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**The Texas High Plains Evapotranspiration Network-
An Irrigation Scheduling Technology Transfer Tool**

Final Project Report

prepared by

**Thomas Marek, P.E.,
Dr. Dana Porter, P.E., and
Dr. Terry A. Howell, P.E.**

of the

**Texas A&M University System
Agricultural Research and Extension Centers
Amarillo & Lubbock, Texas**

and the

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Final Report**

The Texas High Plains Evapotranspiration Network- An Irrigation Scheduling Technology Transfer Tool

Thomas Marek, Dana Porter and Terry Howell¹

Executive Summary

The Texas High Plains Evapotranspiration (TXHPET) network is comprised of two evapotranspiration (ET) networks, namely the North Plains ET and the South Plains ET networks within the Texas High Plains region. The TXHPET network entails the operation of 18 meteorological stations located in 15 Texas counties, and regional coverage is estimated at four million irrigated acres. The network disseminates meteorological data, including ET-based crop water use information used by agricultural producers and consultants in irrigation scheduling, on a daily basis. Through this project, enhancements were developed for the TXHPET network to provide increased utilization and electronic dissemination capabilities for irrigated producers and other users of the TXHPET. The operational and enhancement development objectives set forth in the project were completed within the project duration period; but with a 60-day delay in initiation for contract signatures.

A new database system was designed and developed for the respective ET network station data. The database utilized a mySQL language structure and a pHP language interface. The database utilizes a partitioning station structure whereby additional ET stations can be added without the typical difficulty of expanding database record length. A new listserv was also established with electronic sign-up for user selection of the various station data and file formats. This listserv provides information for the automated (early morning) daily e-mail delivery of the selected files.

Background

Irrigation and water management personnel of The Texas A&M University System - Texas Agricultural Experiment Station (TAES), Texas Cooperative Extension (TCE) at Amarillo, Texas and the USDA- Agricultural Research Service (ARS) at Bushland, Texas have been heavily involved in and dedicated to the development of precision crop water use measurement instrumentation for several decades. The cornerstone research accomplishment of these efforts has been the construction and research operation of some of the world's largest and most accurate monolithic weighing lysimeters. These units have been utilized to accurately assess crop water use requirements (crop evapotranspiration or ET) whereby irrigation requirements can be determined in a near real time (daily) basis). These unrivaled research assessments have been correlated and calibrated to reference and crop ET measurements to daily data from nearby meteorological stations. Thus, accurate estimates of multiple crop ET's

¹ Senior Research Engineer and Superintendent, North Plains Research Field, Texas Agricultural Experiment Station, Amarillo/Etter; Associate Professor - Irrigation, Texas Cooperative Extension and the Texas Agricultural Experiment Station, Lubbock, Texas, and Research Leader, Water Management Unit, USDA-ARS, Bushland, Texas.

can be made for the Texas Panhandle and Rolling Plains region on a daily basis through the use of a distribution of strategically placed and well-maintained meteorological stations, known as the Texas High Plains ET network (TXHPET).

The TXHPET network is made up of two ET networks within the region, the North Plains ET (NPET - which includes estimates for the Rolling Plains area) and the South Plains ET (SPET) networks, but is operated with excellent cooperation as one network in a transparent mode to producers and other users. The TXHPET network coverage represents an approximate irrigated area of four million acres. The TXHPET network currently disseminates over 800 pages of irrigation information daily to producers based on the daily meteorological data. Annually, this equates to nearly 300,000 pages of irrigation and meteorological data relayed to users. The data are acquired through the use of 18 meteorological stations located in 15 Texas counties. Data dissemination is accomplished through delivery of over 400 faxes each morning and 400 web based downloads per day. The prevalent response of producers and consultants using the data to manage irrigation has been positive. Real-time crop water demand is key to true irrigation scheduling practice for area producers. The TXHPET provides this information in a direct, user-friendly format. Accuracy of the data used for the ET computations is derived from consistent maintenance of the network instrumentation and a solid quality assurance/quality control program is entrenched into the daily operations of the TXHPET. However, technological upgrades and enhancements to the current dissemination capabilities of the TXHPET network are warranted to optimize utility of network data and keep pace with today's associated electronic capabilities of data users.

Objective

The overall purpose of this project was to improve the database capability and query structure for the TXHPET network. This was in addition to maintaining current field and processing operations. To accomplish this goal, the following objectives were specified for the effort:

1. Operation and maintenance of TXHPET network for irrigation scheduling purposes,
2. Develop a new, user-friendly web based interface for the TXHPET network,
3. Develop an updated means of delivery and dissemination,
4. Develop a new database structure to allow rapid and efficient interrogation of data pertaining to irrigation scheduling and supporting meteorological parameters, and
5. Assess utilization of the new system.

Development and Results

Objective 1: Operation and maintenance of TXHPET network for irrigation scheduling purposes.

Quality operations were conducted on a daily basis and were carried out in a timely manner for the Texas High ET network regarding instrumentation maintenance, routine scheduled maintenance, quality assurance and quality control implementation measures.

Several items and issues dealing with telecommunication errors, rodent and other predator damage to the field units were corrected throughout the study period. Replacement sensors were installed as required due to the aforementioned events. Significant repair of several protective fences due to livestock at the field sites had to be addressed during this season.

Objective 2. Develop a new, user-friendly web based interface for the TXHPET network.

A new, user-friendly web based interface was established for the TXHPET network. This effort involved members of the TXHPET development team from three cooperating and partnering agencies in which scheduled meetings kept the effort on a good time track. The newly designed interface is located at the web site of: <http://txhighplainset.tamu.edu>. The new format interface is functional and provides convenient access to data sets, background information on data applications and network structure, and other information and tools that represent significant improvements.

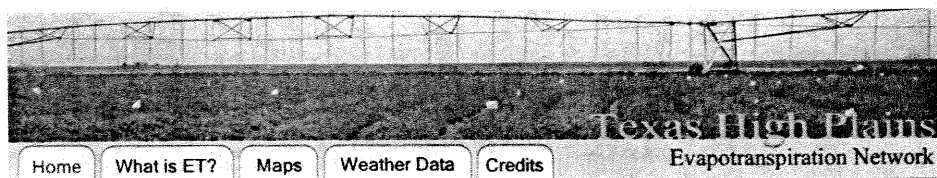
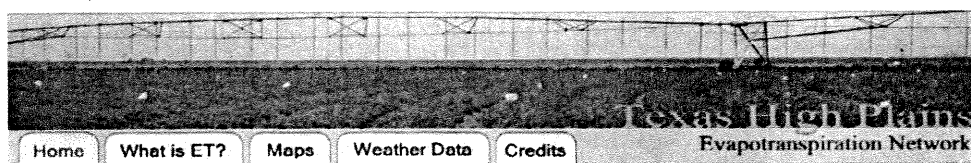


Figure 1. Home page of the new Texas High Plains Evapotranspiration network web site.

The home page of the site is shown in Figure 1. The page gives some general information regarding TXHPET organization and operation. The “What is ET?” page, shown in Figure 2, provides background explanation of ET and application of the data. The Maps section, indicating station locations, is displayed in Figure 3. The Weather Data section of the site is shown in Figures 4 through 13. Figure 4 illustrates the selection of either hourly or daily values to be queried by the user. Figure 5 illustrates the selection of the respective metrological

sites and the data parameters to be queried by the user. Figure 6 of the TXHPET web site allows for user selection of the time range, units of either English or SI (metric), and the output format. Figure 7 illustrates the tabular output format option, while Figure 8 illustrates the text file format output. The text file format output can be downloaded and saved as a text file to be used with other graphics or analysis programs. Figure 9 illustrates a graphed view of the data selected by the user. The user can choose more data or parameters than can reasonably be displayed in a single, on-line graph indicating the robustness of the underlying routines. Figure 10 illustrates the capability of multi-parameter presentation of the output in the graph format. The routine also has the capability of multi-y axis graphing - one on each side of the graph in differing colors. Figure 11 illustrates another dual graphed display of data. Figure 12 shows the hourly meteorological parameters section of the TXHPET site. Lastly, Figure 13 illustrates the advanced graphing capability that can be selected for on-line customized formatting.



What is evapotranspiration (ET)?

Evapotranspiration is a term that describes crop water demand by combining evaporation and transpiration. Evaporation is the process through which water is removed from moist soil and wet surfaces (such as dew on leaves). Transpiration is the process through which water is drawn up through the plant (roots extract water from the soil, and water is eventually removed through stomata on the leaves.)

What is Reference ET (PET)?

Reference crop evapotranspiration, also referred to as Potential Evapotranspiration (PET), is an estimate of water requirement for a well watered reference crop. This reference crop (grass or alfalfa) is essentially an idealized crop used as a basis for the ET model. Reference ET is calculated by applying climate data (temperature, solar radiation, wind, humidity) in a model (equation). It is helpful to note that reference ET is only an estimate of the water demand for this idealized crop, based upon weather station data at a given location. The Texas High Plains ET Network uses an idealized grass reference crop.

How is Crop Evapotranspiration calculated?

Crop-specific ET is estimated by multiplying the Reference ET by a crop coefficient.

$$\text{Crop ET} = \text{Reference ET} \times \text{Crop Coefficient}$$

The crop coefficient takes into account the crop's water use (at a given growth stage) compared with the reference crop. For instance, seedling corn does not use as much water as the idealized grass reference crop, but during silking the corn can use more water than the grass reference crop. The crop coefficient is understood to follow a pattern (curve) of the general shape shown below. Each crop (wheat, sorghum, etc.) will have its own crop coefficient curve.

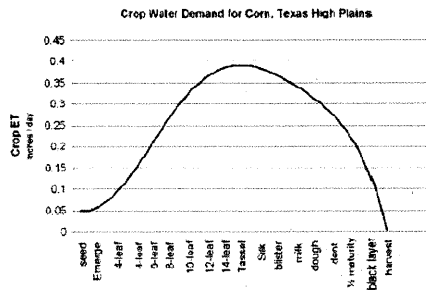


Figure 2. ET background information page of the TXHPET web site.

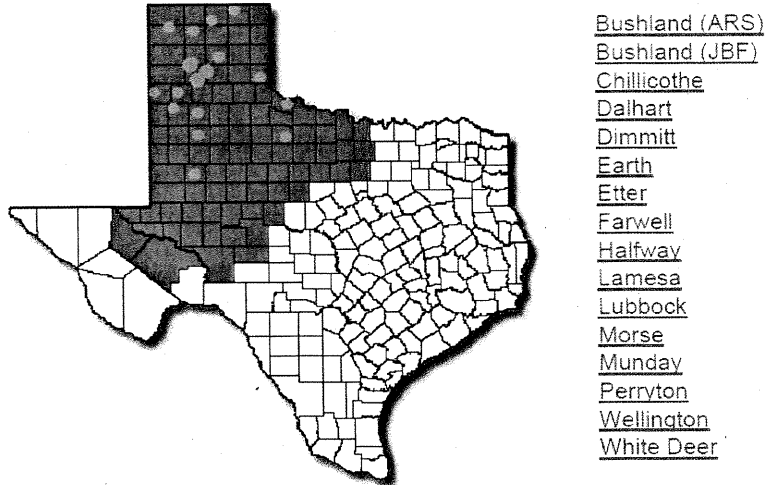
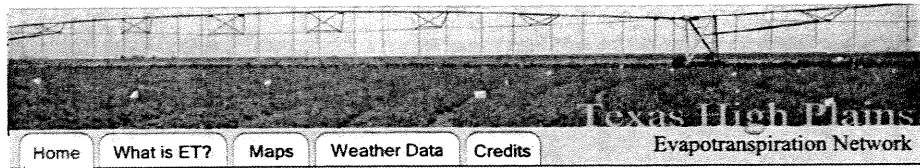
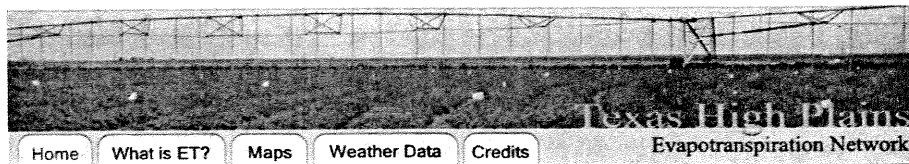


Figure 3. Maps section of the TXHPET web site.



Weather Data

Choose a time interval

Daily

Readings taken every day.

Hourly

Readings taken every hour.

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Agriculture Program

Figure 4. Weather Data section front page of the TXHPET web site.

Daily Weather Data

Select a Location

Select a location from the following list and click the Add button. You may add more than one location. If you wish to remove a location simply click the remove link located next to the location.

Location List Bushland (ARS) Add

Added Locations Lubbock remove

Select Information

Select a group or individual item of information from the following list and click the Add button. You may add more than one item of information at a time. If you wish to remove an item simply click the remove link located next to the item.

Information List ---- Individual Items ---- Add

Added Information Average Air Temp remove
Reference ET Calculation remove

Figure 5. Station and data selection menus in the Weather Data section of the TXHPET web site.

Time Range

Complete the following time range by setting a start date and an end date. Be sure to enter a valid year.

Start Date Date August 5 2005

End Date Date August 20 2005

Units

Select the units of measurement.

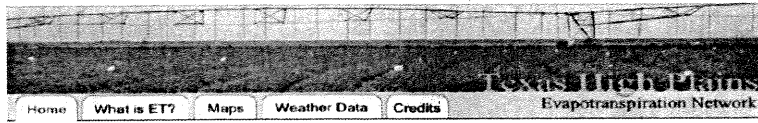
Units English

Output Method

Select an output method for your data.

Output Method Data Table
 Text File
 Graph
 Advanced Graph (next page for options)

Figure 6. Time selection menus in the Weather Data section of the TXHPET web site.



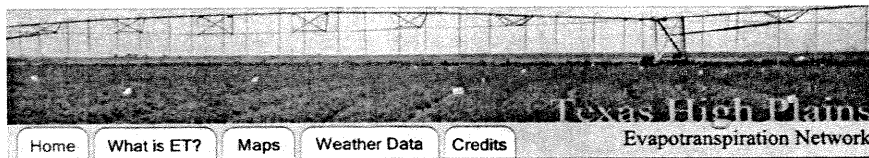
Data Table

Page 1 of 1
 Previous Page 1 of 1 Go to Page Next Page

Date	airT (°F)	ET Ref (in)
08/05/2005	69.8	0.12
08/06/2005	72.9	0.17
08/07/2005	75.9	0.21
08/08/2005	74.2	0.22
08/09/2005	75.2	0.22
08/10/2005	75.2	0.22
08/11/2005	76.6	0.24
08/12/2005	76.5	0.23
08/13/2005	72.5	0.16
08/14/2005	67.0	0.05
08/15/2005	67.5	0.09
08/16/2005	73.1	0.16
08/17/2005	76.8	0.22
08/18/2005	79.6	0.24
08/19/2005	78.3	0.23
08/20/2005	77.3	0.22

[View Graph](#)

Figure 7. Output example in tabular format of data queried in the Weather Data section of the TXHPET web site.



```

airT °F ET Ref in      Lubbock
-----
                                airT      ET Ref
08/05/2005 :           69.8      0.12
08/06/2005 :           72.9      0.17
08/07/2005 :           75.9      0.21
08/08/2005 :           74.2      0.22
08/09/2005 :           75.2      0.22
08/10/2005 :           75.2      0.22
08/11/2005 :           76.6      0.24
08/12/2005 :           76.5      0.23
08/13/2005 :           72.5      0.16
08/14/2005 :           67.0      0.05
08/15/2005 :           67.5      0.09
08/16/2005 :           73.1      0.16
08/17/2005 :           76.8      0.22
08/18/2005 :           79.6      0.24
08/19/2005 :           78.3      0.23
08/20/2005 :           77.3      0.22
  
```

(Text file format)

Figure 8. Output example in text file format of data queried in the Weather Data section of the TXHPET web site.

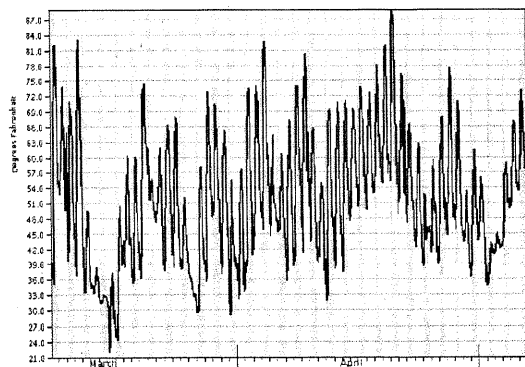
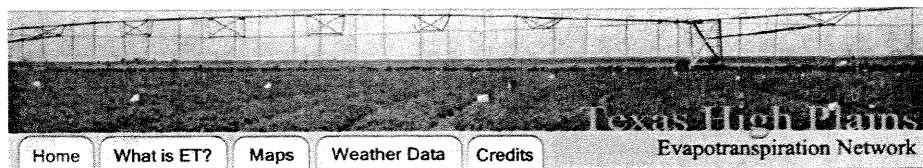
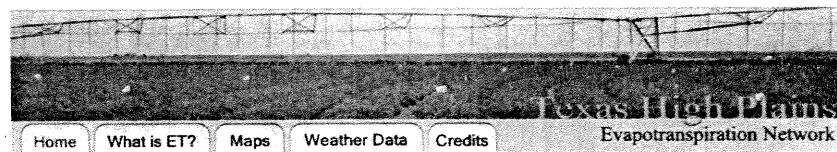


Figure 9. Example of graphed output of selected data in the TXHPET site.



Lubbock, 4/25/2005 to 10/02/2005
 Reference ET Calculation ~ in
 PD1-PET Water Usage (Short Season Cotton) ~ in
 PD1-PET Water Usage (Short Season Corn) ~ in

[View Data](#)

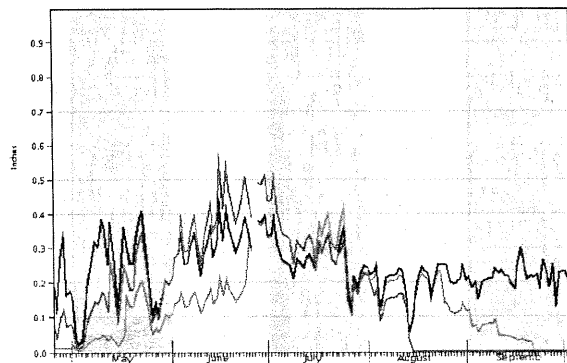
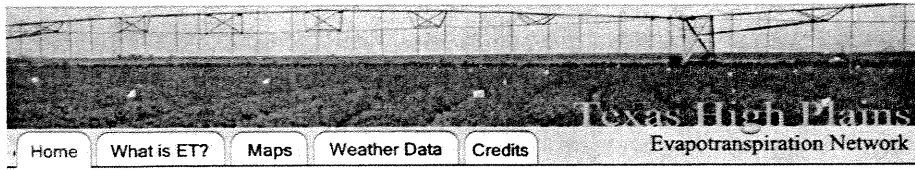


Figure 10. Example of multiple parameters presented in graphical form at the TXHPET site.



Graphed Data

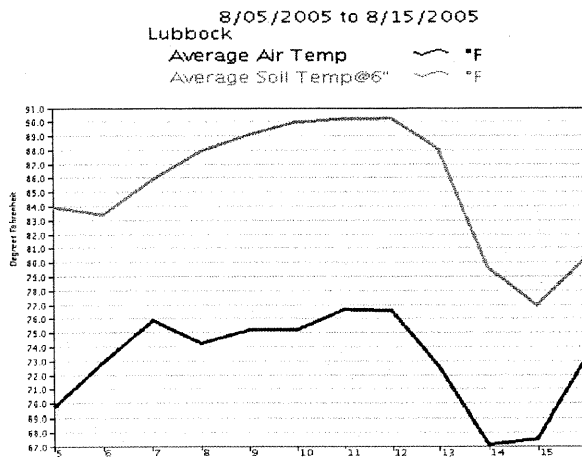
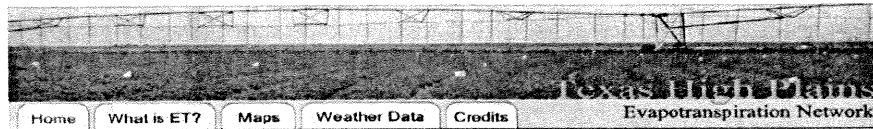


Figure 11. Example of on-line, graphed multiple parameter output of selected data in the TXHPET site.



Hourly Weather Data

Select a Location

Select a location from the following list and click the Add button. You may add more than one location. If you wish to remove a location simply click the remove link located next to the location.

Location List Bushland (ARS) Add

Added Locations Bushland (ARS) remove

Select Information

Select a group or individual item of information from the following list and click the Add button. You may add more than one item of information at a time. If you wish to remove an item simply click the remove link located next to the item.

Information List --- Individual Items --- Add

Added Information Air Temperature remove
Dew Temperature remove

Time Range

Complete the following time range by setting a start date and an end date. Be sure to enter a valid year.

Start Date Date September 25 2005
Time 1 00 a.m.

End Date Date September 20 2005
Time 1 00 a.m.

Figure 12. Example of the hourly data selection page in the TXHPET site.

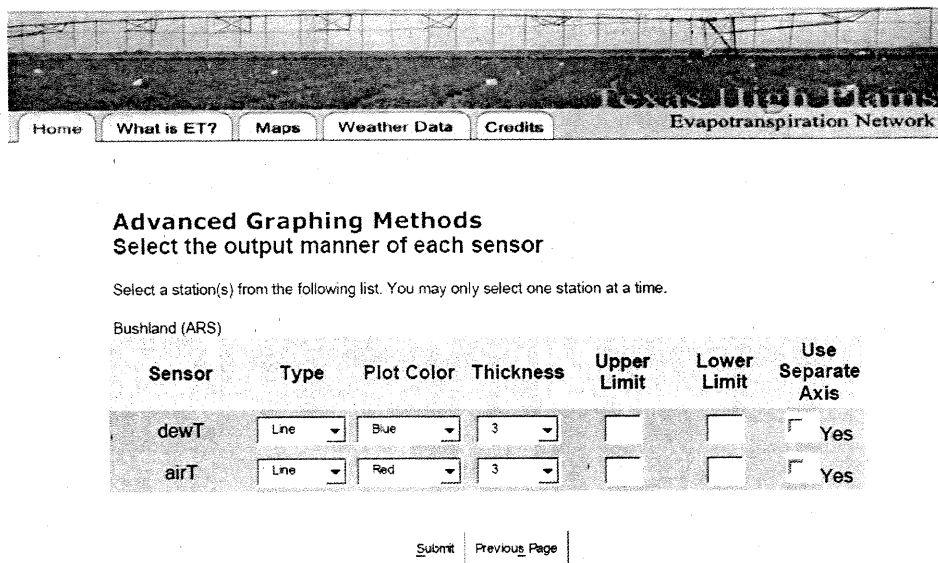


Figure 13. The advanced options page of the on-line graphing section in the TXHPET site.

Objective 3. Develop updated means of delivery and dissemination.

A new TXHPET network listserv was developed whereby users can select individual or multiple station files regarding crop water use and meteorological data. The selection profile per user is then used to automatically e-mail the selected files daily, currently around 4:00 am. The e-mailed files represent the latest up-to-date (yesterdays) data. Currently the sign up site for these files is located at <http://amarillo2.tamu.edu/nppet/listserv>. (This listserv site may be relocated at a later date). Figure 14 illustrates the current, simple sign-up page for e-mail receipt of the user selected stations and associated files. Figure 15 shows the fields that are to be filled by the user upon initial entry to the sign-up site. Figure 16 depicts the selection and respective data sheets that are available for each station to the user. Currently, there are both researcher and user associated files in the selection page. The most generally used sheets for producers are the *.fx (fax) and *.prt (hourly) files. An example copy of a *.fx fax sheet output is shown in Figure 17, and an example *.prt hourly data sheet is shown in Figure 18. The fax files contain daily information on the multiple crop water use and growing degree day information while the hourly files relate the detailed, hourly meteorological data for the day. The site currently allows for on-line user sign-up but modifications are planned beyond the scope of this contract to allow the user to make profile and station selection changes without moderator intervention. Currently change requests are emailed to the system technician.

TXHPET List Serv

Station Data Email Service

Main Menu

[Register As New User](#)

[Unsubscribe from TXHPET listserv: email n-greene@tamu.edu](#)

[Modify your TXHPET account: email n-greene@tamu.edu](#) -- Please include the data files you wish to add or remove in your email.

Figure 14. E-mail listserv front page at the TXHPET web site.

User Management System

Add a User

User Information

First Name:

Last Name:

Street:

City:

State:

Zip:

Home Phone:

Cell Phone:

Email Address:

System Login Information

User Name:

Password:

Business Information

Occupation:

Business Name:

Business Description:

Business Contact:

Business Phone:

Business Fax:

Submit User Information

Figure 15. E-mail listserv user input information page at the TXHPET web site.

User Management System

Select Stations and Files to receive

Using Email Address:

Bushland ARS (bus)

- | | |
|------------------------------|------------------------------|
| <input type="checkbox"/> 24 | <input type="checkbox"/> grs |
| <input type="checkbox"/> fax | <input type="checkbox"/> imp |
| <input type="checkbox"/> prt | <input type="checkbox"/> ssl |

Canyon (cbf)

- | | |
|------------------------------|------------------------------|
| <input type="checkbox"/> 24 | <input type="checkbox"/> grs |
| <input type="checkbox"/> fax | <input type="checkbox"/> imp |
| <input type="checkbox"/> prt | <input type="checkbox"/> ssl |

Chillicothe (chi)

- | | |
|------------------------------|------------------------------|
| <input type="checkbox"/> 24 | <input type="checkbox"/> grs |
| <input type="checkbox"/> fax | <input type="checkbox"/> imp |
| <input type="checkbox"/> prt | <input type="checkbox"/> ssl |

dalhart (dal)

- | | |
|------------------------------|------------------------------|
| <input type="checkbox"/> 24 | <input type="checkbox"/> grs |
| <input type="checkbox"/> fax | <input type="checkbox"/> imp |
| <input type="checkbox"/> prt | <input type="checkbox"/> ssl |

Dimmit (dim)

- | | |
|------------------------------|------------------------------|
| <input type="checkbox"/> 24 | <input type="checkbox"/> grs |
| <input type="checkbox"/> fax | <input type="checkbox"/> imp |
| <input type="checkbox"/> prt | <input type="checkbox"/> ssl |

Earth (ear)

- | | |
|------------------------------|------------------------------|
| <input type="checkbox"/> 24 | <input type="checkbox"/> grs |
| <input type="checkbox"/> fax | <input type="checkbox"/> imp |
| <input type="checkbox"/> prt | <input type="checkbox"/> ssl |

Etter (ett)

- | | |
|------------------------------|------------------------------|
| <input type="checkbox"/> 24 | <input type="checkbox"/> grs |
| <input type="checkbox"/> fax | <input type="checkbox"/> imp |
| <input type="checkbox"/> prt | <input type="checkbox"/> ssl |

Farwell (far)

- | | |
|------------------------------|------------------------------|
| <input type="checkbox"/> 24 | <input type="checkbox"/> grs |
| <input type="checkbox"/> fax | <input type="checkbox"/> imp |
| <input type="checkbox"/> prt | <input type="checkbox"/> ssl |

Hal (hal)

- | | |
|------------------------------|------------------------------|
| <input type="checkbox"/> 24 | <input type="checkbox"/> grs |
| <input type="checkbox"/> fax | <input type="checkbox"/> imp |
| <input type="checkbox"/> prt | <input type="checkbox"/> ssl |

Lamesa (lam)

- | | |
|------------------------------|------------------------------|
| <input type="checkbox"/> 24 | <input type="checkbox"/> grs |
| <input type="checkbox"/> fax | <input type="checkbox"/> imp |
| <input type="checkbox"/> prt | <input type="checkbox"/> ssl |

Lubbock (lub)

- | | |
|------------------------------|------------------------------|
| <input type="checkbox"/> 24 | <input type="checkbox"/> grs |
| <input type="checkbox"/> fax | <input type="checkbox"/> imp |
| <input type="checkbox"/> prt | <input type="checkbox"/> ssl |

Mor (mor)

- | | |
|------------------------------|------------------------------|
| <input type="checkbox"/> 24 | <input type="checkbox"/> grs |
| <input type="checkbox"/> fax | <input type="checkbox"/> imp |
| <input type="checkbox"/> prt | <input type="checkbox"/> ssl |

Munday (mun)

- | | |
|------------------------------|------------------------------|
| <input type="checkbox"/> 24 | <input type="checkbox"/> grs |
| <input type="checkbox"/> fax | <input type="checkbox"/> imp |
| <input type="checkbox"/> prt | <input type="checkbox"/> ssl |

Perryton (per)

- | | |
|------------------------------|------------------------------|
| <input type="checkbox"/> 24 | <input type="checkbox"/> grs |
| <input type="checkbox"/> fax | <input type="checkbox"/> imp |
| <input type="checkbox"/> prt | <input type="checkbox"/> ssl |

Wel (wel)

- | | |
|------------------------------|------------------------------|
| <input type="checkbox"/> 24 | <input type="checkbox"/> grs |
| <input type="checkbox"/> fax | <input type="checkbox"/> imp |
| <input type="checkbox"/> prt | <input type="checkbox"/> ssl |

Figure 16. User selection of available data formats at the TXHPET web site.

North Plains ET Network Weather Station, White Deer, TX

Date	ETo in.	Temperatures (F)				Prec. in.	Growing Degrees Days (F)						
		---Air-- Max	Soil Min	2in. 2in.	6in. 6in.		Crn	Srg	Pnt	Cot	Soy	Wht	
10/03/05	.25	88	62	71	86	0.00	24	25	20	15	28	39	
10/04/05	.21	85	64	72	87	0.00	25	25	20	15	29	39	
10/05/05	.21	77	55	67	84	0.00	16	16	11	6	20	34	
10-day avg min soil temp							69	86	Wind	14.1	mph	from	81 deg.

CORN							SORGHUM									
Seed	Acc	Growth	Day	3day	7day	Seas.	Growth	Day	3day	7day	Seas.	Growth	Day	3day	7day	Seas.
Date	GDD	Stage	-----in/d-----				in.	Stage	-----in/d-----				in.			
04/01	3634	Harvest	.00	.00	.00	31.1	Harvest	.00	.00	.00	38.2					
04/15	3494	Harvest	.00	.00	.00	30.4	Harvest	.00	.00	.06	37.2					
05/01	3338	Harvest	.00	.00	.00	29.4	Blk lyr	.14	.16	.15	36.0					
05/15	3187	Harvest	.00	.00	.00	28.7	Blk lyr	.14	.16	.15	34.2					

COTTON							SOYBEANS									
Seed	Acc	Growth	Day	3day	7day	Seas.	Growth	Day	3day	7day	Seas.	Growth	Day	3day	7day	Seas.
Date	GDD	Stage	-----in/d-----				in.	Stage	-----in/d-----				in.			
05/01	3606	Harvest	.00	.00	.00	27.9	Harvest	.00	.00	.07	29.2					
05/15	3453	Harvest	.00	.00	.00	27.5	Blk lyr	.18	.19	.19	28.3					
06/01	3125	Blk lyr	.18	.19	.18	25.3	H Dough	.19	.20	.20	24.7					
06/15	2846	Blk lyr	.18	.19	.18	22.5	H Dough	.19	.20	.20	21.9					

WHEAT							
Seed	Acc	Growth	Day	3day	7day	Seas.	
Date	GDD	Stage	-----in/d-----				in.
08/15	1952	Tiller	.09	.10	.10	5.7	
09/10	946	Tiller	.09	.10	.11	2.9	
10/01	183	Seeded	.07	.08	.06	0.4	

Fescue/Bluegrass lawn water use 0.20 inch
 Bermuda grass is considered dormant
 Buffalo grass is considered dormant

Figure 17. An example of the fax sheet for Oct. 05, 2005 from the TXHPET network.

Station: WHITE DEER, TX Long 101 deg 5 min Lat 35 deg 26 min
 Date: 10/05/05 Year/DOY: 2005278 Elev: 1012 m Bar. Corr: 11.5
 Sunrise 642 Sunset 1822 Daylight time = 11 hours 39 minutes

Time CST	Rs W/m ²	Ts2 C	Ts6 C	Tair C	TDew C	RH %	AVP kPa	VPD kPa	WSpd m/s	Wdir deg	SDd deg	PREC mm	BP kPa	ETo mm
100	0.0	23.7	31.8	20.7	15.8	74	1.80	0.64	6.7	177	14	0.00	-99.9	0.04
200	0.0	23.4	31.7	20.4	16.4	78	1.87	0.53	6.9	179	14	0.00	-99.9	0.03
300	0.0	23.1	31.5	19.7	16.6	82	1.89	0.41	5.4	188	13	0.00	-99.9	0.02
400	0.0	22.8	31.4	18.9	16.6	87	1.89	0.30	4.9	187	12	0.00	-99.9	0.01
500	0.0	22.5	31.2	18.4	16.8	90	1.91	0.21	4.0	193	13	0.00	-99.9	0.00
600	0.0	22.3	31.1	17.5	16.5	94	1.88	0.11	2.4	183	12	0.00	-99.9	-0.01
700	4.8	22.0	30.9	17.1	16.4	96	1.87	0.07	3.0	187	12	0.00	-99.9	-0.01
800	119.5	21.7	30.8	18.3	17.2	93	1.97	0.14	3.3	199	13	0.00	-99.9	0.04
900	192.4	21.8	30.6	20.1	17.5	85	2.00	0.35	4.5	197	16	0.00	-99.9	0.13
1000	295.7	22.1	30.6	22.6	17.0	71	1.94	0.80	5.3	234	25	0.00	-99.9	0.25
1100	429.0	22.7	30.6	24.0	16.2	62	1.85	1.13	4.7	290	35	0.00	-99.9	0.35
1200	207.3	23.4	30.6	20.2	13.0	64	1.51	0.87	7.7	17	19	0.00	-99.9	0.25
1300	282.4	23.5	30.7	16.0	9.5	65	1.19	0.64	8.6	35	11	0.00	-99.9	0.25
1400	671.6	23.3	30.8	16.2	8.2	59	1.09	0.75	9.1	41	12	0.00	-99.9	0.40
1500	598.7	23.7	30.8	16.5	4.2	44	0.83	1.05	9.2	37	12	0.00	-99.9	0.43
1600	252.3	24.0	30.8	15.9	1.0	36	0.66	1.15	9.0	43	12	0.00	-99.9	0.34
1700	74.7	23.6	30.9	15.0	-0.6	34	0.59	1.12	8.4	46	11	0.00	-99.9	0.28
1800	34.5	22.8	30.8	14.5	-1.1	34	0.56	1.08	8.4	43	10	0.00	-99.9	0.26
1900	3.5	22.1	30.6	13.7	-1.4	35	0.55	1.01	7.8	44	11	0.00	-99.9	0.10
2000	0.0	21.4	30.4	13.4	-1.5	36	0.55	0.98	7.3	48	10	0.00	-99.9	0.10
2100	0.0	20.8	30.1	13.3	-1.4	36	0.55	0.97	6.8	42	11	0.00	-99.9	0.09
2200	0.0	20.3	29.9	13.1	-1.5	36	0.55	0.95	7.1	44	10	0.00	-99.9	0.09
2300	0.0	19.9	29.6	13.0	-1.9	36	0.53	0.97	6.6	41	11	0.00	-99.9	0.09
2400	0.0	19.6	29.4	12.9	-2.2	35	0.52	0.96	6.5	36	12	0.00	-99.9	0.09
Sum	11.4 MJ											0.00		3.63
Avg		22.4	30.7	17.1	8.7	61	1.27	0.72	6.4	81	88		-99.9	
Max	1042.8	24.0	32.3	25.0	17.7	97	2.03	1.29	13.4				-99.9	
Time	1323	1529	4	1035	854	641	854	1036	1444				9999	
Min		19.4	29.0	12.7	-2.6	33	0.51	0.07					-99.9	
Time		2359	2352	2359	2359	1614	2359	645					9999	

Figure 18. An example of the fax sheet for Oct. 05, 2005 from the TXHPET network.

Objective 4. Develop new database structure to allow rapid and efficient interrogation of data pertaining to irrigation scheduling and supporting meteorological parameters.

A new database system was designed and developed for the respective station data. The database utilized a mySQL language structure and a pHp language interface. The database utilizes a partitioning station structure whereby additional ET stations can be added without the typical difficulty of expanding database record length. The database currently includes all data for the length of record for each meteorological station in the combined network. Hence data from multiple years, locations, etc. can be accessed via a single data query. Thus data base underpins the system for query capability.

Objective 5. Assess utilization of the new system.

The increase in number of data accesses since this development has been considered good, especially with the extremely limited promotion thus far given regarding the new TXHPET site. Agricultural board members and county Extension personnel who were informed of the new system have related excitement over the new capability in getting data on their time schedule rather than through conventional request avenues. Test users of the system, used while under development, were also elated at the capability now on-line, particularly the graphic chart viewing option. The overall response to the new system has been very positive.

The communications specialist and the Resident Director of Research at the Amarillo Research and Extension Center have been anxious to get the news out regarding the new site. The "official" unveiling of the system is targeted for the Amarillo Farm and Ranch show, the state's largest, in Amarillo, November 29-December 1, 2005. A seminar presentation for education related researchers and engineers in the Amarillo/Bushland/Canyon area and West Texas A&M University is planned in the early part of November. Other educational venues that have been conducted by Dr. Porter and other TCE irrigation personnel have included technical training sessions for county Extension agriculture agents in Amarillo and Lubbock. Reaction at these meetings to the new system was very positive. Announcement of the new TXHPET web site was also discussed in the Texas Panhandle's largest agricultural radio program recently, whereby the TWDB was given credit for funding part of the project. Additional educational venues will target general audiences and specific stakeholder groups. Planned educational materials will be added to the web site and these will assist users in accessing the online tools, data and in interpretation of the data.

An underlying user utilization log program was built into the new databasing system. It tracks downloading and viewing of the pages for the web site. Thus, in time, analysis of the log files will indicate which stations and files are being utilized most frequently by the users.

Water Saving Estimates from this contract as requested by the TWDB

Since inception of the contract period and operational level testing status of the new network site, it is conservatively estimated that 100 new irrigated High Plains users have used the TXHPET system and have saved on average annually an amount of pumped water equivalent to 1 inch per user. Assuming an average operation of 1,050 acres per user, this equates to a total water savings of 8,750 ac-feet. At the current price of \$15.00 per ac-in (Oct.-05 High Plains cost), this equates to an area pumping value savings of \$131,250. This in turn can be computed as a cost to benefit return of nearly 3 times regarding project funding (\$44,400) received from the TWDB.

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