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Measured Seepage Losses of Canal 6.0 La Feria Irrigation District – Cameron County No. 3

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Rio Grande Basin Initiative
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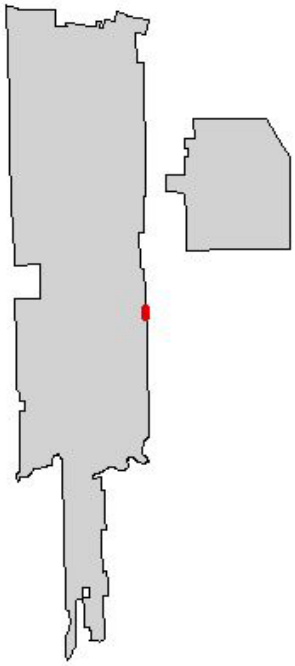
MEASURED SEEPAGE LOSSES OF CANAL 6.0 -

LA FERIA IRRIGATION DISTRICT-CAMERON COUNTY NO.3[1]



by

Eric Leigh and Guy Fipps, P.E.[2]
May 5, 2003

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SUMMARY

This report summarizes the results of seepage loss rate tests conducted in La Feria Irrigation District Cameron County Irrigation District No. 3 (La Feria). These tests were conducted during April 9 - 11, 2003 on Canal 6.0.

Canal 6.0 is located at the east central area of the district and runs perpendicular to and across Expressway 83 (Fig. 1). The southern and northern sections Canal 6.0 are unlined, while the middle portion is brick with a concrete topping. The brick/concrete section is approximately 5,641 ft (1.07 miles) long and varies from 12 to 13 feet in width.

Two segments of the brick/concrete section was tested (Fig. 1), referred to here as the *north* and *south* segments. Test results are summarized in Table 1. Seepage losses were measured at 1.77 and 4.61 gal/ft^2/day for the north and south segments, respectively (or 153 and 369 ac-ft/mile per year). Table 2 lists seepage losses in four methods commonly used for characterizing water loss from canals. The annual water loss amounts given Tables 1 and 2 are based on an in-service life of 365 days per year.

The south segment had approximately six large holes in the canal similar to the one shown in Figure 2. This is likely the reason that the south segments seepage rate is over twice that of the north segment.

Table 1. Seepage losses measured in Canal 6.0 of La Feria Irrigation District. All segments are brick/concrete-lined. Tests 1 and 2 measured seepage losses only.

Test	Segment	Soil	Top Width (ft)	Length (ft)	Seepage Rate (gal/ft^2/day)	Total Loss in Canal (ac-ft/mile) per day	per year*
1	Canal 6.0 (North)	sandy clay loam	12	600	1.77	0.41	152.92
2	Canal 6.0 (South)	sandy clay loam	12	600	4.61	1.01	369.05

*Based on 365 days per year

Table 2. Seepage loss rates of Canal 6.0 given in 4 commonly used methods for characterizing water loss from canals.

Test	ft^3/ft^2/hour	ft/day	inches/day	gal/ft^2/day	acre-ft/mile/year
1 - North	0.013	0.33	3.84	1.77	152.92
2 - South	0.040	0.97	11.64	4.61	369.05

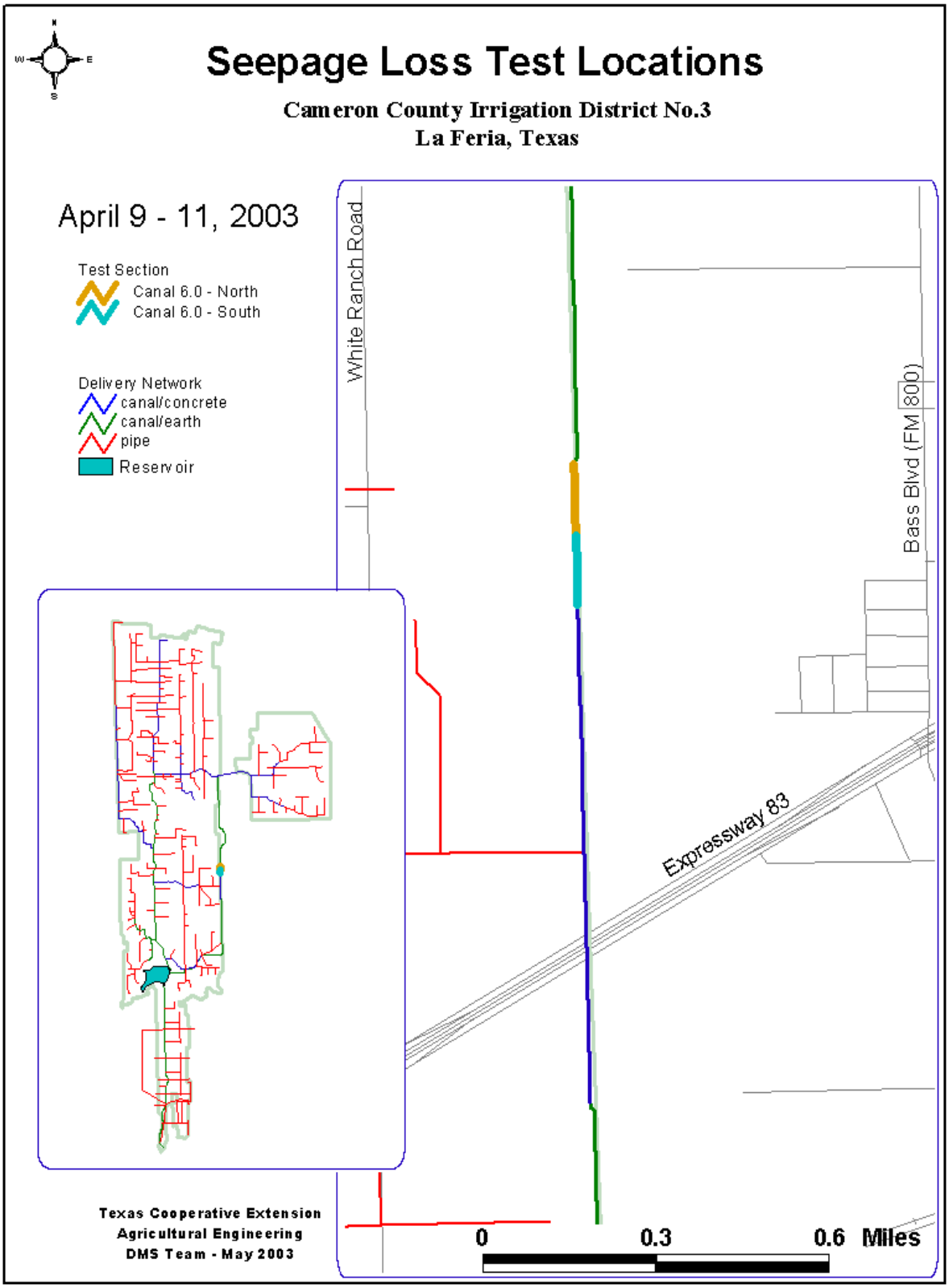

Figure 1. Map showing the locations of seepage loss tests conducted on Canal 6.0.

Figure 2. One of six large holes observed in the brick/concrete lining of the south test segment of Canal 6.0.

MATERIALS AND METHODS

Seepage losses were measured using the ponding method. In this method, the two ends of a canal segment are closed or sealed with earthen dams. Once sealed, water elevations were taken for approximately 48 hours. Two continuous-stage level recorders were used in each test segment to supplement the two locations where stage levels are recorded manually. Canal dimensions and water spans were also surveyed during each test. The segments did not contain valves or gates within the canal; thus, seepage loss rates were measured. Locations of the north and south test segments are shown in Figure 1.

TEST RESULTS

This section summarizes the data collected and seepage loss rates measured. For both tests, a table and charts provide test details. The charts show the surveyed canal profiles at the staff gages along with the *expected* canal shapes. The *expected* shapes were generated by fitting an equation to the measured profile data as shown in each graph. Photographs are also included which show the test segment and a close-up of the canal lining.

Descriptions of the general soil types in the area of Canal 6.0 are provided in a later section, along with a map (Fig. 10) of the detailed soil series taken from the Soil Survey for the county. Table 5 gives the key codes and corresponding soil series and permeability range for the units shown in Figure 10.

Test 1 - North

Figure 3. Canal 6.0 - North

Table 3. Data for Test 1: Canal 6.0 - North.				
District:	La Feria Irrigation District Cameron County No.3	**Test ID:**	Canal 6.0 - North	
Canal:	Canal 6.0	**Lining Type:**	Concrete	
Top Width:	12 feet	**Date:**	April 9-11, 2003	
Test Length:	600 feet	**Start Time:**	3:14 pm	
Total Depth:	5 feet	**Finish Time:**	3:16 pm	
Location: West of Bass Rd., North of Expressway 83				
Staff Gage Readings				
Date	**SG1**		**SG2**	
	Readings	**Time**	**Readings**	**Time**
9-Apr	5.69	15:15	5.68	15:14
	5.67	16:13	5.67	16:12
	5.65	17:18	5.65	17:19
10-Apr	5.37	10:04	5.37	10:03
	5.32	13:02	5.32	13:03
	5.28	16:02	5.28	16:01
11-Apr	5.08	11:50	5.08	11:49
	5.04	15:11	5.04	15:16

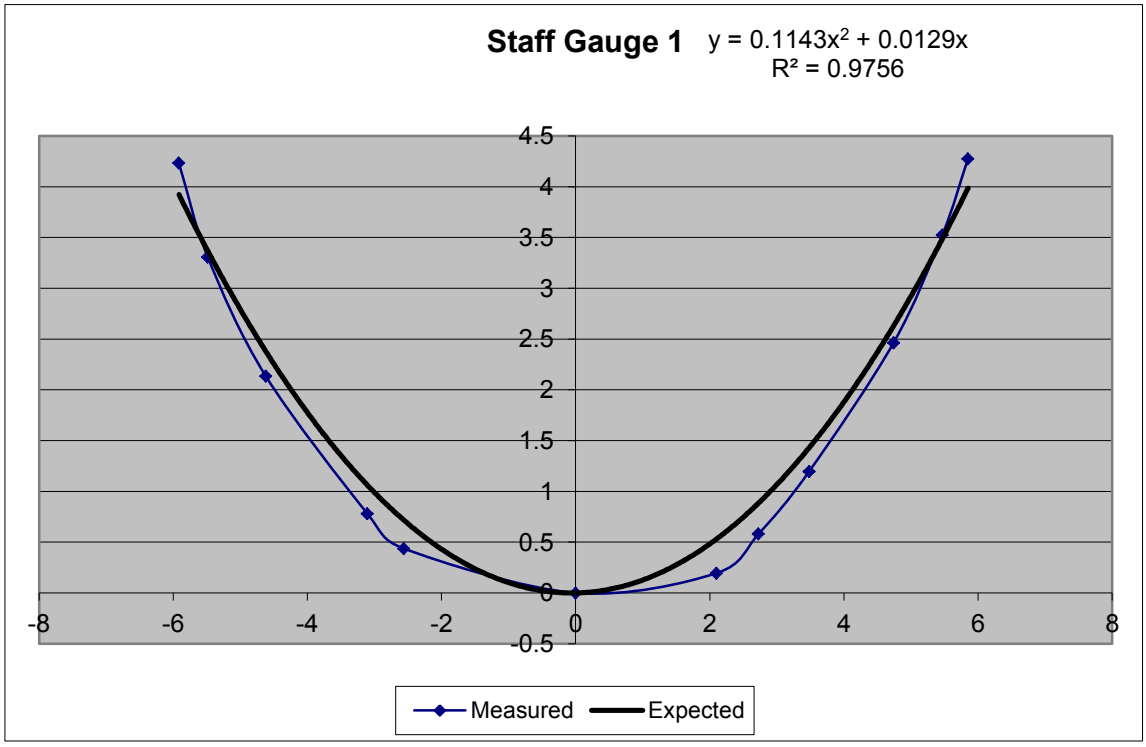

Figure 4. Cross-section of Staff Gauge 1 of Canal 6.0 - North.

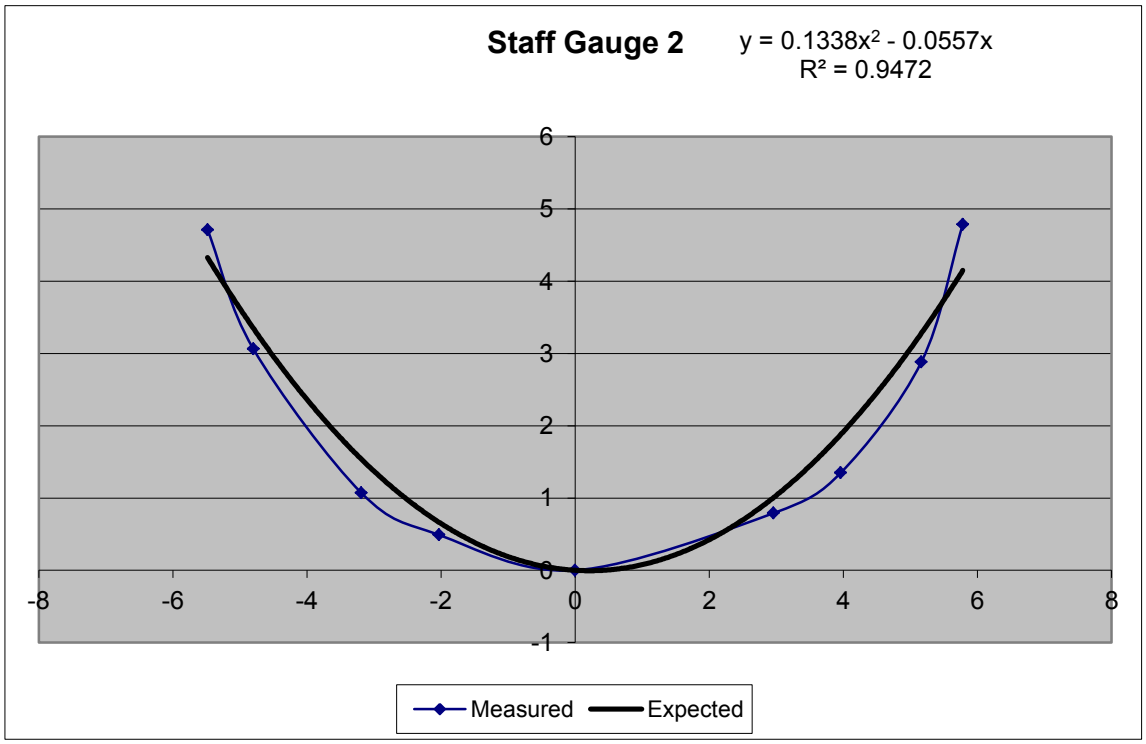

Figure 5. Cross-section of Staff Gauge 2 of Canal 6.0 - North.

Test 2 - South

Table 4. Data for Test 2: Canal 6.0 - South.			
District:	La Feria Irrigation District Cameron County No.3	**Test ID:**	Canal 6.0 - South
Canal:	Canal 6.0	**Lining Type:**	Concrete
Top Width:	12 feet	**Date:**	April 9-11, 2003
Test Length:	600 feet	**Start Time:**	3:11 am
Total Depth:	5 feet	**Finish Time:**	3:24 pm
Location: West of Bass Rd, North of Expressway 83			

Staff Gage Readings				
Date	**SG3**		**SG4**	
	Readings	**Time**	**Readings**	**Time**
9-Apr	2.06	15:12	5.28	15:11
	1.86	16:11	5.07	16:10
	1.64	17:20	4.84	17:21
10-Apr	0.48	10:01	3.68	09:58
	0.42	13:04	3.65	13:05
	0.38	15:59	3.51	15:58
11-Apr	0.16	11:48	3.36	11:46
	0.12	15:18	3.33	15:24

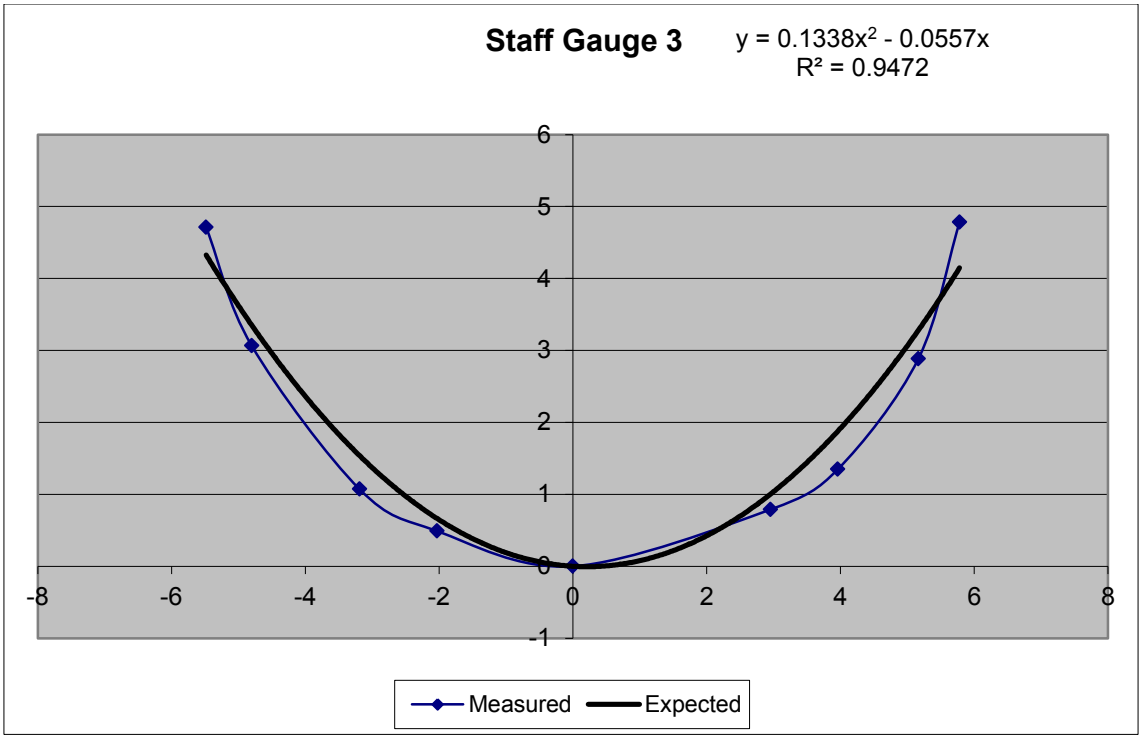

Figure 6. Cross-section of Staff Gauge 3 of Canal 6.0 - South.

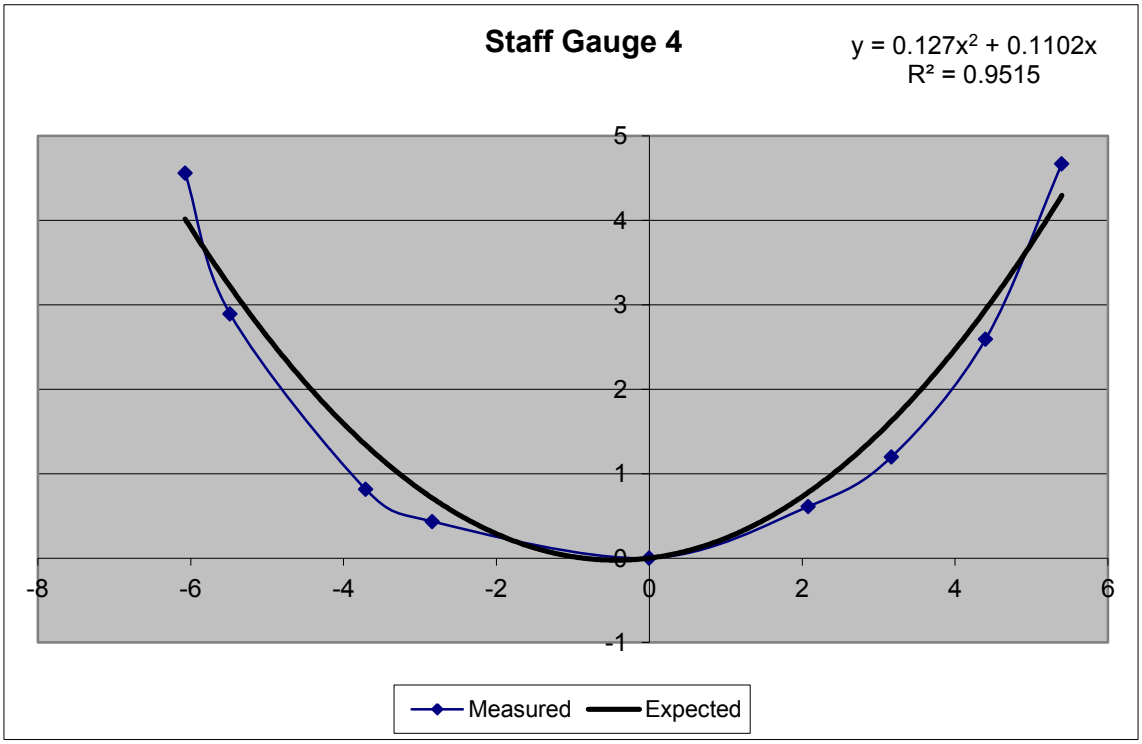

Figure 7. Cross-section of Staff Gauge 4 of Canal 6.0 - South.

Figure 8. Canal 6.0 - South

Figure 9. Large hole in the canal lining of Canal 6.0 - South1

SOIL DESCRIPTIONS

General Soil Series

6 - Willacy-Racombes association: Nearly level to gently sloping, well drained fine sandy loams and sandy clay loams. See figure 10 for soils map.

Detailed Soil Units

Table 5. Soil Series Key Codes and Permeability Ranges.

Soil Unit	Permeability (in/hr)
HO - Hidalgo sandy clay loam	0.63 - 2.0
RA - Racombes sandy clay loam	0.63 - 2.0
WAA - Willacy fine sandy clay loam	2.0 - 6.3

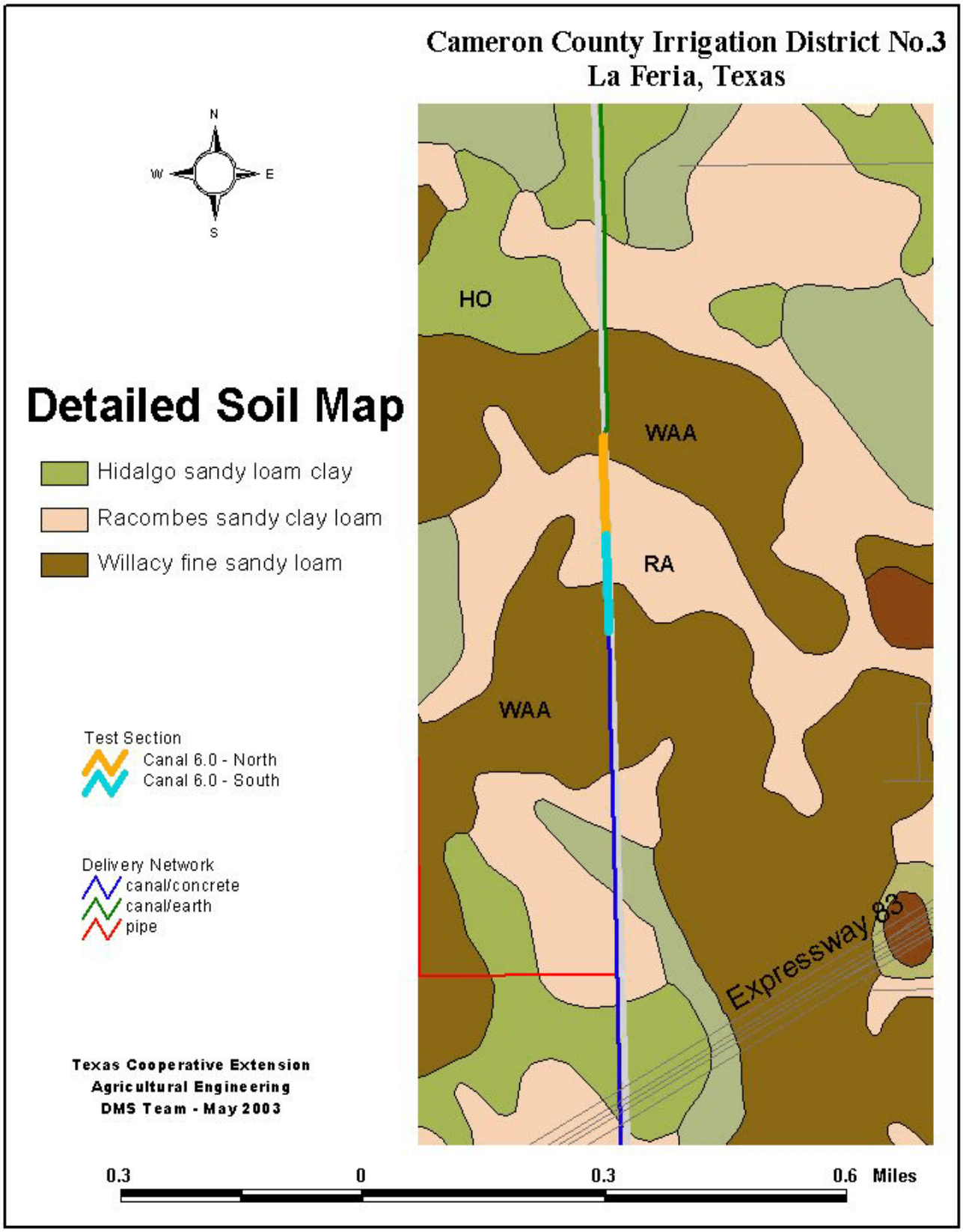

Figure 10. Detail Soil Series with (see Table 5 for soil permeability ranges and key codes).

OTHER TEST RESULTS

Texas Cooperative Extension has conducted approximately 50 total loss tests and seepage loss tests in the Lower Rio Grande River Basin since 1998. The results are summarized in Tables 6 – 8. Table 9 gives seepage rates versus lining type as reported in the scientific literature.

Table 6. Results of seepage loss tests conducted by Texas Cooperative Extension in the Lower Rio Grande River Basin.

Test ID	Year	Canal Width (ft)	Canal Depth (ft)	Class*	Loss Rate	
					gal/ft^2/day	ac-ft/mi/yr
Lined						
16HC2	03			M		
LF1	03	12	5	M	1.77	152.9
LF2	03	10	6	M	4.61	369.1
MA4	03	12	5	S	8.85	529.7
SJ4	00	15	4	M	1.17	111.2
SJ5	02	14	5	M	1.38	145.5
UN1	01	12	6	M	2.32	214.3
UN2	01	8	3	M	2.09	132.2
Unlined						
BR1	03	60	11	M	3.14	794.6
MA3	03	19	5	S	13.9	1690.1
RV1	03	38	4	M	0.15	23.0
SB4	02	16	4	S	0.64	68.3
SB5	02	18	3	S	1.67	188.3
SB6	02	20	5	S	1.44	189.0
SB7	02	16	4	S	0.42	47.4
SB8	02	20	5	S	0.83	104.0

*Classification of canal: M = main, S = secondary

Table 7. Results of total loss tests in lined canals (leaking gates and valves may have contributed to measured loss rates) conducted by Texas Cooperative Extension in the Lower Rio Grande River Basin.

Test ID	Year	Canal Width (ft)	Canal Depth (ft)	Class*	Loss Rate	
					gal/ft^2/day	ac-ft/mi/yr
Lined						
16HC1	03	14	5	M	1.89	192.4
BV1	99	10	5	M	7.97	510.5
BV2	99	9	4	M	8.53	451.5
DL1	00	20	6	M	0.16	18.8
DL2	00	7	4	S	4.12	236.2
DO1	03	5	3	S	1.68	65.2
DO2	03	6	4	S	2.18	121.5
DO3	03	6	3	S	2.71	107.2
ED1	00	6	4	S	34.32	1519.6
ED2	00	6	4	S	21.5	858.2
ED3	00	3	2	T	10.22	308.2
ED4	00	4	3	S	18.72	567.7
ED6	99	9	4	M	8.53	451.5
HA2	00	10	4	M	2.26	135.2
HA3	98	15	2	S	0.64	45.5
ME1	98	38	7	M	1.26	281.9
ME2	98		4	M	1.88	163.5
SJ1	99	12	5	M	2.58	126.8
SJ6	03	12	3	M	1.88	1.63
SJ7	03	19	4	M	1.98	227.1
UN3	02	12	6	M	2.02	169.7

*Classification of canal: M = main, S = secondary, T = tertiary

Table 8. Results of total loss tests in unlined canals (leaking gates and valves may have contributed to measured loss rates) conducted by Texas Cooperative Extension in the Lower Rio Grande River Basin.

Test ID	Year	Canal Width (ft)	Canal Depth (ft)	Class*	Loss Rate	
					gal/ft^2/day	ac-ft/mi/yr
BV3	99	55	8	M	0.15	53.4
ED5	02	105	7	M	2.39	1213.2
MA1	99	50	10	M	1.98	227.1
MA2	99	20	5	S	4.32	371.4
SB1	00	29	7	S	1.27	215.5
SJ2	00	23	6	M	2.74	293.2
SJ3	00	30	5	S	0.95	132.6

*Classification of canal: M = main, S = secondary

Table 9. Canal seepage rate reported in published studies.

Lining/soil type	Seepage rate (gal/ft^2/day)
Unlined[1]	2.21-26.4
Portland cement[2]	0.52
Compacted earth[2]	0.52
Brick masonry lined[3]	2.23
Earthen unlined[3]	11.34
Concrete[4]	0.74 - 4.0
Plactic[4]	0.08-3.74
Concrete[4]	0.06-3.22
Gunite[4]	0.06-0.94
Compacted earth[4]	0.07-0.6
Clay[4]	0.37-2.99
Loam[4]	4.49-7.48
Sand[4]	4.0-19.45

[1] DeMaggio (1990). Technical Memorandum: San Luis unit drainage program project files. US Bureau of Reclamation, Sacramento. [2] U.S. Bureau of Reclamation (1963). Lining for Irrigation Canals. [3] Nayak, et al. (1996). The influence of canal seepage on groundwater in Lugert Lake irrigation area. Oklahoma Water Resources Research Institute. [4] Nofziger (1979). Profit potential of lining watercourses in coastal commands of Orissa. Environment and Ecology 14(2):343-345.

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