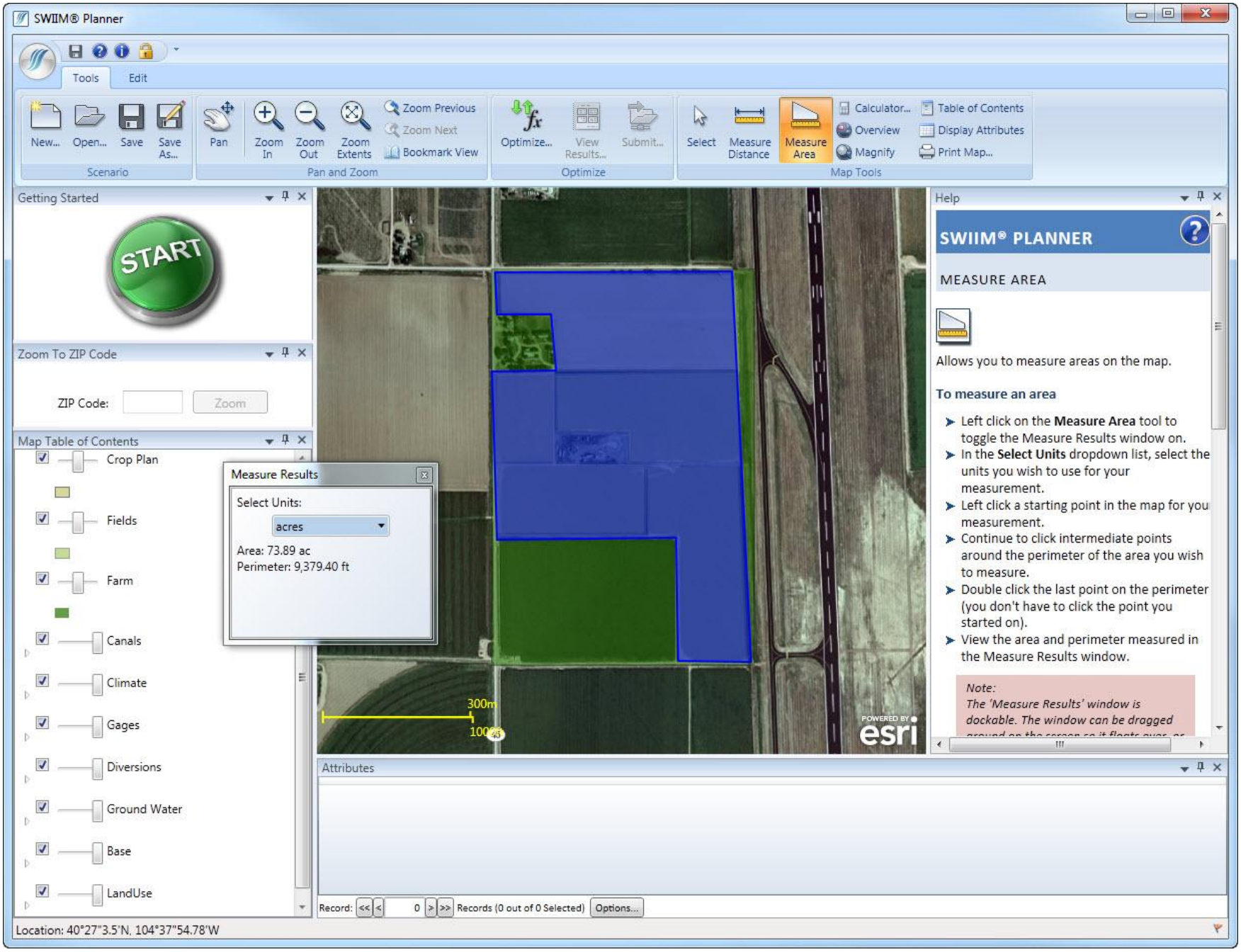
Deficit irrigation …

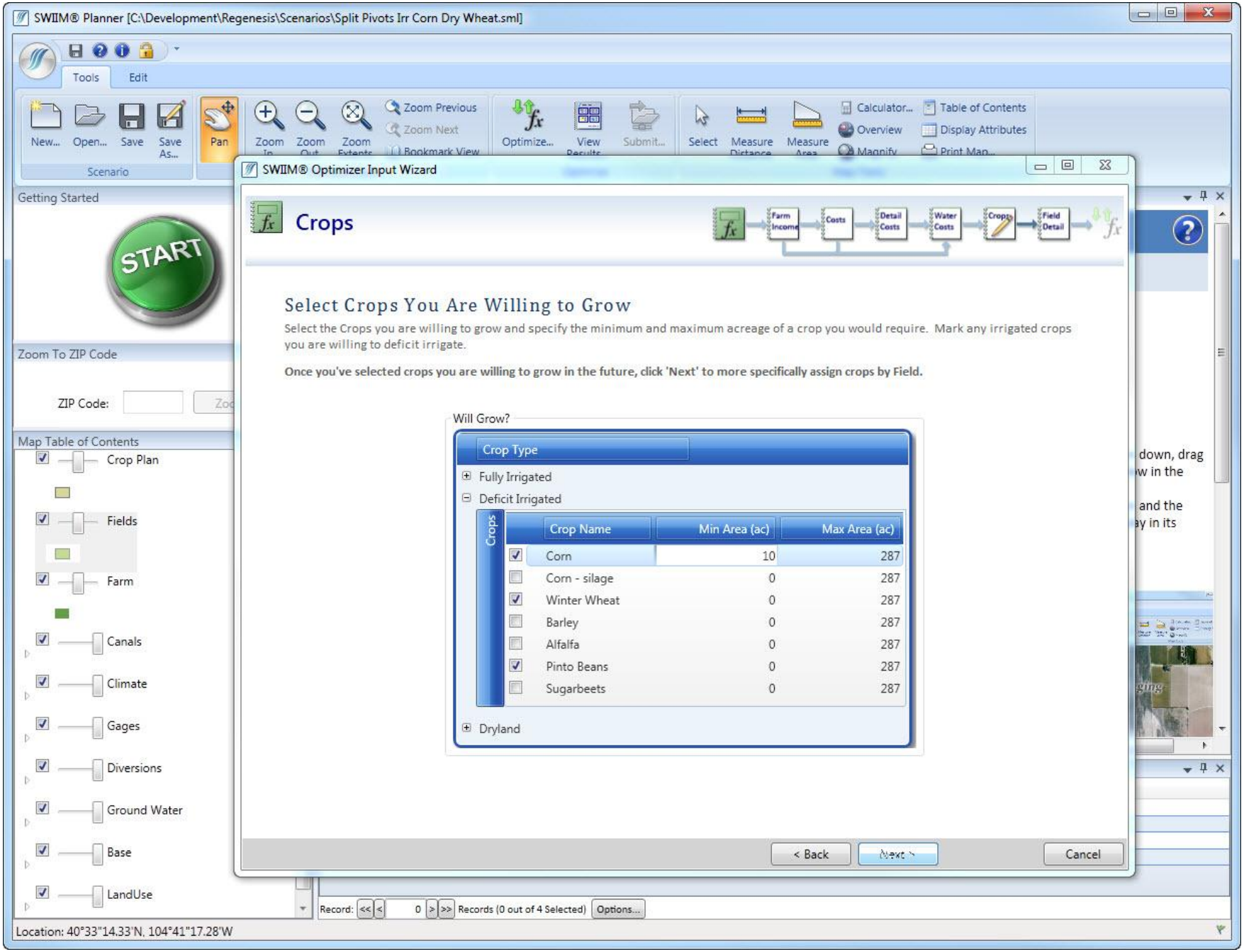
Irrigation that allows stress in a significant fraction of the (field) at times during the season.

– Marshall English, Oregon State Univ.

Deliberately tolerating stress for maximizing the productivity of water. -- Sam Geerts, Univ. of Leuven, Belgium

Irrigation at a level under the expectation of reduced crop yield with economics justifying the deficit. -- Freddie Lamb, Kansas State Univ.


SWIIM® Planner
Tools
Edit
New...
Open...
Save
Save As...
Scenario
Pan
Zoom In
Zoom Out
Zoom Extents
Zoom Previous
Zoom Next
Bookmark View
Pan and Zoom
Optimize...
View Results...
Submit...
Optimize
Select
Measure Distance
Measure Area
Calculator...
Overview
Magnify
Table of Contents
Display Attributes
Print Map...
Map Tools
Getting Started
START
Zoom To ZIP Code
ZIP Code:
Zoom
Map Table of Contents
Crop Plan
Fields
Farm
Canals
Climate
Gages
Diversions
Ground Water
Base
LandUse
Measure Results
Select Units:
acres
Area: 73.89 ac
Perimeter: 9,379.40 ft
300m
100
POWERED BY esri
Help
SWIIM® PLANNER
MEASURE AREA
Allows you to measure areas on the map.
To measure an area
Left click on the Measure Area tool to toggle the Measure Results window on.
In the Select Units dropdown list, select the units you wish to use for your measurement.
Left click a starting point in the map for you measurement.
Continue to click intermediate points around the perimeter of the area you wish to measure.
Double click the last point on the perimeter (you don't have to click the point you started on).
View the area and perimeter measured in the Measure Results window.
Note:
The 'Measure Results' window is dockable. The window can be dragged
Attributes
Record: << < 0 > >> Records (0 out of 0 Selected) Options...
Location: 40°27'3.5'N, 104°37'54.78'W


SWIIM® Planner [C:\Development\Regenesis\Scenarios\Split Pivots Irr Corn Dry Wheat.sml]
Tools
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New...
Open...
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Save As...
Scenario
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Zoom Extents
Zoom Previous
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Bookmark View
Optimize...
View Results
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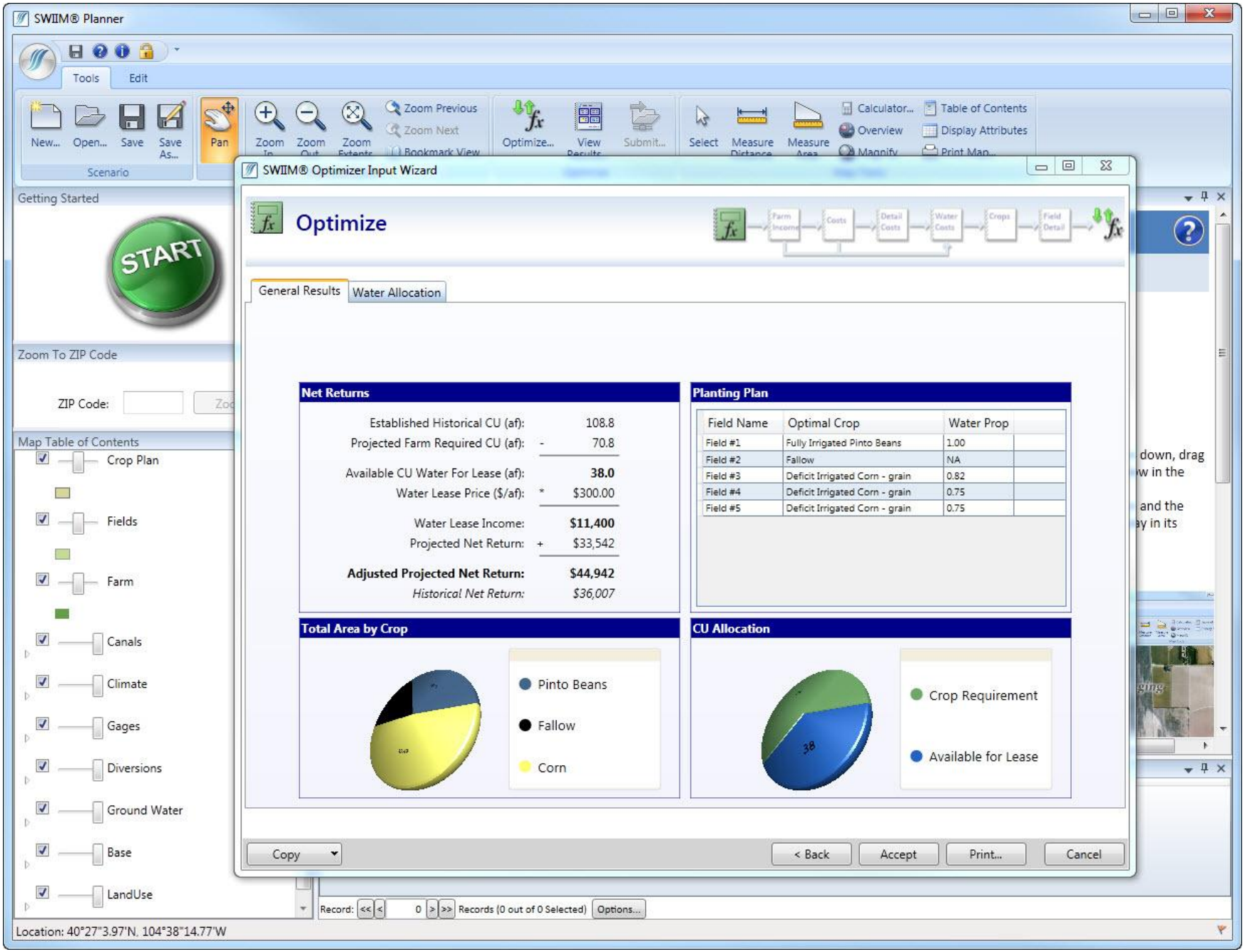
Measure Distance
Measure Area
Calculator...
Overview
Magnify
Table of Contents
Display Attributes
Print Map...
Getting Started
START
Zoom To ZIP Code
ZIP Code:
Map Table of Contents
Crop Plan
Fields
Farm
Canals
Climate
Gages
Diversions
Ground Water
Base
LandUse
SWIIM® Optimizer Input Wizard
Crops
Farm Income
Costs
Detail Costs
Water Costs
Crops
Field Detail
Select Crops You Are Willing to Grow
Select the Crops you are willing to grow and specify the minimum and maximum acreage of a crop you would require. Mark any irrigated crops you are willing to deficit irrigate.
Once you've selected crops you are willing to grow in the future, click 'Next' to more specifically assign crops by Field.
Will Grow?
Crop Type
Fully Irrigated
Deficit Irrigated
Crops
Crop Name
Min Area (ac)
Max Area (ac)
Corn 10 287
Corn - silage 0 287
Winter Wheat 0 287
Barley 0 287
Alfalfa 0 287
Pinto Beans 0 287
Sugarbeets 0 287
Dryland
< Back
Next >
Cancel
Record: 0 Records (0 out of 4 Selected) Options...
Location: 40°33'14.33'N, 104°41'17.28'W


SWIIM® Planner
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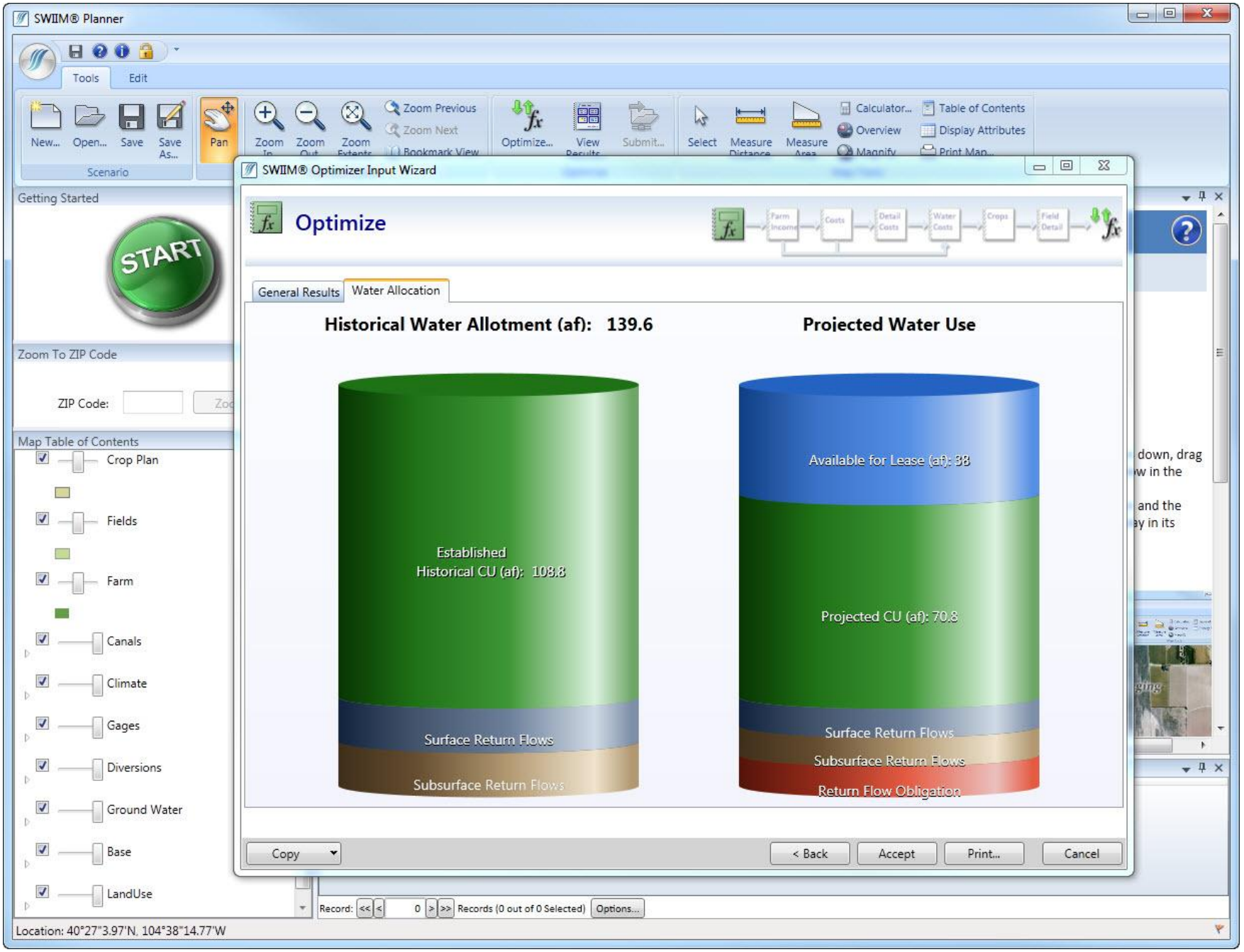
Zoom To ZIP Code
ZIP Code:
Map Table of Contents
Crop Plan
Fields
Farm
Canals
Climate
Gages
Diversions
Ground Water
Base
LandUse
Record: 0 Records (0 out of 0 Selected) Options...
Location: 40°27'3.97"N, 104°38'14.77"W
SWIIM® Optimizer Input Wizard
Optimize
General Results
Water Allocation
Net Returns
Established Historical CU (af): 108.8
Projected Farm Required CU (af): - 70.8
Available CU Water For Lease (af): 38.0
Water Lease Price ($/af): * $300.00
Water Lease Income: $11,400
Projected Net Return: + $33,542
Adjusted Projected Net Return: $44,942
Historical Net Return: $36,007
Planting Plan
Field Name | Optimal Crop | Water Prop
Field #1 | Fully Irrigated Pinto Beans | 1.00
Field #2 | Fallow | NA
Field #3 | Deficit Irrigated Corn - grain | 0.82
Field #4 | Deficit Irrigated Corn - grain | 0.75
Field #5 | Deficit Irrigated Corn - grain | 0.75
Total Area by Crop
Pinto Beans
Fallow
Corn
CU Allocation
38
Crop Requirement
Available for Lease
Copy
< Back
Accept
Print...
Cancel


SWIIM® Planner
Tools
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Crop Plan
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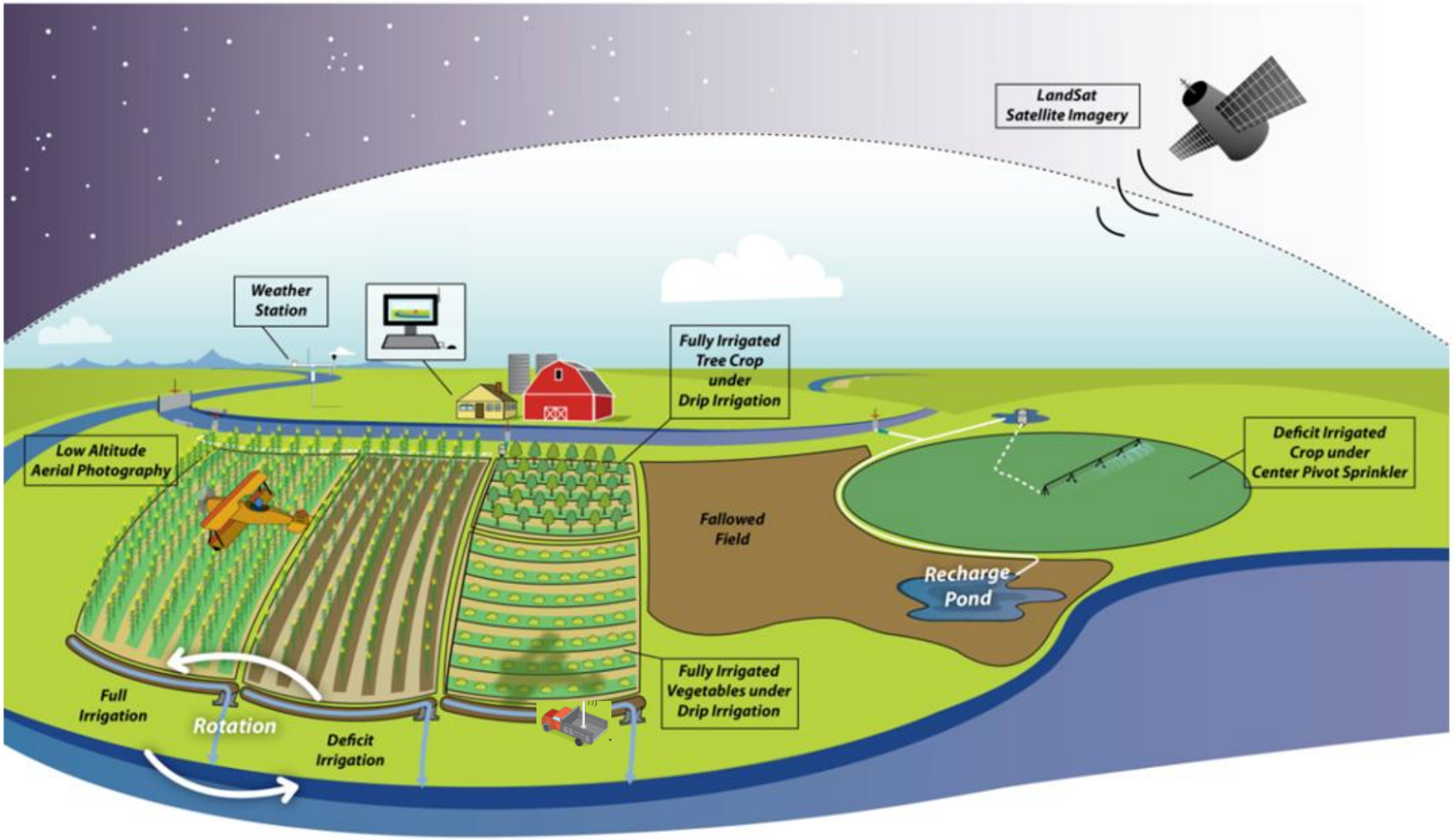
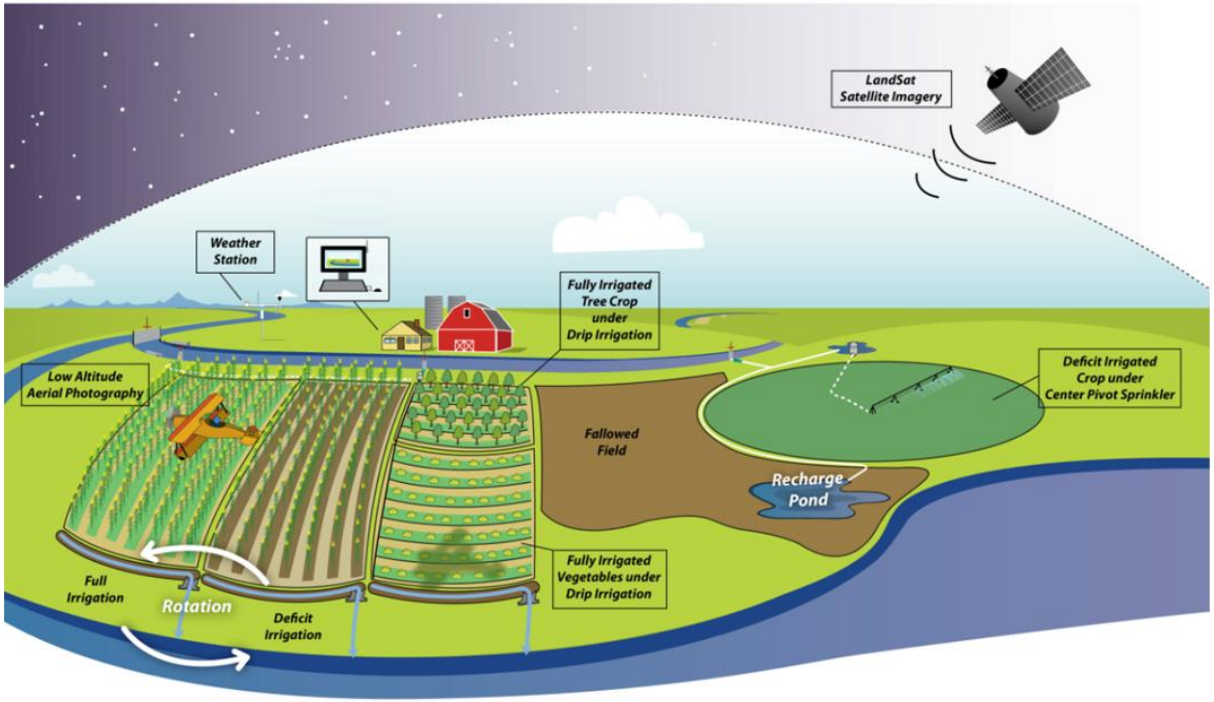
Farm
Canals
Climate
Gages
Diversions
Ground Water
Base
LandUse
SWIIM® Optimizer Input Wizard
Optimize
General Results
Water Allocation
Historical Water Allotment (af): 139.6
Established
Historical CU (af): 108.8
Surface Return Flows
Subsurface Return Flows
Projected Water Use
Available for Lease (af): 38
Projected CU (af): 70.8
Surface Return Flows
Subsurface Return Flows
Return Flow Obligation
Copy
< Back
Accept
Print...
Cancel
Record:
Records (0 out of 0 Selected)
Options...
Location: 40°27'3.97"N, 104°38'14.77"W



A characterization of a full single-farm SWIIM® implementation.

As to the irrigation system:

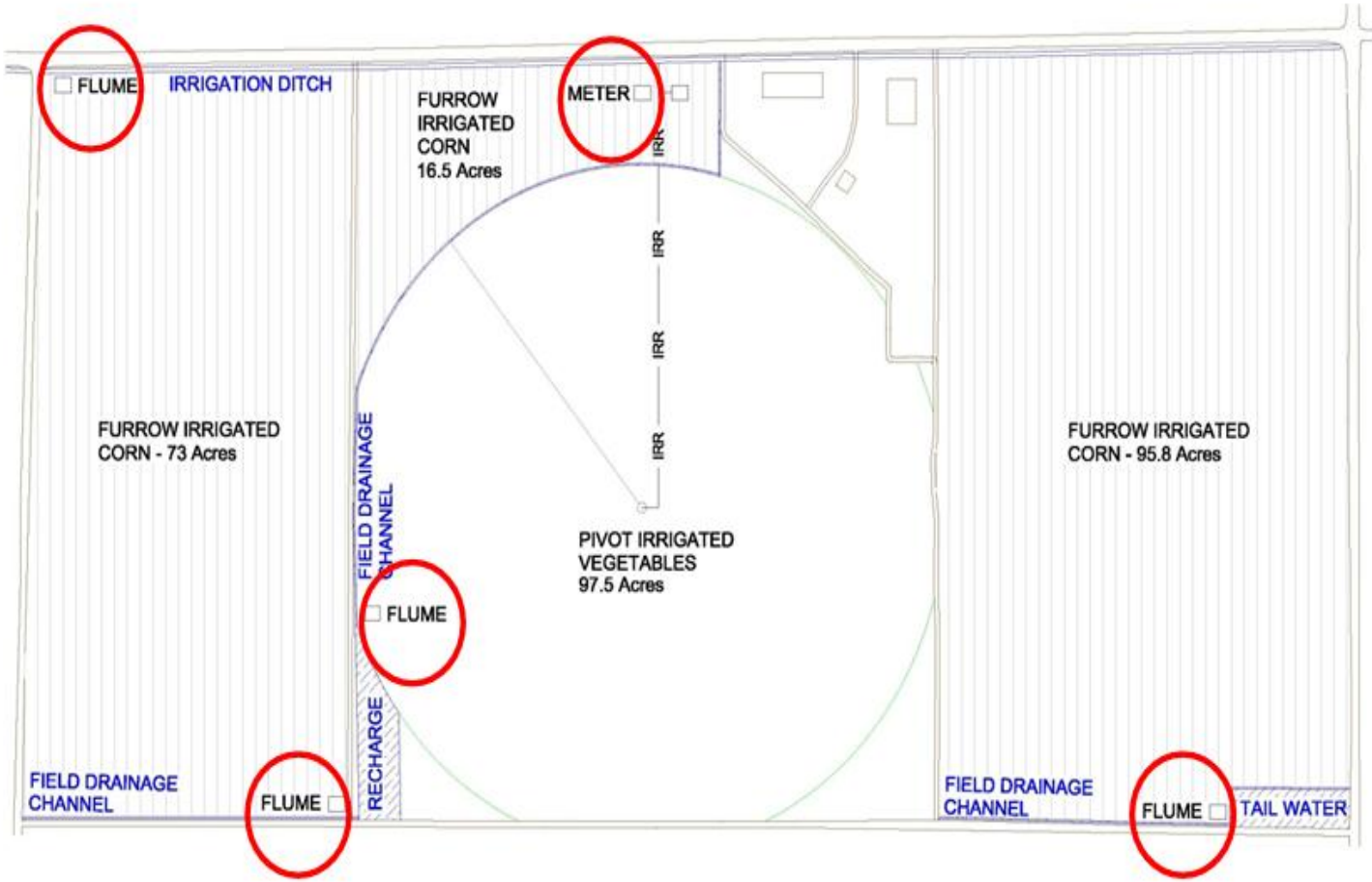
"Do not get wedded to a technology. It's a dance."-- Jack Keller

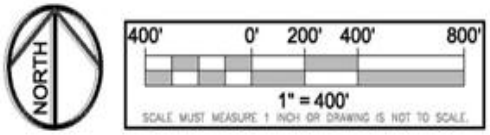


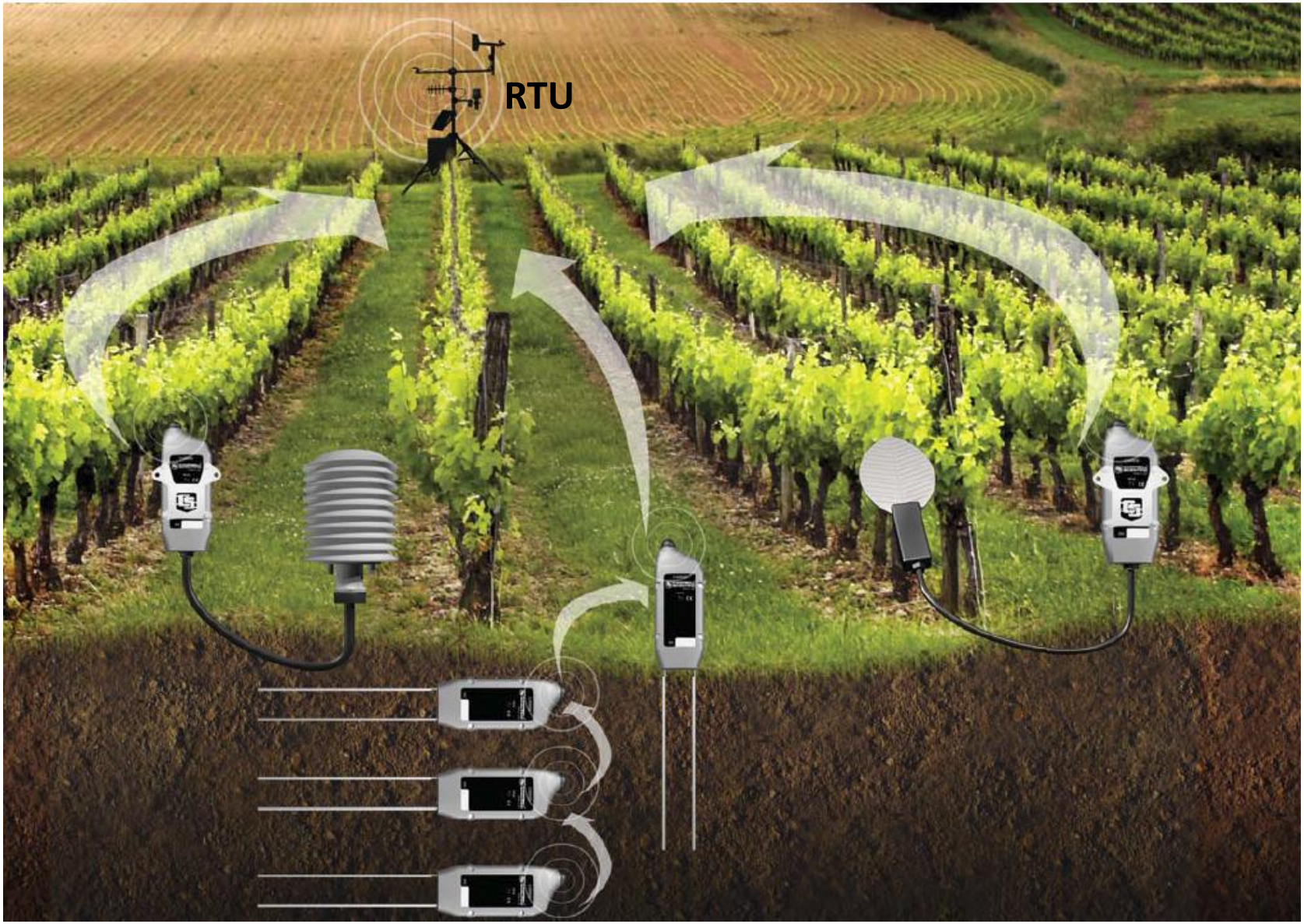
Instrumentation:

- Weather stations.
- Flow measurements.
- Soil moisture monitoring.
- Ground truth for stress conditions.

GeoVantage strut mount and setup for Cessna 150, 172, and 182.

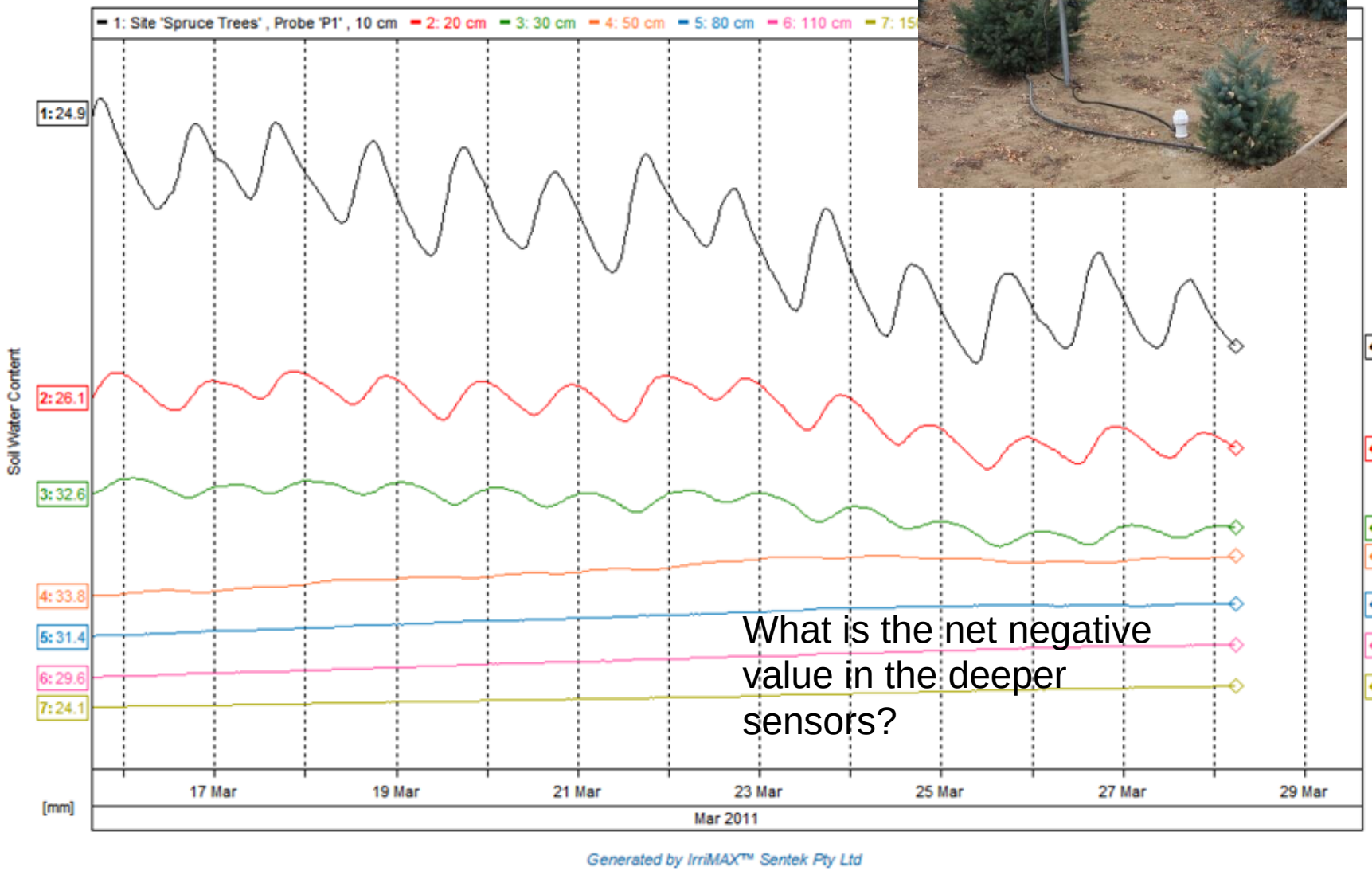

FLUME
IRRIGATION DITCH
FURROW
IRRIGATED
CORN
16.5 Acres
METER
IRR
IRR
IRR
IRR
FURROW IRRIGATED
CORN - 73 Acres
FIELD DRAINAGE
CHANNEL
PIVOT IRRIGATED
VEGETABLES
97.5 Acres
FURROW IRRIGATED
CORN - 95.8 Acres
FLUME
RECHARGE
FIELD DRAINAGE
CHANNEL
FLUME
FIELD DRAINAGE
CHANNEL
FLUME
TAIL WATER


NORTH
400'
0'
200'
400'
800'
1" = 400'
SCALE MUST MEASURE 1 INCH OR DRAWING IS NOT TO SCALE.

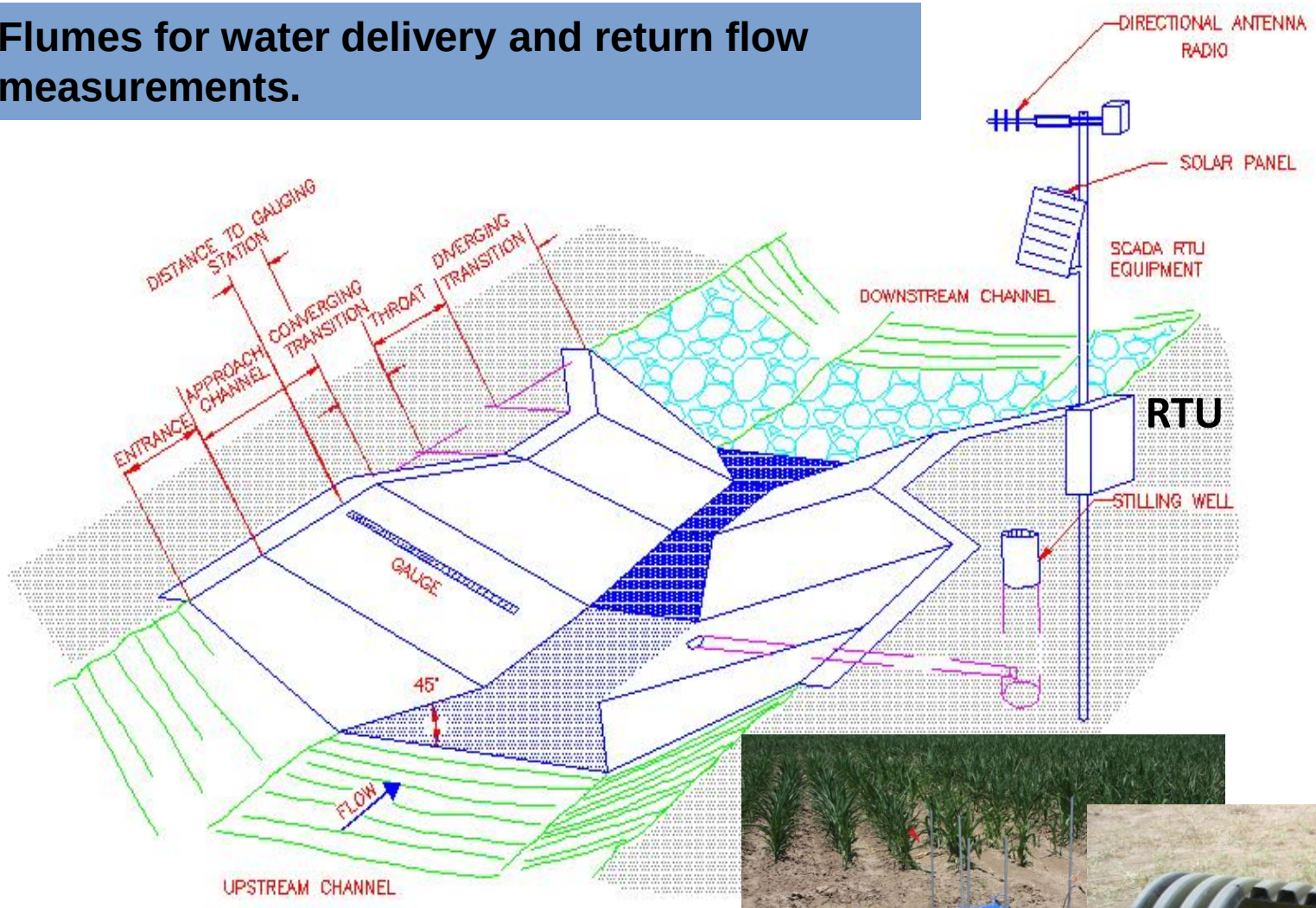


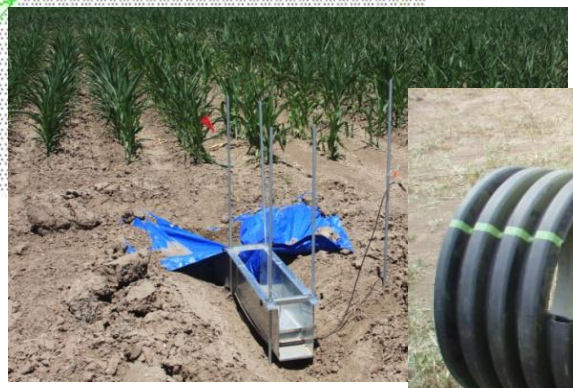
Graphic provided by Campbell Scientific

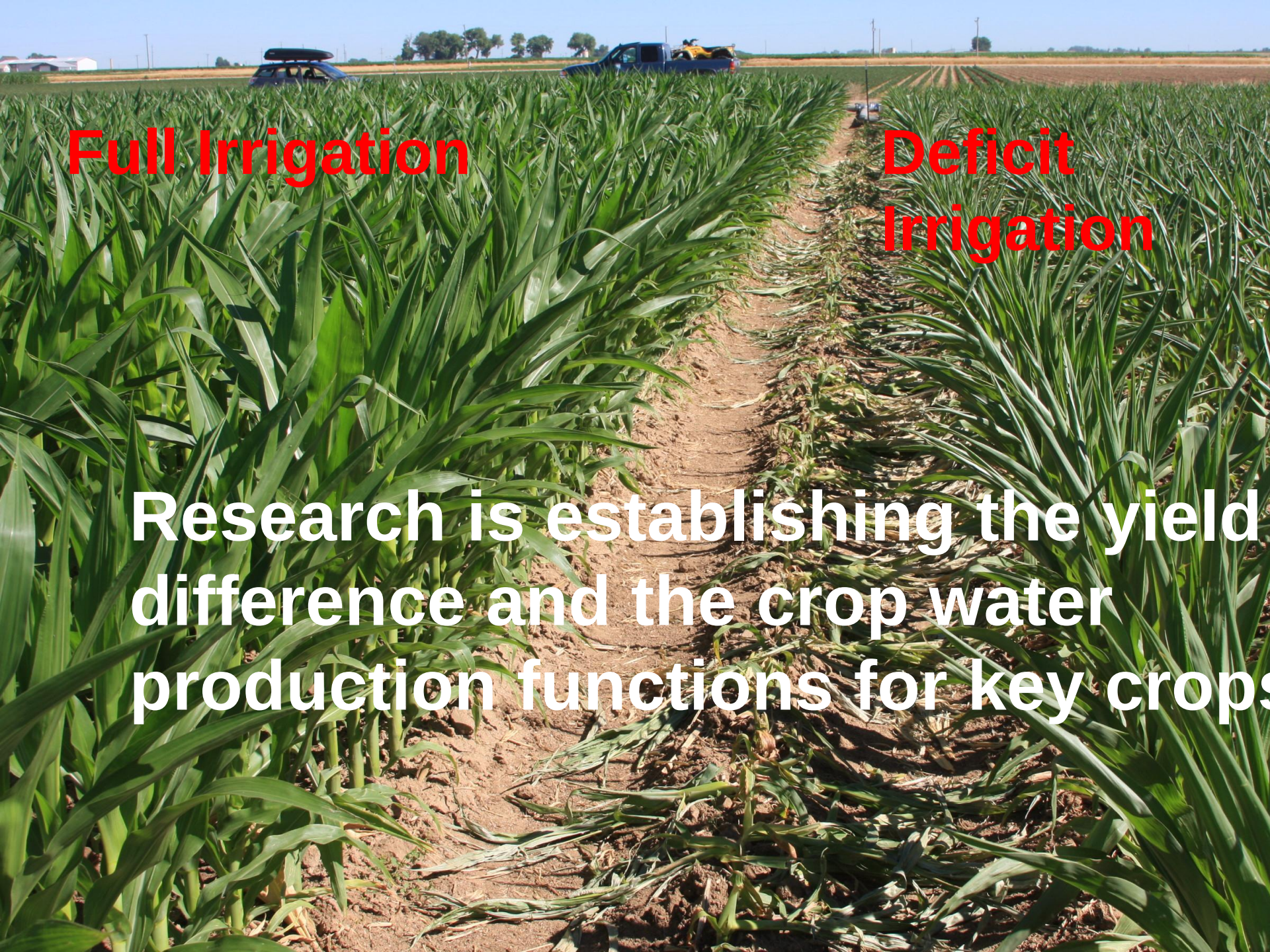
A vertical array of soil moisture sensors.



Flumes for water delivery and return flow measurements.



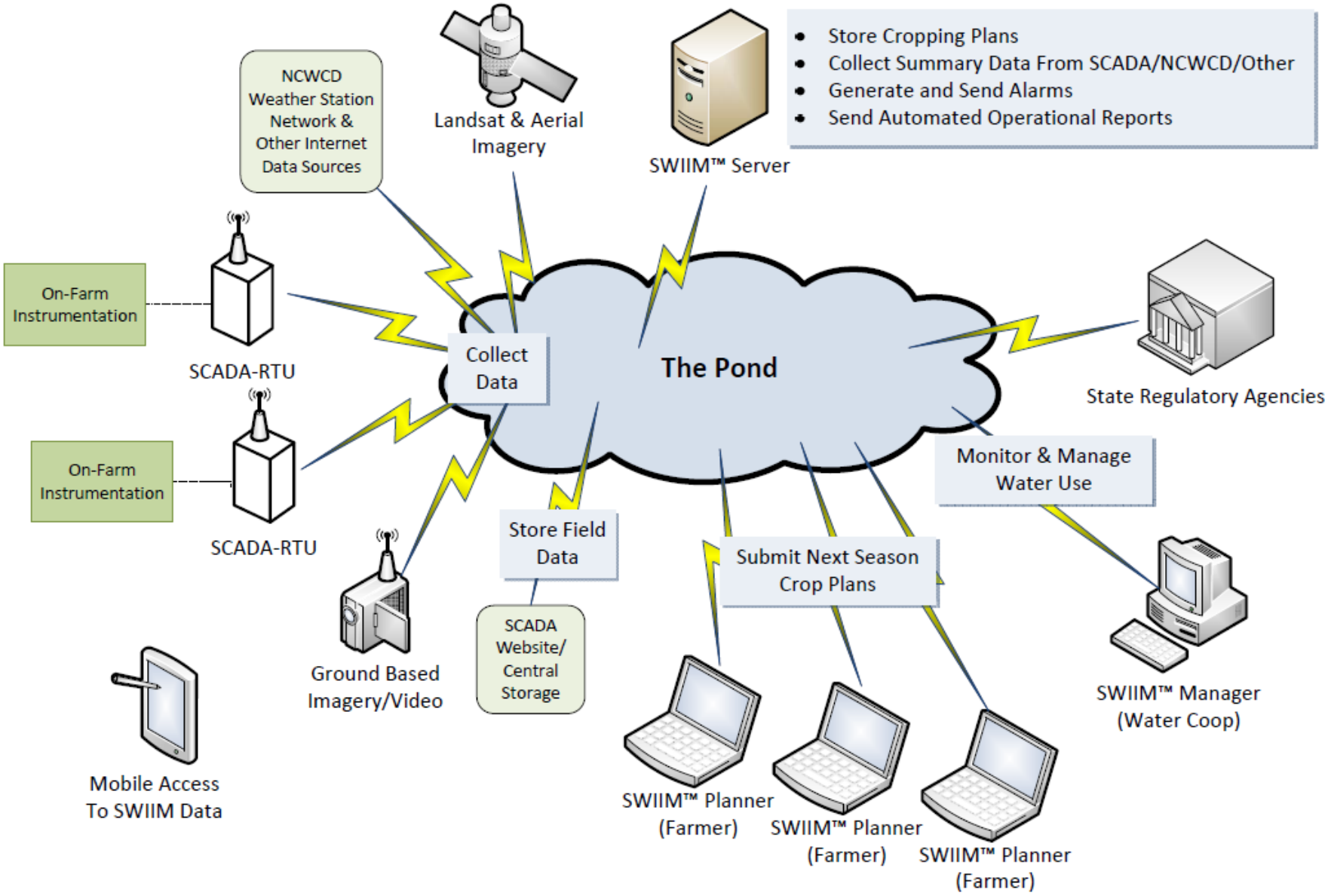



Full Irrigation
Deficit Irrigation
Research is establishing the yield difference and the crop water production functions for key crops

Sample # 1 #2 #3

Corn ear samples from the research site - August 2010

SWIIM™ Instrumentation Architecture

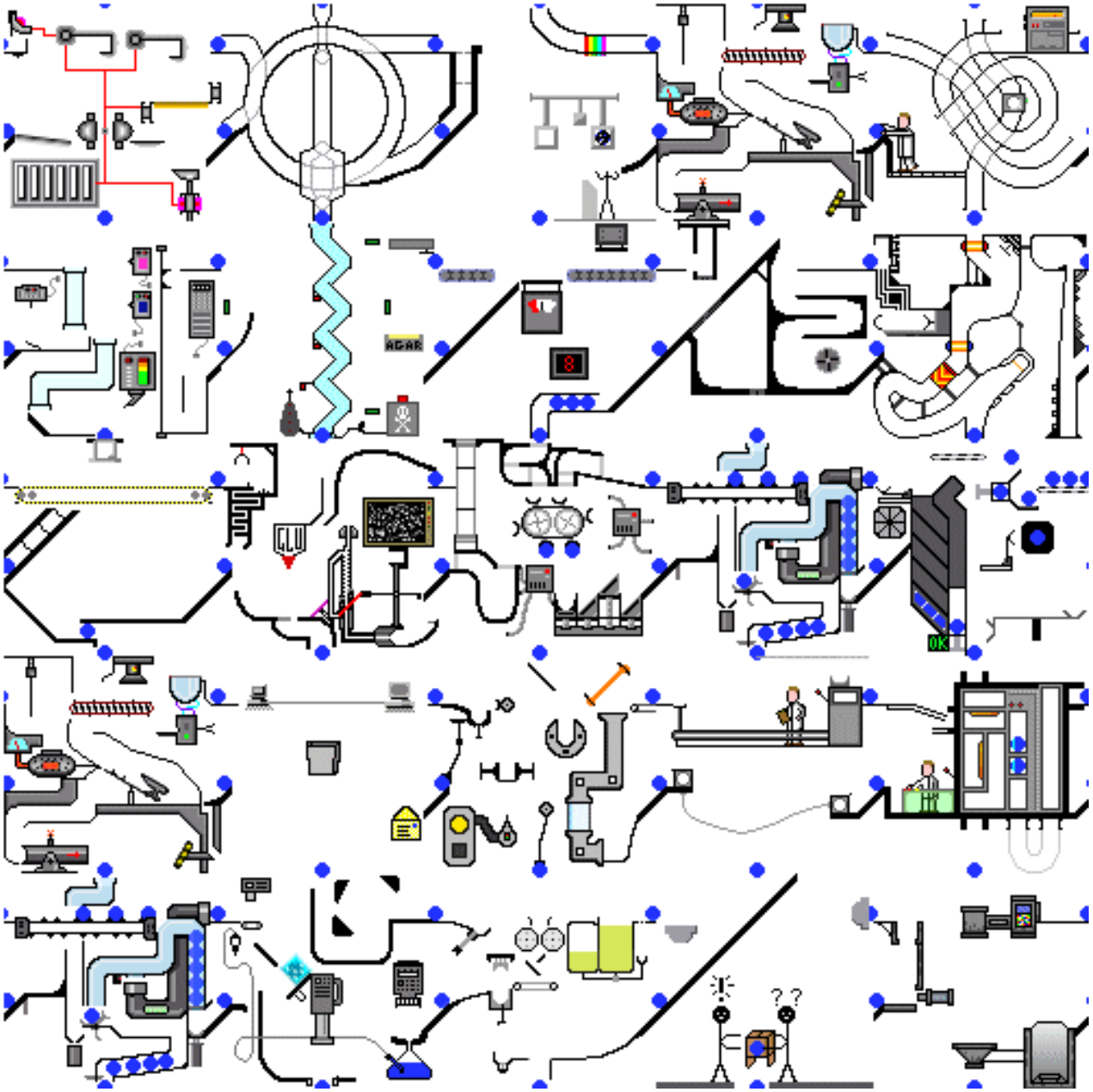


Spring 2013 proof of concept strategy:

- Procuring and installing instrumentation on farms on the South Platte River in Colorado.
- Building a small transferable CU water block.
- Transferring water in Spring 2013 as validation and proof of concept.
  - Politics
  - Sociology

Summarizing:

The following graphic will make everything perfectly clear and understandable …


CLU
OK

Obrigado!

Stephen Smith, PhD
Regenesis Management Group

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http://www.swiimsystem.com

swiim™
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