

# EFFECTS OF USE OF GIS AS A REAL TIME DECISION SUPPORT SYSTEM FOR IRRIGATION DISTRICTS IN TEXAS

*Sixth International Conference on Irrigation and Drainage*

San Diego, California

The Struggle for Efficiency — Actions and  
Consequences

November 15-18, 2011

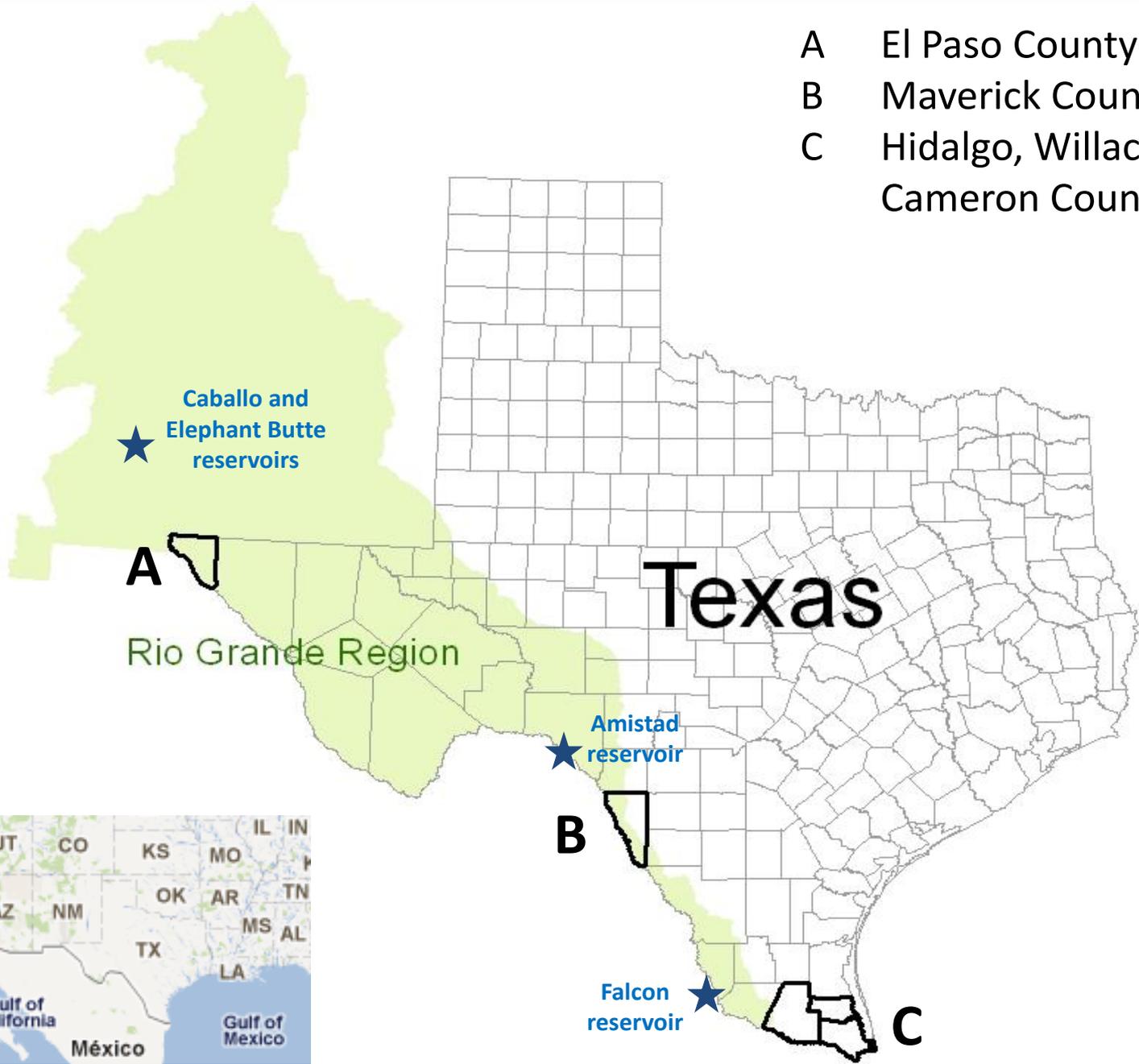
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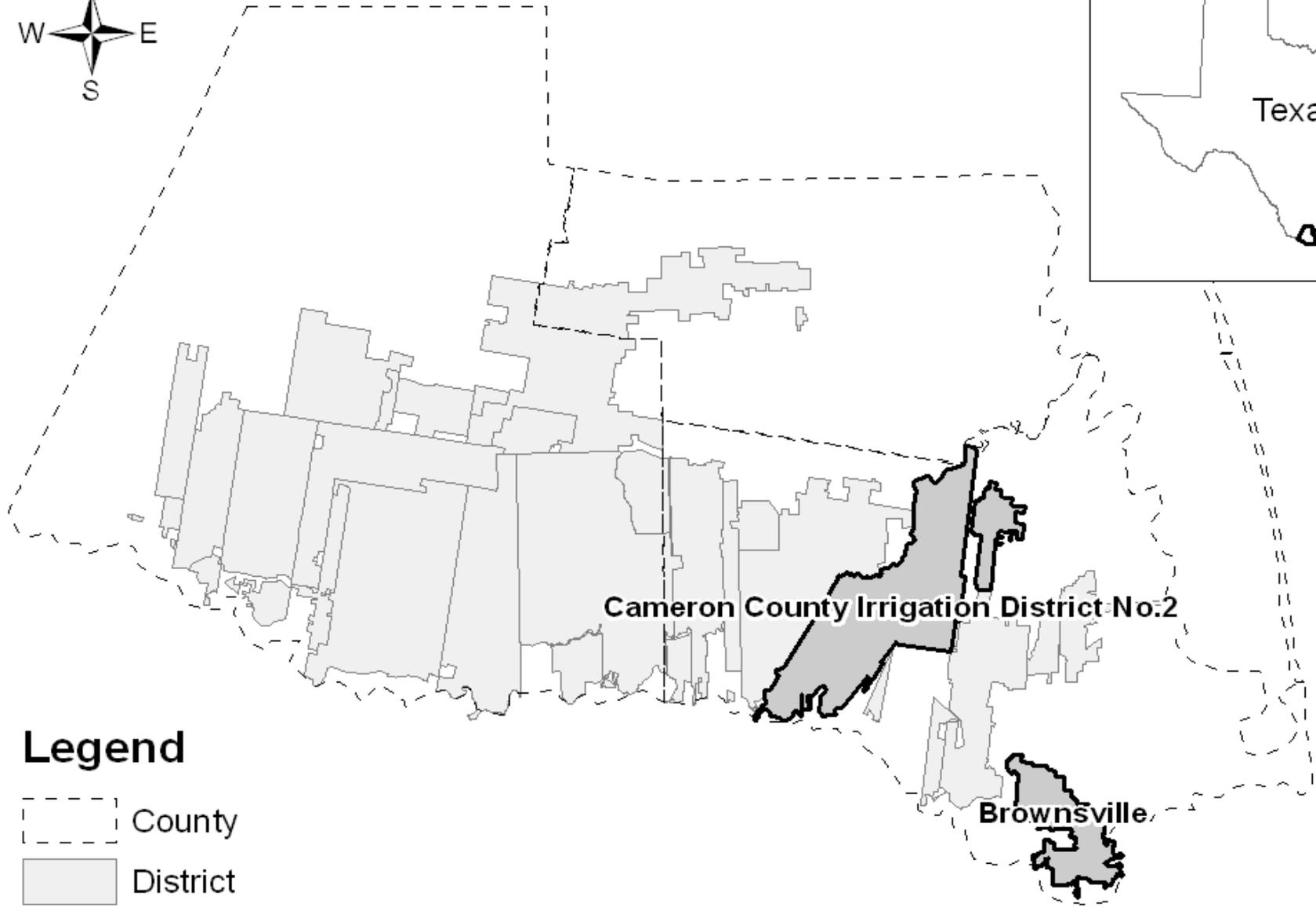
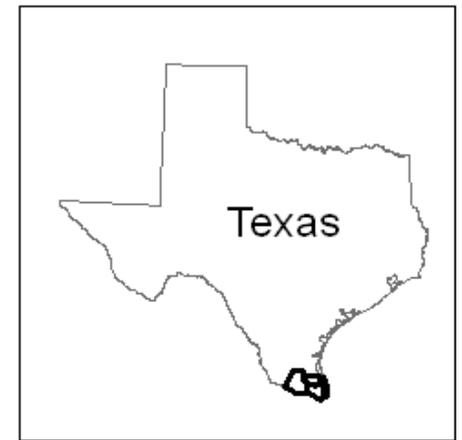
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- A El Paso County
- B Maverick County
- C Hidalgo, Willacy, and Cameron Counties

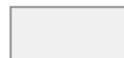


# LOWER RIO GRANDE VALLEY

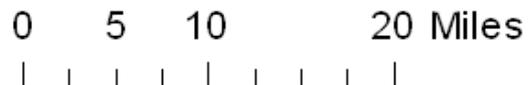


## Legend

 County

 District

 CCID2 and BID



# INTRODUCTION

- Irrigation districts in Texas are aware that more is to be done in terms of efficiency and data management, and that GIS can be a useful tool
- SCADA systems and online information are more being used and linked to GIS
- The integration of these tools, though, is hardly achieved
- Security is an issue when sensitive data are to be displayed online

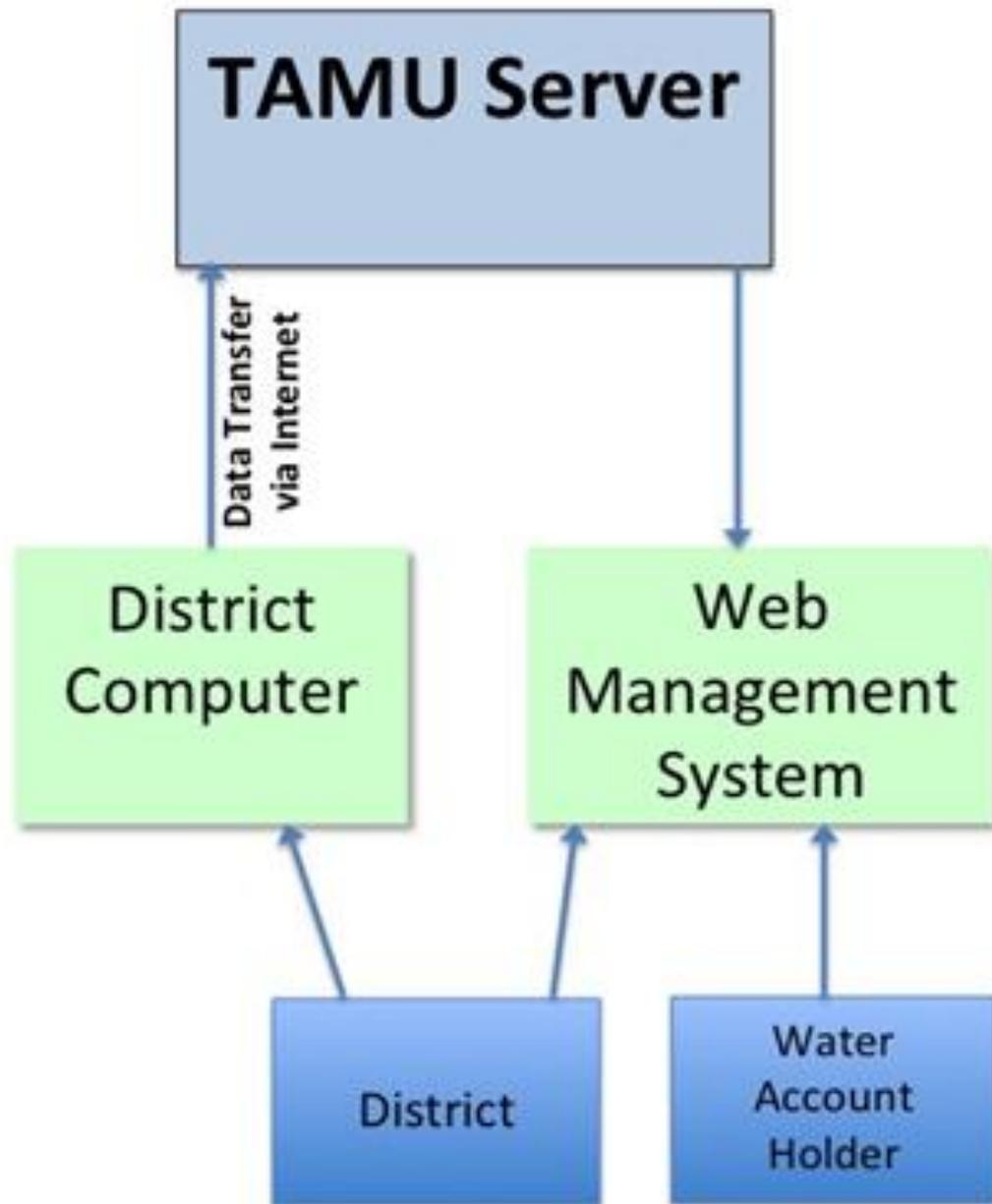
# INTRODUCTION

- We selected irrigation districts with detailed information on water accounts and flows in the canals, with the general objective to improve the efficiency of daily water management
- Two districts that begun in 2009 and 2010. GIS was linked to daily water accounting information and to real time water flow monitoring, and posted in the district website
- Objective of identifying problems and recommendations, proposing changes, and evaluating the effects of adopted changes

# FEATURES

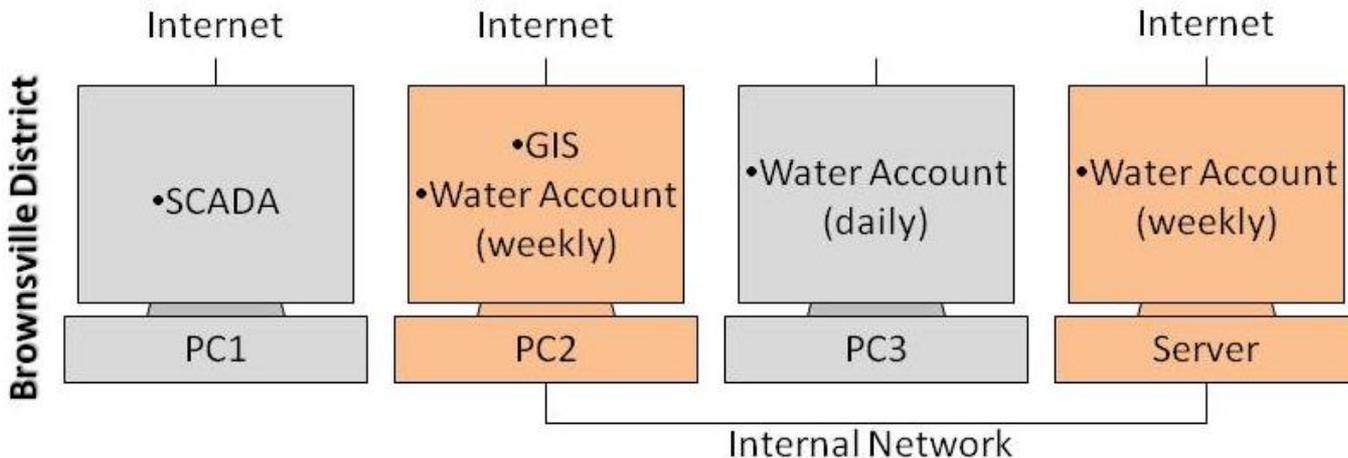
# Improved and simplified management of databases

Problems	Recommended changes
Data are in standalone machines	Connect machines to the network
<b>Water account</b>	
Format is encrypted Infrequent update Irrigated fields ID are missing Crop information is missing	Use standard format Update daily Add irrigated fields ID Add crop information
<b>SCADA</b>	
Data are hidden	Use standard format
<b>GIS</b>	
Is not properly drawn Is not up to date Irrigated fields are missing	Correct data Update at least yearly Add irrigated fields

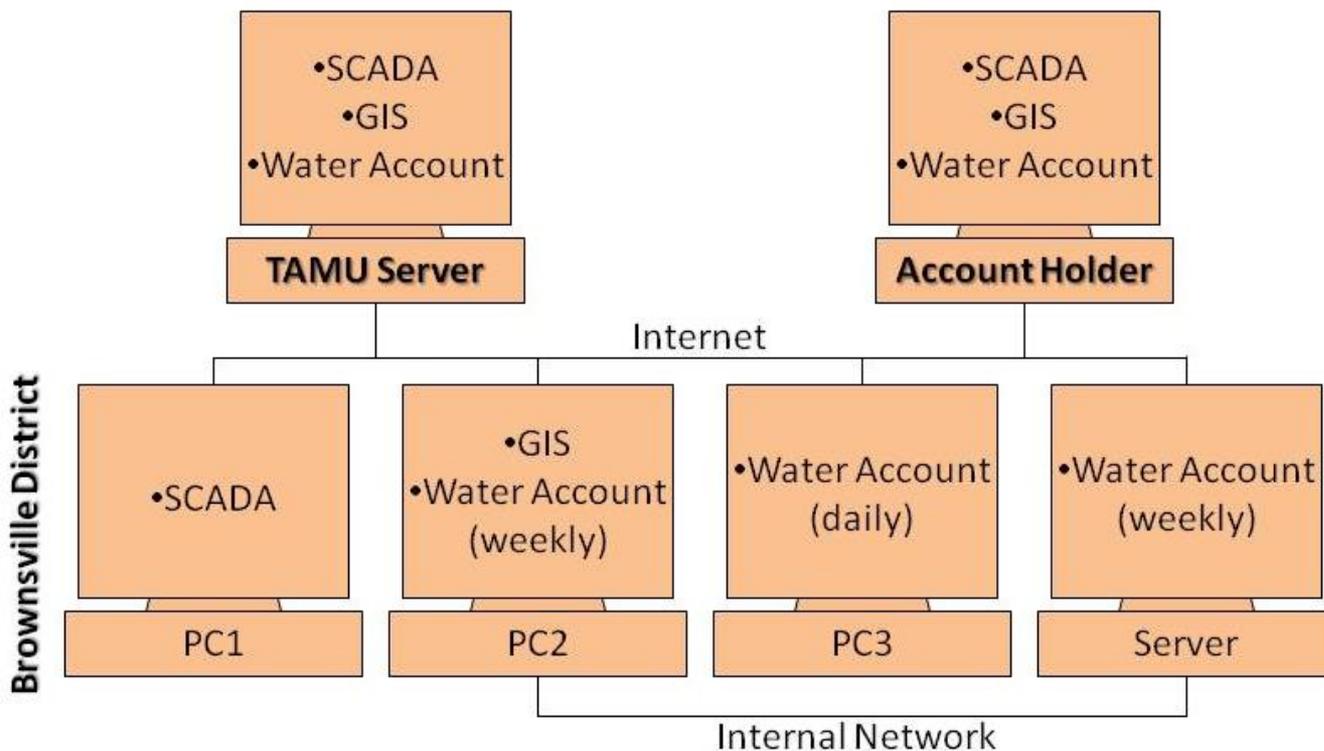


# BID Example

**BEFORE:**



**AFTER:**



# Establishing Data Transfer to TAMU server

1. Automatic extraction of data from existing District database
  - SCADA (polled every 15 minutes)
  - Water accounts (polled once a day)
2. Transfer of data to TAMU server via the Internet
3. Partition of data into a SQL Server database

## Example of data to be included:

- SCADA
  - Pumps status
  - Water levels
  - Gate position
  - Current and cumulative flow
  - Alarms based on water levels
- Water account
  - Water sales
- GIS
  - Water accounts shape

# Web-based tools for use of data through the Internet

# Example 1

- **Query and download real time and historical SCADA data as spreadsheet and charts**

# Cameron County Irrigation District No.2

CCID2

1301 F.M. 510

SAN BENITO, TEXAS 78586

956/ 399-2484

March 15, 2011

**Office Hours**

Mon-Thur: 7:00-5:30

Fri: 8:00-5:00

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Previous Day Summary

(# of days)

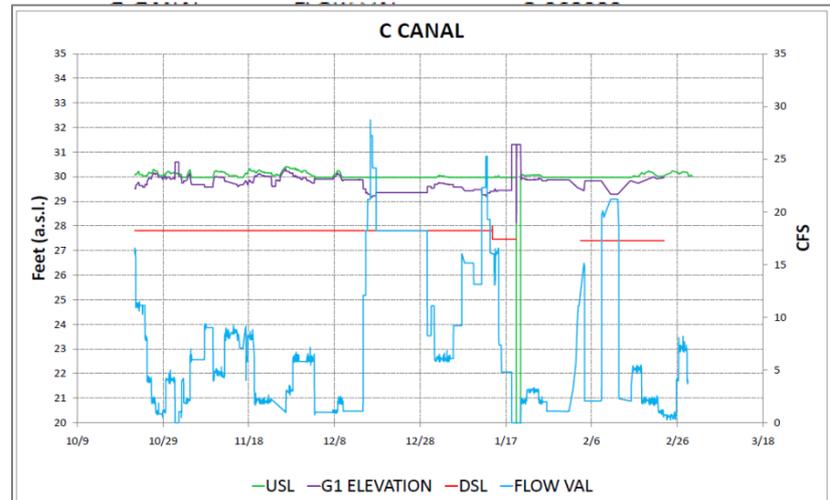
Specify Dates (enter data below)

Start Date  (mm/dd/yyyy)

Stop Date  (mm/dd/yyyy)

Query Data

Date	Canal	Data Type	Value
03/15/2011 10:03:49 AM	C CANAL	FLOW VAL	2.861000
03/15/2011 9:52:49 AM	C CANAL	FLOW VAL	3.085000
03/15/2011 9:19:08 AM	C CANAL	FLOW VAL	2.846000
03/14/2011 9:23:41 PM	C CANAL	FLOW VAL	3.088000
03/14/2011 8:26:35 PM	C CANAL	FLOW VAL	3.090000
03/14/2011 6:55:50 PM	C CANAL	FLOW VAL	2.885000
03/14/2011 6:35:55 PM	C CANAL	FLOW VAL	3.303000
03/14/2011 5:43:06 PM			
03/14/2011 5:28:34 PM			
03/14/2011 4:58:33 PM			
03/14/2011 2:52:51 PM			
03/14/2011 12:49:00 PM			
03/14/2011 10:46:17 AM			
03/14/2011 9:52:57 AM			
03/14/2011 9:34:22 AM			
03/14/2011 9:13:04 AM			
03/14/2011 8:50:53 AM			
03/14/2011 8:31:28 AM			
03/14/2011 6:30:26 AM			
03/14/2011 6:18:48 AM			
03/14/2011 12:52:22 AM			
03/13/2011 11:50:17 PM			
03/13/2011 11:32:57 PM			
03/13/2011 6:24:28 PM			
03/13/2011 6:05:24 PM			
03/13/2011 4:15:16 PM			
03/13/2011 3:43:35 PM			
03/13/2011 3:20:14 PM			
03/13/2011 2:38:43 PM			
03/13/2011 2:22:53 PM			
03/13/2011 2:05:46 PM			



C CANAL	FLOW VAL	2.861000
C CANAL	FLOW VAL	2.023000
C CANAL	FLOW VAL	2.896000
C CANAL	FLOW VAL	1.025000

## **Example 2**

- **Current flows are shown, critical water levels are highlighted in yellow and red**

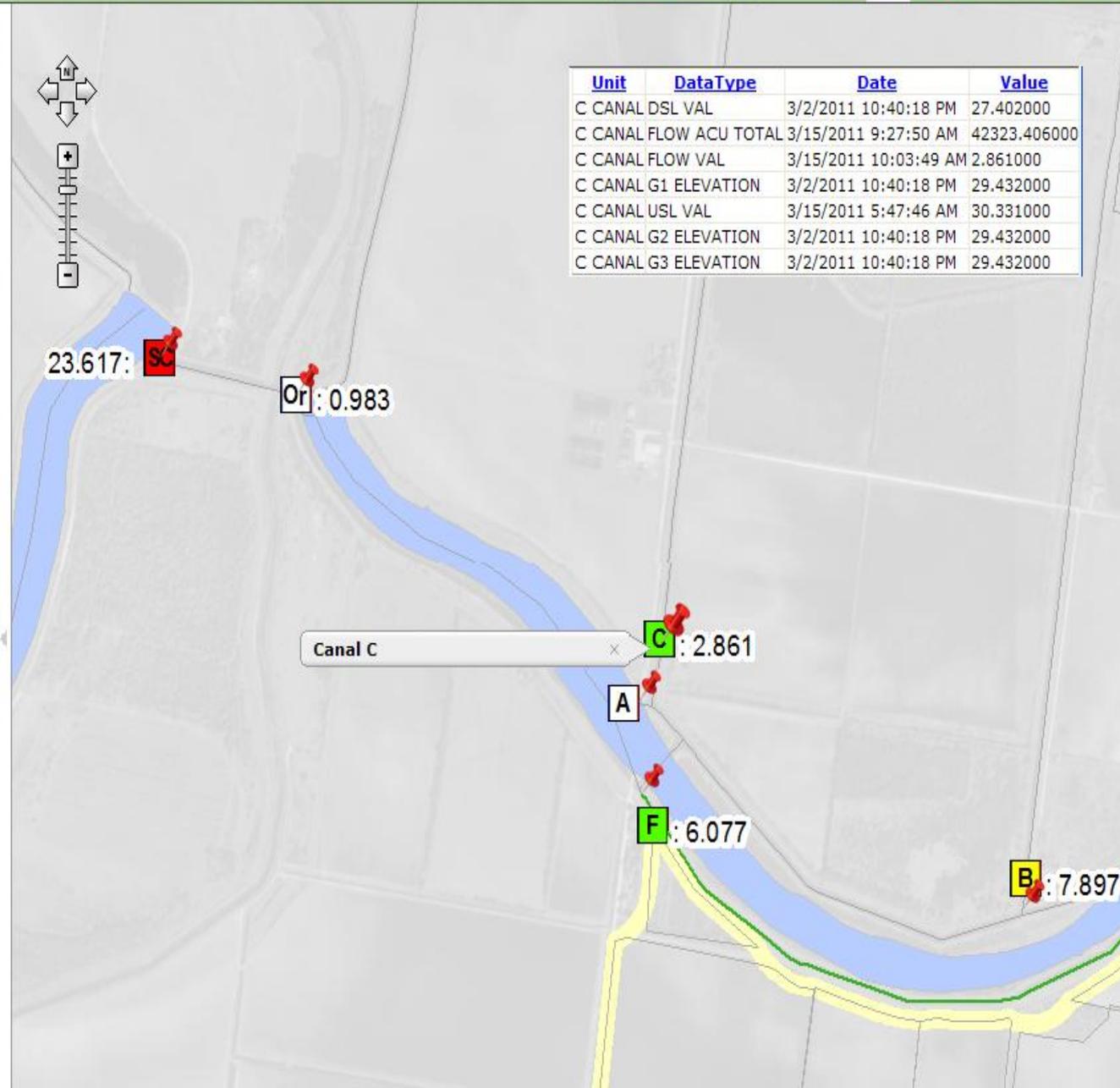
Results

- Canal C
  - [http://waterqis.tamu.edu/other linked documents/C\\_Canal\\_chart.pdf](http://waterqis.tamu.edu/other linked documents/C_Canal_chart.pdf)
  - OBJECTID 4
  - Id 0
  - Location Canal C
  - Max\_CFS 0
  - NumofGates 3
  - ID\_Join 2
  - Gates.ID\_join\_dbo C CANAL
  - Unit\_short C
  - Hyp\_doc



Map Contents

- Flow and Account
    - Flow
      - Rubicon gates
        - Gates IN (label)
        - Gates IN
- No Flow  
 LOW  
 OK  
 HIGH



## **Example 3**

- **Display water account information such as field ID, owner, grower, pending orders**

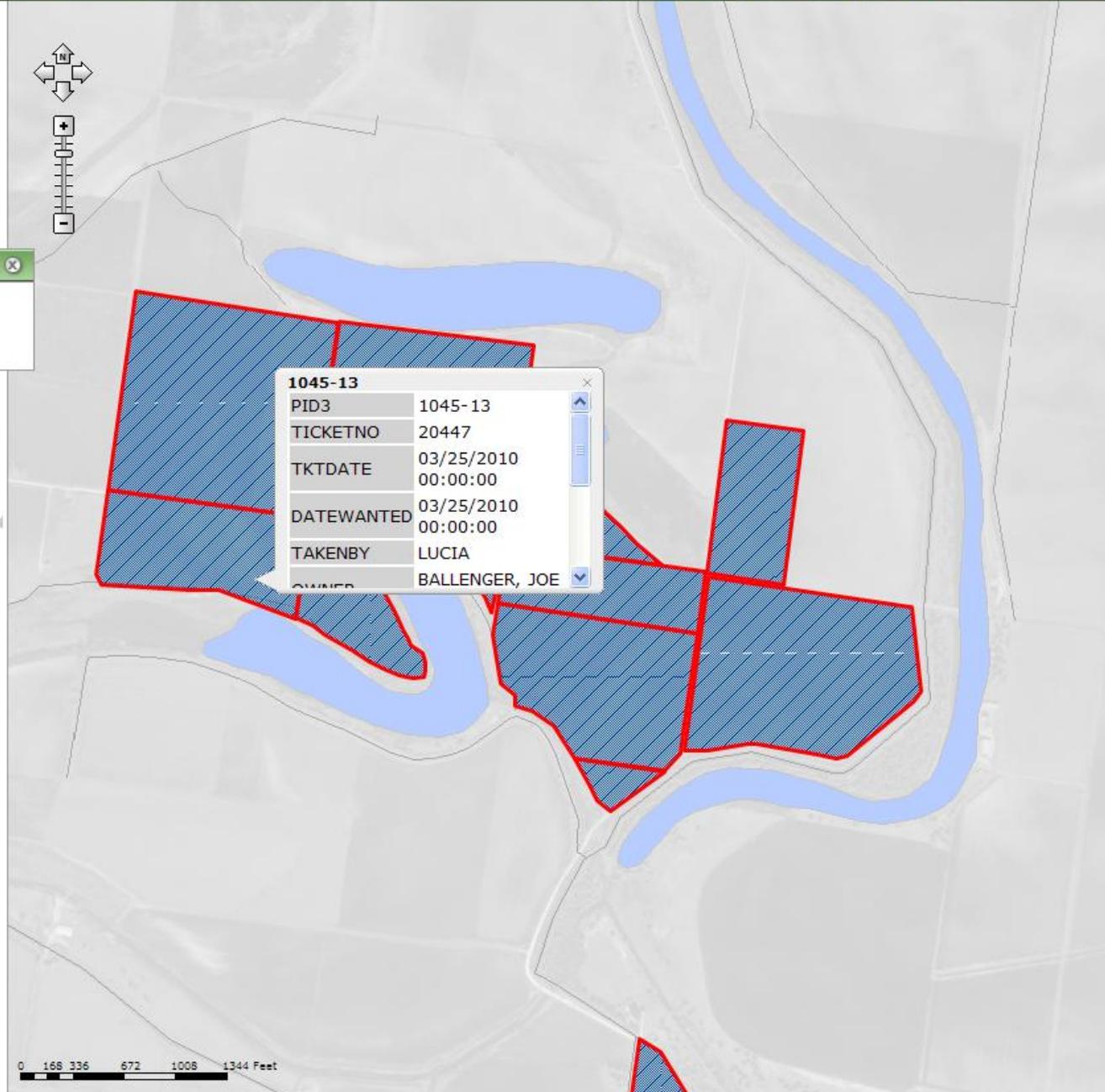
Results

- Account (16)
  - Accounts (16)
    - 1045-13
    - 1045-6
    - 1045-3
    - 1045-1
    - 1045-5
    - 1045-2
    - 1045-9
    - 1045-16
    - 1045-8
    - 1045-7
    - 1045-11
    - 1045-10
    - 1045-14
    - 1045-15
    - 1045-12
    - 1045

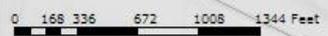
PID	
PID	
24042	
0	
1000-1	
10005-1	
10010-1	
10010-2	
10010-3	
10020-1	
10020-2	
10020-3	
10020-4	
10060-3	
10080-1	
1010-1	
10144-1	
10180-1	
10193-1	
10193-2	
10193-3	
10193-4	
10193-5	
10215-1	
10215-10	
10215-2	
10215-3	
10215-4	
10215-5	
10215-6	
10215-7	

Map Contents

- Flow and Account
    - Flow
    - Accounts
      - Pending Orders
        - Orders IN
- Alfalfa
  - Citrus
  - Corn
  - Cotton
  - Garden
  - Grain
  - Hay
  - Land
  - Onions
  - Other
  - Pasture
  - Pond
  - S/Beans
  - S/Cane
  - S/F
  - Trees
  - Veg
  - grass
  - guayaba



1045-13	
PID3	1045-13
TICKETNO	20447
TKTDATE	03/25/2010 00:00:00
DATEWANTED	03/25/2010 00:00:00
TAKENBY	LUCIA
OWNER	BALLENGER, JOE

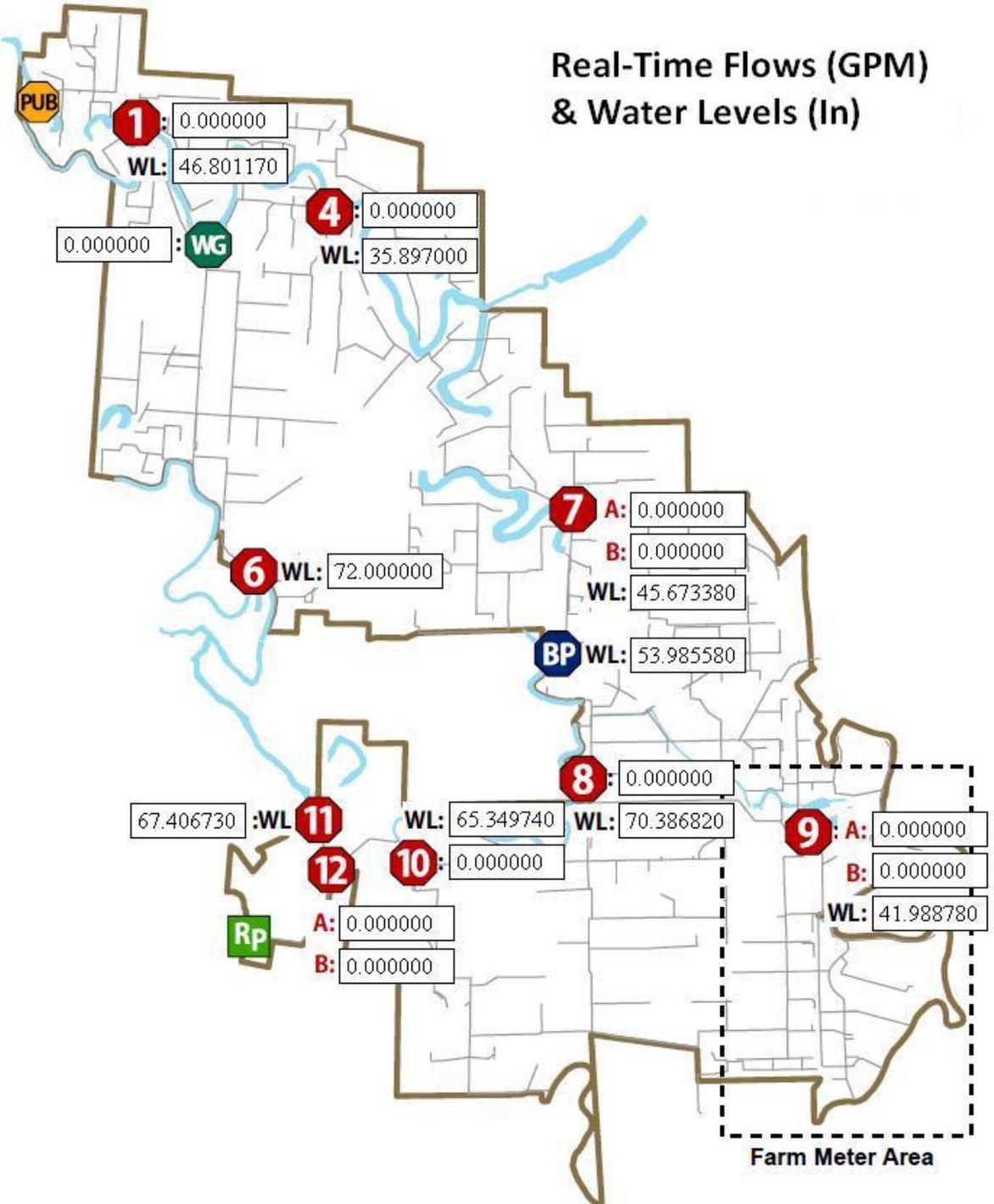


# Maps for display and use of data - Examples

# Example 1

- **Status map set up to show the most relevant information in real time, such as water flow, water levels, alarms**

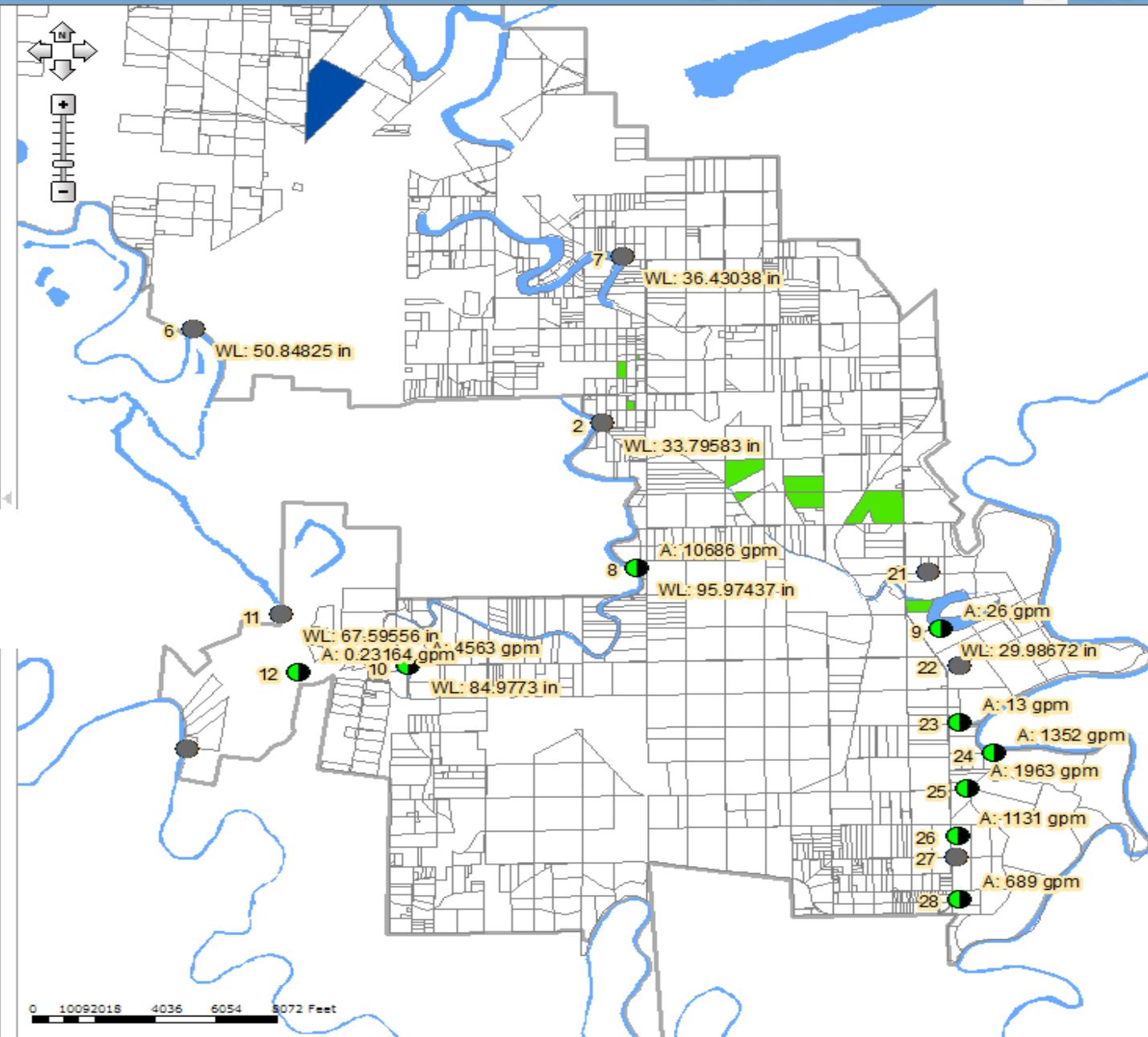
# Real-Time Flows (GPM) & Water Levels (In)



## **Example 2**

- **District personnel can access data by means of a password protected interactive map, on which real time and historical data can be queried and displayed**

- Results
- Map Contents
  - Pumps
    - Flow meter A (ON)
    - Flow meter B (ON)
    - Water Level
    - Units
    - Meters
  - Accounts
    - Pending Orders
    - All accounts
    - Urbanization
  - Background
    - Network
    - Water Bodies
    - Boundaries
    - aerial 2001

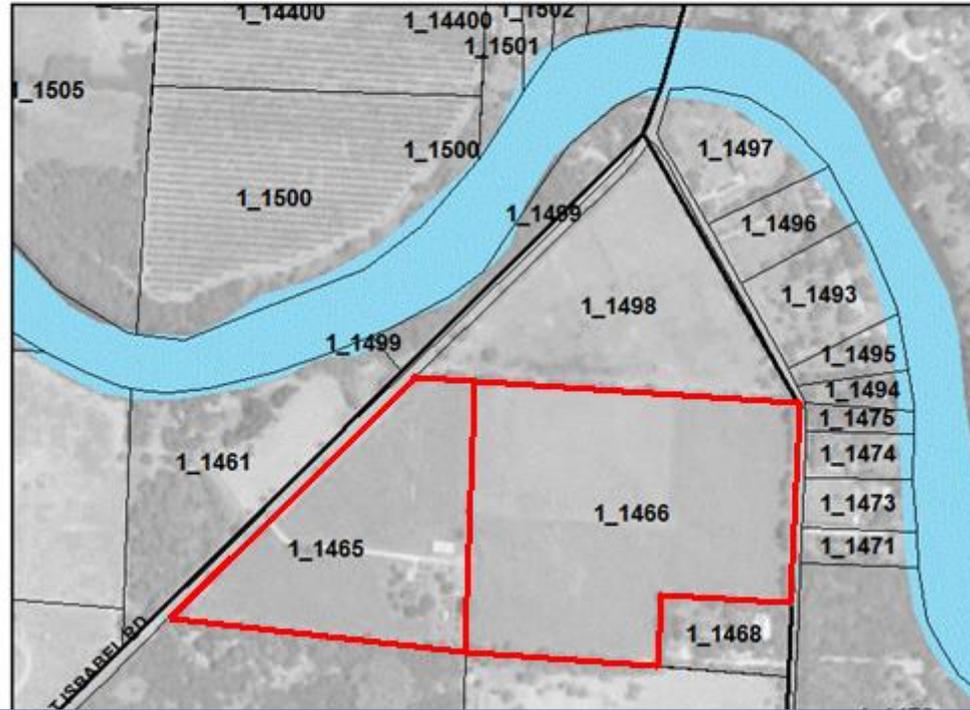


# Enabling access to specific data for water account holders

# Example 1

- **The grower/landowner can locate their fields, and find and print information**

# Map



## Owner Maps

ACCOUNTS	BLOCK	LOT	SUBDIVISION	GROWER	OWNER	NET_ACRES	NET_ACRES
1-1465	161	1	Texas Acres	Joe Jones	John SMITH	10	4
1-1466	162	1	Texas Acres	Sue Smith	John SMITH	16	5

### Owner Maps

- Meters
- District meter
- Farmer meter

### Boundaries < 22500

- Water Bodies

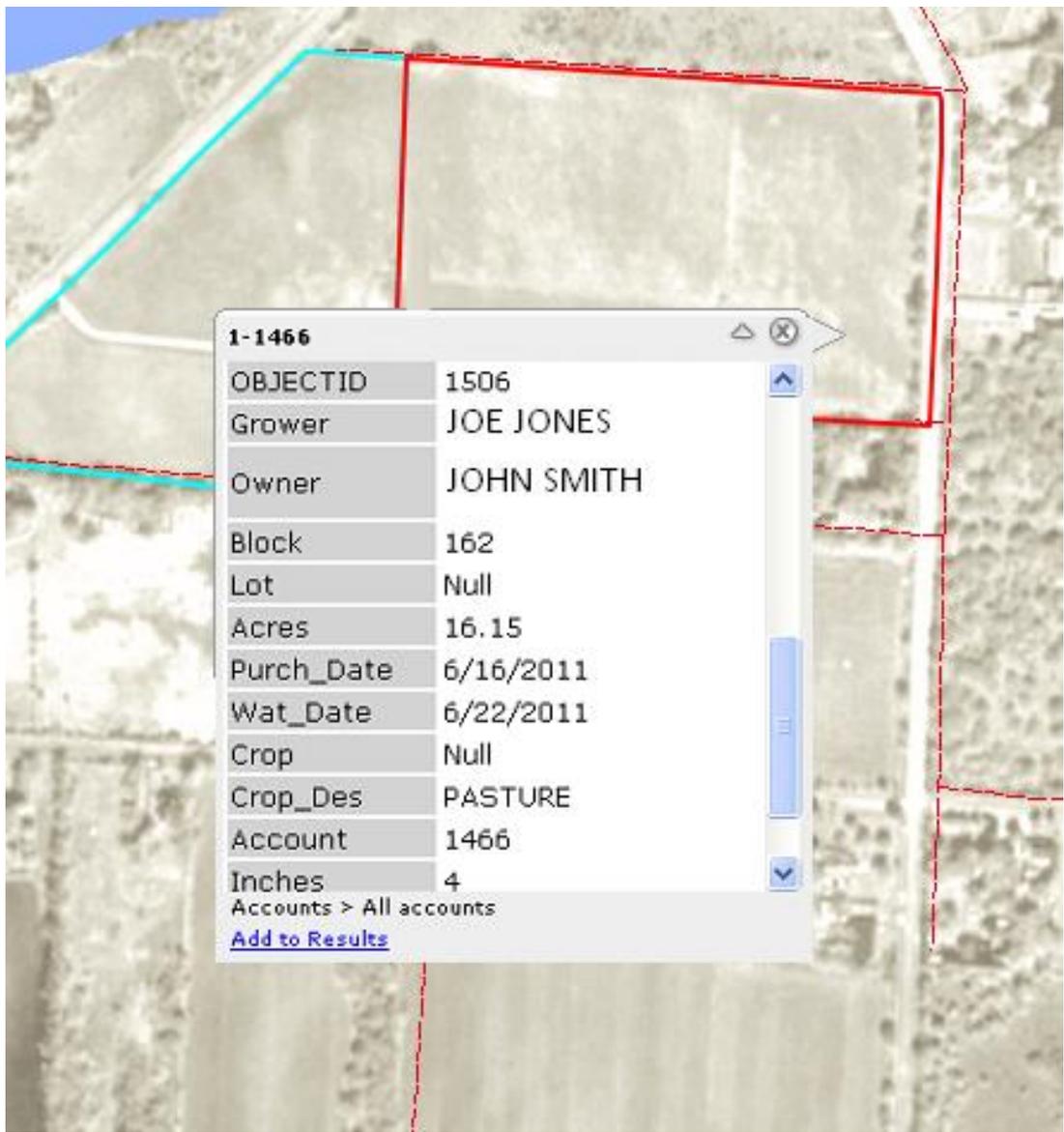
### Owner Map (2)

#### Owner Maps

ACCOUNTS	BLOCK	LOT	SUBDIVISION	GROWER	OWNER	NET_ACRES	NET_ACRES
1-1465	161	1	Texas Acres	Joe Jones	John SMITH	10	4
1-1466	162	1	Texas Acres	Sue Smith	John SMITH	16	5

## **Example 2**

- **Detailed information can be viewed for each field**



## **Example 3**

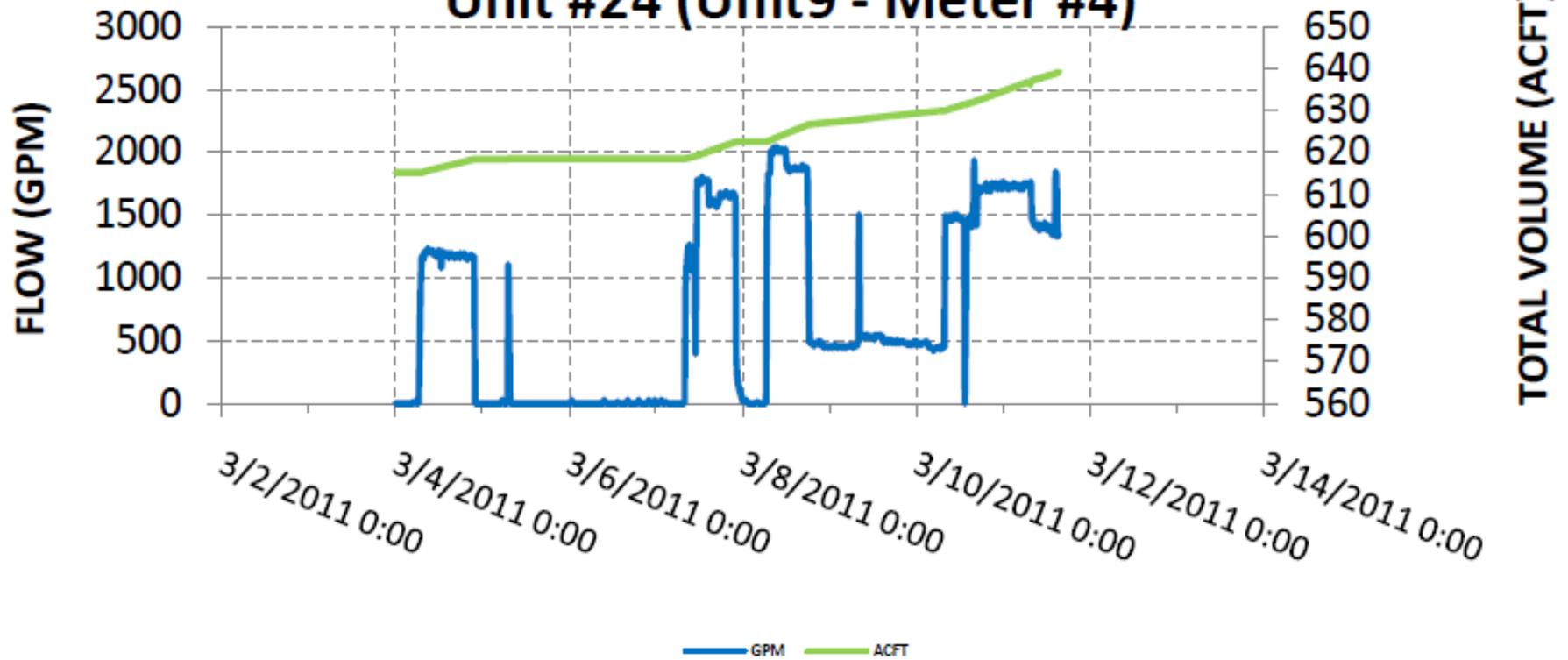
- **Farmer can access his own meter readings**



ENTER PASSWORD :



## Unit #24 (Unit9 - Meter #4)



Tuesday 3/15/2011 8:46

GPM

ACFT

1352

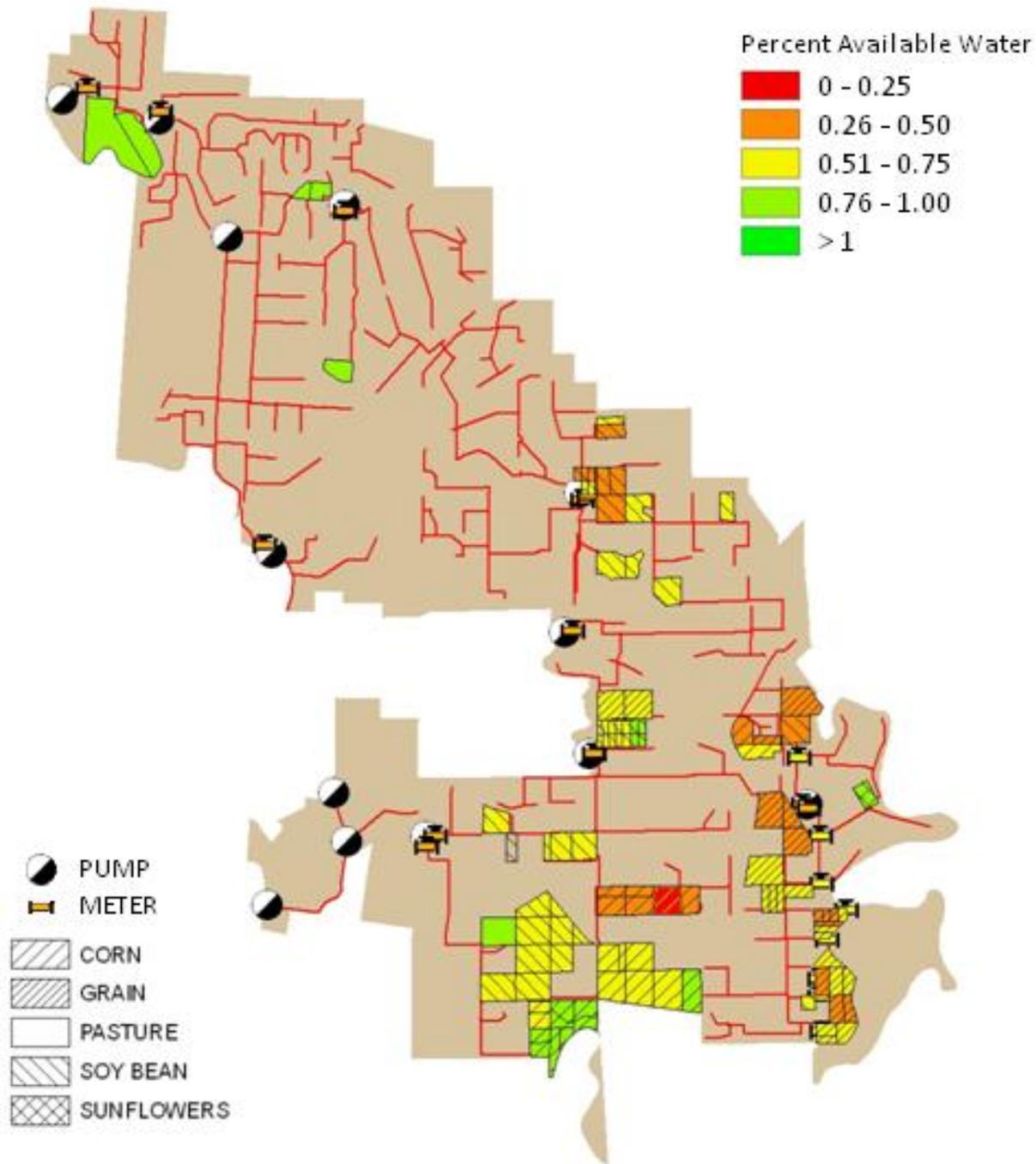
639.127

Date	GPM	ACFT
3/4/2011 0:00	0	615.1078
3/4/2011 0:15	0	615.1078
3/4/2011 0:30	0	615.1078
3/4/2011 0:45	0	615.1078

# Management tools to improve conveyance efficiency and water deliveries

# Example

- **Use of soil-water balance models to create maps showing water status of crops**
- **Red and orange fields need irrigation**



# PROBLEMS AND SOLUTIONS

## Data management

- SCADA and water account databases proprietary format  
→ contractor set-up of a routine creating text output data
- Automatic transfer of data to our server → Specific code to bypass the firewall protecting the TAMU server
- Data storage and management → SQL server database
- Connection to spatial data: geodatabases and “join” operation within the ArcGIS software

# PROBLEMS AND SOLUTIONS

## Collaboration with contractors and consultants

- Only contractors could manipulate the data and knew what data were available
- Contractors sometime saw us as competitors
- District encouraged us to be involved with the contractors
- Beneficial interaction in terms of knowledge and future collaboration, but also in terms of minimizing any impediment to the current organization of the system

# PROBLEMS AND SOLUTIONS

## Identification of district needs and best solutions

- As the district was not familiar with the proposed technology we had to design the project based on our knowledge of the district, rather than on a specific request
- Among other activities, we organized some GIS classes, and demonstration workshops

## Security

- Passwords were set to access farmers meters data and other sensitive data
- District ARCGIS web applications were protected by password

## Data validation

- District typically used SCADA data only as real time source of information
- We set up some simple automatic strategies to overcome most of the common errors (e.g. routines to delete data when outside a minimum or maximum threshold)

# EFFECTS ON DISTRICT ACTIVITY

- Perception that the changes introduced could save water and time
- Districts actively responded to make the changes required
- Compliance to our recommendations for improvement (e.g. change water account database software)
- Availability of flow meters readings to account holders reduces need of talk to the districts personnel
  - Total volumes used
  - Current flow → more efficient field distribution
- Daily update of water account information
- GIS brought up to date

BID Information Management System project - USER EVALUATION FORM

Name: Gvette

Date: 3/31/11

1. Did you use one of the new web pages at least once:

- No  
 Yes

- |                                                                                                |                                           |                                            |                               |
|------------------------------------------------------------------------------------------------|-------------------------------------------|--------------------------------------------|-------------------------------|
| <input checked="" type="checkbox"/> Pump and Meters                                            | <input type="radio"/> Daily               | <input checked="" type="checkbox"/> Weekly | <input type="radio"/> Monthly |
| <input checked="" type="checkbox"/> Water orders                                               | <input checked="" type="checkbox"/> Daily | <input type="radio"/> Weekly               | <input type="radio"/> Monthly |
| <input checked="" type="checkbox"/> Interactive map:                                           | <input checked="" type="checkbox"/> Daily | <input type="radio"/> Weekly               | <input type="radio"/> Monthly |
| <input checked="" type="checkbox"/> Pump Flow                                                  |                                           |                                            |                               |
| <input checked="" type="checkbox"/> Default displayed data (on/off, flow volume, resaca level) |                                           |                                            |                               |
| <input checked="" type="checkbox"/> Unit Chart links                                           |                                           |                                            |                               |
| <input checked="" type="checkbox"/> Other information related to units                         |                                           |                                            |                               |
| <input checked="" type="checkbox"/> Water account                                              |                                           |                                            |                               |
| <input checked="" type="checkbox"/> Default displayed data (current purchased ticket)          |                                           |                                            |                               |
| <input checked="" type="checkbox"/> Account/Owner/Grower/Ticket 2010 queries                   |                                           |                                            |                               |
| <input checked="" type="checkbox"/> Print                                                      |                                           |                                            |                               |
| <input checked="" type="checkbox"/> Historical data:                                           | <input checked="" type="checkbox"/> Daily | <input type="radio"/> Weekly               | <input type="radio"/> Monthly |

2. General comments:

- Useful  
 Sped my work  
 I will use again  
 Too difficult to use  
 Too slow  
 There are no useful information  
 Other: .....

3. Water management improvements (also if based only on perception):

- |                                                                      |                                           |                                           |                            |
|----------------------------------------------------------------------|-------------------------------------------|-------------------------------------------|----------------------------|
| <input checked="" type="checkbox"/> Time saving                      | <input checked="" type="checkbox"/> Major | <input type="radio"/> Minor               | <input type="radio"/> None |
| <input checked="" type="checkbox"/> Money saving                     | <input checked="" type="checkbox"/> Major | <input type="radio"/> Minor               | <input type="radio"/> None |
| <input checked="" type="checkbox"/> Water saving                     | <input checked="" type="checkbox"/> Major | <input type="radio"/> Minor               | <input type="radio"/> None |
| <input checked="" type="checkbox"/> Energy saving                    | <input checked="" type="checkbox"/> Major | <input type="radio"/> Minor               | <input type="radio"/> None |
| <input checked="" type="checkbox"/> Interaction with account holders | <input type="radio"/> Major               | <input checked="" type="checkbox"/> Minor | <input type="radio"/> None |
| <input type="checkbox"/> Other: .....                                |                                           |                                           |                            |

4. What other information would you like us to add to the web site?

Have already added all we need at this time.

5. What changes/improvements would you like us to make?

password protected

6. Any other comment?

.....

# CONCLUSIONS

- Designed for districts that had specific interest in:
  - Make best use of the large amount of available data
  - Adopt web applications
  - Enable customers to access their data through the internet.
- Changes required a long time to be fully implemented:
  - Identifying district needs and accurately designing the project
  - Integrating the non optimal existing data
  - Securing sensitive data
  - Involving contractors and consultants to deal with software that were in a proprietary format
  - Collaboration with contractors resulted beneficial for the sound implementation of the project

# CONCLUSIONS

- The activity looked promising:
  - Adopted most of the new proposed strategies
  - Promptly complied with many recommendations
  - Started suggesting further steps
- Overall feeling from the districts that the adopted changes would help save water and time:
  - Periodical qualitative evaluations
  - Water balances and reliable historical data might help to make these assessments in the future
  - Need to quantitatively estimate such benefits
  - An initial understanding of such benefits might be obtained with a description of improved services provided to growers (e.g. availability of flow meter readings on line reduces the number of calls to the canal rider, and improves irrigation efficiency)