Analysis of the Municipal Water Supply Network in the Lower Rio Grande Valley

Presentation Prepared for the

Region M Water Planning Group

November 19, 2003

McAllen, Texas

Municipal Water Supply Network

"MSN" (*municipal supply network*) will be used in this presentation to refer to

- the portions of the irrigation district distribution networks which also carry municipal water
- Defined by the locations of existing control structures (gates, valves, etc.) which can isolate the MSN

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Professor and Extension Agricultural Engineer

Biological and Agricultural Engineering Dept.,

Texas A&M University, College Station

(since 1988)

Director of the ***Irrigation Technology Center***,

a newly formed center under the Texas Water Resources Institute

Regional Water Planning Experience in the Lower Rio Grande Valley

Conducted the analysis of water savings potential in irrigated agriculture for the:

- ***Lower Rio Grande Integrated Water Resources Plan Project – Phase II***

  (final report: December 22, 1998)
- ***Region M Water Plan***

  (final report: December 22, 2000)

These reports are posted at http://idea.tamu.edu and the full text of our reports was included in the appendixes of each final project reports

Irrigation Technology Center

- Incorporating some existing programs into the ITC, including our

  Irrigation District Engineering and Assistance Program

- For more information:

  http://itc.tamu.edu

Irrigation District Engineering and Assistance Program

Engineering analysis, technical assistance, applied research, workshops and short courses
(see handout for more information)

IDEA Team

Wesalco

Eric Leigh – Extension Associate
Martin Barroso – Ag Technician
Noemi Perez – Ag Technician

Collage Station

Dave Flahive – System Analyst/Programmer
Dr. Yanbo Huang – Extension Associate (1/2 time)

Irrigation District Engineering and Assistance Program

Funding

- About 2/3 of current funding is from the federal legislative initiative:

"*Irrigation Conservation in the Rio Grande Basin*"

(for more information, see http://riogrande.tamu.edu)

- About 1/3 of funding is from grants, contracts, and fees for services and products

Irrigation District Engineering and Assistance Program

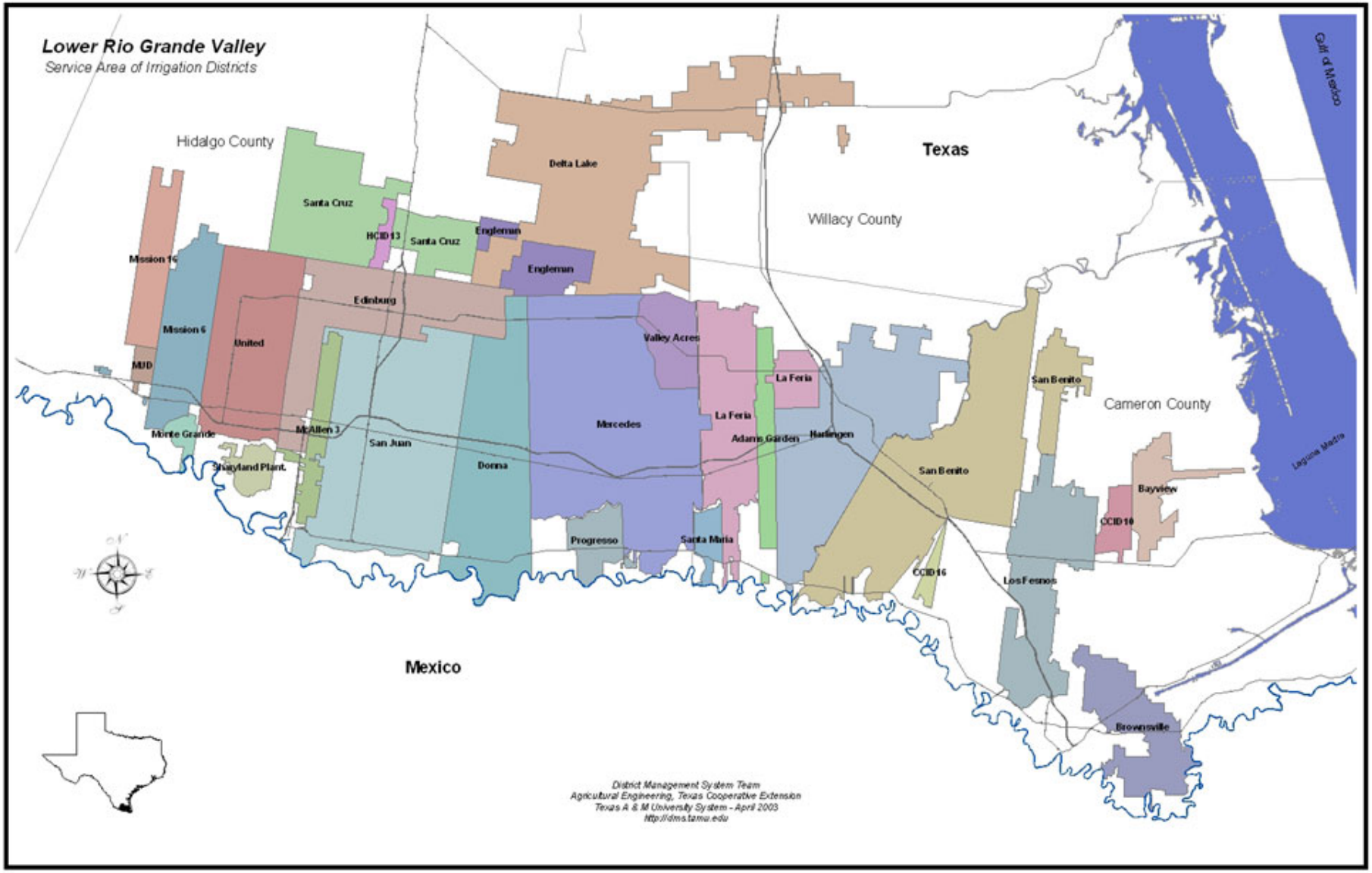
Activities Related to the MSN Analysis

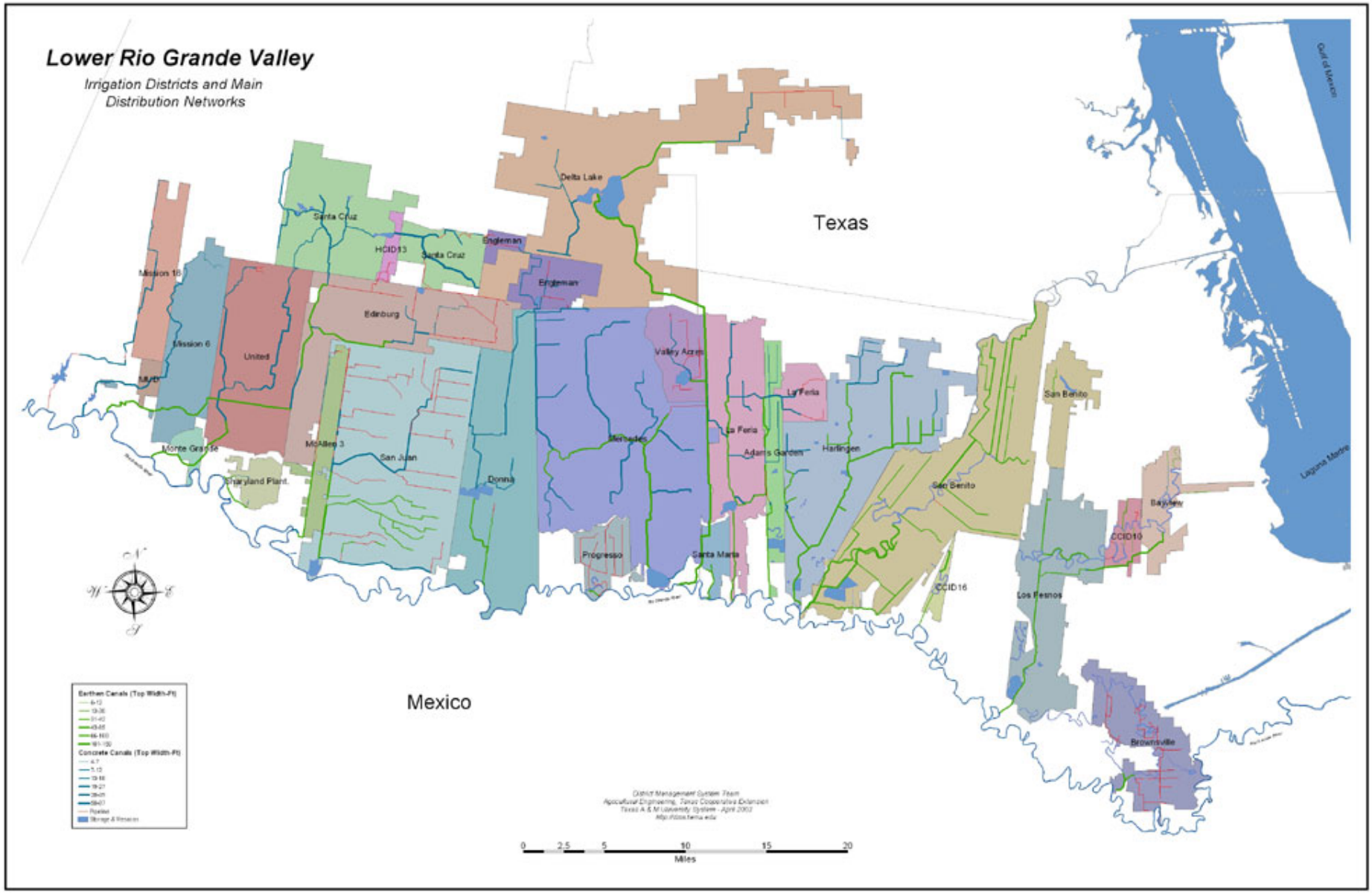
- This year, we have provided assistance to 18 irrigation districts in Region M on seepage loss testing of canals, and analysis of the need for and water savings of rehabilitation projects.
- Released updated GIS-based maps of irrigation districts

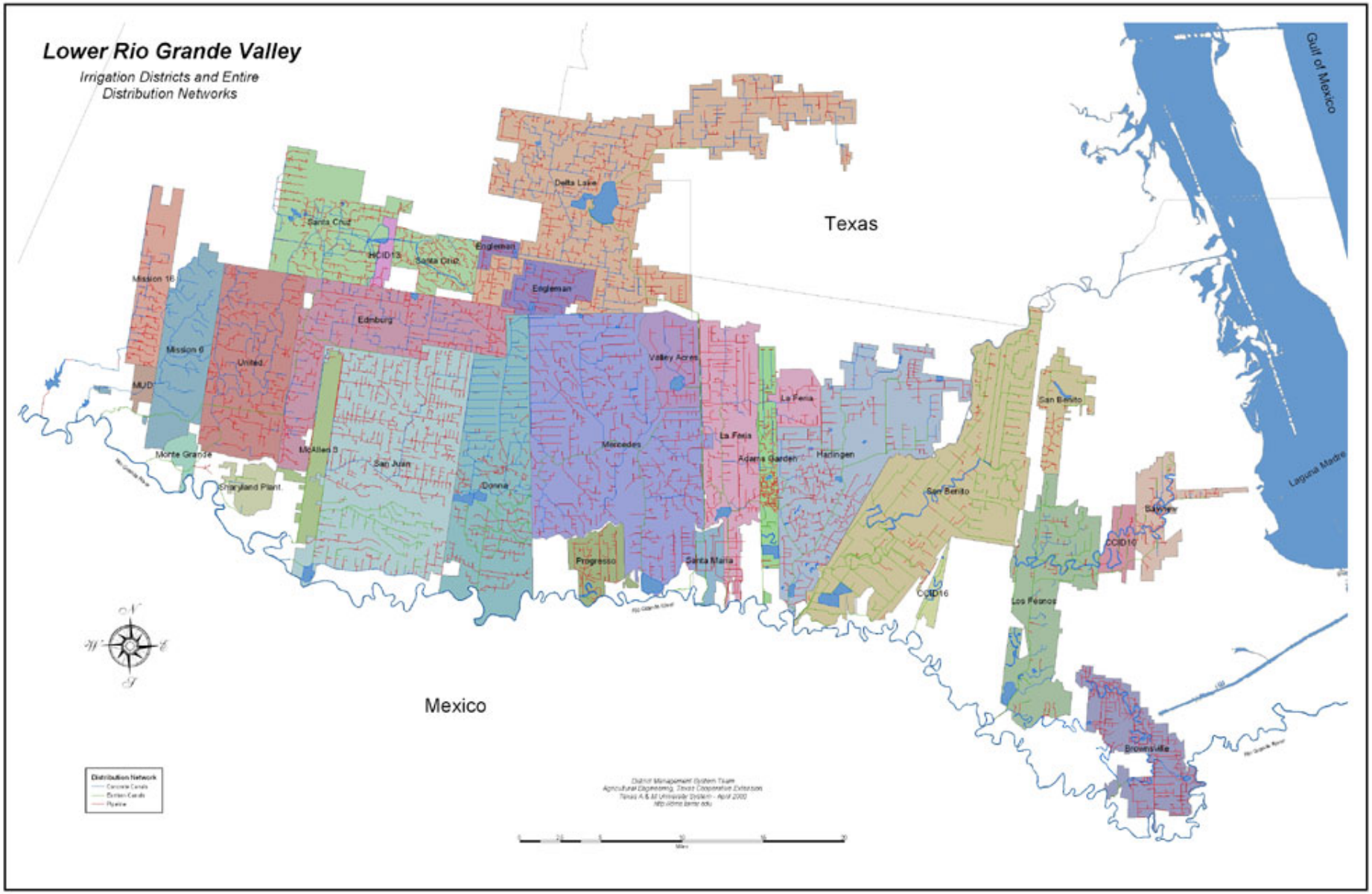
Maps

- New, 3-map series of irrigation districts in the LRGV
- maps of all districts in the Rio Grande Basin
- Complimentary copy of our *“location map”*
- See handouts for additional map information

Location Map




Lower Rio Grande Valley
Irrigation Districts and Main Distribution Networks
Texas
Mexico
Gulf of Mexico
Laguna Madre
Delta Lake
Santa Cruz
HCID13
Santa Cruz
Engleman
Engleman
Mission 18
Edinburg
Mission 6
United
Valley Acres
La Feria
San Benito
La Feria
Mercedes
Adams Garden
Harlingen
Monte Grande
McAllen 3
San Juan
Donna
Sharyland Plant.
San Benito
Bayview
CCID10
Progresso
Santa Maria
CCID16
Los Fresnos
Brownsville
Earthen Canals (Top Width-Ft)
6-12
13-26
31-42
43-65
66-160
161-190
Concrete Canals (Top Width-Ft)
4-7
8-12
13-18
19-27
28-41
58-61
Pipeline
Storage & Reservoir
District Management System Team
Agricultural Engineering, Texas Cooperative Extension
Texas A & M University System - April 2003
http://cotx.tamu.edu
0 2.5 5 10 15 20
Miles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Brownsville
Distribution Network
Concrete Canals
Earthen Canals
Pipeline

Municipal Supply Network Analysis

- Over the last year, received numerous requests for assistance on determining "*push water*" requirements

- Included the MSN analysis in my work plan for the second year of the Rio Grande Initiative which runs: *May 15, 2003 – May 14, 2004*

Municipal Supply Network Analysis

Are our interests in this analysis the same?

Municipal Supply Network Analysis

<u>Concerns</u>

- Definition of "*push water*"
- Data is not easily obtainable
- Planned and unanticipated use of the data
- Degree of accuracy needed

  (accuracy should be related to the planned use of the data)

Municipal Supply Network Analysis

Concerns (continued)

- Complexity of task and labor/effort necessary to produce accurate results
- Details on types of data and analyses needed
- Limited funds from Rio Grande Initiative available for this effort

Procedures Used

Procedures

1) Identification/verification of districts with municipal water deliveries
2) Met with districts to:

- define MSN by locating control structures
- obtain sizes, dimensions and capacities of MSN components

Procedures

Out of the 14 districts

1 district - all needed information was readily available

2 districts - much of the needed information was readily available

Our GIS database has

- top width of most canals,
- but not the water depths and actual water span widths under normal operational conditions

(*needed for MSN calculations*)

Procedures

3) With district staff, took field measurements of MSN
4) Determined the surface areas of reservoirs and resacas using aerial photographs
5) Determined segment lengths from GIS

Procedures

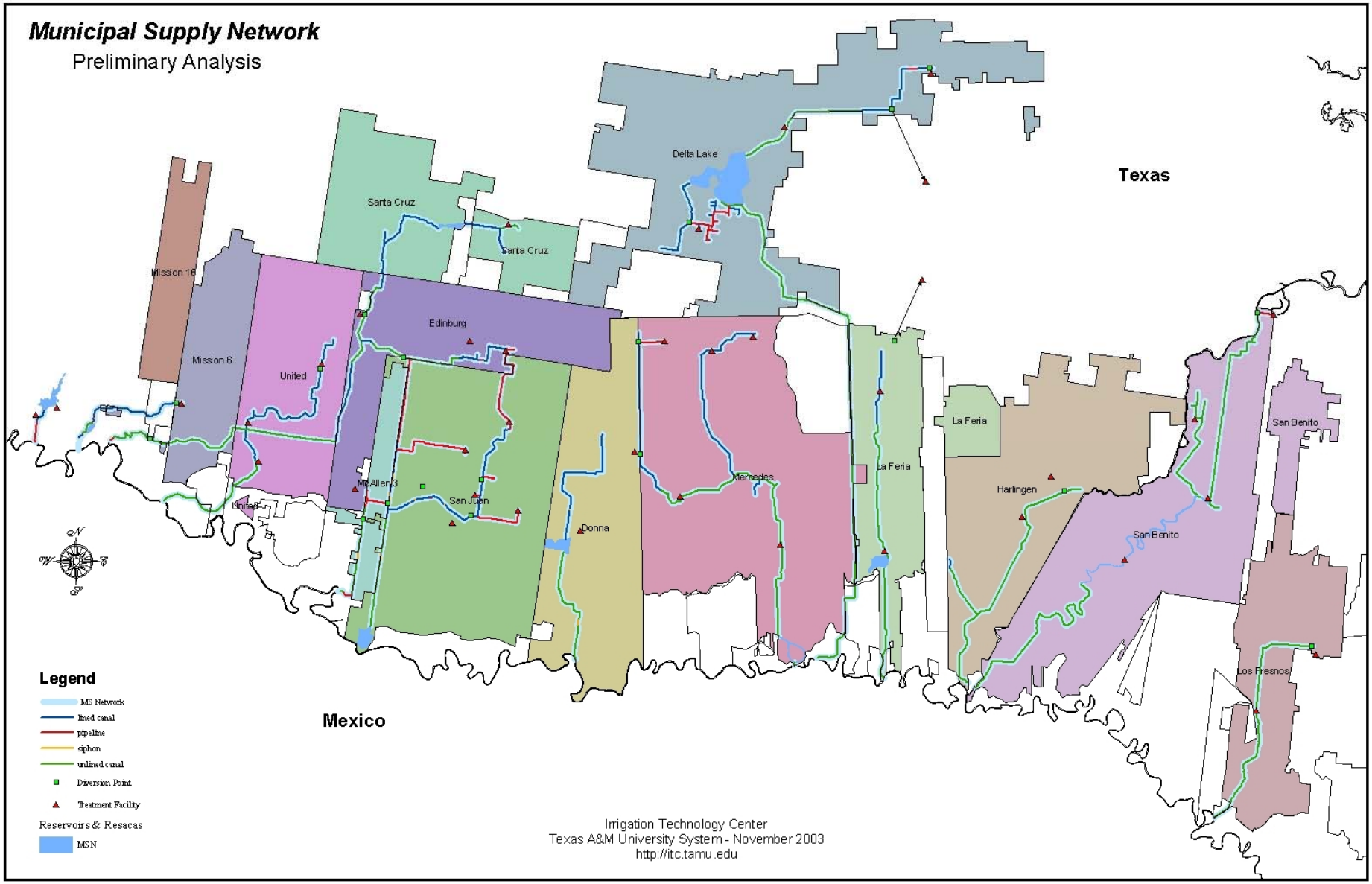
6) Computed initiate MSN estimates
7) Summarized data and produced tables and maps for districts to review
8) Dropped off materials at district offices and followed-up to collect comments/corrections

Procedures

9) Took follow-up field measurements and other efforts to develop complete data sets
10) Completed final MSN estimates under normal operational conditions:
    - static volume
    - evaporation
    - seepage losses
9) Collected available info on the types, sizes and operational criteria of municipal takeout structures
10) Define additional analysis needed (in progress)

Municipal Supply Network

Produced two maps illustrating the extent of the MSN Network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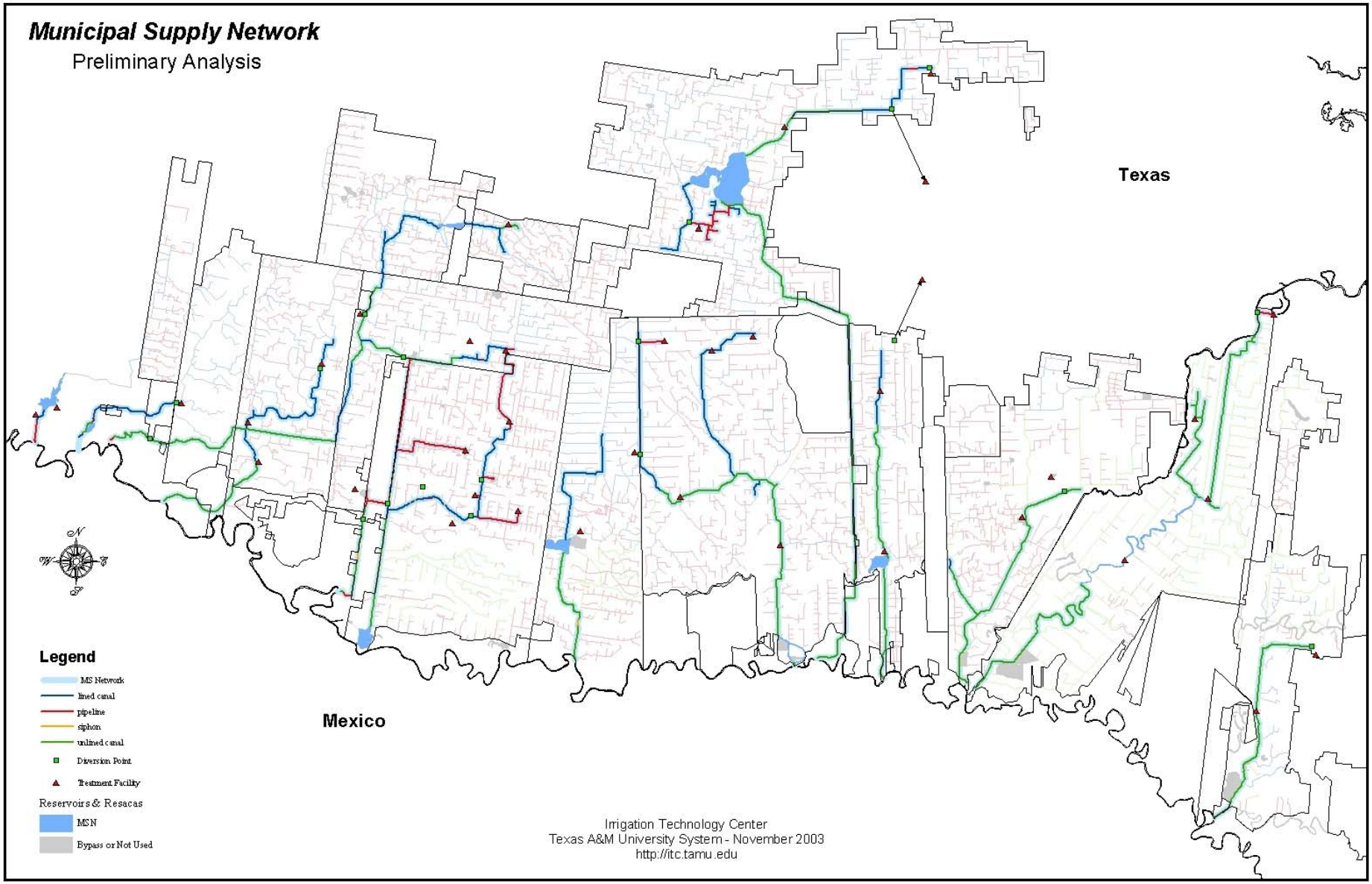
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Bypass or Not Used
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http://itc.tamu.edu

Notes on MSN Maps

- Locations of the 39 municipal treatment plants were not confirmed (based on data provided by the Rio Grande Watermaster office)
- Did not map the municipal supply systems that carries water from the district take-out point to plant

MSN Network Characteristics
(see table 1 for details)

component	widths / diameters	lengths	Surface area
Lined canals	4 – 80 ft	92 mi	
Unlined canals	10 – 150 ft	168 mi	
Pipelines	14 – 72 in	25 mi	
Resacas			377 ac
Reservoirs			3845 ac

Municipal Supply Network

Static Volume of the MSN Network

Municipal Supply Network

Static Volume of the MSN Network

The volume of water needed to fill the system to normal operational levels used for agricultural water delivery

Canal Shapes and Capacities

- few districts had data readily available on
  - canal shapes and related dimensions
    (such as bottom width - for trapezoidal)
  - surface area of resacas

- Some did not have reservoir surface area at normal operating depths

Canal Shapes and Capacities

- For unknowned canal shapes or canals with incomplete data, assumed:

  - parabolic shape

    (*low volume estimate*)

  - rectangular shape

    (*high volume estimate*)

Municipal Supply Network

Static Volume of the MSN Network

15,000 – 17,300 ac-ft

MSN Network Characteristics

(see table 2 for details)

component	Static volume (ac-ft)
Lined canals	722 - 866
Unlined canals	4,382 – 6,527
Pipelines	26.6
Resacas	2484
Reservoirs	8216
TOTAL	**15,001 – 17,291**

These are the preliminary estimates of static volume of water (ac-ft) needed to charge the MSN for normal agricultural water deliveries (excludes siphons, culverts)

Municipal Supply Network

Evaporative and Seepage Losses of the MSN

Municipal Supply Network

Evaporative and Seepage Losses of the MSN

(*at normal operational levels for agricultural water delivery)*

Evaporative Loss Calculations

- Peak evaporation rate:

  canals, resacas
  0.8 x pan evaporation x surface area
  (avg. peak evaporation rate is 0.25 in/day in July)

  reservoirs
  lake evaporation x surface area
  (avg peak evaporation is ~0.33 in/day in the LRGV)

Peak Evaporative Losses
(preliminary data)

component	Evaporation (ac-ft/day)
Canals/resacas	33
Reservoirs	100
TOTAL	**133**

These are estimates of the total <u>peak</u> evaporation (ac-ft/day) of the MSN at normal operational levels

Peak Evaporation Losses

component	**Evaporation (ac-ft/day)**
Canals/resacas	33
Reservoirs	40
TOTAL	**73**

Excluding Delta Lake (58 ac-ft/day)

Seepage Loss

- Most districts have water loss charges based on percentage - ranging *15 - 30%*
- 1 district has a higher charge for municipal deliveries when there is no ag water
- 2 districts use rates based on the gallons delivered

<u>For calculating seepage losses</u>

- we need a rate such as *gal/ft$^{2/}$day*

(most common loss rate used)

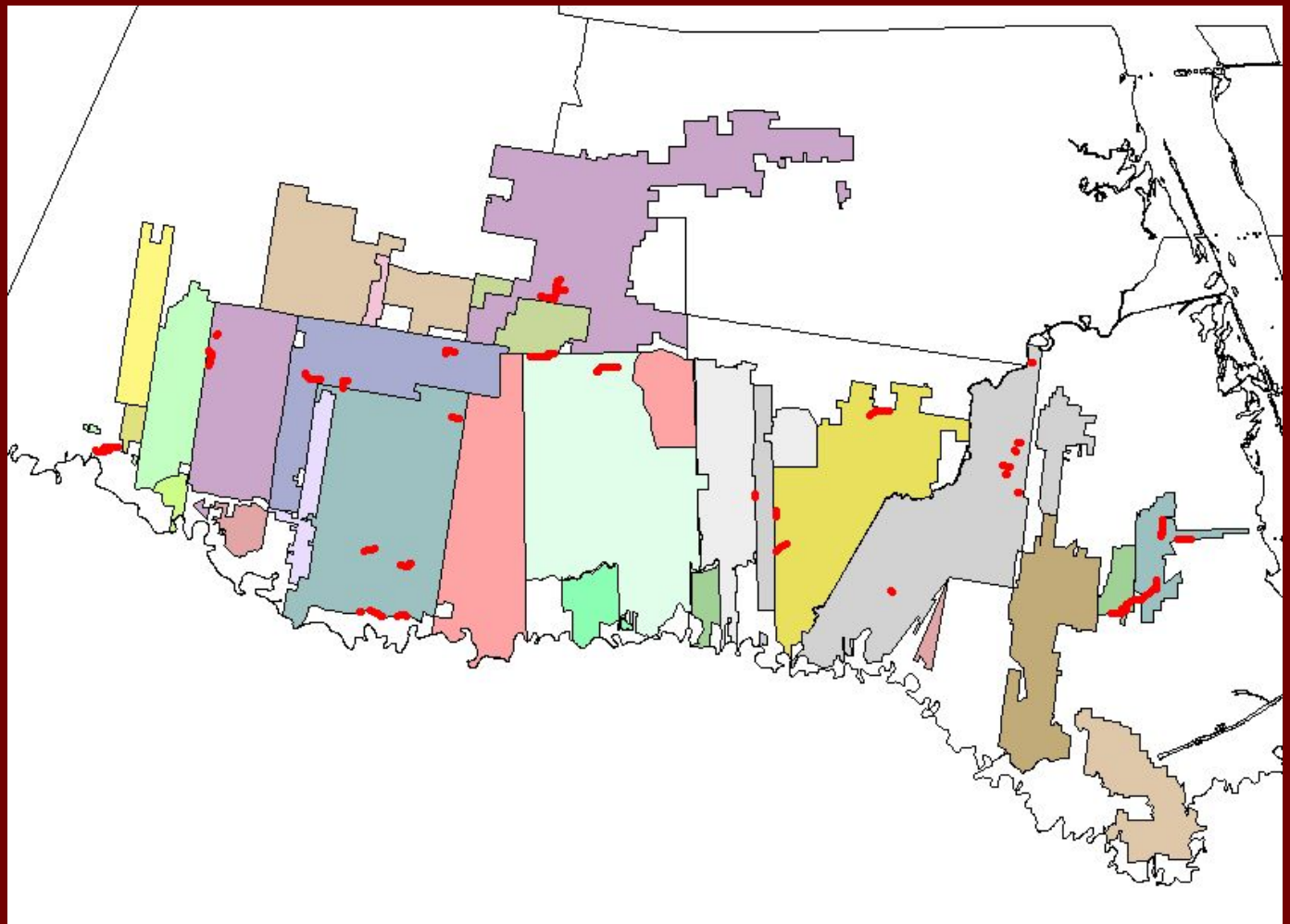
Seepage Loss Tests

We have conducted about 50 ponding tests since 1988 to measure seepage and total losses from canals

Seepage Loss Tests

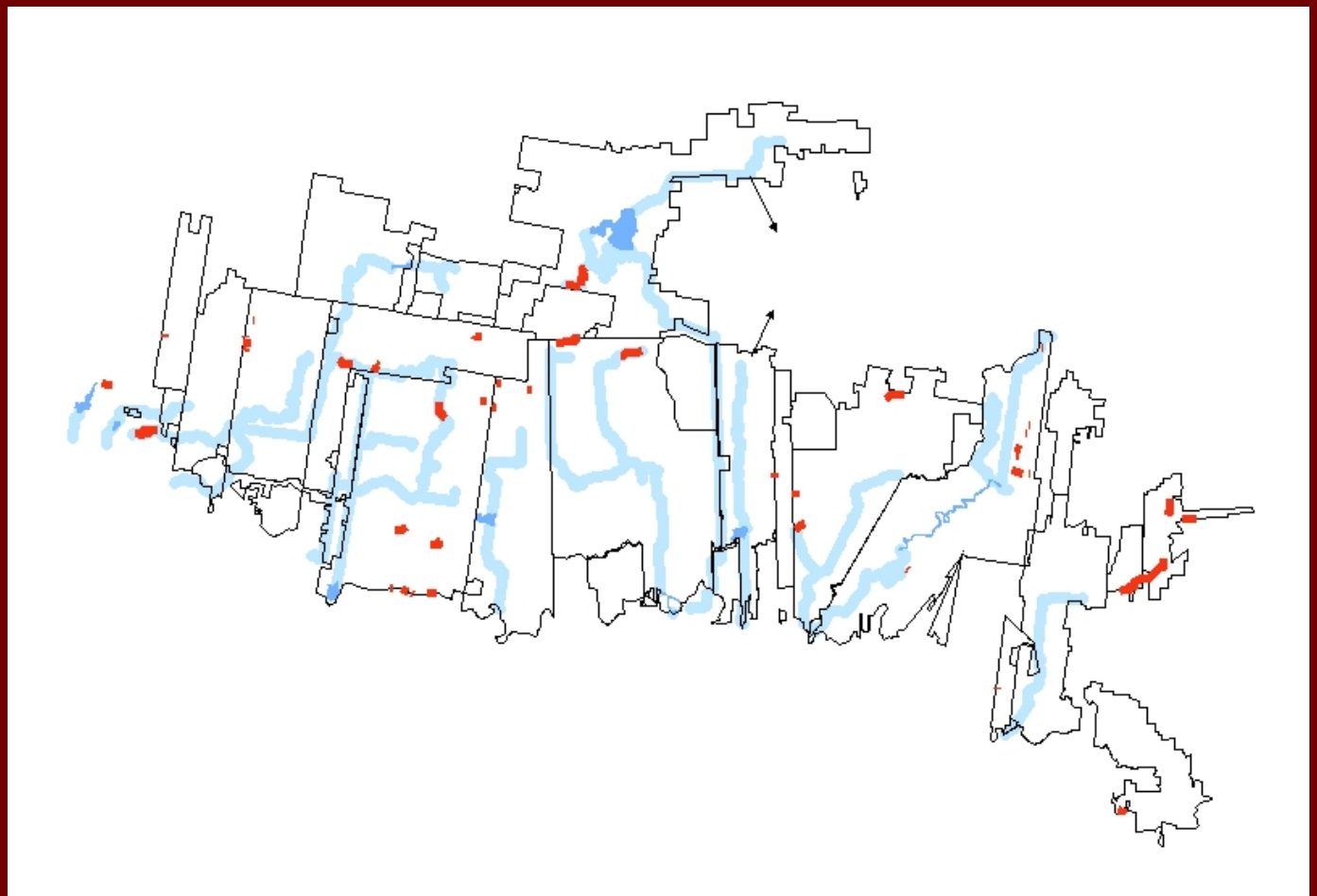
Seepage Losses

These are the locations of our tests



Seepage Losses

However, only a few have been on the MSN



Seepage Losses

- *I do not know what the seepage loss rates are of the MSN*
- *Extrapolating from ponding test results, I expect that losses will be the same range of seepage losses as the majority of tested canals*

Expected seepage loss ranges (gal/ft^2/day)

component	Low	High	High with leaks
Unlined canals	0.15	3.14	4.71
Lined canals	0.25	4.62	6.93
Reservoirs / resacas	0.15		

Leaks for pipelines

- Tested only 1 pipeline
- Loss rate depends on type of materials, type of joint materials (if used), and how full pipe flows
- I *expect that total losses in the 26 miles of pipeline is 0.25 - 18.0 ac-ft/day, but more work is needed to confirm this estimate*

Seepage Losses
Preliminary Analysis, excluding pipelines

117 ac-ft/day (low)

808 ac-ft/day *(high)*

1171 ac–ft/day (high with leaks)

Seepage Losses
Preliminary Analysis (acre-feet/day)

component	Low	High	High with leaks
Unlined canals	27	556	834
Lined canals	9	171	257
Reservoirs/ resacas	81		
TOTALS	117	808	1171

No Agricultural Water

- Operational levels for some districts is lower when only supplying municipal water
- This would reduce both the static volume and seepage losses
  - seepage loss rates, in many cases, are lower at shallower depths
  - the wetted perimeter (or the effective area) decreasing very rapidly with lower depths

No Agricultural Water

Out of the 14 districts,

- 4 have the data on operational levels needed for just municipal water
- 1 district temporarily raises canal levels during municipal diversions

Remaining data would need to be collected from water utilities

No Agricultural Water

Estimating static volume at less than normal operational levels is difficult

- The static volume of the MSN is not necessarily in direct proportion to the reduction of water level at the municipal take-out point
- Distribution network control structures, siphons and culverts also affect static volumes and flow calculations

No Agricultural Water

No calculation have been made.....

Summary

- An initial analysis of the Municipal Supply Network was completed
- Defined the MSN based on the location of existing control structures that can be closed to isolate the MSN
- Collected information on the sizes and extent of MSN components (canals, pipelines, resacas, reservoirs)

Summary

- Computed the static volume of the MSN under normal operational levels
- Calculated peak evaporative losses using pan and lake evaporation data
- Extrapolated seepage losses of MSN based on ponding test data
- Estimated losses from the pipeline component of the MSN
- Checked with districts to see how much data was available on operational levels needed just for municipal water

Next??

Next??

Improve seepage loss estimates

- Complete the RAT (rapid assessment tool) for seepage loss

  - RAT combines a visual rating of canal condition with:

    a) soils information,

    b) maintenance and usage data

    c) existing ponding test data

  -This work is in progress and will be ready to test in about 2 months

  -Can then be used to refined MSN seepage loss rates

Next??

Considering

- obtaining complete data sets on 1 or two districts
- determining operational requirements for just municipal water deliveries using
  - GIS tools and
  - DNM *(an Irrigation District Distribution Network Simulation Model)*

Next??

Producing a MSN Report for the Region M Planning Group?

Cooperative Work with the Region M Planning Group?