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Texas Water Development Board

**Aquifer Test and Related Well Information for
Public Water Supply Wells in Groundwater
Management Area 8**

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Executive Summary

The project developed a database and a suite of visualization tools to support the analysis of information from approximately 1,000 aquifer tests and 4,000 public water supply (PWS) wells located in Groundwater Management Area 8 (GMA 8). The project was funded as part of the TWDB's groundwater availability program. Groundwater availability models (GAMs) are important tools for groundwater conservation districts and regional water planning groups for evaluating water management strategies and assessing present and future groundwater availability trends.

The project information was obtained from the Texas Commission of Environmental Quality (TCEQ) Public Water Supply (PWS) Program. The scanned well information includes more than 100,000 scanned pages, which were assembled into seven PDF document types. The document types include driller logs, well construction sheets borehole lithology, aquifer test results, laboratory reports of water quality, and geophysical logs. From the PDFs of the aquifer test results, text files of the tabulated pumping rates and drawdown values were generated for over 900 PWS wells.

To facilitate the analysis of the project information, the project deliverables include a geodatabase, visualization tools, and analysis tools that produces charts that can be imported into ArcMap. The visualization tool works within ArcMap and can be used to view the PDF documents as well as charts generated by the analysis tools. The analysis tools work outside of ArcMap and provide the capability to develop charts showing well construction, lithology, layers in groundwater models, and measured drawdowns from aquifer tests.

The project deliverables include a hard drive containing the PDF files, the aquifer test data files, visualization tools and the analysis tools. Appendices A and B provide the instructions for installing and configuring the project files.

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1.0 Introduction

This section describes the Texas Water Develop Board (TWDB) Groundwater Availability Modeling program, the project objective, and the project data.

1.1 Groundwater Availability Models (GAMs)

Recognizing the importance of accurate groundwater availability estimates, the 76th Texas Legislature approved initial funding for the Groundwater Availability Modeling program. The program's goal is to provide useful and timely information for determining groundwater availability for the citizens of Texas. The Groundwater Availability Modeling program produces standardized, thoroughly documented, and publicly available groundwater models. These models are important tools for groundwater conservation districts and regional water planning groups in evaluating water management strategies and assessing present and future groundwater availability trends under normal and drought conditions.

In 2005, House Bill 1763 mandated that groundwater conservation districts evaluate and develop desired future conditions for aquifers within their groundwater management areas. In response to the implementation of House Bill 1763, which subtly changed the purpose of the modeling program, the TWDB began modifying GAMs so that they are better suited for predicting groundwater flow within groundwater management areas (GMAs).

The TWDB GAM program aims to produce state-of-the art models that represent the best science available for predicting groundwater-level response to future changes in pumping and climatic conditions. The GAM program considers groundwater models to be dynamic works, with planned updates as new information and technologies become available. As part of a continuing effort to improve the GAM for GMA 8, the TWDB has identified the potential benefits yielded by the analysis of the aquifer test, lithology, and related hydrogeological data assembled by the Public Water Supply (PWS) program at the Texas Commission of Environmental Quality.

1.2 Project Objective

A primary project objective is to develop a database and a suite of visualization tools that supports the analysis of aquifer tests and related information from PWS wells located in GMA 8. The project database and the suite of visualization tools provides the opportunity for TWDB staff

and other hydrogeologists to readily analyze PWS aquifer test information, to calculate aquifer parameters at specific well locations, and to investigate the relationship between lithology and transmissivity. Quantification of this relationship can help provide estimates of the hydraulic conductivity of lithologic units, such a sand or limestone, associated with a specific model layer and/or model region. Example applications of approaches for estimating this relationships are described by Deeds and others (2010) for the Yegua-Jackson Aquifer and by Young and Kelley, (2006) and Young and others (2009) for the Gulf Coast Aquifer System.

1.3 Project Database and Toolbox

The database created for GMA 8 includes two types of information. One information type includes scanned images of aquifer tests, well installation logs, geophysical logs, well specifications and other related data. The other information type includes text files of measured water levels and pumping rates from aquifer pumping tests. All project data related to aquifer tests were obtained from the files with the TCEQ's Public Water Supply (PWS) Program.

The project data contains information on more than 4,000 PWS wells and more than 1,000 aquifer pumping tests. More than 100,000 pages were scanned during the course of the project. To facilitate the analysis of the project information, the project deliverables include a geodatabase, visualization tools, and analysis tools that produces charts that can be imported into ArcMap. The shapefiles can be used to identify wells with different sets of information and attributes. The visualization tool can be used to view existing charts generated by the analysis tools. The analysis tools provide the capability to develop charts showing well construction, lithology, groundwater model layers, and measured water levels from aquifer tests.

2.0 Public Water Supply Data

This section describes the specific types of information considered for the project, the sources for the information, and how the information is distributed among the 45 counties in GMA 8. This section also describes the TCEQ Access database and documents that TCEQ use to track and manage information on the public water supplies.

2.1 TCEQ PWS Naming Convention

The TCEQ is required by the State of Texas to maintain a Public Water Supply Supervision program in order to retain primary enforcement authority (primacy) over Texas public water systems' compliance with the Safe Drinking Water Act (SDWA) and its amendments. As part of this program, TCEQ maintains an electronic database and a set of paper records to manage information regarding the location, construction, borelog lithology, and data from a 36-hour aquifer test for each public supply well.

The TCEQ electronic database and set of paper records use a seven digit number, called the PWS ID, to organize its information. The first three digits represent a county code. The TCEQ state ID for the counties in GMA 8 are shown in Figure 2-1. For example, the county ID for Dallas County is 057. The last four digits assigned to a PWS folder identify the PWS. For example, PWS number 0570048, would represent the information from PWS 0048 in Dallas county.

The TCEQ uses a 9-digit (or 10-digit) number, called the Source Water ID, to track the groundwater and surface water sources. For a groundwater well, the Water Source ID is created by adding a G (Groundwater) to the beginning and adding a letter at the end of the 7-digit PWS ID. Well IDs are created by starting with the letter A and proceeding through the alphabet as additional wells become a part of the PWS. An example Source Water ID for a groundwater well is “G0570048A” (see Figure 2-2). This Water Source ID is broken down into four components that are shown below. These four components are: 1) a “G” for a groundwater source, 2) the first three digits designating the county, 3) the last four digits designating the PWS, and 4) the letter such as “A” to designate a specific well in the PWS well network (when a PWS has more than 26 wells, another letter, the 10th digit, will be appended at the end, for example, G0570048AA).

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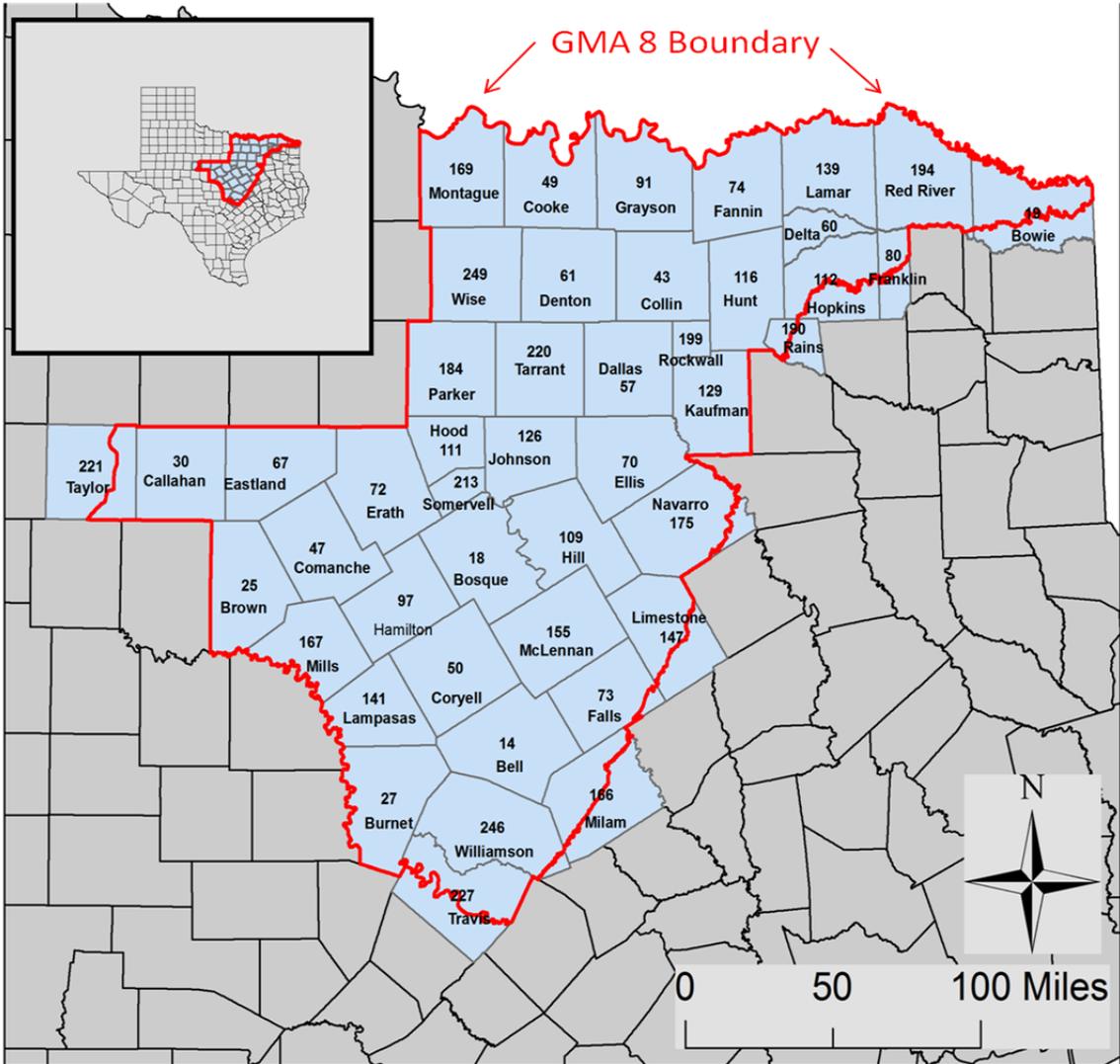


Figure 2-1 The State County IDs for the 45 Counties in GMA 8.

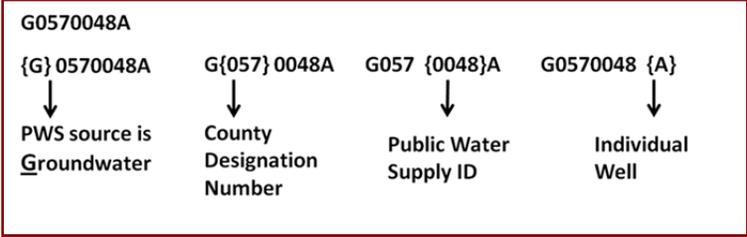


Figure 2-2 Components of a 9-digit for PWS Well ID G0570048A

2.2 TCEQ PWS Database

The TCEQ maintains an Access database to help manage the state's PWS system. The database contains attributes for every PWS registered in the state. In October 2010, TCEQ personnel performed a query for INTERA to identify the PWSs with groundwater wells. The query indicated that there are 4345 PWS wells in the 45 counties that comprise GMA 8. These wells are distributed among 971 PWSs. In June 2012, TCEQ personnel performed another query of their database and provided INTERA with copy of this version of their database. This query indicated that there are 4512 PWS wells in the 45 counties that comprise GMA 8. The final deliverable for this project uses the TCEQ Access database obtained by INTERA in June 2012. This Access database is contained in the geodatabase called GMA8_Geodatabase.mdb, which is described in Section 3.5, Supporting Spatial Data.

The PWS Access Database includes over 50 tables containing information describing the public water systems and their specific water sources. For each PWS groundwater well, the database provides the following information:

- latitude, longitude, and vertical datum;
- county and public water supply;
- well construction information containing casing and screen placement;
- lithologic profiles from drilling logs;
- measured water levels over time; and
- aquifer assignment.

For this project, the TCEQ Access database is primarily used to retrieve information regarding well screen, borehole lithology and geophysical logs of PWS wells. Basic information such as well name and well ID are stored in the "tblPwsWellData" table. The well name (or water source) in this table is the key connection to two other information tables:

"tblPwsWellConstruction" and "tblPwsWellGeology". The tblPwsWellConstruction table contains well screen information that identifies different segments of the well construction in terms of the segment's location, casing material and diameter. The tblPwsWellGeology table records well borehole geologic information by identifying different segments of lithology in terms of segment location and geologic descriptions.

2.3 TCEQ PWS Documents

The TCEQ maintains documents for each PWS. These documents are contained in file folders that are arranged and labeled according to their PWS. Over the a period of about eight months, project staff worked with TCEQ staff to scanned the documents listed in Table 2-1. For purposes of naming the scanned files, each type of document was assigned a three-letter acronym.

Table 2-1 Type of Documents Scanned for Each PWS Groundwater Well.

Type of Document	Acronym
Drillers Formation Description	DFD
Drillers Well Construction	DWC
Electric (Resistivity) or SP Log (Spontaneous Potential)	SPR
Gamma Ray Log and/or Gamma-Gamma Log	GMM
Pumping Test	PTO
PWS System Notes	PSN
Raw Water Geochemistry	RWG
State of Texas Plugging Report	STP
Well Schedule: USGS, TWDB, UGCD	WSC
Other documents	OTH

2.3.1 *Drillers Formation Description (DFD) Documents*

Drillers Formation Description (DFD) documents contain logs of the geologic strata identified by the water well driller. The geologic log is usually represented by a three-column table, in which the first two columns designate the top and bottom of a geologic strata and the third column provides a geologic description. Geologic descriptions will typically include words such as rock, shale, clay, sand, limestone, and one of the primary colors. The format of the DFC documents differ among the wells but all of the have consistent format. During the search of the file folders, INTERA discovered that several hundred of PWS wells were missing DFD documents. As part of the project INTERA located approximately 200 of these documents and have included them as scanned images for this project. Appendix C provides examples of DFD documents.

2.3.2 *Drillers Well Construction (DWC) Documents*

Driller’s well construction (DWC) documents include information regarding the construction techniques and procedures related to the installation, design, and maintenance of the well. In some instances there is a significant amount of data related to the pumps used within the well. Appendix D provides examples of DWC documents.

2.3.3 Electric (Resistivity) and Spontaneous Potential Logs (SPR) Documents

These documents contain resistivity and spontaneous potential geophysical well logs, which can be used to estimate sand thicknesses and groundwater salinity. Geophysical well logs are often printed on extended pieces of paper with one log section potentially being 5-10 feet long. A standard practice in the well logging industry is to label the logging type in the header above the curve. Resistivity logs are indicated by several alternative names including e-logs, electric logs, and induction logs. Appendix E provides examples in of SPR documents.

2.3.4 Gamma Ray and Gamma-Gamma Logs (GMM) Documents

These documents contain gamma ray and gamma geophysical well logs, which can be used to estimate sand thicknesses and aquifer porosity. As with the SPR documents, gamma ray logs are often printed on extended pieces of paper with one log section potentially being 5-10 feet long. Appendix F provides examples of GMM documents.

2.3.5 Pumping Test Data (PTO) Documents

Pumping test data documents provide measured values of changes in the water level in the well and discharge from the well during an aquifer test. Information from these documents was used to create the information (INF) and Aquifer Test Data (ATD) files discussed in Chapter 4. Appendix G provides examples of PTO documents.

2.3.6 PWS System Notes (PSN) Documents

Some of the PWS folders include correspondence between personnel at the PWS and at the TCEQ. In situations where the correspondence includes groundwater or well information of potential value to groundwater modelers, the correspondence was scanned. Appendix H provides examples of PSN documents.

2.3.7 Raw Water Geochemistry (RWG) Documents

Raw Water Geochemistry documents summarize results of analytical measurements of groundwater quality parameters. Among the groundwater quality parameters that are frequently measured are: Total dissolved Solids (TDS), Calcium (Ca), Magnesium (Mg), Iron (Fe), Manganese (Mg), Sodium (Na), Carbonate (CaCO₃), Bicarbonate (HCO₃), Sulfate (SO₄), Chloride (Cl⁻), Fluoride (Fl), Nitrate (NO₄), etc. Appendix I provides examples of RWG documents.

2.3.8 State of Texas Plugging Report (STP) Documents

These documents are the “State of Texas Plugging Report” forms used by the state to record the plugging of an abandoned well. Appendix J provides examples of STPs.

2.3.9 Well Schedule (WSC Documents)

The Well Schedule documents provide information on the construction of the well. This information typically includes the date of drilling, the well location, the well construction, the drilling form, the drilling company, the well owner, and limited production test information. Oftentimes, these document contains the title “Well Schedule” near the top of the first page. Appendix K provides examples of WSC documents.

2.3.10 Other (OTH) Documents

Other documents include scans of images, logs, correspondence, reports or other information sources that could be of potential interest to groundwater modelers but were not identified as one of the previous nine document types in Table 2-1 by the project personnel at the time of the scanning.

2.4 Project Data

The project data includes the TCEQ Access database, PDFs of documents retrieved from the TCEQ folders, and text files of aquifer test data. The aquifer test data consist of two computer-readable text files: a descriptive information file (INF file) and an actual data file (ATD file). Among the key information contained in the INF file is the length of the aquifer test, an initial estimate of the static water level and the units used for the measurements provided in the ATD file. The ATD file provides tabulated values of measured water levels and pumping rates.

Figure 2-3 shows the relationships among the different sources of project data. The primary source of all project data is the TCEQ PWS documents. From the PWS documents, TCEQ updates its PWS Access database and INTERA has developed PDFs of the documents as well as the INF and ATD files.

2.4.1 Information (INF) and Aquifer Test Data (ATD) Files

The information files names are created using the well ID as the root and the letters “TXT” as the file extension. Each information file contains twenty-nine lines. Appendix L describes and provides examples of the INF files. On the second input line of the INF file is a group number assigned by INTERA personnel. The group numbers were assigned after a high-level review of

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the aquifer test documents and prior to the construction of any INF or ATD files. The group names are Category 1, Category 2, Category 3, Category 4, and Category 5. Table 2-2 describes the criteria used to develop the five groupings. In general, the higher category numbers are associated with greater amounts of water level measurements than are the lower category numbers. Appendix L discusses the criteria used to assign a group number to an aquifer test.

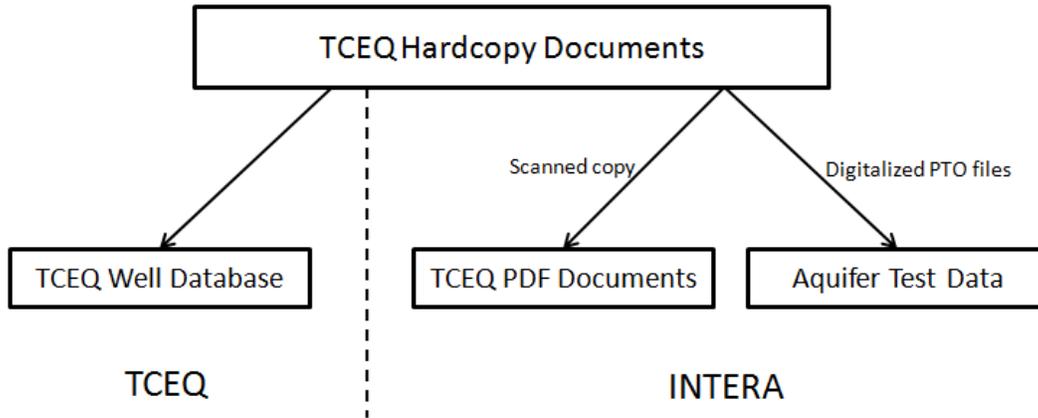


Figure 2-3 Schematic Showing the Difference Sources of Project Data. The dashed line separates the work of TCEQ and INTERA.

Table 2-2 Five Groups Used to Guide the Management of the Aquifer Test Data Files.

Group	Description	Number
Category 1	Data set has major deficiencies and cannot be used to estimate transmissivity using an analytical well solution. For some of these aquifer tests no information file was created.	74
Category 2	Data set appears to indicate a constant drawdown for the majority of the pumping period.	184
Category 3	Data set appears to have relatively few measurements and there is evidence that drawdown changes over time.	148
Category 4	Data set appears relatively well-organized and adequate for using an analytical well solution for calculating a transmissivity value.	584
Category 5	Data set appears have measurements collected using a dataloggers because some of the time intervals are less than 5 minutes.	21
Total		1011

As shown in Table 2-2 the total number of PWS with aquifer test information is 1014. Out of about 1000 aquifer tests, about 970 of the tests had sufficient information to justify having an information and an aquifer test data file created. For each INF file, there is an Aquifer Test Data (ATD) file. The Aquifer Test Data (ATD) files names are created using the well ID as the root and the letters “ATD” as the file extension. Each record or row of information in the aquifer test

file represents a specific measurement time where a water level and/or a pumping rate was made. Each row of the file contains four columns of data. The data associated with each column are listed below. The measurement units associated with each of these measurement in columns 2, 3, and 4 are contained in the INF file.

- Column 1 – date (mm/dd/yyyy)
- Column 2 – time (00:00 am or pm)
- Column 3 – water level
- Column 4 – pumping rate

2.4.2 Summary of Project Data

Table 2-3 lists the number of PWSs, PWS wells, and project data files associated with the counties in GMA 8. Table 2-3 shows that there are 3404 groundwater wells in the GMA 8 counties that have at least one document associated with it. For most of the counties, the number of each PDF document type is less than the total number of wells. The primary reasons for fewer documents than wells is that TCEQ had never received the missing document or that the missing document had been lost during the handling of the PWS folders. In discussion with the TCEQ, the former explanation appears to be the most likely cause of missing documents.

Table 2-4 list the twenty-two PWS wells that have multiple aquifer tests. In all cases, the multiple aquifer tests are recorded on a single PTO file. Wells with multiple aquifer tests have multiple INF and ATD files. The root name for the INF and the ATD files for the second aquifer test includes the number ‘2’ after the well name. Similarly, the third aquifer test includes the number ‘3’ and so forth. For all cases except for one, the multiple aquifer tests were single well tests involving the pumping wells. The only well with an aquifer test that included an observation well was for Well G1550022A. For this well, the INF and ATD file labeled G1500022A2 for the observation well G1550022B, which is located a radial distance of 1250 feet from Well G1500022A.

2.4.3 Directory Structure of the Project Data and Generated Charts

The project is designed so that the user can develop his/her own directory structure. The guidelines for customizing a directory structure are discussed in Appendix B. After the installation of the project files, the directory structure in Figure 2-4 is used for the initial placement of project files.

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Table 2-3 Number of the PWS, PWS Wells, and Project Data Files Associated with GMA 8 Counties.

County		Number of PWS	Number of Wells	Number of PDFs For Each Type of Information Document									ATD Files
Name	State ID			DFD	DWC	PT0	GAM	RWG	SPR	STP	WSC	OTH	
Bell	14	17	26	24	13	13	0	18	8	5	0	14	14
Bosque	18	35	78	65	19	19	8	47	16	42	5	45	17
Bowie	19	5	7	6	3	1	0	2	0	1	0	4	1
Brown	25	3	13	11	1	2	0	4	0	10	0	7	2
Burnet	27	46	111	73	15	17	3	26	3	20	1	57	10
Callahan	30	1	20	20	0	0	0	0	0	0	0	0	0
Collin	43	16	67	44	36	33	21	38	17	12	0	27	33
Comanche	47	1	6	4	1	0	0	1	0	4	0	1	0
Cooke	49	21	75	49	38	17	14	21	32	17	1	44	17
Coryell	50	10	28	22	8	12	2	18	4	16	1	17	12
Dallas	57	20	53	46	20	8	4	26	7	27	2	28	8
Delta	60	2	4	3	2	2	1	1	2	0	0	2	3
Denton	61	104	279	225	100	71	29	91	68	92	3	170	70
Eastland	67	2	16	15	0	4	0	6	0	10	0	13	4
Ellis	70	29	95	86	59	53	21	46	19	19	0	79	55
Erath	72	20	78	63	15	26	12	35	11	35	4	42	25
Falls	73	8	16	12	14	9	3	8	5	3	1	16	8
Fannin	74	20	55	50	40	31	22	38	33	13	1	35	33
Franklin	80	3	8	6	2	1	0	3	1	1	0	5	1
Grayson	91	44	240	171	112	72	62	123	82	84	18	111	70
Hamilton	97	6	12	9	1	5	0	5	1	3	0	6	5
Hill	109	36	80	71	26	23	5	37	11	42	2	53	25
Hood	111	61	231	194	58	83	21	83	49	63	10	168	74
Hopkins	112	9	48	42	37	27	7	29	12	11	0	29	28
Hunt	116	21	65	49	19	20	6	19	8	22	2	41	20
Johnson	126	58	251	207	100	65	34	74	23	55	12	157	65
Kaufman	129	1	2	2	2	2	5	2	3	0	0	1	2
Lamar	139	2	2	2	2	1	0	1	0	0	0	2	1
Lampasas	141	2	3	2	2	0	0	0	0	0	0	2	0
Limestone	147	12	38	32	23	14	7	19	6	8	6	23	13
McLenna	155	61	162	134	78	72	34	80	43	51	5	112	61
Milam	166	9	49	46	37	31	14	38	12	6	2	37	30
Mills	167	5	20	10	2	0	0	0	0	7	1	8	0
Montague	169	11	31	17	7	6	5	15	4	17	3	22	7
Navarro	175	2	4	2	1	0	0	2	2	1	0	2	0
Parker	184	73	248	198	39	73	30	99	22	67	11	182	72
Red River	194	5	15	13	9	2	0	3	6	7	0	1	2
Somervell	213	21	52	44	10	13	0	17	0	8	0	28	5
Tarrant	220	97	363	299	91	56	12	99	26	124	12	222	48
Taylor	221	4	10	6	0	1	0	1	0	0	0	6	1
Travis	227	73	213	170	46	49	4	78	5	84	2	174	42
Williamso	246	35	122	98	38	35	0	51	2	40	4	89	33
Wise	249	38	108	83	34	42	25	54	35	37	2	91	40
Total		1049	3404	2725	1160	1011	411	1358	578	1064	111	2173	967

Note: Description of document acronyms are as follows: DFD – Drillers formation description; DWC-Drillers well construction; PT0-Pumping test data; GMM-Gamma Ray and Gamma-Gamma logs; RWG-Raw water geochemistry; SPR-Electrical and spontaneous logs; STP-State of Texas plugging report; WSC-Well schedule; OTH-Other

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Table 2-4 PWS wells with Multiple Aquifer Tests.

PWS WELL ID			
G0610203B	G1090017B	G1470010D	G1840130F
G0700034F	G1160017D	G1550006B	G2270014F
G0720001F	G1260016G	G1550022A	G2490001A
G0740004B	G1260017O	G1550042C	G2490056B
G0910009E	G1260053C	G1840006E	
G0910013A	G1470006K	G1840111A	

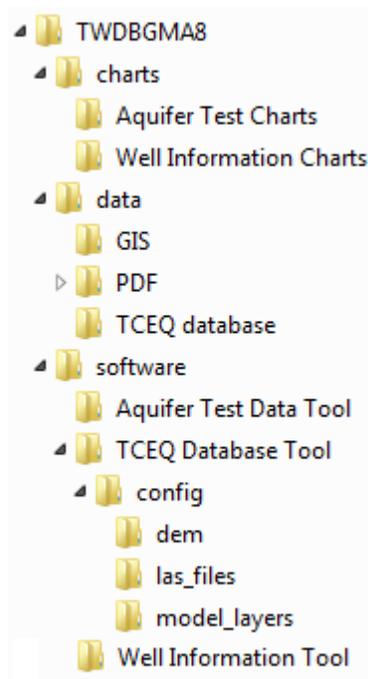


Figure 2-4 File Structure Schema for Project Files.

3.0 Tools for Data Visualization

This section discusses the relationship between the project data and the project tools for generating and visualizing charts. At the end of the chapter, a tutorial is provided for visualizing well and aquifer test information in ArcMap.

3.1 Data and Software Organization

The project visualizes information using ESRI ArcMap (version 10.0 or later). In order to view images in ArcMap, the project data and documents must be prepared according the directory structure outlined in Section 2.4.3. Figure 3-1 shows the relationship between the project tools and the project data. The primary tool for visualizing images is the Well Information Tool, which operates as an embedded program in ArcMap. The key tools for generating charts of well information are the Aquifer Test Tool, which creates charts of change in water level and drawdowns over time during an aquifer test, and the TCEQ database tool, which creates charts of the well information contained in the TCEQ database.

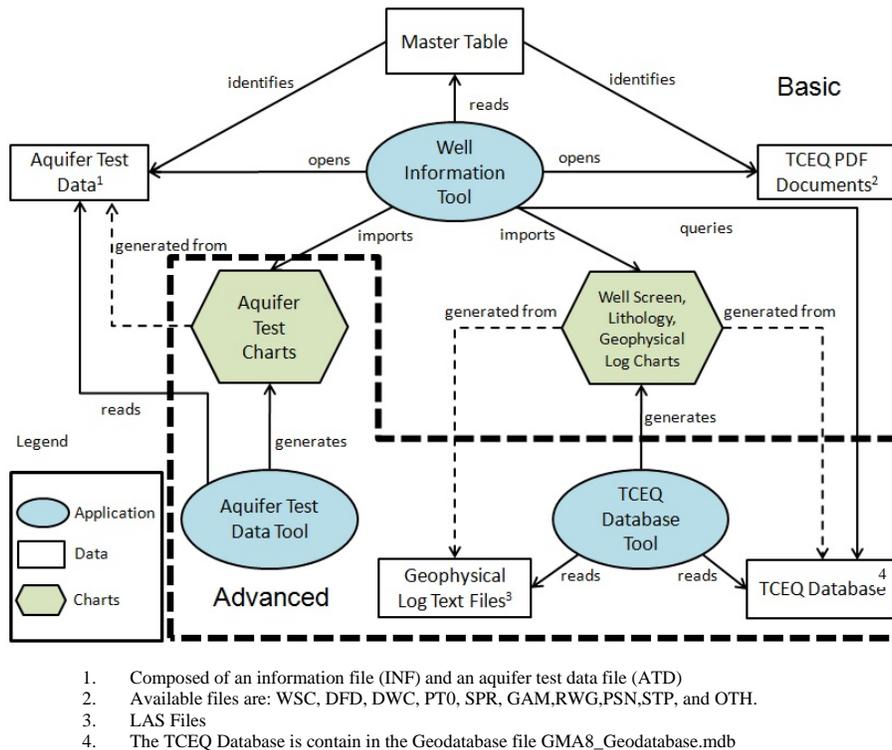


Figure 3-1 Project Software Application-Data Organization Diagram.

3.2 The Master Table

As shown in Figure 3-1, the Well Information Tool reads a Master Table, which is a Microsoft Excel file (data\GMA8.xlsx). The Master Table File is a tabulated set of values for each well that indicate the PDF documents and aquifer test data available for visualization.

Table 3-1 shows the twenty-nine PWS wells listings in the Master Table. The Master Table has 15 columns. The first column contains the PWS well names. The last two columns contain the X and Y coordinates of the well location. Columns two through eleven indicate whether or not a PDFs available for the PWS documents listed in Table 3-1. Columns twelve through thirteen indicate whether or not aquifer test files are available for the PWS wells. If a document or aquifer data does not exist for a well, then the column for that well record is left blank.

3.3 Well Information Tool

As shown in Figure 3-1, the Well Information Tool is used to select and view images of documents or charts of well information. Typically the well documents will be PDFs, while charts of the well construction, borehole lithology, or aquifer test data will be JPGs. The charts that can be imported into the Well Information Tool are divided into the two groups (Figure 3-1). The "Well Screen, Lithology, Geophysical Log Charts" are required to reside in the directory as described in Section 2.4.3. The "Aquifer Test Charts" may be organized in the default fashion shown in Section 2.4.3, or may be organized by the user following the guidelines in Appendix B.

The Well Information Tool allows the user to perform the following:

- Detect and highlight available well information on the map.
- Select a well and view its related TCEQ PDF documents.
- Select a well and plot its well screening, lithology, model and geophysical log information on the map.
- Select a well and plot its aquifer test data on the map.
- Select a well and export its aquifer test data (if any) to AQTESOLV format.
- Associate a selected well with its plots by connecting them with leader lines.
- Adjust the size of the plots.

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Table 3-1 Format of the Master Table File Used by the Well Information Tool.

PWSWELL	WSC	DFD	DWC	PTO	SPR	GAM	RWG	PSN	STP	OTH	INF	ATD	X	Y
G0140027A		DFD	DWC	PTO	SPR						INF	ATD	1751273.50	7432559.63
G0140028A	WSC	DFD		PTO			RWG				INF		1741625.06	7455690.95
G0140035A					SPR		RWG			OTH			1734861.40	7427167.86
G0140035B			DWC	PTO	SPR		RWG			OTH	INF	ATD	1735595.02	7428696.80
G0140035C		DFD	DWC				RWG			OTH			1734265.08	7427772.06
G0140035D		DFD	DWC	PTO			RWG			OTH	INF	ATD	1734570.98	7425926.50
G0140035E		DFD	DWC	PTO			RWG			OTH	INF	ATD	1734485.34	7424998.53
G0140035F		DFD	DWC	PTO			RWG			OTH	INF	ATD	1734555.72	7425401.55
G0140035G		DFD	DWC	PTO			RWG			OTH	INF	ATD	1734712.67	7424464.14
G0140035H		DFD	DWC	PTO			RWG				INF	ATD	1734077.18	7425154.59
G0140035I		DFD	DWC	PTO			RWG				INF	ATD	1733831.04	7424700.20
G0140037A	WSC	DFD	DWC	PTO	SPR		RWG				INF	ATD	1757311.09	7456747.57
G0140042A		DFD	DWC	PTO			RWG			OTH	INF	ATD	1734856.73	7426996.41
G0180002B	WSC	DFD	DWC	PTO	SPR	GAM	RWG				INF	ATD	1722227.95	7536574.97
G0180003A		DFD				GAM							1739198.67	7506821.33
G0180003B		DFD			SPR								1739074.49	7506154.75
G0180025B		DFD	DWC										1745547.28	7532636.47
G0180026A		DFD	DWC	PTO			RWG			OTH	INF	ATD	1736376.25	7523187.75
G0180026B		DFD	DWC	PTO			RWG			OTH	INF	ATD	1730433.40	7515096.62
G0180026C		DFD	DWC	PTO			RWG			OTH	INF	ATD	1734487.85	7521813.15
G0180038A		DFD	DWC	PTO			RWG				INF	ATD	1703356.01	7529658.07
G0180038B		DFD	DWC	PTO			RWG			OTH	INF	ATD	1714652.68	7532466.48
G0180038C		DFD	DWC				RWG			OTH			1714951.78	7519725.21
G0180038D		DFD											1714784.18	7521517.60
G0180038E		DFD								OTH			1727279.73	7518782.63
G0180038F		DFD		PTO			RWG			OTH	INF	ATD	1715148.88	7532074.73
G0180038G		DFD	DWC	PTO			RWG			OTH	INF	ATD	1719942.31	7514676.36
G0180038H	WSC	DFD											1709414.29	7515218.15
G0180040A		DFD				GAM				OTH			1744891.63	7531652.90

Note: Description of document acronyms are as follows: DFD – Drillers formation description; DWC-Drillers well construction; PTO-Pumping test data; GAM-Gamma Ray and Gamma-Gamma logs; RWG-Raw water geochemistry; SPR-Electrical and spontaneous logs; STP-State of Texas plugging report; WSC-Well schedule; OTH-Other

3.4 Generating Charts

As shown in Figure 3-1, there are two tools for generating charts of the project data. The "TCEQ Database Tool" reads the TCEQ database to create charts for well screen, lithology, model and geophysical log data. These charts can then be read by the Well Information Tool and visualized in ArcMap. The "Aquifer Test Data Tool" reads the aquifer test data files to create charts of the water level response during an aquifer test.

3.5 Supporting Spatial Data

As stated previously, the project visualizes well information in ArcMap. To help identify and locate wells and features of interest in ArcMap, the project files include a geodatabase (projected under NAD 1983 Texas Centric Mapping System Albers projection system). The geodatabase is named GMA8_Geodatabase.mdb and it is located in the GIS folder. GMA8_Geodatabase.mdb contains the following:

- a feature data set containing the location of wells with ATD files, with LAS files, with construction information, with lithology information, and with PDFs for the document types listed in Table 2-1
- individual feature classes showing the counties in Texas, the counties in GMA 8, the area covered by GMA 8, and the PWS wells in the GMA8 counties.
- tables containing tabulated values from the 967 information and aquifer test files, tabulated values from 50 LAS files, and paths to the PDF files for 3404 PWS wells.
- a version of the TCEQ PWS well Access database created in 2012.

The project files contains a ArcMAP map document file named Wells.mxd that is located in the GIS folder. Clicking on Wells.mxd will upload the GMA8_Geodatabase.mdb into ArcMap and create the display shown in Figure 3-2. Figure 3-2 shows the Table of Contents that will appear after the project “mxd” is applied. The Table of Contents in Figure 3-2 includes the feature database, the individual feature classes and the tables that are described above and that comprise GMA8_Geodatabase.mdb.

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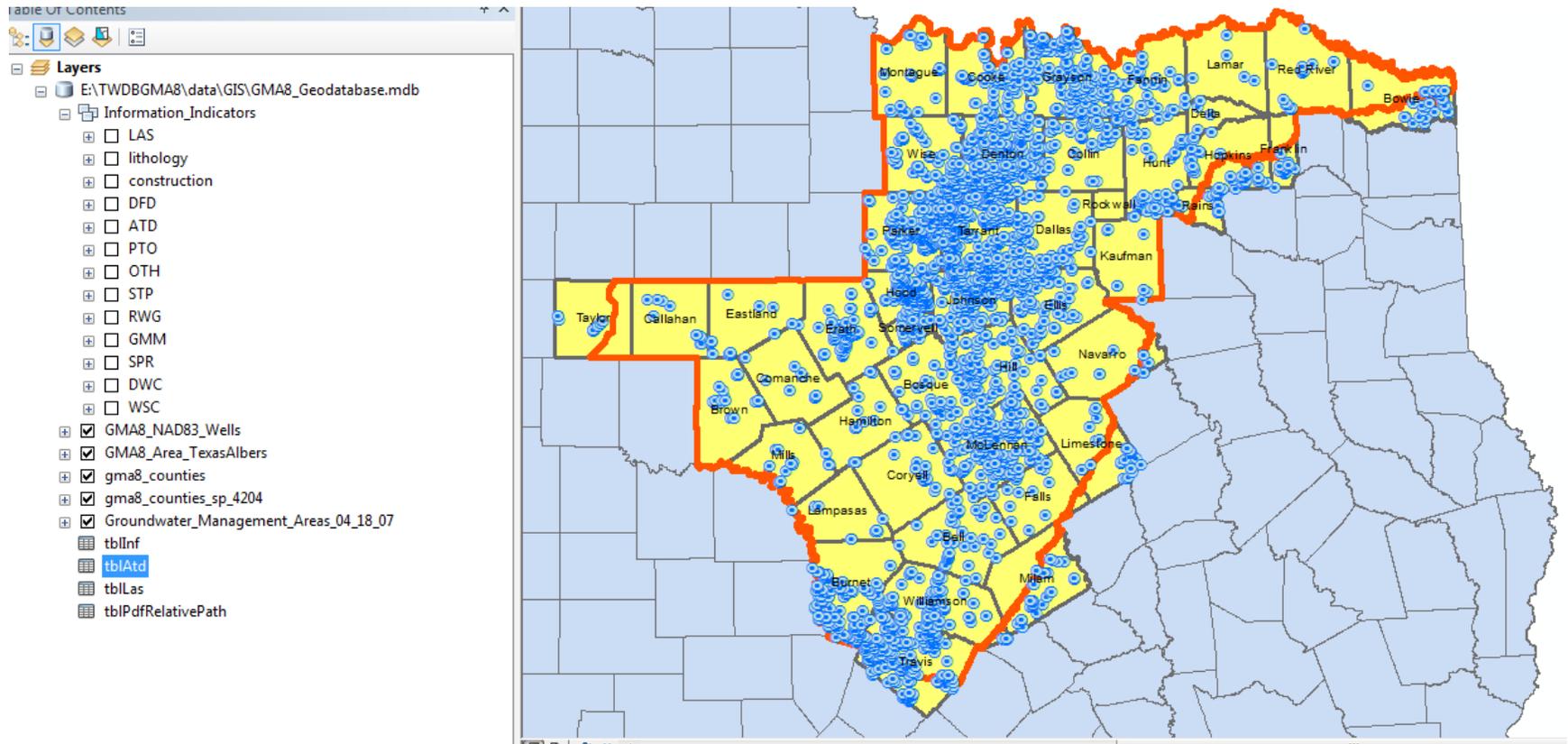


Figure 3-2 Screenshot of the Table of Contents and Layout will appear when Wells.mxd is brought into ArcMap.

3.6 Tutorial on Visualizing Data Using the Well Information Tool

Prior to performing this tutorial, the user needs to complete the installation of the project data (see Appendices A and B). This tutorial would be facilitated if the Wells.mxd was uploaded into ArcMap prior to using the project tools. A successful installation of the INTERA add-in WellInformationIllustrator.esriAddin (see Appendix A) will activate the following tools and their buttons:

-  - Activates the Highlighter Tool
-  - Clears the Highlighter Tool
-  - Activates the Well InformationTool
-  - Reconnects the leader line between a well location and chart
-  - Activates the Resize Plot Tool
-  - Clears all the graphic elements (highlights, leader lines, charts, etc.) on the map
-  - Activates TCEQ Well Database Query Tool
-  - Configuration Tool

During the first application of the Well Information Tool, a user may need to use the configuration tool (see Appendix B) to specify paths of the required files/folders. The files for which the configuration file contains paths for are:

- PDFs of TCEQ documents,
- the master table file, and
- the INF and ADT files.

After having successfully installed the project and software tools, a user will be able to:

- 1) open the TCEQ PDF documents for a highlighted well;
- 2) import well information charts (model, well screen, lithology and geophysical log) and connect them to a highlighted well by a leader line; and
- 3) import aquifer test charts (water level and draw down) and connect them to a highlighted well by a leader line.

3.6.1 Identify and Highlight Wells

There are several types of well information, and a well may have some or all of the associated types. The shapefiles discussed in Section 3.5 are provided to help identify which PDF documents and charts are available for each well. Another method for identifying the type of information available at different wells is by using the  button on the ArcMap toolbar. By selecting the  button, the following window will appear:

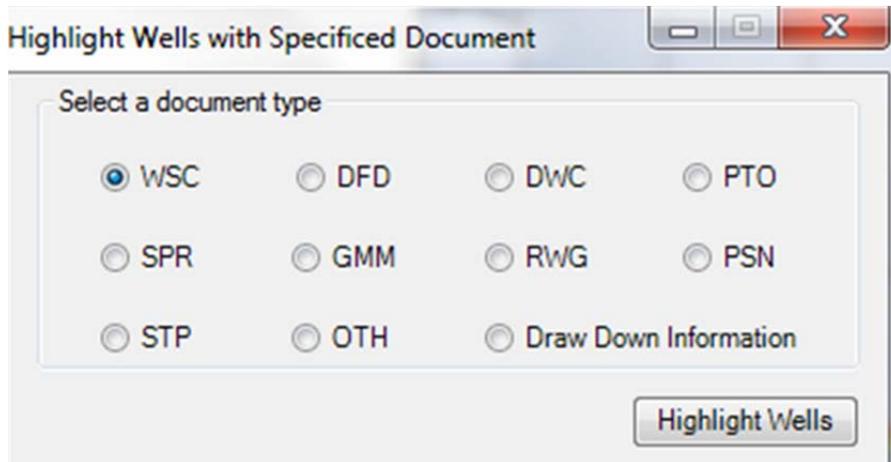


Figure 3-3 Highlight Wells Form.

As shown in Figure 3-3, the Highlight Wells Form lists eleven information types. The association between a well and information type is obtained through the Master Table (see Section 3.2). Only one information type can be selected for a query using the form. After selecting an information type and clicking on the "Highlight Wells" button, ArcMap will highlight the wells that are associated with the selected document. After using the form to highlight wells, the highlighted wells can be cleared by clicking the  button.

The Highlight Well form is designed to disappear behind the ArcMap display if other tools are selected. This option provides as much space as possible to show the highlighted wells and/or the selected pdfs and charts. In order to help track the location of Highlight Wells Form, it is recommend that after the wells have been selected, the user close the form by clicking on the cross in box the upper right of the form.

3.6.2 View PDF of Available Well Documents

To open the Well Information Tool a user clicks the  button. After opening the Well Information Tool, a user is prompted by a form shown in Figure 3-4. If the Well Information Tool cannot find the project data because the configuration file is not properly set up, the tools will prompt the user to change the directory in which the tool searches for the project data.

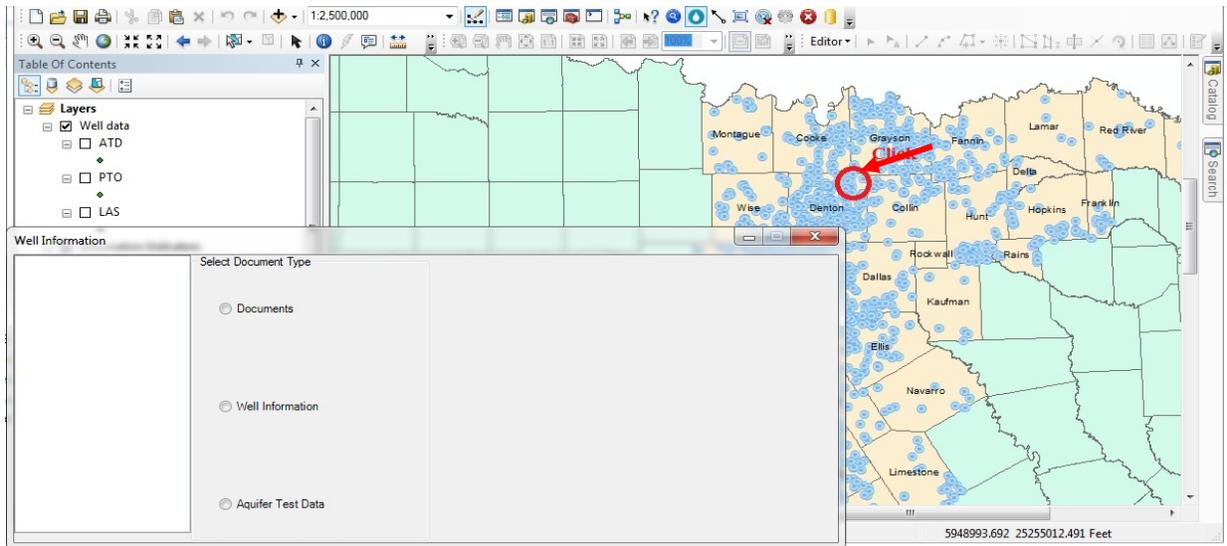


Figure 3-4 Initial start-up of well information form along with locations of selected wells.

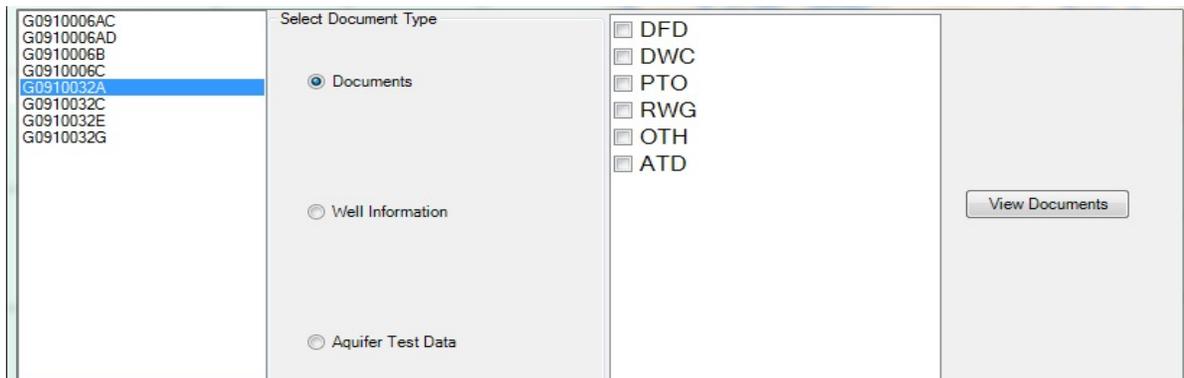
After opening the Well Information Form, a user needs to perform the following five steps to view PDFs for a particular well.

- Step 1. Select one or more wells by clicking on the map with the "Well Information" form opened. After the user completes the well selection, the well(s) will be listed on the left side of the form as shown in Figure 3-5. (Note 1. The Well Installation Form searches on an attribute field in the feature class GMA8_N83_Wells so this feature class needs to be selected. Note 2. In order to assisted with the search, a user could use the Well Highlight Form to identify wells with a specific PDF document)
- Step 2. Select one of the wells in the well list as shown by the blue bar in Figure 3-5.
- Step 3. Click on the radio button labeled “Documents.” After the button has been selected a list of available PDFs for the highlighted well will be shown in the right side of the form as shown in Figure 3-5.

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Step 4. Click in one or more of the boxes for the PDF documents and view the documents using a PDF viewer by clicking on the "View Documents" button on the right side of the form.

Step 5. After a chart has been brought into ArcMap, additional charts can be brought into ArcMap by repeating steps 1 through 4. A user can clear the charts that have been posted to wells by clicking on the  button.



The screenshot shows a web-based form titled "Well Information form populated by selected wells." On the left, there is a list of well IDs: G0910006AC, G0910006AD, G0910006B, G0910006C, G0910032A (highlighted with a blue bar), G0910032C, G0910032E, and G0910032G. In the center, under "Select Document Type", there are three radio buttons: "Documents" (selected), "Well Information", and "Aquifer Test Data". To the right of these radio buttons is a list of document types with checkboxes: DFD, DWC, PTO, RWG, OTH, and ATD. On the far right, there is a button labeled "View Documents".

Figure 3-5 Well Information form populated by selected wells.

3.6.3 View Charts of Well Screening, Lithology, Model Layers and Geophysical Logs

The process for viewing charts is similar to the process explained in Section 3.6.2 except that process may include selecting the directory containing the charts of interest. After opening the Well Information Form, a user needs to perform the following six steps to view charts showing well information for a particular well:

Step 1. Select one or more wells by clicking on the map with the "Well Information" form opened. After the user completes the well selection, the well(s) will be listed on the right-hand side of the form as shown in Figure 3-6. . (Note 1. The Well Installation Form searches on an attribute field in the feature class GMA8_N83_Wells so this feature class needs to be selected.)

Step 2. Select one of the wells in the well list. The highlighted well will be marked by the blue bar in Figure 3-7

Step 3. Click on the radio button labeled "Well Information." After the button has been selected a list of available charts for the highlighted well will be shown in the left-hand side of the form in Figure 3-6. If no charts appear or if the wrong set of charts appear, then the

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user can search for an appropriate set of charts by clicking on the directory button circled in red in Figure 3-6. After the desired directory has been selected, the list of available charts (if any) will appear on the left-hand side of the Well Information Form.

Step 4. Select one more of the charts by clicking the appropriate boxes and then click the “Add Selected Pictures” button to shown the chart in ArcMap and connect the chart(s) to its well via a leader line. To see the chart(s), a user may need to zoom in on the well location because the default dimension for a chart is a 1,000 feet.

Step 5. After a chart has been brought into ArcMap, a user can then move the chart by following the directions in Section 3.6.6 or can then resize the chart by following the directions in Section 3.6.7.

Step 6. After a chart has been brought into ArcMap, additional charts can be brought into ArcMap by repeating steps 1 through 5. A user can clear the charts that have been posted to wells by clicking on the  button.

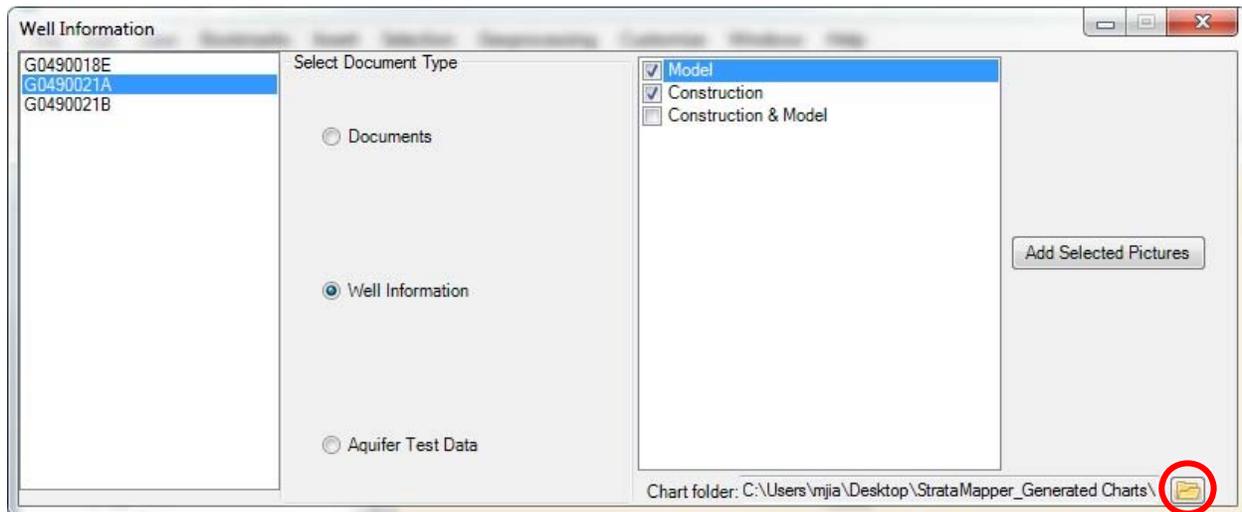


Figure 3-6 Well information form for selecting well information charts to plot (note that the chart directory can be changed by clicking the directory button in the red circle).

3.6.4 View Charts of Aquifer Test Data

The process for viewing aquifer test data is similar to the process explained in Section 3.6.3 for viewing well information. After opening the Well Information Form, a user needs to perform the following six steps to view charts of aquifer test data.

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- Step 1. Select one or more wells by clicking on the map with the "Well Information" form opened. After the user completes the well selection, the well(s) will be listed on the right side of the form as shown in Figure 3-7. . (Note 1. The Well Installation Form searches on an attribute field in the feature class GMA8_N83_Wells so this feature class needs to be selected. Note 2. In order to assisted with the search, a user could use the Well Highlight Form to identify wells that have drawdown data)
- Step 2. Select one of the wells in the well list. The highlighted well will be marked by the blue bar in Figure 3-7.
- Step 3. Click on the radio button labeled “Aquifer Test Data.” After the button has been selected, the right side of the form will be populated with the options shown in Figure 3-7.
- Step 4. If appropriate, a user may click on the folder icon to select the directory for the existing charts. After the correct directory is shown in the directory block a user should then select the box(es) indicating a water level or a drawdown chart. If the “water level” box is clicked, the tool will plot charts with names consisting of the well name concatenated with “_wl.” If the “drawdown” box is clicked, the tool will plot charts with names consisting of the well name concatenated with “_dd.”
- Step 5. After a chart has been brought into ArcMap, a user can then move the chart by following the directions in Section 3.6.6 or can then resize the chart by following the directions in Section 3.6.7.
- Step 6. After a chart has been brought into ArcMap, additional charts can be brought into ArcMap by repeating steps 1 through 5. A user can clear the charts by clicking on the button.

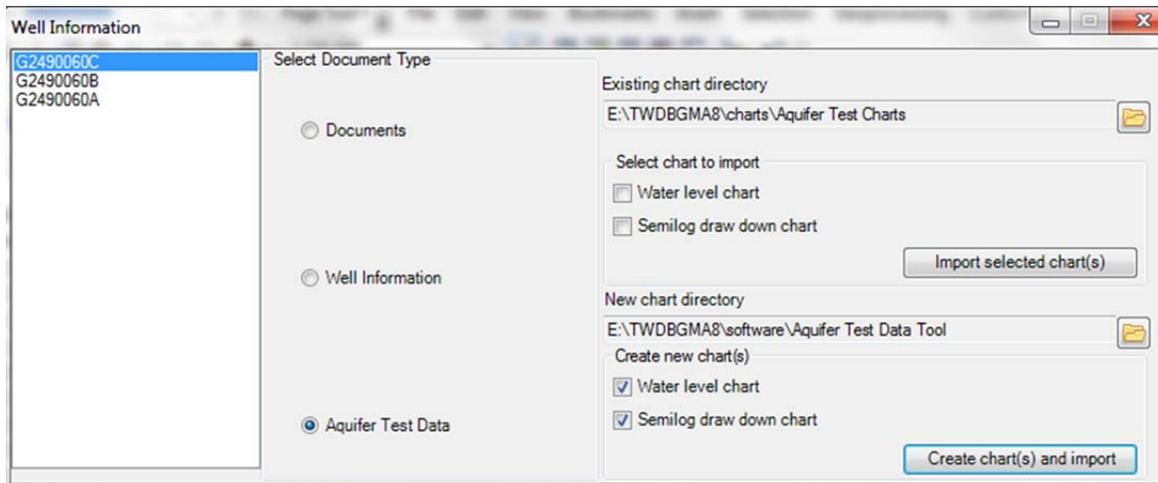


Figure 3-7 Well information form for selecting charts of aquifer test data to plot.

3.6.5 Create and View Snapshot of Aquifer Test Data

The creating and viewing of snapshots is intended to provide a user with the ability quickly view and evaluate the data. The process of creating and viewing snapshots does not allow a user to adjust the chart settings. The process for creating and viewing a snapshot is as follows:

Steps 1 to 3. See steps 1 to 3 listed in Section 3.6.4.

Step 4. If appropriate, a user may click on the folder icon to select the directory that contains the aquifer test data files (INF and ATD files). After the correct directory is shown in the directory block, a user should then click on the box(es) to create new charts of water levels or drawdowns. After selecting the appropriate snapshot boxes, the user creates the snapshots by clicking on the “Create chart(s) and import” button.

Step 5. Figure 3-8 shows an example of a snapshot. After a snapshot has been brought into ArcMap, a user can then move the chart by following the directions in Section 3.6.6 or can then resize the chart by following the directions in Section 3.6.7.

Step 6. After a snapshot has been brought into ArcMap, additional snapshots can be brought into ArcMap by repeating steps 1 through 5. A user can clear the charts that have been posted to wells by clicking on the  button.

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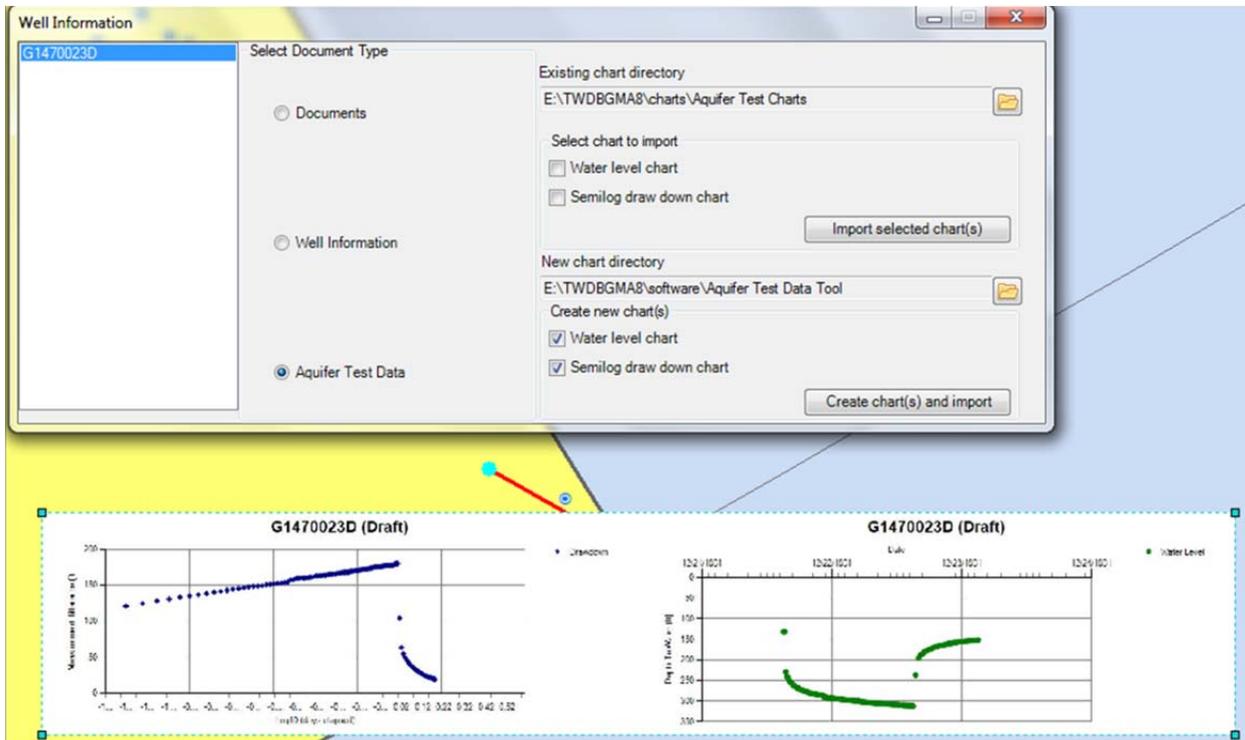


Figure 3-8 Example of a Snapshot of Aquifer Test Data.

3.6.6 Connect Charts to a Well Location Using a Leader Line

After importing charts into ArcMap, a user will see that a red line (the "leader line") connects the well location to a corner on the chart. By default, the charts are imported as a group and are placed on the northeast side of the well. A user can move the chart group by using ArcMap's "Select Elements" tool (the  button). After the chart have been moved, a user can reestablish the leader line simply by clicking the  button. By clicking the  button, the leader line connects the well location to the nearest corner of the plot group. Figures 3-9 to 3-11 show the process of leader line reconnection.

The reconnect function is designed to be used only in the ArcMap session during which the charts are brought into ArcMap. Once this session of ArcMap is closed, the next time the same ArcMap file is open, the reconnect function will not work on previously imported charts. If the user wants to change the plot position, the user will have to remove the plot group and the leader line and import the charts again.

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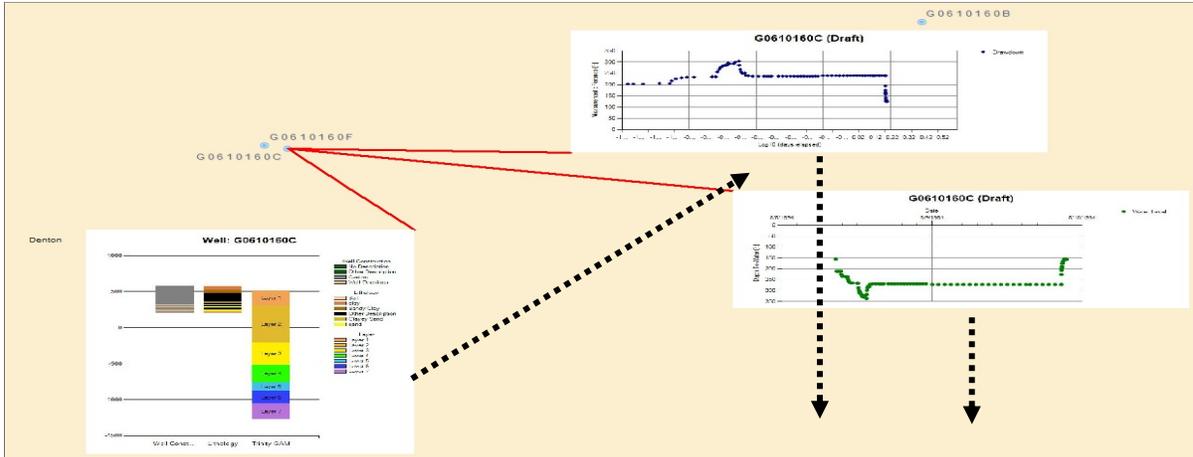


Figure 3-9 The chart group is moved by using the select elements tool. The dash lines show imply the direction of movement.

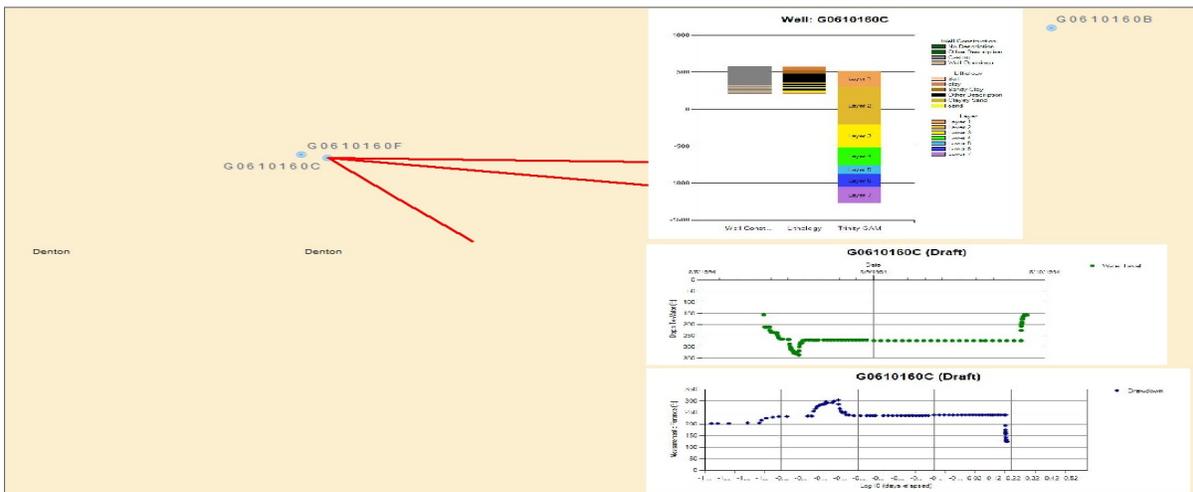


Figure 3-10 After the movement of the chart group, the leader lines remain unchanged.

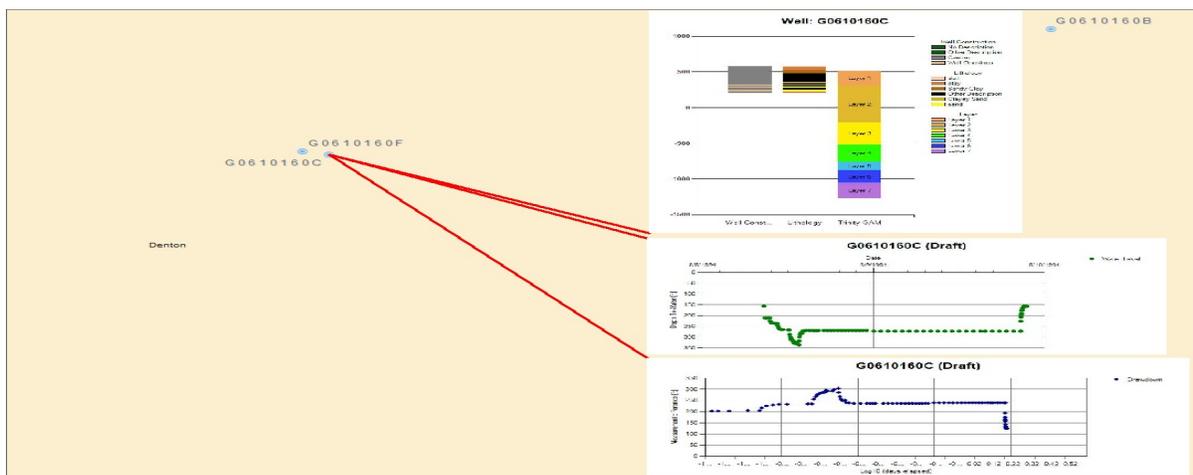


Figure 3-11 After clicking the reconnect button, the leader lines will reconnect with the plots.

3.6.7 *Adjusting Plot Size*

A user can adjust the size of all of the imported charts by using the  button. After clicking on the  button, the form in Figure 3-12 will appear. A user resizes the charts by inputting a size factor to adjust the plot size. For example, if a user enters "0.5", all of the imported charts will be resized to the 1/2 of their original size; if the user enters "2", then all the imported charts will be twice as large as they used to be. There are two limitations to the resize button. One limitation is that the resize button only works on charts entered during the current session of ArcMap. The other limitation is that the resizing applies to all existing plots.

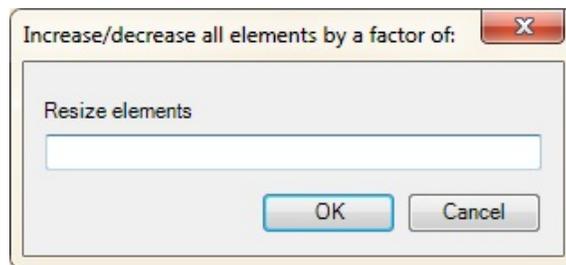


Figure 3-12 **Resize Chart Form.**

3.6.8 *Find and Display TCEQ PWS Well Database Records*

The Well Information Tool provides a limited ability to query the TCEQ PWS Well Database. To query the TCEQ PWS Well Database, a user clicks the  button to open a form similar to that the one shown in Figure 3-13.

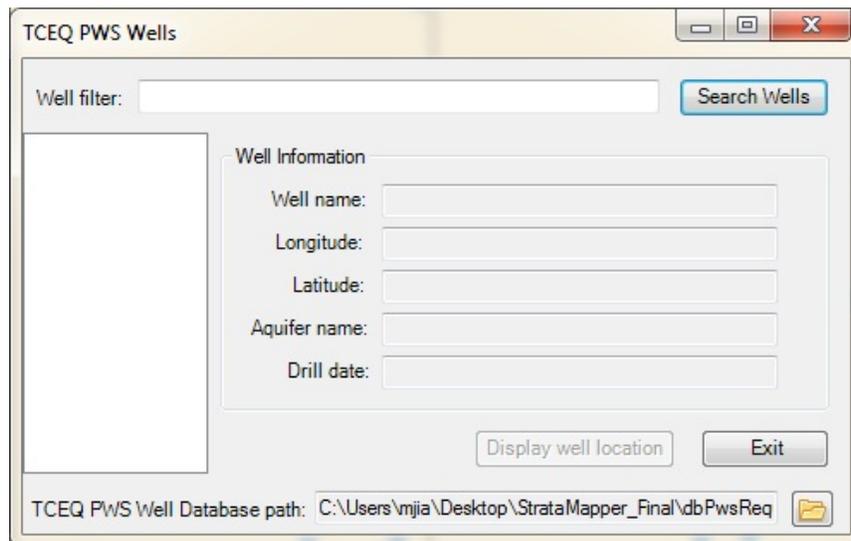


Figure 3-13 **TCEQ PWS Well Database form.**

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The "TCEQ PWS Well Database path" at the bottom of the form shows the path of the TCEQ Access database. After specifying the TCEQ database, a user begins a query by typing part of the well name in the "Well filter" input box (see Figure 3-14) and then clicks the "Search Wells" button. After the button has been hit, the application returns the matched well names. After a well has been selected, the application shows related information (well name, spatial coordinates, aquifer name and drill date) on the right panel as shown in Figure 3-15. If the spatial coordinates of the well are available, a user can display it on the map by clicking the "Display well location" button (Figure 3-16).

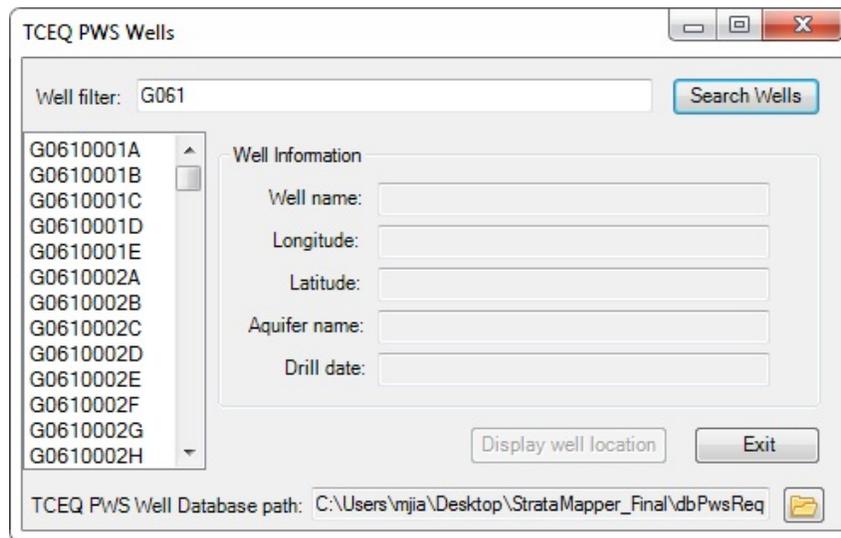


Figure 3-14 Well matches provided by the well filter.

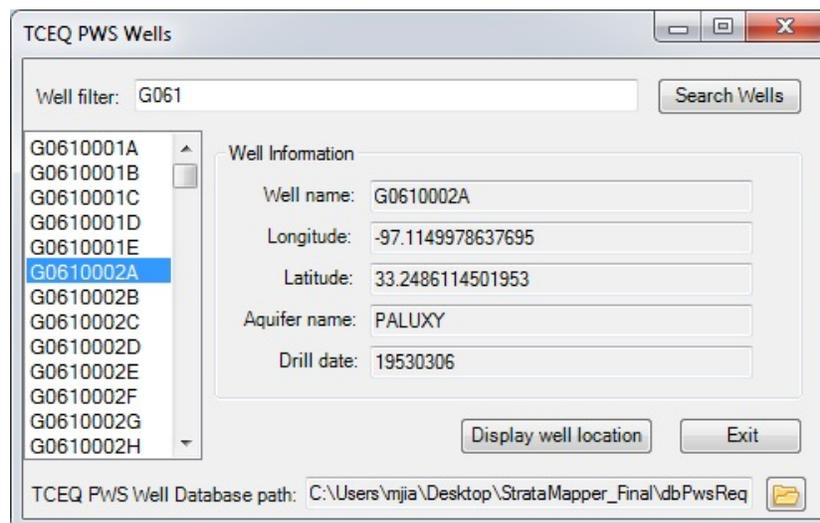


Figure 3-15 Click on a well name displays related information.

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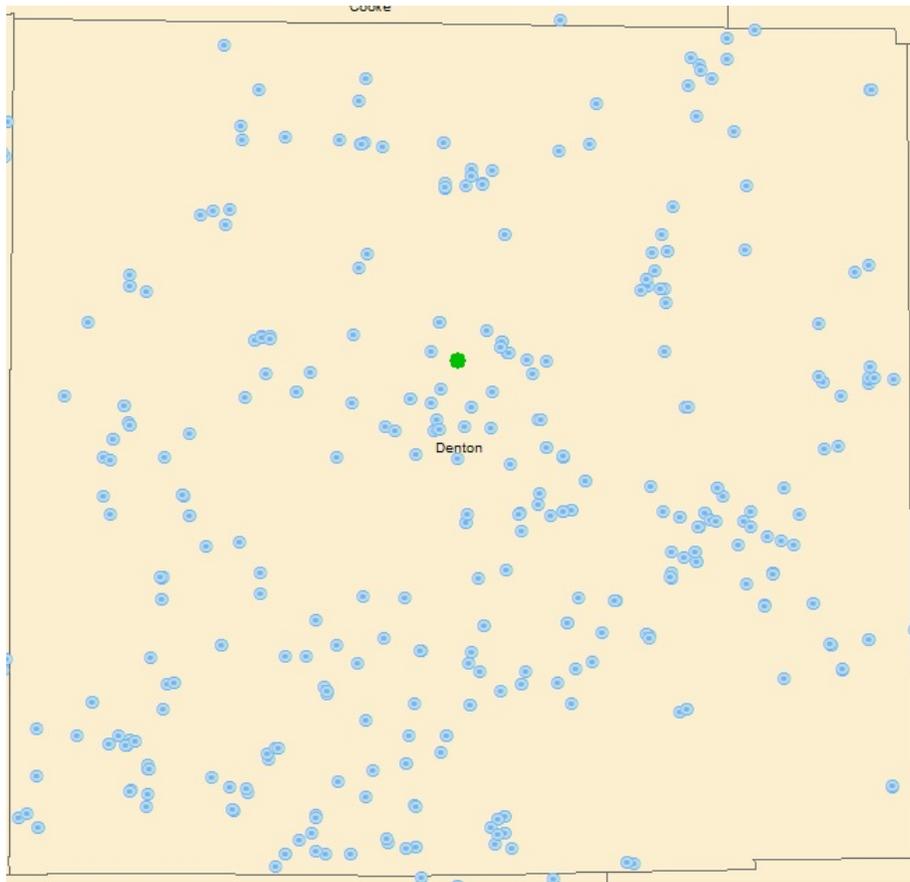


Figure 3-16 Display of the well location.

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4.0 Tools for Creating Charts

In this section, two stand-alone software applications are presented: the TCEQ Database Tool and the Aquifer Test Tool. The two tools generate charts using different sets of project data. The TCEQ Database Tool can be used to generate charts of well constructions (screen locations), model layering, lithology and geophysical logs. The Aquifer Test Tool can be used to generate charts of the aquifer test data.

4.1 TCEQ Database Tool

The application for the TCEQ Database Tool is named TCEQ Database Tool.exe and is located in the folder software\TCEQ Database Tool. The TCEQ Database Tool performs the following functions:

- create/modify mapping sets (color sets) for charts,
- preview charts,
- generate charts for well constructions,
- generate charts for well lithology,
- generate charts of layers in a computer groundwater model, and
- generate charts for well geophysical logs.

Upon opening the TCEQ Database Tool (by double-clicking on the application TCEQ Database Tool.exe), a user is required to read a TWDB well database. The selection is performed by clicking on the "File" menu shown in Figure 4-1 and using the "Open" function to navigate to the database file. The PWS Access database for this project is named dbPWSRequest_june_2012.mdb and is located in the directory data\TCEQ database.

The tool reads the TCEQ database to obtain lithology and well construction information and mapping sets of colors or grouping developed during previous application of the tool. To obtain other relevant information, the tool also reads text files developed for the computer model layers (see Section 4.1.5.3) and on the geophysical well logs (see Section 4.1.5.4)

The TCEQ Database Tool provides the options for developing separate or grouped charts for well lithology, well construction, and model layers. When grouped together the charts share the same vertical axes. The plotting of the geophysical log is always in one single chart and cannot

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be blended with other information. The directory structure for the files used by the tool are discussed in Appendices A and B.

Prior to generating charts, a user should consider developing a project-specific mapping sets (also called color sets) for the charts. A color set includes three parts: 1) strata group colors, 2) well construction material colors, and 3) well model layer colors. Although default colors are assigned to newly created mapping sets, a user has the ability to change the colors.

4.1.1 Selecting a Color Mapping Set

Once the TCEQ database has been uploaded, the main user interface for the TCEQ Database Tool will appear as shown in Figure 4-1 except that there will not be any grouping information. The grouping information will appear after either a mapping set has been imported or the user creates a mapping set.

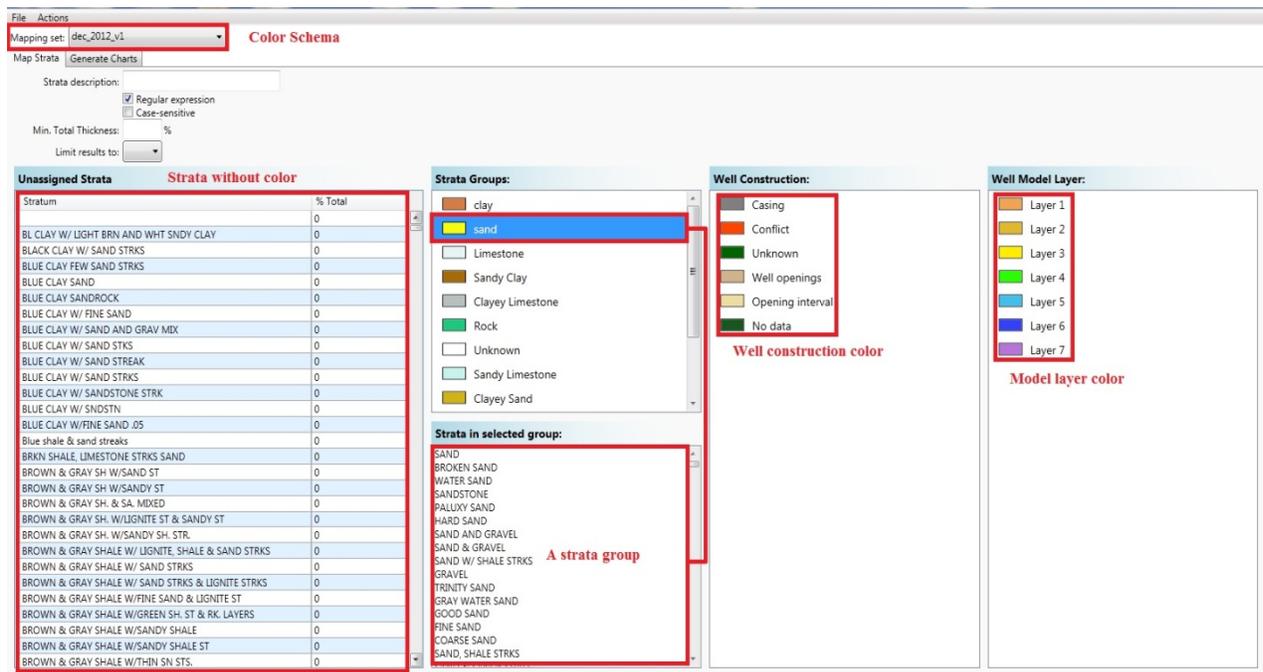


Figure 4-1 The Main User Interface for the TCEQ Database Tool.

A mapping set consists of three color groups shown in Figure 4-1. The “Well Model Layer” group assigns colors to represent the model layers. The “Well Construction” group assigns colors to represent segments of the well construction. The “Strata Group” group assigns colors to represent the lithologic groups created by the user. In Figure 4-1, the names of the unassigned strata originate from the PWS database. In the PWS database used for this project there are

approximately 40,000 of these descriptions. In order to consolidate these strata into a manageable number of groups, the TCEQ Database Tool allows these strata to be ‘dragged and dropped’ into one of the user-defined strata groups. As shown in Figure 4-1, the strata assigned to specific groups are listed in area entitled “Strata in selected group.”

4.1.2 Create a Color Mapping Set

To develop a new color mapping set, a user selects clicks on “Actions -> New mapping set.” After this action, the pop up window in Figure 4-2 will appear. In this tutorial, we call the new mapping set "test". The “test” mapping set is created by clicking on the "Create" button. After a new mapping set is created, a user interface similar to Figure 4-3 will appear. In "Strata Groups", there are no groups but there already default groups and color schema for “Well Construction” and “Well Model Layer.”

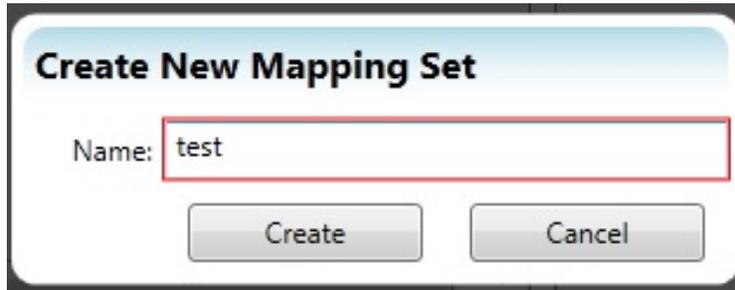


Figure 4-2 Form for entering the name for a new mapping set.

In this tutorial, we create a new strata group named "Sand" and assign stratum descriptions containing the word "sand" into it and then assign a yellow color to it. To find stratum descriptions with the word "sand", type keyword "sand" in the "Strata description" input box and the strata on the left side will be filtered based on this keyword. You can also specify the minimum total thickness so that minor stratum descriptions will be filtered out. In our case, we specify "0.2%" as the value so that stratum descriptions sharing less than 0.2 percent of the total stratum thickness in the database will not be shown in the panel. The filtered result is shown in Figure 4-4. To move the filtered stratum description into the “Sand” Strata Group, the user needs to drag and drop the unassigned stratum descriptions into strata groups panel to create a new strata group. We name this group "Sand" and color it as yellow (Figure 4-5). Additional strata groups can be created using the same process as used to create the Sand strata group.

As a practice, we create another group called "Shale" by assigning it with all the "shale" stratum descriptions that take more than 0.2% of the total thickness.

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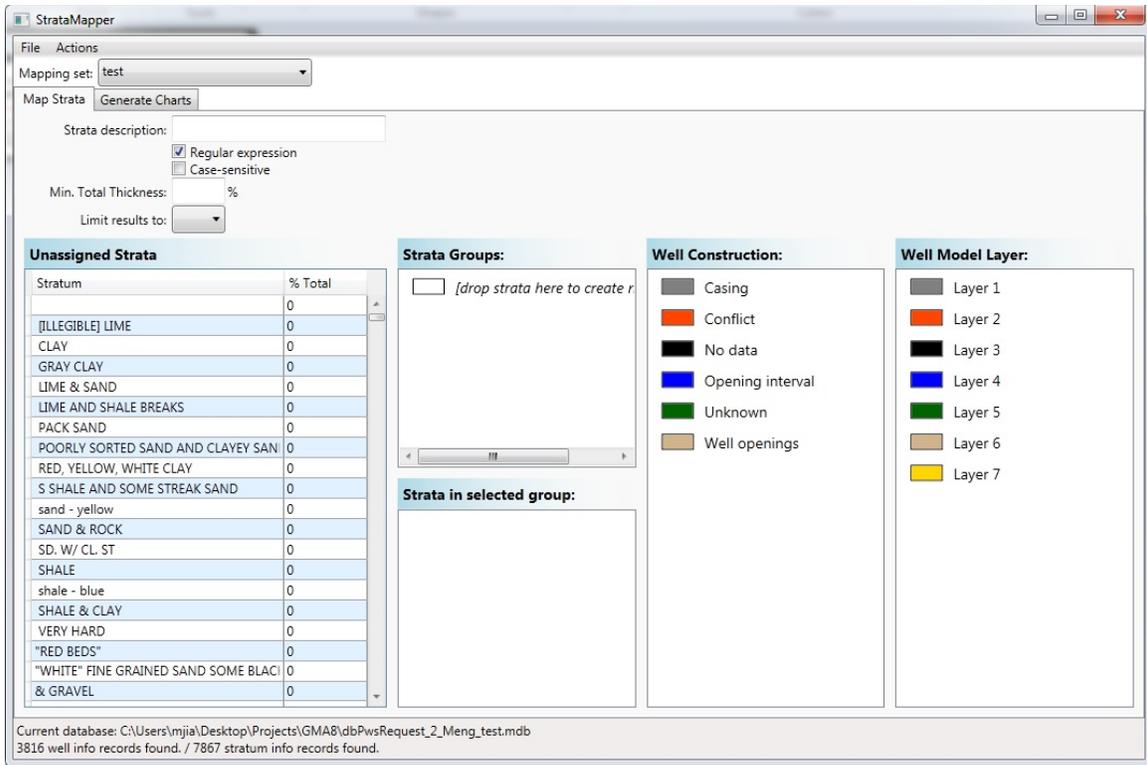


Figure 4-3 User Interface with an unpopulated Strata Group.

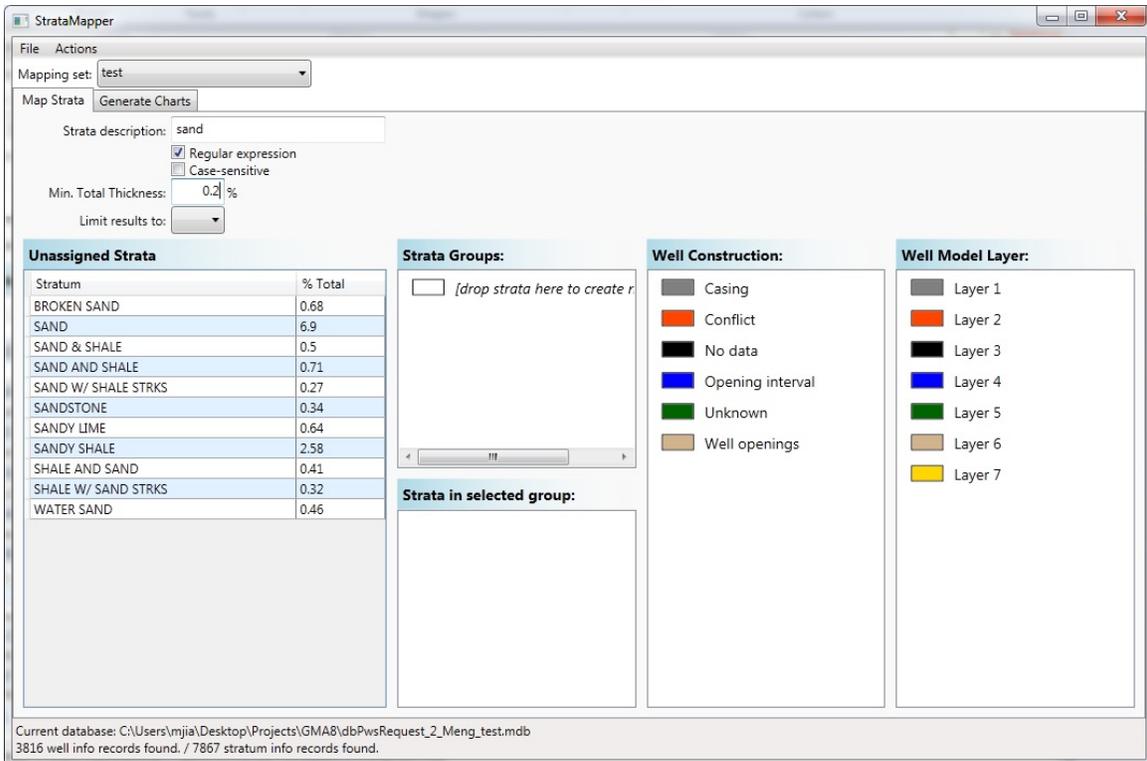


Figure 4-4 Results produced by applying a filter to Locate Sand Strata.



Figure 4-5 Create a new strata group.

Unlike strata color groupings, the well construction and well model layer color groupings are automatically established based on the TCEQ well construction information and the layering in the Northern Trinity GAM Model (Bene and others, 2004). However, a user can modify the colors assigned to each item by clicking on the color box.

After the group creation and color assignment process, all the grouping information and colors are stored in the database. Therefore the next time the tool is open, a user can find the "test" mapping set along with pre-existing mapping sets on the "Mapping set" drop down list. As part of this project, a baseline mapping set called "Baseline" was created. This mapping set assigned approximately 25,000 of the approximately 40,000 stratums to ten strata groups. The assignment of these stratum accounts for over 99.5% of the approximately 450 miles of lithology contained in the PWS database.

4.1.3 *Preview Charts*

After specifying a mapping set, a user can then proceed to the chart generation process by clicking on the "Generate Charts" tab. For this section, we are using mapping set called "test", that contains only two strata groups: "Sand" and "Shale". After navigating to the chart generation tab, the application will resemble the following screenshot shown in Figure 4-6.

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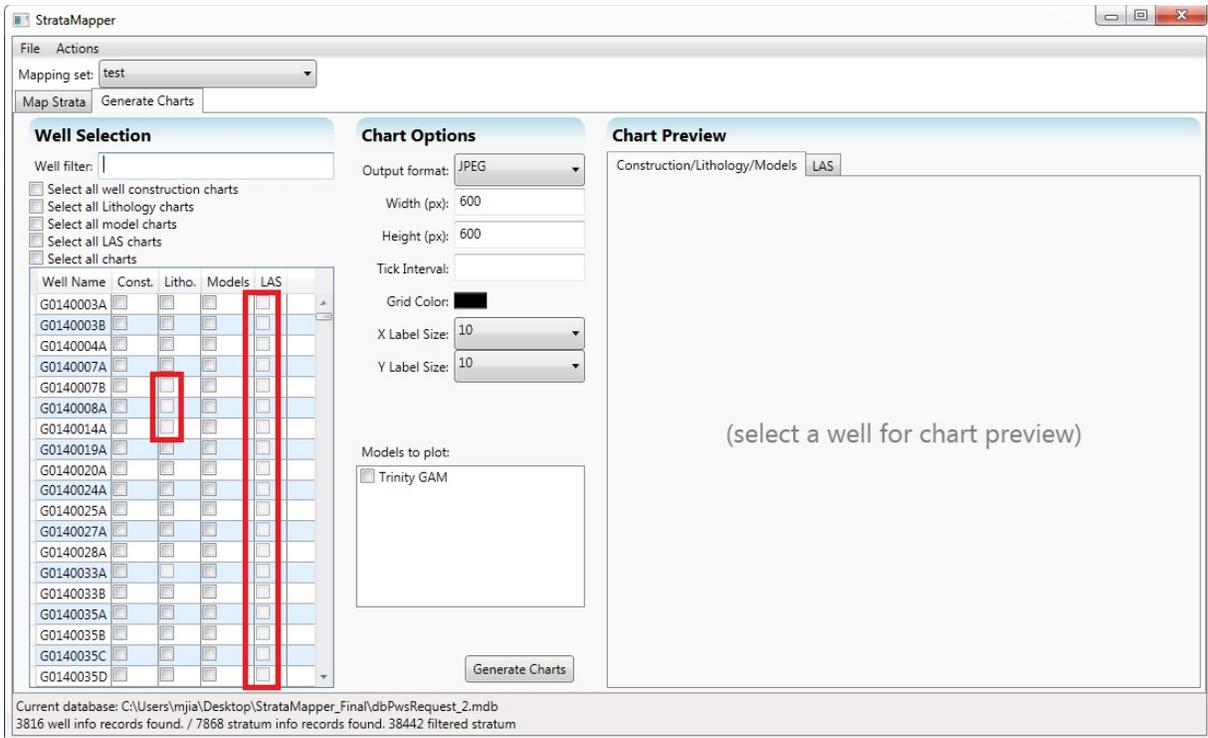


Figure 4-6 Chart generation tab.

All the PWS wells in GMA 8 are listed in the inventory in the left. The columns with checkboxes show available well information. Column "Const." stands for well construction information, "Litho." for lithological data, "Models" for model layering information and "LAS" for geophysical log data. If data is not available for a well, the checkbox for this information will be grayed out (see the red rectangles in Figure 4-6). For this project, only wells that intersect the coverage of Trinity GAM have model layer information and only 50 wells have LAS information. LAS is a standard format for digitized log data and is an acronym for Log ASCII Standard.

When clicking on a checkbox, the row of the checkbox will be highlighted and a bar chart will appear on the "Chart Preview" panel on the right side using the colors associated with the mapping set. For this tutorial, the "Const." checkbox of well "G0910034B" was the last checkbox selected. Note that well "G0910034B" can be quickly located by typing the name in the well filter input box. Figure 4-7 shows the chart preview for well "G0910034B". Note that although items from different rows are checked, the chart preview is only shown for the highlighted well.

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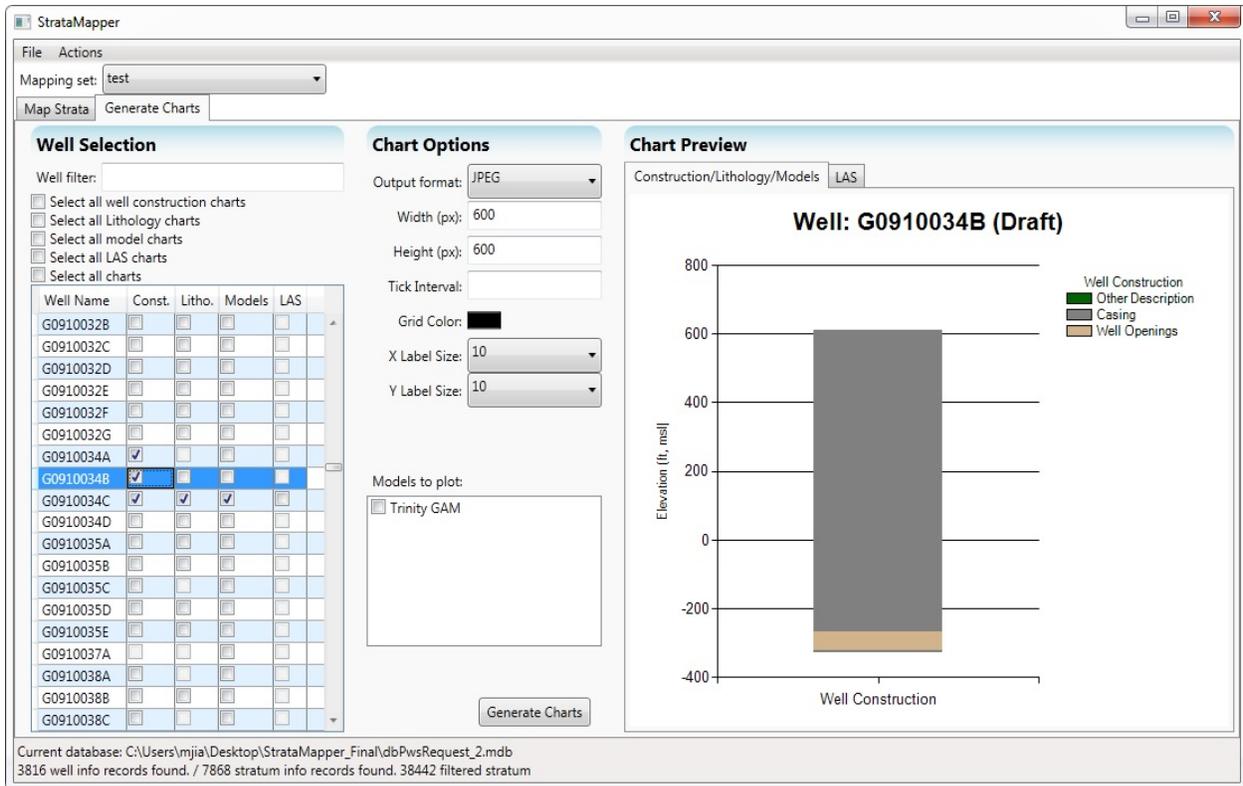


Figure 4-7 Preview of construction chart on well "G0910034B". Notice that well "G0910034A" and "G0910034C" also have items checked, but the preview only contains the highlighted well.

The TCEQ Database Tool provides the options to check multiple items for a well and to bring the items together into a single chart. To demonstrate the tool’s capability to combine multiple charts, all four items are selected for Well "G0910034C". After checking the four items, only two charts for the well lithology and construction are previewed. In order to view the model layer chart, a user will need to choose a model file listed in the "Models to plot" panel. Because the current project only has the a model file for the "Trinity GAM," this model file is selected and Figure 4-8 shows preview of the three well information types combined into a single chart. Because of the typically long lengths associated with geophysical logs, the LAS charts are created independently of the other well information. To preview the LAS chart, a user needs to click on "LAS" tab. Figure 4-9 shows a preview of the LAS chart for Well "G0910034C".

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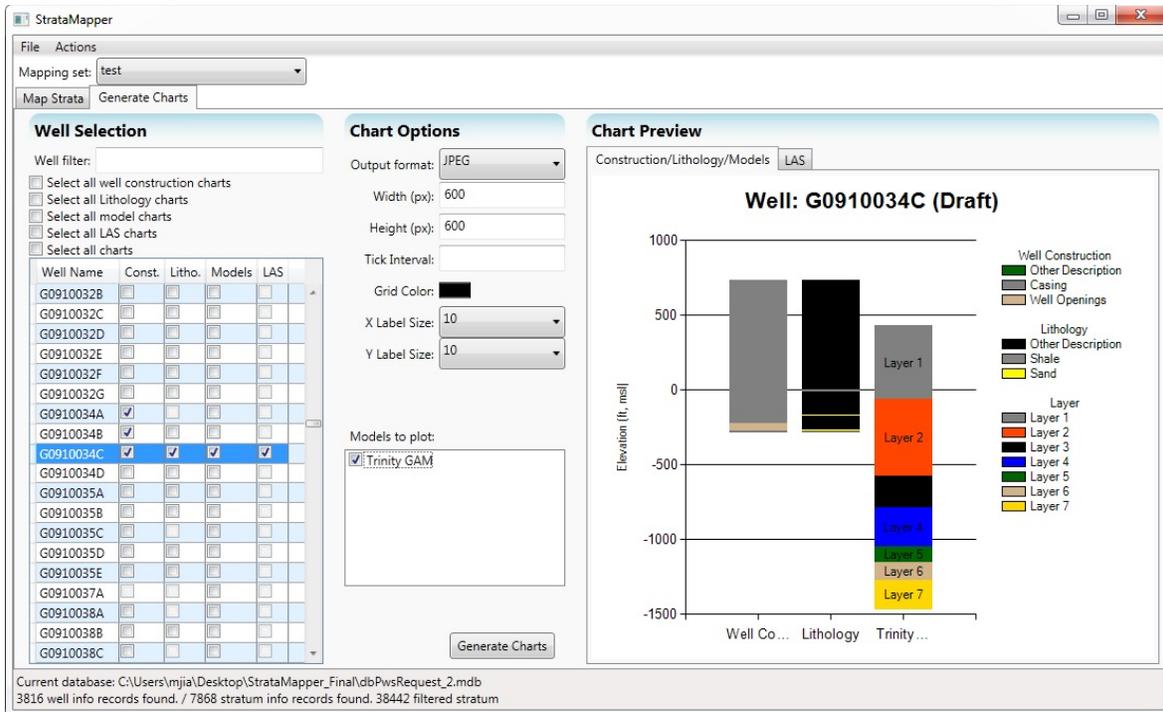


Figure 4-8 Preview of construction, lithology and model of well "G0910034C ". Note that the "Sand" and "Shale" strata groups we specified before are used in the chart.

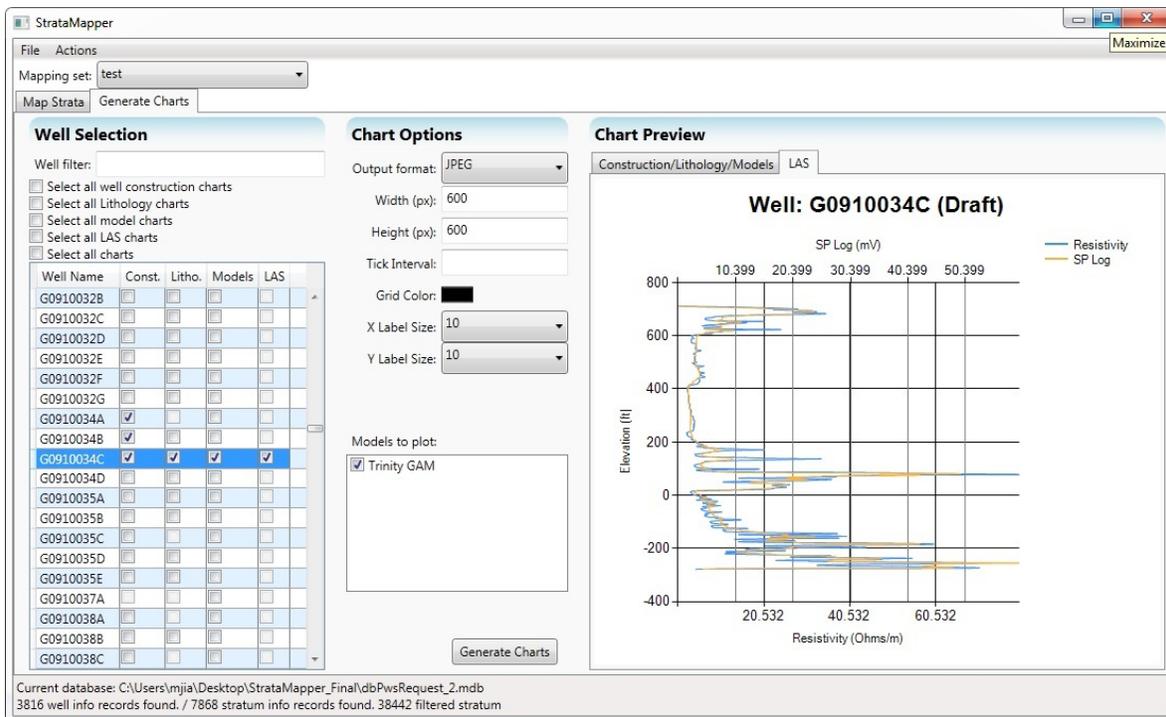


Figure 4-9 Geophysical log chart preview.

4.1.4 Generate Charts

After selecting the charts of interest, a user can click the "Generate Charts" button Tab (next to the Map Strata Tab) to generate and save the charts for visualizing with the Well Information Tool. After the "Generate Chart" button has been clicked, a user will be prompted to select a directory for the images of the charts. Once a chart has been generated, the chart will be stored under a subdirectory named after the mapping set and will be named according to the well name and its content. The naming schema for a chart is:

- "WellName_00m": if the chart contains only model information.
- "WellName_0s0": if the chart contains only lithological information.
- "WellName_c00": if the chart contains only construction information.
- "WellName_cs0": if the chart contains construction and lithological information.
- "WellName_0sm": if the chart contains lithological and model information.
- "WellName_c0m": if the chart contains construction and model information.
- "WellName_csm": if the chart contains all the three data types.
- "WellName_000_LAS": if the chart is a geophysical log chart.
- "WellName.txt" – ASCII file of plotted well information

4.1.4.1 Generate Charts for Well Constructions

A user can generate well construction charts for all wells at once by checking "Select all well construction charts" checkbox on the top of well list. All the construction items that are not grayed out will be selected. Then by clicking the "Generate Charts" button as shown in Figure 4-10, all the construction charts will be exported to the selected directory named using the convention "WellName_c00". Prior to generating the charts, a user can specify the output image format parameters by changing them in the "Chart Options" panel in the upper middle of Figure 4-10.

4.1.4.2 Generate Charts for Well Lithology

Similar to the generation of well construction, a user can click on the "Select all Lithology charts" checkbox shown in Figure 4-11 and export all the lithology charts to a specified folder. All the images will be named as "WellName_0s0".

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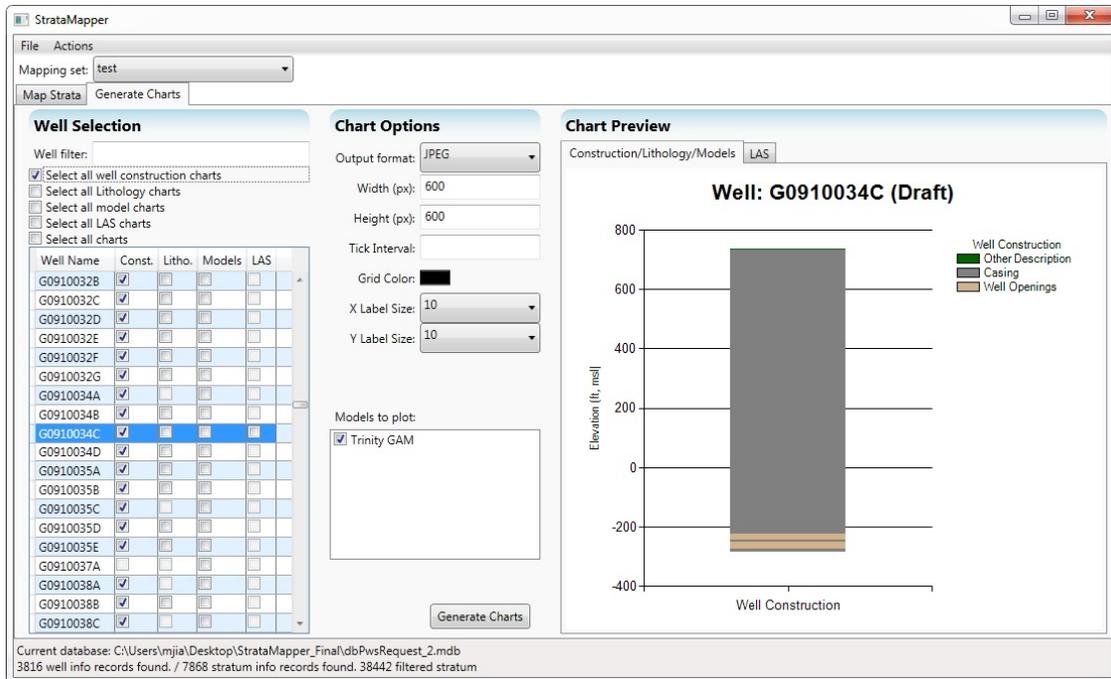


Figure 4-10 Export well construction charts in batch mode.

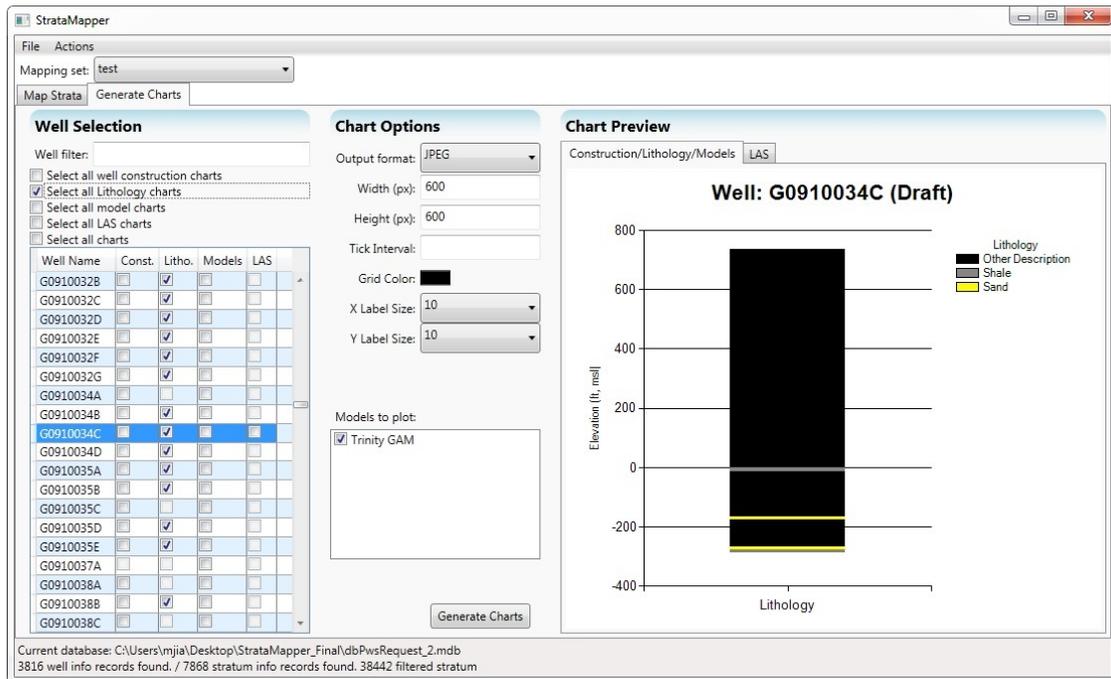


Figure 4-11 Export well lithology charts in batch mode.

4.1.5.3 Generate Charts for Model Layers

Similar to the generation of well construction, a user can click on the "Select all model charts" checkbox and export all the lithology charts to a specified folder. Prior to clicking on the

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“Generate Charts” button, a user needs to select a model file in the "Models to plot" list, otherwise the generated charts will be blank. All the images will be named as "WellName_00m".

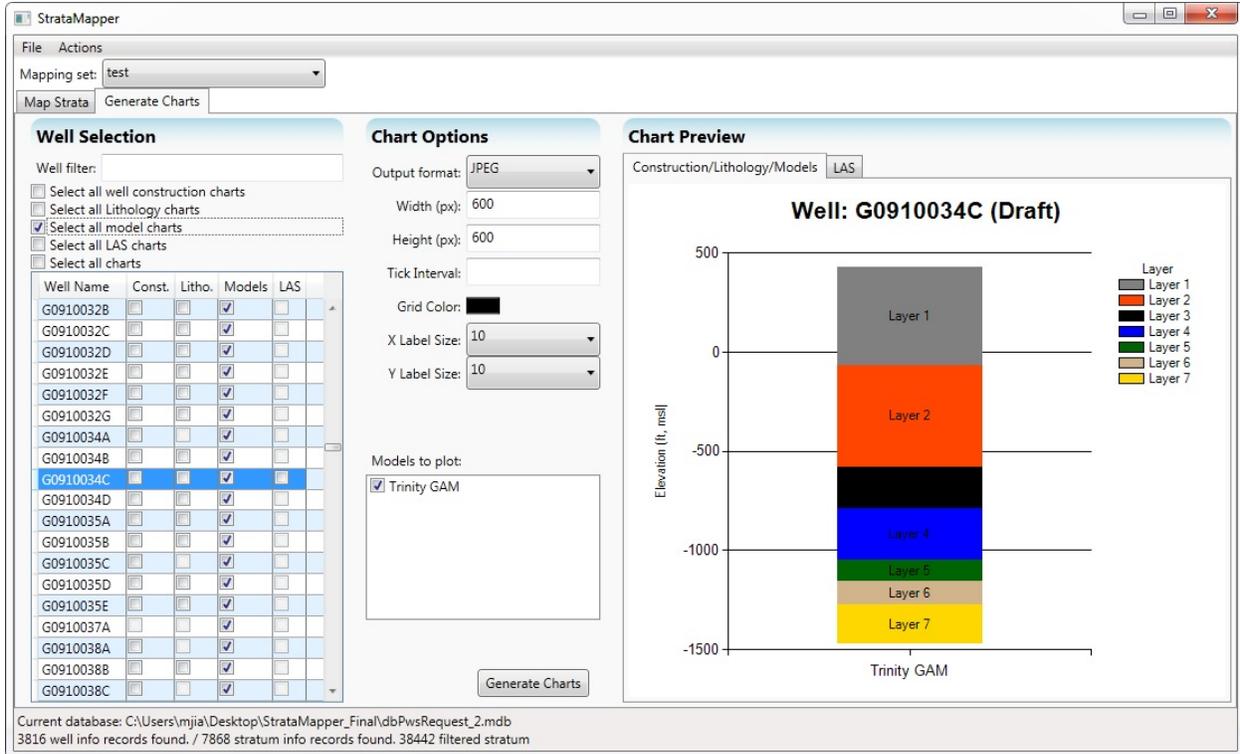


Figure 4-12 Export well model charts in batch mode.

4.1.5.4 Generate Charts for Geophysical Logs

A user can generate LAS charts by checking "Select all LAS charts" and then the “Generate Charts” button. Currently there are only about 50 wells that have the geophysical log information. The exported charts will be named as "WellName_000_LAS".

4.1.5.5 Generate Charts with Multiple Information Types in Batch Mode

The only difference between generation of charts with a single information type and multiple information types is the selection of more boxes on the top of the well list. For example, a user can check "Select all model charts" and "Select all Lithology charts" and export them. If only one information type is available, the exported chart will contain only that type. As noted before, only construction, lithology and model information can be combined in one chart, so the LAS chart will always be plotted separately from other well information.

4.2 Aquifer Test Data Tool

The Aquifer Test Data Tool provides for a quick preview of water level measurements from an aquifer test. The tool provides the capability to calculate drawdown from the water level measurements and to generate charts of changes in water level and of drawdown over time.

For many of the aquifer tests the aquifer response is not reported as a water elevation above mean sea level. Rather the aquifer response is reported in measurements such as depth, feet of water, or pressure head. The measurement unit of depth is likely from ground surface or top of casing but often the reference datum for the depth measurement is not provided. Similarly, “feet of water” or “pressure” likely represents the “feet of water” or “pressure” above a transducer but the location of the transducer is not provided. For aquifer test data, where water level change is not reported in units of elevation, a user should review the aquifer test document and determine how best to convert the measurements into an elevation if a true water elevation is desired.

A drawdown chart plots the changes in the measured water levels over time. The tool plots drawdown as a function of elapsed time. The tool calculates drawdown relative to the water level at the start of the aquifer test and calculates elapsed time relative to the start of the aquifer test. The tool provides a user with the option of selecting the start of the aquifer test.

The tool is activated by double clicking the application Aquifer Test Data Tool located in the directory software\Aquifer Test Data Tool. Figure 4-13 shows the tool’s user interface prior to a well selection. Upon opening the tool, a user should specify the directory (the default directory is software\Aquifer Test Tool) containing the aquifer test data files. These files include the information (INF) and aquifer test data (ATD) text files, which are discussed in Appendix L and Section 2.4.1. As shown in Figure 4-13, wells with aquifer test data will be listed on the right side. After a user selects a well, the tool will populate the gray boxes listed in the “Selected Well Information” and the “Chart Options” sections as shown in Figure 4-14. In Figures 4-13 and 4-14, a user can only enter values for the white boxes. The gray boxes are locked and are automatically populated by the tool using information from the INF and the ATD files.

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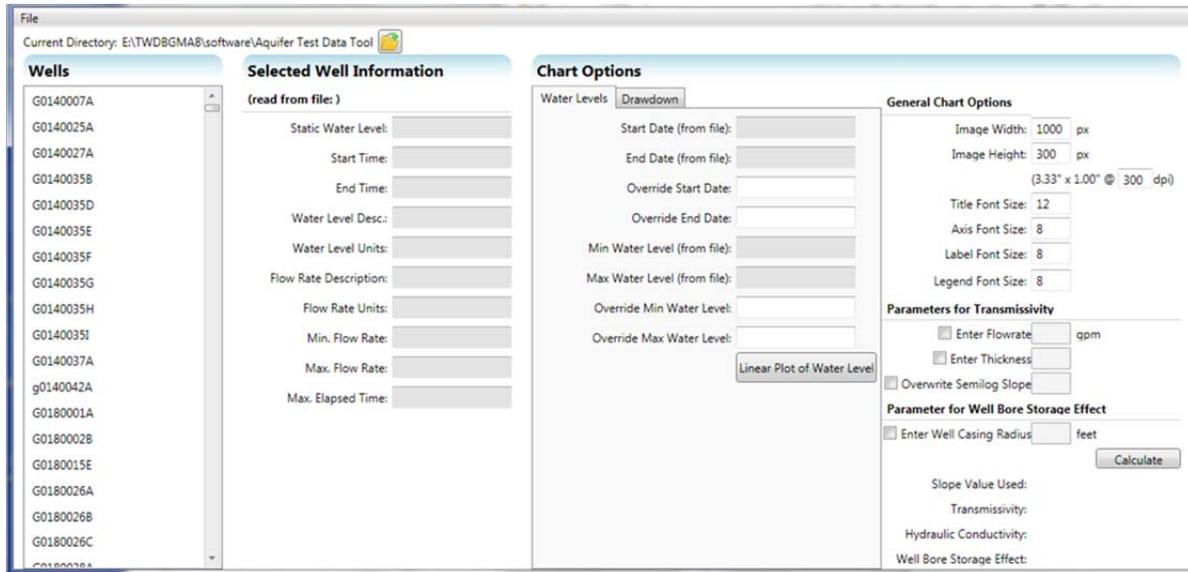


Figure 4-13 Aquifer Test Tool user interface prior to a well selection. (The path shown in the red rectangle designates the location of the aquifer test data files).

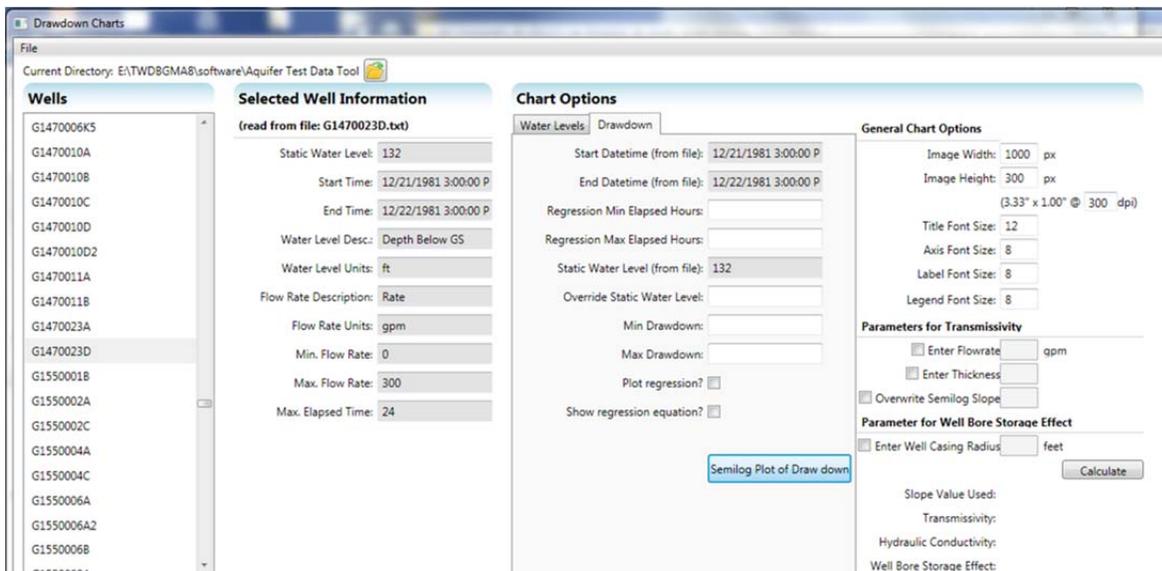


Figure 4-14 Aquifer Test Tool user interface after a well selection.

4.2.1 Generate a Water Level Chart

After the aquifer test data has been uploaded into the Aquifer Test Data Tool, a user can generate a water level chart by clicking the “Linear Plot of Water Level” button located on the “Water Level” tab shown in Figure 4-14. Figure 4-15 shows a water level chart generated for well “G1550020E”, for which the water levels are measured as “ft of water.” Figure 4-16 shows a water level chart for well "G1470023D", for which water level are measured as a “depth to

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water”. For all water level charts, the x axis represents time (expressed as a date) and the y axis represents a measurement of the water level.

In order to plot a particular time period, a user can adjust the range for the chart axes by entering values in the white boxes in the “Chart Options” section of the user interface. As shown in Figure 4-14 the white boxes permit the user to enter values for the minimum and maximum values for the water levels (or other comparable measurement) on both chart axes. In addition, a user can adjust the chart format parameters such as font size and image width in the “General Chart Options” section. After a chart has been generated, the user can either save a chart image by clicking on the “Save Chart” button shown in Figure 4-15 or save an ASCII version (as a “txt” file) of the plotted data by clicking on the “Export Data” button. Both the image and the text file are created in the directory listed in the “Target Directory” box.

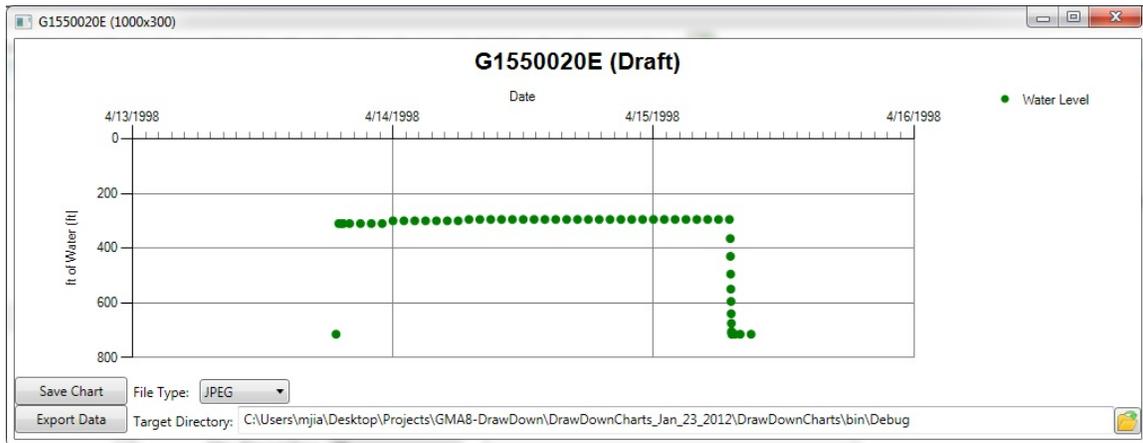


Figure 4-15 Water level chart for Well G1550020E for which water level were measured as an elevation.

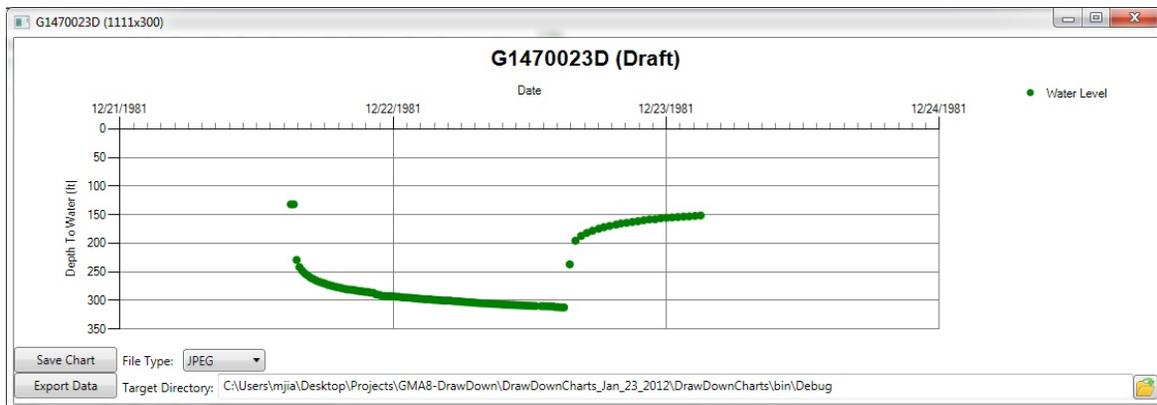


Figure 4-16 Water level chart for Well G1470023D for which water level were measured as a depth to water.

4.2.2 Generate a Drawdown Chart

After the aquifer test data has been uploaded into the Aquifer Test Data Tool, a user can plot drawdown by clicking the “Semilog Plot of Drawdown” button located on the “Drawdown” tab shown in Figure 4-17. The tool’s user interface allows the user to override default values for the starting date and time of the aquifer pump test and the range for the drawdown values.

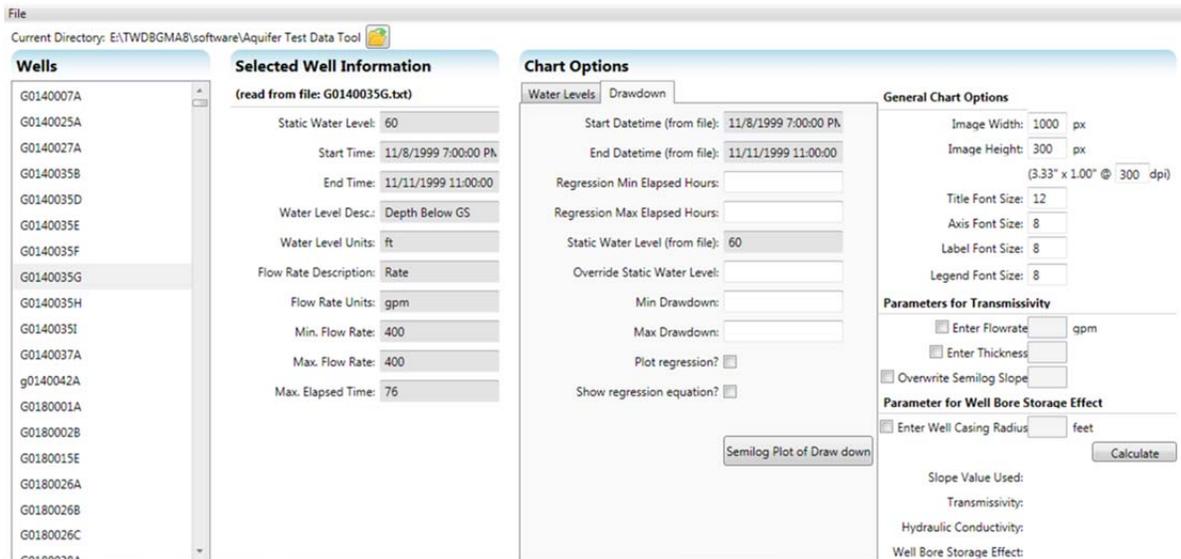


Figure 4-17 Aquifer Test Tool user interface showing options on the Drawdown Tab.

All drawdown charts are plotted on a semilog scale. The x axis is the logarithm (base 10) of elapsed days. The x axis is hard-coded to begin at 0.042 days (1 hour) and to end at 3 days (36 hours). The label for the y axis is either “Drawdown” or “Measurement Difference.” The “Drawdown” label is used when the water level is reported as elevation (feet msl). The “Measurement Difference” label is used when the water level change is measured in units other than elevation (feet, msl). For most cases, the units of “Measurement Difference” is typically feet. The user should note that the measurement unit for the water level affects the slope of the drawdown plot. For example, Figures 4-18 and 4-19 show drawdown charts for instances where the water level measurement was in “ft of water” and “depth”, respectively. In Figure 4-18 the slope of the best-fit line is negative whereas in Figure 4-19 the slope of the best-fit line is positive.

If a user clicks on the boxes for “Plot regression line” and “Show Line Regression,” the chart will be modified to show the results of both actions as shown in Figure 4-20. The regression is performed on the data because the slope from the fitted line can be used to calculate

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transmissivity using the Cooper-Jacob straight-line method (Cooper and Jacob, 1946). The regression line is developed using data points that occur between the minimum and maximum elapsed time in the white boxes shown on the Drawdown Tab in Figure 4-17. If the user enters no values for test boxes, the regression is developed using all of the data. To help demonstrate the regression line option, approximately fifty drawdown plots with fitted regressions are included in the directory \charts\Aquifer Test Charts.

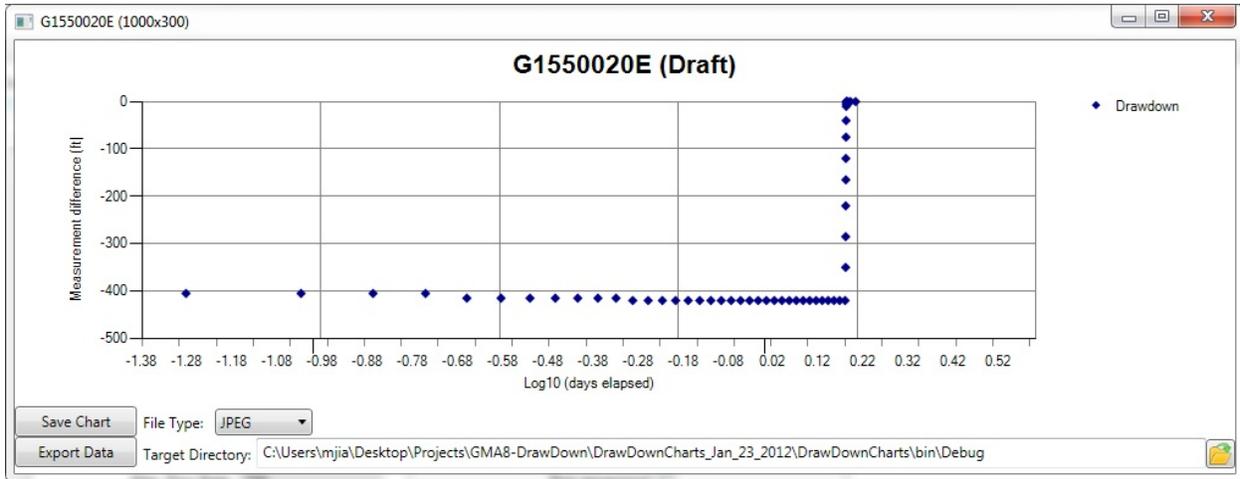


Figure 4-18 Semilog draw down chart for Well G1550020E for which water level were measured as an elevation.

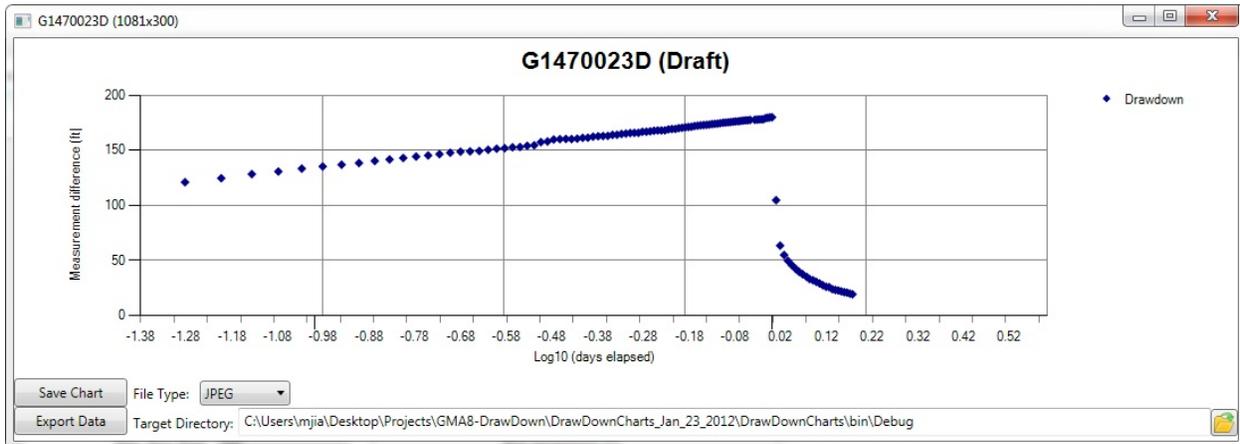


Figure 4-19 Semilog draw down chart for Well G1470023D for which water level were measured as a depth to water.

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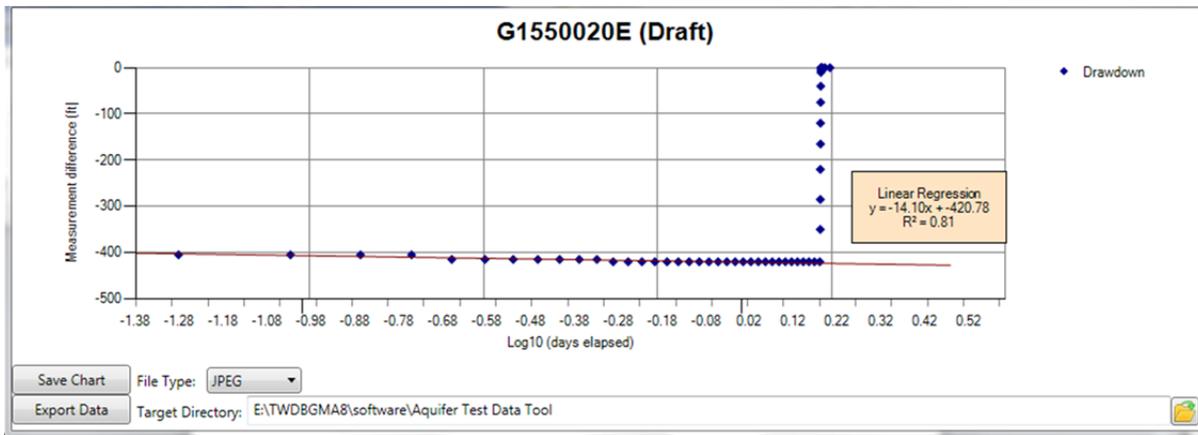


Figure 4-20 Semilog drawdown chart for Well G1550020E that includes a regression line and equation for the regression line.

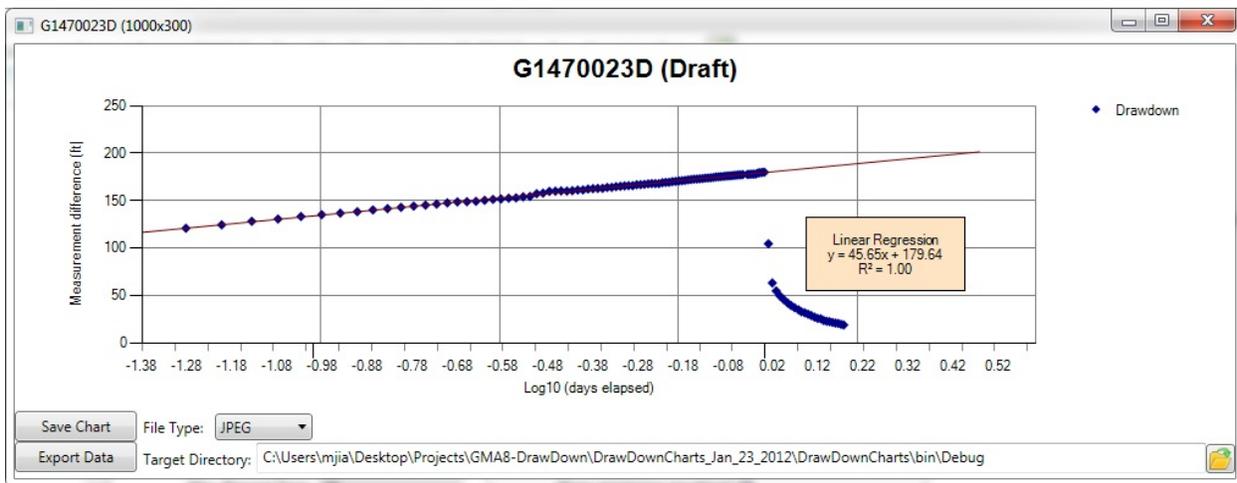


Figure 4-21 Semilog drawdown chart for Well G1470023D that includes a regression line and equation for the regression line.

4.2.3 Calculation of Transmissivity Using the CJSJL Method

The Aquifer Test Data Tool provides the option for calculating the transmissivity from the slope of the semilog plot of drawdown versus time using the Cooper-Jacob Straight-Line (CJSJL) method (Cooper and Jacob, 1946). This option was used to calculate a transmissivity of 624 ft²/day for G1550020E by populating the boxes on the right-hand side of the form under the title “Parameters for Transmissivity” and then clicking on the “Calculate” button. Figure 4-22 shows the parameter values used to calculate transmissivity of 624 ft²/day For this application, the pumping rate of 250 gpm is based on information in the PDF file G1550020E_ PTO.pdf in directory data\PDF\147\1470023\G1470023D and on pumping rate in the ADT file G1550020E_ATD.csv in directory software\Aquifer Test Data Tool. Both of these files indicate

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that the pumping test was performed at a constant pumping rate of 250 gpm. The thickness of the aquifer was set to the vertical interval of the well screen, which is 116 feet. The length of the well interval is calculated from the well construction information in PDF file G1550020E_DFD.pdf, which is shown in Figure 4-23 and is located in directory data\PDF\147\1470023\G1470023D. Figure 4-24 shows a chart of the well information created by the TCEQ Database Tool. Figure 4-24 shows that the well screen is located within a sandy deposit and immediately below a clayey deposit and that the well screen is below the base of the current Northern Trinity GAM.

In order to help evaluate whether well bore storage effects could be a concern, the option exists to calculate the minimum time required for these effects to dissipate based on the findings of Papadopulos and Cooper (1967). To perform this check, the value for the casing radius is entered in the appropriate box. The radius of 0.42 feet is obtained from the well construction information in Figure 4-23. Based on a radius of 0.42 feet, the required time for well bore storage effects to dissipate is 0.07 days, or 1.7 hours. Because the aquifer test data used to calculate the transmissivity occurred after 2 hours of pumping, the calculated transmissivity is determined not to be affected by well bore storage effects.

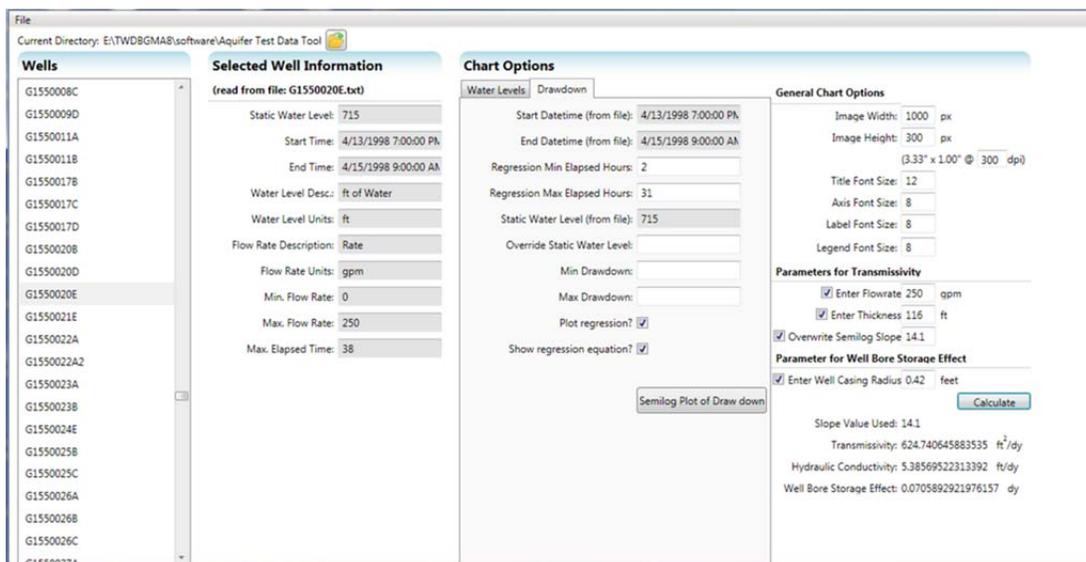


Figure 4-22 Calculation of transmissivity and well bore storage effects using the Aquifer Test Data Tool.

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G1550020E

Send original copy by certified mail to: TNRCC, P.O. Box 13087, Austin, TX 78711-3087 Please use black ink.

ATTENTION OWNER: Confidentiality Privilege Notice on Reverse Side		State of Texas WELL REPORT		Texas Water Well Drillers Advisory Council P.O. Box 13087 Austin, TX 78711-3087 512-239-0530	
1) OWNER <u>Chalk Bluff WSC</u> ADDRESS <u>P. O. Box 127 Elm Mott, TX 76640</u>					
2) ADDRESS OF WELL: County <u>McLennan</u> <u>2.5 Miles North FM 308 & 933</u> GRID # _____					
3) TYPE OF WORK (Check): <input checked="" type="checkbox"/> New Well <input type="checkbox"/> Deepening <input type="checkbox"/> Reconditioning <input type="checkbox"/> Plugging		4) PROPOSED USE (Check): <input type="checkbox"/> Industrial <input type="checkbox"/> Irrigation <input type="checkbox"/> Injection <input checked="" type="checkbox"/> Public Supply <input type="checkbox"/> De-watering <input type="checkbox"/> Testwell <input type="checkbox"/> If Public Supply well, were plans submitted to the TNRCC? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No		5) _____	
6) WELL LOG: Date Drilling: Started <u>3-1</u> to <u>98</u> Completed <u>5-14</u> to <u>98</u>		DIAMETER OF HOLE Dia. (In.) From (ft.) To (ft.) <u>20</u> Surface <u>12</u> <u>14 3/4</u> 0 <u>2149</u>		7) DRILLING METHOD (Check): <input type="checkbox"/> Open <input type="checkbox"/> Driven <input type="checkbox"/> Air Rotary <input checked="" type="checkbox"/> Mud Rotary <input type="checkbox"/> Bored <input type="checkbox"/> Air Hammer <input type="checkbox"/> Cable Tool <input type="checkbox"/> Jetted <input type="checkbox"/> Other _____	
8) Borehole Completion (Check): <input type="checkbox"/> Open Hole <input type="checkbox"/> Straight Wall <input type="checkbox"/> Underreamed <input type="checkbox"/> Gravel Packed <input checked="" type="checkbox"/> Other <u>Perforated</u> If Gravel Packed give interval ... from _____ ft. to _____ ft.		CASING, BLANK PIPE, AND WELL SCREEN DATA:			
9) CEMENTING DATA (Rule 338.44(1)) Cemented from <u>2000</u> ft. to <u>2130</u> ft. No. of sacks used <u>150</u> Method used <u>Circulated From Bottom</u> Cemented by <u>Pumpco</u> Distance to septic system field lines or other concentrated contamination <u>300</u> ft. Method of verification of above distance <u>Measured</u>		10) SURFACE COMPLETION <input type="checkbox"/> Specified Surface Slab Installed (Rule 338.44(2)(A)) <input type="checkbox"/> Specified Steel Sleeve Installed (Rule 338.44(2)(A)) <input type="checkbox"/> Pileless Adapter Used (Rule 338.44(3)(X)) <input checked="" type="checkbox"/> Approved Alternative Procedure Used (Rule 338.71)			
11) WATER LEVEL: Static level <u>715</u> ft. below land surface Date <u>5-14-98</u> Artesian flow _____ gpm. Date _____		12) PACKERS: Type _____ Depth _____			
13) TYPE PUMP: <input type="checkbox"/> Turbine <input type="checkbox"/> Jet <input checked="" type="checkbox"/> Submersible <input type="checkbox"/> Cylinder <input type="checkbox"/> Other _____ Depth to pump bowls, cylinder, jet, etc., <u>1225</u> ft.		14) WELL TESTS: Type test: <input checked="" type="checkbox"/> Pump <input type="checkbox"/> Baler <input type="checkbox"/> Jetted <input type="checkbox"/> Estimated Yield: <u>250</u> gpm with <u>295</u> ft. drawdown after <u>36</u> hrs.			
15) WATER QUALITY: Did you knowingly penetrate any strata which contained undesirable constituents? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No If yes, submit "REPORT OF UNDESIRABLE WATER" Type of water? _____ Depth of strata _____ Was a chemical analysis made? <input type="checkbox"/> Yes <input type="checkbox"/> No					
I hereby certify that this well was drilled by me (or under my supervision) and that each and all of the statements herein are true to the best of my knowledge and belief. I understand that failure to complete items 11 thru 15 will result in the log(s) being returned for completion and resubmittal.					
COMPANY NAME <u>Jimmy Jack Biffle</u> (Type or print)		WELL DRILLER'S LICENSE NO. <u>2741 WI</u>			
ADDRESS <u>P. O. Drawer 1</u> <u>Muenster</u> <u>Texas</u> <u>76252</u>					
(Signed) <u>[Signature]</u> (Licensed Well Driller)		(Signed) _____ (Registered Driller Trainee)			
Please attach electric log, chemical analysis, and other pertinent information, if available.					

TNRCC-0199 (Rev. 11-01-04) TNRCC COPY

Figure 4-23 PDF of the Driller's Formation Description Document for Well G1550020E.

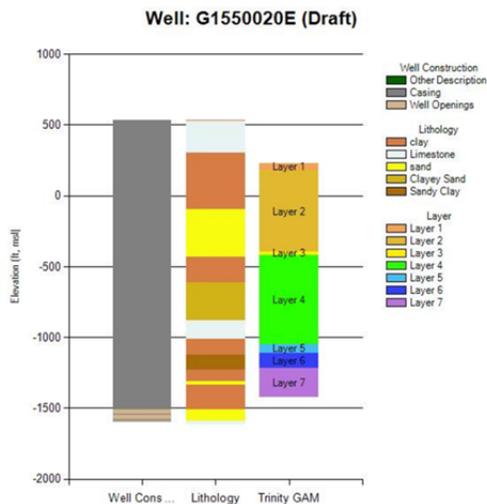


Figure 4-24 Chart of the well construction, lithology, and model layers for the Northern Trinity GAM for PWS Well G1550020E.

Final – Aquifer Test and Related Well Information for Public Water Supply Wells in
Groundwater Management Area 8

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5.0 References

- Bené, J., Harden, B., O'Rourke, D., and Donnelly, A., 2004, Northern Trinity/Woodbine Aquifer Groundwater Availability Model: Texas Water Development Board, GAM Report.
- Cooper, H.H., and Jacob, C.E., 1946, "A Generalized Graphical Method for Evaluating Formation Constants and Summarizing Well-Field History," Transactions of the American Geophysical Union, 217, pp. 626-634.
- Deeds, N.E., Yan, T., Singh, A., Jones, T., Kelley, V., Knox, P., and Young, S., 2010, Groundwater Availability Model for the Yegua-Jackson Aquifer, Texas Water Development Board, GAM Report.
- Papadopoulos, I.S., and Cooper, H.H., 1976, Drawdown in Well of Large Diameter: Water Resources Research, Vol 3, No. 1., pp 241-244.
- Young, S., and Kelley, V., 2006, A site conceptual model to support the development of a detailed groundwater model for Colorado, Wharton, and Matagorda counties, Lower Colorado River Authority LSWP Report, Austin, TX.
- Young, S., Kelley, V., Budge, T., Deeds, N., and Knox, P., 2009, Development of the LCRB Groundwater Flow Model for the Chicito and Evanageline Aquifers in Colorado, Wharton, and Matagorda Counties, Lower Colorado River Authority, Lower Colorado River Authority LSWP Report, Austin, TX.

Final – Aquifer Test and Related Well Information for Public Water Supply Wells in
Groundwater Management Area 8

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APPENDIX A
Project Installation Instructions
and Description of Project Files

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This appendix explains the installation of the project software and data.

Directory and File Structure of the Project Files

The project software and data is contained within a single folder on a hard drive submitted to the TWDB as part of the project’s final deliverable. This folder is called “TWDBGMA8.” The folder “TWDBGMA8” contains over 50,000 files that require approximately 10 GB of disk space. Figure A-1 shows the file structure for folder “TWDBGMA8.”

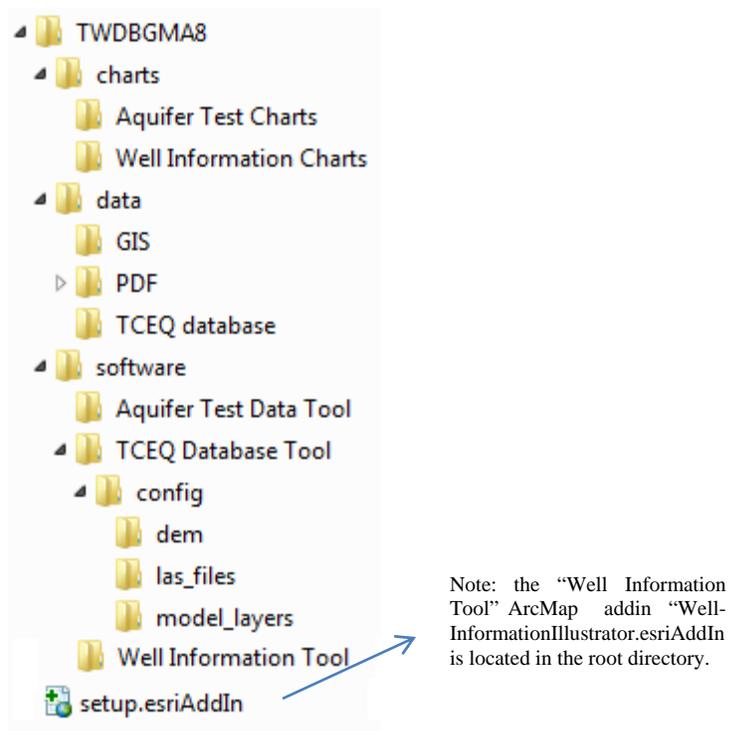


Figure A-1 File Structure Schema for the PDF Files

Step 1 of a Two-Step Project Installation: Copy Project Files onto Hard Drive

The installation of the project files requires two steps. The first step is the copy the entire directory structure and files in “TWDBGMA8” onto a computer hard drive. After a successful file structure, the hard driver should have the same file structure shown in Figure A-1. A critical aspect of using the project files is to make sure that ArcMap and the Project tools will find the location of the project data. To insure that the project files will be properly assessed, the user

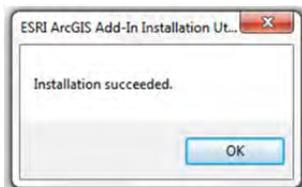
needs to check, and if appropriate change, the directory paths by using the Well Information Tool Configuration described in Appendix B.

Step 2 of a Two-Step Project Installation: Registering the Well Information Tool

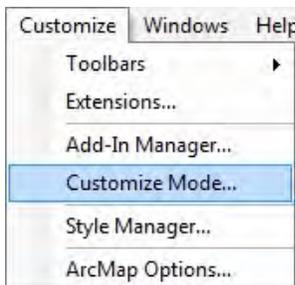
Being an add-in program for ArcMap, the Well Information Tool needs to be registered with the ArcMap software application prior to use. To install the tool, ArcMap 10 or higher will have to be on the user's computer. Also since the application is reading the Master Table (see Section 3.2), which is Microsoft Excel 2007 format, the user needs to have Microsoft Office 2007 or a later version of Microsoft Office installed on the computer.

The installation file of Well Information Tool is an executable file "setup.esriAddIn". The default file folder for the file "setup.AddIn" is the root directory "TWDBGMA8" (see Figure A-1). To install the program, a user needs to double-click on this executable file (setup.esriAddIn).

After a successful installation of the add-in program, a user will receive the following notice:



To integrate the installed add-in application into ArcMap, a user opens ArcMap application, and goes to the menu, go to "Customize" -> "Customize Mode".



In the pop out window, the user goes to the "Commands" tab, and then clicks "INTERA" in the category list on the left. (Note: a user may need to scroll down the list to find it the "INTERA")

category list). Then in the commands list on the right, the user needs to drag-and-drop all the commands onto the ArcMap tool bar as shown in Figure A-2.

After the successful completion of the above tasks, a user will be able to see the command buttons on the tool bar. By clicking on the command buttons, a user can invoke the functions supported by our solution.

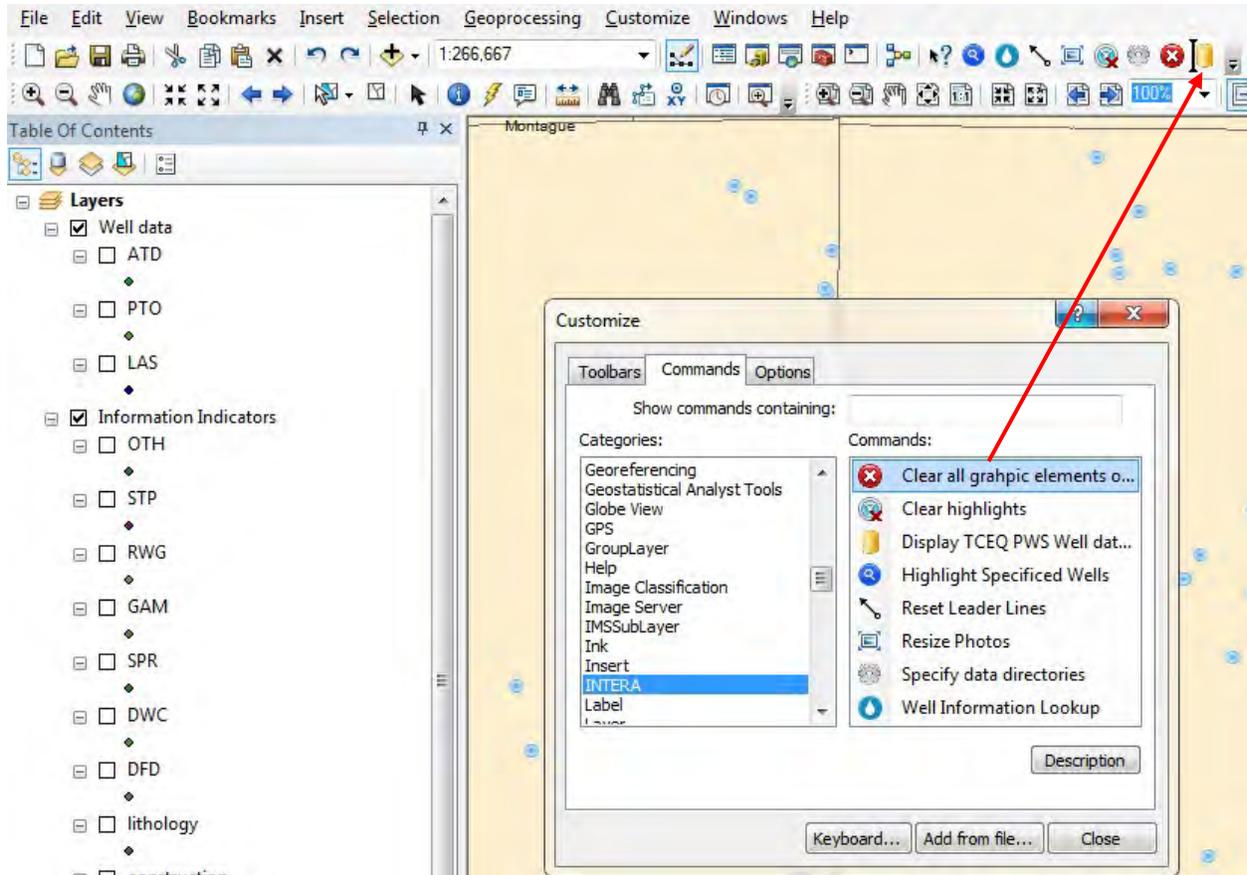


Figure A-2: File Selection of INTERA Tool Set Under the Command Button Tab

Location of Project Data Tools: Aquifer Test Data Tool and TCEQ Database Tool

The Aquifer Test Data Tool and TCEQ Database Tools are applications that are installed onto the computer during the copying of the project folder TWDBGMA8 onto a hard drive.

The application for the TCEQ Database Tool is called AquiferTestDataTool.exe and it is located in the directory "TWDBGMA8\software\Aquifer Test Data Tool". To active the tool, double click on the application file.

The application for the TCEQ Database Tool is called TCEQDatabaseTool.exe and it is located in the directory "TWDBGMA8\software\TCEQ Database Tool". To active the tool, double click on the application file. This application requires that Microsoft .NET 4.0 be installed on the computer before using the TCEQ Database Tool. If the .NET 4.0 software package is not installed on the computer, the installation of the Net 4.0 framework is implemented by doubling clicking on the installation file dotNetFx40Full_x86_x64.exe, which is located in the same directory as the tool (aka "TWDBGMA8\software\TCEQ Database Tool").

Location of Project Data Files

Table A-1 lists the directories that contain the project data and a ArcMap map document file linked to the geodatabase.

Table A-1 Location of Project Data

Directory Contained in Main Folder TWDBGMA8	Description of Data File(s) in this Directory
\Data\	Master file named GMA8.xls , which is an Excel file that describes what information has been collected on a PWS well
\Data\AquiferTestData\PDF	PDF files (*.pdf) of all scanned information documents
\Data\GIS	Geodatabase file named GMA8_Geodatabase.mdb, which contains numerous shape files, the TWDB Access database, and tables of the information contained aquifer test ATD and INF files
\Data\GIS	An ArcMap map document file called Wells.mxd that visualizes the feature classes, feature data sets and tables in the geodatabase file GMA8_Geodatabase.mdb.
\Charts\Aquifer Test Charts	Chart images (*.jpg) of aquifer test information created by the Aquifer Test Data Tool.
\Charts\Well Information Charts	Chart images (*.jpg) of well information (lithology, well construction, model layers, geophysical logs) created by the TCEQ Database Tool
\Software\TCEQ Database Tool	The application "TCEQ Test Data Tool.exe" for creating images well construction, lithology, model layers, and geophysical logs.
\Software\TCEQ Database Tool\config\las_files	Text files (*.LAS) of geophysical log information in LAS format (LAS files)
\Software\TCEQ Database Tool\config\Model_layers	Comma delimited text files (*.csv) that provide the model layer information
\Software\AquiferTest Data Tool	Comma delimited text files (csv) containing aquifer test data (the ATD Files). The application "Aquifer Test Data Tool.exe" for creating images of aquifer test information
\Software\AquiferTest Data Tool	Text files (*.txt) containing information about the aquifer test (the INF Files)

TCEQ PDF Files

As shown in Table A-1, all of the PDF files are stored in the folder called "TWDBGMA8/Data/AquiferTestData/PDF". Within this folder, the files are organized according to the naming schema described in Section 2.1. As shown in Figure A-3, under the PDF folder the TCEQ PDF files are first organized by the county code. Each county has a county designation number and the files belonging to a certain county will go under the corresponding county folder. Next, the files are further classified by Public Water Supply ID. If a well belongs to a Public Water Supply company, then all its related files will be located under the PWS folder. Finally, each well will have its own folder within which all of the wells PDF files are stored. When interacting with the Well Information Tool, the TCEQ PDF folder has to be known by the software and has to remain exactly the same structure as the above figure.

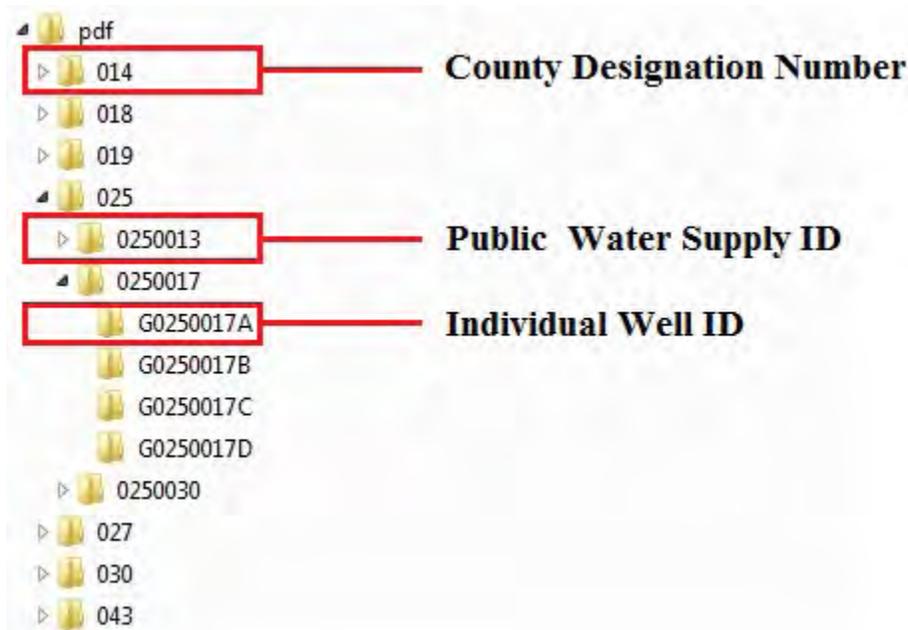


Figure A-3 File Structure Schema for the PDF Files

Aquifer Test Data and the Geodatabase

The Aquifer Test Data files are the digitalized version of scanned pumping test data files listed in the Master Table (see the PTO files in Table 3-1). The aquifer test data files consist of information about the pumping test (INF files) and the drawdown data collected during the aquifer tests (ATD files). The INF and ATD files, which are used by the Aquifer Test Tool are

stored in the directory TWDBGMA8/Software/AquiferTestData. The ATD files have a “csv” file extension and the INF files have a “txt” file extension.

To support review and/or analysis of the information contained in the ATD and the INF files without using the Aquifer Test Tool, the data and the ATD and the INF information is also included as tables in the geodatabase GMA8_Geodatabase.mdb. Within GMA8_Geodatabase.mdb, tables named tblInf and tblAtd contain the information in the INF and the ATD files, respectively. Table tblInf contains one record for each INF file. Table tblAtd contains one record for every drawdown entry in an ATD file. Thus, a ATD file with 48 measurements of drawdown will occupy 48 records in the Table tblAtd. Also included in Geodatabase.mdb are the tables tblLas and tblPath. Table tblPath lists the paths to the PDF files associated with each PWS wells. Table tblLas list the resistivity and spontaneous potential measurements for the PWS wells with LAS files.

APPENDIX B
Project Configuration Files

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This Appendix explains two configuration files that a user can use to set paths to working project files. These files are called; “ Well Information Tool Configuration File” and the “TCEQ Well Database Tool Configuration File.”

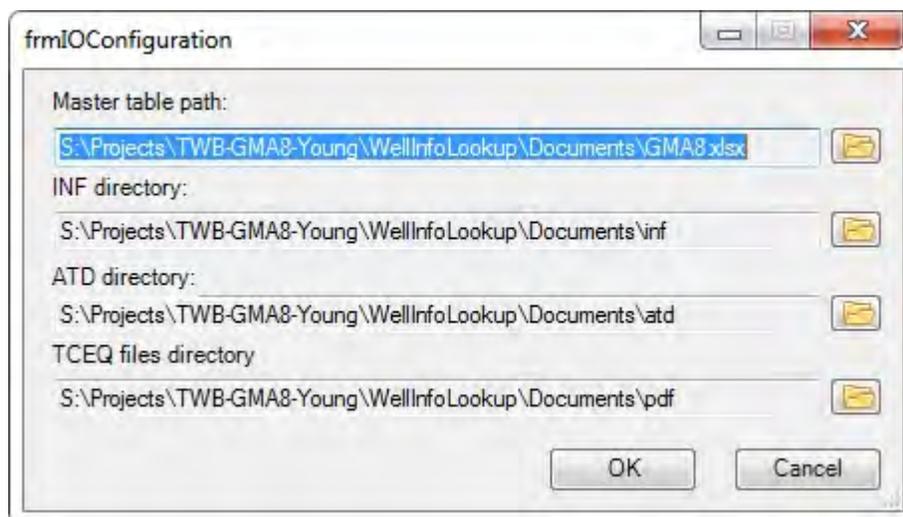
Well Information Tool Configuration

The Well Information Tool uses several data sources that may or may not reside in the same folder. A configuration file of the application stores the locations of the data sources. The first time the project software is used on a computer, the user needs to check to make sure that the configuration file has the proper locations of data sources for the project applications.

Four data sources must be specified correctly: 1) the master table file, 2) folder of INF data, 3) folder of ATD data and 4) folder of TCEQ PDF files.

To configure the data sources, you will need to use the "Configuration" tool from the Well Information Tool. You can find this tool along with other tools in "INTERA" category ("Customize" -> "Customize Mode" -> "Commands" -> "INTERA"). After importing the tool to ArcMap, you can begin the configuration process by clicking the  button.

In the pop up window, choose the paths for the four items.



The master table has to be a worksheet named "MasterTable" in a Microsoft Excel file. The INF and ATD files are in separate folders. Finally, the TCEQ PDF files will all be stored in one folder. After specifying each item, you can click "OK" button to finish the configuration.

A user can change the paths anytime when you moved the data to other hard drives or folders.

Users can also change the TCEQ Database path in the TCEQ Query Tool form and change the chart folders in the Well Information Lookup form.

TCEQ Database Tool Configuration

After installation, the default file folder for the file that lists the model layer elevation at each well location is "TWDBGMA8\software\TCEQ Database Tool\config\model_layers\".

The default dem file is "TWDBGMA8\software\TCEQ Database Tool\config\dem\pws_wells_gridtopelev_dem.csv".

The default file folder for the geophysical log files is "TWDBGMA8\software\TCEQ Database Tool\config\las_files\".

The locations of the three above items are recorded in the configuration file for the TCEQ Database Tool.

The default location for the configuration file is "TWDBGMA8\software\TCEQ Database Tool\config\app.ini". Within the configuration file, the above three items are recorded as relative paths under the following names:

- dem_files
- model_layer_files
- LAS_file_directories

The "dem_files" item specifies the location of the well dem files. By default, the file is under "dem" folder of the configuration folder. Since the path is relative in the file, the location is recorded as "dem\pws_wells_gridtopelev_dem.csv". It is not recommended for a user to change it.

The "model_layer_files" item specifies the location of the model layer files which are then used to generate model charts in TCEQ Database Tool. You can specify different model layer files in

this item by following the convention below:

model_file_foler\model_file_name: model name

By default, the model file for the TCEQ Database Tool is: "TWDBGMA8\software\TCEQ Database Tool\config\Trinity_gAM_pws_wells.csv". If you want to add another model file, it is recommended that you put the file in the "TWDBGMA8\software\TCEQ Database Tool\config\" folder so that you can write in the configuration file a new layer item:

model_layers\YOUR_MODEL_FILE_NAME: YOUR MODEL NAME

The model file should be a csv file that is similar to the Trinity_gAM_pws_wells.csv file (the default model layer file). The model name will appear in the chart generation tab in TCEQ Well Database Tool.

The "LAS_file_directories" item specifies the location of geophysical log files. By default, it locates at ""TWDBGMA8\software\TCEQ Database Tool\config\las_files". It is not recommended for a user the change the default value.

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APPENDIX C
Examples of Driller's Formation Descriptions
(DFD)

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(1985)
LAYNE WESTERN COMPANY, INC.
 DALLAS
WELL LOG

REPORT NO. **0570048 J**
 B. O.
 PAGE
 FILE NO.
 DATE 1/24/85

CUSTOMER LOCATION		WELL DATA	
City of Grand Prairie		NAME WELL	Matthew
Grand Prairie		WELL NO.	1
Dallas		ELEVATION	
STATE Tx.		DATUM	
FIELD		RT	C
LAND MARKS		TEST HOLE SIZE	12 1/4
Matthew Road		TD	2055
		DATE STARTED DRILLING	1/13/85
		DATE FINISHED DRILLING	1/24/85
		DRILLER	J.A. Armstrong
		TYPE MUD	Gel
		ELECTRIC LOG	Gearhart
		TYPE	Micro-log
		SURVEY	TYPE
		OTHER	

TH TA	EACH STRATUM	DESCRIPTION FORMATION
4'		Black clay
10'		Yellow clay
7'		Clay
39'		Sand and gravel and clay
41'		Shale
14'		Sand and blue clay
5'		Hard shale
63'		Sand and blue clay
4'		Shale
44'		Sandy clay and shale
34'		Sand and blue clay
35'		Shale
80'		Shale and lignite
59'		Shale
20'		Hard clay
56'		Shale
18'		Blue clay
117'		Shale
350'		Shale and limestone
10'		Hard shale and limestone
20'		Sandy shale
159'		Shale and limestone
531'		Hard shale and limestone
12'		Limestone and shale and red clay
45'		Shale and sandstone
7'		Sand and limestone and shale
8'		Hard limestone and sandstone
5'		Shale and red clay
25'		Shale and blue clay
5'		Shale and red clay
5'		Blue and red clay
15'		Limestone and shale and blue clay
13'		Red shale and limestone and blue shale
57'		Limestone and blue shale
18'		Sand, limestone and blue shale
77'		Sand and limestone and blue shale

*Twilio well #
3224908*

Figure C-1 First Example (G0570058J) of a Driller's Formation Description.

LAYNE WESTERN COMPANY, INC.

DALLAS

MATERIAL SETTING

REPORT NO. **0570048**
 PAGE OF
 FILE NO.
 DATE

CUSTOMER LOCATION		WELL DATA	
City of Grand Prairie		NAME WELL	Matthew
Grand Prairie, Tx.		ELEVATION	
FIELD		DATUM	
Dallas		STATE	Tx.
LAND MARKS		TYPE WELL	Gravel Wall
Matthew Road		SURFACE CASING CEMENTED	1884' NO. SACKS
		SIZE HOLE UNDERREAMED	24" DEPTH
		GRAVEL TYPE	Brady 8-16 NO. CU. YDS.
		TYPE SCREEN	SS W.W. GAGE .035
		DRILLER	J.A. ARMSTRONG
		OTHER	

TH	LENGTH	SIZE, KIND, WEIGHT MATERIAL	SKETCH
	1886'	16" O.D. (.375 Wall) Black Steel Casing 62.58 lbs./ft. API-5LB	PAGE 2
	100'	10 3/4" O.D. (.365 Wall) Black Steel Blank Liner 40.48 lbs./ft. API-5LB	
	4'	10" X 8" Reducer	
	120'	8 5/8" O.D. Stainless Steel Wire Wrapped "Stancliff" Rib Screen (.035 gauge)	
	50'	8 5/8" O.D. (.322 Wall) Black Steel Liner 28.55 lbs./ft.	
	2'	Bottom Assembly, including Wash Plug and Back Pressure Valve	

Figure C-1 First Example (G0570048J) of a Driller's Formation Description. (con't)

(1972) 0570050
LAYNE TEXAS COMPANY,
 HOUSTON -:- DALLAS

REPORT NO. 8892
 S. O. 1204-1947
 PAGE 1 of 1
 FILE NO. 3603
 DATE 8/2/72

WELL LOG

CUSTOMER LOCATION		WELL DATA	
FOR	Whalen Corporation	NAME WELL	Nursery WELL NO. 3
LOCATION WELL	Irving	ELEVATION	DATUM
SURVEY	FIELD	RT	C
COUNTY	Dallas	STATE	Texas
OTHER LAND MARKS	Nursery	TEST HOLE SIZE	9-5/8" TD 2250'
		DATE STARTED DRILLING	6-19-72
		DATE FINISHED DRILLING	7- 7-72
		DRILLER	Heffernan RIG NO. 3
		TYPE MUD	Gel NO. SACKS 50
		ELECTRIC LOG	Yes TYPE Schlumberger
		SURVEY	Eastman TYPE Single shot
		OTHER	Williams, Tesch

DEPTH STRATA	EACH STRATUM	DESCRIPTION FORMATION	SAMPLES		
			DEPTH	TYPE	NUMBER
0		Surface			
4	4	Top soil			
15	11	Clay			
26	11	Sandy clay			
277	251	Shale			
491	214	Sandy shale			
620	129	Shale			
704	84	Shale & lime streaks			
839	135	Shale & lime			
1147	308	Lime & shale streaks			
1275	128	Shale & lime streaks			
1337	62	Lime & shale streaks			
1655	318	Lime			
1726	71	Shale			
1828	102	Lime & streaks of shale			
1888	60	Shale			
1927	39	Sandy shale (red)			
1947	20	Sand			
1956	9	Black shale (hard)			
2084	128	Sand			
2121	37	Shale & sand streaks			
2147	26	Shale			
2167	20	Sand			
2180	13	Shale			
2210	30	Sand & streaks of shale			
2225	15	Hard shale			
2250	25	Sand & sandy shale			
Total depth 2250		ft.			

Figure C-2 Second Example (G0570050C) of a Driller's Formation Description.

SINGER LAYNE TEXAS DIVISION
HOUSTON -- DALLAS

WELL LOG

REPORT NO. **G-1090001C**
S. O. 1203-3506
PAGE 1 of 1
FILE NO. 3691
DATE 2-28-74

FOR City of Hillsboro		CUSTOMER LOCATION		WELL DATA 30-05-74	
LOCATION WELL	3 Mi. W. of Hillsboro & 1 Mi. North of Hiway 22 on County Road	NAME WELL	Leslie	ELEVATION	WELL NO.
SURVEY	FIELD	DATE STARTED DRILLING	2-12-74	DATUM	
COUNTY	Hill STATE Texas	TEST HOLE SIZE	9-7/8" TD 1633'	DATE FINISHED DRILLING	2-15-74
OTHER LAND MARKS		DRILLER	Williams	RIG NO.	3
		TYPE MUD	Gel	NO. SACKS	70
		ELECTRIC LOG	Yes	TYPE	Schlumberger
		SURVEY	Eastman	TYPE	Single Shot
		OTHER	Benard - Wagoner		

DEPTH STRATA	EACH STRATUM	DESCRIPTION FORMATION	SAMPLES		
			DEPTH	TYPE	NUMBER
0		Surface			
202'	202'	Shale			
260'	58'	Shale & Sand Stks.			
267'	7'	Hard Shale & Rock Stks.			
341'	74'	Hard Shale			
444'	103'	Shale & Sand Stks.			
537'	93'	Shale & Rock			
605'	68'	Shale			
750'	145'	Shale & Lime Stks.			
774'	24'	Lime & Anhydrite Stks.			
840'	66'	Hard Shale			
920'	80'	Sand & Shale			
965'	45'	Shale			
1089'	124'	Lime & Shale			
1225'	136'	Hard Shale & Lime			
1245'	20'	Lime			
1287'	42'	Hard Shale & Anhydrite			
1363'	76'	Sandy Shale			
1610'	247'	Sand			
1633'	23'	Brown Shale & Lime			
T.D.	1633'				

37-103-802

Figure C-4 Third Example(G109001C) of a Driller's Formation Description.

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APPENDIX D
Examples of Driller's Well Construction
(DWC)

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TEXAS WATER WELLS

INC.



951 McCARTY DRIVE • HOUSTON, TEXAS 77029 • PHONE OR 2-7581

D

City of Grand Prairie
Water Well #19
Grand Prairie, Texas

April 1965

BETTING DATA

SET AND CEMENTED IN PLACE 30' of 26" O.D., .281" W.T., 1206'

of 18" O.D., .375" W.T. and 669' of 10-3/4" O.D., .365 W.T.

SCREEN AND BLANK LINER:

<u>FROM</u>	<u>TO</u>	<u>DESCRIPTION</u>
1820'	1880'	6-5/8" O.D., .312" W.T. Blank Liner
1880'	1950'	6-5/8", .030 Ga. S.S. Screen
1950'	1983'	6-5/8" .040 Ga. S.S. Screen
1983'	2039'	6-5/8" .050 Ga. S.S. Screen
2039'	2049'	6-5/8" Blank Liner with wood wash plug & back pressure valve.

MEMBER TEXAS WATER WELL DRILLING CONTRACTORS ASSOCIATION

Figure D-1 First Example of Driller's Well Construction.

MATERIAL RECORD OF
WELL #21 FOR CITY OF
GRAND PRAIRIE, TEXAS

APRIL 1966

<u>FROM</u>	<u>TO</u>	<u>AMOUNT</u>		<u>DESCRIPTION</u>
	40	40'	I	24" O.D. surface pipe set and cemented in place.
2.0	1203	1206'		16" O.D. casing equipped with centralizers spaced at 40 feet intervals, connected by swage nipple
203	1844	641'	II	10 3/4" O.D. casing equipped with centralizers spaced at 40 feet intervals, bottom of 10 3/4" casing equipped with guide shoe and cement float collar near bottom.
522	1844	322'		6 5/8" O.D. blank liner lapping inside 10 3/4" casing, blank liner equipped with centering guides.
844	1989	145'		6 5/8" O.D. stainless steel wire rib type screen equipped with centralizers located at 1886' depth, 1928' depth and 1970' depth.
889	2001	12'		6 5/8" O.D. blank liner equipped with back pressure valve and centralizer.

WELL 22

6

NOTE: All measurements adjusted to ground level from rotary 7 feet above ground level.

Well underreamed to 20" diameter from 1844' to 1991', total screen and blank liner level packed in place from bottom of well to within 5 feet of liner, using TCM's 12-113 selected and graded hard silicious gravel.

TEXAS WATER DEVELOPMENT BOARD
WELL #: 3309704

Figure D-2 Second Example of Driller's Well Construction.

(1947)

0570050

THE LAYNE TEXAS COMPANY, LTD.
HOUSTON :- DALLAS

REPORT NO. 8893
S. O. 1204-1947
PAGE 1 OF 1
FILE NO. 3603
DATE 9/28/72

MATERIAL SETTING

CUSTOMER LOCATION		WELL DATA	
FOR	Whalen Corporation	NAME WELL	Nursery
LOCATION WELL	Irving	WELL NO.	3
SURVEY		ELEVATION	
		DATUM	
COUNTY	Dallas	TYPE WELL	Gravel-wall
STATE	Texas	SURFACE CASING CEMENTED	Yes
OTHER LAND MARKS	Hurwitz Park	NO. SACKS	1080+35
		SIZE HOLE UNDERREAMED	24" DEPTH 2093-2250
		GRAVEL TYPE	112-113- NO. CU. YDS. 30
		TYPE SCREEN	105-131SS WW Barlug GAGE .040"
		DRILLER	Heffernan RIG NO. 3
		OTHER	Williams

DEPTH	LENGTH	SIZE. KIND. WEIGHT MATERIAL	SKETCH
+2'		16" O.D. surface casing 62.58#	
0		Surface	
1993.72'		Top of 8-5/8" O.D. liner	
2093'	2095'	16" O.D. surface casing 62.58#	
2101.65'	107.93'	8-5/8" O.D. blank liner 24.70#	
2124.85'	23.20'	8-5/8" O.D. S.S. W.W. Barlug screen .040" ga.	
2128.85'	4.00'	8-5/8" O.D. blank liner 24.70#	
2169.10'	40.25'	8-5/8" O.D. S.S. W.W. Barlug screen .040" ga.	
2173.10'	4.00'	8-5/8" O.D. blank liner 24.70#	
2214.00'	40.90'	8-5/8" O.D. S.S. W.W. Barlug screen .040" ga.	
2220.00'	6.00'	8-5/8" O.D. blank liner 24.70#	
2240.00'	20.00'	8-5/8" O.D. S.S. W.W. Barlug screen 24.70#	
2248.00'	8.00'	8-5/8" O.D. blank liner 24.70#	
2250.00'	2.00'	8-5/8" O.D. set nipple & back pressure valve	
Well open to 2246 ft. Gravel in lap at 2003 ft.			

Figure D-3 Third Example of Driller's Well Construction.

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APPENDIX E
Examples of Electric Resistivity and/or
Spontaneous Potential Logs
(SPR)

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(1670) 0570050

Schlumberger **INDUCTION - ELECTRICAL LOG**

FIELD or LOCATION WELL CITY OF IRVING NO. 3 COMPANY LAYNE TEXAS CO.	COMPANY <u>LAYNE TEXAS COMPANY</u> WELL <u>WHALEN CORP. - CITY OF IRVING NO. 3</u> FIELD <u>NURSERY ROAD WELL</u> COUNTY <u>DALLAS</u> STATE <u>TEXAS</u> LOCATION Sec. _____ Twp. _____ Rge. _____ Other Services: <u>NONE</u>	
Permanent Datum: <u>GROUND LEVEL</u> , Elev. _____ Log Measured From <u>GL</u> , _____ Ft. Above Perm. Datum Logging Measured From <u>GL</u>		Elev.: K.B. _____ D.F. _____ G.L. _____
Date <u>7-7-72</u> Run No. <u>ONE</u> Depth—Driller <u>2225</u> Depth—Logger <u>2225</u> Log Interval <u>2224</u> Log Interval <u>80</u> Logging—Driller @ @ @ @ Logging—Logger @ @ @ @ Pipe Size <u>9 7/8" - 2180; 7 7/8" - 2225</u> Pipe Fluid in Hole <u>FGM</u> Density Visc. <u>10.6 40</u> Fluid Loss <u>8.0 ml</u> Source of Sample <u>MUDPIT</u> @ Meas. Temp. <u>2.89 @ 94 °F</u> @ Meas. Temp. <u>2.60 @ 94 °F</u> @ Meas. Temp. <u>3.0 @ 94 °F</u> Source: R _m C C @ BHT <u>2.89 @ 94 °F</u> Time Since Circ. <u>2 HRS.</u> Max. Rec. Temp. <u>94 °F</u> Log Location <u>3868 GRM</u> Recorded By <u>CANNON</u> Checked By <u>MRS. PATTON</u>	Scale Changes Scale Up Hole _____ Scale Down Hole _____ Type Log _____ Depth _____ Equipment Data Tool Position _____ Tool Type _____ Run No. _____ °F _____ °F _____	

The well name, location and borehole reference data were furnished by the customer.

FOLD HERE

Figure E-1 First Example of Electric Resistivity and/or Spontaneous Potential Log (First Page).

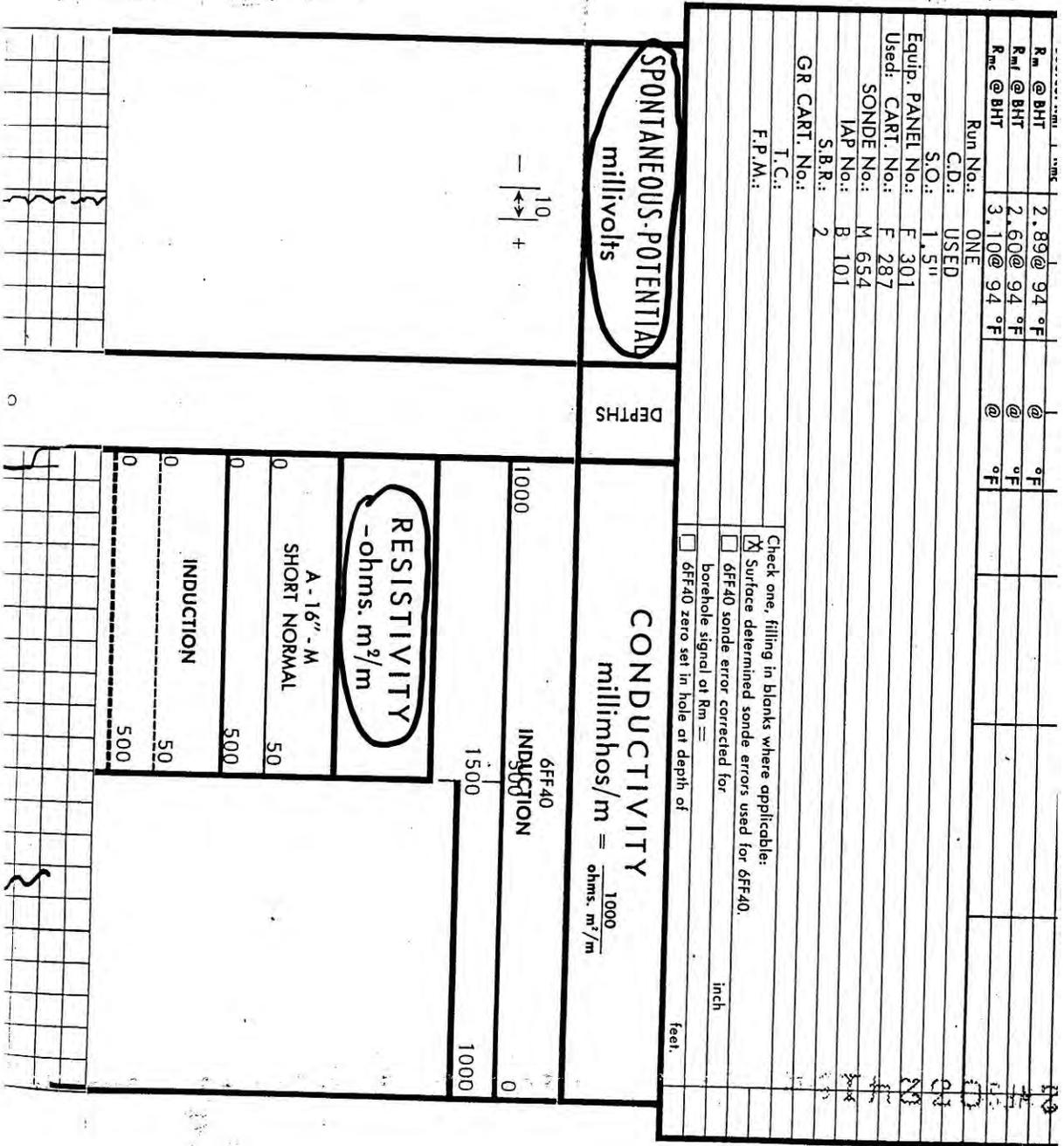


Figure E-2 First Example of Electric Resistivity and/or Spontaneous Potential Log (con't) (Second Page).

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APPENDIX F
Examples of Gamma and Gamma-Gamma Logs
(GMM)

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(2002)

G1090082B

Hayes Evaluation Logging & Perforating		GAMMA RAY DUAL INDUCTION	
CPNY <u>J. J. BIFFLE WATER</u> <u>WELL CO.</u> WELL <u>CITY HUBBARD TEST WEL</u> FIELD <u>HUBBARD</u> CO. <u>HILL</u> ST <u>TEXAS</u>	LOCATION <u>HUBBARD JCT 171 &</u> <u>31 .5 MILES SOUTH ON 171</u> <u>WEST SIDE RD</u> SEC. _____ TWP. _____ RGE. _____		OTHER SERVICES: <u>MICROLOG</u> <u>FORMATION TEST</u>
	PERMANENT DATUM <u>GROUND LEVEL</u> ELEV. _____ LOG MEASURED FROM <u>K. B. 7</u> ABOVE PERMANENT DATUM DRILLING MEASURED FROM <u>K. B.</u>		ELEV.: K.B. _____ D.F. _____ G.L. _____
DATE	<u>09-14-02</u>		
RUN NO.	<u>ONE</u>		
DEPTH-DRILLER	<u>3818</u>		
DEPTH-LOGGER	<u>3812</u>		
BTM. LOG INTER.			
TOP LOG INTER.			
CASING-DRILLER			
CASING-LOGGER			
BIT SIZE	<u>7.875</u>		
FLUID TYPE	<u>NATIVE</u>		
DENS. : VISC.	<u>9.4 @ 45</u>		
PH : FLUID LOSS			
SOURCE OF SAMPLE	<u>PIT</u>		
RM @ MEAS. TEMP.	<u>2.4 @ 76</u>		
RMF @ MEAS. TEMP.			
RMC @ MEAS. TEMP.			
SOURCE: RMF/RMC			
RM @ BHT			
TIME SINCE CIRC.	<u>3 HR</u>		
MAX. REC. TEMP.			
EQUIP.: LOCATION	<u>ARDMORE</u>		
RECORDED BY	<u>HAYES</u>		
WITNESSED BY	<u>BIFFLE H.</u>		

ALL INTERPRETATIONS ARE OPINIONS BASED ON INFERENCES FROM ELECTRICAL OR OTHER MEASUREMENT AND WE CANNOT AND DO NOT GUARANTEE THE ACCURACY OR CORRECTNESS OF ANY INTERPRETATION, AND WE SHALL NOT, EXCEPT IN THE CASE OF GROSS OR WILLFUL NEGLIGENCE ON OUR PART, BE LIABLE OR RESPONSIBLE FOR ANY LOSS, COSTS, DAMAGES, OR EXPENSES INCURRED OR SUSTAINED BY ANYONE RESULTING FROM ANY INTERPRETATION MADE BY ANY OF OUR OFFICERS, AGENTS OR EMPLOYEES. THESE INTERPRETATIONS ARE ALSO SUBJECT TO OUR GENERAL TERMS AND CONDITIONS SET OUT IN OUR CURRENT PRICE SCHEDULE.

Figure F-1 First Example of Gamma and Gamma-Gamma Log (First Page).

REMARKS:

THANKS DOUG HAYES, DAVID CLINE & SCOTT ALEXANDER

STOP DEPTH: 11.9 FEET	MAIN SECTION	FILE DATE: 09-14-2002
DIRECTION: UP 1:240		TIME: 14:11
FILE: BIFF3.PTS		PLOT DATE: 09-14-2002
		TIME: 14:43 U1.57

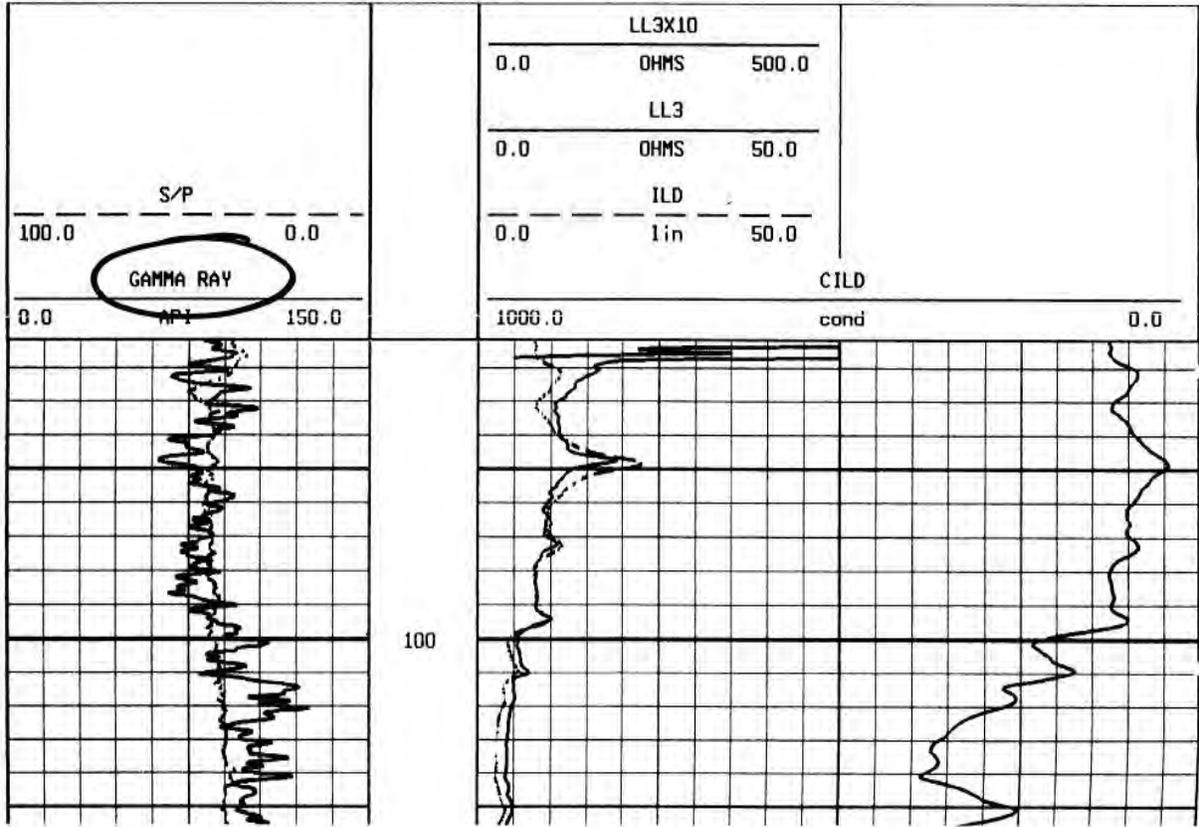


Figure F-2 First Example of Gamma and Gamma-Gamma Log (con't) (Second Page).

APPENDIX G
Examples of Pumping Test Information
(PTO)

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City of Grand Prairie
 Water Well No. 19 D

Date Started: May 4, 1965
 Orifice: 8" x 8"
 Airline: 800 feet

PUMPING TEST

<u>TIME</u>	<u>HEAD IN INCHES</u>	<u>PUMPING LEVEL</u>	<u>G.P.M.</u>
Start		601	
11:00 A.M.		601	
11:30	26	721	805
12:00 Noon	26	723	705
12:30 P.M.	25.5	725	798
1:00	25.5	728	798
1:30	25	726	791
2:00	25	728	791
2:30	25	727	791
3:00	24.5	726	784
3:30	24.5	727	784
4:00	24.5	728	784
4:30	24.5	728 95°F	784
5:00	24	728	776
5:30	23.5	727	768
6:00	24	728	776
6:30	24	728	776
7:00	24	728 slowed mtr.	776
7:30	23	727	760
8:00	22.5	728 95°F	752
8:30	23	727	760
9:00	23	726	760
9:30	22.5	726	752
10:00	22.5	726	752
10:30	22.5	726	752
11:00	22.5	726 slowed mtr.	752
11:30	20	720	708
12:00 Midnight	19.5	720	699

Figure G-1 First Example of Pumping Test Information (First Page).

<u>DATE</u>		<u>AIR LINE</u>	<u>PUMPING LEVEL</u>	<u>HEAD ON</u> <u>ORIFICE</u>	<u>G. P. M.</u>	<u>OPERATOR</u>	<u>REMARKS</u>
<u>H</u>	<u>R</u>	<u>GAGE</u>		<u>INCHES</u>			
1:00		62	837 1/2	38	759		
1:30		61	838 1/2	38	759		
2:00		61	838 1/2	38	759		
2:30		61	838 1/2	38	759		
3:00		61	838	37	754		
3:30		60	839	38	759		
4:00		60	839	38	759		
4:30		60	839	38	759		
5:00		59	840	38	759		
5:30		58	841	38	759		
6:00		58	841	37 1/2	754		
6:30	A.M	57	842	38	759		
7:00		56 1/2	843 1/2	38	759		
7:30		55 1/2	844 1/2	38 1/2	765		
8:00		55 1/2	844 1/2	38	759		
8:30		55 1/2	844 1/2	38+	759+		
9:00		55 1/2	844 1/2	38	759		
9:30		55 1/2	844 1/2	38	759		
10:00		55	845	38	759		
10:30		55	845	38	759		
11:00		54 1/2	845 1/2	38	759		
11:30		54 1/2	845 1/2	38	759		
NOON							
12:00		54 1/2	845 1/2	38	759		
12:30	P.M	54	846	38	759		
1:00		54	846	38	759		
1:30		54	846	38	759		
2:00		53 1/2	846 1/2	38	759		
2:30		53 1/2	846 1/2	38	759		
3:00		53 1/2	846 1/2	38	759		
3:30		53 1/2	846 1/2	38	759		
10-31-72							
4:00	P.M	53	847	38	759		
4:30		53	847	38	759		
5:00		53	847	38	759		Pump off at 5:00 P.M.
5:05		164	736				Recovery
5:10		159 1/2	740.5				
5:15		162 1/2	737.5				
5:20		165	735				
5:25		167	733				
5:30		169	731				
5:40		171	729				
5:50		173	727				
6:00		174	726				
6:15		176	724				

(CONTINUED)

Figure G-2 Second Example of Pumping Information (Second Page). Test

JIMMY JACK BIFFLE WATER WELL DRILLING

36 HR. PUMP TEST
CITY OF HUBBARD

DATE	TIME	GPM	FEET TO WATER
11/3/02	8:00 AM	0	440
	8:15 AM	700	525
	8:30 AM	650	580
	8:45 AM	620	580
	9:00 AM	600	600
	10:00 AM	600	600
	11:00 AM	600	600
	12:00 PM	600	600
	1:00 PM	600	600
	2:00 PM	600	600
	3:00 PM	600	600
	4:00 PM	600	600
	5:00 PM	600	600
	6:00 PM	600	600
	7:00 PM	600	600
	8:00 PM	600	600
	9:00 PM	600	600
	10:00 PM	600	600
	11:00 PM	600	600
	12:00 AM	600	600
	1:00 AM	600	600
	2:00 AM	600	600
	3:00 AM	600	600
	4:00 AM	600	600
5:00 AM	600	600	
6:00 AM	600	600	
11/4/02	7:00 AM	600	600
	8:00 AM	600	600
	9:00 AM	600	600
	10:00 AM	600	600
	11:00 AM	600	600
	12:00 PM	600	600
	1:00 PM	600	600
	2:00 PM	600	600
	3:00 PM	600	600
	4:00 PM	600	600
5:00 PM	600	600	
6:00 PM	600	600	
7:00 PM	600	600	
8:00 PM	600	600	
8:30 PM	0	525	
9:00 PM	0	460	
10:00 PM	0	440	

Figure G-3 Third Example of Pumping Test Information.

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APPENDIX H
Examples of PWS System Notes
(PSN)

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VI. SYSTEM FACILITIES

WELLS (YES) OR RAW WATER PUMPS (NO)

Entry Pt. #	Water Source Code	Owner's Desig.	Location	GPS Lat/Long	Oper. Status	Well Depth	Pump Type	Tested/Est. GPM/Date
004	A	13	214 NW 13th	N 32° 44' 32.97"; W 97° 01' 17.37"	O	2047	Subm	350
005	B	15	938 S Center	N 32° 44' 07.64"; W 97° 00' 15.22"	O	2067	Subm	350
006	C	16	2750 Graham	N 32° 45' 20.77"; W 96° 57' 48.26"	O	2163	Subm	350
007	D	19	634 NE 8th	N 32° 45' 16.53"; W 96° 59' 44.33"	O	2092	Subm	660
008	E	20	1802 Avenue A	N 32° 43' 13.68"; W 96° 59' 01.37"	O	2094	Subm	500
009	F	21	903 W Hunter Ferrell	N 32° 46' 37.78"; W 96° 59' 31.38"	O	2001	Subm	650
010	G	22	501 W Shady Grove	N 32° 48' 18.23"; W 96° 59' 56.98"	O	2094	Subm	650
011	H	23	1702 W Robinson	N 32° 43' 21.32"; W 97° 01' 15.23"	O	2062	Subm	800
012	I	24	2650 W Astar	N 32° 41' 58.97"; W 97° 03' 05.27"	O	1968	Subm	800
013	J	25	5210 Matthew Road	N 32° 38' 51.93"; W 97° 01' 43.87"	O	2040	Subm	800
014	K	26	5021 Red Oak	N 32° 38' 58.55"; W 97° 03' 18.81"	O	2048	Subm	800

STORAGE RESERVOIRS AND PRESSURE TANKS

Type	Capacity	Material	Location
GROUND	100,000	STEEL	WELL 13
GROUND	150,000	CONCRETE	WELL 15
GROUND	150,000	CONCRETE	WELL 16
GROUND	500,000	CONCRETE	WELL 20
GROUND	1,000,000	STEEL	WELL 25
GROUND	1,000,000	STEEL	WELL 26
GROUND	5,000,000	CONCRETE	PUMP STATION NO. 1
GROUND	8,000,000	CONCRETE	PUMP STATION NO. 1
ELEVATED	12,000,000	CONCRETE	STRAUS, CEDAR HILL
ELEVATED	1,000,000	STEEL	1826
ELEVATED	2,000,000	STEEL	2650 ASTAR
ELEVATED	500,000	STEEL	138 NE 14 TH STREET
ELEVATED	2,000,000	STEEL	2201 109 TH STREET

SERVICE PUMPS

No.	Output (GPM)	Location	No.	Output (GPM)	Location	No.	Output (GPM)	Location
1@	800/50	PUMP STATION NO. 1	1@	3,000/250	PUMP STATION NO. 1	2@	750/50	WELL 25
1@	2,000/125	PUMP STATION NO. 1	2@	5,000/350	PUMP STATION NO. 1	2@	800/50	WELL 20
2@	4,000/250	PUMP STATION NO. 1	1@	800/50	WELL 15	1@	800/50	WELL 16
1@	1,000/75	PUMP STATION NO. 1	2@	750/50	WELL 26	2@	800/50	WELL 13

Figure H-1 First Example of PWS System Notes.

(1992)

0570050

TEXAS WATER COMMISSION - PUBLIC WATER SUPPLY WATER SYSTEM DATA

CCN No. 12299 Map attached X Map Previously Submitted
ID No. 0570050 Community X Non-Community Superior X
Name of System IRVING, CITY OF County DALLAS District 4
Physical Address 132 N. BRIERY, IRVING, TEXAS
Responsible Official MR. ROY F. BROWN Title MAYOR Phone No. 214-721-2204
Mailing Address P. O. BOX 152288, IRVING, TEXAS Zip 75015-2288

Supplier and Source CITY OF DALLAS - LAKES GRAPEVINE AND LEWISVILLE -- 4 TRINITY WELLS FOR PEAK DEMAND-UP TO 10%
Retail Connections 36,493 Wholesale Connections -0- Meters 36,493 Population 159,009
Potential No. of Connections Minimum Rate \$5.00/3,000 GAL. Area Served CITY LIMITS OF IRVING

Manager/Supervisor MR. RON McCULLER Health Officer DALLAS COUNTY HEALTH DEPARTMENT
Name and Grade of Chief Certified Operator MR. RON McCULLER "A" No. of Certified Operators 27
Surveyed with MR. STEVE GUNTHER Other Officials Contacted
Date of Last Survey 10-06-89 Reason for this Survey ROUTINE

WELLS OR RAW WATER PUMPS 3296-332 Fps = 113
Table with columns: No., Type, Rated GPM, Tested GPM, Location, Well, Depth, Age, Status. Rows A-E.

Auxiliary Power YES Describe VARIOUS ELECTRICAL FEEDS AND PORTABLE GENERATOR

STORAGE RESERVOIRS AND PRESSURE TANKS

Table with columns: Type, Capacity, Material, Location. Rows for elevated and ground storage.

SERVICE PUMPS

Table with columns: No., Output (GPM/HP), Location. Includes note: 26 PUMPS @ 101,434 GPM LOCATED AT 4 WELL SITES AND 3 PUMP STATIONS

Auxiliary Power YES Describe VARIOUS ELECTRICAL FEEDS AND PORTABLE GENERATOR

Treatment Facilities CHLORINATION FOR GROUND PRODUCTION AND STANDBY FOR PRE-TREATED PURCHASED WATER

Total Well Water Pump Cap. 4,500 GPM Treatment Plant Capacity Purchase Agreement 54,200,000 GPD
Total Service Pump Capacity 101,434 GPM Range of Distribution System Pressures 52 psi to 90 psi
Total Elevated Storage 16,500,000 GAL. Pressure Tank Capacity -0- Ground Storage Capacity 37,600,000 GAL.
Average Daily Usage 29,534,000 GAL. Maximum Daily Usage 58,268,000 7-18-91 Peak Demand

Date of Survey AUGUST 28, 1992 By PAUL LITTLETON
Date of Approval 9/11/92 By [Signature]

Figure H-2 Second Example of PWS System Notes.

APPENDIX I
Examples of Raw Water Geochemistry
(RWG)

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(1952)

0570048

CHEMICAL WATER ANALYSIS REPORT

TEXAS STATE DEPARTMENT OF HEALTH LABORATORIES
1100 WEST 49TH STREET
AUSTIN 5, TEXAS

TOWN GRAND PRAIRIE
COUNTY DALLAS
OWNERSHIP OF SUPPLY CITY OF GRAND PRAIRIE
DATE COLLECTED FEBRUARY 22, 1964

USE PUBLIC FROM WELL
PHYSICAL APPEARANCE CLEAR DEPTH 2047
POINT OF COLLECTION WELLS AGE 17 YEARS
MARKS N.W. 13TH STREET NUMBER 13 A

CHEMICAL ANALYSIS
(VALUES REPORTED ARE FOR MINERALS IN SOLUTION)

LABORATORY NO. 51267W DATE RECEIVED 2/26/64 DATE REPORTED 2/28/64

	P. P. M.		P.P.M.
CALCIUM	3	CARBONATE	12
MAGNESIUM	1	BICARBONATE	495
IRON	0.04	SULPHATE	153
MANGANESE	0.1	CHLORIDE	74
SODIUM	313	FLUORIDE	2.2
		NITRATE	0.4

SPECIFIC CONDUCTANCE MICROMHOS/CM 1470

8.6	DISSOLVED RESIDUE (T.S.) CALCULATED	1050
	PHENOLPHTHALEIN ALKALINITY AS CaCO_3	10
	TOTAL ALKALINITY AS CaCO_3	426
	TOTAL HARDNESS AS CaCO_3	11

RECOMMENDED LIMITS FOR DRINKING WATER (P.P.M.) *from United States Public Health Service*

MAGNESIUM	125	FLUORIDE	1.5
IRON & MANGANESE	0.3	NITRATE	20
SULPHATE	250	TOTAL SOLIDS	1000
CHLORIDE	250		

Figure I-1 First Examples of Raw Water Geochemistry.

(1952) 0570048
SOUTHWESTERN LABORATORIES

FORT WORTH DALLAS HOUSTON

File No. 34

Dallas, TEXAS 5/22/52

J. L. Myers & Sons
 5306 Harry Hines Blvd.
 Dallas, Texas

Date Rec'd 5/20/52

Analysis on Water
 by You

Location Marks City of Grand Prairie Well #15

Parts per Million Grains per U. S. Gallon

Siliceous Residue	17.60	1.03
Iron & aluminum oxide	2.00	0.12
<u>IONS:</u>		
Calcium	3.14	0.18
Magnesium	Trace	Trace
Sodium	267.09	15.57
Carbonate	15.60	0.91
Bicarbonate	345.26	20.13
Sulphate	155.96	9.09
Chloride	83.00	4.84
Total	889.65	51.87

HYPOTHETICAL COMBINATION:

Calcium carbonate	7.84	0.46
Sodium carbonate	19.21	1.12
Sodium bicarbonate	475.42	27.72
Sodium sulphate	230.63	13.45
Sodium chloride	136.83	7.98

pH 8.7

D-73670

SOUTHWESTERN LABORATORIES

Per *D.P. Harper*

BOOSTER

CHLORINE

D. M. M. M. / F. W. L.

Figure I-2 Second Example of Raw Water Geochemistry.

(1972) 0570058
POPE Testing LABORATORIES, Inc.

CONSULTING ANALYTICAL CHEMISTS
 AND TESTING ENGINEERS

P. O. BOX 903
 DALLAS, TEXAS 75221

FOODS, FEEDS, DAIRY PROD.
 WATER, MISCL. ANALYSES
 COTTON SEED PRODUCTS
 SEED GERMINATION
 PACKING HOUSE PRODUCTS

OFFICIAL CHEMISTS
 WEIGHERS AND INSPECTORS
 NATL. COTTONSEED PRODUCTS ASS'N.
 NATL. SOYBEAN PROCESSOR'S ASS'N.
 REFEREE CHEMISTS
 AMERICAN OIL CHEMISTS SOCIETY

Date Rec'd 11-3-72

To: Layne Texas Company
 Dallas, Texas

Report of Tests on Water

Received From: You

Identification Marks: Trinity Well Nursery Rd. City of Irving

Values reported are for minerals in solution

	Parts Per Million
Calcium.....	5.6
Magnesium.....	2.4
Iron.....	0.09
Manganese.....	0.0
Sodium.....	368.0
Carbonate.....	9.6
Bicarbonate.....	495.3
Sulphate.....	255.0
Chloride.....	97.0
Fluoride.....	1.5
Nitrate.....	0.0
Phenolphthalein Alkalinity as CaCO ₃	8.0
Total Alkalinity as CaCO ₃	422.0
Total Hardness as CaCO ₃	24.0
Dissolved Residue (TS) Calculated.....	1234.5
Specific Conductance Micromhos/cm.....	1320
pH.....	8.1

RECOMMENDED LIMITS FOR DRINKING WATER (P. P. M.)

Iron	0.3	Fluoride	0.6—1.0
Manganese	0.05	Nitrate	45
Sulphate	250	Total Solids	500
Chloride	250		

cc:C.D. Amy - Houston, Tex. POPE TESTING LABORATORIES, Inc.

Lab. No. 70476

By *R C Pope*



F-158-1M-6-72

Figure I-3 Third Example of Raw Water Geochemistry.



P.O. BOX 356 • WEST, TEXAS 76691-0356 • (254) 829-8001
 FAX (254) 829-8013

PROJECT NAME: THE WALLACE GROUP
CITY OF HUBBARD – REVERSE OSMOSIS PLANT
 SAMPLE ID: 200.3
 COLLECTION POINT: RAW WELL
 MATRIX: AQUEOUS
 SPECIAL NOTES: ANALYSIS REORDER EVENT

DATE RECEIVED: 01/08/03
 DATE REPORTED: 01/29/03
 REPORT NUMBER: 0011-01

LABORATORY REPORT
TOTAL METALS

Parameters	EPA Method	Detection Limit mg/L	Results mg/L	Analyst	Date Analyzed
Barium	200.7	0.01	0.07	DKB	01/13/03
Calcium	200.7	0.20	6.03	DKB	01/14/03
Iron	200.7	0.10	1.47	DKB	01/13/03
Manganese	200.7	0.10	<0.10	DKB	01/13/03
Magnesium	200.7	0.20	0.67	DKB	01/14/03
Potassium	200.7	0.20	4.35	DKB	01/14/03
Sodium	200.7	2.00	491	DKB	01/14/03
Strontium	200.7	0.02	0.40	DKB	01/13/03

WET CHEMISTRY

PARAMETERS	EPA METHOD	DETECTION LIMIT mg/L	RESULTS mg/L	ANA-LYST	DATE ANALYZED
Alkalinity, Total as CaCO3	310.1	---	454	DKB	01/15/03
Alkalinity, Phenolphthalein as CaCO3	310.1	---	4.00	DKB	01/15/03
Ammonia-N	350.3	0.10	0.63	RMP	01/15/03
Ammonia (NH3)	350.3	0.10	0.77	RMP	01/15/03
Bicarbonate	310.1	1.00	482	NS	01/15/03
Carbonate	310.1	10.0	27.2	NS	01/15/03
Chloride	325.3	0.10	210	GDB	01/15/03
Fluoride	340.2	0.10	4.40	GDB	01/15/03
Nitrate-N	352.1	0.10	<0.10	GDB	01/15/03
Nitrate (NO3)	352.1	0.10	<0.10	GDB	01/15/03
Silica, Reactive	370.1	0.20	33.4	DKB	01/13/03
Sulfate	375.2	1.00	240	GDB	01/15/03
TDS	160.1	10.0	1204	GDB	01/23/03


 Niranjana
 LNS ENVIRONMENTAL SERVICES, INC.


 Ray Janek
 BIO CHEM LAB, INC.

Figure I-4 Fourth Example of Raw Water Geochemistry.

APPENDIX J
Examples of State of Texas Plugging Report
(STP)

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(2010)

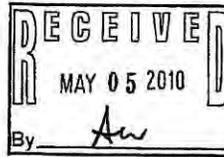
0570048

STATE OF TEXAS PLUGGING REPORT for Tracking #63507			
Owner:	City of Grand Prairie	Owner Well #:	15
Address:	P.O. Box 530011 Grand Prairie, TX 75053	Grid #:	32-24-3
Well Location:	938 South Center Grand Prairie, TX 75051	Latitude:	32° 44' 01" N
Well County:	Dallas	Longitude:	097° 00' 13" W
		GPS Brand Used:	Garmin GPS-12
Well Type: Water			

B

HISTORICAL DATA ON WELL TO BE PLUGGED

Original Well Driller: J. L. Meyers
 Driller's License Number of Original Well Driller: No Data
 Date Well Drilled: No Data
 Well Report Tracking Number: No Data
 Diameter of Well: 16" inches
 Total Depth of Well: 2067' feet



Date Well Plugged: 4/29/2010
 Person Actually Performing Plugging Operation: Jerry Browning
 License Number of Plugging Operator: 2176
 Plugging Method: Other plugging method.
 Plugging Variance #: No Data
 Casing Left Data: 1st Interval: 16 inches diameter, From 1 ft to 802 ft
 2nd Interval: 10 inches diameter, From 802 ft to 1090 ft
 3rd Interval: 6 inches diameter, From 1090 ft to 2067 ft
 Cement/Bentonite Plugs Placed in Well: 1st Interval: From 1 ft to 30 ft; Sack(s)/type of cement used: 30 Cement
 2nd Interval: From 30 ft to 2067 ft; Sack(s)/type of cement used: 160 Bentonite
 3rd Interval: No Data
 4th Interval: No Data
 5th Interval: No Data

Certification Data: The plug installer certified that the plug installer plugged this well (or the well was plugged under the plug installer's direct supervision) and that each and all of the statements herein are true and correct. The plug installer understood that failure to complete the required items will result in the log(s) being returned for completion and resubmittal.

Figure J-1 First Example of State of Texas Plugging Report.



Company Information: Millican Well Service LLC
P.O. Box 820487
Fort Worth, TX 76182

Plug Installer License Number: 2176

Licensed Plug Installer Signature: Jerry Browning

Registered Plug Installer Apprentice Signature: Jaythan Browning

Apprentice Registration Number: 57364

Plugging Method Comments: Tremmie pipe bentonite from bottom to 2 feet from surface, cement top 30 feet.

Please include the plugging report's tracking number (Tracking #63507) on your written request.

Texas Department of Licensing & Regulation
P.O. Box 12157
Austin, TX 78711
(512) 463-7880

<http://134.125.70.235/drillers-new/pluggingreportprint.asp?track=63507>

5/5/2010

Figure J-2 Second Example of State of Texas Plugging Report.

APPENDIX K

**Examples of Well Schedule: USGS, TWDB, UGCD
(WSC)**

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(1961)

00570048

Well # 3224305: Page 1

TEXAS WATER DEVELOPMENT BOARD
WELL SCHEDULE

Aquifer: TWIN MOUNTAINS Field No. 7 State Well No. 32-24-305
Owner's Well No. 13 County Dallas

1. Location: 1/4, 1/4 Sec., Block, Survey
Dallas, 7 between N.W. 12th & N.W. 13th Sts. F.M. First Block
2. Owner: CITY OF GRAND PRAIRIE Address: P.O. Box 146 Grand Prairie, TX
Tenant: Address: 750.50
Driller: LAYNE TEXAS CO. Address: DALLAS, TEXAS
3. Elevation of _____ is 55.0 ft. above seal, determined by TEMP

4. Drilled: _____ 19 46 Dug, Cable Tool, Rotary
5. Depth: Hopt. 224.7 ft. Neas. _____ ft.
6. Completion: Open Hole, Straight Wall, Underreamed, Gravel Packed
7. Pump: Mfg. _____ Type 516
No. Stages _____, Bore Dia. _____ in., Setting 1054 ft.
Column Dia. _____ in., Length Tailpipe _____ ft.
8. Motor: Fuel ELECT Make & Model _____ HP 100
9. Field: Flow _____ gpm, Pump 340 gpm, Rept., Est. 6-11-75 Flow Meter
10. Performance Test: Date _____ Length of Test _____ Made by _____
Static Level _____ ft. Pumping Level _____ ft. Drawdown _____ ft.

CASING & BLANK PIPE			
Diam. (in.)	Type	Setting, ft.	
		from	to
13 3/8	steel	0	700
10 7/8	steel	700	1713
6 7/8	steel	1753	1869

11. Water Level: 597.0 ft. 4-13-56 above LSD @ 415 gpm which is _____ ft. above surface.
8-14-56 ft. 3-25-56 above LSD - AIR LINE CITY which is _____ ft. above surface.
8-14-56 ft. 4-22-56 above " which is _____ ft. above surface.
533.0 ft. 4-6-56 above LSD which is _____ ft. above surface.

12. Use: Dom., Stock, Public Supply, Ind., Irr., Waterflooding, Observation, Not Used.
13. Quality: (Remarks on taste, odor, color, etc.)
Temp. _____ °F, Date sampled for analysis 5-16-74 Laboratory IHD
Temp. _____ °F, Date sampled for analysis 2-1-53 Laboratory IHD
Temp. _____ °F, Date sampled for analysis 2-14-75 Laboratory TSDR

WELL SCREEN		
Diam. (in.)	Type	Setting, ft.
		from to
6 7/8	steel	

14. Other data available as circled: Driller's Log, Radioactivity Log, Electric Log, Formation Samples, Pumping Test.
15. Record by: Gene Davis Date 5-7-56
Source of Data MISC. OWNERS, TOWNE SCH, MR. HUBBARD
16. Remarks: Date SWH Rb 6/11
6-4-54 535'
6-3-53 552'
4-6-56 533' 552'
4-13-56 597' 415'
7-17-56 430'
9-25-56 415'
10-56 ±640
12-30-54 482'

TWDB-WD-2 (Sketch) BACK 2-24-305

http://wiid.twdb.state.tx.us/wwm/wwm_wquery.asp?state_well=3224305&theDB=driller 11/3/2004

Figure K-1 First Example of Well Schedule: USGS, TWDB, UGCD (First Page).

Well # 3224305: Page 2

Form CW-1 TEXAS BOARD OF WATER ENGINEERS
GROUND-WATER DIVISION

WELL SCHEDULE

Date 3/27, 19 41 Field No. _____
Record by W.S. Office No. 3224305
Source of data St. Louis Water Dept.

1. Location: County Tarrant
Map sec. 16 of Grand Prairie
Survey Wells on Dallas St. between NW 12th & NW 13th

2. Owner: Chas. Smith Address _____
Tenant _____ Address _____
Driller: Jay L. Jones Address _____

3. Topography: _____

4. Elevation: 250 ft. above _____
below _____

5. Type: Dug, drilled, driven, bored, jetted 19 46

6. Depth: Rept. 2050 ft. Meas. _____ ft.

7. Casing: Diam. _____ in., to _____ in., Type _____
Depth _____ ft., Finish _____

8. Chief Aquifer: Texas From _____ ft. to _____ ft.
Others _____

9. Water level: _____ ft. rept. _____ 19 _____ above
meas. _____ below
which is _____ ft. above surface
below _____

10. Pump: Type 7-1/2" electric Capacity _____ gpm _____
Power: Kind E Horsepower 100

11. Yield: Flow _____ gpm, Pump 337 gpm, Meas. Rep. Est. 1941
Drawdown _____ ft. after _____ hours pumping _____ gpm

12. Use: Dom., Stock, PS, RR., Ind., Obs. Irr. _____
Adequacy, permanence _____

13. Quality: _____
Temp. _____ °F Sample 56 No. 52

14. Log: Yes _____
No _____

15. Remarks: PS. 802' #8

Figure K-2 First Example of Well Schedule: USGS, TWDB, UGCD (con't) (Second Page).

Well # 3224305: Page 3

Form GW-1 TEXAS BOARD OF WATER ENGINEERS
 GROUND WATER DIVISION
WELL SCHEDULE *Leadman - Water Supply*
 Date 10-16, 1956 Field No. 32-24-305
 Record by Chris Ford Office No. 8
 Source of data Ed Walker

1. Location: County Dallas
 Map _____
 Survey _____

2. Owner: City of Grand Prairie # 13 (Dalworth)
 Tenant _____ Address _____
 Driller Layne-Texas Address _____

3. Topography: _____

4. Elevation: 550 ft. above _____
 below _____

5. Type: Dug, drilled, driven, bored, jetted 19 _____

6. Depth Rept. 2050 ft. Meas. _____ ft.

U 7. Casing: Diam. _____ in., to _____ in., Type _____
 Depth _____ ft., Finish _____

8. Chief Aquifer: TP From _____ ft. to _____ ft.
 Others _____

B 9. Water level: _____ ft. reft. _____ 19 _____ above
 meas. _____ below _____
 which is _____ ft. above surface
 below _____

B 10. Pump: Type _____ Capacity _____ gpm
 Power: Kind _____ Horsepower _____

11. Yield: Flow _____ gpm, Pump _____ gpm, Meas. Rept. Est. _____
PL Drawdown 597 ft. after _____ hours pumping 415 ± 9/13/56

12. Use: Dom., Stock, (PS), RR., Ind., Obs., Irr. _____
 Adequacy, permanence _____

13. Quality: _____
 Temp. _____ °F Sample Yes _____ No _____

14. Log: Yes _____ No _____
 15. Remarks: _____

http://wiid.twdb.state.tx.us/wwm/wwm_wquery.asp?state_well=3224305&theDB=driller 11/3/2004

Figure K-3 First Example of Well Schedule: USGS, TWDB, UGCD (con't) (Third Page).

(1922)

0570048

Well # 3224306: Page 1

B

TEXAS WATER DEVELOPMENT BOARD
WELL SCHEDULE

Aquifer: Twin Mountains Field No. 10 State Well No. 3224 306
Owner's Well No. 15 County: DALLAS

1. Location: 1/4, 1/4 Sec. Block Survey
Center of town Hall Sts.
2. Owner: CITY OF GRANT PRAIRIE Address: GRANT PRAIRIE, TEX.
Tenant: _____ Address: _____
Driller: J. L. MYERS SONS Address: DALLAS, TEXAS
3. Elevation of _____ is 510 ft. above sea level, determined by TOPD

4. Drilled: 4-15-52 by Dug, Cable Tool, Rotary
5. Depth: Rept. 2067 ft. Meas. 2064 ft.
6. Completion: Open Hole, Straight Wall, Underreamed, Gravel Packed
7. Pump: Mfg. _____ Type SUB
No. Stages _____, Bowl Dia. _____ in., Setting 1051 ft.
Column Dia. _____ in., Length Tailpipe _____ ft.
8. Motor: Fuel Elect. Make & Model _____ HP 100
9. Field: Flow _____ gpm, Pump 236 gpm (Meas.), Rept., Est. 10-12-77 St. Water
10. Performance Test: Date 4-5-52 Length of Test _____ Made by _____
Static Level 330 ft. Pumping Level _____ ft. Drawdown _____ ft.
Production _____ gpm Specific Capacity _____ gpm/ft.

CASING & BLANK PIPE			
Cemented From _____ ft. to _____ ft.		Setting, Ft.	
Diam. (in.)	Type	From	to
16	steel	0	802
10 3/4	steel	802	1892
6 5/8	steel	1695	2065

11. Water Level: 438 ft. 4-29-54 15' above surface
560.0 ft. 6-7-54 14' above surface
592 ft. 8-12-54 11' above surface
547.2 ft. 12-29-54 11' above surface

12. Use: Dom., Stock (Public Supply) Ind., Irr., None Observation, Not Used

13. Quality: (Remarks on taste, odor, color, etc.)
Temp. _____ °F, Date sampled for analysis 2-1-53 Laboratory T.H.D.
Temp. _____ °F, Date sampled for analysis _____ Laboratory _____
Temp. _____ °F, Date sampled for analysis _____ Laboratory _____

WELL SCREEN			
Screen Openings _____		Setting, Ft.	
Diam. (in.)	Type	From	to
6 5/8	WW screen	1895	2045

14. Other data available as circled: Driller's Log, Radioactivity Log, Electric Log, Q-16
Formation Samples, Pumping Test,
15. Record by: W. R. DAVIS Date 5-7-55
Source of Data MISC. DATA, G.S. TOWN, G.S. TOWN, G.S. TOWN, G.S. TOWN
16. Remarks: PLS - 3-89-55-523, 2-11-55-585,
1-3-56-558, 4-13-56-604, 6-22-56-634,
7-20-56-669, 10-18-56-540, 570, PLS,
2-28-75-868, 4-21-75-821

Q-16

TWDBE-WD-2

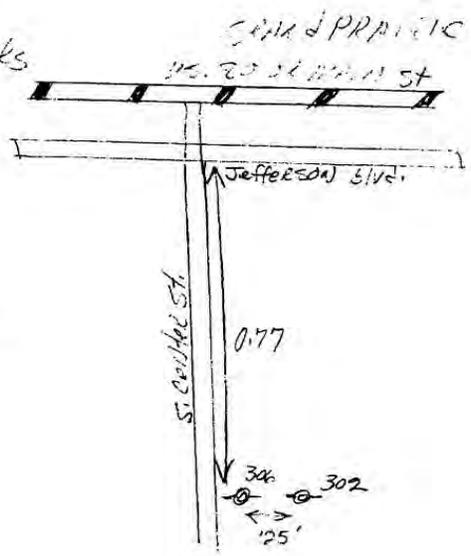
(Sketch)
BACK

3224-306

Figure K-4 Second Example of Well Schedule: USGS, TWDB, UGCD (First Page).

Well # 3224306: Page 2

- DRILLERS LOG
- 0-3- surface soil
- 65- clay
- 30- shale
- 718- lime
- 810- lime & shale
- 942- lime
- 980- SAND
- 1028- SANDY shale
- 1068- SAND
- 1148- Broken Lime
- 1219- Lime
- 1238- SANDY lime
- 1362- Broken Lime
- 1478- Lime
- 1397- SAND
- 1409- SANDY shale
- 1554- Lime & SAND streaks
- 1598- Lime
- 1624- SANDY shale
- 1733- shale & lime
- 1845- Red shale
- 1869- SANDY shale
- 1921- shale
- 2050- SAND
- 2067- shale & lime



http://wiid.twdb.state.tx.us/wwm/wwm_wquery.asp?state_well=3224306&theDB=driller 11/3/2004

Figure K-5 Second Example of Well Schedule: USGS, TWDB, UGCD (con't) (Second Page).

Well # 3224306: Page 3

Form CW-1 TEXAS BOARD OF WATER ENGINEERS
GROUND-WATER DIVISION

WELL SCHEDULE

Date 3-18 1960 Field No. _____
 Record by RWH Office No. HR 3224306
 Source of data Electric log & 1957 Rept. by C. Gard. Travis Park (R-16)

1. Location: County Dallas
Map 0.6 mi. So. of center of Grand Prairie (10)
Summer corner of Tom Hall & Center sts. (see map)

2. Owner: City of Grand Prairie Address _____
 Tenant _____ Address _____
 Driller J.L. Meyers & Sons Address _____

3. Topography: 505 ± 5

4. Elevation: 505.10 ft. ^{above} Sea level below _____

5. Type: Dug, (filled) driven, bored, jetted 3-7-1952

6. Depth: Rept. 2065 ft. Meas. 2064 ft.

Casing: Diam. _____ in., to _____ in., Type _____
 Depth _____ ft., Finish _____

8. Chief Aquifer: Travis pack From _____ ft. to _____ ft.
 Others _____

9. Water level: _____ ft. rept. _____ 19 _____ above
 meas. _____ below
 which is _____ ft. above surface
 _____ below

10. Pump: Type T-pump Capacity 500 gpm
 Power: Kind E Horsepower 150

11. Yield: Flow _____ gpm, Pump 521 gpm, Meas. (Rept.) Est. _____
 Drawdown _____ ft. after _____ hours pumping _____ gpm

12. Use: Dom., Stock, (Ps), RR., Ind., Obs. Irr.
 Adequacy, permanence _____

13. Quality: _____
 Temp. _____ °F Sample Yes _____ No _____

14. Log: (Yes) E-log No _____

15. Remarks: Well # 75 Well # 10 in 1957 Travis Park Rept by Gard.
P. 51 in (R-16)
over E-log
Q-16

Figure K-6 Second Example of Well Schedule: USGS, TWDB, UGCD (con't) (Third Page).

Well # 3224306: Page 4

Form GW-1 TEXAS BOARD OF WATER ENGINEERS
GROUND-WATER DIVISION

WELL SCHEDULE 32-24-306

Date 10-16-56 Field No. _____
Record by Chris Yard Office No. 10
Source of data Ed Walker & Myers

1. Location: County Dallas
Map _____
Survey _____

2. Owner: City of Grand Prairie # 15
Tenant _____ Address _____
Driller: J. L. Myers & Sons Address Dallas

3. Topography: _____

4. Elevation: 507 ft. above _____
5. Type: Dug drilled, driven, bored, jetted 1952
6. Depth: Rept. 2067 ft. Meas. _____ ft.

7. Casing: Diam. _____ in., to _____ in., Type _____
Depth _____ ft., Finish _____

8. Chief Aquifer: TP From _____ ft. to _____ ft.
Others _____

9. Water level: 438 ft. (top) _____ ft. above _____ ft. below _____ ft. above surface
which is _____ ft. below _____

10. Pump: Type B.J. Turbine Capacity 500 gpm @ 700' Power: Kind electric Horsepower 150

11. Yield: Flow _____ gpm, Pump 510± gpm, Meas. Rept. Est. PL
Drawdown 66.9 ft. after _____ hours pumping 510± gpm

12. Use: Dom., Stock, (PS) RR., Ind., Obs. Irr. _____
Adequacy, permanence _____

13. Quality: _____
Temp. _____ °F Sample Yes _____ No _____

14. Log: Yes _____ No _____

15. Remarks: _____

http://wiid.twdb.state.tx.us/wmw/wmw_wquery.asp?state_well=3224306&theDB=driller 11/3/2004

Figure K-7 Second Example of Well Schedule: USGS, TWDB, UGCD (con't) (Fourth Page).

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APPENDIX L
Description of the Information (INF) Files
for the Aquifer Test Data

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The information (INF) files are named using a well ID name as the root name and the three letters “txt” as the file extension. The INF files have to follow this naming convention in order for the Aquifer Test Data Tool to find and read the INF files. The Aquifer Test Data Tool reads the INF files to determine what information is available from the aquifer test and what columns of information are in the aquifer test data (ATD) file. Table L-1 describes the inputs associated with each of the information lines. Several of the INF inputs are based on a preliminary review of the data. Values such as start of the aquifer test or initial estimate of static water level may be modified as hydrogeologist review and use the files. Figure L-1 and L-2 provides examples of INF files.

The INF file contains twenty-nine lines of information. Lines 1 and 2 provide the well name and its group category, which will be discussed in the next paragraph. Line 3 indicates whether the ATD file is for the single-well pumping test or for a multiwell pumping test. Lines 4, 5, 6, and 7 were created for future use and are not used for this project. Line 8 marks whether or not the PDF of the aquifer test should be checked based on concerns with the initial assessment of the integrity of the aquifer test. Line 9 is a flag indicate whether or not the aquifer test is 36 hours or longer. Lines, 10 11, and 13 provides information on the static water level. If no static water level was identify from the PT0 file, then a value of zero is used. Line 14 to 18 provide information on the starting and ending date and time of the aquifer test. If the starting date and time was not identified in the PT0 file, then the date of January 1, 1900 was assumed. Thus, the data stamp of January 1, 1900 is an indicator that the date is unknown. Line 19 is the length of the aquifer test calculated from the start and ending aquifer test times. Lines 20 and 21 provide information on the time information in the ADT file. Lines 23 and 24 provide information on the water level information in the ADT file. Lines 25 and 26 provide information on the flowrate in the ATD file. Line 27 is flag that provides an estimate of the uncertainty with some of the information entered in Lines 2 through 26. A low uncertainty level indicates that the values are fairly reliable but should be check. A high values indicates that the values need to be check before any evaluation of the data is performed. Line 28 is used by INTERA to locate a hardcopy of the PDF in a notebook. Line 29 is reserved for comments by future users of the INF and ATD files.

Table L-1 Description of the Input Records for the Information (INF) Files.

Line #	Input	Description
1	cmbWellName	Name of public water supply well
2	cmbCategory	Category based on amount and type of data available for ATD file
3	frmOF1	=1 if a single well test, <0 if an observation file with negative number representing the radial distance
4	frmPR1	=1 if not relevant, Reserved for future use in case pumping rates are put into a separate file (not used in current project, option is for future use)
5	frmRF1	=1 if not relevant,Reserved for future use in case recovery rates are put into a separate file(not used in current project, option is for future use)
6	frmMT1	=2 if not relevant, Reserved for future use in case different pumping periods are put into a separate files (not used in current project, option is for future use)
7	frmSI1	=2 if not relevant, Reserved for future use in case screen information will be placed into a separate files(not used in current project, option is for future use)
8	frmCP1	=2 if not relevant, Reserved for future use to in case critical information from aquifer test document goes into a separate file
9	frmTL1	=1 if aquifer test is less than 36 hours, =2 if aquifer test is 36 hours or greater
10	txtSW	Value for static water level
11	txtSWD	Measurement for static water level. Options are: elevation ft msl, depth below TOC, dpth below ground surface, depth, feet above pump, unknown
12	cmbSW_U	Measurement unit for static water level. Options are feet, psi, inches of water, unknown
13	txtSD	Start date of aquifer test in format of mm/dd/yyyy. If date unknown then default date is 01/01/1900
14	txtSD_T	Start time of aquifer test in format of HH.MM:SS AM/PM.
15	txtED	End date of aquifer test in format of mm/dd/yyyy. If date unknown then default date is 01/01/1900
16	txtED_T	End time of aquifer test in format of HH.MM:SS AM/PM.
17	chkEDT	Check on end time. -1= valued date and time.
18	chkSDT	Check on start time. -1= valued date and time.
19	txtDUR	Duration of test calculated based on start time and end time
20	txtTD	Two options. "Absolute" indicates that time in ADT file is in terms of date and hours. "Relative" indicates that time is entered as elapsed time.
21	txtTD_U	Measurement units for the time in the ADT file. Options are hours, minutes, or seconds
22	txtSD_T	
23	cmbWL	Property measured to indicate water level during aquifer test. Options are "elevation ft msl." "depth of water," "pressure," "feet above pump," "feet", and unknown
24	cmbWL_U	Units of measurement ofr water level. Options are feet, meters, psi
25	cmbFR	Flowrate for aquifte test. Options are "Rate" meaning flowrates are provided or "Volume" meaning only the total volume pumped is provided
26	cmbFR_U	Units of the flowrate. Options are gpm, cubic feet per second, or barrels
27	txtUN	Uncertainty associated with the aquifer test values. Options are "Low", "Moderate", and "High"
28	txtNN	INTERA booking keeping number. Notebook number in which aquifer test document is

		kept
29	Comments	Comments to be added by users who have reviewed the data

To assist with managing the data entry, all of the aquifer tests were reviewed and assigned a category number from 1 to 5. As a general rule, the higher group numbers are associated with a greater amount of water level information than the lower group number. The rationale for assigning the different categories is as follows: .

Category 1

A Category 1 is assigned to an aquifer test that has insufficient information for estimating a reliable transmissivity value using analytical solutions. Among the major deficiencies that are reasons for assigning a Category1 ranking are the following:

- the data sheet are too faded and/or illegible to read,
- the data sheet is a rating curve or a mechanical test for a submersible groundwater pump,
- the measured water levels were taken over less than a 2 hour time period,
- a large initial drawdown was followed with less than a foot of drawdown over the next 24 hours of pumping,
- no pumping rates or no drawdown data was provided,
- there were less than five different water measurement and fewer pumping rate measurements taken during the aquifer,

Table L-2 lists several of the pumping test PDFs that will be placed into Category 1. All aquifers assigned a Category 1 are identified in the Master Table (see Figure 2-1) by the letters “NA” or “Graph” in the columns representing the information (INF) and aquifer test (ATD) files. The “NA” stands for not applicable. The “Graph” means that no tabulated data was provided for the pumping test but a graph of the water levels over time was provided. The graph of the water level may or may not provide any pumping information. Of the approximate seventy aquifer test PDFs grouped a Category 1, nine of these contained some type of graphed data. These nine aquifer tests are for PWS wells G16600026G, G2270324E, G2270324G, G2270324H, G2270324I, G2270324J, G2200243B, G1260071B, and G0270124B.

Table L-2 Several Aquifer Tests Classified as Category 1.

PWS Well ID	Explanation for Classifying as Group 1
G2270324J	No tabulated time-series data is available; pumping test data has been submitted as a plot of drawdown over time
G2270281A	No tabulated time-series data is available; there is only one drawdown value and only one pumping rate value; pumping test data consists of only a few numbers that represent an average or final condition
G2130037A	No tabulated time-series drawdown data is available; entire data consists of seven pumping rate values measured over a 24-hour period
G2130009F	Only three measured water levels and pumping rates are provided, initial water level prior to start of pumping test appears to be missing

Category 2

Aquifer Tests that appear to have a constant value of drawdown for the majority of the pumping test are classified as Category 2. Category 2 Aquifer Tests may have relatively few or numerous tabulated values of drawdown and pumping rates over time. The adequacy of the number of data points is not a primary consideration for placing an Aquifer Tests into Category 2. The primary evaluation criteria are that for the majority of the pumping test, the change in water table is very small and typically less than a foot. Among the possible reasons for the relatively constant drawdown for most of the test is a pumping rate did not stress the aquifer stress, inadequate precision in either the measurement equipment or the measurement procedure, and or errors with recording the measured water level changes. Table L-3 lists several of the aquifer tests placed into Category 2. Included in Table L- 3 are brief explanations to why the pumping test PDFs will be placed into Category 2.

Table L-3 Several Aquifer Tests Classified as Category 2.

PWS Well ID	Explanation for Classifying as Group 2
G1260017T	Tabulated values for the measured pumping rate and the water level elevations are the same value for the entire pumping test
G1160002A	The tabulated values for the pumping rate are either 150 gpm or 120 gpm . For all 150 gpm values, the water levels are 452 feet. For all 120 gpm values, the water level are 447 feet.
G1260011E	The tabulated water level measurements are 880 feet for elapsed times greater than 2 hours.
G1260004F	The tabulated water level measurements are 970 feet for elapsed times greater than 2 hour.

Category 3

Aquifer Tests with tabulated data should be classified as Category 3 if one of following three situations is valid: 1) the number of tabulated water level measurements are relatively few and can be quickly recorded; 2) the water level measurements are not easily recognized because of partially illegible text and thus some interpretation is needed in the data entry process, and 3) the aquifer test data is not well organized and extraction of information involves a careful examination of the header information and/or unit conversions. Table L-4 lists several of the pumping test PDFs that will be placed into Category 3.

Table L-4 Several Aquifer Tests Classified as Category 3.

PWS Well ID	Explanation for Classifying as Group 3
G0610049P	There are relatively few tabulated values (about 35) for water level elevation and pumping rates and the tabulated values are well organized
G0570048B	The digit for the hour of the measurement has been cut off as a result of improper Xeroxing prior to the submittal to the tabulated data to the TCEQ. As a result, the hour of the measurements need to be inferred from the spacing of the measurements between the 12 noon and 12 midnight markers, which are legible.
G0610035C	The tabulated drawdown data has units of lbs. in an airline. The tabulated pumping rate data has units of inches measured in an orifice. Both the drawdown and the pumping rate data needs to be converted into conventional units of measure compatible with the majority of the other aquifer tests. The conversions needs to be performed by the data entry specialist as part of the data entry process.
G1260004D	The data sheet is difficult to decipher because of copious notes and numerous types of data are contained on two hard-written sheets.

Category 4

Aquifer Tests with data relatively well organized are classified as Category 4. In order to streamline the data entry process and to focus on the most relevant data for aquifer test analysis the following guidelines will be used for the data entry:

- For the first 2 hours of the aquifer test, neither drawdown nor pumping rate data will be transferred into a text file at a time interval less than 1 minute.

- For the time period extending from elapsed time of 2 hours to 24 hours, neither drawdown nor pumping rate data will be transferred into a text file at a time intervals less than 15 minutes.
- For the time period extending beyond 24 hours, neither drawdown nor pumping rate data will be transferred into a text file at a time intervals less than 30 minutes.

Table J-5 lists several of the pumping test PDFs that will be placed into Category 4.

Table J-5 Several Aquifer Tests Classified as Category 4

PWS Well ID	Explanation for Classifying as Group 4
G2270369C	The tabulated pumping rate and water level values are well organized and plentiful. The start and end of the pumping test are clearly marked. This example shows water level measured as a depth below a fixed datum.
G2270324B	The tabulated pumping rate and water level values are well organized and plentiful. The start and end of the pumping test can be determined from the available information. Within the first 2 hours, the measurement time interval between 1 and 5 minutes is necessary to capture the change in the pumping rate from 64 gpm to 13 gpm. .
G2490056B	The tabulated pumping rate and water level values are well organized. The water level units are in pounds per square inch and therefore will need to be converted in order to make them consistent with the majority of the other measurements.
G2460022J	The tabulated water level value are well organized. The pumping rate information consists only of a starting, ending and average pumping rate. Because of the lack of pumping rate information, a separate pumping rate file will be created.

Category 5

Aquifer Tests with drawdown values collected at intervals of 5 minutes or less for most of the are classified as Category 5. The Category 5 likely represents aquifer tests where dataloggers were used to collect data at relatively small time intervals. An example of a Category 5 aquifer test is the aquifer test for well G027012C, which has more than 5,500 drawdown values over a 95 hour period. Data from Category 5 files entered manually using the same guidelines for Category 4.

G0700043C	#	cmbWellName
Category 4	#	cmbCategory
1	#	frmOF1
1	#	frmPR1
1	#	frmRF1
2	#	frmMT1
2	#	frmSI1
2	#	frmCP1
2	#	frmTL1
928	#	txtSW
Depth Below GS	#	txtSWD
ft	#	cmbSW_U
9/6/2005	#	txtSD
10:30:00 AM	#	txtSD_T
9/8/2005	#	txtED
12:00:00 AM	#	txtED_T
-1	#	chkEDT
-1	#	chkSDT
37.5	#	txtDUR
Absolute	#	txtTD
hours	#	txtTD_U
10:30:00 AM	#	txtSD_T
Depth To Water	#	cmbWL
ft	#	cmbWL_U
Rate	#	cmbFR
gpm	#	cmbFR_U
Low	#	txtUN
4d	#	txtNN
Null	#	Comments

Figure L-1 Information File for Well G0700043C.

G0720037C	#	cmbWellName
Category 2	#	cmbCategory
1	#	frmOF1
1	#	frmPR1
2	#	frmRF1
2	#	frmMT1
2	#	frmSI1
2	#	frmCP1
2	#	frmTL1
80.85	#	txtSW
ft of Water	#	txtSWD
ft	#	cmbSW_U
5/3/2001	#	txtSD
12:00:00 AM	#	txtSD_T
5/4/2001	#	txtED
12:00:00 PM	#	txtED_T
-1	#	chkEDT
-1	#	chkSDT
36	#	txtDUR
Absolute	#	txtTD
hours	#	txtTD_U
12:00:00 AM	#	txtSD_T
ft of Water	#	cmbWL
ft	#	cmbWL_U
Rate	#	cmbFR
gpm	#	cmbFR_U
Low	#	txtUN
2b	#	txtNN
Null	#	Comments

Figure L-2 Information File for Well G0720037C.

APPENDIX M
Files for Delineating Model Layers

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The Model Layer File is used by the TCEQ Database Tool to develop a chart of the model layers at a well location. Figure M-1 shows the structure of the model layer file. The first column is the unique identifier in the PWS Database File assigned to the PWS Well ID, which is listed in column 3. Column 2 lists the PWS associated with the Well ID. Columns 4 and 5 are the row and column in which the PWS well is located. Column 6 is a variable called RC. The variable RC is created by multiplying the row by 1000 and adding the column to the number. So that the RC created by row 2 and column 1 is 2001. Columns 7 through 13 provide the top elevation of Model Layers 1 through 6 for the designated row and column. Column 8 provides the bottom elevation of Model Layer 6. Columns 9 through 15 provide the thickness of Model Layers 1 through 6 for the designated row and column. A value of "0" is entered in Columns 7 through 15 if the Model Layer does not exist at the designated row and column.

FID_1	PWS_ID	WELL ID	Row	Col	rc	top1	top2	top3	top4	top5	top6	top7	bot7	thk1	thk2	thk3	thk4	thk5	thk6	thk7
734	730019	G0730019A	175	73	175073	-645.9	-669.3	-1238	-1264	-2070	-2099	-2254	-2899	23.43	568.37	26.15	806.29	28.459	154.99	645.42
736	730021	G0730021B	173	84	173084	-559.5	-593.7	-1165	-1186	-1960	-1995	-2188	-2777	34.218	571.8	20.501	773.93	35.235	192.76	589.26
165	270120	G0270120C	135	5	135005	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	270118	G0270118B	137	5	137005	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
155	270078	G0270078B	137	5	137005	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
135	270045	G0270045A	137	9	137009	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
136	270045	G0270045B	137	9	137009	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
137	270045	G0270045F	137	9	137009	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
120	270018	G0270018A	117	23	117023	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
121	270018	G0270018B	117	23	117023	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
122	270018	G0270018C	117	23	117023	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
35	140159	G0140159A	139	46	139046	0	0	0	889.39	591.37	539.77	465.34	344.33	0	0	-889.4	298.01	51.603	74.432	121.01
143	270052	G0270052C	135	12	135012	0	0	0	0	920.35	873.23	833.35	747.21	0	0	0	-920.3	47.117	39.878	86.142
160	270099	G0270099A	123	8	123008	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
166	270124	G0270124A	137	16	137016	0	0	0	1356.2	1001.3	946.84	892.44	785.26	0	0	-1356	354.85	54.474	54.405	107.18
167	270124	G0270124B	137	16	137016	0	0	0	1356.2	1001.3	946.84	892.44	785.26	0	0	-1356	354.85	54.474	54.405	107.18
150	270059	G0270059A	122	7	122007	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
130	270042	G0270042A	130	22	130022	0	1485.1	1441.7	1409.9	1231.1	1180.4	1125.5	1010.6	-1485	43.402	31.841	178.81	50.707	54.853	114.88
131	270042	G0270042B	130	22	130022	0	1485.1	1441.7	1409.9	1231.1	1180.4	1125.5	1010.6	-1485	43.402	31.841	178.81	50.707	54.853	114.88
163	270108	G0270108A	130	22	130022	0	1485.1	1441.7	1409.9	1231.1	1180.4	1125.5	1010.6	-1485	43.402	31.841	178.81	50.707	54.853	114.88
157	270091	G0270091A	129	13	129013	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
148	270055	G0270055A	128	18	128018	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
144	270053	G0270053A	123	15	123015	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
145	270053	G0270053B	123	15	123015	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
146	270053	G0270053C	123	15	123015	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
164	270113	G0270113B	139	27	139027	0	1158.8	1138.8	1103.7	872.42	809.97	720.17	588.78	-1159	20	35.064	231.3	62.447	89.799	131.4
138	270047	G0270047A	117	17	117017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
139	270047	G0270047B	117	17	117017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
171	270132	G0270132A	117	17	117017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Figure M-1 The First Twenty-Nine Records of the Model Layer File

APPENDIX N
TWDB Comments and Response to Comments

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General Comments

General Comments: Installation directions for accessing the database are important and should be the first files in the Appendix, maybe moving them to Appendix A from Appendix L with some reference in the Executive Summary would be helpful. The file organization in the download were difficult to follow in the current format, please look at reorganizing and renaming into a simpler, more intuitive manner without the user having three choices of files and two executables potentially to open. Relabeling and reorganizing the files so that they are hierarchical and step-driven would help.

Response: We have moved Appendix L (Project Installation Instructions) to Appendix A. We have included a reference in the Executive Summary to the installation instructions. We have modified the installation program so that a single executable installs the three tools required for the applications. We have rewritten and simplified the installation instruction. The instructions were modify to include a tabulation that will help users locate data files and application in the directories.

Specific Comments

Scope of Work Task 2. “The first data collection activity is to copy the PWS Microsoft Access database and create a new database containing only records related to wells located in GMA-8”.

1) Comment: The draft final report (Chapter 2, Section 2.2, page 2-3) indicates the TCEQ PWS database is current as of October, 2010. It seems that the database provided to TWDB is current as of June 2009, please ensure the database provided to the TWDB is updated to the October 2010 version to be current with the TCEQ PWS database.

Response: The database used for the draft report database provided to us by TCEQ in October 2010. Our inspection of the database (after receiving the draft comments) confirms that the database may not have been current as of October 2010. In June 2012 we worked with the TCEQ to obtain an updated version of the TCEQ PWS database in June 2012 and are submitting the June -2012 database as part of the final deliverables. We checked the June 2012 database and have confirmed that it appears to be updated through June 2012.

2) Comment: TCEQ provides its PWS database as MS Access 2003. It is unclear if the TWDB will be able to use future copies of this database since we no longer use that version and currently we use MS Access 2007

Response. The TCEQ provided INTERA with its PWS database as a MS Access 2003 database. The PWS database can be uploaded into a MS Access version that is 2003 or later than 2003. Thus, the PWS database can be read by using MS Access 2007.

Scope of Work Task 2. “For PWS wells that do not contain a driller’s log in the file, we will search the TCEQ well inventory to locate the appropriate log”.

3) Comment: The draft final report is not clear if this task was performed. The most recent data for lithology added to the table tblPwsGeology is June 2009.

Response. This task was performed but was not documented in the draft report. For approximately 200 PWS wells that did not have driller logs, INTERA obtained scanned images of the drillers logs. These scanned images were omitted from the draft deliverable. We have modified Section 2.3.1 to indicate that 200 scanned images of the driller's log were obtained outside of the PWS hard copy files.

4) Comment: We were unable to find this deliverable. INTERA should provide this file as part of the deliverable.

Response. This deliverable was inadvertently omitted from the draft deliverable. INTERA located and included in the final deliverable approximately 200 scanned images of the driller logs (see response above) that are not associated with TCEQ PWS files. The final deliverable included these scanned images. The master table and appropriate shape files were updated to reflect the inclusion of these 200 images. Out of these 200 driller logs, approximately half of these wells did not have lithology information included in the TCEQ database. For these 100 wells, INTERA entered the lithology from the driller's logs into the TCEQ database.

Scope of Work Task 3. "Visualize the numerical grid and aquifer properties of any groundwater availability model for major and minor aquifers in GMA-8".

5) Comment: The draft final report is not clear where this task results are located, please identify where this item is located in the draft report.

Response. The draft report discusses the visualization of the numerical grid in Section 4.1.5.3 "Generate Charts for Model Layers". Figure 4-12 shows a plot of the model layers. Appendix N in the draft report provides the structure of the model file layer used to plot the model layers. In the final report, we have lengthen Section 4.1.5.3 and include a reference to Appendix N.

6) Comment: The draft final report is not clear if this task was performed. Please provide tables or shape files with this information in the deliverables with the final report.

Response. This task was performed and documented. See response to Comment 5.

Scope of Work Task 3. "If more than 50 geophysical logs meet our initial selection criteria, we will prioritize the wells based on additional criteria developed by the Intera Team in conjunction with the TWDB. The 50 logs that best meet these additional criteria will then be digitized".

7) Comment: The actual number of LAS files provided to the TWDB conflicts with the scope of work and what was delivered with the draft final report based on: the LAS.shp file contains 32 records; the folder TWDBGMA8\software\TCEQ Database Tool\config\las_files contains 20 LAS files. Please clarify how many logs met INTERA's initial selection criteria.

Response. The draft deliverable contains only 32 LAS file. The final deliverable contains 50 LAS files. Over 50 geophysical logs meet our criteria. The 50 PWS wells files are provided in the LAS.shp file and the files in the folder: TWDBGMA8\software\TCEQ Database Tool\config\las_files

Scope of Work Task 4: The tools developed as part of this task were meant to interact with the missing geodatabase identified in Task 3. We were unable to verify whether the tools would work with a geodatabase.

8) Comment: The tools, as designed, only work with flat files. They are cumbersome to use. More importantly the "Well Information" and "TCEQ PWS Wells" tools duplicate existing ArcGIS functionality created in the Task 3 deliverable.

Response: The development and use of flat files for the project was discussed with the TWDB Project Manager David Wuerch between February and June 2011. During that time, INTERA and TWDB agreed to a Standard Operating Procedure (SOP) for creating and formatting the flat files and for the directory structure that would contain the flat files. INTERA and TWDB also discussed that the tools would interface with these flat files. While the tools were being developed in early 2011, TWDB did not express any concerns with our modification to the approach in the proposal. We understand the desire for TWDB to have a geobasedata for the project, so we have provided a geodatabase as part of the final deliverable. The database contains all of the tabulated drawdown information in the flat files and contains the directory path to the PDF files. However, the Aquifer Test Tool still obtains the aquifer test data from the flat files.

Scope of Work Task 4: "Tool Development and Application".

9) Comment: (Chapter 2, Section 2.3.4, page 2-5) Naming the Gamma Ray and Gamma-Gamma Logs GAM tools could be confused with the TWDB GAM product, if it is possible to change this, maybe GMM would be a better name.

Response: The changed the acronym for the Gamma ray and Gamma-Gamma Logs from "GAM" to "GMM."

10) Comment: The draft final report (Chapter 2, Section 2.4.1, page 2-6) indicates that the pumping test data were converted to information (INF) and aquifer test data (ATD) files. Appendix J describes the format for INF files. The final report would be improved if a section were appended that describes how TWDB staff could create these two files if future pumping test data were obtained in the project area.

Response: To create these files, a user follows needs to create the files using a text editor (such as Microsoft Notepad) based on the formats in Appendix L for the INF files (see Tables L-1, L-2, and L-3) and on the format in Section 2.4.1 for the ADT files, to locate the file in an appropriate named directory (see Figure A-1), and update the Master File (aka Table 3-1).

11) Comment: on Table 2-3 (Chapter 2, Section 2.4.3, page 2-9) and Table 3-1 (Chapter 3, Section 3-3, page 3-3) please include a footnote to explain the acronyms in the header rows.

Response: The appropriate footnotes have been included.

12) Comment: The Scope of Work indicated that two tools (AQTESOLV Export Tool and the Cooper-Jacob Straight-line Analysis Tool) would be developed and values of transmissivity and hydraulic conductivity would be determined. The scope of work indicates “Included as part of the CJSJL tool will be an analysis of whether well borehole storage effects are a problem”. It is not clear if what was delivered meets the requirements in the scope of work. One tool was developed to create water level and drawdown charts. A discussion of the slope of the regression line is provided on page 4-15 of the draft report, but the tool does not determine values of transmissivity and hydraulic conductivity.

Response: The draft delivery did not meet all of the requirements discussed above. For the final deliverable, the Aquifer Drawdown Tool has been modified to calculate transmissivity from the slope of the regression line and to check if well borehole storage effects were a problem. The final report has been modified (see Section 4.2.3) to discuss both of these options. Despite having this capability, the final deliverables do not contain any transmissivity values calculated from the data except for the value shown in Figure 4-23. No transmissivity values were calculated because during a meeting with TWDB staff on 10 January 2011, TWDB and INTERA agreed not to provide any calculated transmissivity values because the aquifer data had not been properly checked by TWDB staff. (Also, as part of this meeting, it was also agreed to have the work “DRAFT” appear on all charts of drawdown information).

13) Comment: It is unclear what the technical reason was for having the aquifer test data placed in two different subfolders. The folders are: TWDBGMA8\data\Aquifer Test Data; TWDBGMA8\software\Aquifer Test Data Tool.

Response: The final deliverable includes the aquifer test data only in folder TWDBGMA8\software\Aquifer Test Data Tool.

14) Comment: The chart created for LAS files could be improved with a standard resistivity scale based on the original geophysical log (for example, 0-20 or 0-200 ohm-meters). The scale on the LAS chart appears to be based on the data range of the raw data.

Response: No changes were made to the scale on the LAS chart has been made. The LAS chart scale was intentionally set to be based on the range of the raw data.

15) Comment: The chart created for LAS files could be improved with the SP data displayed in a separate track, as it appears on a geophysical well log, with a scale and label consistent with the display. The scale provided appears to be based on the data range on the raw data.

Response: Comment 15 is a repeat of Comment 14. Please see response to Comment 14.

16) Comment: The “Well Information” and “Highlight Wells with Specified Document” forms displayed in GIS could be improved if they behaved in the same way as ESRI’s Identify or Measure forms. The present design allows the forms to disappear behind the ArcMap display if other tools are selected.

Response: We agree both forms disappear behind the ArcMap display if other tools are selected. We agree that there are advantages for the situation where the forms to remain in the front of the ArcMap display. However, the software was designed to move to the back after other tools are selected in order to clear the space for viewing documents and other information. We have kept the current design and have amended the report to inform the user that the two forms moves behind the ArcMap display if other tools are selected.

17) Comment: Selecting the tool “Display TCEQ PWS Well Information” causes the ESRI ArcMap software to crash. The Wells.mxd project, provided with the deliverables, was used for testing and the tools were loaded per instructions provided in the Final Draft Report Appendices K and L.

Response: We agree that there was a problem with the draft deliverable. This problem has been fixed.

18) Comment: The final report would be improved if the names of the two tools (DrawDownCharts.exe; StrataMapper.exe) were added to the appropriate sections of text.

Response: We have incorporated the name of the tools into the appropriate section of the report. For help simplify the learning of the system, we have renamed the “DrawDownCharts.exe” to the “Aquifer Test Tool.exe” and have renamed “StrataMapper.exe” to TCEQ Database Tool.exe.

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