Irrigation District Engineering and Assistance

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Task 1 and 3 Extension Engineering

Task 1: Irrigation District Studies

- Provide technical assistance, applied research and educational programs to improve water management and promote water conservation and modernization.

Task 3: Institutional Incentives

- Evaluate irrigation district infrastructure needs and develop strategies to efficiently deliver water for agricultural use, and to facilitate the adoption of efficient irrigation technologies.

Highlights 2008 - 2009

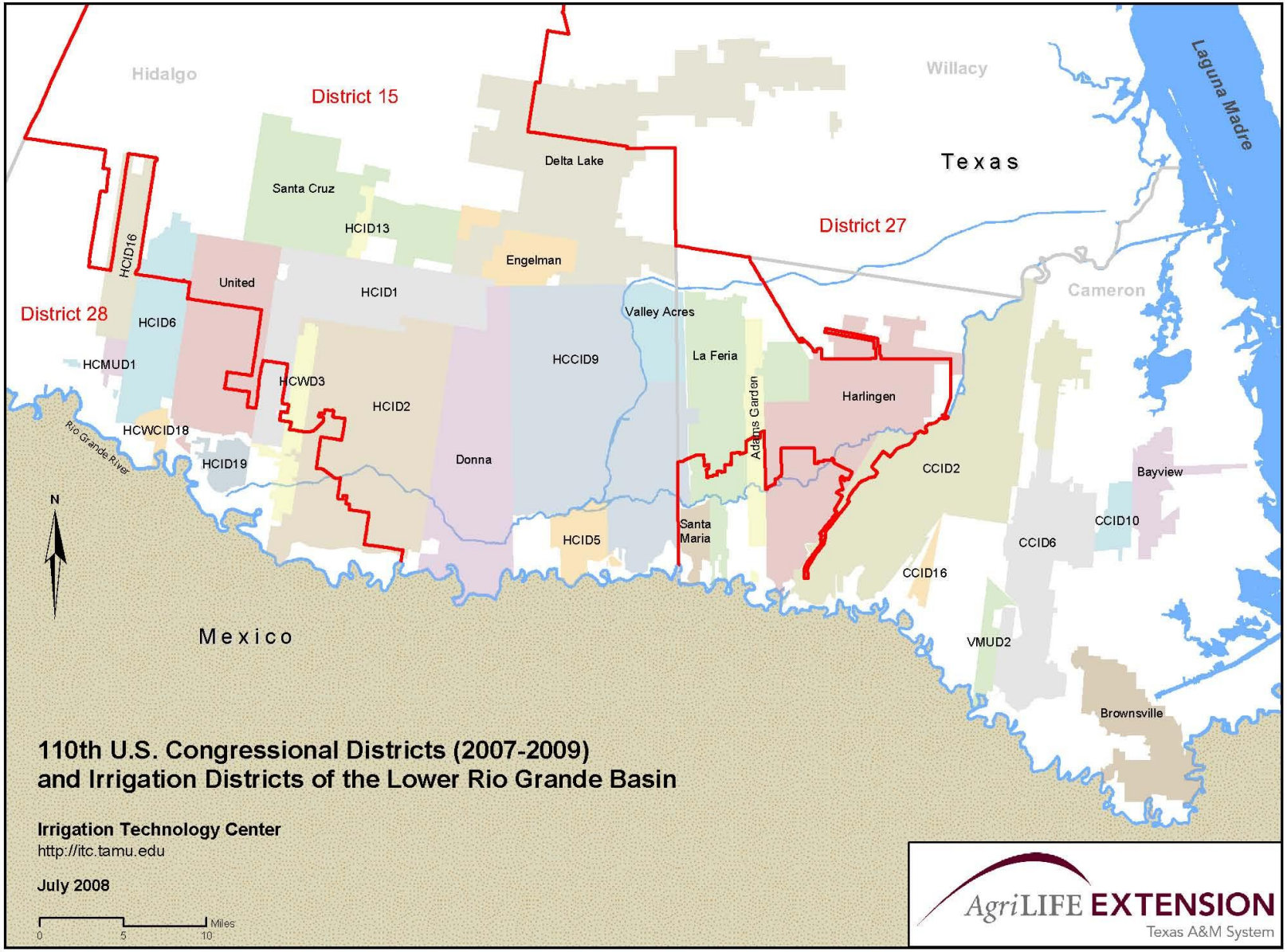
- Map Series
  - Texas Legislation
  - Expansion of Urban Area
- Canal Lining Evaluation Conclusions
- Ponding Test Manual
- Automation/Telemetry Demonstrations

Map Series of the Rio Grande River Basin

- Texas Legislative Districts
- Expansion of Urban Area

Texas Legislative Districts

- 110th U.S. Congressional (2007 – 2009)
- Texas House (2003 – 2012)
- Texas Senate (2003 – 2012)


Hidalgo
District 15
Willacy
Laguna Madre
Texas
Delta Lake
Santa Cruz
HCID13
District 27
Engelman
HCID16
United
HCID1
Cameron
District 28
HCID6
Valley Acres
HCMUD1
HCCID9
La Feria
HCWD3
Harlingen
HCID2
Adams Garden
HCWCID18
Rio Grande River
Donna
CCID2
Bayview
HCID19
N
CCID10
Santa Maria
HCID5
CCID6
CCID16
Mexico
VMUD2
Brownsville
110th U.S. Congressional Districts (2007-2009)
and Irrigation Districts of the Lower Rio Grande Basin
Irrigation Technology Center
http://itc.tamu.edu
July 2008
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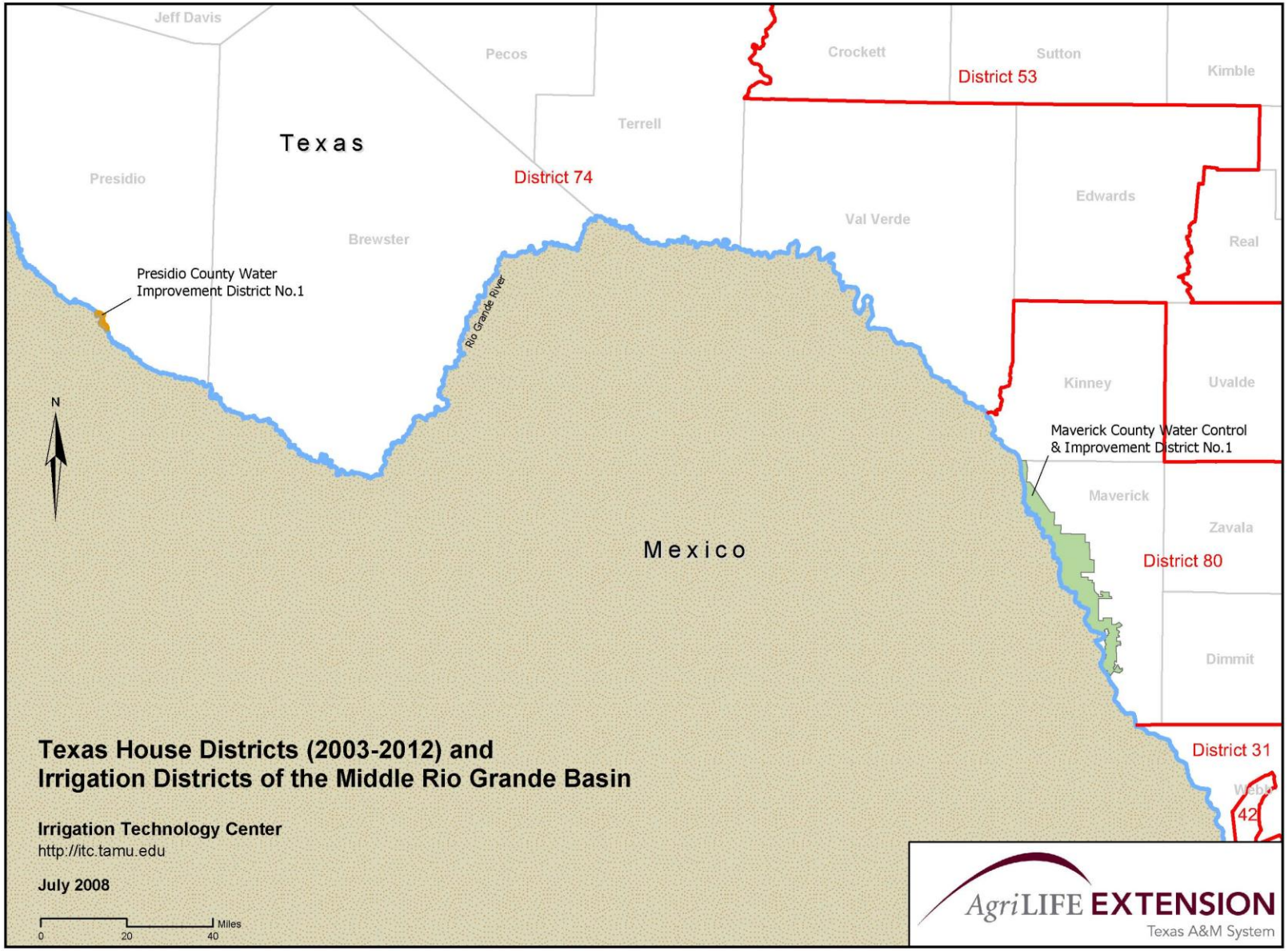
AgriLIFE EXTENSION
Texas A&M System


Jeff Davis
Pecos
Crockett
Sutton
Kimble
District 53
Texas
Terrell
Presidio
District 74
Edwards
Val Verde
Brewster
Real
Presidio County Water
Improvement District No.1
Rio Grande River
Kinney
Uvalde
N
Maverick County Water Control
& Improvement District No.1
Maverick
Zavala
Mexico
District 80
Dimmit
District 31
Texas House Districts (2003-2012) and
Irrigation Districts of the Middle Rio Grande Basin
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http://itc.tamu.edu
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Texas A&M System

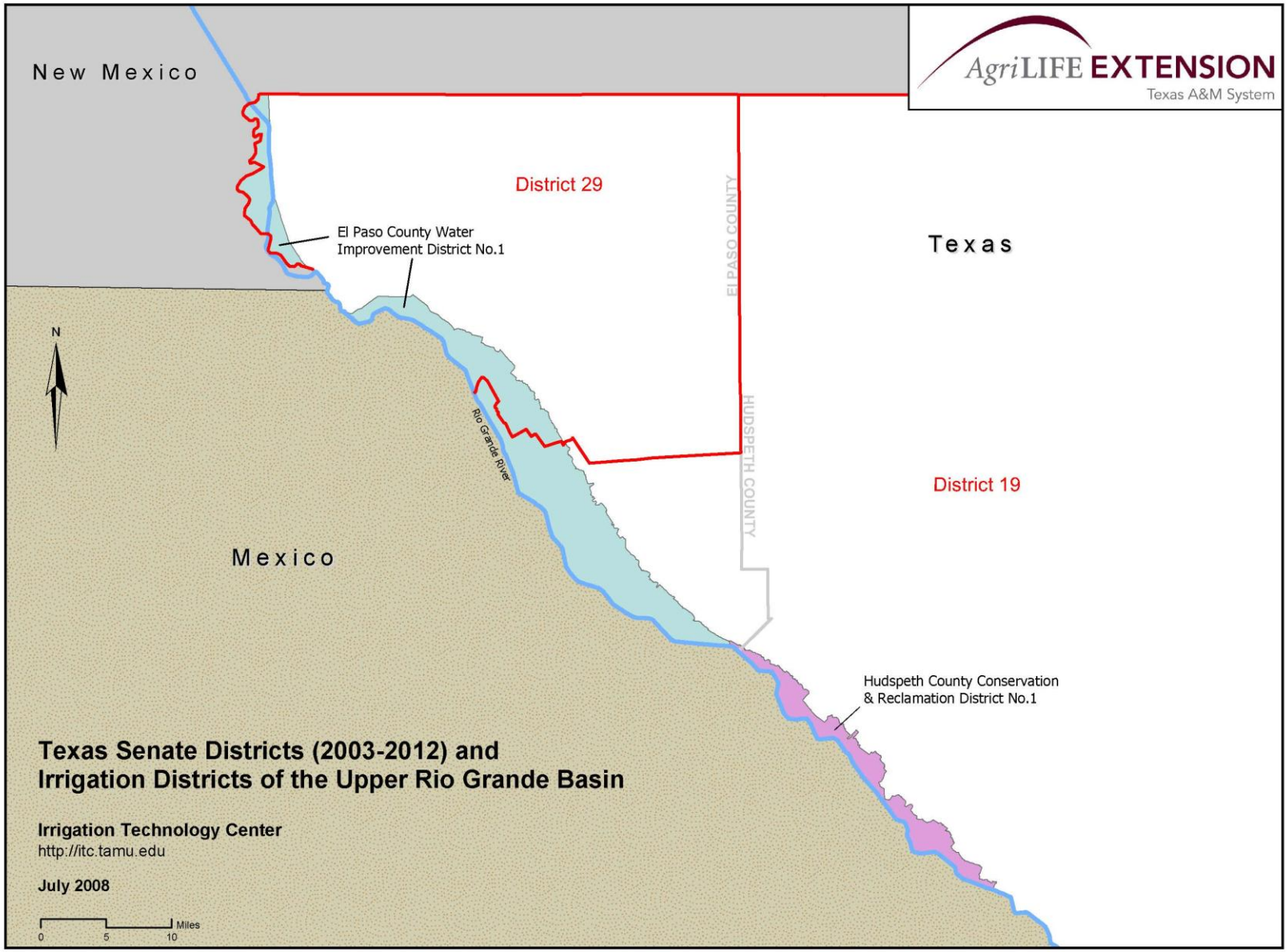
New Mexico
AgriLIFE EXTENSION
Texas A&M System
District 29
El Paso County Water
Improvement District No.1
EL PASO COUNTY
Texas
N
Rio Grande River
HUDSPETH COUNTY
District 19
Mexico
Hudspeth County Conservation
& Reclamation District No.1
Texas Senate Districts (2003-2012) and
Irrigation Districts of the Upper Rio Grande Basin
Irrigation Technology Center
http://itc.tamu.edu
July 2008
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Table 3. Legislative Districts Listed by Irrigation Districts			
District	TX House	TX Senate	U.S. House
Lower Rio Grande Basin			
Adams Garden Irrigation District No.19	38, 43	27	15, 27
Bayview Irrigation District No.11	37	27	27
Brownsville Irrigation District	37, 38	27	27
Cameron County Water Improvement District No.16	38	27	27
Cameron County Irrigation District No.2	38, 43	27	15, 27
Cameron County Irrigation District No.6	37, 38, 43	27	27
Cameron County Water Improvement District No.10	37	27	27

Tables…

Table 4. Legislative Districts Listed by Region	
Region	Legislative District
US House of Representatives	
Lower Rio Grande Basin	15, 27, 28
Middle Rio Grande Basin	23
Upper Rio Grande Basin	16, 23
Texas House of Representatives	
Lower Rio Grande Basin	36, 37, 38, 39, 40, 41, 43
Middle Rio Grande Basin	74, 80
Upper Rio Grande Basin	74, 75, 76, 77, 78, 79
Texas Senate	
Lower Rio Grande Basin	20, 27
Middle Rio Grande Basin	19
Upper Rio Grande Basin	19, 29

Expansion of Urban Area

- Texas Counties (1996 – 2006)
  - El Paso
  - Maverick
  - Cameron
  - Hidalgo
  - Willacy

Urban area defined as…

- continuous developed and/or developing area that is no longer in agricultural use
- included all residential communities and subdivisions (with or without homes)
- properties with more than one dwelling
- single dwellings on large properties outside the city

Irrigation District refers to all...

- irrigation,
- water control,
- water improvement,
- conservation,
- reclamation, and municipal utility districts that deliver agricultural irrigation water and hold Class A Agricultural Water Rights or a similar allocation.

Expansion of Urban Area

Texas Counties

Table 3. Urban Area within Counties in 1996 and 2006.

Counties	Total Acreage	Urban Area 1996	Urban Area 2006	Increase
		Acreage	Acreage	%
Cameron	613,036	66,189	81,635	23
El Paso	656,492	208,180	234,155	12
Hidalgo	1,012,982	118,466	160,095	35
Maverick	826,915	9,816	12,019	22
Willacy	393,819	3,084	3,509	14

Expansion of Urban Area

Districts' Service Areas

Table 4. Urban Area within irrigation districts as a percentage of total district service area in 1996 and 2006.

	Approx. District Area	Percentage of District Area	
District	**Acreage**	**Urban Area 1996**	**Urban Area 2006**
Adams Garden	9,600	5.5 %	14.4 %
Bayview	10,700	0.2 %	1.1 %
Brownsville	22,000	40.0 %	45.3 %
CCWID16	2,200	12.0 %	19.2 %
CCID2	79,000	10.6 %	13.8 %
CCID6	33,000	13.3 %	23.8 %
CCWID10	4,700	3.0 %	4.8 %
Delta Lake	85,600	1.3 %	2.2 %
Donna	47,000	9.3 %	15.5 %
El Paso	92,800	35.5 %	38.2 %
Engelman	11,200	1.3 %	2.9 %
Harlingen	56,500	26.0 %	30.0 %

Expansion of Urban Area

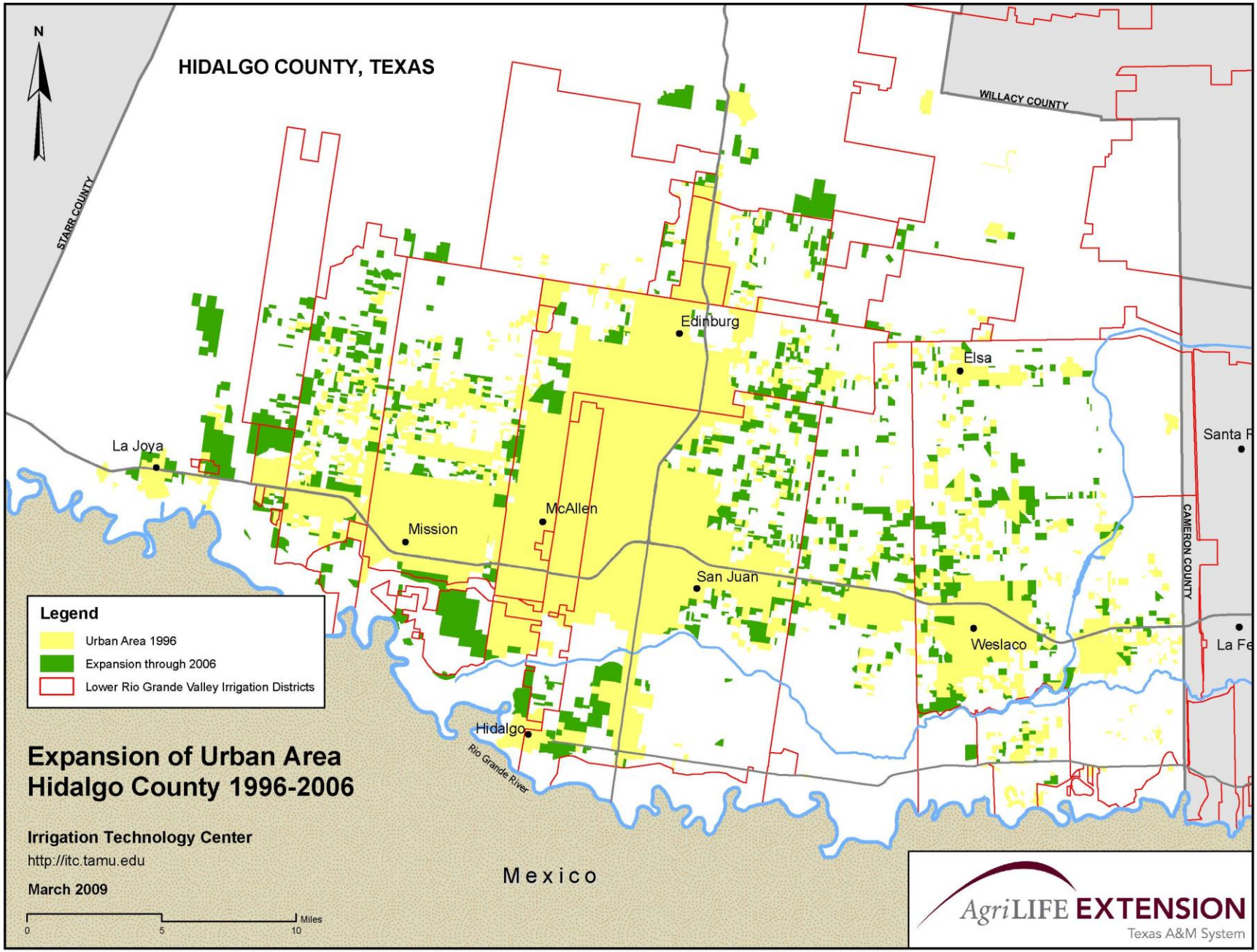
Urban Area Increase

Table 5. Urban Acreage within Irrigation Districts in 1996 and 2006.

	Urban Area 1996	Urban Expansion through 2006	Percent Increase
District	Acreage	Acreage	
Adams Garden	532	1,380	160 %
Bayview	24	120	392 %
Brownsville	8,724	9,915	14 %
CCWID16	260	415	60 %
CCID2	8,384	10,925	30 %
CCID6	4,439	7,948	79 %
CCWID10	135	224	66 %
Delta Lake	1,127	1,841	63 %
Donna	4,357	7,310	68 %
El Paso	32,967	35,443	8 %
Engelman	144	331	130 %
Harlingen	14,662	16,955	16 %
HCCID9	16,721	22,716	36 %
HCID1	22,633	25,327	12 %

Analysis

- Used our estimate of the size of the service areas of the water districts.
- Urban area estimates have about a 10% margin of error.
- No legal descriptions of properties or survey data were used in the development of this map series.


N
HIDALGO COUNTY, TEXAS
STARR COUNTY
WILLACY COUNTY
CAMERON COUNTY
Edinburg
Elsa
La Joya
Santa F
McAllen
Mission
San Juan
Weslaco
La Fe
Hidalgo
Rio Grande River
Mexico
Legend
Urban Area 1996
Expansion through 2006
Lower Rio Grande Valley Irrigation Districts
Expansion of Urban Area
Hidalgo County 1996-2006
Irrigation Technology Center
http://itc.tamu.edu
March 2009
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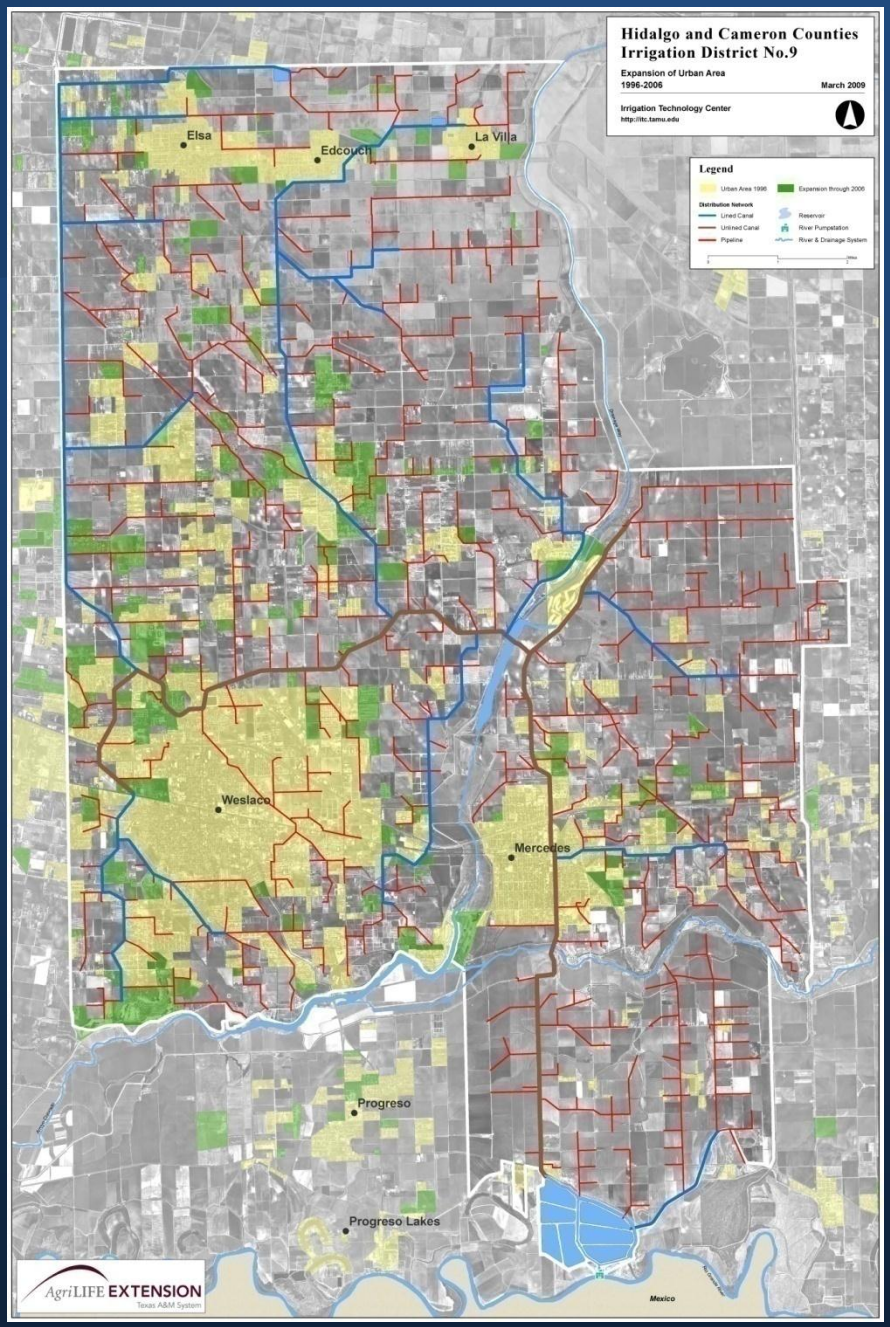
Miles
AgriLIFE EXTENSION
Texas A&M System

Expansion of Urban Area

Individual District Maps

- Sent to Districts along with map series report
- Posted Online at:

http://idea.tamu.edu/gis.php



Summary

- HCMUD1 - most urbanized 89.5%
- Valley Acres & Bayview – least urbanized
- HCID2 - largest number of urban acres
- HCID16 & HCID19 – largest increase in urban acres

Canal Lining Evaluation

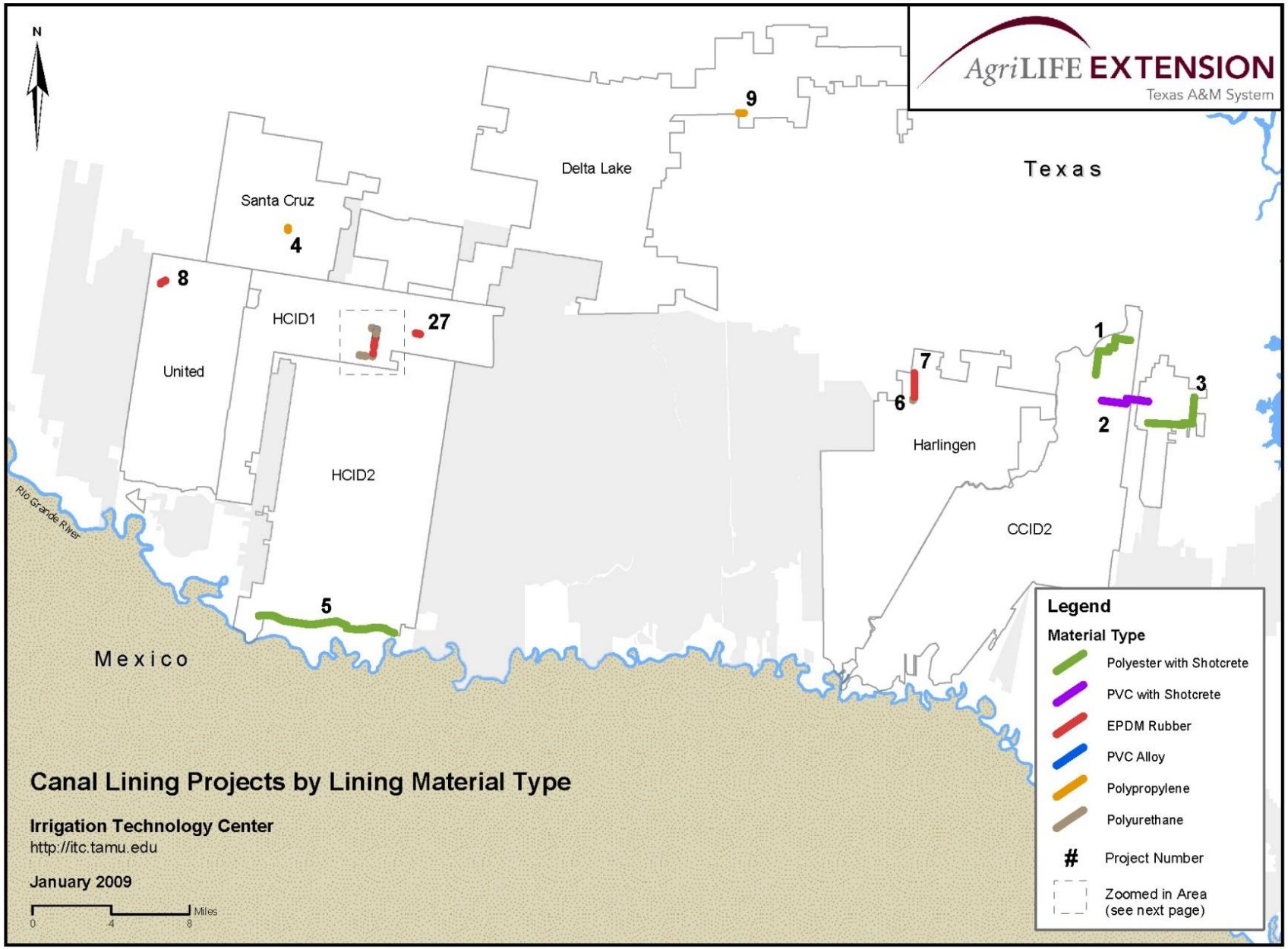
Yearly evaluations and ratings to determine durability and long-term viability of new canal linings.

Purpose of Lining Evaluations

- Ensure continued water savings
- Help districts select durable canal lining material
- Develop guidelines for maintaining performance
  - vandalism
  - material installation
  - maintenance/repair

Activities

- Identified 28 lining segments, totaling 20 miles in 7 irrigation districts with 6 different lining materials
- Inspected each project segment at least once a year for 3 years
- Where possible, performed pre- and post-seepage loss tests to document actual water savings from lining existing canals


N
AgriLIFE EXTENSION
Texas A&M System
Delta Lake
Texas
Santa Cruz
9
4
8
HCID1
27
United
HCID2
7
6
1
2
3
Harlingen
CCID2
Rio Grande River
5
Mexico
Legend
Material Type
Polyester with Shotcrete
PVC with Shotcrete
EPDM Rubber
PVC Alloy
Polypropylene
Polyurethane
Project Number
Zoomed in Area
(see next page)
Canal Lining Projects by Lining Material Type
Irrigation Technology Center
http://itc.tamu.edu
January 2009
Miles
0
4
8

Example of Water Savings

- Performed pre- and post- re-lining seepage loss tests on Lateral A canal of Hidalgo County Irrigation District No.2
- 7 mile long section of concrete canal in poor condition was re-lined with Polyester/shotcrete
- Water losses were reduced after lining by 94%

before

- 1.98 gal/ft2/day
- 11.20 ac-ft/mi/yr

after

1.17gal/ft2/day

227.14 ac-ft/mi/yr

Lining Materials

Table 1. Description of each lining material's composition.	
Material	**Description**
Polyester with protective barrier	A geocomposite consisting of two layers (top and bottom) of 8 oz/yd^2 nonwoven polyester bonded to an olefinic copolymer geomembrane, 20 mil thick. The protective barrier consists of 2-3 inches of shotcrete.
PVC with protective barrier	Non-reinforced Poly Vinyl Chloride (PVC). The protective barrier consists of a wire mesh with 2.5 inches of shotcrete.
Polypropylene	A reinforced polyester scrim 16 oz/yd^2 between polypropylene layers, 24 mil thick.
PVC Alloy	A polyvinylchloride blend, reinforced with a polyester scrim, 40 mil thick.
EPDM Rubber	A non-reinforced EPDM (ethylene propylene diene monomer), 45 mil thick.
Polyurethane	Two layers of 3-oz/yd^2, heat-bonded, non-woven geotextile saturated with liquid polyurethane, 40 mil thick.

Performance Ratings

Table 2. General performance ratings for canal liners.

Rating	Definition
Excellent	0%: no damage and no maintenance required
Good	0 – 5%: mild damage to top anchor and canal interior 1 to 2 significant repairs needed per year
Fair	5 – 20%: mild damage to top anchor and canal interior 3 to 5 significant repairs needed per year
Poor	20 – 50%: mild damage to top anchor and canal interior 6 to 10 significant repairs needed per year
Serious Problems	50 – 100%: mild damage to top anchor and canal interior 10 > significant repairs needed per year

Note: Percentages are based on the linear length of the lining project.

Results

Excellent performance is with a geo-membrane overlaid with a protective barrier (shotcrete, concrete, etc.)

- Polyester with shotcrete
- PVC with shotcrete

Results (no cover)

Polypropylene

- Good performance (Rating of Excellent to Good)
- Some installation problems observed

Results (no cover)

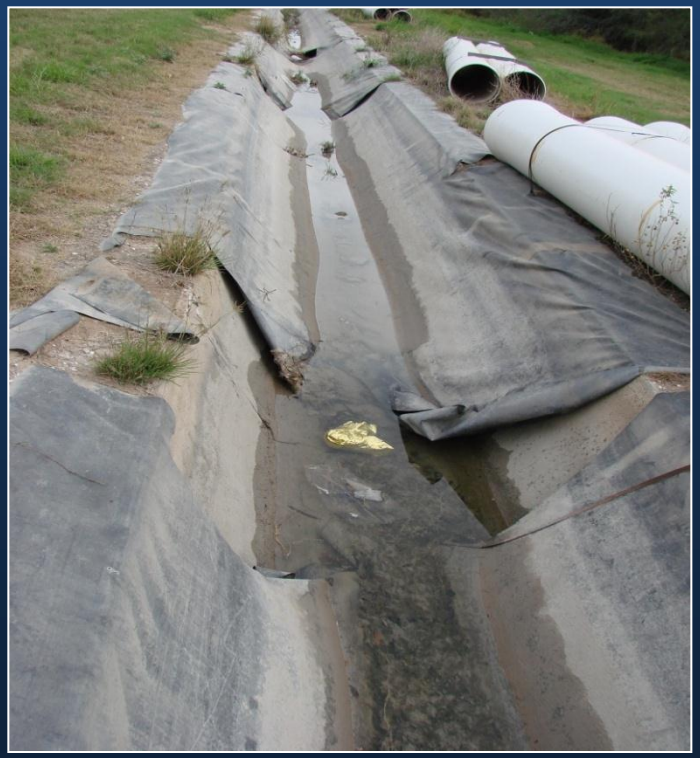
PVC alloy:

- Excellent to Good performance
- Not very susceptible to vandalize, difficult to cut

Results (no cover)

EPDM rubber

- Poor performance (Rating of Excellent to Serious Problems)
- Problems observed: vandalism, mowing damage, rotting, inadvertent damage, vegetation under the material



Results (no cover)

Polyurethane

- Worst performance (Rating of Excellent to Serious Problems)
- Problems observed: vandalism, mowing damage, rotting, inadvertent damage, installation problems)

Results

Table 3. Range of the performance rating results by lining material.			
Material	**No. of Projects**	**Total Miles**	**Rating**
with a protective barrier			
Polyester with shotcrete	4	14.47	Excellent
PVC with shotcrete	1	2.61	Excellent
without a protective barrier			
Polypropylene	2	0.36	Excellent to Good
PVC Alloy	3	0.05	Excellent to Good
EPDM Rubber	8	2.04	Excellent to Serious Problems
Polyurethane	9	1.42	Excellent to Serious Problems

Conclusions

- Regular maintenance is required for all non-covered materials
- Inspections should be carried out al least once a year during non-irrigation season (December-January)
- The materials without a shotcrete layer are exposed to vandalism and other damage, and may be inadvertently damaged by animals/people
- Poor installation of any of the materials makes the product more susceptible to vandalism by leaving folds and loose areas that are easy to cut

Conclusions

- Most damage has occurred on the exposed areas of the liner and top side walls of the canal from cuts made with a sharp object (probably intentional vandalism) unintentional vandalism.
- In areas where kids are playing, swimming in the canals, or being mischievous, intentional and unintentional vandalism will occur.
- Vultures have been reported to pick at the seams on the EPDM Rubber; animal hoofs can cut some liners.

Consideration when Planning New Lining Projects

Lining Installation

- the methods used to overlap and mend/seam the layers of lining material together

- the methods used for attaching the material to the canal walls, around structures, and to the top of the levee (top anchor)

- the total width of the liner and extension on top of the levee in relation to the normal and maximum operating depth of the canals

Use of a Protective Barrier

- Increases cost, but these costs may be offset by the reduction in costs of maintenance and repairs over the life of the project.

- An important consideration is the ability shotcrete to adhere to the liner.
  - The polyester material has small fibers (similar to the harden side of Velcro) to which the shotcrete will stick when sprayed on to the liner (Fig.20
  - The PVC liner has a smooth texture to which the shotcrete will not stick, and a wire mesh needs to be used on the top of the liner to provide grip and added reinforcement.

Maintenance

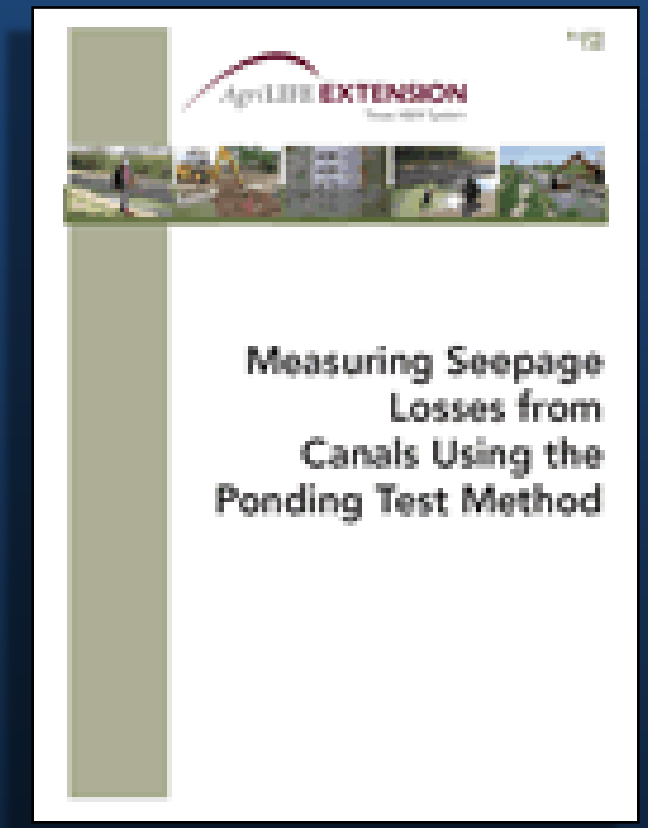
- A regular inspection and maintenance program is important so that repairs can be completed on a time basis.

- Districts should consider having their personnel trained to performed the repair and maintenance which sometimes requires specialized equipment, and similar glues and adhesives used during the installation process.

- Removing sediment from lined canals may be more difficult due to the limitations of using heavy machinery, and may require increased manual labor (Figure 23).

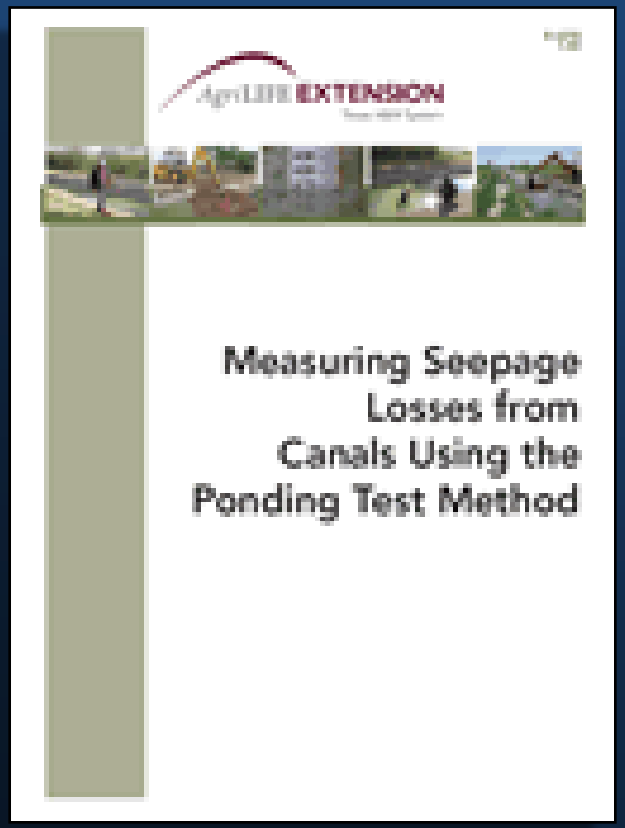
Ponding Test Manual

- The ponding test method is considered to be the most accurate way to measure seepage losses from irrigation canals
- Texas AgriLife Extension Bookstore http://agrilifebookstore.org/



Ponding Test Manual

- Provides complete details for using this method. Including sections:
  - on preparing for the test
  - constructing the dam
  - selecting and installing equipment
  - measuring canal shapes
  - calculating seepage losses from data collected



Automation, Telemetry, and Flow Measurement

Objectives of Demonstrations

- Create in-house capacity in canal operation and control concepts, and automation applications
- Demonstrate cost-effective and alternative technologies for SCADA
- Assist districts in designing/implementing projects which have a water conservation/management purpose
- Evaluate and advise districts on equipment/software options and other technical issues

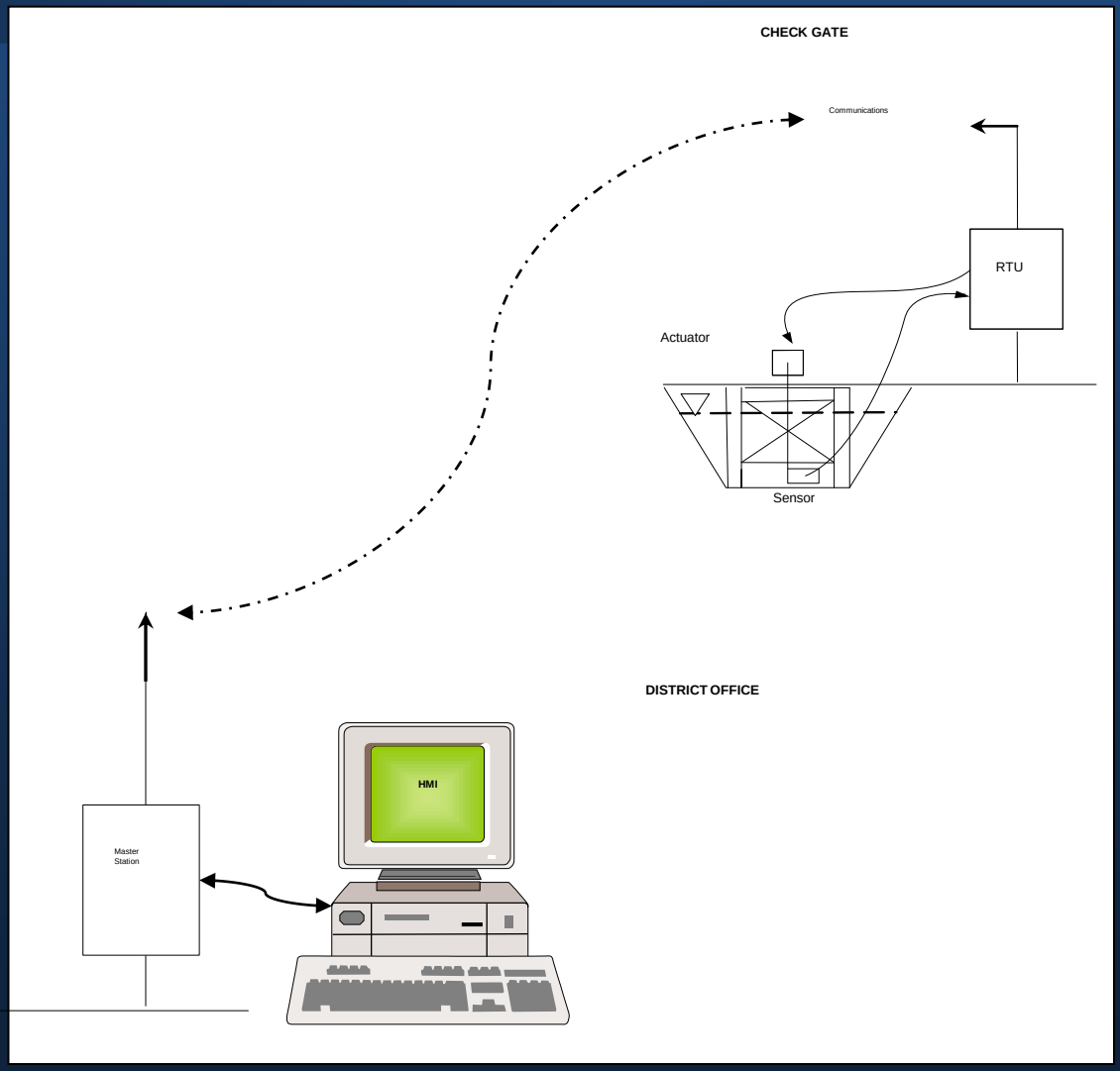
Automation/Telemetry Demonstrations

- United Irrigation District
- HCID6 (Mission #6)
- CCID6 (Los Fresnos)

SCADA Systems

Components

- Master Station
- RTU



Terminology

SCADA - Supervisory Control and Data Acquisition System

A term that includes remote control and automation systems (such as controlling gates in a canal system)

Usually including remote monitoring and collection of data (such as water levels) upon which decisions are made

Terminology

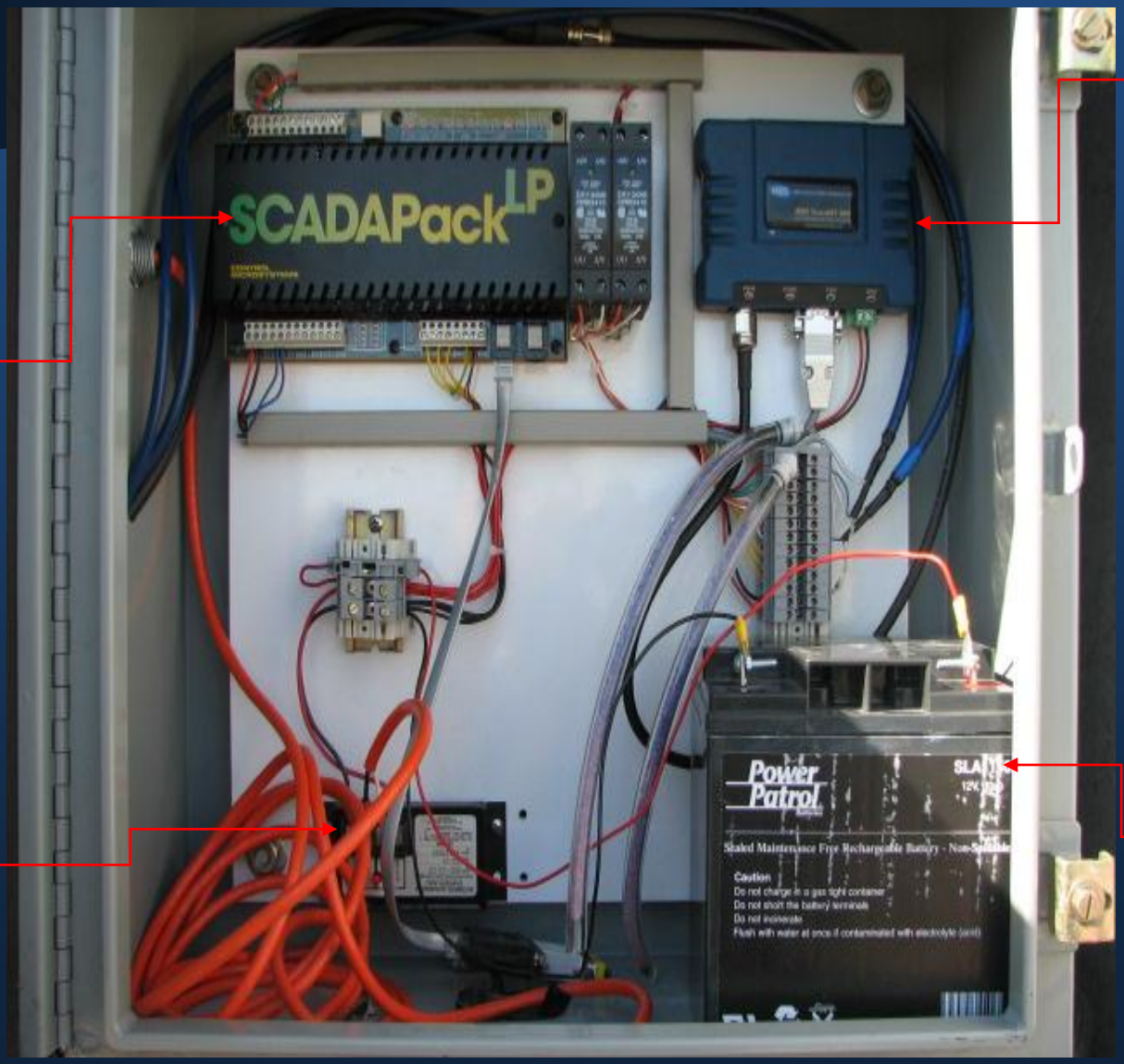
RTU (Remote Terminal Unit)

Deployed in the field and typically includes PLC, radio, power supply, and other electronic devices.

PLC (Programmable Logical Controller)

Monitors the automation site, and based on sensor data and operational rules, decides if adjustments are required, and makes adjustments as needed

Typical RTU

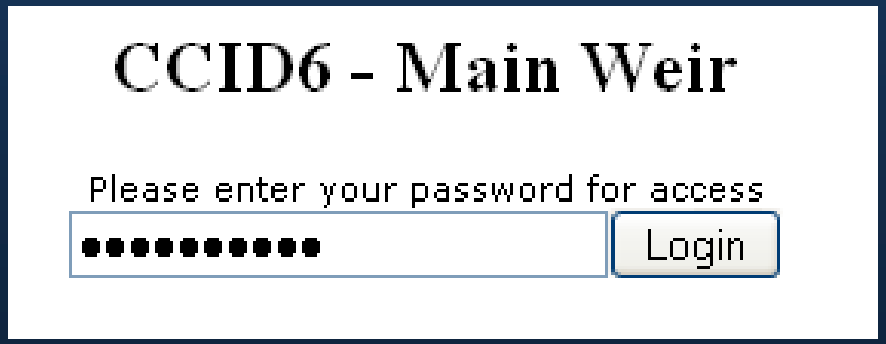

SCADAPack LP
Power Patrol
Caution
Do not charge in a gas tight container
Do not short the battery terminals
Do not incinerate
Flush with water at once if contaminated with electrolyte (acid)
Radio
PLC
Power Supply
Battery

Cameron County Irrigation District No.6 – Main Weir

- Telemetry system to allow monitoring of flow into main canal at the District office (~20 miles away)

Results

- Real-time flow data access in the district office
- Uses simple, inexpensive equipment/software and telephone communications.
- Web-based flow monitoring system where water use can be accessed through internet

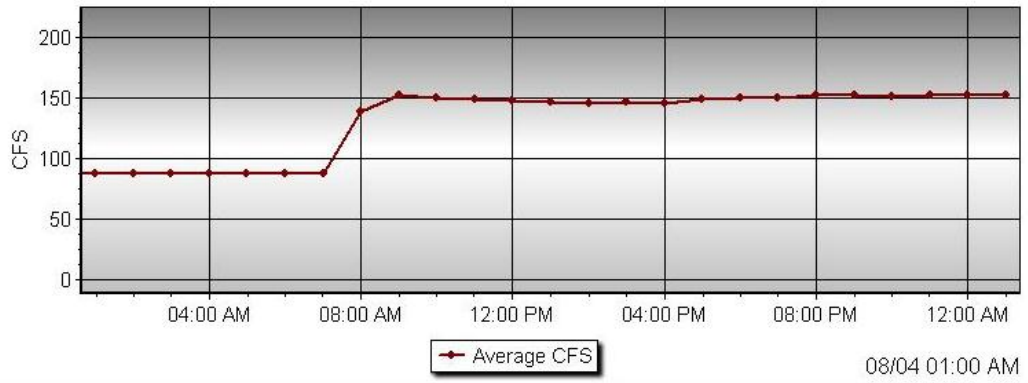


Online Displays

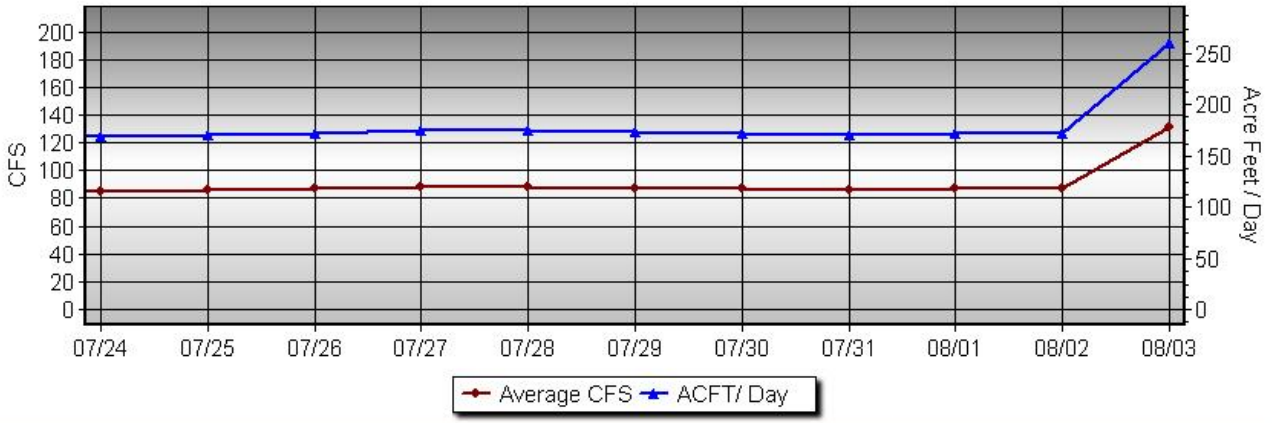
Past Day: **Monday, August 03, 2009**

Avg. Water Level: 1.08 ft Avg. Flow Rate (CFS): 131.20 Total Acre Feet: 260.30

Activity in the Past 24 Hours (CFS)



Activity in the Past 10 Days



Total Dissolved Solids: 769 ppm (24hr average)
(in the testing phase)

United Irrigation District

Initial Work

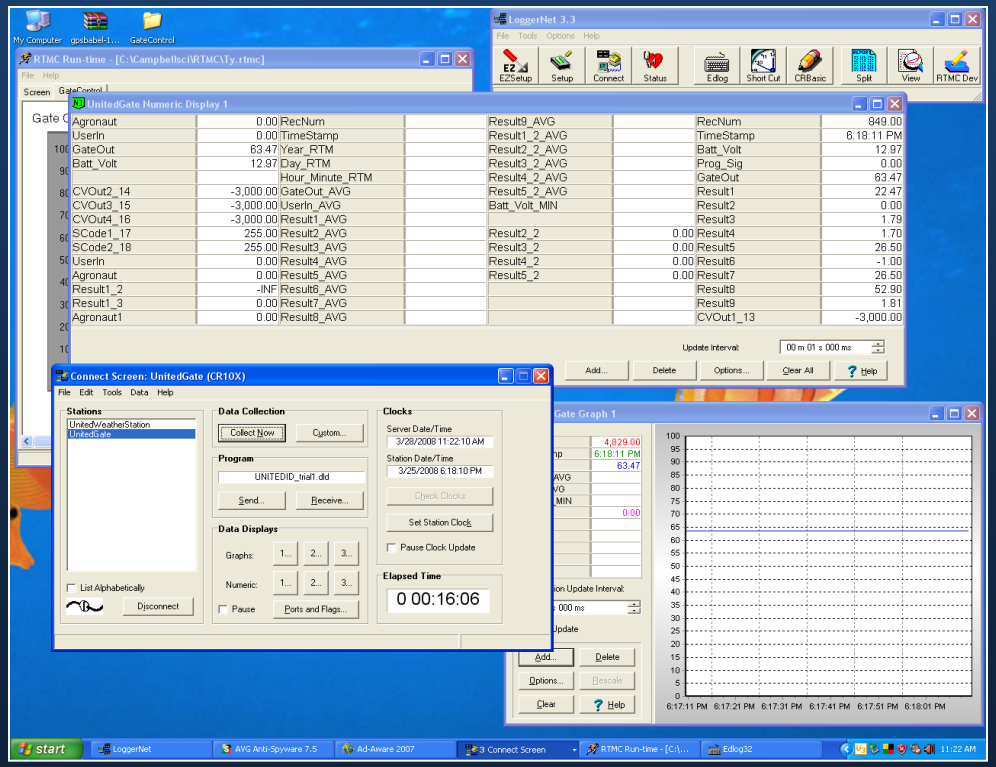
- Replacement of old, manually operated gates on a main canal with a radial gate
- Lean how to operate system based on FLOW

United Irrigation District

- Set up new gate for remote control from District office
- District will move to total automation (or "*full SCADA*")
  - once new gate is calibrated for flow
  - as operational rules are defined

Flow Monitoring

- In June 2008, we installed a flow meter downstream of the gate
- District personnel can now can see flow data and gate openings at the same time in district office

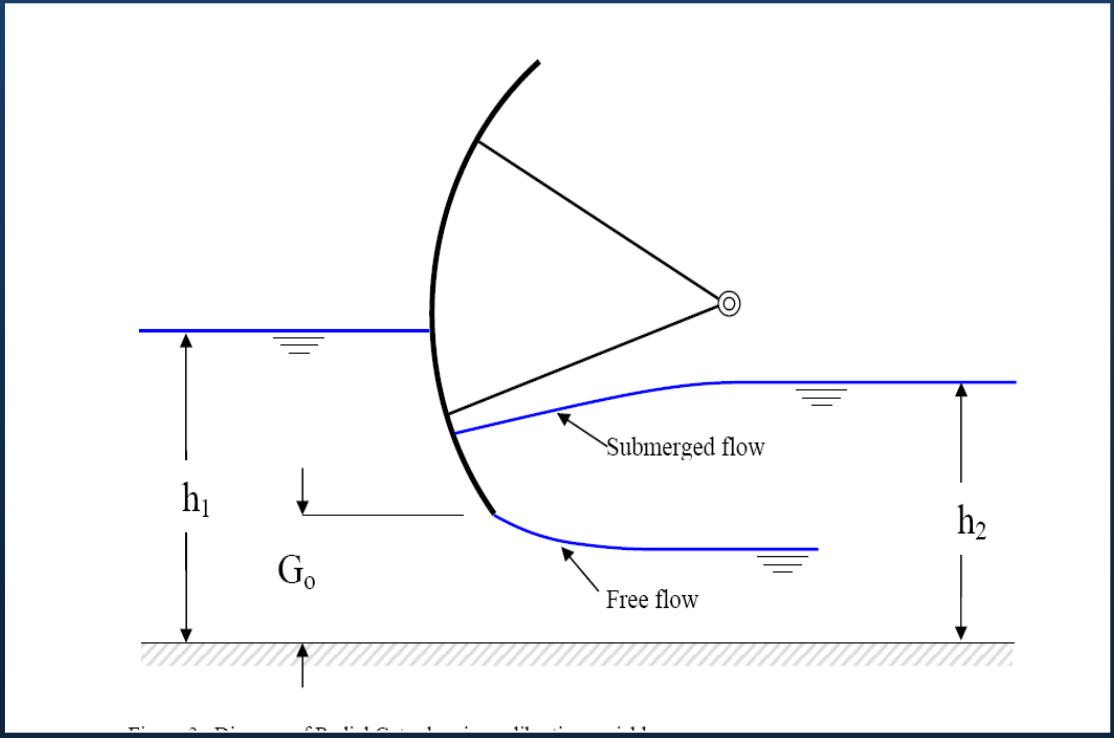


Calibration of Gate

Matching flow with the gate opening (a 4-20mA analog output signal from the actuator) as a percentage of opening

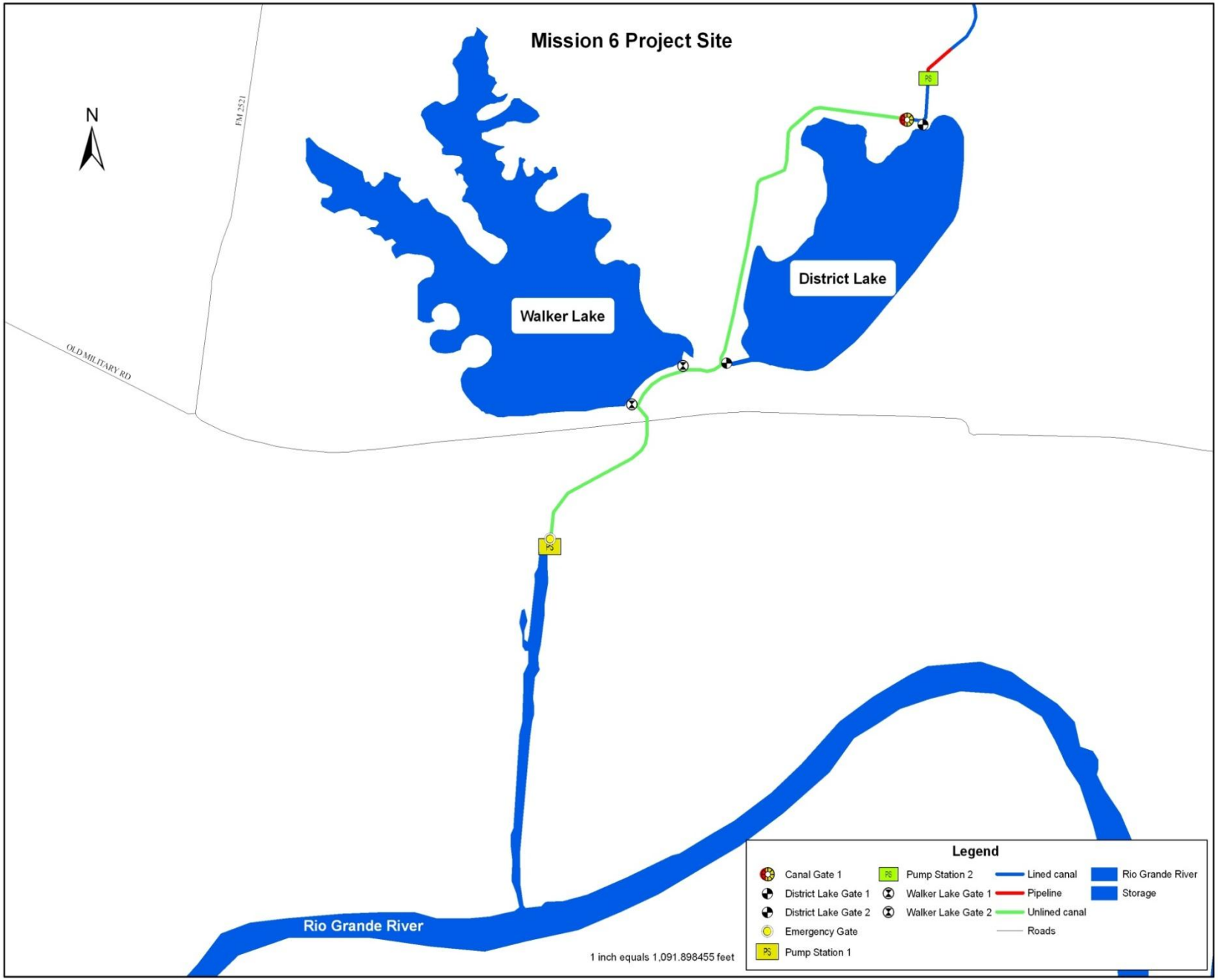
Calibration of Gate

Investigating the use of much cheaper water level sensors instead of a flow meter for gate control and calibration



Hidalgo County Irrigation District No.6

- Full automation with remote control options of main gates and reservoir system
- Purpose:
  - Prevent flooding of area neighborhoods during rain events
  - Improve system management


Mission 6 Project Site
N
FM 2521
OLD MILITARY RD
Walker Lake
District Lake
PS
PS
Rio Grande River
1 inch equals 1,091.898455 feet
Legend
Canal Gate 1
District Lake Gate 1
District Lake Gate 2
Emergency Gate
Pump Station 1
Pump Station 2
Walker Lake Gate 1
Walker Lake Gate 2
Lined canal
Pipeline
Unlined canal
Roads
Rio Grande River
Storage

SCADAPack

690
DANGER
HIGH VOLTAGE
NOTICE
AUTHORIZED PERSONNEL ONLY

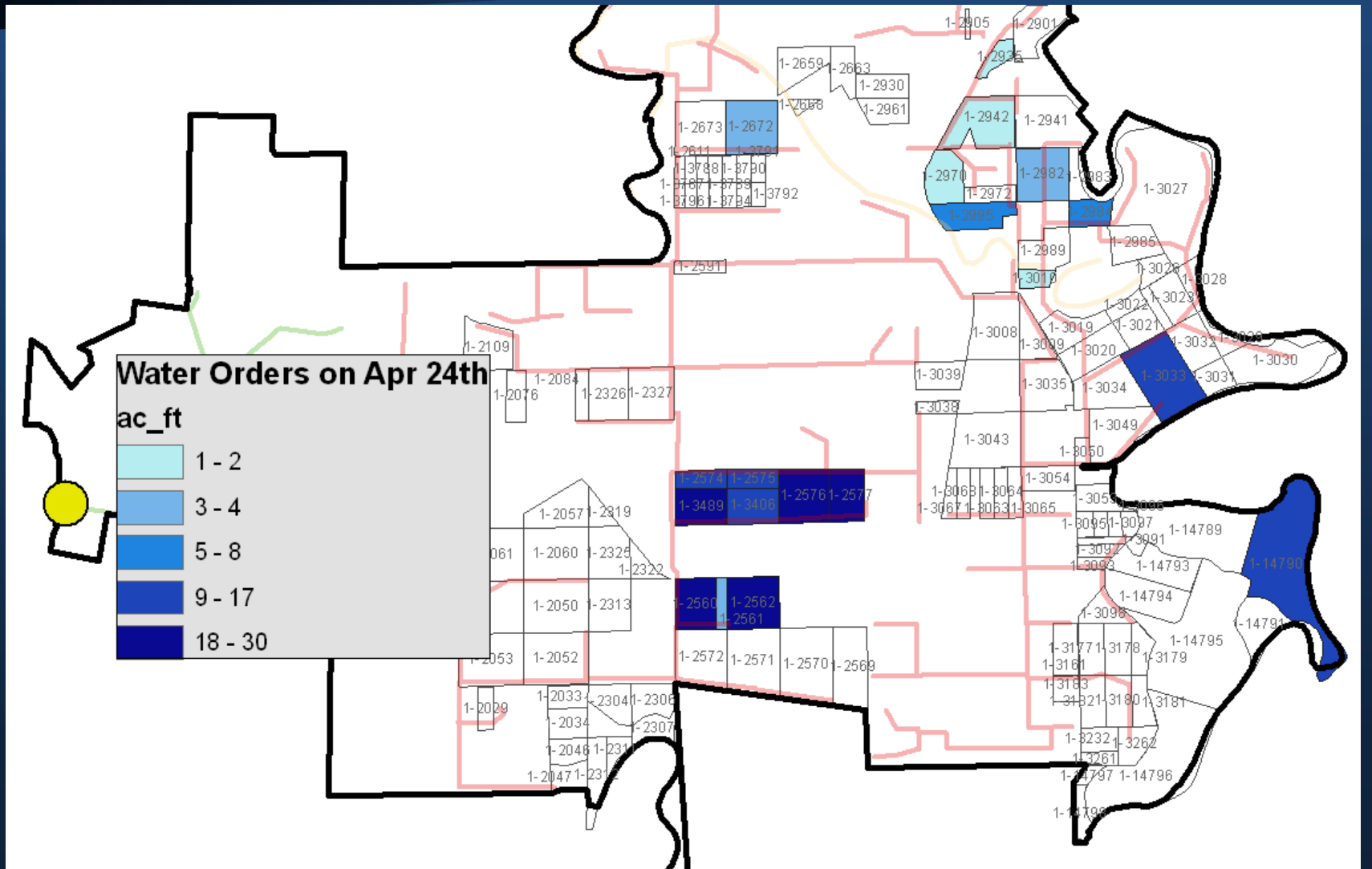
Results

- Automated two additional gates on reservoir system and a flow monitoring station after second lift pump
- Implemented *Clear SCADA* (Human-Machine Interface software) in district office for the gate control, real time data display, store and analysis

Activities for this Year

- Expansion and Development of Automation
- Website Hosting
- GIS Online
- Canal Riders Training Development
- GIS Classes

Irrigation District Database Integration into Geographic Information System (GIS) and the Web



Irrigation District Database Integration into GIS and the Web

INTRODUCTION

Much data is stored at the district level, but it is often difficult for district personnel and others to use. Integration of the district's database into a Online GIS will help in the use of this data.

PURPOSE OF WORK

- Setup daily mapping of water accounts (e.g. orders and distributed volumes) to help in daily operations and management
- Provide online modeling results that predicted crop water needs and irrigation scheduling

Irrigation District Database Integration into GIS and the Web

ACTIVITIES

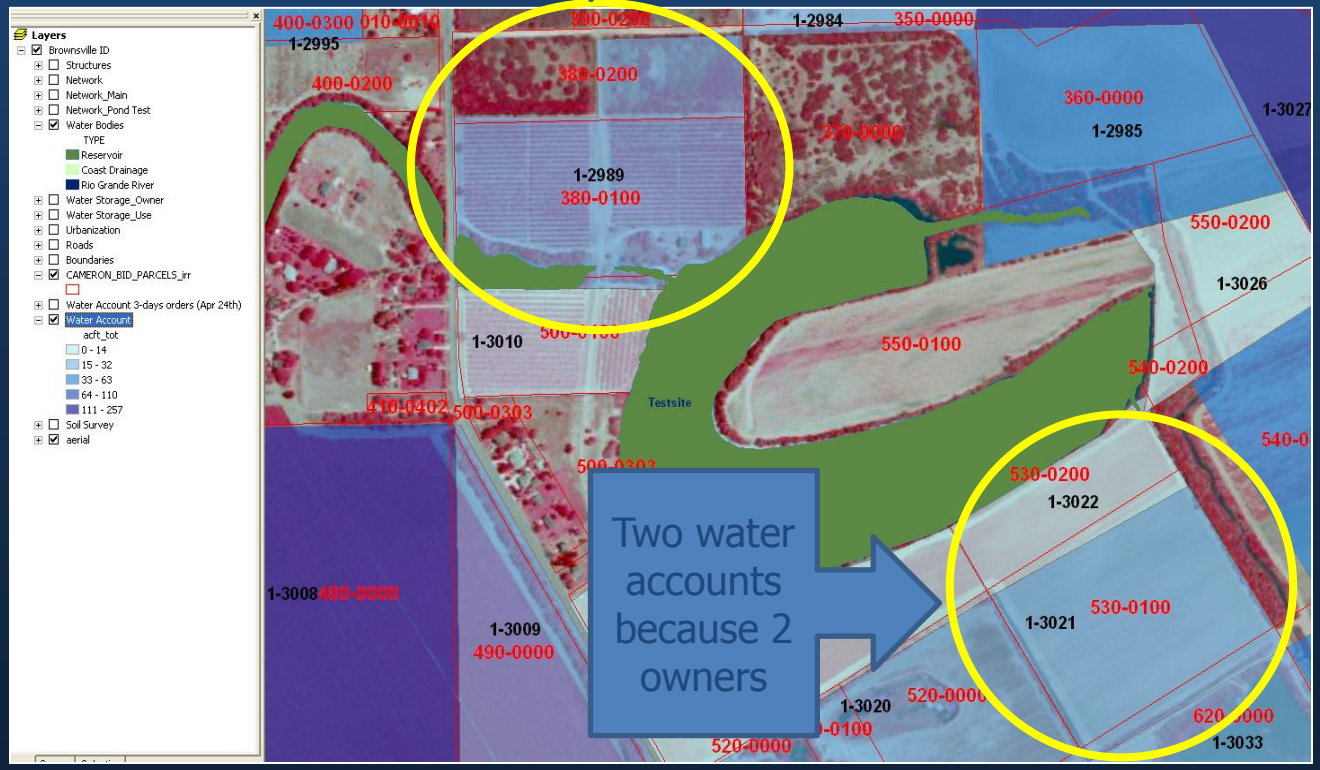
- Adapt Brownsville I.D.'s water account database for automatic daily GIS integration
  - Analyze & provide recommendations for Brownsville Irrigation District's database
  - Setup automatic link between water account database and GIS maps
- Create interactive on-line maps at http://watergis.tamu.edu/
- Setup password protection to enable district personnel and farmers to access account and operational data
- Evaluate mathematical models that predict soil moisture and compare results with observed field data

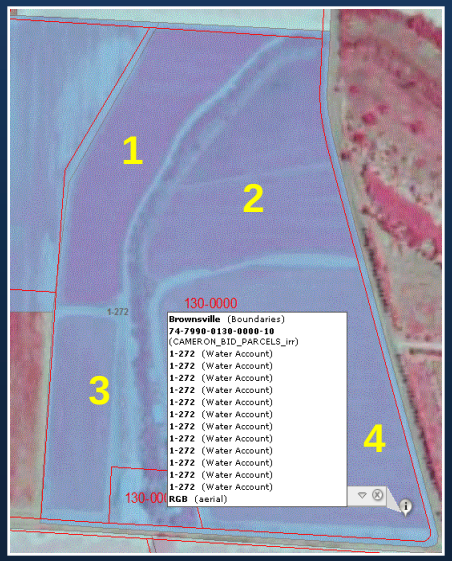
Irrigation District Database Integration into GIS and the Web

Example of Brownsville I.D. database analysis and link to GIS

One water account but 2 legal parcels and 2 fields (cultivated area less than total)

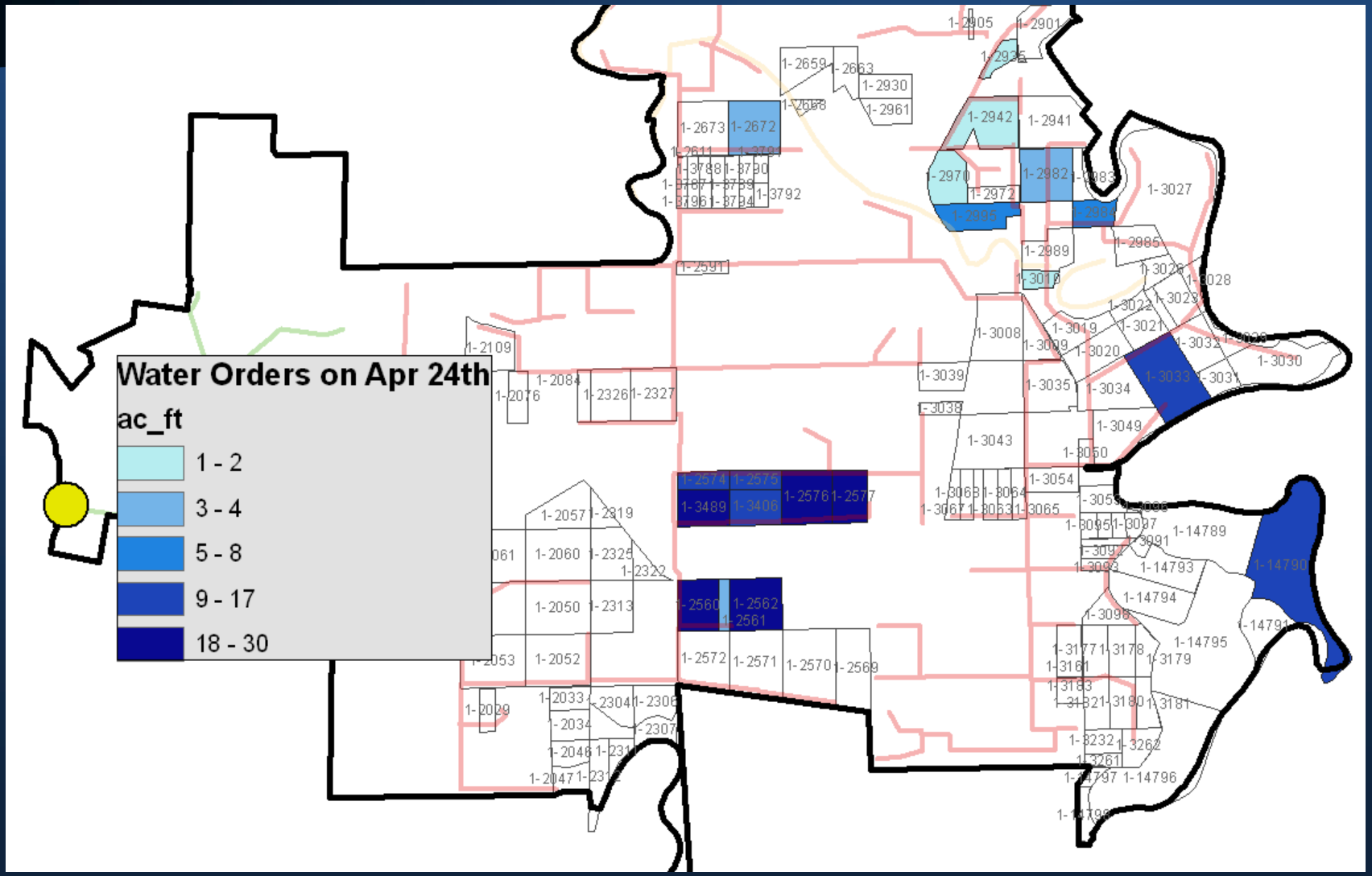
One water account but 4 fields managed differently (many water orders, sometimes simultaneous, planting date unknown)





Irrigation District Database Integration into GIS and the Web

Example of Brownsville I.D. database analysis and link to GIS



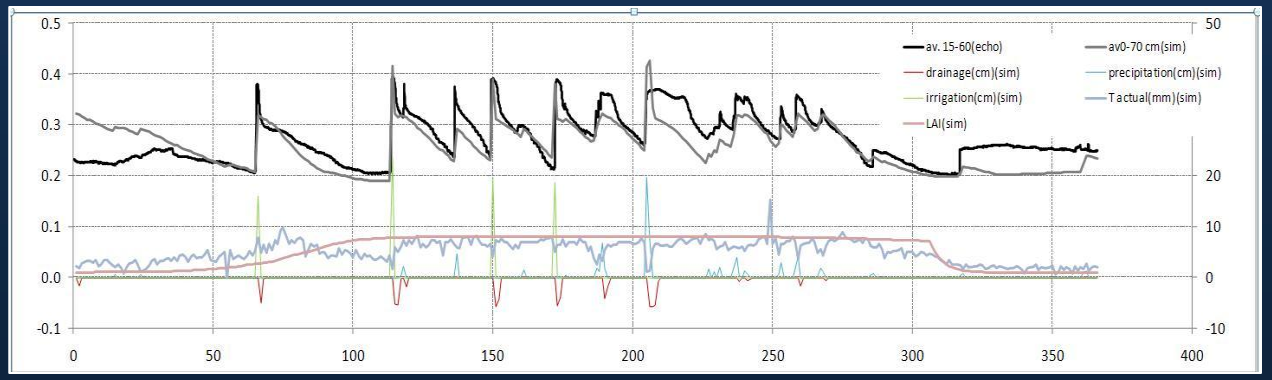
Irrigation District Database Integration into GIS and the Web

Example: Comparison of soil moisture observed and predicted

Input data:

- Local rainfall and temperature
- Soil texture and observed moisture
- Farm operations: crop, tillage, irrigation (dates, volumes, and method), drainage

Testing of the field component of the CRITERIA model is on progress at 3 sites. Field data have been collected by the AgriLife Research personnel at Weslaco



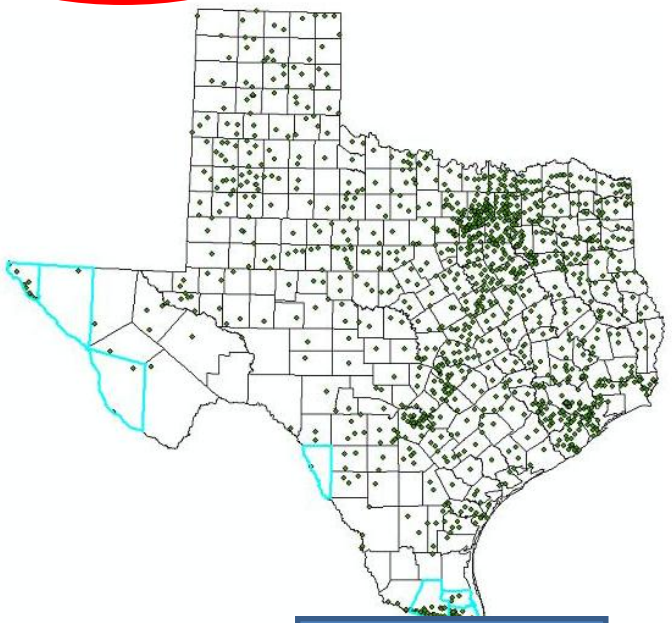
Irrigation District Database Integration into GIS and the Web

RESULTS - http://watergis.tamu.edu/

Water GIS

Web GIS Applications:
Lower Rio Grande Valley
Lower Rio Grande Valley (Cache)
Maverick County
West Texas

Public maps



Password protected maps

Projects:
BID.HTML

Help:
Web GIS Application Help

Texas AgriLIFE Extension – Texas A&M University System

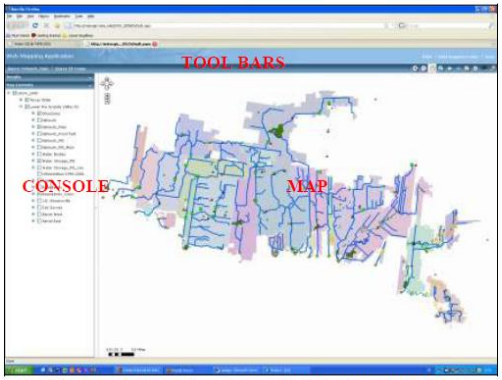
Help on line

http://watergis.tamu.edu
Web GIS Application Help

Click on the desired Web GIS Application link. The following will be displayed:

- a console with a list of information on the left
- a map in the centre displaying the information checked in the list,
- a tool bars on top to help find and interact with data

Note that the first time the web application is opened it takes long because all data is downloaded to the local computer



Example of a Web Application main page (Lower Rio Grande Valley 2009)

In the console chose the information to be displayed. Note that some might be grouped at different levels. To see the description of symbols all levels must be exploded

Irrigation District Database Integration into GIS and the Web

RESULTS - Interactive on-line maps

- Tools (identify, queries, reports, etc.):

http://watergis.tamu.edu
Web GIS Application Help

Click on the desired Web GIS Application link. The following will be displayed:

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- a map in the centre displaying the information checked in the list,
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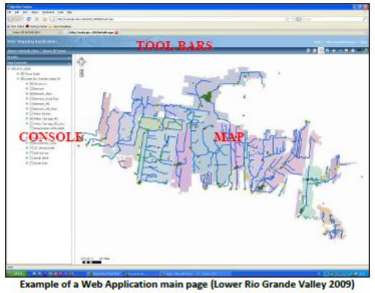
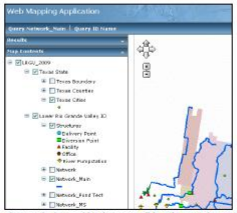


Example of a Web Application main page (Lower Rio Grande Valley 2009)

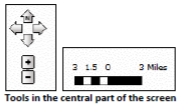
In the console chose the information to be displayed. Note that some might be grouped different levels. To see the description of symbols all levels must be exploded



To see the symbols used in the map all levels must be exploded

Explore the map in the central part of the screen, which displays the information checked in th console list. A tool in the left high corner helps to quickly zoom in, zoom out, and pan the ma and a ruler in the bottom right corner that show the scale adopted

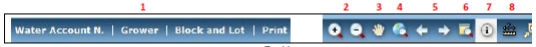
http://watergis.tamu.edu
Web GIS Application Help



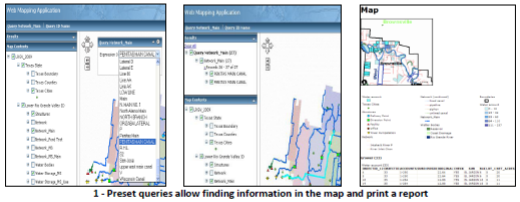
Tools in the central part of the screen

Operate queries and interact with the map using the tool bars. It is possible to:

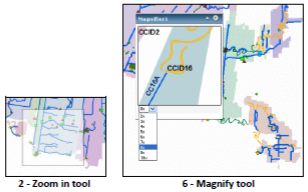
1 - find information in the map using preselected queries and print a report
2 - zoom in and out
3 - pan
4 - go to the full map extent
5 - go to back and forward extent
6 - magnify up to 10x
7 - map identify
8 - measure point coordinates, and line or polygon extent
9 - show an overview of the map



Tool bars



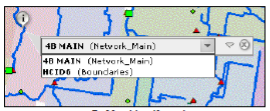
1 - Preset queries allow finding information in the map and print a report



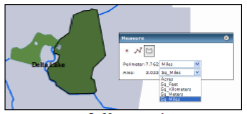
2 - Zoom in tool

6 - Magnify tool

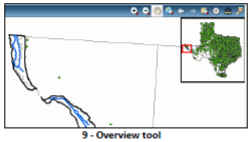
http://watergis.tamu.edu
Web GIS Application Help



7 - Map identify tool

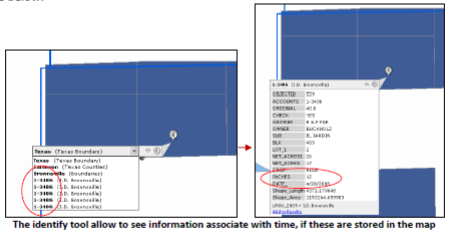


8 - Measure tool



9 - Overview tool

Note that the identify tool allows you to see information associate with time, if these are stored in the map (e.g. irrigation dates and volumes for the same water account field), as described in the example below:



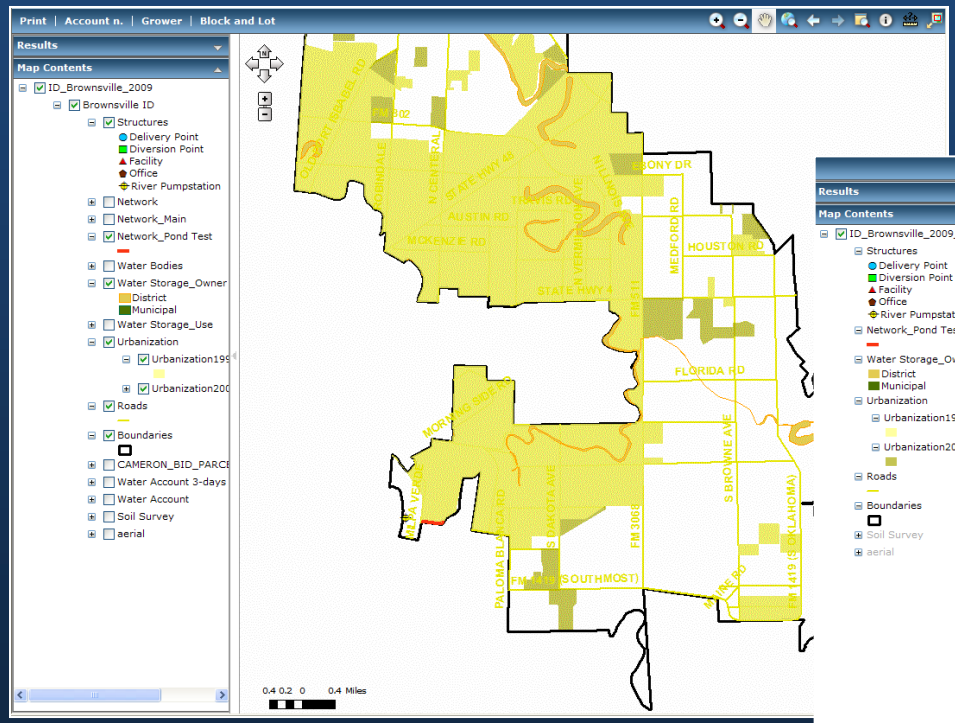
The identify tool allow to see information associate with time, if these are stored in the map

A default "Web Mapping Application Help" describe additional features of the Web GIS Applications

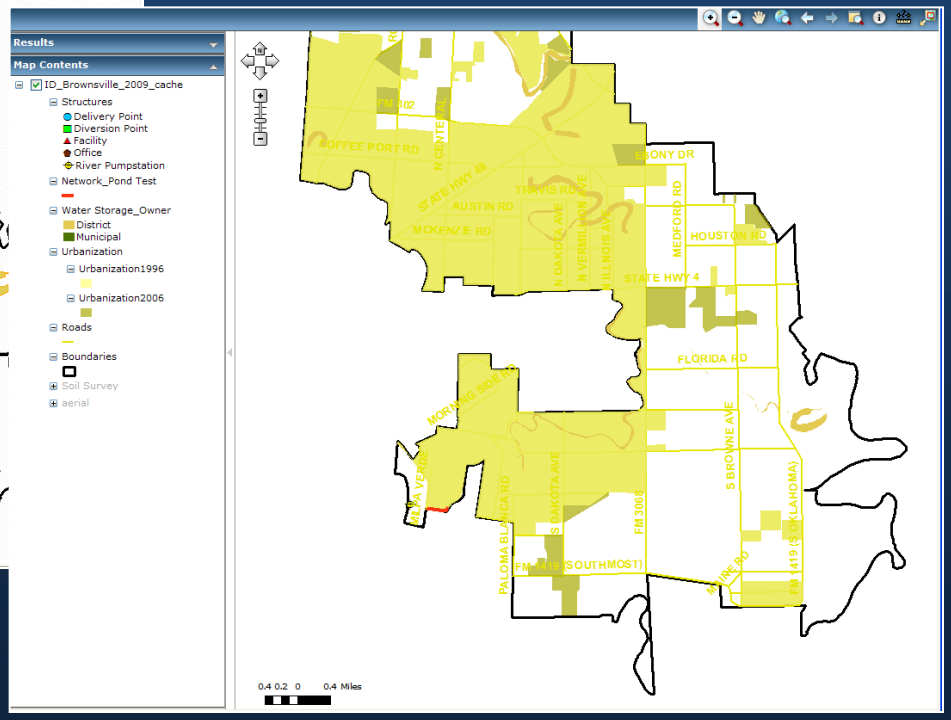
Irrigation District Database Integration into GIS and the Web

RESULTS - Interactive on-line maps

- Compressed maps to improve performances:



not compressed

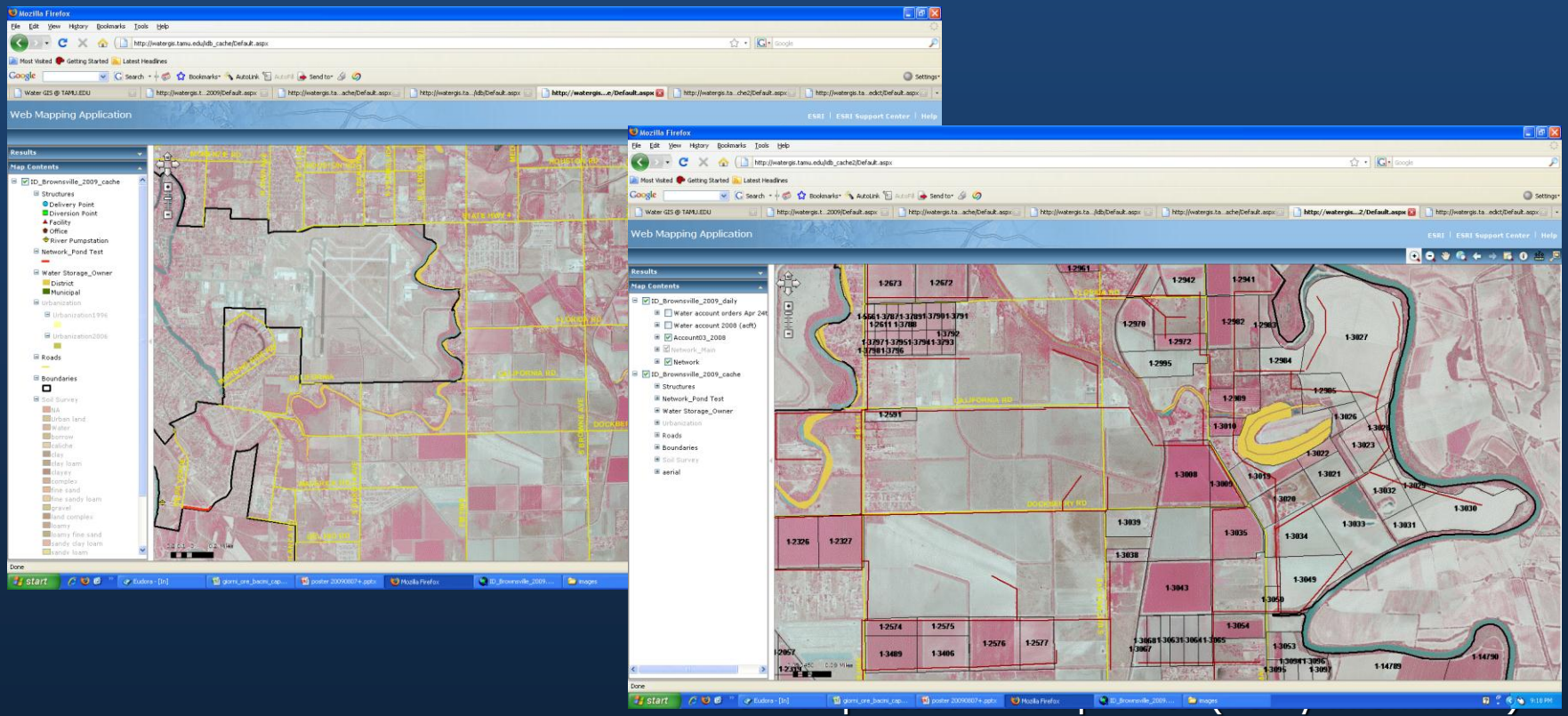


compressed (faster, same information, no check boxes)

Irrigation District Database Integration into GIS and the Web

RESULTS - Interactive on-line maps

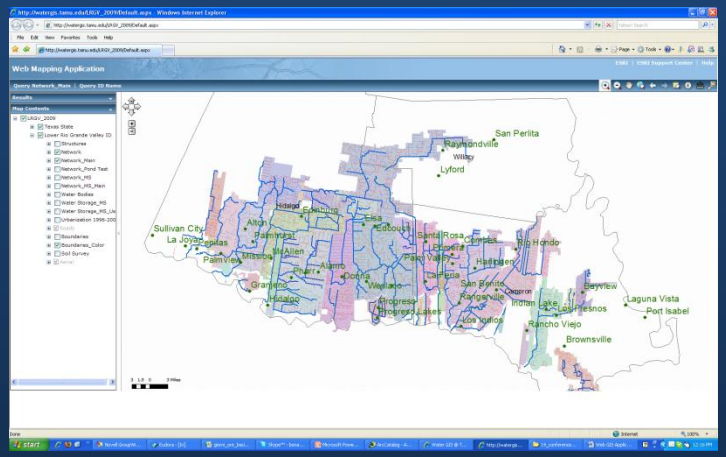
- Mix compressed and not compressed:

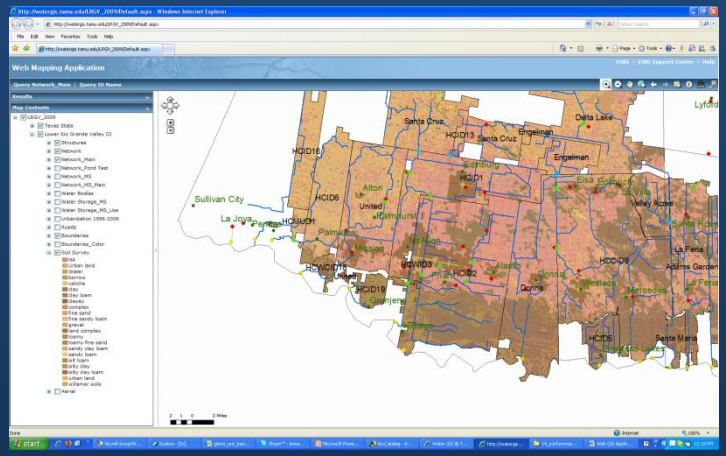


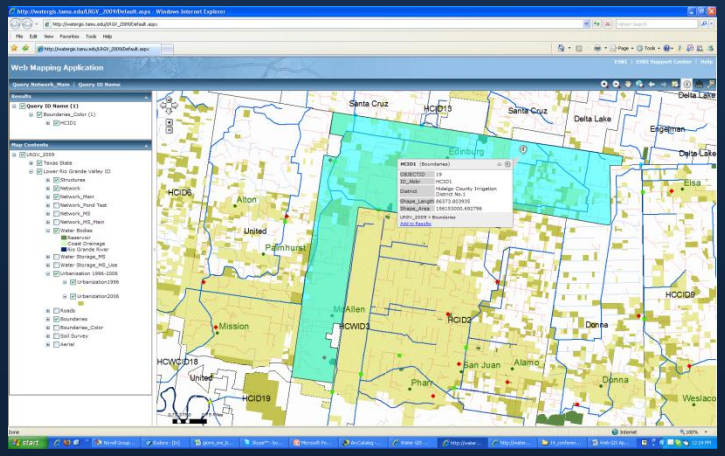
Irrigation District Database Integration into GIS and the Web

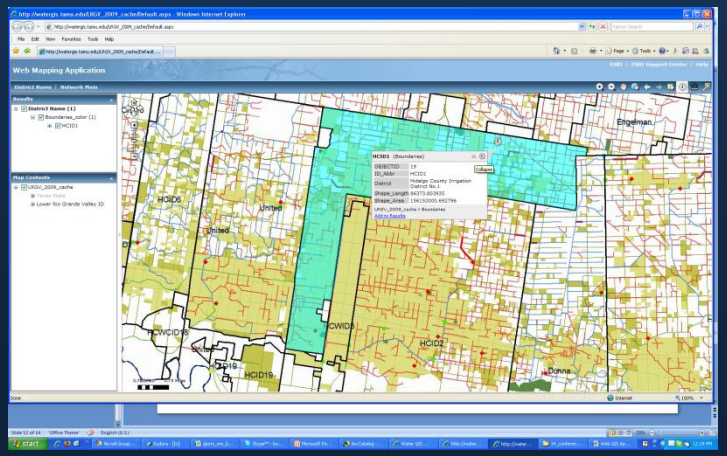
RESULTS - Interactive on-line maps

- Public maps:







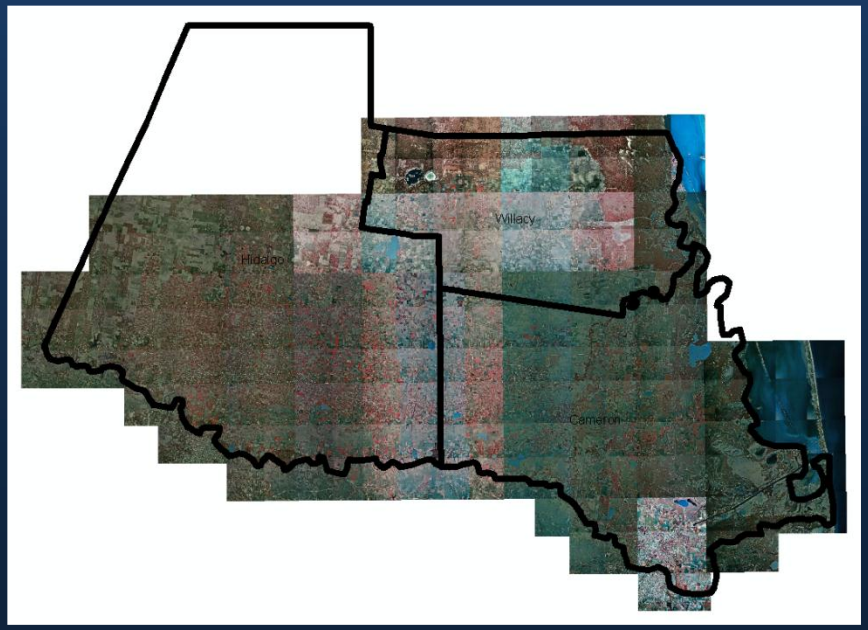


Irrigation District Database Integration into GIS and the Web

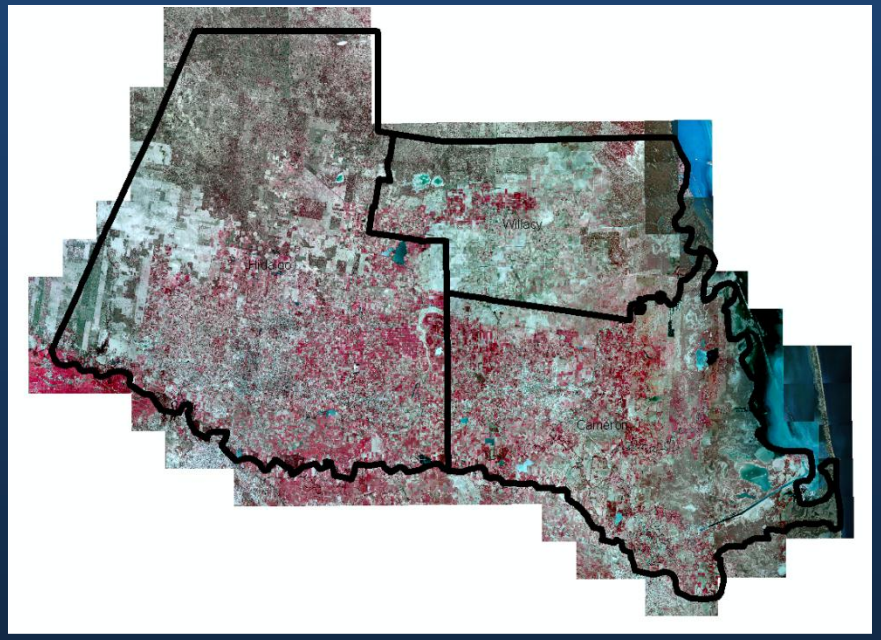
RESULTS - Interactive on-line maps

- Image services:

2001



2006

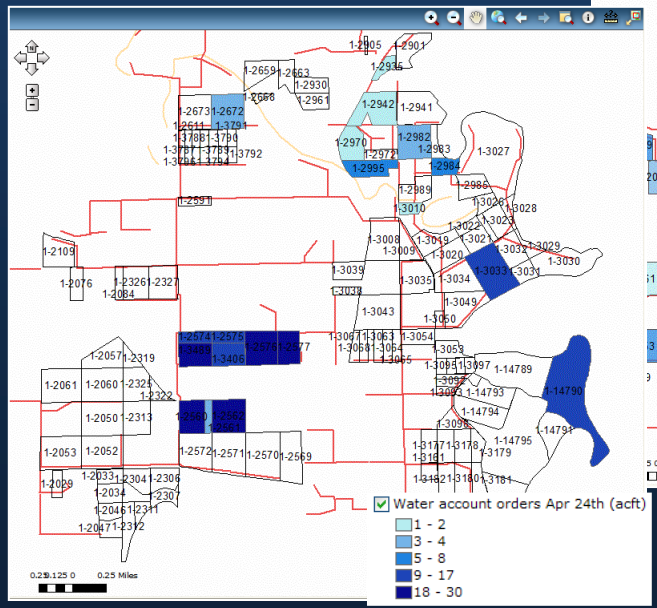


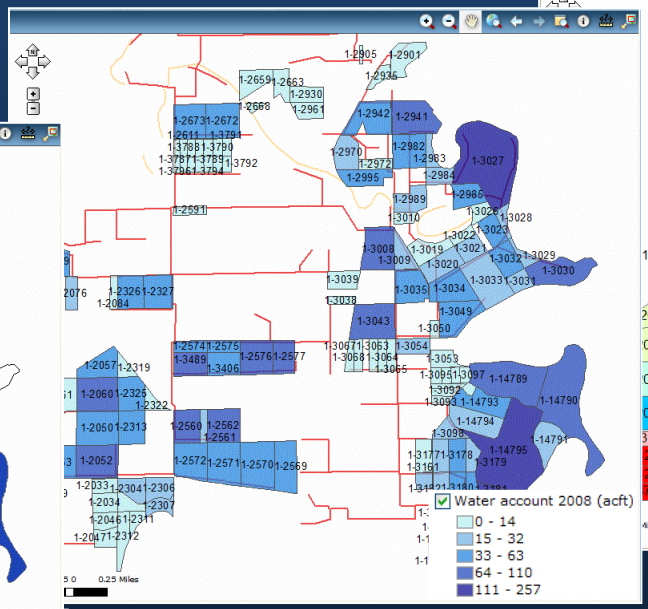
Irrigation District Database Integration into GIS and the Web

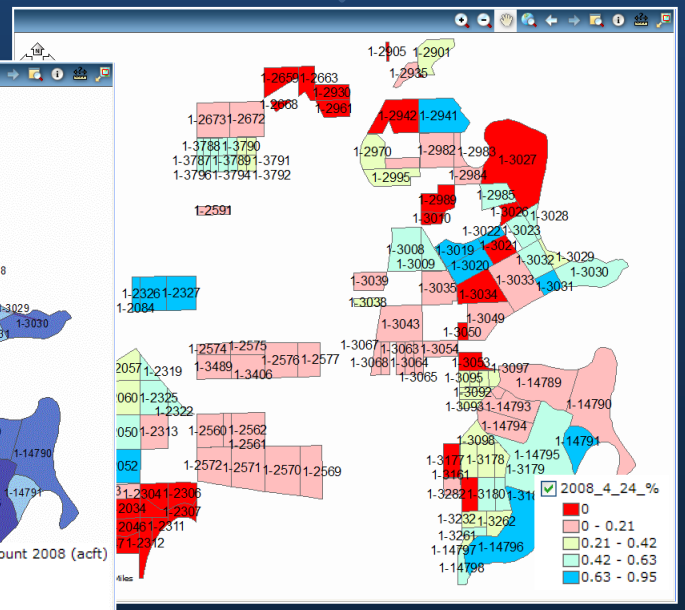
RESULTS - Interactive on-line maps

- Real time products for Districts:

meteorology soil crop







Map & Publications

- 5 County Maps showing expansion of urban area
- 3 Maps showing 110th US Congress (2007- 2009)
- 3 Maps showing Texas Senate (2003-2012)
- 3 Maps showing Texas House (2003-2012)
- 30 Individual Irrigation District Maps showing the expansion of urban area

Map & Publications

- TR-353: Evaluation of Canal Lining Projects in the Lower Rio Grande Valley of Texas. June 2009
- B-6218: Measuring Seepage Losses from Canals Using the Ponding Test Method. January 2009.
- EM-105: Expansion of Urban Area in Irrigation Districts of the Rio Grande River Basin, 1996-2006: A Map Series. March 2009.
- EM-102: Texas Legislative and Irrigation Districts of the Rio Grande River Basin: A Map Series. July 2008.

Irrigation District Engineering and Assistance

http://idea.tamu.edu