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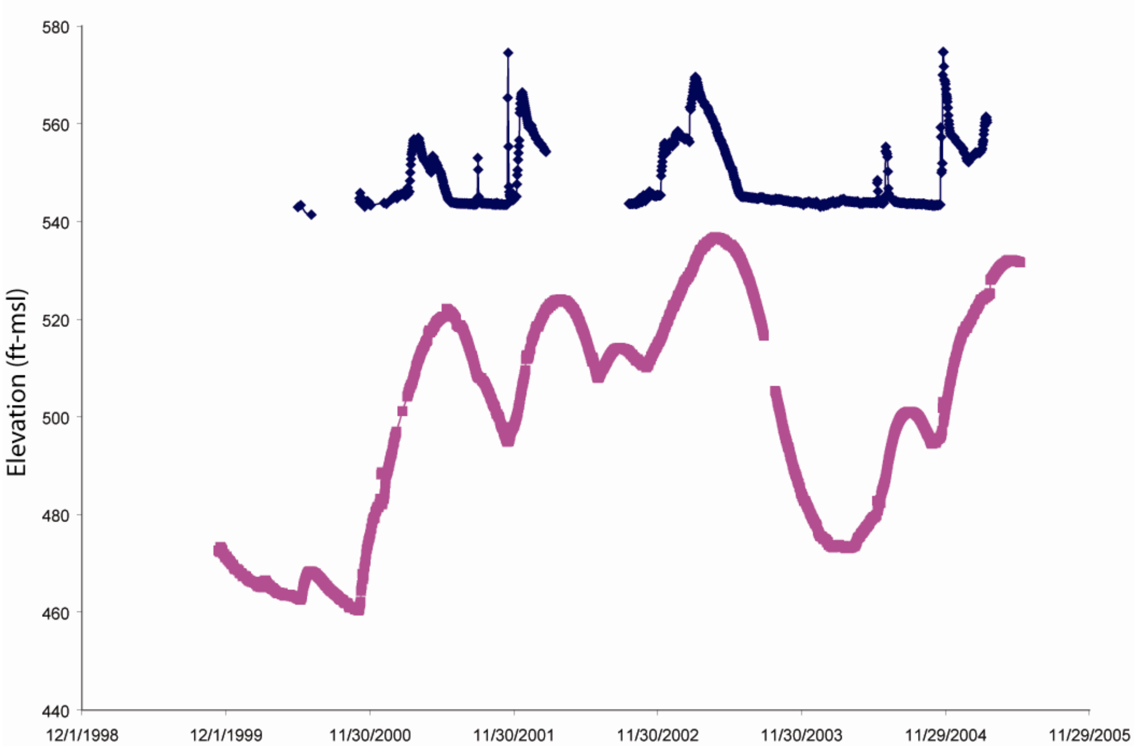
GROUNDWATER LEVELS IN THE BALCONES FAULT ZONE, HAYS AND TRAVIS COUNTIES, TEXAS, 1937-2005



BSEACD Data Series Report 2006-1025

Barton Springs/Edwards Aquifer Conservation District
1124 Regal Row
Austin, Texas

Disclaimer
All of the information provided in this report is believed to be accurate and reliable; however, the Barton Springs/Edwards Aquifer Conservation District (District) assumes no responsibility for any errors or for the use of the information provided. While this report has attempted to provide a comprehensive database of water level data, there may be unintended omissions of data or wells.

Cover. Hydrograph of two wells; top hydrograph is from the Zumwald Well (58-50-417) and is highly influenced by conduit development within the aquifer; the lower hydrograph is from the Lovelady Well (58-50-301) and is highly influenced by diffuse flow within the aquifer.

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Brian B. Hunt, P.G. and Brian A. Smith, Ph.D., P.G.

BSEACD Data Series Report 2006-1025
October 2006

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GROUNDWATER LEVELS IN THE BALCONES FAULT ZONE, HAYS AND TRAVIS COUNTIES, TEXAS, 1937-2005

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ABSTRACT

More than 50,000 water-level measurements from 1937 to 2005 in the Balcones Fault Zone of Central Texas were compiled from 49 wells, and one quarry. Data represent water levels from the Edwards, Trinity, and Austin Chalk Aquifers. A simple database was constructed to compile the water-level and well-construction data. The purpose of this report is to provide a foundation for future hydrogeologic investigations.

INTRODUCTION

Groundwater is an important resource for Texans and constituted nearly 60% of all water used by Texans in 1999 (TWDB, 2002). Aquifers along the Balcones Fault Zone in Central Texas provide an important groundwater resource for industrial, domestic, recreational, and ecological needs. The study area is located along the Balcones Fault Zone of Central Texas within portions of Travis and Hays counties (**Figure 1**). Water-level data within this report are primarily from wells completed within the Edwards, and to a lesser extent, the Trinity Aquifer. A relatively minor, locally water-bearing unit in the study area is the Austin Chalk.

This paper and accompanying database present a compilation of continuous water-level data from groundwater resources in the study area. Groundwater levels provide critical information about the hydrologic relationships of recharge and discharge to storage within an aquifer, and the direction of groundwater flow. Long-term, systematic measurements of water-level data are essential to develop groundwater models and to design, implement, and monitor the effectiveness of groundwater management programs (Taylor and Alley, 2001). This report includes data that numerous agencies have collected over the years: the United States Geological Survey (USGS), Texas Water Development Board (TWDB), Edwards Aquifer Authority (EAA), Hays-Trinity Groundwater Conservation District (HTGCD), San Antonio Water Systems (SAWS), and the Barton Springs/Edwards Aquifer Conservation District (BSEACD).

Purpose and Scope

This report compiles more than 50,000 water-level measurements made from 1937 to 2005 for 49 wells (and one quarry) completed in the Edwards, Trinity, and Austin Chalk Aquifers. A simple Microsoft® Excel-based database was constructed and accompanies this report. The database contains well-completion information and water-level data. The purpose of this report is to provide a foundation for future hydrogeologic investigations and evaluations of water resources in central Texas. The database presented in the report is currently the most comprehensive available for the study area.

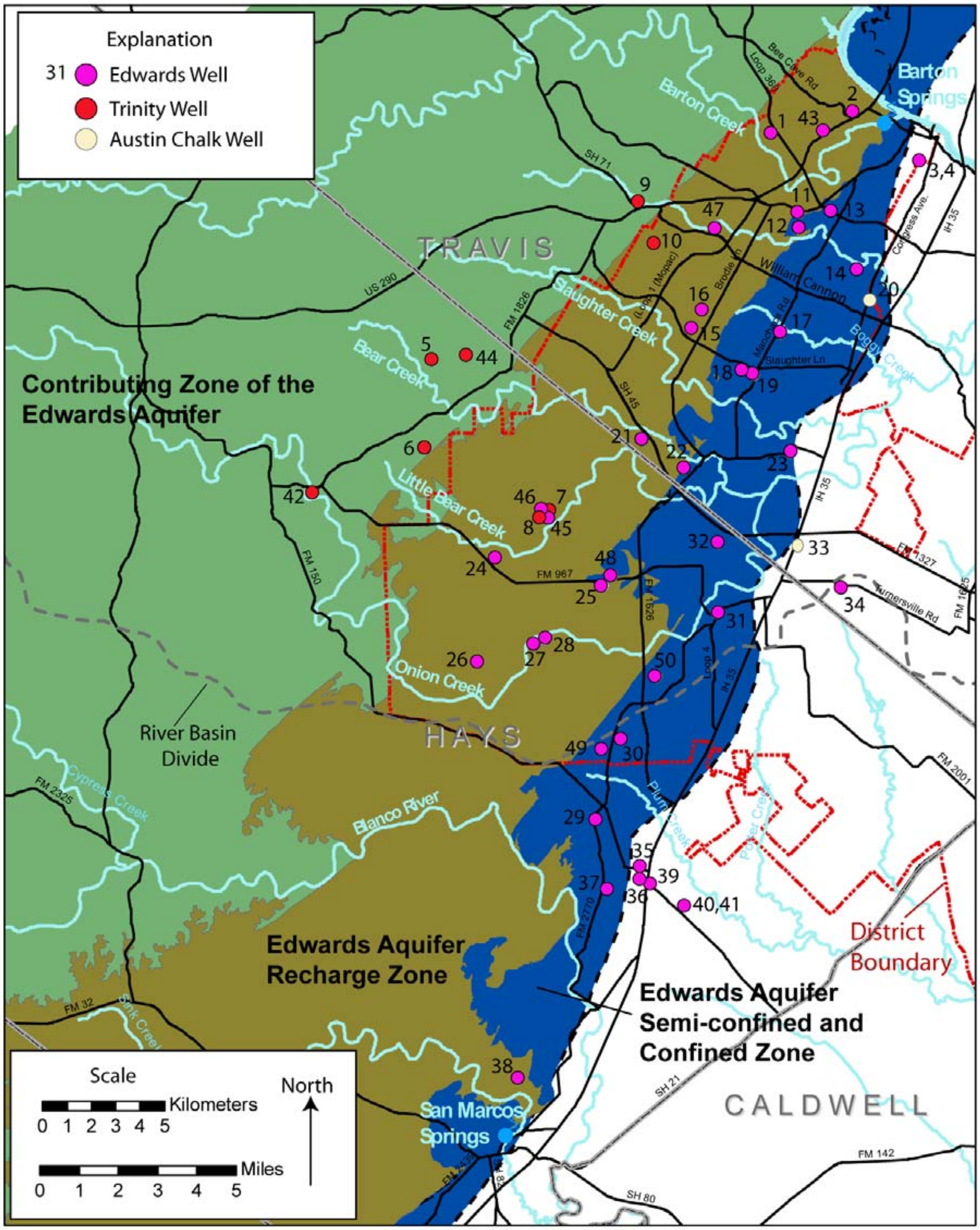

Figure 1. General well location map showing aquifer hydrologic zones, District boundaries, rivers and creeks, roads, major cities/towns, springs, and other landmarks.

WELL AND DATA INVENTORY

This report contains tabulation of wells and data summarized in **Table 1**. More information about the completion and construction of the wells can be found in the accompanying database or in the BSEACD Data Series Report 2006-0818.

Table 1. Well and Data Inventory.

	SWN	Well Name	Well Owner	County	DD Lat	DD Long	Lat/long Source	LSD (ft)[1]	LSD Source	M.P. (ft)[2]	TD (ft)[3]	Date Drilled	Aquifer Code[4]	Period of record	Data Count
1	5842819	Greenbelt	City of Austin	Travis	30.26101000	-97.81757000	GPS	680	USGS Quad	1.94	311	1982	218EBFZA	1999	1,974
2	5842911	Bee Caves	Bee Caves Properties	Travis	30.26861111	-97.78250000	USGS Quad	517	USGS Quad	0.00	135	1920	218EBFZA	1937 to 1982	133
3	5842927	Tx School for Deaf	Tx School for Deaf	Travis	30.25055600	-97.75361100	USGS Quad	505	COA topo	?	285	1986	218EBFZA	1986	93
4	5842929	Tx School for Deaf	Tx School for Deaf	Travis	30.25055600	-97.75361100	USGS Quad	505	COA topo	?	561	1986	218EBFZA	1986	95
5	5849406	Slopes of Nutty Brown	J. Howeth	Hays	30.17833330	-97.96277780	USGS Quad	1015	USGS Quad	1.00	530	1985	218GLRS	1986	31
6	5849706	Radiance Colony	Radiance Colony	Hays	30.14569444	-97.96701111	GPS	1060	USGS Quad	2.45	1050	1986	218GLRT	2004 to 2005	497
7	5849925	Borheim Trinity	City of Austin	Hays	30.12594000	-97.90382000	USGS Quad	789.86	Survey (toc)	3.63	1000	1985	218GRHC	1985	538
8	5849926	Borheim Trinity-Edwards Hybrid	City of Austin	Hays	30.12512778	-97.90510000	USGS Quad	794.24	Survey	0.22	609	1985	218EBFZA	1995	32
9	5850120	HEB	TWDB	Travis	30.23500000	-97.87305600	USGS Quad	832	USGS Quad	2.30	855	1984	217HSTN	1987	950
10	5850121	Legend Oaks	Legend Oaks Home Owners Assoc.	Travis	30.22018000	-97.86961000	USGS Quad	830	USGS Quad	2.20	950	1989	218GRLU	2001	999
11	5850205	Allred	unknown	Travis	30.23138890	-97.80583330	USGS Quad	685	USGS Quad	0.00	265	1887	218EBFZA	1939-1949	56
12	5850212	Sunset	City of Sunset Valley	Travis	30.22548000	-97.80618000	GPS	674	COA topo	1.70	336	1955	218EBFZA	1997	2,253
13	5850216	Target	USGS	Travis	30.23222220	-97.79277780	USGS Quad	690	USGS Quad	3.17	582	1978	218EBFZA	1981	1,097
14	5850301	Lovelady	Texas Middle School Association	Travis	30.21035000	-97.78159000	GPS	654	COA topo	1.35	388	1949	218EBFZA	1948	5,144
15	5850411	Circle C	Stratus Development	Travis	30.18666670	-97.84916670	GPS	770	USGS Quad	1.50	469	1940	218EBFZA	1978-1997	896
16	5850417	Zumwald	City of Austin	Travis	30.19536000	-97.84640000	GPS	804	COA Topo	1.70	330	1938	218EBFZA	2001	1,341
17	5850501	Garner	L.J. Garner	Travis	30.17333330	-97.83055560	USGS Quad	726	USGS Quad	0.00	?	<1958	218EBFZA	1949 to 1958	27
18	5850502	Herndon	Shelly Hansen	Travis	30.18694444	-97.81416667	USGS Quad	742	USGS Quad	0.00	300	1937	218EBFZA	1949 to 1985	52
19	5850511	Johnson	Rodney Johnson	Travis	30.17158611	-97.82578611	GPS	699	GPS	1.85	285	1956	218EBFZA	1956	16
20	5850601	TWDB Chalk well	H.S. Lawson	Travis	30.19861100	-97.77611100	USGS Quad	660	USGS Quad	0.00	25	<1937	211ASTN	1937	237
21	5850702	Charles	C.R. Charles	Travis	30.14777778	-97.87333333	USGS Quad	765	USGS Quad	0.00	217	1945	218EBFZA	1949 to 1959	36
22	5850704	Marbridge	Marbridge Foundation	Travis	30.13722220	-97.85583330	USGS Quad	727	USGS Quad	0.70	345	1968	218EBFZA	1968	79
23	5850801	Dowell	Caroline Dowell	Travis	30.14281000	-97.81076000	GPS	660	USGS Quad	1.50	264	1939	218EBFZA	1941	4,912
24	5857201	Rutherford	Mike Rutherford	Hays	30.10305560	-97.93722220	USGS Quad	925	USGS Quad	0.50	320	1945	218EBFZA	1950	91

Table 1. Well and Data Inventory.

	SWN	Well Name	Well Owner	County	DD Lat	DD Long	Lat/long Source	LSD (ft)[1]	LSD Source	M.P. (ft)[2]	TD (ft)[3]	Date Drilled	Aquifer Code[4]	Period of record	Data Count
25	5857301	Thames	John Thames	Hays	30.09388890	-97.89055560	USGS Quad	883.00	Survey	1.10	312	1937	218EBFZA	1937	47
26	5857502	Hoskins	City of Austin	Hays	30.06634722	-97.94447222	GPS	890	USGS Quad	0.00	346	1963	218EBFZA	1977	287
27	5857509	Onion Creek Lodge	Madelyn Uresti	Hays	30.07240278	-97.92031111	GPS	781	USGS Quad	0.60	258	1988	218EBFZA	1988	57
28	5857602	Old Onion Creek Lodge	Micheal Thames	Hays	30.07420833	-97.91579722	GPS	798	GPS	1.00	208	<1975	218EBFZA	1975 to 2002	789
29	5857902	Gregg	Paul Gregg	Hays	30.00861110	-97.89611110	USGS Quad	822	USGS Quad	0.00	450	<1943	218EBFZA	1943	190
30	5857903	Negley	Plum Creek/Negley Ranch	Hays	30.03851000	-97.88618000	Survey	826.80	Survey	0.62	400	1943	218EBFZA	1949	2,351
31	5858101	Buda	Keith Thornsberry	Hays	30.08358000	-97.84263000	Survey	707.84	Survey	1.15	237.5	1907	218EBFZA	1937	5,368
32	5858123	Porter	Elizabeth Porter	Hays	30.10943000	-97.84173000	GPS	712	GPS	2.80	510	1985	218EBFZA	1994	3,100
33	5858201	Heep	Heep Estate	Travis	30.10805600	-97.80777800	USGS Quad	700	USGS Quad	?	105	1938	211ASTN	1938-1956	123
34	5858301	United Gas	United Gas Pipeline	Travis	30.09222220	-97.78944440	USGS Quad	734	USGS Quad	?	703	1943	218EBFZA	1943	477
35	6701303	Old Kyle PWS	Edwards Aquifer Authority	Hays	29.99000000	-97.87555600	USGS Quad	719.24	Survey	1.10	594	1939	218EBFZA	1959	3,027
36	6701304	Selbera	Raynaldo Selbera, Jr.	Hays	29.98472200	-97.87638900	USGS Quad	717.55	Survey	0.25	372	1934	218EBFZA	1934	413
37	6701311	Kyle Test Hole #1	San Antonio Water Systems	Hays	29.98138900	-97.89138900	USGS Quad	768	USGS Quad	?	810	1997	218EBFZA	1997	75
38	6701809	Knispel	A.F. Knispel	Hays	29.91191700	-97.92877200	Survey	601.27	Survey	?	34	1937	218EBFZA	1937	4,311
39	6702104	Kyle Test Hole #2	San Antonio Water Systems	Hays	29.98279167	-97.87153056	GPS	674	GPS	?	975	1998	218EBFZA	1998	254
40	6702105	Kyle Test Hole #4	San Antonio Water Systems	Hays	29.97472200	-97.85722200	USGS Quad	647	USGS Quad	?	970	1998	218EBFZA	1998	29
41	6702106	Kyle Test Hole #3	San Antonio Water Systems	Hays	29.97472200	-97.85722200	USGS Quad	678	USGS Quad	?	1100	1998	218EBFZA	1998	50
42	57569CB	Camp Ben McCulloch	Unknown	Hays	30.12960931	-98.01430184	GPS	963	GPS	2.40	360	2002	218TRNT	2002	36
43	58428TW	Eye Care	Tom Walters	Travis	30.26140000	-97.79518056	GPS	632	GPS	0.00	404	<1993	218EBFZA	1993	76
44	58495MH	Hills of Texas	unknown	Hays	30.17986418	-97.94807433	GPS	955	GPS	0.95	840	1996	218TRNT	2001	41
45	58499BQ	Borheim Edwards	City of Austin	Hays	30.12550000	-97.90366000	USGS Quad	787.38	Survey (toc)	0.90	180	2003	218EBFZA	2003	533
46	58499QL	Borheim-Quarry Lake	City of Austin	Hays	30.12697222	-97.90738889	USGS Quad	754.57	Survey	0.00	15	n/a	218EBFZA	2002	25
47	58501W2	Brush Country	City of Austin	Travis	30.22640000	-97.84147000	GPS	742	COA topo	1.45	187	1986	218EBFZA	1999	1,373
48	58573GC	Callon	Gary or Susan Callon	Hays	30.09758056	-97.88685556	GPS	825	GPS	0.00	235	<1994	218EBFZA	2000	1,366
49	58579A	Miller	Susan Miller	Hays	30.03002778	-97.89255556	USGS Quad	835	USGS Quad	2.05	300	<1991	218EBFZA	1991	2,397
50	58584CT	Centex	Centex Materials	Hays	30.06020000	-97.86848000	Survey	734.80	Survey	1.13	206.4	<1994	218EBFZA	1994	2,034

[1]Land Surface Datum (LSD) is the elevation in feet above mean seal level.
[2]Measurement Point (MP), measured in feet above the LSD.
[3]Total Depth (TD) of well in feet.
[4]Aquifer code of the Texas Water Development Board.

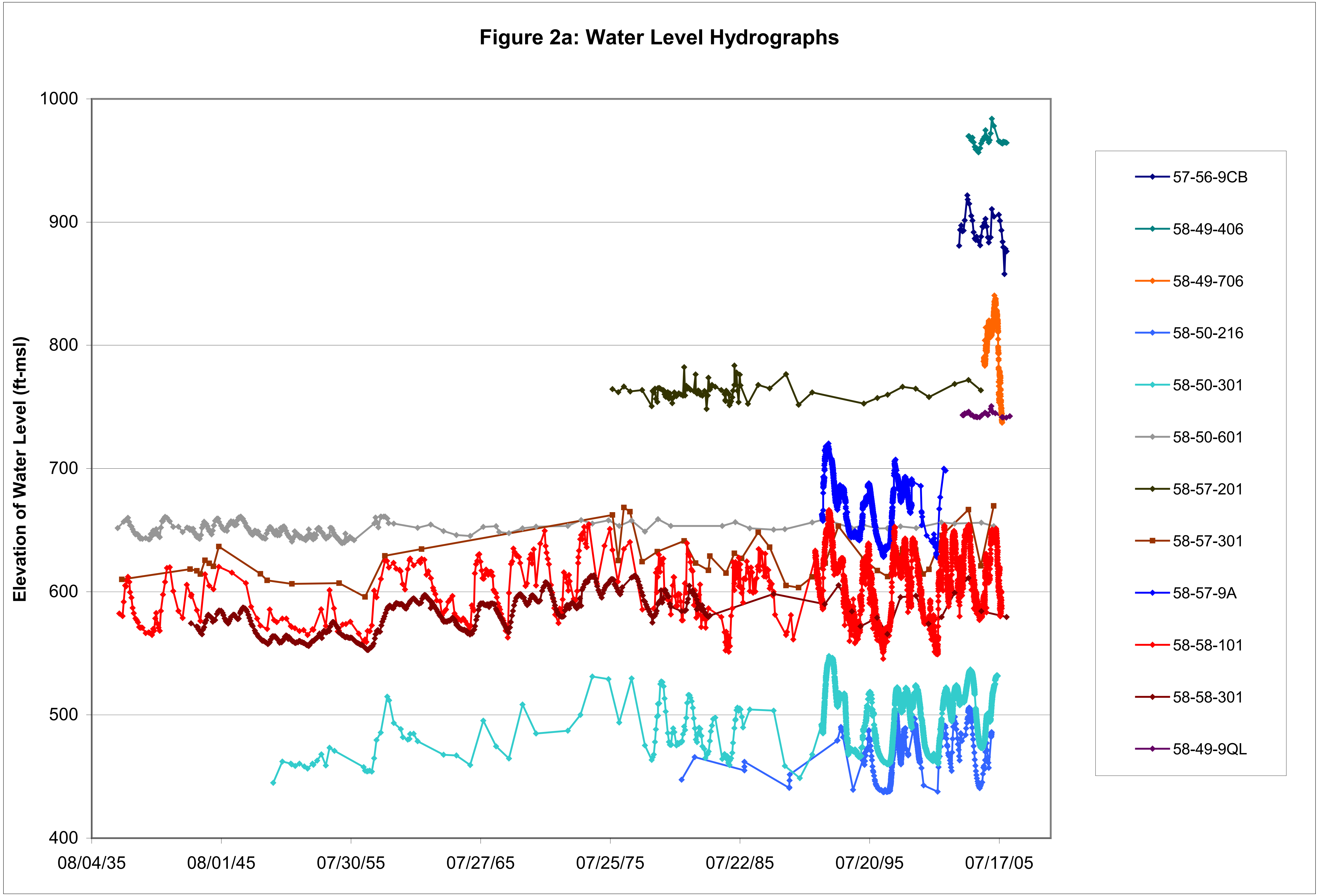
Figure 2a: Water Level Hydrographs
Elevation of Water Level (ft-msl)
1000
900
800
700
600
500
400
08/04/35
08/01/45
07/30/55
07/27/65
07/25/75
07/22/85
07/20/95
07/17/05
57-56-9CB
58-49-406
58-49-706
58-50-216
58-50-301
58-50-601
58-57-201
58-57-301
58-57-9A
58-58-101
58-58-301
58-49-9QL

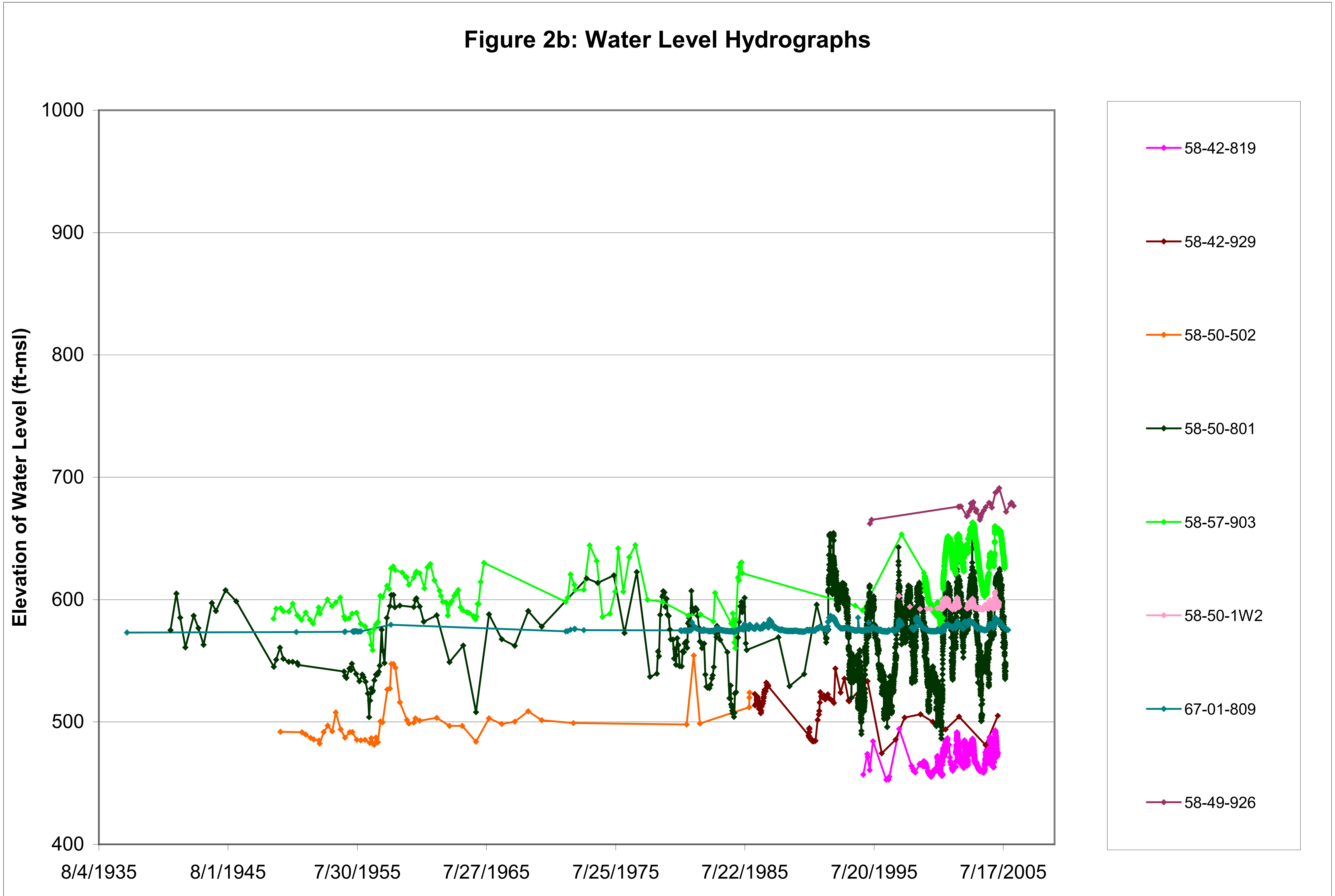
Figure 2b: Water Level Hydrographs
Elevation of Water Level (ft-msl)
1000
900
800
700
600
500
400
8/4/1935
8/1/1945
7/30/1955
7/27/1965
7/25/1975
7/22/1985
7/20/1995
7/17/2005
58-42-819
58-42-929
58-50-502
58-50-801
58-57-903
58-50-1W2
67-01-809
58-49-926

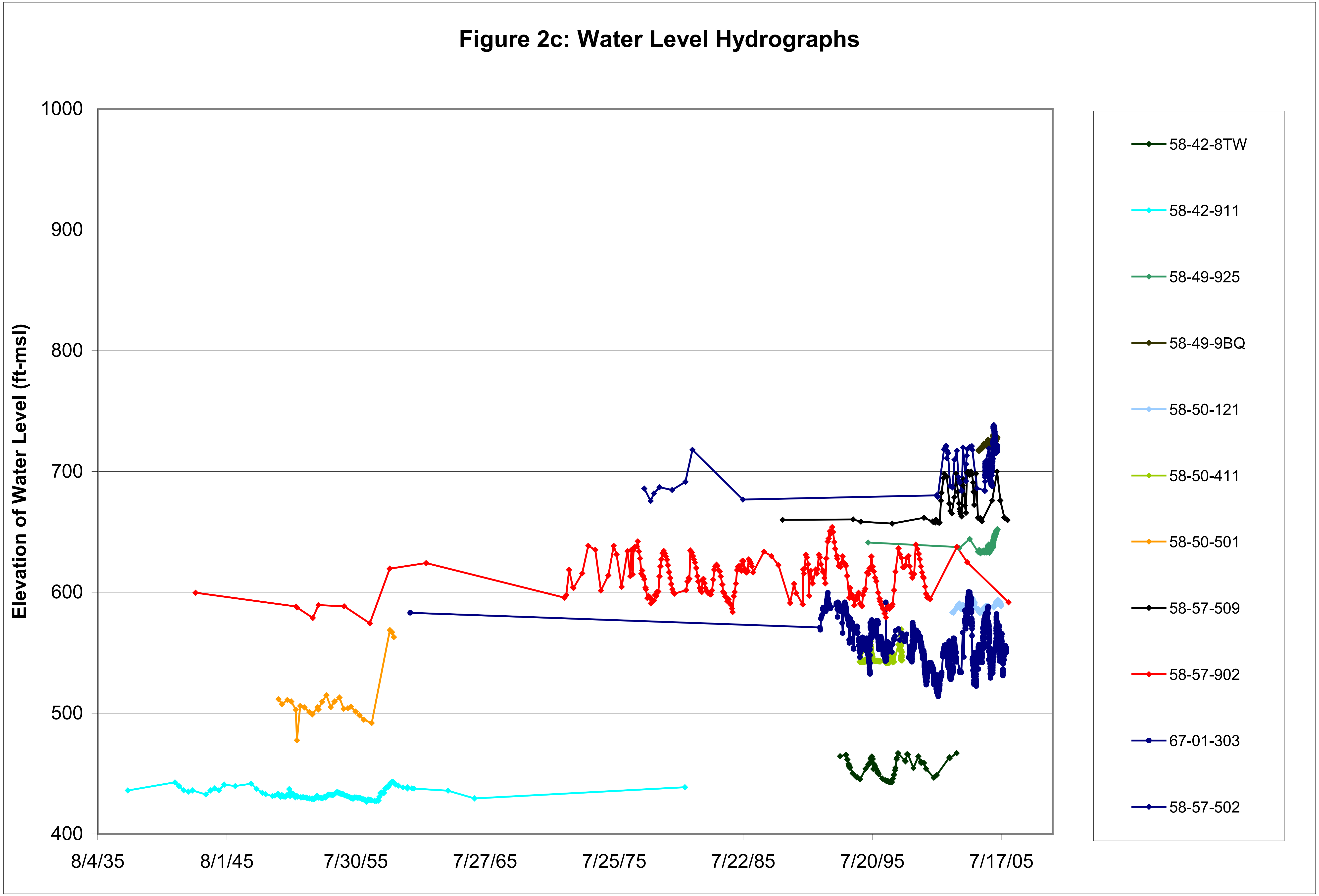
Figure 2c: Water Level Hydrographs
Elevation of Water Level (ft-msl)
1000
900
800
700
600
500
400
8/4/35
8/1/45
7/30/55
7/27/65
7/25/75
7/22/85
7/20/95
7/17/05
58-42-8TW
58-42-911
58-49-925
58-49-9BQ
58-50-121
58-50-411
58-50-501
58-57-509
58-57-902
67-01-303
58-57-502

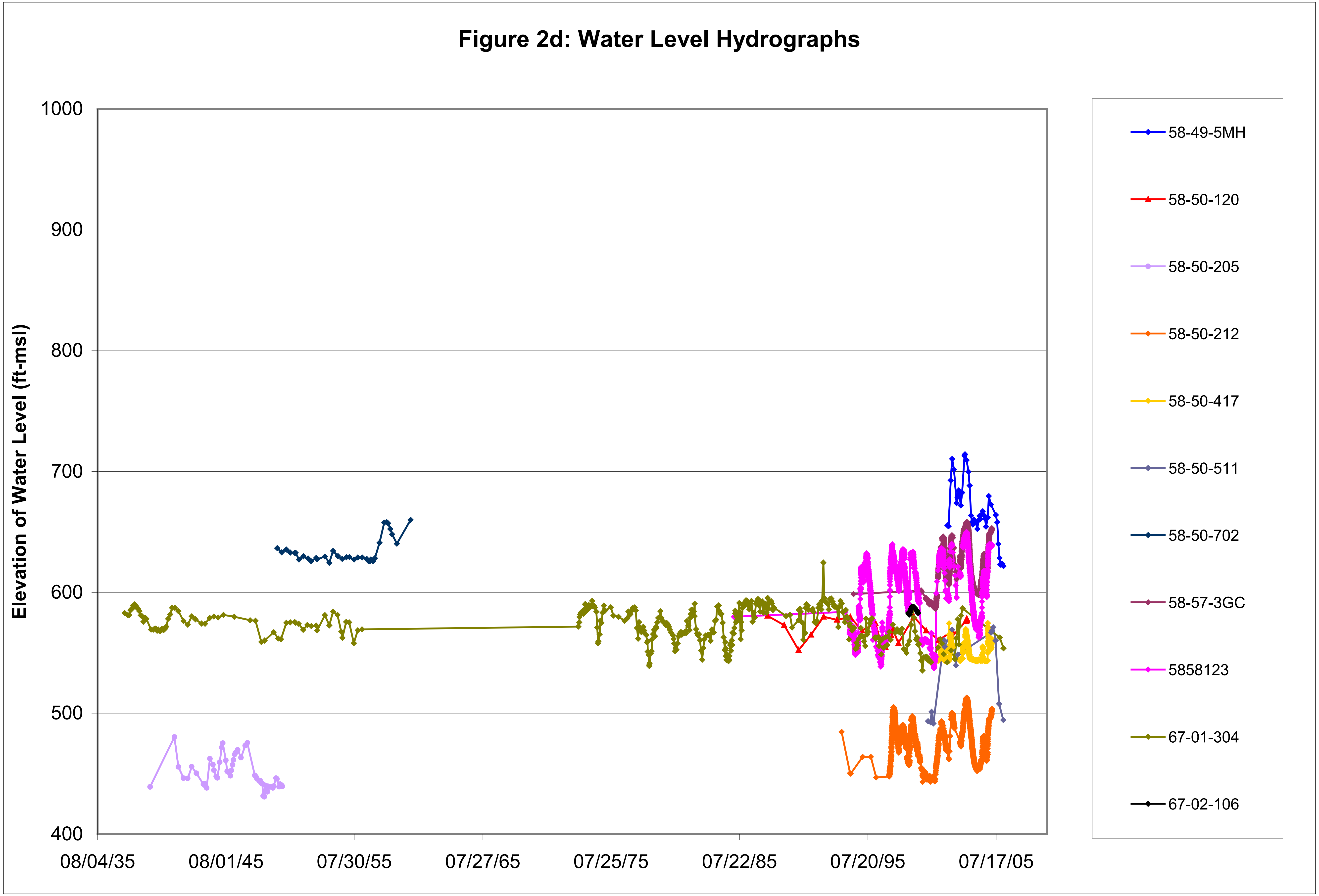

Figure 2d: Water Level Hydrographs
Elevation of Water Level (ft-msl)
1000
900
800
700
600
500
400
08/04/35
08/01/45
07/30/55
07/27/65
07/25/75
07/22/85
07/20/95
07/17/05
58-49-5MH
58-50-120
58-50-205
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67-01-304
67-02-106

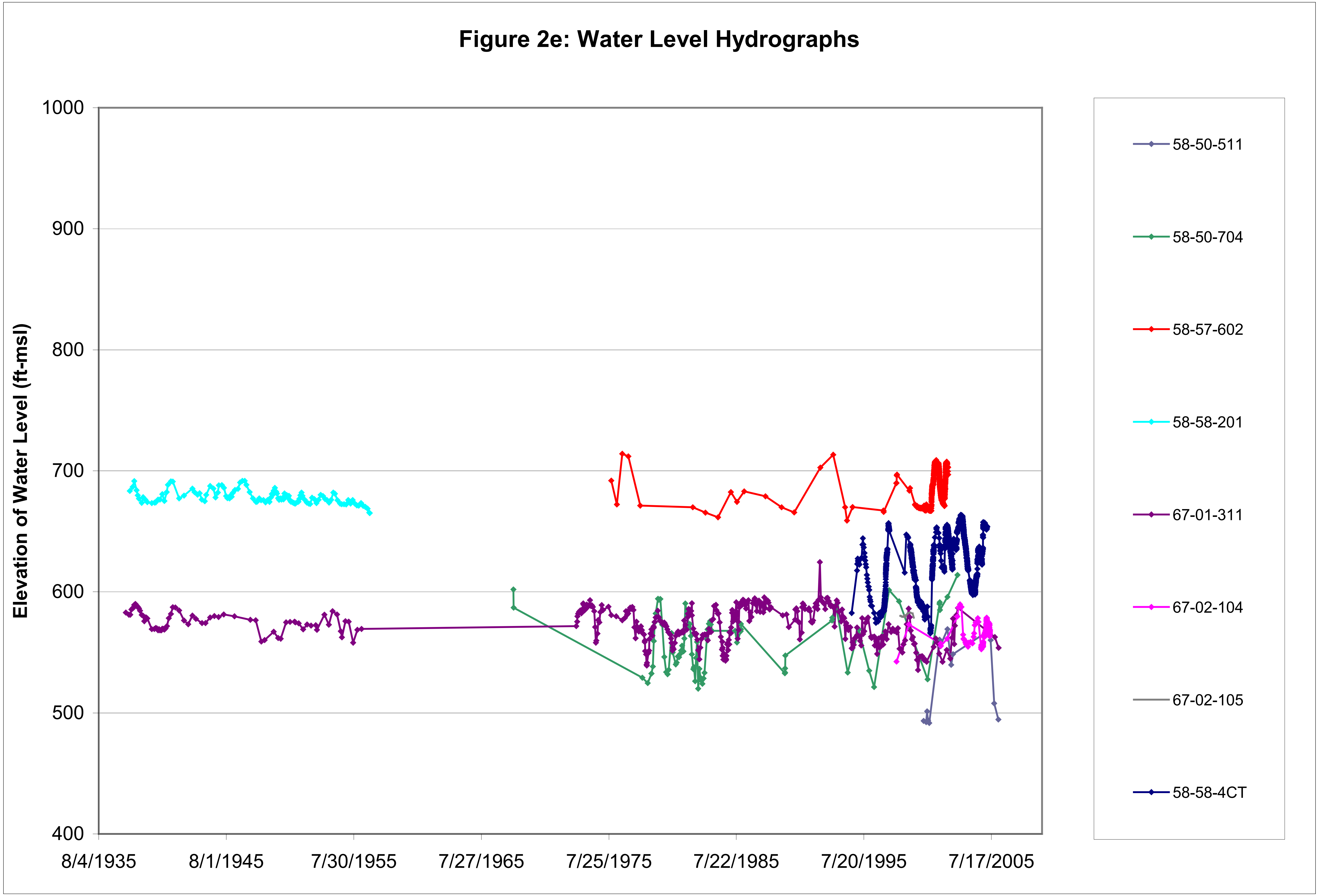

Figure 2e: Water Level Hydrographs
Elevation of Water Level (ft-msl)
1000
900
800
700
600
500
400
8/4/1935
8/1/1945
7/30/1955
7/27/1965
7/25/1975
7/22/1985
7/20/1995
7/17/2005
58-50-511
58-50-704
58-57-602
58-58-201
67-01-311
67-02-104
67-02-105
58-58-4CT

WATER-LEVEL DATA

Hydrographs of the data within this report are presented in **Figures 2a-e**. A simple database accompanying this report contains water-level and well-construction data (see **Appendix**). The period of record for this report includes continuous data through March 2005, however some wells have data through August 2006.

Data Collection Methods

Data within this report were collected by a variety of agencies including: TWDB, BSEACD, USGS, EAA, SAWS, and HTGCD. It should be noted that each of these agencies has their own protocols and methods for the collection of data, which in some cases have changed over time. Methods are only briefly discussed in this report and individuals interested in the details of those methods are encouraged to contact the corresponding agencies. Data collection methods employed by the BSEACD are described in Hunt et al. (2004).

Water-level data compiled in this report were collected with either manual measurements or with automated recorders. Manual measurements were often made with a steel tape or electric lines (eline). Automated instruments include chart recorders or pressure transducers with data loggers. Manual measurements are periodically made in conjunction with automated instruments for calibration and verification purposes. Manual measurements are generally accurate to within ±0.1 feet. These data are also contained in the report where available and provide quality control and assurance for the automated data.

Measurement Points and Datums

Water-level measurements are made in reference to a measurement point (MP) at the well head. Commonly the MP corresponds to the top of casing (TOC). The MP or TOC measurement is subtracted from the depth-to-water measurement to reflect a depth from the land surface datum (LSD). LSD is generally defined as the top of the concrete slab around the casing, or from ground level. Data obtained from the TWDB, USGS, EAA and HTGCD are reported as depth from LSD; however, some data may actually be from the TOC. Historic data from the BSEACD were originally reported as depth from TOC (both manual and transducer data), but have been adjusted in this report to reflect the depth from LSD. Depth to water below LSD is a positive value, negative values reflect a level above the LSD, such as flowing artesian wells (see 58-42-927, 58-42-929; 58-50-601).

Elevations for LSDs were obtained from USGS topographic maps (10-ft contours), City of Austin topographic maps (2-ft contours), or from surveys. Vertical datums from those maps are either North American Vertical Datum 1929 (NAVD29) or North American Vertical Datum 1988 (NAVD88). Many of the horizontal coordinates were collected with a Global Positioning System (GPS), or by locating on a USGS topographic map, or by survey. Horizontal datums are in World Geodetic System 1984 (WGS84) or North American Datum 1983 (NAD83).

Frequency of Water-Level Measurements

All the data in this report are considered “continuous” because there is a significant density of data over a given period of time from a well allowing some inference as to the hydraulic stresses on the aquifer or well. However, a majority of the data are actually periodic in nature with data spanning weeks to years. Data prior to about 1980 consist of periodic manual measurements of this type. After the 1980’s, automated data collection systems (chart recorders and pressure transducers with data loggers) were used more frequently within the study area. These automated systems collect data continuously, like chart recorders, or at a high frequency (such as hourly to daily), such as pressure transducers with data loggers. These large datasets have been reduced to daily measurements by the various agencies and may represent an average value for the day, or as in the case of the BSEACD data, represent the maximum elevation (minimum depth) for that day. Accordingly, data from automated recorders do not generally have a time associated with the date. However, many manual measurements do have an associated time. Those with an unknown time are indicated by a 0:00 AM or 1:00 AM in the date column.

Data Compilation and Quality Assurance

The TWDB database was the source of most of the historical data before 1990. Only data listed as publishable were incorporated into the database. TWDB data are available on their website at:

http://www.twdb.state.tx.us/GwRD/waterwell/well_info.asp

Additionally, the USGS collected a significant amount of historical data, and those are available via their website or in published reports. After about 1990, agencies such as the EAA, SAWS, BSEACD, and the HTGCD began collecting data from more sites, and more frequently.

A systematic quality-assurance review was conducted for this report and database. Automated data from the BSEACD since about 1988 provided the greatest challenge for quality control and assurance. Manual measurements were compiled from field notebooks and were plotted with the automated data for quality control and assurance purposes.

All of the information provided is believed to be accurate and reliable; however, the BSEACD assumes no responsibility for any errors or for the use of the information provided. BSEACD makes no guarantees or warranties as to the accuracy, completeness, currency, or suitability of the data provided in this report. All data from agencies other than the BSEACD should be regarded as provisional.

SOURCES OF WATER LEVEL FLUCTUATIONS

The purpose of this report is to present data without significant interpretations. However, a brief discussion of the factors and hydrologic stresses on the groundwater resources is warranted.

Water-level fluctuations represent changes in storage within the aquifer and are caused by hydrologic stresses. Long-term fluctuations in water levels represent changes in storage due to recharge and discharge (**Table 2**). Fluctuations from drought-of-record conditions to high-flow conditions in the Edwards Aquifer are on the order of 75 and 100 feet in the unconfined and confined portion of the Edwards Aquifer, respectively. Although data from the Trinity Aquifer are more limited, Trinity wells appear to have a similar dynamic range in water-levels, although they vary within specific Trinity units.

Table 2. Source of water-level fluctuations in the Edwards Aquifer.

Hydrologic Stress	Approximate magnitude of fluctuation	Comment
Long-term Climatic (months to years)	up to 100 ft (confined) up to 70 ft (unconfined)	
Pumping (daily)	up to 50 ft (confined)	Influenced by nearby large-capacity pumping wells
Recharge (daily)	up to 15 ft (confined) up to 10 ft (unconfined)	
Barometric (daily)	up to 0.1 ft	Confined conditions only
Tidal (daily)	0.1-0.01 ft?	Needs further study

The dynamic nature of water levels in the Edwards Aquifer is a result of triple porosity of the aquifer, with diffuse, fracture, and conduit porosity (Hovorka et al., 1998). The Edwards and to a lesser extent, the Trinity Aquifer, are very heterogenous and anisotropic aquifers. Accordingly, the response of water levels to the various hydrologic stresses can be markedly different for each well site. For example, many wells correlate very well with Barton Springs, such as the Porter Well (58-58-123), which indicates they are heavily influenced by conduit flow. However, the Lovelady well (58-50-301) appears to have a muted response to recharge and is dominated by diffuse flow to the well. Other wells appear to be dominated by conduit flow such as wells 58-50-411 and 58-50-417.

The Trinity Aquifer is dominated by diffuse flow; however there is some indication of dynamic water-level responses that could indicate fracture or conduit flow within certain limestone units (see well 58-49-706).

Proximity to a pumping well can also influence water levels within a well. Although most of the wells in the database are not located close to actively pumping wells, or are not significantly impacted by their "cones of influence," there are some wells that are heavily influenced by pumping, and their water levels can be temporarily lowered by 50 feet from the static level. The Buda (58-58-101) and Dowell monitor wells (58-50-801) are two examples of wells heavily influenced by nearby pumping. Other wells, such as the

Porter (58-58-123) and Centex (58-58-4CT) wells also have relatively minor pumping influences, on the order 2 to 3 feet under average conditions. However, these fluctuations are generally discernable on hourly data. It is important to note that the BSEACD collects data hourly with pressure transducers and data loggers, but the daily measurement reported is the maximum elevation for a given day. This method appears to filter out most minor fluctuations due to local pumping effects.

Barometric Effects

Barometric pressure acts upon the aquifer rock matrix and water levels within a well. Water levels have an inverse relationship to barometric pressure changes and are most commonly observed in confined aquifers because of the hydraulic gradient between the well and the surrounding aquifer. Barometric responses are not commonly observed in wells completed within unconfined aquifers because the pressures are evenly distributed between water levels within a wells and the water table (Domenico and Schwartz, 1990). The barometric efficiency of the Negley well (58-57-903) in the confined portion of the Barton Springs aquifer, and determined from a 2-day period, is 0.67, indicating a good relationship between water-level and barometric changes.

BSEACD water-level data after 2002 were collected with non-vented (absolute pressure-transducer) probes. Most data have been compensated for barometric fluctuations unless otherwise noted.

WELL COMPLETION

Well completion information was obtained from drillers logs, many of which are within the TWDB database. Most wells were drilled as water-supply wells that have been converted into monitoring sites. Most wells have an open borehole completion with diameters of at least 4 to 6 inches. Many wells within the Edwards Aquifer only partially penetrate the entire saturated thickness. Water levels from a partially penetrating well may not be representative of the aquifer as a whole. Wells reported as completed within the Trinity Aquifer are often hybrids of the upper and middle Trinity aquifers.

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Appendix. Database of groundwater levels in the Balcones Fault Zone, Hays and Travis Counties, Texas, 1937-2005.

The compact disk contains a simple Microsoft® Excel-based database. It contains a summary worksheet titled: 'Figure 1-Well & Data Summary' with an internal hyperlink to each well and corresponding data set. Figure 2a-e hydrographs are also presented as worksheets in the database.